



Capture and Utilization of CO₂ from Power Plant Flue Gas: Technology Development and Demonstration

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Overall Concept: CO₂ Utilization

CO₂ as flue gas



Cultivation in low cost PBR



Flocculation/
Sedimentation



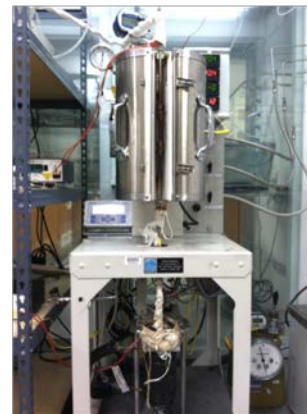
Gravity Filtration



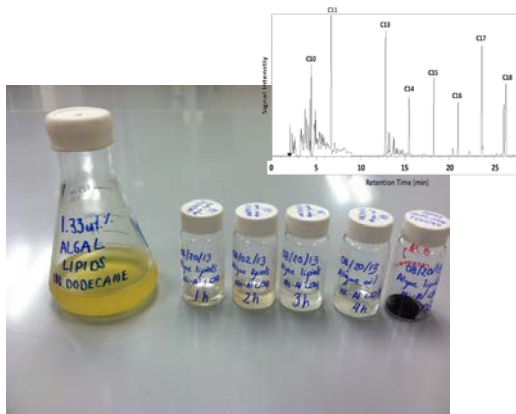
Bio-Plastics



Catalytic Upgrading of Lipids



Fuel Like Hydrocarbons



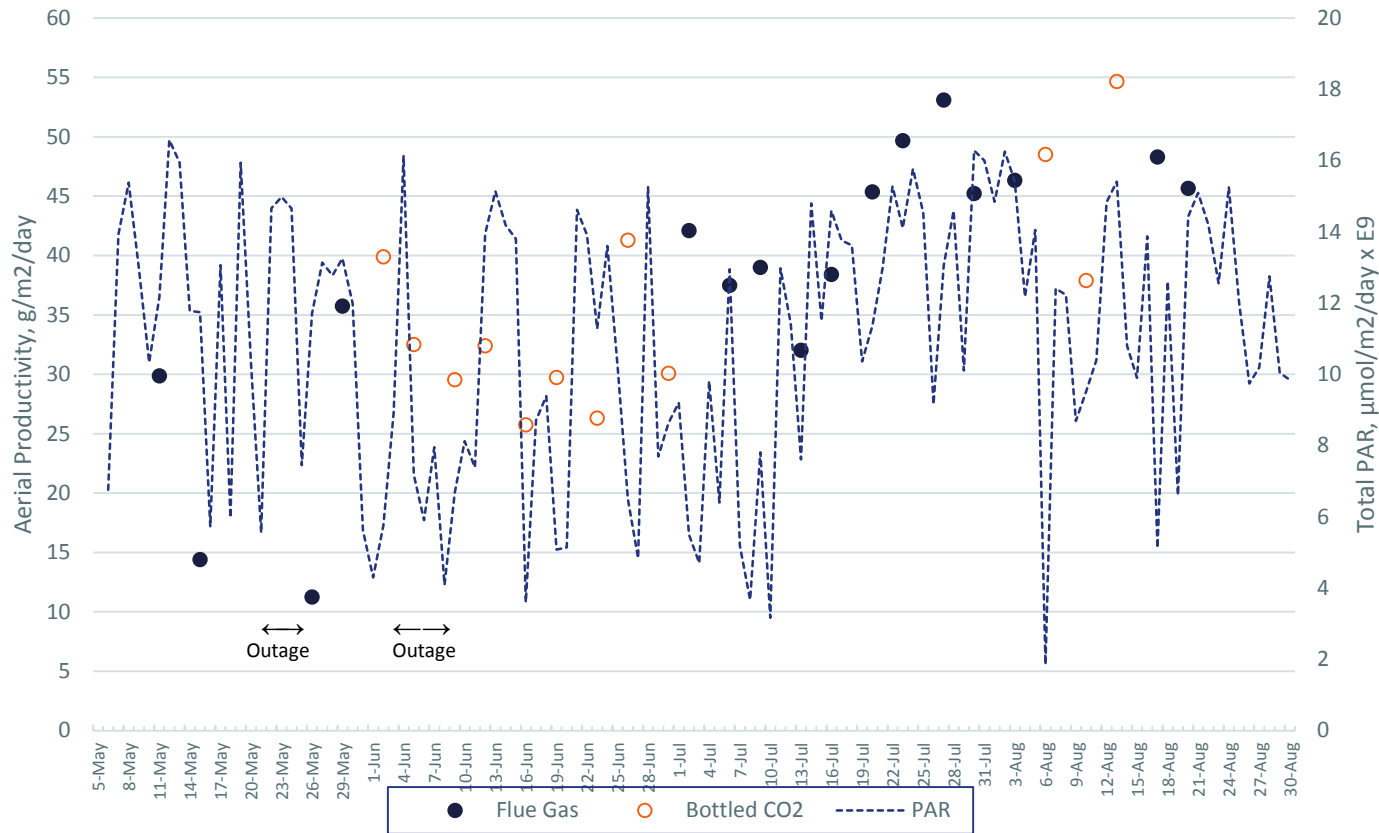
East Bend Station Demonstration Facility



- Cyclic flow to minimize energy consumption
- Buoyant pipe pigs to mitigate biofilm formation

System Productivity

East Bend TBO May 5 - Aug 30



Productivity: 25-55 g/m²/day

Mass Balance Determination



Reactor Measurements

Temp
dissolved O₂
pH

Flue Gas Measurements

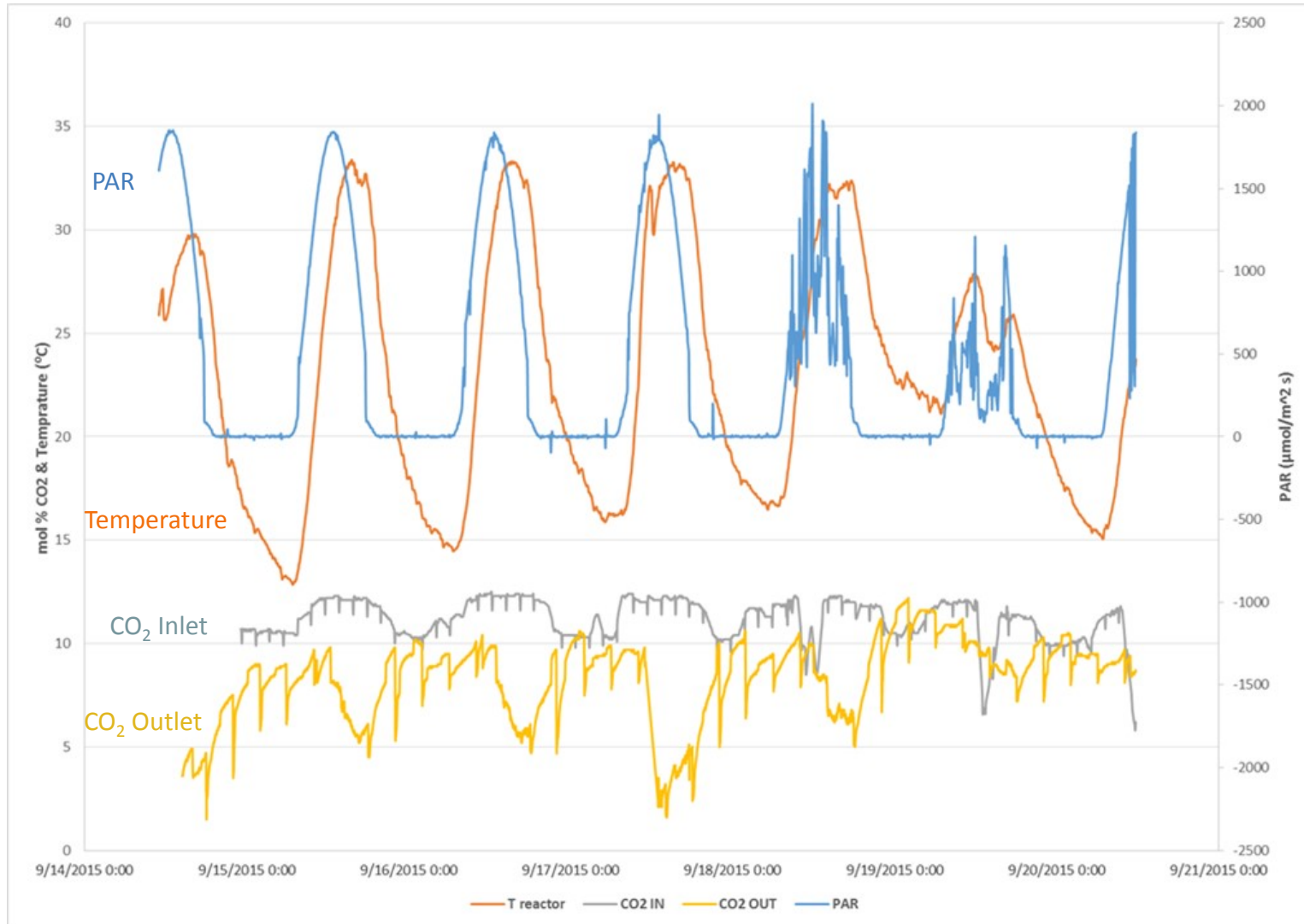
inlet and outlet streams

MRU Flue Gas analyzers

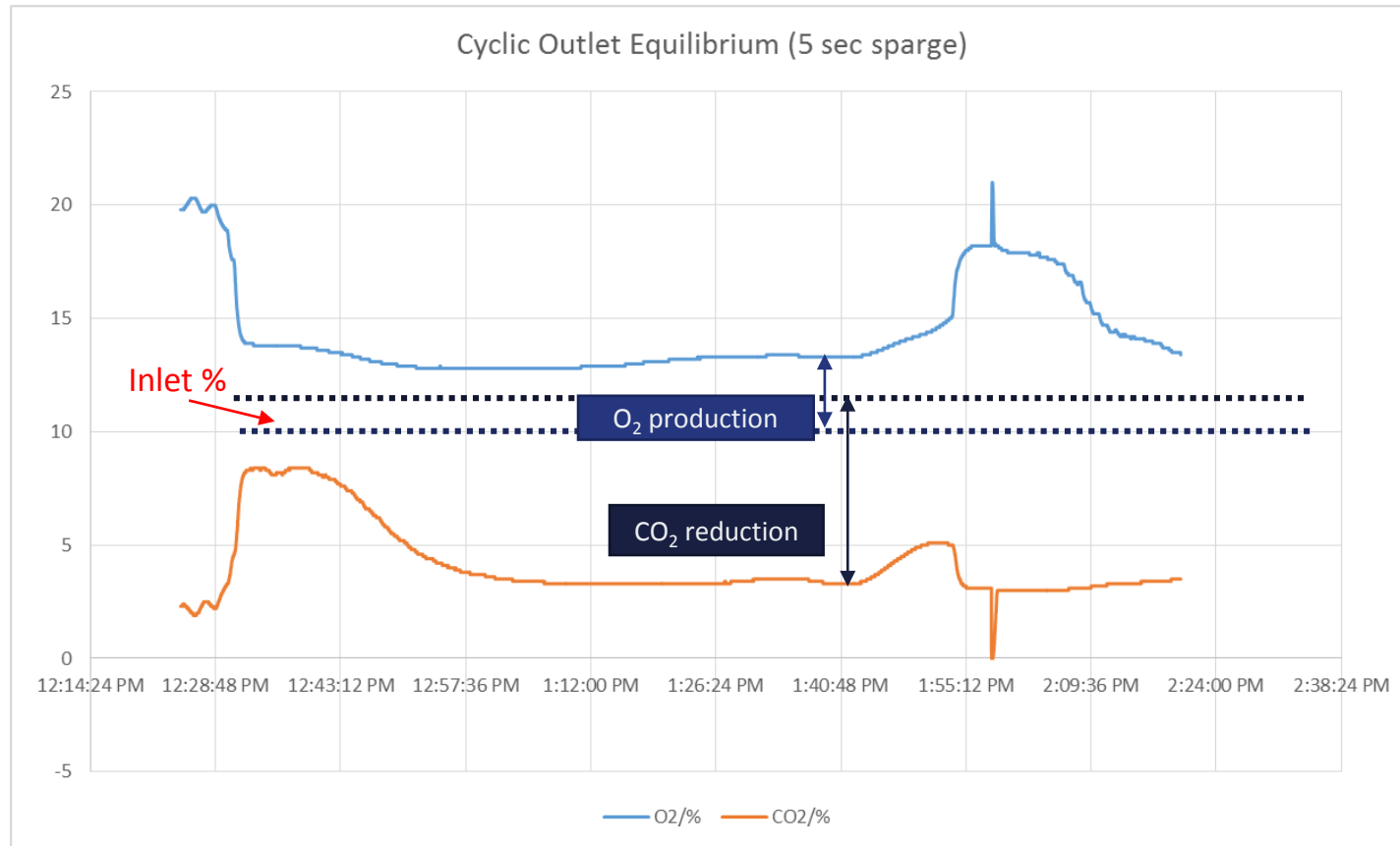
Temp
CO₂
O₂
NO_x
SO_x
CO
CH₄

Data measured every 30 seconds and stored automatically.

Mass Balance Data: CO₂



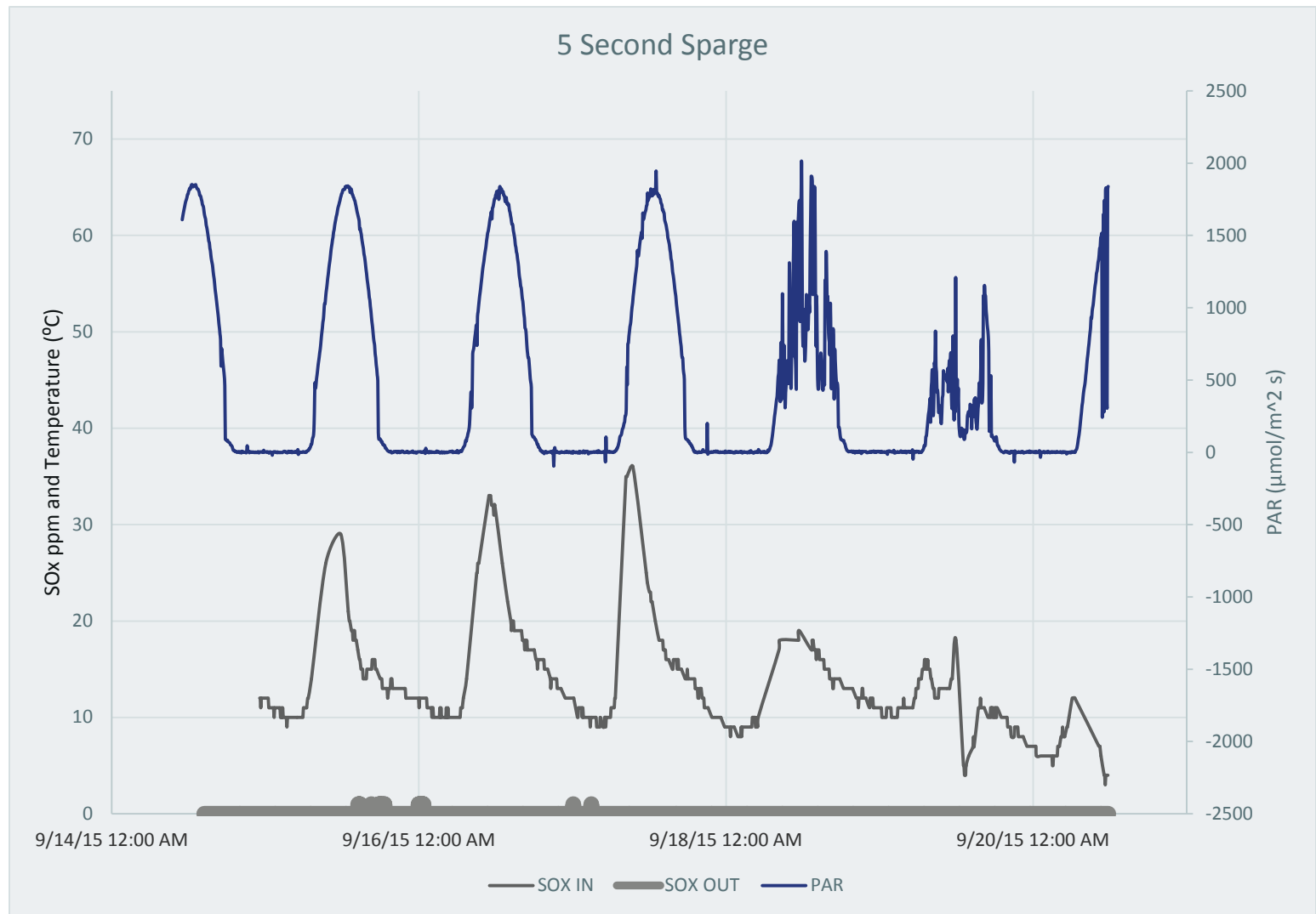
Mass Balance Data



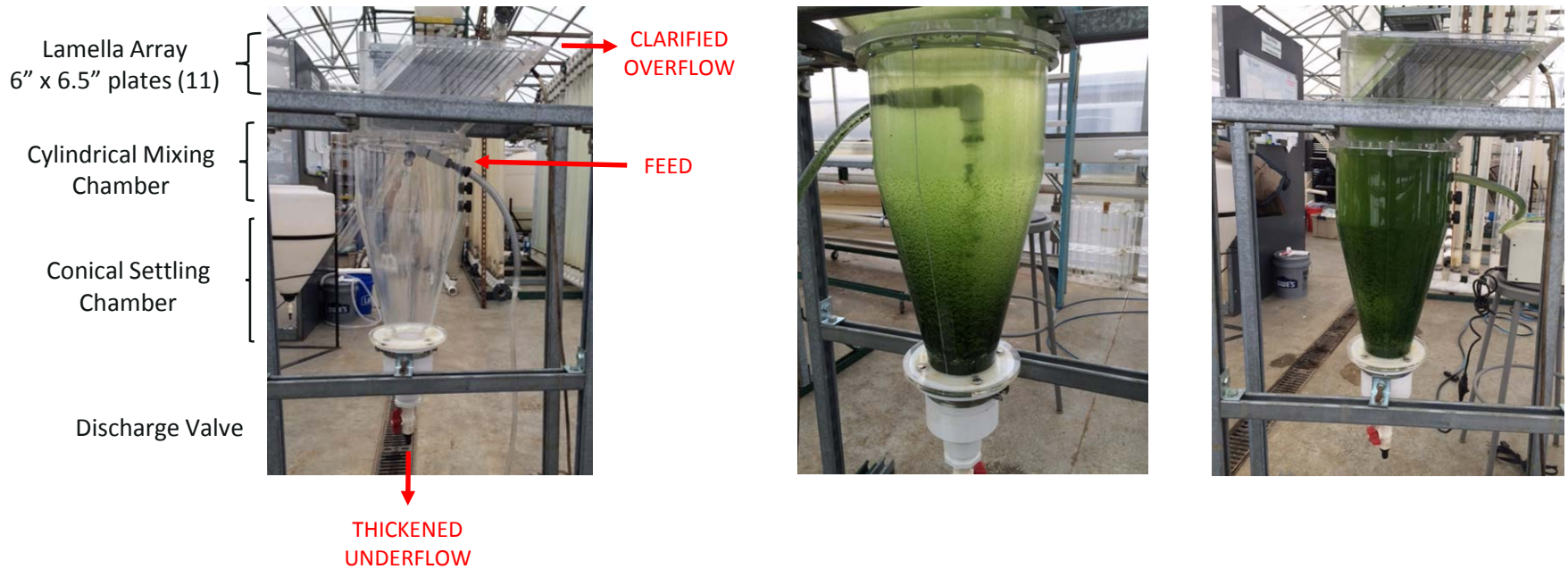
Indicates CO₂ conversion to O₂ via photosynthesis.

Highlights opportunity to optimize CO₂ conversion. Targeting 75%

Mass Balance Data: SO_x



Continuous Thickener Prototype



- 25 L lamella thickener with inclined lamella plates
- >95% solids capture with proper flocculant addition

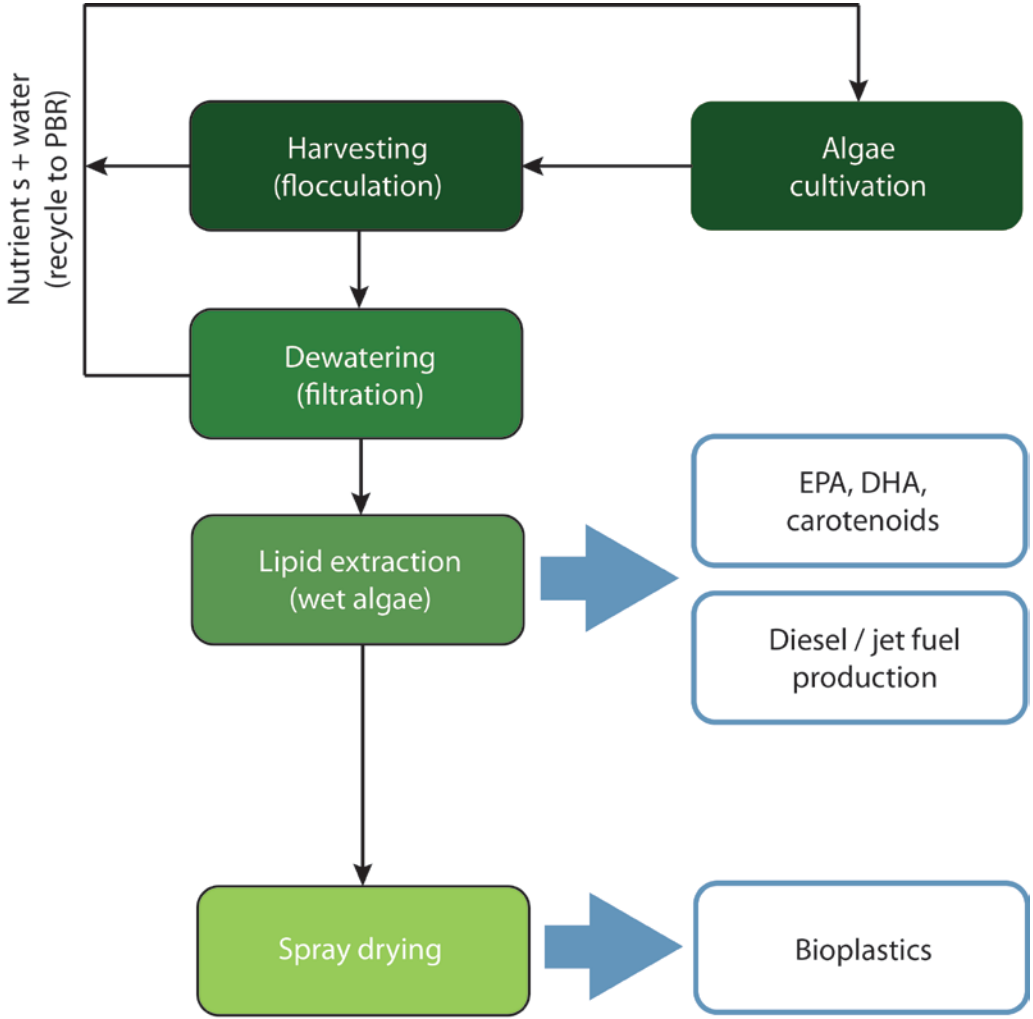
Prototype Gravity Filter



During

- Multifilament nylon media for rapid cake formation and high solids capture (>99%)
- Allows separation and recycling of all free water containing unused nutrients
- Produces 10-25% solids for utilization

UK Concept for CO₂ Capture / Algae Utilization



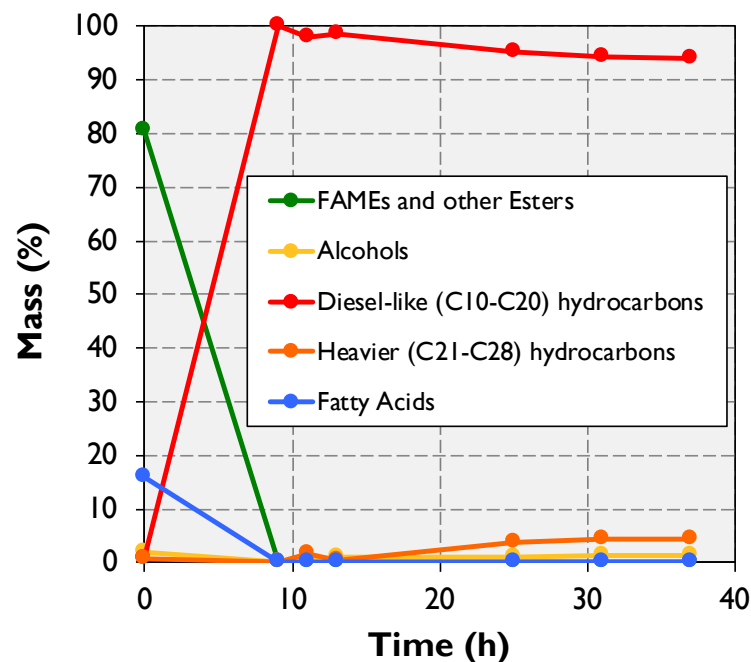
Upgrading of Algal FAMES to Hydrocarbons

75 wt% algal FAMES in dodecane, WHSV = 1 h⁻¹, Temp. = 375 °C

20% Ni – 5% Cu/Al₂O₃ catalyst



Yield of esterifiable lipids = 6.3 (+/- 0.1) wt%,

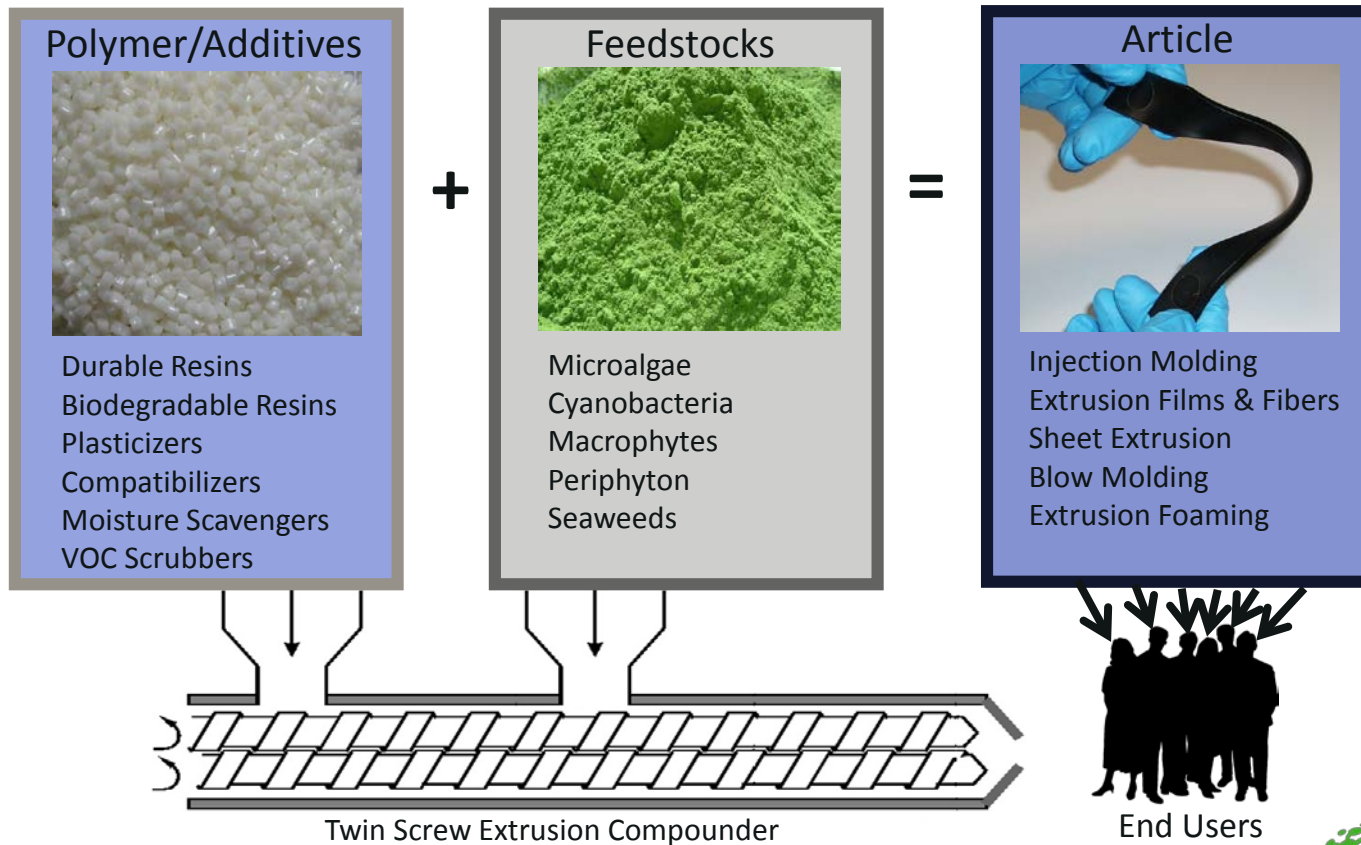


- >90% liquid products are **diesel-like hydrocarbons** at all reaction times
- Methane yield decreases after induction period, indicating poisoning of cracking sites

E. Santillan-Jimenez, R. Loe, M. Garrett, T. Morgan, M. Crocker, *Catal. Today*, 2017, <http://dx.doi.org/10.1016/j.cattod.2017.03.025>.

Plastic Production Process

SOLAPLAST™



 **ALGIX**®

Composition of Whole and Defatted Algae

Sample	Ash (wt%)	Protein (wt%)	Volatiles (GC/MS)
Whole	11.1	44.2	16 peaks at 140 °C; 196 peaks at 200 °C
Defatted	15.6	50.7	12 peaks at 140 °C; 121 peaks at 200 °C

- **Increase in protein** and ash content consistent with removal of lipids
- Fewer compounds were released upon heating to 200 °C for the defatted algae, suggesting that lipid extraction may have **improved thermal stability**
- Defatted algal biomass has **improved odor properties**
- Defatted algae used for production of maleic anhydride compatibilized EVA (ethylene vinyl acetate) composite, containing 30 wt% algae



EVA composite test parts

Utilization of Algae for Bioplastics



Solaplast pellets

- Algae can **substitute for up to 50 wt% of polymer**
- High protein content in algae beneficial for polymer properties – acts as a **functional filler**
- **“Sequestration” of CO₂** in durable plastics such as HD polypropylene
- **Enhancement of biodegradability** when added to polylactic acid, polybutylene adipate terephthalate

- Targeting applications in:

- footwear
- consumer packaging
- horticulture
- automotive industry
- 3D printer filament
- etc.



3D printer filament



Yoga Mats



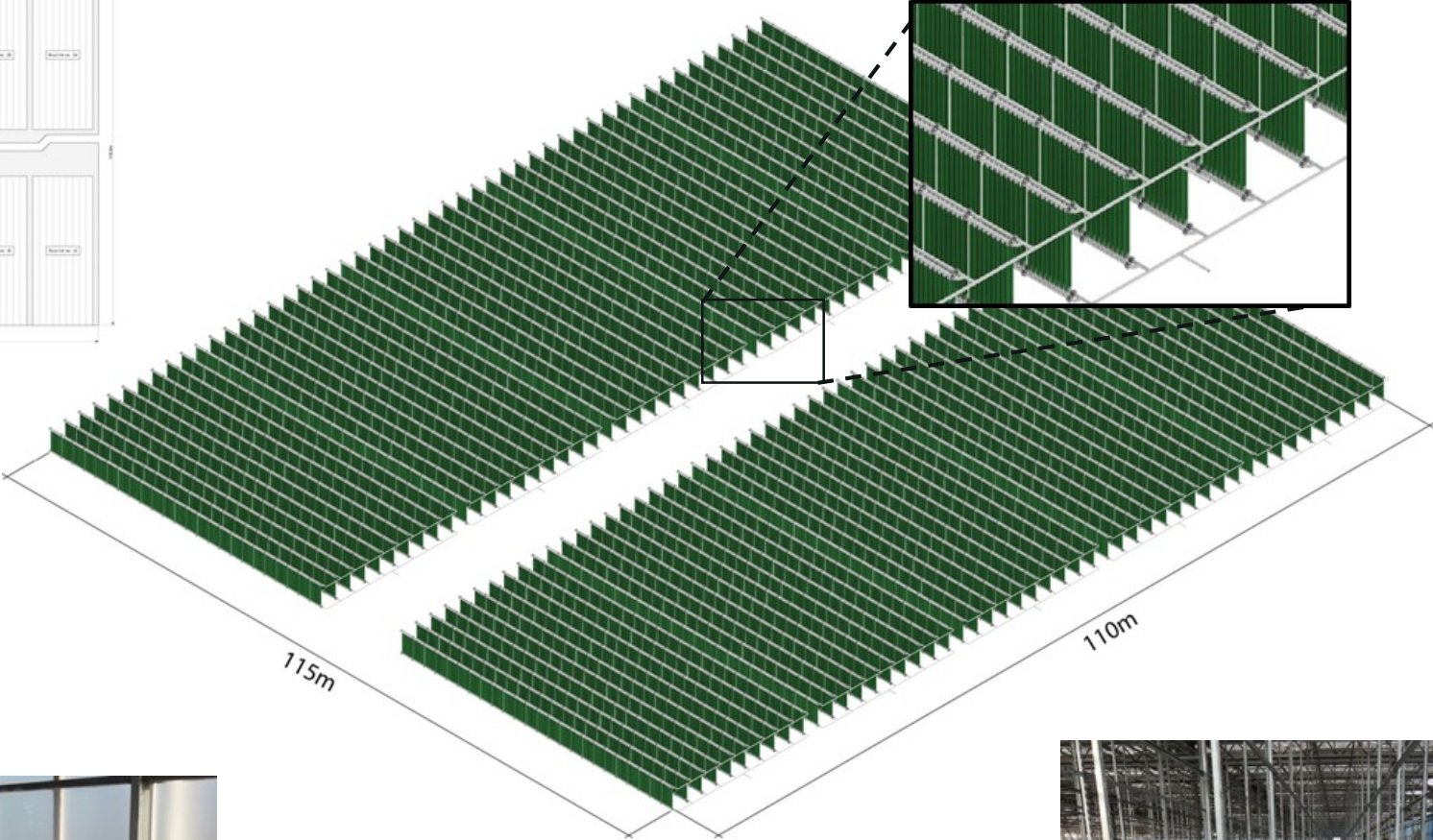
BLOOM algae-enhanced foams

How Big?

		1 MW	500 MW
Emissions	tons CO ₂ /MW	1	1
Emission rate	tons CO ₂ /day	24	12,000
@40% CO ₂ Capture			
	tons CO ₂ /day	9.6	4,800
@1.78 tons CO ₂ /ton algae			
	tons algae/day	5.4	2,697
@35 g/m ² /day productivity			
	g algae/day	139,916	69.96x10 ⁶
Land Required	acres	35	17,287

Layout of 3 Acre Photobioreactor

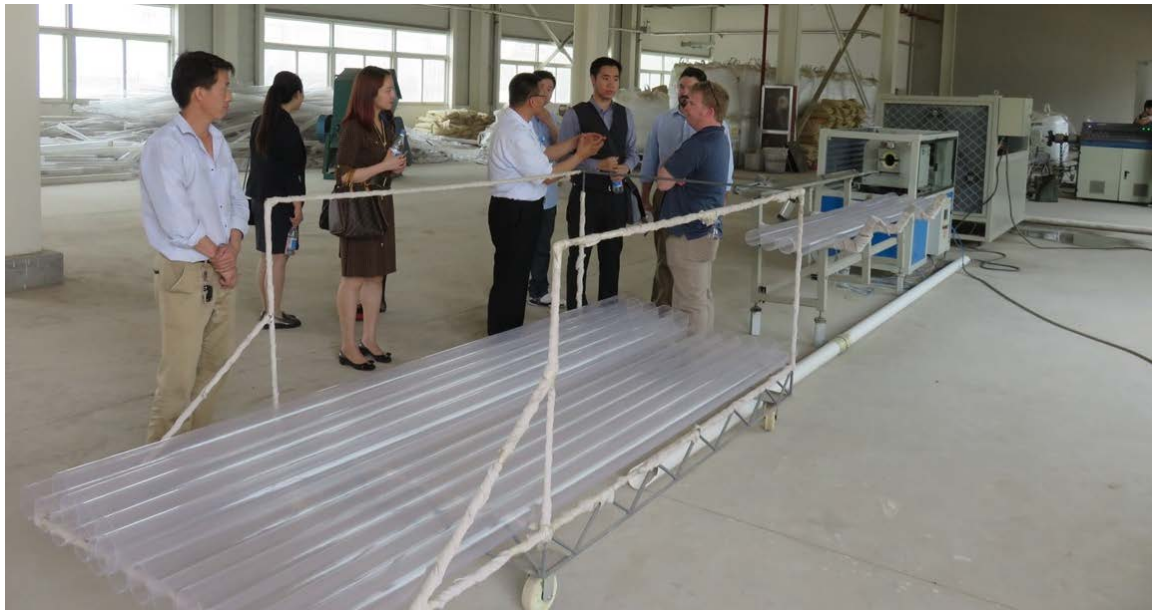
Zhengzhou, China

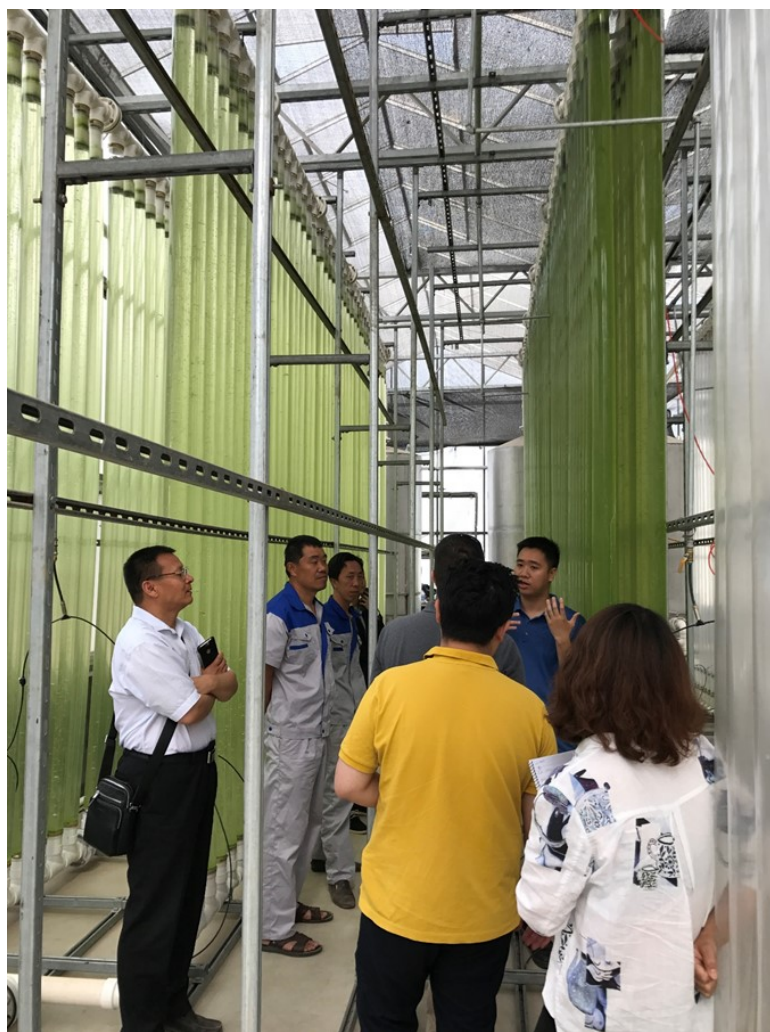


East Bend:
72 tubes
300 gallons

Lian Heng Hui:
57,600 tubes
265,000 gallons







Commercial Development Site

Henan Province, China

