DOCKETED	
Docket Number:	19-ERDD-01
Project Title:	Research Idea Exchange
TN #:	243540
Document Title:	Marine BioEnergy Inc Comments
Description:	N/A
Filer:	Chester Hong
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	6/15/2022 3:17:45 PM
Docketed Date:	6/15/2022

Marine BioEnergy, Inc, a Public Benefit Corporation
Cindy Wilcox, cindy.wilcox@marinebiomass.com, 818.952.6018
www.marinebiomass.com

California Energy Commission, Docket #19-ERDD-01

Communities, Equity, and Environmental Workshop Regarding Establishing a Long-Term Gas Research Strategy to Achieve Aggressive Statewide Carbon Neutrality Goals

Spinning generators are the backbone of the modern electric grid system. With carbon-neutral feedstocks, the spinning generators can meet the goals of "establishing a long-term gas research strategy to achieve aggressive statewide carbon neutrality goals"

Marine BioEnergy is proposing to grow millions of tons of Giant Kelp (brown seaweed) on open ocean farms towed by drone submarines. We are funded by US Dept of Energy, Advanced Research Projects Agency – Energy (ARPA-E). The kelp will be digested into methane for renewable energy. With adequate nutrients, Giant Kelp grows a foot a day and does not require land, fresh water or artificial nutrients or pesticides.

The kelp absorbs CO_2 from the surface of the ocean (and atmosphere) while it grows and releases the same CO_2 after it has been digested into methane, injected into the pipelines and burned to run the spinning generators on days of low wind and low sun. Then the CO_2 is absorbed again by the ocean farms in a carbon-neutral cycle.

Kelp has been demonstrated to be a reliable feedstock in a digester system at bench-scale by CR&R, Inc.[1] The kelp performed 5% better when compared to the normal feedstock of lawn & garden cuttings. Once digested, CR&R cleans up the bio-gas (removes sulfur, etc), injects the methane into the regional pipeline to supplement and eventually replace fossil methane. Users of the pipeline methane will never need to change out their equipment or appliances, and that includes the utility-sized spinning generators. All consumers will seamlessly become green energy consumers – most won't even be aware of the upgrade – and in many ways, that makes kelp methane a great solution.

CR&R takes the remainder of the feedstocks, chops it evenly, and sends it to home improvement stores for soil supplements. In particular, Giant Kelp is high in potash, which is of high value. The remaining liquid is run back through the digester – nothing goes to the landfill or sewer.

We agree that, as part of making a sustainable system, the gas pipeline owners must maintain the pipelines and storage systems. This requires that the infrastructure gets regular maintenance to prevent leaks, and a commitment to scheduled leak detection and repair using proven technologies.[2]

The key risk for the open ocean farms has been retired and results published in a peer-reviewed journal under an ARPA-E award (DE-AR0000689).[3] The key technology addresses the fact that the surface waters of the open ocean do not contain nutrients. The deeper cold water has plenty of nutrients, starting at the thermocline (~150 meters) and all the way to the bottom (~4,000

meters on average). When the kelp was surfaced during the day to absorb sunlight and submerged at night to absorb nutrients, Giant Kelp thrived, producing four times more biomass when compared to the controls. This paves the way for hundreds of ocean farms towed by drone submarines. The drones will surface the farms during the day to absorb sunlight and submerge the farms at night to absorb nutrients. The farms will also dive to avoid ships and major storms. The farms will rendezvous with harvesters 3-4 times a year. Giant Kelp is a year-round crop and is harvested by the haircut method, leaving the base of the plant to grow for the next harvest.

Marine BioEnergy has patented the depth-cycling concept and recently received next-round of funding from ARPA-E. Working with naval architects, marine engineers and dynamic modeling experts, the funds will be used to complete the design of the first farm. With approval from ARPA-E and additional matching funds from investors, Marine BioEnergy will continue working with subcontractors to build and test a first farm system. This new technology is putting the California in the lead for ocean-based renewable fuels.

The West Coast has existing digesters at numerous locations including:

- Hyperion serving Los Angeles waste treatment which sends gas to the adjacent Scattergood Power Plant
- Santa Barbara/Goleta, serving waste treatment and injecting in the pipeline
- Sacramento, serving waste treatment
- CR&R at Perris location, serving waste processing and injecting in the regional pipeline
- Digesters for cattle manure at various locations

Wind farms and solar farms are important renewable energy sources. However, the energy produced is intermittent, and the down-time can continue for more than a few hours or days at a time (see summary article on seasonal wind drought in Europe, 2021[4]). And yet the consumers are fully dependent on a reliable, affordable grid. With millions of tons of kelp available to digesters injecting into the pipeline, the gas pipelines can become renewable as rapidly as funds are available to deploy ocean farms. The methane storage will use the existing natural gas storage and pipeline systems. Additional storage is in "the kelp" that is growing on the farms at any given time. This will create seamless, continuous storage and availability of green methane to run the spinning generators - to maintain a clean, reliable, cost-effective grid system on days of low wind and low sun.

Employment for underserved populations:
Marine BioEnergy is planning to deploy ocean farms in coastal areas. These areas are often suffering from over-fishing. As a result, employment by the fishing fleets and related industries has been severely reduced. (The California 2019 catch was less than 1/5 the 2000 catch, measured in pounds.[5])

The ocean farms will require expertise and labor in many areas. We will be purchasing hundreds of thousands of meters of kelp seed string, which can be supplied by new companies or by companies that support the existing shellfish aquaculture industry. We will need engineers and technicians to assemble the drones and farm arrays, and later support the upgrade and overhaul of the farm systems (overhaul planned once every 7.5 years). Teams with ocean expertise will be needed to deploy the farms and to manage ships transporting the harvest. We will need a

software/communications/navigations team to run the "ocean traffic control" system, which will maintain contact with each farm several times a day, ensure that each farm avoid collisions with other farms and hazards, and monitors the rendezvous with the harvesters. Technical, marketing and sales team will assist in locating new customers and developing products.

Eventually, Marine BioEnergy expects to license the technology to other companies and countries. With the experience we will have developed deploying farms, we will train the new teams at our California location. The drones and farm components will be shipped to the licensees in containers, ready for final assembly at their location. In summary, Marine BioEnergy looks forward to building this industry in collaboration with coastal regions and unions, collaborating to help train people for these many skilled jobs.

Impact

As the CEC is probably aware, hard tech/clean tech projects are difficult to fund with private investment prior to the prototype test and demonstration. If CEC can assist with funding for the first demonstration of these promising projects, that will reduce the time to launch these new technologies.

Farming 5% of the oceans would allow replacement of all fossil fuels used globally. The existing fossil-fuel infrastructure (pipelines, ships, spinning generators, etc.) and existing long-haul vehicle fleets (trucks, ships and airplanes) can continue to be utilized with little or no modifications or lost investment. The kelp depth-cycling technology provides the long-term solution to achieve aggressive statewide carbon neutrality.

---

[1] https://crrwasteservices.com/sustainability/anaerobic-digestion/

[2] https://www.arpa-e.energy.gov/technologies/programs/monitor

[3] Ignacio A. Navarrete, Diane Y. Kim, Cindy Wilcox, Daniel C. Reed, David W. Ginsburg, Jessica M. Dutton, John Heidelberg, Yubin Raut, Brian Howard Wilcox. Effects of depth-cycling on nutrient uptake and biomass production in the giant kelp Macrocystis pyrifera, *Renewable and Sustainable Energy Reviews*, Volume 141, 2021, https://doi.org/10.1016/j.rser.2021.110747, https://www.arpa-e.energy.gov/technologies/projects/biofuel-production-kelp

[4] https://energypost.eu/climate-change-wind-droughts-and-the-implications-for-wind-energy/

[5] Commercial Fish Landings, CA, 2019 https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=178009&inline
Commercial Fish Landings, CA, 2000, https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=31476&inline