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California Air Resources Board
1001 I Street
Sacramento, CA 95812
Attention: Richard Corey (Executive Officer), Rajinder Sahota (Industrial Strategies Division Chief), Arpit Soni (Manager, Alternative Fuels Section Air), and LCFS Staff

Subject: Oberon Fuels Comments re LCFS Amendments Workshops

Dear Mr. Corey, Ms. Sahota, Mr. Soni, and Members of the LCFS Staff,

Oberon Fuels is a California-based company that produces innovative, ultra-low-carbon or carbon-negative dimethyl ether (DME), which can used directly as a diesel replacement fuel, a feedstock for renewable hydrogen and as a carbon reducer when blended with propane. We thank the California Air Resources Board (CARB) for the opportunity to comment on these important updates to the Low Carbon Fuel Standard (LCFS).

Oberon Fuels is committed to accelerating California's carbon-reduction effort by adding innovative, first-of-its kind fuels to the state's fuel supply. We submit these comments in the interest of informing and broadening the knowledge base of the LCFS staff and the public in developing policies that lead us to carbon-neutrality by 2045, with the added benefit of bringing the existing fleet of liquid-fueled vehicles to carbon neutrality well before that deadline.

Background. Dimethyl ether's (DME) clean-burning properties and versatility as a fuel can reduce greenhouse gas emissions and criteria pollutants in three different ways (see below). Thus, we believe DME has a key role to play in CARB's LCFS and other fuel and vehicle GHG and criteria emission policies. DME can be produced from a variety of waste streams and renewable feedstocks and holds the potential to support the state's additional goals of methane reduction (SB 1383) as well as fossil fuel replacement. Finally, DME also provides an economical pathway to the end goal of zero-emission mobility and carbon neutrality.

1) DME as a Diesel Replacement. DME has long been recognized as an excellent diesel replacement fuel. DME is a clean-burning, non-toxic and can be produced from renewable feedstocks. Its high cetane value (55-60) and quiet combustion, as well as its inexpensive fueling system, make it an excellent, inexpensive diesel alternative that will meet strict emissions standards and facilitate utilizing cleaner trucks and equipment, particularly Class 7-8 trucks and off-road equipment in the hard-to-electrify sector.

Oberon Fuels is currently leading a project funded by the California Energy Commission to upgrade its pilot DME production facility to demonstration scale and to produce the first renewable DME in the US at its plant in Brawley, California.

DME has been used for decades as an energy source in China, Japan, Korea, Egypt and Brazil, and can be produced domestically from a variety of feedstocks, including biogas from organic waste produced in cities or by agricultural operations, as well as renewable natural gas. Ideal uses in North America are in the transportation, agriculture, emergency power and construction

industries. DME made from a range of renewable feedstocks can make it extremely competitive, if not more affordable, than traditional diesel.

DME is a gas under ambient conditions. However, because it can be stored as a liquid under moderate pressure (similar to propane/LPG), it eliminates the need for the high-pressure containers used for CNG or cryogenics, as in the case of LNG. DME's easy handling properties make fueling and infrastructure relatively simple and inexpensive.

CARB's LCFS staff calculated the carbon intensity of DME from dairy biogas feedstocks produced by the Oberon process to be -278 (negative 278). In addition, DME is approved as a renewable fuel under the U.S. Environmental Protection Agency's Renewable Fuels Standard, making it eligible for RINs credits when made from biogas with the Oberon process. The EPA estimated that biogas-based DME offers a 68% reduction in greenhouse gases. Argonne National Laboratory, at the direction of the US Department of Energy, worked with Oberon, Volvo, Ford, Haldor Topsoe, and Lulea University in 2016 to update the GREET lifecycle analysis of DME. When using renewable feedstocks, the updated GREET analyses estimated DME to offer 85-101% GHG reduction. DME has also been issued specifications by ASTM International and the International Organization for Standardization (ISO) to ensure that as DME is rolled out as a fuel the right standards and regulations are in place to ensure a stable high-quality supply chain.

2) DME for Propane Blending. The second way that DME can be used to put cleaner vehicles on the road and decarbonize transportation is to blend it with propane for use in propane-powered vehicles. Up to 20% DME can be blended with propane with no changes required to the vehicles or fueling infrastructure. As mentioned, under ambient conditions, DME is a gas that can be stored as a liquid under moderate pressure, making it ideal for blending with propane.

As calculated by the California Air Resources Board, the current carbon intensity (CI) score of propane is 83 gCO_2e/MJ. CARB has calculated that, when DME is made from dairy biogas (which itself has a CI of -150), DME has a CI value of -278. With only a 5% blend (based on energy content) of DME, propane's baseline CI value decreases from 83 to 65, and at a 20% blend the CI value decreases to just 11, enabling propane to approach carbon neutrality in an economic manner using the same vehicles and fueling infrastructure. Particularly during the current economically challenging time, the ability to continue to achieve carbon reductions cost-effectively with existing assets is extraordinarily powerful.

The combination of DME's handling properties, its ability to be produced from diverse, abundant, renewable resources, and its significant greenhouse gas-reducing qualities make it an excellent choice for blending with propane in the transportation sector and beyond.

3) DME as a Hydrogen Carrier. The third way in which DME can decarbonize transportation is as a hydrogen carrier. DME is an excellent carrier molecule for transporting hydrogen to power a new generation of light- and heavy-duty fuel-cell electric vehicles and to provide increased supplies of renewable hydrogen:

- DME is particularly dense in hydrogen, with six hydrogen atoms on each DME molecule.
- DME can be made from a wide variety of renewable feedstocks, creating a new pathway for renewable hydrogen production.
- DME liquefies at low pressure (~73 psi), making it much easier and less expensive to transport than hydrogen, which can need to be compressed at up to 10,000 psi of pressure. Extracting hydrogen from DME is a relatively simple, inexpensive process compared to natural gas to hydrogen conversion.

Discussion. Even the most rapid transition to an electrified transportation system envisioned in SB 100 and the Governor's recent Executive Order indicates that tens of millions of light-, medium- and heavy-duty vehicles will continue to be fueled for decades by liquid fuels, including innovative, ultra-low-carbon or carbon-negative fuels in development. To secure GHG reductions and air quality improvements in the gap between the present and a future date – when the state aims to have zero-emission vehicles be the predominant transportation mode – California needs to focus on and incentivize innovative, ultra-low-carbon or carbon-negative fuels that can deliver immediate health and environmental benefits to the state and its residents. Supporting the production of powerful molecules such as DME that can be used today to achieve carbon reductions and pave the way for in-state renewable hydrogen production going forward will help the state continue to lead the world in innovative solutions for climate change.

Recommendations

- **Accruing CI Credits for New, Innovative Fuels** – New, innovative fuels do not have the same Carbon Intensity (CI) credit advantage as incumbent fuels, which can capture CI credits up front due to legacy production capacity and existing fuel pathways, whereas new fuels cannot. New, innovative fuels have additional costs to build production capacity and infrastructure but are delayed compared to incumbent fuels on the ability to accrue credits. We recommend granting innovative fuels the ability to capture and trade in CI credits upfront, based on CI pathway emissions modeling, as opposed to requiring three months of production emissions data before being allowed to accrue any credits. The plus-or-minus accounting for the upfront credits can be done at the first reporting period.
- **Book & Claim Accounting** – Please clarify the suggested methodology for book-and-claim accounting when biomethane pulled from the pipeline is chemically converted to H2.

For almost 10 years, Oberon has appreciated the opportunity to work with the CARB team on how to launch innovative fuels like DME into the California market and to ensure the proper regulatory framework is in place. Thank you for your consideration of our comments, and we look forward to continuing to work with CARB to move our state towards carbon neutrality.

All the Best,

Rebecca Boudreaux

Rebecca Boudreaux, Ph.D.
President and Chief Executive Officer