

Ten Essentials for an Algal CC&R Industry

I. Flexibility in Cultivation and Harvesting

High algal product value requires precise control of cultivation parameters to support diverse crop species and varying harvesting protocols. Superior algae variety development will be paralleled by evolution of process pathogens and consumptive invaders. Control and flexibility in the growth environment and harvesting is critical.

II. Long-Term Biologic Stability

High productivity, profitability, and industrial relevance require uninterrupted PBR operation over periods of 1 year or more. Threats of bacteriological infection, virus infection, weed algae invasion, and rotifer population explosions must be sustainably managed in order to provide industrial reliability, energy and food source technology.

III. Efficient Temperature Control

Broad global deployment requires high-efficiency utilization of water and energy to control algae farm temperatures. Algal photosynthesis captures, at most, only 5% to 10% of the solar energy spectrum. Accordingly, all energy and water expended in heating or cooling PBRs will greatly impact the overall energy and water balance.

IV. Functionally Unlimited Scalability

CC&R industry infrastructure construction and operations must be viable at any scale using only sustainable and abundant planetary resources. Once a CC&R industry is set in motion via the engine of commerce it will be difficult to stop, making it essential that this growth expansion occurs in a planet-healthy and sustainable fashion.

V. High Areal Light Productivity

High algal biomass productivity per square meter of sunlight is required to minimize land area, thereby controlling high technology infrastructure costs. High-technology infrastructure elements are required to maximize the productive growing season, crop value, and industrial reliability that will be needed for algae farms to propagate.

VI. Frequent Cellular Re-Suspension

During cultivation, the entire algal cell population must be kept in fluid suspension to provide each cell sufficient access to nutrients and light so that a state of generalized maximum productive health is maintained. Periodic re-suspension of settled pockets of stranded cells is required to prevent cell death, bacterial growth and PBR crashes.

VII. Frequent Biofilm Management

Biofilms are readily deposited on the light transmission and containment surfaces of all PBRs. Sustainable management of biofilms is required to maximize light transmission efficiency and minimize deleterious bacteriological infections. Biofilms can provide synergistic benefits and extra biomass productivity when well-managed.

VIII. Efficient Gas and Nutrient Management

Every kg of algal biomass produced will require more than two kg of CO₂ and plant nutrients to be fed into the CC&R PBRs. Energy consumption must be minimized in handling these quantities of CO₂; and especially using flue gas. Sustainable sources and process recycling strategies for the vast quantities of nutrients are mandatory.

IX. Industrial Reliability

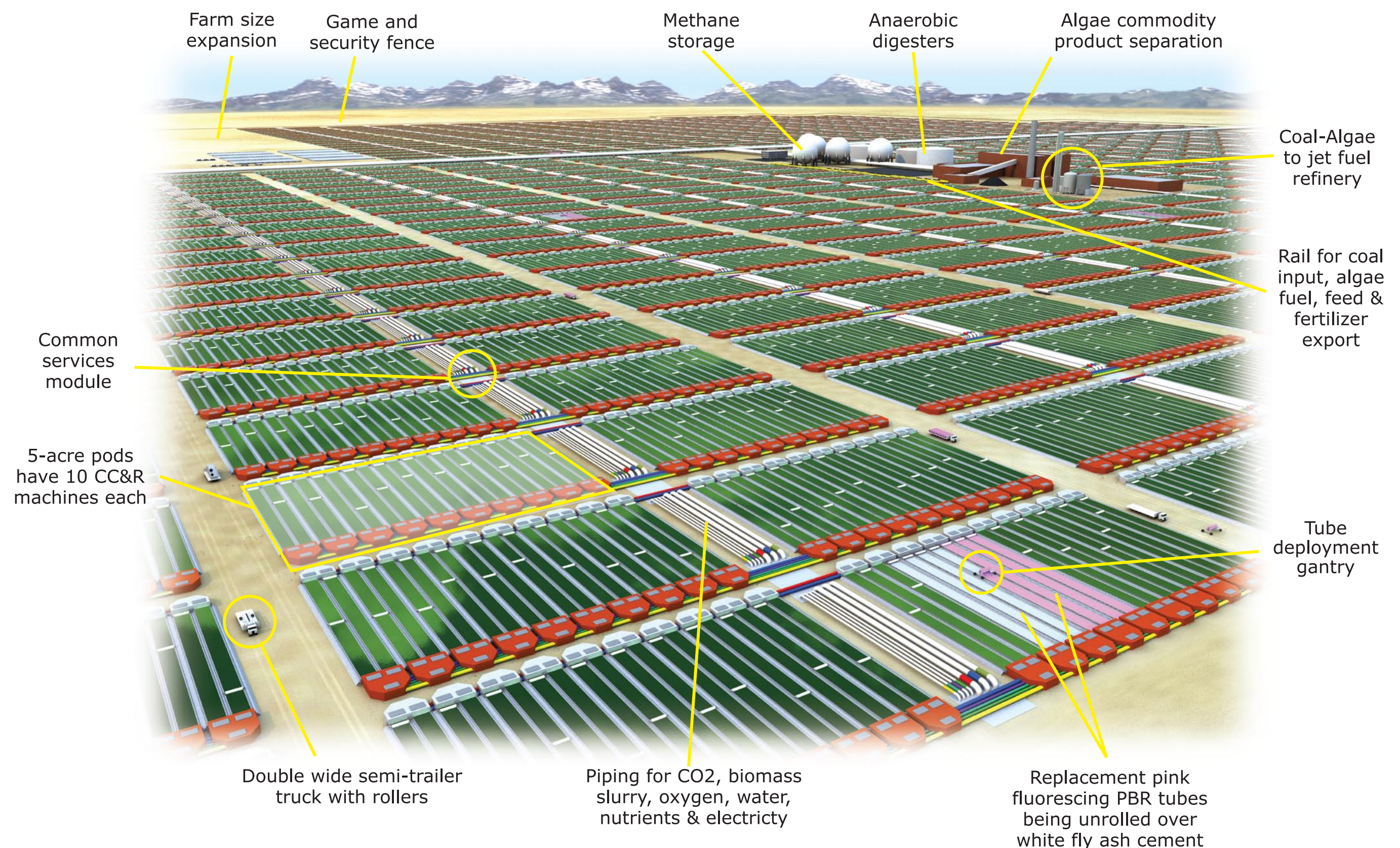
The CC&R industry must work in tandem with upstream and downstream industry partners to convert constant process flows of CO₂ into feedstocks, refine them into products and distribute them to waiting markets. There is no room for unreliability or disruption due to weather, infection, regulation, terrorism, or scalability challenges.

X. Politically Deployable

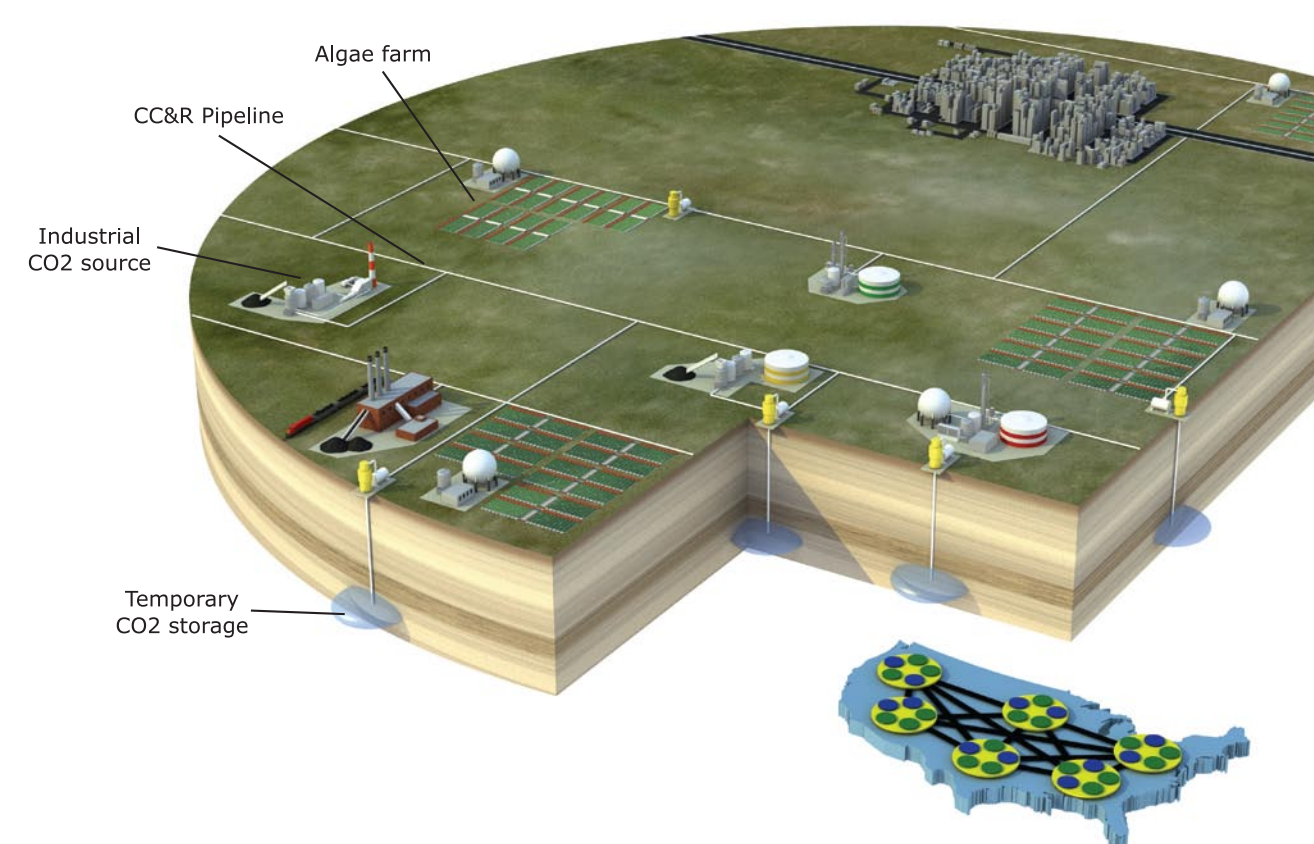
There is no more fundamental requirement for an algal CC&R technology than to be politically deployable, on a massive industrial scale, providing broad local benefits. Deployment and operational plans must withstand the muster of planning boards, regulatory agencies, funding agencies, lending banks, and environmental interests.

Algal-based CC&R (Carbon Capture & Recycle) will become one of the planet's largest industries as it simultaneously addresses peak oil, climate change, food prices, soil depletion, and water shortages. CC&R will meet these challenges while generating prosperity through global job growth. However, for this industry to be successful, the core CC&R technologies must fulfill ten essential requirements.

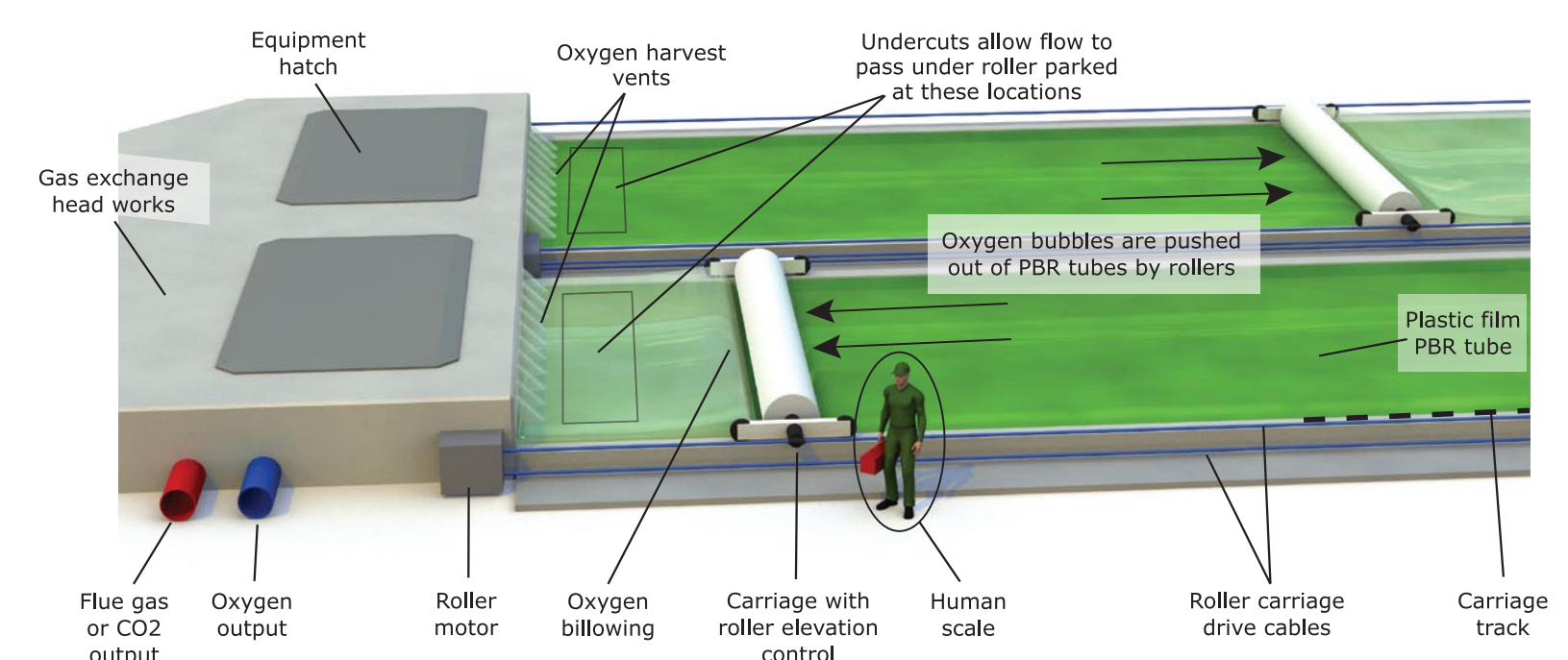
Zero emissions algae farms converting coal to food, fuel, electricity and fertilizer



Hybrid CO₂ Recycle and Storage grid damps and distributes CO₂ to national algae farm network



Carbon Capture & Recycle Roller-Film PBR (CC&R Machine)



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