DOCKETED	
Docket Number:	19-IEPR-01
Project Title:	General/Scope
TN #:	230880
Document Title:	California Hydrogen Business Council Comments on 2019 Draft IEPR
Description:	N/A
Filer:	System
Organization:	California Hydrogen Business Council/Emanuel Wagner
Submitter Role:	Public
Submission Date:	11/27/2019 11:29:43 AM
Docketed Date:	11/27/2019

Comment Received From: Emanuel Wagner
Submitted On: 11/27/2019
Docket Number: 19-IEPR-01

CHBC Comments on 2019 Draft IEPR

Additional submitted attachment is included below.

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CHBC Comments on 2019 Draft IEPR

The California Hydrogen Business Council (CHBC)[1] appreciates the opportunity to comment on the Draft 2019 Integrated Energy Policy Report. We thank the California Energy Commission (CEC) and its staff for the major effort of amassing a fine overview of issues the state must address with regard to energy planning at a challenging time. Overall, we support the draft report, but we also urge the CEC to strengthen its treatment of hydrogen and fuel cell technology for various sectors in some sections of the report, which inappropriately omit or downplay the use of hydrogen, where in fact, hydrogen could play pivotal roles. Of particular concern are the dismissal – or at least underestimation - of the potential for hydrogen to decarbonize the transportation and building sectors, as well as the neglect to examine the role hydrogen can play decarbonizing the industrial sector.

Please find the comments and edits below on a few specific passages, which illustrate these concerns, and incorporation of which we think could make the 2019 IEPR both stronger and more accurate. Also included are general comments that emphasize how the CEC could more carefully consider the hydrogen and fuel cell sector.

I. Ch. 1 Electricity Sector, Decarbonizing the State's Electricity Sector, pp. 30-31

1. **"At the workshop, Ms. Kenderdine explained that natural gas fuel is needed to run the system reliably with a lot of wind and solar on the electric system. Further, she noted that hydrogen made from renewables could substitute natural gas and serve as the fuel needed to run the system. ~~Yet it is unclear whether~~ While it is unclear the extent to which existing infrastructure can be used for hydrogen in time to meet the 2030 and 2050 targets, she emphasized that hydrogen innovation should be a focus of long-term planning."**

We recommend the redlined edit above because Ms. Kenderdine of the Energy Futures Initiative (EFI) specifically said at the workshop on Near Zero Electricity that hydrogen is an "important focus and should be a focus of innovation in the 2050 timeframe, and (that the state should) figure out how

[1] The CHBC is comprised of over 100 companies and agencies involved in the business of hydrogen. Our mission is to advance the commercialization of hydrogen in the energy sector, including transportation, goods movement, and stationary power systems to reduce emissions and dependence on oil. The views expressed in these comments are those of the CHBC, and do not necessarily reflect the views of all of the individual CHBC member companies. Members are listed here: www.californiahydrogen.org/aboutus/chbc-members.

much of the existing infrastructure can be used in basically a hydrogen future."[2] This echoes the findings of the EFI report "Optionality, Flexibility, and Innovation: Pathways to Deep Decarbonization in California"[3] Section on Decreasing State's Reliance on Fossil Fuels in Buildings. The description of her message as written underplays her strong recommendation that hydrogen should be a priority in California's energy related research and planning.

II. Ch. 2 Building Decarbonization and Energy Efficiency, Decreasing the State's Reliance on Fossil Fuels in Buildings

1. **p. 41 - "Clean hydrogen could also be blended with natural gas, but there are limitations with regard to the amount that could be safely injected into pipelines." It is among the "options (that) should be considered when looking at potential decarbonization of the natural gas system."**

We strongly agree that clean hydrogen should be among the options considered for decarbonizing the gas system, and we urge California to examine how to safely inject hydrogen into the natural gas network, beginning with studying blending limits and creating injection standards and protocols based on study results. Ultimately, the state ought to examine the potential for up to 100% hydrogen injection, as is being done around the world, including in:

- Europe, where the European Commission, in partnership with the fuel cell and hydrogen industry, is focusing on the potential converting pipelines to 100% hydrogen.[4] In the UK, there are a number of projects underway to demonstrate this concept, as part of the national effort to achieve deep decarbonization.[5] Notably the UK is particularly focused on hydrogen to decarbonize building heat.
- Japan, which is planning to convert its entire energy system to hydrogen, including using pipelines to carry hydrogen and its derivatives.[6]

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[2] See p. 110, Transcript of September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity, https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C 0&sdata=veAVcyBq05aqBtCd37GO%2FR2uvwGQTD2PPV7rIa5xm1E%3D&reserved=0. The E3 study did not evaluate scenarios to achieve carbon neutrality by 2045, which will require accelerating these measures further or identifying additional measures.

[3] Optionality, Flexibility, and Innovation: Pathways to Deep Decarbonization in California, Energy Futures Initiative; April 2019 https://energyfuturesinitiative.org/s/EFI_CA_Decarbonization_Full-b3at.pdf

[4] pp. 7, 34, *Hydrogen Roadmap Europe,* European Commission/FCH; January 2019 https://www.fch.europa.eu/sites/default/files/Hydrogen%20Roadmap%20Europe_Report.pdf

[5] See H21 https://www.h21.green/

[6] p. 21, *Basic Hydrogen Strategy;* Ministerial Council on Renewable Energy, Hydrogen and Related Issues; December 2017 https://www.meti.go.jp/english/press/2017/pdf/1226_003b.pdf

- New Zealand, which has established a national vision for shifting to an economy based on renewable hydrogen[7]
- Australia, where Evoenergy and the Canberra Institute of Technology are partnering on testing 100% hydrogen on existing materials, equipment and work practices, in preparation for application to the existing gas distribution network.[8]

Thoroughly and scientifically examining the potential for the gas system to be repurposed for decarbonized gas, including hydrogen, for use in buildings and other applications ought to be among the recommendations in this section. We acknowledge and appreciate that the CEC touches upon these issues in Appendix A.

2. **p. 43 "And none of the gas advocates have made a clear case for a realistic long-term pathway in which most or all retail customers will have a choice of safe, carbon-free gas for use in buildings."**

In our comments on the CEC's Building and Efficiency Plan workshop,[9] the CHBC pointed to a number of international initiatives, such as those listed above, that are working on creating such pathways. Notably none are mentioned in the Draft IEPR. That said, we acknowledge that there are gaps in understanding how to achieve safe, zero carbon gas use for most or all building customers that need to be filled. We strongly urge the 2019 IEPR to include addressing this knowledge gap in its recommendations in the chapter on building decarbonization. This would be in line with the US Department of Energy's H2@Scale project, which includes hydrogen for building heat as one ifs areas of focus.[10] Specifically, we urge the state to pursue peer-reviewed, scientific studies into how to optimize the gas system for decarbonized building energy that balances cost-effectiveness and consumer choice, while maximizing reliability under all scenarios, including natural disasters. We think such studies should also include various combinations with efficiency and electrification measures.

We also note that knowledge gaps remain in all electrification scenarios as well, due to the many issues we raised in comments, including reliability and uncertain electricity pricing concerns in the face of heightened natural disaster-related risks and electricity system impacts. The 2019 IEPR ought to avoid being overly optimistic about the favorability of such scenarios in view of such glaring gaps.

3. **p. 50 – "When packaged with deep energy efficiency measures, building electrification presents the next most cost-effective path to decarbonization after the direct greening of**

[7] New Zealand government vision for hydrogen - https://www.mbie.govt.nz/dmsdocument/6798-a-vision-for-hydrogen-in-new-zealand-green-paper
[8] https://www.evoenergy.com.au/emerging-technology/hydrogen-test-facility
[9] See pp. 12-13, *CHBC Comments on August 27 Joint Agency Workshop on Energy Efficiency and Building Decarbonization* https://ww2.energy.ca.gov/2019_energypolicy/documents/2019-08-27_workshop/2019-08-27_comments.php
[10] https://www.energy.gov/eere/fuelcells/downloads/fiscal-year-2019-h2scale-funding-opportunity-announcement-selections

sources of electricity. (footnote source: *Decarbonization of Heating Energy Use in California Buildings* https://www.synapse-energy.com/sites/default/files/Decarbonization- Heating-CA-Buildings-17-092-1.pdf. 2018. Synapse Energy Economics, Inc. Introduction. p. 7.)

The citing of one study does not make it fact. Given the nascent markets of building electrification technologies, such as heat pumps, the difficulty – if not impossibility - of making accurate projections for electricity rate impacts in the current era of catastrophic wildfires of increased frequency, size, and liability costs in California, and the challenges of PSPS policies, it is not at all clear that building electrification represents the most cost-effective path to decarbonizing buildings. A more detailed analysis of this issue is found in CHBC Comments on E3's Final Project Report, Natural Gas Distribution in California's Low-Carbon Future.[11]

III. Chapter. 3 Clean Transportation

1. ZEVs on the Global Stage[12]

On Page 70, the draft mentions the May 2, 2019 *IEPR workshop to discuss the latest status of the ZEV market*. As mentioned in our comments and conversations with staff, that workshop unfortunately covered PHEVs and BEVs exclusively, rather than including FCEVs, one of the two only ZEV technologies available today. This omission continues throughout most of this chapter of the IEPR. This is contrary to state policy, which aims to support both types of ZEV technologies. This omission in the IEPR sends the signal that the CEC, and possibly California, dismisses FCEVs, which is both contrary to many state laws and policies, but also out of step with global market analysts.

Global Market Insight, for example, projects the global FCEV market to exceed $11.6 billion by 2025, propelled by advantages of short refueling time and long-range capability.[13] Earlier this month, industry analysts forecasted FCEVs to see the highest compounded annual growth rate (CAGR) of any type of electric vehicle, due to technology advantages and Asian investment in technology and infrastructure.[14] Analysts like BNEF[15] are also pointing to growth of fuel cell options in the heavy duty sector, especially for long haul applications that are "hardest segments for (battery) electrics to crack."

[11] https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-MISC-03
[12] See. pp. 70-71, *Draft 2019 IEPR*
[13] https://www.gminsights.com/pressrelease/fuel-cell-electric-vehicle-market
[14] https://www.marketsandmarkets.com/Market-Reports/electric-vehicle-market-209371461.html
[15] https://about.bnef.com/blog/electric-transport-revolution-set-spread-rapidly-light-medium-commercial-vehicle-market/

In a 2017 KPMG survey, 78% of Global Automotive Executives absolutely or partly agree that FCEVs will be the real breakthrough for electric mobility.[16] Furthermore, in the 2018 survey, fuel cell electric vehicles replaced battery electric vehicles as this year's #1 key trend until 2025.[17]

While infrastructure for FCEVs remains a hurdle, the 7,000+ FCEVs in California alone show that the technology is mature and holds promise to be cost competitive at scale.

CHBC recommends that the CEC include such data on the development of the fuel cell electric vehicle market, similar to that gathered in the workshop conducted on BEVs and PHEVs.

2. Fuel Cell Electric Vehicles in the Transportation Portfolio is in Line with State and Federal Policy and an Important Part of Sustainable Transportation Strategy

Since 2009, California legislation and executive orders have prioritized both battery electric and hydrogen fuel cell electric vehicles in its zero emissions transportation strategy. We strongly support this approach over adopting the battery-only strategy. The U.S. federal government also embraces both types of technology.[18]

Supporting broad advancement of ZEVs that includes both battery electric and fuel cell electric vehicle technology, as well as combination fuel cell and battery options, is critical to reaching California's clean air and climate goals. The need to not focus exclusively on only one technology is clearly recognized in Executive Order B-48-18, which calls for California putting 5 million ZEVs on state roads by 2030 and for infrastructure development to support deployment of both types of technologies. The fuel cell electric vehicle industry has committed to bringing 1 million FCEVs to market to help that goal, with the right infrastructure made available.

Lifecycle analysis show that hydrogen fuel cell electric vehicles can provide significant GHG emission improvements, even over BEVs, see Figure below.[19]

[16] https://assets.kpmg/content/dam/kpmg/xx/pdf/2017/01/global-automotive-executive-survey-2017.pdf; p. 14
[17] https://automotive-institute.kpmg.de/2018/brain.html#automotive-key-trends
[18] https://www.energy.gov/articles/department-energy-announces-50-million-commercial-truck-road-vehicle-and-gaseous-fuels
[19] http://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-scaling-up-Hydrogen-Council.pdf

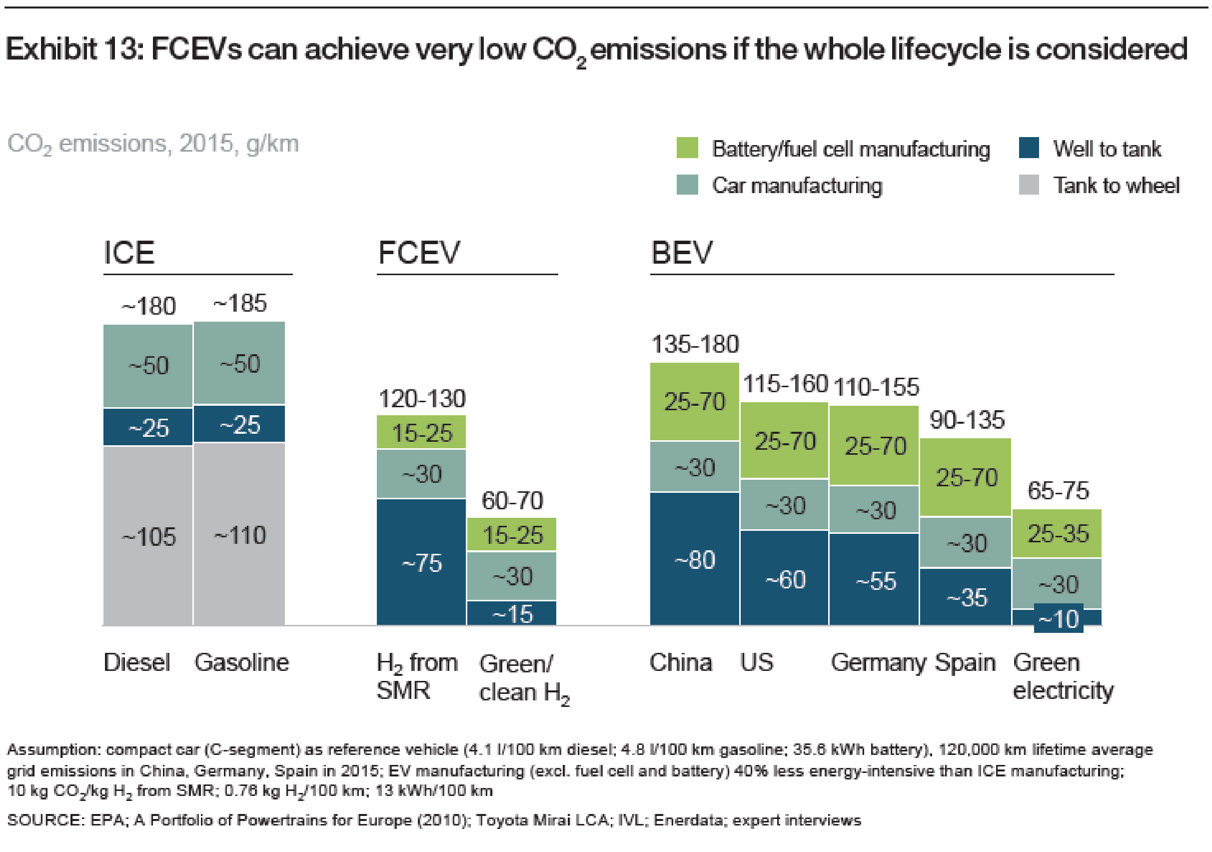


Figure 1 – FCEV, BEV and ICE CO2 Emissions over Entire Lifecycle

Battery and fuel cell electric transportation technologies are more and less appropriate for certain applications and situations, They are also complementary both in the ecosystem of zero emissions transportation and even swithin vehicles that use a combination of plug in and fuel cell electric technologies. While BEVs are a convenient choice for single family home dwellers who can easily charge at home, there are serious limitations for consumers that lack dedicated parking via garages or driveways. FCEVs are a good choice for those drivers.

FCEVs also are beneficial who need fast refueling in a few minutes and longer ranges. Earlier this month, the CEO of GM noted their consumer surveys show that range anxiety remains the number one barrier to mainstream adoption of BEVs. [20] The BEV industry is seeking to overcome this barrier with bigger batteries, but this approach risks being constrained by mineral resource availability, recycling

[20] https://www.cnn.com/2019/11/25/perspectives/gm-electric-cars/index.html

challenges, and environmental and humanitarian impacts of mining. See Section below on Supply Trends in the ZEV Industry for more details.

Light duty passenger FCEVs have achieved a 380 mile range, surpassing battery electric options, an advantage that is amplified in adverse weather conditions.[21] The Hyundai Nexo is currently the electric vehicle with the farthest range, at a refueling time of less than 5 minutes. Press reports indicate that Toyota's goal is to be offer FCEV models in 2025 at the same cost as their hybrid vehicles[22], while offering ranges of 400-650 miles per fill.[23] In October 2019, press reports show that Toyota's next generation Mirai will achieve a 30% increase in range from its prior model, achieving the 400 mile range by 2020.[24]

In the medium- and heavy-duty sectors, FCEVs have similar advantages, along with lighter payloads due to the heavy weight of batteries compared to hydrogen fuel cells that make them more economical than battery electric options.

Beyond the vehicles sectors, Germany has introduced hydrogen-powered rail as another application[25], and the UK is planning to do so by 2022.[26] The shipping industry is also developing hydrogen-powered projects, including the Bay Area Red and White Fleet's fuel cell "Water-Go-Round" ferry[27], and cruise ships for Royal Caribbean Cruise Line and Viking Ocean Cruises.[28] In aviation, fuel cell planes have been tested since 2015[29] and electrolytic hydrogen based synthetic fuels are being researched internationally as a high volume pathway to decarbonized aviation.[30]

We encourage the CEC to include such data in the final 2019 IEPR to avoid painting a picture that unfairly and inappropriately underplays the hydrogen fuel cell transportation imperative, as well as market development activity and potential.

3. Infrastructure challenges

[21] The Hyundai Nexo has an EPA rated range of 380 miles, https://www.hyundaiusa.com/nexo/index.aspx. The highest battery electric range listed is in the Tesla S is 335. https://www.tesla.com/models
[22] https://www.autocar.co.uk/car-news/industry/hydrogen-cars-cost-same-hybrids-2025-say-toyota
[23] https://www.reuters.com/article/us-toyota-hydrogen/toyota-plans-to-expand-production-shrink-cost-of-hydrogen-fuel-cell-vehicles-idUSKBN1KG0Y0
[24] https://www.motor1.com/news/375766/2021-toyota-mirai-fuel-cell/
[25] https://www.cnbc.com/2018/09/17/worlds-first-hydrogen-powered-train-enters-into-service.html
[26] https://www.telegraph.co.uk/cars/news/hydrogen-fuel-cell-trains-run-british-railways-2022/
[27] https://www.sfchronicle.com/bayarea/article/Bay-Area-to-build-first-hydrogen-fuel-cell-ferry-13376358.php
[28] http://www.cruisington.com/cruise-lines-looking-to-pioneer-fuel-cells-as-green-power-source/
[29] https://www.aerospace-technology.com/projects/hy4-aircraft/
[30] https://www.icao.int/environmental-protection/GFAAF/Pages/Project.aspx?ProjectID=46

Infrastructure for FCEVs remains an issue, as the upfront cost tends to be higher compared to other zero emission technologies. However, a “Comparative Analysis of Infrastructures: Hydrogen Fueling and Electric Charging of Vehicles” by the German Institute of Electrochemical Process Engineering (IEK-3) at the Research Center Jülich showed that for Germany, once electrification of vehicles exceeds 20 million, FCEV infrastructure becomes cheaper than BEV infrastructure, as shown in Figure 6.[31]

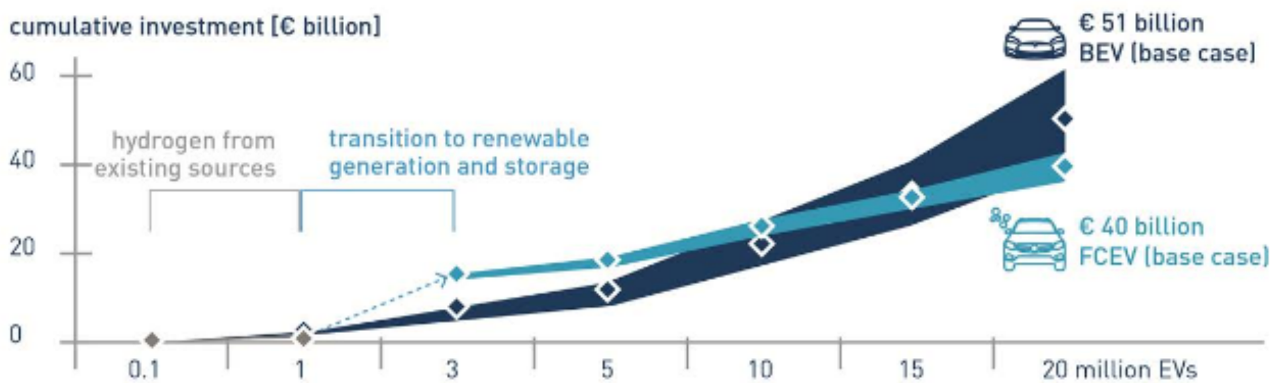


Figure 2 – Comparison of the Cumulative Investment of Supply Infrastructures (BEV & FCEV)

In addition, the study showed “mobility costs per kilometer are roughly equal in the high market penetration scenario at 4.5€ct/km for electric charging and 4.6€ct/km for hydrogen fueling. Because hydrogen permits the use of otherwise unusable renewable electricity by means of on-site electrolysis, the lower efficiency of the hydrogen pathway is offset by lower surplus electricity costs.”

Regional planning, such as the South Coast Air Quality Management District 2016 Air Quality Management Plan,[32] furthermore views hydrogen fuel cell vehicle technology as among the solutions to solving the region’s pernicious pollution problems.

4. **FCEVs are quickly becoming cost competitive to BEVs and PHEVs**

CEC staff indicated during the July 22 *Transportation Forecast* workshop that FCEVs are cost prohibitive compared to BEV and PHEV options, but this is not based on evidence.

[31] https://www.californiahydrogen.org/wp-content/uploads/2017/10/Energie_Umwelt_408_NEU.pdf

[32] http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2016-air-quality-management-plan/final-2016-aqmp/final2016aqmp.pdf?sfvrsn=15

In fact, it is difficult to assess the true cost of FCEVs vs. BEVs and PHEVs because unlike FCEVs, BEVs and PHEVs are supported by generous federal tax credits and are currently at an earlier stage of market development and hence produced at lower volume than highest selling BEV brands like Tesla.

That said, Toyota has indicated that they expect the cost for their FCEVs to be similar to those of hybrid vehicles by 2025, most likely due to scaling of production and innovation.[33]

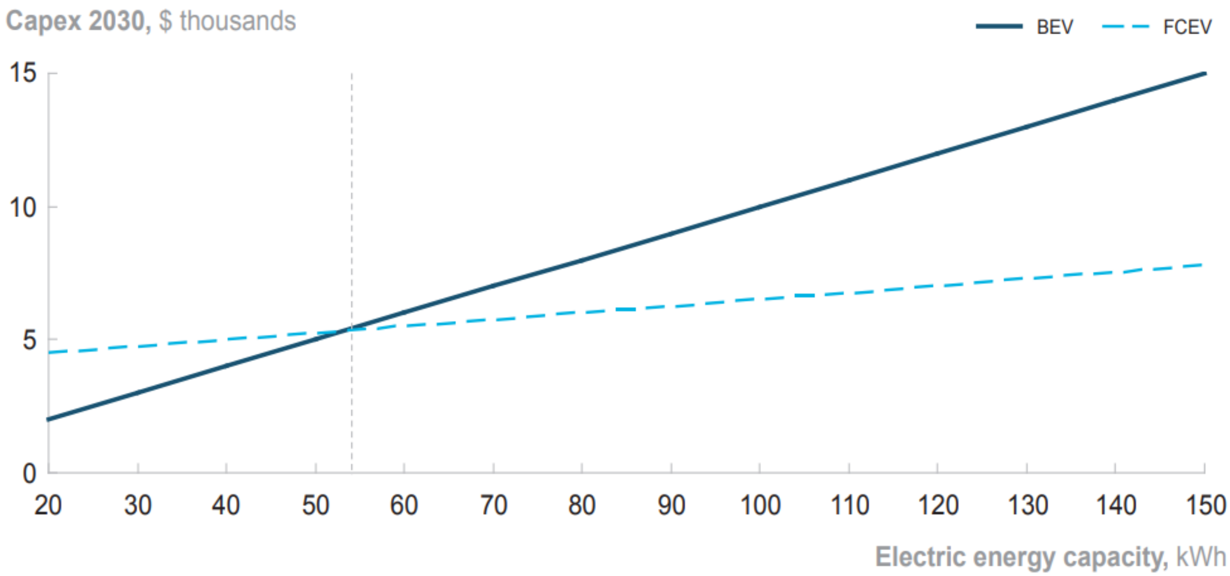
McKinsey developed 2030 cost projections for BEV and FCEVs by 2030 that show that as range increases, FCEVs become cost competitive. Specifically, the report projects that BEVs will have the cost advantage when they are under 55 kWh energy capacity, but above that, FCEVs have the advantage. The report implies the crossover point for lowest cost switches over from BEV to FCEV at a range of about 185 miles.[34] Given that, as mentioned above, range anxiety remains the top barrier to BEV adoption – indeed, by far the best selling BEVs are Teslas, which are at the top tier of range for BEVs on the market - it is likely that the BEV industry will continue to trend toward longer range vehicles, putting FCEVs at a cost advantage.

[33] https://www.autonews.com/executives/toyota-sees-fuel-cell-costs-par-hybrids

[34] http://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-scaling-up-Hydrogen-Council.pdf, p. 32

Exhibit 9: FCEVs have lower investment costs for long-range vehicles

Scenario analysis of powertrain costs for FCEVs and BEVs at different capacity levels, 2030



Assumptions: battery $100/kWh, fuel cell of 100 kW with $40/kW, hydrogen tank $24/kWh, FCEV battery with 1% of total capacity, FC to electricity efficiency 55%

SOURCE: Avere-France; DoE fuel cell technology office; McKinsey: Automotive revolution – perspective towards 2030

5. Fuel Cell Electric Buses can play a significant role in California's Transit Sector

The Innovate Clean Transit (ICT) Regulation requires significant investment and conversion a 100% ZEV fleet purchase mandate by 2029 and an entire 100% ZEV fleet for all California transit agencies by 2040.

The L.A. Metro Board Report (File #:2019-0458) on the "Metro Bus Fleet Forecast and Zero Emission Bus Program Update" dated July 18, 2019, outlines the estimated costs for a full conversion to BEV fleet as well as other challenges. Those include: low-end estimate capital required for charging infrastructure of $700 million to $1 billion, an unknown TCO for buses (utility and operating costs), overhead charging requiring 15MW of power, curb weight limits as an issue for range of the fleet, and CNG buses outperforming Zero Emission Buses (ZEBs), possibly requiring more ZEBs to cover the same service level, thus requiring additional BEB purchases to maintain current level of service.

Based on existing projects, we offer the following data: the liquid hydrogen delivery approach for the new Orange County Transportation Authority (OCTA) fuel cell electric bus fleet is completely applicable to LA Metro's transit bus fleet.

OCTA's fueling station infrastructure, developed by Trillium, is sized for a 50-bus fleet, with the total station project costs $4.7 million for 50 buses amounting to **$94,000 per FCEB**.[35] This includes 3 years of warranty and full maintenance. For better comparison, just CAPEX with a standard 1-year warranty is closer to $4 million for the above referenced 50 bus station. In addition, liquid hydrogen stations have great scaling characteristics. According to Trillium, with an additional investment of $2 million at the start of the project at OCTA, the station could have supported 200 buses. Trillium stated that a 200 bus station would cost $7 million, which would equate to **$35,000 of capex per fuel cell electric bus** for the infrastructure investment. This compares to LA Metro's low-end infrastructure estimate of $700 million for 2,300 buses, which would be at least **$304,000 per battery bus**.

In addition, Shell projects economical delivered cost for hydrogen supply[36] of $5/kg for fuel contracts of 10 tons/day (= 333 buses) or $3/kg for 50 tons/day (=1,667 buses), excluding cost of the station. L.A. Metro would create such demand very quickly.

We would also reference the CHBC & California Fuel Cell Partnership Fuel Cell Electric Bus factsheet, which outlines the performance of FCEBs, especially as a 1:1 replacement for current diesel (or CNG) buses while providing the same range, power, refueling time, and duty cycle with zero emissions.[37] An analysis by AC Transit from last year also indicates that today's FCEBs can replace 95% of their routes without compromise.[38] This was validated by AC Transit after conducting an in-service test with their new FCEB. L.A. Metro would not need to look into purchasing additional buses to maintain its current service with FCEBs.

SunLine Transit has also stated that for their FCEBs in operation, "the total cost per mile is comparable to CNG buses we have in service"[39]. AC Transit reported that current fuel cost is at $7.42 per kg of hydrogen ($.60 more than diesel equivalent MPG). Their maintenance cost is at $187,000 per year per fuel station.

6. **Medium- and Heavy-Duty forecasts are lacking fuel cell electric trucks and key limitations of other alternative drive trains.**

Fuel Cell Electric Trucks (FCETs) are lacking comprehensive forecasting in the draft IEPR, and CHBC disagrees with CEC's assessment that hydrogen prices and vehicle cost will create prohibitive barriers

[35] OCTA is sized for 1,500kg/day = 50 buses at 30kg per day
[36] https://www.shell.com/energy-and-innovation/new-energies/hydrogen/_jcr_content/par/textimage.stream/1523053290426/9c3eb9f6ee6f68ecdbb311a9254e621355b52b21/path-toward-competitive-refueling-infrastructure-for-hydrogen-brochure.pdf
[37] https://www.californiahydrogen.org/wp-content/uploads/2017/10/CHBC-CaFCP-Fuel-Cell-Electric-Bus-Fact-Sheet.pdf
[38] http://www.actransit.org/wp-content/uploads/board_memos/18-134%20ZEB%20Assessment.pdf
[39] https://www.sustainable-bus.com/fuel-cell/el-dorado-national-fuel-cell-bus-ballard-completed-successfully-testing/

for FCET introduction. Fuel cost at scale, especially for high volume fueling with liquid hydrogen, allows for significant cost reduction over current fueling cost for light duty vehicles, see station cost and hydrogen cost comments above. While cost data for FCETs are difficult to ascertain, Nikola Motor[40], Hyundai[41], Horizon Fuel Cells[42] and Kenworth/Toyota are all working on large scale deployments of FCETs and thus do not share CEC's point of view.

Nikola Motor reports over 14,000 FCETs pre-orders to date, indicating strong demand. Nikola reports that fleet managers specifically look at zero emission solutions that will enable them to move at least 40,000 pounds of payload for at least 600 miles. Battery electric trucks (BETs) are highly unlikely to achieve such benchmarks. Nikola has already built two FCETs for the North American market, and is ramping to build 25 test FCETs by 2021 for testing and 100 FCETs on the road in 2022. Large-scale production of FCETs is scheduled for 2023 in Arizona. Production volume is designed for 2,200 FCETs in 2023 and full capacity of 36,000 FCETs per year is scheduled for 2027. To support this volume of FCETs, Nikola will plan to build one 8,000 kg per day hydrogen production and refueling station to support 200 FCETs. Their plan is to build one 2,000 kg station in Phoenix by 2021, one 8,000 kg station in California by 2021 and at least nine more 8,000 kg stations in California by 2023. To support their full capacity production, Nikola is planning to build 700 more stations around the country by 2027.

With new solar power generation coming from Nikola's business partners and their ability to buy interruptible power by storing excess hydrogen to satisfy their customer's fueling demand, Nikola is planning to purchase power for less than 4 cents per kWh on average. California power costs might be a bit higher than the average but Nikola will supply hydrogen fuel and a FCET and truck maintenance for 95 cents per mile for a 700,000 mile 7-year lease. This cost structure is on par with diesel fuel for fleets and enables fleets to avoid the operational risk and capital cost associated with buying a FCET. BET's cannot compete with this due to the weight of the batteries, which affects the payload capacity and/or the range.

Based on the feedback from freight operators, long charging times required for BETs will not allow operators to meet customer needs. Unlike the light duty sector, the freight sector is time constrained and requires fast turnaround times.

In addition, range will be limited for BETs due to weight issues of the battery pack and catenary systems by the electrified routes. These limitations will significantly impede adoption of this technology, whereas hydrogen does not suffer from either limitation. The heavy weight of batteries in

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[40] In 2018, Nikola reported $9 billion in pre-order reservations for their FCETs: https://nikolamotor.com/press_releases/anheuser-busch-continues-leadership-in-clean-energy-places-order-for-800-hydrogen-electric-powered-semi-trucks-with-nikola-motor-company-23

[41] https://www.electrive.com/2019/04/15/hyundai-h2e-1600-fuel-cell-trucks-for-european-market/

[42] https://fuelcellsworks.com/news/horizon-fuel-cell-technologies-signs-agreement-to-supply-1000-fuel-cell-electric-heavy-vehicles-for-cleaner-port-operations/

BETs needed to achieve a manageable range will reduce the payload possible to be carried by each truck. This will require additional trucks to be used to carry the same payload of a diesel or CNG truck. This analysis is missing in the presentation. An analysis is recommended to identify these costs for freight transport.

As mentioned in comments, volume production can significantly reduce the price of the fuel cell electric vehicles, including trucks. Buses see a 40% price reduction by quadrupling the production volume from 25 to 100. There is no reason to not assume a similar price reduction for FCETs. However, since ZETs are not commercial yet, any price forecasts are marketing, not data driven. We urge CEC not to rely on marketing data from individual companies, especially if their record on announcing vehicles at certain prices has been spotty, at best. Extensive modeling data, which member companies are willing to share confidentially, has shown FCETs being more affordable than for BETs from a total cost of ownership perspective, and that much earlier than 2030. Shell New Energies recently released an assessment that sees cost parity of hydrogen fueling with diesel in the heavy duty market at 10,000 vehicles.[43] Additionally, repeated use of fast charging also has the potential to deteriorate the large battery packs, and fast charging of large battery packs itself will create more strain on the grid than overnight charging or workplace charging.

7. Supply Trends in ZEV Industry

California must be careful not to become overly dependent on energy choices that are prone to supply constraints and disruption. Li-ion battery technology, which currently dominates the BEV industry, requires cobalt, lithium and graphite, which are prone to resource constraints or trade and market upheavals.[44] Resource shortages for BEV materials have been publicly acknowledged as an issue by Tesla.[45] McKinsey also projects that the battery electric vehicle industry is likely to be challenged by mineral constraints by 2025.[46]

Furthermore, lithium cannot be recycled, and graphite is difficult and costly to recycle, creating constant demand for further resource extraction.

Fuel cells only require platinum in an amount equivalent to what is currently used in regular catalytic converters of regular combustion vehicles. Furthermore, more than 95% of the platinum in fuel cells, when reaching their end of life, is recycled and can be used indefinitely in new fuel cells, reducing the need for new resource extraction. No other rare or precious metals are required, creating a robust

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43 https://www.hydrogen.energy.gov/pdfs/htac_dec18_06_munster.pdf
44 https://www.theguardian.com/environment/2017/jul/29/electric-cars-battery-manufacturing-cobalt-mining
45 https://www.euractiv.com/section/batteries/news/tesla-expects-global-shortage-of-electric-vehicle-battery-minerals-sources/
46 https://www.mckinsey.com/industries/oil-and-gas/our-insights/metal-mining-constraints-on-the-electric-mobility-horizon

supply chain independent of international trade disputes or shortages in raw materials and allowing for full homegrown domestic production.

This is reflected in Chairman of Audi Board of Management, Bram Schot's recent announcement to intensify fuel cell development: *"at the end of the day, batteries are not sustainable enough — it is sustainable, but if you want to go all the way, you need fuel cells."*[47]

According to UK scientists, "*currently projected estimate of two billion cars worldwide, based on 2018 figures, annual production would have to increase for neodymium and dysprosium by 70%, copper output would need to more than double and cobalt output would need to increase at least three and a half times for the entire period from now until 2050 to satisfy the demand*." For just UK "*electric car targets for 2050, we would need to produce just under two times the current total annual world cobalt production, nearly the entire world production of neodymium, three quarters the world's lithium production and at least half of the world's copper production*."[48]

g. Recommendations on pp. 83-8, lack any support for FCEVs.

The CHBC encourages the Recommendations in this section to include support for FCEV technology. Specific examples include:

1) Support renewable electricity grid integration via establishing a power to gas target area for CTP funding

- Power-to-gas would allow the CEC to support the integration of excess renewable generation into the electricity grid by absorbing it to produce renewable hydrogen, which can be used for multiple applications, including transportation fuel.
- Expansion of funding for power-to gas facilities would help scale up hydrogen production and enable cost reduction.

2) Support station deployment for medium- and heavy-duty transportation, including trucks and buses

- Funding and other incentives are needed to help deploy infrastructure for transit agencies needing to meet ICT regulation requirements as well as for medium- and heavy-duty fleets used for long haul trucking and ports operation.

3) Secure access to low cost electricity for hydrogen production and stations

- Hydrogen fuel costs from electrolysis are highly dependent on the cost of electricity.

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47 https://fuelcellsworks.com/news/audi-increasing-investment-into-hydrogen-fuel-cells/

48 https://www.nhm.ac.uk/press-office/press-releases/leading-scientists-set-out-resource-challenge-of-meeting-net-zer.html

- CEC could support efforts to help establish electric rate design and rate setting that is supportive of cost-effective hydrogen production and fueling station electric demand.

4) Incentivize investment in a robust production and distribution network

- Reliance on sole companies supplying the hydrogen fueling network creates significant challenges in case of interruptions at the production or distribution level.
- Incentivizing competition in this nascent market is needed to overcome bottlenecks in the fuel supply, which affect FCEV drivers region wide, and creates a more resilient hydrogen supply chain network.

5) Funding support in California for transportation electrification, in terms of both vehicles and infrastructure, is heavily tilted towards charging and PHEVs/BEVs, with marginal support for FCEVs.

- We encourage increased funding for FCEVs and hydrogen fueling infrastructure where possible to even the playing field and diversify California's strategy toward adopting zero emissions vehicles. By our calculations, using publicly available data, 97% of transportation electrification funding in California went to charging infrastructure, BEVs and PHEVs, and only 3% went to FCEVs, fueling infrastructure and hydrogen production facilities. That is reflected in the distribution of vehicles - 99% of the EV market is BEVs and PHEVs, 1% is FCEVs. Not customer choice, but lack of funding is currently the greatest obstacle to further adoption of FCEVs in the Golden State.
- The CHBC supports developing additional innovate funding programs to help station buildout at an accelerated rate.

8. Appendix A-16 Section on Potential Natural Gas System Impacts From Hydrogen

The CHBC appreciates inclusion of this section and looks forward to working with the CEC and other agencies on accelerating the effort to address issues involved in developing electrolytic, as well as other low and zero carbon, hydrogen production and supply infrastructure.

IV. Conclusion

The CHBC thanks the CEC for its major effort on the 2019 IEPR and all its work to include hydrogen as an integral part of California's clean energy future. We hope you will consider the comments above as ways to improve upon an otherwise thoughtful effort.

Respectfully,

Regards,

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California Hydrogen Business Council