

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**

POWER PLANT MDAC AND FGXB REDUCES FUEL CONSUMPTION AND BIOSEQUESTERS

American Institute of Chemical Engineers 2022 National Meeting

Brian Kolodji, PE, President and Owner

Kolodji Corp and Black Swan, LLC

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

ENERGY CARBON MANAGEMENT

Dr. Bruce Kimball, Retired USDA (Green Leaf Group);

Dr. Brian Marsh, County Director Advisor University of California Cooperative Extension- Kern County

Paramjit Dosanjh, Manager/Owner Dosanjh Brothers Orchards

Dr. Amit Gunasakara, Formerly with California Department of Agriculture, Chief Scientist

Manual Aguayo, Kolodji Corporation, Supervisor Operations

Dr. Marc Straub, Vice President, Formerly with Generon

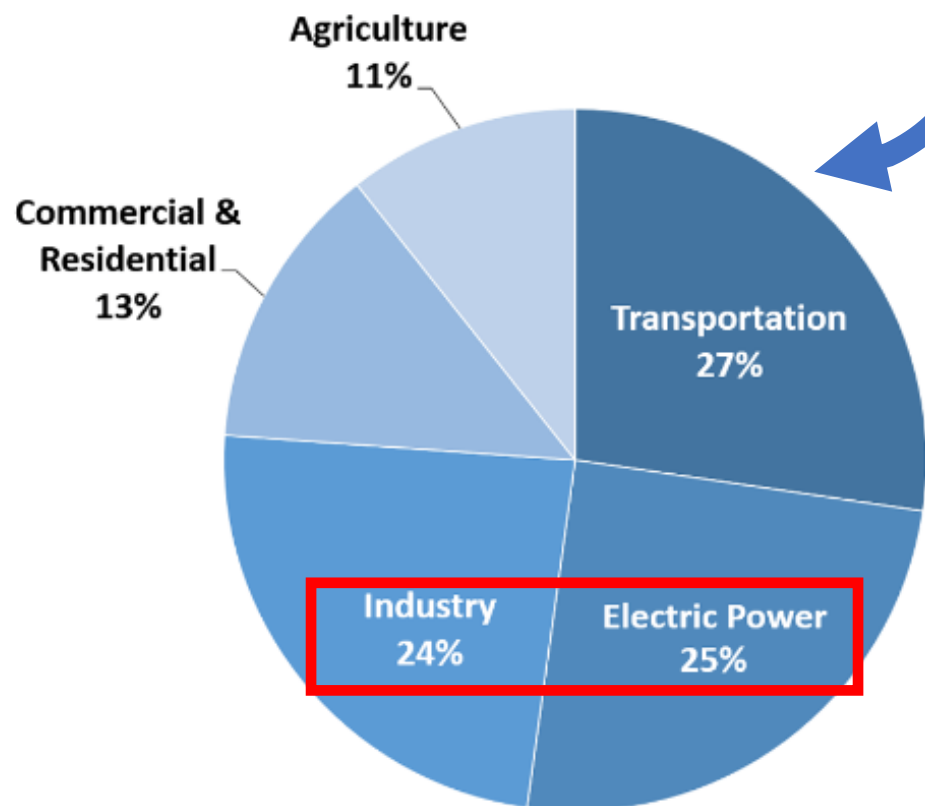
11/14/2022



2020 REFERENCE



Total U.S. Greenhouse Gas Emissions
by Economic Sector in 2020

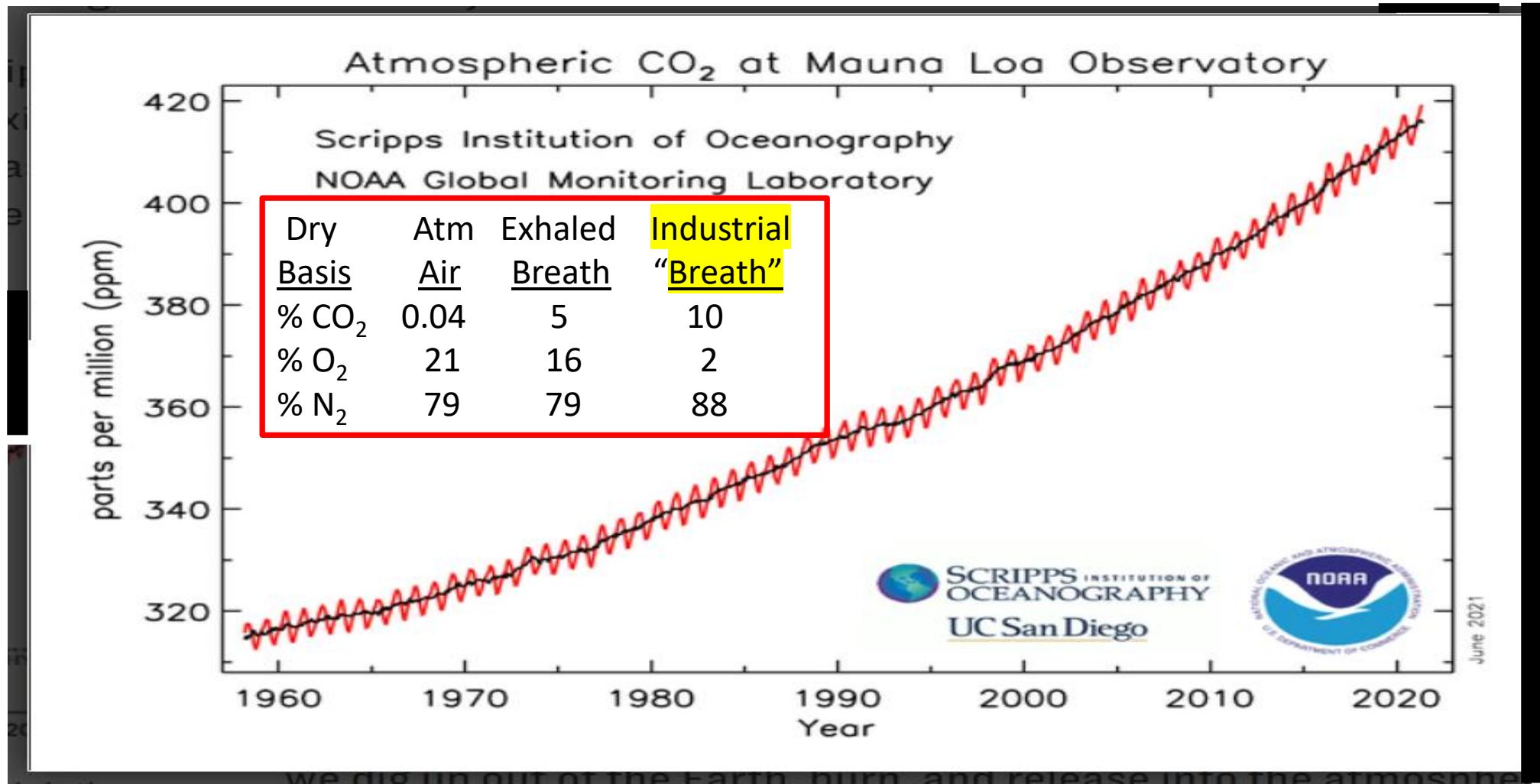


BLACK · SWAN FXGB & MDAC:

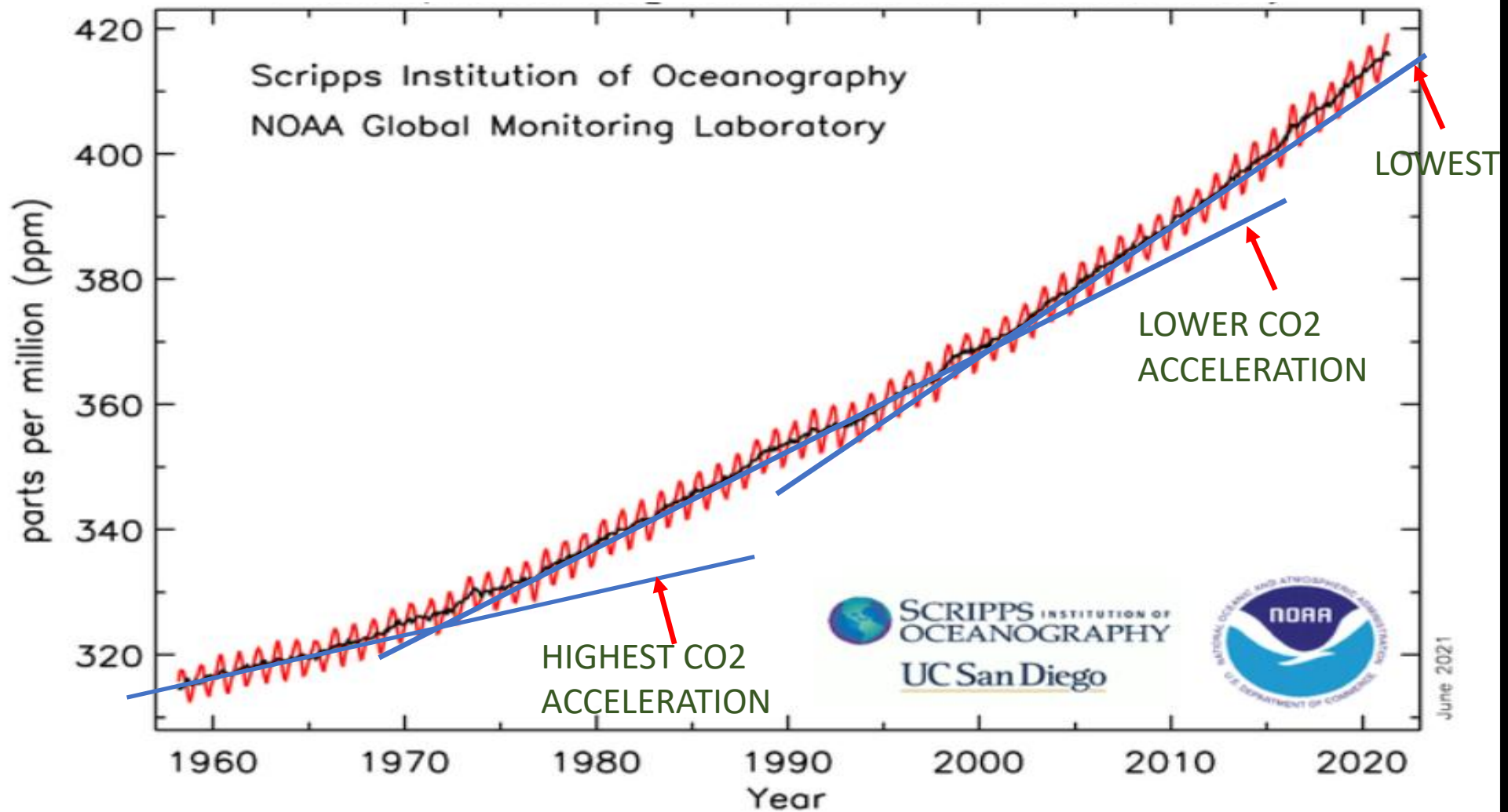
1. Remove All five (5) GT/Y CO₂ produced from All US Sectors
2. Remove another 5 GT/Y from air
3. Achieve Carbon Neutrality and beyond...Carbon Management...

Energy Carbon Management!!!

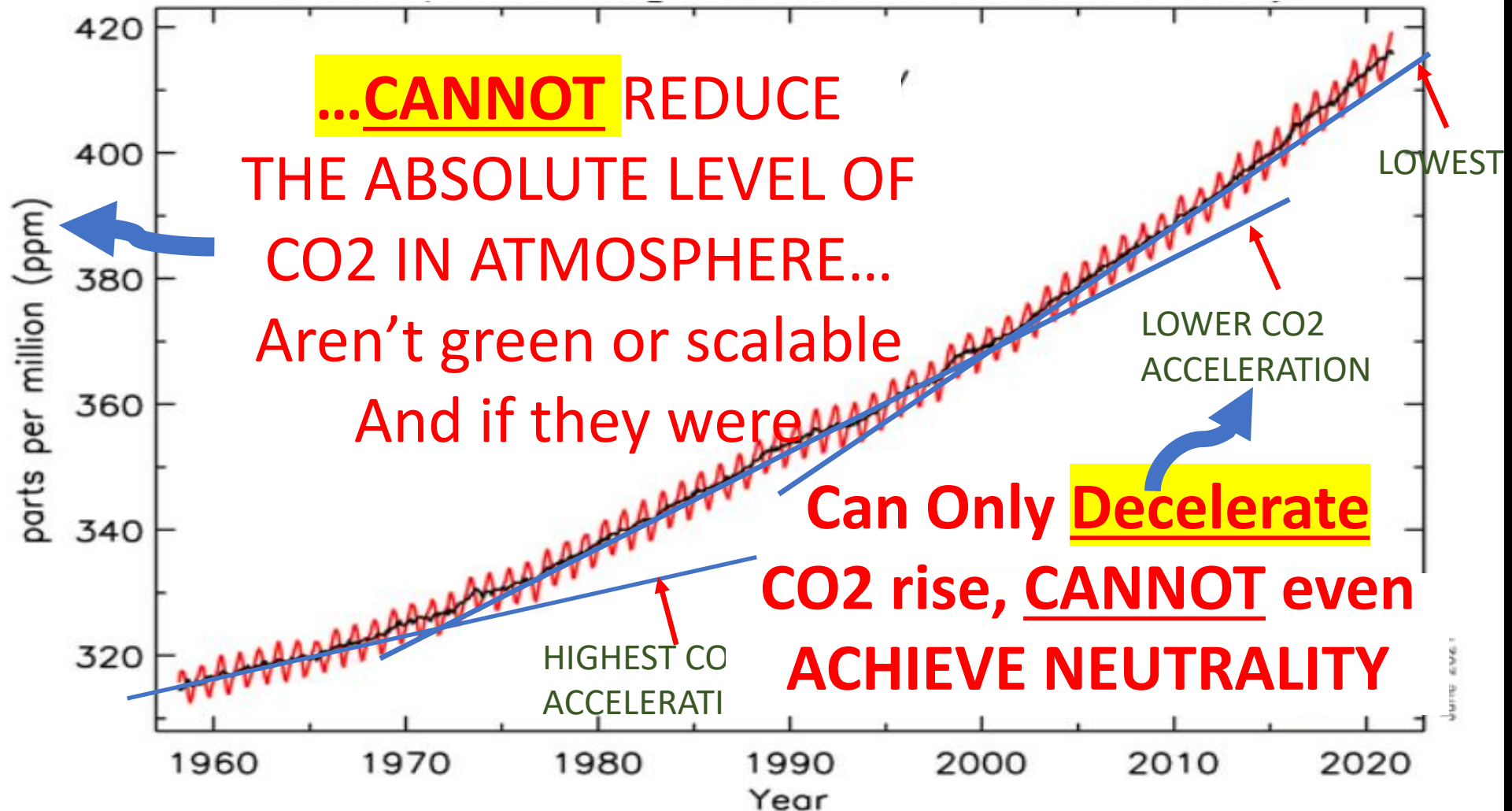
“Keeling” Curve



Cause? Energy Carbon Mis-management

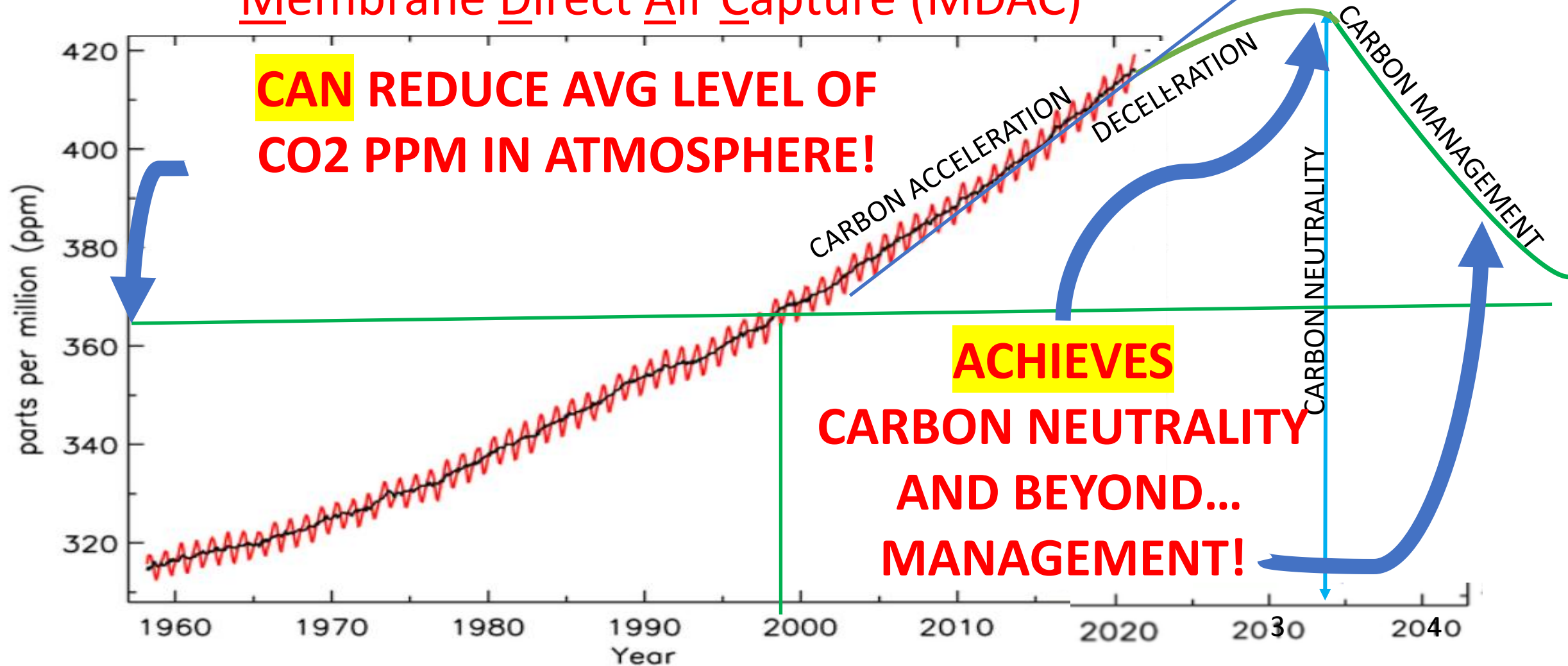


CURRENT CONVENTIONAL CO2 CAPTURE TECHNOLOGY

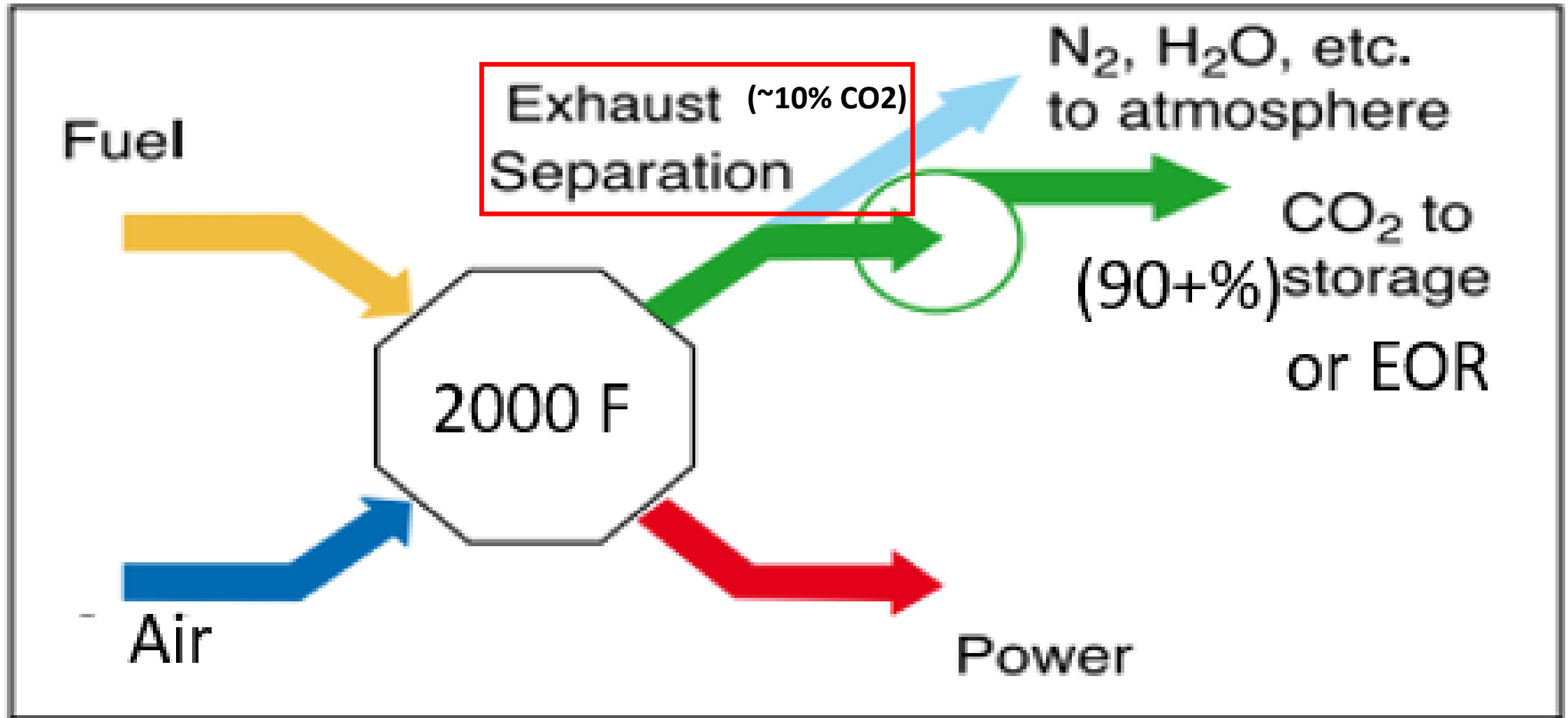


We dig up out of the Earth, burn, and release into the atmosphere

Flue Gas eXtraction and Bio-sequestration (FGXB) & Membrane Direct Air Capture (MDAC)



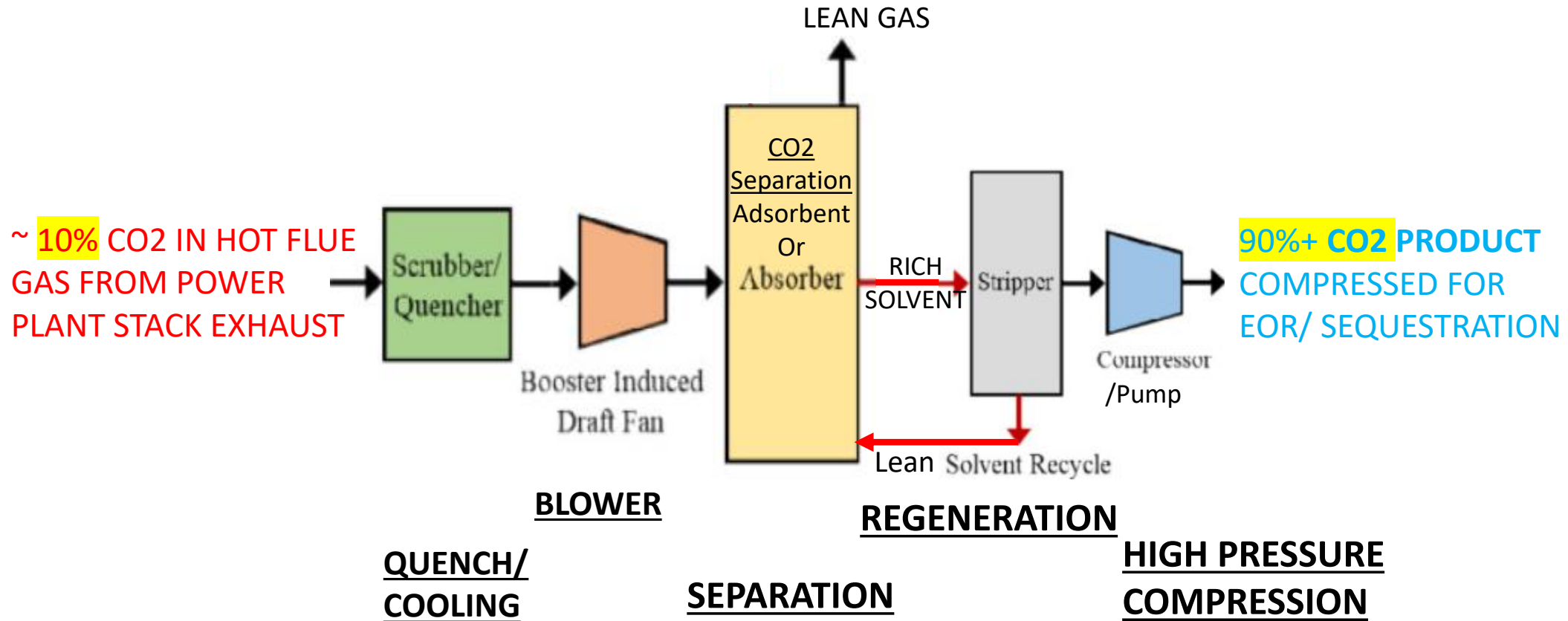
CONVENTIONAL POST-COMBUSTION CO₂ CAPTURE



Separates CO₂ from Exhaust Stream

CONVENTIONAL POST-COMBUSTION CO2 CAPTURE UNIT

KEY COMPONENTS, SEQUENCE, STREAMS



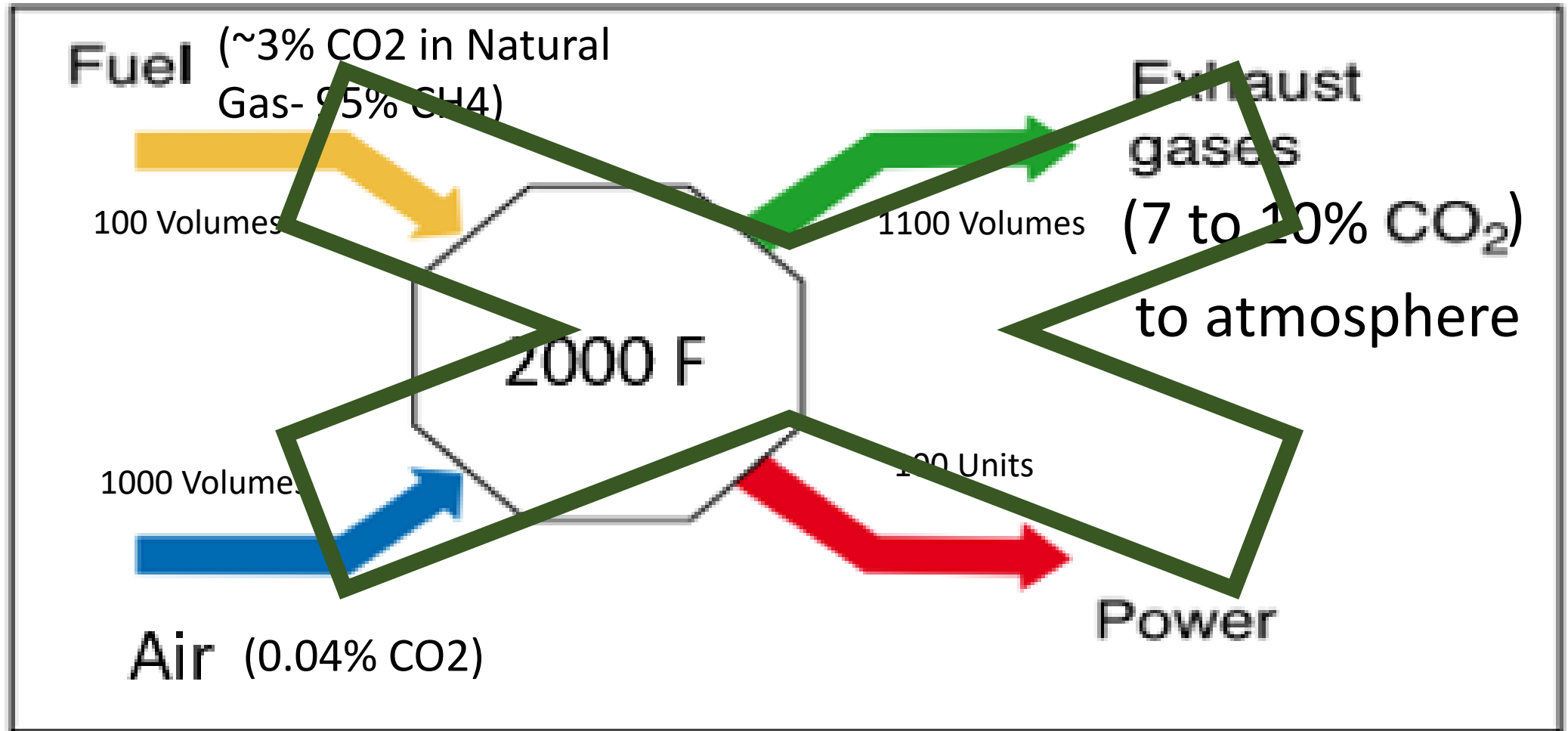
HIGH CAPITAL/ ENERGY/ RESOURCE CONSUMPTION COMPONENTS

PETRA NOVA- CONVENTIONAL POST-COMBUSTION CAPTURE



- LARGEST: 1.6 Million Ton/Year (MMT/Y)
- 99% CO₂ Product from 10% in Fluegas
 - for Enhanced Oil Recovery (EOR)
 - (Carbon Positive, Not Green)
 - Makes more carbon than removed!
- Not Economic at \$1B (\$600+/Ton)
- Cost: \$4 Trillion for US 6GT/Y Removal

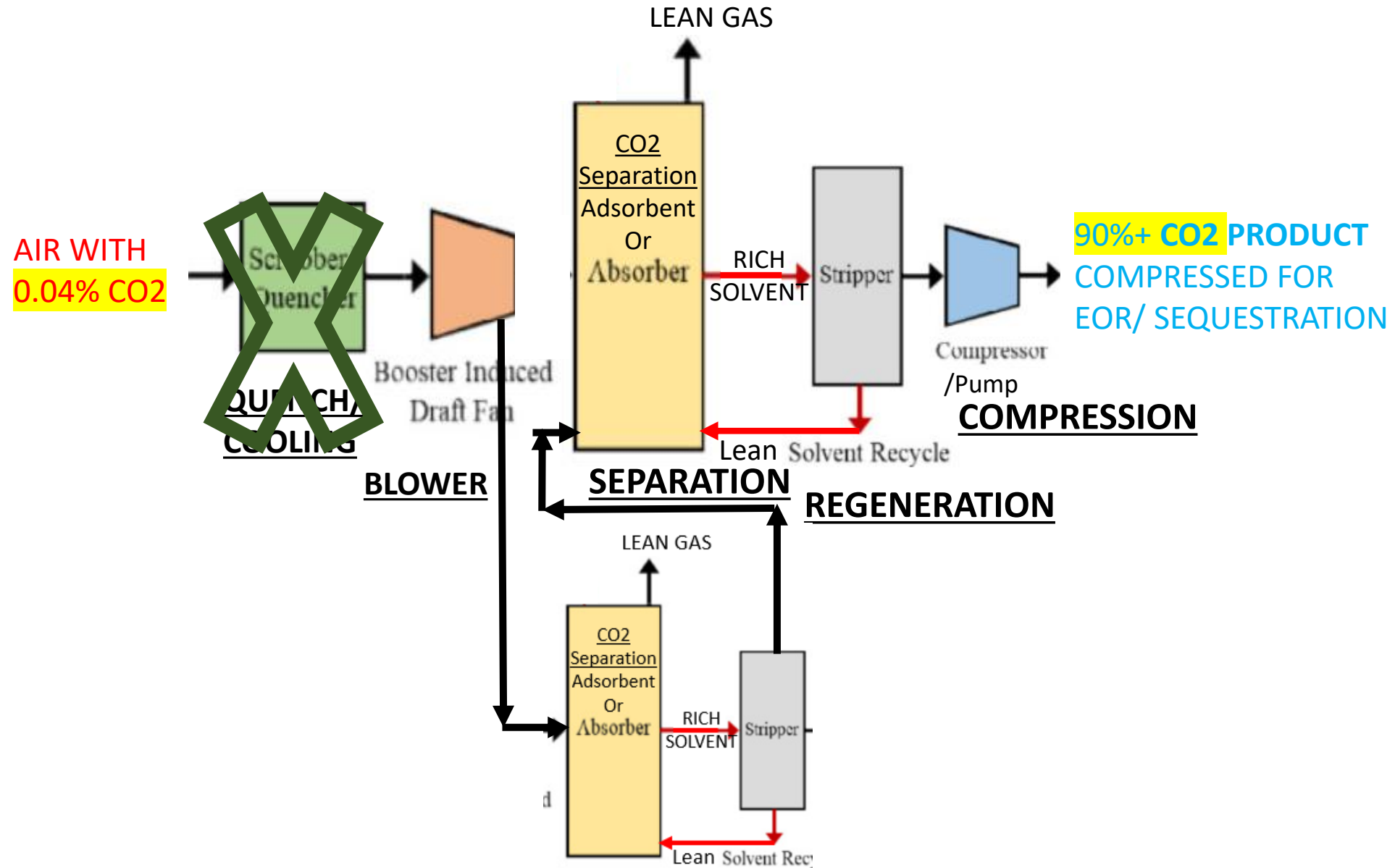
CONVENTIONAL DIRECT AIR CAPTURE (DAC)



NOT RELIANT UPON POWER GENERATION

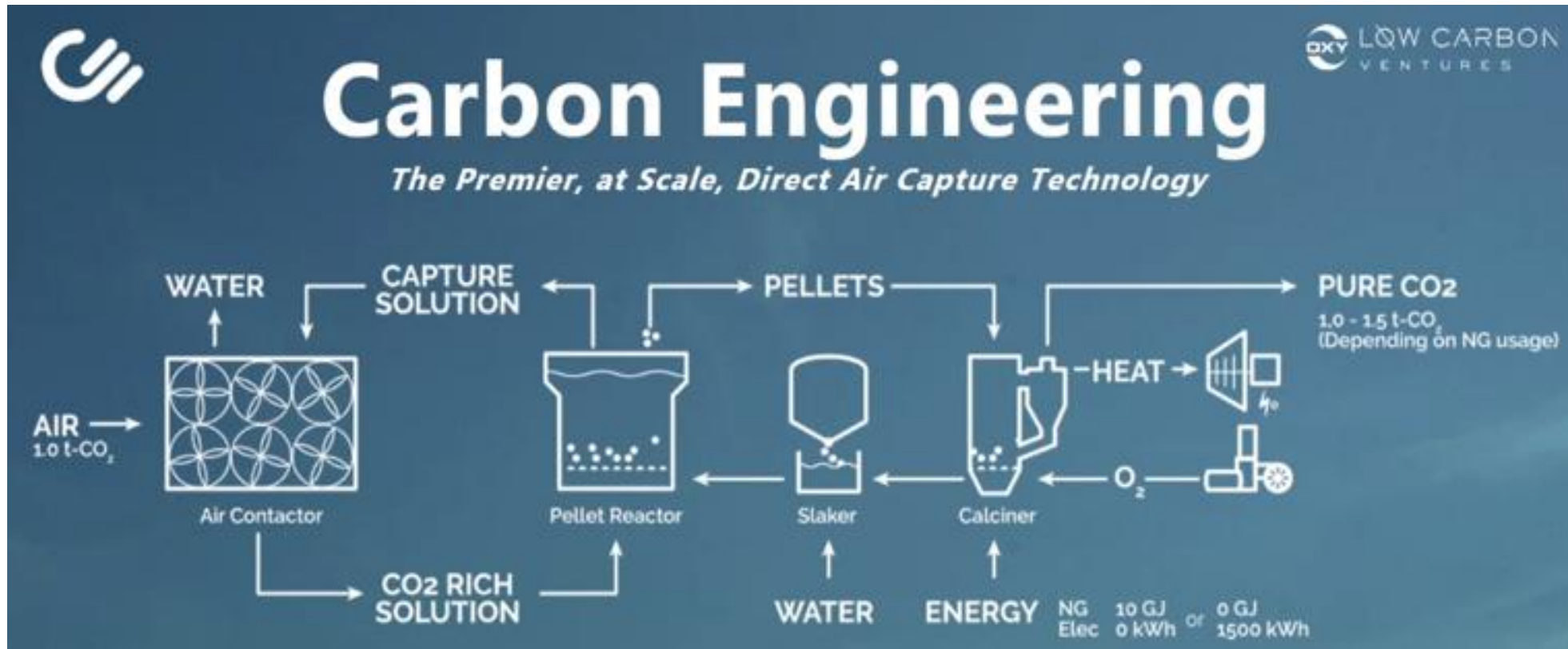
CONVENTIONAL DAC or Direct Air Capture Unit

KEY COMPONENTS, SEQUENCE, STREAMS- Same but double the number as Post-Comb



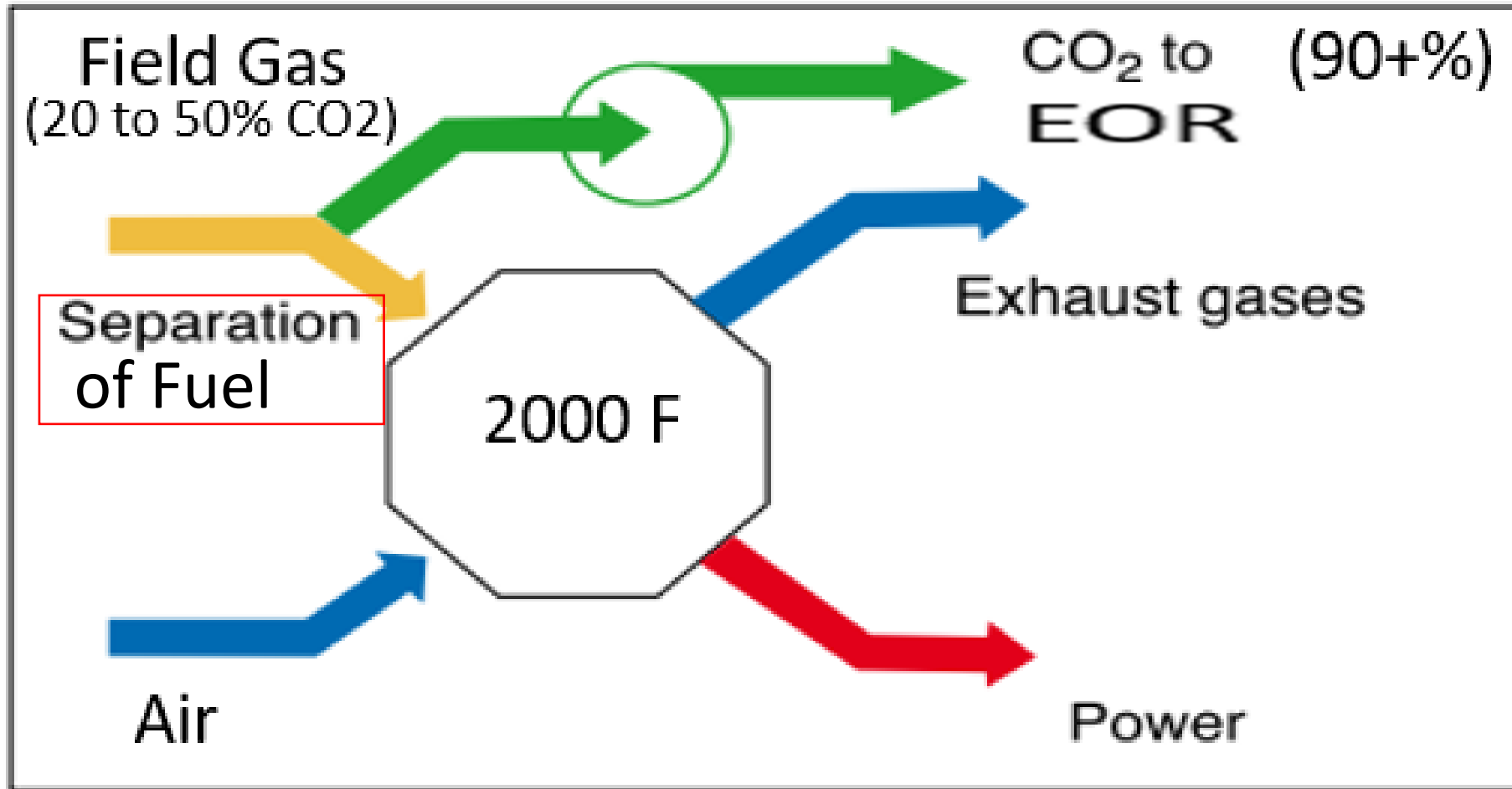
CONVENTIONAL DIRECT AIR CAPTURE (DAC)/ EOR

OXY LOW CLIMATE VENTURES/ CARBON ENGINEERING
\$1000+/Ton, Looks expensive/complicated? It is!



Highest Driving Force Required- Dual sep/regen cycles & EOR

CONVENTIONAL PRE-COMBUSTION CO₂ CAPTURE

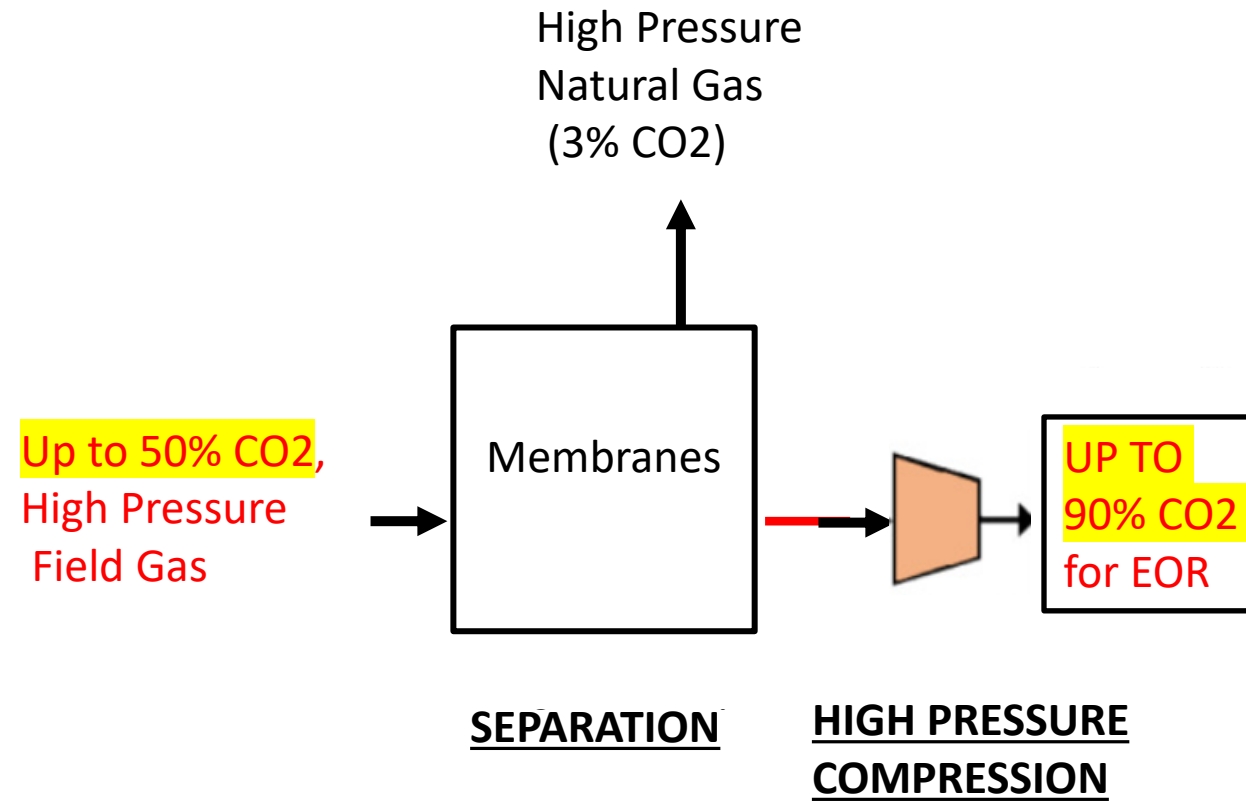


Separates CO₂ from Fuel Stream



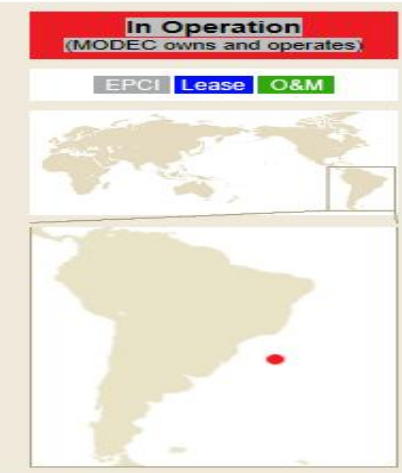
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CONVENTIONAL PRE-COMBUSTION CAPTURE



PRE-COMBUSTION Carbon Capture/ EOR with Membranes

FPSO Cidade de Angra dos Reis MV22



3.2 Million Tons CO₂/ Year **LARGEST EVER** Captured

The FPSO Cidade de Angra dos Reis MV22 is moored in 2,149m of water in the Lula (formerly Tupi) field, Santos Basin.

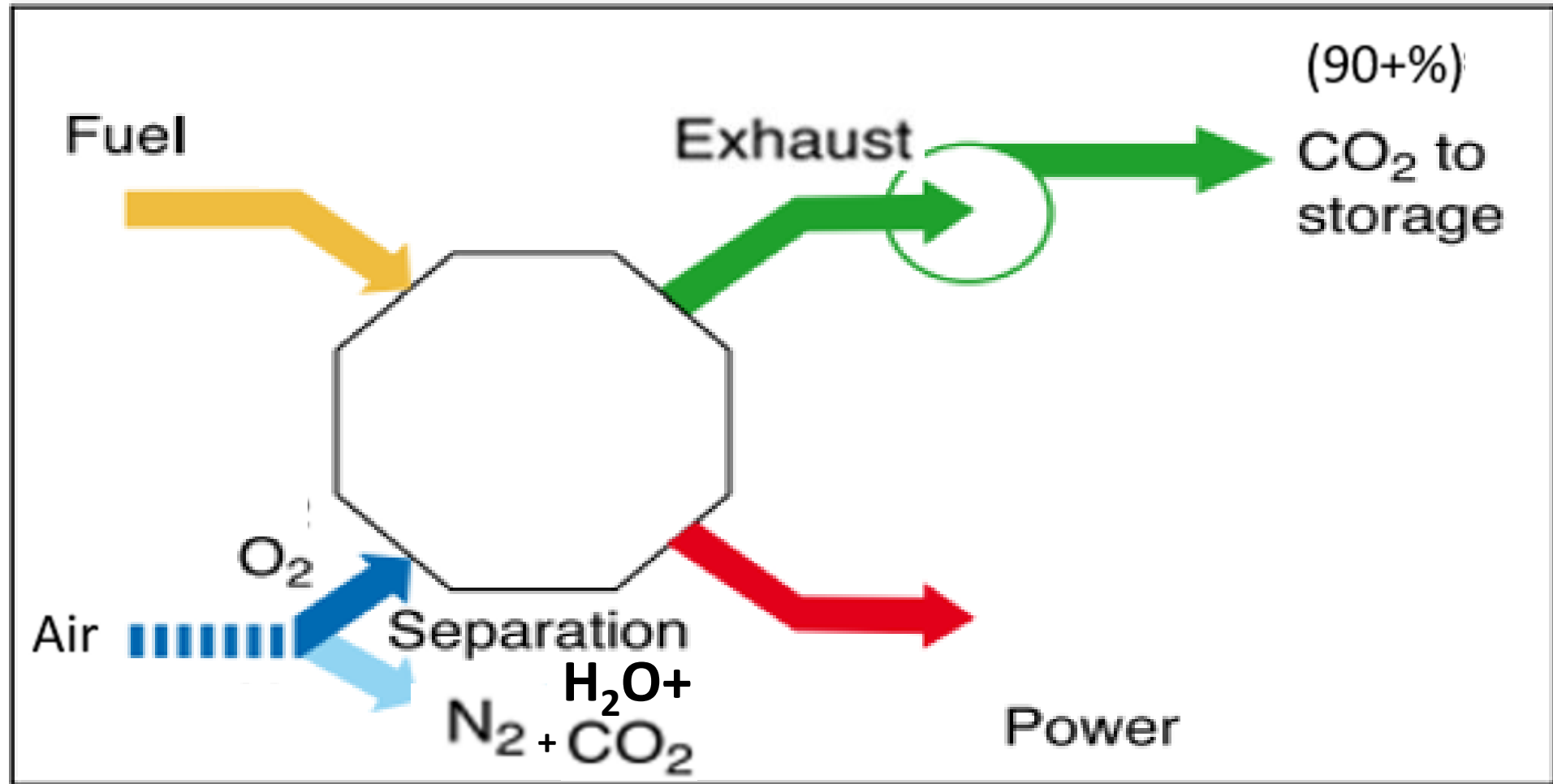
MODEC converted the VLCC "M/V Sunrise IV" into the FPSO. The FPSO is capable of processing up to 100,000 barrels of oil per day and 5 million m³ of gas. The facility is designed for H₂S and CO₂ removal and is capable of reinjecting CO₂ downhole at 550 bar in addition to exporting sales gas to shore. The FPSO will initially gather production from five subsea wells and has the ability to accommodate four additional production wells in the future.

The contract is for a 15 year lease with 5 one-year options. The FPSO is designed to remain on the field for up to 20 years.

Unit Name : FPSO Cidade de Angra dos Reis MV22			
Field Location	: Lula (formerly Tupi) Field	Storage Capacity	: 1,600,000 bbls
Country	: Brazil	Oil Production	: 100,000 bopd
Water Depth	: 2,149 m	Gas Production	: 150 mmscfd
Mooring Type	: SOFEC Spread Mooring	Water Injection	: 100,000 bwpd
		New/Conv	: Conversion
Client : Petróleo Brasileiro S.A. (Petrobras)			

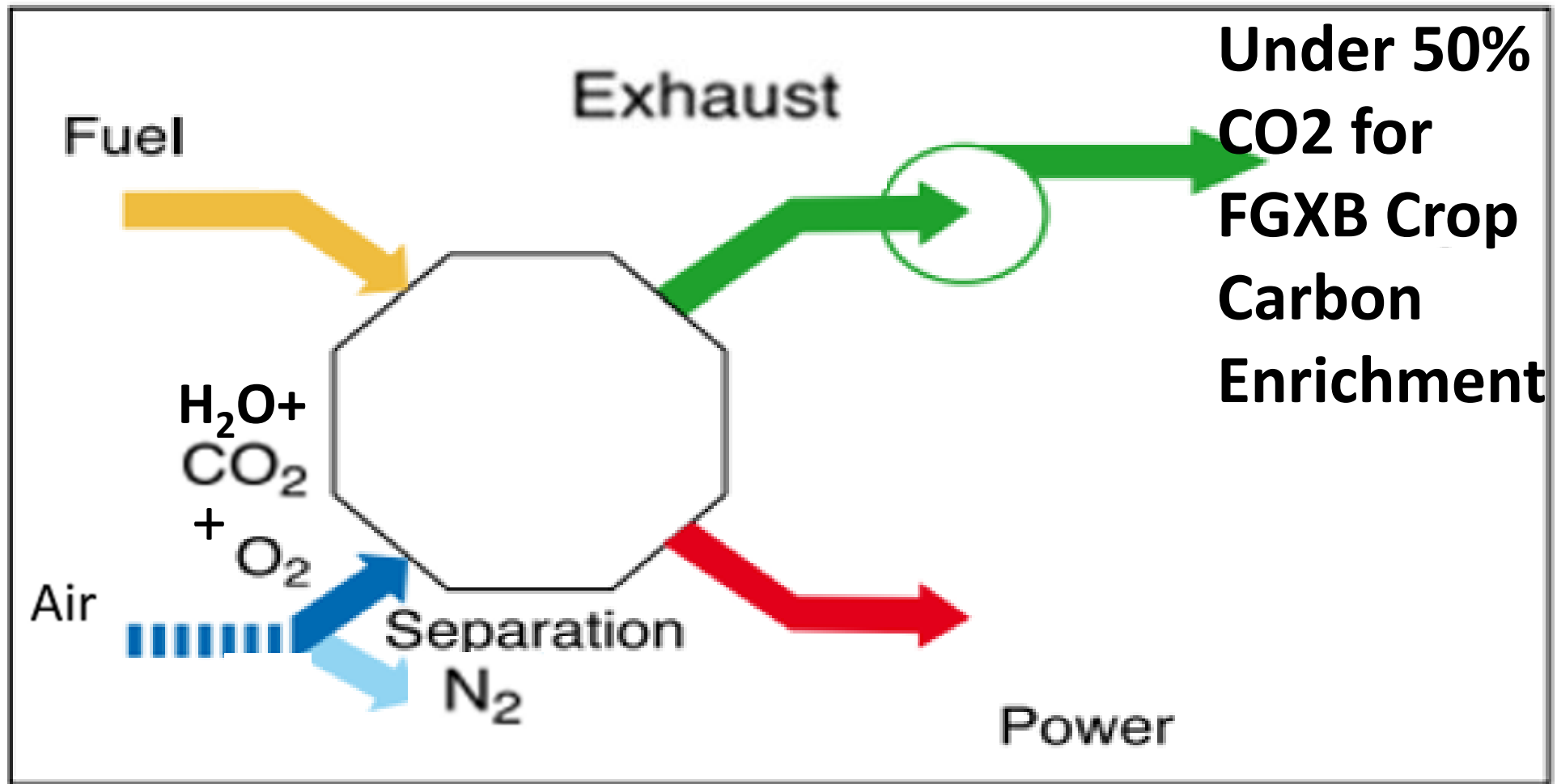
CO₂ for EOR Produces 100,000 BOPD & 150MMSCFD Oil and Gas

SEPARATING NITROGEN FROM AIR TO CONCENTRATE CO₂ IN EXHAUST



CONVENTIONAL OXY-FUEL COMBUSTION

BLACK · SWAN MDAC/ FGXB



**SAVES CAPITAL/TAKES ADVANTAGE OF DIMINISHING RETURNS ON
FUEL SAVINGS AND DIRECT AIR CAPTURES CO₂ WITH O₂**



Energy Tips – Process Heating

Process Heating Tip Sheet #3 • September 2005

Industrial Technologies Program

Oxygen-Enriched Combustion

Figure 2. Energy savings from oxygen injection

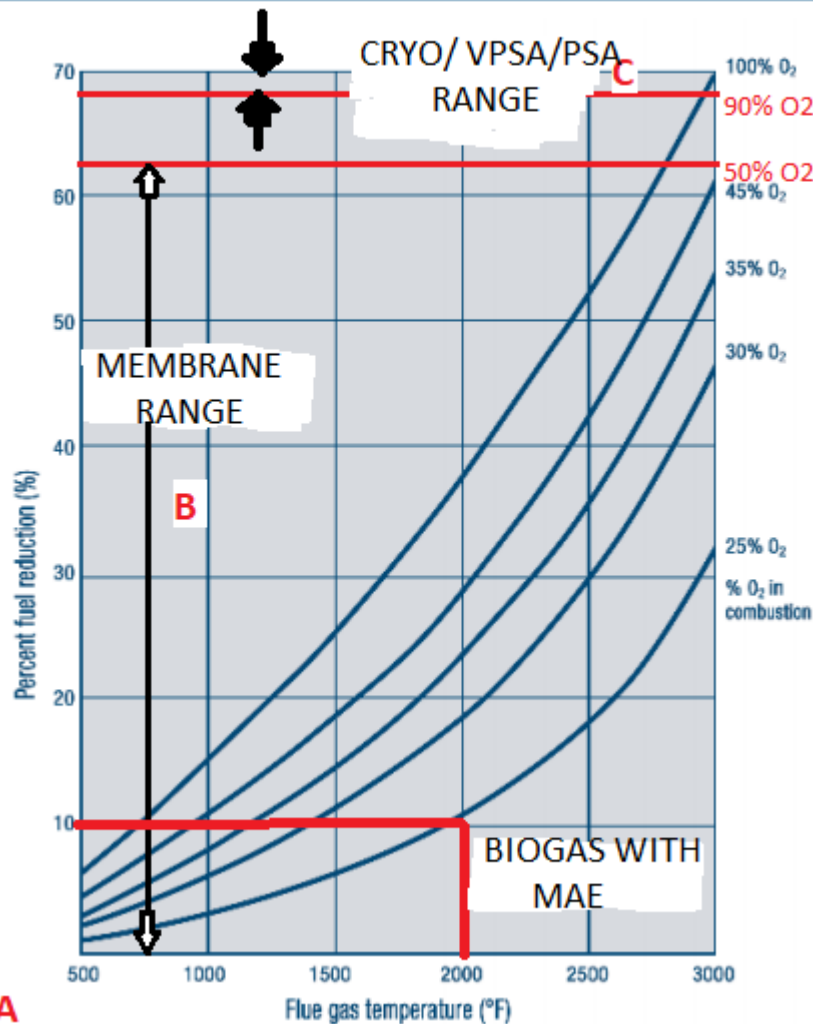


Figure 2 Reference:

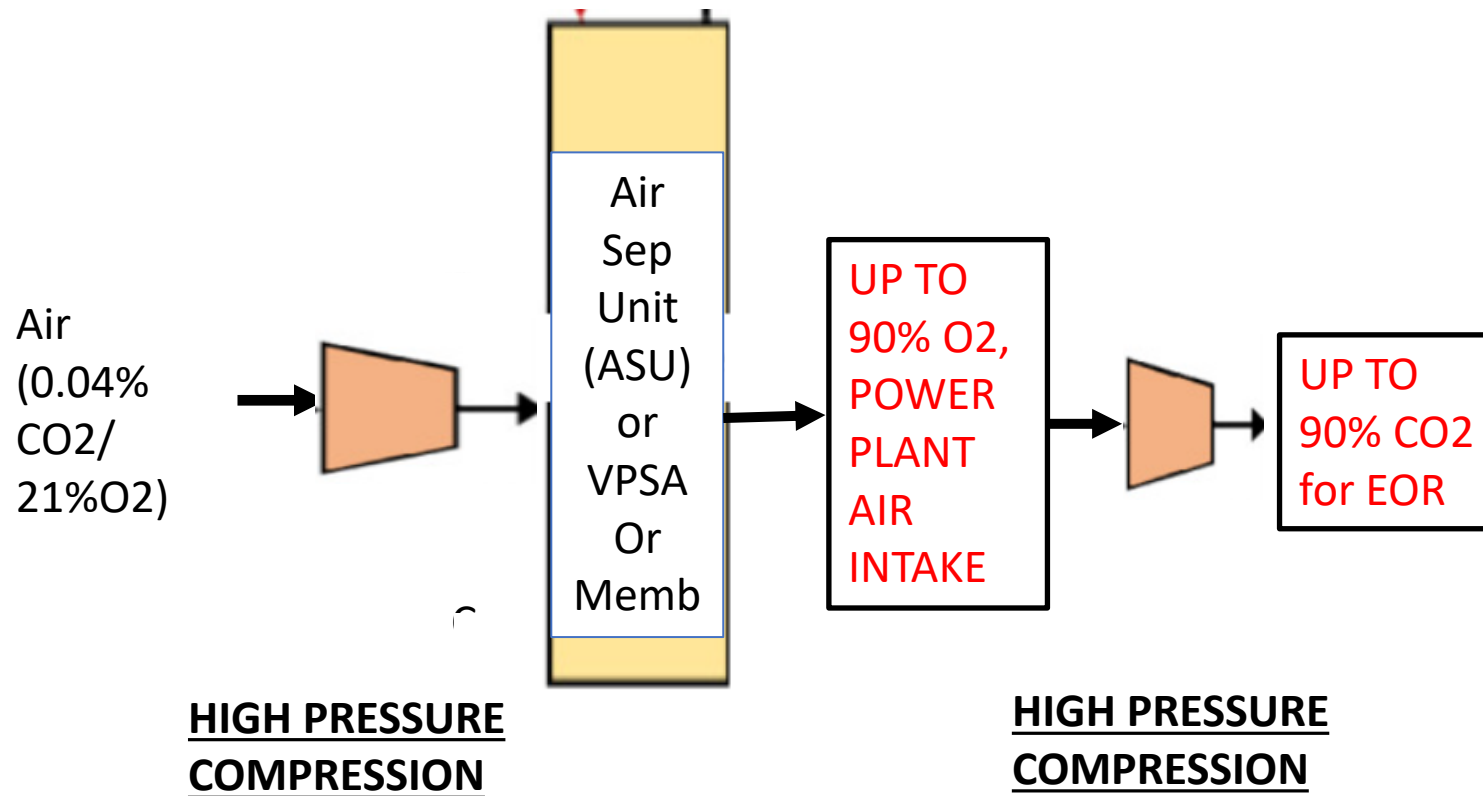
DOE/GO-102005-2178
September 2005
Process Heating Tip Sheet #3

<u>O2 Source</u>	<u>%O2 Purity Dry Concen</u>	<u>%O2 Net Increase</u>	<u>% Fuel Savings</u>
A Air	20.9	0 BASELINE	0
B MDAC	21-50	~1-30	30-60
C ASU Cryo/ VPSA/ PSA (Cryo/V/PSA)	90-99+%	70-80	70 Max



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CONVENTIONAL OXY-COMBUSTION

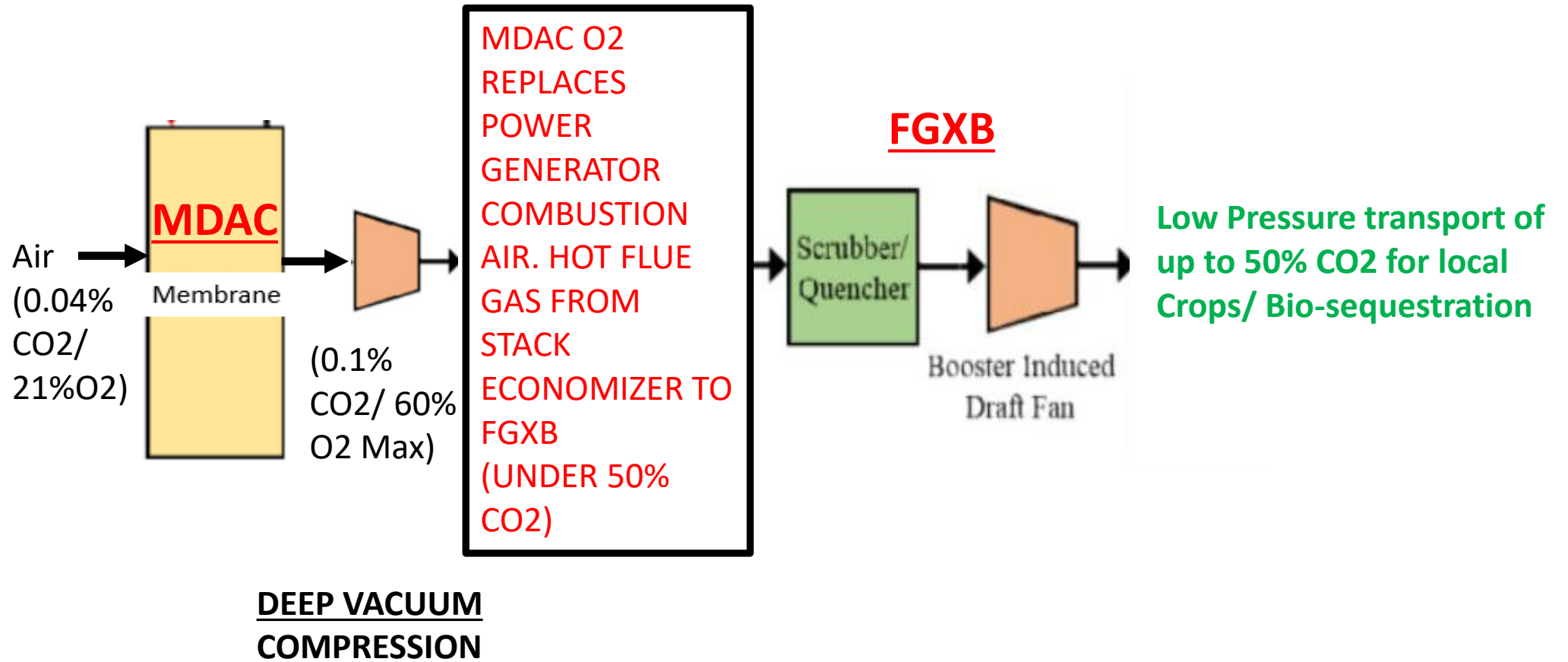




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MDAC/FGXB

PRE/POST/ DAC/ OXY-COMBUSTION CO₂ CAPTURE





Only “Green” Capture : **BLACK · SWAN** **MDAC/FGXB** Advantage Summary

“Cherry picks” from the best, decades proven **SCALABLE** technologies

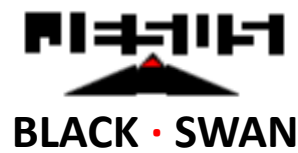
- Both are Direct Air Capture (DAC), Pre- and Post-Combustion
- Both based on large scale commercial practice for over 50 years
- Bio-sequestration (per USDA/USDOE/UCBerkeley) to 30 GT/Y Capture

Least capital/energy/resource intensive, hence **only** “green” tech

- No regeneration, high pressure compression/ high temperatures
- Min 30% less power plant fuel consumption/ No recycle for cooling

Least investment/ profitable (**2 y ROI**)/ sustainable renewable energy

- “Plug and play”-No furnace/pipe material mods- simplifies install
- 1/5 cost for conventional oxy-combustion/ a tenth of conv. DAC
- Fuel, water savings, more agriculture/biomass (renewable fuel)



Free Air Carbon dioxide Enrichment **FACE**

FLUE GAS RELEASE POINT

Before FACE

With FACE

1.Release Elevation:	100 + Ft	< 10 Ft (grow zone)
2.Release Temp:	Hot (320F)	Cold (80F)
3.Water Content	High	Very Low
4.Density/Congestion:	Low	High
5.Velocity/ Direction:	High/Upwards	Low/Downwards

Cool, Denser than Air, Slumping Enriched Gas Lingers In Orchard

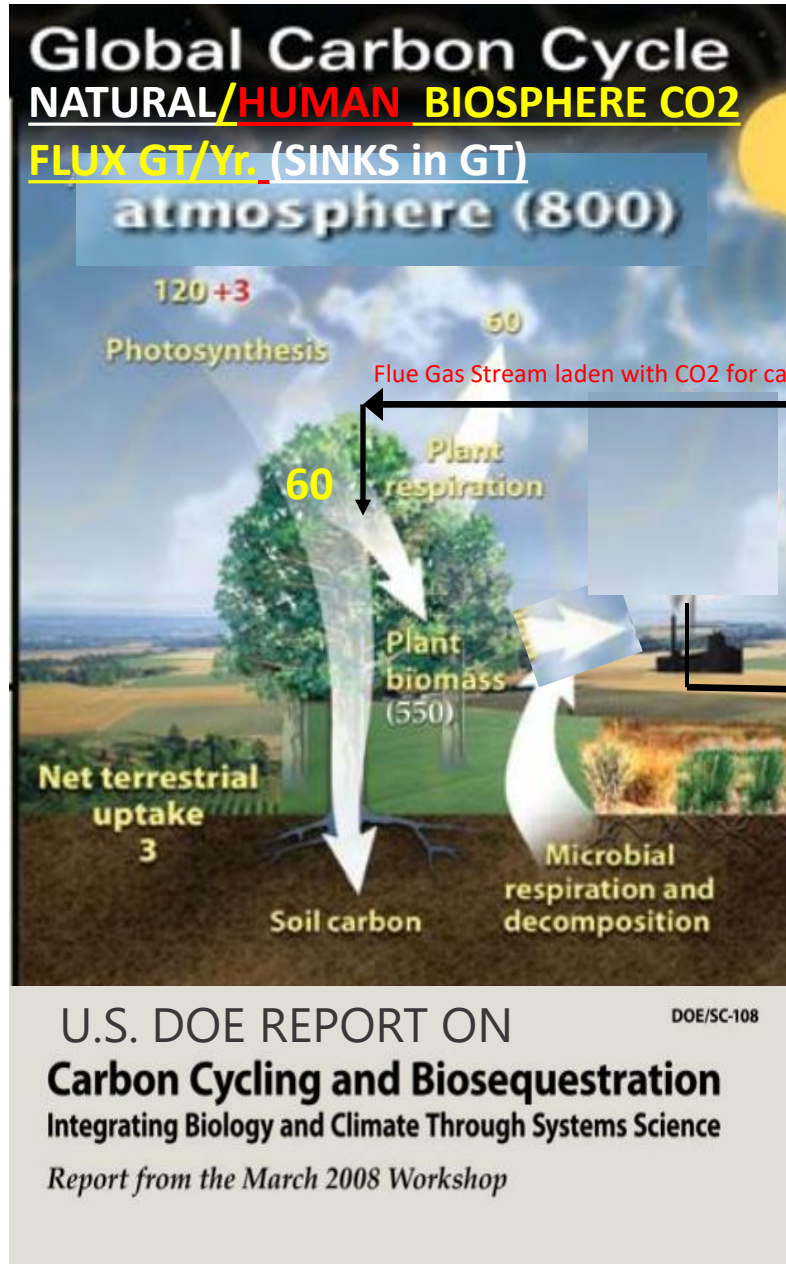


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NOW...

... and with Global Carbon Neutrality Targets for 2035!!!

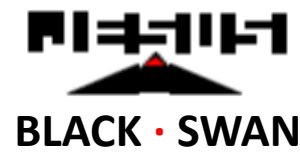
17 MILE TROPO/STRATOSPHERE ATMOSPHERIC SINK



	Before FACE	With FACE
1. Atmospheric CO ₂ Sink	800 GT	Target: 650 GT (-19%)
2. Avg Atmos CO ₂ Conc.	400+PPM	Target: 350 PPM (-12%)

FLOOD Global Boundary (100') Layer Growing Zone

3. Carbon Inventory/ Flux	0.150 GT/Y	+60 GT/Y Available
4. CO ₂ Concentration, PPM	400	Target: 800 (+100%)
5. Plant Biomass CO ₂ Sink	550 GT	700 GT (+19%)
6. Atm to Plant Flux, GT/Y	60	90
7. Biomass Fuel to Power	0.001 GT/Y	30 GT/Y



MORE RECENT GROUND BREAKING RESEARCH!

2020 BERKELEY NATURAL CYCLE/ BIOSEQUESTRATION STUDY

- GLOBAL CO2 CONCENTRATIONS...GREW...17% HIGHER FROM 360 PPM TO 420 PPM...
- 12% HIGHER PHOTOSYNTHESIS...FROM 1982 TO 2020...AN ALMOST 40 YEAR PERIOD...
- **14 GIGATONS/YR** OF ADDITIONAL CARBON (WAS) REMOVED BY PLANTS (BIOSEQUETERED)...
- ...EQUIVALENT OF THE CARBON EMITTED WORLDWIDE FROM BURNING FOSSIL FUELS IN 2020

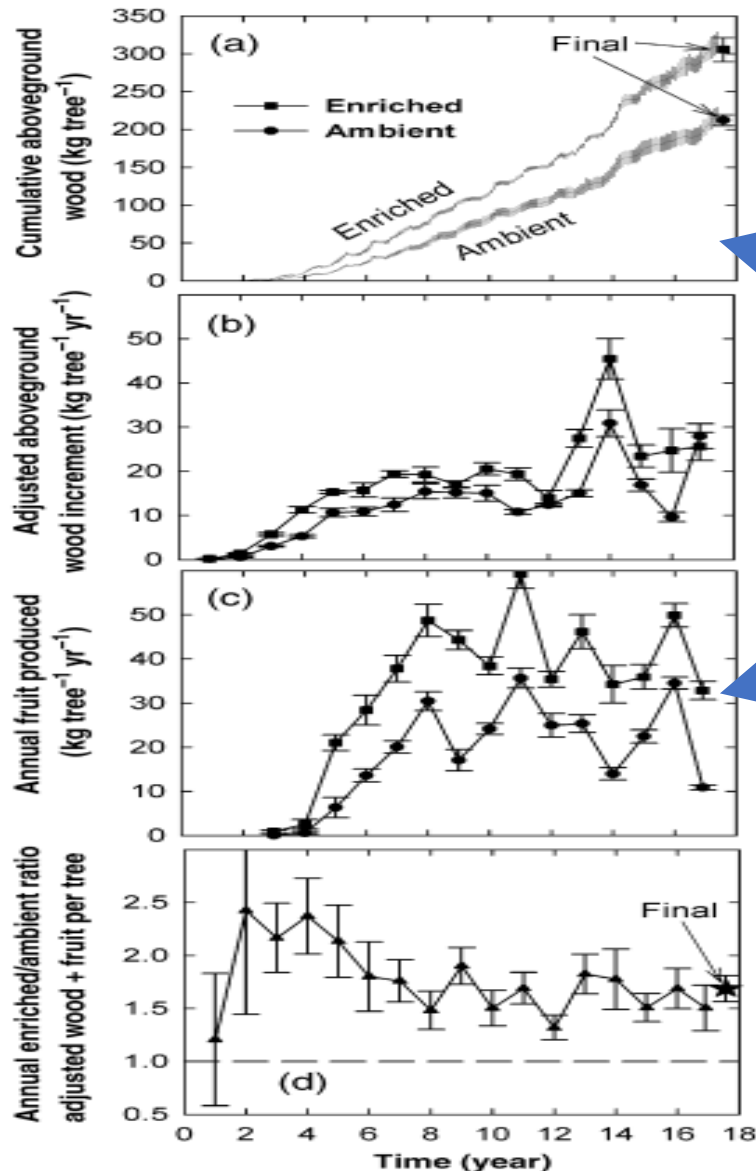
2020 BERKELEY STUDY by KEENAN ET AL WAS PUBLISHED IN NATURE...

17-YEAR CO₂ ENRICHMENT OF ORANGE TREES

B. A. KIMBALL *et al.*

MOST DRAMATIC EVIDENCE!

USDA/USDOE PUBLISHED 2007 STUDY

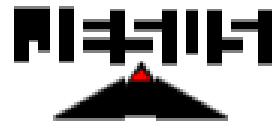


CIRCA 650 PPM in Open Top Chamber Crop Carbon Enrichment

- CAPTURE: AVG 50.5% INCREASE IN BIOMASS
 - MOST BIOMASS INCREASE IN FRUIT YIELD
 - 10 MT/Y/A more than unenriched mature trees

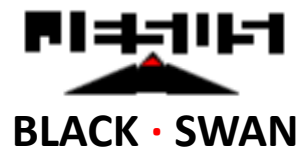
- AVG +70% YIELD (including 4 non-producing years)
 - FOUR PEAK YEARS AT +100% YIELD (6,7,11,13)
 - THREE TROUGH YEARS AT +200% YIELD (9,14,17)
- WATER UTILIZATION EFFICIENCY (WUE) INCREASED 70%

Up to Double the Fruit with 10% Less Water!



Dozen other Crop Studies on Benefits of Crop Carbon Enrichment
60 Years of Data where Biosphere is Raised from 300 to 650 ppm CO₂
of +80 to 200% for Corn, Soybeans, Cotton, and Sweet Potatoes Yields
with Boost of Agricultural Yield and Water Use Efficiency With
USDOE/BNL Free Air Carbon Dioxide Enrichment (FACE) Technology

- 1967: Ford & Thorne (Corn +70% yield)*
- 1983: Rogers (Corn and Soybean Water Use Efficiency +100%)*
- 1984: Havelka (Wheat +35% yield)*
- 1985: Acock & Allen (Soybean +40% biomass)*
- 1985: Bhattacharya et al (Sweet Potatoes +83% yield)*
- 1986: Cure & Acock (Cotton +200% yield)*
- 1987/1989: Kimball et al (Cotton +100% yield)*
- 1993: Kimball et al (Rice/Soybeans)*
- 1994-7: Bindi et al: Grapes (+50 to 70% yield)
- 2002: Leavitt, Kimball, et al 70% Water Utilization Efficiency Increase for Citrus
- 2007: Kimball et al: Citrus (up to +70% yield, +55% WUE- using OTC, see previous slide)



FGXB

MIN EXPECTED INCREASED RETURN ABOVE COST Per UC Davis

CITRUS CROP CARBON ENRICHMENT

BASIS: MIN + 60% YIELD

<u>Dollars/Carton</u>	<u>%</u>	<u>\$/100 ACRES</u>
18.80	888%	\$362,000
19.80	436%	\$400,000
20.80	304%	\$422,000

ALMOND CROP CARBON ENRICHMENT

BASIS: MIN + 50% YIELD

<u>Dollars/lb</u>	<u>%</u>	<u>\$/100 ACRES</u>
3.00	318%	\$335,300
3.50	200%	\$445,300
4.00	145%	\$510,300



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POTENTIAL Immediate BENEFITS of FGXB FACE Implementation

100% GREEN Capture With Just CA ALMOND ACREAGE (1.6MM):

16 Million Tons/ Year CO2

This is Over 5% of California's 300 MM T/Y CO2 Emissions

POTENTIAL ADDITION TO CALIFORNIA GDP:

\$4.5+ BILLION/YR PROFIT (NOT COST!!)

BONUS: MINIMUM 10% LESS WATER USAGE

IN CALIFORNIA'S HIGHEST WATER USER (Agriculture!)

WITH CO2 SUPPLIED BY INDUSTRIALLY SOURCED FLUE GAS



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KOLODJI CORPORATION- DOSANJH ALMOND ORCHARD CARBON ENRICHMENT PILOT FGXB

QUENCH COLUMN MADE WITH DUCTING AND SPRAYERS

Reduce gas temperature



UC
CE

University of California

Agriculture and Natural Resources | Cooperative Extension



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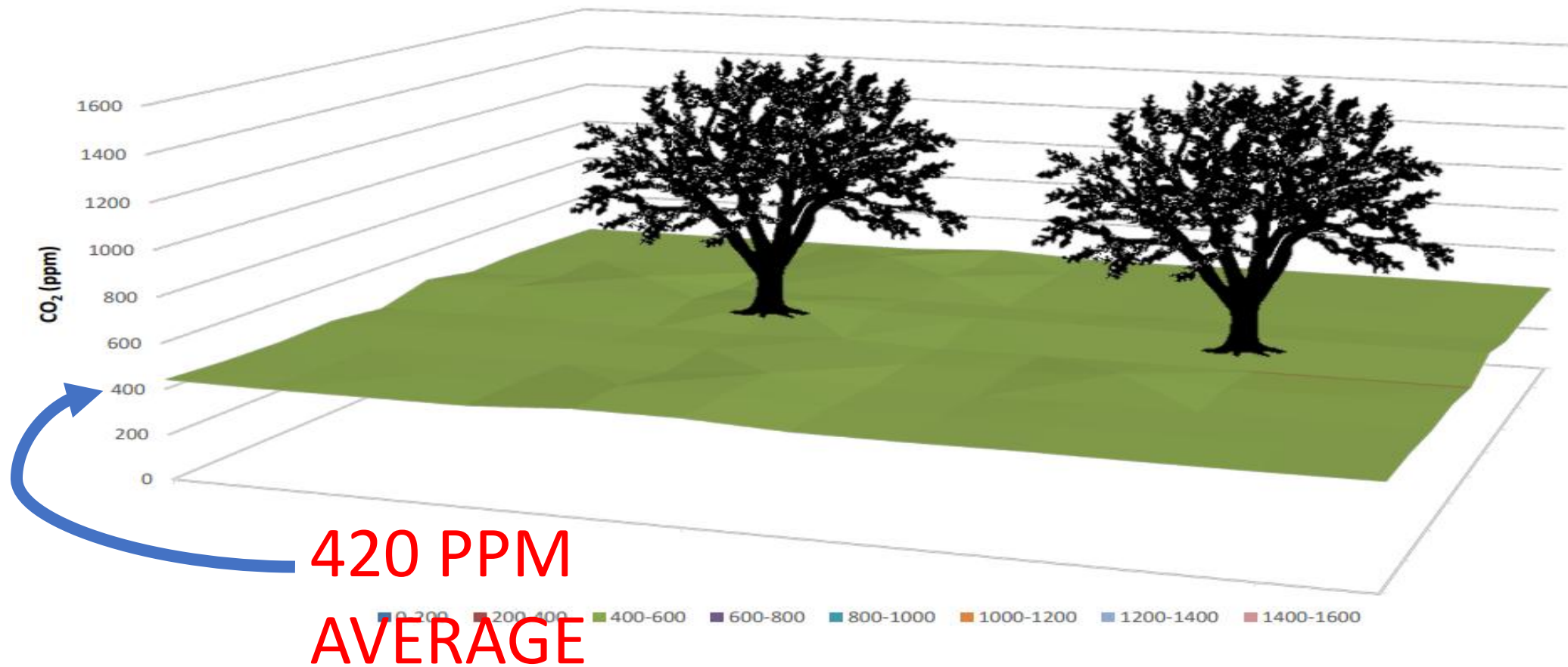
KOLODJI CORPORATION- DOSANJH ALMOND ORCHARD CARBON ENRICHMENT PILOT FGXB
CARBON DIOXIDE INSTRUMENTATION AND DISTRIBUTION DUCTING



600+PPM Sustained for Multiple Hours!

BASE LINE AMBIENT CO₂ (3-CONCENTRATION AT GRADE)

Ambient day time CO₂ concentration. Tree images display the location of trees in relation to 3D CO₂ data for the following images of CO₂ concentration over time during enrichment.

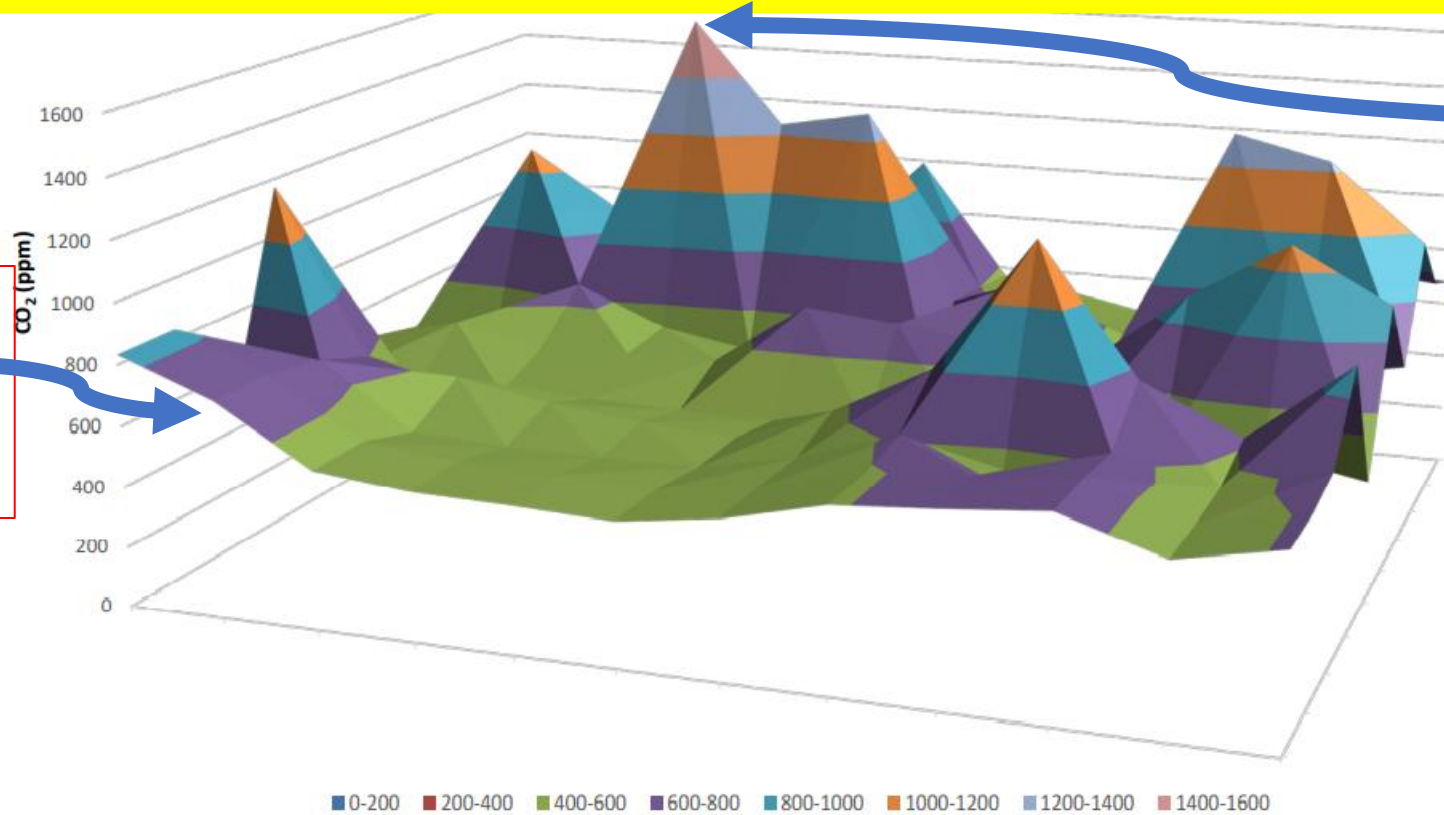




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FGXB

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

700 PPM
AVERAGE

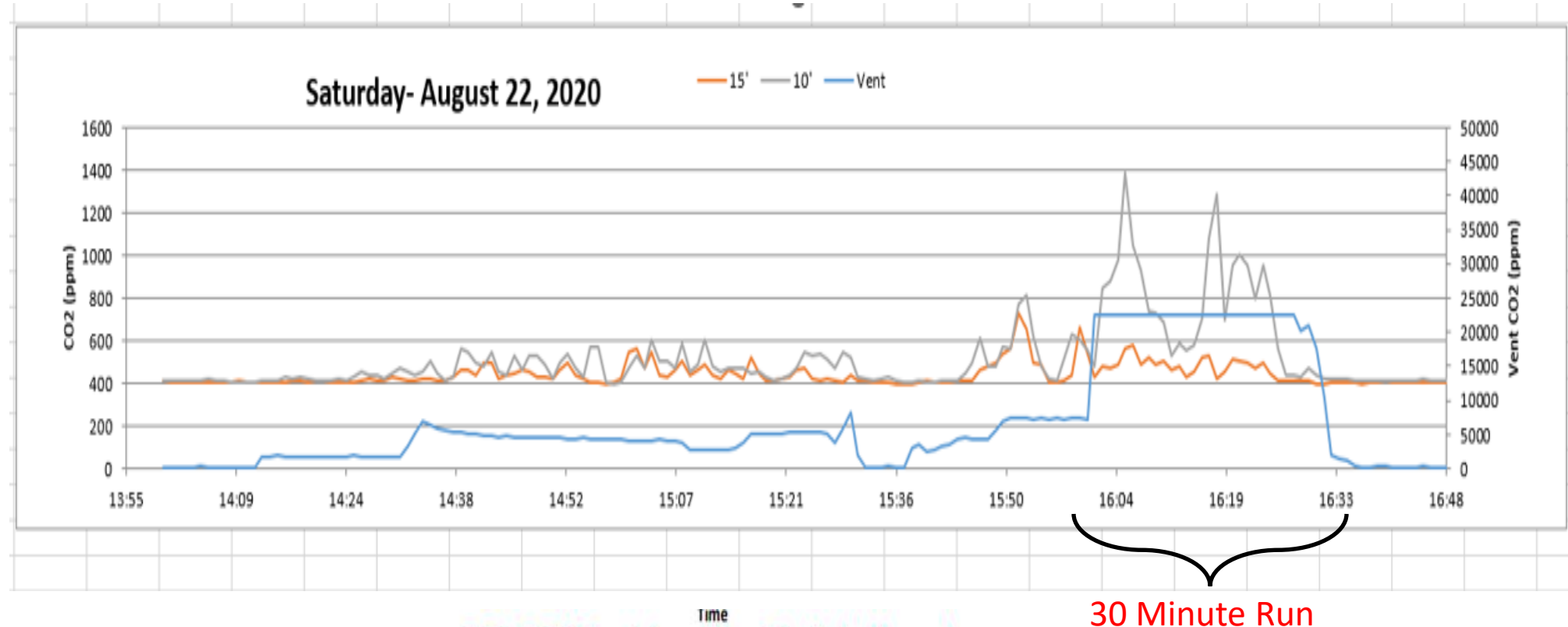


1500 PPM
PEAK



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“KITTY HAWK MOMENT”



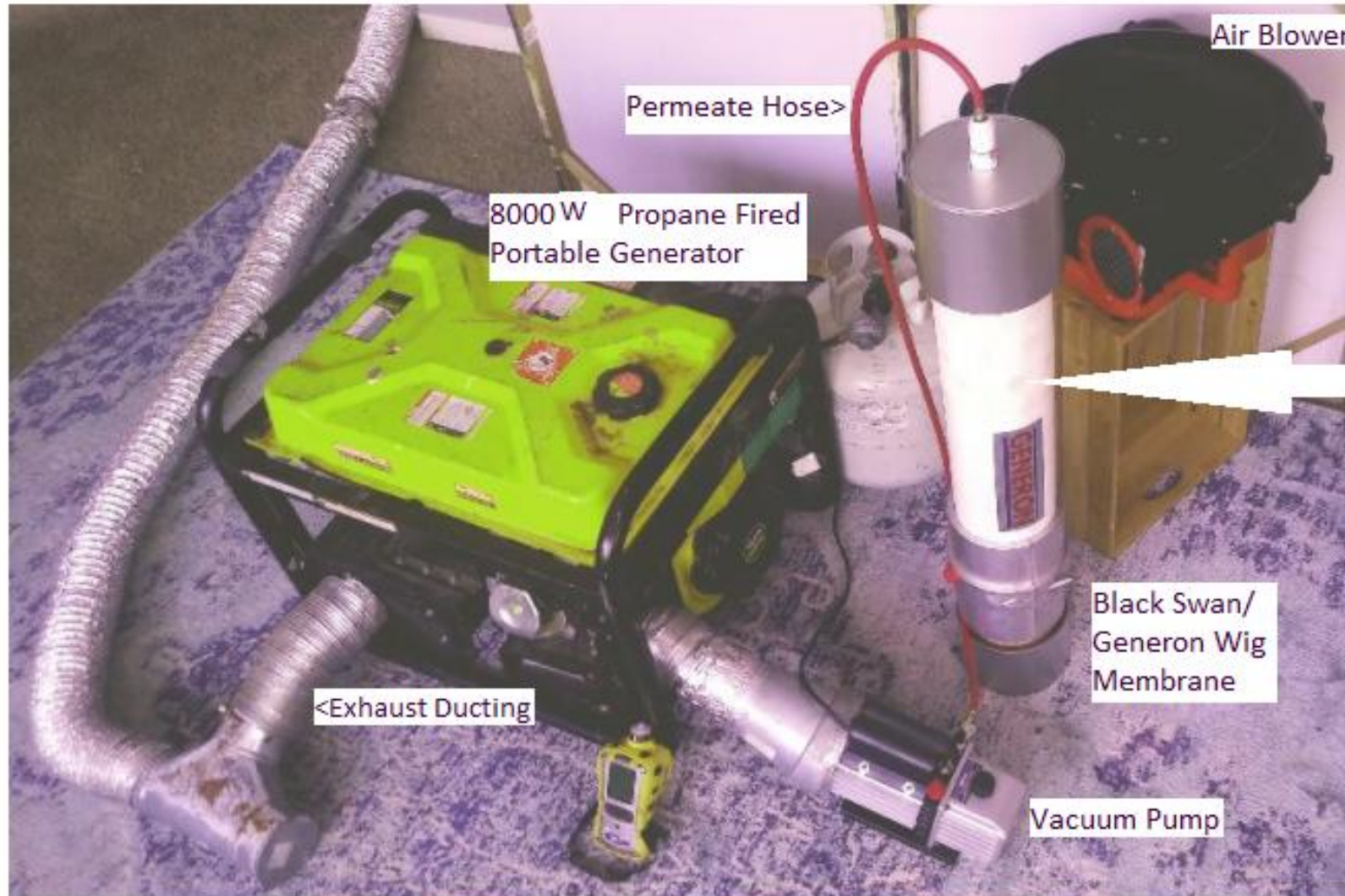
30 Minute Run
1000 ppm avg at 10'
550 ppm avg at 15'



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100 Ton/Year CO₂, 12HP, 8 KW

Bench Scale M/DAC OxyComb Wig™ Membrane



DETAIL OF AIR INLET PORTS





...ELEGANT...NATURAL...GRACEFUL...

OBVIOUS ONLY IN HINDSIGHT

COUNTER-INTUITIVE



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THE ONLY “GREEN” ECONOMIC CAPTURE TECHNOLOGY
QUICKLY SCALABLE TO 50 GT/YEAR

- Achieve Carbon Neutrality in CA by 2025!
- Achieve US Carbon Deceleration at -0.04 GT/Yr^2 by 2030!
- Achieve Carbon Neutrality around the World by 2035.

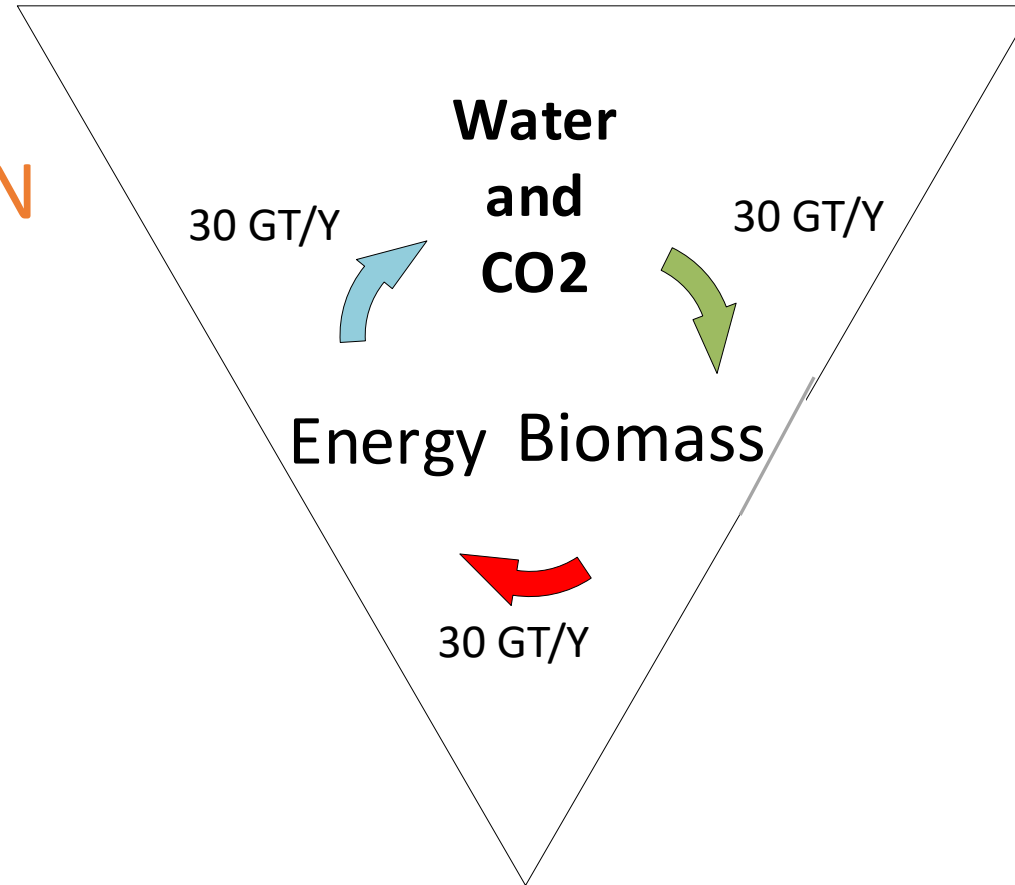
Carbon Management that Profitably makes Fuel, Water, and Sugar with...!



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mDAC/
OXY-COMBUSTION

eDAC/ FACE



BIOMASS/ BIOFUEL

CARBON MANAGEMENT HARNESSSED with “POWER OF BREATH”



Black Swan, LLC

11/14/2022

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@Csbcbglobal.net, ell: (713) 907-8742