Black Swan, LLC

"-then the Lord God formed the man out of the dust of the ground and blew into his nostrils the breath of life, and the man became a living being." **Genesis** 2:7

Enhanced Nature-Based Direct Air Capture (eDAC) Scaled to 1 million Tons/Year of CO2 by 2027

Making Food by Using Free Air Carbon dioxide Enrichment (FACE)

as opposed to absorbent-based DAC (aDAC) with potential for Negative Impact to Food Security

presented at

American Institute of Chemical Engineers

April 9th, 2025

by

Brian Kolodji, PE, President and Owner

bkolodji@sbcglobal.net, cell: (713) 907-8742

Kolodji Corp / Black Swan, LLC

ENERGY CARBON MANAGEMENT/ INTELECTUAL PROPERTY HOLDING COMPANY

Broken Natural CO2 Cycle- Repaired with enriched Direct Air Capture (eDAC)

Over 95% of plant growth is dependent upon carbon supplied at 400ppm CO_2

$6CO_2 + 6H_2O$ + sunlight >> $6O_2 + C_6H_{12}O_6$: photosynthesis

Natural Cycle is broken and overwhelmed by industrial respiration

$6O_2 + C_6H_{12}O_6$ (carbohydrate) >> $6CO_2 + 6H_2O$: natural respiration

$(3X/2+1)O_2 + C_xH_{x+2}$ (fossil fuel) >> $XCO_2 + (X+2)/2\ H_2O$: industrial "respiration"

Where: X= 6000

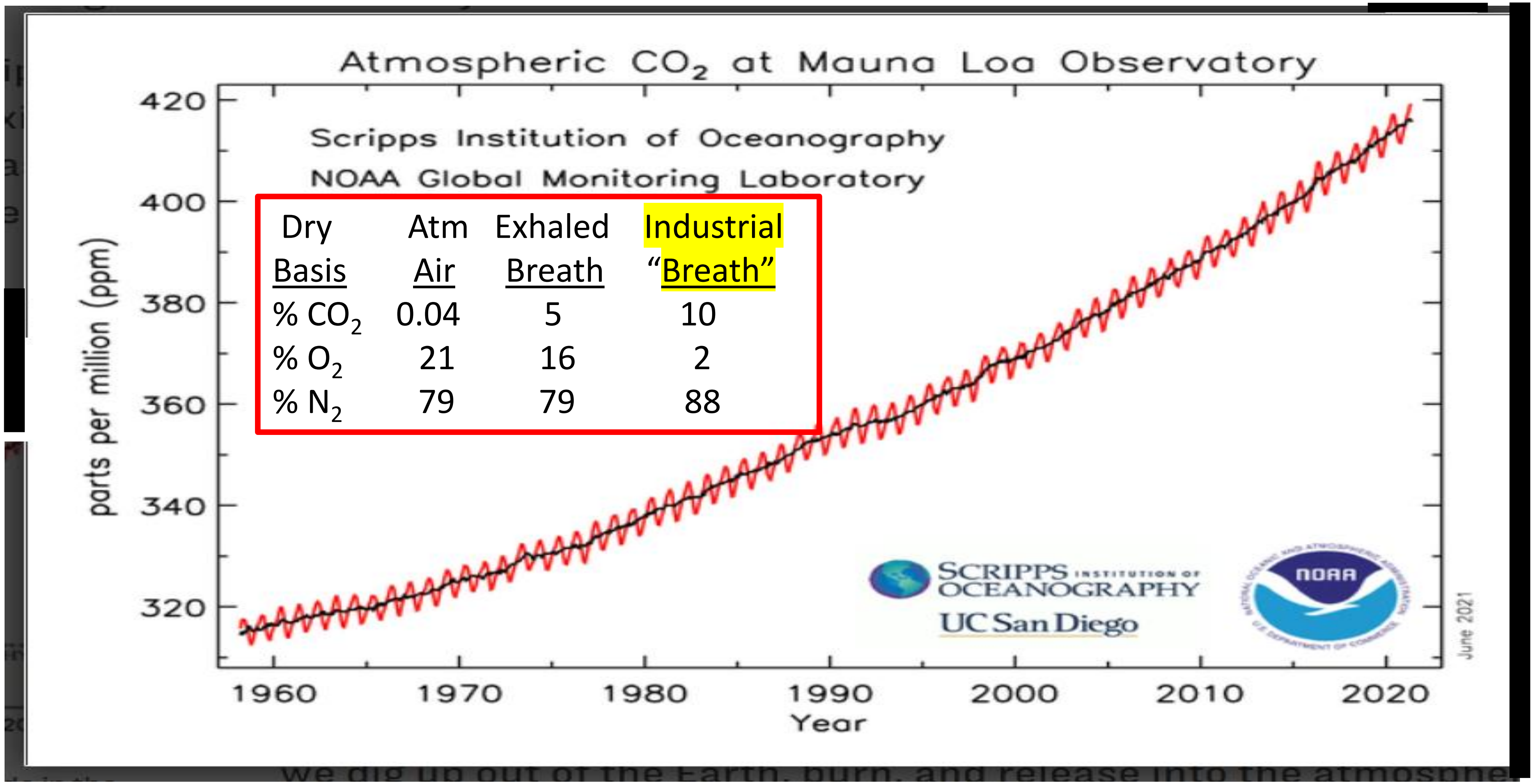
Double down on photosynthesis- to match overactive respiration

Spiking crop biosphere with CO2 between 600 to 1000 PPM

Biomass/ agricultural production increased 40% to 200%

eDAC- Low Cap/Energy/Resource Intensive Direct Air Capture

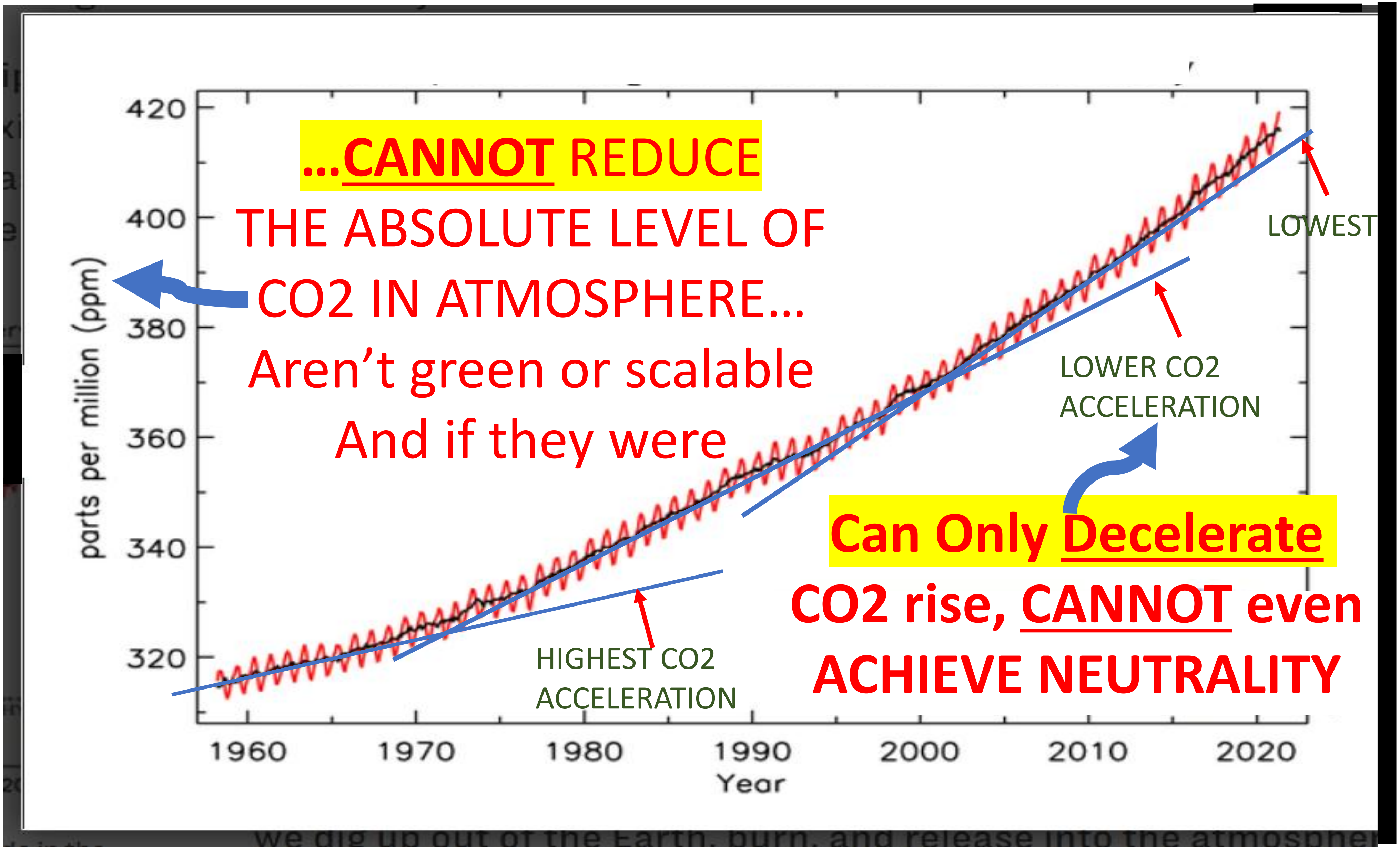
“Keeling Curve” Started in 1959



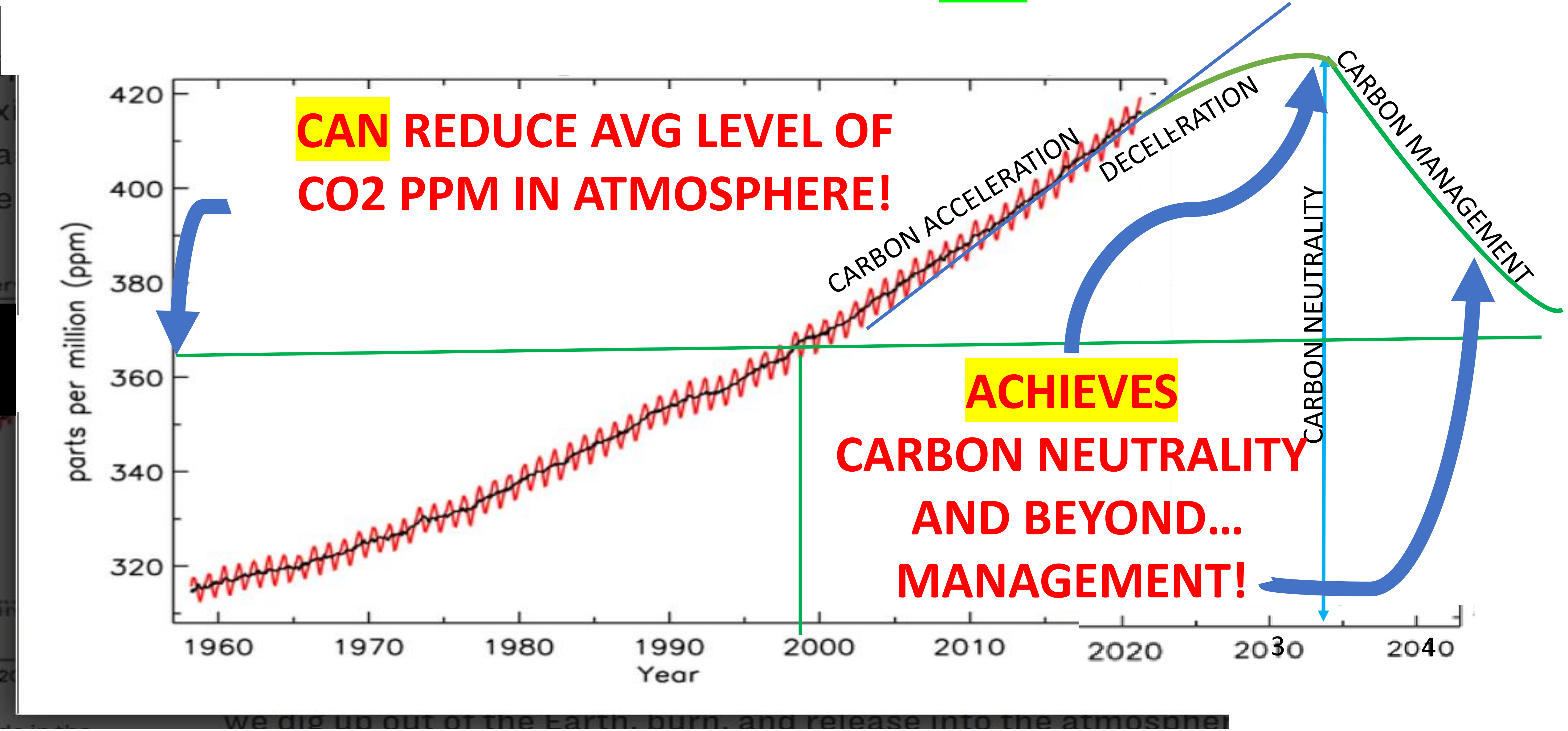
Dry Basis	Atm Air	Exhaled Breath	Industrial “Breath”
% CO_2	0.04	5	10
% O_2	21	16	2
% N_2	79	79	88

Cause? Energy Carbon Mis-management

CURRENT CONVENTIONAL DIRECT absorbent-based AIR CAPTURE (aDAC) TECHNOLOGY



“Keeling-Kimball-Kolodji” Curve
can only be achieved with eDAC that…



CALIFORNIA
AIR RESOURCES BOARD

December 2022

2022 Scoping Plan for Achieving Carbon Neutrality

Refer to pages 92 and 96 (Table 2.3)

Reference Link: 2022 Scoping Plan Update (ca.gov)

https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf

“Preliminary estimates indicate that, globally,
capacity from already announced projects will range from
... about 2,000 metric tons per year (MTCO2/y)
to 1 MMT CO_2/y from DACs by 2027
which indicates that California’s 2030 target
is an ambitious, but achievable, goal”
(as identified by Governor Newsom
and the Legislature- see Pages 95-97 and Table 2-3 below.)

STATEMENT AND TARGETS FROM CARB 2022 SCOPING PLAN FOR CARBON NEUTRALITY:

"To achieve carbon neutrality, mechanical CDR will therefore need to be deployed… Direct air capture (DAC) is one available option that is under development today and could be widely deployed."

	2030 ($MMTCO_2e$)	2045 ($MMTCO_2e$)
GHG Emissions	233	72
AB 32 GHG Inventory Sector Emissions	226	65
Net NWL GHG Emissions Across All Landscapes (annual average from 2025–2045)	7	7
Carbon Capture and Sequestration (CCS): Avoided GHG Emissions from Industry and Electric Sectors	(13)	(25)
Carbon Dioxide Removal (CDR) including natural and working lands carbon sequestration,[165] Direct Air Capture, and Bioenergy with CCS (BECCS).	(7)	(75)
Net Emissions (GHG Emissions + CDR)	226	(3)

SEE TABLE LISTING DAC FACILITIES FROM PAGE 19 OF REFERENCE IN NEXT SLIDE

iea

Direct Air Capture

A key technology for net zero

2022

International Energy Agency

Reference Link: Direct Air Capture: A key technology for net zero (iea.blob.core.windows.net)

https://iea.blob.core.windows.net/assets/78633715-15c0-44e1-81df-41123c556d57/DirectAirCapture_Akeytechnologyfornetzero.pdf

TWO KNOWN LEADING DAC TECH TYPES:

#2 Greenhouse Crop CO2 Enrichment (eDAC)
Commercialized for 60 years in greenhouses>>>

#1 Solid Absorbent (aDAC)eg. Climeworks' ORCA>>

DAC plants in operation worldwide

Company	Country	Sector	CO_2 storage or use	Start-up year	CO_2 capture capacity (tCO_2/year)
Global Thermostat	United States	R&D	Not known	2010	500
Global Thermostat	United States	R&D	Not known	2013	1 000
Climeworks	Germany	Customer R&D	Use	2015	1
Carbon Engineering	Canada	Power-to-X	Use	2015	Up to 365
Climeworks	Switzerland	Power-to-X	Use	2016	50
Climeworks	Switzerland	Greenhouse fertilisation	Use	2017	900
Climeworks	Iceland	CO_2 removal	Storage	2017	50
Climeworks	Switzerland	Beverage carbonation	Use	2018	600
Climeworks	Switzerland	Power-to-X	Use	2018	3
Climeworks	Italy	Power-to-X	Use	2018	150
Climeworks	Germany	Power-to-X	Use	2019	3
Climeworks	Netherlands	Power-to-X	Use	2019	3
Climeworks	Germany	Power-to-X	Use	2019	3
Climeworks	Germany	Power-to-X	Use	2019	50
Climeworks	Germany	Power-to-X	Use	2020	50
Climeworks	Germany	Power-to-X	Use	2020	3
Climeworks	Germany	Power-to-X	Use	2020	3
Climeworks	Iceland	CO_2 removal	Storage	2021	4 000

Carbon Dioxide Management Agreements (CDMAs)[1], submitting new permits to the EPA and attracting new greenfield project capital to California," said Francisco Leon, CRC's President and Chief Executive Officer. "The most recent release of California's first draft Class VI permits for the 26R reservoir and the Department of Energy (DOE) development grant awarded to the California Direct Air Capture (DAC) Hub reflects our continued commitment to carbon management solutions for hard-to-abate industries and decarbonization technologies in the Golden State. Finally, the recently announced agreement to combine with Aera Energy will enhance our carbon management business, providing greater scale with which to accelerate CRC's efforts to decarbonize California."

2023 Highlights

Solid Absorbent (aDAC)

MORE FAST TRACK DEVELOPMENT (rapid scale-up and skipping smaller pilots) HEADLINES

- The Environmental Protection Agency (EPA) released California's first draft Class VI well permits for underground CO_2 injection at the 26R storage vault, located at the proposed Clean Energy Park at Elk Hills Field in Kern County
- California DAC Hub, led by CTV's subsidiary CTV Direct, LLC, was selected to receive approximately $12 million in DOE funding for a regional initiative focused on the development of California's first full-scale DAC plus storage (DAC+S) network
- Submitted 51 million metric tons (MMT) of Class VI permits to EPA for CTV IV and CTV V storage reservoirs in Northern California. In total, CTV has submitted permits for 191 MMT of CO_2 storage with an estimated injection rate of 5.3 MMT per year
- Announced CTV's first capture-to-storage project at CRC's Elk Hills cryogenic gas plant, located in Kern County. This project is expected to sequester 100 thousand metric tons per year (KMTPA) of CO_2 in the 26R reservoir by year-end 2025
- Signed 760 KMTPA of storage-only CDMAs[1] with several greenfield project developers, helping to decarbonize California's energy value chain
- CTV's total CO_2 injection rate capacity under CDMAs[1] or agreements is 1.1 million metric tons per year (MMTPA)

Solid Absorbent (aDAC)

FAST TRACK DEVELOPMENT HEADLINES (skipping pilots)

Newsweek

Better Planet | Texas | Climate Change | Greenhouse Gas Emissions | Carbon Dioxide | CO2

World's Largest Carbon Capture Plant Being Built in Texas

Published Oct 31, 2024 at 3:45 PM EDT | **Updated** Nov 01, 2024 at 10:53 AM EDT

A facility under construction in West Texas aims to be the world's largest direct air carbon capture plant, though experts remain divided on the technology's viability and environmental impact.

Houston-based Occidental Petroleum (Oxy) is spearheading the STRATOS project, a $1 billion venture designed to remove 500,000 metric tons of carbon dioxide from the atmosphere annually once commercially operational in mid-2025.

https://www.newsweek.com/worlds-largest-carbon-capture-plant-being-built-texas-1978220

EXPERTS REMAIN DIVIDED ON ABSORBENT DAC (aDAC) TECHNOLOGY'S VIABILITY…

- COST: \$1Billion / 0.5 Million Tons/Year = \$2000/Ton of CO_2 Captured

- To Achieve Neutrality: Remove 5 Billion Tons/Year of CO_2 at \$2000/Ton = Budget Busting \$10 Trillion

AND WORST CASE ENVIRONMENTAL IMPACT…

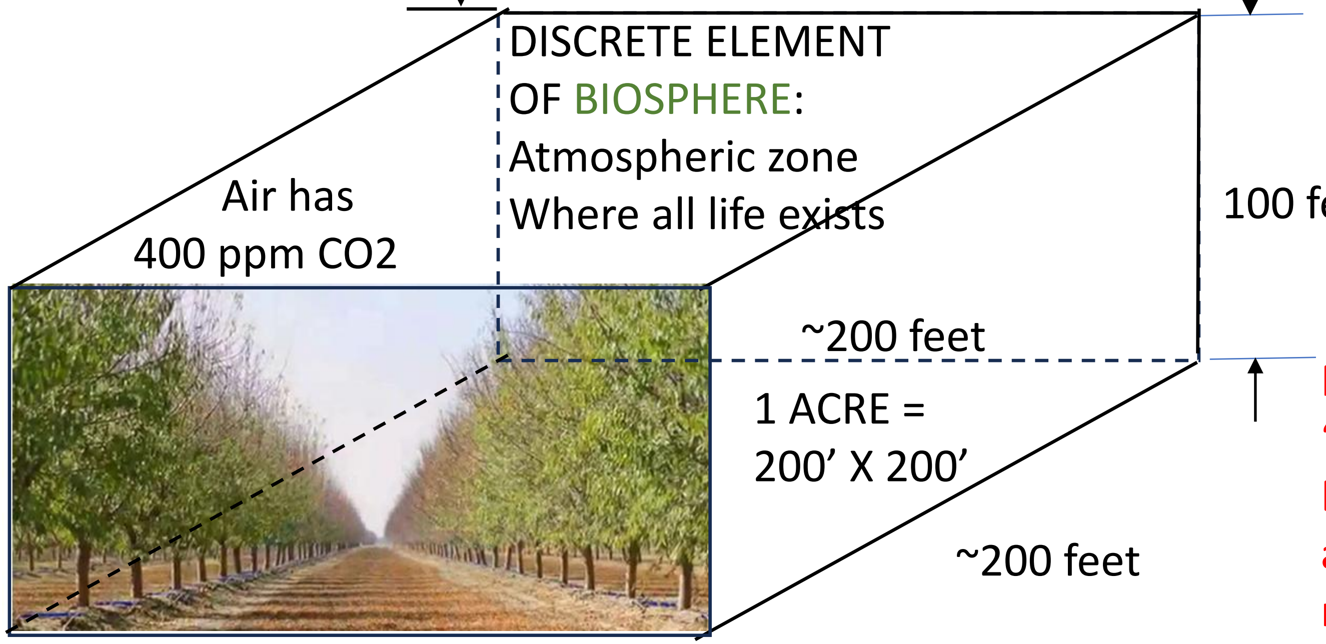
- RISK: Absorbent based DAC (aDAC) is banking on the trickle down of CO_2 from the miles (62) of upper atmosphere to prevent Excessive Depletion of CO_2 in the tiny sliver (100 feet) of biosphere from Impacting Food Security. Plants cannot grow without CO_2 in the biosphere. This facility will be taking CO_2 from near grade atmosphere.

- CO_2 in absorbent DAC (aDAC) is removed at near grade level, within the biosphere of fauna and flora where all life thrives:

  0.5 Million Tons CO_2 at near grade / 0.1 Tons/A-100'= Equivalent to 5 million acres of Biosphere depletion/Year

62 miles = 300,000 feet
of Upper Atmosphere >
where no life exists

Calculated and Depicted Below: ONLY 200 pounds of CO_2 in an acre X 100 feet of Air!!!

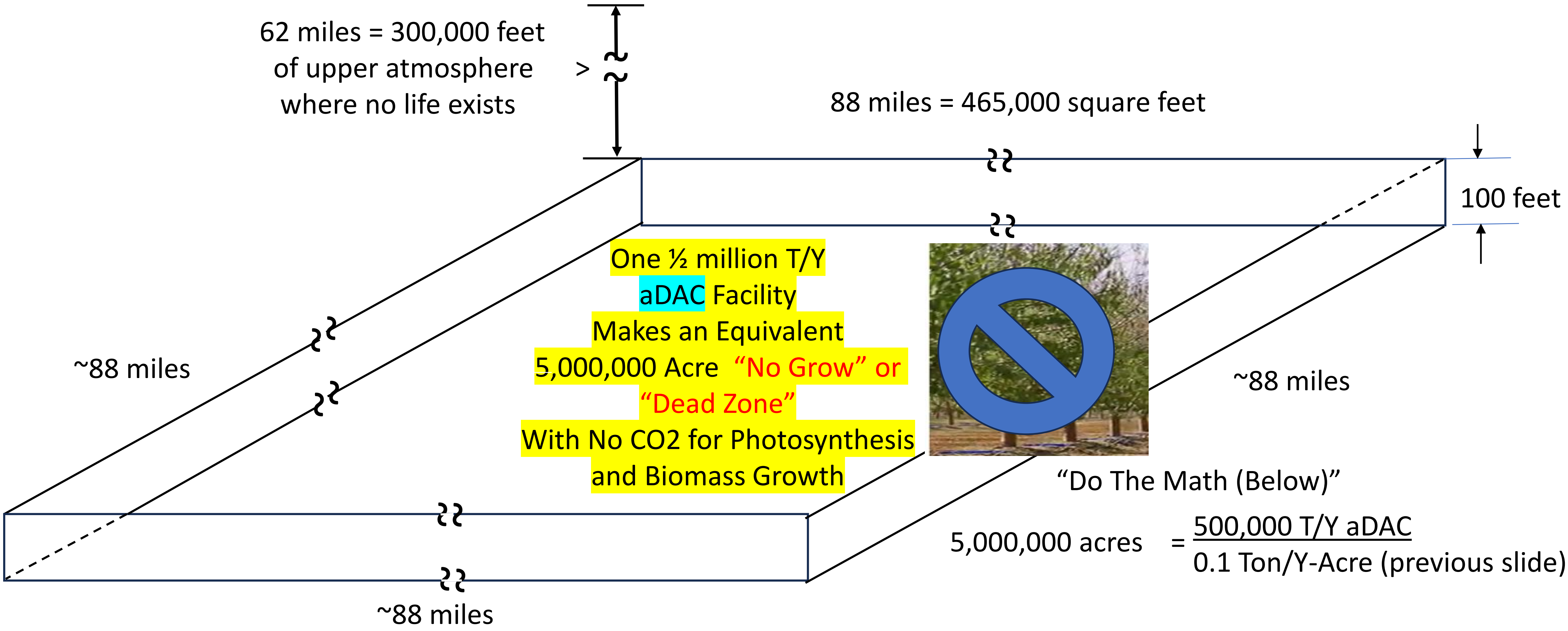


Prove this with the “Bedroom Dry Ice Challenge” By using 1 ounce of Dry Ice in a 10’X10’X10’ room, and measure with a CO_2 monitor to get 800 ppm in the room.

- Baseline: Ambient Mass of CO_2 in a discreet volume of biosphere 100 Feet High X Acre with 400 ppm:

- $1\ \text{Acre} \times \frac{43{,}560\ \text{Sq. Ft}}{\text{ACRE}} \times 100\ \text{Ft High Air} \times \frac{400\ \text{PPMV CO}_2}{1{,}000{,}000\ \text{Parts Air}} \times \frac{0.114\ \text{Lbs CO}_2}{\text{Cubic Ft CO}_2} = \frac{200\ \text{Lbs CO}_2}{\text{AcreX100Ft Volume of Air (Biosphere)}}$ = 0.1 Ton CO_2/A-100’

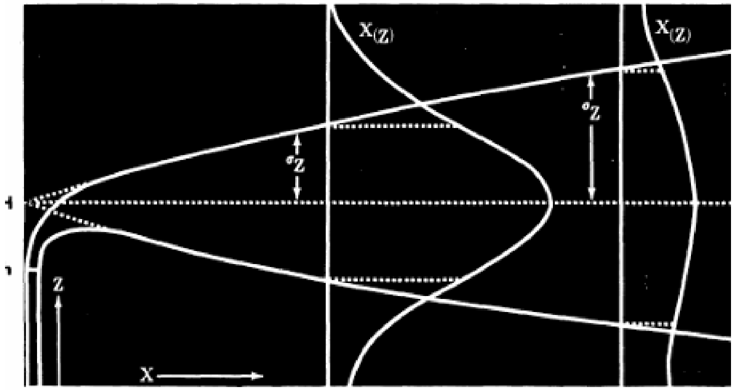
WORST CASE ABSORBENT DAC (aDAC) TECHNOLOGY'S IMPACT…



10 Million Tons/Yr of aDAC (1/7 of CARB 2050 Goal of 70 Million Tons of CO_2)
Is Equivalent to Depleting a 100-foot high layer of biosphere for California's Entire ~100 Million Acre Land Mass
Kern County, California's largest ag producing county has 80 Million Tons/Year DAC planned before 2035

ABSORBENT DAC (aDAC) TECHNOLOGY'S NEGATIVE IMPACT on AGRICULTURE
...per Decades Accepted USEPA Methods

WORKBOOK
OF
ATMOSPHERIC DISPERSION
ESTIMATES



U.S. ENVIRONMENTAL PROTECTION AGENCY

1973

Found at USEPA Link as follows- https://nepis.epa.gov/Exe/ZyPDF.cgi/9101S7UT.PDF?Dockey=9101S7UT.PDF

ABSORBENT DAC (aDAC) TECHNOLOGY'S IMPACT

Calculation for Concentration of Depleted CO2 Near Ground Level Concentration Miles Downwind of a Million Ton/Year aDAC Facility

$$\chi\,(x,0,0;0) = \frac{Q}{\pi\,\sigma_y\,\sigma_z\,u}$$

SIGMA Y SIGMA Z from curves that follow:

Ground Level Continuous Concentration (*x*) Directly Down Wind at Distance x from the Source

χ ($g\ m^{-3}$) or, for radioactivity (curies m^{-3})

Q ($g\ sec^{-1}$) or (curies sec^{-1}) Uniform Emission Rate

u ($m\ sec^{-1}$) Mean Wind Speed

σ_y, σ_z, H,x,y, and z (m) Stack and Plume Height (H and z) and y are zero

SIGMA Y, SIGMA Z – Gaussian Distribution of Standard Deviation Plume Concentrations in the Horizontal and Vertical Planes

USEPA DATA TABLE USED TO ACCOMMODATE WIND AND CLIMATE

used in SIGMA Y and SIGMA Z Curves that follow:

KEY TO STABILITY CATEGORIES

Surface Wind Speed (at 10 m), m sec⁻¹	Day			Night	
	Incoming Solar Radiation			Thinly Overcast or ≥4/8 Low Cloud	≤3/8 Cloud
	Strong	Moderate	Slight		
< 2	A	A-B	B		
2-3	A-B	B	C	E	F
3-5	B	B-C	C	D	E
5-6	C	C-D	D	D	D
> 6	C	D	D	D	D

The neutral class, D, should be assumed for overcast conditions during day or night.

Curve for SIGMA Y Values

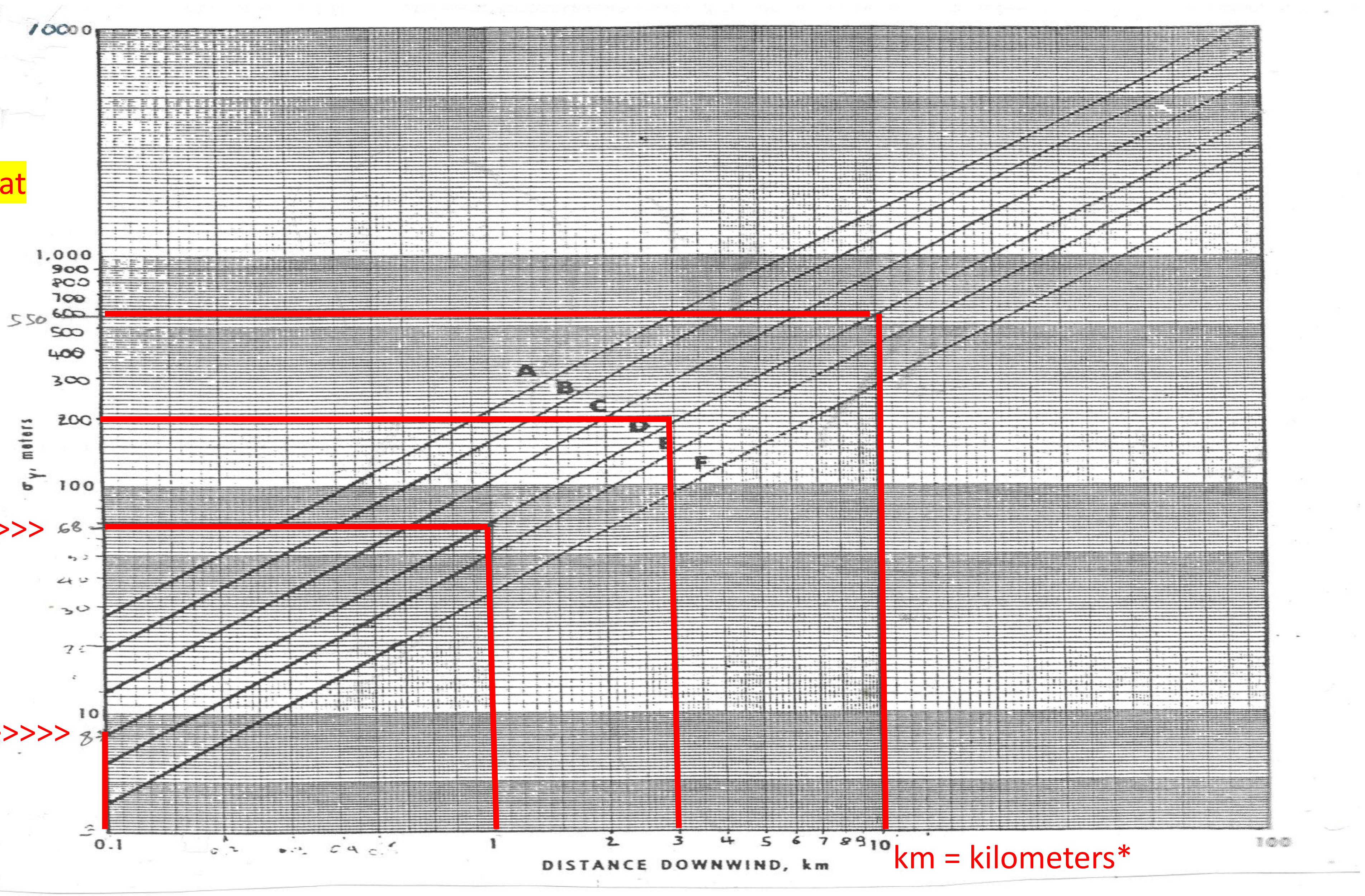
SIGMA Y Values at "D" Stability for MM Ton/Y aDAC

550m @ 10 km* >

200m @ 3 km >

70m @ 1 km >>>>>>

8m @ 0.1 km >>>>>>>



Curve for SIGMA Z Values

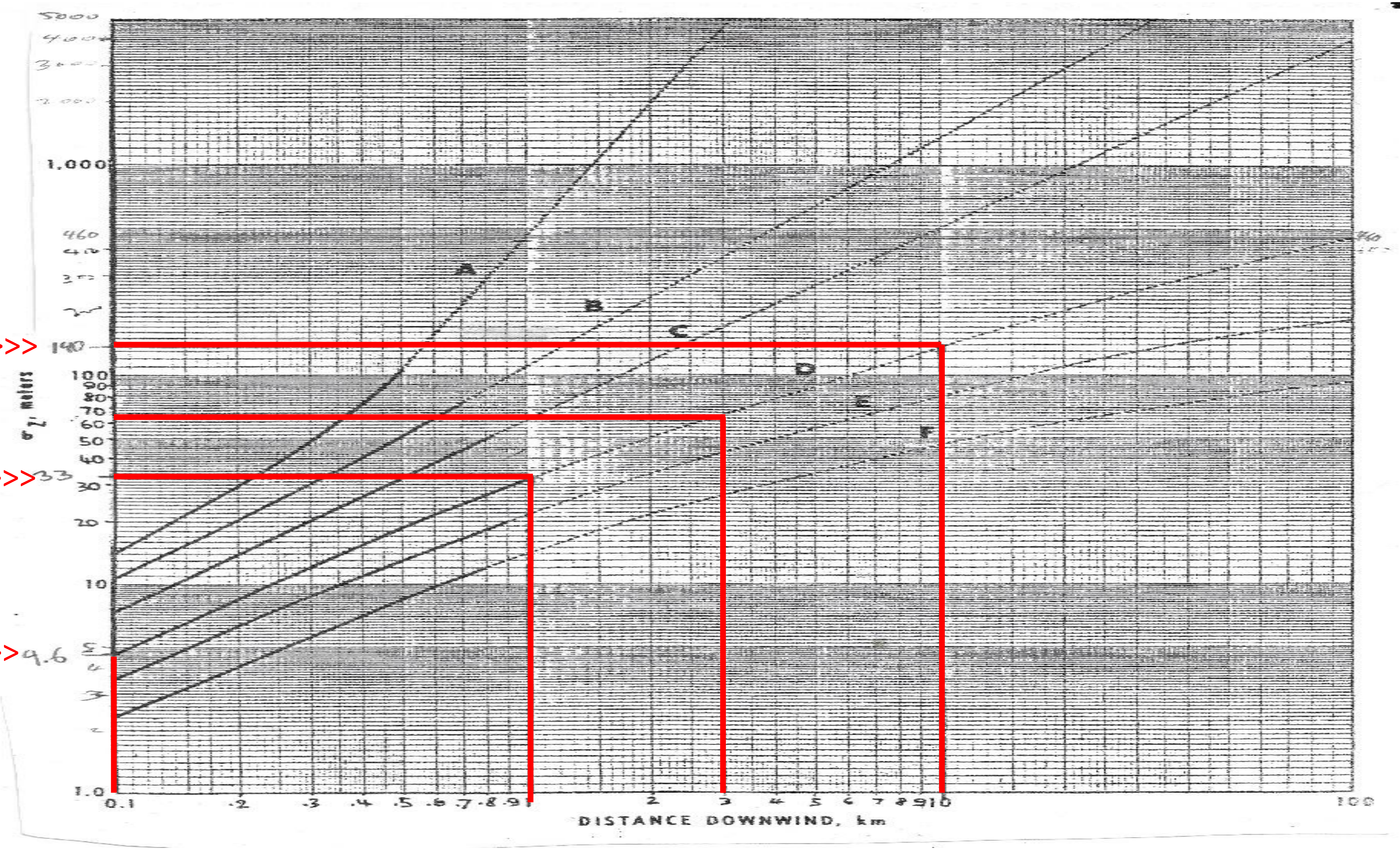
SIGMA Z Values at “D” Stability for MM Ton/Y aDAC

140m @ 10 km >>>>>>>>

64m @ 3 km >>>>>>>

32m @ 1 km >>>>>>>>>>

4.6m @ 0.1 km >>>>>>>



Calculation for Ground Concentration ($x_{(0.1km,0,0,0)}$ in g/m^3) as Mass of Depleted Air, as g released into Volume of Normal Air, as m^3 with "D" Stability and 2 m/s Wind at x=0.1 km Downstream of 1MMT/Y aDAC

$$\chi(x,0,0;0) = \frac{Q}{\pi \sigma_y \sigma_z u}$$

Q, Depleted Air Emission Rate (g/s) = CO2 Removed (g/s)/ Mass Fraction Concentration of CO2 in Normal Air

CO2 Removed from Normal Air (g/s) = (1MM T/Y) X (1MM grams/T) X (1 year/31,536,000 seconds) = 28,827 g/s

Conc conversion in Normal Air = (200 lbs of CO_2/ 4365000 cubic feet air) X (1000 g/ 2.2 lbs) X (1 cubic foot/ 0.028317 cubic meter) = 0.736 g CO_2/ m^3 normal air (g/m^3)

Using results from above and the R Constant 8.206 X 10^{-5} the Q, Depleted Air Emission Rate (g/s) is calculated below:

Q, Depleted Air Rate from aDAC (g/s)= 28,827 g/s CO_2 X (29 g/gmol Air) / 0.736 g/m^3 / 8.206 X 10^{-5} / 298.15 K = 4.8 X 10^7 g/s

$x_{(0.1km,0,0,0)}$ = 4.8 X 10^7 g/s / (pi X 8 X 4.5 X 2 m/s) = 212,207 g Depleted Air/ m^3 Air (g/m^3) at 0.1 km from MMT/Y aDAC

Convert concentration Depleted Air in Normal Air ($x_{(0.1km,0,0,0)}$ in g/m^3) to ppmv CO_2 in Atmosphere with "D" Stability& 2 m/s Wind

Depleted CO_2 Concentration at x= 0.1 km Downstream of 1MMT/Y aDAC

For x at 0.1 km, the R Constant of 10.73 calculates a conversion factor to ppmv Depleted Air in Normal atmospheric air:

(1 lb/29 lbmol) X (2.2 lb/ 1000 g) X (10.73/ 14.7 psia) X (520 R X 0.028317 m^3/ft^3 X 10^6) = 815.4 ppmv/(g/m^3)

815.4 ppmv/(g/m^3) X (212,207 g/m^3) = 173 X 10^6 ppmv of Depleted Air in Air at x from aDAC

Calculating the concentration ppmv of CO_2 in Atm at x, the following equation is derived:

ppmv of CO_2 in Atm at x = ppmv of CO_2 in Depleted Air at x + ppmv of CO_2 in Normal Atmosphere at x:

Since ppmv of CO_2 in Depleted Air at x = zero or 0 ppmv, thus

ppmv of CO_2 in Atm at 0.1km = (400 parts CO_2 in Normal /(173 X 10^6 parts Depleted Air+ 1 X 10^6 Parts Normal Air)) X 10^6

2.3 ppmv CO_2 in "D" Stability atmosphere at 0.1 km downwind from 1MMT/Y aDAC unit

x or Depleted Air in Normal Air, ppmv and CO2 in atmosphere, ppmv
at 0.1, 1, 3, and 10 km Downstream of 1MMT/Y aDAC

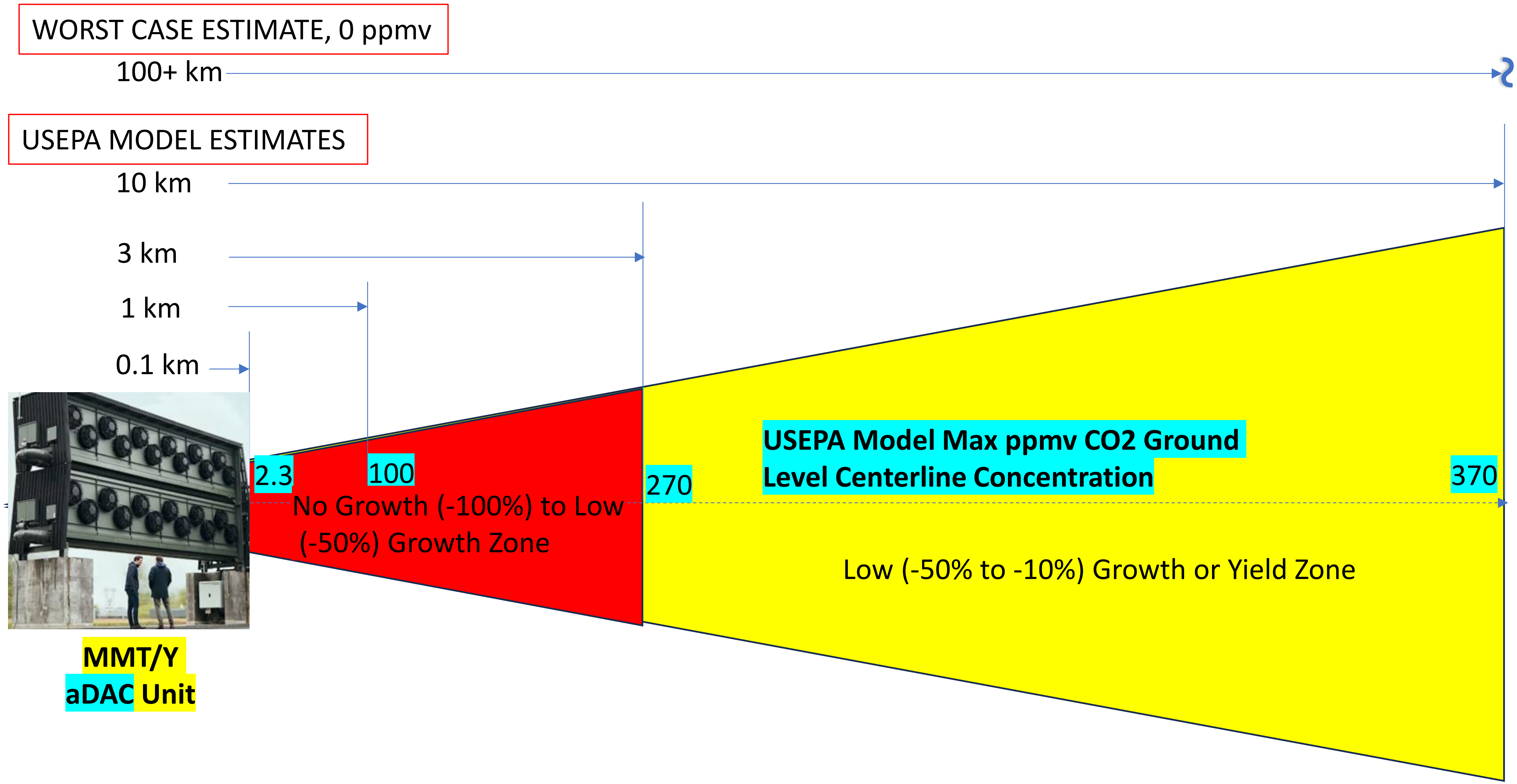
$x_{(0.1km,0,0,0)}$ = (4.8 X 10^7 g/s / (pi X 8 X 4.5 X 2 m/s)) X 815.4 = 173 X 10^6 ppmv Depleted/Normal Air at 0.1 km from MMT/Y aDAC
2.3 ppmv CO2 at 0.1km = (400 parts in Normal /(173 X 10^6 parts Depleted Air+ 1 X 10^6 Parts Normal Air)) X 10^6

$x_{(1.0km,0,0,0)}$ = (4.8 X 10^7 g/s / (pi X 70 X 32 X 2 m/s) X 815.4) = 2.8 X 10^6 ppmv Depleted/Normal Air at 0.1 km from aDAC
100 ppmv CO2 at 1km = (400 parts in Normal /(2.8 X 10^6 parts Depleted Air+ 1 X 10^6 Parts Normal Air)) X 10^6

$x_{(3km,0,0,0)}$ = (4.8 X 10^7 g/s / (pi X 200 X 64 X 2 m/s) X 815.4) = 0.49 X 10^6 ppmv Depleted/Normal Air at 0.1 km from aDAC
270 ppmv CO2 at 3km = (400 parts in Normal /(0.49 X 10^6 parts Depleted Air+ 1 X 10^6 Parts Normal Air)) X 10^6

$x_{(10km,0,0,0)}$ = (4.8 X 10^7 g/s / (pi X 550 X140 X 2 m/s) X 815.4) = 0.085 X 10^6 ppmv Depleted/Normal Air at 0.1 km from aDAC
370 ppmv CO2 at 10km = (400 parts in Normal /(0.085 X 10^6 parts Depleted Air+ 1 X 10^6 Parts Normal Air)) X 10^6

Distances from MMT/Y aDAC



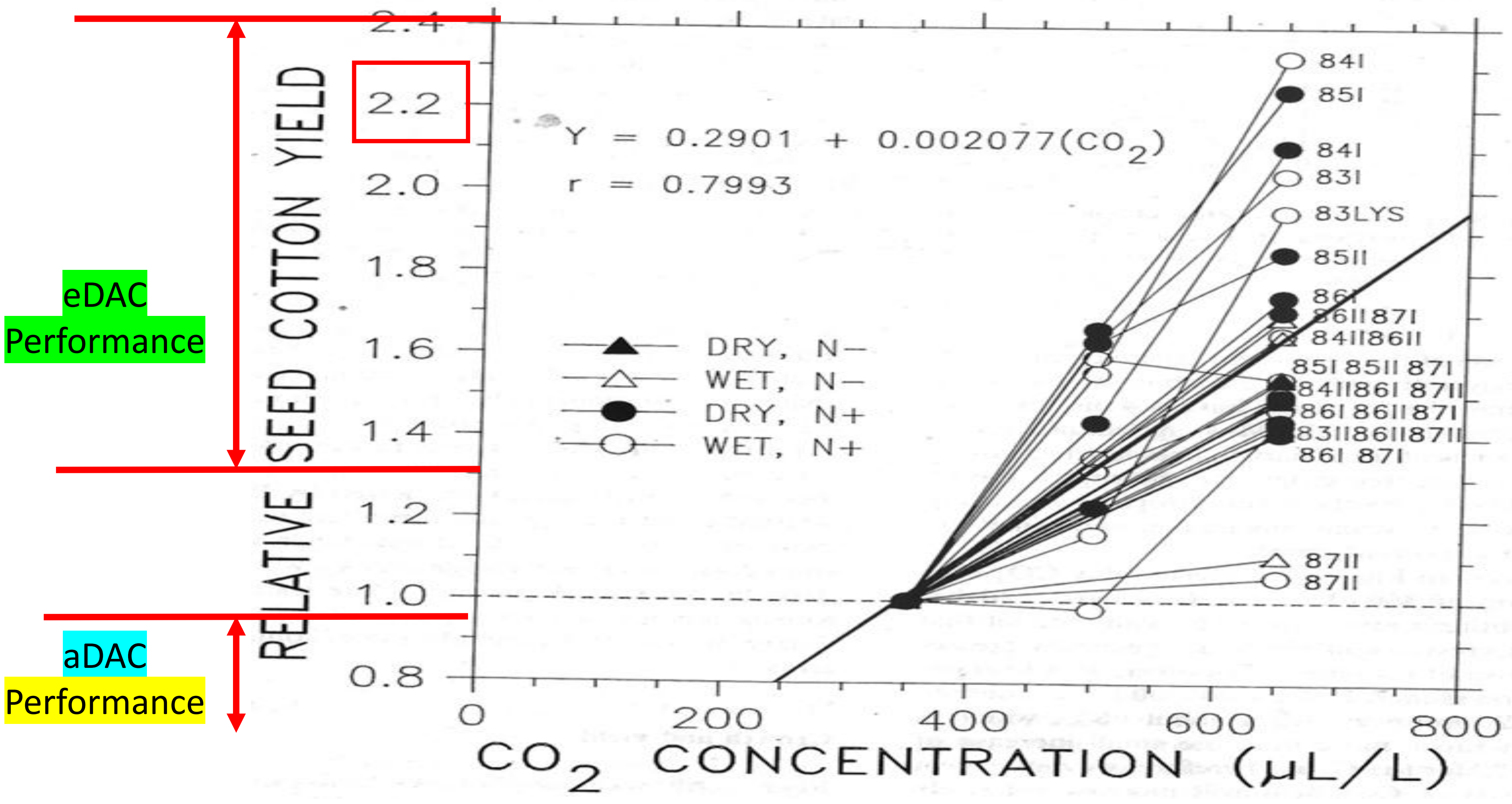


Fig. 2. Seed cotton yield (lint and seed) relative to the yield obtained from ambient CO_2 control chambers versus CO_2 concentration for 5 years' worth of experiments with open-top chambers at Phoenix, AZ. The labels on the right identify the year and replicate of the particular data points. From Kimball *et al.* (1987).

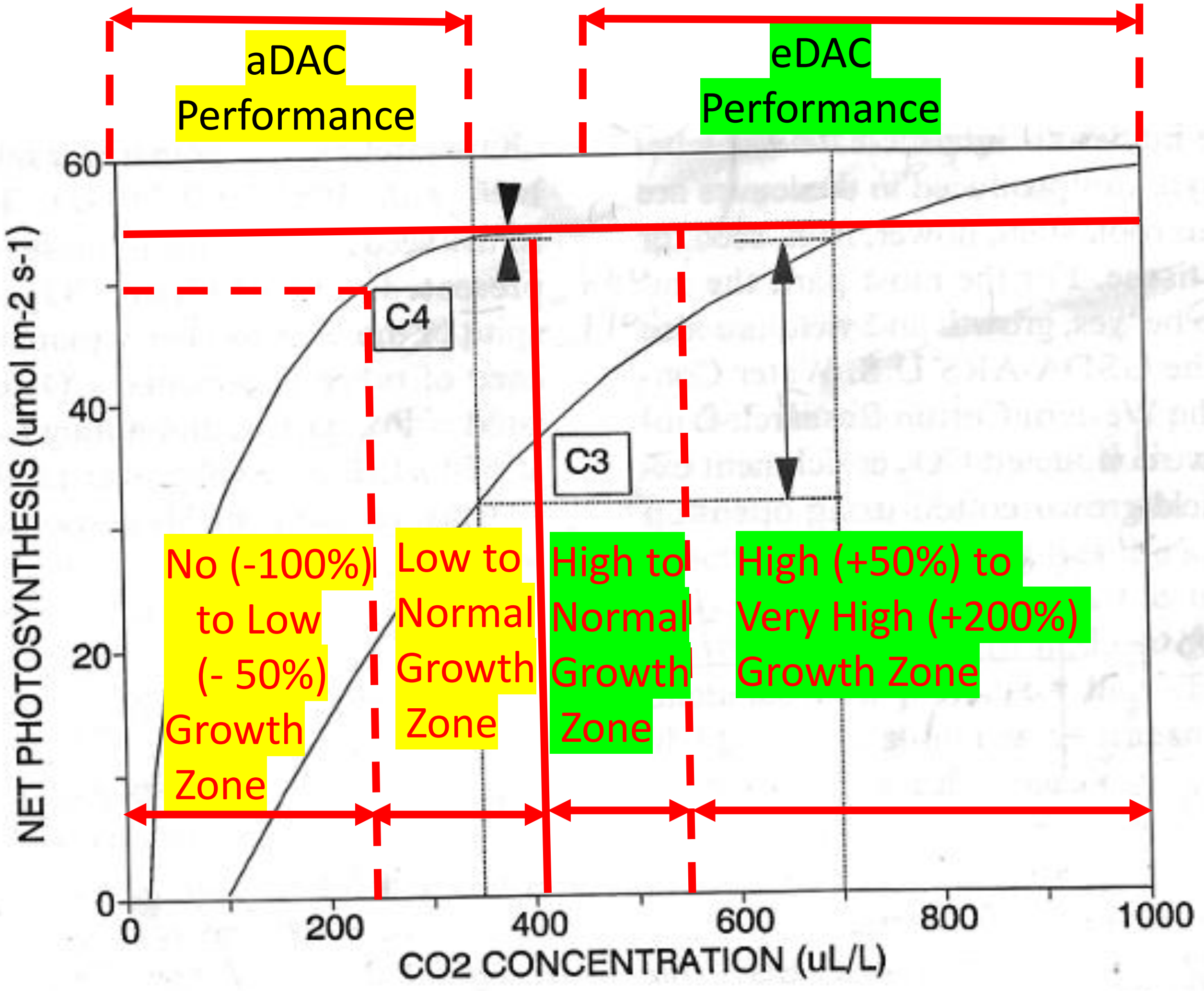


Fig. 1. Net photosynthesis of typical C_3 and C_4 plants versus CO_2 concentration, adapted from Taiz and Zeiger (1991). The vertical dotted lines at 350 and 700 μL/L indicate the present-day CO_2 concentration and the doubled concentration projected to occur sometime near the end of the next century (Houghton *et al* 1990), respectively. The double arrows indicate the amounts of increase in photosynthesis due to the CO_2 doubling.

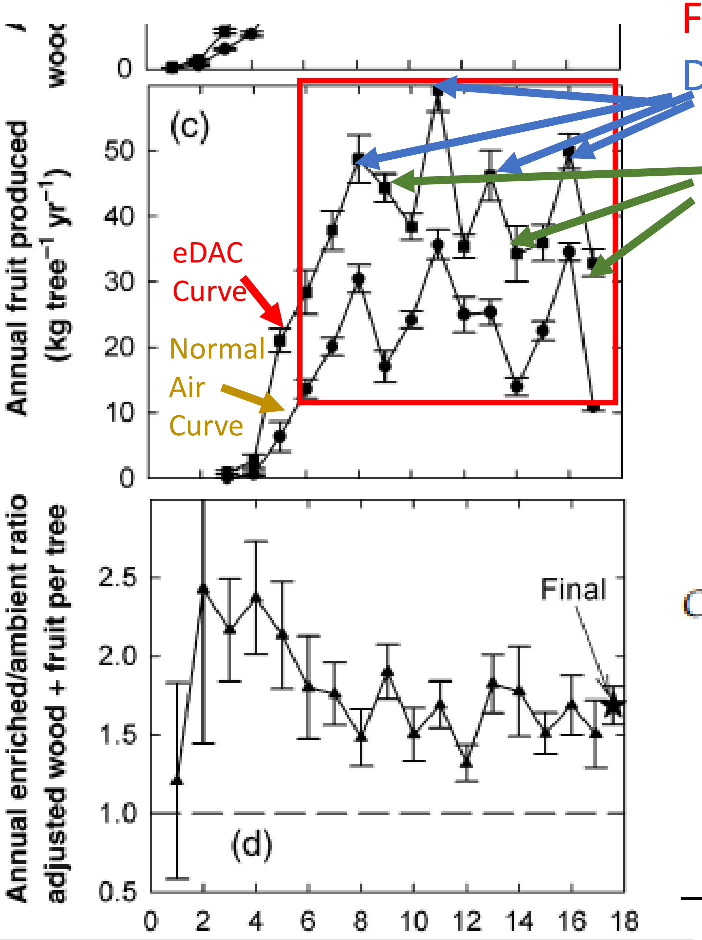
Global Change Biology (2007) 13, 2171–2183, doi: 10.1111/j.1365-2486.2007.01430.x

USDA STUDY!

Seventeen years of carbon dioxide enrichment of sour orange trees: final results

A Form of eDAC

BRUCE A. KIMBALL*, SHERWOOD B. IDSO†, STEPHANIE JOHNSON* and MATTHIAS C. RILLIG‡§



Form of eDAC with INCREASED YIELDS and with No impact to Nutrition per below:

Data Points showing FOUR PEAK PRODUCTION YEARS AT + 100% YIELD INCREASE

Data Points showing THREE TROUGH PRODUCTION YEARS AT + 200% YIELD INCREASE!

The almost complete lack of changes in elemental composition (C, N, P, K, Ca, Mg, S, Na, Fe, Zn, Mn, Cu, and B) due to elevated CO_2 (Table 2) is rather surprising considering that at least in the case of N, it is common for elevated CO_2 to cause lower concentrations (e.g. Cotrufo *et al.*, 1998; Curtis & Wang, 1998;

Cumulative parameters summed over duration of experiment

Harvested fruit biomass (kg tree^{-1})	518.2	26.4	280.8	11.5
Number of fruit per tree	13 840	350	7660	180
Fruit size (kg fruit^{-1})	37.3	0.9	36.4	0.7
Biomass of prunings (kg tree^{-1})	197.7	16.0	110.8	13.7
Total cumulative biomass (kg tree^{-1})	1127	35	664	25

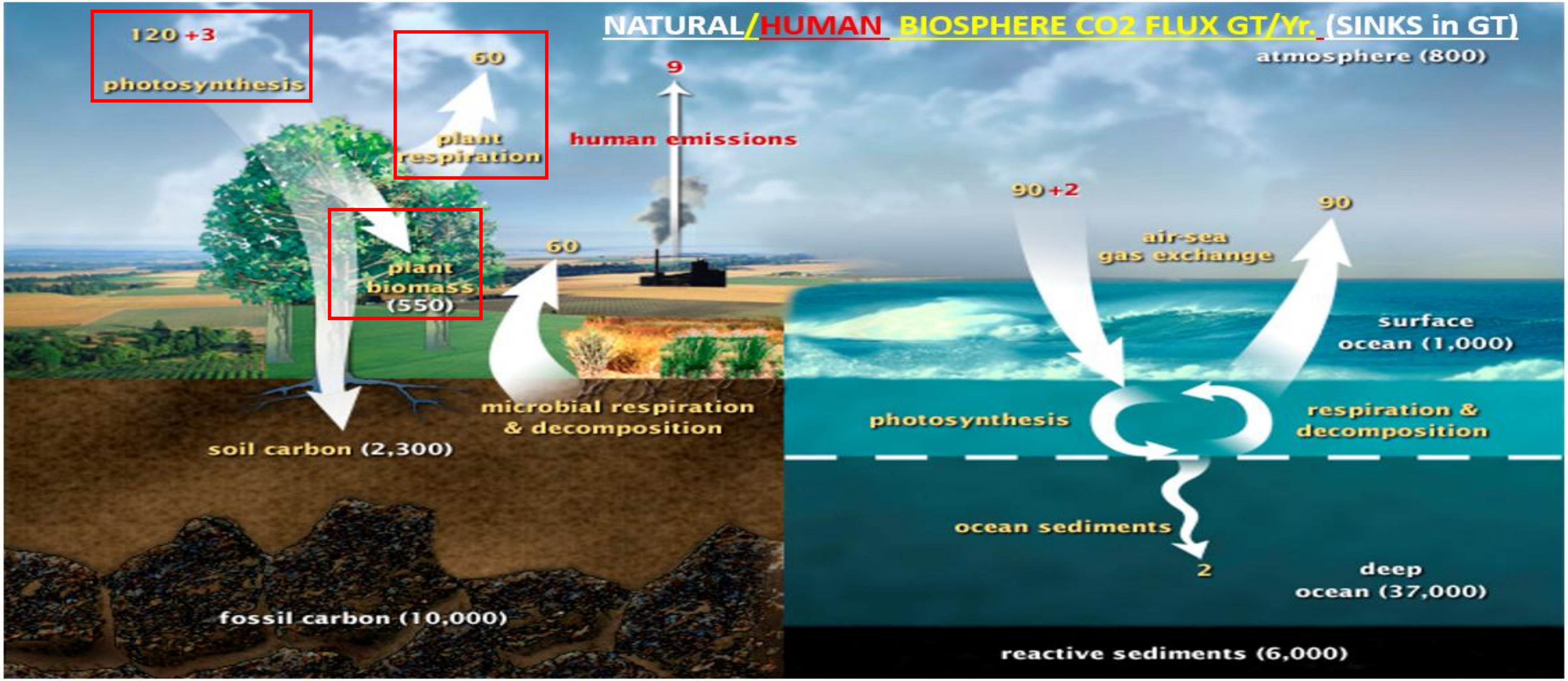
Black Swan, LLC

eDAC- Enhanced Nature Based Direct Air Capture, Use, and Bio-Sequestration

	Basis:	Tons/Year Captured			
	100	Trees/acre			
	Total Cumulative Biomass (kg/Tree)				
	Summed over duration of experiment (10 Producing Years)				
	Enriched	Ambient	Net	Kg/Tree/Year	kg/acre/yr
Total Biomass Increase/Tree	1127	- 664	= 463	46.3	4630
		MINUS			
	or about		est		
	5 MT/Year/acre		10 MT/Year/acre		
CO2 ENRICHMENT LEVEL	at 550 ppm		at 1000ppm		

- The Difference between aDAC and eDAC?
- Enhanced Nature Based DAC (eDAC) is banking on building an "Infrastructure of CO_2 Absorbing Machines" in the form of nature based Biomass Generating Plants converting and drawing down the CO_2 concentration levels from the miles of upper atmosphere by supplementing CO_2 in the tiny sliver (100 feet) of biosphere and improving Food Security by increasing yields.

Nature Based Direct Air Capture (nDAC)



(Diagram adapted from U.S. DOE, Biological and Environmental Research Information System. 12/2008)

120 GT/Y Photosynthesis Flux – 60 GT/Y Plant Respiration Flux = 60 GT/Y Global Plant Biomass Sink (Biosequestration) Increase

Enhanced nature-based DAC (eDAC), can increase bio-sequestration potentially 50% or to 90 GT/Y

FREE AIR CARBON DIOXIDE ENRICHMENT (FACE)- CROP CARBON DIOXIDE ENRICHMENT (FACE) **WITHOUT** ENCLOSURES

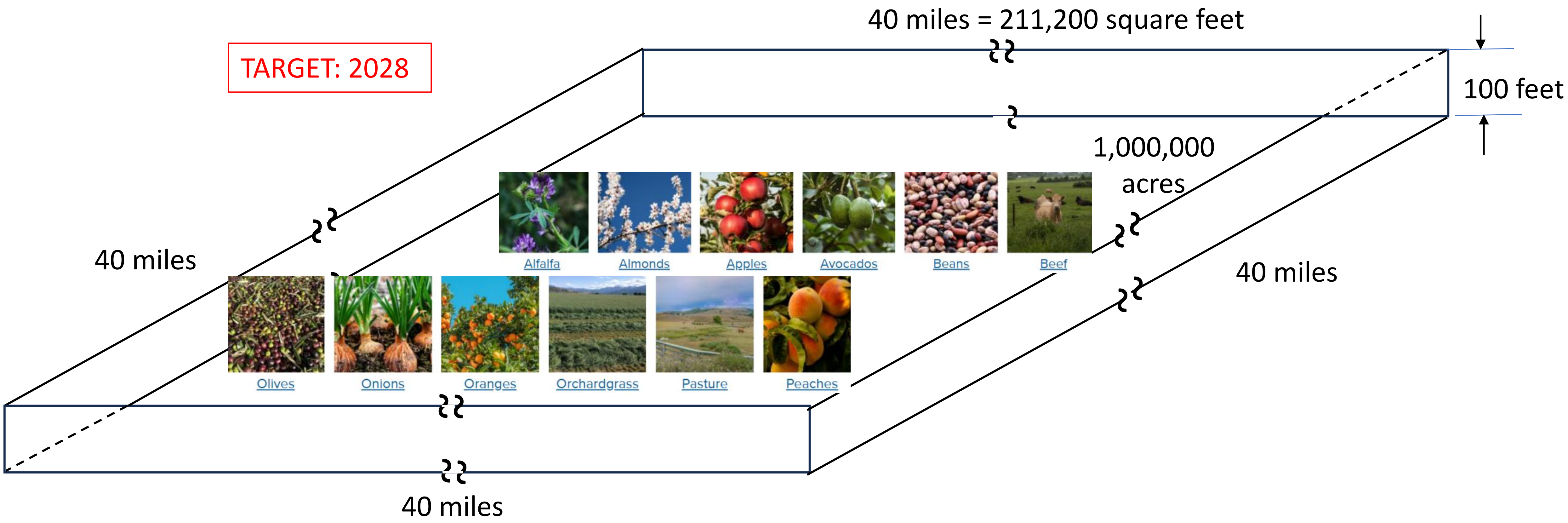
a Form of eDAC

https://ess.science.energy.gov/wp-content/uploads/2020/12/facereport2020.pdf

Quote from “Lessons and Legacy of US DOE’s CO2 Research Program of FACE, a Form of eDAC stated on page 99:

“What was learned from these experiments? If there is a single scientific conclusion from the many years (40-YEARS see below) of investigation and more than $100 million invested, it might simply be that most of the C3 plants and terrestrial ecosystems studied do respond positively to increased concentration of atmospheric CO2.”

5 to 10 Million Tons/Yr of capture potential with 1,000,000 acres of eDAC (up to 1/6 of CARB 2050 Goal)
Is Equivalent to Doubling the CO_2 in a 100-foot high layer of biosphere
for 1/2 of California's Almond and Pistachio Crop
Potentially adding $3 Billion to California's $25 Billion Farm Operations Economy (over 10% increase)



REFERENCE: https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=CALIFORNIA

UNIVERSITY OF CALIFORNIA AGRICULTURE AND NATURAL RESOURCES
COOPERATIVE EXTENSION
AGRICULTURAL ISSUES CENTER
UC DAVIS DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS

SAMPLE COSTS TO ESTABLISH AN ORCHARD AND PRODUCE
ALMONDS

SAN JOAQUIN VALLEY SOUTH

DOUBLE LINE DRIP IRRIGATION - 2016

Mohammad Yaghmour	UC Cooperative Extension Area Orchard Systems Advisor, Kern County
David R. Haviland	UC Cooperative Extension Farm Advisor, Kern County
Elizabeth J. Fichtner	UC Cooperative Extension Farm Advisor, Tulare County
Blake L. Sanden	UC Cooperative Extension Farm Advisor, Kern County
Mario Viveros	UC Cooperative Extension Farm Advisor Emeritus, Kern County
Daniel A. Sumner	Director, UC Agricultural Issues Center

2016 EXPECTED INCREASED RETURN ABOVE COST Per UC Davis for eDAC

Net Return per Acre above Total Costs for Almond

PRICE ($/lb.)	YIELD (lb./acre)						
Almonds	2,000	2,300	2,600	3,000	3,300	3,600	3,900
1.00	-4,185	-3,902	-3,619	-3,241	-2,957	-2,674	-2,391
1.50	-3,185	-2,752	-2,319	-1,741	-1,307	-874	-441
2.00	-2,185	-1,602	-1,019	-241	343	926	1,509
2.50	-1,185	-452	281	1,259	1,993	2,726	3,459
3.00	-185	698	1,581	2,759	3,643	4,526	5,409
3.50	815	1,848	2,881	4,259	5,293	6,326	7,359
4.00	1,815	2,998	4,181	5,759	6,943	8,126	9,309

https://coststudyfiles.ucdavis.edu/2024/09/30/AlmondsSJVNorth%20Final%20draft4.pdf

BLACK · SWAN

eDAC

2016 EXPECTED INCREASED RETURN ABOVE COST Per UC Davis

CITRUS CROP CARBON ENRICHMENT
BASIS: MIN + 60% YIELD

Dollars/Carton	%	$/100 ACRES/Y
18.80	888%	$362,000
19.80	436%	$400,000
20.80	304%	$422,000

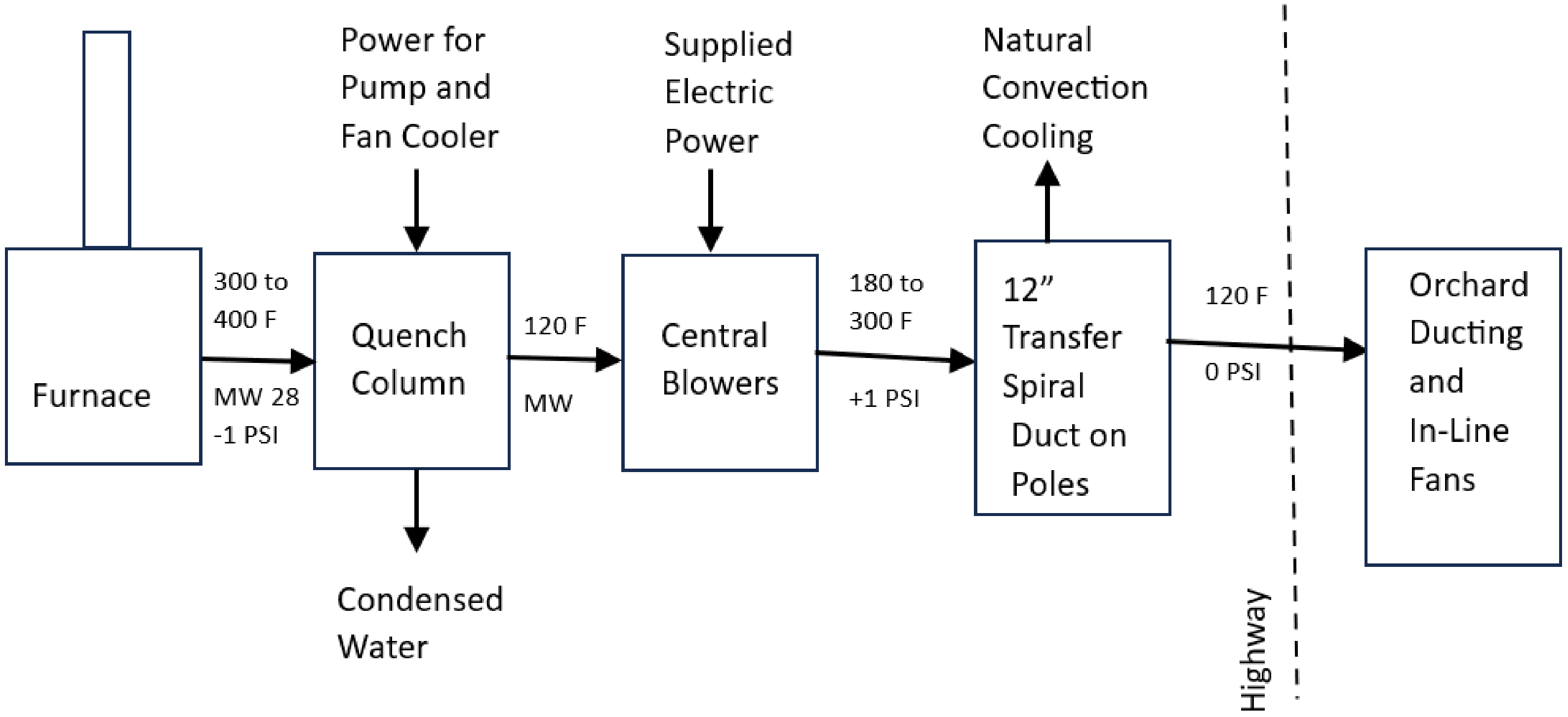
ALMOND CROP CARBON ENRICHMENT
BASIS: MIN + 50% YIELD

Dollars/lb	%	$/100 ACRES/Y
3.00	318%	$335,300
3.50	200%	$445,300
4.00	145%	$510,300

With eDAC…enough capacity to capture global industrial carbon…AND … with a profit … that benefits food security … not like aDAC…a societal budget busting cost… and food security threat…

Black Swan, LLC

CONVENTIONAL DESIGN BLOCK FLOW DIAGRAM FOR eDAC



Black Swan, LLC

eDAC

Schedule to Scale/ Cost of Implementation

PHASE 1: Complete 2024- circa 500 tons/year to 10 trees

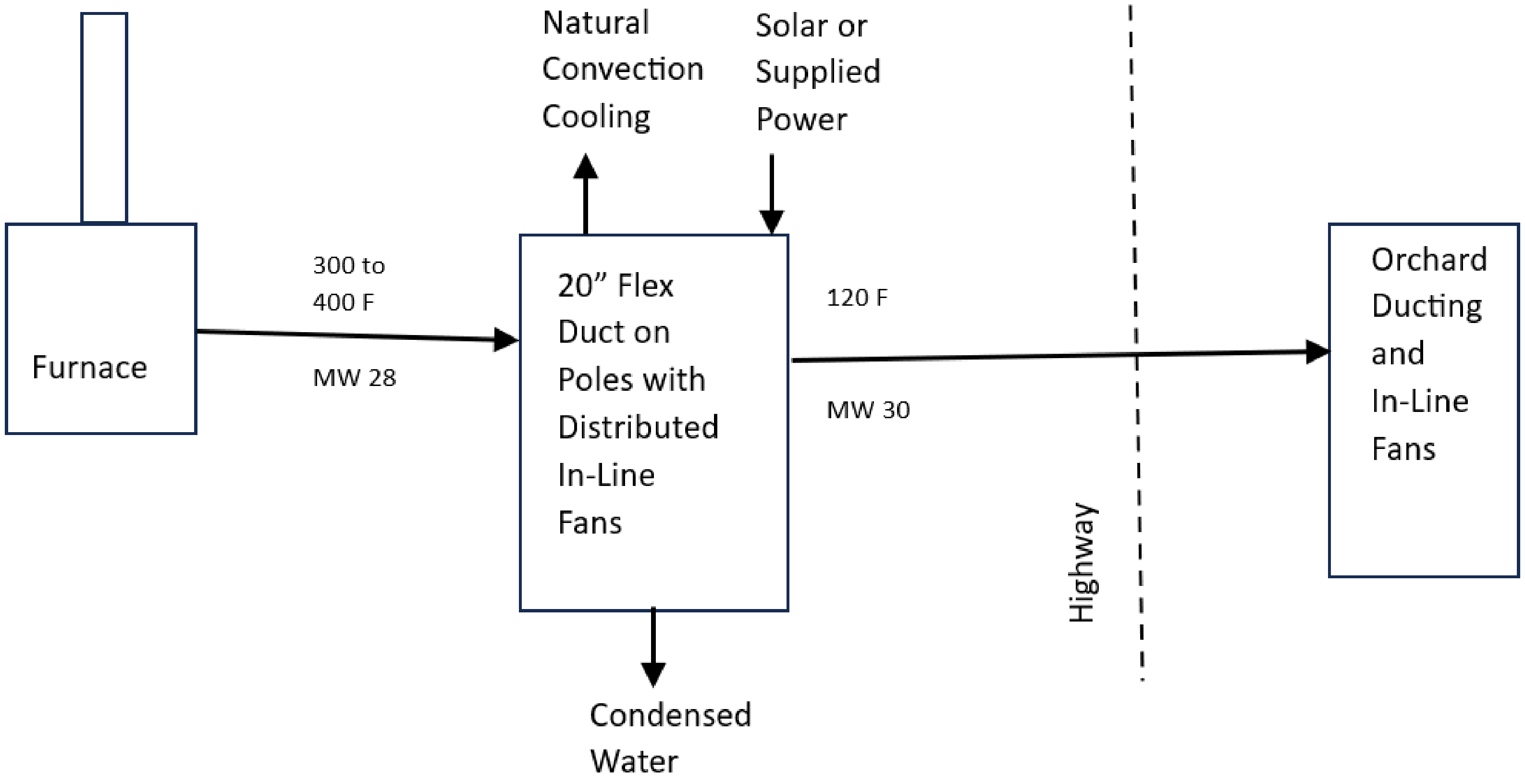
1 or 2 Legs of flex ducting at 20" with distributed fans, quench column in orchard.

Cost: under $1 Million.

“Does a lion roar in the forest when it has no prey?” Amos 3:4

Black Swan, LLC

LOW-COST DESIGN- Low Op Cost/ Low Energy/ Med Cap Cost



eDAC Block Flow Diagram

Black Swan, LLC

500 HP Natural Gas Fired Engine for an Irrigation Well Pump

eDAC SCALE: 2000 tons/year CO_2

Black Swan, LLC

Pathway and Temperature of CO2 Bearing Flue Gas

- 3-400 F
- 200 F
- 60-80 F

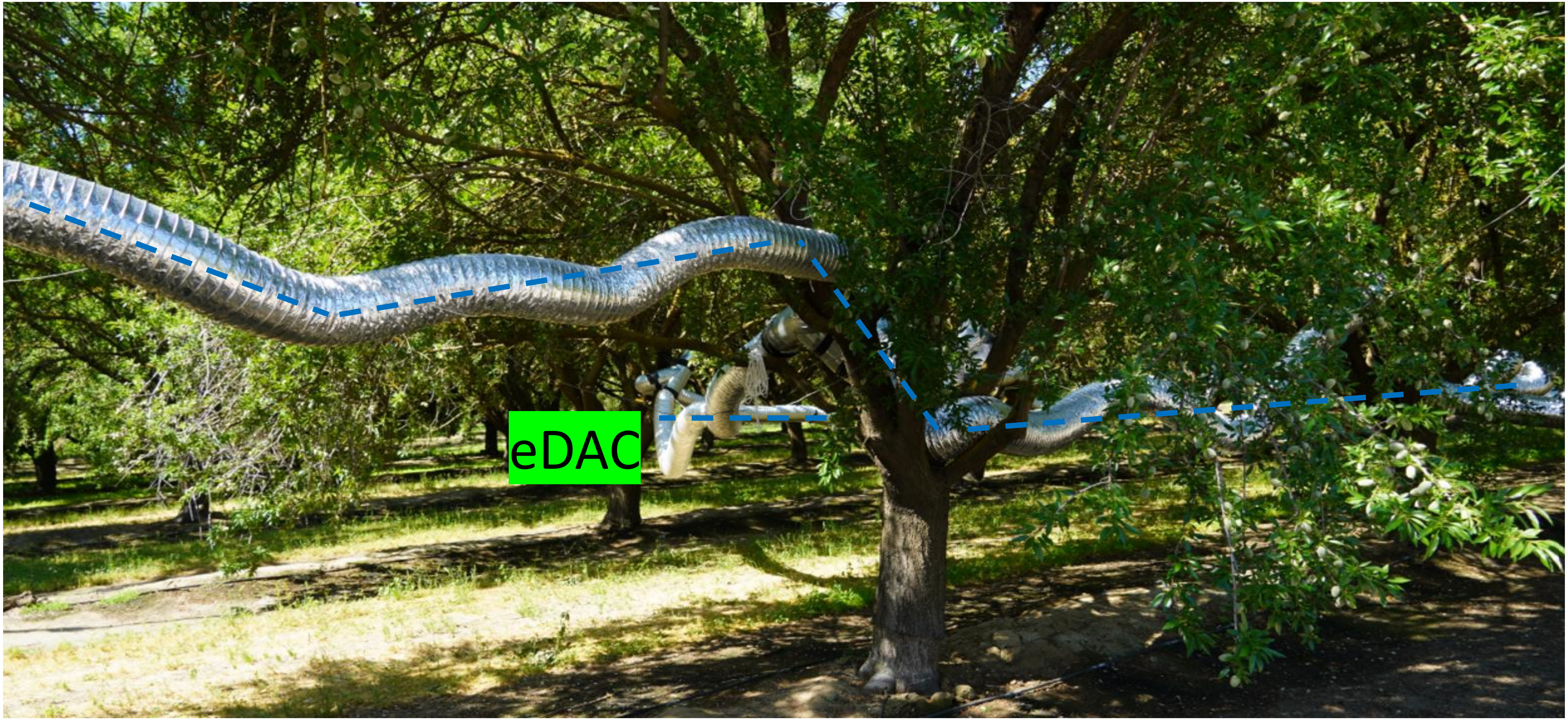
Black Swan, LLC

BWDAC

Pathway and Temperature of CO2 Bearing Flue Gas

60-80 F

Black Swan, LLC



CO2 Distribution Ducting Delivers CO2 for Dispersal of CO2 into Almond Tree Canopy

Black Swan, LLC

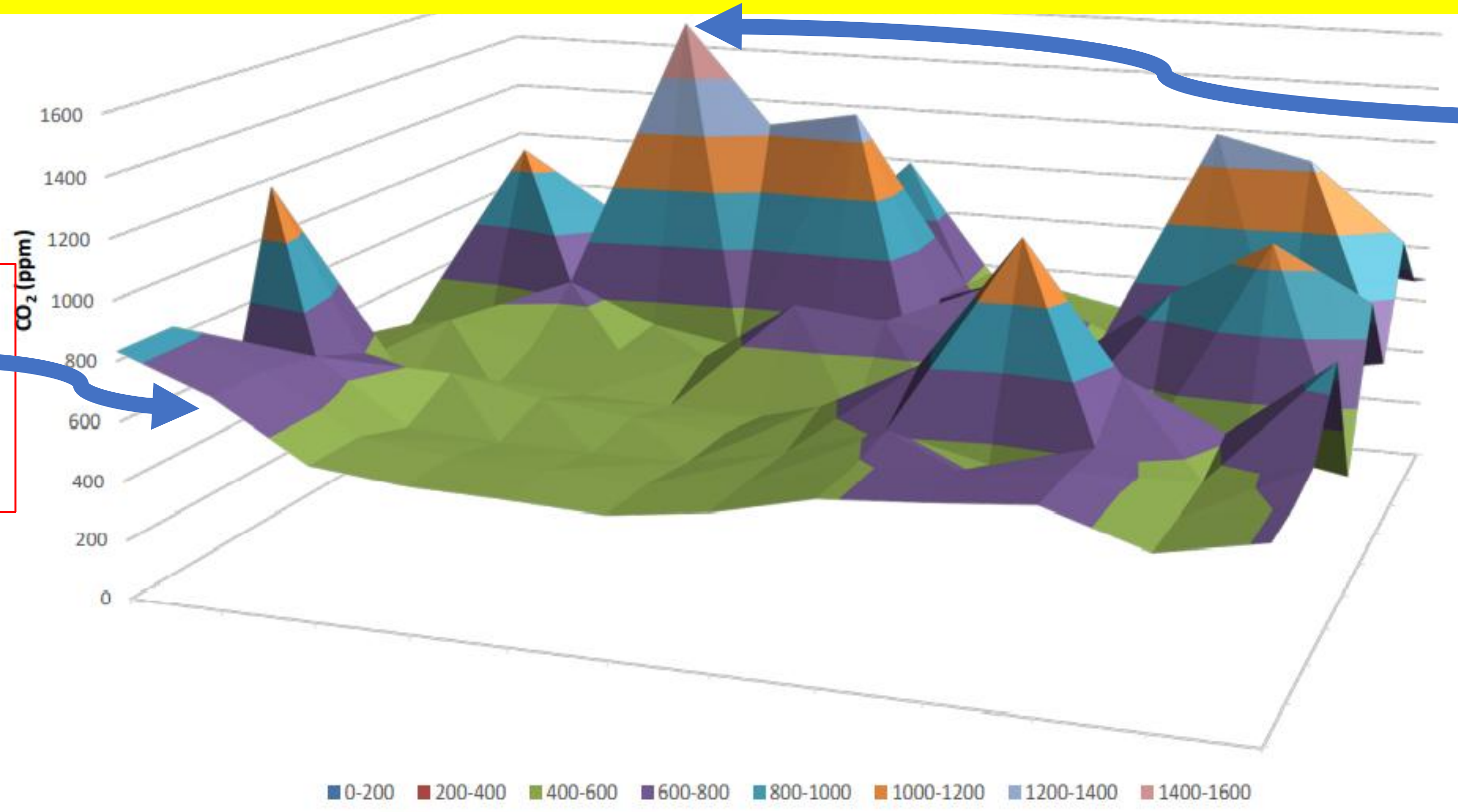
BLACK · SWAN

eDAC Results

TWO TREE ENRICHED CO2 3-D CONCENTRATION PROFILE BELOW 10 FEET PEAKS

1500 PPM PEAK

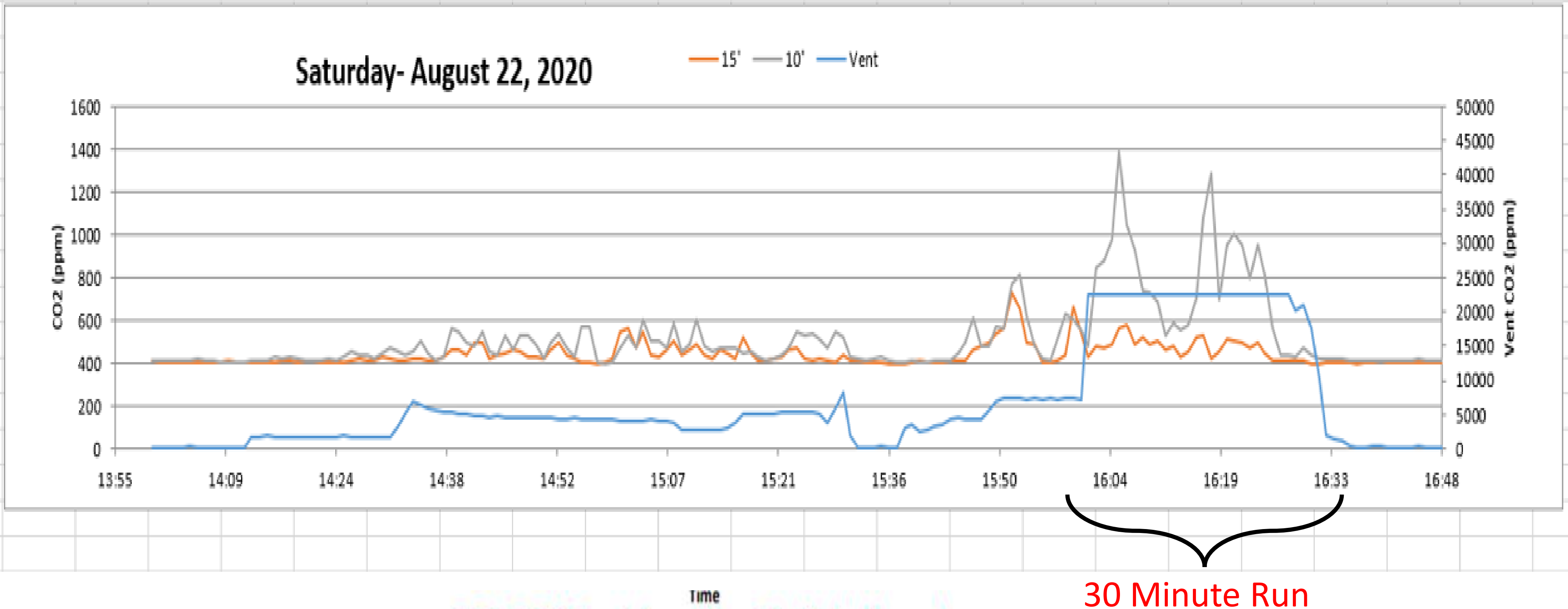
700 PPM AVERAGE



UC CE | University of California
Agriculture and Natural Resources | Cooperative Extension

BLACK · SWAN

"KITTY HAWK MOMENT"



30 Minute Run

eDAC Results

1000 ppm avg at 10'

550 ppm avg at 15'

UC CE | University of California
Agriculture and Natural Resources | Cooperative Extension

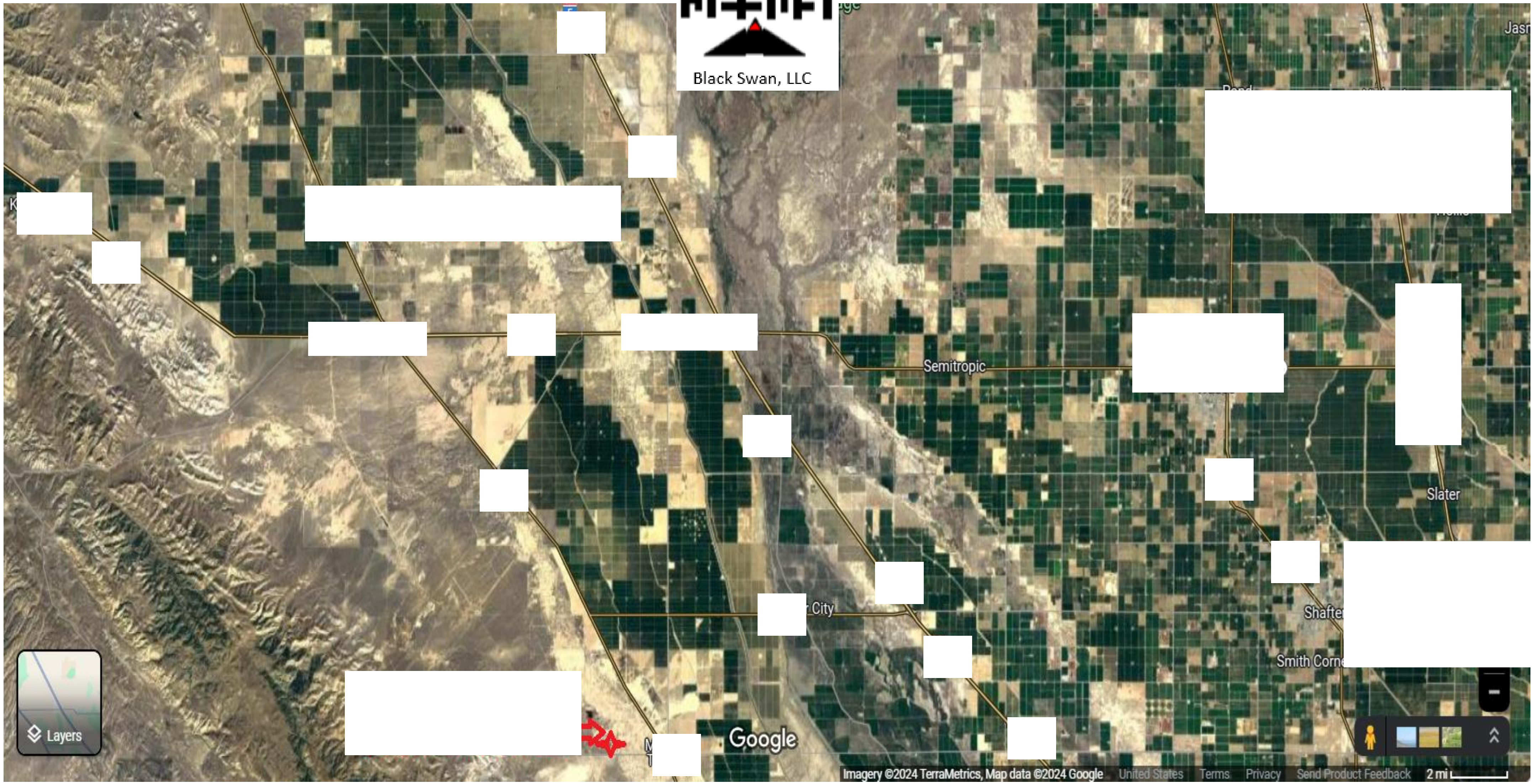
Schedule to Scale/ Cost of Implementation

PHASE 3: 100,000 to 200,000 Tons/Year Sequestration Target 10,000 to 40,000 acres: Complete 2026

Costs Scaled off of above.

Black Swan, LLC

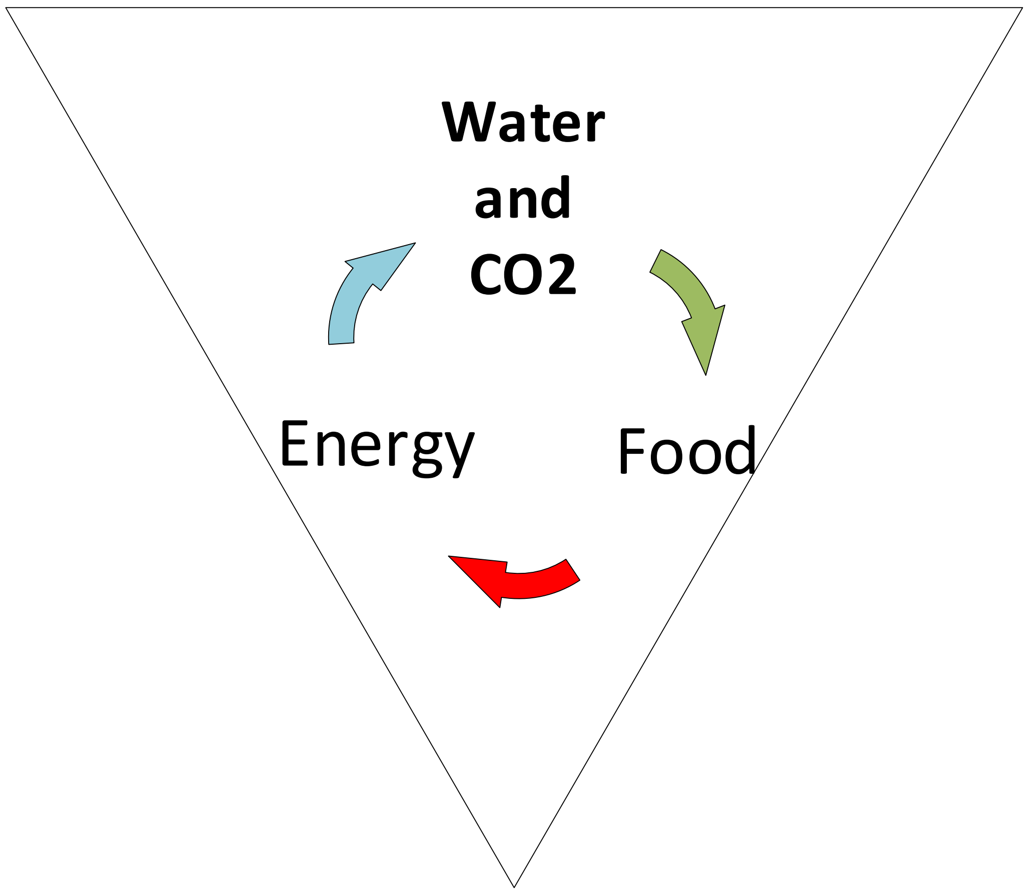
Black Swan, LLC



SUMMARY OF ROUGH ORDER OF MAGNITUDE COST ANALYSIS:

		IN&OUT-OF-ORCHARD OPTION CAP COSTS		IN-ORCHARD ($2000/ACRE)		INCREASED
	TONS/YEAR	DISTRIBUTED OPTION		ACRES	TOTAL	20Y RETURN
	CAPTURED	CAP COST	OPER HP	APPLIED	CAP COST	+50% YIELD
CAP COST/TON/20 YEAR LIFE		$52				
EARLY CASE	2,000	$2.1MM	58HP	200	$0.4MM	$12MM
MID CASE	20,000	$21MM	580HP	2000	$4MM	$120MM
MAX CASE	140,000	$145MM	4,000HP	14,000	$28MM	$840MM

Black Swan Cycle



Black Swan, LLC

11/13/2024

Jesus said to them, again,

"Peace be with you. As the Father has sent Me, so I send you."

And when He had said this,

He breathed on them and said to them,

"Receive the Holy Spirit."

THANK YOU FOR YOUR TIME & PATIENCE!!!!!

Brian Kolodji, PE, President and Owner

Kolodji Corp and Black Swan, LLC

bkolodji@sbcglobal.net, cell: (713) 907-8742

Black Swan, LLC

"-then the Lord God formed the man out of the dust of the ground and blew into his nostrils the breath of life, and the man became a living being." **Genesis** 2:7

Enhanced Nature-Based Direct Air Capture (eDAC) Scaled to 1 million Tons/Year of CO2 by 2027

Making Food by Using Free Air Carbon dioxide Enrichment (FACE)

as opposed to absorbent-based DAC (aDAC) with potential for Negative Impact to Food Security

presented at

American Institute of Chemical Engineers

April 9th, 2025

by

Brian Kolodji, PE, President and Owner

bkolodji@sbcglobal.net, cell: (713) 907-8742

Kolodji Corp / Black Swan, LLC

ENERGY CARBON MANAGEMENT/ INTELECTUAL PROPERTY HOLDING COMPANY