USE OF MICROALGAE FOR WASTEWATER TREATMENT AND PRODUCTION OF RENEWABLE BIOFUELS

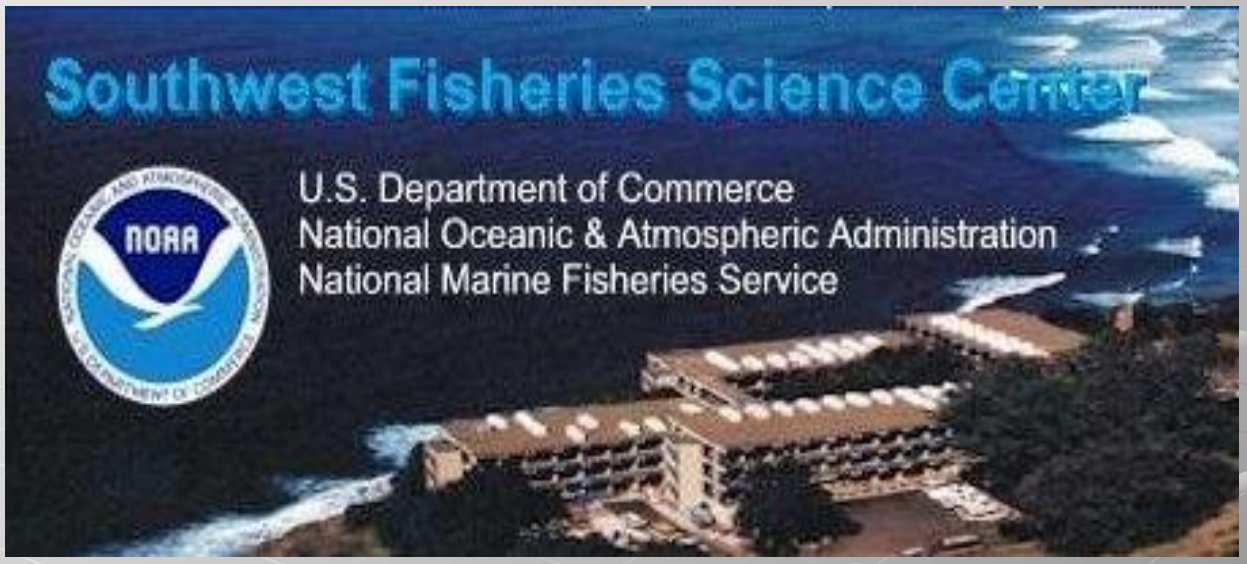
Kent BioEnergy Corporation

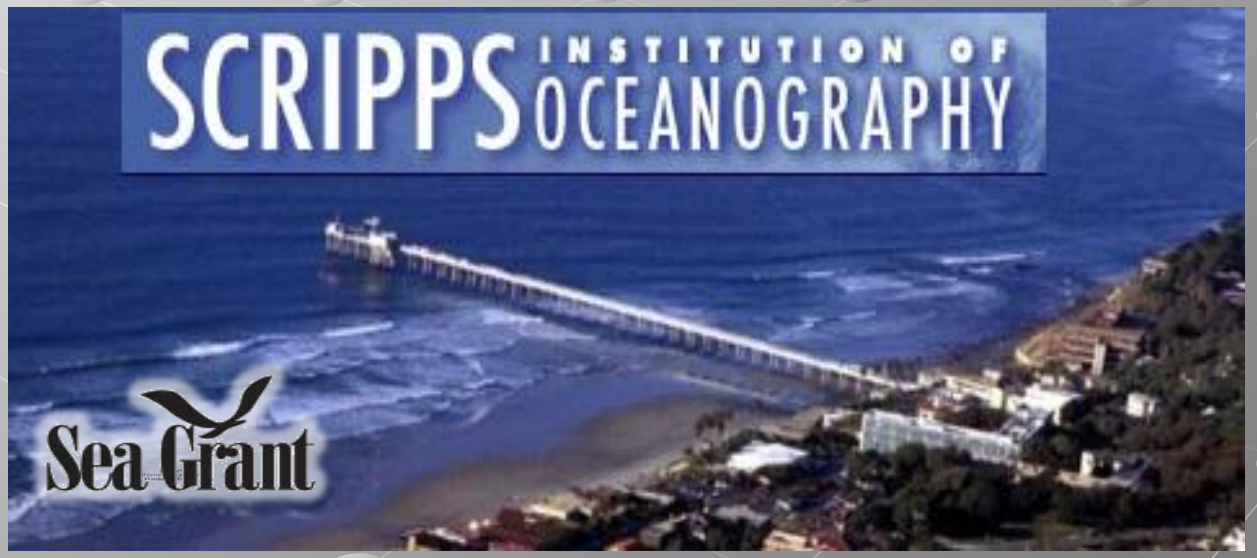
WESTCAS 2010 – San Diego, CA, June 18, 2010

Dr. James C. Levin, Director of Molecular Studies

CONTROLLED EUTROPHICATION PROCESS (CEP) FOR TREATING AQUACULTURE DRAIN WATER

INITIAL RESEARCH SUPPORTED BY SEA GRANT

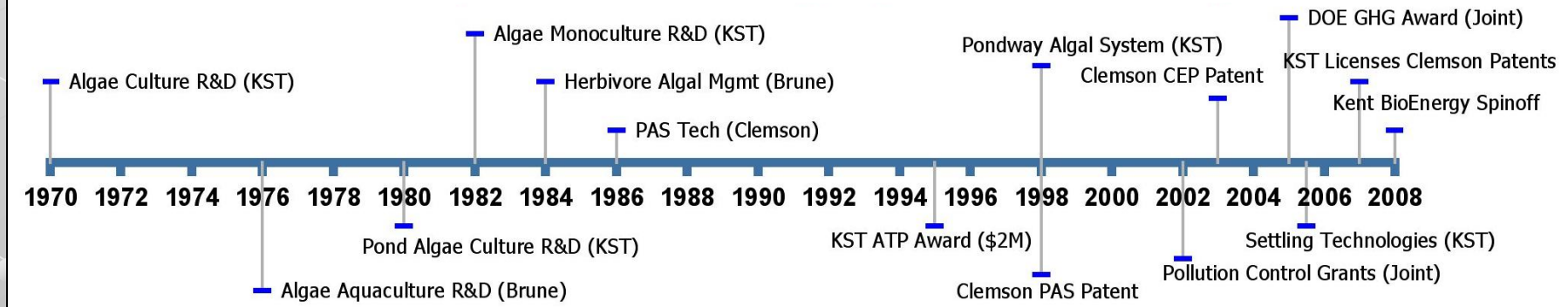




KENT BIOENERGY HAS RECEIVED NEARLY $7.0 MILLION IN GOVERNMENT & PRIVATE SUPPORT FOR ALGAE RESEARCH

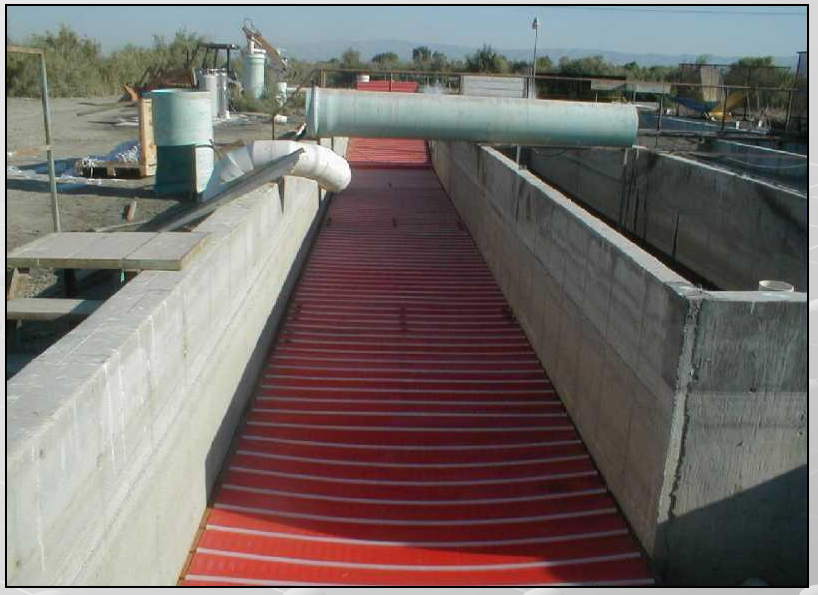
Agency	Research Topic	Award
US Dept of Commerce ATP	Techniques for Recycling of Aquaculture Effluents	$2,000,000
US Dept of Agriculture	Treatment and Reuse of Aquaculture Effluents	$350,000
State of California (SSA)	Reducing Eutrophic Conditions in the Salton Sea	$1,000,000
EPA	Management of CAFO Discharges	$50,000
US Dept of Energy	Utilizing Microalgae for Carbon Sequestration and Greenhouse Gas Abatement	$750,000
National Science Foundation	Microalgae Production, Harvest and Oil Extraction	$150,000
Corporate Client	Treatment of Landfill Effluents	$2,600,000

TIMELINE OF DEVELOPMENT OF KENT BIOENERGY ALGAE TECHNOLOGY



KENT BIOENERGY 160 ACRE MICROALGAE RESEARCH FACILITY LOCATED IN THE COACHELLA VALLEY

ALGAL HARVESTING AND DEWATERING SYSTEMS



CONTROL OF EXCESS NUTIRENTS ENTERING THE SALTON SEA (Efforts to sustain fish and bird populations)

THE PROBLEM:

Terminal lake

- Salinity
- Eutrophication

  High tributary flow rate (600,000 gpm)

  Low nutrient concentrations (N & P)

  Phosphorus is the limiting nutrient
- Use of CEP to reduce eutrophication

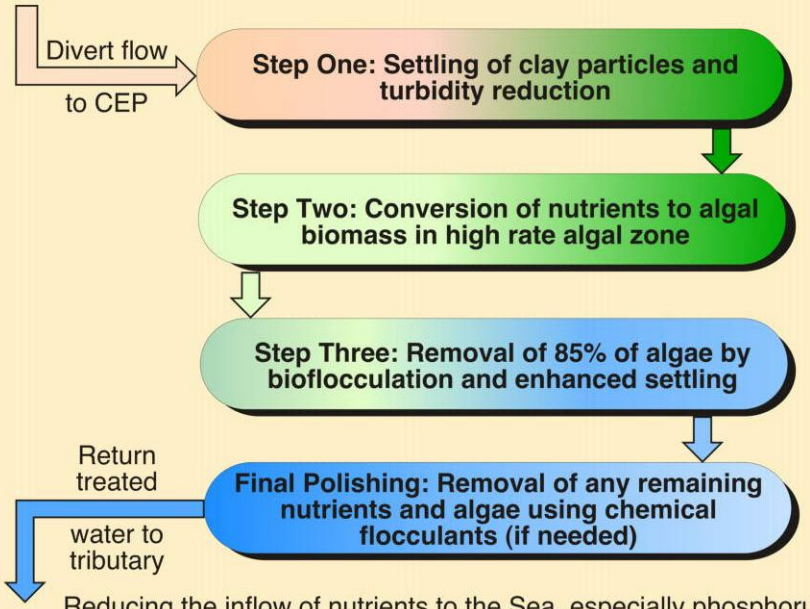
KBE LARGE-SCALE MICROALGAE CONTROLLED EUTROPHICATION PROCESS (CEP)

SALTON SEA BIOLOGICAL REMEDIATION PROGRAM
2002 – 2009
FOUR STAGE PROCESS OF CEP

The Problem: Excess Nutrients

High levels of nutrients enter the Salton Sea through the New River, the Alamo River, and the Whitewater River. The nutrients cause large plankton blooms, which under certain conditions can die and decay, causing widespread problems for the fish and bird populations.

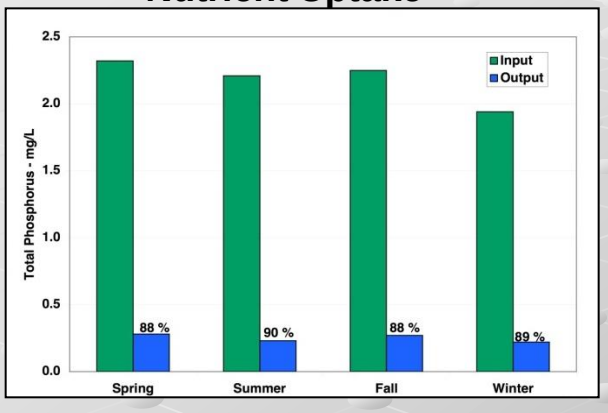
The Solution: Controlled Eutrophication



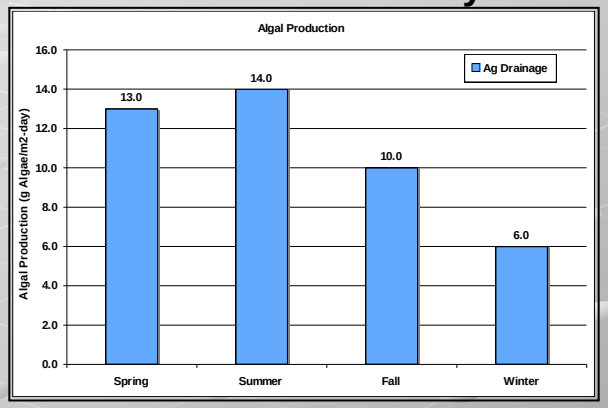
Reducing the inflow of nutrients to the Sea, especially phosphorus, should result in more stable populations of plankton, which will greatly enhance the Salton Sea ecosystem. By-products from the CEP treatment process will include valuable fish and fertilizer concentrates.

KENT BIOENERGY FIELD DATA ALLOWS US TO OPTIMIZE CEP OPERATING PARAMETERS FOR MAXIMAL PRODUCTIVITY, NUTRIENT UPTAKE, AND CARBON CAPTURE

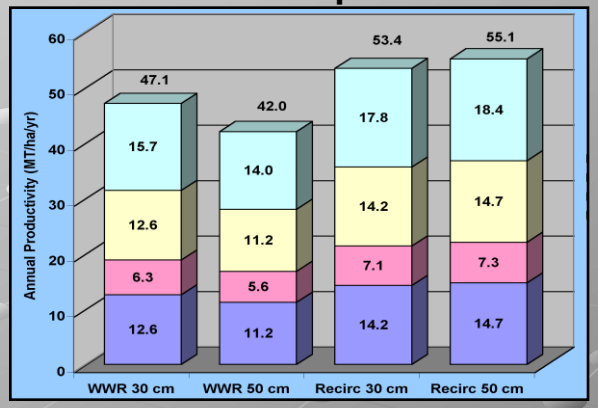
Nutrient Uptake



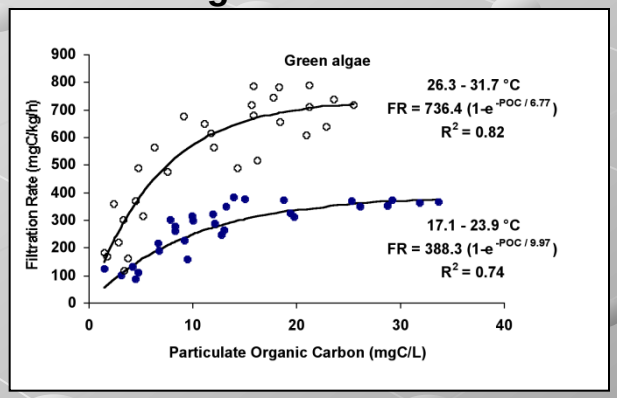
Seasonal Productivity



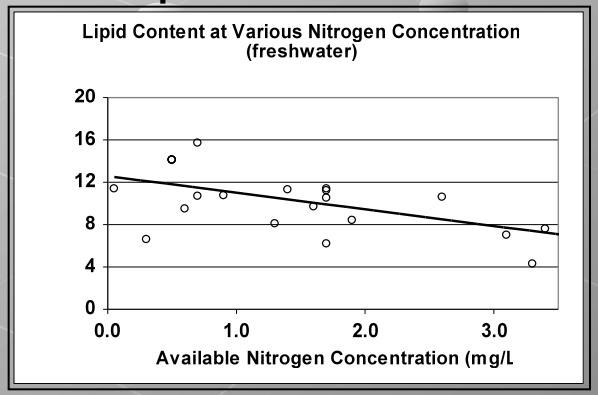
Water Depth



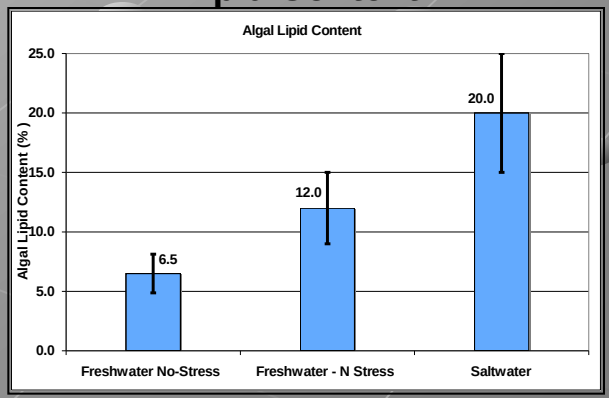
Algal Harvest



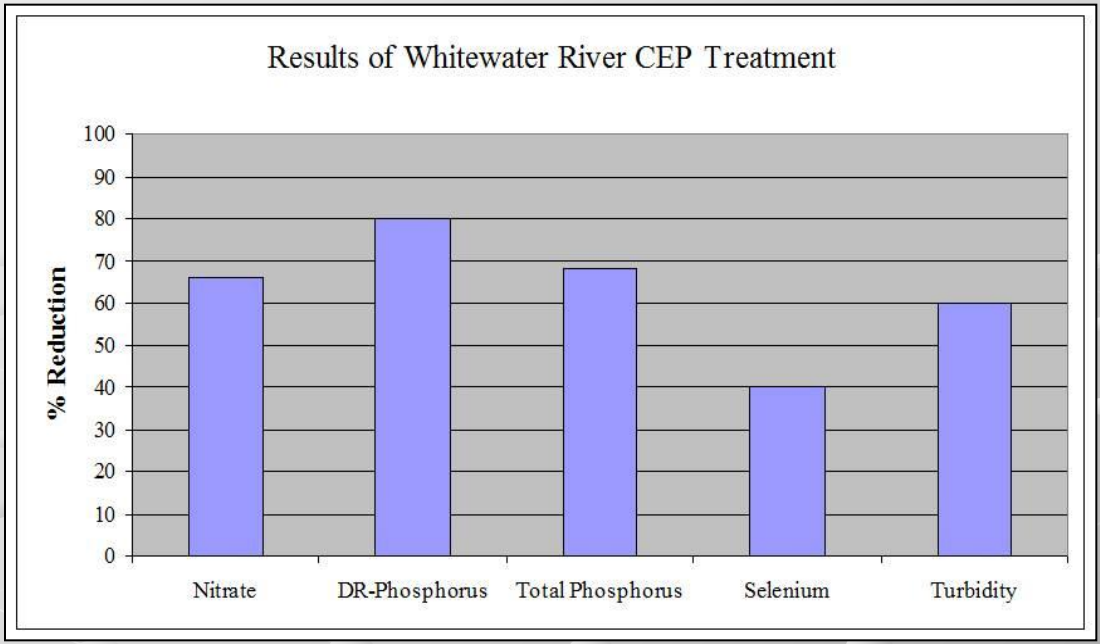
Lipid Maximization



Lipid Content

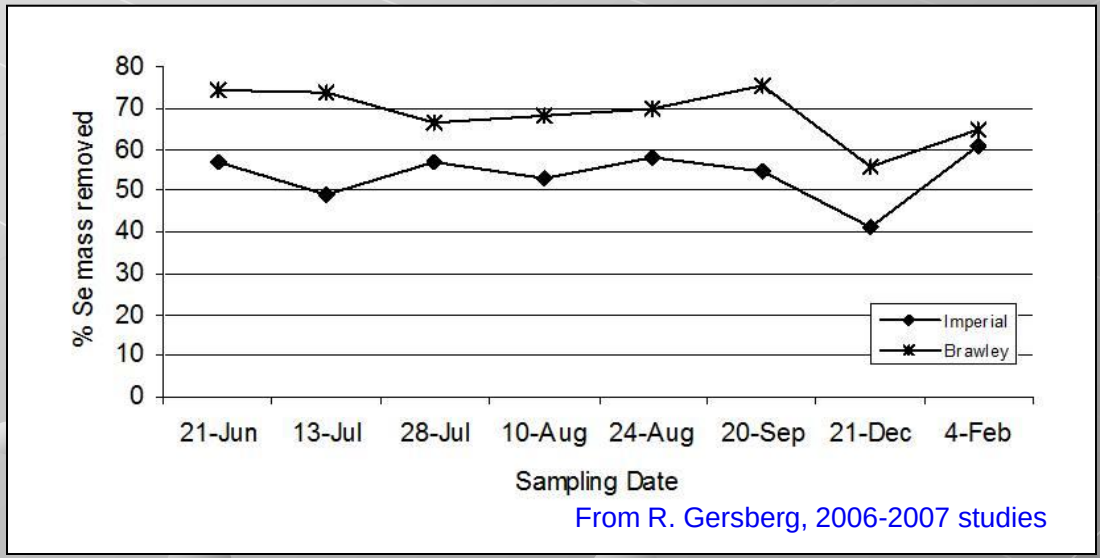


SELENIUM REDUCTION OF SALTON SEA AG DRAINAGE



CEP

40% Se reduction with 4 – 6 Day Retention

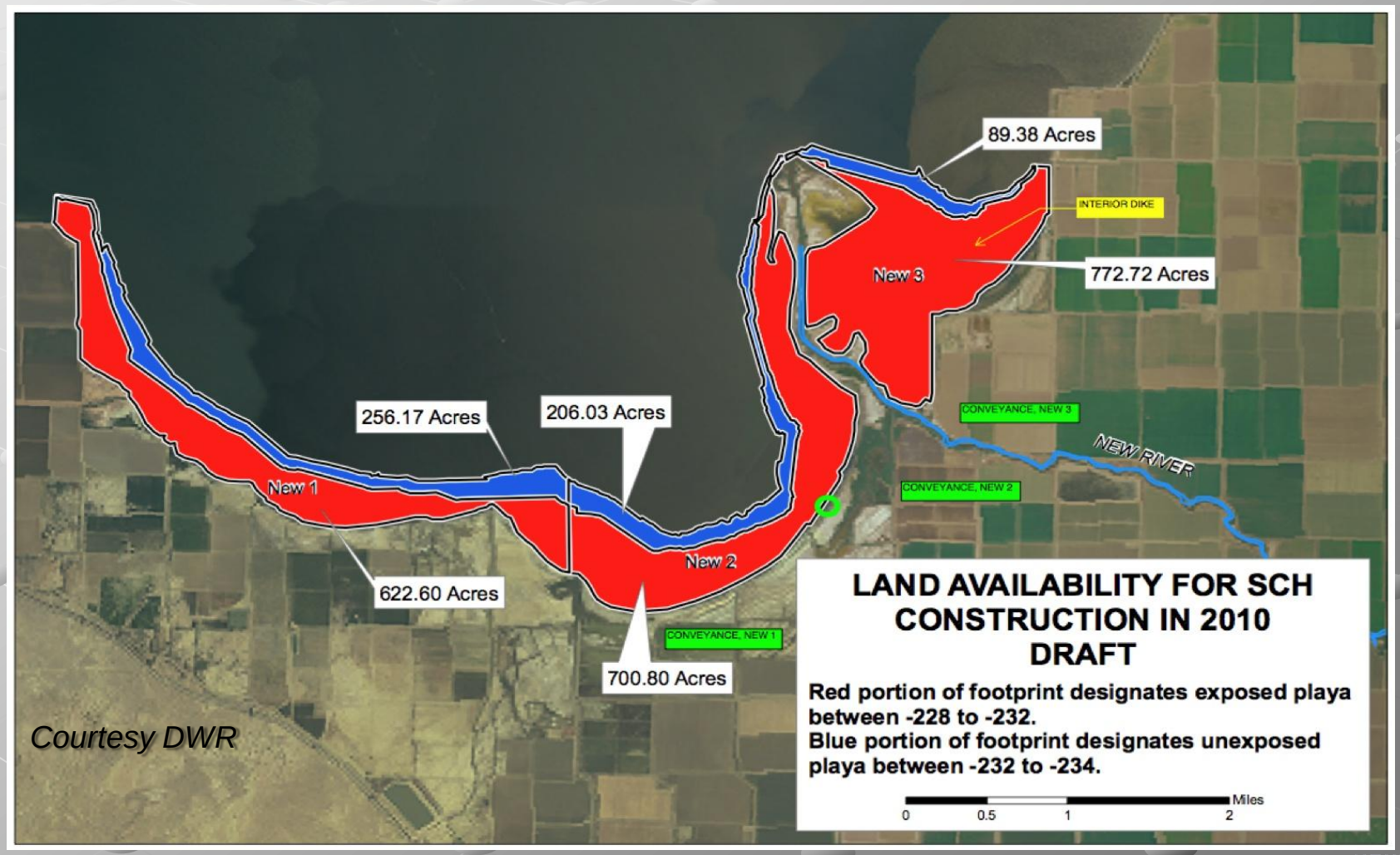


From R. Gersberg, 2006-2007 studies

WETLANDS

54% (Imperial) and 69% (Brawley) Se reduction with 9 – 18 Day Retention

SPECIES CONSERVATION HABITAT (SHC) SITES AT THE MOUTH OF THE ALAMO & NEW RIVERS IN THE IMPERIAL VALLEY



Courtesy DWR

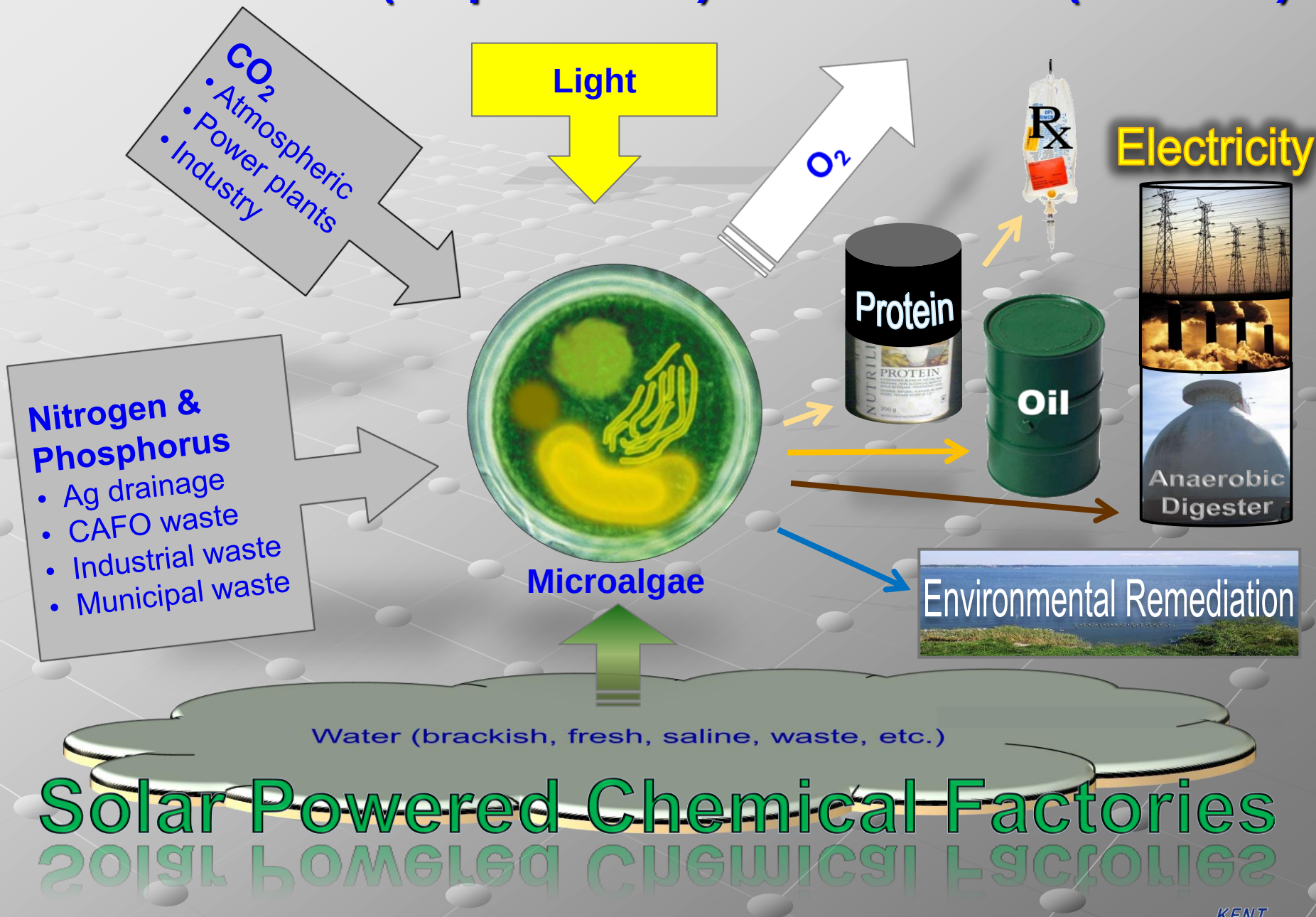
EARLY START HABITAT – USGS ALAMO RIVER IN THE IMPERIAL VALLEY

Courtesy of USGS

CONSTRUCTED WETLANDS – TMR WHITEWATER RIVER IN THE COACHELLA VALLEY

Courtesy TMR

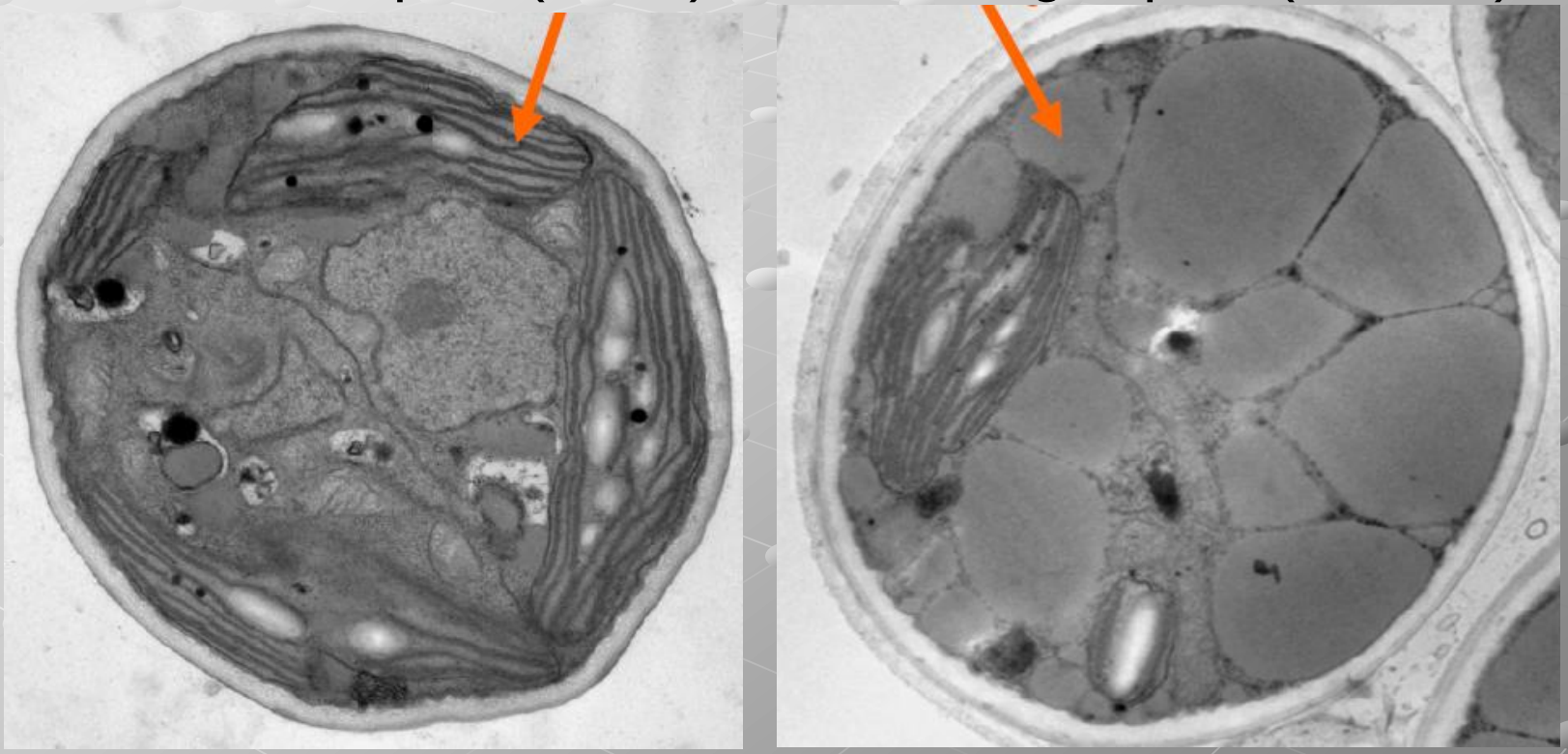
ALGAE INPUTS (Requirements) AND OUTPUTS (Products)



ALGAL LIPIDS

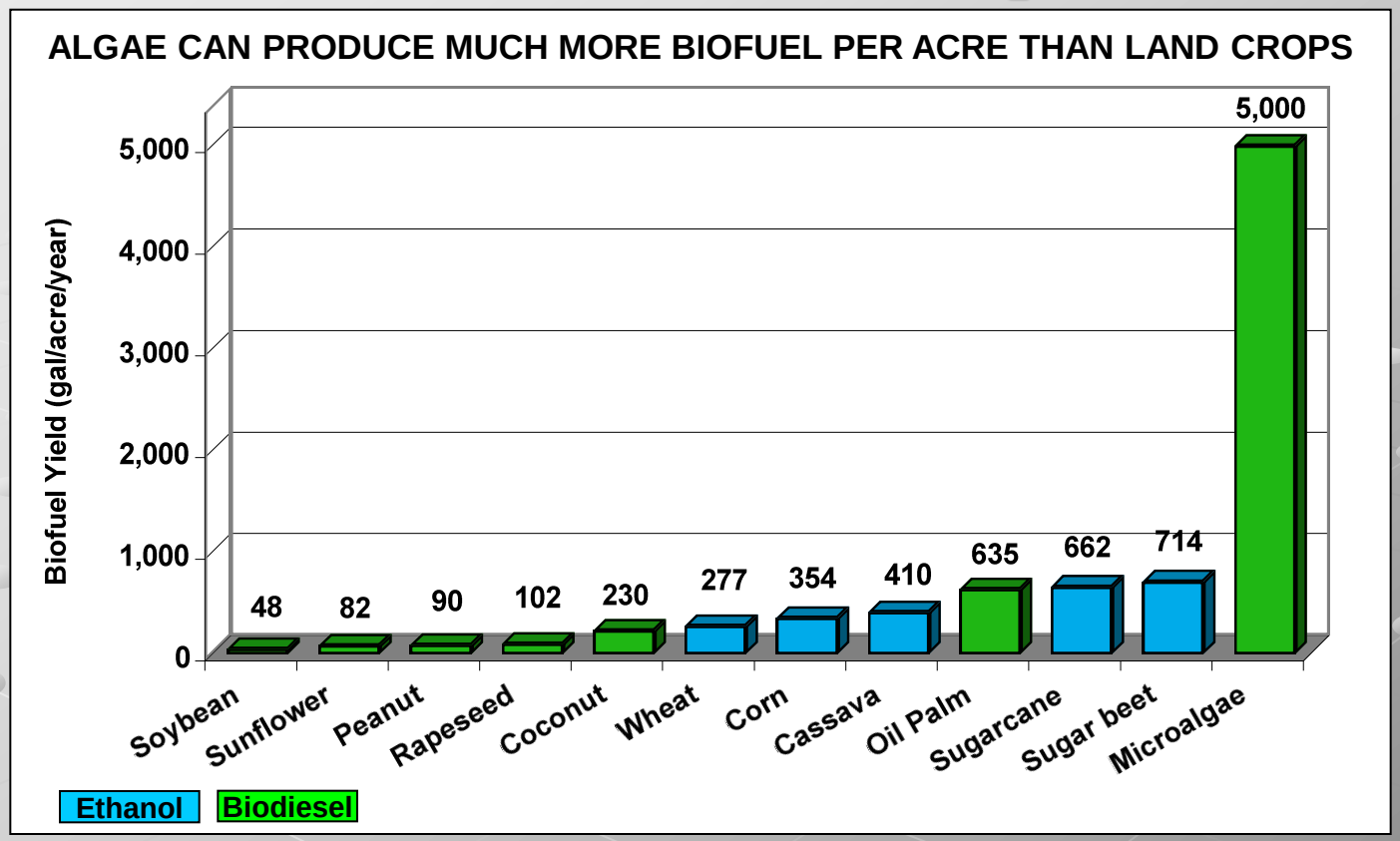
Membrane lipids (Polar)

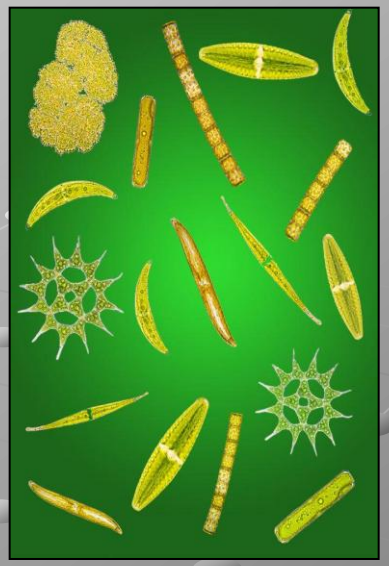
Storage lipids (Neutral)



Dr. Qiang Hu, Arizona State University

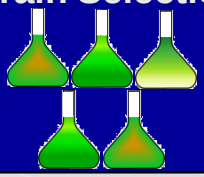
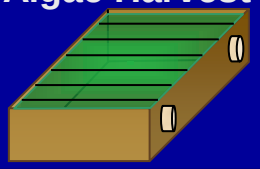
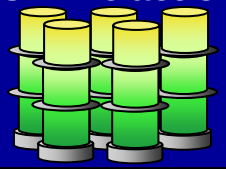
MICROALGAE ARE MICROSCOPIC AQUATIC PLANTS THAT USE SUNLIGHT AND CO_2 TO CREATE BIOMASS



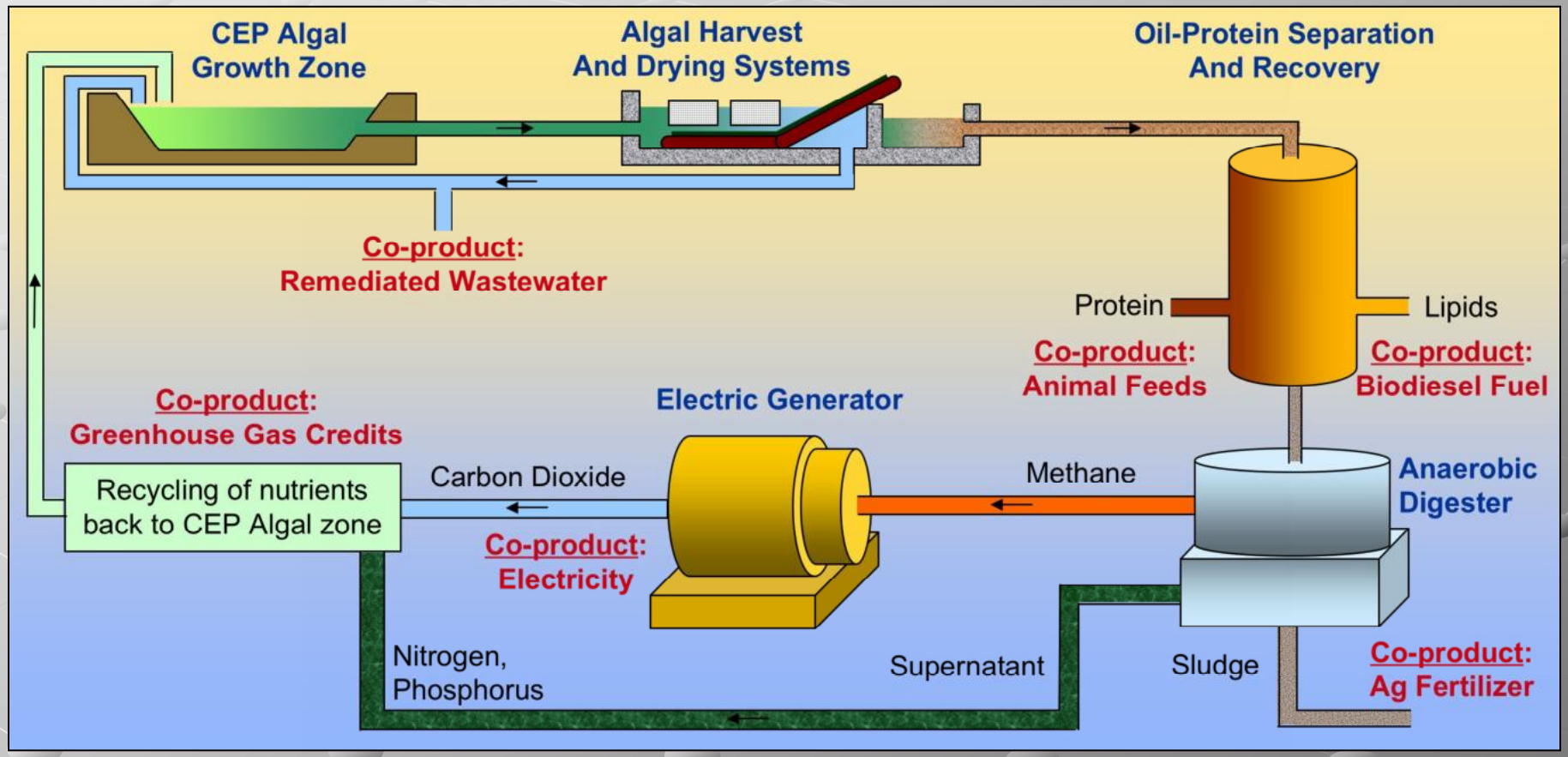


High Biomass Yields	Require only Sunlight, CO_2 & Nutrients for Growth
Potentially Very High Lipid Yields	CO_2 Neutral and Eligible for Carbon Credits
Can Utilize Low Quality Fresh or Saline Water	Potential for Recycling Valuable Nutrients
Can Utilize Low Quality Non-Arable Land	Potential for Valuable Co-Products

A VARIETY OF PROCESS OPTIONS HAVE BEEN PROPOSED FOR THE PRODUCTION OF ALGAE-BASED BIOFUELS

		Kent BioEnergy Process			
Step 1	Strain Selection 	Allow Wild Species to Dominate	Select Strains Optimal for Local Conditions	Manipulate Environment to Minimize Competitors	Use Biological Controls to Minimize Competitors	Use Genetically Modified Algae Strains (GMO)
Step 2	Algae Culture 	Managed Natural Water Bodies and Static Ponds	High Rate Open Ponds	Hybrid System (High Rate Ponds + PBRs)	Photo-bioreactors (PBRs)	Light Diffusion and Fiberoptics Technology
Step 3	Algae Harvest 	Mechanical Centrifuge or Filtration	Biologically Enhanced Settling	Biological Harvest & Conversion	Chemical Flocculation	Electrical Floatation (DAF)
Step 4	Oil Extraction 	Roller Press Crushing	Soxhlet Hexane Extraction	Cold Hexane Extraction	Supercritical Fluid Extraction (CO_2)	High Pressure Pulsing / Sonication / Electroporation
		Cost				

KENT BIOENERGY PROCESS FOR ENERGY AND CO-PRODUCT GENERATION IN CEP MICROALGAE SYSTEMS

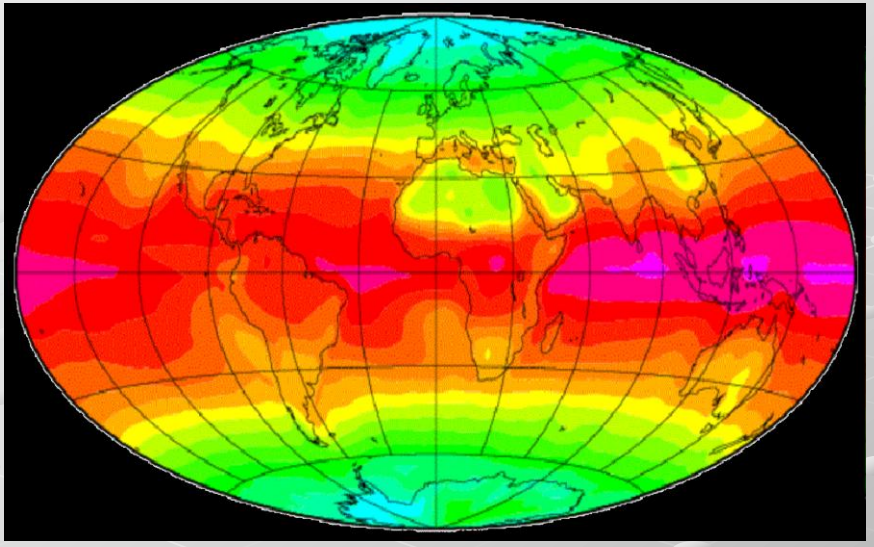


KBE TECHNOLOGY HAS MARKET APPLICATIONS IN POLLUTION CONTROL AND BIOMASS PRODUCTION

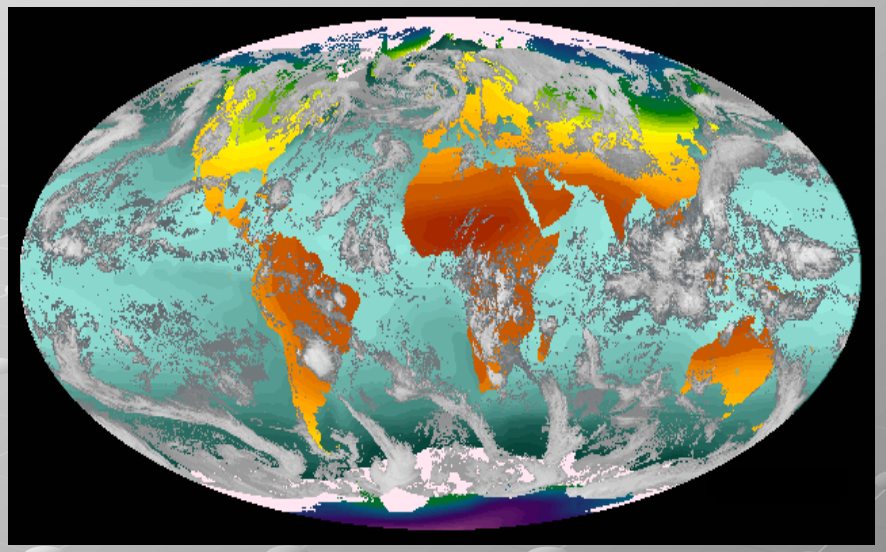
Pollution Control		Co-Products	
Agricultural Runoff		Biofuels	
Dairy Waste		Feed Additives	
Industrial Effluent		Fertilizers	
Digester Effluent		Electricity	
Greenhouse Gases		Chemicals & Biopolymers	

CRITERIA FOR LOCATION OF FULL-SCALE COMMERCIAL SITES

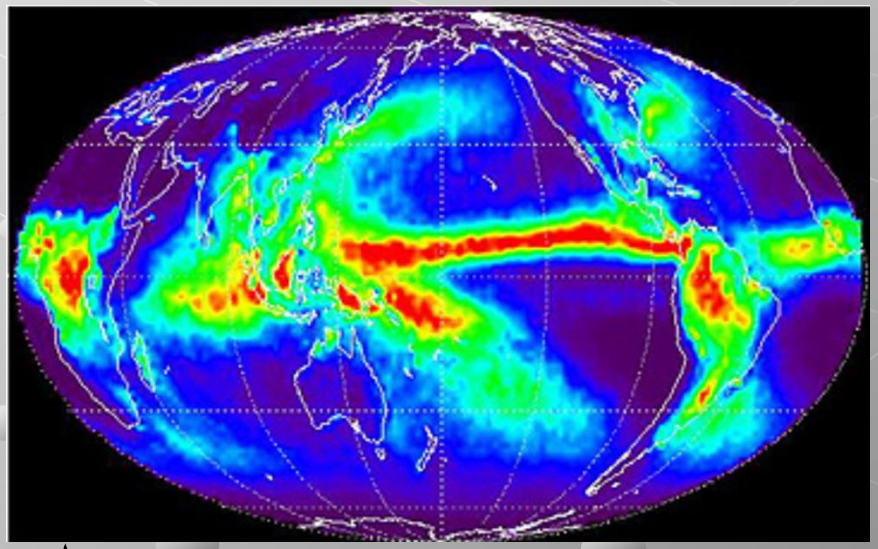
Temperature



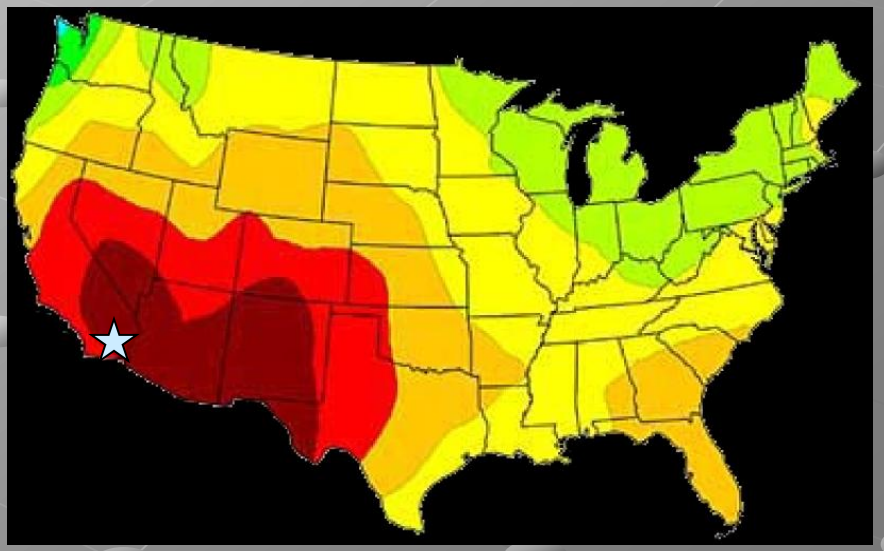
Cloud Cover



Rainfall



Optimal U.S. Locations



☆ - existing KBE site

ALGAE CULTURE ACTIVITIES IN THE IMPERIAL AND COACHELLA VALLEYS

Earthrise

Carbon Capture

Kent BioEnergy

SunEco Energy

CONCLUSIONS

- ALGAE CULTURE DOES NOT COMPETE WITH FOOD PRODUCTION
- NON-ARABLE LAND LOCATED IN ARID CLIMATES
- EXPOSED PLAYAS AND REDUCE FINE DUST IRRITANTS
- NON-POTABLE WATER (WASTEWATER, BRACKISH, SALINE)
- USE OF WASTE NUTRIENTS (ORGANIC) – AGRICULTURAL & MUNICIPAL
- REMOVES POLLUTANTS AND RESTORES VALUABLE HABITAT
- RECYCLES CARBON DIOXIDE & MITIGATES GHG EMMISSIONS

- PRODUCES MANY VALUABLE PRODUCTS, INCLUDING BIOFUELS
- PROVIDES NEEDED JOBS IN THE VALLEY
- STIMULATES LOCAL COMMERCE

- IS ELEGABLE FOR GOVERNMENT GRANTS
  a) Water reclamation
  b) Habitat restoration
  c) Renewable energy

DISCUSSION

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ALGAE BIOMASS REQUIRE MUCH LESS AGRICULTURAL LAND THAN TERRESTRIAL CROPS