

Biofuels?

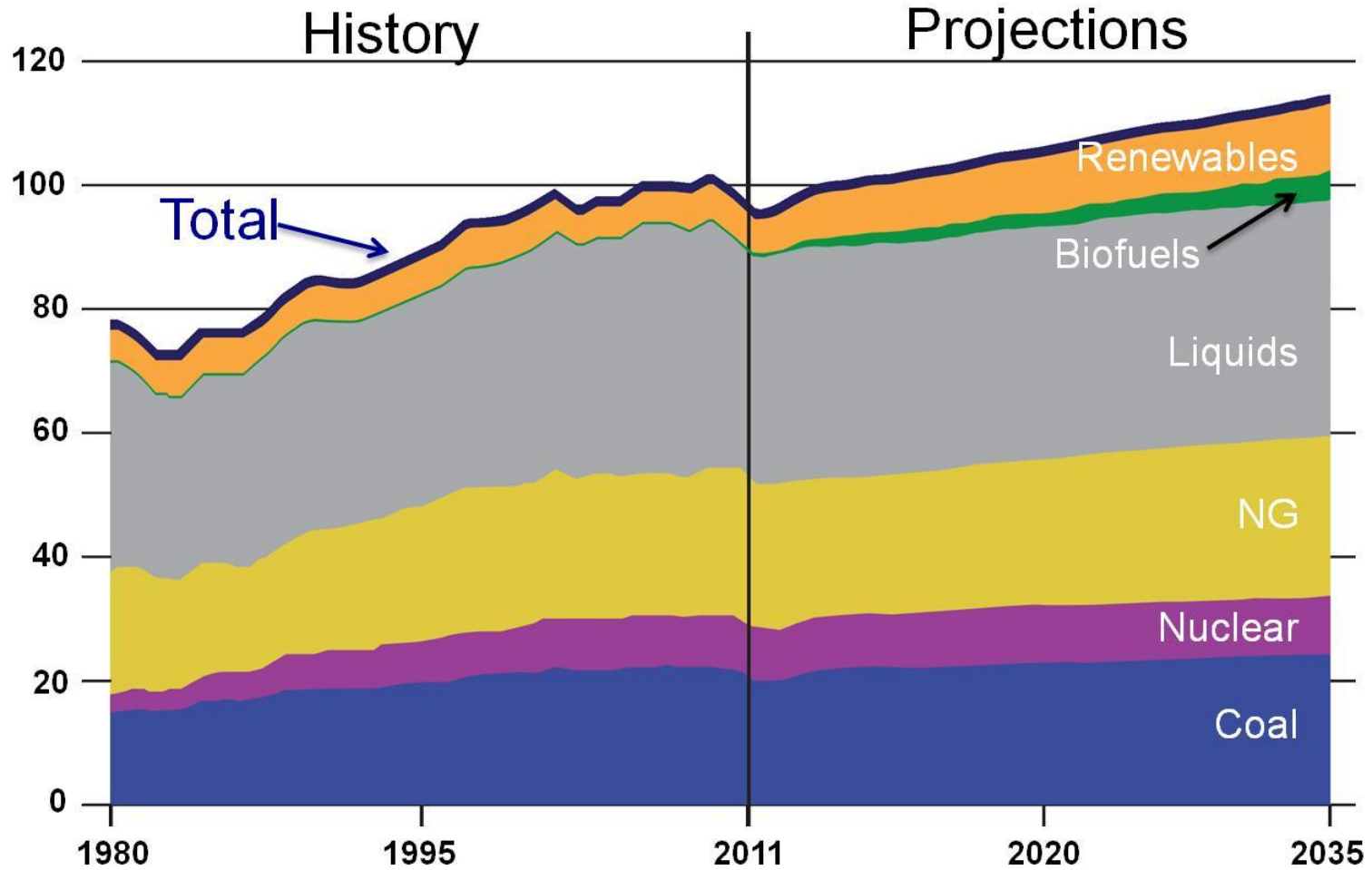
Feasible, affordable, scalable, sustainable...

Does not compete with agriculture:

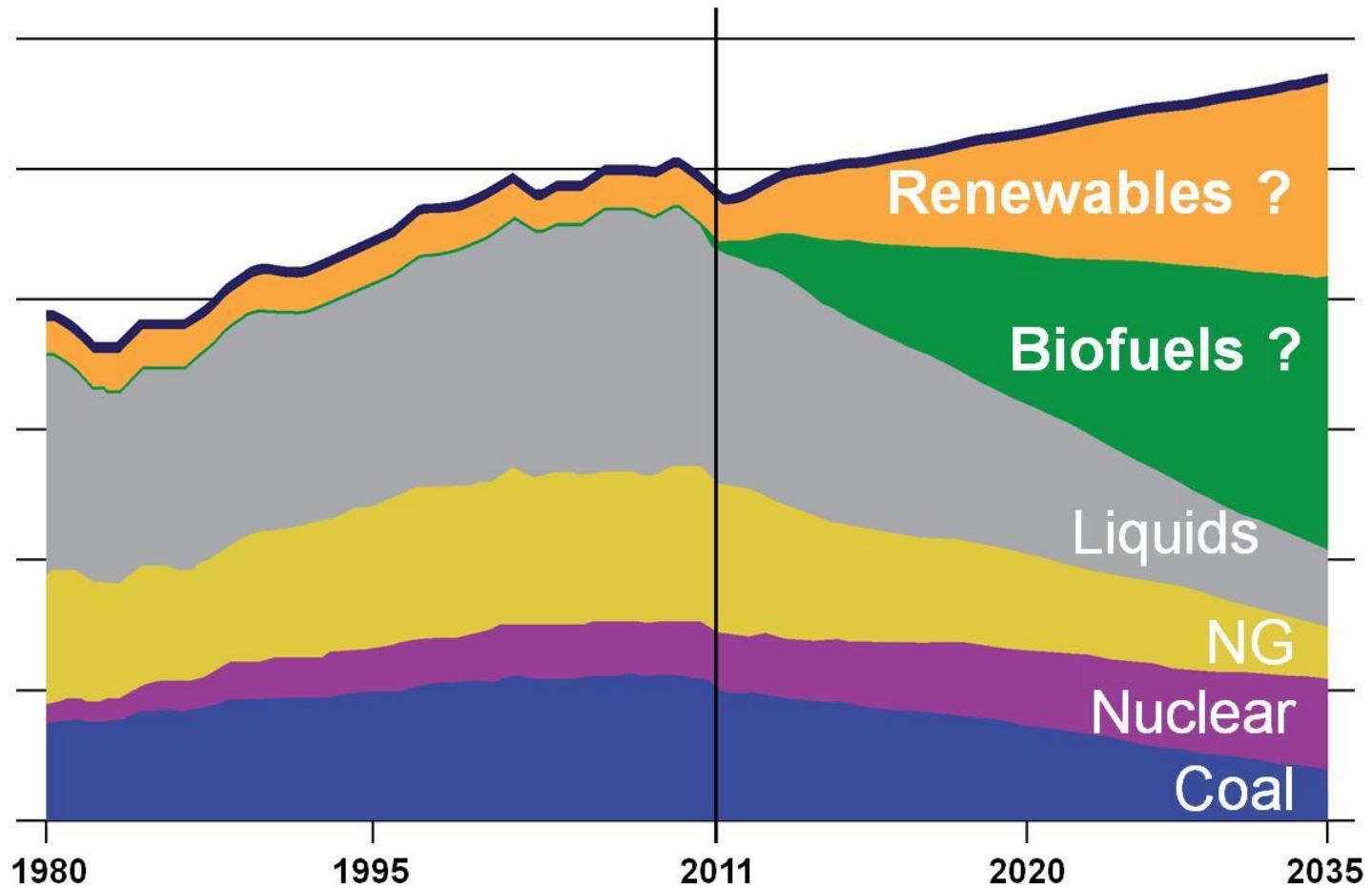
- WATER
- FERTILIZER
- LAND

NOW!

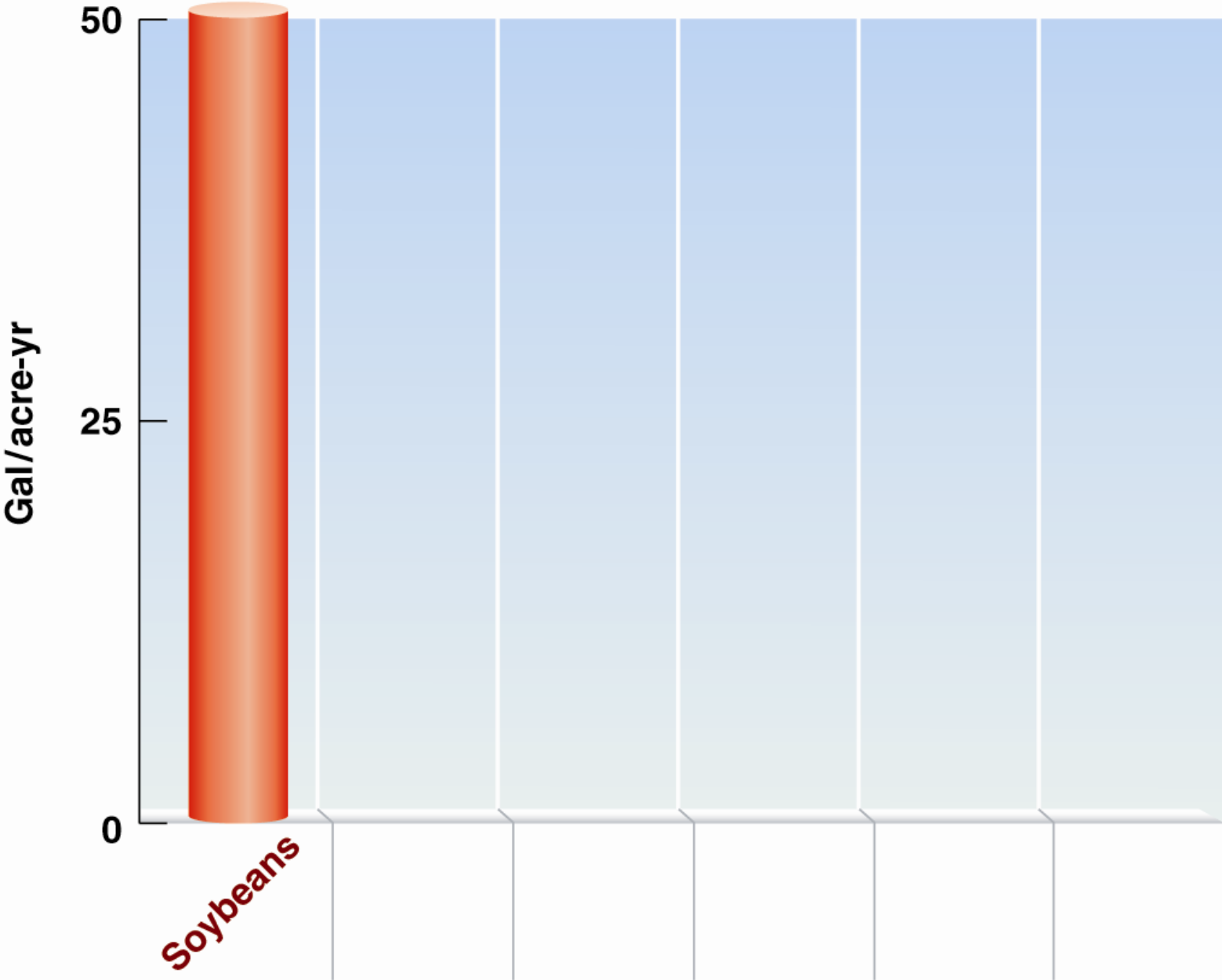
U.S. Primary Energy Consumption, 1980-2035 (Quadrillion BTUs)



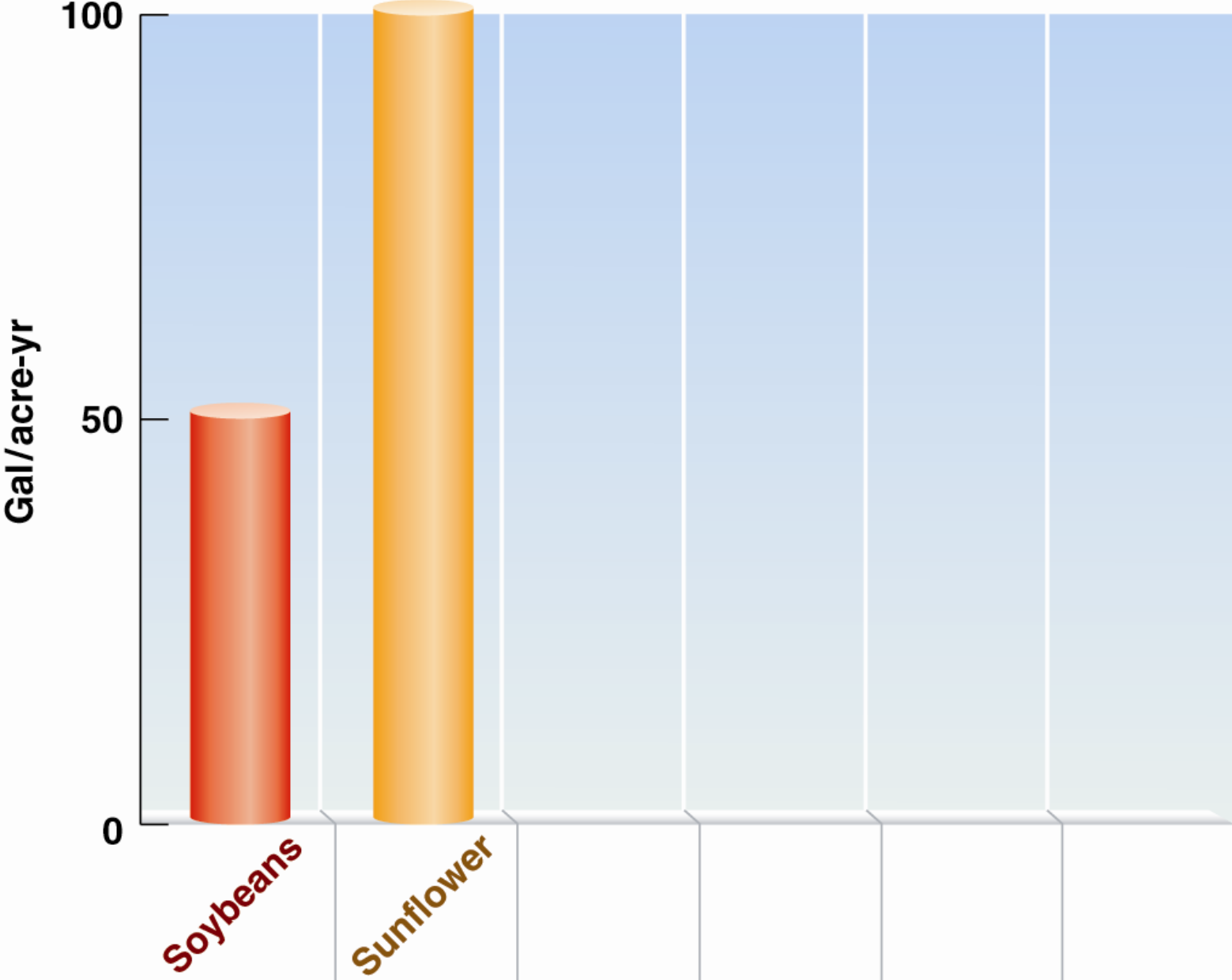
U.S. Energy Consumption (Quadrillion BTUs)



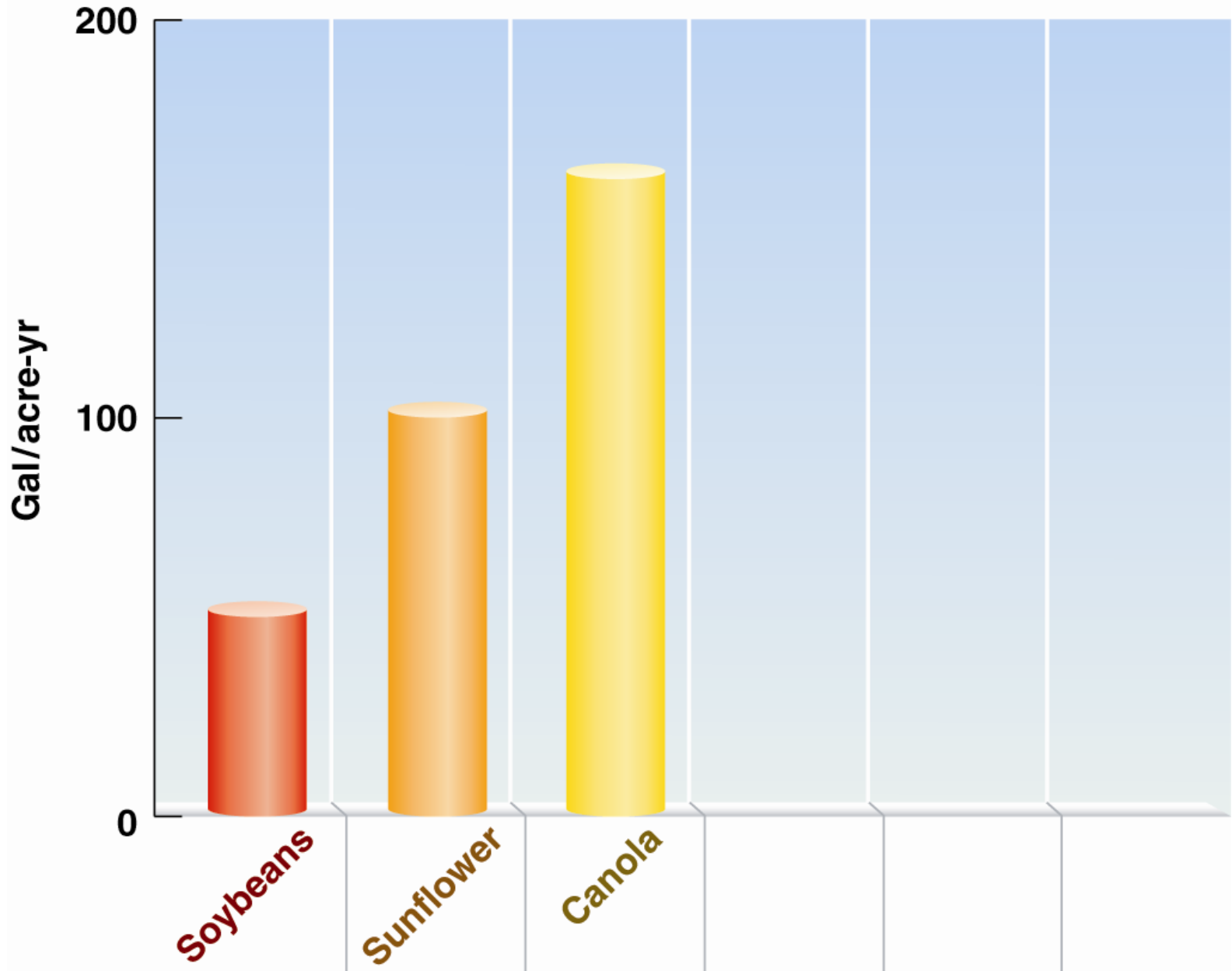
BIODIESEL CROPS AND PRODUCTION



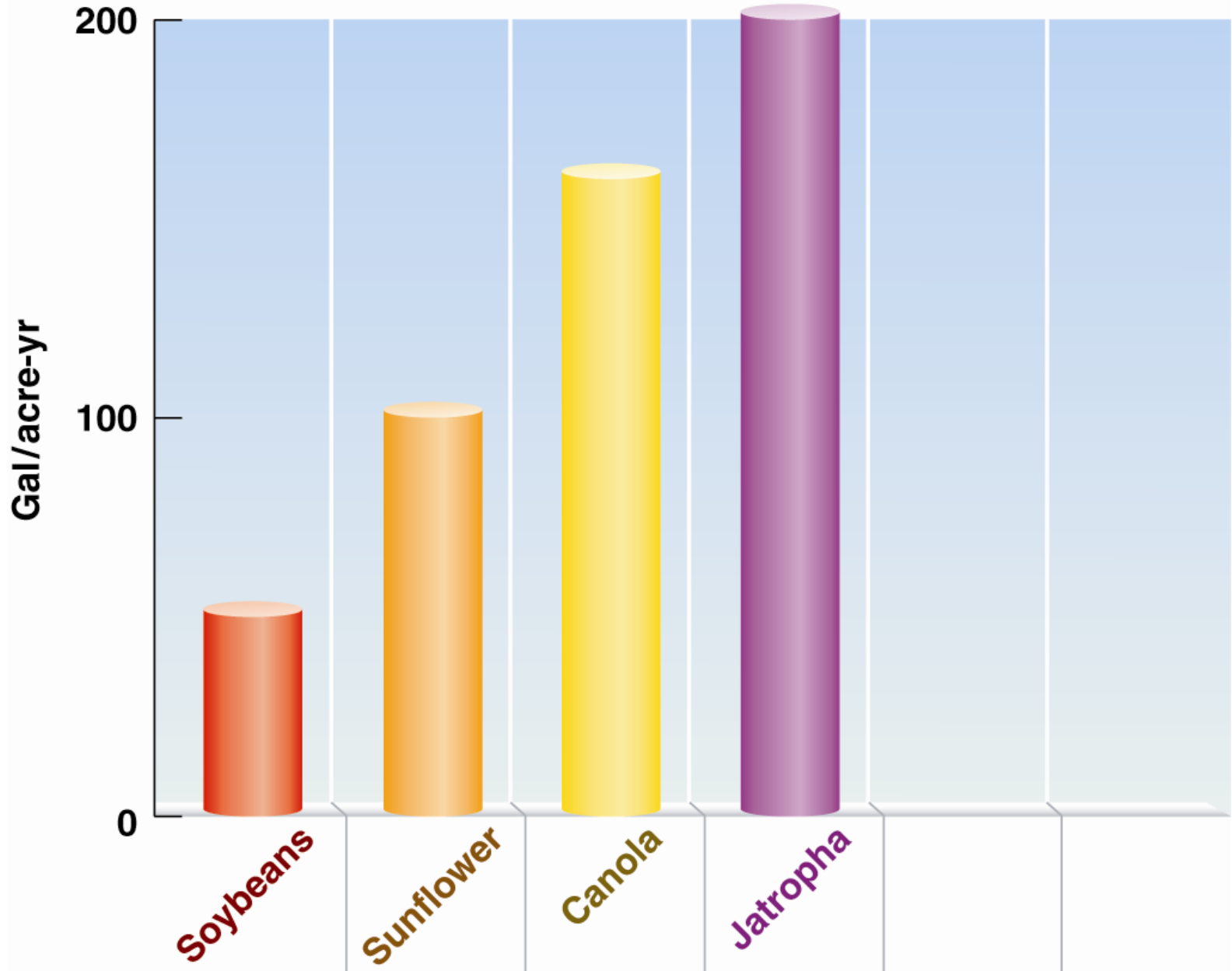
BIODIESEL CROPS AND PRODUCTION



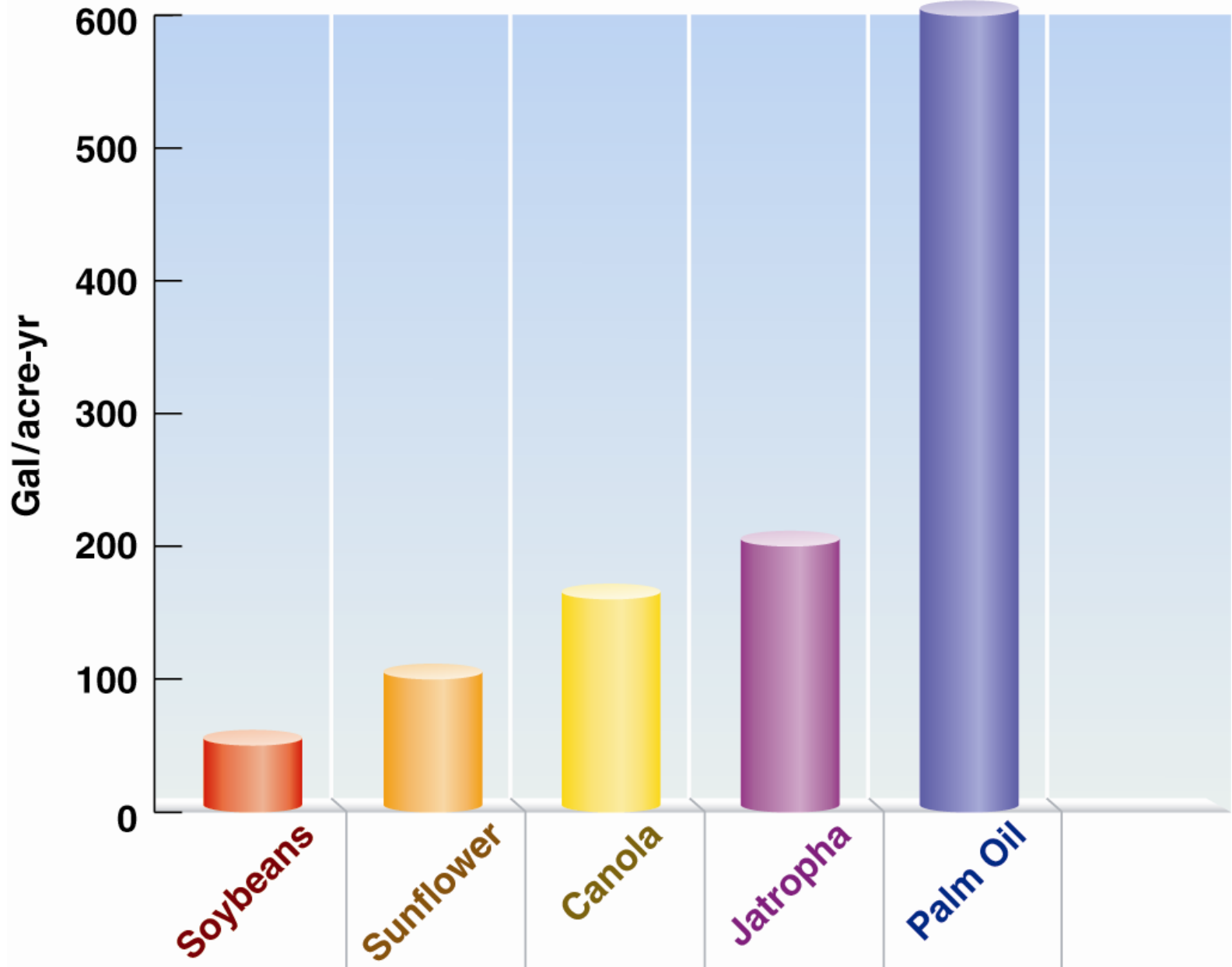
BIODIESEL CROPS AND PRODUCTION



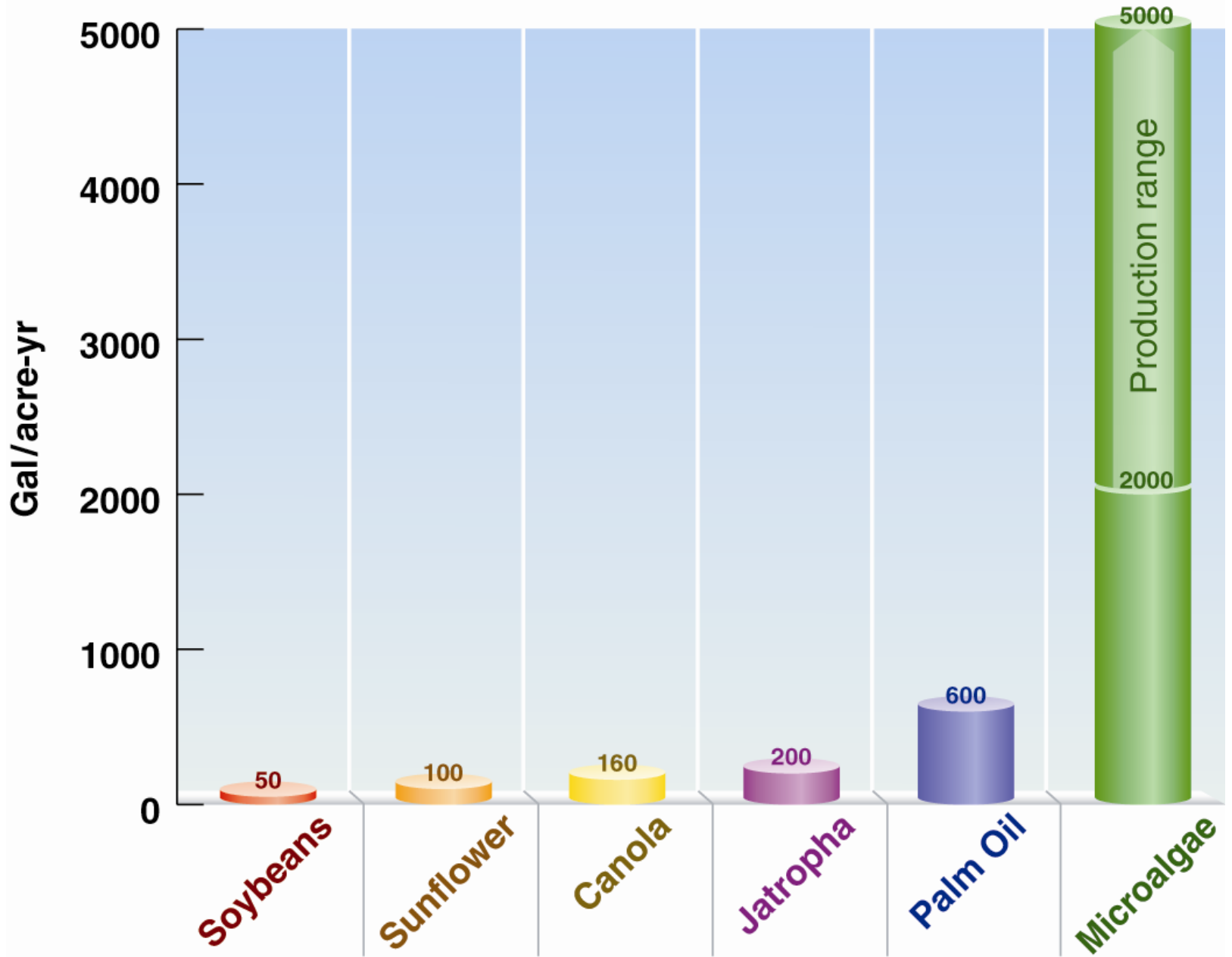
BIODIESEL CROPS AND PRODUCTION

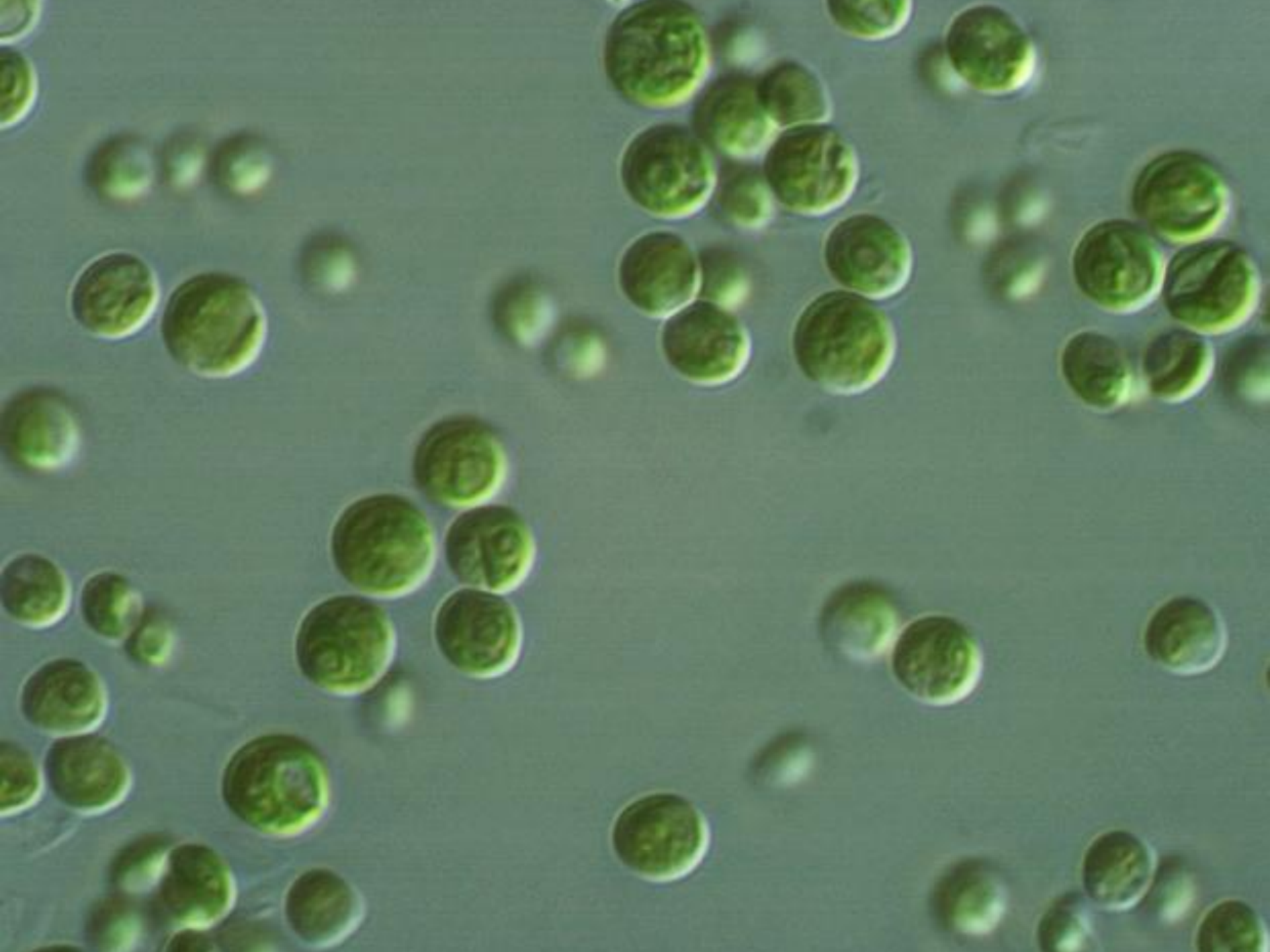


BIODIESEL CROPS AND PRODUCTION



BIODIESEL CROPS AND PRODUCTION





Algae Biofuels?

Feasible, affordable, scalable, sustainable?

Do not compete with agriculture!

- WATER?
- FERTILIZER?
- LAND?

NOW?

San Francisco,
Southeast WPCP 67 MGD

San Jose Santa Clara Water 112.7 MGD

Santa Cruz 9.1 MGD

Monterey Regional 29.6 MGD

**Wastewater
= 1.87 BILLION
GAL/DAY**

Santa Barbara 8.5 MGD

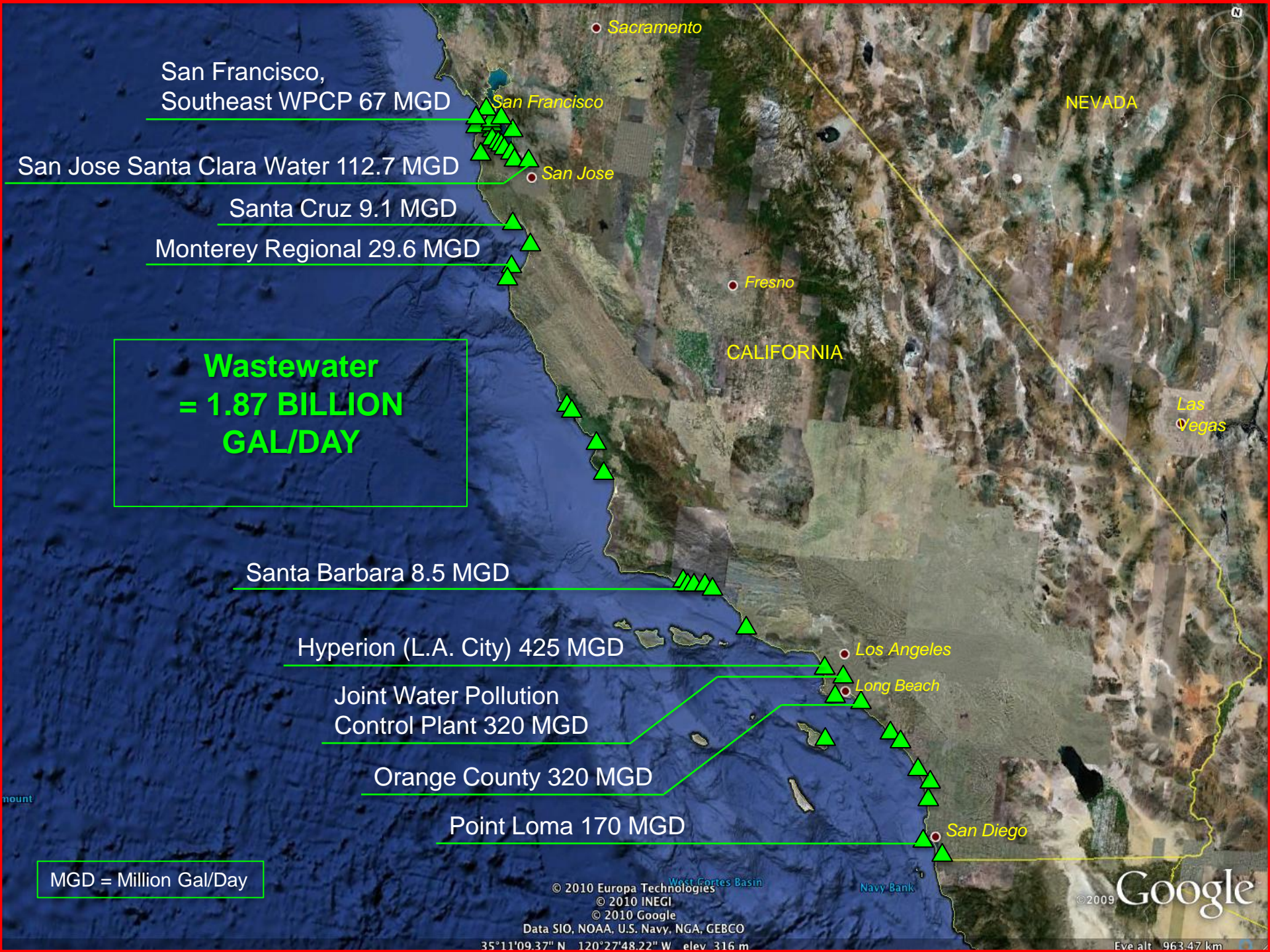
Hyperion (L.A. City) 425 MGD

Joint Water Pollution
Control Plant 320 MGD

Orange County 320 MGD

Point Loma 170 MGD

MGD = Million Gal/Day



Algae Biofuels?

Feasible, affordable, scalable, sustainable?

Do not compete with agriculture!

[• WATER & FERTILIZER= wastewater] • LAND?

NOW?

Algae cultivation...

**Open circulating ponds
(raceways)**

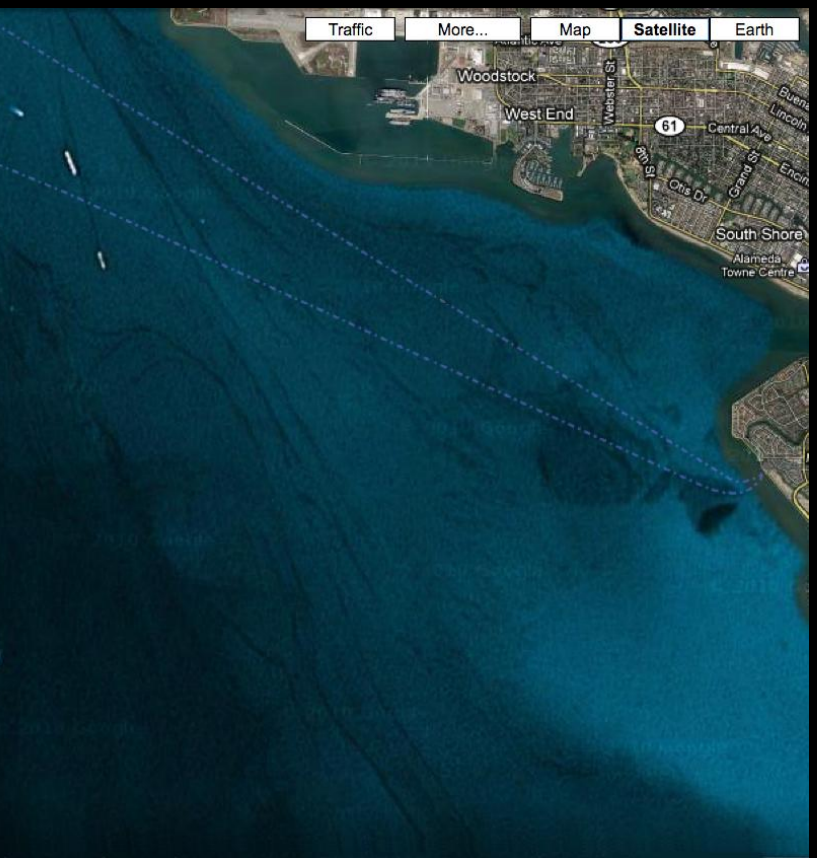
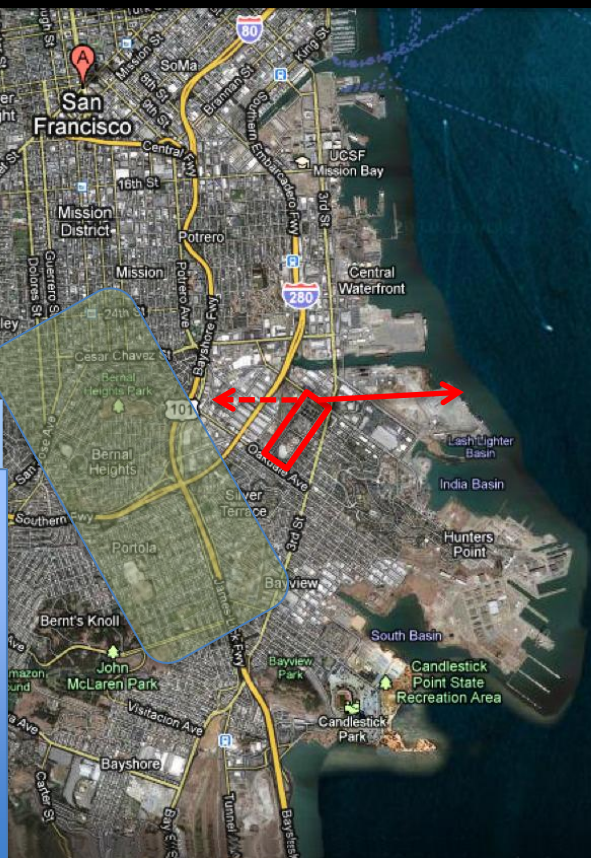
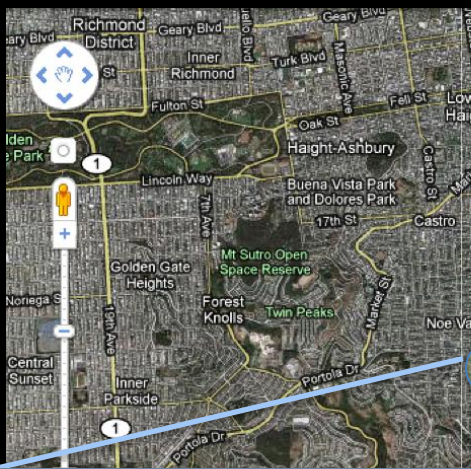
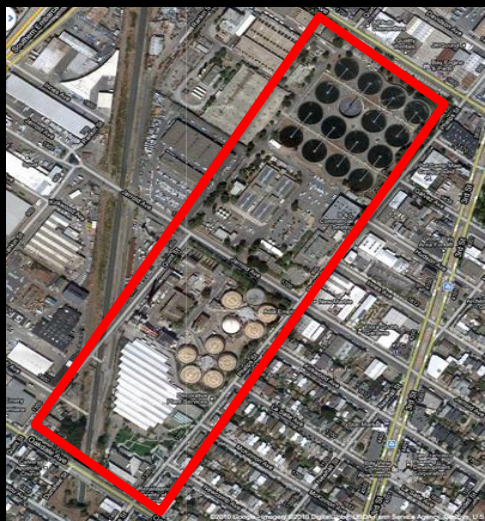


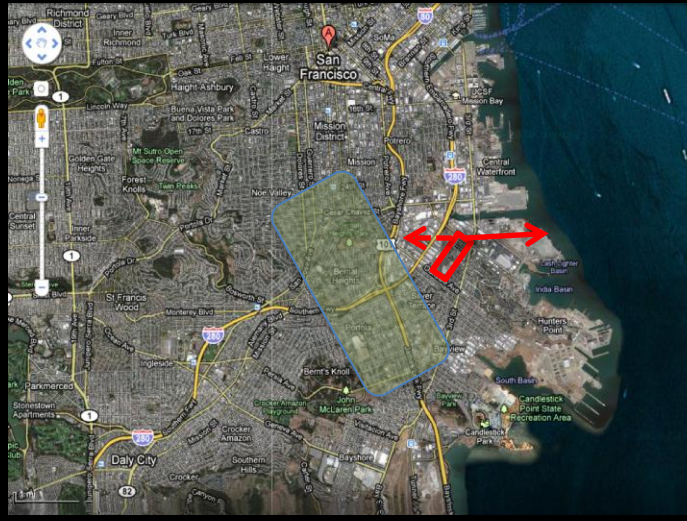
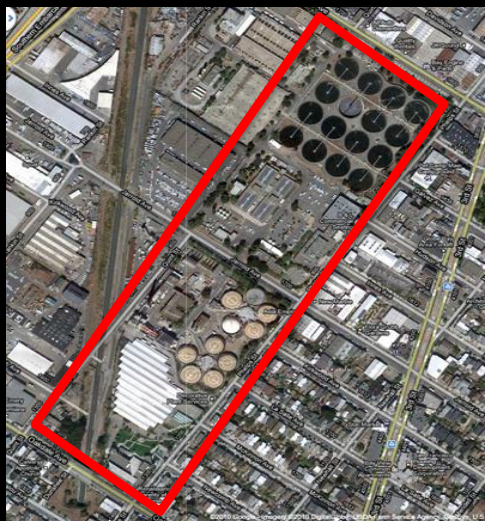
**Closed PhotoBioReactors
(PBRs)**

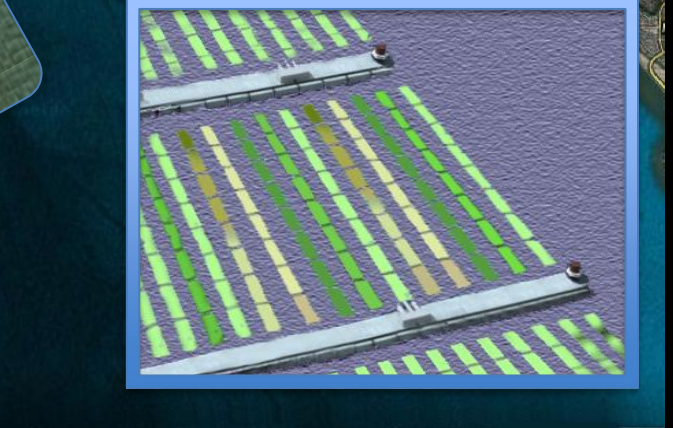
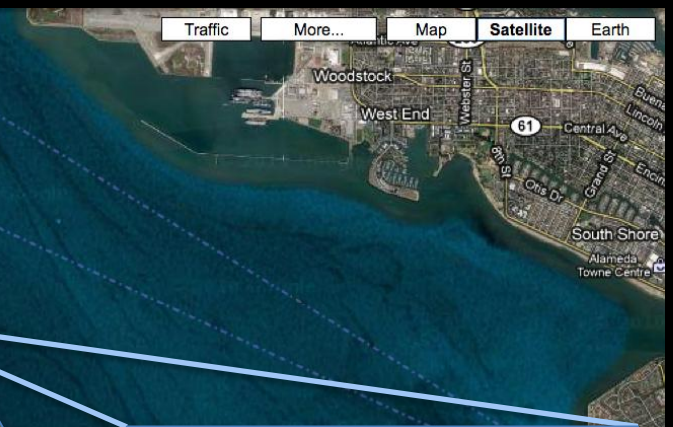
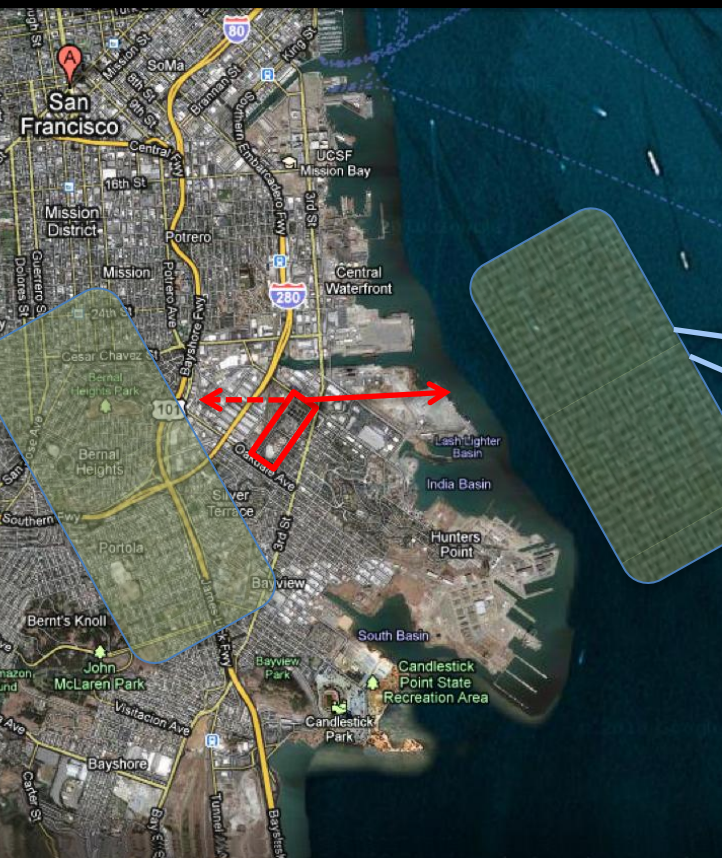
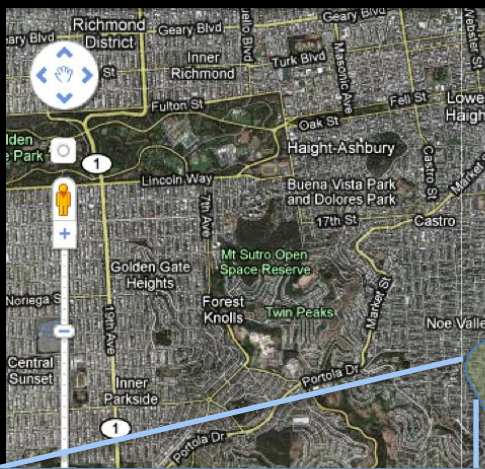
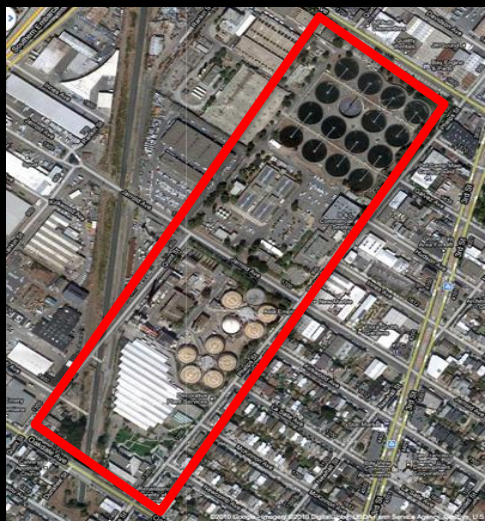


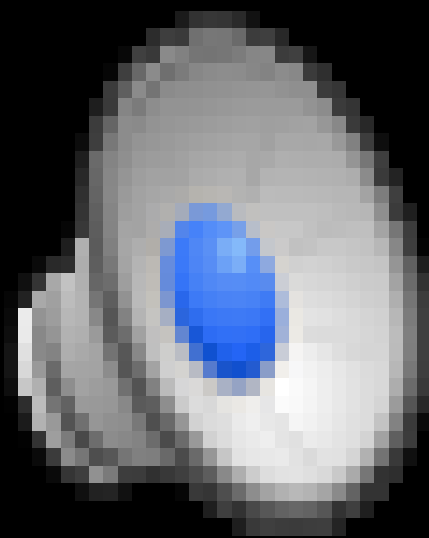




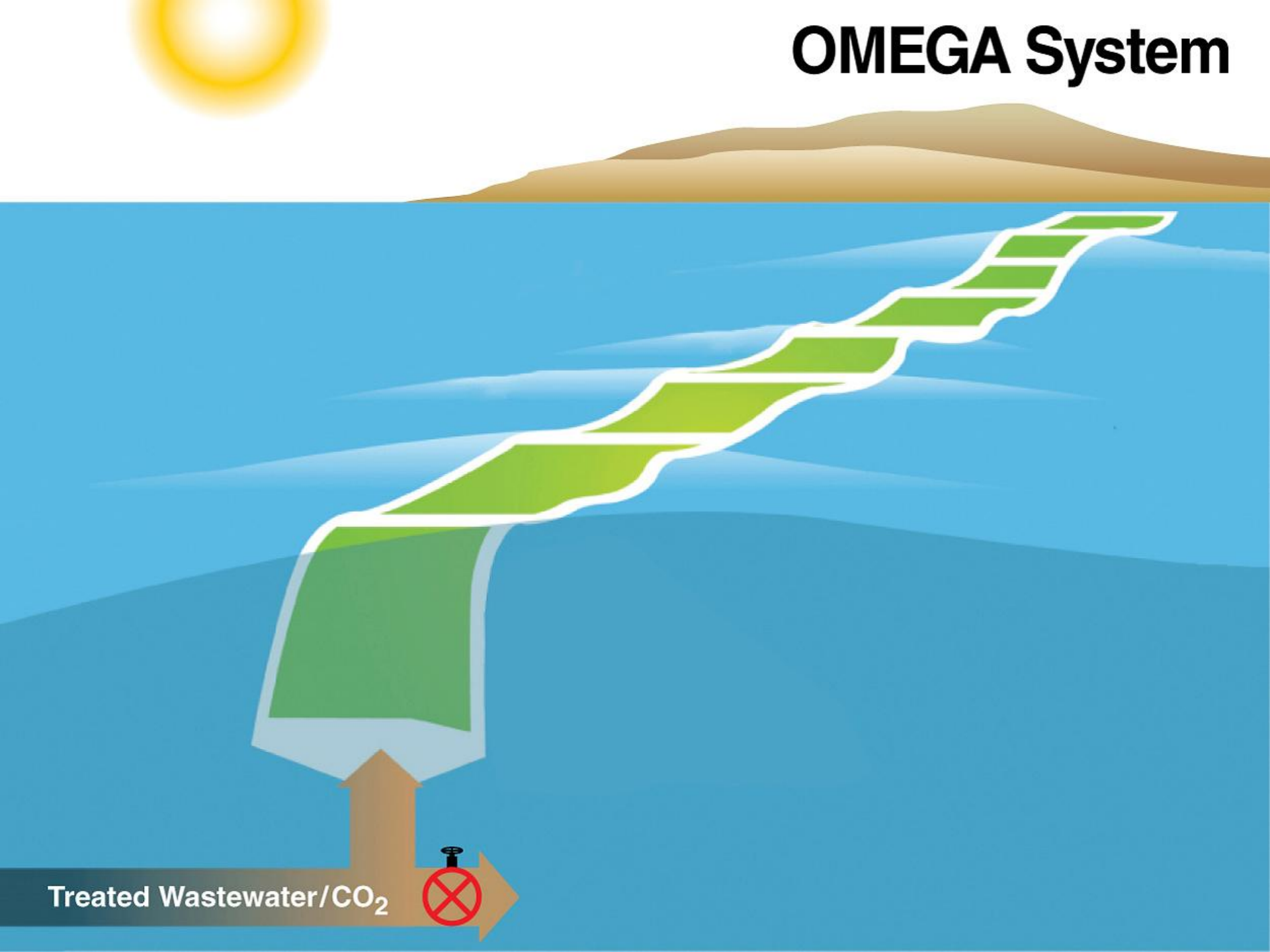






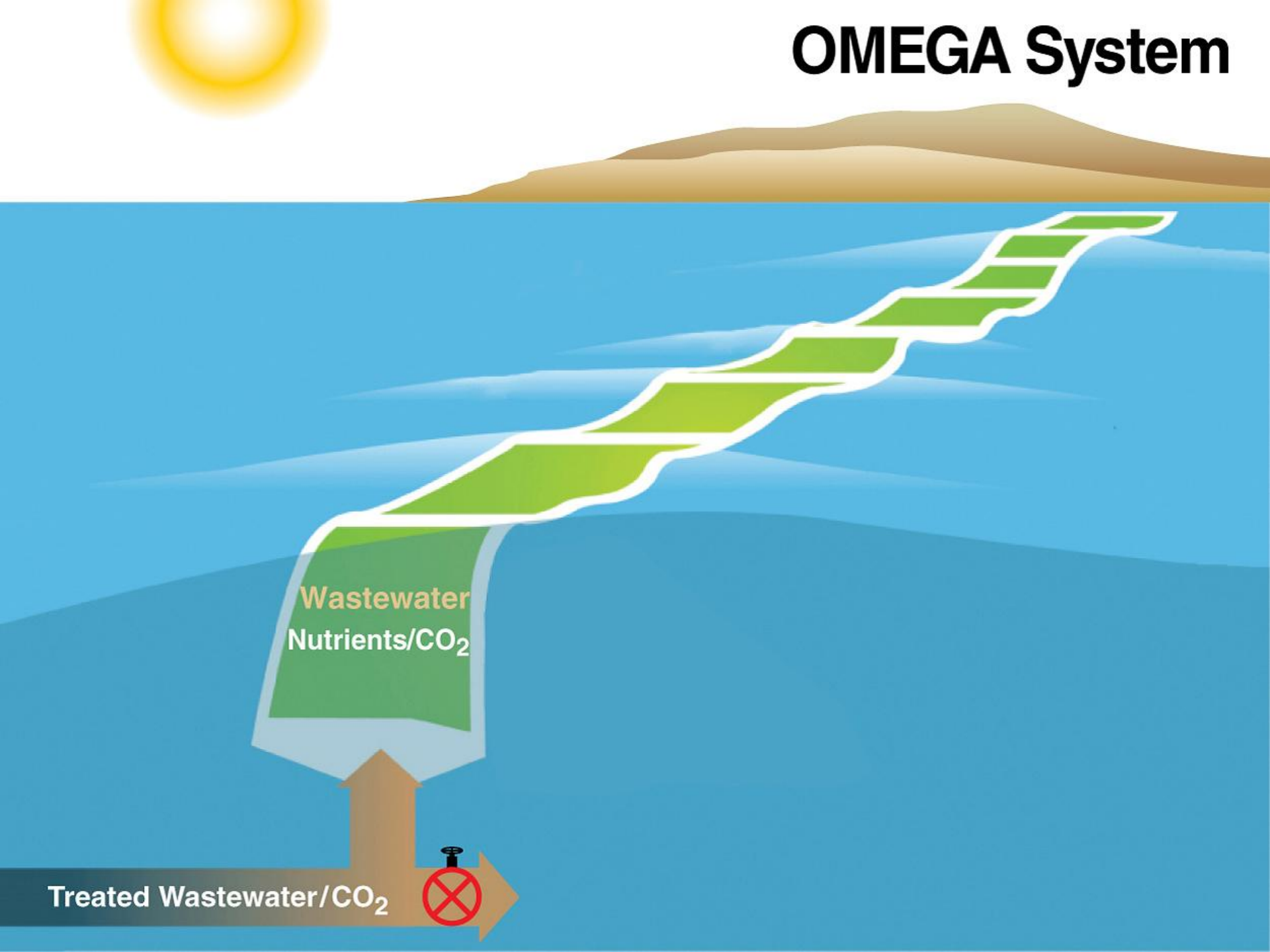


OMEGA System



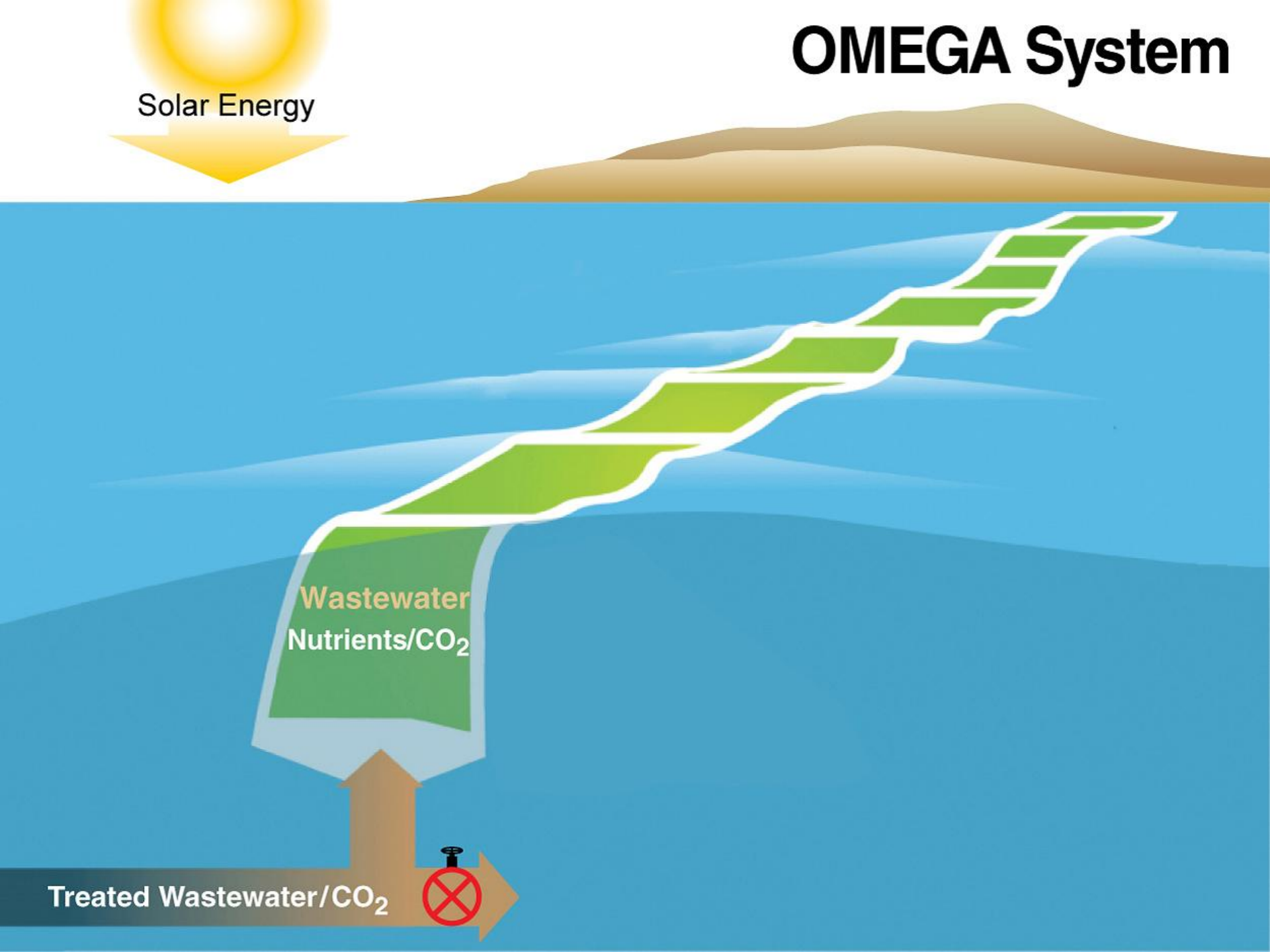
Treated Wastewater/CO₂

OMEGA System



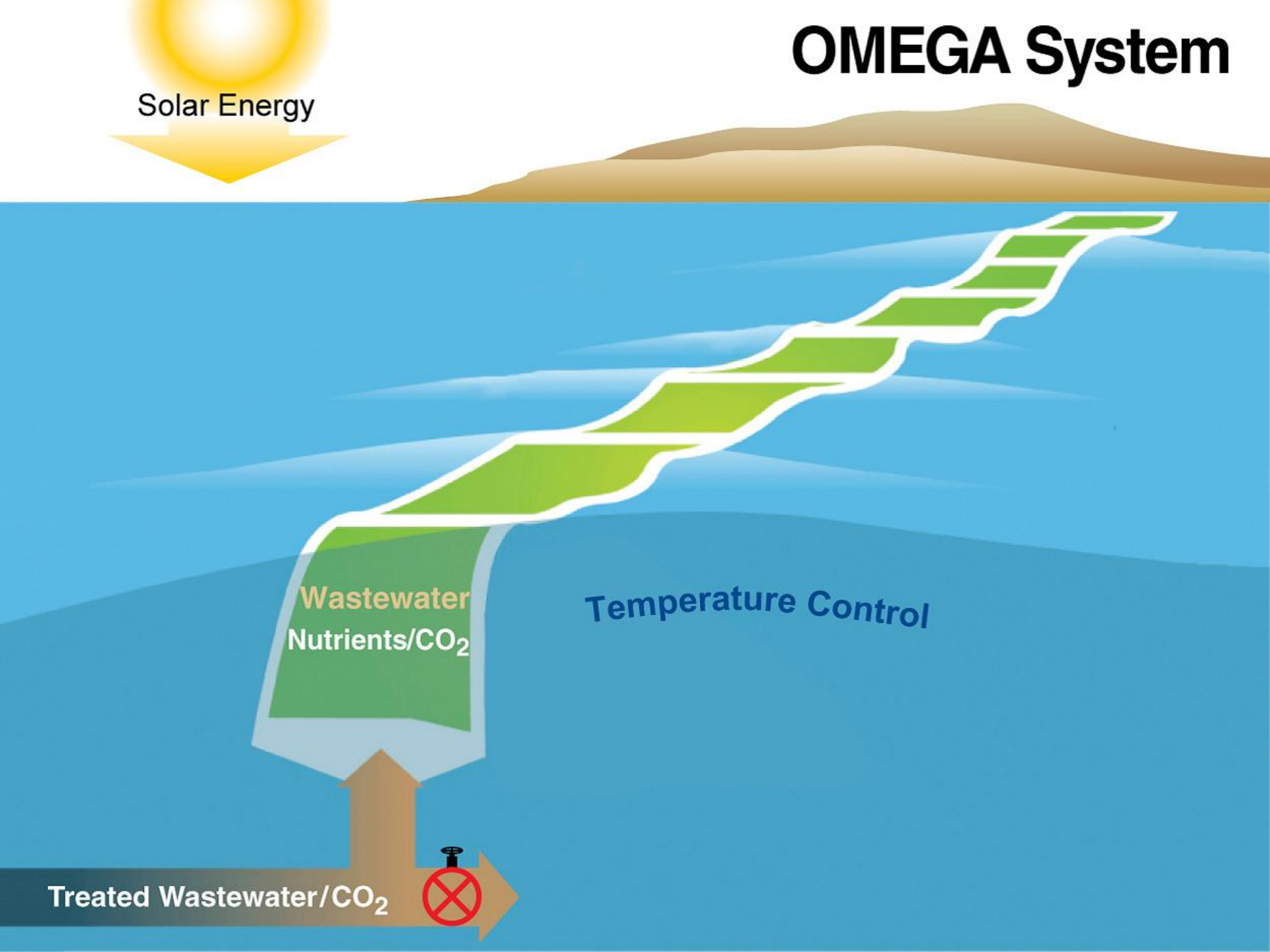
OMEGA System

Solar Energy



OMEGA System

Solar Energy



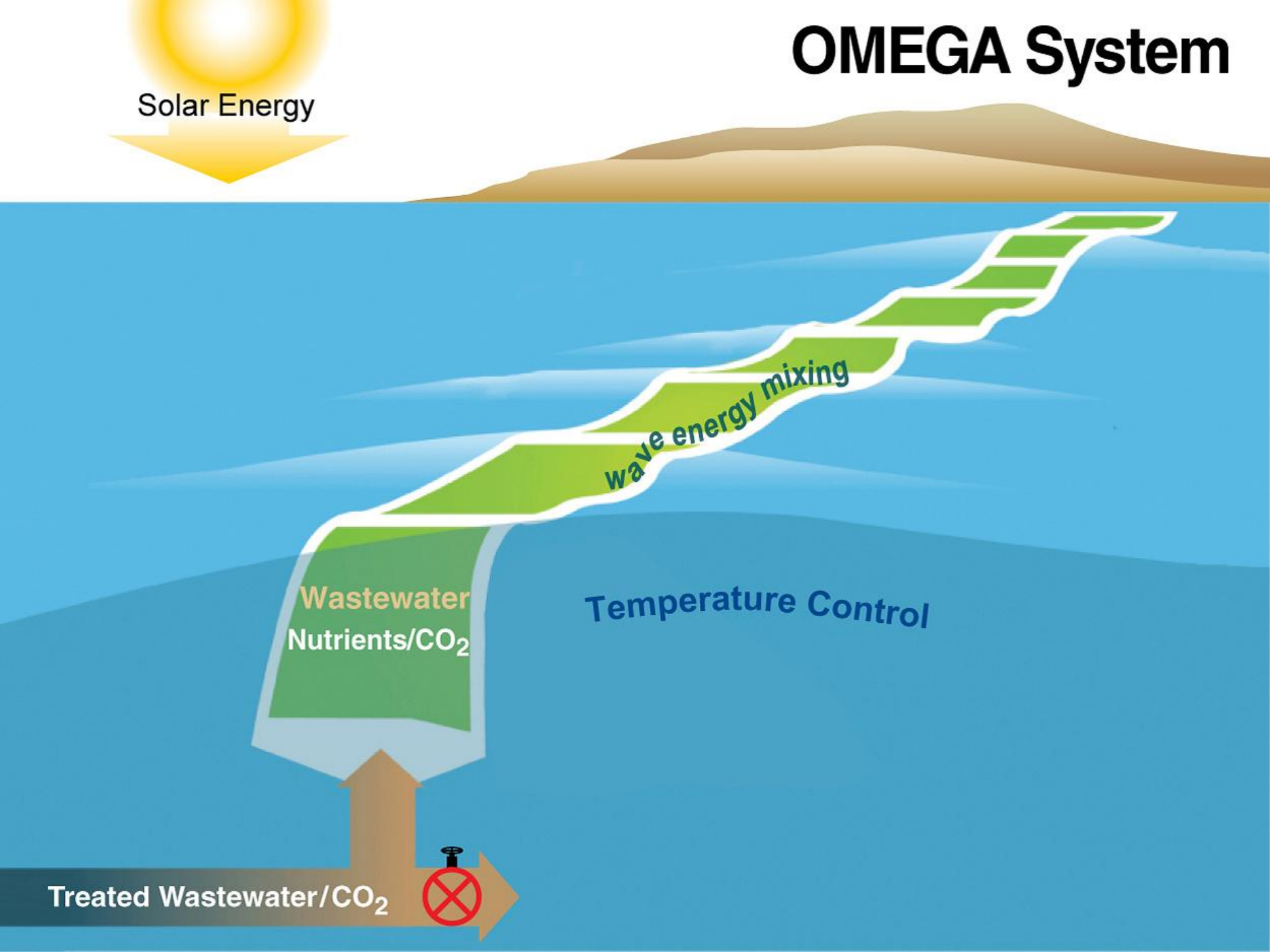
Wastewater
Nutrients/CO₂

Temperature Control

Treated Wastewater/CO₂

OMEGA System

Solar Energy



Wastewater
Nutrients/CO₂

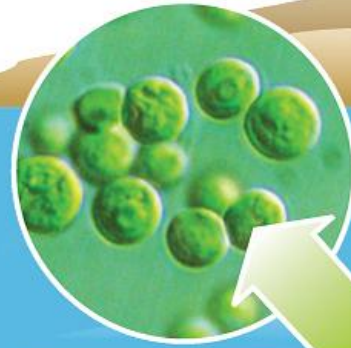
Temperature Control

wave energy mixing

Treated Wastewater/CO₂

OMEGA System

Solar Energy

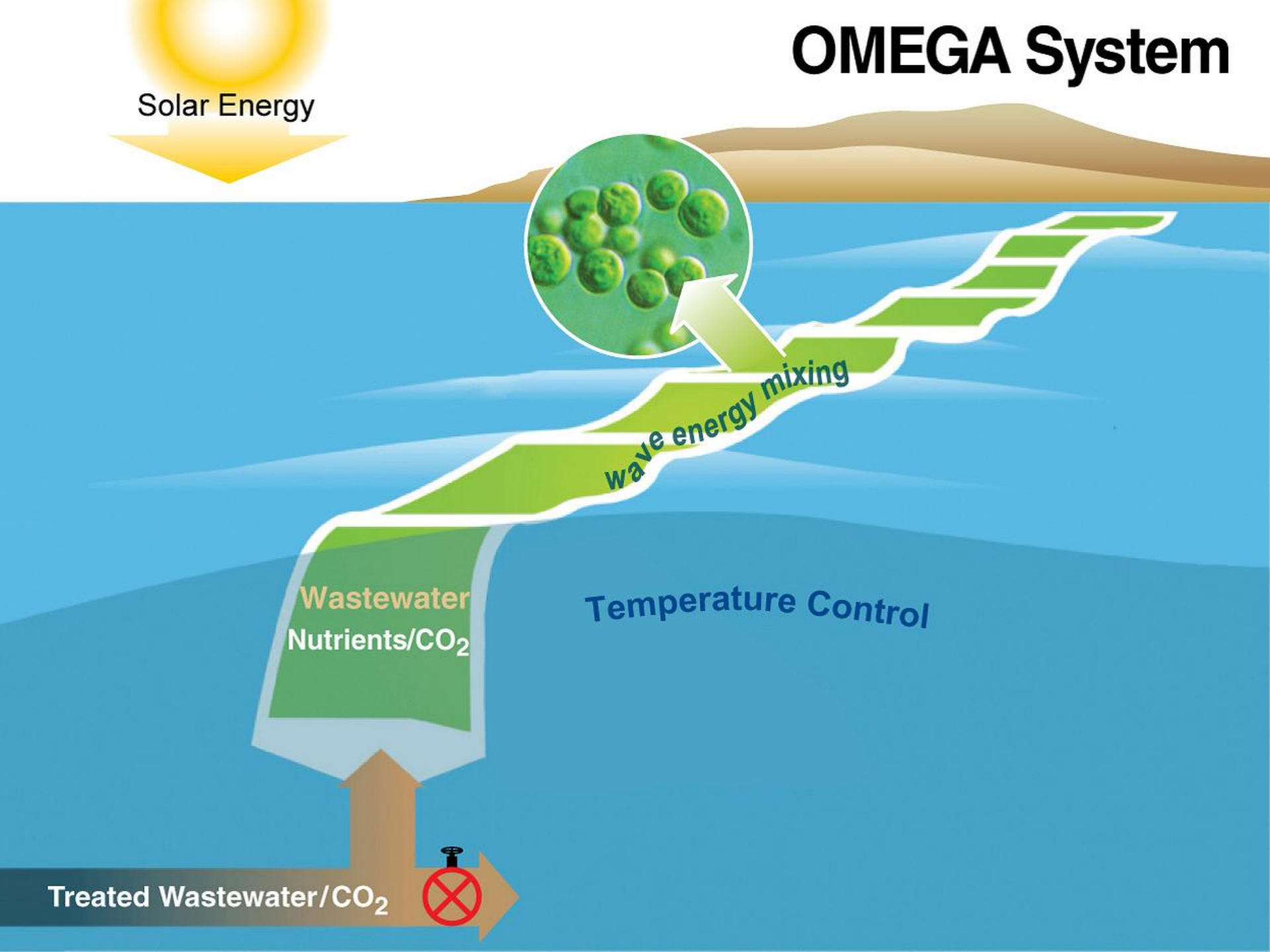


Wave energy mixing

Wastewater
Nutrients/CO₂

Temperature Control

Treated Wastewater/CO₂



OMEGA System

Solar Energy

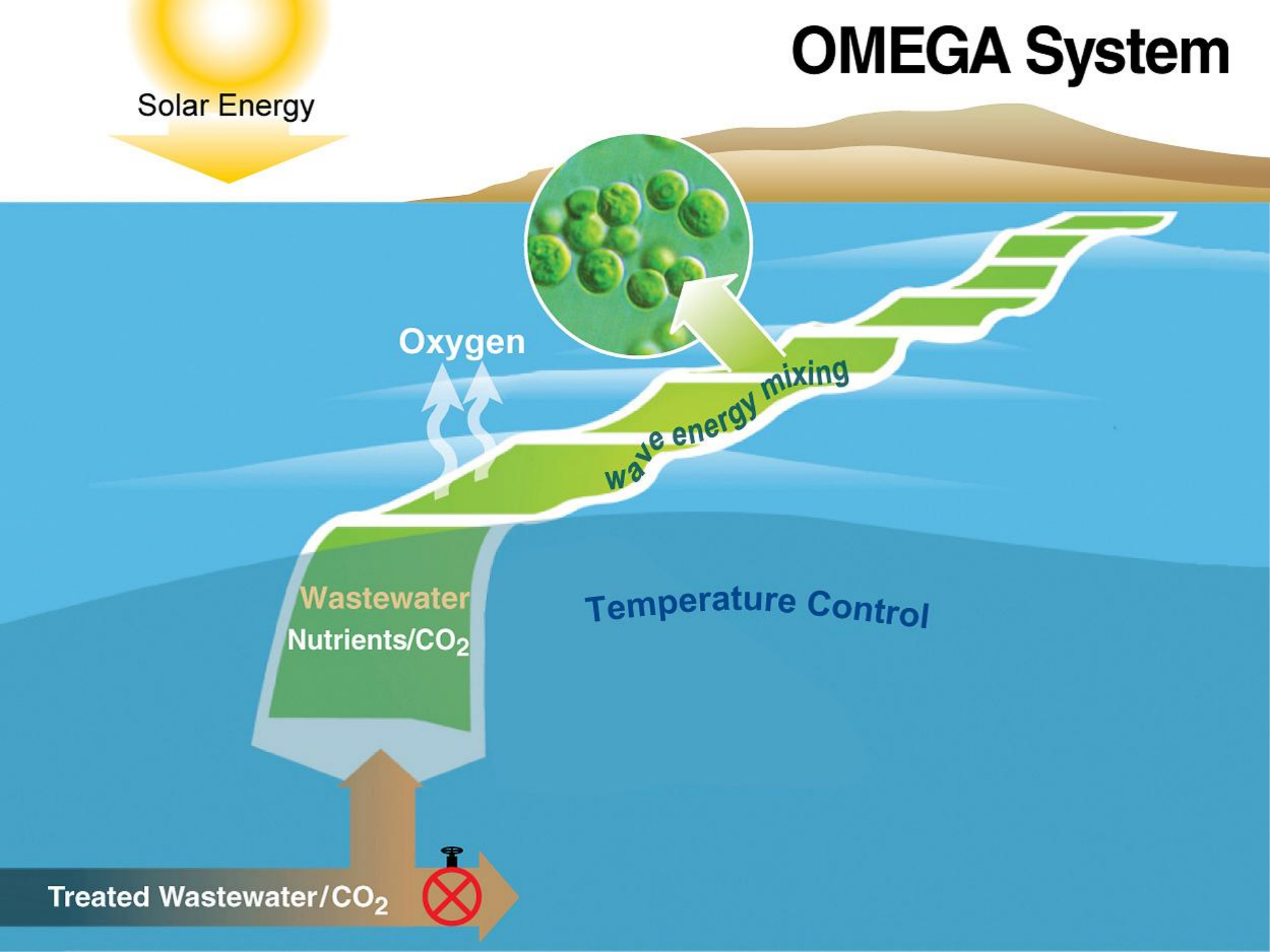
Oxygen

Wave energy mixing

Wastewater
Nutrients/CO₂

Temperature Control

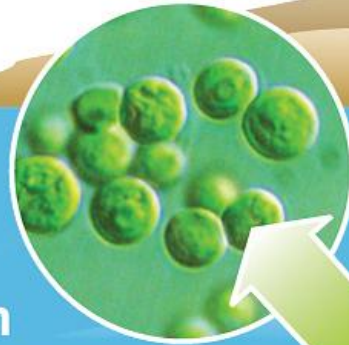
Treated Wastewater/CO₂



OMEGA System

Solar Energy

Oxygen

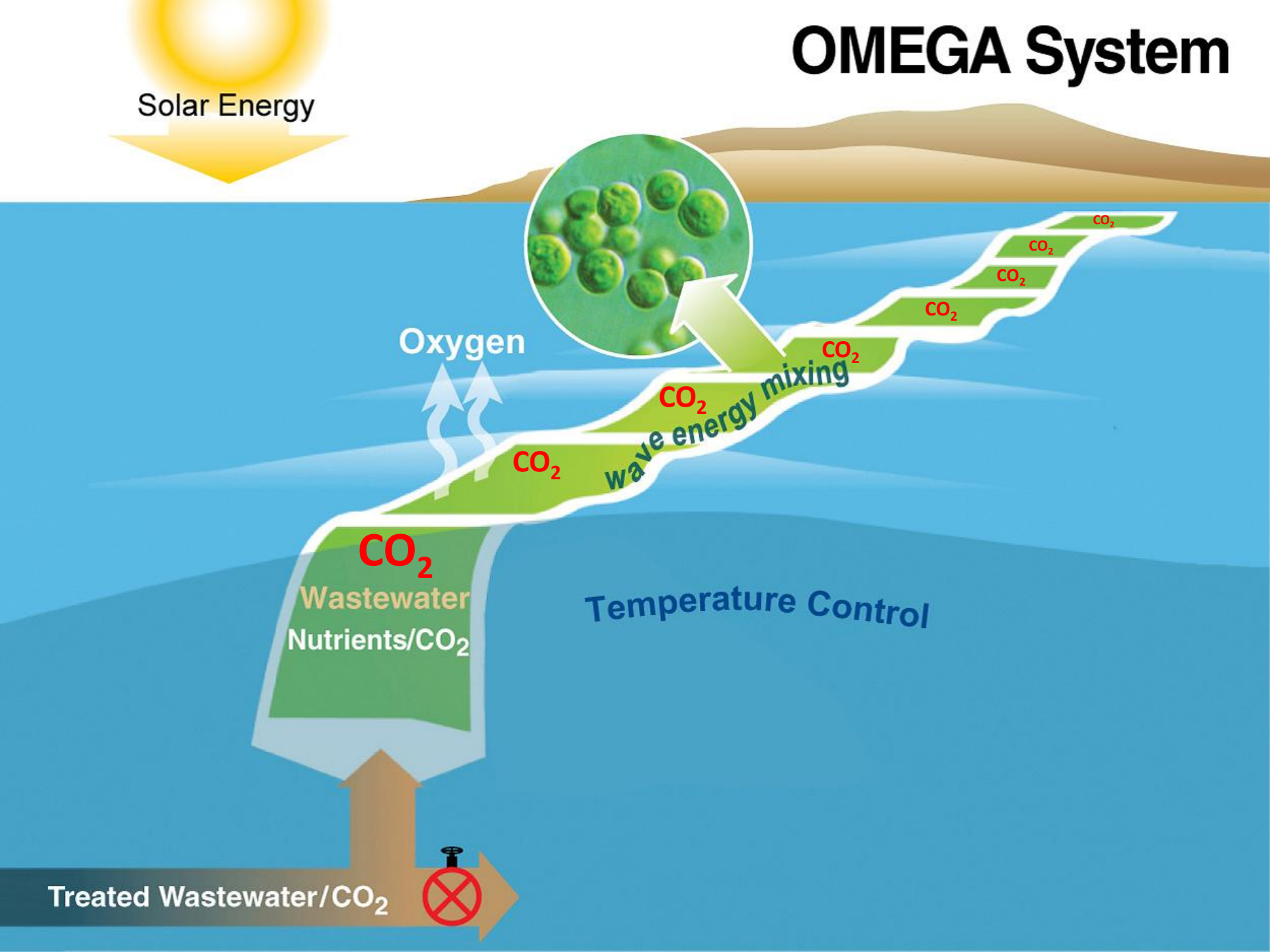


CO₂ wave energy mixing

CO₂
Wastewater
Nutrients/CO₂

Temperature Control

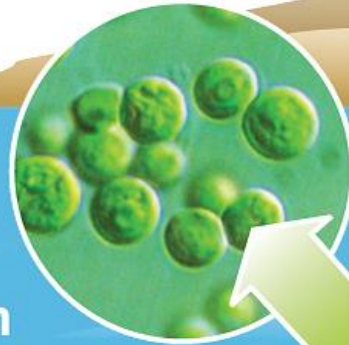
Treated Wastewater/CO₂



OMEGA System

Solar Energy

Oxygen



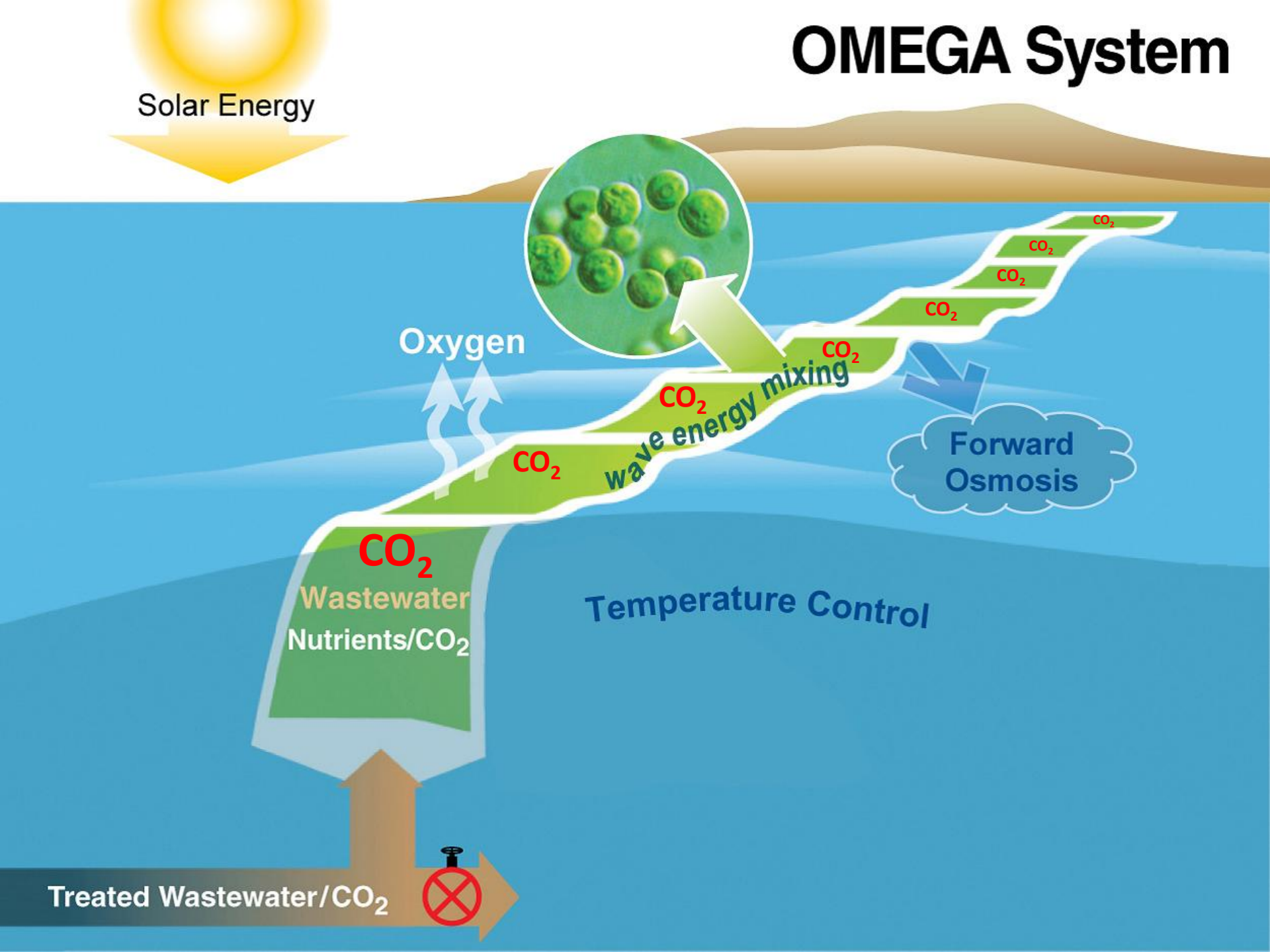
CO₂ wave energy mixing

Forward Osmosis

Temperature Control

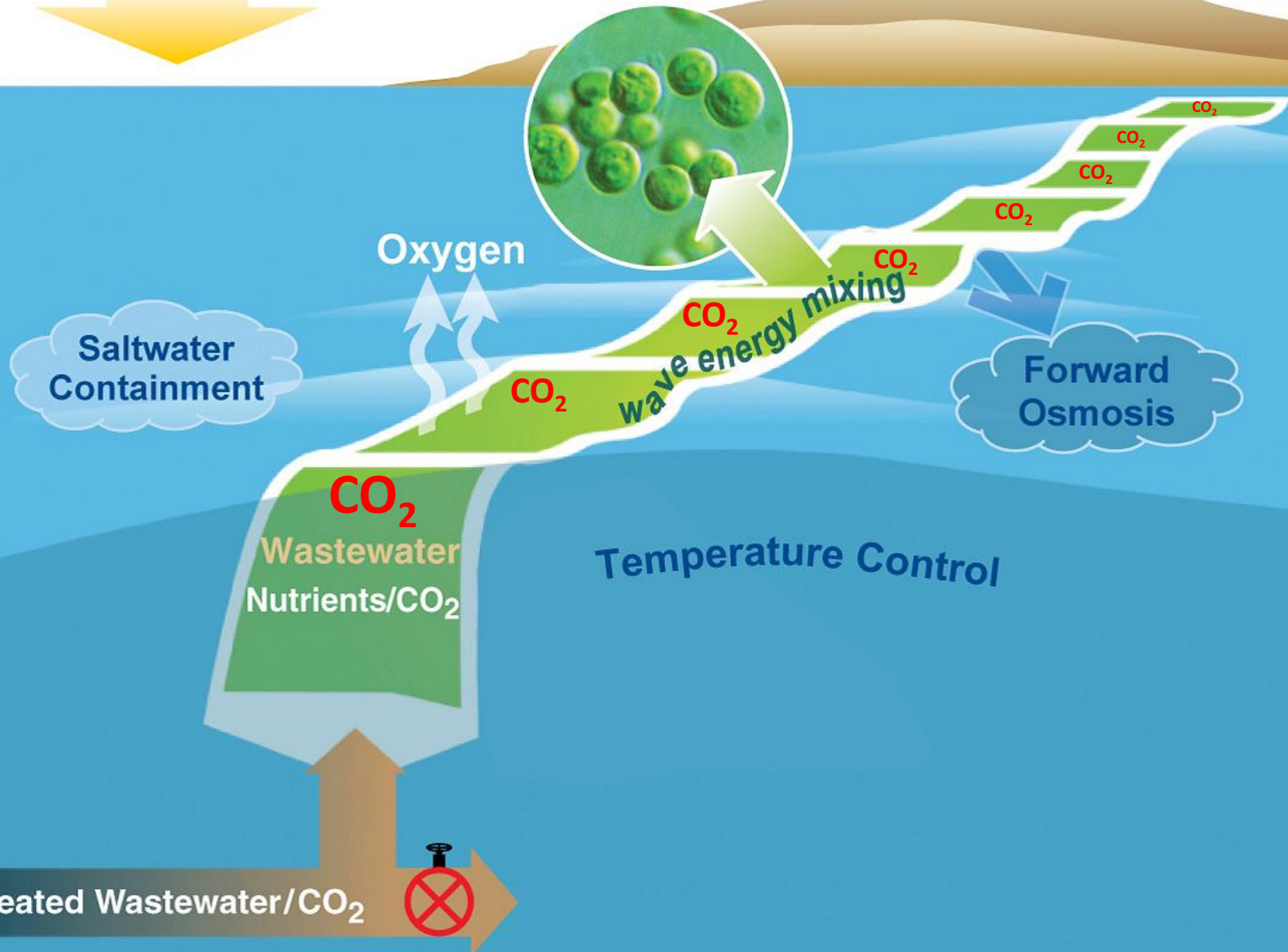
CO₂
Wastewater
Nutrients/CO₂

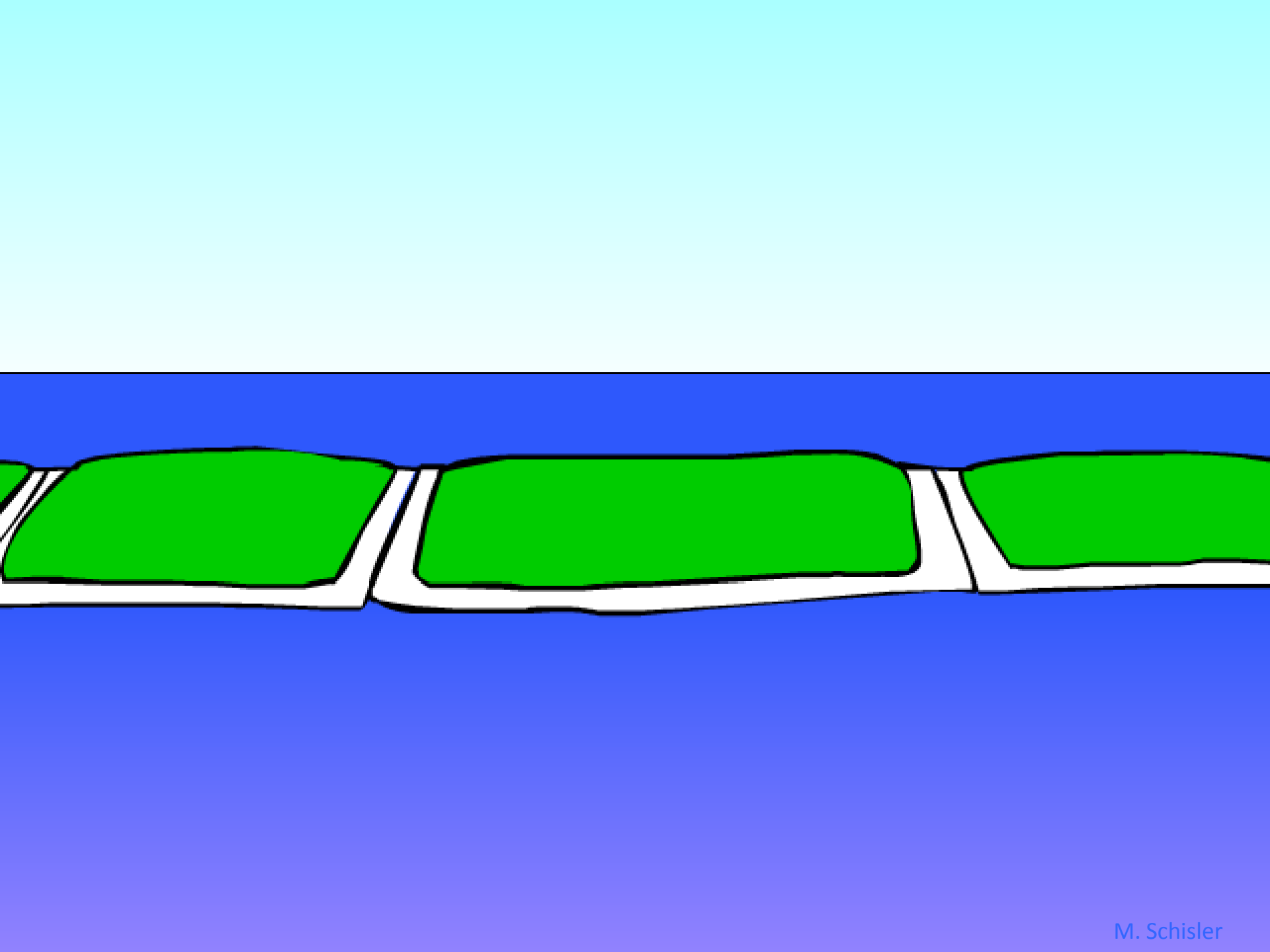
Treated Wastewater/CO₂



OMEGA System

Solar Energy





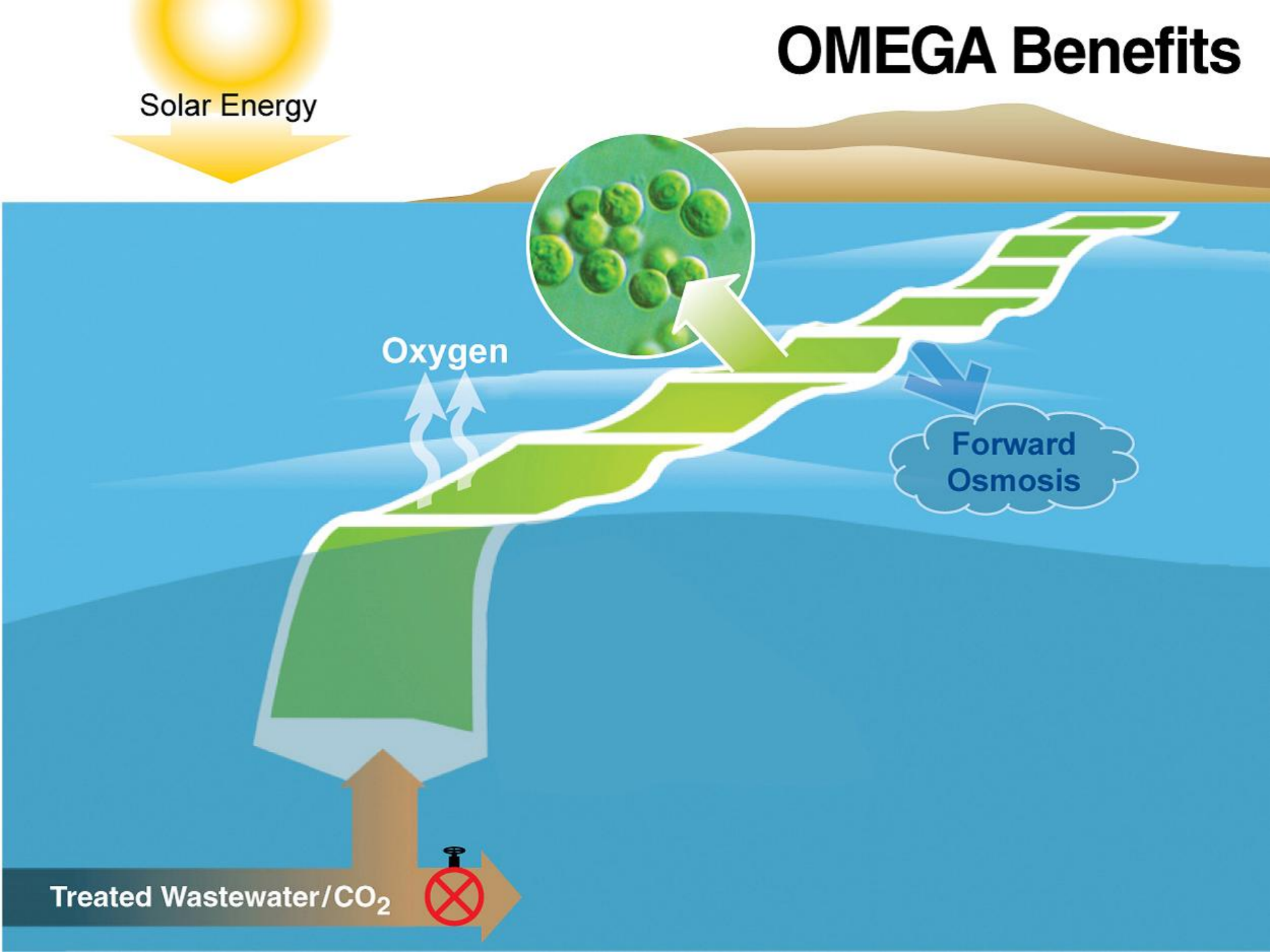
OMEGA Benefits

Solar Energy

Oxygen

Forward
Osmosis

Treated Wastewater/CO₂



OMEGA Benefits

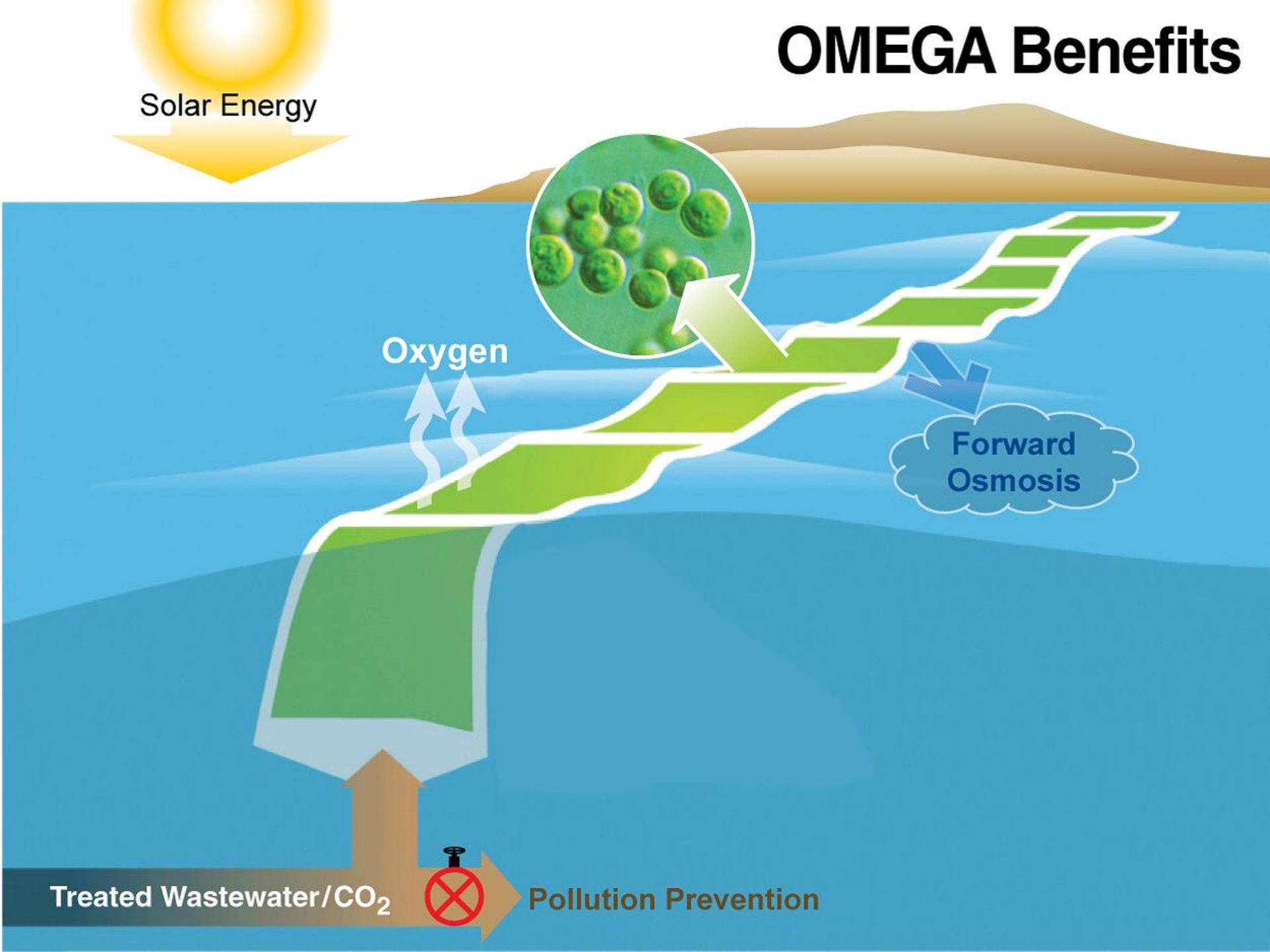
Solar Energy

Oxygen

Forward Osmosis

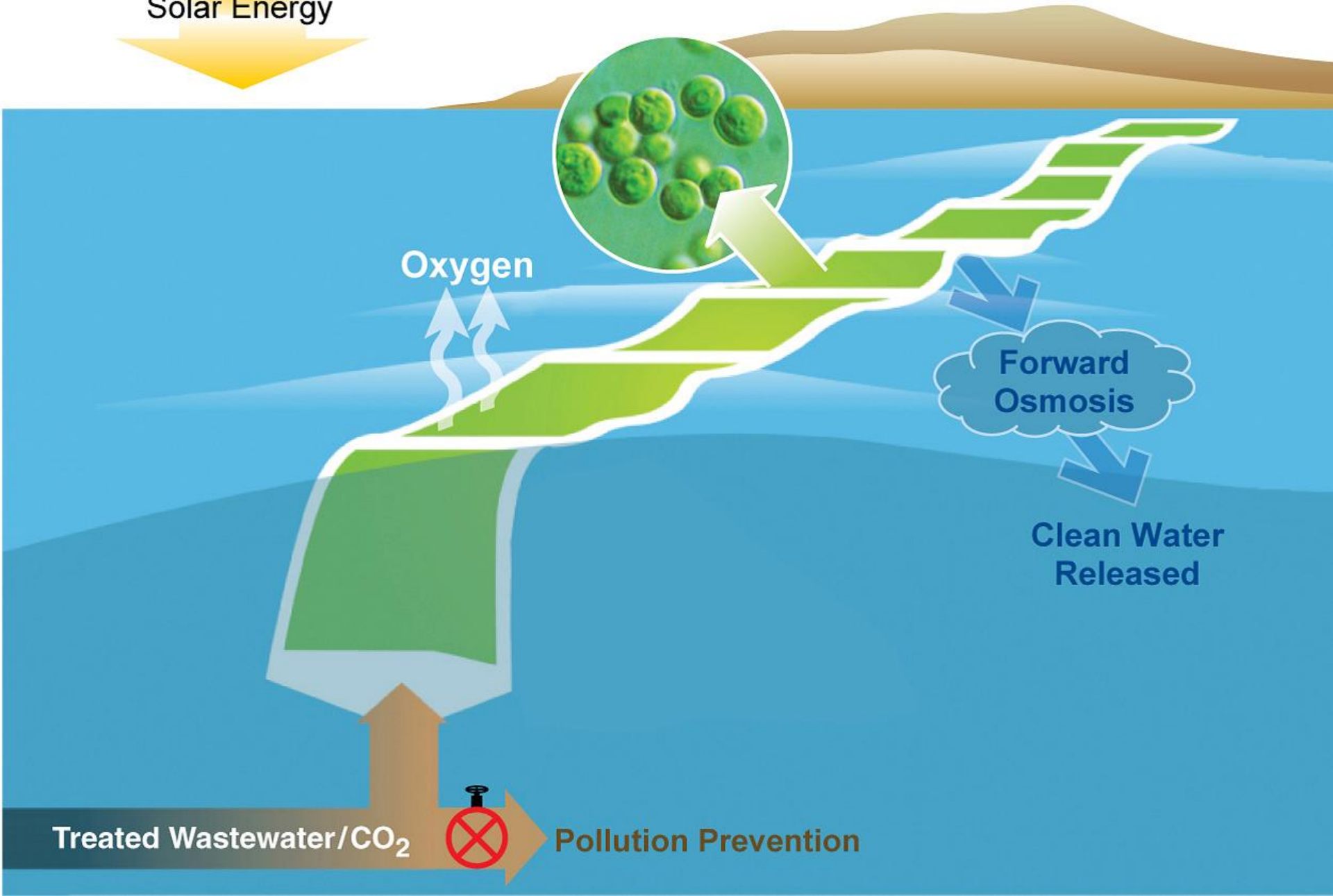
Treated Wastewater/CO₂

Pollution Prevention



OMEGA Benefits

Solar Energy



Oxygen

Forward
Osmosis

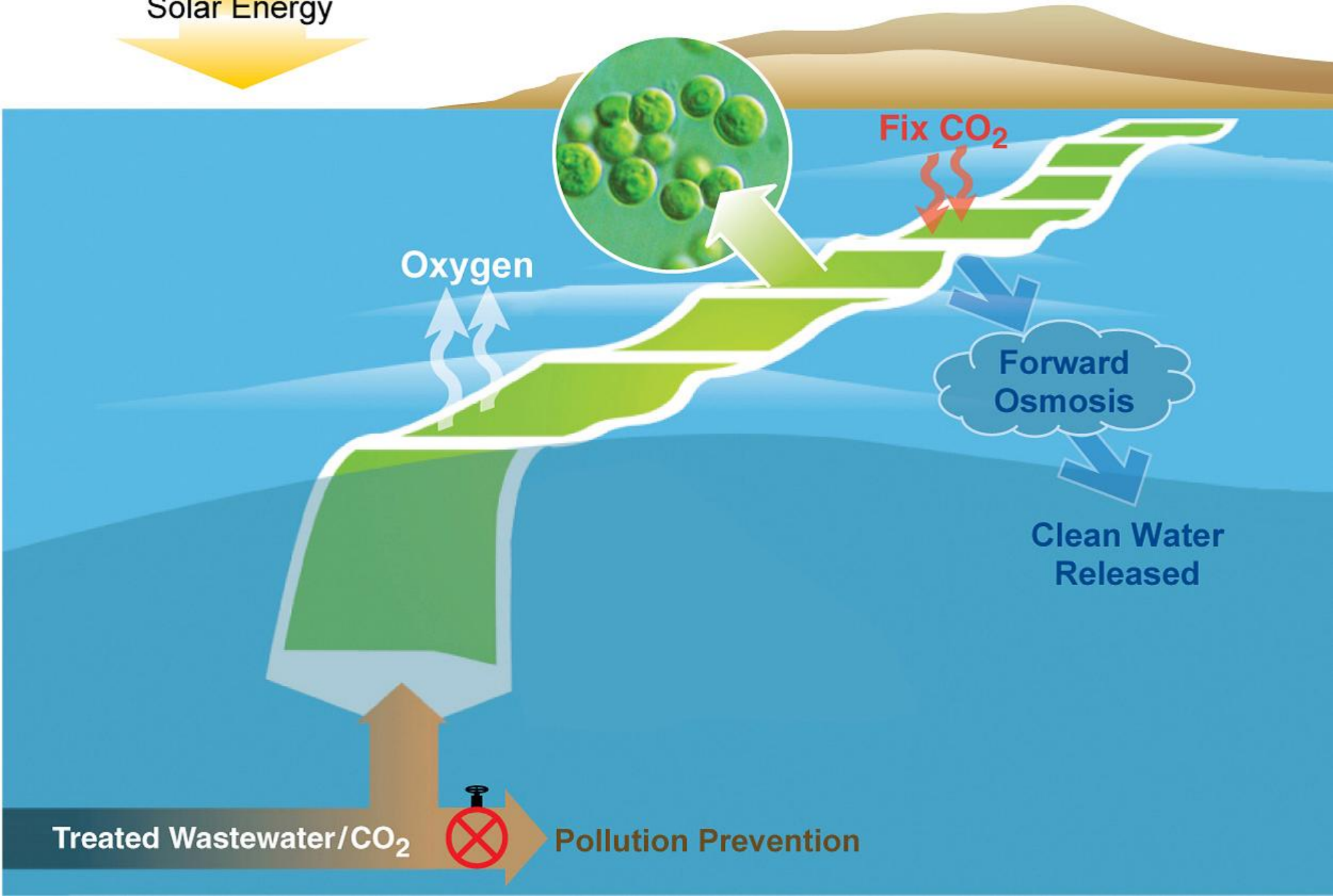
Clean Water
Released

Treated Wastewater/CO₂

Pollution Prevention

OMEGA Benefits

Solar Energy



Oxygen

Fix CO₂

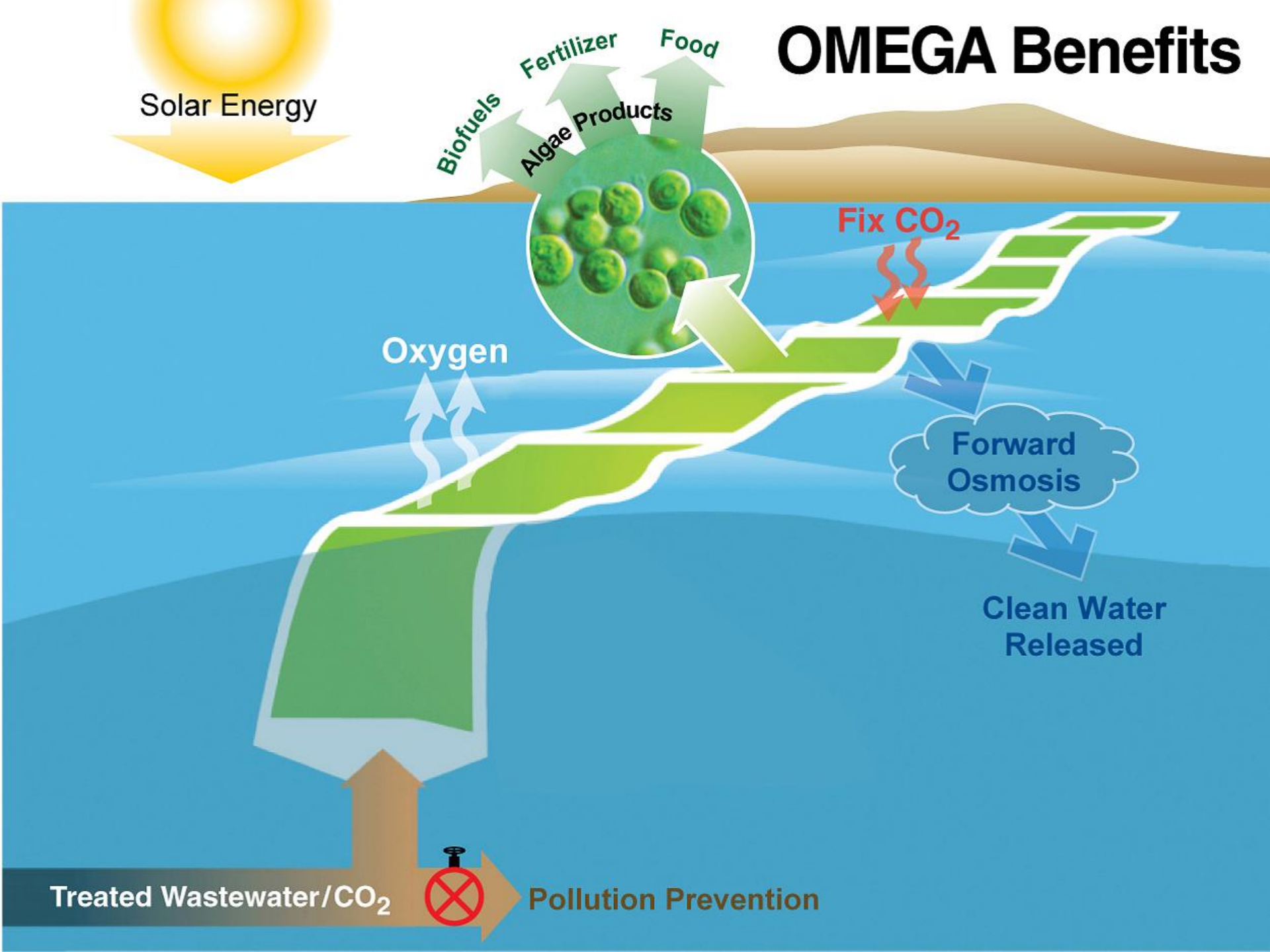
Forward
Osmosis

Clean Water
Released

Treated Wastewater/CO₂

Pollution Prevention

OMEGA Benefits



Solar Energy

Biofuels
Fertilizer
Food
Algae Products

Fix CO₂

Oxygen

Forward
Osmosis

Clean Water
Released

Treated Wastewater/CO₂

Pollution Prevention

OMEGA Benefits

Solar Energy

Biofuels
Fertilizer
Food
Algae Products

Fix CO₂

Oxygen

Forward
Osmosis

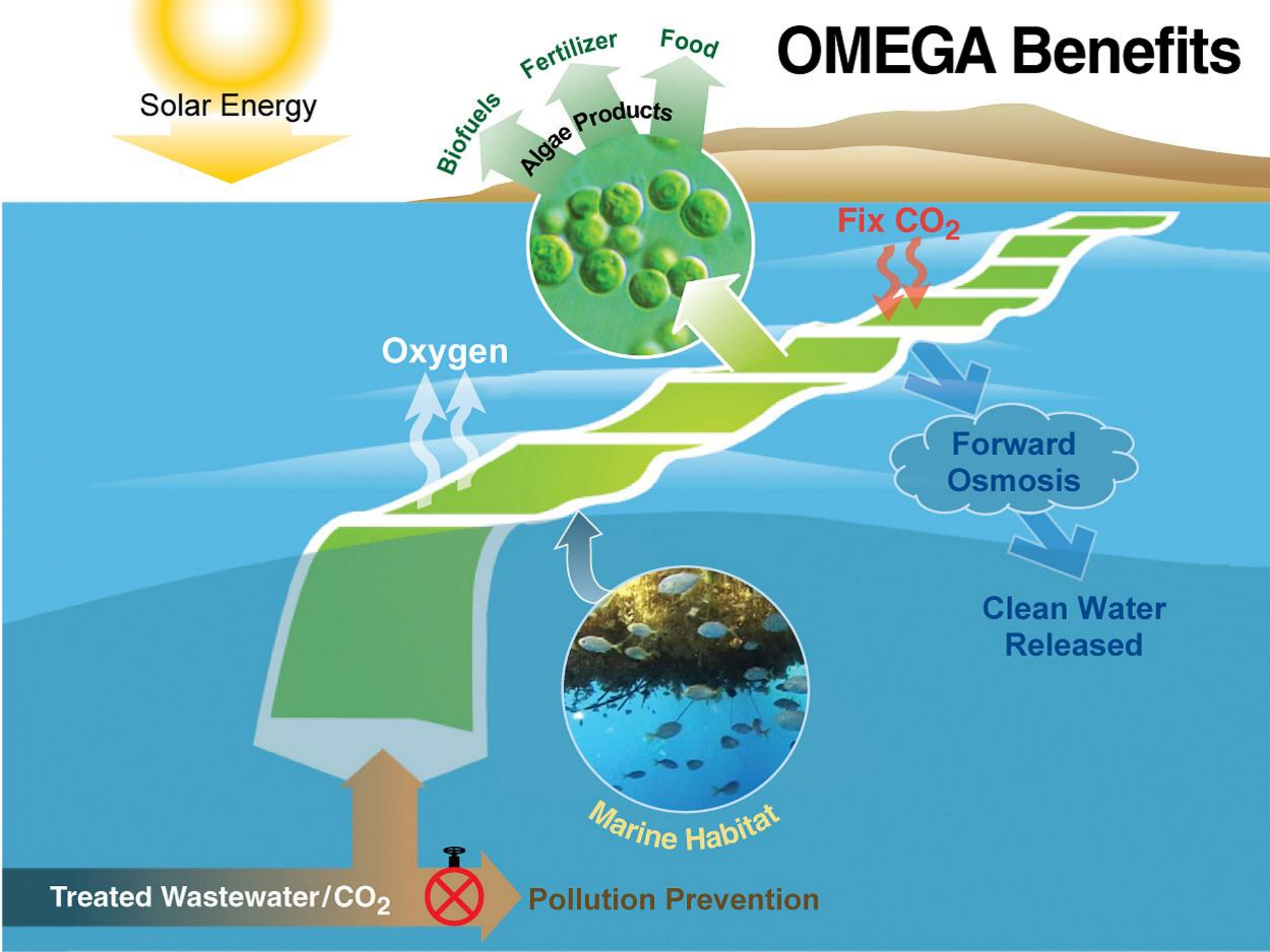
Clean Water
Released

Marine Habitat

Treated Wastewater/CO₂



Pollution Prevention

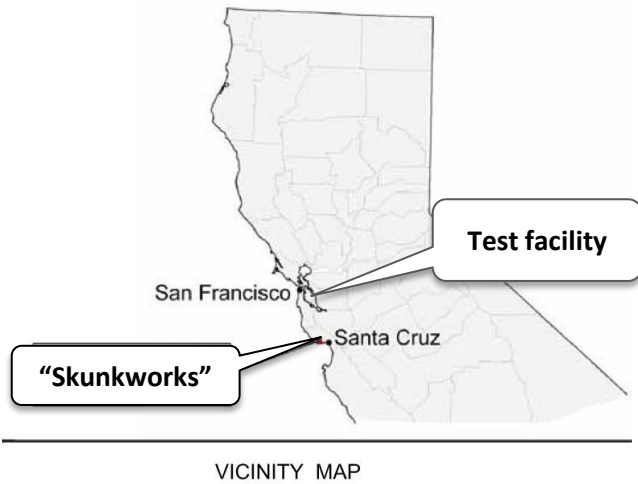




Research Site



Wastewater Plant



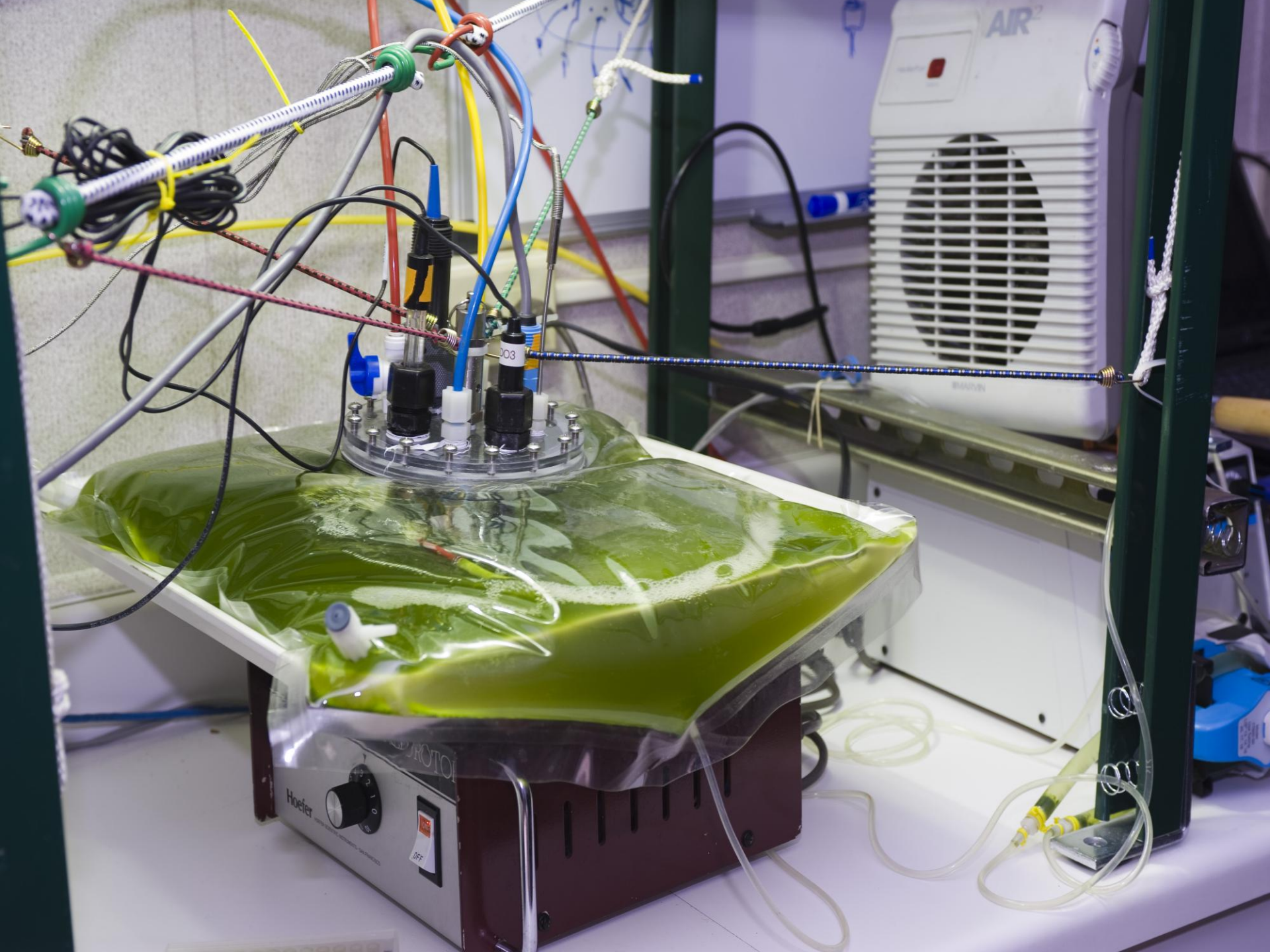


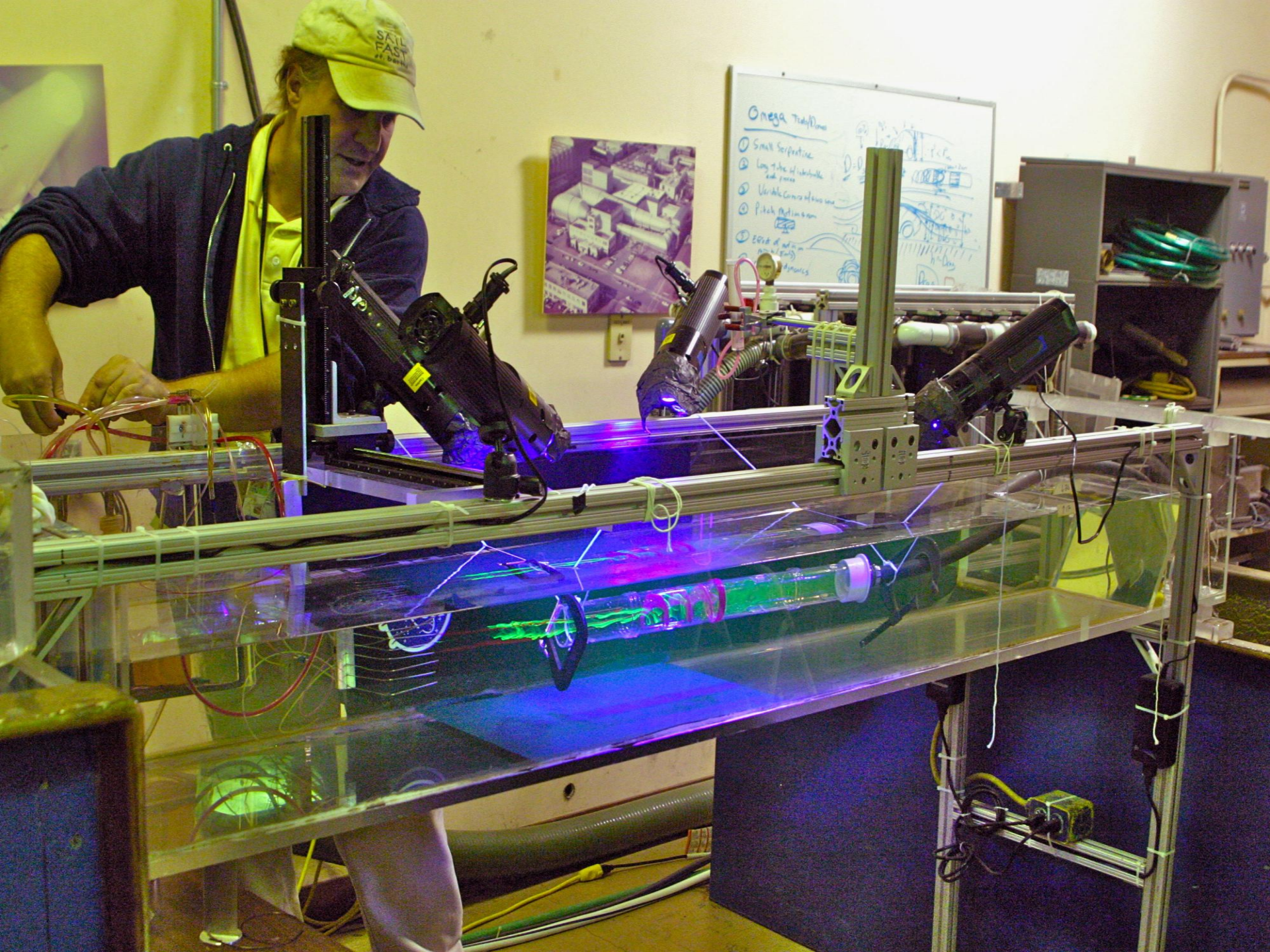




GE Lighting
Incandescent Lamps

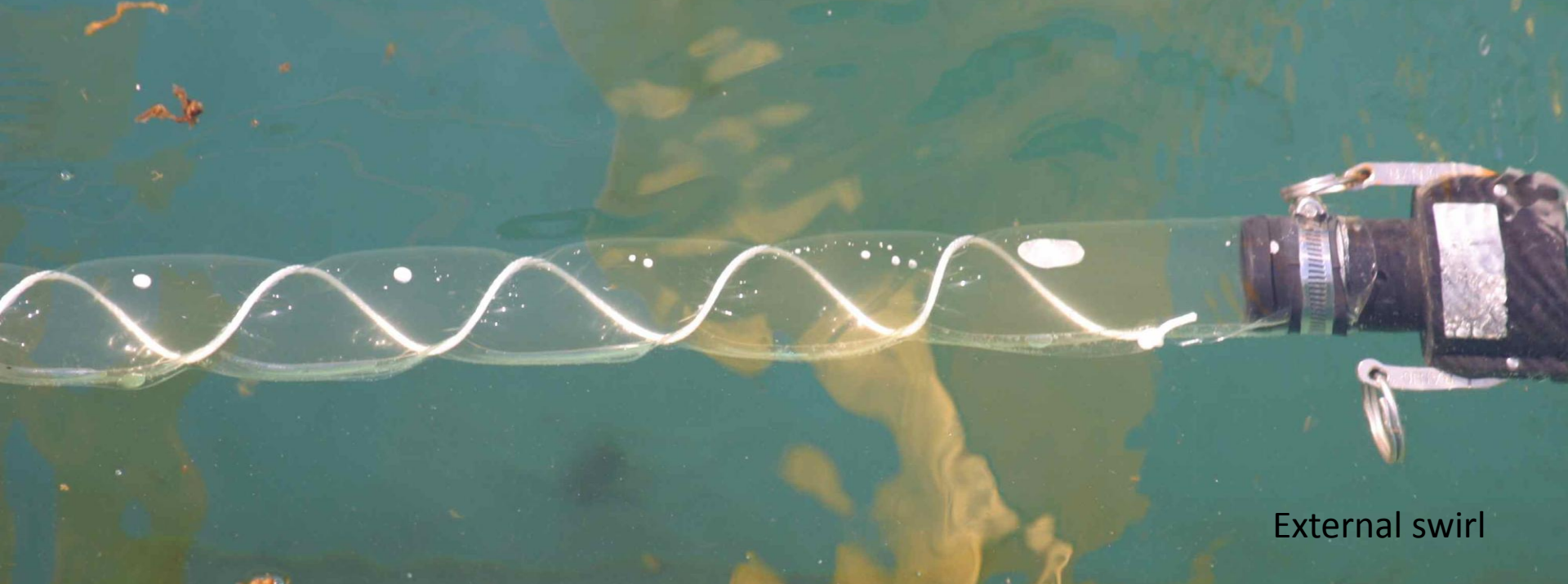
2.5 2.5





Omega Testflow

- 1 Small Serpentine
- 2 Long tube of variable width
- 3 Variable Cross section
- 4 Pitch Motion from

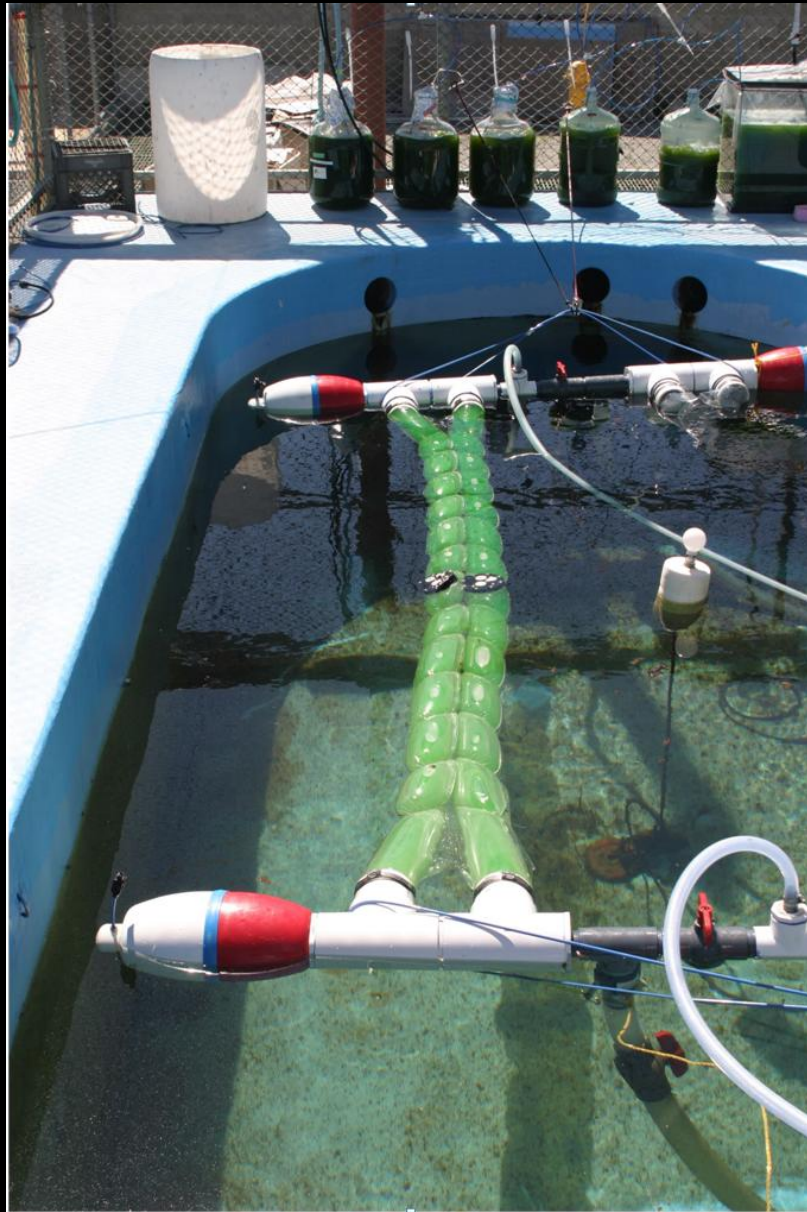


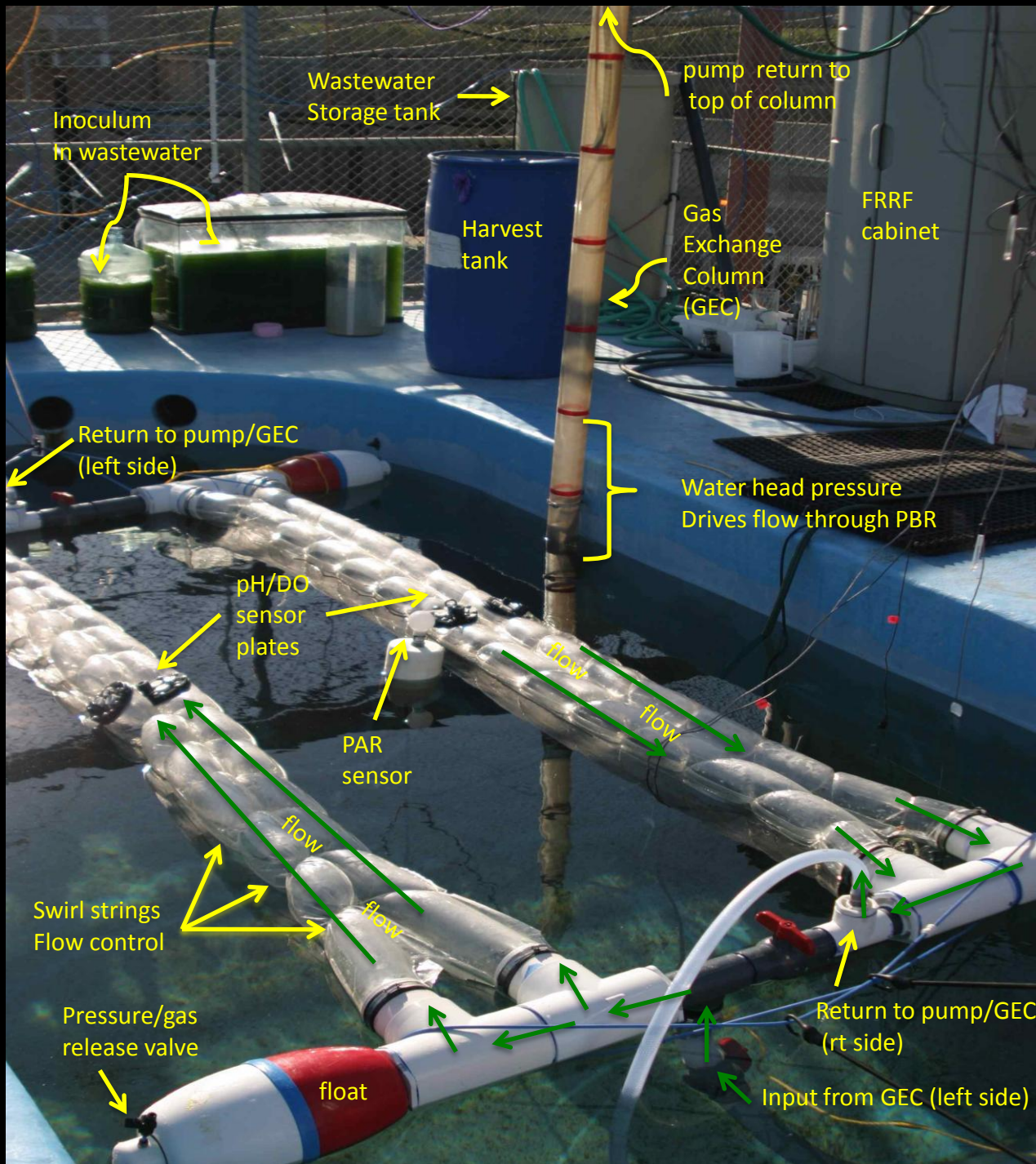
External swirl



Internal swirl vane







Inoculum
In wastewater

Wastewater
Storage tank

Harvest
tank

pump return to
top of column

Gas
Exchange
Column
(GEC)

FRRF
cabinet

Return to pump/GEC
(left side)

Water head pressure
Drives flow through PBR

pH/DO
sensor
plates

PAR
sensor

flow

flow

flow

flow

flow

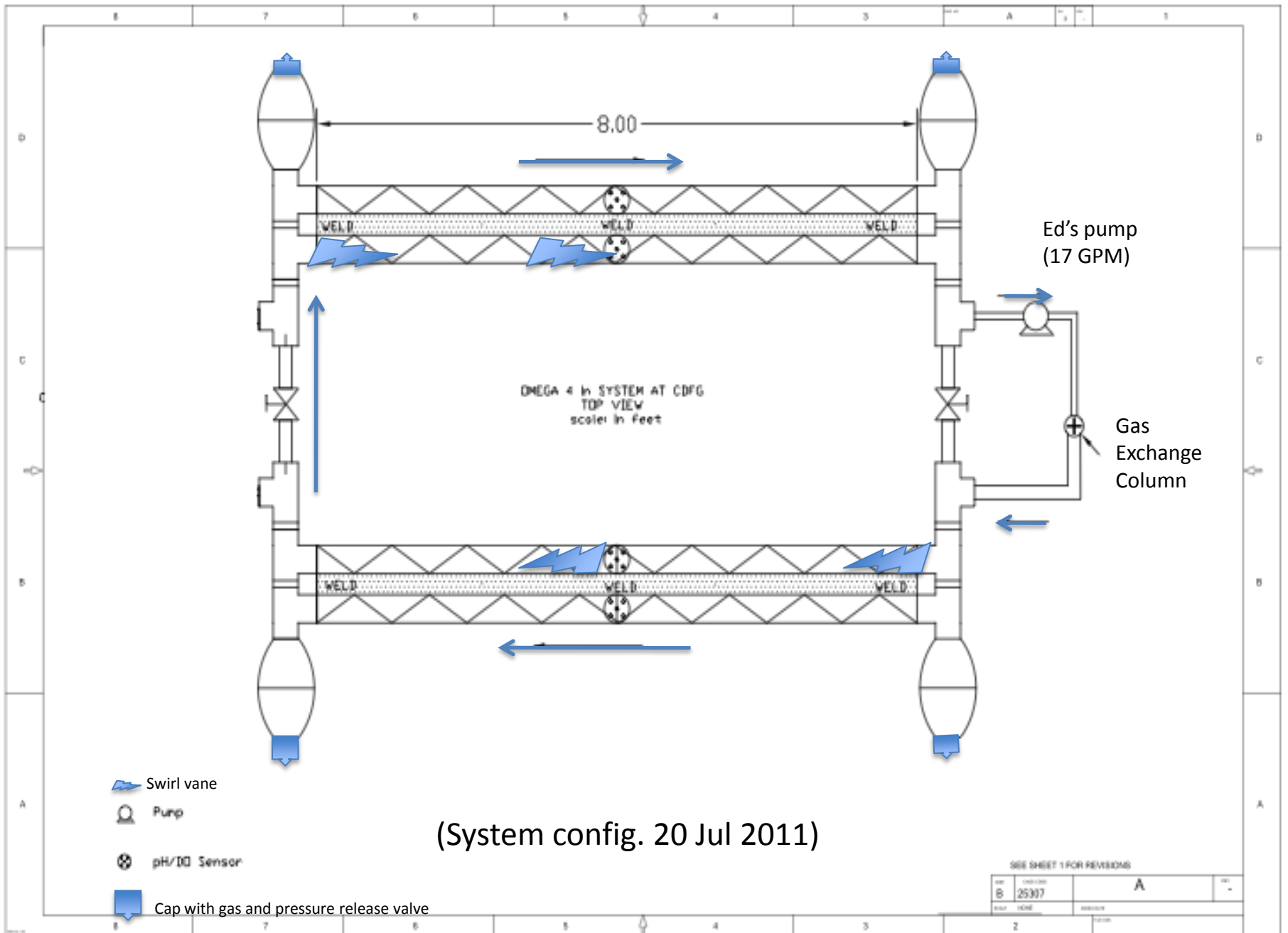
Swirl strings
Flow control

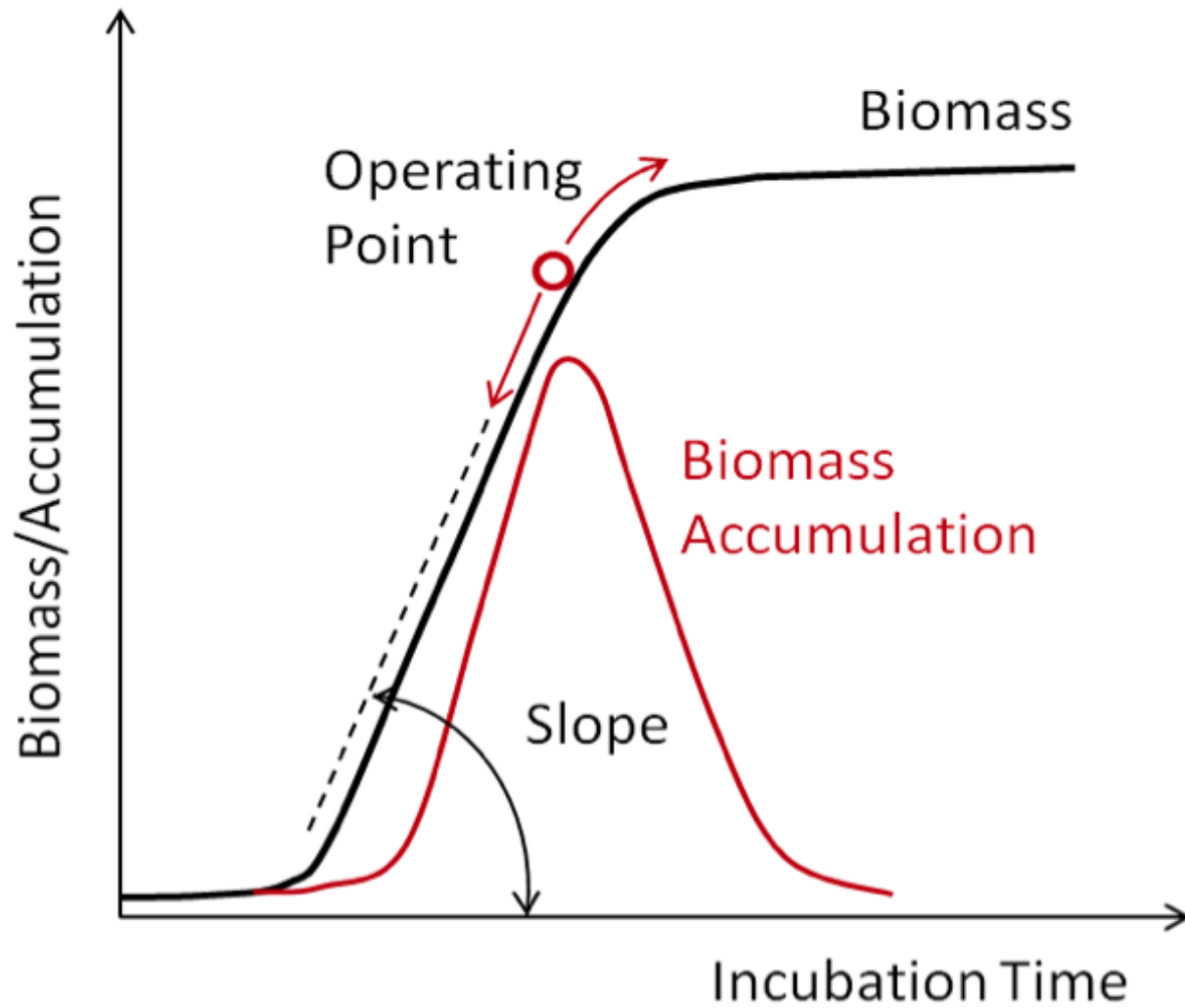
Pressure/gas
release valve

float

Return to pump/GEC
(rt side)

Input from GEC (left side)

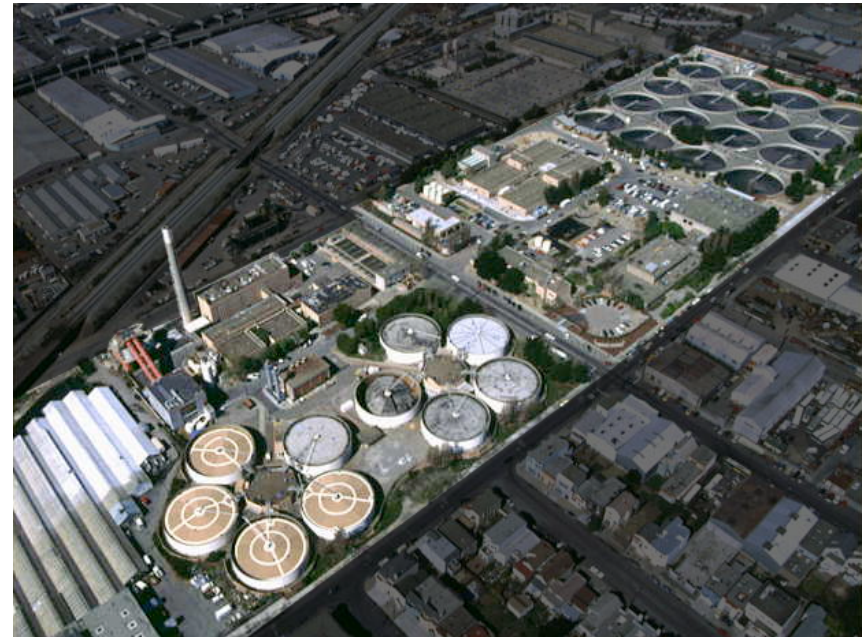
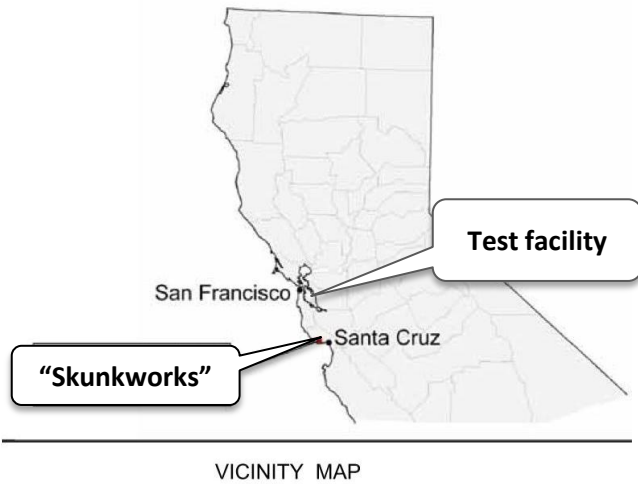




Research Site



Wastewater Plant





wastewater

tanks

Flue gas











Research Site



Wastewater Plant

