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November 12, 2015

The Honorable Mary Nichols, Chair
California Air Resources Board
1001 I Street
Sacramento, CA 95814
(Comment submitted electronically)

RE: Cap-and-Trade Auction Proceeds, Second Investment Plan, Draft

Dear Chair Nichols,

Sierra Energy appreciates the opportunity to provide comments regarding the Air Resources Board's ("ARB"), Cap-and-Trade Auction Proceeds Second Investment Plan ("Second Investment Plan"). In association with the US Defense Logistics Agency, Sierra Energy is developing the capabilities to produce hydrogen from municipal solid waste ("MSW"). We are also working with our sister company, Sierra Northern Railway, to deploy hydrogen fuel cells in freight applications.

We are very supportive of ARB's Second Investment Plan and ARB's crucial leadership in this policy arena. In addition to the important investment strategies already outlined by your agency, we would like to suggest opportunities to enhance the Second Investment Plan by facilitating the production of clean hydrogen, and the resulting development of truly zero emission transportation and energy solutions. In particular, this letter recommends that the ARB:

- ***Develop and include recommendations specific to the production of clean hydrogen in the Second Investment Plan;***
- ***Explicitly include hydrogen production within the scope of any program that provides incentives for the in-State production of low carbon intensity fuels;***
- ***Integrate a hydrogen component into the Waste-to-Fuel program and include contaminated organics as well as segregated organics in the program;***
- ***Incentivize the use of biogas and syngas to produce hydrogen, and the use of fuel cells as distributed energy power sources within the Energy Efficiency and Renewable Energy program; and,***
- ***Identify short line railroad locomotives and freight yard fuel cell tenders as priority areas for zero emission funding.***

Sierra Energy's Expertise

Sierra Energy and Sierra Northern Railway are both companies within the Sierra Industrial Group. Sierra Energy is a waste gasification company founded in Davis, California in 2004. Sierra Northern Railway was formed in August 2003 through the merger of two Northern California short line railroads: the Sierra Railroad Company and the Yolo Shortline Railroad. As a result, Sierra Energy has relevant experience and capabilities that range from the generation of power from methane-emitting municipal solid waste ("MSW") to the reduction of black carbon from locomotives.

Sierra Energy's FastOx Gasifier has been demonstrated at the Department of Defense's Renewable Energy Testing Center to be a robust and flexible technology capable of processing MSW, hazardous waste, medical waste, construction and demolition waste, and other organic and inorganic waste streams. Waste gasification can be applied to further reduce the air, soil and water pollution created by landfills and to produce clean, low carbon energy and fuel for power and transportation. The syngas generated by FastOx gasification is also suitable for reformation into fuel grade hydrogen. Therefore, Sierra Energy's waste gasification technology is an excellent complement to existing waste diversion, reduction and recycling programs and technologies, helping to end the lifecycle of waste streams while creating new energy sources.

To further demonstrate the effectiveness of Sierra Energy's FastOx gasification system, we are currently installing a community-scale system at U.S. Army Garrison Fort Hunter Liggett in Monterey County. Sierra Energy's technology was selected by the US Department of Defense's ("DoD") Environmental Security Technology Certification Program to help increase DoD energy security, reduce waste and energy costs, drastically reduce greenhouse gas emissions, and help meet the U.S. Army's net-zero initiatives. The project has also received grant support from the California Energy Commission to convert the resulting syngas into Fischer-Tropsch diesel fuel for transportation applications. And the US Defense Logistics Agency has awarded Sierra Energy a Phase 1 Small Business Innovation Research grant to demonstrate the effective conversion of FastOx gasifier syngas into low carbon intensity hydrogen.

Our sister organization, Sierra Northern Railway, has also been at the forefront of reducing black carbon emissions from locomotives. Short line railroads are typically exempted from state regulations by federal preemption. Nonetheless, Sierra Northern Railway has worked with local air districts on a number of projects to retrofit locomotives and reduce emissions. Given its fleet of locomotives, network of rail lines, and relationship to Sierra Energy, Sierra Northern Railway is ideally situated to develop and execute zero emission freight projects, especially those that take advantage of distributed hydrogen production.

Hydrogen's Flexibility as a Clean Energy Solution

Hydrogen is a uniquely clean and flexible energy solution in both the power and transportation sectors. In the power sector, electrolysis can be utilized to convert intermittent renewable resources such as wind and solar into energy-dense hydrogen fuel. In addition, biogas and syngas can provide feasible and ultra low carbon intensity sources of hydrogen fuel through reformation, thereby increasing the total availability of hydrogen production for transportation uses. The resulting hydrogen fuel can also be utilized in stationary fuel cell applications as on-demand power on site in commercial and industrial settings.

Since hydrogen power is released not through combustion but through a controlled chemical reaction that releases neither GHG emissions nor criteria pollutants, it provides a versatile low carbon solution in the energy and transportation sectors. Hydrogen is ideal as a clean and compact distributed energy storage and distributed generation solution. With the rapid adoption of hydrogen fuel cells by data centers, hospitals, and universities because of the quality and reliability of fuel cell power and its zero emission profile, the need for low carbon hydrogen production technologies is self-evident.

In the transportation sector, hydrogen fuel cell electric vehicles ("FCEVs") have been demonstrated to be suitable for use in passenger, goods movement and mass transit settings. FCEVs can be refueled as quickly as fossil fueled vehicles, and have comparable driving ranges. Like stationary fuel cells, the proton exchange memory fuel cells typically used in vehicle applications emit only pure water and heat.

The shift to mass production of passenger FCEVs has been led by Toyota with the recent introduction of the Mirai. Similar announcements of vehicle platforms from other major automotive manufacturers are expected in the near future. The State of California's investment in hydrogen fueling stations throughout the state indicates a strong policy implementation that will require distributed sources of clean hydrogen production. The development of an expanded hydrogen economy can potentially facilitate enhanced vehicle electrification with extended range battery technology, as demonstrated by the recent announcement from Lawrence Livermore National Laboratories that hydrogen can dramatically enhance the performance of lithium ion batteries.[1]

[1] See Lawrence Livermore National Laboratories, "Using Hydrogen to Enhance Lithium Ion Batteries," November 5, 2015, at https://www.llnl.gov/news/using-hydrogen-enhance-lithium-ion-batteries (last viewed November 10, 2015).

The Importance of Clean Hydrogen to California

Sierra Energy supports the further development of hydrogen as an energy and transportation solution due to its ultra clean emissions profile. As previously noted, hydrogen provides exceptionally clean tailpipe and power plant emissions performance. However, to realize the full potential of hydrogen from an environmental perspective, it is necessary to also produce hydrogen in the manner that releases the least possible GHG, criteria pollutant, and toxic air contaminant emissions ("Clean Hydrogen"). The GHG emissions component of conventional hydrogen production from natural gas reformation is well illustrated by the LCFS pathways that currently exist for hydrogen:

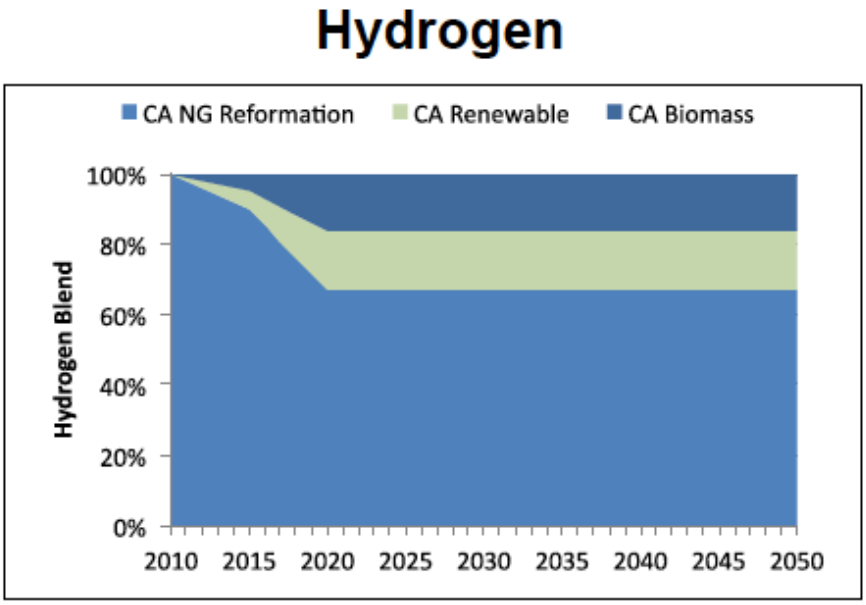
Fuel	Pathway Identifier	Pathway Description	Carbon Intensity Values (gCO2e/MJ)		
			Direct Emissions	Land Use or Other Indirect Effect	Total
	HYGN003	Compressed H2 from central reforming of NG (no liquefaction and re-gasification steps)	98.80	0	98.80
	HYGN004	Compressed H2 from on-site reforming of NG	98.30	0	98.30
	HYGN005	Compressed H2 from on-site reforming with renewable feedstocks	76.10	0	76.10
Hydrogen	HYGN001	Compressed H2 from central reforming of NG (includes liquefaction and re-gasification steps)	142.20	0	142.20
	HYGN002	Liquid H2 from central reforming of NG	133.00	0	133.00

Two of these LCFS hydrogen pathways have a carbon intensity ("CI") score in the high 90's which is comparable to the CI of conventional gasoline and diesel fuel derived from crude oil. Two of the other hydrogen pathways have CI scores that exceed the CI scores of conventional liquid fossil fuels by more than 30%. Only a single LCFS pathway (Compressed H_2 from on-site reforming with renewable feedstocks) provides a CI reduction relative to conventional fossil fuel.[2] Importantly, FCEVs are inherently more efficient that internal combustion engines and thereby achieve overall GHG reductions compared to conventional vehicles utilizing fossil fuels. Nonetheless, conventionally produced hydrogen's CI profile as characterized by the ARB's LCFS program illustrates the major opportunity to capture additional GHG reductions through the deployment of Clean Hydrogen production methods.

[2] Air Resources Board, Low Carbon Fuel Standard, Table 6, Carbon Intensity Lookup Table for Gasoline and Fuels that Substitute for Gasoline, at http://www.arb.ca.gov/fuels/lcfs/lu_tables_11282012.pdf

ARB has recognized the importance of Clean Hydrogen production in its long-range planning process. ARB's Vision scenario planning process provides an opportunity for ARB and stakeholders to engage in the methodical long-range scenario analysis that is necessary to support achievement of California's aggressive environmental policy goals. Recognizing that the figures contained in Vision 2.0 are scenarios and not hard targets, the most recent overview presentation of Vision 2.0 illustrates the vital importance of Clean Hydrogen.

Specifically, the Vision 2.0 presentation includes Bio- H_2 as a distinct category of hydrogen. Bio- H_2 refers to hydrogen that is produced from waste feedstock.[3] Bio- H_2 has remarkably low or negative GHG performance because the conversion of waste feedstocks to hydrogen results in avoided methane emissions. An analogous situation exists for renewable natural gas derived from waste in the LCFS program, resulting in the lowest carbon intensity score of any fuel for a specific facility.[4] Due to this unique environmental opportunity, ARB includes Bio- H_2 ("CA Biomass") in its Vision 2.0 scenario plan as a significant source of hydrogen for the state[5]:



[3] See Vicki McConnell, Renewable Energy Focus.com, "The Economics of Waste to Energy," January 31, 2015 at http://www.renewableenergyfocus.com/view/41092/the-economics-of-waste-to-energy-part-i/ for a detailed discussion of Bio- H_2 (last viewed November 10, 2015).

[4] Utilizing biomethane produced from the high-solids anaerobic digestion of food and green wastes, the Clean World Sacramento Biodigester has a carbon intensity score of negative 15.29 for its CNG. See Air Resources Board, Facilities with Approved Physical Pathways, at http://www.arb.ca.gov/fuels/lcfs/reportingtool/registeredfacilityinfo.htm (last viewed November 10, 2015).

[5] See Air Resources Board, Vision Scenario Planning, March 2015 Staff Presentation at p. 49 (Bio-H2 as blendstock potentially consumed to meet demand), and at p. 55 (Baseline Fuel Blending, hydrogen chart) at http://www.arb.ca.gov/planning/vision/docs/vision_workshops_march2015_staff_presentation.pdf (last viewed November 10, 2015).

The diagram above includes Bio-H_2 at approximately a 5% market penetration into the hydrogen market in 2015, and a 17% penetration in 2020. Unfortunately, there is currently no commercial production of Bio- H_2 in California.[6]

As is recognized in the Second Investment Plan,

> *"Projects supported in 2016-17 through 2018-19 will realize benefits beyond 2020 and should be focused on helping deliver successes in meeting the State's mid- and long-term climate targets and goals. Therefore, this document encourages investment in programs and projects that lay the groundwork for the approaches to zero and near-zero emission transportation systems with enhanced mobility options, low carbon energy, and resource and waste management that are needed to meet the State's long-term reduction targets*."[7]

Within this context, Bio- H_2 is an essential component of a hydrogen strategy that will enable California to meet its mid- and long-term climate targets and goals. For these reasons, Sierra Energy is providing a series of recommendations that will enable the production of Clean Hydrogen to be rapidly advanced and commercialized in the state.

Recommendations

- ***Develop and include recommendations specific to the production of Clean Hydrogen in the Second Investment Plan***

The Second Investment Plan currently does not discuss the distinction between hydrogen produced from natural gas reformation and Clean Hydrogen produced from feedstocks that minimize or reduce emissions of GHG's, criteria pollutants, and toxic air contaminants. The nature of hydrogen production is a crucial distinction that ARB has measured and quantified in the LCFS Program, and that has dramatic impacts on the GHG and emissions profile of hydrogen used in both the vehicle and power sectors. In today's hydrogen market, hydrogen is utilized primarily to produce ammonia for fertilizers, and to fuel hydrocrackers in the petrochemical industry. Neither of these hydrogen markets has valued the carbon intensity reduction potential of Clean Hydrogen. Instead, both markets have driven the widespread use of natural gas reformation to produce hydrogen for economic reasons.

[6] The Orange County Sanitation District's tri-generation project was a successful Bio-H_2 demonstration project in Fountain Valley, California. See http://www.eenews.net/stories/1060009156 (last viewed November 12, 2015).
[7] Second Investment Plan at 1.

In order to decarbonize hydrogen production, the nascent Clean Hydrogen production industry requires incentive support and a strong market signal to enable commercialization. As discussed throughout this comment letter, Clean Hydrogen delivers a wealth of environmental benefits. While these environmental benefits do not yet have corresponding economic value, the target feedstocks create great potential for the industry's long-term success. Clean Hydrogen production can utilize a wide range of low cost or negative cost feedstocks as is illustrated by Sierra Energy's focus on MSW. The establishment of a California Climate Investment program supporting pilot and demonstration level Clean Hydrogen production facilities will be highly valuable in proving the feasibility of these technologies and will dramatically shorten the time period required for commercialization. In addition, it will leverage California's existing leadership in the fuel cell and hydrogen station sectors to enable even greater hydrogen technology development, job expansion, and economic growth in the state.

- ***Explicitly include hydrogen production within the scope of any program that provides incentives for in-state production of low carbon intensity fuels***

The Second Investment Plan includes incentives for the in-State production of low carbon intensity fuels in its draft investment concepts for transportation. It is not clear from the Plan whether ARB plans to extend this incentive program to hydrogen production. Sierra Energy would recommend that Clean Hydrogen be explicitly included in any such program. We would note that only clean methods of hydrogen production such as Bio- H_2 and electrolysis from renewable energy sources produce low carbon intensity fuel and would therefore recommend that any such incentives be directed at in-State production of Clean Hydrogen.

- ***Integrate a hydrogen component into the Waste-to-Fuel program and include contaminated organics as well as segregated organics in the program***

The Second Investment Plan discusses the opportunities inherent in the capture and conversion of waste to energy and fuels, as well as policy strategies to eliminate future disposal of organic materials at landfills. However, the Plan limits its draft investment concepts to reducing methane release from organic waste and utilizing traditional composting and anaerobic digestion technologies.[8]

[8] Second Investment Plan at p. 21.

While constructive, these proposed measures to reduce methane emissions from future landfilling activities do not effectively address existing landfill wastes or the considerable amounts of organic waste from non-MSW sources, e.g. rice straw. As the ARB recognized in its Concept Paper on Short-Lived Climate Pollutants:

> *"Even if we eliminate new organics in landfills, existing organic waste in landfills will remain a source of methane emissions for years to come."*[9]

To achieve California's GHG reduction and air quality goals, it is necessary to more aggressively reduce emissions in the waste sector. California has developed a waste treatment and diversion policy that currently renders it infeasible to convert the methane released from MSW into energy or fuels. In particular, existing policies preclude the development of gasification techniques that would otherwise better enable the state to achieve GHG, petroleum and criteria pollutant reduction goals while maintaining air, water and soil quality, and attaining renewable energy standards. These policy limitations are evidenced by the impossible standard imposed on MSW to qualify as renewable energy under the state's renewable portfolio standard.[10]

In order to maximize the impacts of the Second Investment Plan, ARB should leverage existing and future technologies that are capable of converting MSW to energy and fuel in an environmentally sound and beneficial manner. In addition to organic waste in landfills, this material includes contaminated organic waste that is impractical to separate from MSW and other materials that have organic and inorganic components that are unable to be readily separated. Sierra Energy looks forward to working with ARB and other interested agencies in developing a strategy that reduces methane from all sources, not just methane from separated organics.

- ***Incentivize the use of biogas and syngas to produce hydrogen, and the use of fuel cells as distributed energy power sources within the Energy Efficiency and Renewable Energy program***

As discussed above, conventional methods of hydrogen production do not deliver significant GHG emission reductions as they utilize fossil fuel. While fuel cells are significantly more efficient than internal combustion engines, the full promise of hydrogen is to provide clean energy and transport on a life cycle basis, not just at the vehicle or fuel cell level.

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[9] Air Resources Board, Short-Lived Climate Pollutant Second Investment Plan, Concept Paper, May 7, 2015, at p. 20-21.
[10] Public Resources Code §25741(b)(1)-(5).

The Second Investment Plan's draft investment concepts for clean energy include supporting clean biomass facilities and biomass conversion technologies for renewable energy generation. We would recommend expanding this to encompass the use of Clean Hydrogen derived from biogas and syngas, as well as hydrogen derived via electrolysis powered by intermittent renewable energy sources. The overall program goals would benefit from the inclusion of Clean Hydrogen production.

- ***Identify short line railroad locomotives and freight yard fuel cell tenders as priority areas for zero emission funding***

The Second Investment Plan recognizes that,

> *Furthermore, continued financial support is critical to transition to a zero emission freight system. This approach includes significant investment in pre-commercial development and demonstrations of innovative freight technologies, followed by greater funding to support widespread deployment.*
>
> *Funding is also needed for the alternative renewable fuels and fueling infrastructure to support these advanced technologies. (...)*[11]

Sierra Energy is in agreement that there are significant opportunities in the locomotive sector for the development and deployment of fuel cell tenders. As the ARB has recognized, locomotives are far less constrained than heavy-duty trucks by space and weight issues thus the larger and heavier footprint of fuel cells is not problematic. Locomotive engines are electrically powered and travel on pre-determined routes on tracks between stations with infrastructure capabilities thus further enabling fuel cell technologies.

In addition to these factors, short line railroads are particularly well-suited for fuel cell tenders. California short line railroads:

1. Operate primarily or exclusively within the state of California;
2. Have shorter routes to travel;
3. Have lesser rates of locomotive utilization than national locomotives; and,
4. Can become a vital part of California's clean energy economy.

For all of these reasons, California's short line railroads provide the optimal proving ground for ZEV and other demonstration projects in the locomotive sector.

[11] Second Investment Plan at p. 32.

Conclusion

Thank you for your consideration of our input. We look forward to continuing to participate in the development of fuels and technologies that support the ARB's major transportation goals and targets.

Sincerely,

Michael Hart

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