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Making a difference today for a better world tomorrow.

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Clerk of the Board
California Air Resources Board
1001 I Street
Sacramento, CA 95814

RE: ClimeCo Comments regarding the Low Carbon Fuel Standard – December 7, 2021, Public Workshop: Potential Future Changes to the LCFS Program

Dear California Air Resources Board:

Thank you for the opportunity to comment on the potential future changes to the Low Carbon Fuel Standard (LCFS) program. ClimeCo is committed to making a difference today for a better world tomorrow. Founded in 2009, ClimeCo pioneered the development of emission-reduction projects at U.S. bio-digester and nitric acid plants and has rapidly evolved into a global full-service environmental commodity firm. Inc. Magazine named ClimeCo on their 2021 Best in Business List for Environmental Services and as an honoree of the Inc. 5000 List of America's Fastest-Growing Private Companies in 2020. ClimeCo combines unrivaled commodity market expertise with engineering and Environmental, Social, and Governance (ESG) advisory to help clients maximize their environmental assets and minimize regulatory costs.

We are pleased that the California Air Resources Board (CARB) is discussing updates to help the LCFS program to further support and grow the alternative fuels market. Our comments today are focused on straightforward changes that would incentivize the use of low carbon intensity anhydrous ammonia derived nitrogen fertilizers ("low-CI ammonia") for biofuel producers and encourage the use of ammonia as a hydrogen carrier, each providing incentives for industry to invest in decarbonization of hydrogen, ammonia, and related fertilizer production.

The California LCFS program has proven to be an incentive for biofuel producers to reduce the carbon intensity of their fuel. CARB's data clearly shows that biofuel manufacturers have responded to this incentive, modifying many aspects of their production processes to their co-products to their energy sources, to reduce their CI score. Since 2011, the CARB incentive program has encouraged innovative production changes resulting in a remarkable 25% reduction in the average CI score for biofuels. As a result of the success of the program, other jurisdictions

have begun duplicating it which magnifies the impact and makes it all the more important to drive GHG emissions reductions to as many parts of the biofuel supply chain as possible

One area that could lead to continued improvements in CI scores for biofuel producers is in the nitrogen fertilizer space. Nitrogen fertilizer is an essential crop nutrient for major biofuels. While nitrogen fertilizer production is a traditionally emissions-intensive process, relying on the century-old Haber Bosch process, there are opportunities to decarbonize production in ways that could have a significant impact on lifecycle CI of biofuels.

The certified biofuel CI pathways do not, however, currently allow the final CI score to be modified based on the contribution of nitrogen fertilizer manufacturing. We believe allowing for modifications in this area would be of great benefit to biofuel manufactures who are looking for additional opportunities to lower their CI scores but lack new options to do so. Our recommendation to specify for the use of low-carbon nitrogen fertilizer in the pathway calculations for CI would provide that option, similar to the use of low carbon hydrogen in the manufacturing of renewable diesel.

Beyond the use of low-CI anhydrous ammonia for biofuel production, such an incentive would have broader emission reduction impacts that would complement California's goal for low carbon fuels. Low-CI hydrogen and low-CI anhydrous ammonia are expected to be critical contributors to reducing global emissions. Ammonia, which is composed of three parts hydrogen and one part nitrogen, has an energy density that is 300% of gaseous hydrogen and 150% of liquid hydrogen and exists as a liquid at moderate temperatures, making it a highly efficient transport and storage mechanism for hydrogen as well as a fuel in its own right. Many regions around the world such as Japan and the European Union (EU), are looking to ammonia as a means to connect the hydrogen economy as the world decarbonizes, but that starts with decarbonizing existing ammonia production which today is primarily used as an agricultural fertilizer.

ClimeCo has developed these comments in response to the Public Workshop hosted by the CARB staff on December 7, 2021. We look forward to continued dialogue with CARB staff to ensure the effective development of future program changes that will support the continued success of the program and further reduce transportation related greenhouse gas (GHG) emissions.

1. Background on ammonia/nitrogenous fertilizer production emissions.

Most North American ammonia manufacturing begins with the production of hydrogen from natural gas using a steam-methane reforming process. The hydrogen is then combined with atmospheric nitrogen and converted to ammonia through the Haber-Bosch process. Conventional ammonia produced in this manner generates GHGs, with most of the direct (Scope 1) and indirect (Scope 2 and Scope 3) GHGs resulting from the production of hydrogen.[1]

[1] In other parts of the world, notably China, ammonia is produced through coal gasification, which results in much higher GHG emissions. Other nations, such as Russia and India, produce ammonia through a natural gas-based

Technologies are being reviewed to decarbonize ammonia through multiple pathways, including carbon capture and sequestration (CCS) or the use of electrolyzers (with renewable electricity), although there is currently no demand or requirement for the production of such decarbonized product. The International Energy Agency has recently completed an intensive review of potential technological pathways to ammonia decarbonization.[2]

2. Enable use of low-CI ammonia and ammonia-derived nitrogenous fertilizers and recognize "site-specific agricultural inputs" in fuel pathway life cycle analyses.

One of the most significant components in the CI of fermentation biofuel is the "upstream" GHG footprint of the ammonia or ammonia-derived nitrogenous fertilizers used in the production of feedstock crops. There are, however, many opportunities to abate these upstream emissions during the ammonia, and downstream fertilizer products, manufacturing processes. For example, facilities may install CCS technology, utilize renewable electricity, or install technology to directly abate nitrous oxide (N_2O). The current California LCFS regulation and CA-GREET 3.0 model, however, do not offer an alternative for utilization of low-CI ammonia or other ammonia-based fertilizers (such as urea or urea ammonium nitrate (UAN) solution) as the regulation and model are currently limited to the default values for conventional fertilizer production practices.

These default values do not allow for flexibility of user selected CI and thus the benefit of low-CI ammonia emission reductions cannot be recognized. To correct this gap and account for these upstream emission reductions, we recommend that CARB amend the LCFS program such that biofuel producers that purchase feedstock produced with low-CI fertilizer can achieve a lower overall CI score. To accomplish this, we suggest that CARB update the CA-GREET model to recognize site-specific fertilizer CI designations in fuel pathway life cycle analyses (LCAs).

We suggest that the existing Tier 2 Fuel Pathway and CA-Greet model include the option to switch from the default (conventional) nitrogenous fertilizer to a lower CI nitrogenous fertilizer as an input when appropriate. The Argonne National Laboratory's GREET Model, the basis for the CA GREET 3.0 model, has continued to expand the fuel lifecycle options than can be effectively defined and modeled. In the most recent release of the Argonne's GREET model (GREET 2021), and the companion "Feedstock CI Calculator" spreadsheet, Argonne does recognize the potential for biofuel CI reduction through use of low-CI fertilizer alternatives. We recommend that the CA-GREET model also include the user-selectable functionality that enables the distinction of unique fertilizer lifecycles to reflect the spectrum of emission reduction possibilities on a source-specific basis – from process changes (e.g., abatement of

process but with significantly higher GHG emissions intensity as compared with U.S. producers. See, e.g., EIA, **Natural Gas Weekly Update** at 1 (April 1, 2021), accessed at https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2021/04_01/.

[2] International Energy Agency, Ammonia Technology Roadmap (Oct. 2021), accessed at https://www.iea.org/reports/ammonia-technology-roadmap.

N_2O emission from nitric acid production leading to ammonia nitrate-derived fertilizers) to CCS applied to hydrogen production on the front-end of the ammonia production process, as well as ammonia produced using electrolytically-produced hydrogen.

These emission reductions at site-specific ammonia facilities can meet the verification standards required by LCFS. Site-specific utilization of low-CI fertilizer can be demonstrated and verified with normal commercial documents (e.g., purchase orders, receipts, etc.) and the verifiable records do not rely on a proprietary system or tool. GHG emission reductions achieved through ammonia, nitric acid and urea/ammonia nitrate production practices are commercially proven, permanent and irreversible, can be accurately measured, and directly attribute to each downstream ammonia-derived fertilizer product. For example, GHG reductions of up to 79% for fertilizer production are achievable, with that reduction passed through the fuel production lifecycle to potentially yield biofuel feedstock CI reductions by as much as 4.1-5.5 gCO_2/MJ.

A customizable low-CI ammonia option will help incentivize the switch to lower CI fertilizers and yield emission reductions in the near-term and enable the long-term transition to a low-carbon energy future. The optionality to select site-specific inputs will incentivize immediate GHG reductions in biofuel feedstocks (e.g., ammonia CO_2 and nitric acid N_2O abatement). Other than enabling a user-inputted upstream fertilizer CI, the existing GREET Model default values can remain unchanged, making this a relatively straightforward modification enabling this site-specific input to be properly considered through the fuel lifecycle pathway.

The emission reduction investments being considered (CCS, secondary and tertiary N_2O abatement, etc.) would also be additional (and therefore, not biasing existing GREET default values) as such reductions are not commonly practiced in the fertilizer industry today since there is no economic return on the low-CI ammonia/fertilizer products in the agricultural marketplace today, and one does not appear on the horizon. For this reason, fertilizer production facilities require a price signal to incentivize long-term GHG reduction investments such as growing low-CI ammonia supply to meet developing demand as an alternative transportation fuel. Recognition of the biofuel feedstock CI reduction through the LCFS program will provide the incentive for ammonia facilities to make long-term emission reduction investments and farmers to select low-CI fertilizer products.

Additionally, there are secondary emission reduction benefits through low-CI fertilizer use beyond biofuel feedstock crop uses. A significant portion of ammonia will be used for biofuel feedstock production; however, the remaining fraction of the lower-CI products will be available to meet other market demands. We anticipate demand will grow for low-CI inputs across other market sectors, including industrial applications where desire for lower carbon products is developing. While that demand growth occurs, the relative certainty of value creation through CARB fuel pathways provides sufficient justification for such emissions reduction project investments.

3. ***Extend the applicability of "Book & Claim Accounting" to hydrogen carriers, such as low-CI ammonia.***

The current regulations allow Book & Claim Accounting considerations for low-CI electricity and biomethane (§95488.1). However, as written, the regulatory language does not allow low-CI hydrogen and hydrogen carriers, such as low-CI ammonia, to be tracked and appropriately accounted for. To fill this gap, we support CARB staff's consideration to allow Book & Claim Accounting of new or expanded low-CI hydrogen. Additionally, we recommend that CARB further expand the Book & Claim concept, with all the appropriate accounting practices, to nitrogen fertilizer products, such as ammonia and UAN, that may also rely on existing transportation and distribution systems where "conventional" and "low-CI" products may be co-mingled.

Products such as ammonia and ammonia-derived fertilizers are routinely stored, transported, and distributed in large and costly aggregated systems that may contain products from multiple sources; like natural gas or pipeline hydrogen that are aggregated for distribution, it is impossible to deliver specific molecules from a single low-CI ammonia production site to a specific end-use customer. However, accounting records can demonstrate the unique purchase and use of the low-CI products on an input and output basis, and thus preclude double-counting. It is economically and operationally impractical to develop a parallel distribution system for low-CI ammonia, just as it is for pipeline hydrogen. The expansion of Book & Claim Accounting to hydrogen carriers is essential to facilitate the transition to low-CI fuels and support CARB's goal of increasing hydrogen fuel availability.

4. ***Expand entities eligibility to create LCFS credits through CCS.***

The LCFS regulation [§ 95490(a)(1)] articulates what entities within the lifecycle of a fuel can create credits through CCS, however neither ammonia nor nitrogen fertilizer manufacturers are listed as an eligible entity. Currently, biofuel ("Alternative Fuel") producers are utilizing CCS from emissions generated through their production process to reduce the CI of their fuel products, hence creating LCFS credits through CCS. Where the CCS is practiced by a producer of an input to the biofuel lifecycle, it is unclear if the eligibility is afforded to the biofuel producer extends to the upstream "input" producer. We recommend that CARB elaborate and expand the eligibility for LCFS credit creation via CCS to additional entities along the fuel production pathway, specifically to ammonia and ammonia-derived fertilizer manufacturers.

If the regulation is updated, biofuel producers could receive CCS credits to the extent that CCS reduces the fertilizer footprint in the production of their agricultural feedstock. The reduced GHG feedstock could subsequently pass the emission reductions on to the alternative fuel product. This would appear to be analogous to a third-party hydrogen producer employing CCS to reduce the CI of hydrogen subsequently used as a process input for an alternative fuel (i.e., renewable diesel).

Thank you again for this opportunity to comment on future changes to the LCFS program. We support the effort to update the LCFS program and believe site-specific low-CI fertilizer sourcing to reduce biofuel CI is an additional, measurable, and verifiable pathway to reduce GHG emissions in the liquid transportation fuel lifecycle for both today (biofuels) and tomorrow (low-CI hydrogen to hydrogen).

Investments in low-CI fertilizers in the near term (i.e., to meet demand for gasoline-blending biofuels) will build a supply of low-CI ammonia to serve as a direct transportation fuel and/or hydrogen energy carrier, supporting the long-term transition to low/zero-emission fuels. We appreciate the diligent efforts of CARB staff and will continue to actively participate in ongoing public engagement efforts to incentivize the growth of the alternative fuels market in California and beyond.

Sincerely;

ClimeCo LLC

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