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Subject: BATTERY-POWERED LINE-HAUL and PASSENGER TRAINS

Comment:

BATTERY-POWERED LINE-HAUL and PASSENGER TRAINS

By Phil Birkhahn, Co-Chair, Transportation Committee of San Diego 350

Change requested to E3's Slide 17: Under "Hydrogen" change Alts. 1 to 4 to read "50% +/- of ZEV share for line haul/pass . . . . ." Under "Electricity" add "50% +/- of ZEV share for battery-powered line-haul/passenger rail for 2030, 2035, and 2045".

or,

CARB could, at the very least, add a note to Slide 17 stating that "Comparative performance of battery- and hydrogen-powered trains is under review. Some or all of the trains listed under Hydrogen could move to Electricity."

Justification for Changing Slide 17.

Assuming hydrogen-powered trains is speculative. No one can say whether CARB's assumed biomass gasification with carbon capture and sequestration noted on Slide 17 will be feasible enough and cost low enough. That may be why Slide 24 Electricity Loads by Scenario says, "Loads for direct air capture and hydrogen production are assumed to be provided by off-grid renewables and are not included in this graphic."

Yet battery trains are not in the plan, while hydrogen trains are. Battery-powered trains deserve to be shown with a 50% +/- share in all scenarios until the technologies sort themselves out.

This is a rare misstep in the Scoping Plan Draft and California's Zero Emission Vehicle programs. Correct this by adding battery train pilot projects and subsidies comparable to the hydrogen train program. CARB's hybrid freight train pilot with BNSF over Tehachapi is a start but ignores the likely ability of batteries to replace diesel across the full spectrum of rail transportation for freight and passengers.

Battery trains are feasible now, while CARB excludes them based on six-year-old analysis of an even older design. The only way hydrogen trains can win, is by preventing fresh analysis of battery trains and fair support by CARB and State of California.

Contrary to hydrogen advocates' talking points and out-of-date CARB technology assessment used to justify the hydrogen train program, battery trains can run long distances using existing technology. They just need a fair chance to demonstrate their lower acquisition cost and lower operating cost. Batteries enable low-cost efficient direct electrification. Hydrogen trains need three times as much electricity to provide hydrogen by electrolysis and complete other electricity hogging steps before hydrogen is pumped into a train. The consequences of hydrogen's low energy efficiency make hydrogen no better than diesel.

Battery trains are likely to cost about one-fourth less than hydrogen trains, just like found in other heavy-duty land transportation such as Class 8 trucks and buses. Achieving tolerable operating cost also requires huge reductions in hydrogen cost promised by 2030, but success of that is speculation. I think doubling battery capacity by 2030 is a better bet. So is eliminating plug-in and overhead charging by 2030 using magnetic resonance charging that can charge trains moving at their normal operating speed with connection at all. Hydrogen can never do that.

It is time to revisit obsolete assumptions dating from 2016, when battery tenders for freight rail were last evaluated using a design from 2012 (Transpower, 2012 and 2014). Batteries back then limited the tender to 6.2 MWh of storage for a loaded box car. That capacity was assumed in reports published in

2016 (Railtec, 2016 and CARB, 2016). After allowing for a 20% to 100% operating range for state of charge, 5.0 MWh was left.

Then 5.0 MWh was cut in half by a mysterious railroad operating "rule" limiting discharge to 50%, leaving just 2.5 MWh available per battery tender. The "rule" is probably for the two-ton lead-acid battery used to start the locomotive's diesel engine. Those lead-acid batteries have an operating range of 50% to 100%. The supposed 50% rule, if used, should apply to the 6.2 MWh total capacity, not 5 MWh.

Fresh analysis by CARB must account for increases in battery energy density since 2012. Then the result should be worked into ZEHTRANS, which is a program of CARB, CalTrans, Energy Commission, and Go-Biz, followed by integration with the State Mobile Source Strategy. Because the Scoping Plan Update is on a faster track, the language added to Slide 17 should be flexible enough to encompass battery-powered trains and let technology results determine the mix of hydrogen and battery power.

Luckily, fresh analysis by others was published late last year by staff from Lawrence Berkeley National Laboratory, UCLA Institute of the Environment and Sustainability, and UC Berkeley Department of Agricultural and Resource Economics (Popovich and others, 2021). Nowadays, 14 MWh of battery storage with its power electronics fits in a standard boxcar. LFP batteries share the 20% to 100% operating range for state of charge, leaving 11.2 MWh.

They showed that a freight train carrying 6,806 revenue tonnes (7,487-tons) of payload could go 150 miles with four 14 MWh battery tenders. Such a train would weigh 15,656 tons counting the locomotives, rail cars, and battery tenders. Their calculation is based on annual nationwide figures for revenue-tons hauled and diesel consumed.

I got a similar result with basic vehicle dynamics calculations, finding four battery tenders (45 MWh of useable energy) would be needed. One of the four could move a 3,900-ton train 150 miles.

CARB must change course to fully evaluate battery-powered trains before making any total commitment to hydrogen trains. But somehow CARB dropped the ball by not keeping up with capabilities of battery trains and shows no signs of reconsidering.

A 600-ton passenger train like the Surfliner, with its single locomotive and one tender, could go all the way from San Diego to San Luis Obispo, or maybe even farther as in the new AMTRAK plan, from San Diego all the way to San Francisco!

REFERENCES

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