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Carbon Capture, Utilization,
Storage, and Oil & Gas Technologies
Integrated Review Meeting



Beneficial Reuse of CO₂ from Coal Fired Power Plants for Production of Animal Feeds

U.S. Department of Energy, Office of Fossil Energy, NETL (Andy Aurelio)
Cooperative Agreement DE-FE0031717, 2019 –2020



MicroBio Engineering, Inc.
San Luis Obispo, California

Tryg Lundquist, Ph.D., P.E., CTO
Principal Investigator for the Project

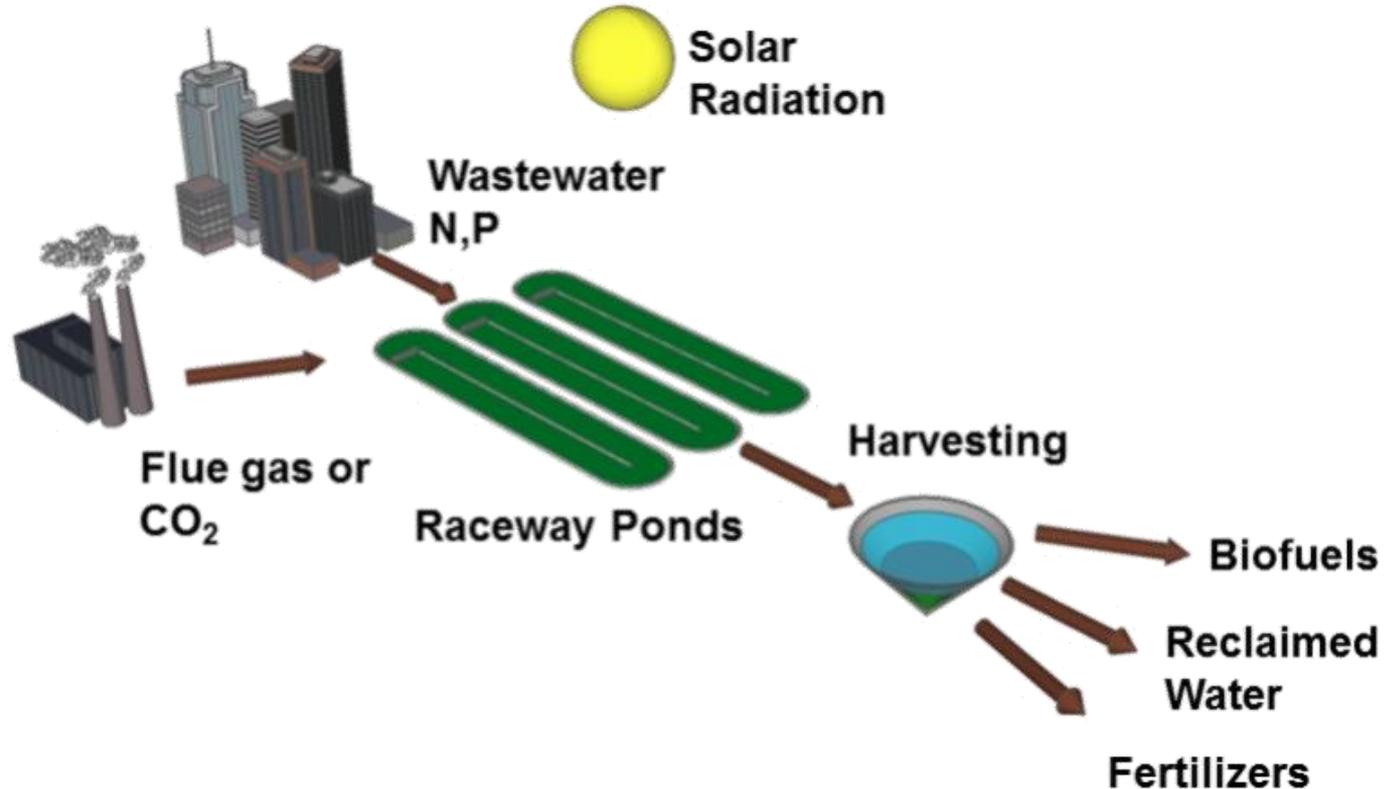


Pittsburgh, Pennsylvania | August 29, 2019

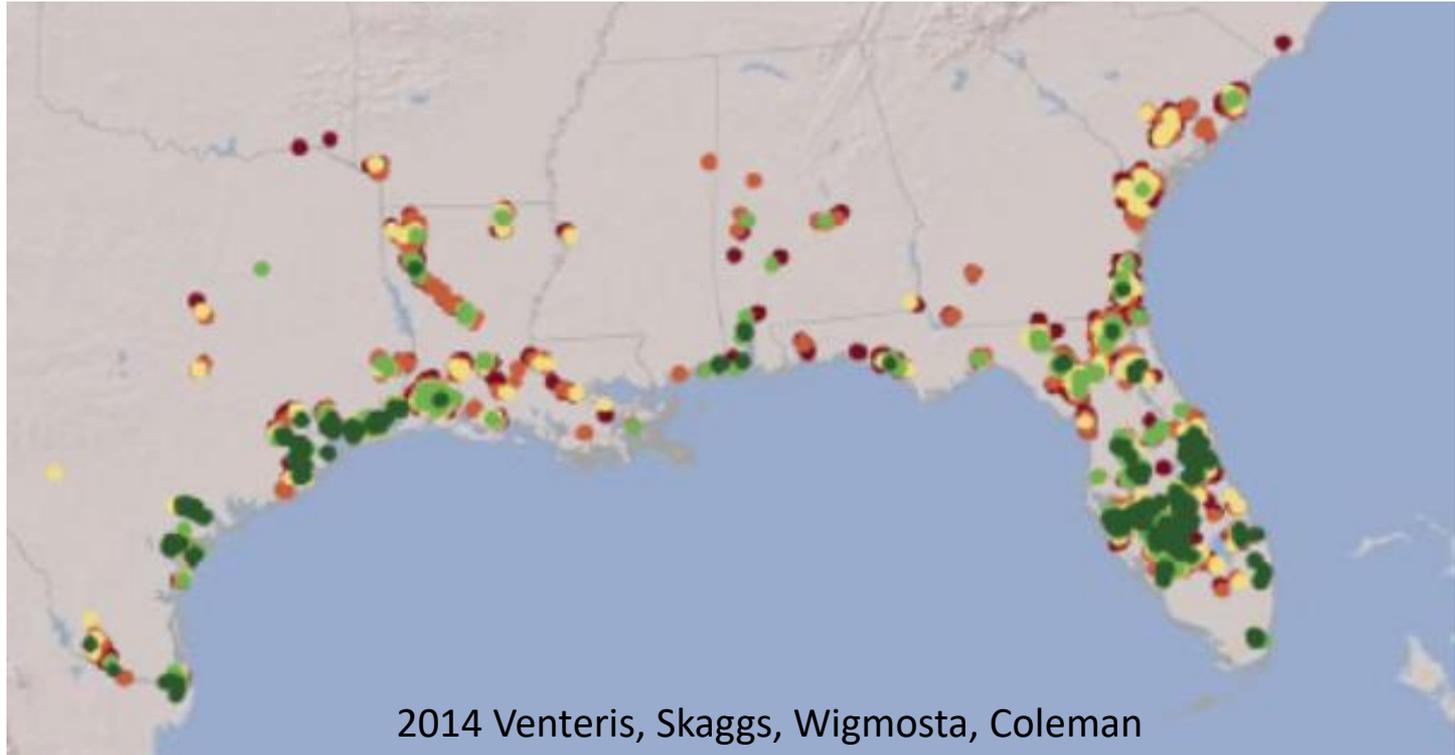
The Technology: MicroBio Engineering RNEW[®] Process

Algae wastewater treatment with commodity production: recycled water and biomass for animal feeds or biofuels+biofertilizers

Recycle
Nutrients
Energy
Water



The Location: Florida has great potential for algae farming: sun, water, warmth ... and, at Orlando Utilities Commission, flat open land + flue gas.



2014 Venteris, Skaggs, Wigmosta, Coleman



**Global
Thermostat**

Phase-2 Project Participants

- **MicroBio Engineering Inc.**
 - Lead, cultivation, TEA, LCA
- **Orlando Utilities Commission**
 - Customer, site hose
- **Cal Poly State University**
 - Feeding trials
- **University of Central Florida**
 - Carbon mass tracking
- **Global Thermostat**
 - Flue gas transport scale-up design



- Facility Designs
- Algae Equipment
- Research and Development
- Business Consulting
- Techno-Economic Analyses
- Life Cycle Assessments
- 27 staff members

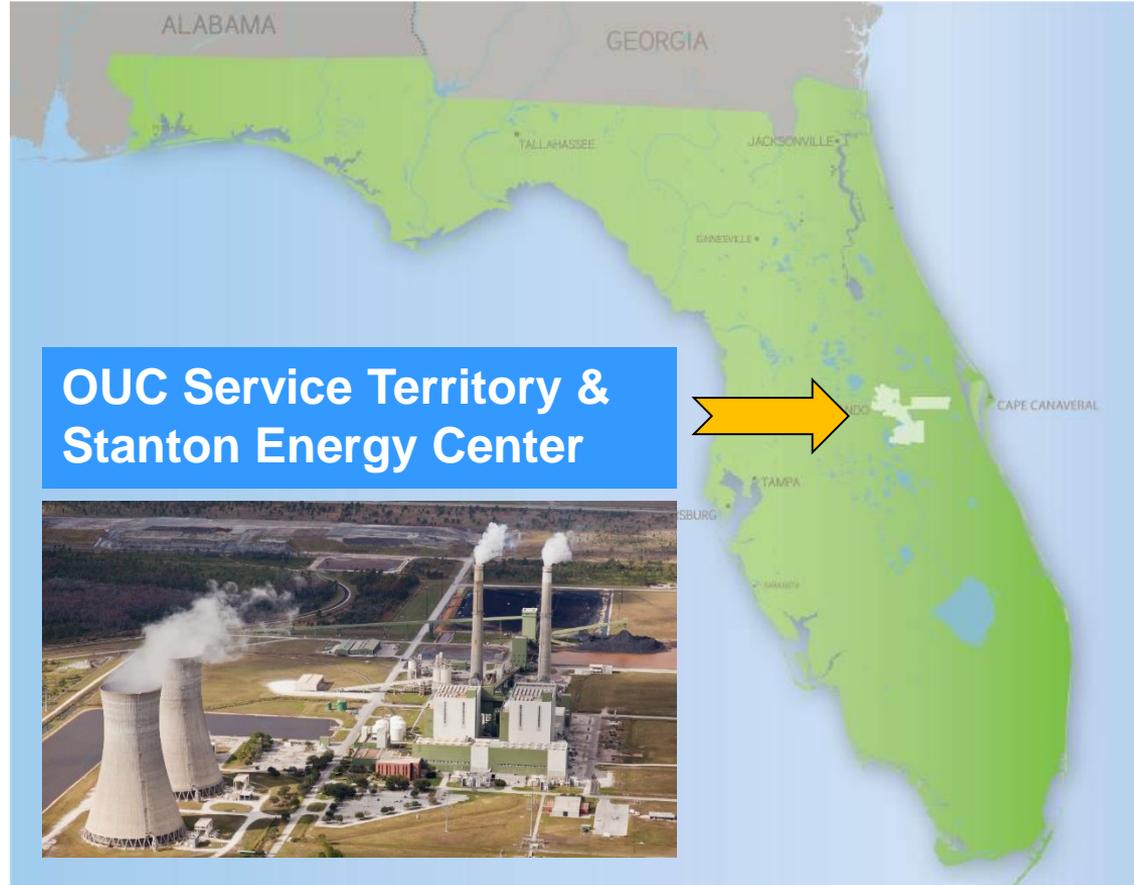




Orlando Utilities Commission

The Reliable One

- **Coal-fired power plant**
 - 900-MW, completed 1980
 - 4:1 turndown on coal
 - Coal, biogas, natural gas
- **Electric Service**
 - 210,000 meters
- **Water Service**
 - 135,000 meters
- **Central cooling plant**
- **Photovoltaic farms**



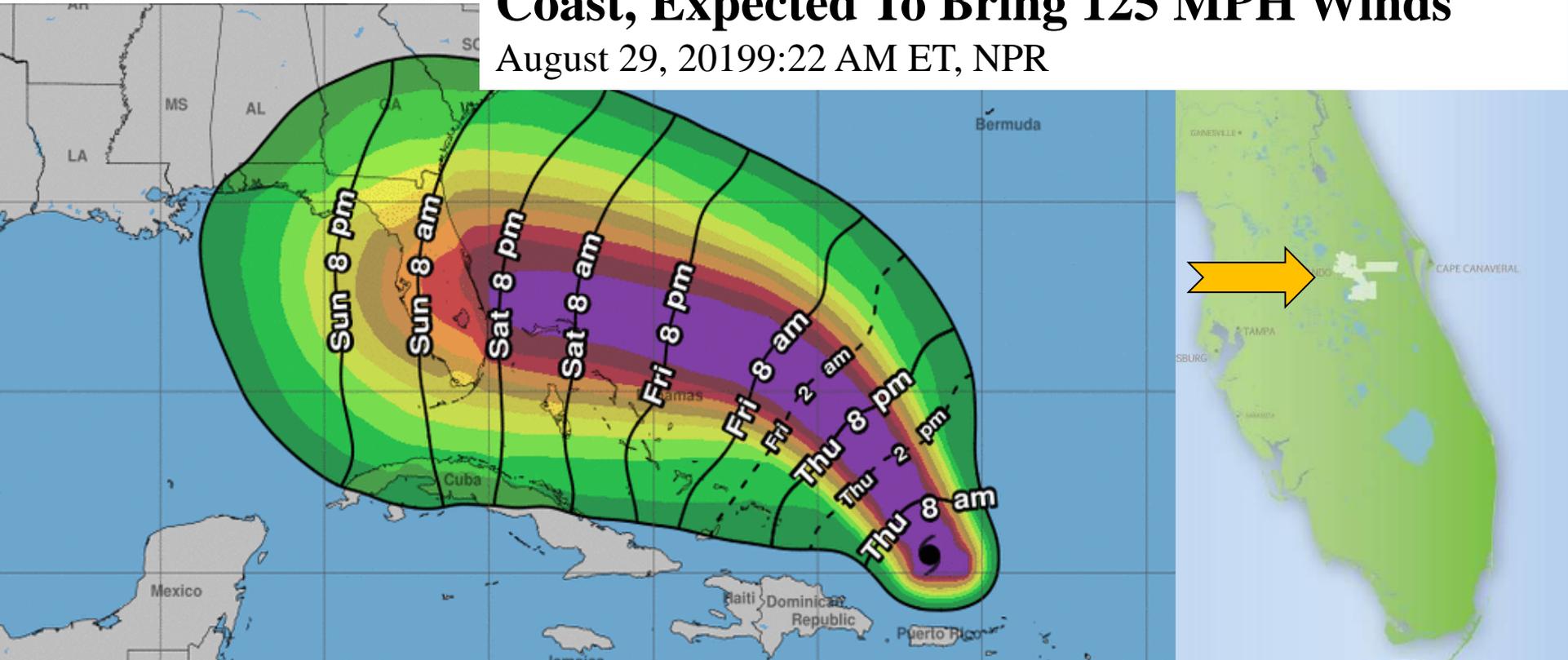


The *Reliable One*

Orlando Utilities Commission

Hurricane Dorian Churns Toward Florida Coast, Expected To Bring 125 MPH Winds

August 29, 2019 9:22 AM ET, NPR



Two Scenarios for CO₂ utilization were evaluated in Phase-1.

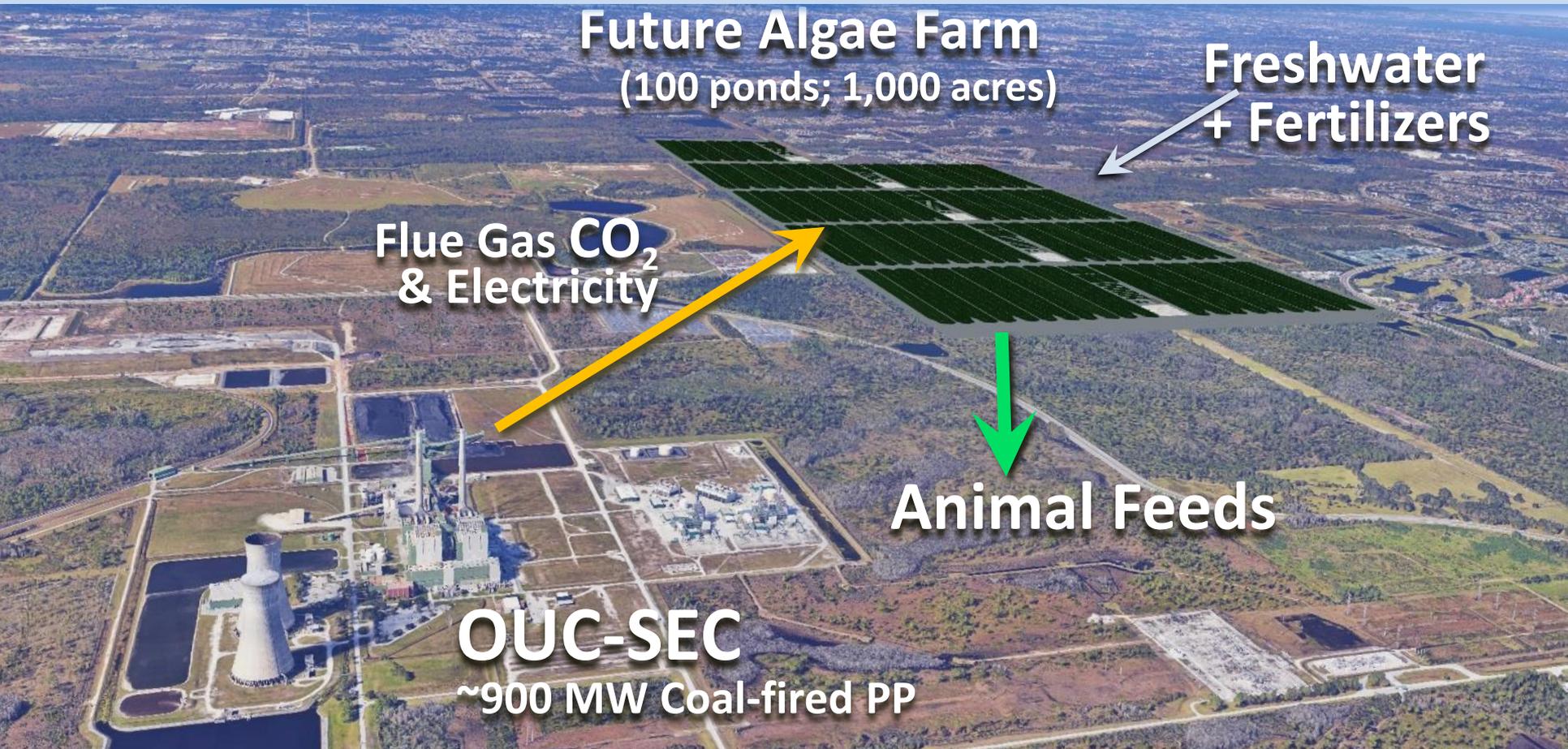
Biogas / Renewable natural gas production in conjunction with wastewater treatment & carbon credits



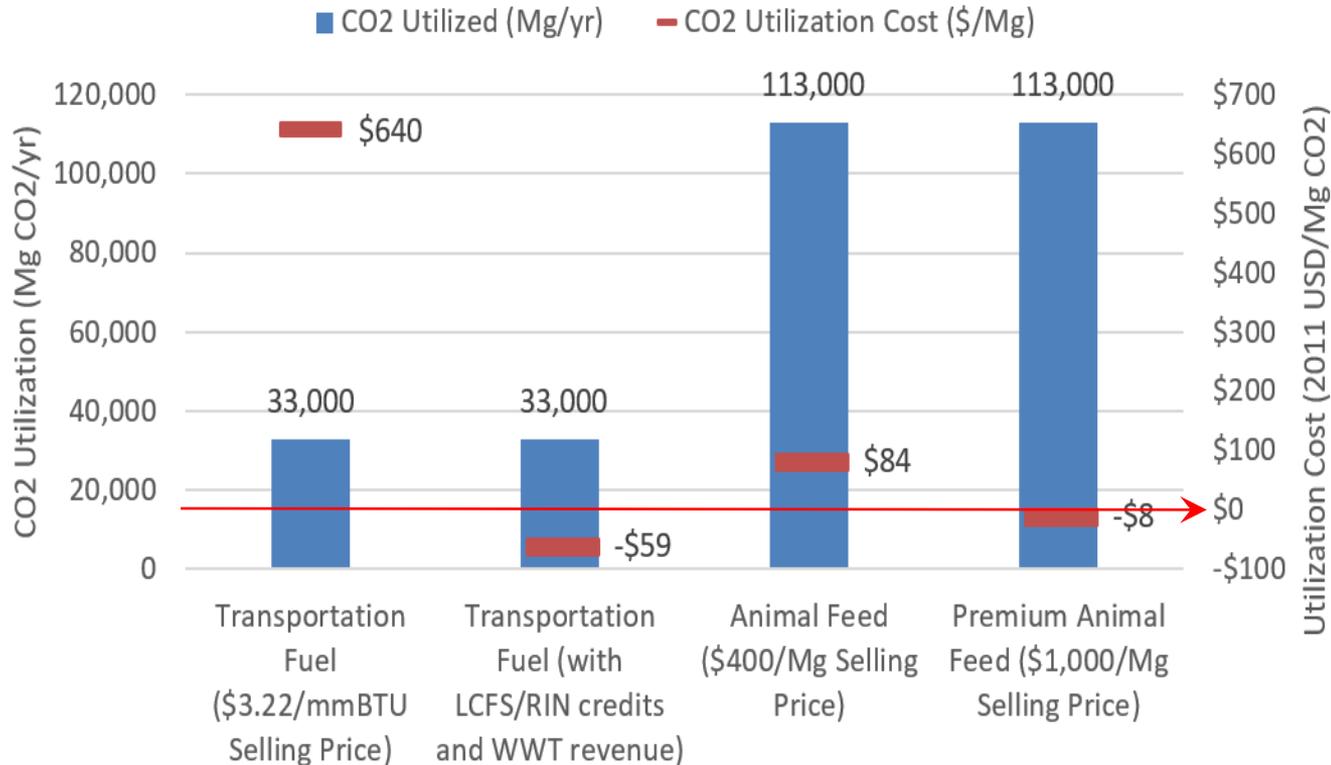
Commodity animal feeds production for large market. Offset GHG emissions from new soybean farming



Case 2. Algae animal feed production design



Phase-1 Project Conclusion: Premium animal feeds increase utilization at a lower cost.

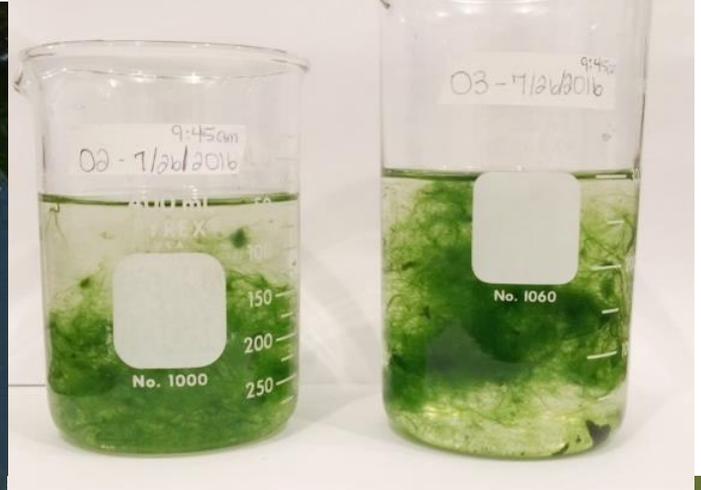


- 400-ha farm
- Orlando
- Breakeven at \$1,000/Mg algae
- Therefore, algae must be a premium feed with omega-3 fatty acids, nutritional pigments, etc.

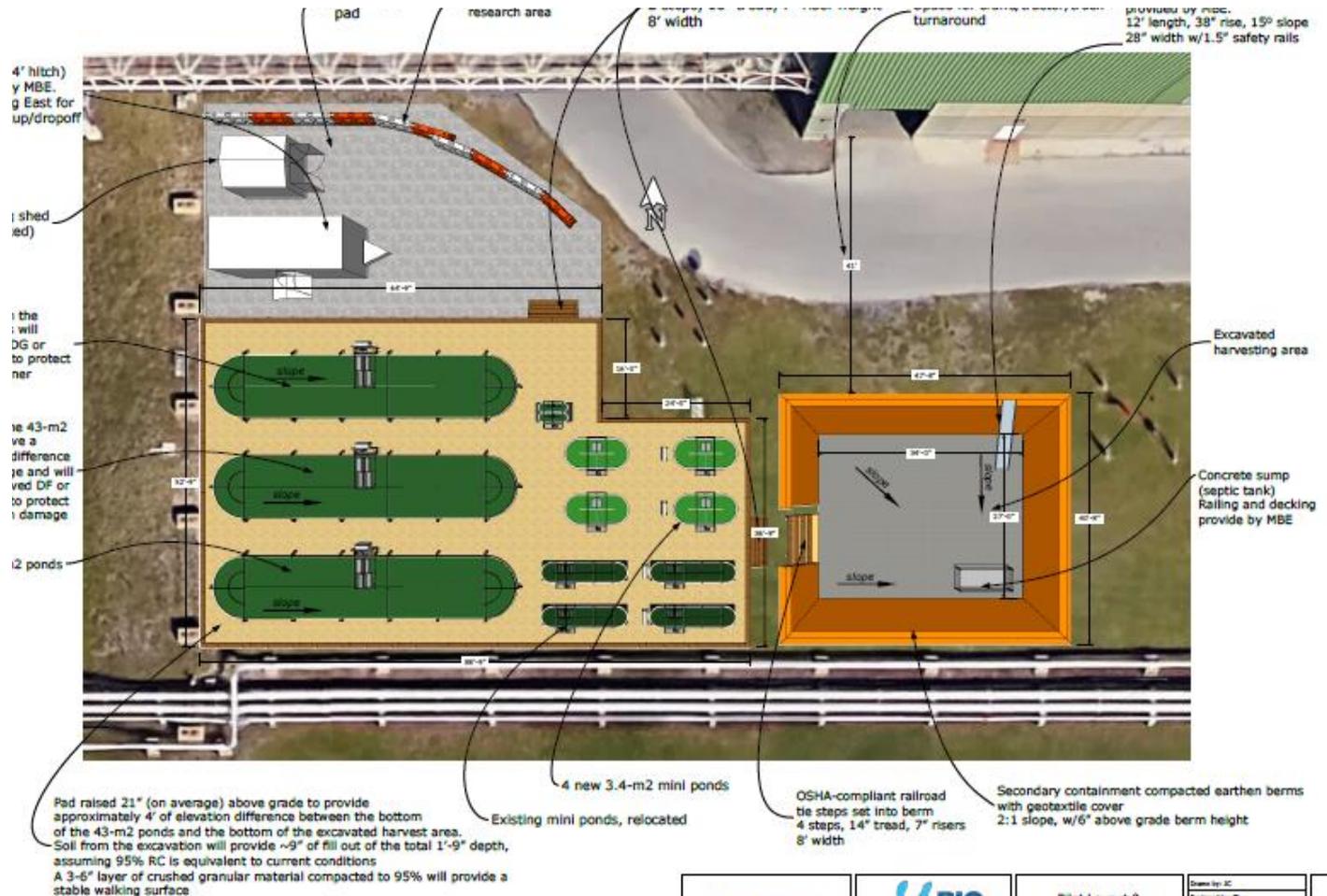
Phase-2 Technical Tasks

- **Task 2: Strain selection, cultivation, optimization and biomass analysis in lab and small raceways (MBE)**
 - Goal: highly productive, robust and stable strains in outdoor cultures
- **Task 3: Algae feed production using flue gas CO₂ (MBE/OUC)**
 - Goal: Efficient and low cost harvesting, dewatering and drying
- **Task 4: Carbon balances during algal flue gas utilization (UCF)**
 - Goal: Determine the carbon utilization efficiency using mass balances.
- **Task 5: Poultry feeding trials with algal biomass (Cal Poly)**
 - Feed manufacturing and layer & broiler chicken feeding trials
 - Goal: Determine value of algae component for feed
- **Task 6: Engineering design, techno-economic and life cycle assessments (MBE/OUC/GT)**
 - Goal: Use project outcomes to evaluate the economic and environmental impact potentials of the process.

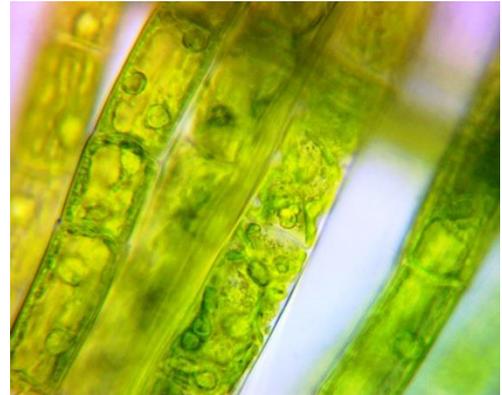
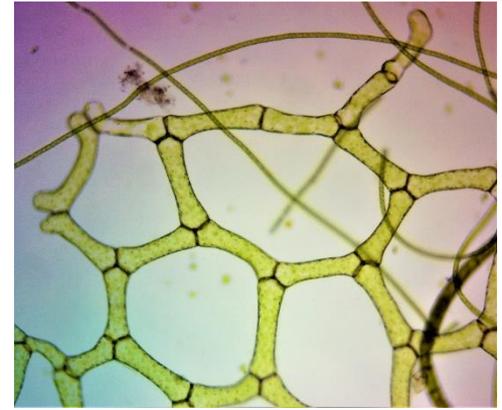
Focusing on filamentous algae for easy biomass harvesting.



Site plan includes production and experimental raceways, and harvest area.



Strain selection and small pond cultivation underway. Large pond installation after Dorian.





Thank you!

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