Cashing in on Carbon

Carbon Capture and Utilization (CCU)
Industry Challenges and Opportunities

Moderator
Mark Allen - VP Integrated Carbon Solutions, Accelergy Corporation

Panelist
Raffi Mardirosian - VP Corporate Development, Joule Unlimited
Laurel Harmon – VP Public Relations, LanzaTech
David Hazlebeck – CEO, Global Algae Innovations
John Benemann – CEO, MicroBio Engineering
Jacques Beaudry-Losique -  SVP Business and Corporate Development Algenol Biotech
“a turning point for our planet”

“will open the floodgates for low-carbon innovation at a scale we haven’t seen before”

Barack Obama – President of the United States

"no agreement is perfect, and this one must be strengthened over time, but groups across every sector of society will now begin to reduce dangerous carbon pollution through the framework of this agreement.”

Al Gore – Venture Investor, former VP
ETS carbon price

SCC carbon price

Social Cost of Carbon (SCC) $36
Global CO2 emissions averaging 35.9 gigatons per year

Estimated $800 Billion to $1.1 Trillion Annual (2030)

CCU
CAPTURE and USE
 Transforming Into Valuable Products

DECARBONIZATION
Energy Efficiency, Clean Renewable Energy

ADAPTATION
Managing Impacts of Climate Change

CAPTURE and STORAGE
Long-Term Sequestration

Progress but Not Fast Enough
Increasingly Necessary
Necessary but Costly

Market-Driven Approach
Nature’s ancient but powerful formula:

$$6\text{H}_2\text{O} + 6\text{CO}_2 \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$$

**Construction Materials**
- Cement and concrete
- Asphalt
- Aggregate
- Timber/super hardwood

**Fuel**
- Synthetic (methanol, butanol, natural gas, syngas, etc.)
- Micro-algae fuel
- Macro-algae fuel

**New materials**
- Carbon fiber
- Carbon nanotubes and fullerenes
- Graphene

**Industrial gas & fluids**
- Enhanced oil recovery
- Enhanced coal bed methane recovery
- Enhanced water recovery
- Semiconductor fabrication
- Power cycles

**Plastics**
- Polyurethane foams
- Polycarbonate (glass replacement)
- Acrylonitrile butadiene styrene
- Many more

**Agriculture & food**
- Algae-based food or animal feed
- Microbial fertilizer
- Biochar, bio-pesticides, bio-cosmetics

**Chemicals**
- Preservatives (formic acid)
- Medicinal
- Antifreeze (ethylene glycol)
- Carbon black
- Many more

The Global CO$_2$ Initiative
Algae have real, substantial potential to contribute to biomass supply \textbf{AND} \textit{CO}_2 mitigation

- 75,000 farms ($\approx 140,000$ sq. miles) suitable for open pond production
- Sufficient \textit{CO}_2 for 1.4 B tons algae

DOE goal of 20 MM tons algae by 2022 achievable

- Much larger quantities possible beyond 2030, especially with \textit{CO}_2 price/regulation
- Little/no competition with terrestrial biomass
Nitrogen & CO$_2$ from Atmosphere

Reduced Emission of Nitrogen Oxide

TerraSync

Algae

Biofertilizer

Replaces Conventional N Fertilizer

Carbon Sequestered in Soil

Reduced N compounds to surface water runoff

Reduced N compounds to groundwater
TerraSync™ BioFertilizer – Local Algae Strains for Production

27 local strains isolated for plant trials
50% increase in harvested plant weight
Cultivation Scale up for Field Plant Trials

- PBR’s located in production greenhouse
- Multiple 330 Liter Nautilus units
- Algae strain screening & cultivation
- Fully automated
• Local strain of blue-green algae
• Increased Yields of 15+% Per Acre
• High Quality Organic Rice for Premium Market
• Now Evaluating Single vs Multiple TerraSync Applications for Long Term Benefits
• Reduced CO2 emissions from conventional N fertilizer production and reduced NO3 emission from field