California Dreamin' about H_2

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1. Introduction

Although I frequently write about my home state, this paper will focus entirely on the Golden State. This is because (1) my post two weeks ago (described and linked below) had a major focus on my state and (2) there were many stories intended for that post that were left untold.

Hydrail: *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.*

The one word title of this post is an abbreviation for Hydrogen Rail. And I found much information about this subject for this post.

https://energycentral.com/c/ec/hydrail

One of the things that I like about California is that we have the most aggressive climate change mitigation agenda in the U.S. Every time I look, they have self-imposed more aggressive climate-related goals, and they tend to keep meeting these goals.

Recently, The California Public Utilities Commission (CPUC) *adopted a 35 million metric ton (MMT) 2032 electric sector greenhouse gas (GHG) planning target, which is more stringent than the 46 MMT GHG target that was adopted previously, and equates to 73 percent Renewables Portfolio Standard (RPS) resources and 86 percent GHG-free resources by 2032.*[1]

The decision adopts a portfolio of cost-effective preferred resources that includes approximately 25,500 megawatts (MW) of new supply-side renewables and 15,000 MW of new storage and demand response resources by 2032; enough clean energy to power approximately 11.5 million homes. This preferred system plan portfolio differs from the one previously adopted in that it includes more solar and battery storage, as well as new long-duration storage, out-of-state wind, and offshore wind resources. The inclusion of offshore and out-of-state wind resources demonstrates their increased viability as cost-effective resources to help meet state goals. The CPUC's modeling and independent analysis conducted by the California Energy Commission demonstrates that the portfolio meets stringent reliability standards.

The CPUC's preliminary analysis of the preferred system plan portfolio of the load serving entities (LSEs) indicates there is sufficient space for all of these new resources on the existing transmission system, with only limited transmission upgrades needed by 2032. This finding will be validated at a more granular level by the California Independent System Operator (CAISO) in its 2022-2023 Transmission Planning Process (TPP). The TPP is an evaluation of the CAISO transmission grid to identify upgrades.

[1] California public Utilities Commission, "CPUC Approves Long Term Plans To Meet Electricity Reliability and Climate Goals," Feb 10, 2022, https://www.cpuc.ca.gov/news-and-updates/all-news/cpuc-approves-long-term-plans-to-meet-electricity-reliability-and-climate-goals

Today's decision also orders utility procurement of two battery storage projects that were identified by the CAISO as alternatives to transmission upgrades in the previous TPP cycle. These alternatives achieve the same level of system reliability at lower costs to ratepayers…

Mark Specht, senior energy analyst at the Union of Concerned Scientists, said he is supportive of the more aggressive goals, but believes there is more work to be done. "I believe a future target of 30 million metric tons in the next IRP cycle will be necessary to put California on the path to reducing emissions from the power sector that appropriately responds to our climate emergency," he said…[2]

Climate advocacy group, the Union of Concerned Scientists, has been actively supporting the development of programmatic procurement requirements in IRPs. While IRPs set procurement targets, they are not enshrined requirements. In support of the development of procurement requirements, Sen. Dave Min (D-Irvine), introduced SB 881, which would clarify and formalize the CPUC's authority to establish and enforce emissions targets for the electricity sector. The Union of Concerned Scientists has sponsored the bill, which moves IRPs past planning and ensures load-serving entities follow through with climate commitments.

2. H_2

Week before last I posted Hydrail, which is described and linked in the Introduction. The "Hyd…" in Hydrail refers to the same gas as the title of this section. In this section we will present some new news and a suggestion, all focused on California.

2.1. LA Gas

This week, Southern California Gas Co. announced its proposal to develop what would be the nation's largest green hydrogen[3] *energy infrastructure system (the "Angeles Link," logo below) to deliver clean, reliable renewable energy to the Los Angeles region.*[4]

As proposed, the Angeles Link would support the integration of more renewable electricity resources like solar and wind and would significantly reduce greenhouse gas emissions from electric generation, industrial processes, heavy-duty trucks, and other hard-to-electrify sectors of the Southern California economy.

The proposed Angeles Link would also significantly decrease demand for natural gas, diesel, and other fossil fuels in the Los Angeles Basin, helping accelerate California's and the region's climate and clean air goals.

[2] Ryan Kennedy, PV Magazine, "California lifts renewable energy target to 73% by 2032," Feb 14, 2022, https://pv-magazine-usa.com/2022/02/14/california-lifts-renewable-energy-target-to-73-by-2032/

[3] Green Hydrogen is hydrogen made using electrolysis (electrically splitting water into hydrogen and oxygen) that uses renewable electricity.

[4] CalChamber, "SoCalGas Proposes to Develop Largest U.S. Green Hydrogen Energy System," Feb 2022 https://advocacy.calchamber.com/2022/02/17/socalgas-proposes-to-develop-largest-u-s-green-hydrogen-energy-system/

"The challenges we face on climate require solutions of scale and urgency," said Scott Drury, chief executive officer of SoCalGas. "The Angeles Link is designed to meet those challenges head-on. Today in Southern California we're announcing plans for one of the world's largest clean energy infrastructure systems, to help tackle emissions for which there are no easy answers. Those emissions — from power plants, industry, and heavy-duty trucks — very much 'count' and must be significantly reduced to reach our, and the State's climate goals."

As the nation's largest manufacturing hub, the Los Angeles Basin is home to many potential green hydrogen users. As proposed, Angeles Link's green hydrogen could:

- *Displace up to 3 million gallons of diesel fuel per day by replacing diesel powered heavy-duty trucks with hydrogen fuel cell trucks*
- *Eliminate up to nearly 25,000 tons of smog-forming nitrogen oxide (NOx) per year*
- *Provide the clean fuel to convert up to four natural gas power plants to green hydrogen*

As contemplated, the Angeles Link would deliver green hydrogen in an amount equivalent to almost 25% of the natural gas SoCalGas delivers today. Building the system to provide a clean alternative fuel could, over time and combined with other future clean energy projects, reduce natural gas demand served by the Aliso Canyon natural gas storage facility, facilitating its ultimate retirement while continuing to provide reliable and affordable energy to the region.

"California policymakers, thought-leaders, business, academic, labor, and environmental communities all agree green hydrogen is vital to achieving our climate and clean air goals," Drury continued. "With relationships to thousands of industrial end users, a regulatory framework that promotes a transparent and robust stakeholder process serving the public interest, and an extraordinary workforce to do the job safely, SoCalGas is well positioned to work with California to capitalize on this pioneering opportunity to build what would be America's largest green hydrogen hub. The Angeles Link project, if approved and completed, is poised to extend our state's position as a leader on clean energy well into the future while helping to attract billions of dollars in new investment and maintaining and creating thousands of skilled jobs."

2.2. Small Gas

There are now basically two ways to get green hydrogen: (1) have it delivered in tanks (typically not green hydrogen today) (2) use electrolysis to generate it yourself using renewable electricity delivered through the grid (definitely green hydrogen).

In the post "Hydrail (linked in the Introduction)," I described Valley Link, our local commuter rail connector system in the Livermore Valley that will soon start construction. This system will probably use green hydrogen for fuel, and the only viable method to generate enough of this gas is through electrolysis.

Also, another local commuter rail in the Livermore Valley: Altamont Corridor Express (ACE),[5] currently uses diesel-electric locomotives. ACE probably will be required to transition to a clean-fuel by 2035. Valley link will cross tracks with ACE on the eastern

[5] Altamont Corridor Express, https://acerail.com/

side of Livermore, and this would be a good place for a green hydrogen refueling station, complete with an electrolyzer and storage tanks. The latter two facilities might be provided by an existing hydrogen provider, like some of the partners in the organization linked below.

https://californiahydrogencoalition.org/about/

Since most rail systems in California will be required to transition to a clean fuel, they will also need refueling stations, and these facilities might also provide the following services:

- Distribution of green hydrogen to nearby large users, including:
    - Those that currently use diesel backup generation,
    - Those that use hydrogen for processes (like chemical manufacturers),
    - Hydrogen refueling stations for on-road vehicles, and
- Emergency electric power generation for the grid.

3. The Expansion of H_2 Users

It's been a few years since I surveyed the users of the subject gas. Although I pointed out a few of these in the prior subsection, below I will drill down a bit.

3.1. Emergency Electric Power

There are two applications here: backup power for large facilities, and emergency capacity for the grid. The former can probably best be met by fuel-cells. The latter can probably best be met by hydrogen-fueled combustion turbines. The largest facilities/ campuses, especially in the near term, may also require combustion turbines. I haven't recently posted regarding fuel-cells, but they do appear to be getting more cost-effective over time. Also they are very fuel-efficient, so they can also be used for peaking power.

I did post a paper that took a deep dive into hydrogen-fueled combustion turbines in subsection 2.1 earlier this week, and this is described and linked below.

Reasonable Transition: *This paper covers how existing natural gas combined cycle and combustion turbine power plants can be upgraded to operate on partial hydrogen or 100% hydrogen.*

https://energycentral.com/c/gn/reasonable-transition

3.2. Hydrogen-Fueled On-Road Vehicles

3.3. Light Vehicles

Currently there are only three models of light vehicles available that use hydrogen fuel cells to provide electricity to drive propulsion motors as well as meet other vehicle electric needs. These are basically very similar to normal electric vehicles, but offer somewhat longer ranges and quicker refueling. They also use EV-type batteries for peak power, albeit much smaller batteries than pure battery-electric vehicles.

In researching fuel-cell electric vehicles, I found the following are currently available in parts of California. Currently, fewer vehicles will be available in other states.

2022 Toyota Mirai, base price, $49,500*, EPA range: 402 Miles
https://www.toyota.com/mirai/

2022 Hyundai NEXO Fuel Cell**, base price: $59,435*, EPA range: 380 miles
https://www.hyundaiusa.com/us/en/vehicles/nexo

2021 Honda Clarity Fuel Cell**, $379/month on a 36 month lease, EPA range 360 miles
https://automobiles.honda.com/clarity-fuel-cell#specifications

*Rebates up to $4,500

**Currently available only at select California dealers, and may require buyers to be reasonably close to a hydrogen fueling station (I am not)

3.4. Medium and Heavy Vehicles

I have opined in the past that, in the near term battery-electric trucks and buses will cover most of the applications in this market, but there may be niche-market for long-range (more than 500 miles) that hydrogen-fueled vehicles can occupy. Regarding the former, there are many medium and heavy battery-electric trucks and buses – see the recent post linked below. Regarding the long-range niche, there are four models of hydrogen-fuel-cell buses (from two manufacturers) on the site linked below. There is at least one hydrogen-fuel-cell semi-tractor under development and in pilot testing (Nikola Corporation, see section 3.3.1.3 in the post linked below)

https://energycentral.com/c/ec/electric-trucks-and-buses-california