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Comments of the CHBC on the draft 2017 IEPR

Additional submitted attachment is included below.

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California Hydrogen Business Council Comments on 2017 Draft IEPR Report

The California Hydrogen Business Council (CHBC) appreciates the opportunity to comment on the California Energy Commission's *2017 Draft IEPR Report.* The CHBC is a California industry trade association with a mission to advance the commercialization of hydrogen in transportation and stationary sources to reduce greenhouse gas, criteria pollutant emissions and dependence on oil. Our more than 100 members include fuel cell and electrolyzer companies, auto manufacturers, industrial gas companies, and natural gas companies with an interest in hydrogen and hydrogen infrastructure in California[1].

The CHBC would first like to thank the Commission for their efforts to incorporate many of our membership's concerns and suggestions into the *2017 Draft IEPR Report*. We especially appreciate the inclusion of renewable hydrogen in several key pieces of the report, such as in the definition of renewable gas, the discussion on storage and other strategies for managing excess electricity generation, and in the strategy for lowering transportation greenhouse gas emissions and reaching zero-emission vehicle targets.

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[1] 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 Advanced Emission Control Solutions, Air Liquide Advanced Technologies U.S. LLC., Airthium, 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, Beijing SinoHytec, Black & Veatch, BMW of North America LLC, Boutin Jones, Cambridge LCF Group, Center for Transportation and the Environment (CTE), CNG Cylinders International, Community Environmental Services, CP Industries, DasH2energy, Eco Energy International, LLC, ElDorado National – California, Energy Independence Now (EIN), EPC - Engineering, Procurement & Construction, Ergostech Renewal Energy Solution, EWII Fuel Cells LLC, First Element Fuel Inc, FuelCell Energy, Inc., GenCell, General Motors, Geoffrey Budd G&SB Consulting Ltd, Giner ELX, Gladstein, Neandross & Associates, Greenlight Innovation, GTA, H2B2, H2Safe, LLC, H2SG Energy Pte Ltd, H2Tech Systems, Hitachi Zosen Inova ETOGAS GmbH, HODPros, Horizon Fuel Cells Americas, Inc., Hydrogenics, Hydrogenious Technologies, Hydrogen Law, HydrogenXT, HyET - Hydrogen Efficiency Technologies, Hyundai Motor Company, ITM Power Inc, Ivys Inc., Johnson Matthey Fuel Cells, Kontak, LLC, KORE Infrastructure, LLC, Life Cycle Associates, Linde North America Inc, Longitude 122 West, Inc., Loop Energy, Luxfer/GTM Technologies, LLC, McPhy Energy, Montreux Energy, MPL Consulting, Inc., National Renewable Energy Laboratory (NREL), Natural Gas Fueling Solutions – NGFS, Natural Hydrogen Energy Ltd., Nel Hydrogen, New Flyer of America Inc, Next Hydrogen, Noyes Law Corporation, Nuvera Fuel Cells, Pacific Gas and Electric Company - PG&E, PDC Machines, Planet Hydrogen Inc, Plug Power, Port of Long Beach, PowerHouse Energy, Powertech Labs, Inc., Primidea Building Solutions, Proton OnSite, RG Associates, Rio Hondo College, Rix Industries, Sacramento Municipal Utility District (SMUD), SAFCell Inc, Schatz Energy Research Center (SERC), Sheldon Research and Consulting, Solar Wind Storage LLC, South Coast Air Quality Management District, Southern California Gas Company, Sumitomo Corporation of Americas, Sunline Transit Agency, T2M Global, Tatsuno North America Inc., The Leighty Foundation, TLM Petro Labor Force, Toyota Motor Sales, United Hydrogen Group Inc, US Hybrid, Verde LLC, Volute, Inc., WireTough Cylinders, LLC, Zero Carbon Energy Solutions.

There are also, however, several places in the report that ought to be strengthened for accuracy, consistency, and/or technology neutrality. These are detailed below. Specific wording change requests are indicated in red line.

Four major themes run through most of our proposed changes:

1. **The discussion of renewable gas ought to consistently maintain a technology neutral definition of renewable gas and not repeatedly revert to a narrow focus on bio-based gas**, while excluding other renewable gases like electrolytic hydrogen and its derivatives, especially in Chapter 9.

2. **The discussion of electric transportation ought not repeatedly focus narrowly on plug-in electric vehicles**, while excluding fuel cell electric vehicles, and use current data, especially in Chapter 7.

3. **The discussion of energy storage ought not exclude hydrogen energy storage and power to gas**, especially in Chapter 4.

4. **The discussion of the economics of power to gas, especially in Chapters 3 and 9, ought to take into account projections by the CHBC, US Department of Energy and others, that electrolytic hydrogen and methane formed from it could be cost-competitive with conventional fuels by 2030 with**

    - ***access to favorable electricity rates for electrolyzers*** that should be doable in California with utility scale solar falling to <3 cents per kWh and excess renewable electricity causing negative pricing,

    - ***expansion of the technology in global markets*** that is already underway

    - ***increased intermittent renewable electricity generation*,** which will create more excess electricity for electrolyzers to absorb and make power-to-hydrogen more economically competitive.

    - ***support for research and development*** which has already brought fuel cell costs down 80% with projections of further decreases,

    - ***with favorable policies and market mechanisms that support the technology*** in ways that even the playing field by extending equivalent support to that given to bio-based renewable gas, plug-in electric transportation, and other forms of energy storage like batteries, all of which the CHBC also supports, and none of which would have the market opportunities they do today without state support.

Table of Contents

I. Comments on Executive Summary

A. Correcting instances in the Executive Summary where hydrogen fuel cell electric vehicle technology is represented inaccurately or given inequitable treatment to plug-in electric vehicle technology.

The following are three instances in which the Executive Summary is inaccurate or inappropriately excludes hydrogen fuel cell electric technology from coverage of zero emissions vehicles, along with proposed corrections. We urge the Commission to also update corresponding sections of the main body of the report to reflect these changes, which will bring the report more in line with California's long time technology neutral zero emissions vehicle policies.

1. Page 3 (Executive Summary, Section: Trends in Greenhouse Gas Emissions in the Transportation and Electricity Sectors):

Starting in 2018, at least one automaker will offer a hydrogen fuel cell electric vehicle that can also be charged via plug-in. In order to not potentially exclude vehicles like this, we propose a change to the following sentence as follows:[2]

"Because of these high emissions, a major push in California's energy policy is to shift from gasoline to zero-emission and near-zero emission vehicles (ZEVs) that run on electricity provided by batteries or hydrogen fuel cells (~~both~~ hydrogen fuel cell ~~fuel-cell~~ electric, ~~and~~ plug-in electric, or a hybrid between the two)."

2. Page 6 (Executive Summary, Section: Advance Transportation Electrification)

Note that in addition to smart charging, an important option raised in the report -hydrogen production via electrolysis- can also help address grid issues, such as overgeneration of renewables, while producing a zero-emission transportation fuel that can help reduce electricity demand from plug-in charging. Especially in a highly electrified transportation future, ZEV alternatives like hydrogen fuel cell electric vehicles can reduce the potential strain on the grid from unmanaged, simultaneous charging of large numbers of BEVs. We therefore recommend adjusting the draft report language below as follows to reflect such an approach:

"Planning for the growth in plug-in electric vehicles is important. "Smart charging" (charging with internal controls that adjust to customer and grid needs) offers opportunities to make the grid more resilient to variations in renewable generation and help reduce greenhouse gas emissions, provided that pricing and charging infrastructure is in place to encourage charging at midday. "Smart fuel production" (producing electrofuels like hydrogen from excess grid electricity) for fuel cell electric vehicles also has a role to play in grid management and renewable integration offers to reduce grid strain by reducing future electric demand from electric vehicle charging by producing hydrogen for fuel cell electric light, medium and heavy duty vehicles. Access to preferred electric rates will need to be in place to capture these societal and grid benefits and provide an economic case. Continued strategic investments are needed to ensure low-income customers, especially

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[2] https://media.mbusa.com/releases/release-80848dccd3f3680a764667ad5318497e-glc-f-cell-goes-into-preproduction-worlds-first-electric-vehicle-with-fuel-cellbattery-powertrain

those living near heavily used freeways, also have access to the use of plug-in and fuel cell electric buses and vehicles and related economic and environmental benefits."

3. Page 9 (Executive Summary, Section: Zero-Greenhouse Gas Emission Solutions)

In bullet four on this page, the report narrowly defines storage to include storing electricity or heat at one time of day to be fed back into the grid at another time of day, which excludes valuable storage options. For example, ice storage does not provide the electricity taken from the grid and return it, but rather makes ice during times of excess electricity generation to help with cooling at a later time, while still serving valuable grid management functions. Similarly, hydrogen produced from excess electricity can be stored for later use, either by returning energy to the grid as electricity, or by being used for other zero emission, greenhouse gas free energy applications, such as for transportation fuel, equipment fuel or renewable gases for industrial uses like oil refining. Below is a proposed amended version of this bullet point that would capture this concept:

- Energy storage in the electric power sector to capture electricity or heat for use at a later time as either electricity or other products to help manage fluctuations in supply and demand.

B. Ensuring Definition of Renewable Gas is Consistently Not Exclusive to Bio-Based Gas in Executive Summary, Section: Exploring Renewable Gas as a Tool for Reducing Methane Emissions

To ensure accuracy and that the Executive Summary reflects the main body of the report, as well as the spirit of SB1383, both of which seek to include broad range of renewable gases beyond those that are bio-based, the second sentence on page 11 ought to read:

"SB 1383 also requires the Energy Commission, in consultation with CARB and the CPUC, to 'develop recommendations for the development and use of renewable gas, including biomethane and biogas as part of its 2017 Integrated Energy Policy Report.' Renewable gas has been used, or proposed for use, as a substitute for conventional natural gas in a variety of applications and ~~can be used to make hydrogen~~ consists of a broad range of gases in addition to biomethane and biogas, including but not necessarily limited to hydrogen made from biomethane, biogas, electrolysis powered by renewable electricity, or pyrolysis, and synthetic methane made from renewable hydrogen."

II. Comments on Chapter 1: Primary Policy Drivers, Section on Transportation Sector Policy Drivers

We thought that perhaps the Volkswagen Settlement – Electrify America bears mention in this section, or elsewhere in the report, since it represents a large pool of investment into ZEV infrastructure that is being approved by state authorities.[3] We also call attention to the state's advocacy for hydrogen to be better represented in the funding plan, which we fully support and hope will be reflected in future rounds.

[3] https://www.arb.ca.gov/msprog/vw_info/vsi/vw-zevinvest/vw-zevinvest.htm

III. Comments on Chapter 2: Implementing the Clean Energy and Pollution Reduction Act, Senate Bill 350

A. Recommended addition for equal opportunity of medium & heavy-duty hydrogen transportation electrification

On Page 46 (Section: Encouraging Widespread Transportation Electrification) the report states:
"Representatives from CalSTART, the Port of Los Angeles, and the California Transportation Commission agreed about the need to plan immediately for the interconnection of heavy vehicle energy and demand to avoid unnecessary grid upgrades or impinging upon the economic or timely operations of freight and goods movement companies. In particular, these parties juxtaposed the grid impacts of electrifying the light-duty sector against the volume of heavy-duty vehicles needed to attain air quality standards and the magnitudes more demand expected from heavy vehicle fleets and goods equipment."

The CHBC would like to expand that statement by encouraging the CEC to work with the ARB to start the planning of medium and heavy duty hydrogen fueling stations in California. An example could be the development of a tool similar to the California Hydrogen Infrastructure Tool (CHiT) to assess the best placement for medium and heavy duty hydrogen fueling station based on freight corridors and non-attainment zones in support of the anticipated roll-out of heavy-duty hydrogen fuel cell electric trucks. Strategically located high-volume, high throughput stations would allow for a much needed zero-emission freight alternative with long distance capability and 5-10 minute refueling.

B. Recommended addition to account for GHG emissions from transportation electrification

Under bullet 3 on page 81, "Align with established emissions assessment methods", it is recommended to include in that metric a quantification of the GHG emission profile of electricity during the day (e.g. at a 15 minute interval), to better determine the actual GHG emission reduction potential at different charging cycles during the day.

C. Recommended addition of hydrogen and fuel cell outreach and education groups

Insufficient hydrogen and fuel cell education is a considerable hindrance to broader adoption of the technology. Education on electric vehicles is mentioned several times in this chapter, e.g. page 45 ("increase educational efforts"), p. 47 ("Customer education and outreach efforts"), p. 48 ("expanded customer education and outreach"), p. 51 ("Furthering Customer Education - One critical hurdle to rapidly increasing uptake of zero emission vehicles is that most of the public does not realize that these vehicles are here and available for purchase. Programs to continue consumer education about electric cars and available options to refuel these cars are essential to driving rapid adoption […]").

On page 82, under bullet 2, "Support the Development of specialized consumer education and engagement tools", the Report mentions *Veloz* as an outreach group dedicated "to enhance the public understanding of the adequacy of electric vehicles for their transportation needs, […]". However, Veloz does not see hydrogen fuel cell education as a necessary need at this time, as is displayed in the Q&A to their "Request for Proposal for Phase 1: Expanding Electric Car Awareness in California"[4], specifically answering the question by a potential applicant which was:

"With so many types of EVs (plug-in hybrids, pure battery electrics, fuel cell, hydrogen, etc.), is there a specific type of technology you believe this work should focus on? Or will you look to agency recommendations to guide this approach?" with this reply: *"We are looking to focus on battery-electric and plug-in hybrid electric cars. We do see fuel cells as another technology coming soon but* ***this technology should not be the focus of the campaign at this time****. Ideally, the campaign would allow for fuel cells to be rolled into the campaign when the time is right"* (emphasis added).

Neither is defined when "the time is right" for fuel cell education, nor does this delay in education help build public awareness for a technology that is already being adopted in California. We therefore recommend the addition of the California Fuel Cell Partnership as a second example of the organizations dedicated to educating the public on electric vehicle technologies, as they are already conducting work in this field. The CHBC also recommends that when using public funds, organizations like Veloz should be required to provide education on all available electric vehicle technologies to not distort public perception in their education efforts.

IV. Recommended Corrections for Accuracy to Chapter 3

A. Section: Opportunities to Use Excess Energy, Subsection on Hydrogen Production from Electrolysis of Water

We applaud the Commission for including this section in the report on hydrogen produced by electrolysis. The following wording revisions are recommended for accuracy.

1. Page 115

a) Wording corrections for accuracy

The use of the word "reformed" on this page is commonly used in conventional hydrogen production via steam methane reforming; however, this is not so when hydrogen is produced via electrolysis. Also, either renewable hydrogen produced by electrolysis or renewable methane made from this hydrogen can be directly injected into the natural gas pipeline, albeit the former in smaller percentages. Additionally, power-to-gas has multiple applications other than storage, including decarbonized transportation fuel, electricity generation, gas end uses, industrial use, or auxiliary grid services.

To ensure correct wording to reflect the facts specified above, we propose the following paragraph in this section be adjusted as follows:

"Alternatively, the hydrogen produced from excess renewable electricity can be ~~reformed~~ ~~into methane~~ combined with waste or captured carbon dioxide to create renewable methane for the direct displacement of

[4] http://www.veloz.org/wp-content/uploads/2017/09/170929_rfp_QA.pdf

fossil fuel natural gas, and this renewable hydrogen or methane can also be directly injected into natural gas pipelines. This strategy of transferring electrical energy into gaseous chemical energy for energy storage or other useful purposes is termed power-to-gas."

b) *Inaccuracy in description of UC Irvine finding*

The report reads: *"At UC Irvine, the portion of renewable energy used in the campus microgrid increased from 3.5 percent to 35 percent by implementing a power-to-gas strategy."*

Modeling showed that this *could* happen. The Press Release on this project specifically uses the term "could increase", as well.[5] Therefore, to be accurate, the word "increased" in this sentence ought to be changed to "could increase."

c) *IEPR uses draft and incomplete E3 Study findings*

The E3 results cited on p. 115-116 are based on a **draft report** by the firm. Their analysis has not yet considered recent data on power to gas, and these results and conclusions are therefore premature and inappropriate to include in the IEPR Report at this time. CHBC members will seek to supply E3 with the latest relevant data on power to gas, and we ask that the Commission wait to consider or include in any reports the E3 conclusions about power to gas until E3 has the opportunity to consider the latest data in their final analysis and report. Furthermore, the $/ton metric referenced in this section includes a blended cost of hydrogen and synthetic methane and is therefore misleading in this section, which specifically discusses hydrogen**.**

2. Page 116: Correction to use cases for power-to-gas and power-to-hydrogen

"Commenters suggested that power-to-gas and power-to-hydrogen could provide various grid services, such as voltage and frequency regulation, demand response, ramping services, and avoiding curtailment or negative pricing of renewables. "

This is true, although they do not encompass all the use cases for these technologies, which were included in CHBC's comments.[6] To correctly describe these technologies' applications, we request that the following sentence be added:

"They also could decarbonize electricity generation, natural gas end uses, hydrogen production for refineries and other industries, as well as provide a zero-emissions transportation fuel that is greenhouse gas free over its lifecycle."

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[5] https://www.prnewswire.com/news-releases/socalgas-and-university-of-california-irvine-demonstrate-power-to-gas-technology-can-dramatically-increase-the-use-of-renewable-energy-300432101.html

[6] See CHBC comments submitted following the June 27 Joint Agency Workshop on Renewable Gas, *RE: Comments by the California Hydrogen Business Council to Panel 5: Emerging Technologies and Market Opportunities (http://docketpublic.energy.ca.gov/PublicDocuments/17-IEPR-10/TN220238_20170717T105400_Emanuel_Wagner_Comments_Comments_by_the_California_Hydrogen_Bus.pdf)*, and CHBC's addendum to these comments, *CHBC Comments: Market Development Opportunities and Pathways for Renewable Hydrogen in California (http://docketpublic.energy.ca.gov/PublicDocuments/17-IEPR-10/TN220613_20170808T162152_Emanuel_Wagner_Comments_CHBC_Comments_Market_Development_Opport.pdf)*

B. Adjustments to ARFVTP proposal for funding renewable hydrogen production to ensure funding parameters are meaningful for electrolytic hydrogen and other emerging renewable gas technologies

1. Funding amount proposed ought to be increased 10-fold

The CHBC is wholly supportive and appreciative of the Commission's proposal discussed on p. 116 to release a competitive solicitation to fund the production of renewable hydrogen. The $2 million amount recommended in the draft IEPR, however, must be increased 10-fold to make meaningful progress toward reaching state goals of promoting instate production and supporting a broad renewable gas market and encourage strong in-state hydrogen production. Like any emerging clean energy technology market, power-to-hydrogen needs significant support to reach economies of scale. $2 million would only cover one project and give an unfair advantage to bio-based gas technologies, which unlike power-to-hydrogen, have benefitted from years and millions of dollars of state support. Considering the billions of dollars of state funds that have gone into supporting the scale up – and hence cost reduction - of other critical clean energy technologies like solar,[7] considering that CARB is projecting a significant shortfall of hydrogen in the transportation sector alone in the next few years,[8] and considering the importance to California's climate goals of eliminating greenhouse gas emissions from hydrogen production, raising the $2 million sum to $20 million is appropriate.

2. Solicitation structure needs to ensure an even playing field

We also request that the final *2017 IEPR Report* specify that the solicitation for renewable hydrogen will structure the awarding of points in such a way that does not force power-to-hydrogen and other emerging technologies that have not yet benefited from state funding to compete on an uneven playing field with bio-based renewable gas technologies, which have been and continue to be the beneficiary of millions of dollars in state support. While CHBC fully agrees with continued state support of bio-based fuel development, it would not be fair or in line with a technology agnostic approach to structure a funding solicitation that ignores the disparity in public funding history between that industry and emerging renewable gas industries like hydrogen made via electrolysis. Energy analysts project that, as with any useful new energy technology, there will be significant cost drops in power-to-hydrogen in the coming years, some of which will happen due to global industry maturity, and some of which will need appropriate market structures and initial public funding to launch the market. Similar to how research and development support slashed projected fuel cell costs 80% between 2002 and 2014, research and development funding is also estimated to greatly reduce electrolyzer capital costs. This capital cost reduction, coupled with low or negative pricing of renewable "duck-belly" electricity for hydrogen production, could drop from twice as expensive as conventional hydrogen production to significantly cheaper.[9]

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[7] For example, the California Solar Initiative, which dedicated $2.167 billion to small scale solar electricity generation development. http://www.gosolarcalifornia.ca.gov/about/csi.php

[8] http://www.energy.ca.gov/2017publications/CEC-600-2017-002/CEC-600-2017-002.pdf

[9] Source: H2@Scale https://energy.gov/sites/prod/files/2017/06/f34/fcto_may_2017_h2_scale_wkshp_ruth.pdf

C. Adjustments to Chapter 3 Recommendations Section to ensure accuracy, technology neutrality and policy effectiveness

1. Correction to bullet that starts with "Use excess renewable electricity productively"

On page 121, the report includes among its recommendation various approaches to "use excess renewable electricity productively." While we agree with these broadly, the meaning of "mobile fuel cells" in this bullet point is unclear, as is the meaning of "storage power." There is also an incomplete description of what hydrogen can provide, as hydrogen is capable of storing energy for power, as well as for transportation, natural gas end uses, or industrial purposes. Assuming what is meant by "mobile fuel cells" is fuel cells for vehicles; we recommend that the wording in the last sentence be changed to:

"California should continue to explore means to exploit this excess electricity by desalination and/or conversion to hydrogen either to fuel stationary ~~or mobile fuel cells or storage power~~ fuel cells, fuel cells for vehicles, power plants, industrial processes or energy storage."

V. Comments on Chapter 4 – Accelerating the Use of Distributed Energy Resources on the California Grid

A. Addition of Hydrogen Energy Storage and Power-to-Gas to Figure 22: Energy Storage Technologies by Discharge Time, Size and Use

The chart on p. 129 leaves out hydrogen energy storage and power to gas. CHBC is concerned that despite repeatedly communicating about these technology options, and despite other sections of the Draft IEPR Report acknowledging that they are storage options, the CEC is still using storage data and figures that exclude these technology options.[10] We request that in lieu of this chart, the Commission use one such as that in our White Paper on Power-to-Gas[11], or a similar one issued by ITM Power.[12] Exclusion of these technologies in these graphs would promote incomplete information, especially at a time when large scale projects like the Nel Hydrogen 100 MW Power-to-Gas project[13] in Europe are starting to be deployed commercially.[14,15]

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[10] For example, see CHBC comments on the June 27 Joint Agency Workshop on Power to Gas and our submission on the Economics of Power to Gas, in which we explicitly described how power to gas (hydrogen or methane) is the only storage technology capable of terawatt scale storage. The Draft IEPR Report acknowledges that power to gas is capable of large scale storage in Chapter 3

[11] See p. 10 : https://californiahydrogen.org/sites/default/files/CHBC%20Hydrogen%20Energy%20Storage%20White%20Paper%20FINAL.pdf

[12] See p. 10: https://www.slideshare.net/beckymarkillie/company-update-february-2017

[13] http://news.cision.com/nel-asa/r/nel-asa--enters-into-exclusive-nok-450-million-industrial-scale-power-to-gas-framework-agreement-wit,c2286835

[14] http://docketpublic.energy.ca.gov/PublicDocuments/17-IEPR-07/TN217733_20170525T152821_Emanuel_Wagner_Comments_California_Hydrogen_Business_Council_Co.pdf

[15] https://www.bloomberg.com/news/articles/2017-09-05/better-than-a-battery-big-energy-backs-hydrogen-power-storage

B. Addition of Cost Reduction with Hydrogen Fuel Cells, Electrolyzers

This section addresses the considerable cost reductions for batteries in 2014 by 74% to 2008. The CHBC would like to add that similar cost reductions have been seen with PEM fuel cells and electrolyzers. According to the Office of Energy Efficiency & Renewable Energy at the Department of Energy, high volume automotive fuel cell costs were reduced by 60% since 2006; the cost of electrolyzers has dropped by 80% since 2002.[16] Furthermore, the amount of platinum needed has been reduced for fuel cells in some upcoming vehicle models to the amount similar to ordinary catalytic converters, addressing one of the key drivers of cost for fuel cells.[17]

VI. Comments on Chapter 7 – Transportation Energy

A. Outdated assumptions for fuel cost per Mile Trends for Light-Duty Vehicles (Midsize Cars)

Figure 53 on page 211 projects an average cost for hydrogen at about $0.21/mile for 2017, with costs per mile not nearing $0.15 for another 10+ years. Notably these projections are cited as having been made in 2015, but progress in the industry since then that warrants a fresh look at these projections. The recently showcased car from Toyota reportedly[18] has an approximate 550 mile range[19] with a 6 kg tank (92 miles/kg), allowing for a cost per mile between $.11/mile to $.18/mile with current cost ranges of hydrogen.[20] The underlying data used for the projections in this graph should be reviewed to account for these recent announcements. Adjustments need to be made to showcase the considerable cost reductions for cost per mile of hydrogen past 2020, accounting for gains in vehicle efficiency as well as cost reductions for hydrogen upon further commercialization of hydrogen production and fueling stations buildout.

B. Vehicle Attributes Section ought to be revised to address FCEV improvements

On page 213, the report reads, “Energy Commission staff specifically revisited and revised assumptions relating to BEV and PHEV prices and electric driving range”. In addition, the section “Electrifying Light-Duty Vehicles” projects BEV ranges and BEV pricing, but makes no similar projections to FCEV pricing and range. However, in October 2017, Toyota made two significant announcements that should be considered by CEC staff in this regard, and be either added as a new chart or incorporated in the existing ones. First, Toyota announced that they would be able to price their FCEVs in 2025 similar to hybrids.[21] Second, as mentioned above, the manufacturer expects considerable improvements to the efficiency of their next generation fuel cell stack, effectively increasing range and decreasing cost of fueling. In combination, this will allow FCEVs to play a significant role in the electrification transportation efforts and this should be recognized in the report in a similar fashion to the projections made for BEVs and PHEVs.

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[16] https://energy.gov/sites/prod/files/2017/10/f37/fcto-progress-fact-sheet-august-2017.pdf

[17] http://www.miningweekly.com/article/daimler-slashes-platinum-needed-by-new-fuel-cell-mercedes-car-2017-07-12

[18] https://www.autocar.co.uk/car-news/motor-shows-tokyo-motor-show/toyotas-s-class-rival-showcases-next-gen-hydrogen-technology

[19] The report cites a 620 mile range under Japanese test cycles. According to the manufacturer, this roughly equals to approximately 550 miles with the LA#4 test cycle.

[20] Current cost of hydrogen at the station ranges between $10 and $17 per kg. With a fuel efficiency of 92 miles/kg, that amounts to $.11/mile to $.18/mile.

[21] https://www.autocar.co.uk/car-news/industry/hydrogen-cars-cost-same-hybrids-2025-say-toyota

C. Figure 54 on Fuel Cost per Mile Trends for Medium-Duty (Class 4–6) Trucks should include hydrogen

The CEC should work with medium duty fuel cell truck manufacturers to develop trends for fuel cost for hydrogen FCEVs. Kenworth, FedEx, UPS and other companies are using fuel cells in their medium duty truck operations and should be able to provide initial data to plot cost curves for hydrogen.

D. Additional data on renewable hydrogen

On page 216, the report states:

"The hydrogen used to fuel FCEVs comes primarily from the reformation of methane or biomethane, as discussed in Chapter 9. However, hydrogen can also be produced from excess renewable electricity entering the grid (via electrolysis, discussed in Chapter 3)."

Based on the ARB's AB8 report, the amount of renewable hydrogen used in California for hydrogen FCEV fueling in 2016 was 43% and for 2017 is 44%[22], which should be included, as it underscores the fact that hydrogen is one of the cleanest transportation fuels currently available in the State.

"The hydrogen used to fuel FCEVs comes primarily from the reformation of methane or biomethane, as discussed in Chapter 9. However, hydrogen can also be produced from excess renewable electricity entering the grid (via electrolysis, discussed in Chapter 3). In 2016, the share of renewable hydrogen amounted to 43% of dispensed fuel for FCEVs, and is projected to reach 44% in 2017."

E. Lack of hydrogen data in Figure 63

On page 222, Figure 63 projects new truck sales, but excludes hydrogen fuel cell trucks entirely. Considering the announcements made by Toyota, Loop Energy, Kenworth, Nikola Motors, UPS and US Hybrid on their demonstration and commercialization plans for medium and heavy duty trucks, the CEC ought to consider hydrogen as likely comprising a share of new truck sales by 2029. More data on this subject is available from the California Fuel Cell Partnership in their *2016 Medium- & Heavy-Duty Fuel Cell Electric Truck Action Plan For California*.[23]

VII. Comments on Chapter 9 – Renewable Gas

We applaud the Commission for including references to renewable hydrogen and electrolytic gases in this chapter, however, this chapter is also repeatedly inconsistent and confusing in its definition of renewable gas and focuses too narrowly on bio-based gases. Clearer language and more important information about other renewable gases, including power-to-hydrogen, is needed to ensure accuracy and technological neutrality. The following are point-by-point recommendations to address this issue.

[22] https://www.arb.ca.gov/msprog/zevprog/ab8/ab8_report_2017.pdf and personal communication with ARB staff.
[23] https://cafcp.org/sites/default/files/MDHD-action-plan-2016.pdf

A. The section on *In-State Renewable Gas Resource Potential* has a confusing and potentially misleading definition of "renewable gas."

The definition of "renewable gas" p. 254 should be modified as follows:

"Renewable gas includes, but is not limited to, biogas, biomethane ~~(also known as renewable natural gas or renewable gas)~~, synthetic natural gas generated from a renewable resource, such as organic material or renewable electricity, renewable hydrogen made from organic material, renewable electricity, or direct solar energy, and gaseous products composed of the aforementioned. ~~such as renewable dimethyl ether.~~"

The definition of renewable gas as originally written in the draft report is confusing because it at once attempts to include a broad group of gases and parenthetically equates renewable gas with biomethane. While "renewable gas" and "renewable natural gas" have commonly been used by industry interchangeably with biogas and biomethane, this is misleading and inappropriate for the purposes of state policy because renewable gas does in fact, and as intended by the author of SB 1383, encompass a broader group of gases than just those that are bio-based. We strongly urge the Commission to use the more specific language as proposed above for the definition of renewable gas, in order to ensure accuracy, clarity, and technology neutrality and to make all mentions of "renewable gas" throughout the report consistent with this definition.

The definition as written in the draft is also potentially confusing with the addition of renewable dimethyl ether, which is more commonly a liquid. There are other renewable gases that carry this trait that go unmentioned, for example, ammonia produced from electrolytic hydrogen. We are not discounting the value of such products – in fact, they can make an important contribution to reducing greenhouse gases and moving away from fossil fuels – but we are concerned that the inclusion of renewable dimethyl ether could be confusing.

Also, this very case underscores that including all renewable gases in the definition is likely beyond the scope of this policy document, but at the same time, the Commission ought not to inadvertently exclude, or be misinterpreted as excluding, some either. This is why we suggest adding the "but is not limited to" clause. We also encourage the Commission to undertake continuous deeper analysis of what renewable gases are available, as technologies and markets evolve, with a view toward ensuring a broad spectrum approach.

B. The section on *In-State Renewable Gas Technical Potential* focuses almost entirely on bioenergy-based gases and ought to include more data on others, including electrolytic hydrogen. Corrections are proposed below.

The subsection on *In-State Renewable Gas Technical Potential* correctly opens on p. 260 with acknowledgement that there "are many technology pathways that can produce renewable gas, including anaerobic digestion, gasification, pyrolysis, and electrolysis". Following that, the section equates renewable natural gas with renewable gas, which is incorrect as per the definition under SB1383, especially as the rest of the section lacks any data about renewable gases other than bioenergy. We request that the following data on electrolytic renewable gas be included in this section:

- Total annual hydrogen production capacity in California is more than 1.8 million metric tons.[24]
- California is the second largest user of hydrogen in the United States, behind only Texas.[25]
- Researchers are forecasting major growth of power-to-gas between 2017 and 2026, with annual installed capacity of power-to-gas in North America reaching more than 1700 megawatts during that period, and production of hydrogen via electrolysis reaching more than 450,000 metric tons. North America is the leading continent in the world for projected power-to-gas capacity and projected hydrogen production using electrolysis.[26]
- Renewable hydrogen can replace conventional hydrogen production and help decarbonize refineries, which emit 31% of greenhouse gases from California's industrial sector.[27] For large emitters that use hydrogen, like refineries and fertilizer producers, options are limited for meeting greenhouse gas reduction requirements. Renewable hydrogen provides an important, greenhouse gas-free, drop-in alternative.[28]
- Because of the geographic flexibility and scalability of both electrolysis and renewable power generation, and because it is not dependent on a limited feedstock, power-to-hydrogen is able to produce the largest volumes of hydrogen of all renewable hydrogen technologies.
- As the report acknowledges, over-generation of renewable electricity and the challenge of flattening the duck belly is both an increasing problem in California, as well as an opportunity. The technical potential for power-to-hydrogen is correlated to the increasing amount of surplus electricity, which is only expected to grow over the coming years. Power-to-hydrogen and power-to-gas facilities, as previously explained in the report, provide a solution by using otherwise curtailed renewable generation to power electrolysis to produce hydrogen, with the unique capability of absorbing surplus generation continually and storing the energy at the terawatt-hour scale, or producing hydrogen for a range of applications, from transportation fuel, to fuel for electricity generation, to natural gas end uses for buildings and industrial processes.

C. The section on *In-State Renewable Gas Economic Potential* focuses exclusively on biomethane and ought to include more data on other gases, including electrolytic renewable hydrogen.

By solely covering biomethane production, this section belies its title and is inconsistent with the correctly broader definition of renewable gas found at the top of this chapter. It also ignores important information about renewable hydrogen that merits being part of California's policy discourse. To help correct this, **we recommend adding to this section the data below**.

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[24] Based on IHS Chemical Economics Handbook statistic that California's daily hydrogen production is 5.1 million kg (5.1 million kg to metric tons is 5100 x 365 = 1,861,500). As referenced in *CHBC Comments: Market Development Opportunities and Pathways for Renewable Hydrogen in California.*

[25] Source: Brian Pivovar, NREL, As referenced in CHBC Comments: Market Development Opportunities and Pathways for Renewable Hydrogen in California.

[26] Source: Navigant Research

[27] Source: CARB https://www.arb.ca.gov/cc/inventory/pubs/reports/2000_2014/ghg_inventory_trends_00-14_20160617.pdf

[28] See CHBC Comments: Market Development Opportunities and Pathways for Renewable Hydrogen in California

1. Economic potential of electrolytic hydrogen for vehicle fuel:

- CHBC analysis projects that based on expected progress on technology cost, along with electricity prices ranging from zero (excess generation) to $.06 per kWh, electrolytic hydrogen and methane can be can be produced at costs comparable to conventional vehicle fuel, and this is without consideration of any renewable fuel premium.[29]
- Reaffirming this finding, the cost of electrolytic hydrogen for vehicle fuel on the worldwide market is currently projected by other energy analysts to reach cost parity to 2017 gasoline prices by 2025, after which it is projected to become the cheaper option.[30] Given that California is a global frontrunner in intermittent renewable power development, given that utility scale solar power is already falling to less than $.03 per kilowatt-hour,[31] and given that Europe's bullish policies on power to gas, as well as developments in other regions, are spurring technology development,[32] these projections indicate that electrolytic hydrogen and gasoline could reach cost parity in California by 2025.

2. Economic potential of power-to-hydrogen and power-to-gas for energy storage:

Electrolytic hydrogen and methane produced using renewable electricity compare favorably to lithium ion batteries, pumped hydro, and compressed air energy storage (CAES), particularly at continuous capacity – which is foreseen as the state seeks to integrate larger shares of renewable generation. CHBC's submission to the IEPR docket on the *Economics of Power-to-Gas* contains a detailed comparative cost analysis of power-to-gas and lithium ion batteries, as well as comparisons of power-to-gas to pumped hydro and CAES. Key points of this economic analysis include:

- Power-to-Gas-to-Power (P2G2P), that is power-to-gas-systems used to return energy in the form of electricity generation via a power plant, could reach cost parity with a battery system with a storage duration of less than 5 hours. For storage duration of greater than about 50 hours, P2G2P is forecast to provide storage less expensively than batteries even when comparing current P2G2P costs to forecast future costs for batteries.
- Initial results from UC Irvine modeling, using a capacity factor of 50%, or 12 hours of charging time per day, suggest a levelized cost of storage (LCOS) for batteries of 10-22 ¢/kWh compared to P2G of 11-40 ¢/kWh, depending upon the technologies and pathways considered. Under future systems cost and efficiency forecasts, the model suggests an LCOS of batteries of 5-15 ¢/kWh compared to P2G of 8-21 ¢/kWh. In other words, P2G can be cost competitive with batteries and promises to serve an important role fulfilling the need for energy storage in California.
- Recently a study conducted by McKinsey & Company found that converting renewable power into hydrogen via electrolysis followed by salt cavern hydrogen storage and use of combined cycle power

[29] Source: CHBC White Paper on Power-to-Gas: The Case for Hydrogen

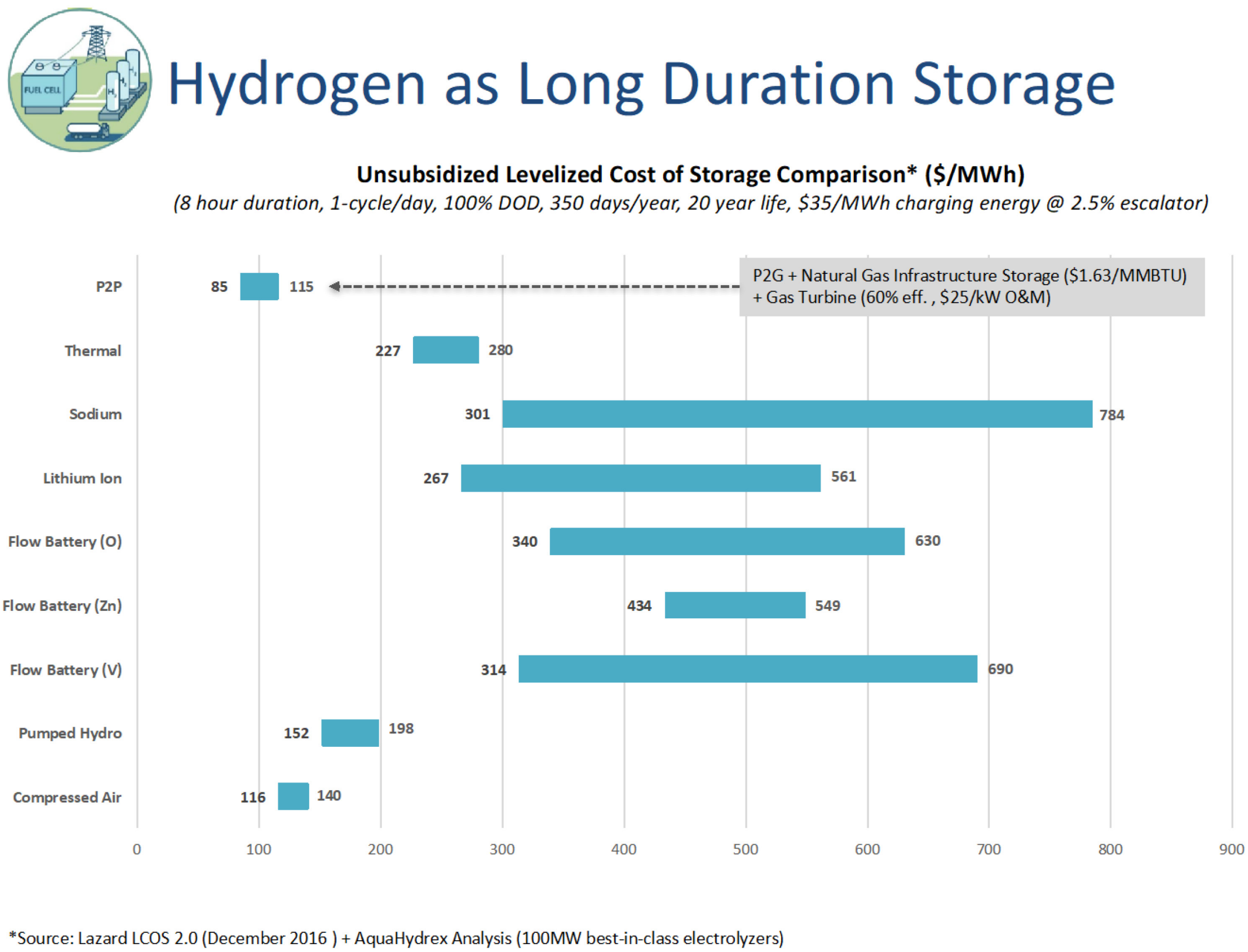
[30] Source: Navigant Research, International Energy Agency, International Monetary Fund, US Department of Energy

[31] https://www.pv-magazine.com/2017/05/25/tep-to-buy-solar-power-at-under-3-cents-per-kwh/

[32] See CHBC's *Economics of Power-to-Gas* and June 27 Workshop submissions to the IEPR docket for examples of strong support in European countries for power to gas development. See http://docketpublic.energy.ca.gov/PublicDocuments/17-IEPR-10/TN219923_20170626T180524_Emanuel_Wagner_Comments_Economics_of_Power_to_Gas.pdf

plant conversion back to electricity (i.e. P2G2P) was cheaper than pumped hydro storage. The findings showed that with a round trip efficiency of 40% and capital costs of $1000/kW, this approach has a lower levelized cost of electricity than pumped hydro storage, the current lowest cost energy storage solution.[33]

- NREL states: "Initial cost analysis indicates that hydrogen systems could be competitive with battery systems for energy storage and could be a viable alternative to pumped storage hydro and CAES at locations where these latter two technologies are not favorable."[34]
- Additional 2016 analysis by PwC suggests that worldwide, the LCOS for electrolytic hydrogen used as energy storage will be competitive with lithium ion batteries, pumped hydro, and CAES by 2030.[35]
- The chart below shows the potential cost competitiveness of hydrogen as energy storage compared to other carriers.



[33] McKinsey & Company, "Commercialisation of Energy Storage in Europe," Fuel Cell and Hydrogen Joint Undertaking, European Commission, March, 2015.
[34] http://www.nrel.gov/docs/fy16osti/64764.pdf
[35] https://www.worldenergy.org/wp-content/uploads/2017/03/WEResources_E-storage_2016.pdf

3. Economic potential of electrolytic hydrogen for other use cases:

Recent reports project that worldwide costs of electrolytic hydrogen will reach cost parity with conventional hydrogen production (steam methane reforming) by about 2025 and become competitive with natural gas end uses for power and building heating within the next decade. Driving these dynamics will be technology cost declines as the P2G industry expands internationally, increasing amounts of and cheaper renewable electricity that will available for P2G lower rates, pressure to reduce greenhouse gas emissions, and opening wholesale markets to P2G, and allowing P2G to access low and negative rates for excess power generation.[36]

D. The section on Priority End Uses for Renewable Gas repeatedly focuses too heavily on bio-based gas at the exclusion of other renewable gases, such as power-to-hydrogen.

This section repeats the tendency in this chapter of suggesting a false equivalency between bio-based gases and renewable gas, which is inconsistent with the broader definition of renewable gas elsewhere in the report and with the intent of SB 1383. To be clear, we do not object to focusing on bio-energy, only to doing so while excluding, underrepresenting or misrepresenting other renewable gases, such as hydrogen made with renewable electricity. The brief section renewable hydrogen is greatly appreciated, although contains little substance, particularly about electrolytic hydrogen. Specific areas where we propose this section could be improved are below.

1. On p. 269, the list of commercial-ready end uses for renewable gas in the section's first paragraph is inaccurate and incomplete. It ought to be amended for accuracy as follows:

"Renewable gas has been used, or proposed for use, as a substitute for conventional natural gas in several energy sectors. The most commercial-ready end uses are electricity generation, natural gas vehicle fuel displacement, pipeline natural gas displacement, energy storage, industrial use, and ancillary grid services.

It makes no sense that natural gas vehicle fuel should be a substitute for natural gas, hence we propose the word "displacement" be added after "natural gas vehicle fuel," given that presumably the goal is to displace natural gas fuel for transportation with renewable gas alternatives like biomethane and hydrogen.

Examples of data to back up the addition of energy storage, industrial use and ancillary grid services are:

- *Energy Storage*: There are numerous commercial power-to-gas storage projects contracted or operational around the world. In the current phase of development, projects are being developed that are up to 100+ MW in size, for example, a series of 7 grid-injected hydrogen plants of approximately 100 MW each that are being installed in France. The European Union recently issued a bid for a 10+ MW P2G facility.[37] Hydrogenics is contracted with IESO, Ontario Canada's independent system operator, to supply utility scale energy storage[38]

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[36] Sources: Navigant Research, International Energy Agency, International Monetary Fund, US Department of Energy

[37] See CHBC *Economics of Power-to-Gas* IEPR docket submission for sources and more information.

[38] Source: IESO

- *Industrial Use:* Electrolytic hydrogen is a drop-in replacement fuel for conventional hydrogen in industrial applications and can be an immediate pathway to reducing greenhouse gas emissions among major polluters. For example, ITM Power is engaged in a joint project with Shell to install a 10MW electrolyser to produce hydrogen at the Wesseling refinery site within the Rheinland Refinery Complex in Germany.[39]
- *Grid Services:* Power-to-gas can serve many useful ancillary grid services (US Department of Energy, NREL). The utility-scale Biocat power-to-gas project, for example, is providing frequency regulation to the Danish grid.[40]

2. The Transportation Fuel subsection ignores hydrogen and solely focuses on bioenergy.

Hydrogen is a long-time cornerstone of California's clean transportation policy, and renewable hydrogen is key to ensuring that hydrogen production and use reduces greenhouse gases and criteria pollutants on a lifecycle basis. Therefore, the absence of renewable hydrogen from this subsection, which only addresses bio-based renewable methane, is a striking omission. We therefore request that the following data be added to this subsection:

- The results of CHBC analysis show that, based upon a range of input electricity prices of zero (free curtailed electricity) to $0.06/kWh, as well as upon expected progress on technology cost, electrolytic hydrogen and methane can be produced at costs comparable to conventional vehicle fuel. This is without consideration of any renewable fuel premium, which could be in the range of $2 per gasoline gallon equivalent in the 2030 time frame.[41]
- CARB forecasts that demand for hydrogen for transportation will outweigh production by 2020.[42] SB 1505 also requires that a third of hydrogen sold in state-funded fueling stations be renewable. Therefore, economical production of renewable hydrogen for vehicles is a state priority.
- Electrolytic hydrogen is already being produced to fuel vehicles in California. For example, a fueling station in Riverside uses an ITM Power electrolyzer to provide hydrogen 24/7 to passenger vehicles and buses[43], and a Proton electrolyzer is producing hydrogen for AC Transit buses in San Francisco[44]. ITM Power has another project in development in Chino, StratosFuel will soon have an electrolytic hydrogen station online in Ontario[45], and Nel Hydrogen and Proton OnSite recently announced that they are building a 900kg/day refueling station at the SunLine Transit bus fueling depot in Palm Desert[46].

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[39] http://www.itm-power.com/news-item/10mw-refinery-hydrogen-project-with-shell

[40] http://biocat-project.com/about-the-project/facts-figures/

[41] See CHBC's Economics of Power-to-Gas submitted on the IEPR docket. Original source: CHBC's White Paper – Power to Gas: the Case for Hydrogen

[42] http://www.energy.ca.gov/2017publications/CEC-600-2017-002/CEC-600-2017-002.pdf

[43] http://www.itm-power.com/project/california-hydrogen-stations

[44] http://www.actransit.org/environment/the-hyroad/energy-stations/

[45] http://www.stratosfuel.com

[46] http://nelhydrogen.com/news/awarded-usd-8-3-million-hydrogen-electrolyser-fueling-station-contract/

3. The subsection on On-Site or Grid Connected Electricity Generation also focuses solely on bioenergy and leaves out other important renewable gas options like renewable hydrogen.

By limiting its discourse to bioenergy, this subsection again is inconsistent with the broader and more appropriate definition of renewable gas found elsewhere in the report. Including renewable hydrogen is also important here because this is the only zero-greenhouse gas emissions, zero criteria pollutant pathway to providing energy for fuel cell electricity generation and to displacing natural gas in gas power plants. Electrolytic renewable hydrogen is the only option to do so at high volume. We request that these facts be included in this subsection.

4. Pipeline Injection Challenges

The subsection on Pipeline Injection ought to consider that the first 5% of decarbonizing the gas system is the easiest, but getting beyond this is going to be critical to meet state greenhouse gas emissions targets – and difficult, if not impossible to do with bio-based systems alone. It is essential to also take a longer view and to consider that power-to-gas carries a far larger volume potential than bio-based gases.

The cost figures on p. 276, which the report states were based on the PATHWAYS model, based on a **draft analysis** that has not yet considered latest data on power to gas. Using this incomplete draft analysis led to the conclusion that "Power-to-gas was by far the least cost-effective strategy out of the ones considered", as our comments also mention on p. 8. Because this conclusion about power to gas costs is premature, it is inappropriate to include this analysis in the IEPR Report at this time. We respectfully request this analysis not be using until a final analysis is being presented by the authors of the PATHWAYS model.

E. Section on Economic Assessment of Renewable Gas End Uses

This section repeats the error of implying that renewable gas and bio-based gas are virtually synonymous. Outside a brief mention of hydrogen fuel cell on p. 281 in reference to a chart, the nearly ten-page section leaves out discussion of any other renewable gases, including hydrogen. This imbalance ought to be corrected. Specific additions requested are below:

1. There is no mention of key renewable hydrogen end-uses

This section is entirely silent on the opportunity for renewable hydrogen to be used to reduce GHG emissions in the chemicals as well as the refining sector, which is currently the largest user of hydrogen. Nearly all hydrogen for these sectors is produced using fossil fuels. As California seeks to reduce greenhouse gas emissions from these industries, renewable hydrogen is a drop-in, greenhouse gas free alternative. California's ambitious mandate to reduce greenhouse gas, along with the state's cap and trade and LCFS programs could be accessed to encourage large emitters, which use hydrogen, to replace their conventional hydrogen with renewable hydrogen. In addition, incentives or requirements for all industrial hydrogen buyers to purchase renewable hydrogen could be developed.

2. The subsection on Renewable Gas Revenue Streams leaves out important revenue streams for renewable gas produced using electrolysis and, again, focuses almost exclusively on biomethane.

This section repeats the imbalanced emphasis on biomethane, making mention of other renewable gases in only one small instance in the introduction in Table 24 on p. 282, which incorrectly suggests that hydrogen fuel cell vehicle fuel is the singular revenue stream for hydrogen. The section's subsections on *Vehicle Fuel Revenues*, *Electricity Generation Revenues*, and *Additional Renewable Gas Project Revenues* leave out mention of renewable hydrogen entirely.

As previously indicated, CHBC's submission to the docket on *Market Opportunities and Pathways for Renewable Hydrogen*, mentions five revenue streams for electrolytic renewable hydrogen, one of which is fuel for zero emissions transportation, and the other four of which are electricity generation, industrial use, grid services, and energy storage. We are disappointed to see none of these discussed in this section. We respectfully ask that this omission be corrected. Key data to include are below.

3. In "Vehicle Revenue" Subsection

- When referencing how the LCFS program can support renewable gas, rather than focusing on biomethane exclusively, this subsection ought to include that the LCFS program should also facilitate production and use of power-to-hydrogen and power-to-methane. The LCFS program has the strong support of the hydrogen industry, and as mentioned previously, the increased production of renewable hydrogen is urgent given the projected shortfall of hydrogen for vehicle fueling in California in the near future, given the state mandate to ensure a third of hydrogen at fueling stations is renewable, and given the state requirements to lower greenhouse gas emissions and criteria pollutants. We specifically mention CHBC's support for the LCFS and recommendation to leverage this program for renewable hydrogen development in our submission to the docket on *Market Development Opportunities and Pathways for Renewable Hydrogen in California*. Notably, renewable hydrogen is already being used by AC Transit to generate LCFS credits with a carbon intensity of 0g CO2. If electrolysis were to be provided access to wholesale power from renewables, the revenue from vehicle fuel sales would be substantial. The LCFS program could also be leveraged to help oil refineries lower their Carbon Intensity, as CARB has been working on. We strongly urge the Commission to encourage these approaches.
- It bears mention that thanks to California policies, such as the Governor's Executive Order B-16-2012 and ZEV Action Plan, the Clean Vehicle Rebate Project, AB 8, and the Energy Commission's Alternative and Renewable Fuel and Technology Program, California is on its way to achieving its initial goal of 100 hydrogen fueling stations, and there are thousands of hydrogen fuel cell electric vehicles (FCEVs) on the state's roads. Automakers have also invested in hydrogen transportation technology, with several offering FCEVs models in their lineup, including Honda, Toyota, Hyundai and others having announced models like BMW, Lexus, and Mercedes-Benz (Daimler), and more are developing demonstration

vehicles like GM, Audi, and Ford.[47] Several recent announcements have focused on medium and heavy-duty vehicles from US Hybrid[48], Toyota[49], Kenworth[50], GM[51], Loop Energy[52], Nikola Motor Company[53], FedEx[54], and UPS[55].[56] In addition, major retailers have lately been changing over from battery-powered to fuel cell powered forklifts, with Amazon, Walmart, and Kroeger among the companies that have deploying hydrogen fuel cell forklifts.[57]

4. In "Electricity Revenues" Subsection

The report states on p. 286:

"Bioenergy developers and California utilities – Bioenergy Association of California, American Biogas Council, Organic Waste Systems, Victor Valley Wastewater Reclamation Agency, Clean Energy, PG&E, and SoCalGas – suggested opening a proceeding to allow for changes to the RPS and BioMAT to better support and promote bioenergy. Proposed changes may include allowing for procurement of larger or variable power capacities or creating a mandated ratio of renewable energy from biomass. Also suggested is increasing Self-Generation Incentive Program funding for renewable gas generation and use."

We respectfully request that the Commission add that the CHBC also proposes that if any changes are made to the RPS that favor bioenergy are made, such as those mentioned above, the changes ought to include equivalent incentives for renewable hydrogen fuel cells.

F. Long-Term and Alternative Pathways for Renewable Gas

1. Clarification on Power-to-Gas subsection needed.

CHBC appreciates the subsection on Power-to-Gas. We recommend the following red text to be added for clarity:
"Detailed economic analyses by the National Fuel Cell Research Center calculated the levelized cost of returned energy for a power-to-gas system to be $20.57–$66.60/MMBtu under current costs and efficiencies. These costs can be reduced to $14.97–$44.38/MMBtu with future cost reductions and efficiency improvements. The first

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[47] http://www.businessinsider.com/12-hydrogen-car-projects-2017-5/ - the-epa-recently-gave-the-car-an- estimated-range-of-366-miles-the-longest-range-of-any-zero-emissions-vehicle-honda-says-the-clarity-has-a- refuel-time-of-just-three-to-five-minutes-2
[48] https://www.trucks.com/2017/05/04/us-hybrid-hydrogen-fuel-cell-truck
[49] https://www.trucks.com/2017/10/12/toyota-hydrogen-fuel-cell-electric-truck-hits-road
[50] https://www.trucks.com/2017/05/02/kenworth-class-8-hydrogen-fuel-cell-truck
[51] http://media.gm.com/media/us/en/gm/news.detail.html/content/Pages/news/us/en/2017/oct/1006-fuel-cell-platform.html
[52] http://www.marketwired.com/press-release/loop-energy-fuel-cell-range-extended-yard-truck-in-operation-2228935.htm
[53] https://arstechnica.com/cars/2017/09/nikola-motor-company-and-bosch-team-up-on-long-haul-fuel-cell-truck
[54] https://www.gasworld.com/plug-power-fuel-cell-engines-power-fedex-/2012236.article
[55] https://www.trucks.com/2017/05/02/ups-fuel-cell-electric-delivery-truck
[56] https://www.trucks.com/2017/05/08/hydrogen-fuel-cell-trucks-holy-grail ; https://www.forbes.com/sites/heatherclancy/2014/01/30/run-your-engine-on-water-sprint-fedex-test-hydrogen- fuel-cells/#736b4ef874ec
[57] https://arstechnica.com/information-technology/2017/04/amazon-will-replace-some-of-its-electric-forklifts-with-hydrogen-fuel-cell-ones

numbers refer to the production cost of fuel with free electricity, and the second numbers refer to the costs of re-injected electricity for a power-to-gas-to-power use case."

It should also be highlighted in this section for perspective that as with all new energy technologies, costs for power to gas will come down with industry expansion, which is already underway worldwide, and supportive market and policy frameworks that allow access to attractive electricity rates, revenue streams, and public incentives like funding opportunities to launch the industry. Clearly, the solar industry would not be the success story it is today without similar support schemes in California and around the world. Analysts project that with these elements, power-to-gas can reach cost parity to conventional fuels in most other sectors by 2030, including gasoline for transportation, steam methane reformed hydrogen for industrial processing, and natural gas for power and heating.[58]

2. The CHBC supports the recommendations in this section, but with some important adjustments.

- The CHBC generally supports the recommendations, in particular, as previously indicated, the recommendations to continue the LCFS, to have CARB consider the feasibility of a pathway for renewable gas to electric vehicle charging and hydrogen fuel production under the LCFS, and to examine power-to-gas as a means to use excess renewable generation.
- However, we strongly urge that the final report adjust the recommendation to "implement policies to build commercial markets for renewable gas," so that state agencies are not only directed to continue and refine efforts to advance dairy gas, but also other renewable gases, including electrolytic hydrogen.
- We also request adding recommendations that allow the electricity grid to act as the carrier of renewable electricity, so that an electrolytic hydrogen facility can purchase renewable power that is not co-located with the facility, much like the natural gas pipeline acts as the carrier in biogas based LCFS schemes.
- We also hope the state will consider launching a multi-stakeholder process with OEMs, state energy agencies, utilities, fueling station companies, electrolyzer companies and other key players to advance renewable hydrogen, not only for transportation fuel, but also for other end uses discussed in this document. This model has been effective for advancing EVSE and other clean energy technologies and would be timely for renewable hydrogen development.

[58] Sources: US DOE https://energy.gov/sites/prod/files/2016/12/f34/fcto_h2atscale_workshop_pivovar_2.pdf; Navigant, International Energy Agency, International Monetary Fund