

# Engineering, Ethics and Society: Ethical Environmental Engineering

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Engineering 183W, UCLA SEAS  
Lecture 9

# Our Environment – A Reminder



Image courtesy Malin Space Science Systems, 2004

# Lecture Contents

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- Case Study 1: LA Smog
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# Ethical Overview

The environment affects:

- How human beings live today
- The future lives of human beings
- The future viability of animal and plant species

Many environmental problems are the result of society's technical advances, so technologists must solve them considering:

- Rights Ethics: Peoples' right to a safe and healthy environment
- Duty Ethics: We're breaking it, it's our duty to fix it
- Virtue Ethics: The new obligations of world eco-citizenship
- Utilitarianism: Most happiness for most people, balanced costs
- Pragmatism: Compromise solutions, local and/or worldwide

# Major Environmental Problems

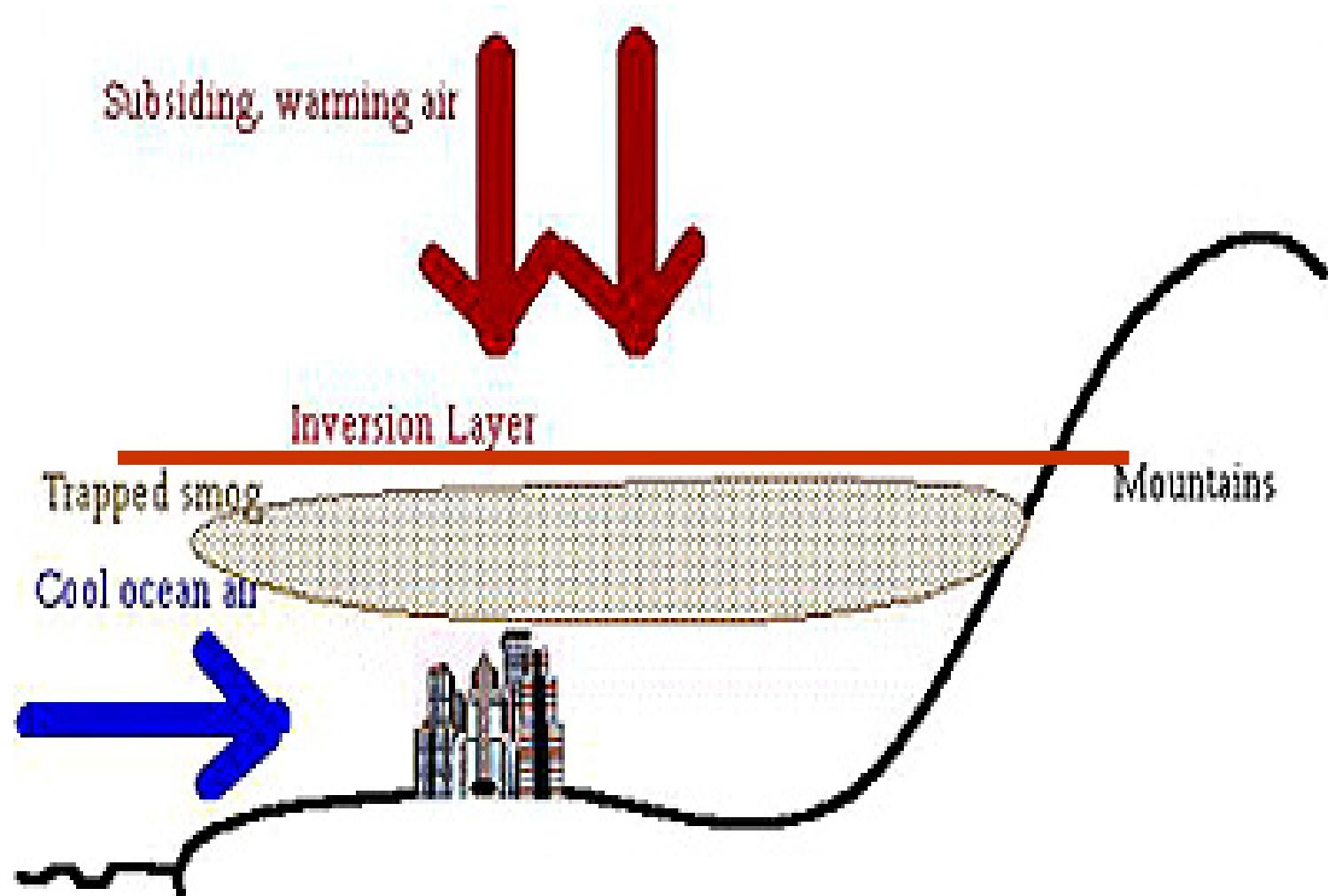
- Depletion of Natural Resources
- Industrial and Urban Pollution
  - Smog & Air Quality
  - Chlorofluorocarbons & the Ozone Layer
  - Greenhouse Gases & Global Warming
  - Wastes & Contamination

*Industrial Technology*  
meets  
*Natural Phenomena*

# Case Study 1: Los Angeles Smog



# LA's Geography Traps Smog



# In the San Fernando Valley



# LA's Historical Smog Sources



Factories

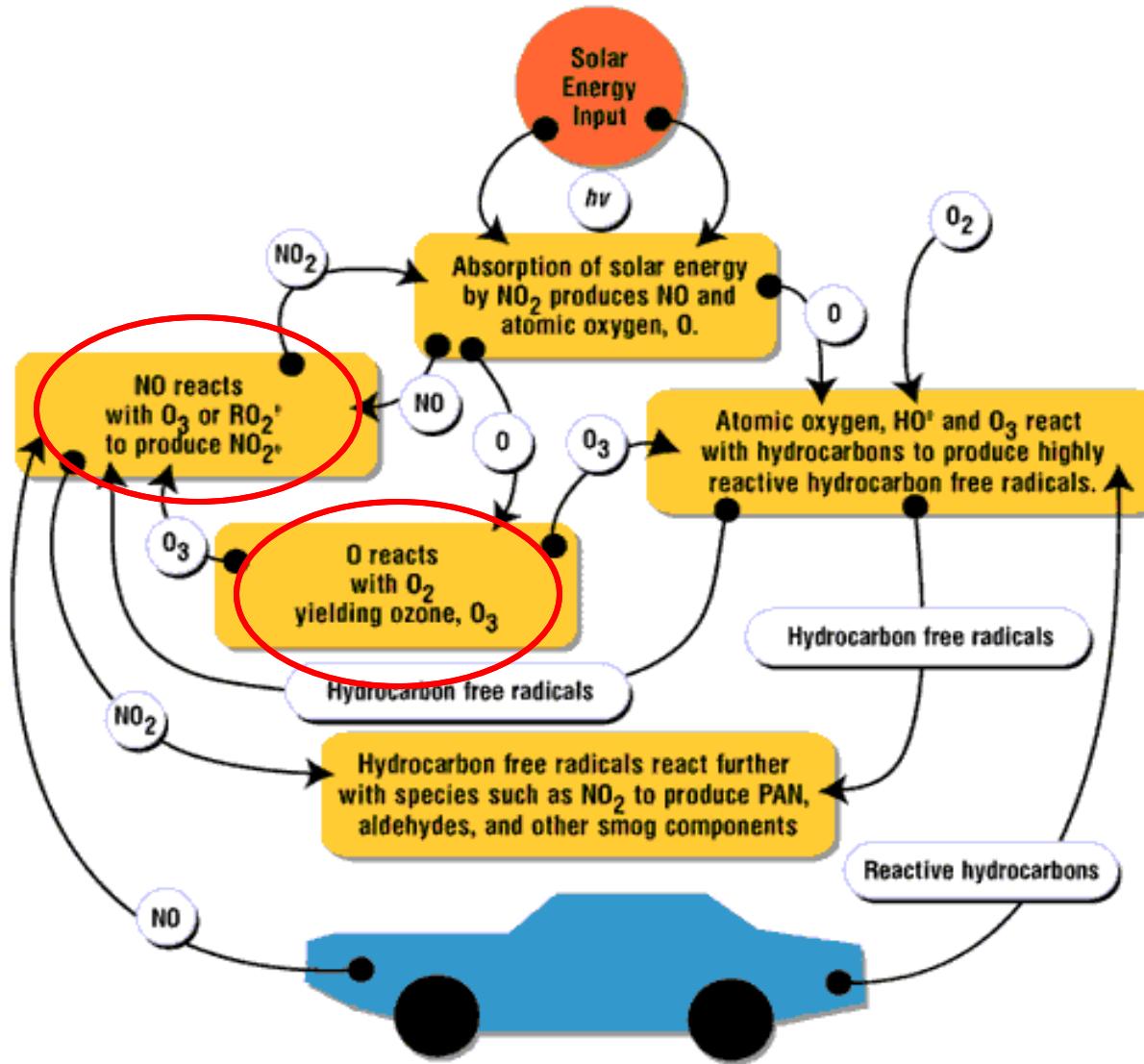


Home  
Incinerators

Family Cars



# Cars Produced Photochemical Smog



# LA Smog Control

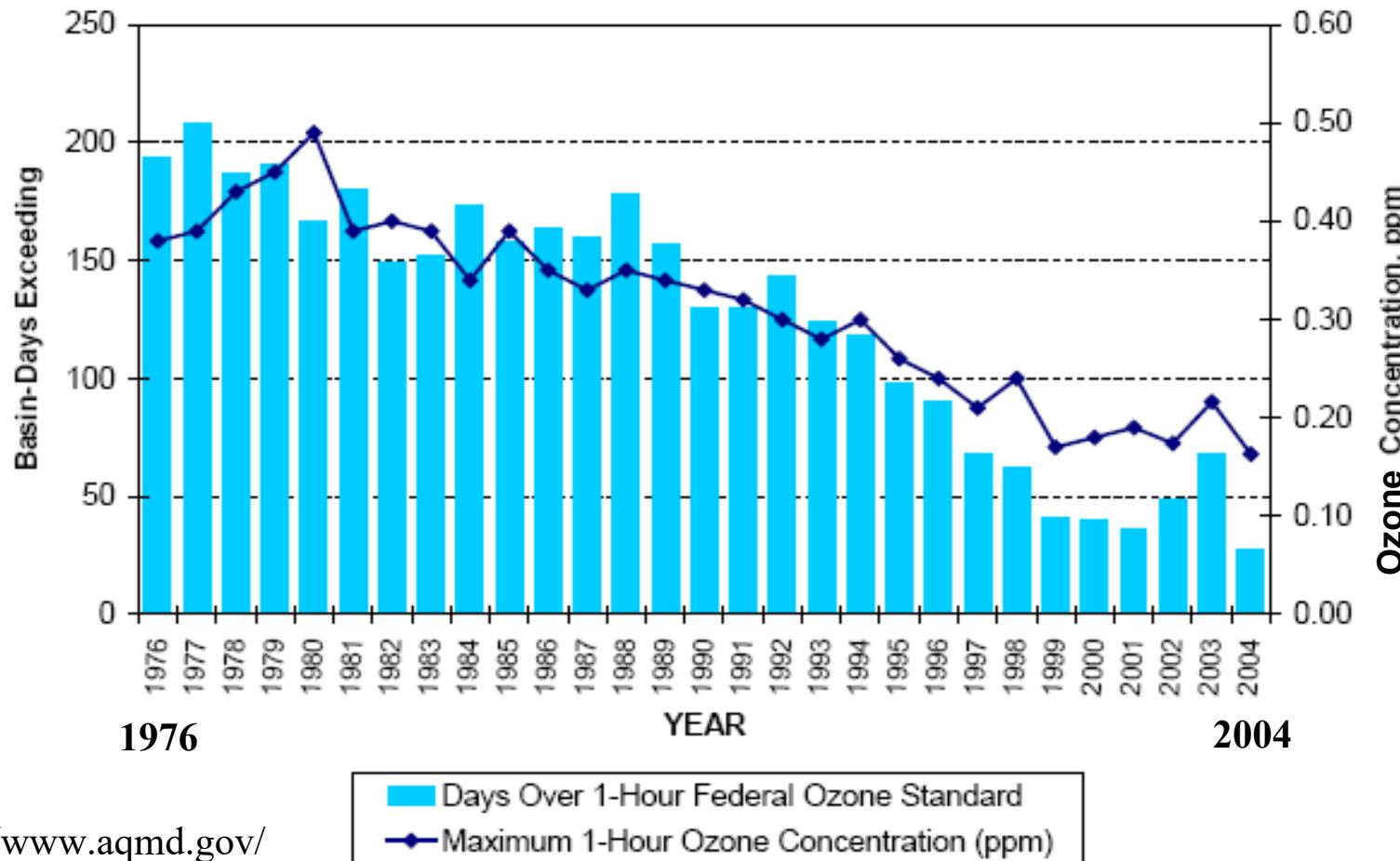
- Recognize the Problem
- Regulate Locally and Statewide
- Ban Home Incinerators
- Convert Local Industry
- Reduce Gasoline Effluents
  - Catalytic converters
  - Filling shields
  - Non-lead composition
  - Tests for smoggy cars



YOU, TOO, CAN GET RID OF THAT BACK-YARD EYESORE  
Pop Watson, 2217 Berkeley Ave., isn't waiting for the Tuesday deadline.

# Los Angeles Area Results

## South Coast Air Basin Smog Trend

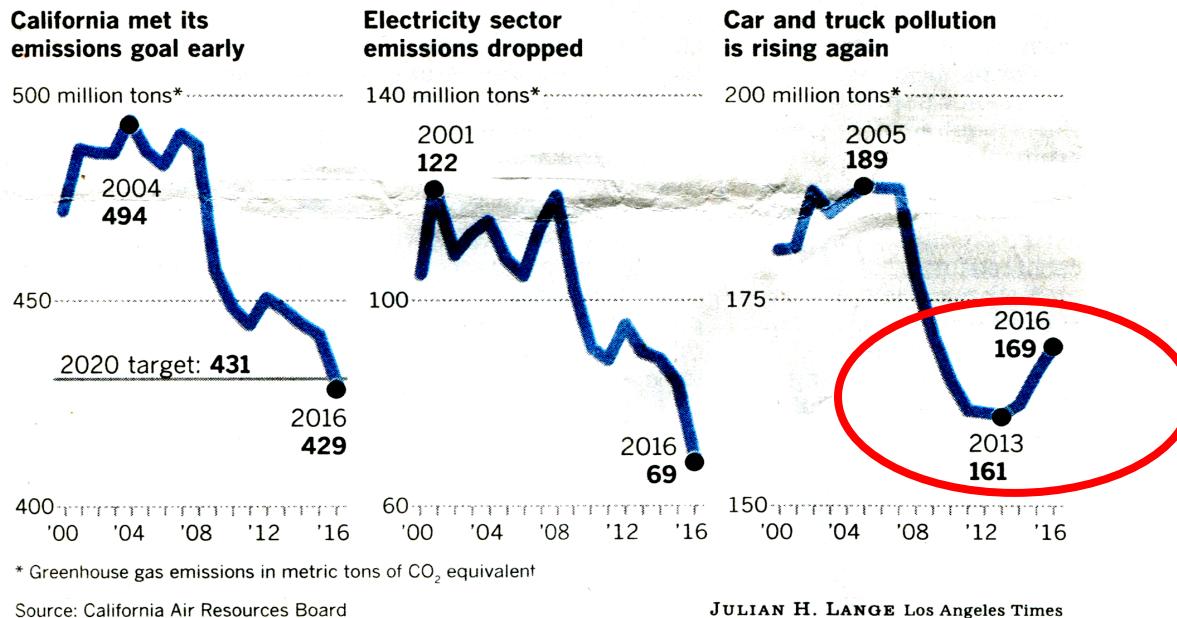


<http://www.aqmd.gov/>

# But Some Signs of Trouble I

## Climate milestone, but uneven progress

California's greenhouse gas emissions have dipped below 1990 levels, largely due to renewable energy growth. But rising pollution from the transportation sector makes future targets harder to reach.

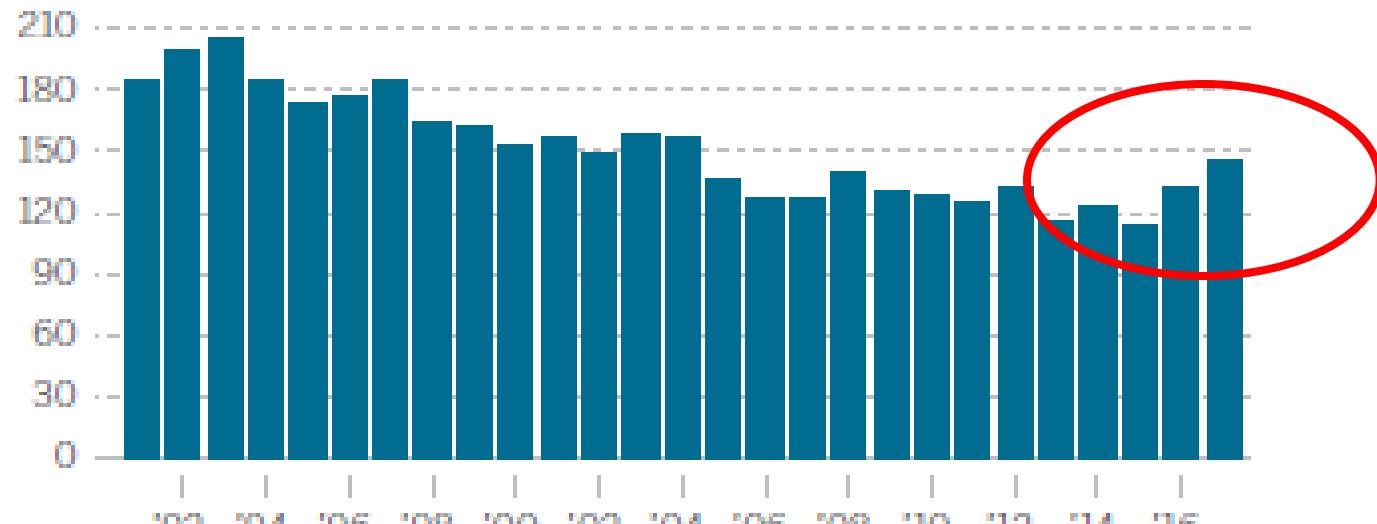


Los Angeles Times, July 24, 2018

Recent uptick in CA car emissions is apparently due to increased mileage.

# But Some Signs of Trouble II

Southern California bad air days for ozone



Source: South Coast Air Quality Management District      Tony Barboza / [@latimesgraphics](#)

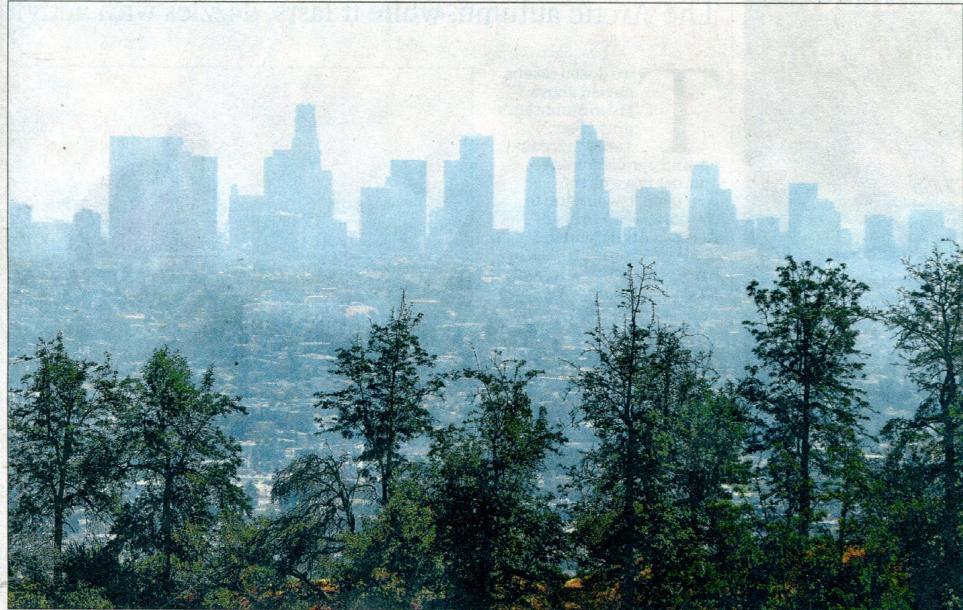
Uptick in general area ozone tracks the general increase in car emissions.

# But Some Signs of Trouble III

HER © 2018 WST



SATURDAY, SEPTEMBER 22, 2018



WALLY SKALIJ Los Angeles Times

**UNHEALTHFUL** summer haze is not unusual in Southern California, but this year's persistence is troubling.

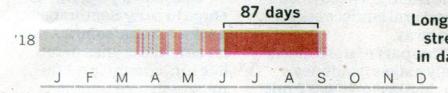
## L.A.'S BAD AIR DAYS

Ozone readings violated standards for nearly three months straight, the longest span in 20 years.

BY TONY BARBOZA

### Stretch of smoggy days

Ozone exceeded the federal health standard for 87 consecutive days in Southern California.



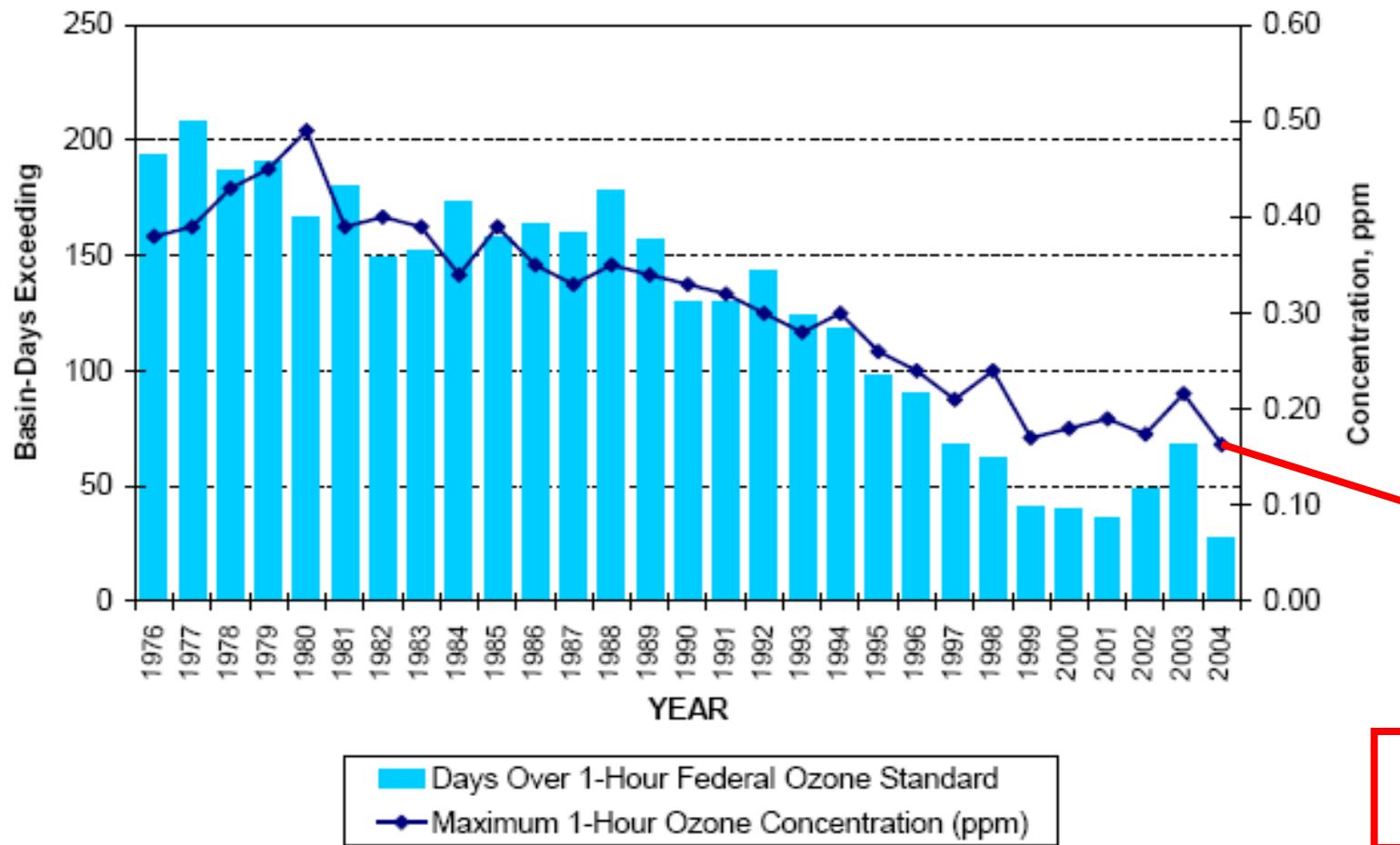
ades of dramatic improvement.

The ozone pollution spell began June 19 and continued through July and August, with every day exceeding the federal health standard of 70 parts per billion somewhere across Los Angeles, Orange, Riverside and San Bernar-

The public is starting to take notice. Will this require a new cycle of problem identification, regulation and solution? Will it be a success?

# Los Angeles' New Target

## South Coast Air Basin Smog Trend



# With Some Government Help

LATIMES.COM

Los Angeles Times

TUESDAY, APRIL 27, 2021 A9

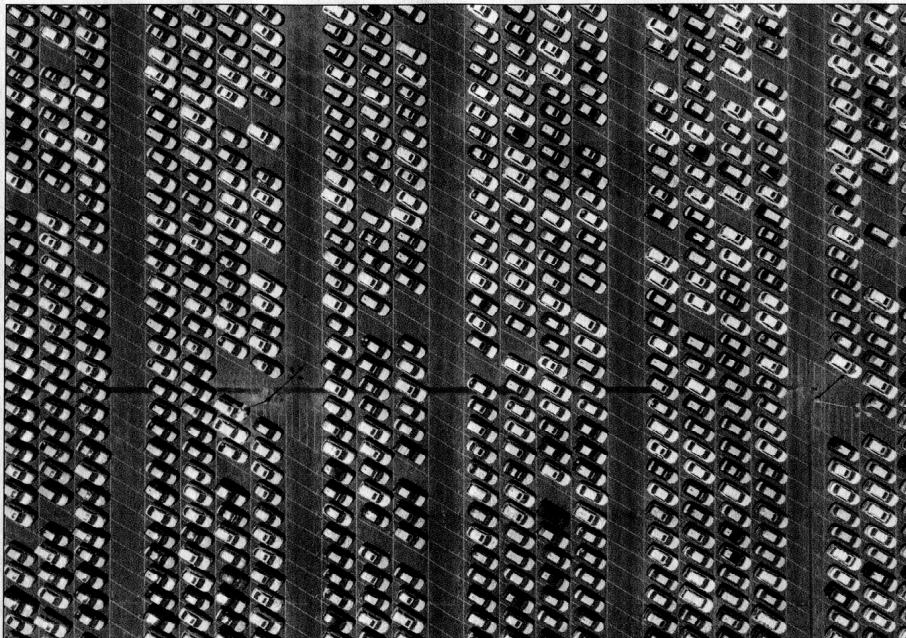
## EPA to restore state's power over car rules

[Pollution, from A1] follow California's more stringent standards, altogether accounting for nearly 40% of auto sales in the United States. A smaller number have also signed on to the state's mandate that automakers produce more zero-emission vehicles.

The agency's action was widely expected — and eagerly anticipated by state officials and environmentalists. Over the last five decades, every president except for George W. Bush and Trump accepted California's power to set its own tailpipe pollution rules under the 1970 Clean Air Act.

"I am a firm believer in California's long-standing statutory authority to lead," EPA Administrator Michael S. Regan said in a statement. "The 2019 decision to revoke the state's waiver to enforce its greenhouse gas pollution standards for cars and trucks was legally dubious and an attack on the public's health and well-being."

Gov. Gavin Newsom praised the move, saying the announcement "begins the process of restoring this critically important tool" to California and the other states that have followed its



ROBERT GAUTHIER Los Angeles Times

**RESTORING CALIFORNIA'S** special authority to set auto pollution standards could also pressure carmakers into accepting tougher national rules. Above, new vehicles at a Toyota yard in Long Beach last year.

roll back car pollution regulations, Nichols brokered a deal in 2019 with five automakers to reduce auto emissions — regardless of what the federal government did. The Biden administration is expected to use that agreement as a model for its talks with car manufacturers.

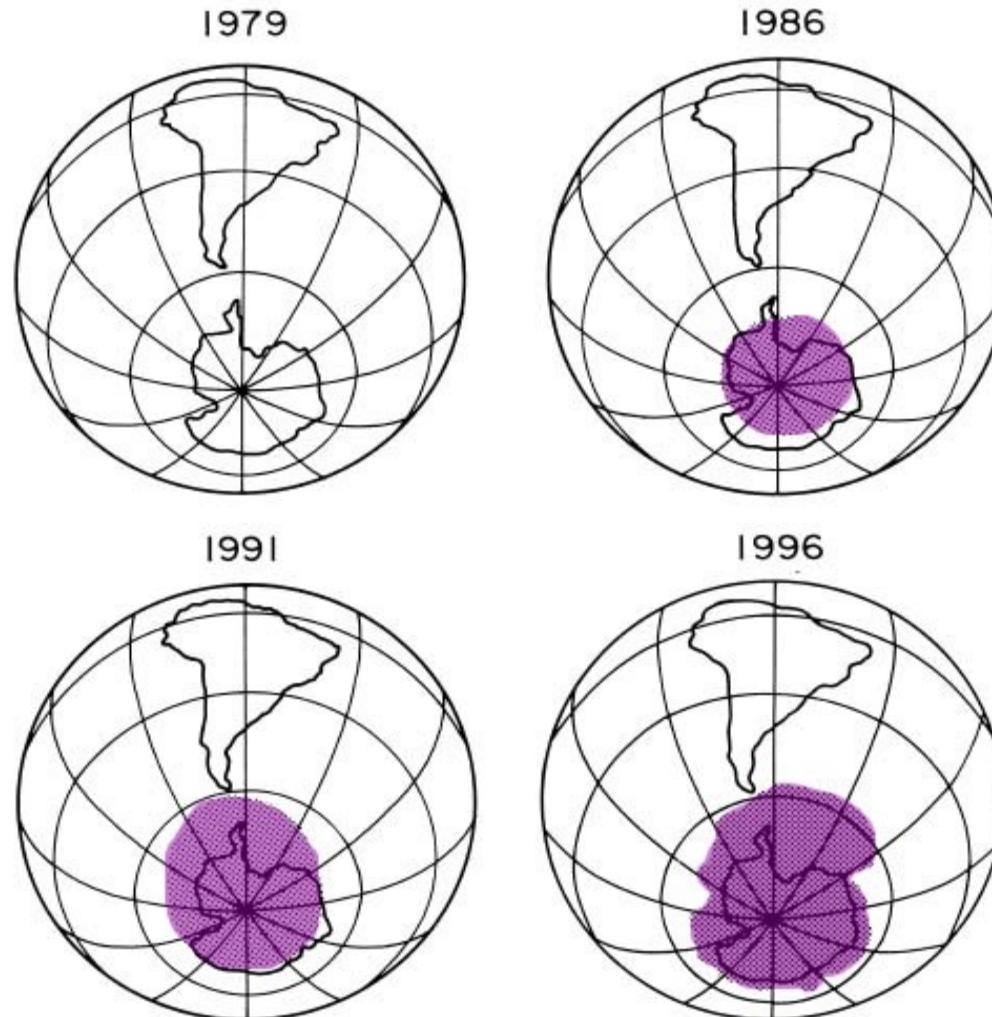
Some environmental groups say that deal doesn't do enough to reduce greenhouse gas emissions and prevent the worst effects of climate change. They want the Biden administration to hold automakers to the tougher standards they agreed to under Obama, which required new cars and SUVs to average about 36 miles per gallon under real-world driving conditions by 2025. Under the California agreement, car companies would have until 2026 to meet that standard.

General Motors and other automakers have argued that the tougher Obama-era standards aren't achievable because of Americans' continued preference for less-efficient SUVs and pickup trucks. They are expected to ask the Biden administration to require only small fuel-efficiency improvements over

The Biden administration is reversing Trump's actions against California

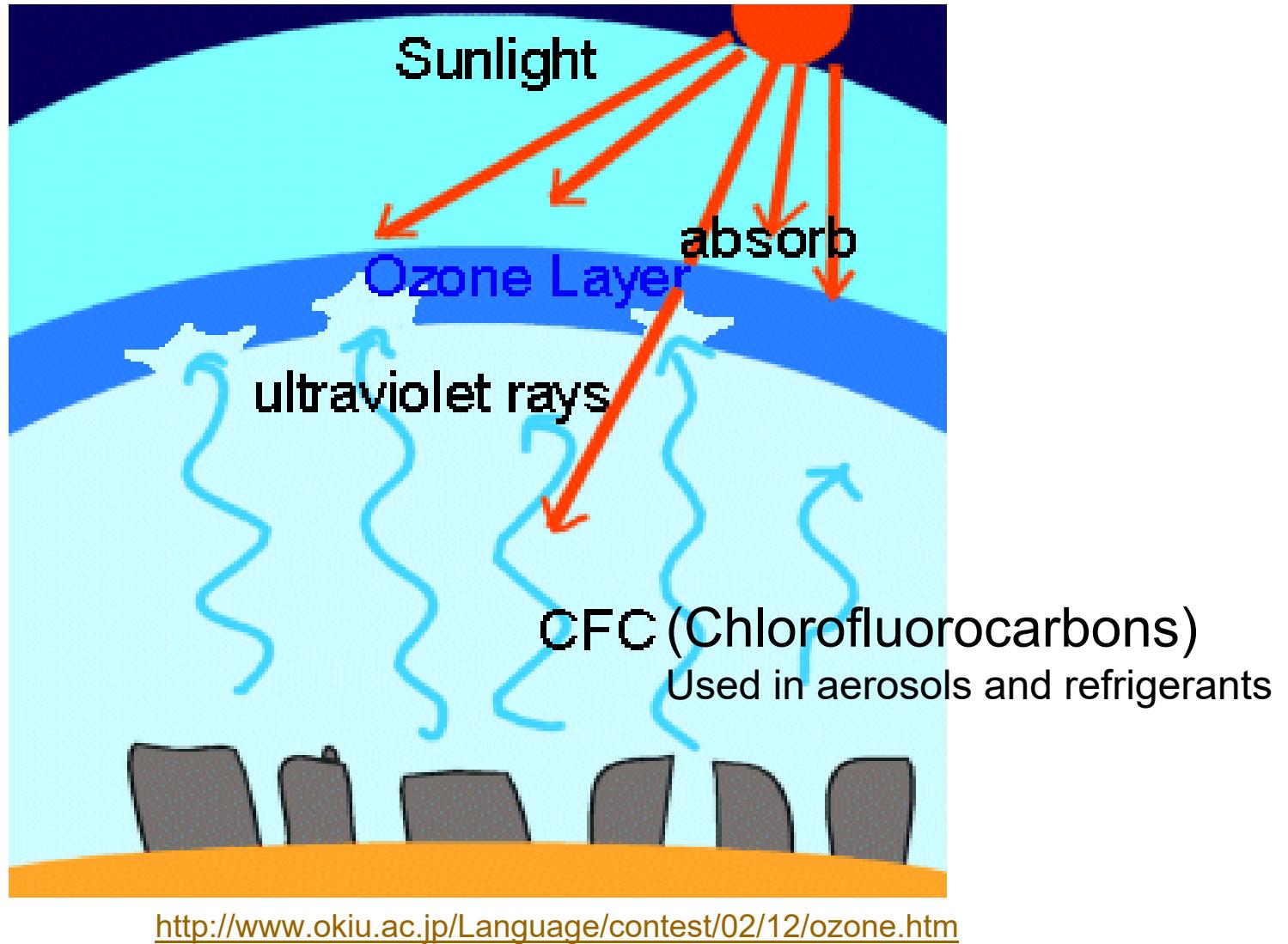
But the Supreme Court is scaling back the power of EPA to regulate

## Case Study 2: The Hole in the Ozone Layer

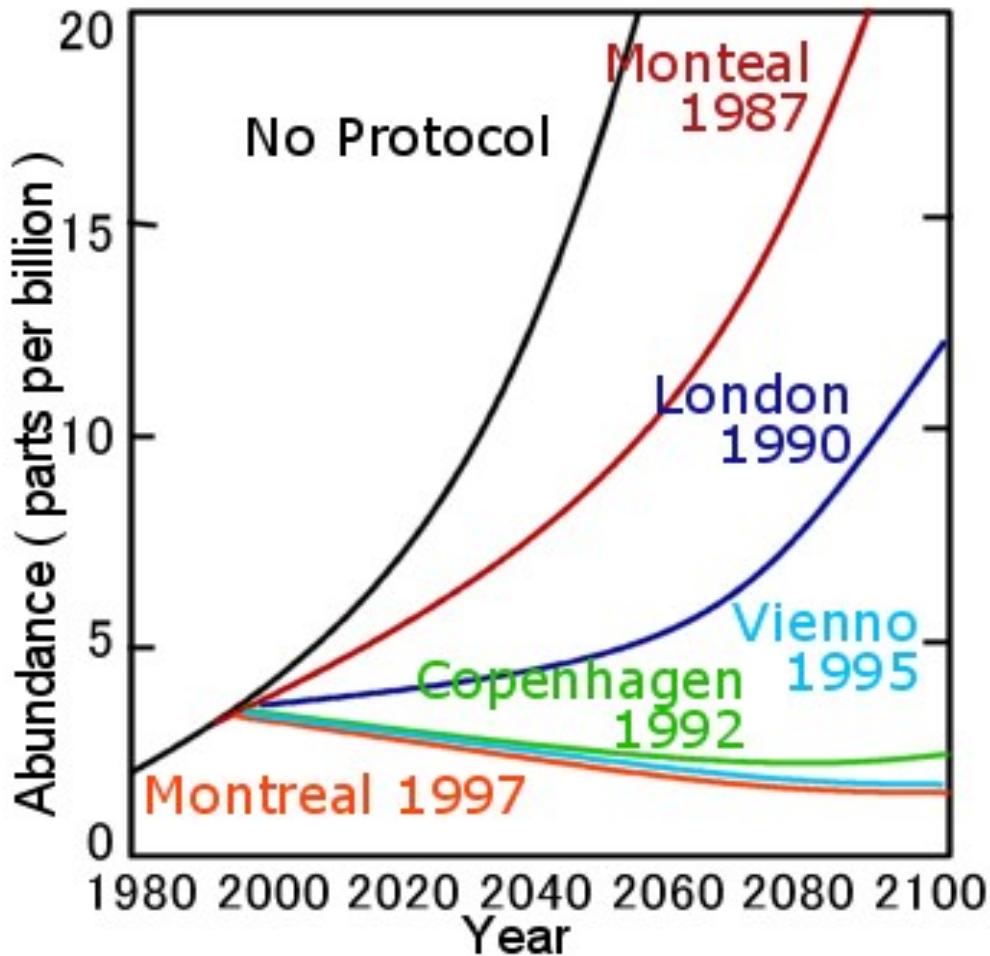


<http://www.okiu.ac.jp/Language/contest/02/12/ozone.htm>

# The Cause of the Hole

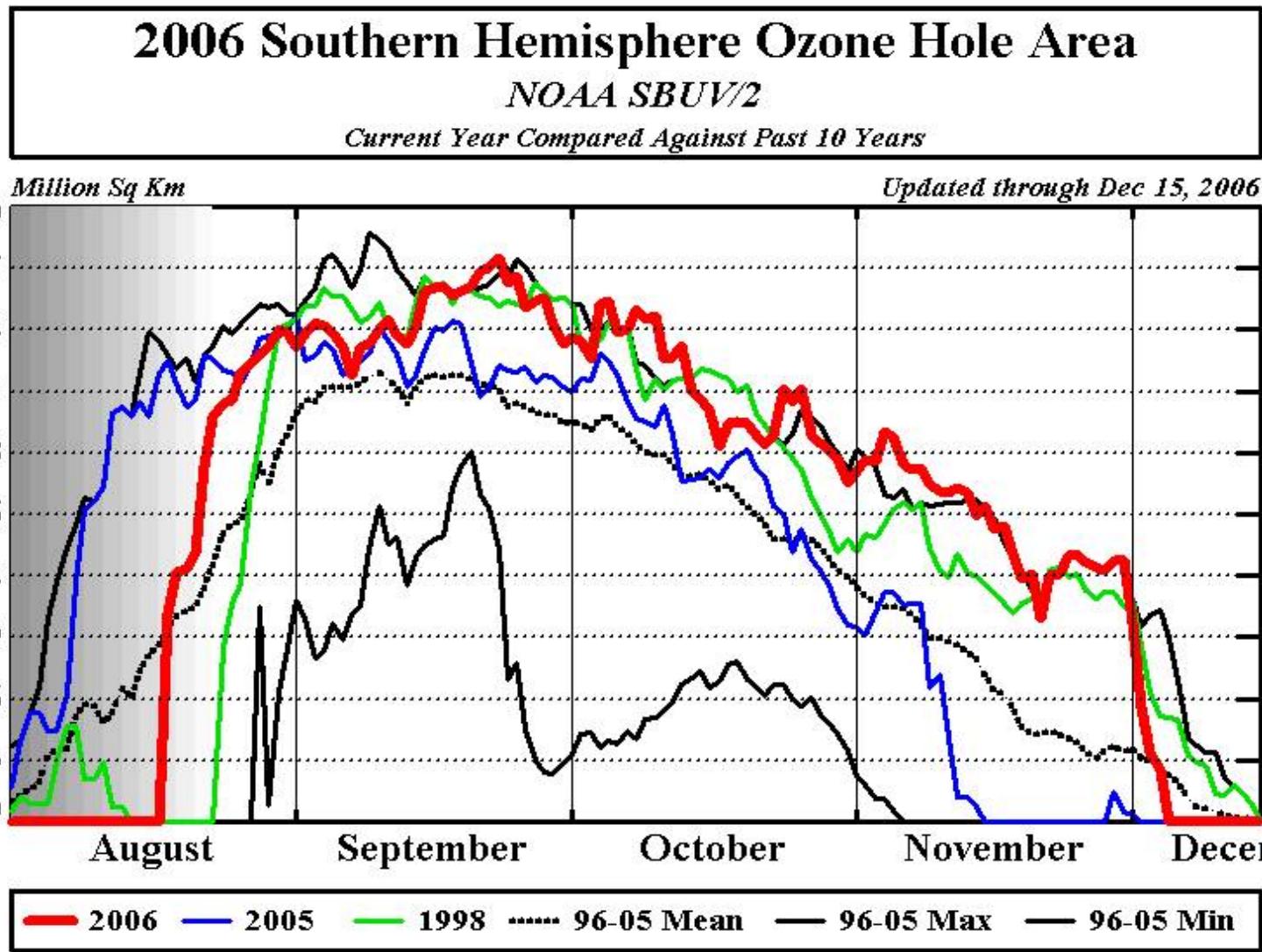


# Models of Emission-Limiting Protocols

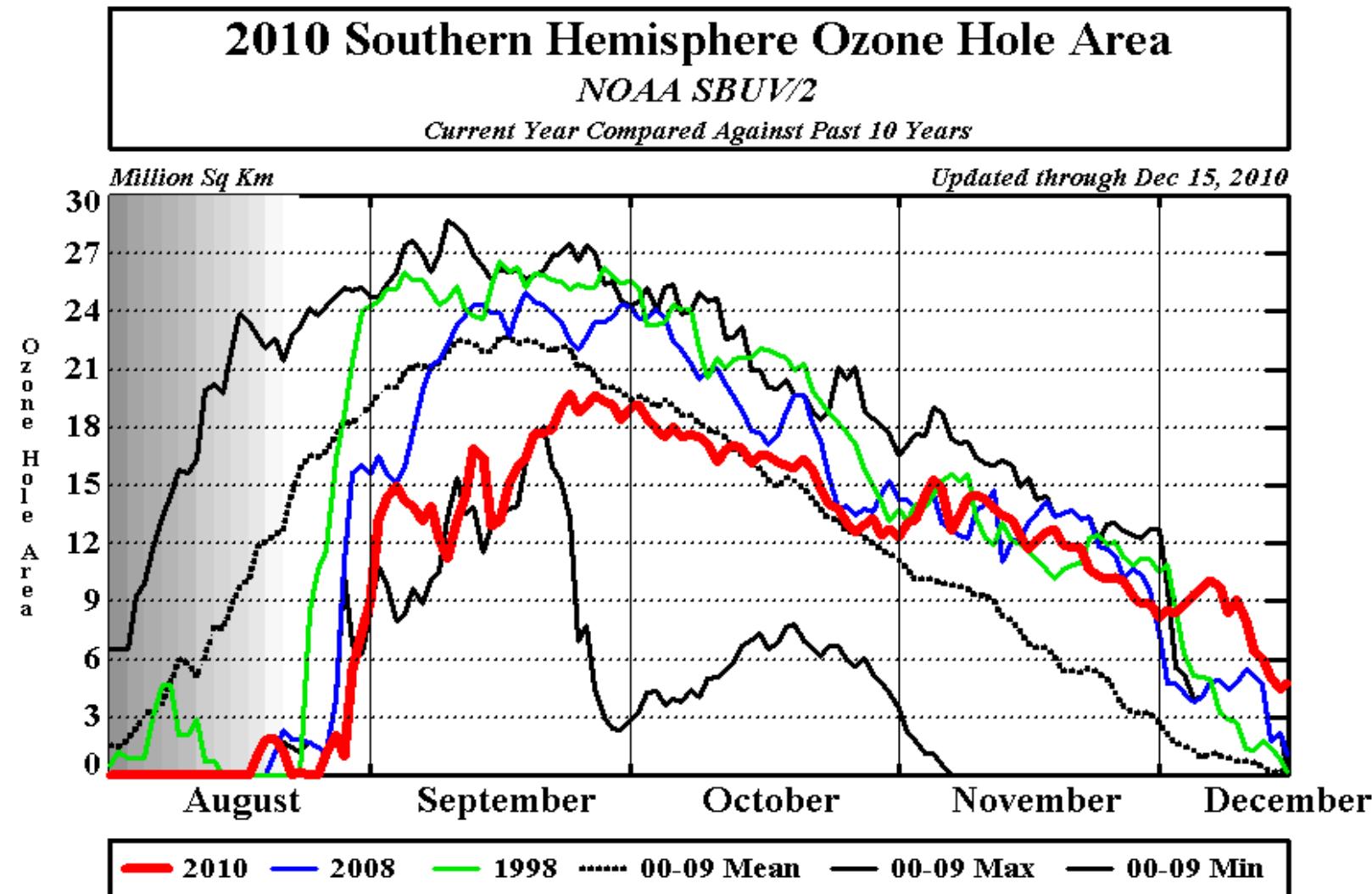


The protocols called for moving from CFCs to HFCs (hydrofluorocarbons)

# Initial Good Results



# Initial Good Results

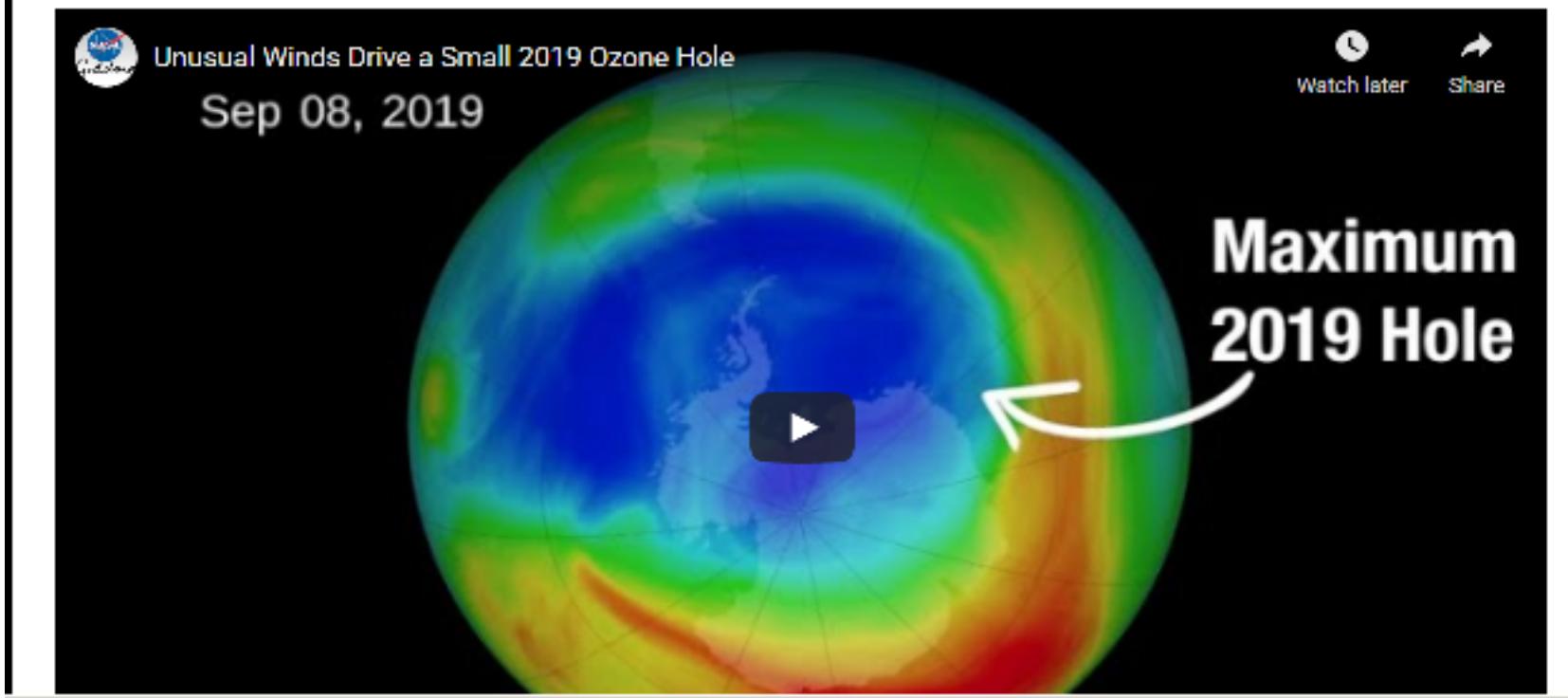


# With Continued Optimism...

## 2019 Ozone Hole is the Smallest on Record Since Its Discovery



Abnormal weather patterns in the upper atmosphere over Antarctica dramatically limited ozone depletion in September and October, resulting in the smallest ozone hole observed since 1982, NASA and NOAA scientists reported today.



# ...But 1<sup>st</sup> Solution is 2<sup>nd</sup> Problem

**Historic climate pact aims high**

Nearly 200 nations agree to phase out coolant once touted as ozone's savior.

BY WILLIAM YARDLEY

KIGALI, Rwanda—First they were a solution. Then they were a problem. Now they are being phased out.

Hydrofluorocarbons seemed like a straightforward remedy to a pressing environmental crisis of the 1980s: the depletion of the ozone layer caused by a worldwide rise in emissions of chemicals used in air conditioning and refrigeration.

Because the new compounds could do everything

to them as the perfect substitute. The swap was formalized in the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer.

In time, the protocol would be viewed as one of the most effective international environmental agreements in history. But the new chemicals were far from perfect.

The ozone layer, which protects against the sun's harmful rays, has recovered dramatically. But climate change is much worse, and hydrofluorocarbons, or HFCs, are partly to blame.

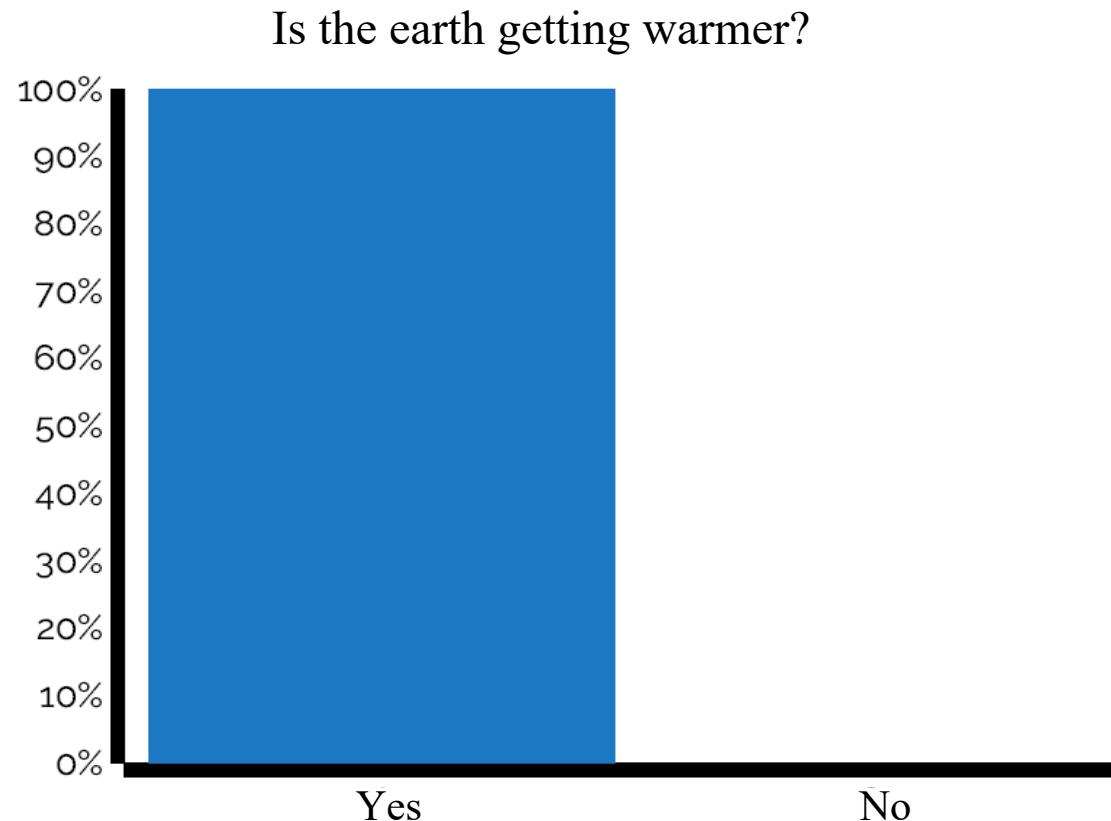
[See Climate, A4]

**Why are HFCs so important?**

The takeaway is that control of environmental problems is never ending.

The switch from chlorofluorocarbons to hydrofluorocarbons for aerosols and refrigerants helped the ozone hole problem, but began contributing severely to an even bigger problem – **human-caused climate change**. This is being addressed by a new agreement to move away from HFCs for refrigeration, which is growing rapidly in newly wealthy populations.

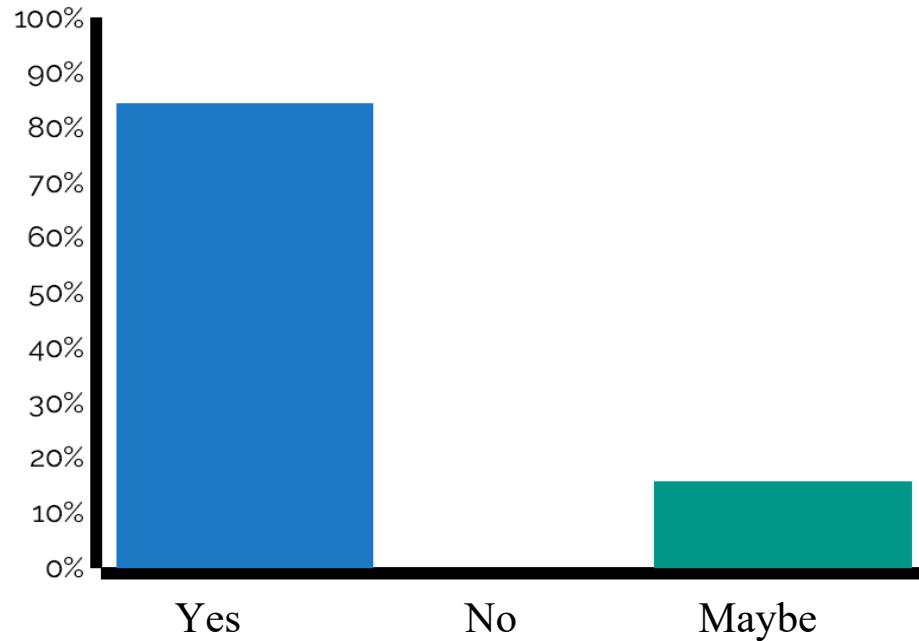
# Case Study 3: Climate Change – Is it Real?



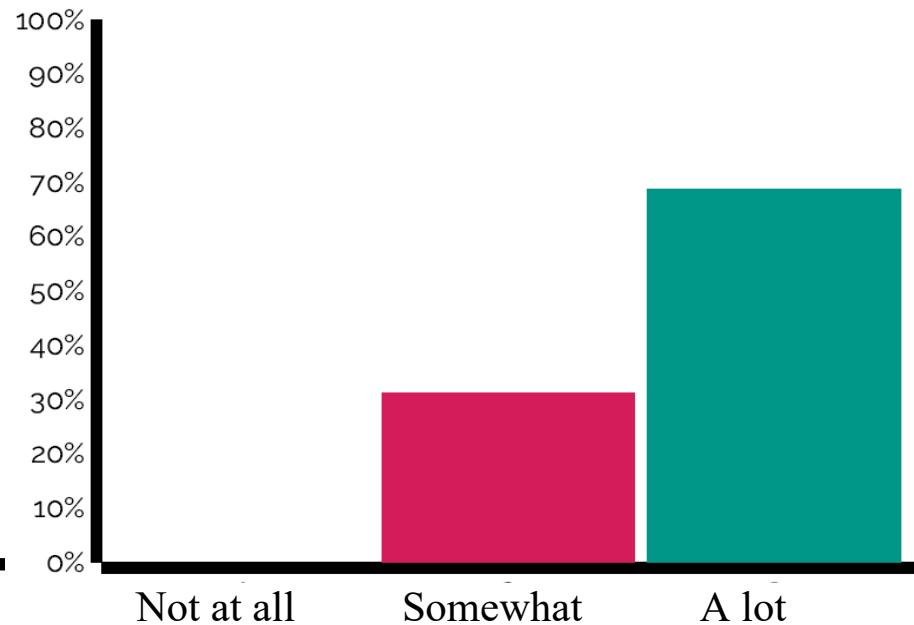
Bravo, 100% of a previous class believed the earth is warming.  
We will see that this is consistent with scientific findings.

# Online Poll Results 2

Is human activity a contributing factor?



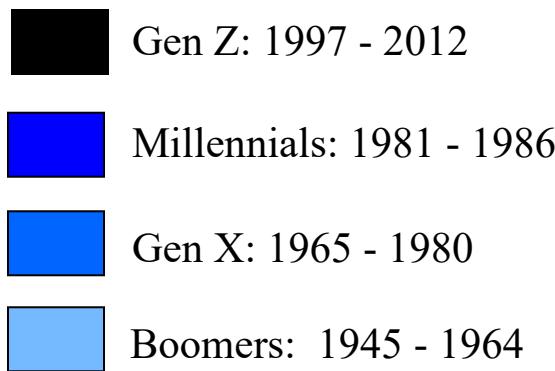
How worried should we be about this?



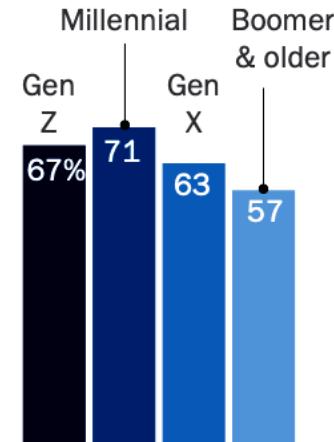
A full 100% of the class said yes or maybe to human contribution, and 100% were also somewhat or a lot worried – a rational level of knowledge and concern.

# Youth Leads

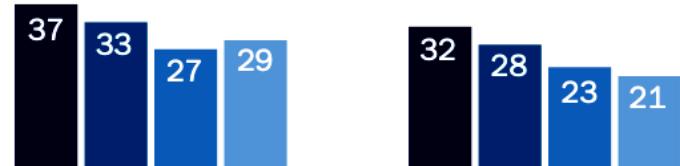
Born



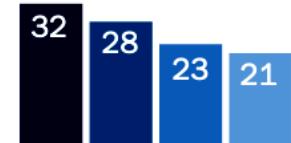
Climate should be top priority to ensure sustainable planet for future generations



Addressing climate change is my top personal concern

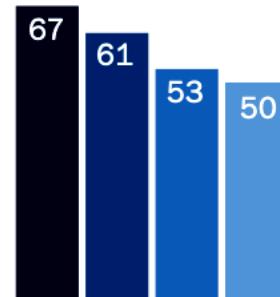


Have personally taken action to help address climate change within the last year

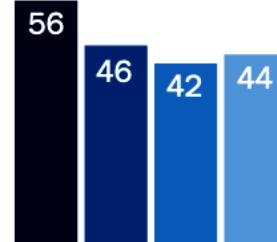


In the past few weeks ...

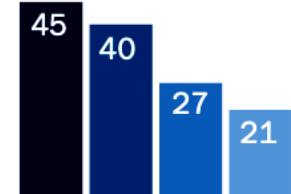
Talked about need for action on climate at least 1-2 times



Seen content on social media about need for climate action

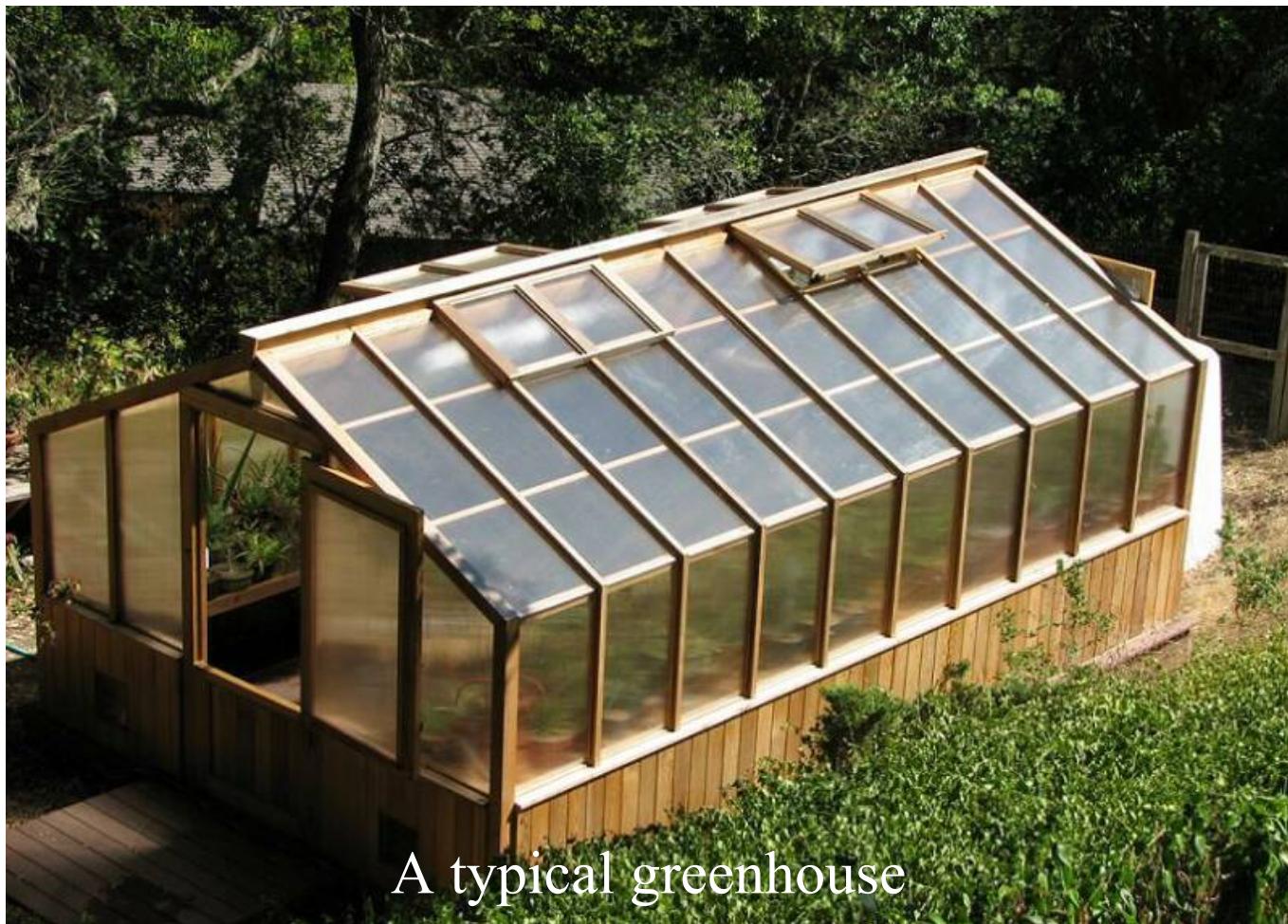


Engaged on social media with content on need for climate action



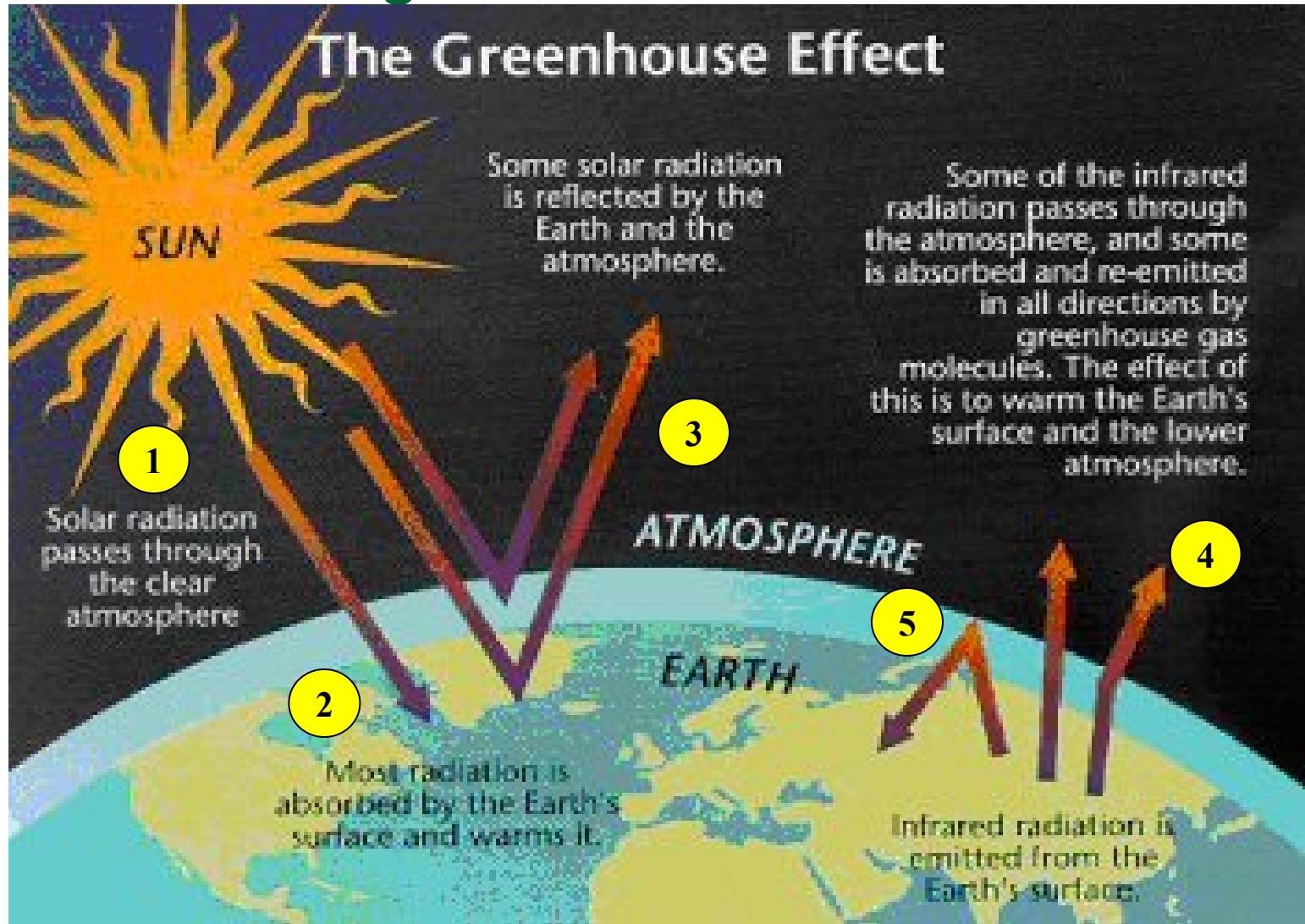
Pew Research Center; May 25, 2021

# Global Warming: “*The Greenhouse Effect*”



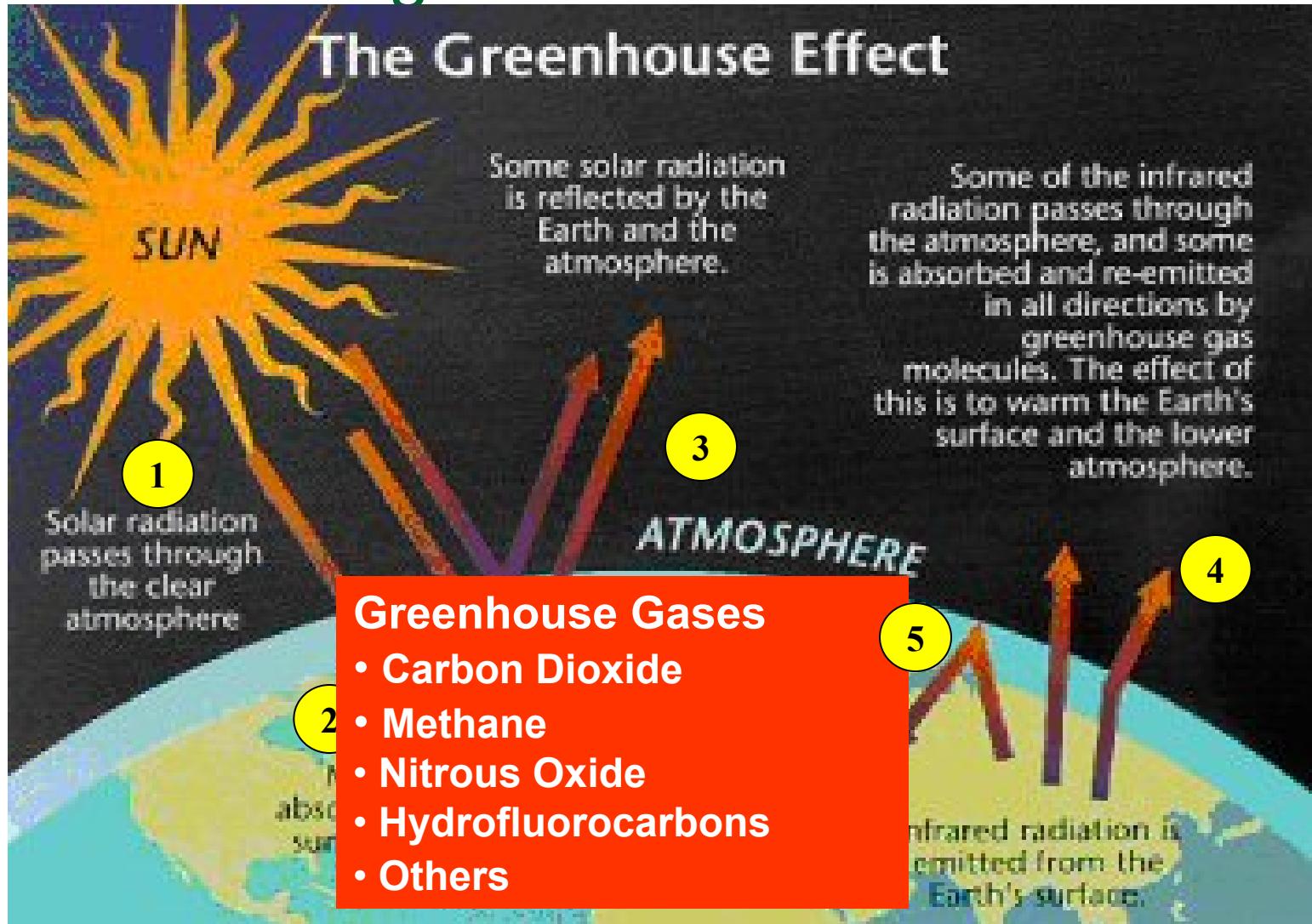
A typical greenhouse

# Global Warming: The Greenhouse Effect



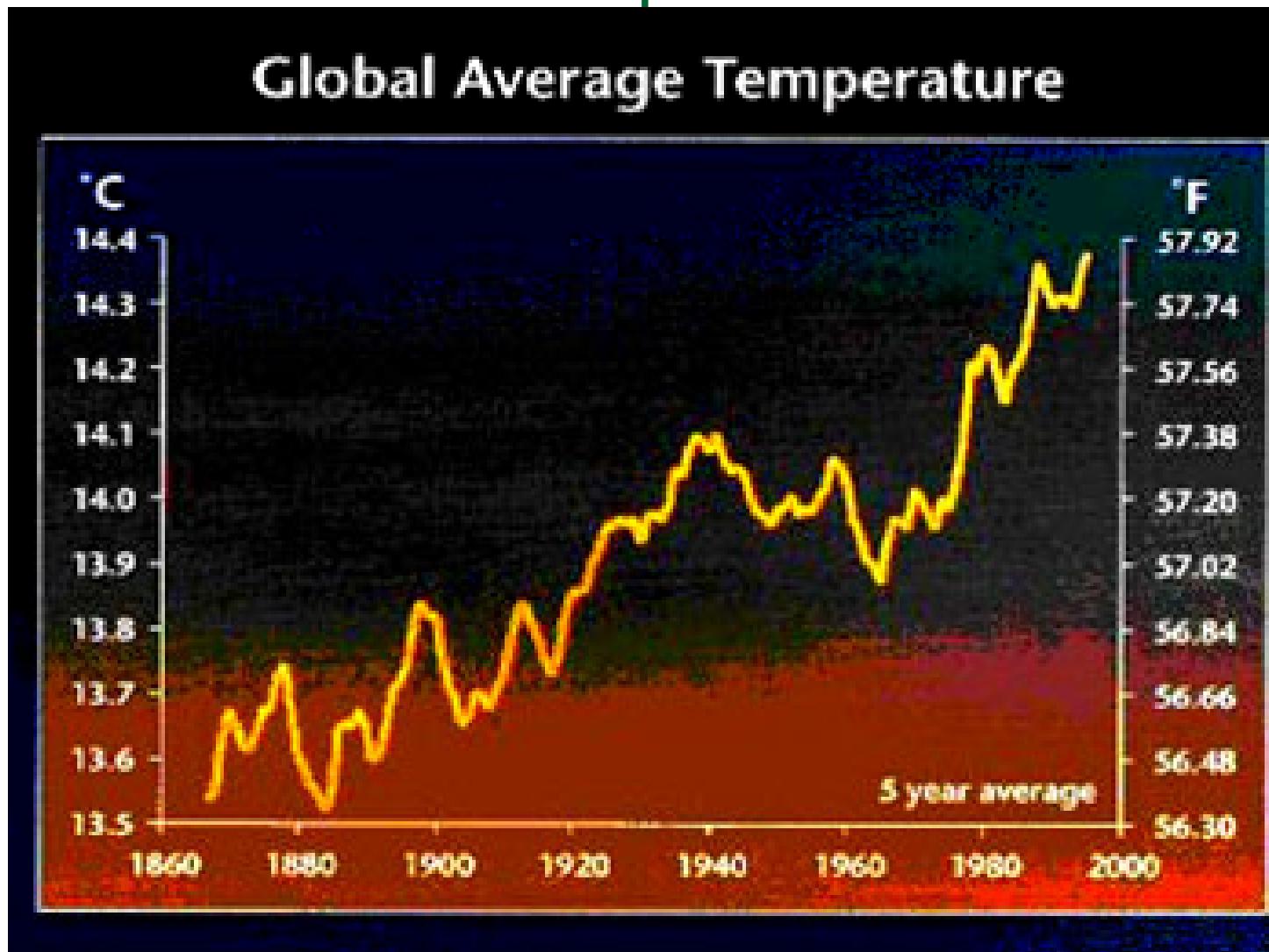
[http://www.ecy.wa.gov/programs/air/globalwarming/Global\\_Warming\\_site.html](http://www.ecy.wa.gov/programs/air/globalwarming/Global_Warming_site.html)

# Global Warming: The Greenhouse Effect



[http://www.ecy.wa.gov/programs/air/globalwarming/Global\\_Warming\\_site.html](http://www.ecy.wa.gov/programs/air/globalwarming/Global_Warming_site.html)

# Increase in Global Temperature



[http://www.ecy.wa.gov/programs/air/globalwarming/Global\\_Warming\\_site.html](http://www.ecy.wa.gov/programs/air/globalwarming/Global_Warming_site.html)

# Increase in Greenhouse Gases

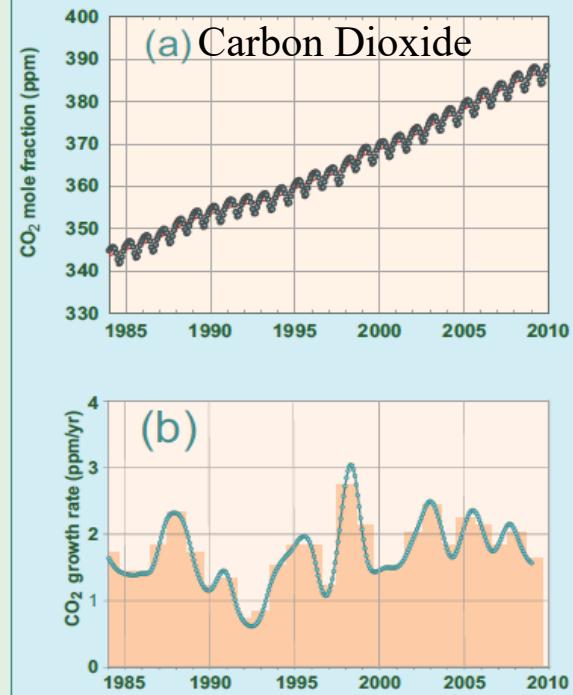


Figure 3. Globally averaged CO<sub>2</sub> mole fraction (a) and its growth rate (b) from 1984 to 2009. Annually averaged growth rate is shown by columns at (b).

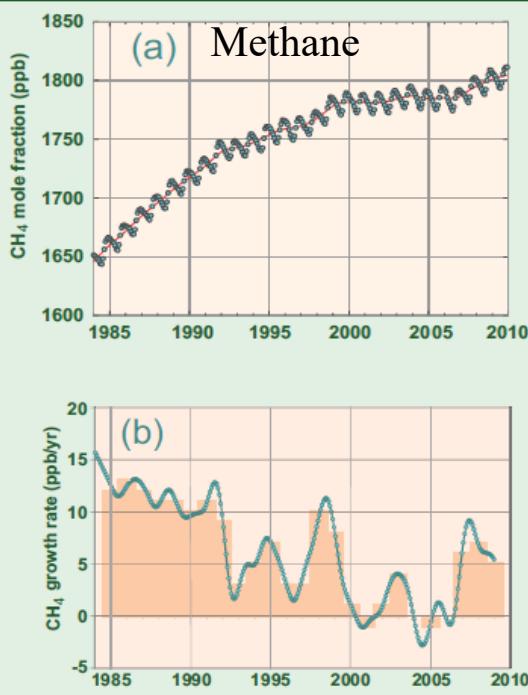


Figure 4. Globally averaged CH<sub>4</sub> mole fraction (a) and its growth rate (b) from 1984 to 2009. Annually averaged growth rate is shown by columns at (b).

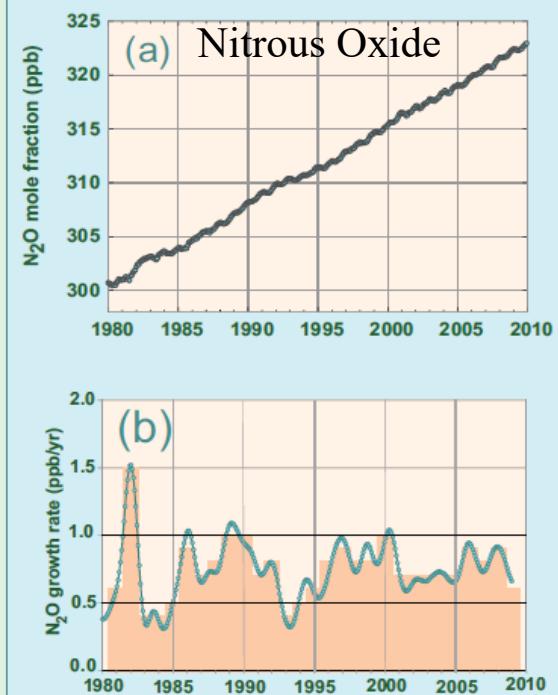
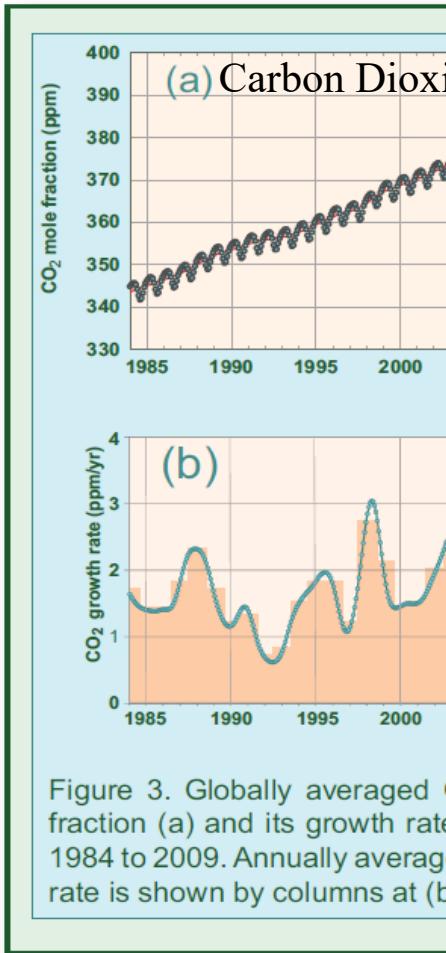


Figure 5. Globally averaged N<sub>2</sub>O mole fraction (a) and its growth rate (b) from 1980 to 2009. Annually averaged growth rate is shown by columns at (b).

World Meteorological Association Bulletin, November 2010

# Increase in Greenhouse Gases



Copyright Gershon Weltman, 2020

## Greenhouse gas levels reach new record in 2020

U.N. report finds rate of increase surpassed previous averages, even as lockdowns led to a drop in emissions.

ASSOCIATED PRESS

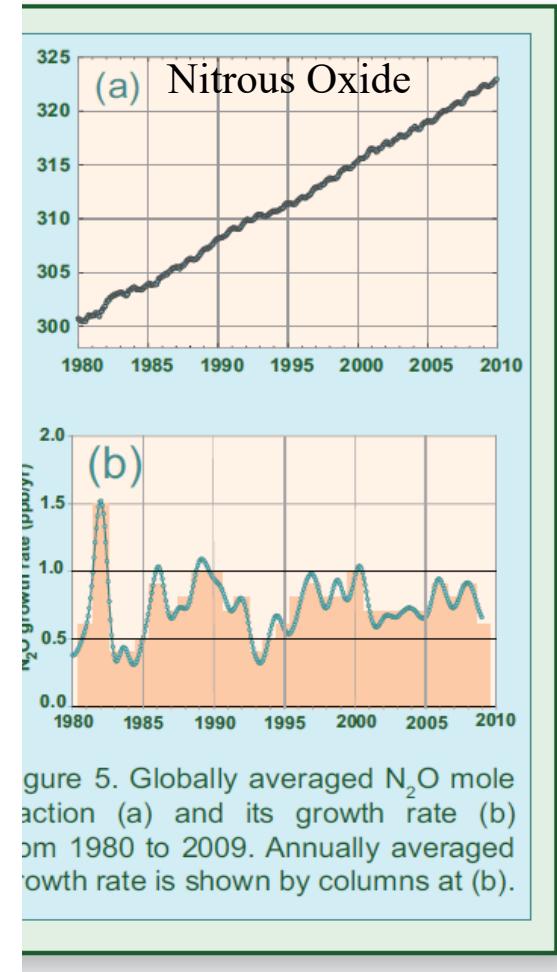
GENEVA — Greenhouse gas concentrations hit a new record high last year and increased at a faster rate than the annual average for the last decade despite a temporary reduction during pandemic-related lockdowns, the World Meteorological Organization reported Monday.

sius [2.7 to 3.6 degrees Fahrenheit] above preindustrial levels.

"We are way off track," he said.

The report draws on information collected by a network that monitors the amount of greenhouse gases that remain in the atmosphere after some quantities are absorbed by oceans and the biosphere.

"One of the striking messages from our report is that the Amazonian region, which used to be a sink of carbon, has become a source of carbon dioxide," Taalas said. "And that's because of deforestation. It's because of changes of the global local climate, especially. We have



# Emitters We've Talked About



Power Plants In Colstrip, Mont. (Associated Press/Billings Gazette, Larry Mayer)



A Crowded Street In The Southern Indian City Of Bangalore. (Credit: Reuters)

# The Heating Trend Continues

## For U.S., 2017 was a hot and costly year

Weather and climate disasters set the nation back a record \$306 billion, NOAA statistics show.

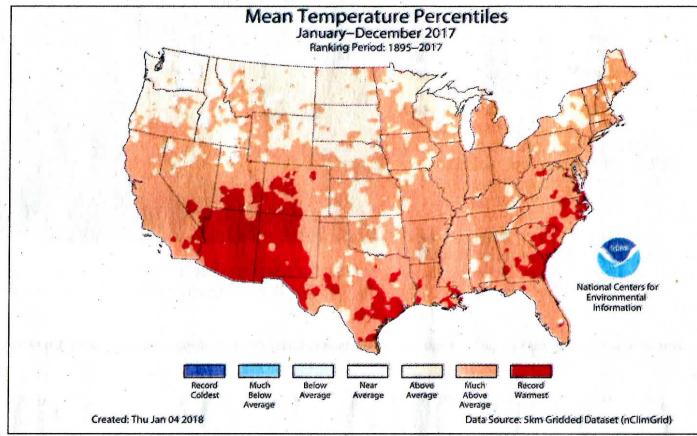
**AMINA KHAN**

The year 2017 was the third-warmest on record for the United States, and featured a pileup of weather and climate disasters that cost the nation a record \$306 billion, according to the National Oceanic and Atmospheric Administration.

The preliminary data released by NOAA's National Centers for Environmental Information serve as another indication that climate change shows little sign of relenting — with troubling implications for the risk of extreme weather and climate events in the future.

"Clearly, 2017 underscores what we've seen in the past with regard to better mitigating our risk and enhanced frequency of weather and climate extremes," Adam Smith, an applied climatologist at NOAA, said at a briefing Monday.

Here are some highlights from the NOAA report.



**THIS MAP** shows the temperature percentiles for 2017 over the contiguous United States. Several states saw their highest-ever annual temperatures.

— have taken place since 2006.

With heat hitting parts of the Southwest, the southern Plains and the Southeast, several individual states saw their highest-ever annual temperatures: Arizona, New Mexico, Georgia, North Carolina and South Carolina. Thirty-two states, including Alaska, had annual temperatures that ranked in their top-10 warmest. Some areas, such as part of the interior North-

row.

Last year also marks the 21st year in a row that the average annual temperature has been higher than the 1901-2000 average, Crouch said.

### Extremes

The year 2017 also included 16 weather and climate disasters with losses exceeding \$1 billion each — two inland floods, one freeze event, eight severe storms, three tropical cyclones, as

include the massive Northern California fires last fall as well as the blazes that burned through Southern California in December.

Last year was also the country's 20th-wettest on record, as well as the fifth year in a row that had above-average precipitation. The year started with a very wet winter for the Northwest, but ended with the ninth-driest December on record. This helped lay the deadly groundwork for the fires that scarred California, the scientists pointed out.

"The really wet winter there allowed vegetation to flourish, and then during the typically dry summer and autumn period that vegetation dried out — providing ample fuels for wildfires," Crouch said. "It's been a pretty devastating year out west, in that respect."

### What's to blame

The scientists could not say how much of the high costs of this year's major disasters was attributable to risks associated specifically with global warming and climate change, and how much was attributable to the fact that humans tend to live in cities and build vital infrastructure along coasts, rivers and

### Lottery results

For Saturday, Jan. 13, 2018

**SuperLotto Plus**  
Mega number is bold

3-24-28-33-40—**Mega 27**

**Jackpot:** \$14 million

**Winners per category:**

	No. of winners	Amount of prize(s)
5 + Mega	0	—
5	2	\$18,282
4 + Mega	16	\$1,142
4	288	\$105
3 + Mega	503	\$54
3	12,741	\$10
2 + Mega	6,609	\$11
1 + Mega	33,045	\$2
Mega only	50,407	\$1

### Powerball

Powerball number is bold

14-25-35-58-69—**Powerball 24**

**Jackpot:** \$50 million

**California winners per category:**

	No. of winners	Amount of prize(s)
5 + P-ball	0	—
5	0	—
4 + P-ball	1	\$30,672
4	38	\$403
3 + P-ball	75	\$212
3	2,240	\$8
2 + P-ball	1,760	\$9
1 + P-ball	13,990	\$5
P-ball only	34,351	\$4

Winning jackpot ticket(s) sold in other states: None

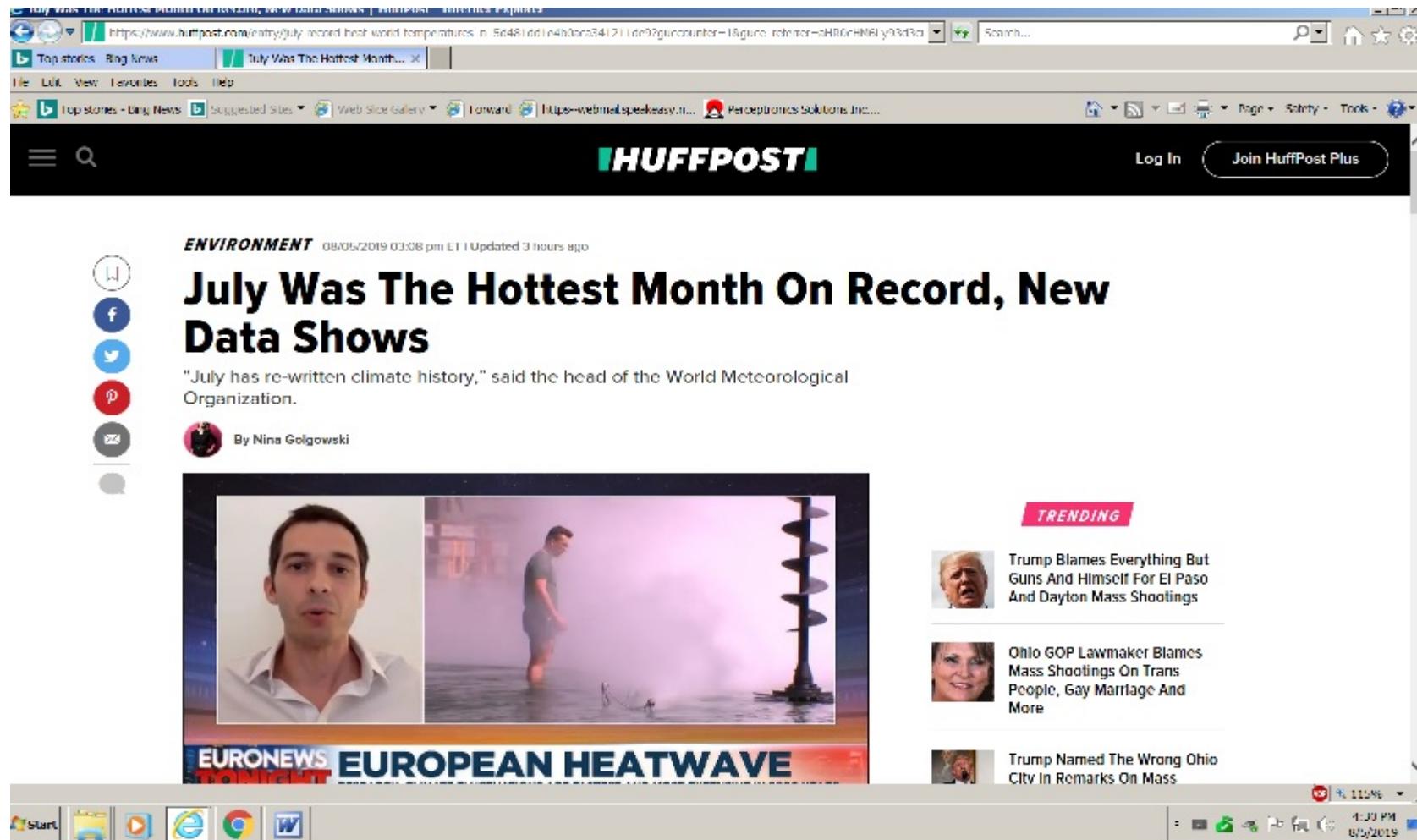
For Sunday, Jan. 14, 2018

**Fantasy Five:** 13-23-25-31-37

**Daily Four:** 2-2-8-2

2015 was hotter than 2014, 2016, 2017 was second hottest, 2018 was in the top four.

# July 2019 Hottest Ever



# July 2021 Even Hotter

Apps Suggested Sites Forward Mail (3) Webmail... https://webmail.speak... Imported From 1P Webmail 2.0 Speak! 2.0 Mail gwt

**npr**

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ENVIRONMENT

f July Was The Hottest Month In Recorded Human History

August 13, 2021 · 4:12 PM ET

JOE HERNANDEZ



Start | File | Back | Forward | Home | Favorites | Help | Search | Stop | Refresh | Windows | Google | Microsoft | YouTube | Gmail | Wikipedia

# 2023 Hottest Ever

 The New York Times

## BREAKING NEWS

**It's official: 2023 was Earth's warmest year in a century and a half, with temperatures breaking records month after month.**

Tuesday, January 9, 2024 7:21 AM ET

Averaged across the year, temperatures were 1.48 degrees Celsius, or 2.66 Fahrenheit, higher than they were in the second half of the 19th century, E.U. scientists confirmed. This year may be even hotter.

# People Are Already Suffering

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• **LIVE UPDATES**

## Millions face extreme heat in the US, Europe and China

By Helen Regan, Adam Renton, Christian Edwards, Lauren Said-Moorhouse, Aditi Sangal, Adrienne Vogt, Tori B. Powell, Maureen Chowdhury and Elise Hammond, CNN

Updated 7:25 PM ET, Tue July 18, 2023



See what it's like in Rome amid record-breaking heat 02:36

### What we're covering

- Blisteringly **high temperatures** are being reported across the world, breaking records on multiple continents — the latest in a trend caused by the **climate crisis**. The first week of July was the **hottest week on record**, data shows.
- Southern Iran registered a heat index value — the apparent “feels like”

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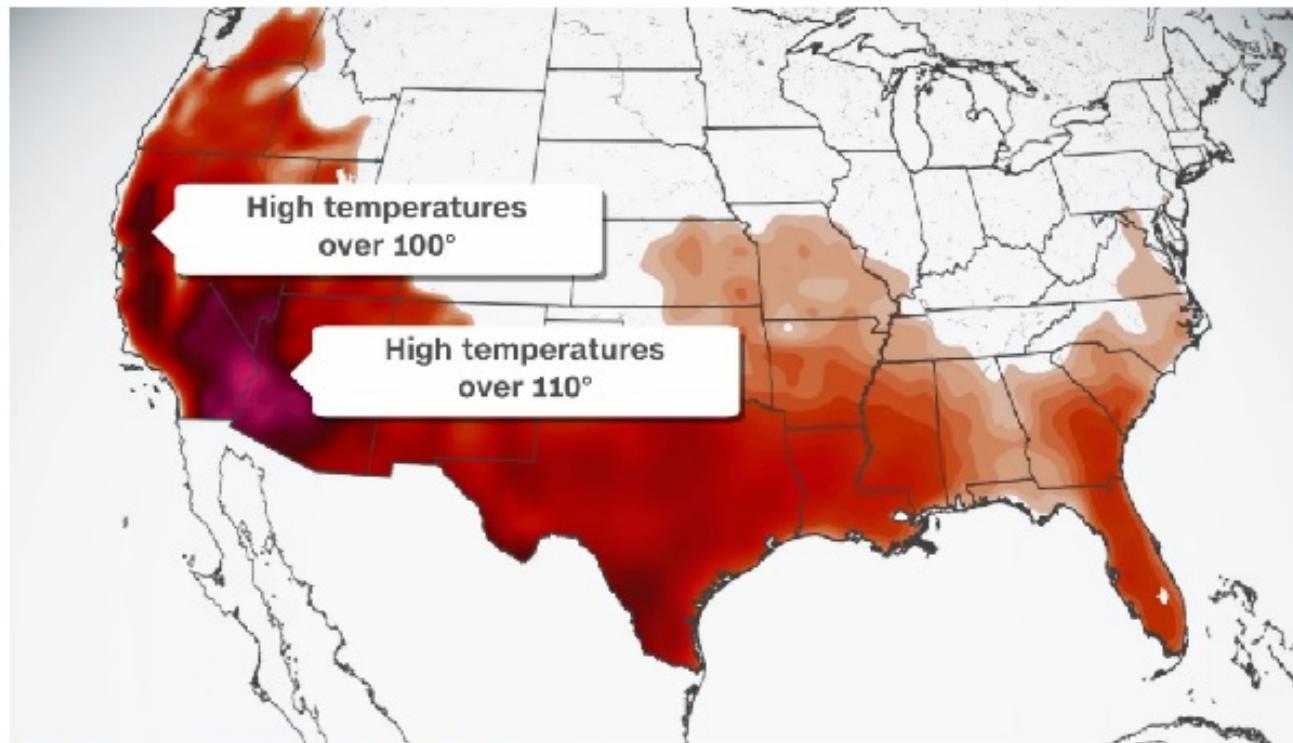
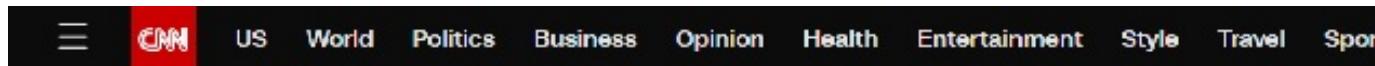
12 min ago

### Miami-Dade County considers heat protection ordinance for outdoor workers

From CNN's Carlos Suarez

Miami-Dade County could soon mandate certain protections from the heat for outdoor workers including breaks in the shade and water while on the job.

# The Problem is Immediate and Local



All of the areas shaded in red will exceed 90 degrees on Saturday.

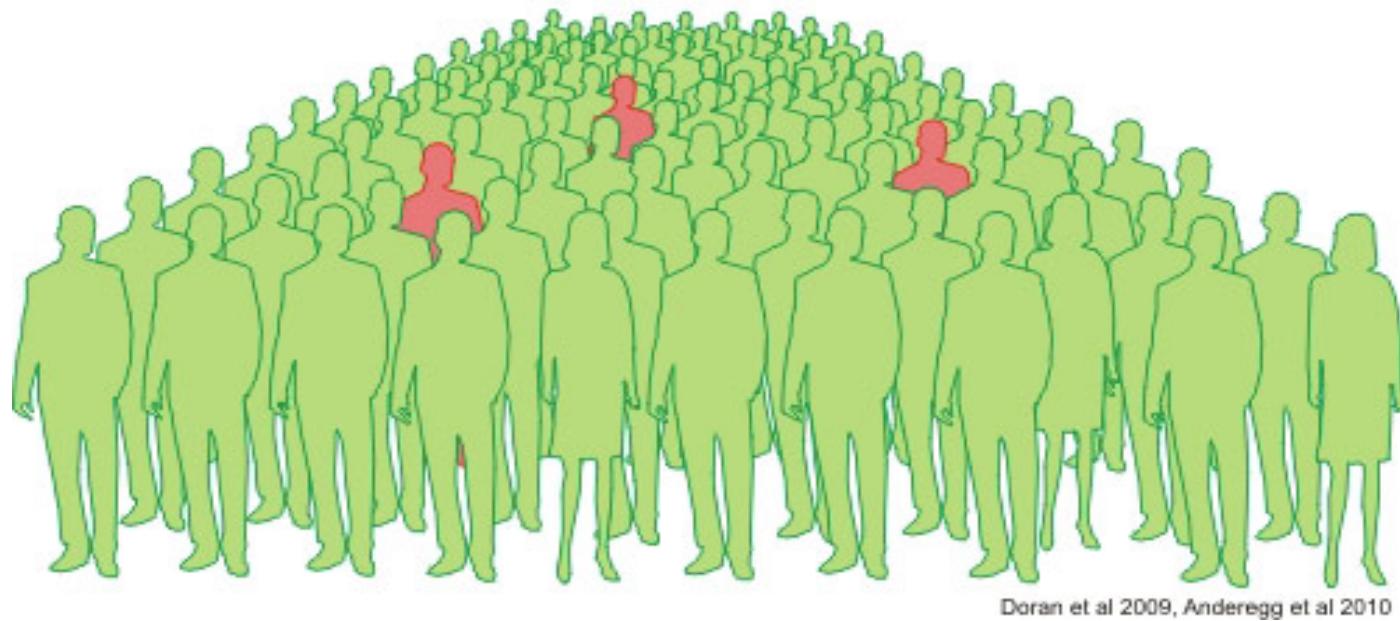
Before the latest wave, heat has already killed at least 12 people in Phoenix's Maricopa County this year, and killed 425 people last year. The city has opened "respite centers" to help provide relief and the state has asked residents to keep their vehicles stocked with water.

# Causes, Effects & Solutions

- Causes of Temperature Change
  - Natural Cycle? Something new?
  - Human contribution? Science Implicates us.

# In 2010: Most Climate Scientists Agreed

97 out of 100 climate experts think humans are changing global temperature



# In 2023: Virtually All Climate Scientists Agreed

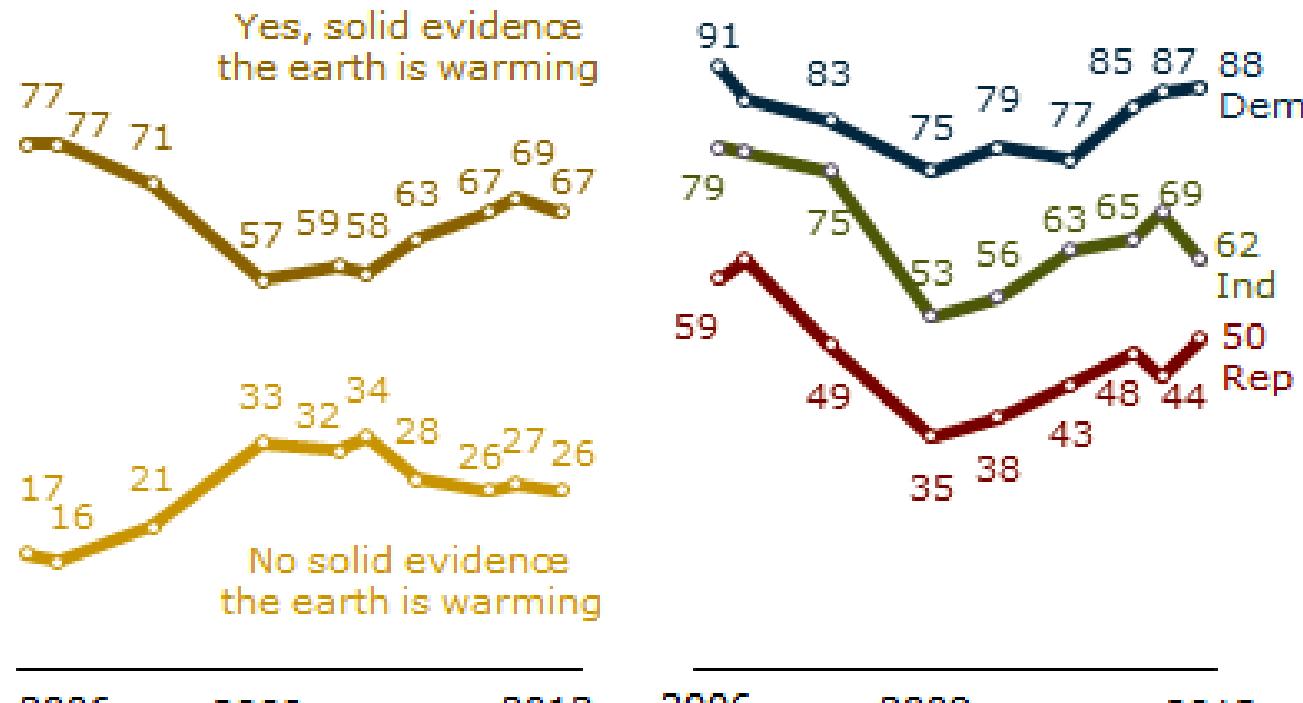
**99 out of 100 climate experts think  
humans are changing global temperature**



The United Nations' Intergovernmental Panel on Climate Change report issued August 9, 2021 concludes it is "unequivocal" that humans have caused the climate crisis and confirms that "widespread and rapid changes" have already occurred, some of them irreversibly.

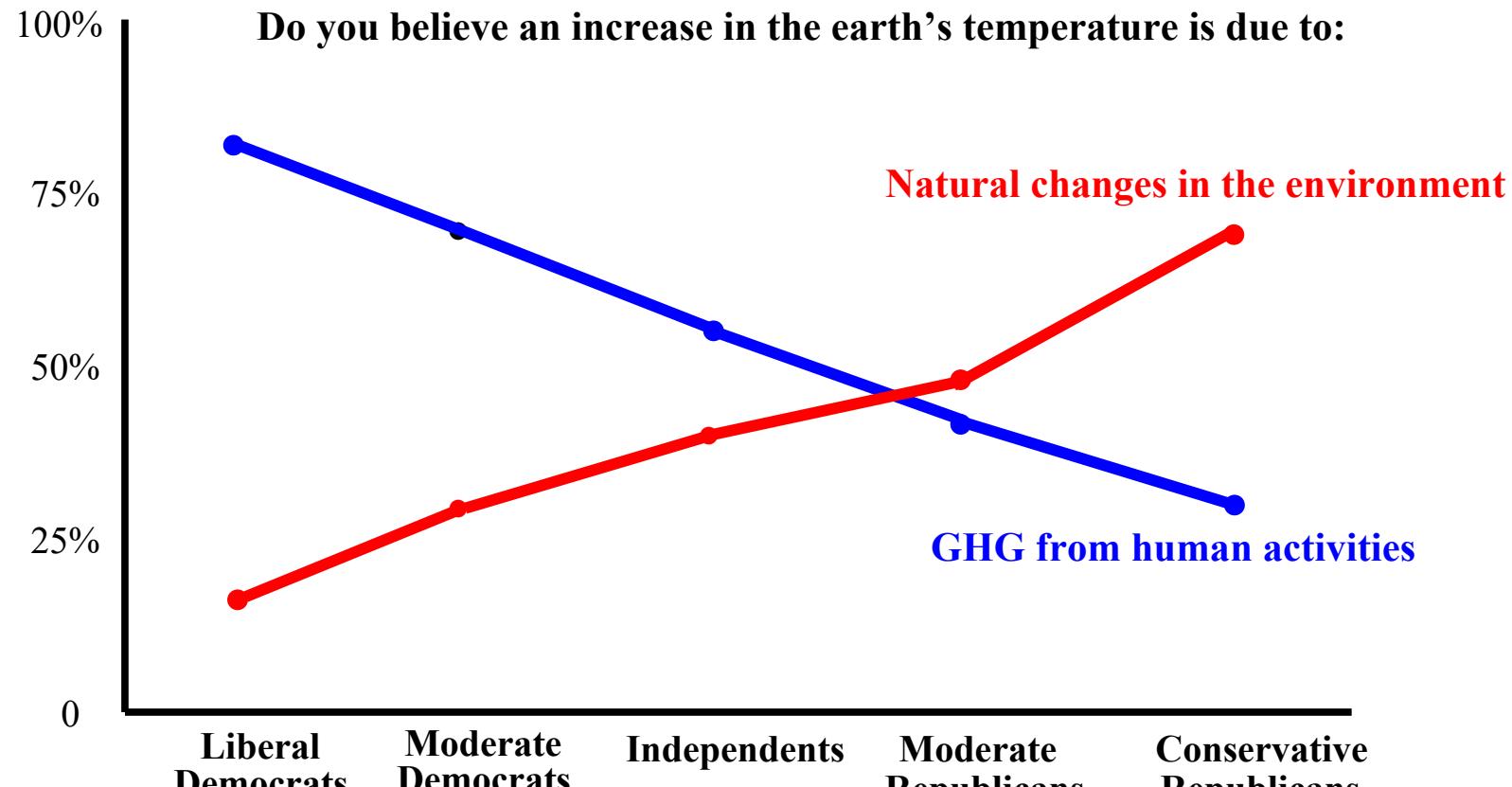
# Our Problem is Political Divisions on Basics...

## Is There Solid Evidence Earth is Warming?



PEW RESEARCH CENTER Oct. 9-13, 2013.

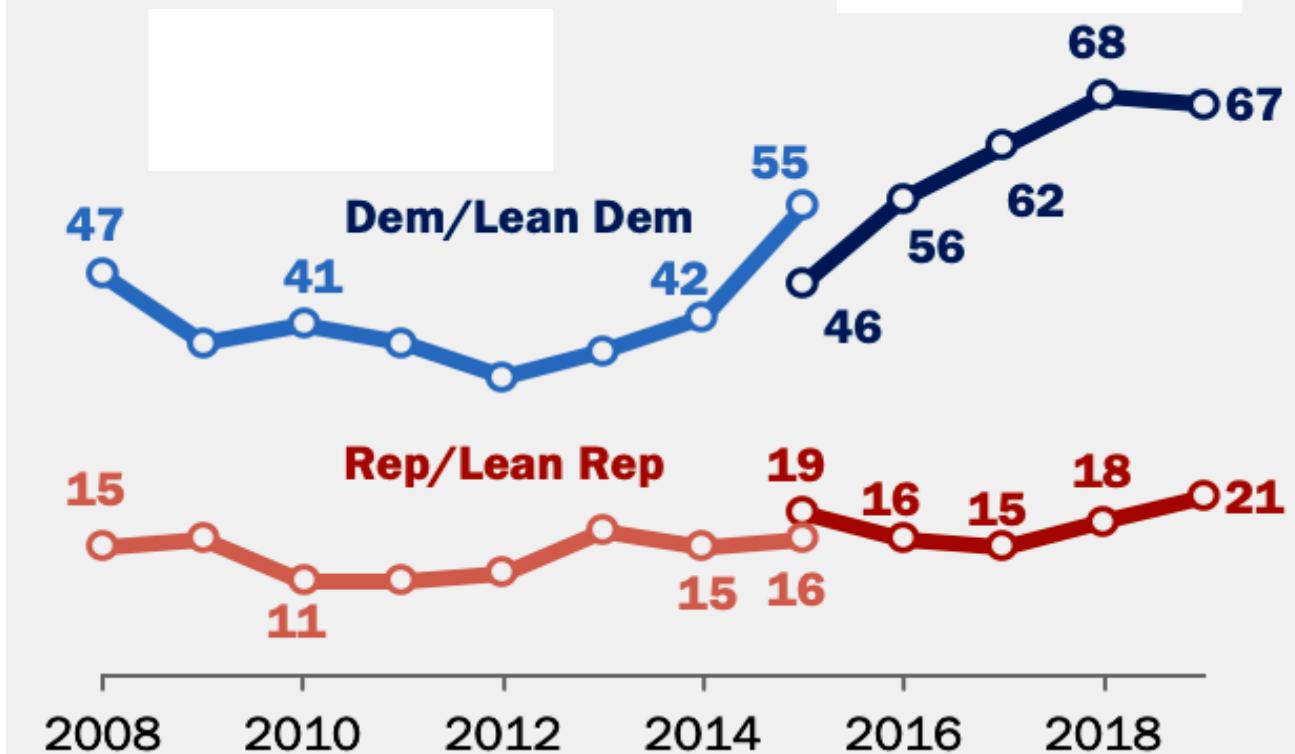
# ...on the Cause...



<http://news.gallup.com/poll/182807/conservative-republicans-alone-global-warming-timing.aspx>

# ...and on How to Prioritize Actions

Climate change action should be a top priority of the President and Congress



<https://www.pewresearch.org/fact-tank/2019/08/28/u-s-concern-about-climate-change-is-rising-but-mainly-among-democrats/>

# Causes, Effects & Solutions

- Causes of Temperature Change
  - Natural Cycle or Something New?
  - Human Contribution: What percent?
- Potential Effects & Problems
  - Heating of Oceans + Melting of Polar Ice and Glaciers:
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    - Rise in Ground Water Levels – Affecting infrastructure and buildings
    - Loss of Coastal Lands – In US and elsewhere
  - More Severe Weather Events: Floods, Draughts, Storms, Wildfires

# Some Effects Are Already Obvious...



The Coast Guard Icebreaker Healy in the Recent Arctic  
(Credit: Dave Withrow/United States Coast Guard Via Associated Press)

# ...Storms...



Super storm Sandy inundates the New Jersey seacoast, October 2012  
(Credit: HANDOUT/REUTERS)

# ... Flooding...



# ...All Over the World...



**Heavy flooding in Liege, Belgium**

<https://www.cnn.com/2021/07/15/europe/gallery/flooding-western-europe/index.html>

## ...Seaside Erosion...



WALLY SKALIJ Los Angeles Times

**MAUREEN SASSOON** hikes in Rancho Palos Verdes. A study examined cliffs from San Diego to Point Conception to project the rate of bluff erosion by 2100, which could severely affect homes, parks and facilities.

# Southland cliffs are on losing end of rising sea

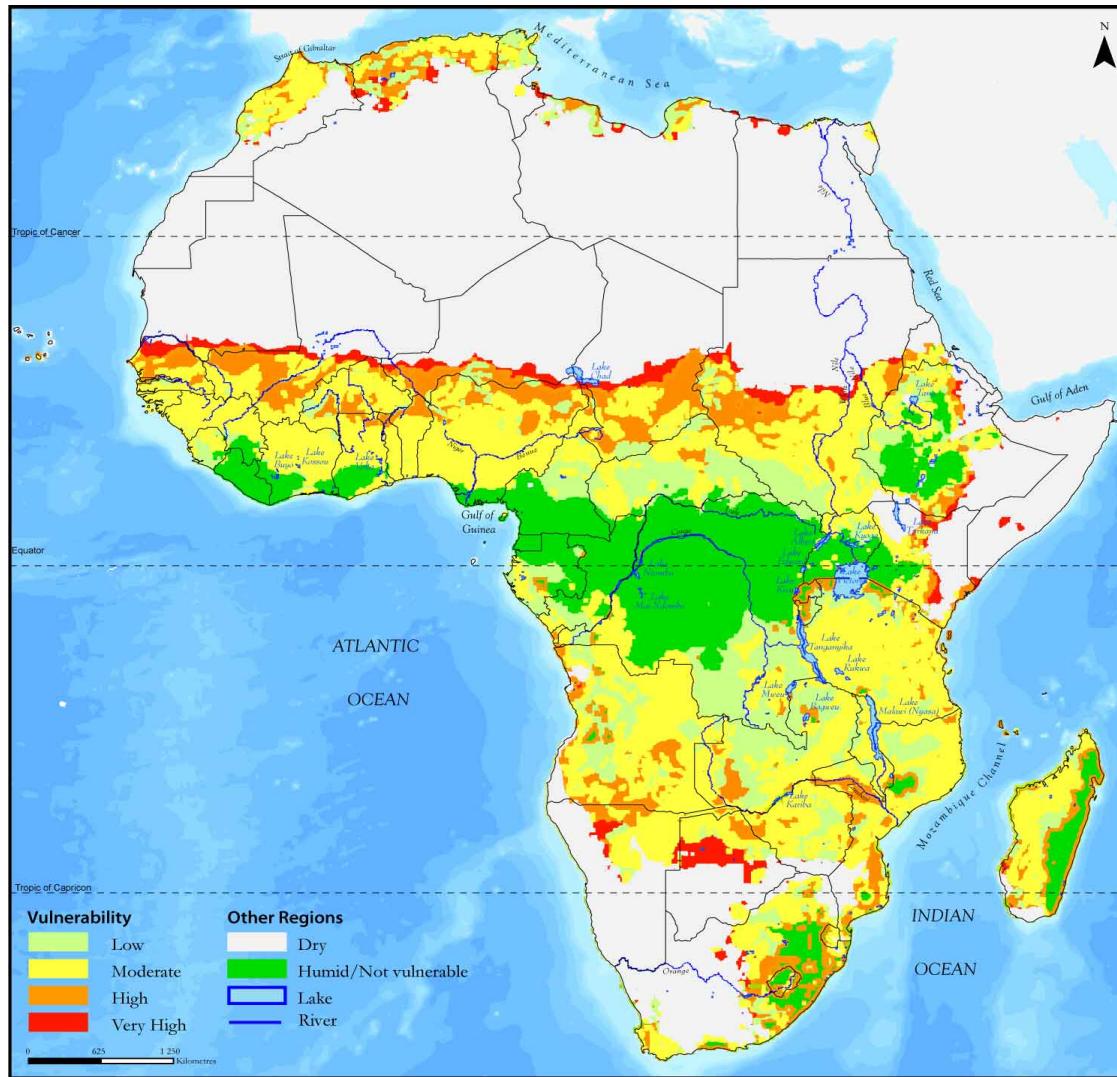
They could recede by more than 130 feet by 2100, study says

# ...Disappearing Rivers...



**The world's rivers are drying up from extreme weather. See how 6 look from space**

# ...African Desertification...



# ...African Desertification...



# ...Warming Oceans...

## 2018 hottest year on record for oceans

Scientists say heat trapped by increased emissions is warming Earth's waters faster than was recognized.

BY TONY BARBOZA

Earth's oceans had their warmest year on record in 2018, a stark indication of the enormous amount of heat being absorbed by the sea as greenhouse gas emissions continue to rise, scientists reported Wednesday.

The analysis by an international team of scientists confirms that the oceans are heating up much faster than previously recognized and that the pace of warming has accelerated sharply since the 1990s.

Rising ocean temperatures are already having profound consequences across the globe, scientists say, contributing to more intense hurricanes, destroying coral reefs and causing sea levels to rise.

The report in the journal *Advances in Atmospheric Sciences* builds on a study last week that found oceans are warming 40% more, on average, than was estimated



TANE SINCLAIR-TAYLOR James Cook University

**THE LONGER** oceans continue to warm, the more devastating the effects, scientists say. Marine ecosystems, including coral reefs already stressed by warming, will be unable to recover from heat waves and bleaching.

mated floats in operation since the mid-2000s that periodically descend into the ocean to measure temperature and salinity, then transmit the readings to satellites.

The new analysis is based on Argo's measurements of the upper 6,500 feet of the ocean combined with earlier readings that go back to the 1950s. Scientists compared four different estimates of ocean warming completed since the United Nations' Intergovernmental Panel on Climate Change report in 2014 and found them converging in agreement: Oceans were warming faster than prior estimates.

The findings of record ocean warming come one day before the National Oceanic and Atmospheric Administration and NASA were scheduled to release data on the average global surface temperature for 2018. The federal agencies are expected to report that 2018 was the fourth-hottest year on record, but their announcements have been delayed indefinitely by the partial government shutdown.

Once full operations are restored, it will take at least three days for scientists to finalize their reports, said Gavin Schmidt, head of the

## ...Local Fires...



Photographs by MARCUS YAM Los Angeles Times

A HOME in Lakeport, Calif., burns Tuesday. In hot weather, some heat can be carried away by water, as moisture in the soil evaporates. But soil with little moisture, as in a drought, leaves the heat nowhere to go.

# A troubling pattern of drought and heat

## ...and Remote Fires...



A fire in Siberia in early June; Yevgeny Sofroneyev/TASS, via Getty Images

... Resulting in Strong Warnings

THE NEW YORK TIMES INTERNATIONAL MONDAY, NOVEMBER 3, 2014

# U.N. Panel Issues Its Starkest Warning Yet on Global Warming

By JUSTIN GILLIS

COPENHAGEN — The risks of climate change are profound that they could even reverse generations' progress against poverty if greenhouse gases continue at a runaway pace, according to a major new United Nations report.

Despite growing efforts by many countries to tackle the problem, the global situation is becoming more acute as more countries join the ranks of those burning huge amounts of fossil fuels, the Intergovernmental Panel on Climate Change said here on Sunday.

Failure to reduce emissions, the group of scientists and other experts found, could threaten society with food shortages, refugee crises, the flooding of major cities and entire island nations, mass extinction of plants and animals, and a climate so drastically altered it might become dangerous for people to work or play outside during the hottest times of the year.

"Continued emission of house gases will cause warming and long-lasting changes in all components of the climate system, increase the likelihood of severe, pervasive and irreversible impacts on people and ecosystems," the report found.

In the starker language ever used, the expert panel said, "we must clear the way for society from having any serious limit to global warming."

Doing so would require the vast majority of the world's nations to stop using fossil fuels in the ground or, alternatively, develop

new technologies to capture and store their carbon dioxide emissions. There is attention to the climate crisis

continued unchecked,

and the main finding is that cli-

mate change poses serious risks

to progress in areas

like eradicating poverty. Unfor-

tunately, in some cases scenarios, fac-

ing food prices and in-

creased weather disasters

are likely to leave poor peo-

ples worse off. In fact, the report

said, already happened

in some cases, like

the Obama administra-

tion welcomed the re-

port's president's science

adviser, Dr. John P. Holdren, calling

it a "wake-up call to the

international community that we

must act together swiftly and ag-

gressively in order to stem cli-

mate change and avoid its worst

consequences." The adminis-

tration is pushing

for limits on emissions from

power plants, but faces

resistance in Congress and

among Republicans.

Opposition to the report

came from some Republi-

cans, who argued that it was

based on faulty science.

Opposition also came from

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## "Continued emission of green-

Nations secretary general, Ban Ki-moon, appealed for strong action in Lima.

The group, along with Al Gore, was awarded the Nobel Peace Prize in 2007 for its efforts to call

for a small drag on overall global production, and could become a far larger one if emissions

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# Causes, Effects & Solutions

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    - Quality of Life: Coastal vs. inland, developed vs. undeveloped, rich vs. poor, flooded vs. arid
    - *Social Conflict: Violence and warfare in fighting over land and resources*

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- Approaches to Reversing Effects:
  - Agreement on Requirements and Targets

# Early Signs of Agreement...

- The U.S. and China account for about 33% of the world's carbon emission
- Their 2014 agreement was a precursor to more effective protocols, like those for smog and chlorofluorocarbons
- A worldwide agreement was the goal of the 2015 United Nations Conference on Climate Change



Los Angeles Times, November 12, 2014

# ...Resulting in Worldwide Pledges...

## What Does a Climate Deal Mean for the World?



Christophe Ena/Associated Press

An event at the U.S. pavilion during the Paris climate conference, known as COP21.

A group of 195 nations reached a landmark climate agreement on Saturday. Here is what it means for the planet, business, politics and other areas.

195 (!) United Nations countries pledge to try and reduce their carbon emissions as part of the 2016 Paris Climate Accord.

**Interactive Graphic:**  
China's Coastal Cities,  
Underwater



By DEREK WATKINS

Some cities in China will be dramatically affected by rising seas as the atmosphere warms.

**Short Answers to Hard Questions About Climate Change**



By JUSTIN GILLIS

The issue can be overwhelming. The science is complicated. We get it. This is your cheat sheet.

**The Marshall Islands Are Disappearing**



By CORAL DAVENPORT and JOSH HANER

Most of the Marshall Islands rise less than six feet above sea level. For the residents, the destructive

...Followed by an American Retreat...



US joins Nicaragua and Syria outside the agreement, with unknown effects.

# ...Then by an American Return!

NEWS ARTS & LIFE MUSIC SHOWS & PODCASTS SEARCH

Inauguration Day: Live Updates

## Biden Moves To Have U.S. Rejoin Climate Accord

January 20, 2021 · 5:42 PM ET

NATHAN ROTT  

**Updated 5:45pm Eastern Time**

In one of his first acts in the Oval Office, President Joe Biden signed an executive order to have the United States rejoin the Paris climate agreement, the largest international effort to curb global warming.

The U.S. officially withdrew from the accord to limit climate-warming greenhouse gas emissions late last year,



President Joe Biden is directing the U.S. to rejoin the

# ...Then by an American Return!

A6 THURSDAY, JANUARY 28, 2021

Los Angeles Times

LATIMES.COM

## Biden makes climate change a priority

[Climate, from A1]

The executive orders included directives to federal agencies to end fossil fuel subsidies, called for a task force to plan for reducing greenhouse gas emissions, and declared climate change a national security priority for the first time.

The president also directed his administration to protect 30% of federal land and coastal waters by 2030, a proposal that climate scientists and environmentalists have advocated for internationally to curb global warming and protect endangered species.

According to the U.S. Geological Survey, the extraction and consumption of oil, gas and coal from federal lands and waters account for nearly a quarter of the nation's total carbon dioxide emissions.

Biden also called for the creation of a Civilian Climate Corps that will put Americans to work restoring forests, improving recreation on public lands and addressing the effects of climate change.

Other orders gave priority to the needs of people living in communities burdened by industrial pollu-



EVAN VUCCI Associated Press

**PRESIDENT BIDEN** signs executive actions Wednesday in the White House dealing with climate change. "We've already waited too long to deal with this climate crisis," Biden said. "We can't wait any longer."

sured by investors, are moving away from fossil fuels and investing in renewable energy. Many are still sitting on leases they stockpiled during the Trump administration.

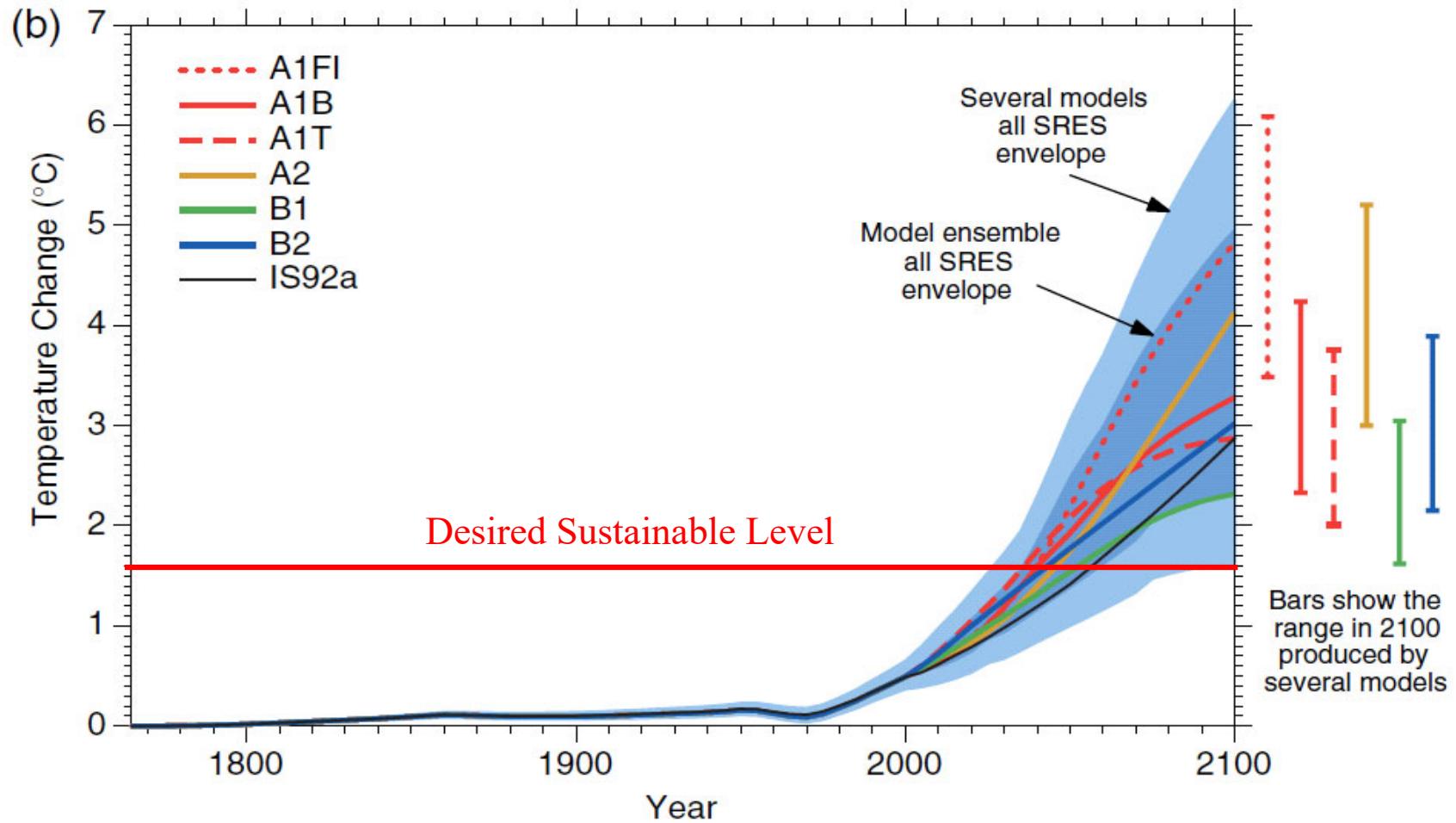
These companies may ultimately blunt the effect of the pause on leasing by continuing to extract oil and gas from existing leases. And because most of the tax revenue from fossil fuel development comes from royalties on oil produced, the moratorium's effect on states like New Mexico and Wyoming could be less than critics predict.

"If what this pause does is say to the oil companies, 'OK, you have thousands of permits you're not using, let's work on those,' that's still a lot," said Nada Culver, vice president of public lands for the National Audubon Society.

It's not clear how the moratorium will affect leases sold in the final weeks of the Trump administration. In California, oil companies bought rights to drill on federal land in Kern County at an auction in December. But some leases aren't final, raising questions

President Joe Biden has made fighting global warming a major part of his agenda.

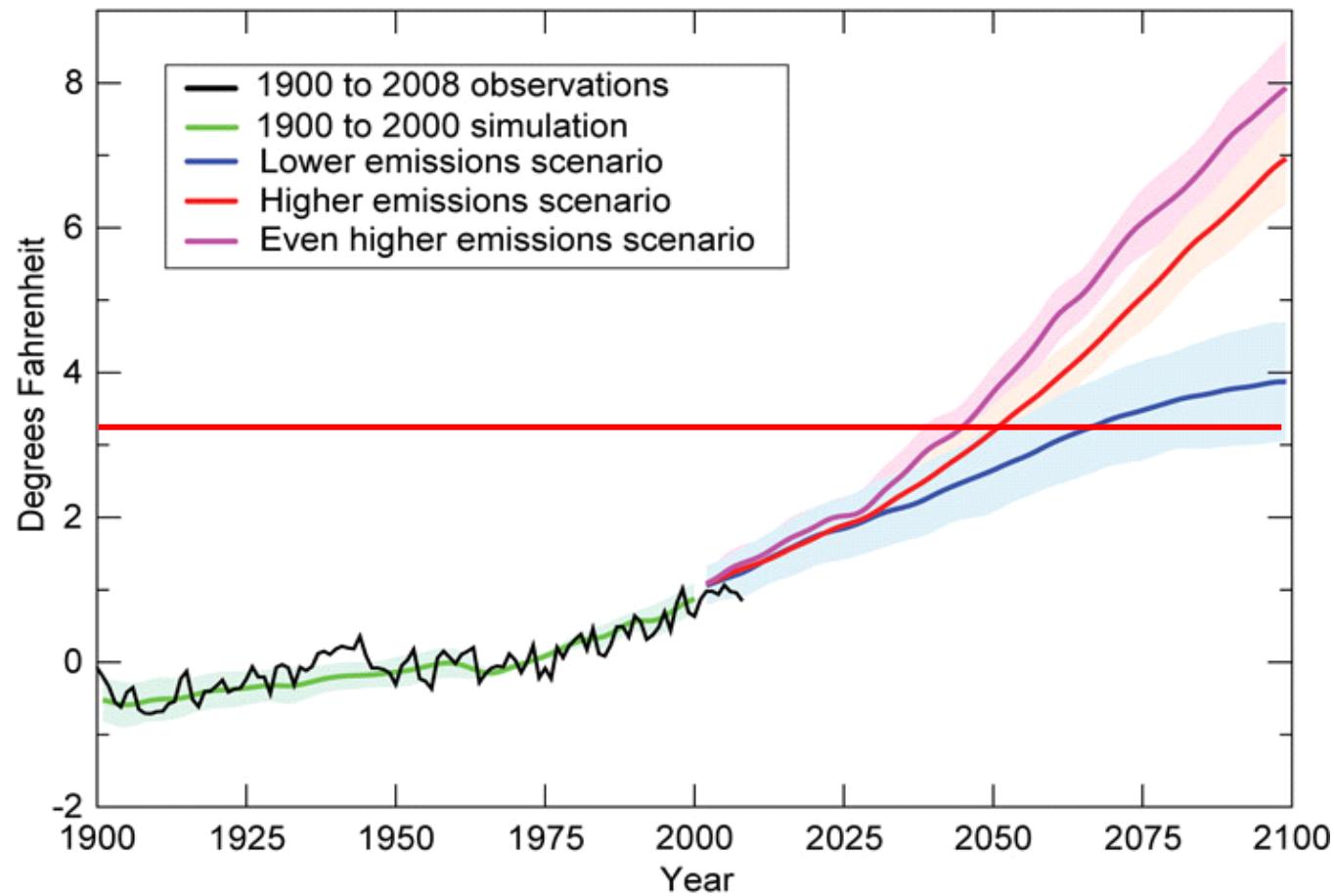
# Projections Based on Varied Emissions



# A Variety of Solutions

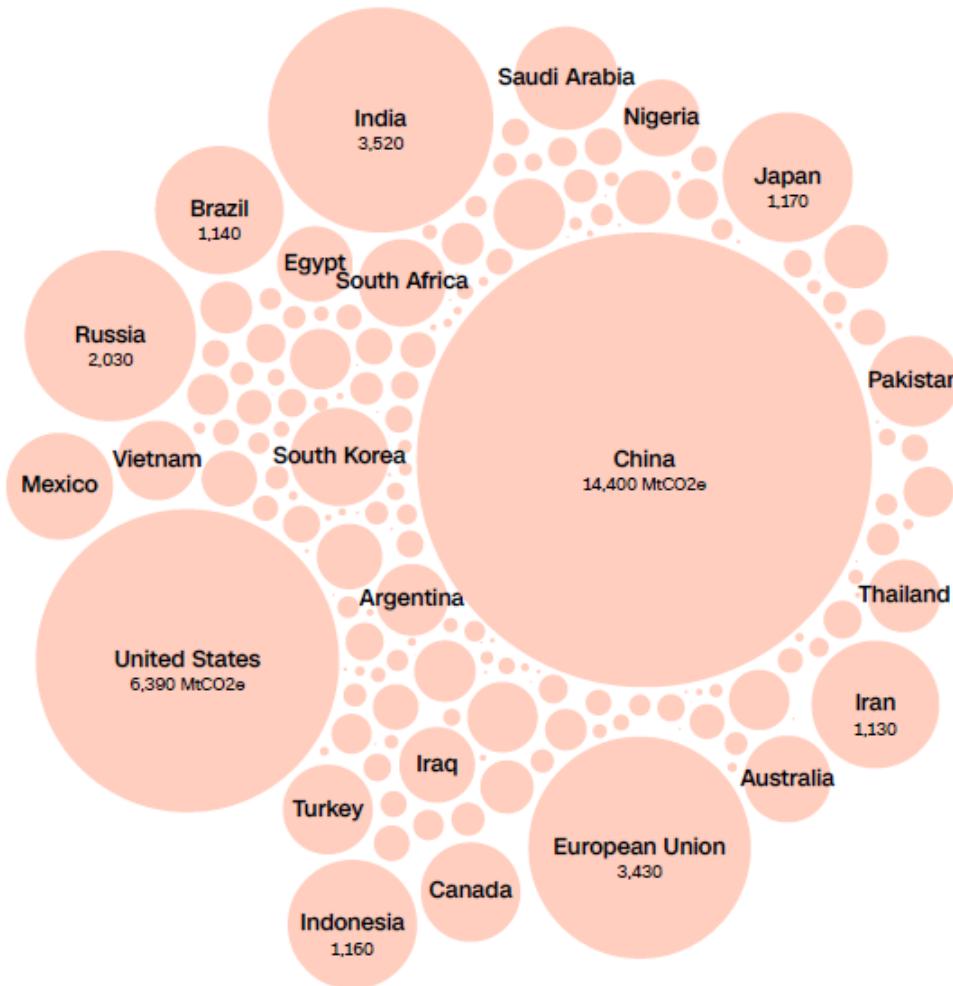
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  - Reduce Greenhouse Gas Emissions

# Projections Based on Reduced Emissions



# It Isn't Easy to Reduce

Total greenhouse gas emissions  
in 2022



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# Carbon Capture, Utilization and Storage

**UCLA HSSEAS Dean Alissa Park was quoted in a collaborative publication:  
“If we were in a global war against climate change, we would carry out large scale  
carbon capture, utilization and storage (CCUS).”**



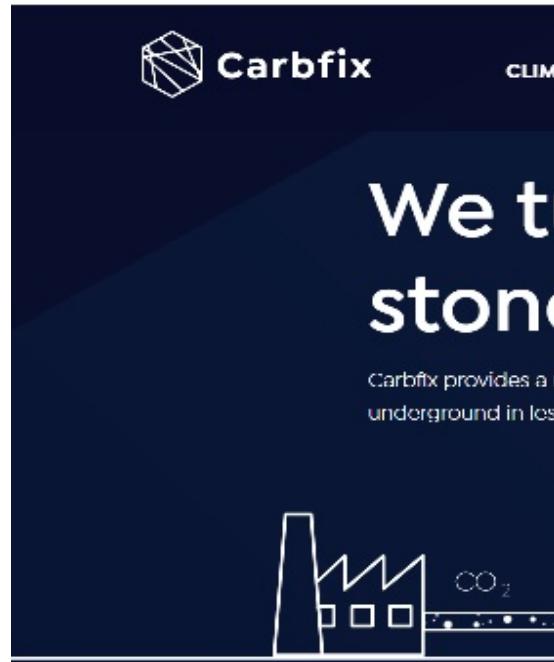
Dean Park's research focuses on sustainable energy and materials conversion pathways with an emphasis on using integrated CCUS technologies to address climate change.

# Carbon Capture: Vacuum the Air



Climeworks carbon vacuum plant, Switzerland

# Carbon Capture: Vacuum the Air



The image shows the Carbfix logo, which consists of a stylized cube icon followed by the word "Carbfix" in white. Below the logo, there is a graphic illustration of an industrial facility with pipes and structures, with the chemical formula "CO<sub>2</sub>" written next to it.

## State revisits giant carbon vacuums in global-warming war

By EVAN HALPER

WASHINGTON — Solar panels, wind turbines and electric cars will go far in helping California and the Biden administration meet their aggressive climate goals — but not far enough. As time runs short, scientists and government officials say the moment to break out the giant vacuums has arrived.

The art of industrial-scale carbon removal — sucking emissions from the atmosphere and storing them underground — has long been an afterthought in climate-action circles: too expensive, too controversial, too unproven.

But as the deadline to avert climate catastrophe barrels nearer, the Biden administration is making the

technologies prominent in its plans, and California is scrambling to figure out how to put them to use.

It is no small undertaking. Installing sci-fi-type machinery to pull carbon from the air — or divert it from refineries, power plants and industrial operations — and bottle it up deep underground is a monumentally expensive and logically daunting challenge. It is one climate leaders now have no choice but to try to meet as they race to keep global temperatures from rising more

[See Vacuums, A7]

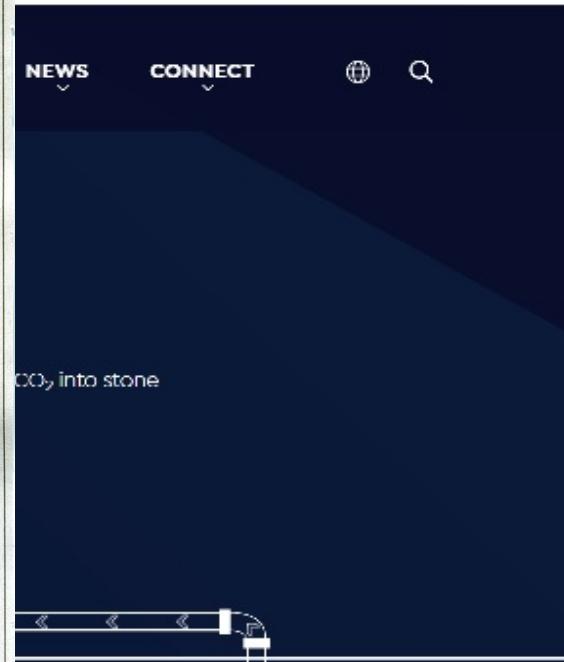
### Biden raises bar in climate fight

As host, president kicks off a global summit by doubling U.S. emissions reduction goal. **WORLD, A3**



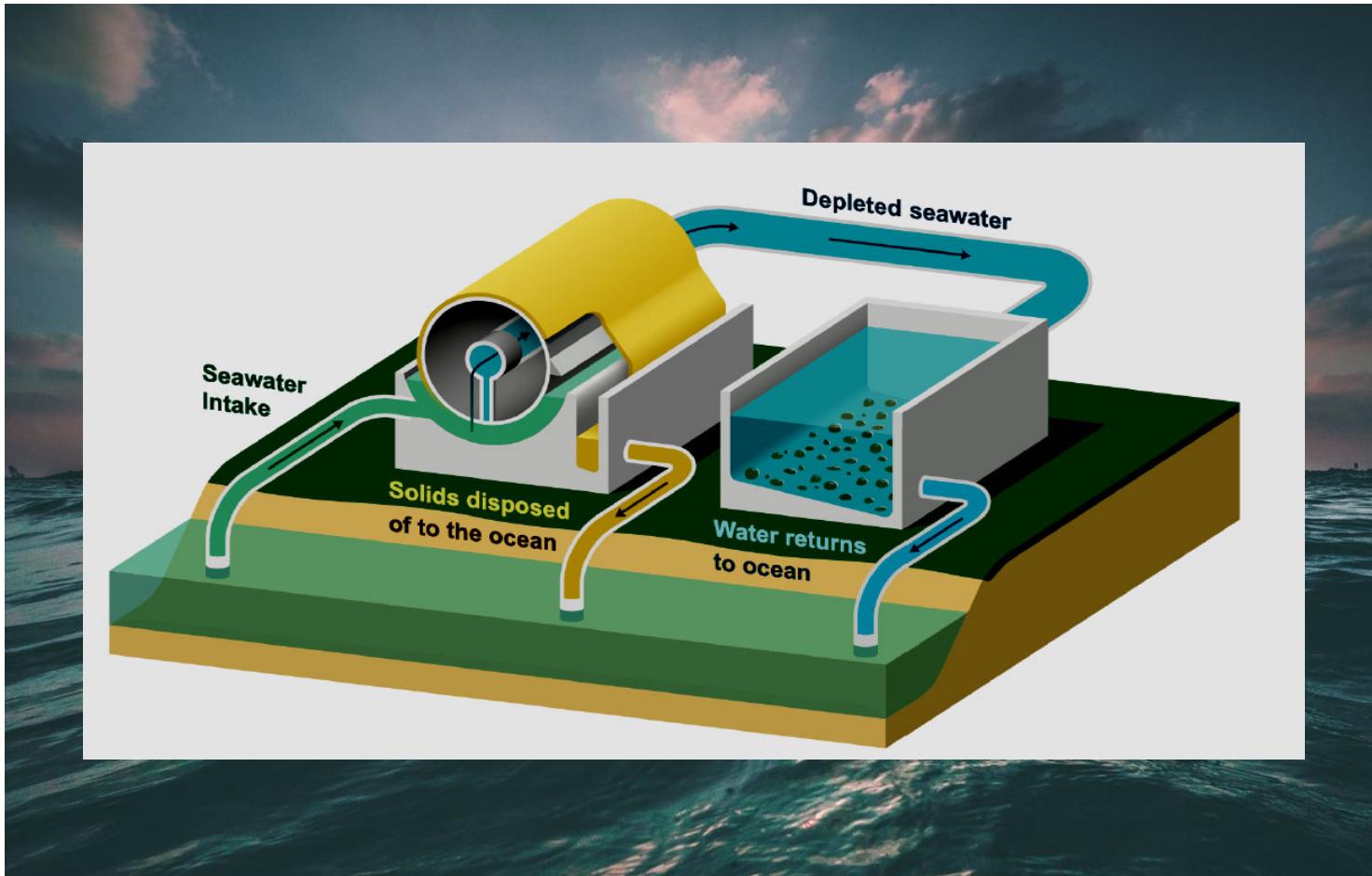
Aerial photograph of a large industrial facility, identified as a pilot plant for carbon capture, located in a desert-like environment. The plant includes several large tanks, pipes, and processing units.

**CARBON** removal on an industrial scale is a costly, daunting challenge. Above, a pilot plant in Canada.



The image shows a screenshot of the New York Times news website. At the top, there are navigation links for "NEWS" and "CONNECT", along with icons for search and international coverage. Below the navigation, there is a dark banner with the text "CO<sub>2</sub> into stone". The main content area of the page is visible at the bottom.

# Carbon Capture: Scrub the Oceans



UCLA Institute for Carbon Management will remove CO<sub>2</sub> from the ocean and solidify the carbon, thus creating a natural sink for atmospheric CO<sub>2</sub>.

# Carbon Capture: Major Investments

## U.S. begins pouring billions into carbon-capture technology

BY ARI NATTER  
AND BRIAN KAHN

The Biden administration is throwing its weight behind technology that sucks planet-warming carbon dioxide out of the air, selecting the first winners of a \$3.5-billion fund dedicated to developing the machines scientists say will be needed to stop the worst effects of climate change.

Projects proposed by a subsidiary of Occidental Petroleum Corp. for Kleberg County, Texas, and by Climeworks, Battelle Memorial Institute and Heirloom Carbon Technologies Inc. for Calcasieu Parish, La., were selected for the first tranche of funding, up to \$1.2 billion, the Energy Department said.

The technology is "essentially a giant vacuum that can suck decades of old carbon pollution straight out of

the sky," Energy Secretary Jennifer M. Granholm told reporters. "If we deploy this at scale, this technology can help us make serious headway toward our net-zero emission goals."

Once operational, the hubs are expected to remove more than 2 million metric tons of carbon dioxide a year from the atmosphere, the equivalent of taking nearly half a million gas-powered cars off the road, Granholm said. Additional projects are expected to be announced next year, the Energy Department said.

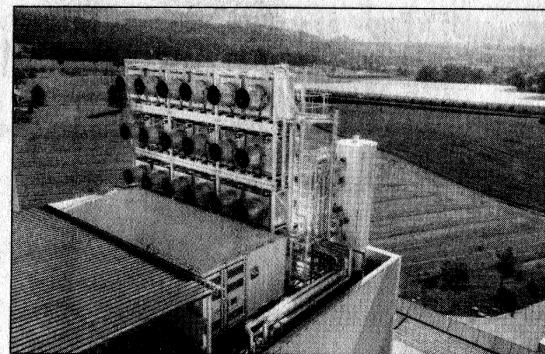
In addition, the agency said it had selected 19 projects for smaller "award negotiations," including \$3 million for a direct air capture hub proposed by a division of Chevron Corp. in San Ramon, Calif., and \$12.5 million for the Wyoming Regional Direct Air Capture Hub proposed by privately held Carbon Capture Inc.

Environmental officials have embraced carbon-capture technology as a way to grab atmosphere-warming carbon dioxide from oil refineries, power plants and other industrial smokestacks and then store it deep underground.

Direct air capture is another type of carbon-capture technology that involves using machines to pull CO<sub>2</sub> out of the ambient air and store it using a variety of techniques. The industry is young and the installations are costly and require a large amount of energy to operate.

Critics worry that carbon capture is too untested to be a reliable tool in fighting climate change. And some opponents see carbon capture efforts as a way to extend the life of facilities that produce or use fossil fuels.

Swiss startup Climeworks operates the largest direct air capture plant in



JULIA DUNLOP Climeworks  
**CLIMEWORKS**, which operates this carbon-removal plant in Switzerland, is proposing one in Louisiana.

the world in Iceland, which is able to capture 4,000 tons of CO<sub>2</sub> annually. That's equivalent to a few seconds of humanity's carbon emissions.

The company is building a plant that it says will be capable of capturing 36,000 tons of CO<sub>2</sub> each year, and other startups are looking to build plants capable of grab-

bing thousands of tons of the greenhouse gas from the air.

The world will need direct air capture as well as other forms of carbon dioxide removal to scale up rapidly. Nearly every scenario to limit global warming will require removing billions of tons of carbon from the atmosphere each

year by mid-century, climate scientists say.

A good milestone to gauge whether that's achievable will be whether the industry can capture 1 million tons of CO<sub>2</sub> a year by 2030.

The market for those services could reach \$1 trillion before the end of the 2030s, according to BloombergNEF research.

About 18 direct air capture projects are operating around the world, but the ones being announced by the Energy Department will become the first commercial-scale deployment in the U.S., said Sasha Stashwick, director of policy for the non-profit Carbon180.

"This is a really big deal in the world of carbon removal," Stashwick said. "This is going to be the largest deployment of carbon removal ever."

Natter and Kahn write for Bloomberg.

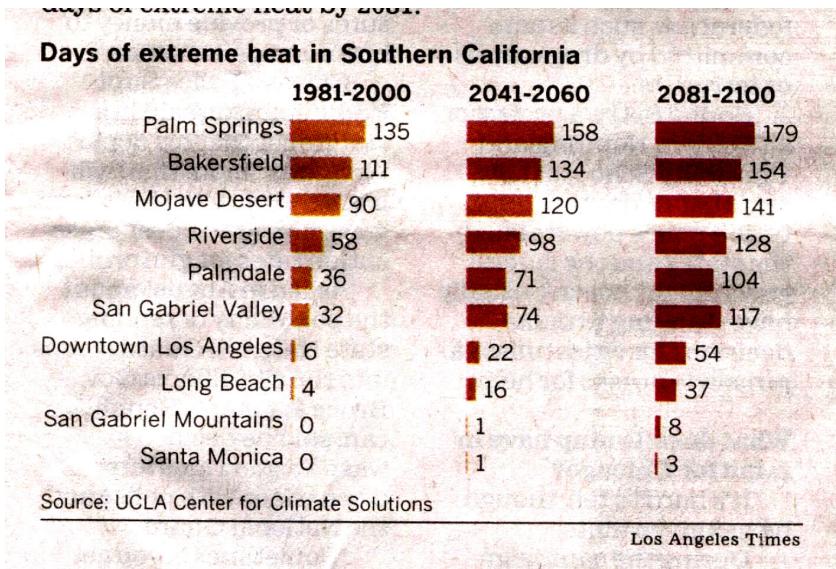
With Dean Park's leadership we expect UCLA will be a major player in this field.

Los Angeles Times, August 12, 2023

# A Variety of Solutions

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  - Local Cooling

# Local Cooling



## Reduce Extreme Heat by:

- Reflective streets
- Reflective roofs
- More trees
- Other approaches

## Start with System Analysis

Los Angeles Times, February 12, 2017

Copyright Gershon Weltman, 2024



**BIG CITIES** such as Los Angeles, with their asphalt streets, dark roofs, sparse vegetation and car-clogged roads, are a few degrees warmer than surrounding areas, in what's known as the urban heat island effect.

## L.A. seeks cool ways to stave off a sizzling future

Scientists study how to cut the city's temperature 3 degrees

BY DEBORAH NETBURN

**Hotter days ahead**  
A study done by scientists at UCLA predicts that downtown Los Angeles could see nearly 10 times as many days of extreme heat by 2081.

### Days of extreme heat in Southern California

	1981-2000	2041-2060	2081-2100
Palm Springs	135	158	179
Bakersfield	111	134	154
Mojave Desert	90	120	141
Riverside	58	98	128
Palmdale	36	71	104
San Gabriel Valley	32	74	117
Downtown Los Angeles	6	22	54
Long Beach	4	16	37
San Gabriel Mountains	0	1	8
Santa Monica	0	1	3

Source: UCLA Center for Climate Solutions

Los Angeles Times

**S**oak up these rainy days, Southern California. They are not going to last forever. Summer will be here before you know it, and if recent trends continue, it will probably be a hot one.

Globally, 2016 was the warmest year on record. Here in Los Angeles, temperature records were shattered last summer during scorching heat waves that saw highs of 100 degrees for five days straight.

If you think the city is too hot, you've got company at City Hall. Los Angeles Mayor Eric Garcetti agrees, and he wants to do something about it.

As part of a sweeping plan to help L.A. live within its environmental means, Garcetti has pledged to reduce the average temperature in the metropolis by 3 degrees over the next 20 years.

It's a noble goal. Not only would it make you more comfortable, it would reduce energy consumption and improve air quality. It may even save lives — extreme heat kills more people nationwide each year than hurricanes, floods or tornadoes.

But how do you turn down [See Cooling, A12]

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  - Geoengineering

# Geoengineering: A Radical Approach



Major volcanic eruptions cool the earth due to particles in the atmosphere

# Geoengineering: A Radical Approach

Particles in Atmosphere Emulate Volcanic Layer



Artificial Cloud Layer Decreases Warming Effect

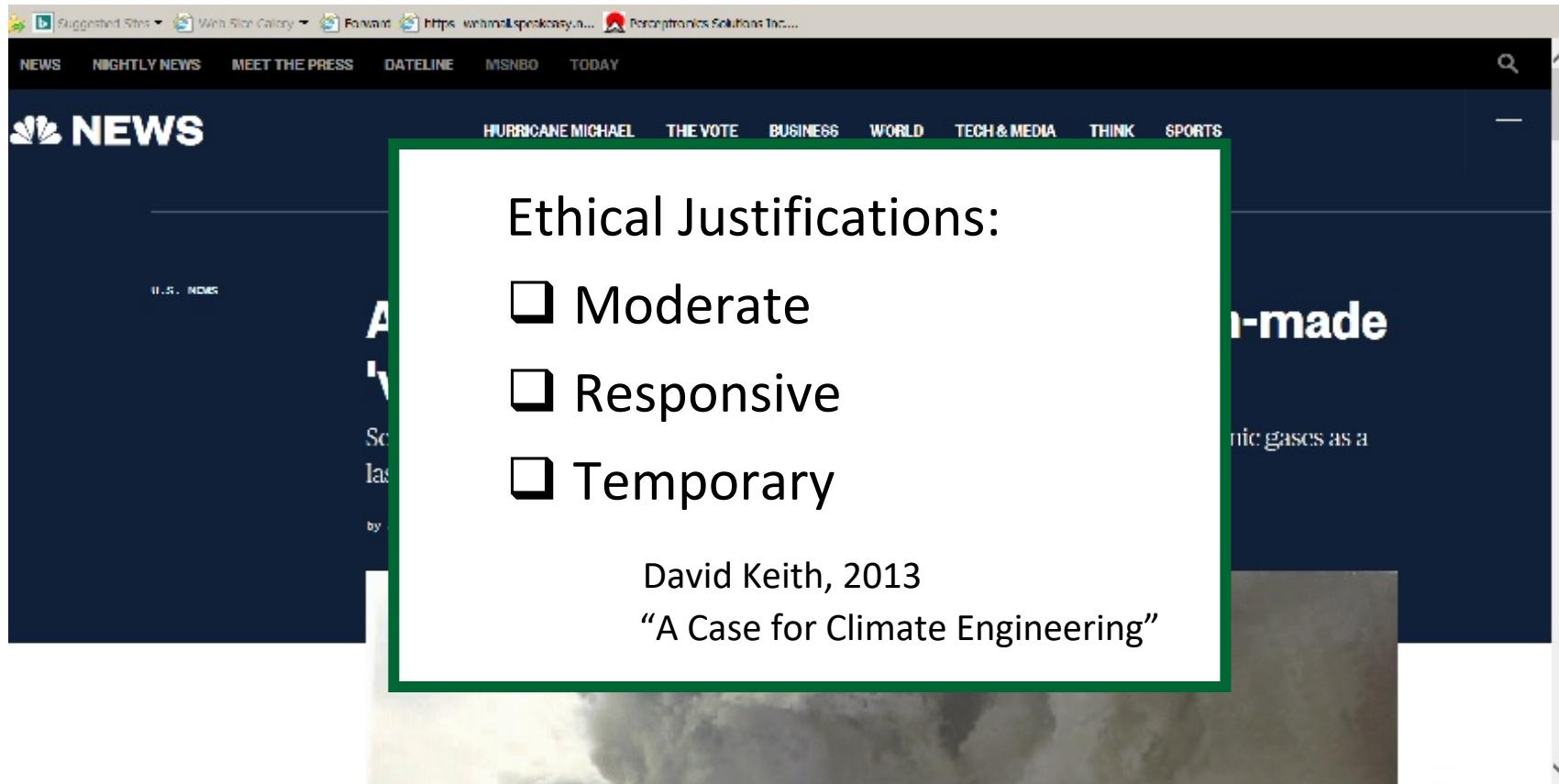
# Geoengineering: In Extremis



The screenshot shows a news article from NBC News. At the top, there's a navigation bar with links like "Suggested Sites", "Web Ricochet", "Forward", "https://uhm.edu/~speckley/a...", and "Perceptronics Solutions Inc...". Below that is a secondary navigation bar with categories: NEWS, NIGHTLY NEWS, MEET THE PRESS, DATELINE, MSNBC, TODAY, HURRICANE MICHAEL, THE VOTE, BUSINESS, WORLD, TECH & MEDIA, THINK, and SPORTS. The main headline is "A last-ditch global warming fix? A man-made 'volcanic' eruption". A sub-headline below it reads: "Scientists and some environmentalists believe nations might have to mimic volcanic gases as a last-ditch effort to protect Earth from extreme warming." The author is listed as "by James Rainey / Oct. 11, 2018 / 8:47 AM PDT". Below the text is a large, dark, smoky or cloudy image.

Is “geoengineering” a global warming solution? Is it feasible? Safe? Ethical?

# Geoengineering: Ethically Justified?



# Geoengineering: A Potential Disaster?

The screenshot shows a news article from CNN's website. At the top, there is a navigation bar with the CNN logo, followed by links to World, Africa, Americas, Asia, Australia, China, Europe, India, Middle East, United Kingdom, Audio, Live TV, and a search icon. The main title of the article is "Supporters of a controversial climate solution say it could be key. Critics believe it is the path to catastrophe". Below the title, the author is listed as Laura Paddison, CNN, and the date is updated 12:13 PM ET, Sun February 12, 2023. There are social media sharing icons for Facebook, Twitter, Email, and Print. The article text discusses a plan by US startup Makani to release weather balloons into the skies above Mexico's Baja California peninsula to reflect sunlight and cool the Earth. The text includes a quote from the article: "(CNN) — When US startup Makani released two weather balloons into the skies above Mexico's Baja California peninsula last year, it kicked up a fierce debate about one of the world's most controversial climate solutions. The plan was for the balloons, filled with helium and a small amount of sulfur dioxide, to float high into the stratosphere. There they would burst, dispersing their load of sun-reflecting sulfur dioxide particles and cool the Earth just a tiny bit." At the bottom of the article, there is a yellow banner with the text "Is ‘geoengineering’ a global warming solution? Is it feasible? Safe? Ethical?"

**Supporters of a controversial climate solution say it could be key. Critics believe it is the path to catastrophe**

By Laura Paddison, CNN  
Updated 12:13 PM ET, Sun February 12, 2023

[Facebook](#) [Twitter](#) [Email](#) [Print](#)

(CNN) — When US startup Makani released two weather balloons into the skies above Mexico's Baja California peninsula last year, it kicked up a fierce debate about one of the world's most controversial climate solutions. The plan was for the balloons, filled with helium and a small amount of sulfur dioxide, to float high into the stratosphere. There they would burst, dispersing their load of sun-reflecting sulfur dioxide particles and cool the Earth just a tiny bit.

Is ‘geoengineering’ a global warming solution? Is it feasible? Safe? Ethical?

# An Overarching Societal Approach

LATIMES.COM

Los Angeles Times

FRIDAY, JUNE 19, 2015 A5

## Pope decries a culture of excess

[**Encyclical**, from A1] mental crisis was also a spiritual problem caused by the rise of individualism and a greed for personal happiness.

He warned that it could leave future generations to inherit a damaged world if not addressed.

"The pursuit of individual happiness has been made into an ideal in our time," he said. "Ecological sin is due to human greed, which blinds men and women to the point of ignoring and disregarding the basic truth that the happiness of the individual depends on its relationship with the rest of human beings."

He said the ecological crisis was growing in conjunction with the spread of social injustice. "We cannot face successfully the one without dealing with the other."

A draft of the more than 180-page document titled "Laudato Si" (Be Praised) had been leaked to the Italian press this week, but even long before that, parties on



BULLIT MARQUEZ Associated Press

**POSTERS** bearing messages for Pope Francis greet recyclers at a dump in Quezon City, in the Philippines. Free-market policies that ignore damage to people or the environment must be changed, the pope said.

also oil and, to a lesser degree, gas — needs to be progressively replaced without delay."

The same ingenuity that provided humanity with extraordinary technological progress has so far proved incapable of dealing with grave environmental and social problems worldwide, Francis said. This failure pointed to a deep need for humanity to change its relationship to nature, but also to one another. Free-market policies that ignored damage to people or the environment must be changed, while income and resource inequalities also need to be addressed.

What was needed, Francis wrote, was a global consensus that could lead to the planning of sustainable and diversified agriculture; better forest and marine management; development of renewable and less polluting forms of energy; and universal access to drinking water.

Ultimately, however, people must aim for a new life-

Pope Francis has called for policies to "drastically" reduce polluting gases, saying technology based on fossil fuels "needs to be progressively replaced without delay" and sources of renewable energy developed.

# Sometimes Priorities Conflict

**CNN** politics

The Biden Presidency   Facts First   US Elections

Audie

## A rush to mine lithium in Nevada is pitting climate advocates and environmental groups against each other



By [Ella Nilson](#) and [René Marsh](#), CNN

Updated 3:39 PM ET, Fri December 17, 2021



[www.firebaseio.com...](http://www.firebaseio.com...)

### CONTENT BY DR. MARTY'S

[3 Ways Your Dog Asks For Help](#)

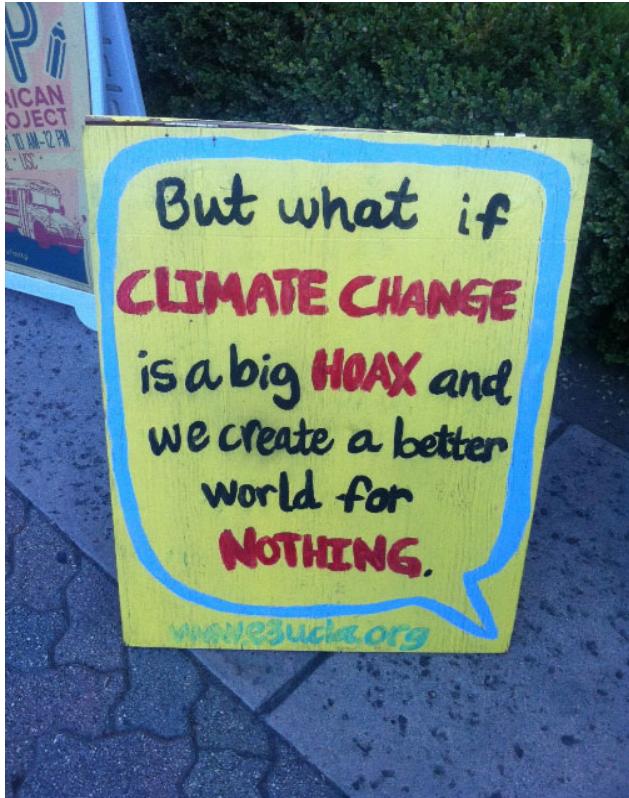
[Celebrity Veterinarian Reveals Silent Clues That Your Dog is in Distress](#)

[A Discovery In Animal Science Is Causing Quite A Stir Among Dog Owners](#)

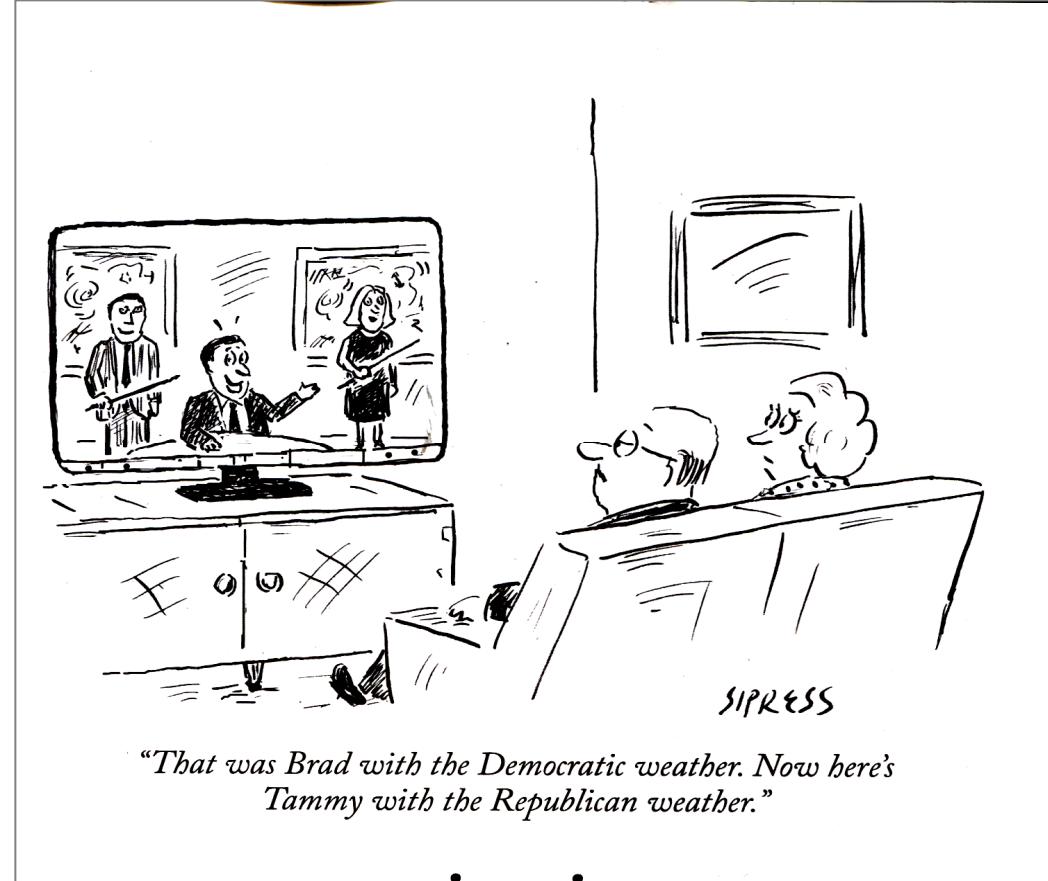
[US Vet: 'This Dog Behavior Isn't Normal'](#)

[Top Veterinarian Shares 3 Warning Signs Every Dog Owner Should Know](#)

# A Humorous Side



Sign on Bruin Walk 2016

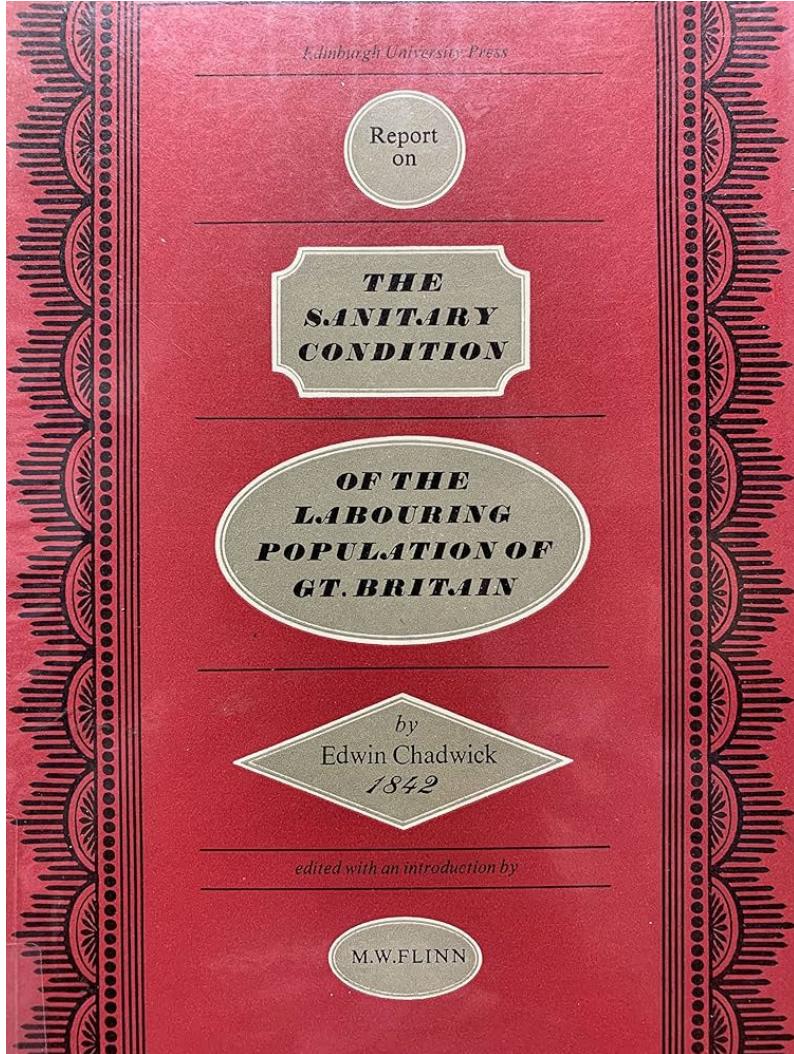


David Sipress, The New Yorker, Feb 13 & 20, 2017

# Case Study 4: Waste Management

- Pre-Historic: Throw it out, build on it, use it for fertilizer
- Greco-Roman: Sewer systems, landfills, dump sites, personal responsibility
- Medieval: Same approaches, little or no improvement
- Industrial Revolution: New wastes in bigger cities, waste collection services, *environmental science*, early connection to disease

# A Point of Inflection



The great innovation of Edwin Chadwick's 1842 report was the use of statistical information to highlight the variations in British life expectancy caused by class or residence, and also to show that improving the health of the poor would be an overall economic benefit. His self-published report caused great debate, and six years later resulted in passage of the Public Health Act.

# Case Study 4: Waste Management History

- Pre-Historic: Throw it out, build on it, use it for fertilizer
- Greco-Roman: Sewer systems, landfills, dump sites, personal responsibility
- Medieval: Same approaches, little or no improvement
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- 19<sup>th</sup> Century *Paradigm Shift*: Germ theory shows disease associated with waste, so *sanitation engineering* includes improved drainage, sewers, trash removal, clean water, local medical officers
- 20<sup>th</sup> Century Growing Populations: More urbanization and industry brings new types of waste and *waste management technologies* – i.e., more efficient applications of old methodologies
- 21<sup>st</sup> Century: Is another *Paradigm Shift* imminent?

# Waste on Today's Urban Scene



“Garbage city” (Cairo) by [Bas Princen](#); “Tire Dump, Gorton” by David Johnson

## ....and in Suburban & Country Waterways



# Waste Hits the Headlines

TUESDAY, NOVEMBER 19, 2013

The Washington Post

E

## A worldwide problem that continues to pile up

Increase in trash is likely to keep growing into the next century

BY JOSEPH STROMBERG

If you're someone who cares about the environment, your first and foremost concern is probably climate change. After that, you might worry about such things as radioactive contamination, collapsing honeybee colonies and endangered ecosystems.

But a number of researchers are focused on a problem that has faded out of the news cycle: the piles of garbage that are growing around the world.

A recent World Bank report projected that the amount of solid waste generated globally will nearly double by 2025, going from 3.5 million tons to 6 million tons per day. And we likely won't hit peak garbage — the moment when our global trash production hits its highest rate, then levels off — until after 2100, when we will produce 11 million tons of trash per day, according to the projection.

Why does this matter? One reason is that much of this waste isn't handled properly: Millions of plastic fragments are flooding oceans and disrupting marine ecosystems, and plenty of trash in developing countries is either



Among the trends that trouble experts contemplating the future of solid waste: People create much more trash when they move to cities (and begin consuming more packaged products) and when they become wealthier (and increase their consumption overall).

ing this century.

How can we address the consumption problem? One of the main things to consider is that it's largely driven by people in the developing world moving to cities and improving their standard of living, both signs of economic progress. But even if these demographic shifts continue, the projected rates of garbage growth aren't entirely inevitable. There are also cultural and policy dimensions to waste production.

For instance, the average person in Japan creates about one-third less trash than an American, even though the two countries have similar levels of GDP per person. This is partly because of Japan's higher-density living arrangements and higher prices for imported goods. But also, trash in many Japanese municipalities must be disposed of in clear bags (which reveal who isn't bothering to recycle) and recyclables are routinely sorted into dozens of categories. Such policies are driven by the limited amount of space for landfills in the small country.

Creating similar incentives to produce less waste in other countries could be a way of tackling the problem. But Hoornweg and his co-authors argue in their article that accelerating increases in education and economic development in the developing world, especially in Africa, might be even more important. That would probably cause urban populations to grow and alter the amounts

# Major Industrial Waste Sources

- Energy Industries
  - Coal Mines
  - Atomic Reactors
- Clothing Industries
  - Textile Plants
  - Tanneries
- Material Industries
  - Wood Fiber Industries
  - Metal Industries
  - Liquid Material Industries
- Food Industries
  - Animal Farming and Processing
  - Fruit and Vegetable Farms
  - Canneries
  - Dairies
  - Wineries and Distilleries
  - Pharmaceutical Plants
- Chemical Industries
  - Organic Compounds
  - Acids and Bases
  - Explosives

# Adverse Effects of Waste Products

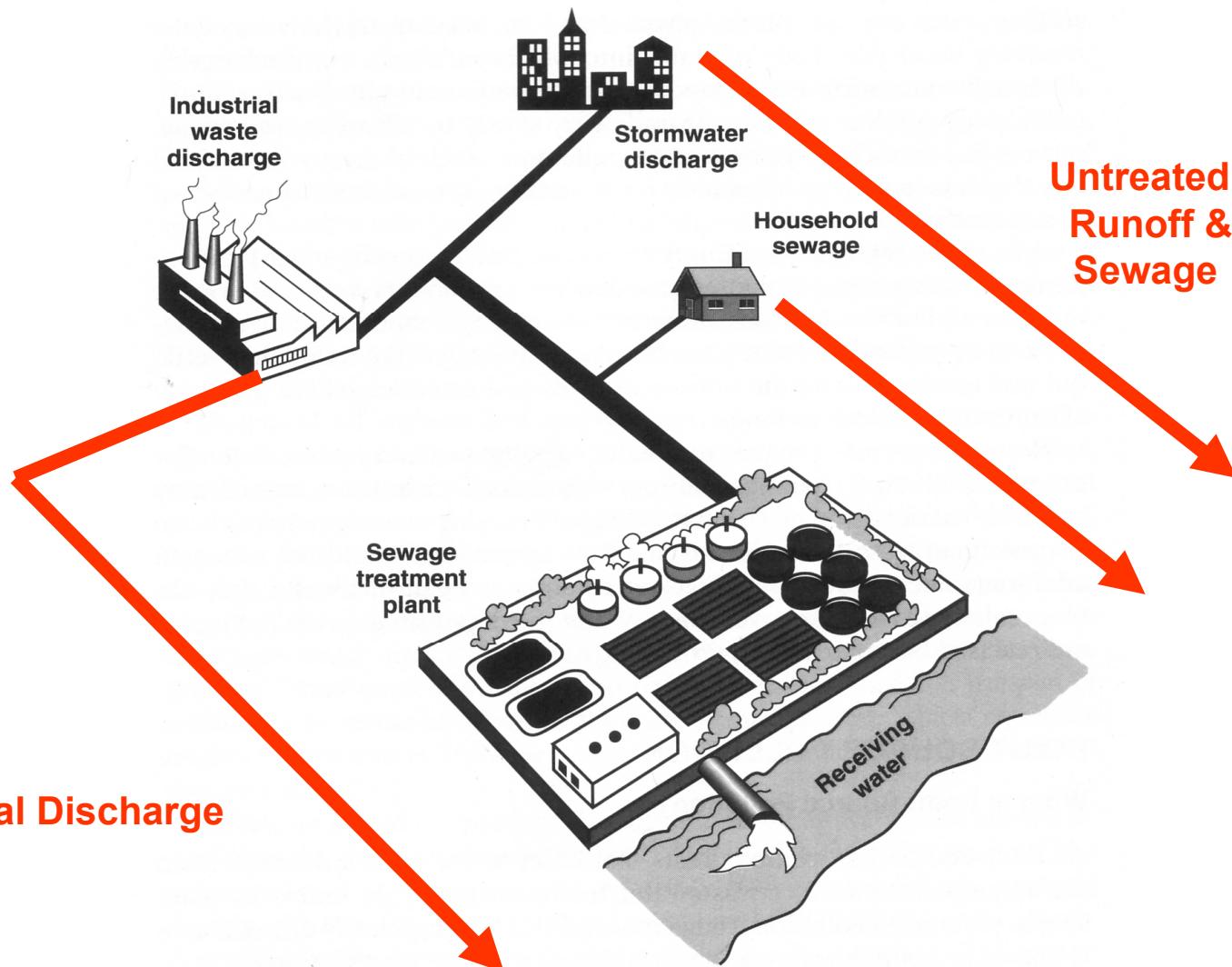
## Ecological Effects

- Direct Human Health
- Plant and Animal Species Destruction
- Human Food Chain Contamination

## Contamination Pathways

- Rivers, Lakes, Oceans
- Ground Water
- Air Pollution
- Direct and Indirect Radioactivity

# Example: Open Water Pollution



# Recently in Los Angeles

A6 WEDNESDAY, JULY 14, 2021 \*

Los Angeles Times

LATIMES.COM

## County kept sewage spill quiet for hours

[**Sewage**, from A1] told The Times his crews found out about the beach closure around noon — after seeing a county worker posting a sign on a lifeguard tower.

"That's how we received official notification of the closure of the beaches," he said.

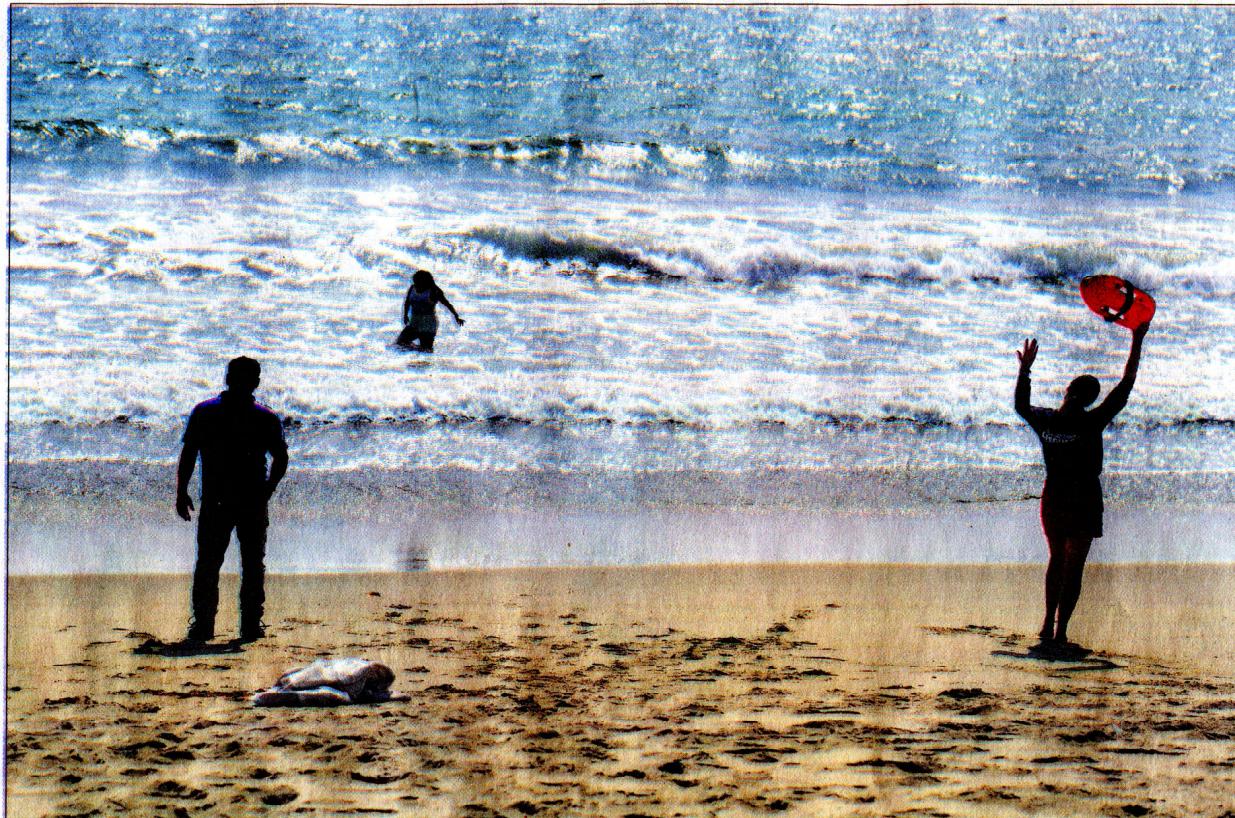
After seeing the sign, Rodriguez said, lifeguards began warning beachgoers to stay out of the water.

Los Angeles County Supervisor Janice Hahn said Tuesday that she was seeking answers from county health officials and the city, which operates the Hyperion Water Reclamation Plant.

"What happened yesterday was unacceptable and irresponsible," Hahn said in a statement. "We need answers from L.A. City Sanitation about what went wrong and led to this massive spill, but we also need to recognize that L.A. County Public Health did not effectively communicate with the public and could have put swimmers in danger."

A spokesman for the Department of Public Health said the agency was in the process of gathering information on its notification process and protocols.

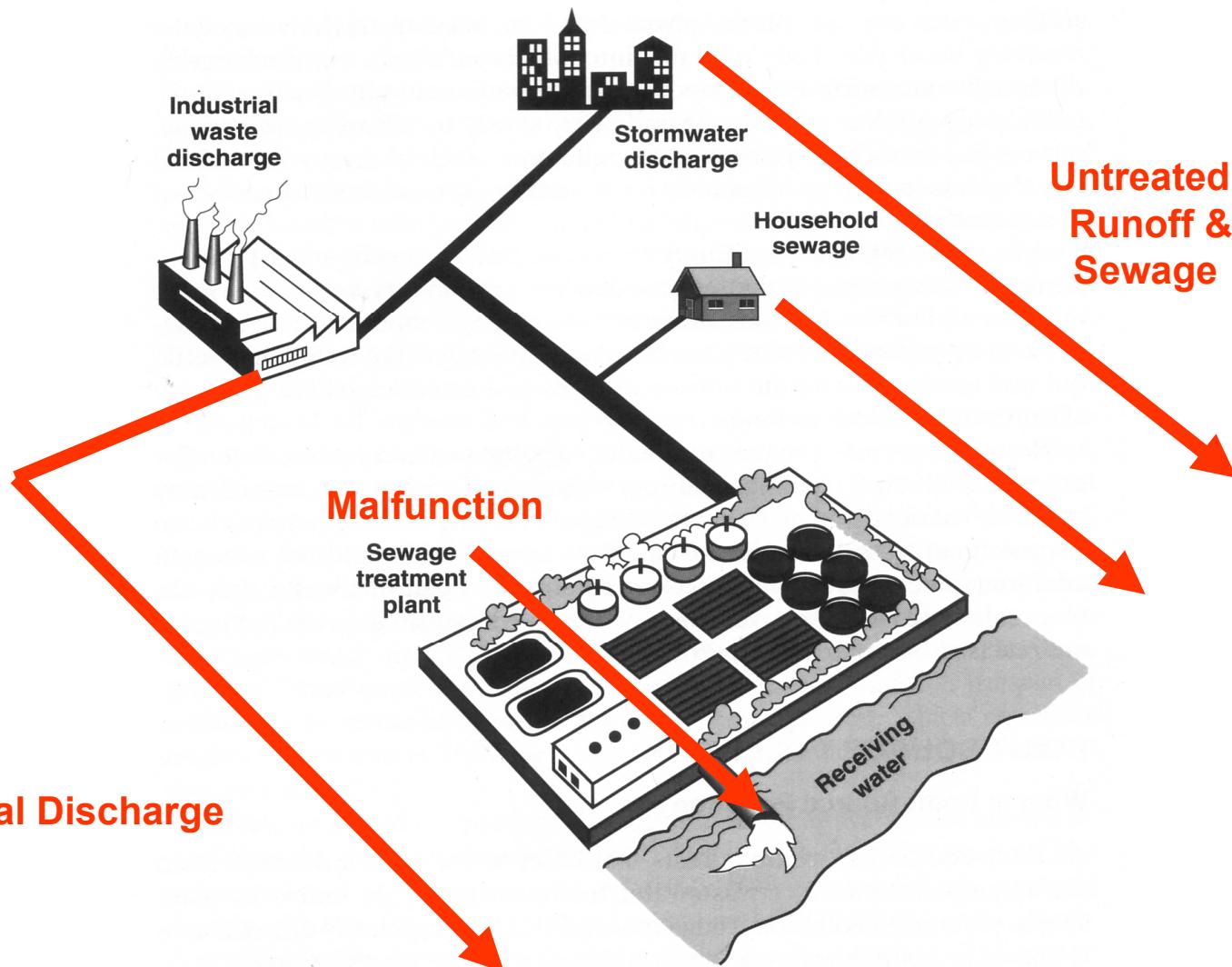
Timeyin Dafeta, executive plant manager at the Hyperion Water Reclamation Plant, said an investigation was ongoing, but his



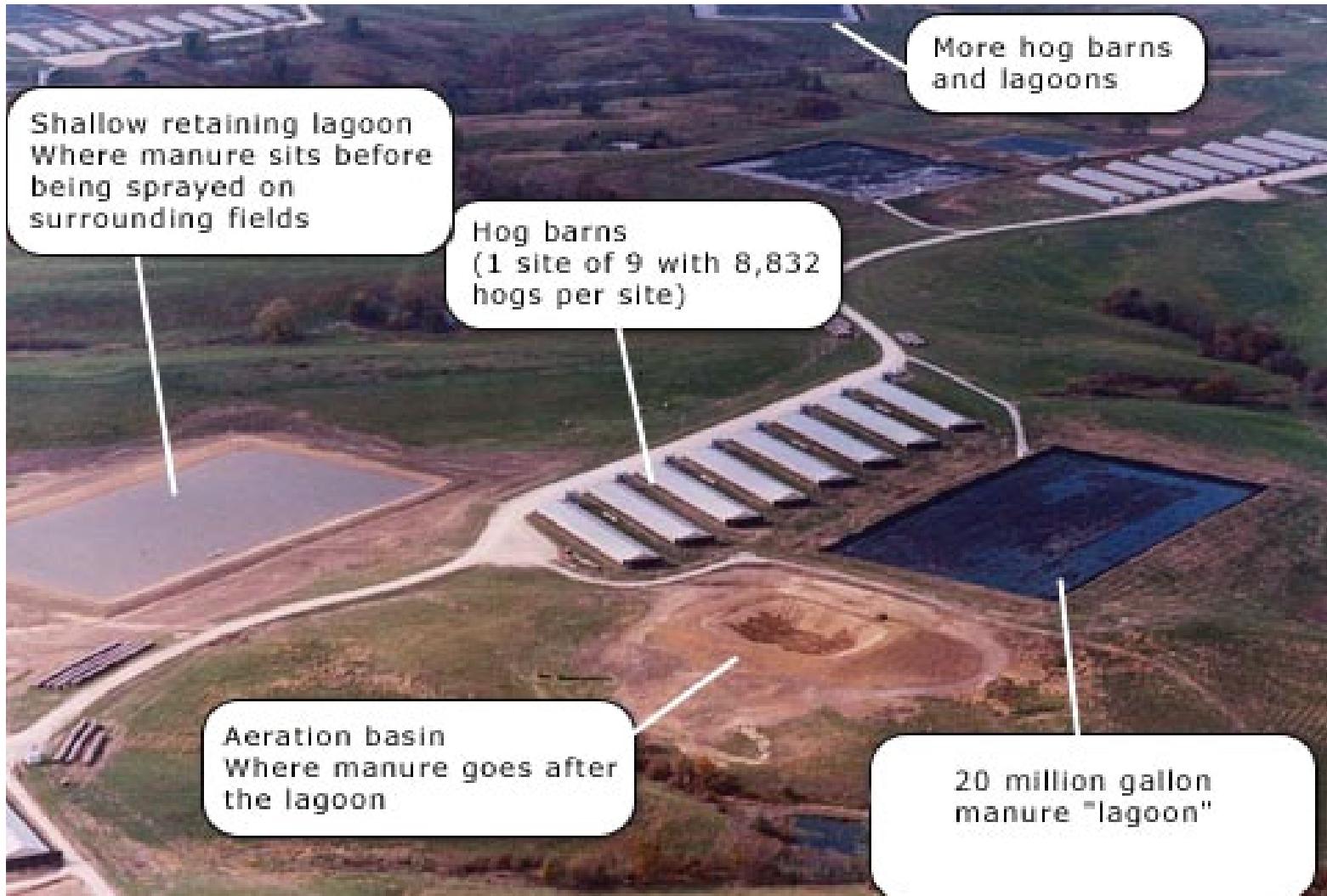
MEL MELCON LOS ANGELES TIMES

**A LIFEGUARD** tells a swimmer to get out of the water. Several people said they didn't know Dockweiler Beach was closed for swimming.

# Example: Open Water Pollution



# Example: Factory Farm Pollution



<http://www.flickr.com/photos/sustainabletable/2950338288/>

# Example: Factory Farm Pollution

**Raw animal waste can be seen moving off site with the floodwaters before these “lagoons” were totally submerged.**



## Example: Oil Drilling Pollution...



# ...and Oil and Gas Fracking Pollution



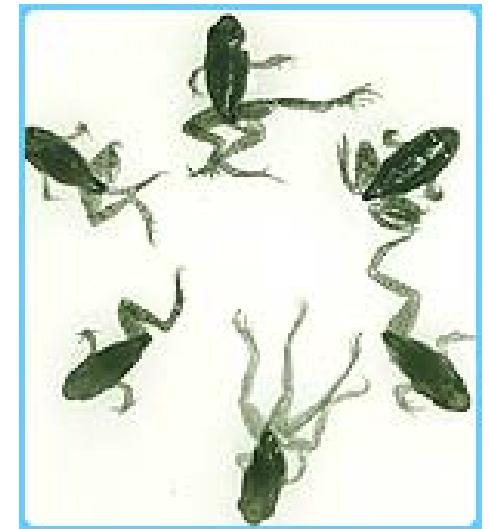
# Sample Results: Mutations

“Frogs around the world are being born with severe deformities because of pollution, say scientists.”

BBC News, 2002



(COURTESY: BIOINFO)



# Sample Results: New “Silent Springs”



# Sample Results: Insect Disappearance

Recent studies indicate the “insect apocalypse” is coming, and ask what this means for the rest of life on Earth.



# Ethical Considerations

## Traditional

- *Rights* of people to a healthy and pleasant life
- *Duty* not to inflict harm on other people
  - Current populations
  - Future generations
- *Virtue* of being a non-polluter
- *Utilitarian* balance of benefits and costs
  - Immediate costs
  - Near and long term benefits
- *Pragmatic* solutions with conflicting objectives

## Non-Traditional

- *Rights of Nature, and of other Species*
- *Duties to Eco-System as a whole*

# Current Waste Management Strategies

## Conventional

- Regulation
- Source Reduction
- Combustion/Incineration
- Physical Containment

## Less Conventional

- Recycling
- Eco-Efficiency

# Regulation of Waste Management

- 1969      *National Environmental Policy Act (New paradigm)*
- 1972      Clean Water Act (Rigorous control of toxic waste)
- 1974      Safe Drinking Water Act (National water standards)
- 1976      Toxic Substances Control Act (EPA tracks and controls 75,000 industrial chemicals)
- 1976      Resource Conservation and Recovery Act (Cradle-to-grave control of hazardous waste)
- 1980      Comprehensive Environmental Response, Compensation and Liability Act (“Superfund” clean-up of closed and abandoned sites after Love Canal disaster)
- 1980      Low-Level Radioactive Waste Policy Act (Regional control of normal radioactive waste disposal)
- 1982      Nuclear Waste Policy Act (Federal high-level waste disposal)  
■ 2002      Selection of Yucca Mt, Nevada as nuclear disposal site

# Yucca Mt. Time Line

In 2002 the Department of Energy (DOE) set a new target date for the opening of the proposed Yucca Mountain repository in 2017. But the project was mired in popular and political dissent from its beginning.

**And while receipt of waste was scheduled 35 years after the original bill passage, it has not yet happened. Funding for the repository was cut off in 2011 and DOE has paid \$2 billion in damages to energy firms for waste storage, which may rise to \$20 billion!**

35 Years after Enabling Bill



## New Target Dates for Yucca Mountain

Design for License Application Complete.....	30 November 2007
Licensing Support Network Certification.....	21 December 2007
Supplemental Environmental Impact Statement (EIS) Issued.....	30 May 2008
Final Rail Alignment EIS Issued.....	30 June 2008
License Application Submittal.....	30 June 2008
License Application Docketed by NRC.....	30 September 2008
Start Nevada Rail Construction.....	5 October 2009
NRC Authorizes Construction.....	30 September 2011
Receive and Possess License Application Submittal to NRC.....	29 March 2013
Rail Access In-Service.....	30 June 2014
Construction Complete for Initial Operations .....	30 March 2016
Start up and Pre-Op Testing Complete .....	31 December 2016
<b>Begin Receipt of Waste.....</b>	<b>31 March 2017</b>

# Problems with Traditional Strategies

- Regulation
  - Administrations change
  - Waste producers dispute, delay and evade
- Source Reduction
  - Technologies are expensive
  - Industries fight compliance
- Combustion/Incineration
  - Creates pollution
  - Adds to greenhouse gases
- Physical Containment (Landfills)
  - Modern materials resist biodegradation
  - Toxic leakage affects groundwater and air

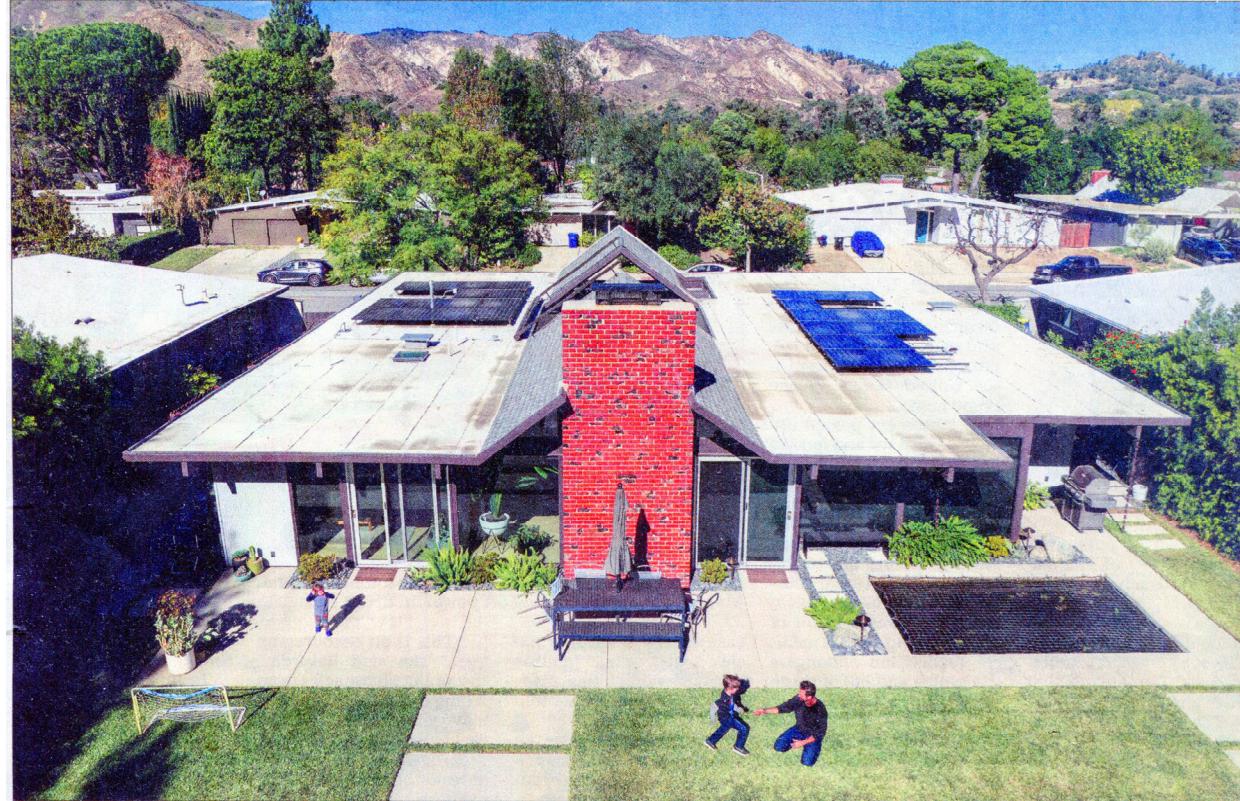


# A Modern Suburban Problem

HER © 2023

TUESDAY, DECEMBER 12, 2023

latimes.com



MYUNG J. CHUN Los Angeles Times

**GRANADA HILLS** resident Erick Fefferman and his family live near the Sunshine Canyon landfill where odors are a constant irritant.

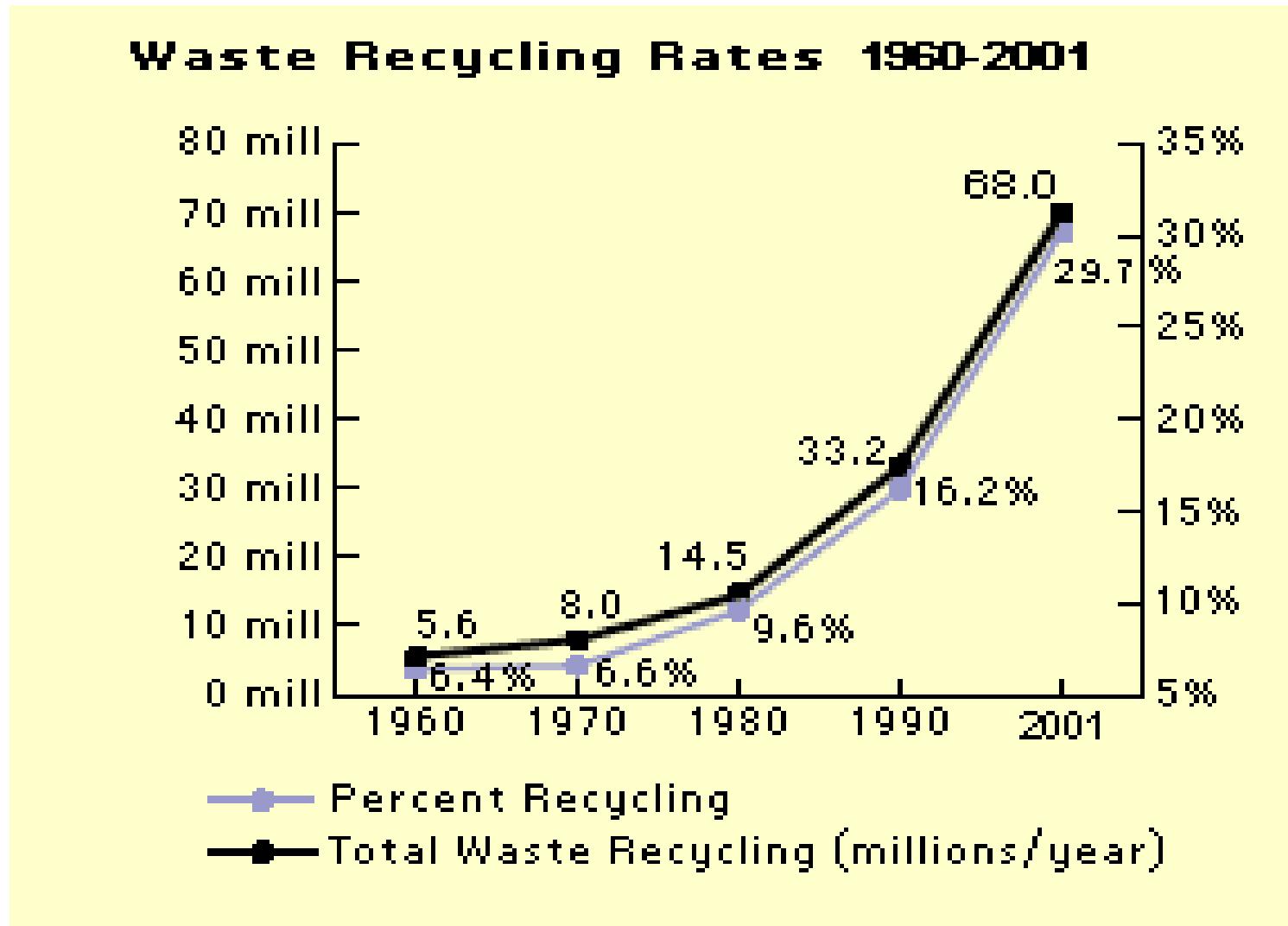
## Living in shadow of leaky landfills

# Problems with Traditional Strategies

- Regulation
  - Administrations change
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- Source Reduction
  - Technologies are expensive
  - Industries fight compliance
- Combustion/Incineration
  - Creates pollution
  - Adds to greenhouse gases
- Physical Containment (Landfills)
  - Modern materials resist biodegradation
  - Toxic leakage affects groundwater and air
  - NIMBY (Not in My Back Yard)
  - Economical available space is scarce

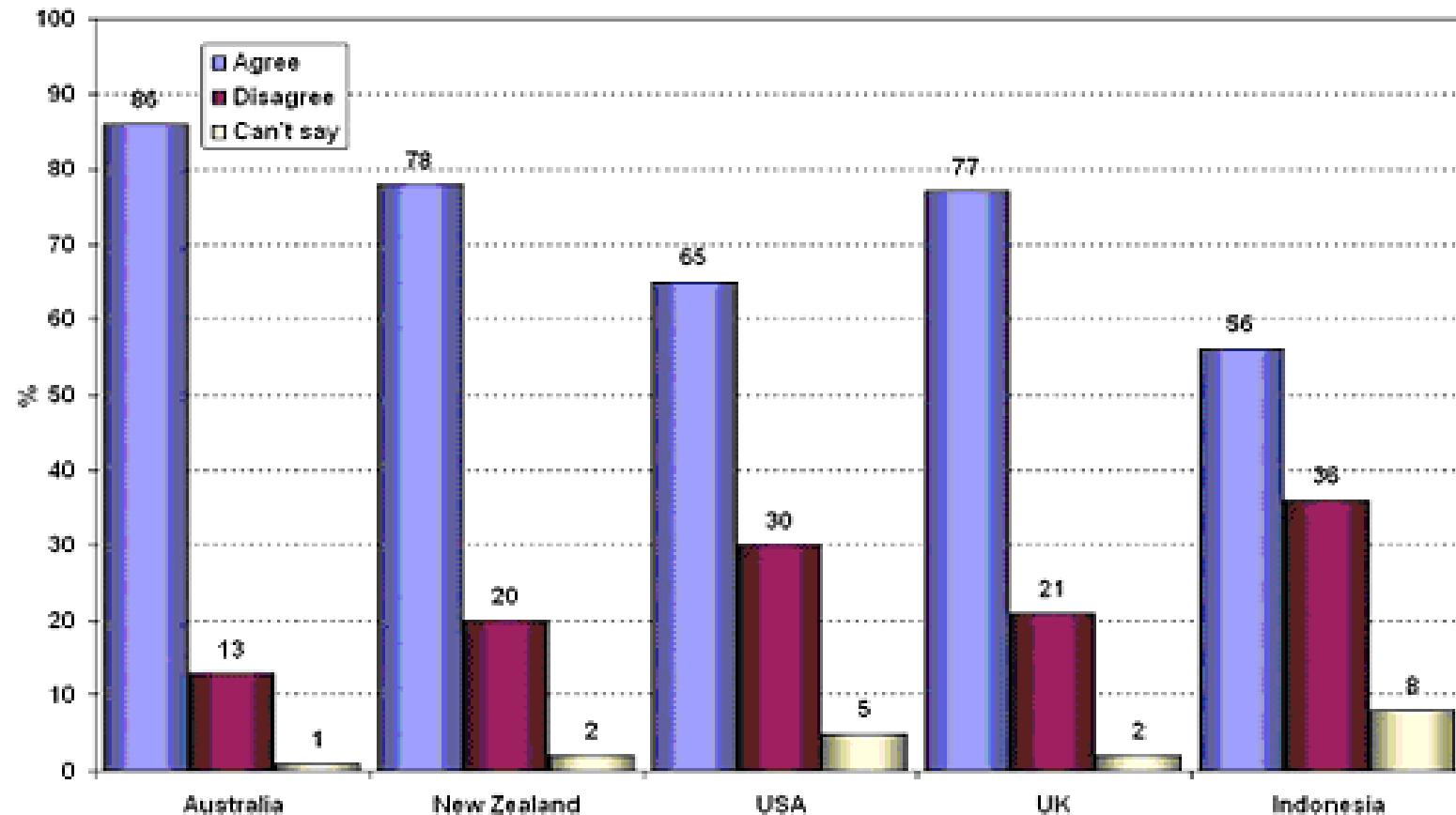


# Recycling: Upward Trend



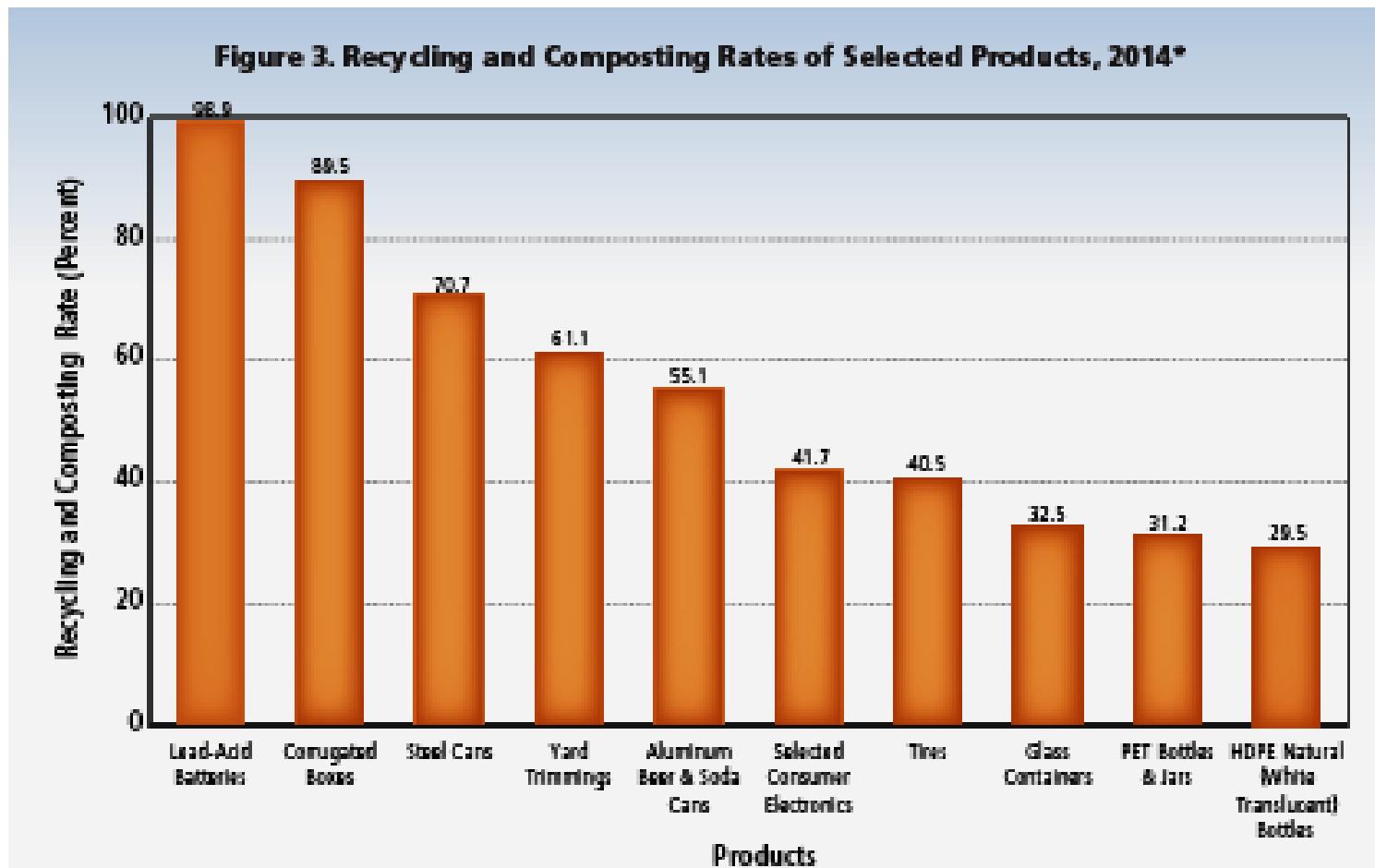
# Recycling: Positive Attitudes

“I try to recycle everything I can”



Survey from Roy Morgan Research <http://www.roymorgan.com>, The Australian, 4 May 2006

# Recycling: Varied Success



US Environmental Protection Agency, Advancing Sustainable Materials Management, 2014 Fact Sheet

# Recycling: Big Business...

Berg Mill Supply Co., Inc. - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back

Address http://bergmill.com/ Go Convert Select

Google Search Bookmarks Check Translate AutoFill

Mcafee SiteAdvisor Sign In

Berg Mill Supply Co. Inc.

HOME PRODUCTS NEWS ABOUT CONTACT

Your By-Product is our Buy-Product.

Berg Mill Supply offers an environmentally and economically sound alternative to the rapidly-diminishing availability of landfills.

Mixed Rigid Plastics MRF Film Mixed Paper

Who we are. 

Welcome to Berg Mill Supply Co., Inc., a domestic and international waste paper, plastic, and metal

News

Berg Mill Supply Company has moved to Suite #2350!  
Tue 7-28-2009

Berg Mill launches new website!  
Wed 2-18-2009

Done Deep Green Us... 183 Lectures Webmail - gwe... CourseWeb | ... Berg Mill Supply... Microsoft Pow... Google Internet 4:05 PM

# Recycling: Innovative Applications



Los Angeles-based startup ByFusion has created a system to collect troublesome plastic trash. Similar in size and shape to the concrete blocks commonly used in construction, ByBlocks are made entirely of reclaimed plastic waste.

# Recycling: Frequently Dangerous ...



Landfill, Mumbai, India; <http://images.businessweek.com/ss/09/08/0805>  
<http://img1.photographersdirect.com/img/2293/wm/pd139285.jpg>

© jeroenbouman.com

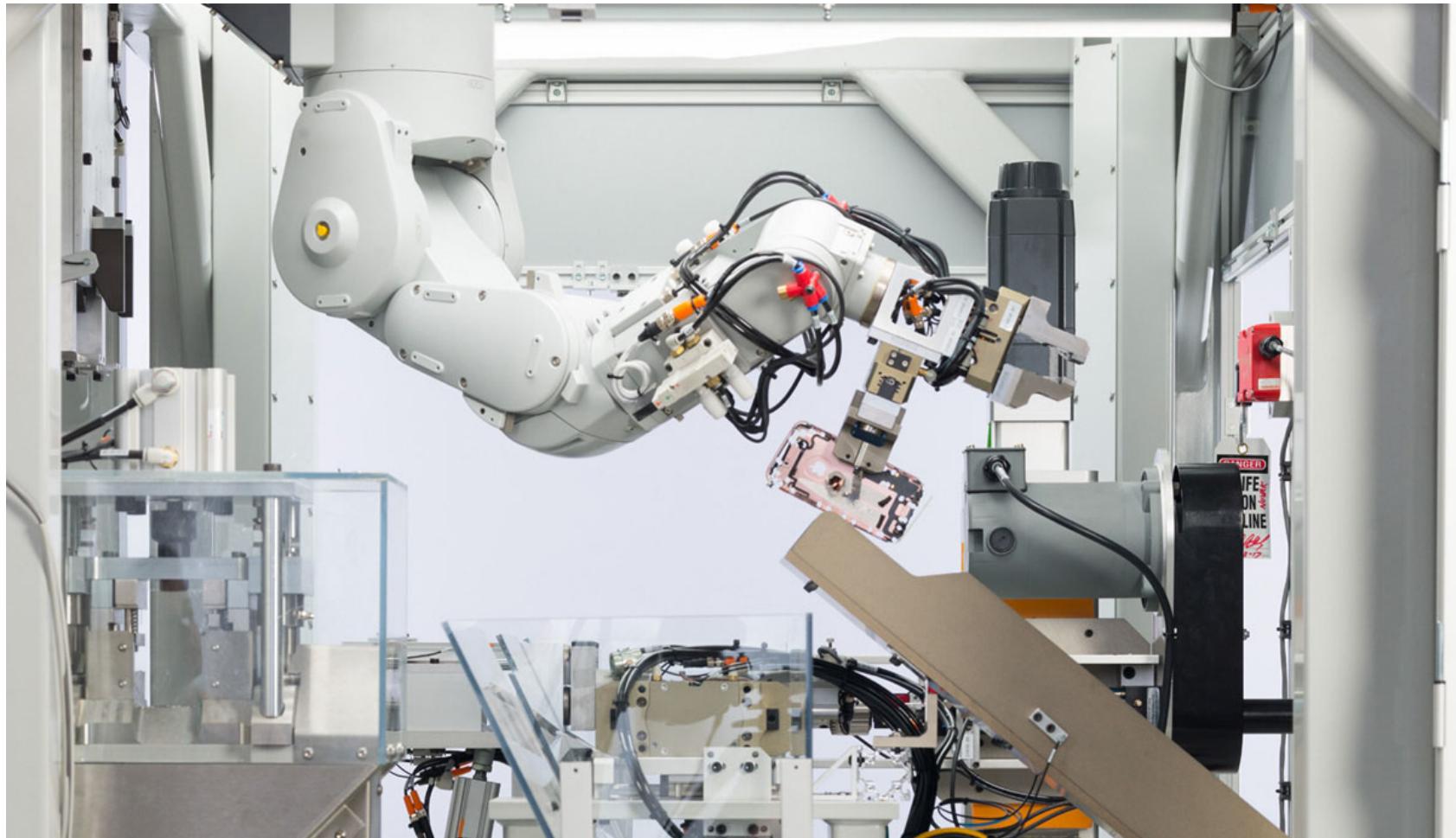
# ...and an International Child Labor Problem



Original page: <http://www.decentcomedy.com>

<http://www.english-online.at/society>

# One High-Tech Solution



Apple's Daisy robot disassembles iPhones for recycling expensive materials

# Issues with the Re-Cycling Paradigm

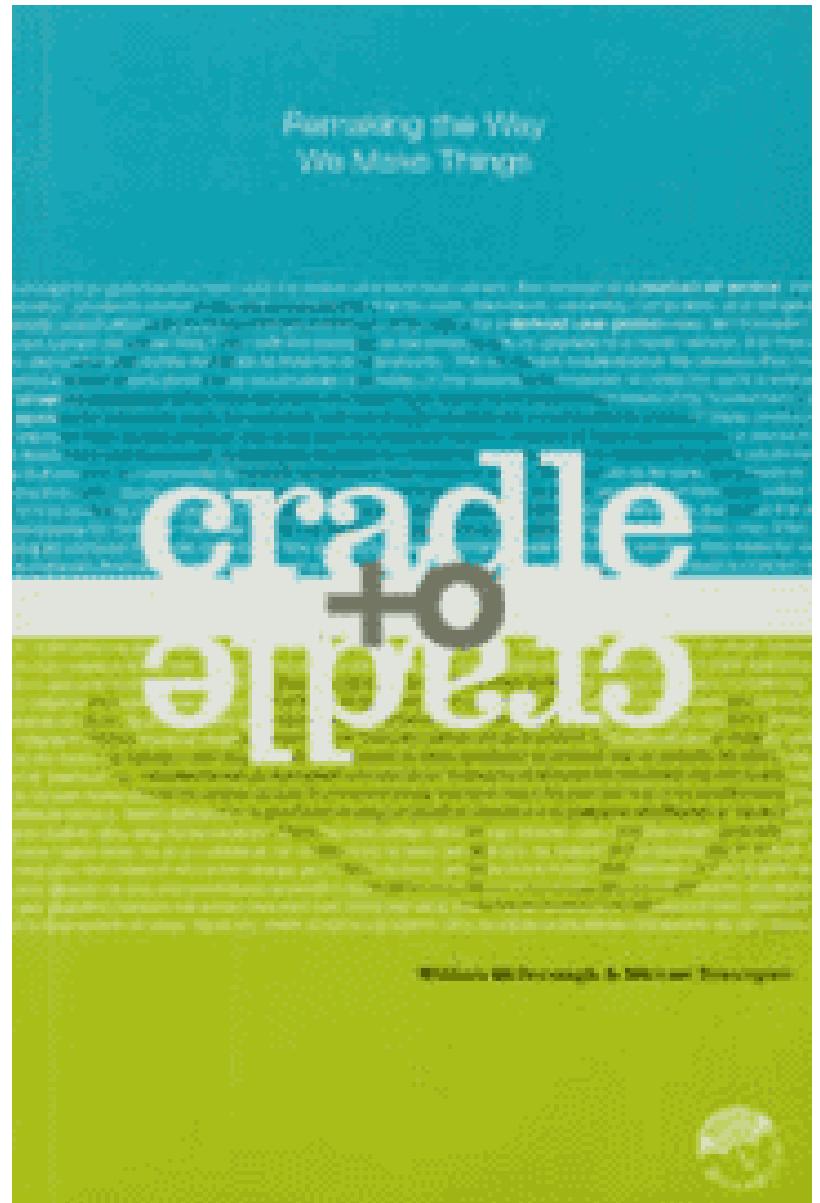
- Dangerous and Unethical
  - Toxic materials
  - Child and forced labor
- Inefficient
  - Can use more energy than it saves
  - Too much individual initiative
- Inadequate
  - Sustaining dwindling resources
  - Maintaining a fundamentally flawed system

# A New Ethical Paradigm

Prof. Michael Braungart  
Hamburg, Germany



William McDonough  
Charlottesville, Virginia



# Cradle to Cradle Rationale

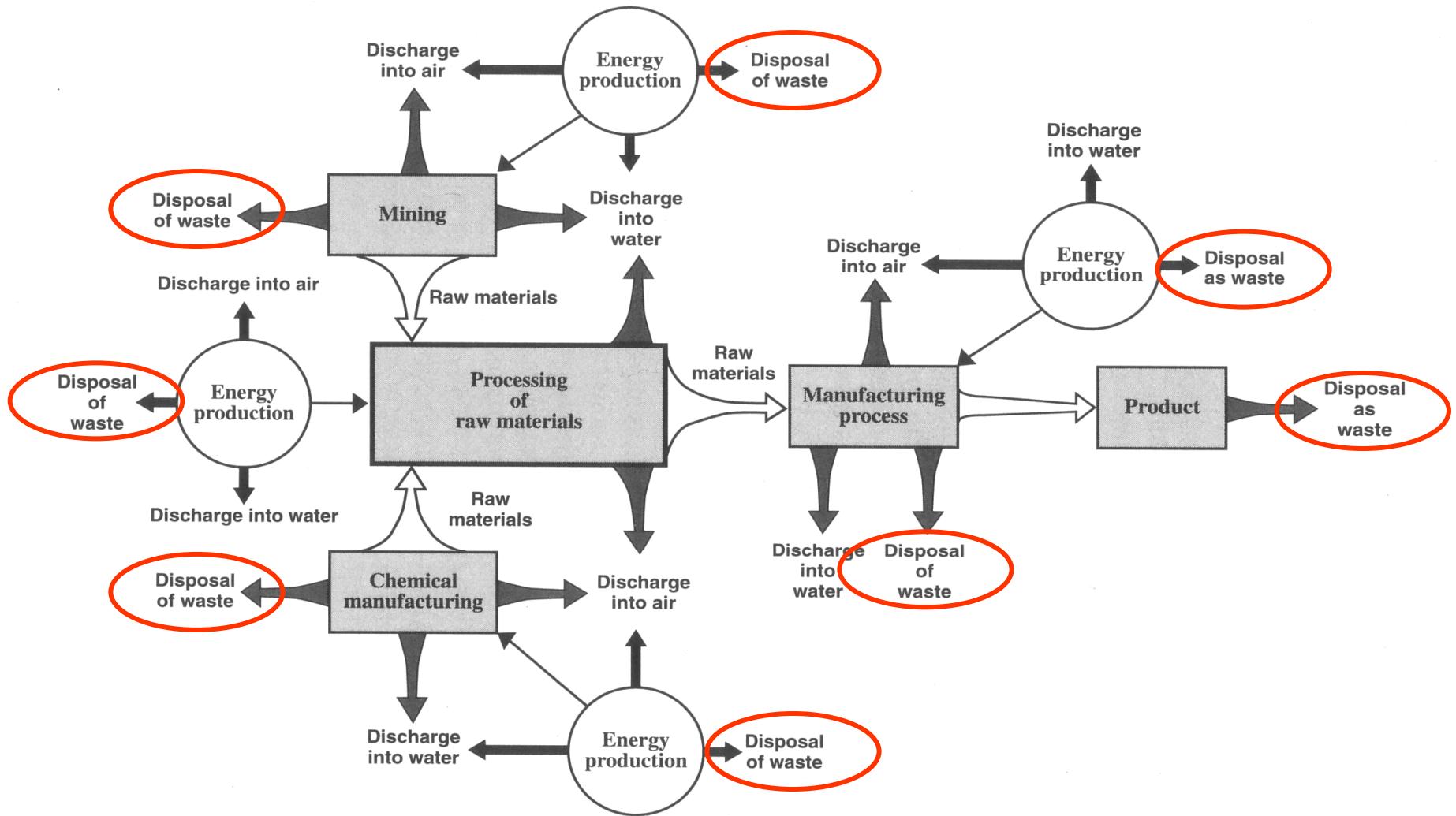
- Rethink the Industrial Revolution
- Redesign the way we make things
- Abandon linear processes of waste production
- Use nature as a model: Waste equals Food



Prof. Michael Braungart

“Let’s start designing things with the idea that they will never become waste but will always be reused in some form or other.”

# Linear Process of Waste Production



# The Cradle to Cradle Alternative<sup>1</sup>

## The 1<sup>st</sup> Industrial Revolution:

- Generates gigantic amounts of waste
- Puts billions of pounds of toxic material into air, water and soil every year
- Requires constant vigilance of highly dangerous materials
- Buries valuable materials
- Necessitates thousands of complex regulations
- Creates prosperity through *destruction* of natural resources
- Erodes the eco-environment

## The New Industrial Objectives:

- Factory affluent water that is cleaner than the influent
- Products that become food for plants, animals and soil or raw materials for new products
- Buildings that produce more energy than they consume
- Trillions of dollars worth of materials *accrued* each year
- A world of *abundance*, not one of limits, pollution and waste

<sup>1</sup>MBDC (2004) [www.mbdcc.com](http://www.mbdcc.com)

# Example: Simple C-to-C Design Protocol

Categories of chemicals in products:

- **Green** Little or no risk
- **Yellow** Low to moderate risk
- **Orange** Lack of information
- **Red** High risk



In applying the Protocol, materials in products are first inventoried and then evaluated according to their characteristics within the desired application, and placed into one of four categories (Green, Yellow, Orange, or Red) based on human health and environmental relevance criteria. After all chemicals are assessed, the materials in a product are optimized by positively selecting replacements for chemicals characterized as Red and using Green chemicals as they are available.

# Example: Complete C-to-C Product

In 1993, William McDonough and Michael Braungart undertook a design assignment to create an attractive and functional fabric that could safely return to the environment at the end of its useful life. After extensive R&D, they devised a toxin-free blend of wool and organically grown ramie, a linen-like fiber, in a process so clean that it generates potable wastewater, and the mill turns scrap trimmings into felt which Swiss farmers use for mulch in strawberry fields.<sup>1</sup>



climatex® lifecycle(tm)  
mcdonough braungart design chemistry

<sup>1</sup>Copyright Gershon Weltman, 2024  
[www.designboom.com](http://www.designboom.com)

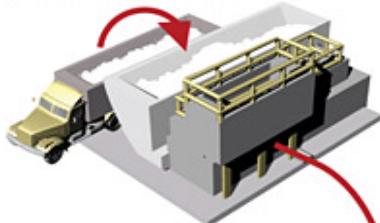
# Example: Energy from Onion Waste

## Energy with a peel

The onion-to-energy conversion is expected to save Gills Onions \$700,000 a year in utility expenses.

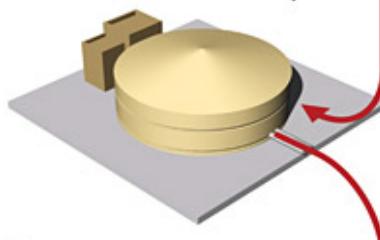
### ① Juice plant

Most onion waste from the processing plant is pressed into juice and cattle feed.



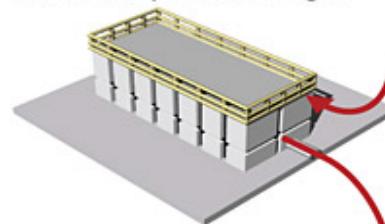
### ② Juice preparation

The juice is transferred to a holding tank, where its temperature, pH, strength and micronutrient levels are adjusted.



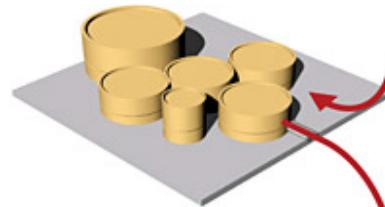
### ③ Anaerobic digester

The juice is then conveyed into a 145,000-gallon reactor, where anaerobic bacteria digest the carbohydrates and convert the juice into biogas.



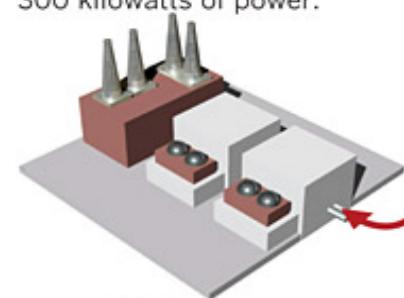
### ④ Biogas conditioning

The biogas is purified, dehumidified and compressed.



### ⑤ Power conversion

The gas is then supplied to two fuel cells, which each generate 300 kilowatts of power.



Sources: Gills Onions  
Graphics reporting by **TIFFANY HSU**  
**LORENA I. ELEBEE** Los Angeles Times

# Example: Energy-Efficient Buildings



Otis' Gen2® elevator with regenerative drive

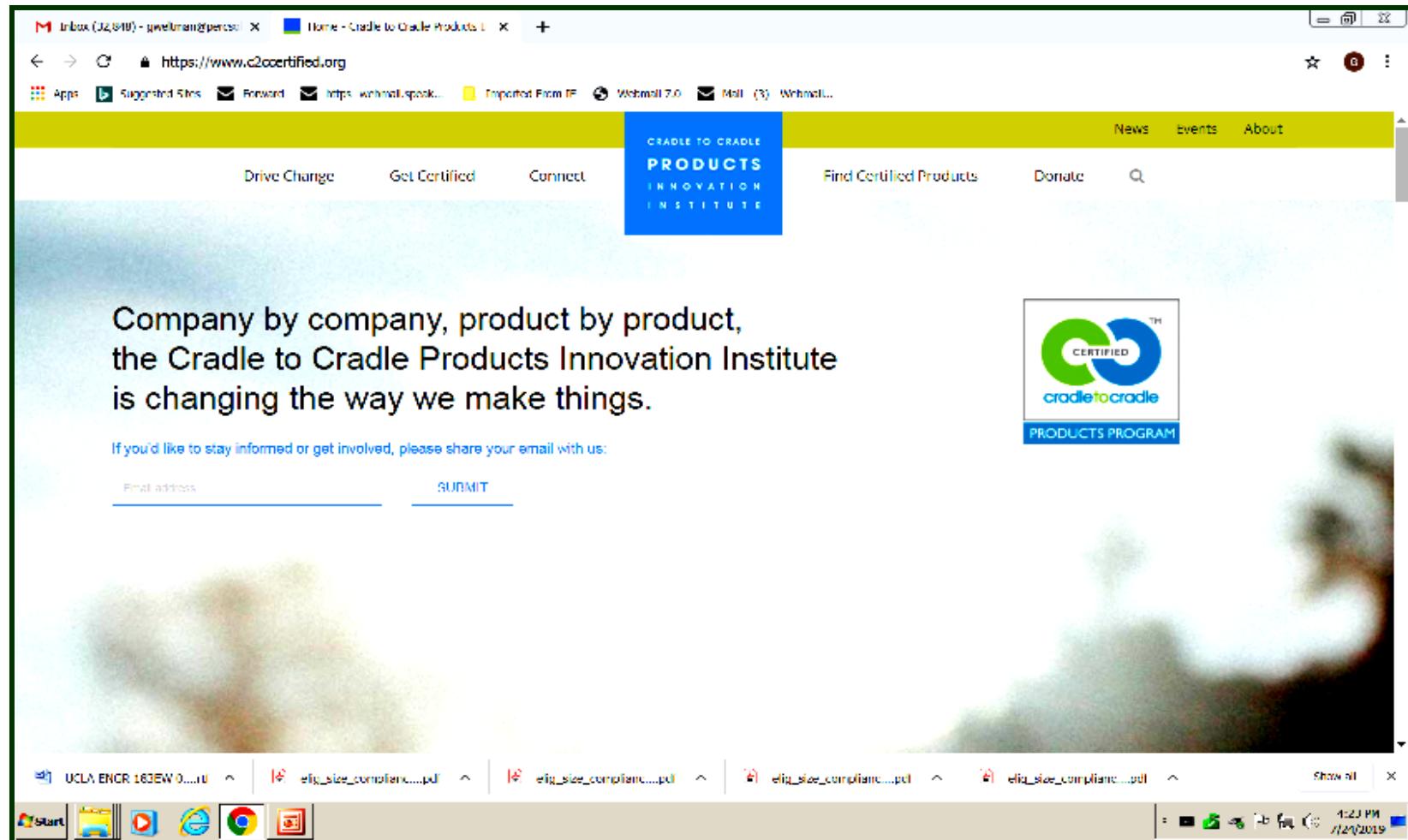
UTC's PureComfort® CCHP (combined cooling, heating and power) system

UC Santa Barbara researchers in energy efficiency of buildings are a part of the national research effort in integrated building systems, which includes commercial (United Technologies) and government laboratory partners (Lawrence Berkeley Laboratory).  
(Graphic courtesy of United Technologies)

Buildings consume 39% of the total energy we use in the U.S., and 71% of all our electricity, generating almost half (48%) of our total carbon emissions.<sup>1</sup>

<sup>1</sup>Building Better Buildings, Convergence, UC Santa Barbara, Winter 2010

# Trying to Institutionalize



# Summary: Critical 21<sup>st</sup> Century Problems

- Ambitious Goals, Including:
  - Improved sources of quality water
  - Increased food production
  - “Clean” power generation and transportation
  - “Waste-free” product manufacturing and usage
  - Better quality of life for the growing human population
  - Protection of the complete ecosystem
- Difficult Ethical Engineering Requiring:
  - Understanding (and agreeing on) the problems
  - Setting correct priorities for addressing them
  - Developing innovative new solutions
  - Ensuring the solutions don’t make things worse

# UCLA is Concerned and Involved

## UCLA Professor Creates New Course on Engineering and Environmental Justice



*UCLA Samueli*

Assist. Prof. Regan Patterson's 2023 course defined environmental justice and explored how engineers can partner with communities to address local environmental issues.