Tri-Valley San Joaquin Valley
REGIONAL RAIL AUTHORITY

Board of Directors
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Correspondence

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- "VDE study finds battery trains 35% cheaper than hydrogen. In addition, the cost of energy and multiple replacements of fuel cells during a 30-year working life means that hydrogen trains are also more expensive to use than the diesel trains they would replace. However, the study assumes that only 'green' hydrogen made by electrolysis using electricity from renewable sources will be used. In reality, the cheaper so-called 'grey hydrogen,' made as a by-product of the chemical and oil industry, will be used in some cases." [1]
    - "According to the Florida Solar Energy Center, hydrogen produced by steam reformation costs three times the amount natural gas does per unit of energy produced. This means that if natural gas costs $6 per million British thermal unit (MMbtu), then hydrogen will be $18 MMBtu or 3x the cost. Furthermore, stream reformation with fossil fuels is the most cost-effective method to produce hydrogen. Cleaner green hydrogen processes are 2x to 5x more expensive than gray or black SMR." [2]
        - The cost of hydrogen could fall to $1.40 per kilogram in 2030 compared to a price range of $2.50 to $6.80 per kilogram today. By 2050, a kilogram of renewable hydrogen could even fall to 80 cents, equivalent to the price of natural gas
- "Diesel-powered trains transfer about 30-35 percent of the energy generated by combustion to the wheels, while supplying electricity directly from an overhead powerline transfers about 95 percent of the energy to the wheels. However, this [Hydrogen] is an inefficient process. Typical efficiencies for electrolysis and fuel cells are respectively 68% and 52%. Compressing hydrogen for storage requires 6% of its chemical energy. So the overall cycle efficiency is 33%. Hence hydrogen traction requires 3kW of electricity to deliver 1kW of power to the wheel. An electric train has no on-board energy conversion so only needs 1.2kW. " [3] [4]
    - "This low overall cycle efficiency potentially undermines the green credentials of hydrogen trains as they require 2½ times the electrical energy of a comparable electric train, especially if hydrogen is delivered by the much cheaper CO2-producing reforming process. A further constraint is hydrogen's low energy density. At 350bar, the volumetric energy density of hydrogen is 4.6MJ/litre, compared with 35.8MJ/litre for diesel. So a hydrogen train requires fuel storage eight times the size of a diesel train's fuel tank." [4]
- While other countries are looking into hydrogen trains to replace diesel. they are mostly looking to replace rural trains where they might pass through 2-3 times a day, which makes less sense than a commuter rail which uses overhead powerlines. [5]

1. https://www.railway-technology.com/features/next-stop-hydrogen-the-future-of-train-fuels/
2. https://www.forbes.com/sites/arielcohen/2021/12/17/chevron-bnsf-united-expand-hydrogen-for-trains-and-planes/?sh=173b27453cbf
3. https://www.railjournal.com/technology/vde-study-finds-battery-trains-35-cheaper-than-hydrogen/
4. https://www.eesi.org/articles/view/electrification-of-u.s.-railways-pie-in-the-sky-or-realistic-goal
5. https://www.imeche.org/news/news-article/could-hydrogen-trains-be-the-future-of-rail