California Hydrogen Business Council

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CHBC Comments on IEPR Commissioner Workshop on the Status of the Zero Emission Vehicle Market

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INTRODUCTION

The California Hydrogen Business Council (CHBC)[1] appreciates this opportunity to offer comments on the May 2, 2019 IEPR Commissioner Workshop on the Status of the Zero Emission Vehicle (ZEV) Market. We strongly support the Commission's regular examination of the ZEV market. We are also concerned and disappointed that this workshop focused virtually exclusively on plug-in/battery electric vehicle (BEV) technology[2] and ignored hydrogen fuel-cell vehicle (FCEV) technology. This is misaligned with California ZEV policy, which includes both battery and fuel cell electric vehicle technologies. For example, Executive Order B-48-18 calls for at least 5 million ZEVs on California roads by 2030 and to support this, scaled up installation of both electric vehicle chargers *and* hydrogen refueling stations by 2025. This inclusive approach should have been taken in the May 2 workshop, and we hope that it is reflected in the final 2019 IEPR Report.

The CHBC has repeatedly raised the issue of a one-sided approach to ZEV market support that supports BEV over FCEV technology. We submit these comments to continue to highlight why a balanced approach to both zero emissions electric transportation options is vital to California's climate goals, emission reduction targets, economy and self-reliance on domestic resources.

[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 of the CHBC include Air Liquide Advanced Technologies U.S. LLC.; Alameda-Contra Costa Transit District (AC Transit); American Honda Motor Company; Anaerobe Systems; Arriba Energy; Ballard Power Systems, Inc.; Bay Area Air Quality Management District (BAAQMD); Beijing SinoHytec; Black & Veatch; BMW of North America LLC; Center for Transportation and the Environment (CTE); Charm Industrial; Chiyoda Corporation; Clean Energy Enterprises; Community Environmental Services; CP Industries; DasH2energy; Dominion Energy; Eco Energy International, LLC; EcoNavitas; ElDorado National – California; Energy Independence Now (EIN); EPC - Engineering, Procurement & Construction; Ergostech Renewal Energy Solution; EWII Fuel Cells LLC; FIBA Technologies, Inc.; First Element Fuel Inc; General Engineering & Research; General Motors, Infrastructure Planning; Geoffrey Budd G&SB Consulting Ltd; Giner ELX; Gladstein, Neandross & Associates; Greenlight Innovation; GTA; H2B2 USA; H2Safe, LLC; Hexagon Lincoln; Hitachi Zosen Inova ETOGAS GmbH; HODPros; Hydrogenics; Hydrogenious Technologies; Hydrogen Law; HyET - Hydrogen Efficiency Technologies; HyperSolar, Inc.; Hyundai Motor Company; IGX Group Inc; ITM Power Inc; Ivys Inc.; Iwatani Corporation of America; Johnson Matthey Fuel Cells; KORE Infrastructure, LLC; Kraft Powercon; Life Cycle Associates; Longitude 122 West, Inc.; Loop Energy; Magnum Energy; Manticore Advocacy LLC; Millennium Reign Energy; Mitsubishi Hitachi Power Systems Americas; Motive Energy Telecommunications; Natural Gas Fueling Solutions (NGFS); Natural Hydrogen Energy Ltd.; Nel Hydrogen (US); Neo-H2; Neuman & Esser USA, Inc; New Flyer of America Inc; Next Hydrogen; Noyes Law Corporation; Nuvera Fuel Cells; Pacific Gas and Electric Company - PG&E; Pacific Northwest National Laboratory (PNNL); PDC Machines; Planet Hydrogen Inc; Plug Power; Politecnico di Torino; Port of Long Beach; Powertech Labs, Inc.; Primidea Building Solutions; RealEnergy, LLC; RG Associates; Rio Hondo College; Rix Industries; Sacramento Municipal Utility District (SMUD); SAFCell Inc; Sheldon Research and Consulting; South Coast Air Quality Management District; Southern California Gas Company; Strategic Analysis Inc; Sumitomo Corporation of Americas; Sumitomo Electric; Sunline Transit Agency; T2M Global; Tatsuno North America Inc.; Terrella Energy Systems Ltd; The Leighty Foundation; TLM Petro Labor Force; Toyota Motor Sales; Trillium - A Love's Company; University of California, Irvine; US Hybrid; Valley Pacific Petroleum Services Inc; Vaughan Pratt [Individual]; Verde LLC; Vinjamuri Innovations LLC; Winkelmann Flowform Technology; WireTough Cylinders, LLC; Worthington Industries; YanliDesign; Zero Carbon Energy Solutions.

[2] Note, for simplicity, we are using BEV to mean all types of battery electric reliant vehicle technology, including plug-in hybrid/battery electric with gas backup.

COMMENTS

1. It is State policy to include both battery electric and fuel cell electric technology in its pursuit of zero emissions vehicles (ZEVs), and CEC ignores this by exclusively focusing on battery electric technologies in its review of ZEV market status.

The May workshop on Zero Emission Vehicles hosted by the Energy Commission excluded any discussion of the fuel cell electric vehicle market, nor is there a separate workshop on FCEVs planned. This is not in keeping with California policy, which has consistently included both battery and fuel cell electric technology in its definition and support of zero emissions vehicles.

Executive Order B-18-48, for example, supports development of both types of vehicles and accompanying infrastructure to put 5 million ZEVs on California roads by 2030. The Governor's 2018 ZEV Action Plan "Priorities Update" builds on this in its market status update section, which specifically addresses both battery and fuel cell electric technologies.[3] The document furthermore specifically directs the CEC to be among the lead agencies to

> *" further forecast the charging and fueling needs to support 5 million ZEVs by 2030" and "(d)evelop innovative infrastructure deployment strategies and 2030 infrastructure need projections that spur greater private investment in the construction of infrastructure."*[4]

How can the CEC develop those strategies without including FCEV technologies in its market assessment?

Both FCEVs and BEVs are also included in CARB's most recent Mobile Source strategy to reduce emissions from the transportation sector,[5] as well as its last Scoping Plan on achieving state greenhouse gas targets.[6]

And, in fact, the California Energy Commission itself has acknowledged that ZEV policy in California is inclusive of battery-based and fuel cell electric technologies in its recent IEPRs, and its alternative fuel program has reflected this in its support a range of ZEV solutions, which has included FCEVs and hydrogen fueling infrastructure, along with BEVs. The departure of the recent IEPR workshop on market status of ZEVs from this tradition is worrisome and difficult to understand. By exclusively focusing on BEVs in its 2019 IEPR preparation, however, the agency sends a signal which risks undermining its investments and its long-held commitment to technology neutrality. This is to the detriment of California's ability to achieve its ambitious climate goals, as well as the FCEV and hydrogen fueling industries ability to develop a self-sufficient market.

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[3] See "State of the Market" on pp. 2-3 http://business.ca.gov/Portals/0/ZEV/2018-ZEV-Action-Plan-Priorities-Update.pdf
[4] ibid, p. 6
[5] https://ww3.arb.ca.gov/planning/sip/2016sip/2016mobsrc.pdf
[6] https://ww3.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf

2. Although hydrogen transportation is embedded in state policy, additional regulatory and legislative support is required to ensure the FCEV market develops swiftly beyond its currently nascent stage, while maximizing emissions reductions.

While hydrogen fuel cell transportation is a cornerstone of California climate, clean air and clean energy policy, and the state has made progress in implementing these policies, the effort still requires additional sustained support to fully succeed. The rollout of hydrogen FCEVs in California is an early success for the light duty ZEV market, with more than 6,000 vehicles on the road, according to the California Fuel Cell Partnership. This market needs to be nurtured and built upon to become self-sufficient. Further development of the retail and supply chain is also needed. The most urgent task, though, is the required focus on infrastructure build out. Only with further station deployment can the early progress of the FCEV market be turned into long-term success.

To this point, Shell New Energies recently released an assessment that sees cost parity of hydrogen fueling with gasoline in the light duty market at 100,000 vehicles and diesel in the heavy duty market at 10,000 vehicles.[7] Achieving such significant cost savings would allow for hydrogen fueling stations to develop a self-sufficient market with the possibility of profitability.

To get there, several gaps must be closed in legislative and regulatory support, which are slowing progress and threaten to keep California from implementing its hydrogen transportation policies. For example:

- *Incentive funding to support station build out* - Last year, the California legislature did not approve the Governor's budgetary request for $92 million to support hydrogen fueling infrastructure expansion from 100 to 200 by 2025.

- *Pipeline injection standards for hydrogen* - The Public Utilities Commission has yet to develop standards for hydrogen limits on the common carrier gas system, which inhibits low and zero carbon hydrogen production and delivery optimization, although this is being considered for possible review.[8]

  Low electricity costs for clean H2 – Access to low and no cost renewable electricity rates and reasonable T&D and demand charges for electrolytic hydrogen production, as well as attractive rates for hydrogen liquefaction and fueling, also have yet to be established to enable renewable and low carbon hydrogen to become economically competitive, although the CPUC is currently looking at this possibility for the transportation sector.[9]

- *LCFS credit values* are uncertain, feeding uncertainty in the pace of growth in demand for renewable hydrogen.[10]

The CEC needs to include these aspects in its review of ZEV market status, as it is important to review market barriers and how the state may help overcome them.

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[7] https://www.hydrogen.energy.gov/pdfs/htac_dec18_06_munster.pdf
[8] This is currently under discussion in CPUC R.1302008
[9] See Scoping Memo and Ruling for CPUC R1812006.
[10] See Jeffrey Reed, PhD Comments Presentation - Renewable Hydrogen Roadmap Progress Report to Stakeholders, submitted to CEC Docket 17-HYD-O1 on November 15, 2018

A Joint Agency report on AB 8 predicts a shortfall of hydrogen supply to keep up with ZEV fueling demand by 2020, highlighting the urgency of removing regulatory barriers to increased hydrogen production and transfer to fueling stations in California.[11]

3. Market demand factors for ZEV passenger vehicles sector suggest a pluralistic approach that includes FCEVs and BEV-FCEV hybrids will be necessary – rather than a BEV-only future.

CHBC's long held position is that hydrogen fuel cell transportation technology should not be viewed as competitive with battery electric transportation technology, but rather as complementary, and that both ought to be supported in California's ZEV efforts. This is, as outlined above, California policy.

The current vehicle market support for passenger BEV sales in California compared to FCEVs is not guaranteed to be a sustained trend. BEV passenger cars suit many people but also have limitations that become hindrances, as the market moves from early adoption to mass scale. Range anxiety and charging limitations – for example, for those who live in multi-unit dwellings or who have to drive long distances under varying conditions – are significant barriers for a large portion of the population. For such people, FCEVs may be the more practical option, as they can be fueled in a few minutes at hydrogen stations and have longer ranges under any weather and road conditions than BEVs.

Also warranting attention is the promise of combining battery and fuel cell electric technologies, such as the case in the Mercedes-Benz GLC F-Cell model,[12] currently available in Germany, and which is being pursued by companies like Ballard Power Systems in the bus market.[13]

4. Renewable hydrogen transportation can be a key to cost effectively meeting California zero emissions transportation and climate goals.

Research indicates that at mass scale and when holistically considering well-to-wheel costs, renewable hydrogen can additionally ensure ZEV transportation is achieved cost effectively. 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 1, when inexpensive renewable electricity is used as a feedstock.[14]

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[11] http://www.energy.ca.gov/2017publications/CEC-600-2017-002/CEC-600-2017-002.pdf , p. 3
[12] https://www.mbusa.com/mercedes/future/model/model-Mercedes_Benz_GLC_F_Cell#module=future-gallery&submodule=future-gallery-0&gallery=UNIQUE-GALLERY-ID|0|0
[13] https://blog.ballard.com/fuel-cell-electric-powered-bus
[14] The study concluded that "*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*." https://www.californiahydrogen.org/wp-content/uploads/2017/10/Energie_Umwelt_408_NEU.pdf

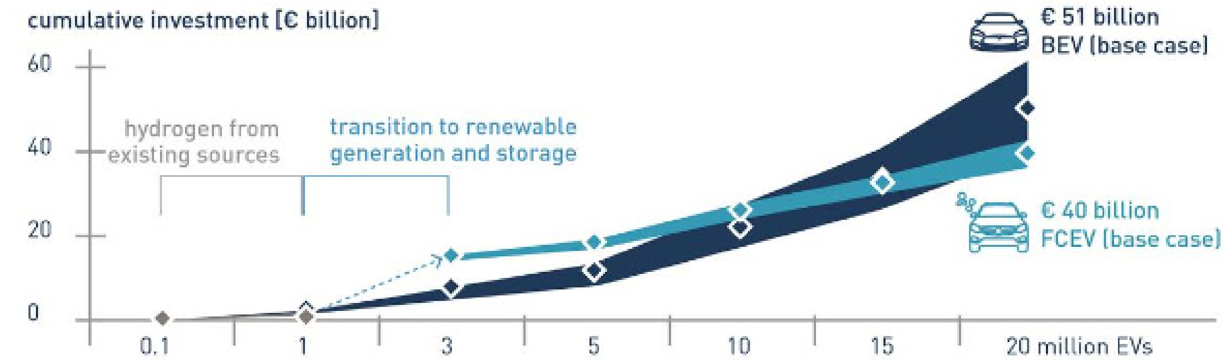

Figure 1 – Comparison of the Cumulative Investment of Supply Infrastructures (BEV & FCEV)

In addition, lifecycle analysis show that hydrogen fuel cell electric vehicles can provide significant GHG emission improvements, even over BEVs, see Figure 2.[15]

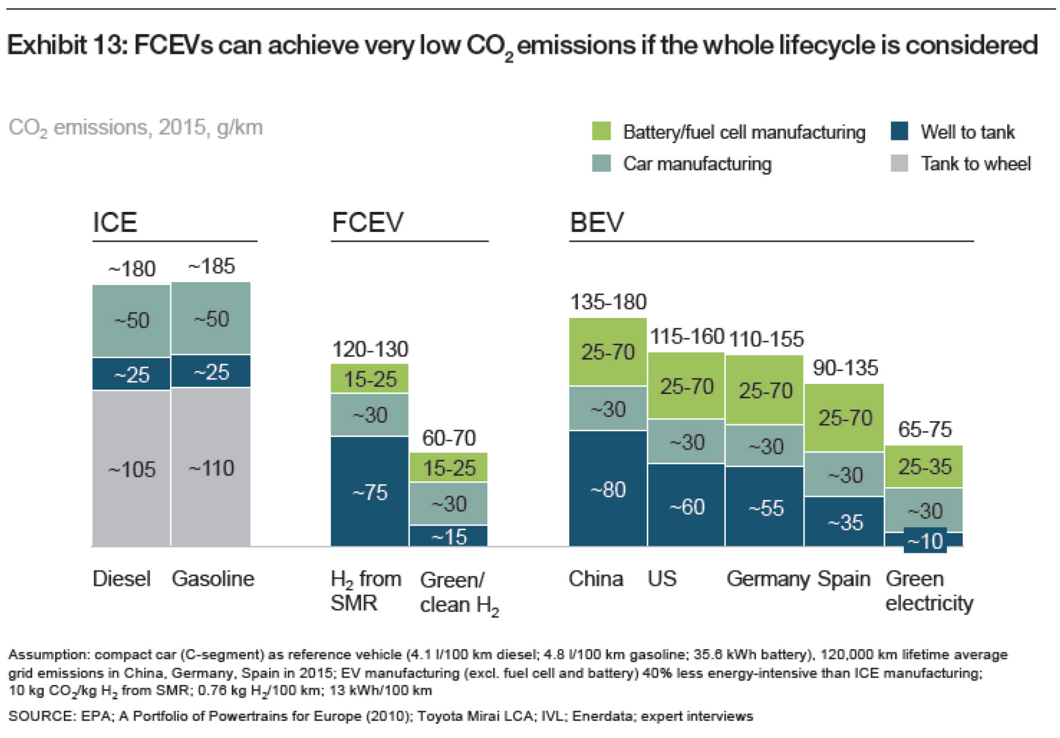

Figure 2 – FCEV, BEV and ICE CO2 Emissions over Entire Lifecycle

[15] http://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-scaling-up-Hydrogen-Council.pdf

4. Hydrogen-based solutions also promise to play critical roles in the transportation sector beyond private mobility, additionally enabling zero emissions mass transit, rail, shipping, and aviation, all of which are essential to addressing climate and clean air challenges.

Hydrogen fuel cells, due to their relatively low weight, long range, and quick fueling, are the most promising zero emission solution to fully replace heavy duty diesel vehicles, including buses, trucks, rail and other transport equipment, without the need to change the behavior or impact operations. Heavy duty diesel engines are among the leading causes of pollution in areas that fail to attain air quality standards and where disadvantaged communities are especially vulnerable to negative health impacts.[16]

Hydrogen fuel cell technology also allows for silent operation, thereby reducing noise pollution in heavy trafficked areas. Fuel cell bus manufacturers include New Flyer, ElDorado National California, BAE Systems, American Fuel Cell Bus, Van Hool. SunLine transit has stated that "**the total cost per mile is comparable to CNG buses we have in service"**.[17] The Innovative Clean Transit rule puts further pressure on transit agencies to go zero-emission, and fuel cell technology is part of the considerations in meeting the mandate.

Goods movement also works well with fuel cell technology. Medium duty fuel cell trucks are used by FedEx and UPS[18], while heavy duty trucks are in being developed and tested by Toyota[19], Kenworth, Nikola Motor, Hyundai[20] and Loop Energy.[21] Germany has additionally introduced hydrogen-powered rail[22], and the UK is planning to do so by 2022.[23]

The shipping industry is also developing hydrogen-powered projects, including the Bay Area Red and White Fleet's fuel cell "Water-Go-Round" ferry[24], and cruise ships for Royal Caribbean Cruise Line and Viking Ocean Cruises.[25]

In aviation, fuel cell planes have been tested since 2015[26] and electrolytic hydrogen based synthetic fuels (power-to-liquids) are being researched internationally as potentially the only high-volume pathway to decarbonized aviation.[27, 28, 29]

We request that the CEC include hydrogen and fuel cell technologies for these applications as part of transportation electrification and ZEV market.

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16 See diesel to FC truck comparison: https://www.youtube.com/watch?v=Od81_2mglRE
17 https://www.sustainable-bus.com/fuel-cell/el-dorado-national-fuel-cell-bus-ballard-completed-successfully-testing/
18 https://spectrum.ieee.org/green-tech/fuel-cells/ups-to-deploy-fuel-cellbattery-hybrids-as-zeroemission-delivery-trucks
19 https://www.electrive.com/2019/04/24/toyota-reveals-an-improved-fuel-cell-truck/
20 https://www.trucks.com/2018/09/21/hyundai-fuel-cell-electric-trucks-switzerland/
21 https://www.globenewswire.com/news-release/2017/08/03/1199568/0/en/Loop-Energy-Fuel-Cell-Range-Extended-Yard-Truck-in-Operation.html
22 https://www.cnbc.com/2018/09/17/worlds-first-hydrogen-powered-train-enters-into-service.html
23 https://www.telegraph.co.uk/cars/news/hydrogen-fuel-cell-trains-run-british-railways-2022/
24 https://www.sfchronicle.com/bayarea/article/Bay-Area-to-build-first-hydrogen-fuel-cell-ferry-13376358.php
25 http://www.cruisington.com/cruise-lines-looking-to-pioneer-fuel-cells-as-green-power-source/
26 https://www.aerospace-technology.com/projects/hy4-aircraft/
27 https://www.icao.int/environmental-protection/GFAAF/Pages/Project.aspx?ProjectID=46
28 https://www.icao.int/Meetings/altfuels17/Documents/20170208_ROTH_V1-0_submitted.pdf
29 https://www.umweltbundesamt.de/sites/default/files/medien/377/publikationen/161005_uba_hintergrund_ptl_barrierrefrei.pdf

5. Fuel cells rely far less on natural resources than lithium-ion batteries, which make them less prone to supply chain disruption issues, adding to reasons for diversifying technology options in the ZEV market.

California must be careful not to become overly dependent on energy choices that are prone to supply constraints and disruption. Overreliance on the limited commodity of oil has sent shockwaves across the industrialized countries since the 1970s, forcing the US to focus on domestic and sustainable energy production ever since. 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.[30] Furthermore, lithium cannot be recycled, and graphite is difficult and costly to recycle.

Fuel cells only require platinum in an amount equivalent to what is currently used in regular catalytic converters of regular combustion vehicles. Furthermore, fuel cells, when reaching their end of life, are recycled, and the platinum is recaptured 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 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."*[31]

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*."[32]

6. Diversification & Resiliency

Hydrogen fuel cell transportation pathways also support resilience of the future zero emissions transportation system by diversifying beyond reliance on the electricity grid that is prone to outages. Recent wildfires caused by the electric grid and region wide failures and shutoffs of the grid to avoid downed power lines that could cause wildfires directly affects Californians and shows the precarious nature of solely relying on the electric grid for our transportation future. If the grid goes down, all charging ceases. Hydrogen by contrast is modular and decentralized, and one hydrogen station going down does not impact other hydrogen stations.

Expanding the renewable hydrogen supply market for transportation can also help open markets to deploy affordable renewable hydrogen for other critical applications, such as storage, ancillary services,

[30] https://www.theguardian.com/environment/2017/jul/29/electric-cars-battery-manufacturing-cobalt-mining
[31] https://fuelcellsworks.com/news/audi-increasing-investment-into-hydrogen-fuel-cells/
[32] https://www.nhm.ac.uk/press-office/press-releases/leading-scientists-set-out-resource-challenge-of-meeting-net-zer.html

and zero carbon electricity generation, which are called for by SB 1369 and will also likely be required to support California's transition to 100% renewable and zero carbon electricity, per SB 100.

7. Auto OEM Perspective and Global Investments

In a 2017 KPMG survey, 78% of Global Automotive Executives absolutely or partly agree that FCEVs will be the real breakthrough for electric mobility.[33] Furthermore, in the 2018 survey, fuel cell electric vehicles replaced battery electric vehicles as this year's #1 key trend until 2025.[34] While infrastructure for FCEVs remains a hurdle, the 6,000+ FCEVs in California alone show that the technology is mature. Pointing to promise that FCEVs can cost competitive at scale, Toyota announced that their goal is to be offer FCEV models in 2025 at the same cost as their hybrid vehicles,[35]with ranges of 400-650 miles per fill.[36]

Most recently, China's "Father of Electric Cars", Wan Gang, minister for science-and-technology minister and vice chairman of China's national advisory body for policy making says he sees hydrogen as the future.[37]

The CHBC believes the CEC should take the thinking of OEM Executives seriously and include this in their review of ZEV market status.

In addition, almost all OEMs are working on a hydrogen fuel cell program, often in collaboration with each other. Toyota, Honda and Hyundai continue to spend billions of dollars in advancing the technology. South Korea[38,39], Japan[40] and China[41] are also spending billions in developing the hydrogen and fuel cell market.

CONCLUSION

We appreciate the Energy Commission's serious consideration of these points. We would be happy to explore them further in detail.

Sincerely,

Emanuel Wagner
Deputy Director
California Hydrogen Business Council

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[33] https://assets.kpmg/content/dam/kpmg/xx/pdf/2017/01/global-automotive-executive-survey-2017.pdf; p. 14
[34] https://automotive-institute.kpmg.de/2018/brain.html#automotive-key-trends
[35] https://www.autocar.co.uk/car-news/industry/hydrogen-cars-cost-same-hybrids-2025-say-toyota
[36] https://www.reuters.com/article/us-toyota-hydrogen/toyota-plans-to-expand-production-shrink-cost-of-hydrogen-fuel-cell-vehicles-idUSKBN1KG0Y0
[37] https://www.bloomberg.com/news/articles/2019-06-12/china-s-father-of-electric-cars-thinks-hydrogen-is-the-future
[38] https://www.greencarcongress.com/2018/06/20180625-korea.html
[39] https://www.gasworld.com/south-korea-unveils-hydrogen-economy-plans/2016332.article
[40] https://www.msn.com/en-us/money/markets/how-toyota-is-helping-japan-with-its-multibillion-dollar-push-to-create-a-hydrogen-fueled-society/ar-BBU6jYU
[41] https://www.bloomberg.com/news/articles/2019-06-27/china-s-hydrogen-vehicle-dream-chased-by-17-billion-of-funding