$100 Billion to Feed the World, Fuel the World, and Reverse Climate Change By 2100
OceanForesters, May 9, 2019

People have been considering uncoordinated non-synergistic programs to address each of these three big challenges facing humanity. OceanForesters' floating flexible reef ecosystem solves all three simultaneously. The table of opportunity below shows how long it takes to achieve each goal depending on the amount of investment.

Funding, initial	$10 M	$1 B	$100 B
Feed the world (all 9 billion people)	2050	2040	2030
Fuel the world (replace all fossil fuels)	2100	2080	2050
Reverse climate to 1980 (350 ppm)	2300	2200	2100

Feed the World is accomplished with restorative aquaculture[1] replacing capture fisheries and the unsustainable type of aquaculture that feeds fishmeal to penned finfish. Restorative aquaculture involves building floating flexible reefs growing locally appropriate plants: seaweed, seagrass, or coral. The plants are fed inexpensive plant fertilizer and/or recycled nutrients. Sunlight and photosynthesis convert the plants' primary productivity into a locally-desired blend of seafood, such as free-range finfish, conch, lobster, shellfish, sea cucumbers, octopus, sponges, seaweed. OceanForesters' has co-written proposals and results publications with over a hundred top experts in the world.[2]

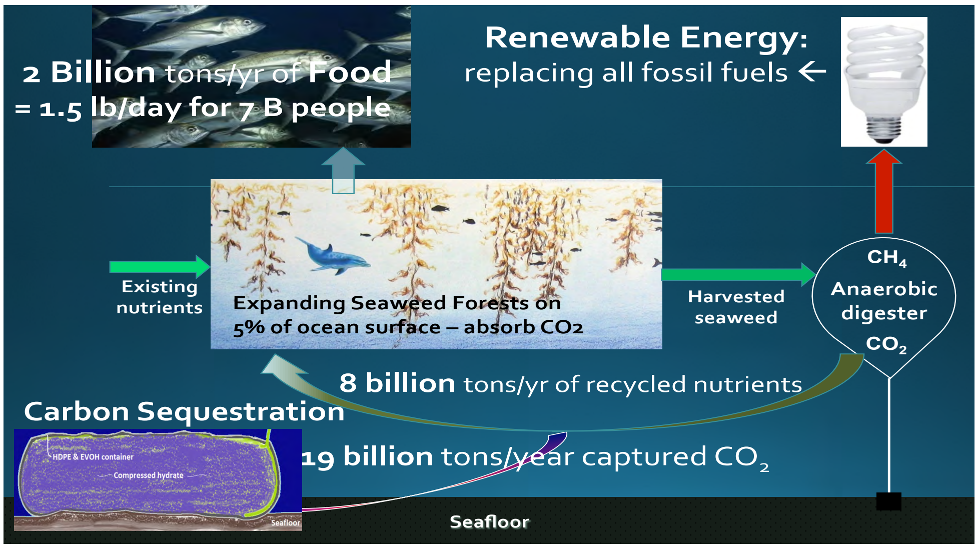
Favorable economics, see figure at right, mean that restorative aquaculture reefs can grow geometrically based on profits. The plant nutrients can come from pasteurized people-waste. This allows the reefs to directly address at least nine UN Sustainable Development Goals.[3] Together, the continental shelves in the Gulf of Mexico and the Gulf of Thailand provide more than enough ocean area to feed the entire planet, with only 0.006% of the world's oceans. However, it's better if many coastal communities each own a few of the 100,000 20-ha reefs needed to feed the world.

Fuel the World is accomplished by harvesting a seaweed-for-biofuel crop from the flexible floating reefs. Seaweed can be harvested for biofuel with negligible impact on high-value seafood production, as explained in this report to the U.S. Department of Energy's Advanced Research Projects Agency-Energy[4]. The economics of seaweed-for-biofuel are challenging, but the

[1] See presentation to WorldAquacultureSociety,March2019: https://drive.google.com/file/d/1Ihr1vLW7L9EXlN7Wealoh2xi750dFAOt/view?usp=sharing
[2] See bios, testimonials and list: https://drive.google.com/open?id=15Os1VqhKxGbFHTHP6SrYso2UPjzpss0g
[3] See summary: https://drive.google.com/open?id=1WI-qHhPJ9CdDtWtYkVuQ0zm4COQbNg9b
[4] OceanForesters developed the ideas and organized the teams that were awarded a total of $1 M for two successful ARPA-E MARINER Phase 1 seaweed-to-biofuels projects. A team member has been operating a prototype at the University of New Hampshire for over a decade. See Phase 1 Final Report DE_AR0000916, posted here: https://drive.google.com/open?id=1uIudPOFZi1qZCXSbQq_vSZuDFmkSqio_

OceanForesters team, working with CleanCarbon Energy[5], believe they can produce a low-sulfur marine biofuel for $70/barrel. The CleanCarbon Energy process can be economically scaled as an "organic waste recycling process" with income from waste tipping fees[6], biocrude oil, biochar, plant fertilizers, and clean water. Replacing all fossil fuels requires 40 million flexible floating reefs covering 2% of the world's oceans, equal to the area of Australia, supplying compatible seaweed-to-biofuel facilities.

Reverse Climate Change is accomplished by capturing and sequestering bio-CO_2. Bio-CO_2 is produced when biofuel burns in an engine[7]. The figure below, based on our peer-reviewed scientific publication[8], shows one of many possible nutrient cycles spinning off food and biofuel while reversing climate change.



The economics of reversing climate change are equally challenging. The advantage of floating flexible reefs is that the food and energy production is paying for the direct air capture by photosynthesis. When the bio-carbon is released by burning the biofuel, the resulting concentrated CO_2 is relatively inexpensively captured. For example, the Allam Cycle[9] can make electricity while, without extra expense, also produce pure liquid CO_2 for sequestration.

The biofuel from 40 million flexible floating reefs would enable sequestering 30 billion tons of bio-CO_2 per year. The seaweed-to-biofuel-to-sequestered CO_2 would be decreasing atmospheric CO_2 concentration. It will take 30 years to remove a trillion tons. There are many sequestration options which can accommodate this volume of CO_2, including OceanForesters' low-cost, permanent, easily-monitored CO_2 sequestration on the ocean seafloor.[10]

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[5] See: https://www.facebook.com/cleancarbonenergy/

[6] "Tipping" fees are what landfills and compost facilities charge to accept waste.

[7] Some seaweed-to-biofuel processes produce by-product CO_2 that is easily captured and sequestered.

[8] "Negative carbon via Ocean Afforestation." N'Yeurt, A.de R., Chynoweth, D.P., Capron, M.E., Stewart, J.R., Hasan, M.A., 2012. *Process Safety and Environment Protection*, Vol. 90, p. 467-474: http://dx.doi.org/10.1016/j.psep.2012.10.008, https://drive.google.com/open?id=1DiZ14teC1DUdoMTTt4Mp817BJGUWOsOW

[9] The Allam Cycle uses supercritical CO_2: https://www.ammoniaenergy.org/the-allam-cycles-nexus-with-ammonia

[10] Secure Seafloor Container CO_2 Storage Mark E. Capron, P.E., Jim R. Stewart, PhD, and R. Kerry Rowe, PhD, OCEANS'13 MTS/IEEE San Diego Technical Program #130503-115 (2013) DOI: 10.23919/OCEANS.2013.6741182. Paper at https://drive.google.com/open?id=1VeEZ2s2rdELwrP7F_mc_75bPefjX7_v8