Rail Technologies: Costs and GHG Emissions

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BACKGROUND

PASSENGER

- Passenger transportation comprises about 17% of all domestic rail energy consumption (NREL)
- Approx. 2-3% of passenger rail track is electrified (Amtrak), but due to high frequency of passenger traffic in NE, operation is split about evenly between diesel and electric (TEDB)
- Amtrak nationwide ridership ↑ 29% since 2005; Commuter rail ridership ↑ by 2.9% in 2014 (APTA)

FREIGHT

- Freight accounts for about 83% of all rail transportation energy consumption in the U.S. (NREL)
- (Virtually) all freight in the U.S. runs on diesel power (NREL)
- Nearly 1.5 Billion Locomotive Unit Miles in 2013 (AAR)
- Over $11 Billion spent on diesel fuel in 2014 (AAR); Close to 4 Billion gallons consumed in 2014 (AAR)
- California's freight rail network includes 6,863 miles of track and moved 156.1 million tons of commodities (2011, Caltrans)

ANALYSIS ASSUMPTIONS

All LCA GHG emissions values are based on GREET, 2014, values. (And liquid H_2 is derived via current methods of Steam Methane Reformation. Newer, improved methods would likely reduce emissions from diesel.) All technological efficiency assumptions come from GREET, 2014, except for LNG HPDI, whose efficiency is assumed as same as diesel.

Passenger Rail

Passenger chart values are modeled off of a standard sized Capitol Corridor (CA) train, with actual current annual mileage adjusted to a potential future schedule. Diesel fuel consumption is based on a slight improvement over current Cap. Corridor fuel consumption, based on latest available engine technology.

Passenger locomotive maintenance has been estimated, based on consultant input, at $1.20/mile for Diesel, Biodiesel, and LNG; $0.72/mile for Hydrogen and Electricity (adjustments for latter two based on literature).

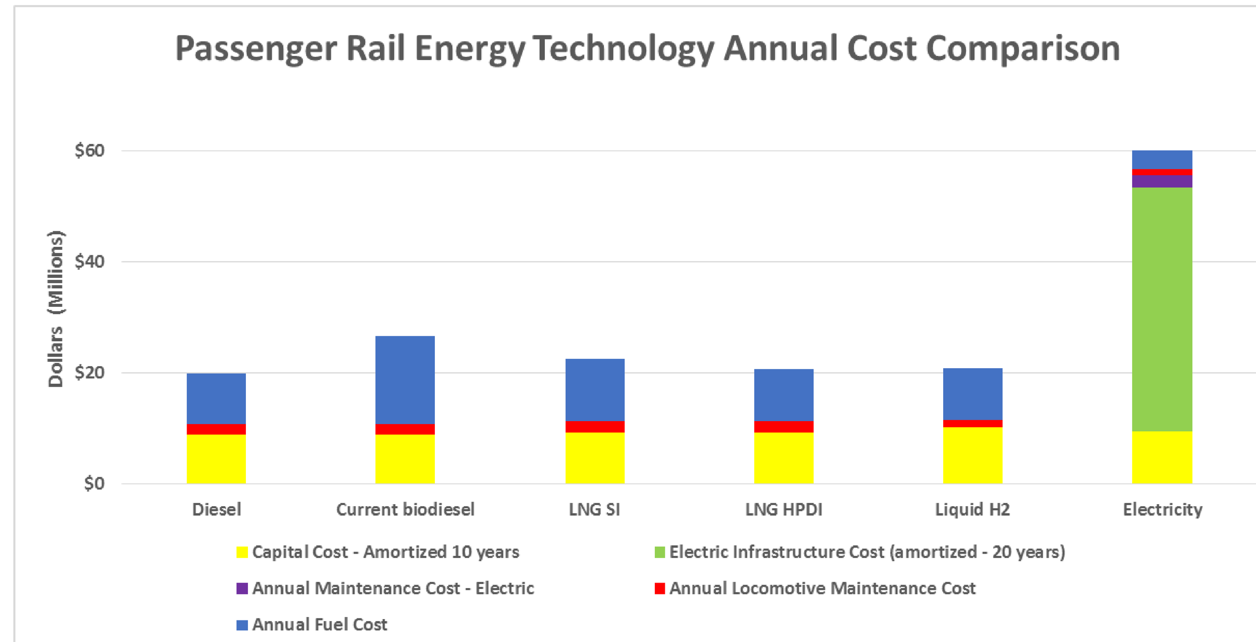
Freight Rail

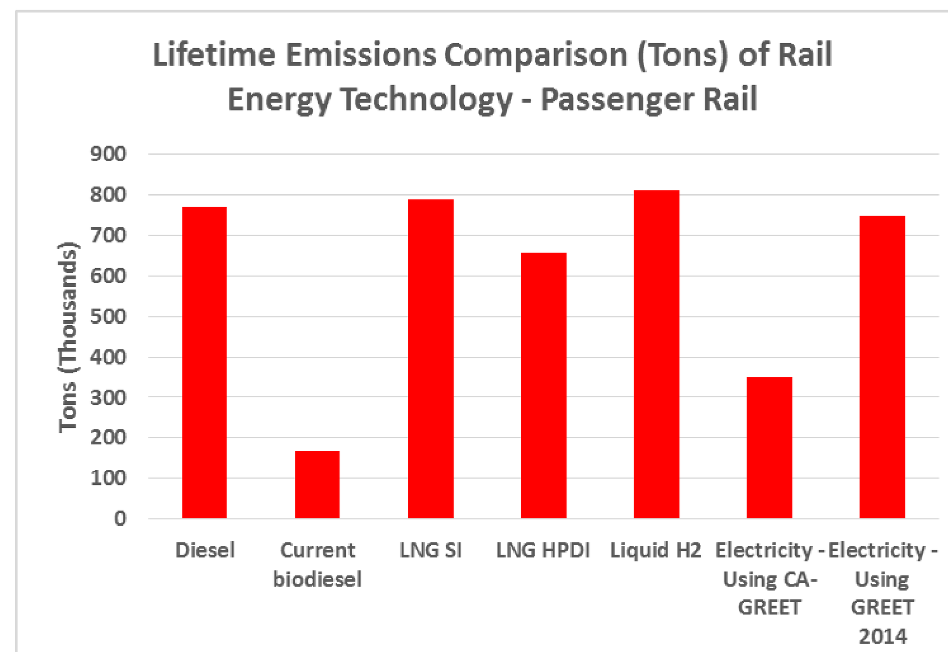
Freight rail scenarios assume ten trains per day operating specified distance over a full year (with the two scenarios combined, this accounts for approx. 3% of all annual freight traffic) , with 30 new locomotives purchased for each of the ten trips (based on an assumed three locomotives per train). Diesel fuel consumption is modeled after a combination of national consumption data from the Association of American Railroads (AAR) combined with data on typical train weight for intermodal trains provided by Union Pacific. Locomotive fuel tank size information was also provided by Union Pacific.

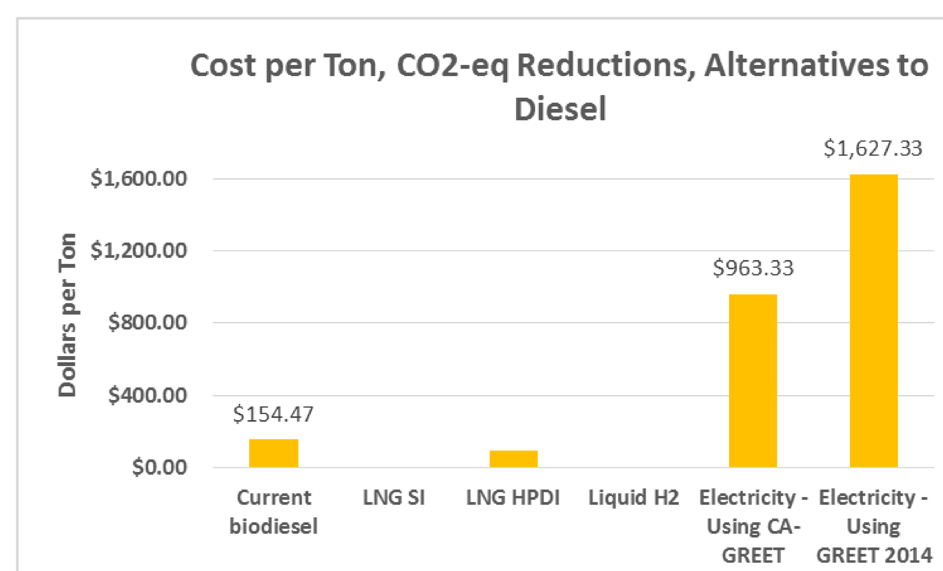
Number of tenders required for LNG and H_2 assume similar refueling frequency to diesel train for given trip.

• Freight locomotive maintenance has been estimated, based on consultant input, at $1.00/mile for Diesel, Biodiesel, and LNG; $.60/mile for Hydrogen and Electricity (adjustments based on literature).

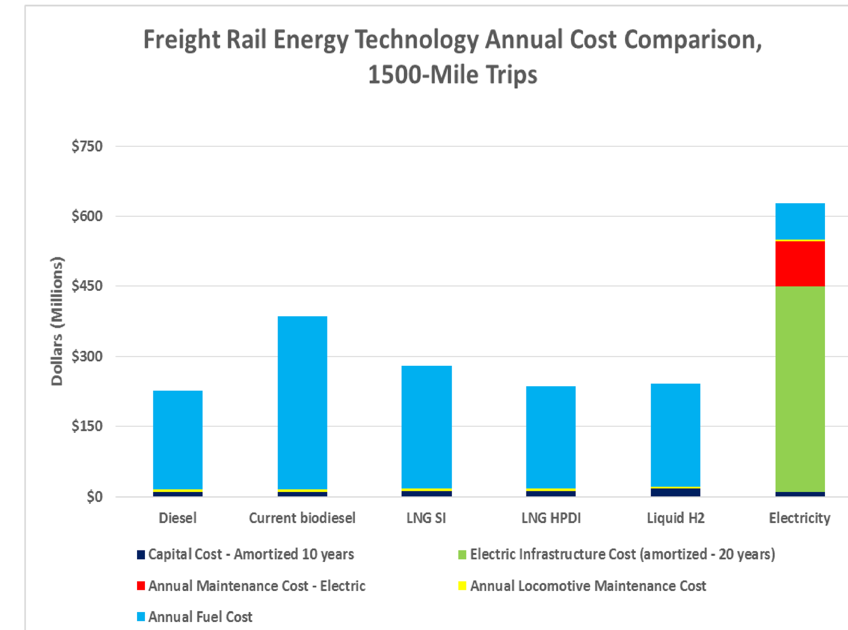
PASSENGER RESULTS

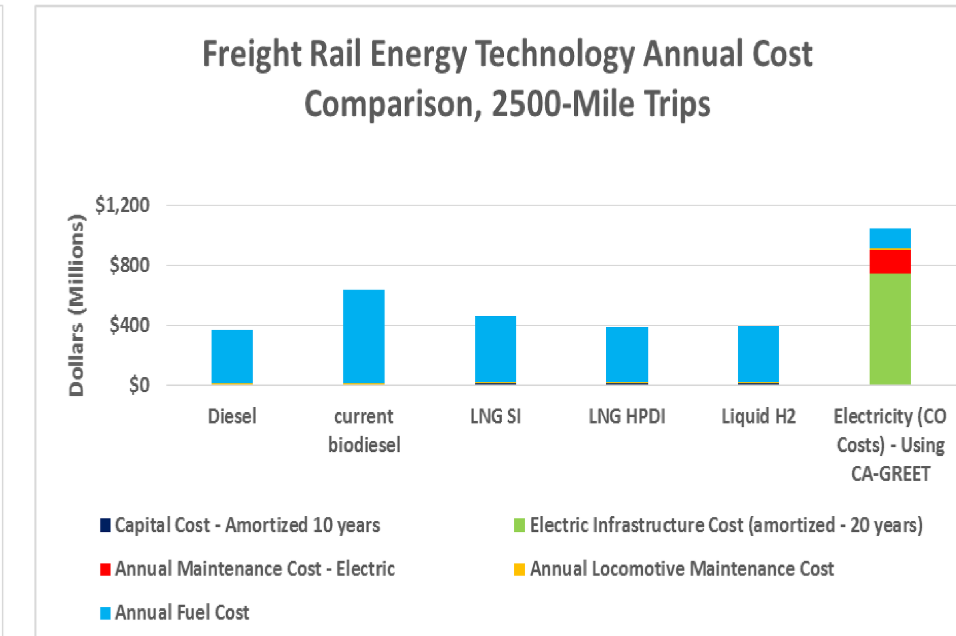


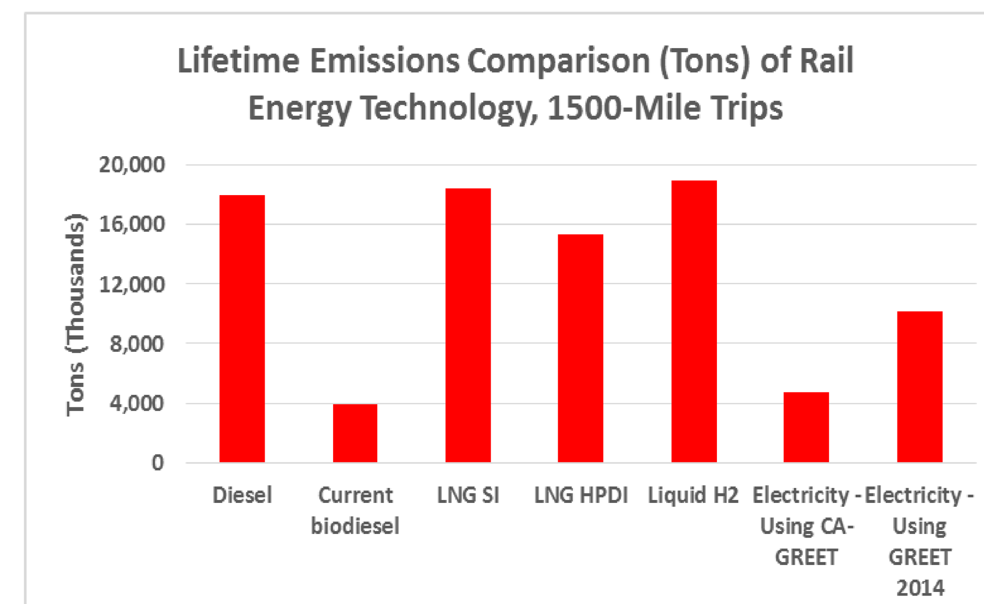


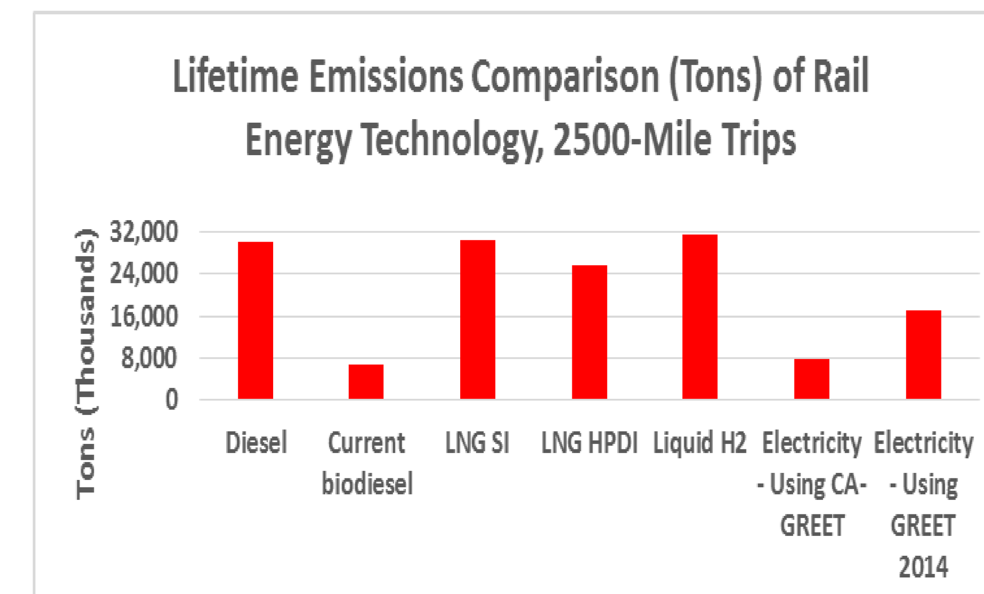


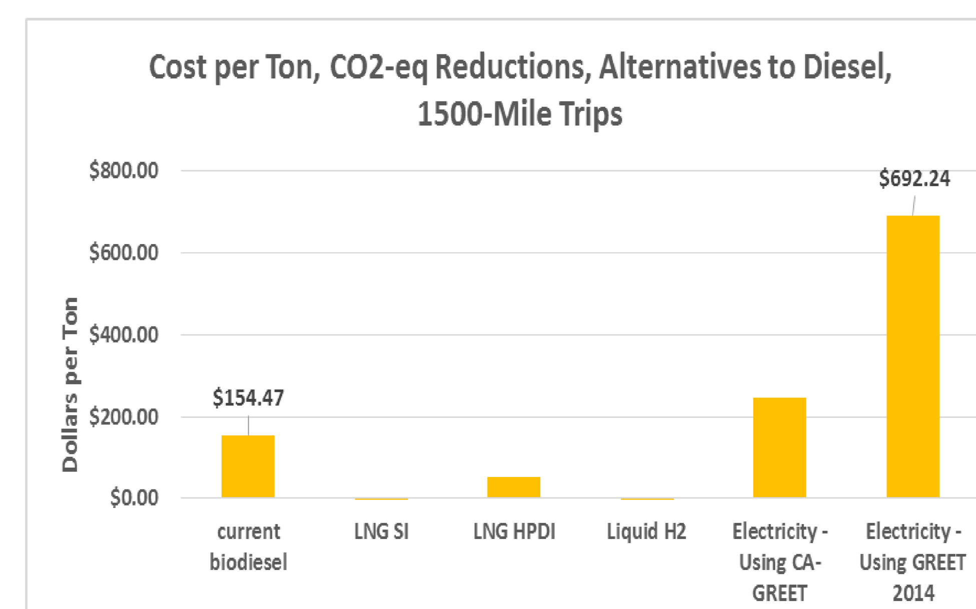
FREIGHT RESULTS

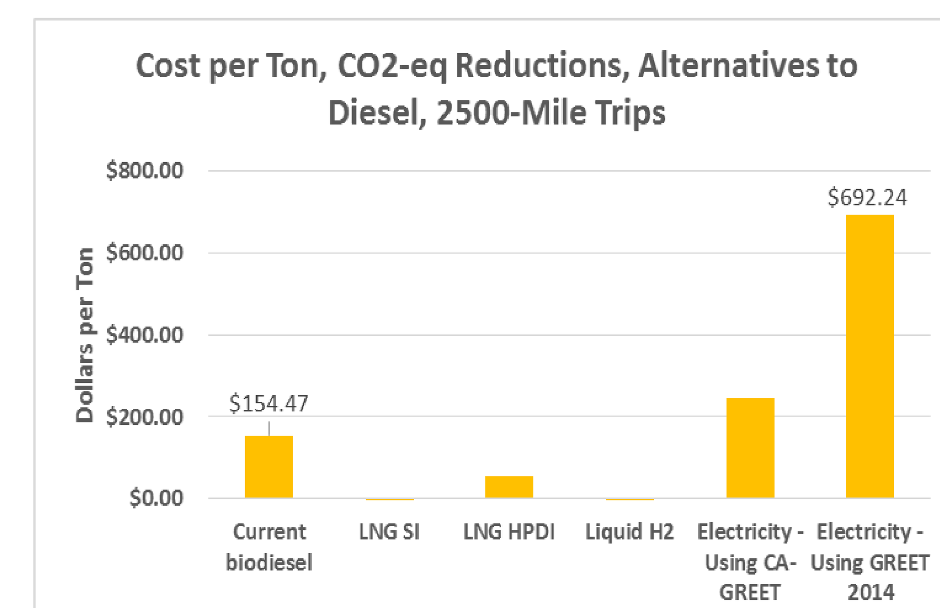




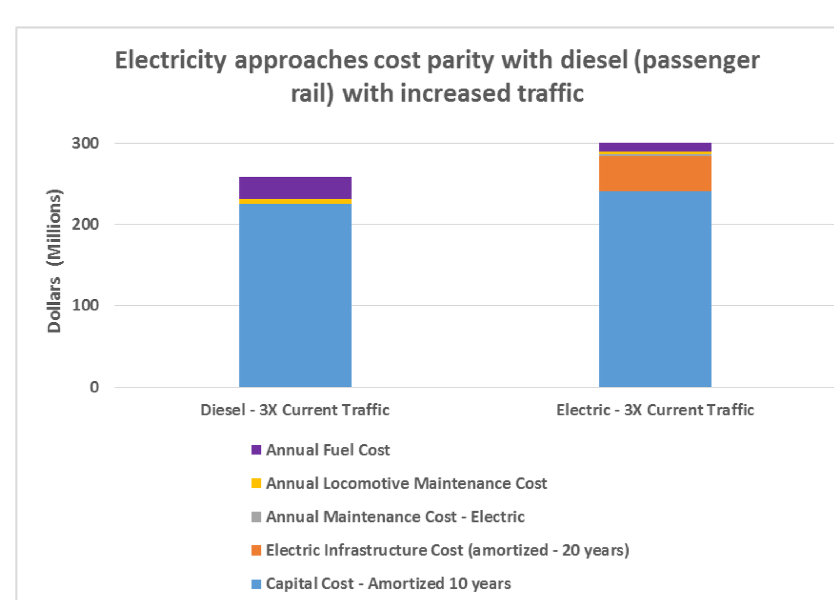








ELECTRICITY SENSITIVITY



* While not specifically modeled here, the additional traffic could come from freight trains, in which case electric infrastructure costs would be shared, and even lower for the passenger rail agency (and possibly involving a lease from a freight firm)

RESEARCH NEXT STEPS

- Add sensitivities for different train types and weights (potentially including lighter weights for electric vs. diesel locomotives)
- Learn more about potential for further improvements with diesel engine technology
- Add hybridized powertrains into analysis (Hybridization could potentially help with technology lifetimes and efficiencies. Regenerative braking, to be available on the Siemens "Charger," is just one example.)
- Address broader findings for the rail system as a whole

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