September 19, 2023

Comments on the September 5, 2023 Workshop on the SB 1075 Report: Hydrogen Development, Deployment, and Use

The purpose of SB 1075 (Skinner, Hydrogen: green hydrogen: emissions of greenhouse gases, 2022) is to aid California in meeting its carbon emission reduction mandates: 40 percent below 1990 levels by 2030, and 85 percent below 1990 levels by 2045. **We must not allow ourselves to be sidetracked in this difficult process by debating arguments of economic infeasibility.** The costs of dealing with accelerated global heating will far outstrip any budgets we are negotiating in 2023 or 2024. **"There is no economy on a dead planet."**

Now is the time when we must marshal our resources to fight this emergency, concentrating on both long-term and short-term solutions. It is clear that the present global trajectory will cause us to exceed the IPCC-determined tipping point of 1.5C warming by early 2030.[1] At only 1.1C presently, we see the lethal effects of more and hotter wildland fires, droughts, floods, hurricanes and tropical storms.[2] We cannot even imagine what the world will have to cope with in the 2030s, much less beyond, if we fail to take immediate action to reverse emissions. This is well summarized in the New York Times article cited.[3] The world is clearly not on the correct trajectory at present where an earlier IPCC report showed carbon emissions increased 1 percent from 2021 to 2022.[4] The trends for 2023 are also in the wrong direction. According to a CNBC report, "...the (International Energy Agency) estimated that, under current spending plans, the planet's carbon dioxide emissions would be on course to hit record levels in 2023 and continue to grow in the ensuing years. There was, its analysis claimed, "no clear peak in sight."[5]

When considering any production method for hydrogen, the carbon footprint of the entire process must be measured against the benefit to be gained from the use of hydrogen energy. An August 2021 paper by Howarth and Jacobsen[6] showed that ""the greenhouse gas footprint of blue hydrogen (hydrogen made by steam reforming of methane) is more than 20 percent greater than burning natural gas or coal for heat." Presently, less than 2 percent of hydrogen meets the standards (see below) for truly "green" hydrogen.

What should the plan for SB1075 focus on for the greatest impacts?

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[1] https://www.ipcc.ch/report/ar6/syr/
[2] https://www.nytimes.com/2023/03/20/climate/global-warming-ipcc-earth.html
[3] Ibid.
[4] https://www.nytimes.com/2022/11/10/climate/carbon-dioxide-emissions-global-warming.html
[5] https://www.cnbc.com/2021/07/20/co2-emissions-will-hit-record-levels-in-2023-iea-says.html
[6] https://onlinelibrary.wiley.com/doi/10.1002/ese3.956

Hydrogen used in California and developed by a Clean Hydrogen Hub should be truly "green" (i.e., electrolytic hydrogen created using only nearby, additional, clean-energy resources), and deployed for those sectors that are hard to electrify directly. The opportunities are:

- Chemical processes currently using SMR-generated hydrogen
- Fuel for long-distance aviation and shipping
- Locomotives, if clean electrification is not feasible or available
- Heavy-duty, long-haul trucks and agricultural/industrial vehicles
- Industrial heating processes such as steelmaking
- Long-term energy storage

What should the SB1075 plan not encourage?

1. **Hydrogen should not be mixed into existing or future pipelines intended for natural gas use.** There are several reasons for this.

    - The first is that only small amounts, up to 10 percent, can be mixed into methane without endangering the reliability of the system to embrittlement of the pipeline by hydrogen, and gas leakage.[7]
    - Secondly, no natural gas appliances have been certified to be used with any amount of hydrogen. This risks many dangers to homes and commercial sites which have not been tested for this use in furnaces, gas stoves, and ovens.
    - Finally, this small admixture will displace only 10 percent of the methane burned, and will thus have only a minimal climate impact. Effort (and funds) will be better spent electrifying these uses and eliminating gas service wherever possible—measures which will have the important co-benefit of eliminating methane leakage in the distribution system.

    For these reasons we cannot support the recommendation to do this by Simon Baker of the CPUC in his presentation at this workshop.

2. **Fueling stations for light duty vehicles should not be given any state or federal support.** As we have pointed out in our hydrogen white paper, the ship has sailed on this market. As we state in that paper:

    > *There are 1 million battery electric vehicles in our state[8], but only 15,000 hydrogen fuel cell (HFC) cars.[9] According to the Hydrogen Fuel Cell Partnership, which provides charging information to HFC drivers, there are only 55 public hydrogen filling stations in California at this writing.[10] In 2021, the median cost of a new hydrogen fueling station was "approximately $1.9 million in capital."[11] In contrast, the California Energy Commission reports that there are over 80,000 public and shared private EV charging stations in the state (not counting home*

[7] https://www.nrel.gov/docs/fy23osti/81704.pdf
[8] https://www.gov.ca.gov/2022/02/25/california-leads-the-nations-zev-market-surpassing-1-million-electric-vehicles-sold/
[9] https://www.caranddriver.com/features/a41103863/hydrogen-cars-fcev/
[10] https://m.h2fcp.org/
[11] https://www.hydrogen.energy.gov/pdfs/21002-hydrogen-fueling-station-cost.pdf

chargers).[12] Federal Inflation Reduction Act funding for chargers will further accelerate this growth. Efficiency is also an issue. A recent journal article showed that the round trip efficiency of renewable electricity powering a battery electric vehicle was 73 percent, vs. 22 percent for a hydrogen fuel cell vehicle.[13]

3. **No hydrogen production should be supported by state funding unless it is truly green.** In our white paper we suggest that as a minimum the definition used in Section 45V of the IRA for the lowest carbon intensity hydrogen be used as the benchmark, "California should not spend public money to support development of hydrogen that is more carbon intensive than the IRA's definition of "clean," 0.45 kg CO_{2e}/kg H_2. For example, the federal Infrastructure Act calls hydrogen that is 2.00 kg CO_{2e}/kg H_2 "clean" hydrogen. When applied to other processes such standards may indicate good investments for industry, but California should only support the build-out of increasingly inexpensive green hydrogen. For these reasons we oppose the definition of "clean renewable hydrogen" proposed by Simon Baker of the CPUC at this workshop, emitting less than 4 kg CO_{2e}/kg H_2. We fully support the idea of the three pillars of green hydrogen as proposed by several environmental organizations so that the production of green hydrogen does not cannibalize the electricity needed to fuel California's march to a fully electrified economy. These pillars state that the green hydrogen should be:
    - Produced by additional sources of green electricity, not existing sources,
    - Produced at close to the same time as the electricity used to produce it ("time-matching"), and
    - Produced close to the site of production of the green electricity used to make it. This last requirement is to avoid the necessity of constructing more transmission lines and long H_2 pipelines. The latter have not yet been certified for high pressure hydrogen service and could be prone to leaks. For this reason we cannot support the Angeles link project described by Simon Baker of the CPUC in his presentation at this workshop.
4. California should not depend on carbon capture and storage (CCS) to "green" its hydrogen. So far smokestack CCS of any kind has fallen woefully short of expectations both in terms of carbon capture efficiency and added costs.[14] It cannot be relied on for any long-term carbon intensity reductions and should not be supported by public funds. CCS also does nothing to reduce any toxic air pollutants associated with carbon combustion (Scope 3 emissions). In addition, if methane is the source of the hydrogen, then methane leaks of even a few percent can overwhelm the supposed climate benefits.

The narrative about the future of transportation and energy production has been in constant flux, but there's growing consensus that electricity is set to dominate most sectors, eclipsing the role of hydrogen. Despite the hype around hydrogen as a "clean" fuel alternative, especially in aviation and marine transport, its limitations make it less promising than many suggest. Its low energy density and high conversion losses reduce its overall efficiency as an energy storage solution, challenging its viability in these sectors.

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[12] https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics/electric-vehicle

[13] https://insideevs.com/news/332584/efficiency-compared-battery-electric-73-hydrogen-22-ice-13/

[14] https://ieefa.org/resources/carbon-capture-has-long-history-failure

Moreover, the carbon emissions resulting from hydrogen production through steam reformation of methane (natural gas) are still highly problematic from an environmental standpoint. As for blue hydrogen with carbon capture, the only way it qualifies for the $3.00 subsidy is with two separate carbon capture technologies, with greater than 35 percent energy consumption for the process and serious sequestration needs.

As of August 2022, green hydrogen costs roughly $5.50-$9.50 per kilogram, depending on the technology and the location, while gray hydrogen costs roughly $1.80-$2.40 per kilogram for steam methane reforming without carbon capture and storage, depending on the location. Furthermore, these costs escalate considerably during the distribution phase. Presently, gray hydrogen, which is considered inexpensive, costs around $10 per kilogram when delivered in bulk and $15–20 per kilogram at a pump. These distribution costs are unlikely to change, making hydrogen even less affordable for consumers in the long run.

Heavy-duty transportation appears to be taking a rational route toward electrification. Technological advancements in batteries are already making it feasible for trucks to haul cargo 500 miles on a charge, with the promise of 1,000-mile ranges in the near future. Likewise, rail systems globally are moving steadily towards electrification. For both passenger and freight rail transportation, all that is needed are overhead electrical lines or an electrified third rail for locomotives or trains with boxcar batteries. In India, for instance, 85 percent of the rail network is electrified with the the aim is to reach 100 percent electrification by 2025. Meanwhile, China and Europe are also making rapid strides, leaving the United States as an outlier due to policy confusion and resistance from the American Association of Railroads.

For maritime shipping, the future seems to lean toward batteries and biofuels rather than hydrogen-based solutions. Crude oil shipping, itself, is set to markedly decrease in coming decades as electrified transportation expands at an increasing rate. Unlike hydrogen, biologically derived methanol has already gained some acceptance as a maritime fuel.

With climate change requiring urgent action, hydrogen may not be the panacea it's often portrayed as. The U.S. steel industry, for instance, already meets most of its demand through recycled materials, making the need for hydrogen-based solutions less pressing. Nuclear-powered electrolysis could provide some niche applications for internal usages, where it is presently trucked in by tanker trucks, but a broader expansion of the U.S. nuclear fleet for making pink hydrogen seems highly unlikely, not cost effective, and unneeded in the bigger picture.

In summary, we believe that SB 1075 presents a significant opportunity to take advantage of hydrogen's properties for a range of specific uses. In developing regulations, CARB must make sure that neither funds nor effort are spent developing use cases that will fail to serve California's clean energy goals.

Thank you for considering these comments.

Sincerely,

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