

algae@work™

A new paradigm for biofuels,
biofeedstocks, and climate change
mitigation and adaptation.

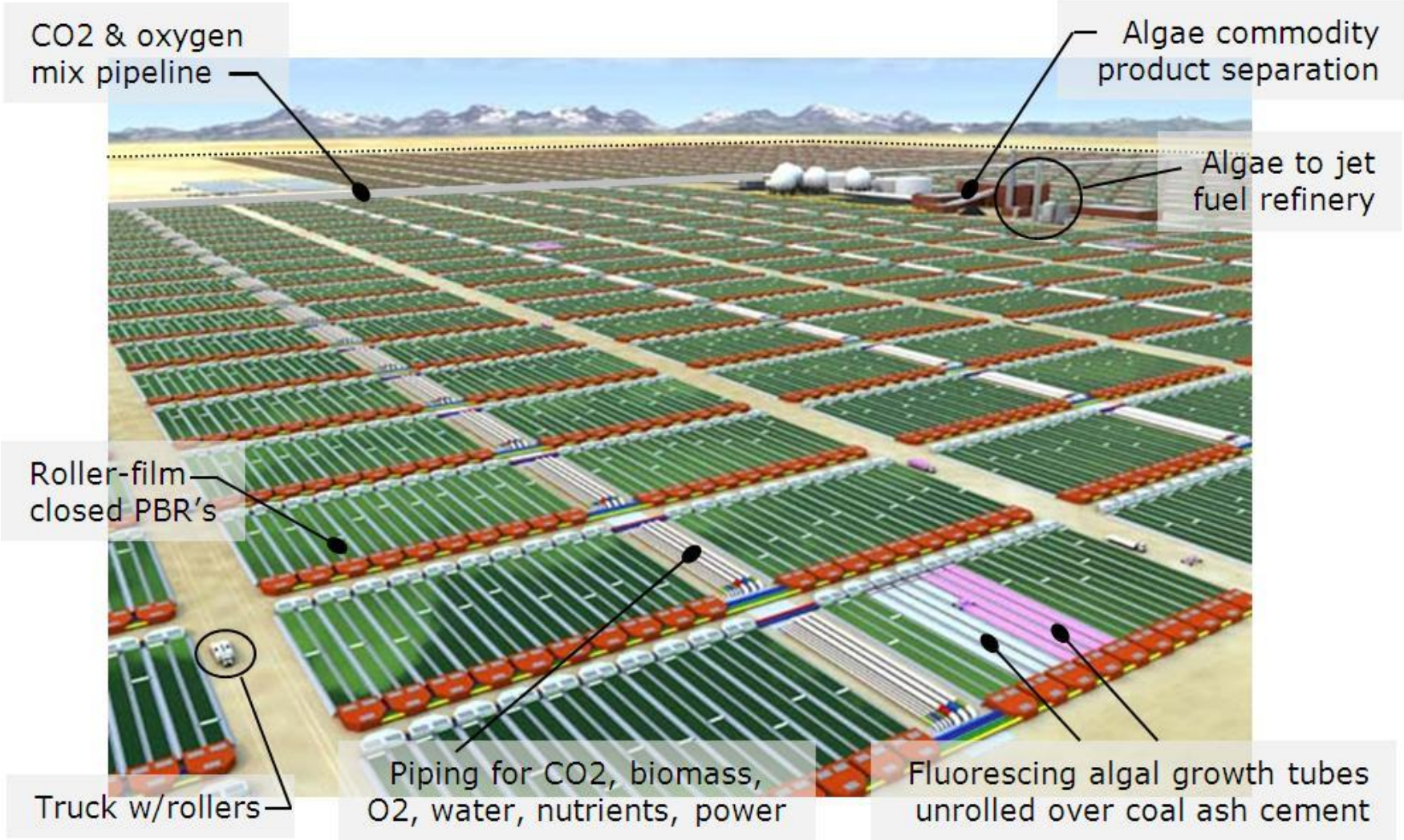
**Utility-Scale Algae for Beneficial Reuse of CO₂
and Synergy with CCS** – 12 Conversations.

**Ninth Annual Conference on Carbon Capture
and Sequestration – Pittsburg, 1:30, May 11th, 2010**

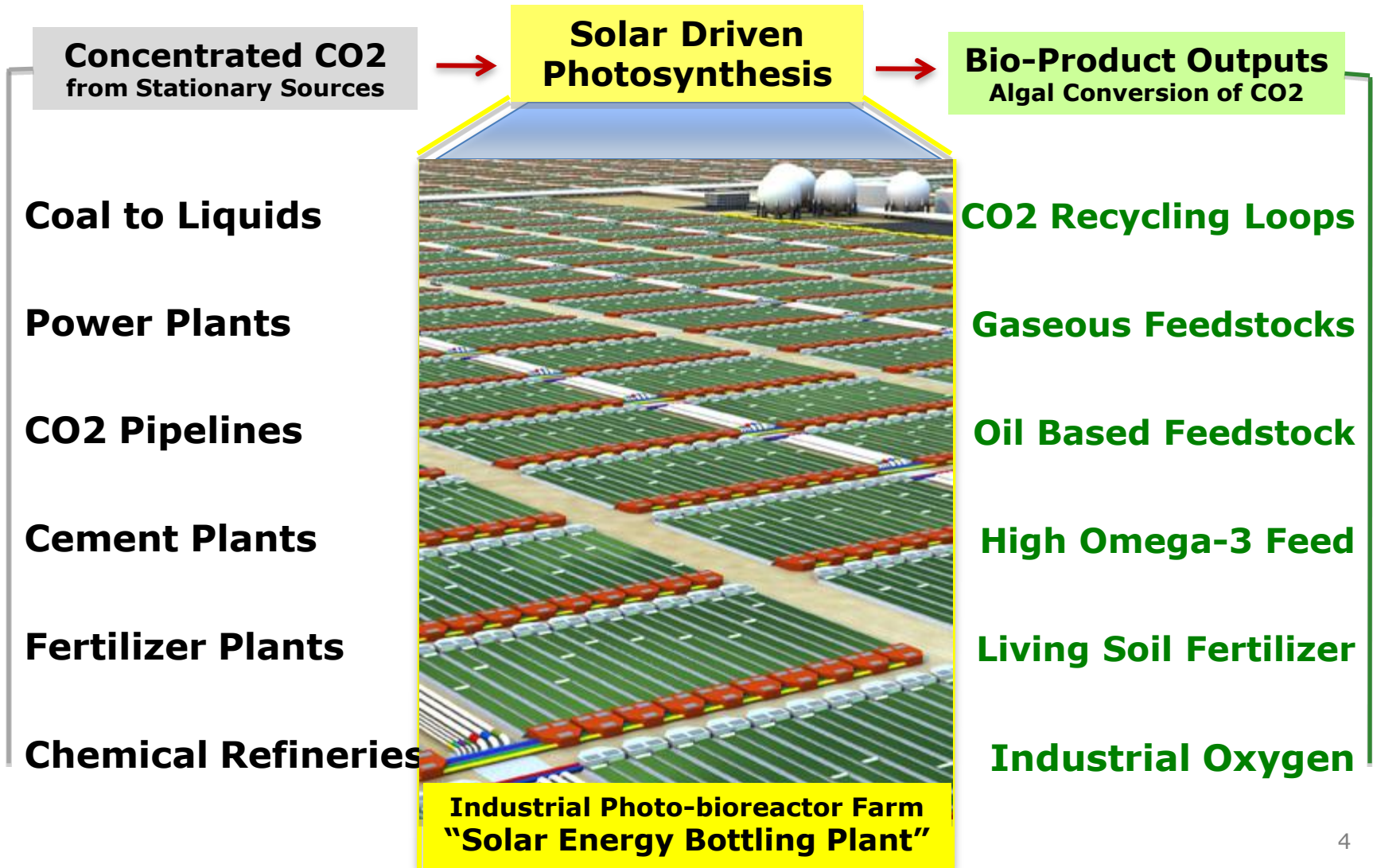
Jim Sears
Chief Technology Officer
A2BE Carbon Capture LLC
www.AlgaeAtWork.com

- 1) **Destination:** CO₂ Capture and Recycle (CC&R) Farm
- 2) Industrial Algae will **"Re-Productize" CO₂ Emissions**
- 3) **Scaling** Chokepoints Throttling Algal Industry Growth
- 4) Bringing Order to the Industry: ABO **Technical Standards**
- 5) **Algae Cultivation** Options Favor "Closed PBRs"
- 6) 1 MW Scaling for **Algae & Oxyfuel-Combustion**
- 7) **Low-Carbon Synthetic Fuel** uses Algal Recycle of CO₂
- 8) Combining **CCS and Beneficial Reuse** Enhances Both
- 9) **Largest Applications** for Algal-Based Beneficial Reuse
- 10) **TerraDerm™** for Atmospheric CO₂ Drawdown into Soils
- 11) **Purpose of** algae@work **Alliance Network**
- 12) Finding **Reliable Information**

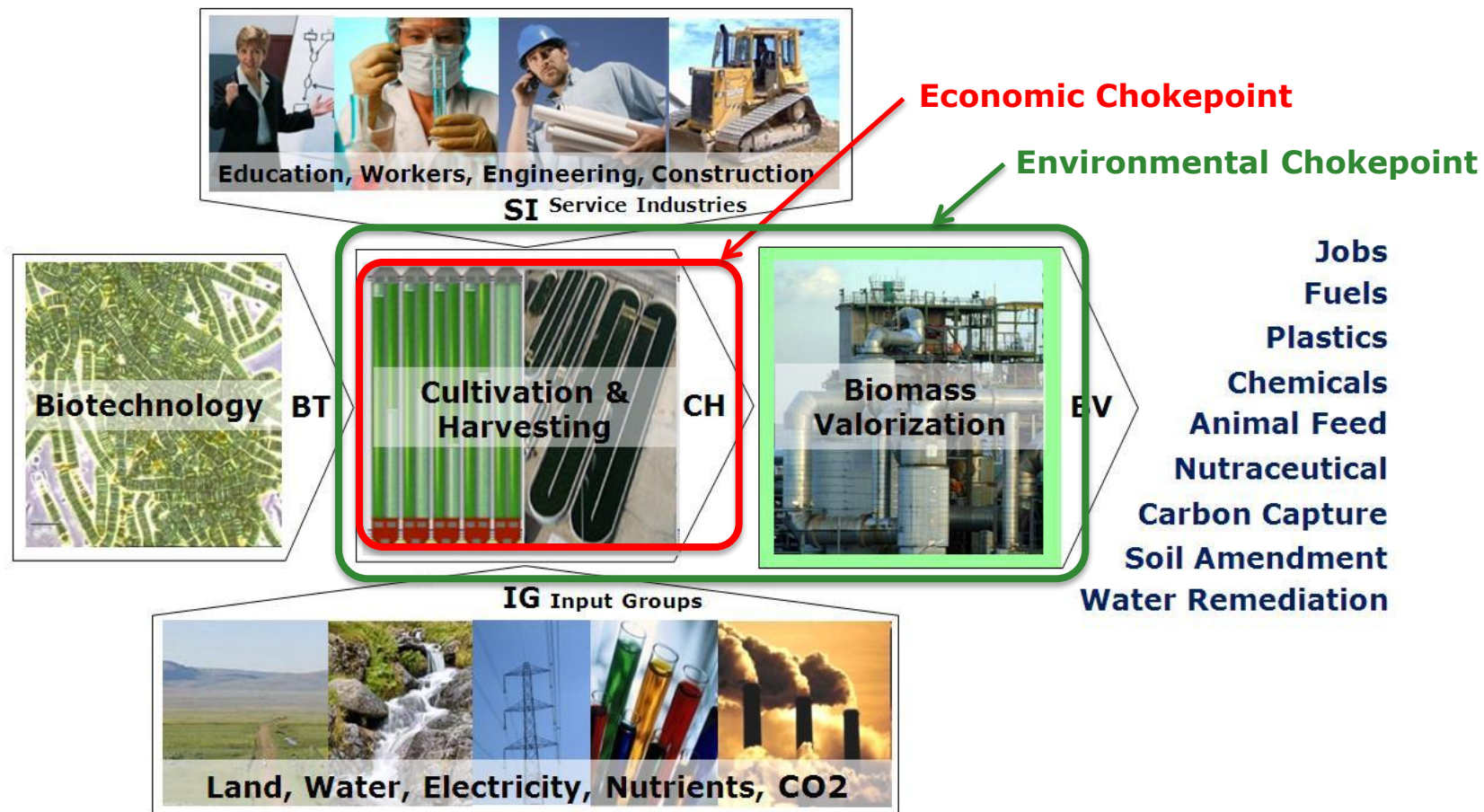
Industrially Compatible, Environmentally Scalable and Politically Permittable



Sun Restores Value to CO2 by Recycling it back to Energy Bearing Products



Scaling Chokepoints Throttling Algal Industry Growth algae@work



Biotechnology -

- ✓ Lion's share of investment \$\$
- ✓ Technology advancing rapidly
- ✓ Many suitable species identified

Cultivation and Harvesting -

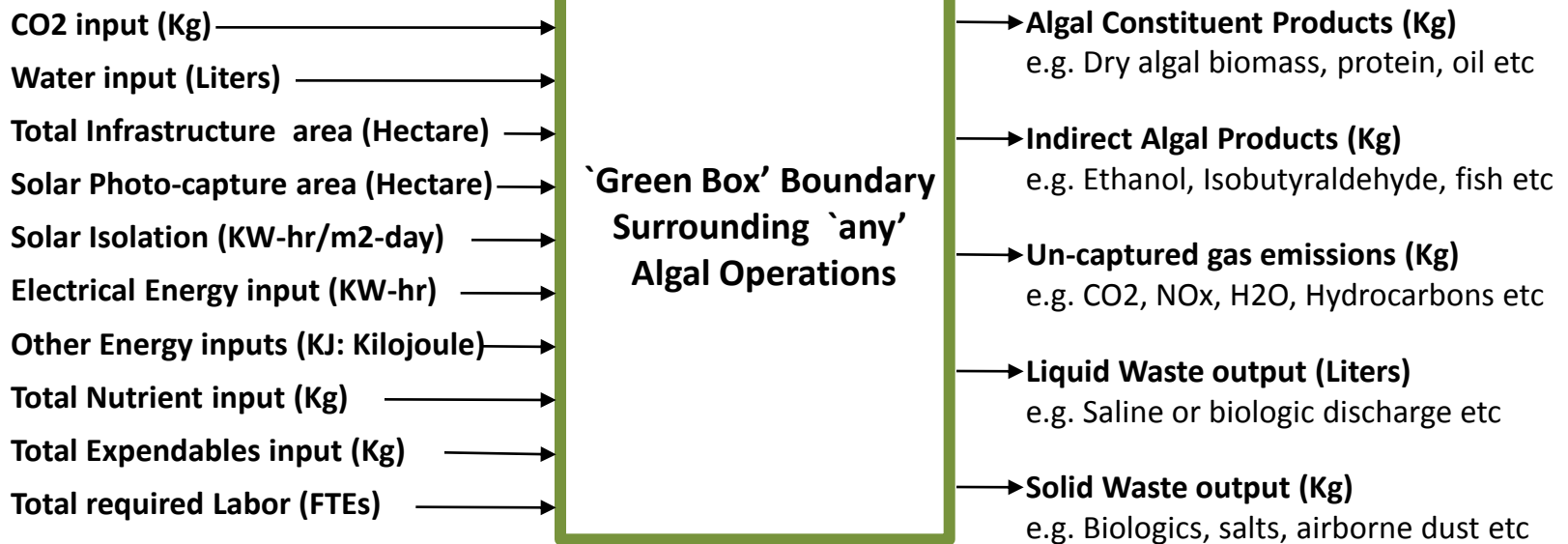
- **Limited C&H investment to date**
- **Open ponds have serious limitations**
- **No commercial-scale PBR systems**

Biomass Valorization -

- ✓ Biomass conversion technologies exist
- ✓ Large international markets await
- **But success requires more biomass!**

- **Algal Biomass Organization:** largest algal Industry trade group www.algalbiomass.org
- **Initial Objective:** Recommend Descriptive Language and Measurement Methods by Oct 2010
- **Future Objective:** Integrate Algal Industry metrics with Other Standards Organizations

Job #1: Define Industry Inputs and Outputs Using "Standardized" Descriptive Language



Standards Committee Member Representation: Industry, Government, and University



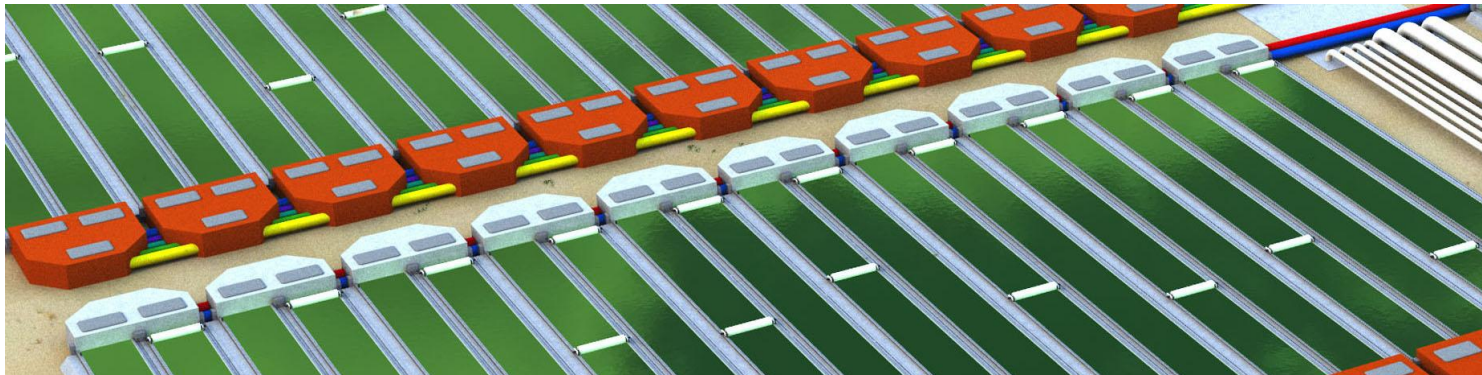
“Open Raceway Ponds” (Algal growth media is exposed)

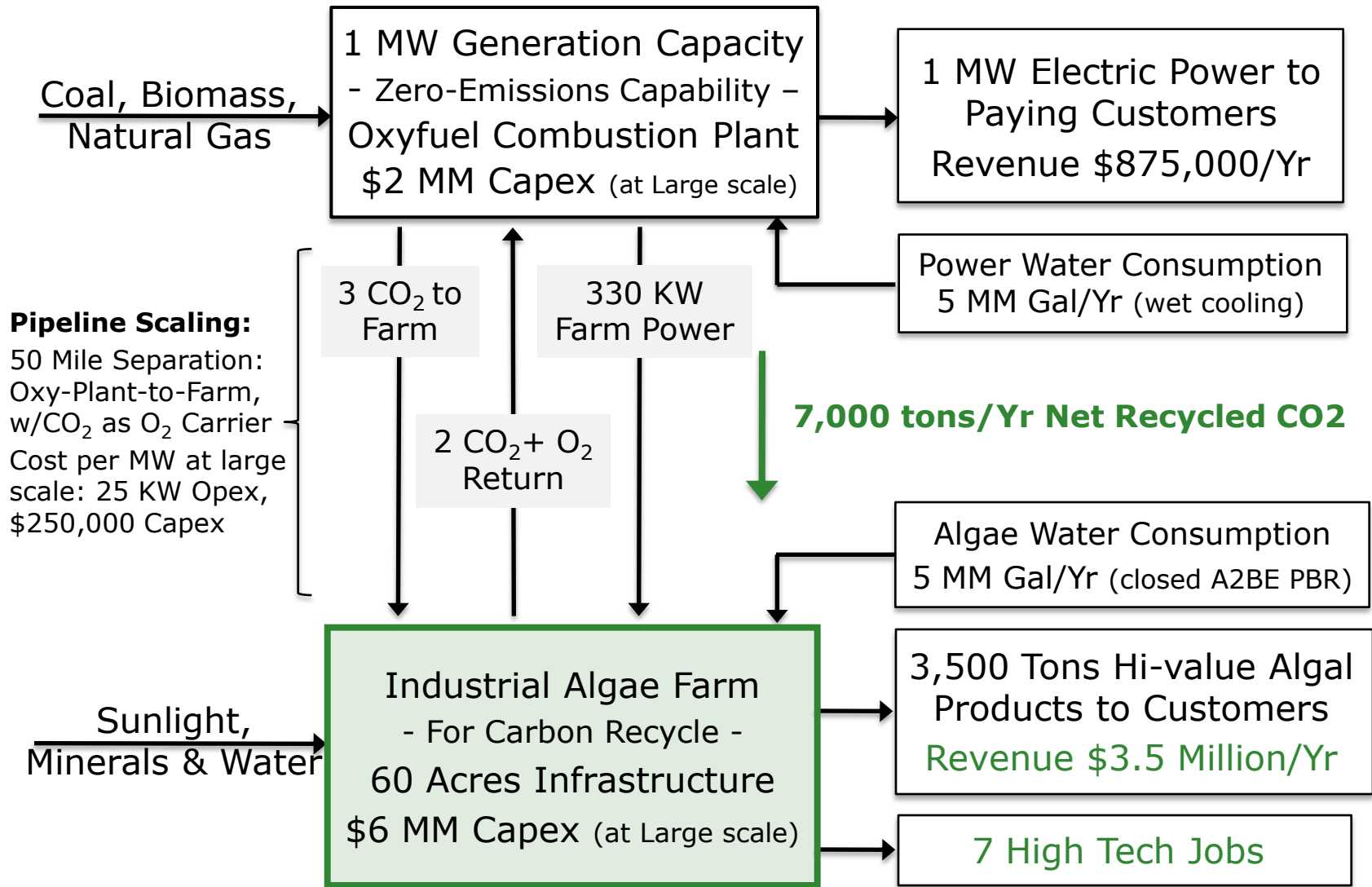
- Traditional growing technology, yet minimal usage
- Req. 30X more fresh water than PBRs or Fossil Emitters
- Substantial CO₂ leakage Emissions. Wild algal species
- Limited to tropical climates or partial growing seasons



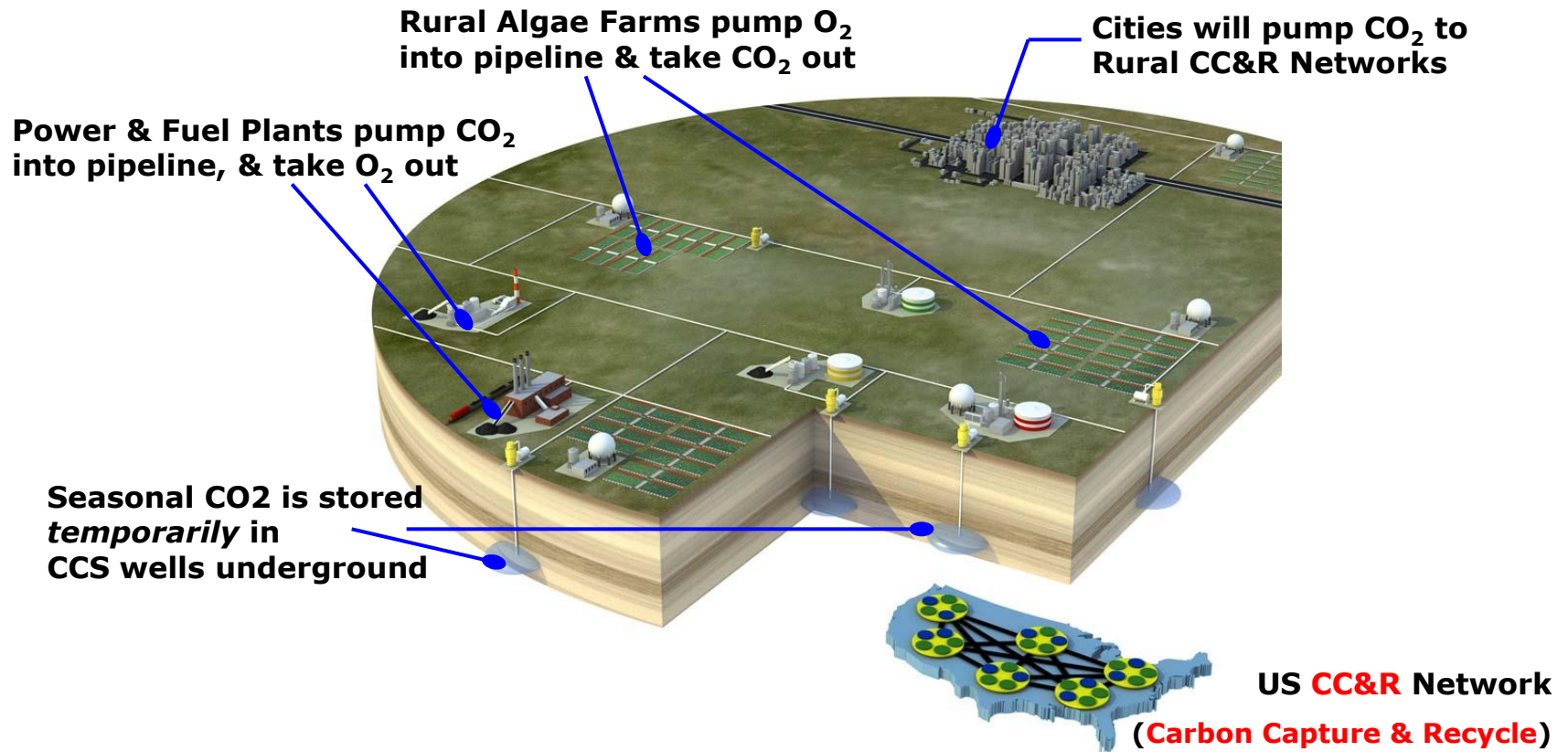
“Closed Photobioreactors” (Transparent protective containment)

- Still in research & development, No commercial usage
- Very low water consumption if using Passive Cooling
- Maximum control of CO₂ and algal species type
- Constant Production of High yield, High value algae





Note: These 1 MW unit scaling factors are designed to estimate *large plant* operations.



Pipelines, CCS Stockpiling and Algal Recycling of CO₂ across North America will **Distribute Sustainable Jobs and Prosperity.**

Chemical Industry –

Recycling Process Emission CO₂ Back to O₂ and C Feedstock

- Example: Coal plus biomass to liquid process – Accelergy, A2BE, Algenol, DOW
- Benefits: Enables zero-emissions and Solar energy input

Fuel Industry -

Recovering Dissolved-in-Media Volatile Feedstocks

- Example: Hydrogen, Alcohol, Isobutyraldehyde – Algenol, Joule, A2BE, DOW
- Benefits: High volatile production rate without algal cell harvest

All Industry -

Extracting Inter- and Extra-Cellular Algal Oil Feedstocks

- Example: Fuels, Nutraceutical, Food additives and Bio-plastics – Cereplast , A2BE
- Benefits: High molecular purity sustainable oil feedstock

Food Industry -

Producing High Omega-3 and Protein Content Animal Feed

- Example: Fish farming, Poultry and Beef production – A2BE, Danforth Consortium
- Benefits: High intensity growth, High nutrition, High purity

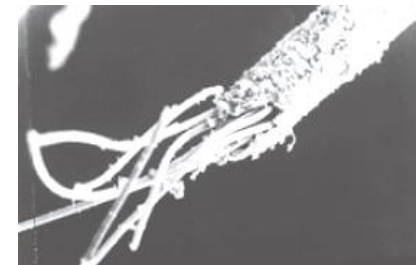
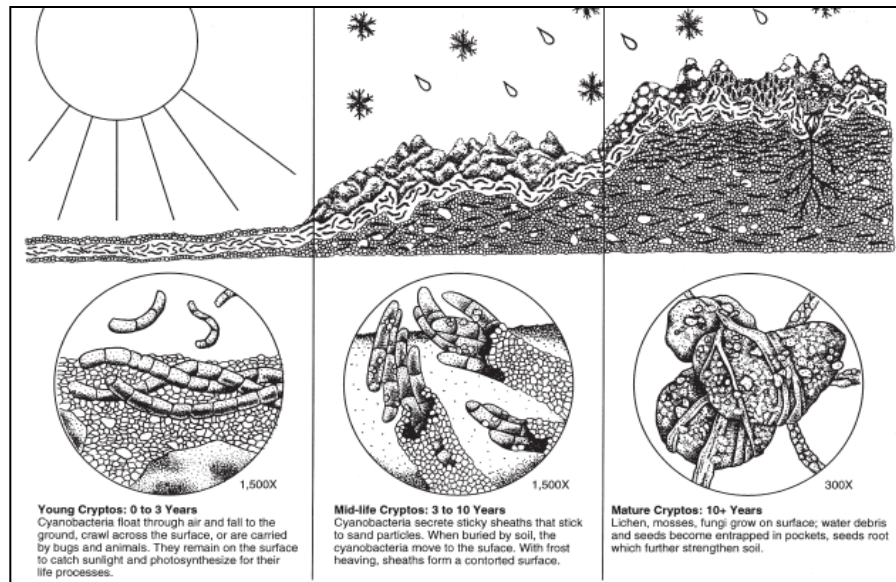
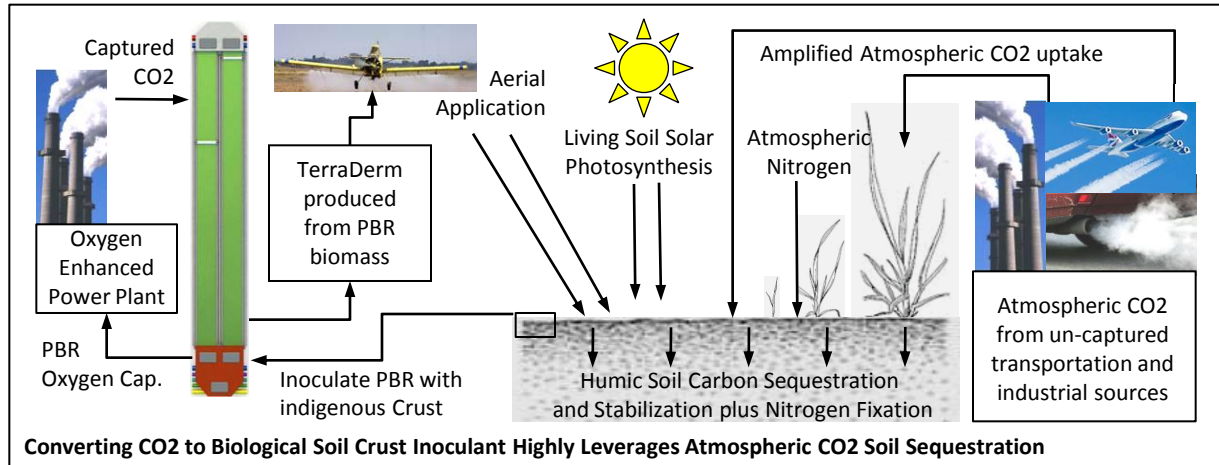
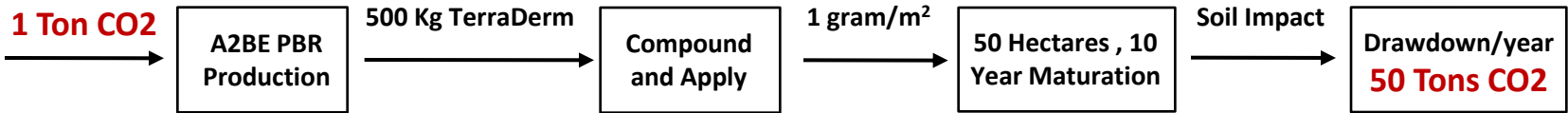
Farming & Climate Mitigation Industry -

Growing Photosynthetic Soil Inoculant and Fertilizer

- Example: Exp. TerraDerm™ Soil treatment – A2BE, Battelle, Accelergy, Raytheon
- Benefits: Atmospheric carbon capture, Soil stabilization and Fertilization

Note: Algal Based technology for the beneficial reuse of CO₂ and financial models are **still in development.**

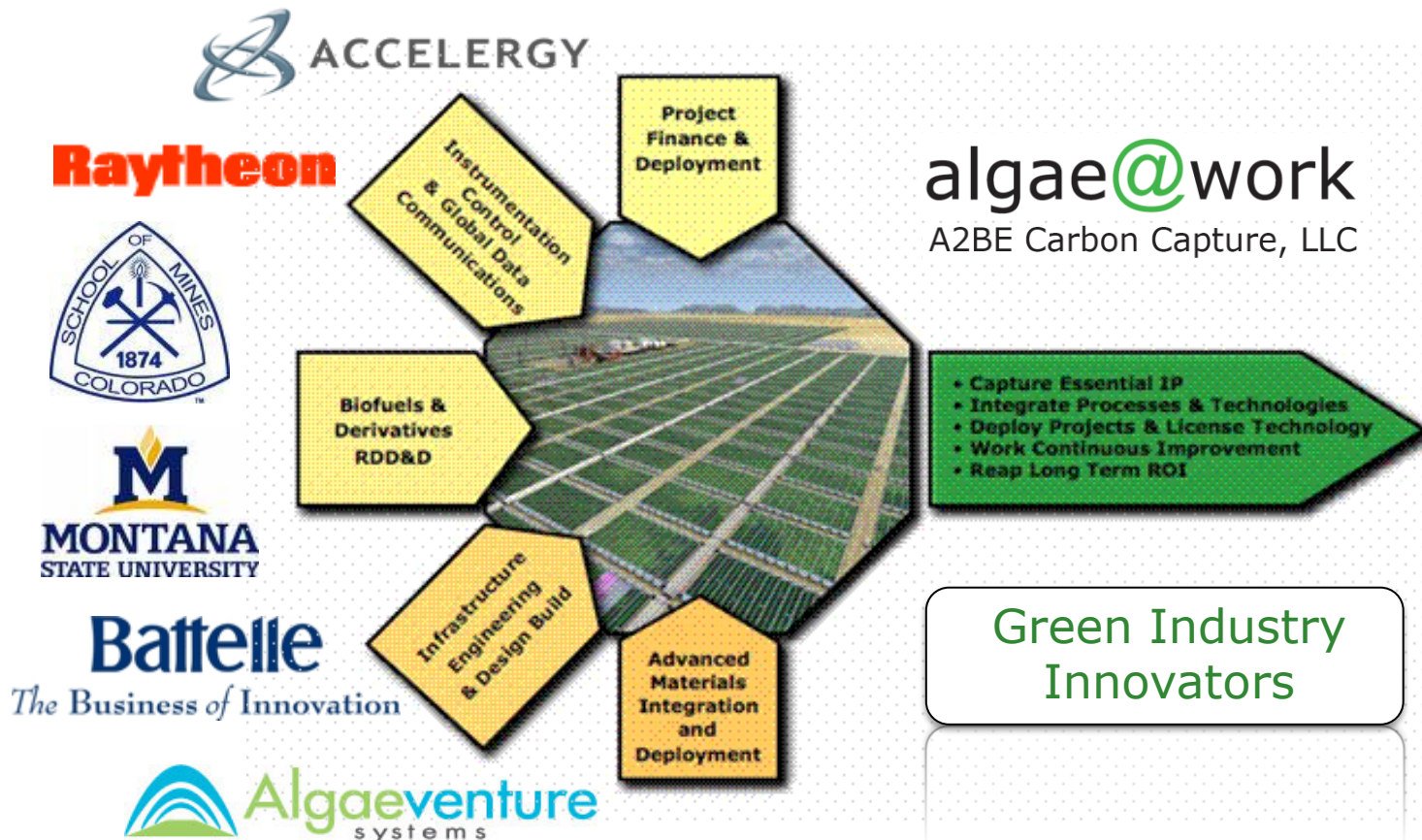
TerraDerm™ for Atmospheric CO2 Drawdown into Soils



Microcoleus vaginatus
Blue-Green Algae shown with gelatinous sheath is part of many biological soil crusts. *USGS Crust Manual*

- **Solar Powered Crop Fertilizer Too**
- **Blue-Green Algae Survives Desert**
- **Sequesters C & N into Sandy Soil**
- **Reduces Wind and Water Erosion**
- **Global Arid Land Reclamation** ¹²

- **Model** Sound System Engineering
- **Attract** Common Pool of Intellectual Property
- **License** Manufacturing, Operation and Staffing
- **Propagate** Profitable Turnkey Business Solutions
- **Demonstrate** Environmental and Economic Sustainability



algae@work
A2BE Carbon Capture, LLC
www.algaeatwork.com

A2BE Carbon Capture LLC (Our Evolving viewpoint)

www.algaeatwork.com

Algal Biomass Organization (Trade Org. – Conference: Phoenix Sep 28)

www.algalbiomass.org

Algae Industry Magazine (Popular Press)

<http://www.algaeindustrymagazine.com/>

DOE National Algal Biofuels Roadmap (Draft Workshop Result)

[https://e-center.doe.gov/iips/faopor.nsf/UNID/79E3ABCACC9AC14A852575CA00799D99/\\$file/AlgalBiofuels_Roadmap_7.pdf](https://e-center.doe.gov/iips/faopor.nsf/UNID/79E3ABCACC9AC14A852575CA00799D99/$file/AlgalBiofuels_Roadmap_7.pdf)

General Accounting Office Energy-Water Nexus Nov 2009 (GAO)

<http://www.gao.gov/new.items/d10116.pdf>