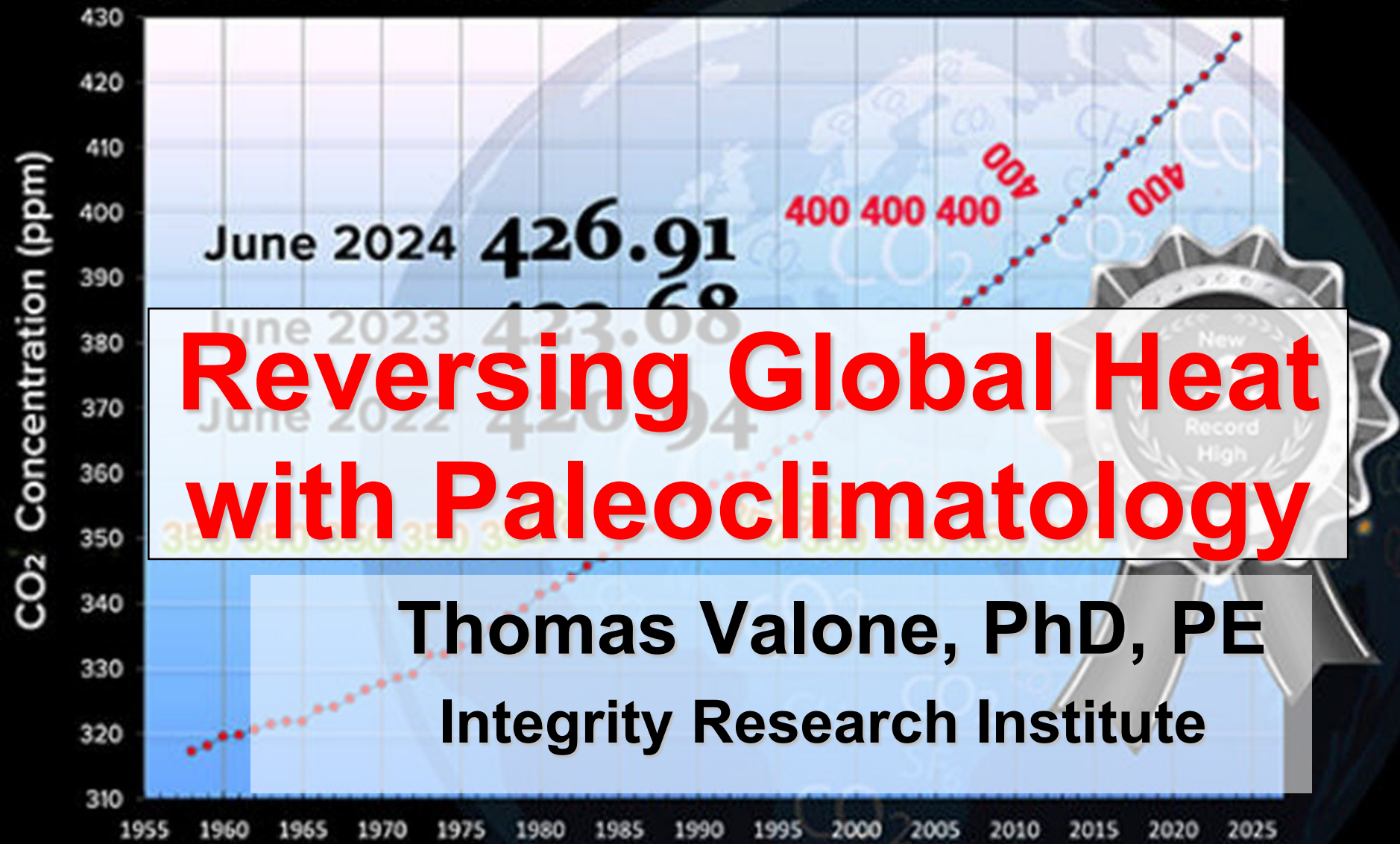


Atmospheric CO₂

June CO₂ | Year-Over-Year | Mauna Loa Observatory



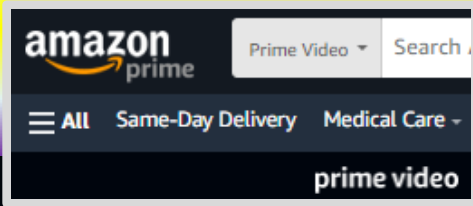
Reversing Global Heat Outline

- 1. Ethics and Morality as Applied to the World with Consequences**
- 2. Environment and Climate Change Problem and Solution**

An aerial night photograph of a city, likely New York City, showing a dense grid of lights from buildings and streets. The city is surrounded by water, with lights reflecting on the surface. The sky is dark with some clouds, and the overall color palette is dominated by the warm yellows and oranges of the city lights against the cool blues and purples of the night sky and water.

Ethics and Morality Applied to the World

Dr. Norman Borlaug



The Man Who Tried to Feed the World

Follow the story of Norman Borlaug, a man who not only solved India's famine problem but would go on to lead a "Green Revolution" of worldwide agriculture programs estimated to have saved one billion lives.

★★★★★ 16 IMDb 8.6 53min 1988 13+

Documentary • Edifying • Frightening

Free trial of PBS Documentaries, rent

1950 – Only 2 billion world pop.
with 1 billion starving

PhD Biologist Norman Borlaug became a Nobel Prize winner
Hybrid grains that withstand drought and increase yield



He single-handedly created the "Green Revolution"

Global **population** has tripled (3x) since 1950; **CO₂ emissions** have quadrupled (4x); and global **energy demand** has quintupled (5x), all in the same time period.

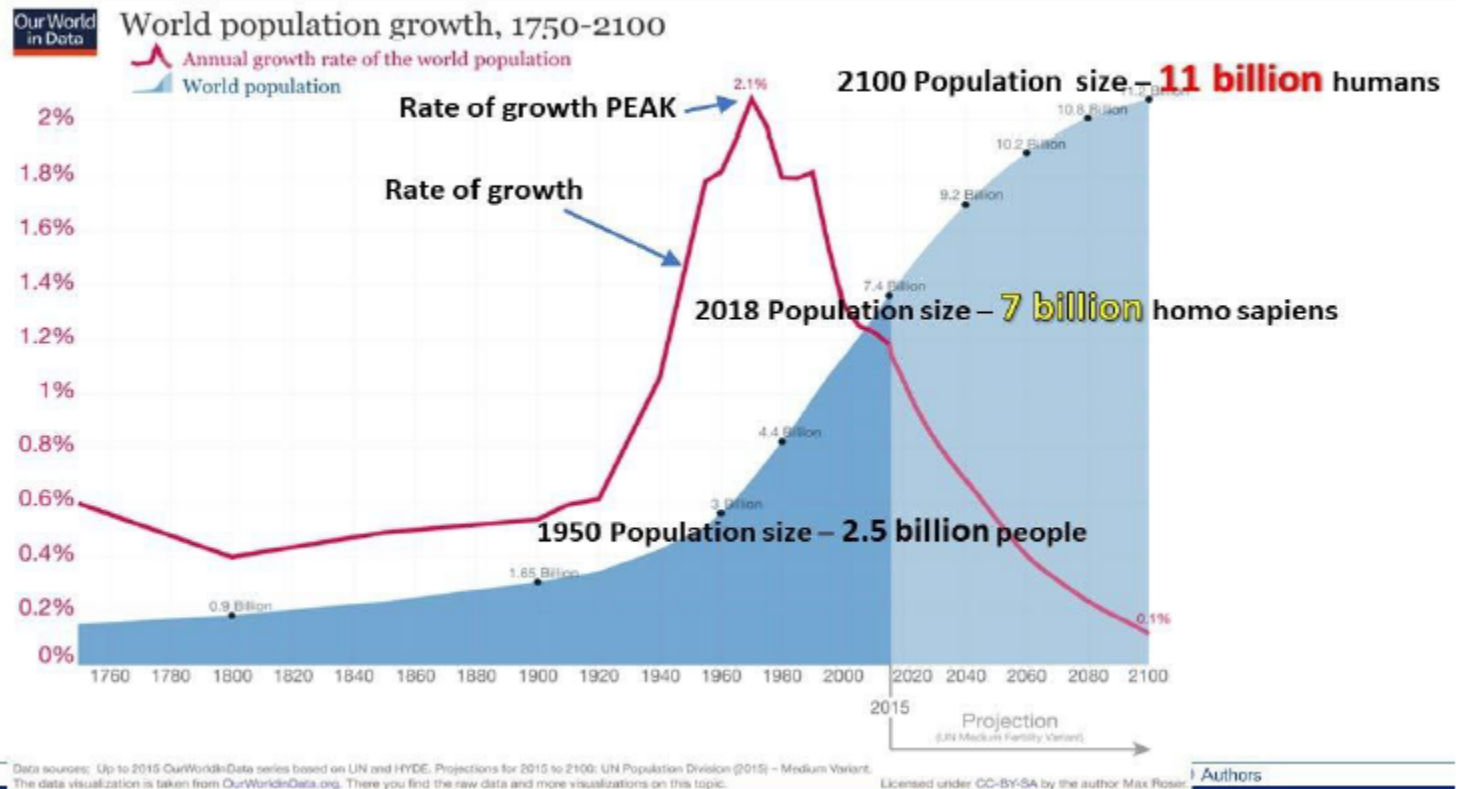


Fig. 1. World population growth [2]

The background of the slide features a close-up of an olive branch with several green olives. The branch is positioned diagonally across the frame. In the background, a bright sun is setting or rising, creating a warm, golden glow that filters through the leaves and branches. The sky is filled with soft, white clouds. The overall mood is serene and natural.

Environment and Climate Change

IEEE ISTAS 2019 ALASKA Columbia Glacier ONLY SIX Years Apart

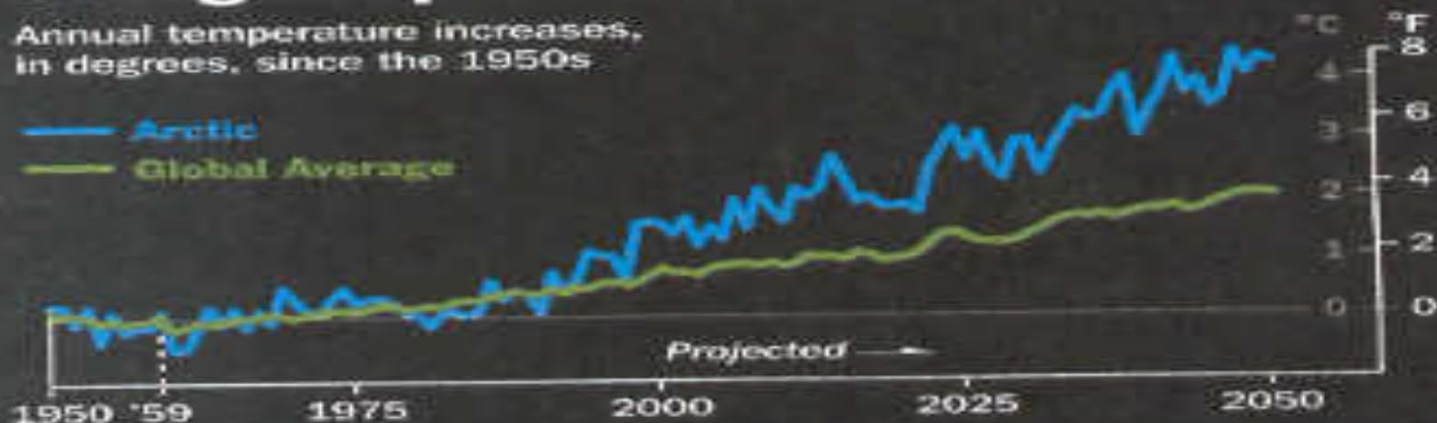
Columbia Bay, Alaska – Photographer James Balog, Nat. Geo. magazine: **Extreme Ice Survey of 18 Glaciers**
The most extreme: Columbia Glacier is losing one mile every three years – so two miles of loss are shown below.
Since 1980, this glacier has lost height equal to the Empire State Building!



Fig. 6. Extreme climatic event [9]

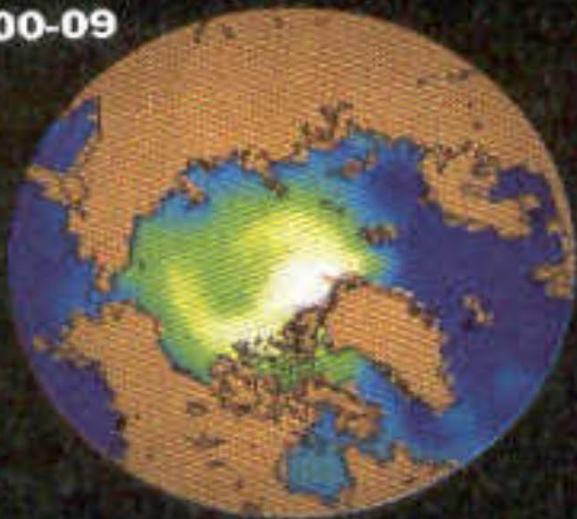
Rising temperatures . . .

Annual temperature increases,
in degrees, since the 1950s



. . . and the Arctic ice cap to shrink

2000-09



Ice thickness

8 ft.

2 m

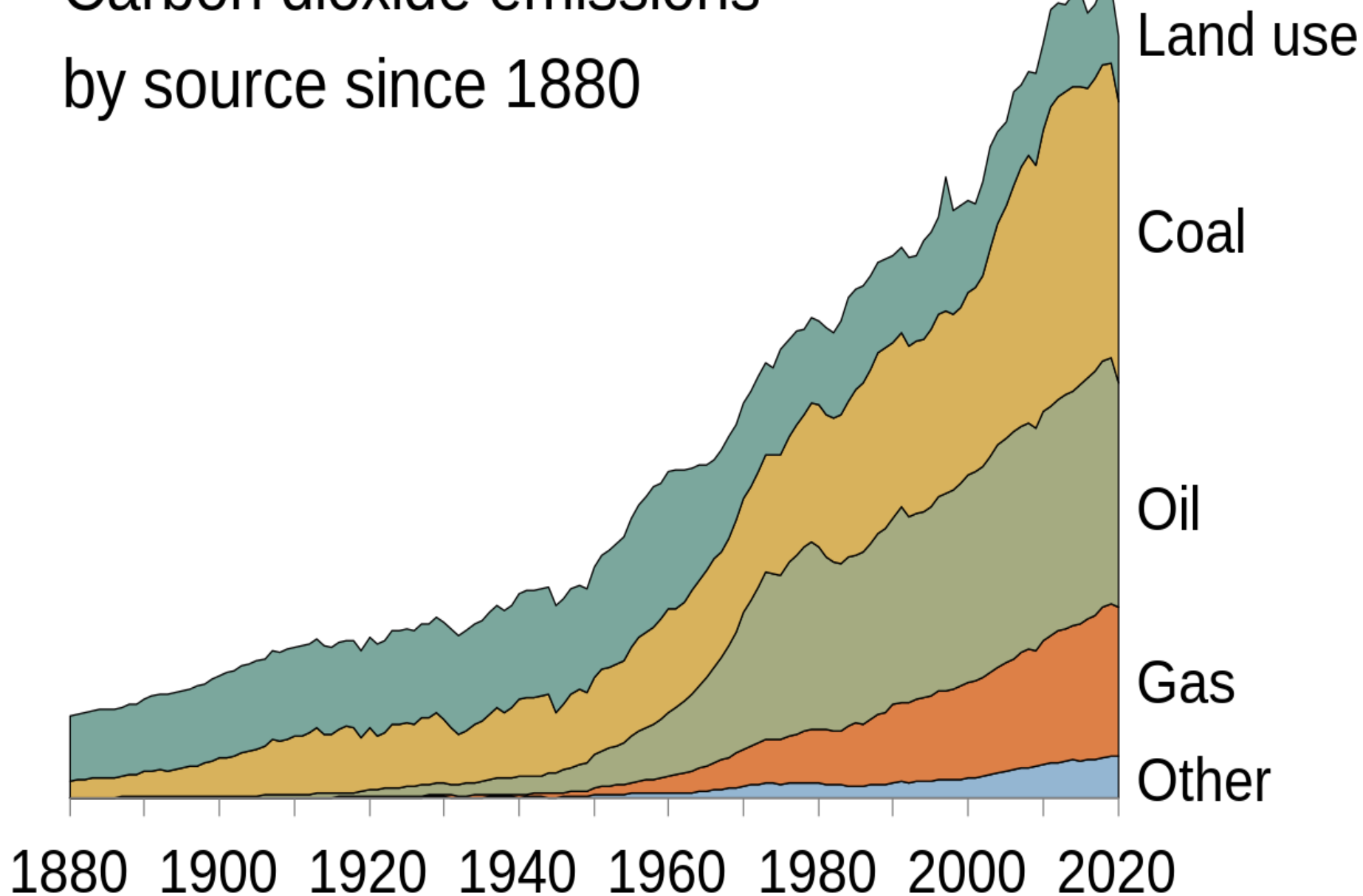
POLAR NOTES

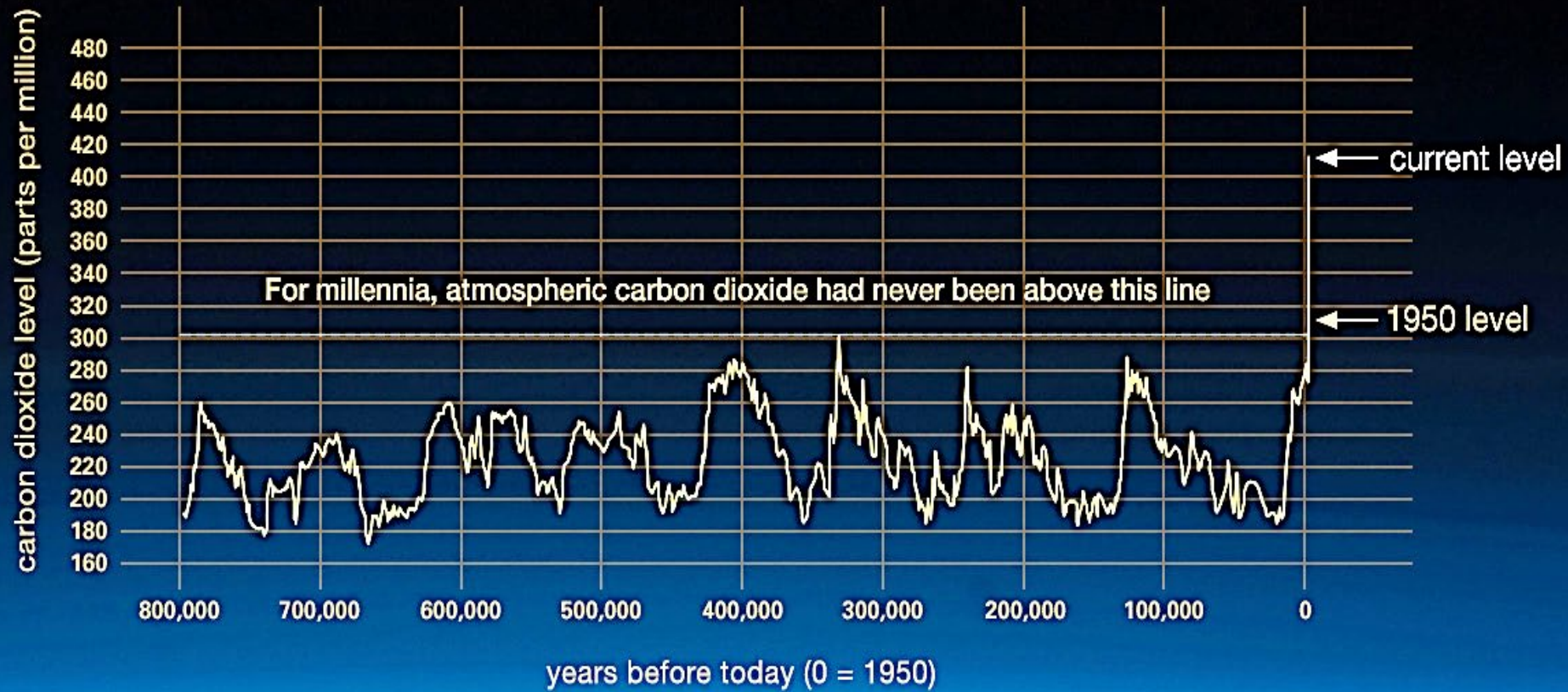
The Hole at 90°N



ARCTIC "LAKE": Not all that unusual

Carbon dioxide emissions by source since 1880





Earth's Most Recent 400,000 Year Climate History

credit: Jim Hansen, NASA Goddard Inst. for Space Studies

CO₂ and the "Ornery Climate Beast"

How might today's human-caused increases in atmospheric concentrations of carbon dioxide and other greenhouse gases change the planet? The past provides clues. Geological records show that in the past 400,000

years, atmospheric concentrations of carbon dioxide, average Earth temperature, and sea levels have risen and fallen roughly in tandem, in 100,000-year cycles paced by slight oscillations in Earth's orbit. These oscillations

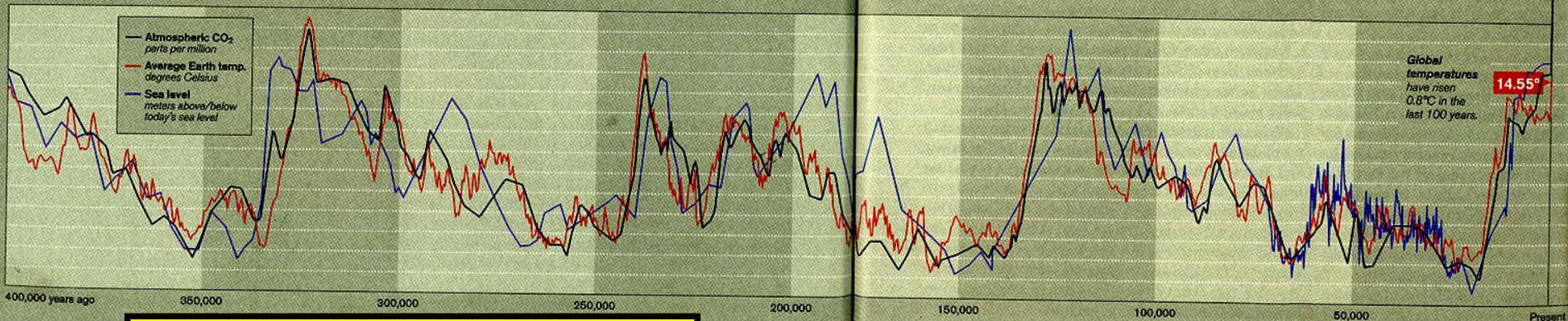
affect the distribution of sunlight, hardly affecting the total amount reaching Earth; yet, scientists believe, this has been enough to set in motion chains of events that raise and lower temperatures, launch and end ice ages, and trigger vast changes in sea level.

What's coming next? Carbon dioxide—the number one greenhouse gas—has

much more power to affect Earth's temperature than the orbital changes do. And in just the past 150 years, humankind has boosted carbon dioxide concentrations by 32 percent. NASA planetary scientist Jim Hansen says that if we continue to increase greenhouse-gas emissions, temperatures will rise between 2 and 3 °C this century, making

Earth as warm as it was three million years ago, when seas were between 15 and 35 meters higher than they are today. His predictions bear weight partly because he can verify his methods: using geological records, he has calculated past temperatures, and his results closely match the measured temperatures shown here. **DAVID TALBOT**

377



See: tinyurl.com/400000years

LY/AUGUST 2006

TECHNOLOGY REVIEW JULY/AUGUST 2006

MIT's *Technology Review*, July/August, 2006

A WORLD 4°C WARMER

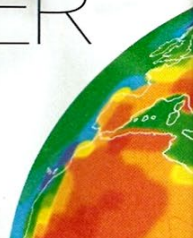
It may happen in our lifetime. **Shanta Barley** investigates what life will be like

BY 2055, climate change is likely to have warmed the world by a dangerous 4°C unless we stop pumping greenhouse gases into the atmosphere the way we do now. This is the startling conclusion of a study by the UK Met Office, unveiled at a conference in Oxford this week.

Why so soon? Because temperature rises caused by greenhouse gas emissions are expected to trigger dangerous feedback loops, which will release ever increasing amounts of greenhouse gases. The nature and scale of these feedback loops is a subject of vigorous debate among climate scientists, but warmer oceans, for instance, may liberate more

dissolved CO₂, and plants may decay faster in a warmer climate. The Met Office ran 17 different models with these feedbacks. All concluded a 4°C world by 2055 was likely if emissions continue to rise. Even if we are lucky, we are still likely to hit 4°C by 2070.

Institute for Climate Impact Research, Germany. Even the less pessimistic estimate of a 0.65-metre rise by 2100 would put at least 190 million people a year at risk from floods, says Rahmstorf's colleague Jochen Hinkel.



**Then in 2009,
TWO DIFFERENT
CLIMATE GROUPS:
SAME PREDICTION**

The Amazon - gone

In a 4°C world, climate change, deforestation and fires spreading from degraded land into pristine forest will conspire to destroy over 83 per cent of the Amazon rainforest by 2100, according to climatologist Wolfgang Cramer at the Potsdam Institute for Climate Impact Research in Germany. His climate models show global warming alone

With
your
130 c
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increa
15°C
of the
Califo
rise b
Stefa

The Nation

Washington Post, 9/25/09, p. A4

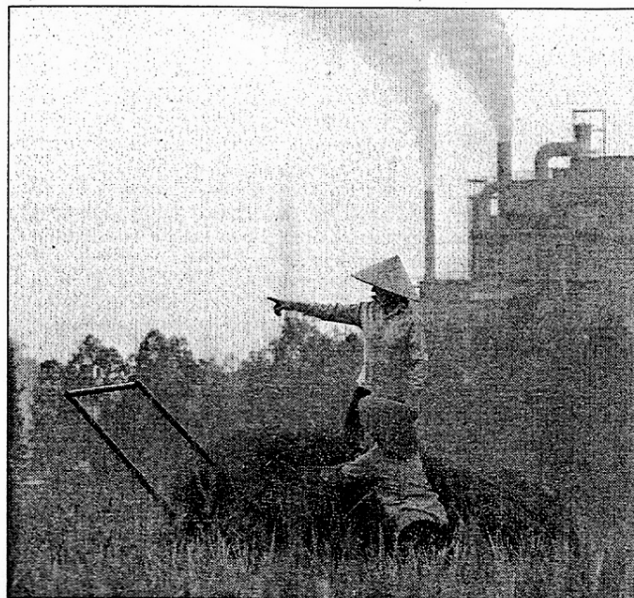
New Analysis Brings Dire Forecast Of 6.3-Degree Temperature Increase

By JULIET EILPERIN
Washington Post Staff Writer

Climate researchers now predict the planet will warm by 6.3 degrees Fahrenheit by the end of the century even if the world's leaders fulfill their most ambitious climate pledges, a much faster and broader scale of change than forecast just two years ago, according to a report released Thursday by the United Nations Environment Program.

The new overview of global warming research, aimed at marshaling political support for a new international climate pact by the end of the year, highlights the extent to which recent scientific assessments have outstripped the predictions issued by the Nobel Prize-winning U.N. Intergovernmental Panel on Climate Change in 2007.

Robert Corell, who chairs the Climate Action Initiative and reviewed the UNEP report's scientific findings, said the significant global temperature rise is likely to occur even if industrialized and de-



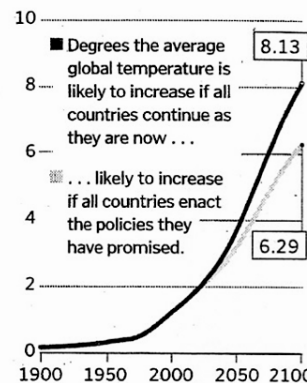
BY KHAM — REUTERS

Farmers are overshadowed by a smoke-belching cement factory outside Hanoi. Even with sharp emissions curbs, temperatures may rise disastrously.

Warming Trend

Researchers say global temperatures as likely to rise more than six degrees by the end of the century even if every country enacts all climate legislation it has promised to enact to date.

Temperature increases, in degrees Fahrenheit



SOURCE: Sustainability Institute

THE WASHINGTON POST

PRIZE FIGHT
Time to revamp
the Nobels

News

WEEKLY October 3 - 9, 2009

**Future
Earth**

New Scientist, 10/3/09

Linear Global Temperature Correlation to Carbon Dioxide Level, Sea Level, and Innovative Solutions to a Projected 6°C Warming by 2100

Thomas F. Valone

Integrity Research Institute, Beltsville, USA.

DOI: 10.4236/gep.2021.93007 **PDF** **HTML** **XML** **3,489** Downloads **13,636** Views

[Citations](#)

Abstract

Too many climate committees, conferences, articles and publications continue to suggest a one and a half (1.5°C) to two degrees (2°C) Celsius as an achievable global limit to climate changes without establishment of any causal link to the proposed anti-warming mechanism. A comprehensive review has found instead that observationally informed projections of climate science underlying climate change offer a different outlook of five to six-degree (5°C - 6°C) increase as "most accurate" with regard to present trends, climate history and models, yielding the most likely outcome for 2100. The most causative triad for the present warming trend from

CO₂ and the "Ornery Climate Beast"

How might today's human-caused increases in atmospheric concentrations of carbon dioxide and other greenhouse gases change the planet? The past provides clues. Geological records show that in the past 400,000

years, atmospheric concentrations of carbon dioxide, average Earth temperature, and sea levels have risen and fallen roughly in tandem, in 100,000-year cycles paced by oscillations in Earth's orbit. These osc

Global
CO₂ Level
in 2024

420 ppm

Temp Gap: 6°C (10°F)

Sea Level Gap

Baseline:

0 m Sea Level = 290 ppm CO₂ = 15 °C World Temp

Atmospheric CO₂
parts per million
Average Earth temp.
degrees Celsius
Sea level
meters above/below
today's sea level

Global
temperatures
have risen
0.8°C in the
last 100 years.

14.55° C

CO₂, Temp, Sea Level inextricably correlated historically for 400 kY always in lockstep

400,000 years ago 350,000 300,000 50,000 years ago Present

Break in graph

FEATURE STORY

Technology Review, July/August 2006

KEY to graph: 20 ppm = 1°C = 20 meters

See: tinyurl.com/400000years

Graph enhancements by Thomas Valone, PhD, PE
updated 2024

Projected Sea Level
Rise is 80 meters



YouTube

Search

Nat Geo “Six Degrees Could Change the World” documentary

WHY 6°C?

(20 ppm=1°C)

So then:

120 ppm x
7.8 = **936 Gt**
of excess
CO2 above
our
ignorant
heads!



[Climate change](#)

United Nations • Climate change refers to long-term shifts in temperatures and weather patterns. Human activities have been the main driver of climate change, primarily due to the burning of fossil fuels like coal, oil and gas.

Six degrees could change the world



Stephan Nitz
112 subscribers

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700



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112K views 8 years ago

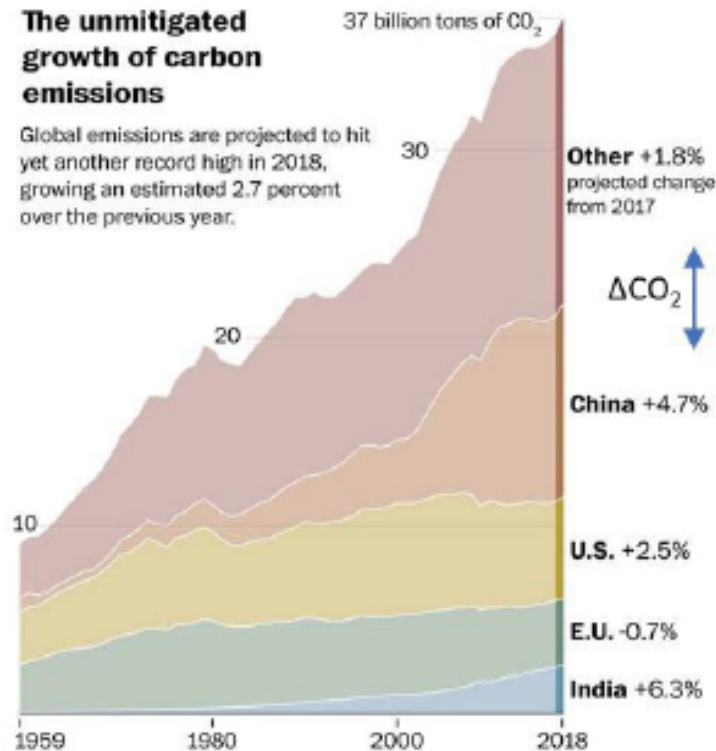
The film runs through the effect each degree in temperature change has on the world. ...more



IEEE ISTAS 2019 CARBON EMISSIONS PER ANNUM

The unmitigated growth of carbon emissions

Global emissions are projected to hit yet another record high in 2018, growing an estimated 2.7 percent over the previous year.



Figures show emissions from fossil fuels and industry, which includes cement manufacturing but not deforestation.

Source: Global Carbon Project

JOHN MUYERS/STYLING THE WASHINGTON POST

- CO₂ up to 40 gigatons per year worldwide rapidly *increasing rate*
- compared to 30 Gt/yr ten years ago

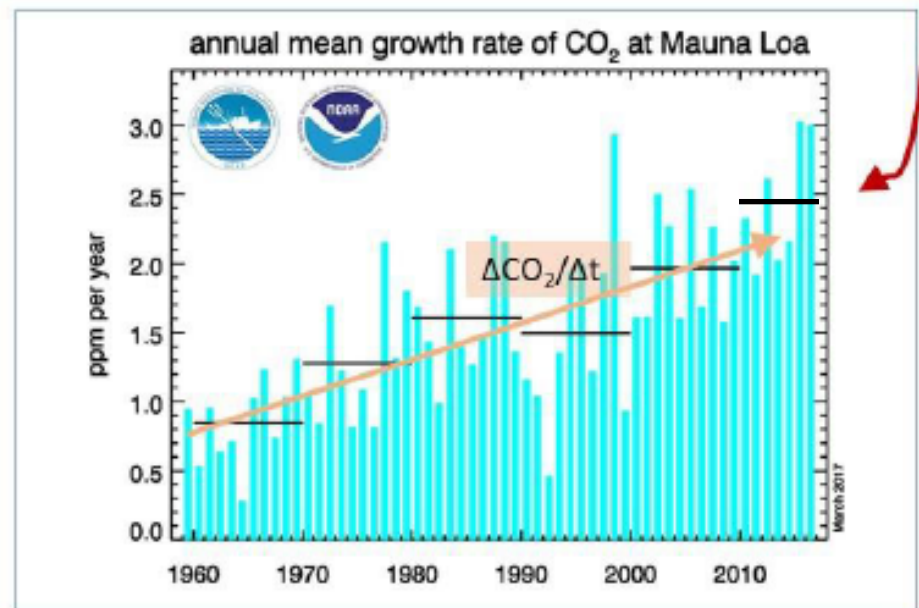


Fig. 2. Rate of change for CO₂ emissions per year [4]

A blue abstract graphic with flowing, wavy lines is located in the top-left corner of the slide.

Since this year's **Global Climate Change** report states that 0.96 W/m^2 is the new heat trapping imbalance, **TWICE that of 20 years ago** (doi.org/m27m),

A CHALLENGING QUESTION ASKED GREENSAND IN DENMARK

Denmark has decided to move ahead with the Greensand carbon capture and storage pilot project in the Danish North Sea. The pilot targets the first offshore injection by late 2022. (CREDIT: Creative Commons)

As early as 2005, carbon capture and storage was identified by the UN's Intergovernmental Panel on Climate Change (IPCC) as one of the solutions for tackling climate change. So why aren't we going full steam with carbon capture?

ProjectGreensand.com

partnered with INEOS company for
CDR and DAC

Capable of reaching 8 million
tonnes of CO₂ per year by 2030

Already the first carbon storage
injects CO₂ in 1800 meters below
the North Sea seabed.

BISON

An aerial photograph of a vast solar farm in a desert. The solar panels are arranged in neat, rectangular rows, stretching across the arid landscape. In the background, a range of blue mountains is visible under a clear sky with scattered white clouds. The overall scene conveys a sense of large-scale renewable energy production in a natural setting.

CarbonCapture Inc. announces Project Bison: our five megaton direct air capture project in Wyoming



Why Do We Need Carbon Removal?

Climate change •
Climate change refer...

**Why we need
carbon removal
to address
the climate crisis**



Analysis by the National Academy of Sciences (NAS) and Intergovernmental Panel on Climate Change (IPCC) shows that deployment of carbon removal is critical to achieve U.S. and global emissions reduction targets by 2050. Even with rapid investment in emission reductions, the United States could need to remove about 2 gigatons of CO₂ per year by midcentury to reach net-zero — that's about 30% of U.S. 2019 greenhouse gas emissions. Globally, scientists predict that up to 10 GtCO₂ will need to be removed annually from the atmosphere by 2050, with increased removal capacity up to 20 GtCO₂ per year by 2100.

Dan Lashof, Dir. World Res. Inst.

Gigaton CO₂ Removal



Anu Khan (She/Her) · 3rd

Science & Innovation at Carbon180

United States · [Contact info](#)

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John Kerry's Climate Warning: 'Even If We Get To Net Zero, We Need Carbon Removal'

HuffPost

About

Reformed electrochemist working at the intersection of technology, policy, equity, and justice to bring the carbon removal sector to gigaton scale.

Integrity Res. Inst. wants to help save the world by advocating Gigaton Carbon Dioxide Removal (CDR) or Direct Air Capture (DAC). Will billionaires and Congress help?



BIOLOGY

CHEMISTRY

EARTH

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HOT TOPICS

JUNE 28, 2022 | NASA CAPSTONE LAUNCHES SUCCESSFULLY – WILL TEST NEW LUNAR ORBIT FOR

HOME

EARTH NEWS

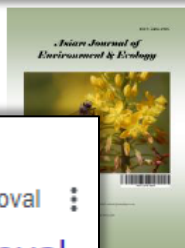
Metals Supercharge Method To Bury Billions of Tons of Harmful Carbon Dioxide Under the Sea for Centuries

TOPICS: Atmospheric Science Carbon Capture Chemical Engineering Climate Change Popular

University Of Texas At Austin

Denmark has decided to move ahead with the Greensand carbon capture and storage pilot project in the Danish North Sea. The pilot targets the first offshore injection by late 2022. (CREDIT: Creative Commons)

As early as 2005, carbon capture and storage was identified by the UN's Intergovernmental Panel on Climate Change (IPCC) as one of the solutions for tackling climate change. So why aren't we going full steam with carbon capture?



Asian Journal of Environment & Ecology

Volume 20, Issue 2, Page 42-58, 2023; Article no.AJEE.97404
ISSN: 2456-690X

XPRIZE Foundation

<https://www.xprize.org> > prizes > carbonremoval

\$100M Prize For Carbon Removal

This four-year global competition invites innovators

Gigatonne Carbon Dioxide Removal Can Reverse Global Heating Trend

Research Open

Geology, Earth and Marine Sciences

Volume 4 Issue 3

Thomas F. Valone^{a*}

., Suite. 209, Beltsville MD 20705, US.

Author's contribution

interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/AJEE/2023/v20i2436

Research Article

Direct Air Capture and Removal of Gigatons of CO₂ Offers Hope for Climate Recovery


Thomas F. Valone PhD*

Using the Oceans to Help Capture Carbon > How can the deep blue seas fight climate change best?

BY PRACHI PATEL | 15 AUG 2023 | 5 MIN READ | 

Alkalinity Generation Constraints on Basalt Carbonation for Carbon Dioxide Removal at the Gigaton-per-Year Scale

Benjamin M. Tutolo*, Adedapo Awolayo, and Calista Brown

 Cite this: *Environ. Sci. Technol.* 2021, 55, 17.

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Atlantic Council

<https://www.atlanticcouncil.org> > [blogs](#) > [energysource](#) 

Gigaton carbon removal and the Paris Climate Agreement

May 14, 2021 — **Gigaton-scale removal**, capture, and storage technologies will be



This large-scale Captura facility, shown in an artist's rendering, could capture gigatons of carbon dioxide dissolved in ocean water. CAPTURA CORP.

Scientists Turned Carbon Dioxide into Oxygen by Zapping It with a Laser



SCIENTIFIC REPORTS

CHEMICAL CONVERSION

WEATHERING OF ROCK WASHES ALKALINE MOLECULES INTO THE OCEAN, THEREBY CONVERTING DISSOLVED CO₂ INTO BICARBONATE AND CARBONATE FORMS

Air Capture Summit

News | 06.04.2023

Disintegration of Carbon Dioxide Molecules in a Microwave Plasma Torch



Vesta Earth

<https://www.veda.earth> > approach

The Approach

From Pilot Project to Gigaton-scale CO₂ Removal.

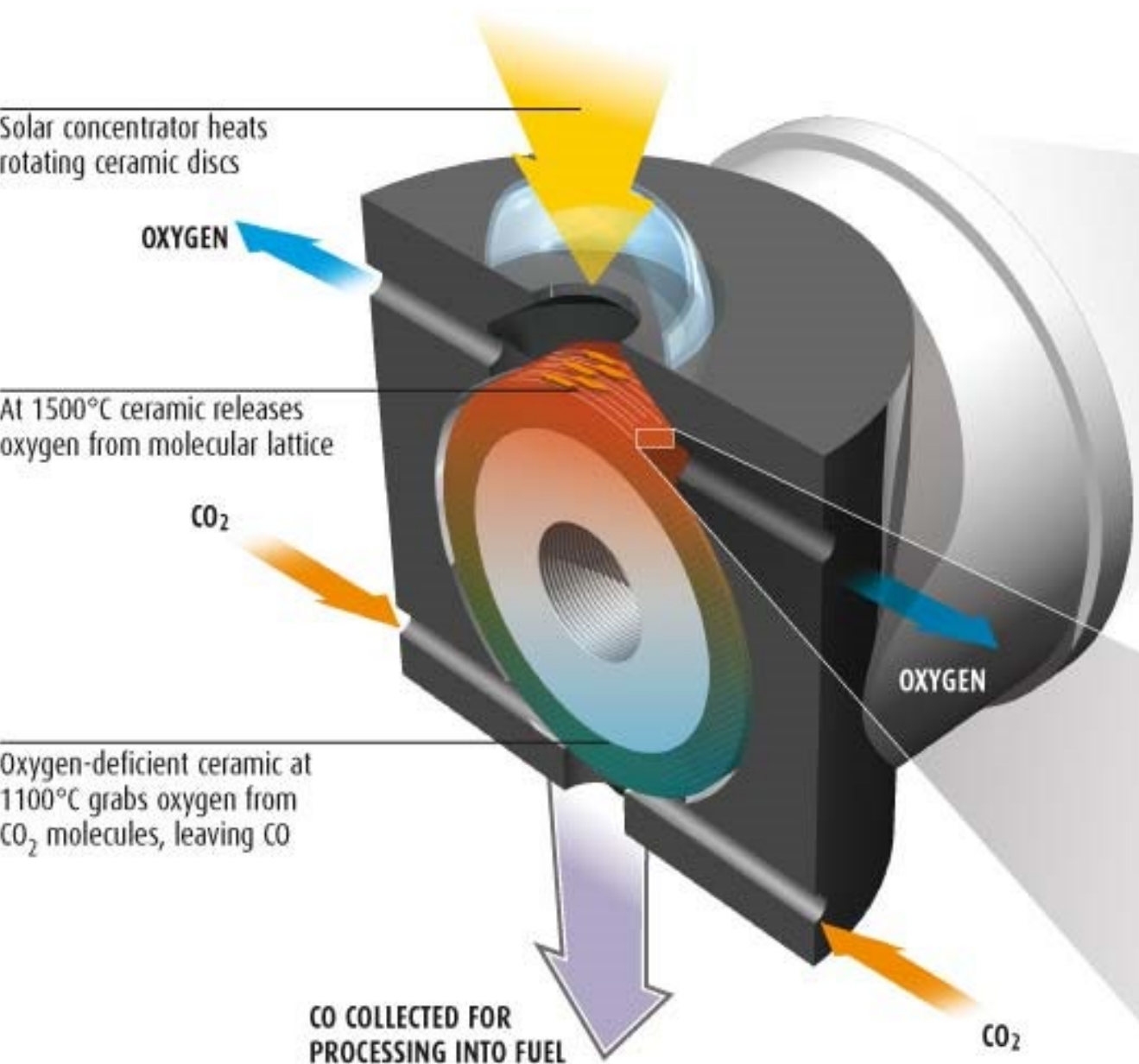
CO₂ in Denmark's subsurface on March 8, 2023, at the First Carbon Storage event.

Project Greensand
(megaton CDR)

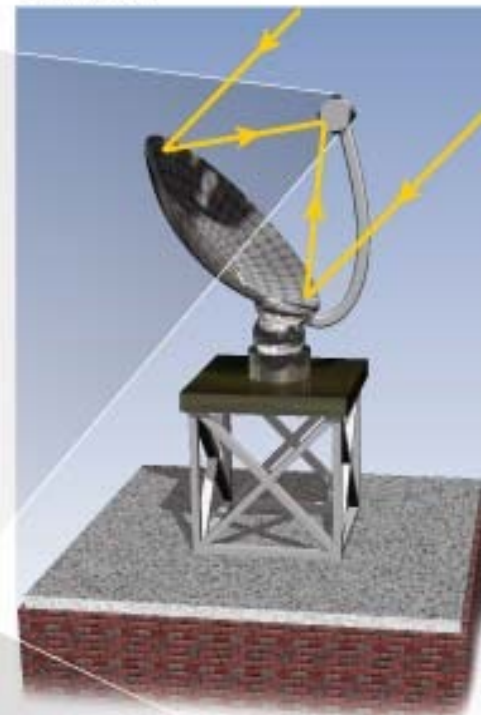
Top contender: **Enhanced Rock Weathering**, proven in Florida 2022 and Halifax Harbor 2023, as low as **\$25/tonne** and up to **15+ billion tonnes/year** (gigatonnes)!

CO₂ SPLITTER

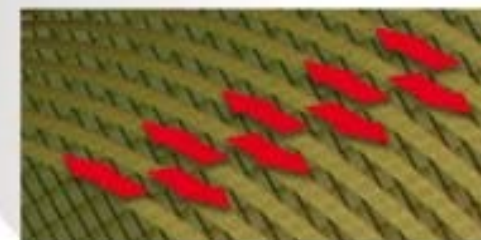
Heat from the sun provides energy to break down CO₂, releasing CO which can then be used to produce synthetic fuels



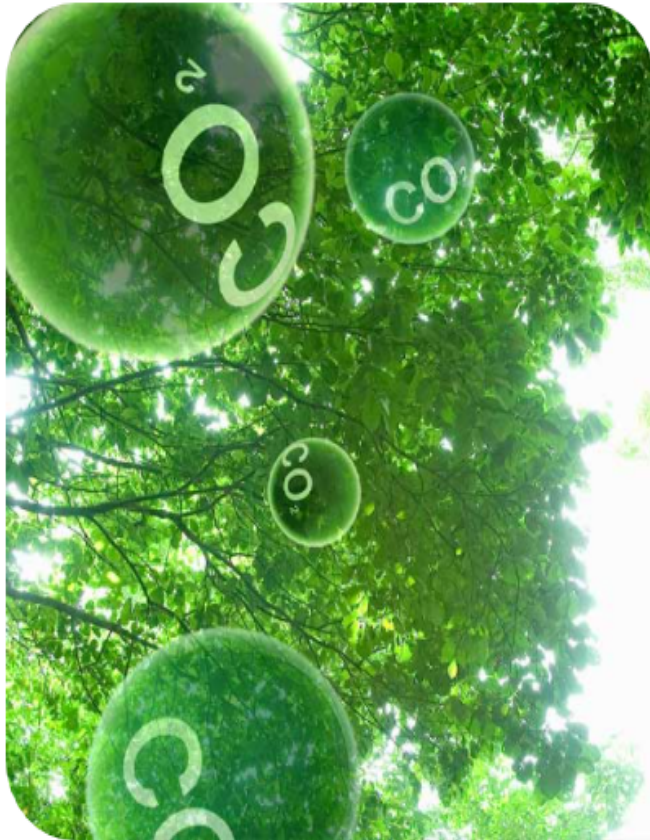
A MIRRORED DISH TRACKS THE SUN AND FOCUSES HEAT ON REACTION CHAMBER



ALTERNATE DISCS ROTATE IN OPPOSITE DIRECTIONS



GIGATONNE CARBON DIOXIDE DISPOSITION



Scaling to Billions of Tons of Carbon Capture & Management Infrastructure

Effective decarbonization requires that carbon capture, management and disposition infrastructure and systems be planned and implemented at “GT scale” (Giga Tonne scale), and not through a piecemeal project-based approach.

Enabling GT scale carbon capture and management requires common, scalable and seamless carbon disposition infrastructure; commoditized cost of carbon capture, storage and disposition; mechanisms for risk transfer & arbitrage for CO₂; mechanisms for net-back and utilization of carbon credits; and enabling policy design.

DasturEnergy.com – aims at 5 Gtpa CDR soon and over 10 Gtpa later on

Support the scale-up of direct air capture

Join our community of forward-thinking Climate Pioneers who are removing CO₂ from the air.

“almost 1000x more effective than trees on the same land”



Act now



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Direct air capture supports nature by scaling CO₂ removal

Trees are critical in the fight against climate change for their ability to remove CO₂ from the atmosphere.



JUNE 28

World's largest direct air carbon capture facility will reduce CO2 by .0001%

Jameson Dow - Jun. 28th 2022 12:08 pm PT



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The world's largest carbon direct air capture facility has started construction in Iceland, run by Swiss startup Climeworks AG.

Integrity Research Institute

“Dedicated to researching scientific integrity in the areas of energy, propulsion, and bioenergetics”



GOALS

40 gigatons CDR/year by 2030
100 gigatons CDR/year by 2050

www.integrity-research.org

www.futureenergy.org

www.BioenergyDevice.org