Hydrail

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1. Introduction

In July of last year I posted an update on California's various rail projects, including our High-Speed Rail (HSR, under construction, first segment is planned to be operational before 2030), and the Northern California and Southern California commuter rail systems that are planned to connect to the HSR.

I did not really find any major new news with any of the above when I reviewed these subjects recently. This previous post was thorough and a major key to California's electrified transportation future, so I've put a description and link to it below.

California Rail Electrification - 2021 Update: *This paper will use portions of a similar paper I posted in 2019, but contain enough new information to justify posting as a new comprehensive report. We (California) continue to move forward at a slow, steady pace. As in many things, we do not do this because we choose to, but because we must.*

The California High Speed Rail System (HSR) is an important part of our state's efforts to reduce our greenhouse gas emissions. Currently, there is a huge amount of travel between the San Francisco Bay Area and the Los Angeles Area, and this is exclusively by auto or airlines. Although there are efforts to reduce the greenhouse gas from both of these transports, a viable rail system (powered by 100% renewable energy) between these two areas will contribute mightily to this effort.

https://energycentral.com/c/ec/california-rail-electrification-2021-update

Also, when I checked our local project to connect our BART station to the Central Valley (Valley Link Project), some text (below) caught my attention, which eventually led me to the word that is the title of this post among other electrified rail information.

Vehicles: *The Authority adopted a Sustainability Policy (December 2018) with an overarching goal to be a model of sustainability in the design, construction, and operation of the Valley Link Project and includes specific strategies to achieve this goal. The preferred rolling stock choice, based on this policy guidance, will be net zero vehicles operated on renewable energy from its own stored and created source…* ***Hydrogen powered vehicles have been identified as being highly-effective in meeting Board Sustainability Policy guidance.***[1]

This is the first time I've seen the statement in bold text. In the previous (above linked) post Valley Link was undecided on the rolling-stock technology.

This brings up an interesting application gap for short light rail systems that led me through my travels and to Hydrail as discussed in the first section below.

[1] Tri-Valley San Joaquin Valley Regional Rail Authority, "Valley Link Project," https://www.valleylinkrail.com/valleylink-project

2. The Rail Application Gap

For high-volume electric passenger rail (like HSR), including major commuter rail systems (like BART), selection of the technology to power them with has been a no-brainer: power them from the grid, and make them fully electrified.

Most lower-volume commuter rail systems and all freight systems use some form of diesel-electric propulsion. There is just one problem with this going forward.

The state agency responsible for all transportation planning is Caltrans. Its current action plan is referenced ant the end of this paragraph, and the Introduction is quoted below.[2]

Transportation is the largest source of greenhouse gas (GHG) emissions in California– with tailpipe emissions, oil extraction, and oil refining combined accounting for roughly 50 percent of all in-state emissions. California leads the nation's climate change response since passing the Global Warming Solutions Act in 2006, which called for a reduction of statewide GHG emissions to 1990 levels by 2020. In 2016, California codified additional GHG emissions reductions of 40% below 1990 levels by 2030.

Recent California legislation and Executive Orders put the state on the path to implement a zero-carbon electricity grid by 2045 and call on the state to reduce emissions in the transportation sector:

- *Executive Order (EO) N-79-20 sets the following targets for California:*
  a. *100% of in-state sales of new passenger cars and light-duty trucks will be zero-emission by 2035;*
  b. *100% zero-emission Medium and Heavy Duty (MHD) vehicles in the state by 2045 and by 2035 for drayage trucks; and*
  c. *100% zero-emission off-road vehicles and equipment operations by 2035…*

Note that off-road vehicles includes all rail vehicles – commuter and freight. Thus for Valley Link, which currently plans to start initial service in 2028, buying a diesel-powered unit is a non-starter. Depending on the specifics of the regulations that CARB adopts, many existing non-electrified commuter rail service providers (we have one of these operating in the Livermore Valley: ACE) and freight trains that use diesels may need to convert to zero-emissions operation by 2035, See below for CARB's current plans:

Locomotives: *By 2022, propose an In-Use Locomotive Regulation that sets fees based on locomotive operations. Funds would be used to mitigate emissions through use and development of cleaner technologies, including zero-emissions equipment and infrastructure.*[3]

Key Collaborators: Locomotive Manufacturers; Railroads; Grid Operators, Electricity and Hydrogen Providers; Local and Regional Government; Federal and Tribal Governments; California Energy Commission; Caltrans; California State Transportation Agency; California Transportation Commission; Organized Labor…

[2] Caltrans, Zero Emission Vehicle Action Plan 2.0, March 1, 2021, https://static.business.ca.gov/wp-content/uploads/2021/03/Caltrans_ZEV-Action-Plan_Web_v2.pdf
[3] California Air Resources Board (CARB) ZEV Action Plan, March, 2021, page 8, paragraph 12 https://static.business.ca.gov/wp-content/uploads/2021/03/CARB_ZEV-Action-Plan.pdf

The proposed concept would result in emission reductions from locomotives operating across the state, including those operating in lower-income and disadvantaged communities.

3. Hydrogen as a Fuel

Many, including your author, have opined that green hydrogen[4] may be an excellent choice to replace diesel-electric rolling stock going forward. A locomotive's electricity can be produced from hydrogen either by fuel cells or combustion-turbine gen-sets. With either design, battery energy storage optimizes operation by providing peak-power.

But what about Hydrail. Therein lies an interesting story.

The birth of hydrail —hydrogen fuel cell railways — may be the first industrial paradigm shift whose "DNA" has been accurately recorded. It's all on the Internet.[5]

One of its earliest known ancestors is German geophysicist, Dr. Holger Busche. While traveling in Northern Germany circa 1998, he was struck by the obvious potential for powering local diesel trains with clean energy instead, from the many local wind turbines—using hydrogen electrochemistry to make the connection.

Another is Dr. Alistair Miller, a Scots-Canadian scientist then at Canadian Nuclear Laboratories. A keen environmentalist, Dr. Miller asked himself, "If nuclear and other carbon-free energy were to power all transport, what would be the optimum progression?" Trains and ships — he concluded in the paper that launched hydrail — would come first because they could carry high volumes of H_2 and ubiquitous service and fueling would not be needed. Then would come trucks, buses and ferries, whose support sites are already established; then aviation for the same reason…

Far away in Japan, the Government's Railway Transport Research and Innovation organization was vying with Japan's biggest rail operator, Japan Railways East, to produce the first hydrail prototype.

Soon after Drs. Busche and Miller shared their visions, Mooresville—a small town in North Carolina best known for its racing R&D shops—was looking for partial funding for a transit connection to Charlotte, 25 miles south. The Mooresville South Iredell Chamber of Commerce's incoming Chairman and future town mayor, Bill Thunberg, was attracted by the hydrail vision of the Chamber's transportation chair, Stan Thompson.

Stan was a retired futurist in transportation and environmentalism from BellSouth, now part of AT&T. During President George W. Bush's pro-hydrogen administration Stan had pre-retirement connections with the US Government in his specialties.

Through those connections, Stan was invited to share Mooresville's passenger hydrail vision with the military team that, with BNSF Railways and others, was devising HH 1205—the world's first hydrail locomotive. He named his presentation the Mooresville Hydrail Initiative, choosing hydrail as the generic name for H_2 fuel cell railways because the simple contraction of hydrogen and rail made it easy for pioneers to search online and collaborate…

[4] Green hydrogen is hydrogen produced by electrolysis using very-low-carbon power (typically photovoltaic, wind and nuclear power).

[5] Timothy Sasseen, Ballard Power Systems, Linkedin, "The birth of Hydrail, a brief history," https://www.linkedin.com/pulse/birth-hydrail-brief-history-timothy-sasseen

Since then (2005) hydrail has been used as an informal term for hydrogen-fueled rail. More recently two industrial heavyweights: Ballard Power Systems, a major producer of fuel cells, and one of my former employers, Siemens, came together to manufacture the first production hydrail commuter rail train (below), the Mireo Plus H.

Another major European rail manufacturer, Stadler, produced another hydrail commuter rail train, the hydrogen-powered FLIRT (Flinker Leichter Intercity-und Regional-Triebzug or Fast Light Intercity and Regional Train), and won an order from San Bernardino County Transportation Authority in Southern California (see image below).

4. California Hydrogen Business Council (CHBC)

Some of the positions I have filled during my professional career included Product Manager, Marketing Manager and Business Development Manager. An important responsibility of these positions is to attend industry (in this case Electric Utility Industry) conferences and give presentations. I know that a frequent practice to keep sessions flowing smoothly is to upload all of the presentations, and glue them together in the order that they are given. Then after the conference, post the merged presentations on-line.

I found such a (huge) merged presentation for this section's title organization, and have referenced it here.[6]

Rather than me repeating this information, I would suggest you click through to the presentation, and go to the following slides:

Presenters: Slide 2

Briefing Title Sposors, Slide 3

Description of CHBC, Slide 5

CHBC Members, Slides 6 and 7

Clarification: The first presenter, Lynn Harris, is from DB Engineering USA. DB is an acronym for Deutsche Bahn (translation: German Train), from Wikipedia: *Deutsche Bahn AG is the national railway company of Germany. Headquartered in the Bahntower in Berlin, it is a private joint-stock company (AG), with the Federal Republic of Germany being its single shareholder.*

Deutsche Bahn describes itself as the second-largest transport company in the world, after the German postal and logistics company Deutsche Post / DHL, and is the largest railway operator and infrastructure owner in Europe. Deutsche Bahn was the largest railway company in the world by revenue in 2015, in 2019, DB Passenger transport companies carried around 4.8 billion passengers, and DB logistics companies transported approximately 232 million tons of goods in rail freight transport.

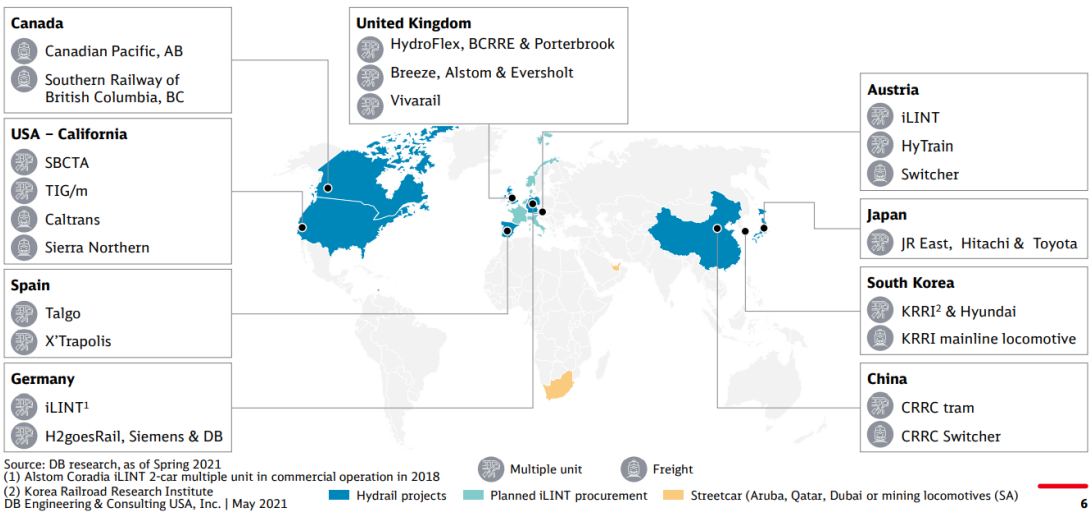
DB Engineering & Consulting USA leverages the expertise of the world's largest integrated transportation operator, improving the quality of life in the U.S. by introducing sustainable mobility solutions. These include Hydrail.

I've included one (very good) DB slide below (next page).

And finally, CHBC is a very large organization with an impressive roster of members. I'm sure they will effectively promote hydrail. These presentations are an excellent primer for the progress this technology is making.

[6] CHBC Briefing: Hydrogen Rail Project Showcase, May 19, 2021, https://www.californiahydrogen.org/wp-content/uploads/2021/05/20210519-CHBC-Briefing-Slides_Final-3.pdf

Current Worldwide Hydrail Projects



Source: DB research, as of Spring 2021
(1) Alstom Coradia iLINT 2-car multiple unit in commercial operation in 2018
(2) Korea Railroad Research Institute
DB Engineering & Consulting USA, Inc. | May 2021

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