



A Novel Technology for Large Scale Algae Feedstock Production



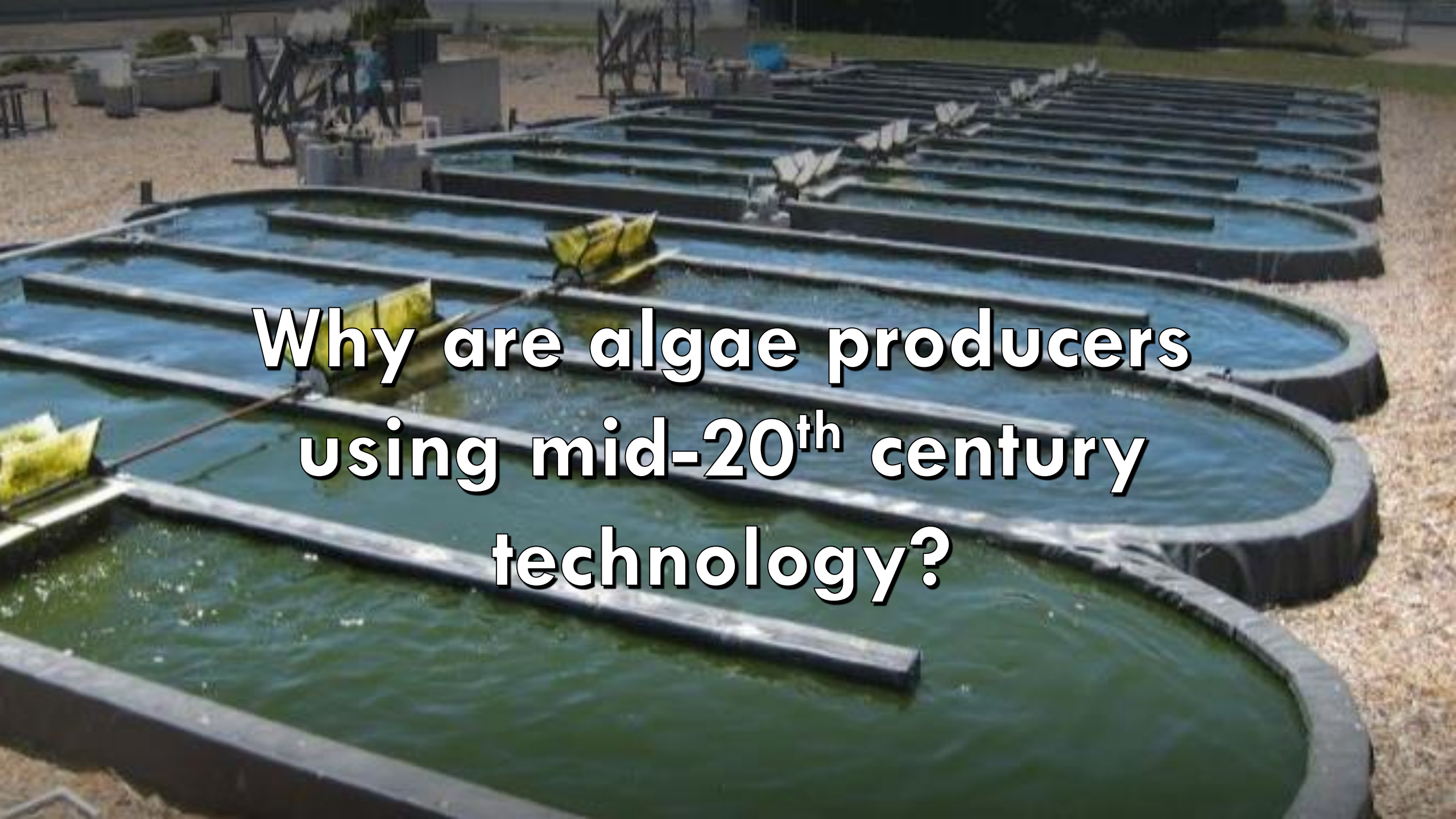
Over 90% of algae cultivation occurs in open raceway ponds.

**Open to species predation & “crash”.
Hinders predictable output.**

The background image shows a vast, rectangular open raceway pond used for algae cultivation. A large, dark, rectangular floating cover is positioned in the center of the pond. The water is a deep blue-grey color. In the background, there are orange-brown hills and some industrial structures under a clear blue sky.

Over 90% of algae cultivation occurs in open raceway ponds.

Extreme Water and Land Use prevents economies of scale.



**Why are algae producers
using mid-20th century
technology?**



Time to get out
of the pond
and into a

PURE ALGAE GROWTH SYSTEM





PURE ALGAE GROWTH SYSTEM

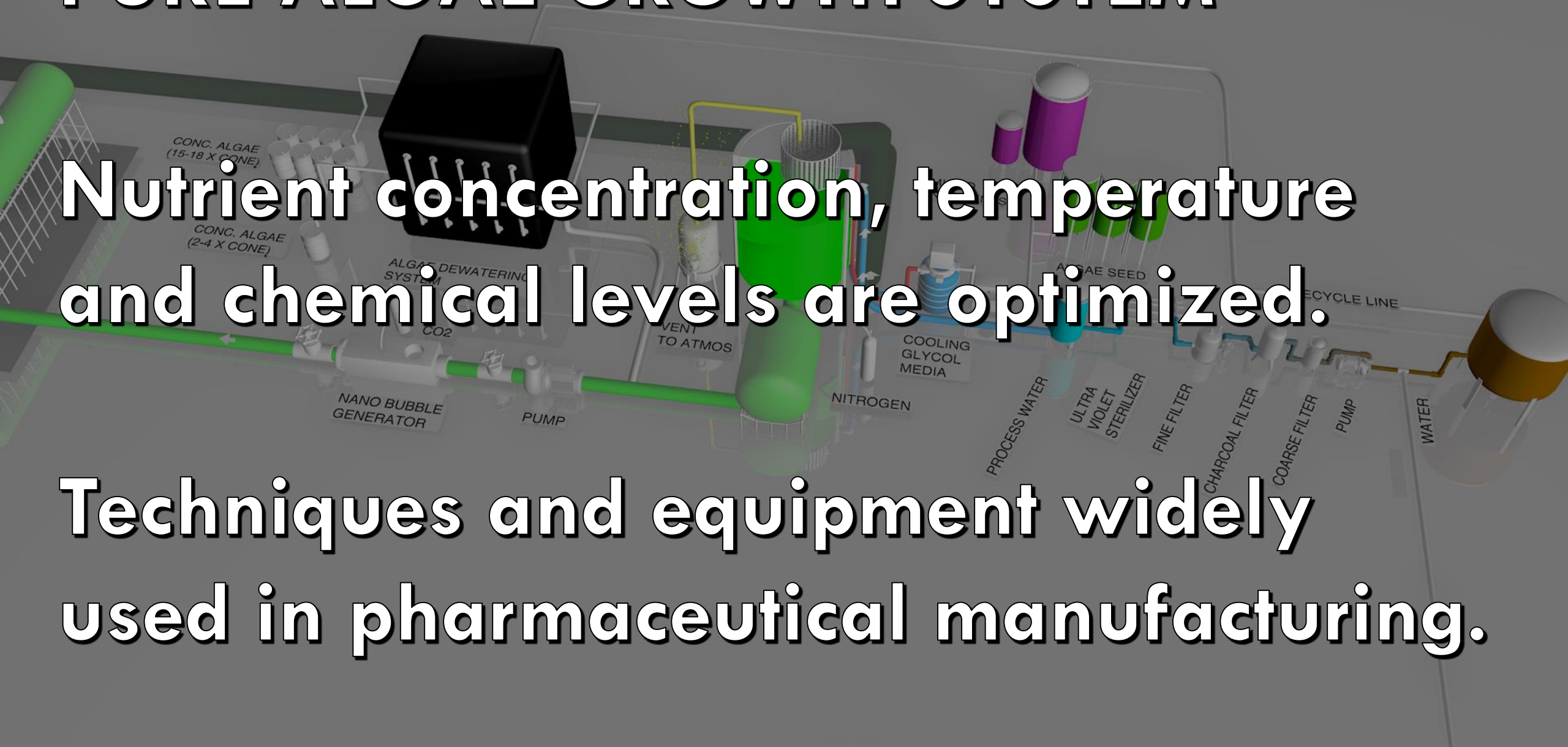
**100% closed, pressurized environment
prevents outside influences.**

**Nutrients, diluents and carrier media
in a near sterile condition.**

PURE ALGAE GROWTH SYSTEM

Nutrient concentration, temperature and chemical levels are optimized.

Techniques and equipment widely used in pharmaceutical manufacturing.



PURE ALGAE GROWTH SYSTEM

**Continuous 24/7/365 algae growth
and harvest. Predictable output.**

**95% recycling and reuse
of water and all nutrients.**

PURE ALGAE GROWTH SYSTEM

Very low land use.

Easy to site.



PURE ALGAE GROWTH SYSTEM



ALGAE NIRVANA



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Contact: Dean Higuchi, 808-541-2711, higuchi.dean@epa.gov

U.S. EPA recognizes Kuehnle AgroSystems for innovative algae biofuel work

Hawaiian company recognized for first-of-its-kind achievement in protecting the environment

Industrial Waste CO₂ used for:

- GROWING MICRO ALGAE**
- WASTE WATER NUTRIENT DEPLETION**
- ECONOMIC BYPRODUCT MATERIALS**



Chevron Refinery Hosts Algae Demonstration Project

**Kuehnle AgroSystems Commissions an Algae Cultivation Project
at Chevron's West Oahu facility**

The Chevron refinery opened its doors in 2011 to Kuehnle AgroSystems, Inc. (KAS), a Hawaii-based company that produces specialized algae strains and bulk concentrated algae, to construct and operate an algae demonstration project partly funded by the Hawaii Renewable Energy Development Fund and the Office of Naval Research. In January, KAS held a commissioning ceremony after undergoing a system start-up and testing period of 1,000 continuous hours of operation.

The KAS project uses recycled CO₂ waste streams and wastewater by-product to cultivate algae in specially designed

closed growing systems.

"We believe this project is the first U.S. demonstration of refinery waste streams being recycled into valuable algae products," said Dr. Adelheid Kuehnle, founder and CEO of KAS.

"We're thankful to the Chevron Hawaii refinery for making their facility available to us as a host site," she said.

The live algae used in this project are sourced in Hawaii. KAS will conduct the project to cultivate and evaluate different strains of algae at production scale through August.

The goals for this demonstration project include transitioning algae into a sustainable

source, linking industrial effluents for scalable algae production, and linking biomass produced from KAS algae species with highly effective conversion processes to produce biofuels.

"Although we have not invested in the KAS project, advanced biofuels research and development is definitely of interest to Chevron. Chevron Corporation has committed to invest \$2.2 billion in renewable energy and efficiency in the years 2011 to 2013," said Chris Cavote, refinery manager.

"It's great to see our Hawaii refinery's involvement in this demonstration project," he said.



Algae Nirvana 1.0

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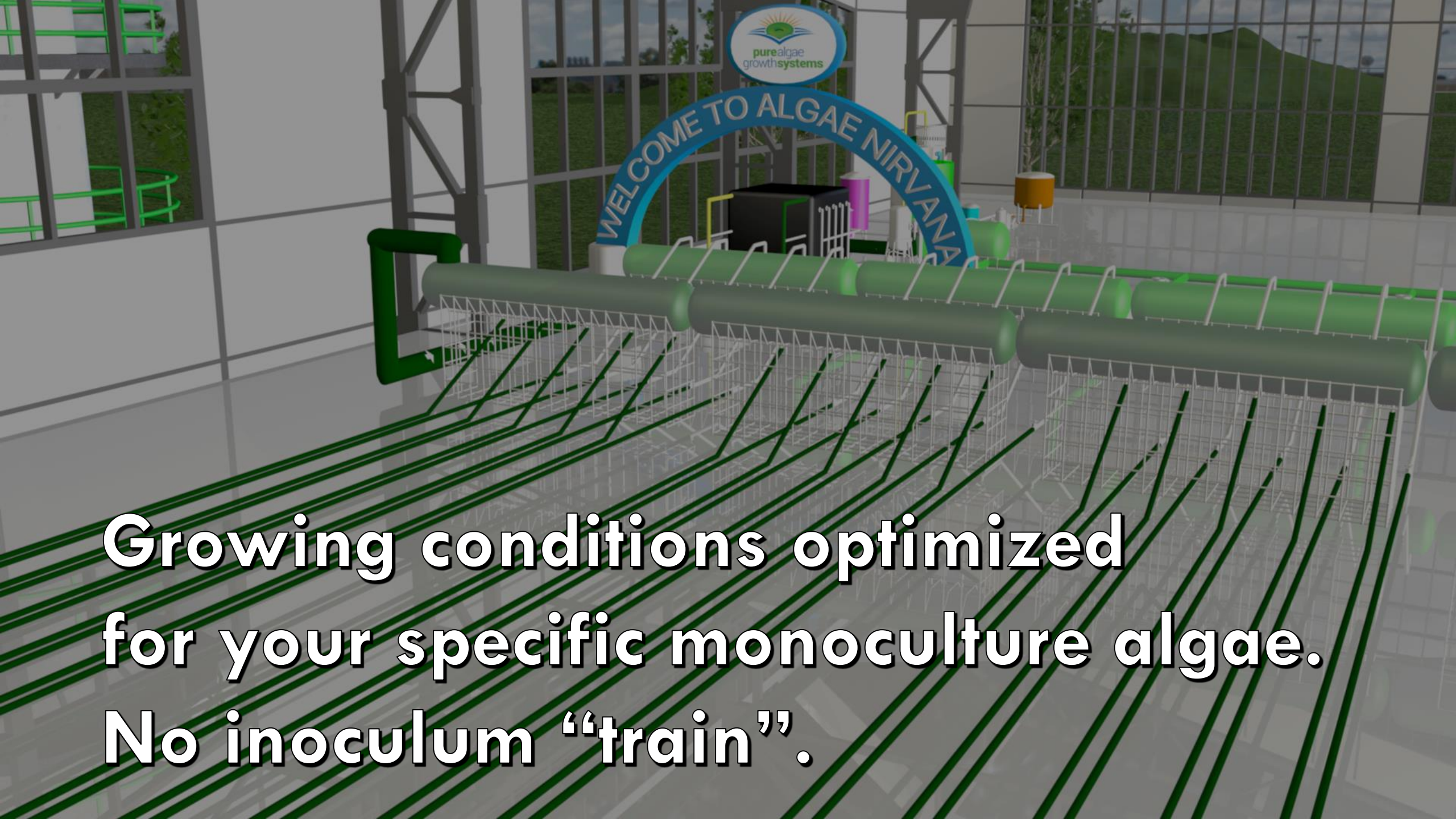
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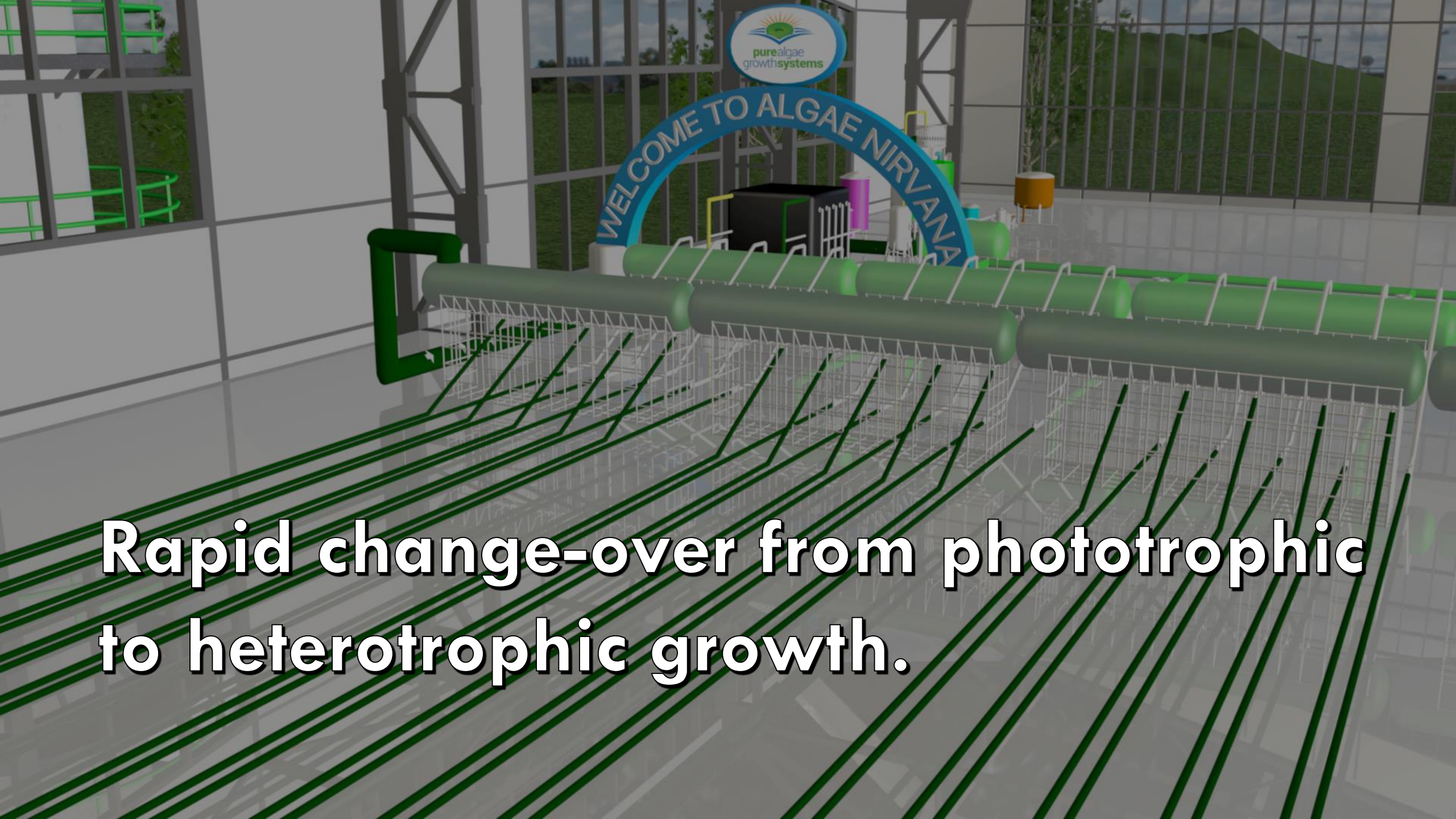
The KAS algae demonstration project will run through August at the Chevron



**Pressurized, closed-loop, sanitary
industrial unit operations.**



**Growing conditions optimized
for your specific monoculture algae.
No inoculum “train”.**



Rapid change-over from phototrophic to heterotrophic growth.

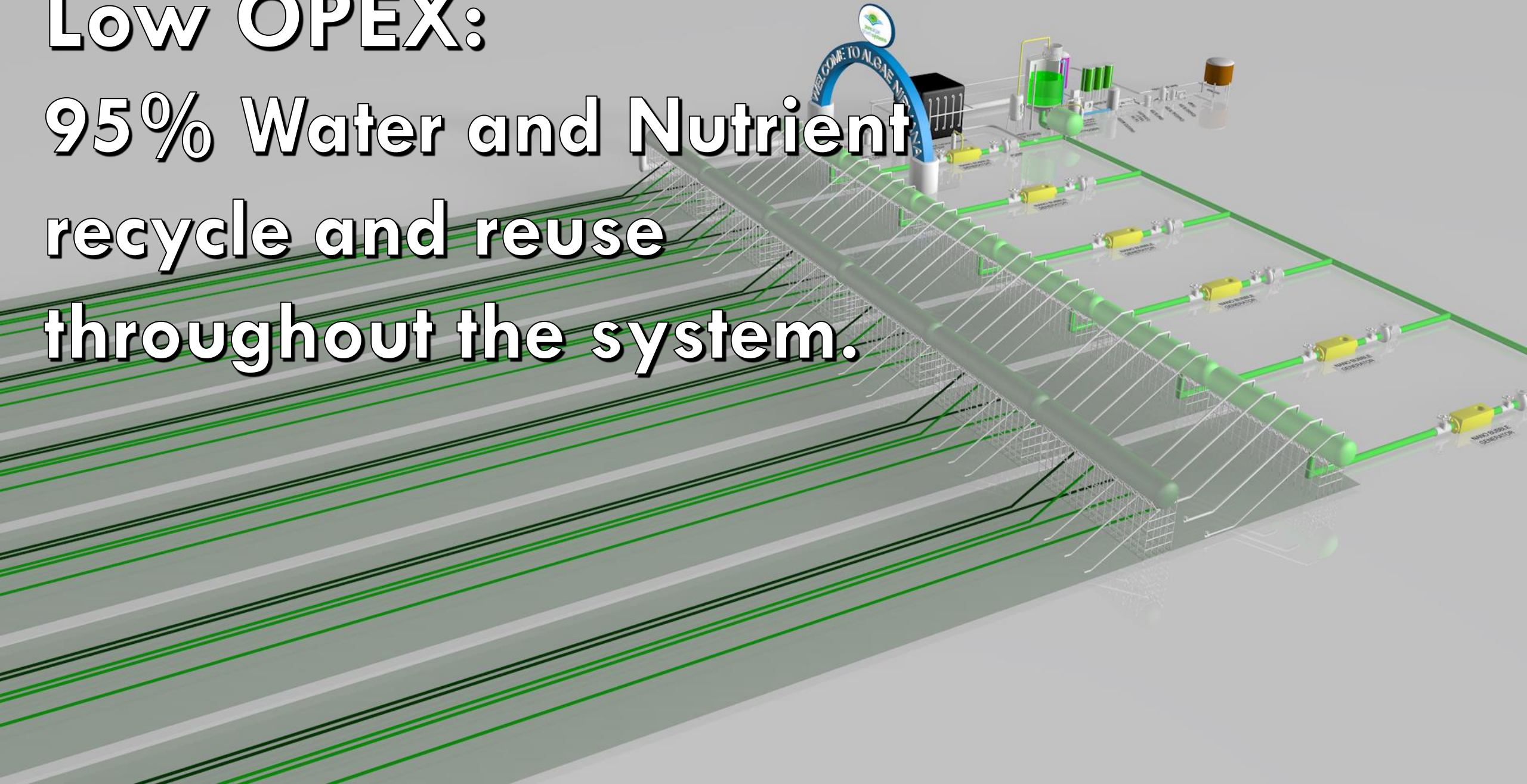
**Low CAPEX:
Commercially available
standard industrial
equipment.**



Low CAPEX:
<5% of Land Use
needed by ORPs.



**Low OPEX:
95% Water and Nutrient
recycle and reuse
throughout the system.**





Raceway Configuration

Process Water	350 kg / day	8900 kg / day
CO2 Feed	15 kg / day	300 kg / day
Micro Nutrients	5 kg / day	120 kg / day
Algae Seed	0 kg / day	160 kg / day
Algae Production	3.9 kg / day	3.9 kg / day

3100 pounds / year

Low OPEX:
Labor required to operate
facility is significantly
lower.



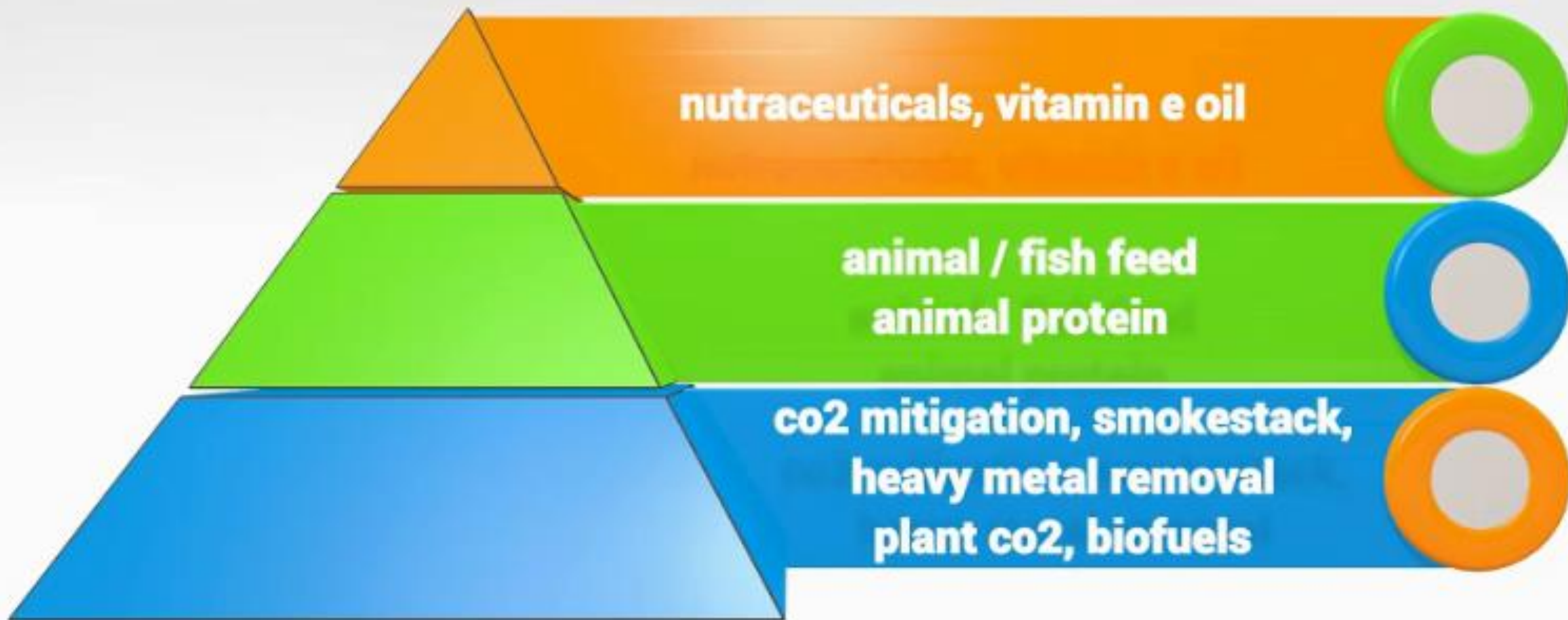
Economies of Scale:

10x Output : 2x CAPEX



Plant Size	Biomass Output /YR	System Capacity	CAPEX	OPEX	Site Size
DEMO	1 METRIC TON	11,000 LITERS	\$2,250,000	\$340,000	50' x 250'
1SGM	4 METRIC TONS	23,000 LITERS	\$5,000,000	\$1,300,000	3 ACRES
10SGM	40 METRIC TONS	230,000 LITERS	\$10,000,000	\$2,700,000	8 ACRES
100SGM	400 METRIC TONS	2.3 M LITERS	\$20,000,000	\$5,400,000	16 ACRES

2015 Algae oil market \$1.38 bn, 4.3% CAGR 2025



Algae biofuels \$10.73 bn, 8.8% CAGR 2025

Plant Size	Biomass Output / YR	Cost / Kg AFDW	Cost / Lb AFDW	Cost / Ton AFDW	
DEMO	1 METRIC TON	\$340	\$154.55	\$309,091	
1SGM	4 METRIC TONS	\$325	\$147.73	\$295,455	
10SGM	40 METRIC TONS	\$68	\$30.68	\$61,364	
100SGM	400 METRIC TONS	\$43	\$19.55	\$39,091	



Discover a better way to grow!

www.purealgae growthsystems.com

info@purealgae growthsystems.com