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California Air Resources Board
Attn: Rajinder Sahota & Jim Duffy
1001 I Street
Sacramento, CA 95812

RE: Comment in Response to Implementation of Low Carbon Fuel Standard (LCFS) Guidance 19-06: Efficiency Standard for Dairy Biogas to Electricity Pathways

Dear Ms. Sahota and Mr. Duffy,

Maas Energy Works, Inc. ("Maas") appreciates the opportunity to provide written comments in response to the public LCFS workshop held by CARB Staff on 10/14/2020. Maas is an owner and developer of dairy biogas to electricity and renewable natural gas projects in California. We are thankful for Staff's efforts enabling carbon-negative electricity from dairy digesters to be used for electric vehicle charging under the Low Carbon Fuel Standard. Our comments herein are in reference to the May 2019 Low Carbon Fuel Standard (LCFS) Guidance 19-06: Determining Carbon Intensity of Dairy and Swine Manure Biogas to Electricity Pathways, specifically the implementation of a CI adjustment factor for project specific electrical efficiency. Maas operates dairy digester generators with nearly every digester type in seven separate jurisdictional air authorities in multiple states. We have experimented with a variety of technologies, and this letter provides suggestions based on that experience.

Per conversations with CARB Staff, we support the adoption of a "benchmark efficiency" standard, or similar incentive, to encourage the industry to employ the cleanest, most efficient technologies available to beneficially use dairy methane emissions. We continue to be surprised, however, at CARB Staff's selection of a 50% efficiency standard for implementation into the LCFS Regulation since this level has not been achieved by any existing biogas technologies. We worry that placing too high of an efficiency standard will result in substantially reduced LCFS credits to most or all dairies that participate, and thus fewer projects built—especially on smaller dairies.

The 19-06 guidance document states the 50% efficiency standard is reasonable based on the "average efficiency of NG-derived electricity at California Power Plants…". However the document referenced, a California Energy Commission (CEC) staff paper "Thermal Efficiency of Natural Gas-Fired Generation in California, 2017 Update" demonstrates that the California average efficiency is not 50%, but rather is just 44% (see Table 3 from the CEC report below: (3,412 BTU/kwh divided by State Total heat rate of 7,761 BTU equals 44%).

Table 3: California Natural Gas-Fired Power Plant Summary Statistics for 2016

Category	Capacity (MW)	Share of Capacity	Energy (GWh)	Share of Energy	Capacity Factor	Heat Rate (Btu/KWh)
State Total (All Types)	44,224	100.0%	105,820	100.0%	25.4%	8,680
State Total (w/o Cogeneration)	38,388	N/A	80,659	N/A	22.3%	7,761
Combined-Cycle	20,026	45.3%	71,172	67.2%	40.5%	7,338
Aging	8,636	19.5%	3,892	3.7%	3.9%	12,312
Peaking	8,898	20.1%	3,898	3.7%	5.0%	10,269
Cogeneration	5,836	13.2%	25,161	23.8%	48.7%	11,627
Miscellaneous	828	1.9%	1,697	1.6%	23.3%	9,296

Source: QFER CEC-1304 Power Plant Data Reporting.

The most efficient technology on in the CEC report was Combined Cycle Gas Turbine, or "CCGT." This technology achieved only 46.5% efficiency. Putting aside the fact that 46.5% is less than 50%, it is highly questionable whether performance achieved by a CCGT is therefore achievable by any dairy digester. As page 6 of the referenced CEC report makes clear, the average size of a California CCGT is 571 MW (the report says California has 35 CCGT's, with a combined 20,000+ MW). In comparison, the average digester engine installed in California is about 0.8 MW. In addition to being about 700 times larger than a digester generator unit, a CCGT runs on pipeline natural gas that is already purified, cleaned, dried, compressed, and delivered on a steady and continuously available basis. None of these factors apply to a dairy digester generator, and thus the "theoretical maximum" conversion to electricity from a digester biogas generator is much less than a pipeline-fed, utility-scale CCGT.

Other than the CCGT technology, all remaining natural gas generation technologies listed on the CEC report are in fact quite similar to digesters in size and employment, such as Peaking systems. These technologies have efficiencies that range from 27.7% to 36.7% (see again Table 3 from CEC report, above). Consequently, a benchmark efficiency standard of just 37% would exceed the efficiency of every installed NG technology category in the state, other than CCGT. Thus, a 37% benchmark efficiency standard would already meet CARB's goal in providing an incentive to increase efficiencies of all categories of biogas generation equipment above the industry average for natural gas.

The 19-06 guidance also states that solid oxide fuel cells can achieve 50%+ efficiency. To document this statement, 19-06 quotes two scholarly articles from Sciencedirect.com. Both articles are pure research into theoretical performance of systems to produce mathematic models showing high efficiency. They are not case studies of any deployed technology and they do not include any field data or even bench-scale tests of experimental equipment. The references are replete with warnings about the challenges faced in actually deploying these future, theoretical systems. It is telling that no real-world biogas fuel cells examples are available to be cited by 19-06. In practical experience, fuel cells have been tried unsuccessfully at two major California biogas sites: City of Tulare Wastewater Treatment Plant and Inland Empire Utilities District digester. Both were built at great cost and later abandoned. No dairy digester is known anywhere in the country to have successfully deployed commercial fuel cells. The 19-06 cites these studies to say 50% efficiency is achievable, but the introduction to the second article conversely states:

"Although the SOFC-gas turbine cycle was first proposed over 30 years ago, the

technology has not yet left the demonstration phase [12,29,30]. Moreover, no system has demonstrated the record level efficiencies predicted from system calculations…"

Just so. CARB and Air District benchmarks are traditionally based on technologies that meet demonstration standards such as "Achieved in Practice" or "Best Available Control" or result in some recognized technology demonstration, often overseen by CEC or other agencies to show real world data. Biogas fuel cells have met none of these tests, even in highly controlled environments, and 19-06 does not even claim otherwise.

Farmers' willingness to install digesters depends on their confidence that the associated technologies are proven and can be reliably maintained in a farm setting. The vast majority of small and medium sized farms cannot afford a fuel cell, which in many cases costs more than the dairy facilities themselves. American dairies, almost without exception, have used lean burn internal combustion engines with air-district compliant emission catalysts, which operate at 30-35% efficiency under the best possible real-world circumstances. Thus the 50% benchmark efficiency standard results in a 30-40% penalty on LCFS credits received per cow on dairies in the LCFS program—unless those dairies can locate and install fuel cells that actually achieve this unprecedented level of efficiency. Effectively, the 50% requirement is a penalty on all dairies except the largest and most well-funded dairies. The result will be an incentive to experiment with expensive systems on just a few large dairies that can install and maintain highly complex, unproven equipment—likely with large state grants to subsidize the capital cost.

The recent history of digester development already confirms this trend of digesters biased heavily towards large dairies. Other than a some of our company's own clients, 100% of digesters installed since 2014 have been on dairies over 3,000 cows. The 50% efficiency benchmark will exacerbate, not reverse this trend. Four fuel cell digesters were proposed on the 2019 CDFA dairy digester grants, all by the same developer, all with the same fuel cell vendor, on some of the largest dairies in the state. The requested sizes were 3.5 MW, 2.0 MW, and 1.2 MW and 3.5 MW, each needing the maximum $3,000,000 in state grants to proceed. Only a tiny fraction of California dairy herds are large enough support digesters of this scale (and even these appear to need very large grants).

EV charging (without the 19-06 benchmark efficiency reduction in credits) offers the first profitable opportunity for smaller dairies to the enter the digester market—especially those dairies not near a dairy pipeline "cluster," and especially for dairies that have not been able to secure the state grants that so far have tended to fund large, clustered dairies. We should not miss this opportunity to encourage farmers to invest in technology to mitigate manure emissions. We propose the following alternatives tools to modify the proposed 50% benchmark efficiency standard.

1. Use a benchmark efficiency standard of 37% for digester generators below 1 MW capacity, and 50% for larger generators.

2. Set the benchmark efficiency standard for all sites to 37%, until such time as a California dairy has demonstrated higher real-world efficiencies, with comparable up-time, for a 24-month period necessary for a certified LCFS pathway. Make the demonstrated efficiency the new standard thereafter, perhaps with a phase-in period or small-digester exemption. CARB Staff has enough data now through certified dairy biogas to electricity pathways to determine a realistic and accurate efficiency benchmark.

Each of these approaches may have various attributes for CARB Staff to consider, and the ultimate plan may involve a combination of these and other elements. To achieve the various goals of the state, we suggest that the best program will consider what is technologically possible for California dairies to achieve.

We look forward to collaborating with CARB Staff to implement an appropriate solution.

Sincerely,

Daryl Maas

Chief Executive Officer