



# WHO'S AFRAID OF THE BIG, BAD JEVONS PARADOX?

BY ZACK SEMKE



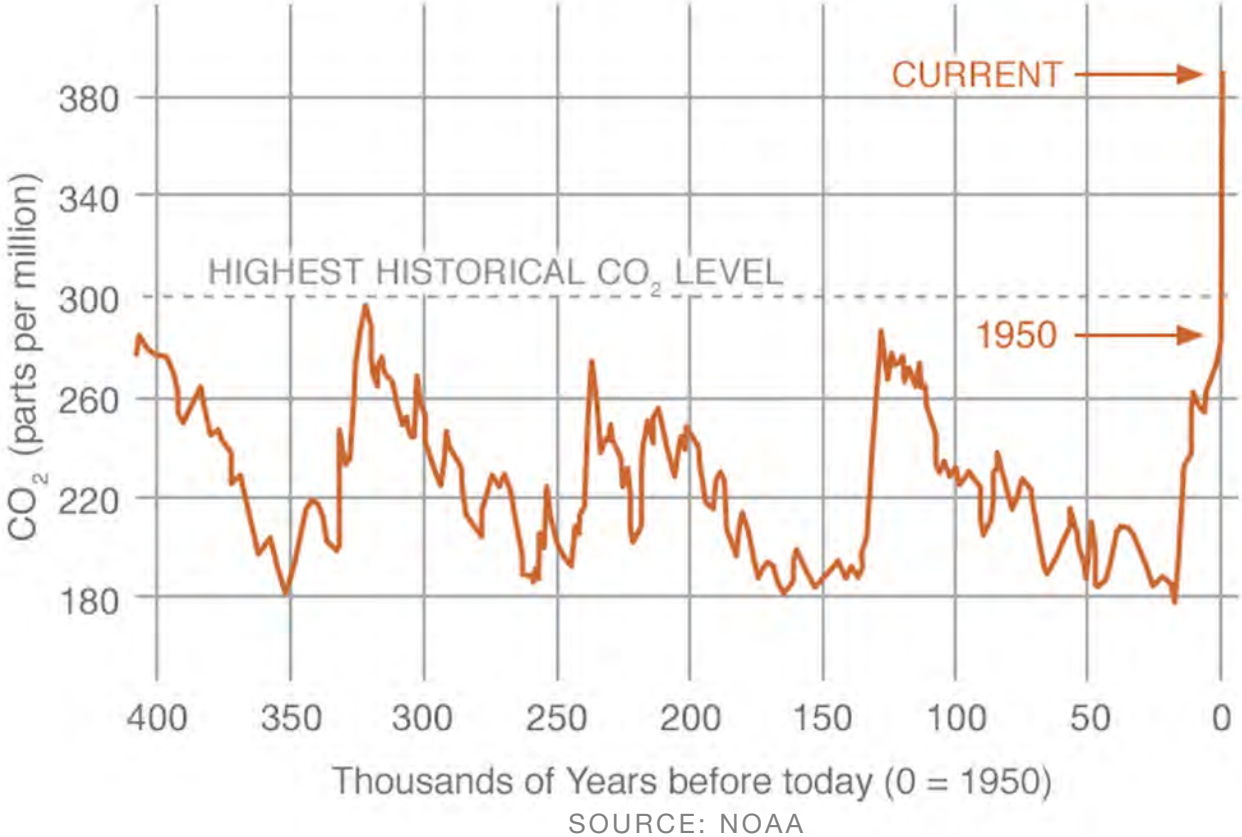
CLIMATE CRISIS



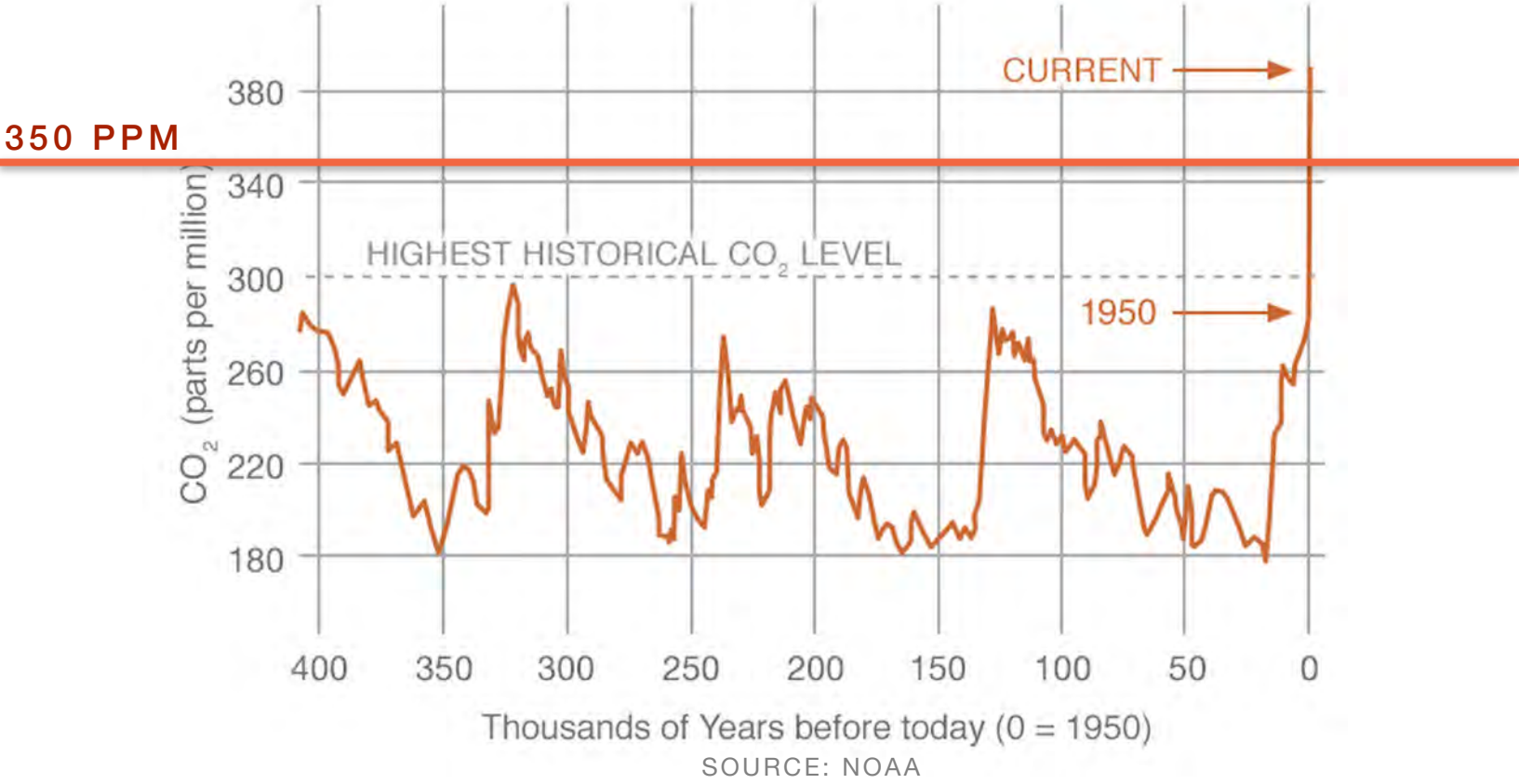
SOURCE: [www.flickr.com/photos/mugley/](http://www.flickr.com/photos/mugley/)



# GLOBAL GREENHOUSE GASSES

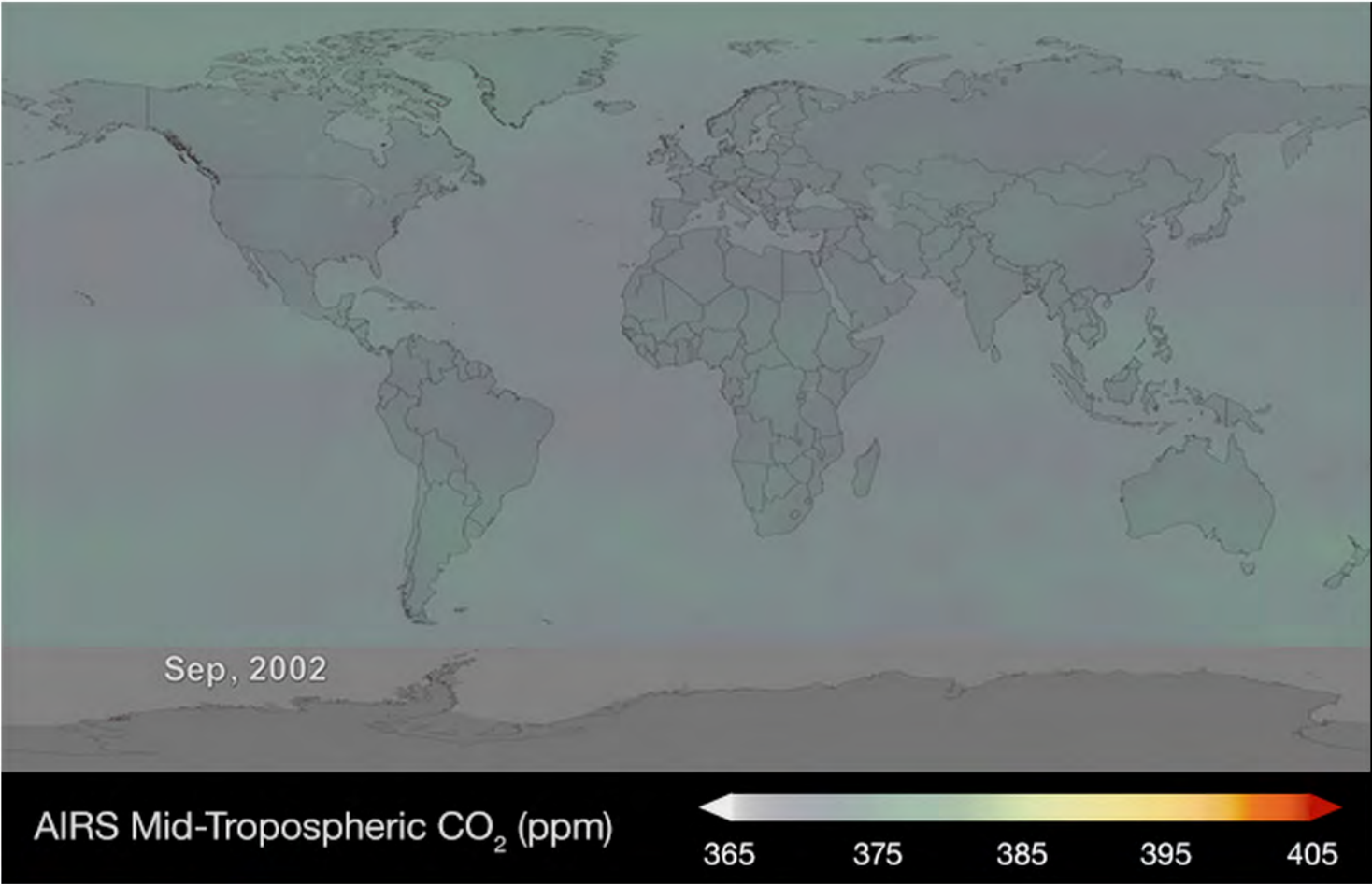


# GLOBAL GREENHOUSE GASSES





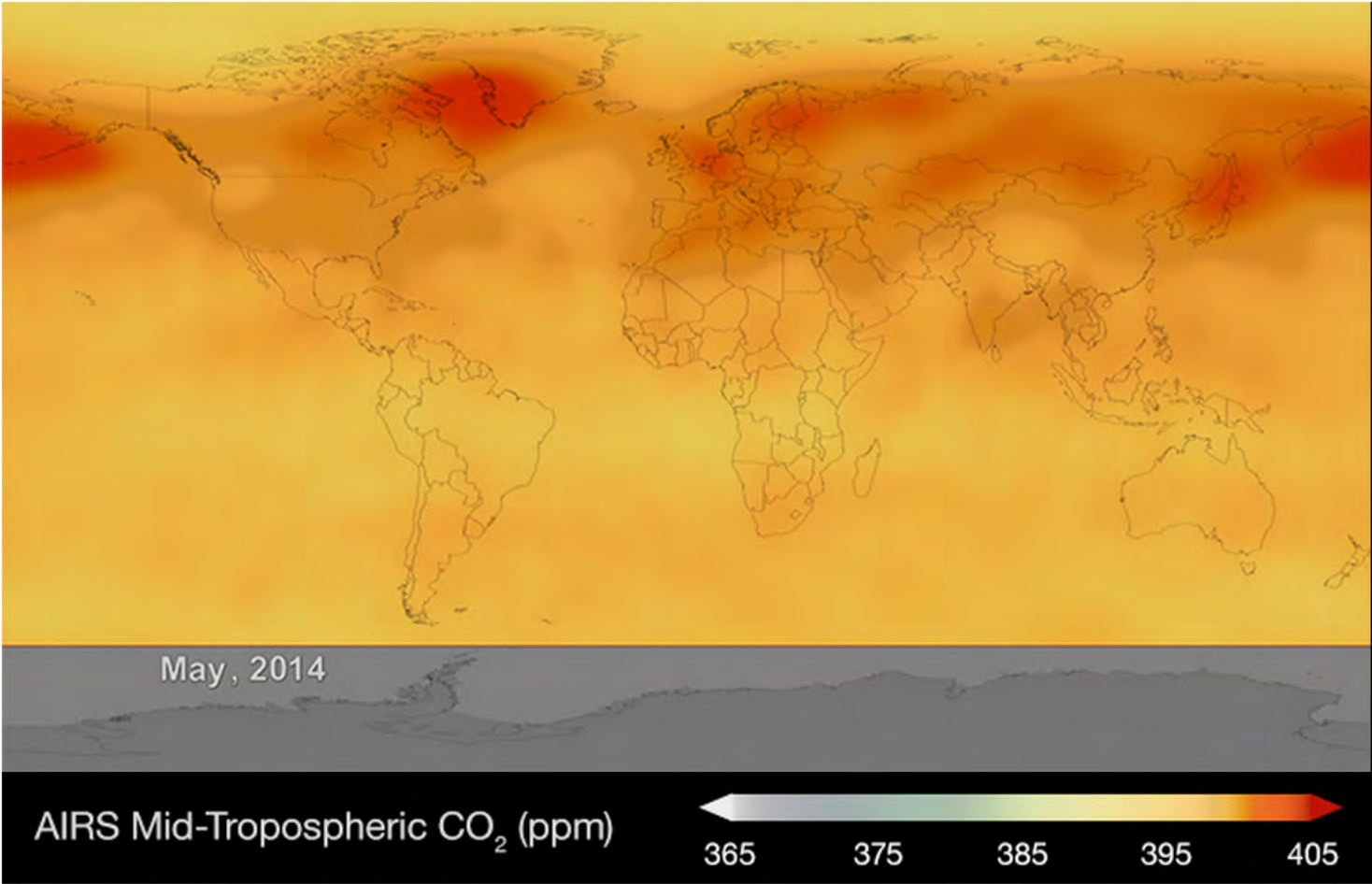
# GLOBAL GREENHOUSE GASSES



SOURCE: NOAA



# GLOBAL GREENHOUSE GASSES



2002

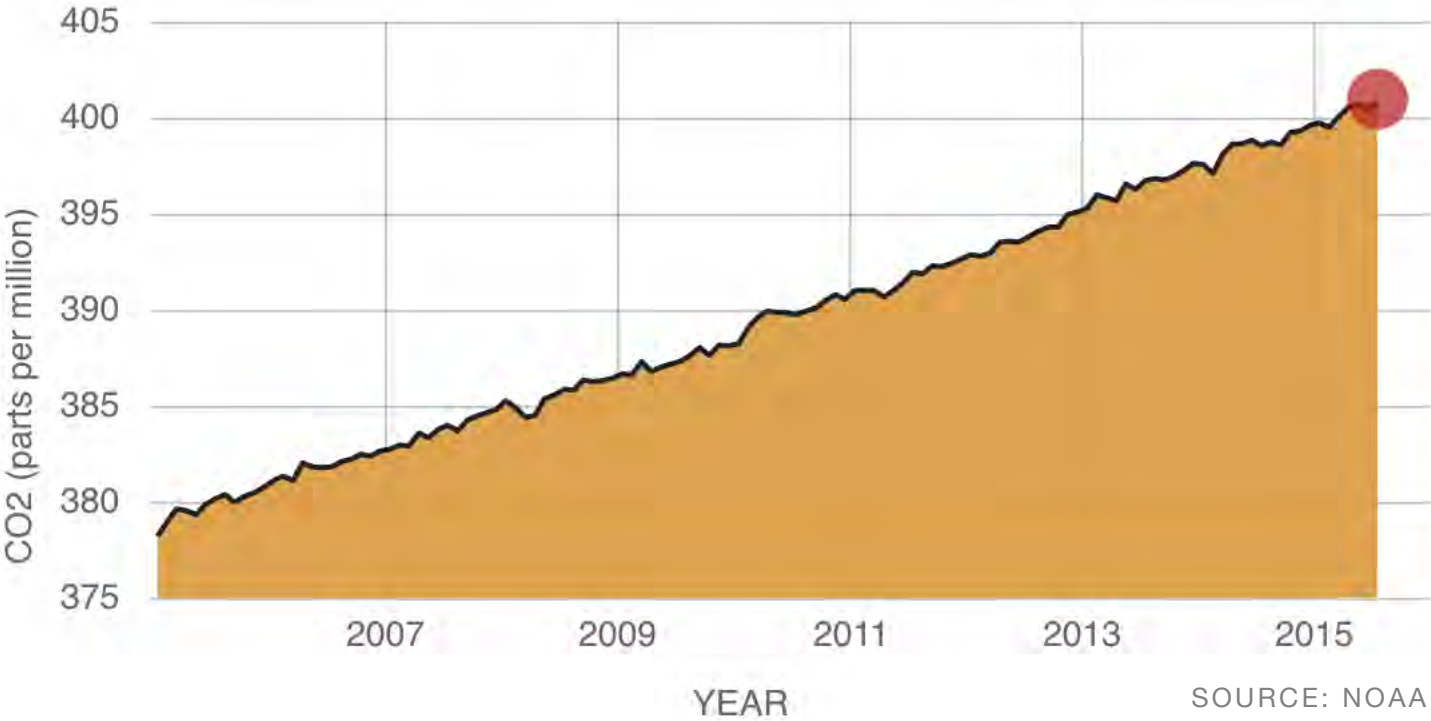


2014

SOURCE: NOAA




# GLOBAL GREENHOUSE GASSES



SCIENCE | WORLD BRIEFING

# Coverage of Arctic Sea Ice Shrinks to a Winter Low

By HENRY FOUNTAIN MARCH 19, 2015

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There was less sea ice coverage in the [Arctic](#) this winter than in any year since satellite measurements began nearly four decades ago, researchers said Thursday. The National Snow and Ice Data Center, a government-sponsored research group, said that in late February ice cover in the Arctic Ocean reached its maximum extent, 5.61 million square miles, which is about 7 percent less than the average from 1981 to 2010 and about 1 percent less than the previous lowest year, 2011. The center said that changes in the jet stream created warmer than normal conditions on the Pacific side of the Arctic. While the extent of Arctic sea ice is naturally variable, it has been generally declining over the past several decades as the region warms more quickly than other parts of the planet.

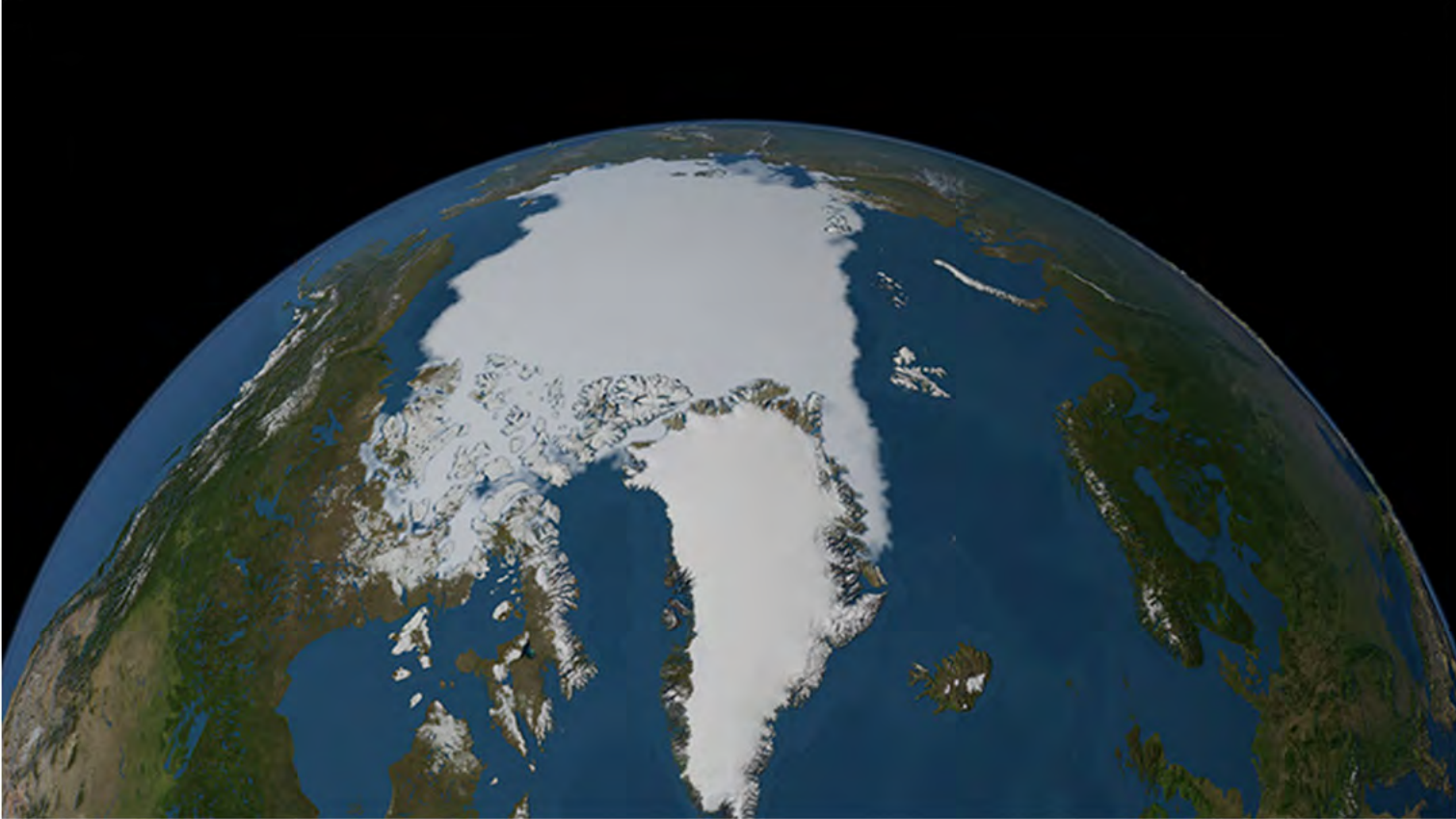


ARCTIC SEA ICE



SOURCE: Corey Accardo/NOAA/AP

# ARCTIC SEA ICE



▶ 1979 ○

2014

SOURCE: NASA



# ARCTIC SEA ICE



▶ 1979

○ 2014

SOURCE: NASA






The New York Times

WORLD

## *The Big Melt: Antarctica's Retreating Ice May Re-Shape Earth*

By THE ASSOCIATED PRESS FEB. 27, 2015, 4:02 P.M. E.S.T.

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CAPE LEGOUPIL, Antarctica — From the ground in this extreme northern part of Antarctica, spectacularly white and blinding ice seems to extend forever. What can't be seen is the battle raging thousands of feet (hundreds of meters) below to re-shape Earth.

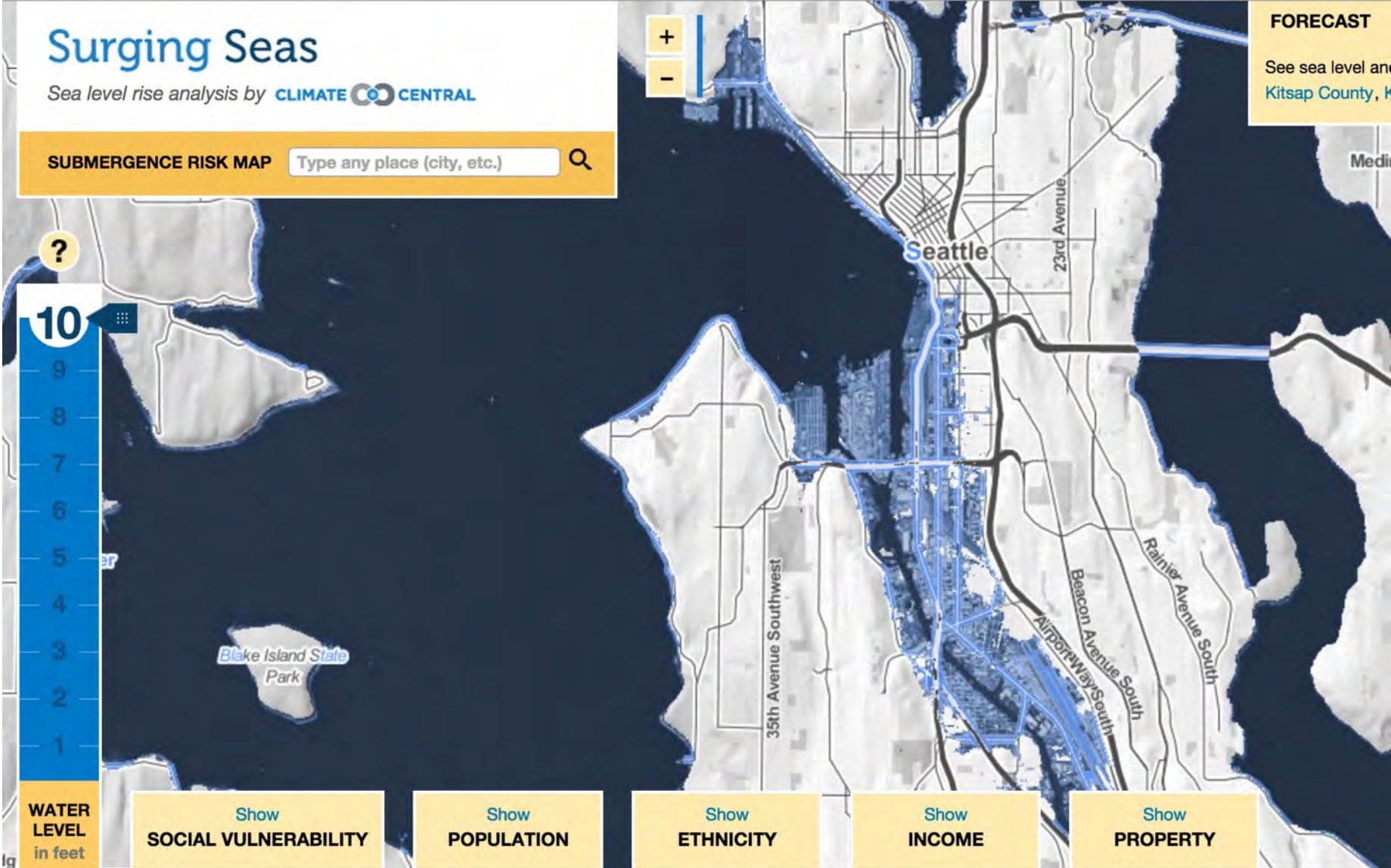
Water is eating away at the Antarctic ice, melting it where it hits the oceans. As the ice sheets slowly thaw, water pours into the sea — 130 billion tons of ice (118 billion metric tons) per year for the past decade, according to NASA satellite calculations. That's the weight of more than 356,000 Empire State Buildings, enough ice melt to fill more than 1.3 million Olympic swimming pools. And the melting is accelerating.

In the worst case scenario, Antarctica's melt could push sea levels up 10 feet (3 meters) worldwide in a century or two, recurving heavily populated coastlines.

Parts of Antarctica are melting so rapidly it has become "ground zero of global [climate change](#) without a doubt," said Harvard geophysicist Jerry Mitrovica.



# SEA LEVEL RISE



SOURCE: ClimateCentral



Environment | Local News

## Acidity in ocean killed NW oysters, new study says

Originally published April 11, 2012 at 10:45 pm | Updated April 12, 2012 at 5:54 am



*Olympia oysters from a tank at University of Washington's ocean acidification research lab at Friday Harbor.*

**Researchers said Wednesday they have conclusive evidence that ocean acidification is at least partly responsible for killing oysters on the West Coast.**

By [Craig Welch](#)

Array

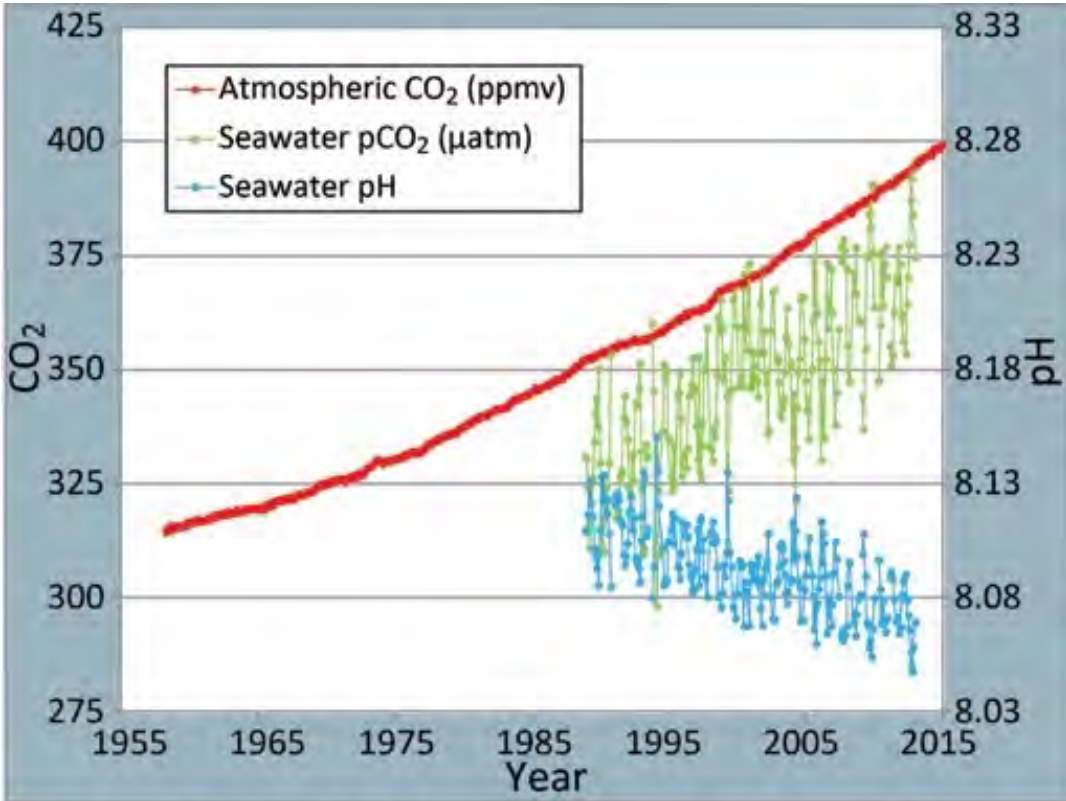
It's been eight years since baby oysters started dying by the billions at an Oregon hatchery and in Washington's Willapa Bay.

In 2009, [top scientists drew global attention](#) when they said evidence suggested the culprit might be changing ocean chemistry from the same greenhouse gases that contribute to global warming. They just couldn't prove it — until now.

Researchers said Wednesday they can definitively show that ocean



# OCEAN ACIDIFICATION

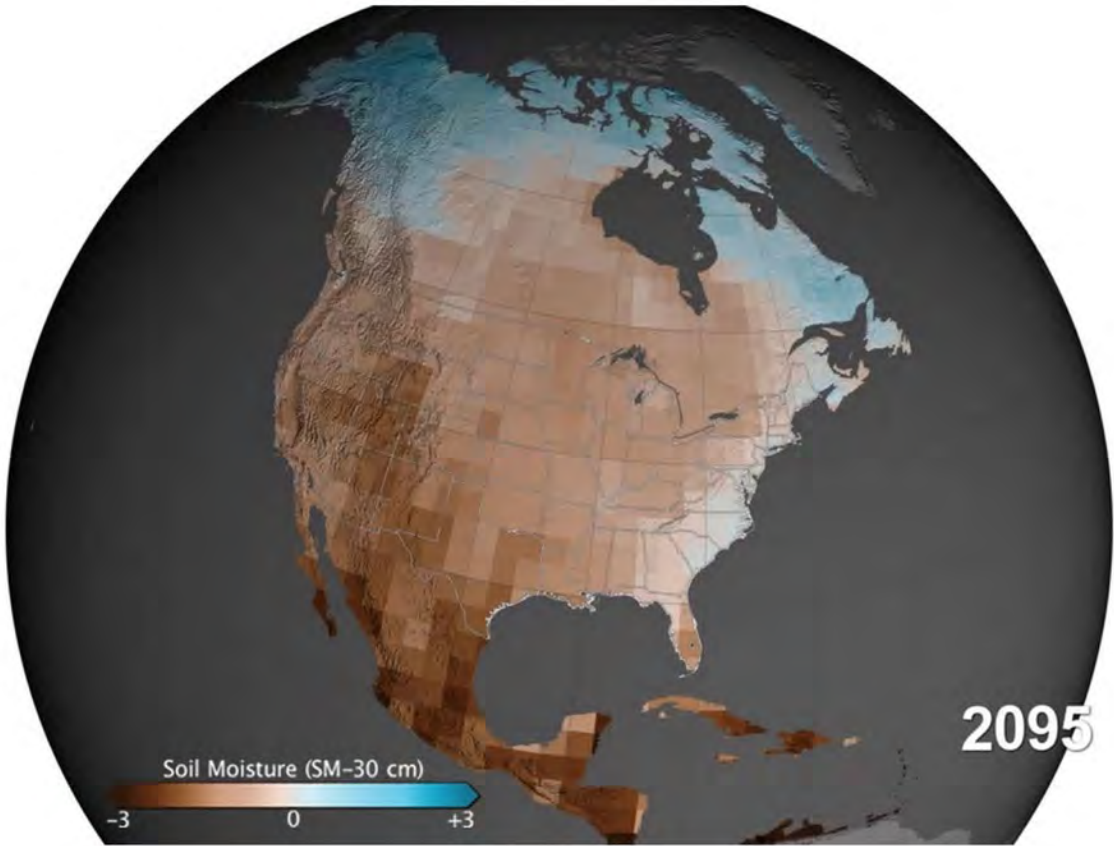


SOURCE: NOAA





A 'megadrought' will grip U.S. in the coming decades, NASA researchers say



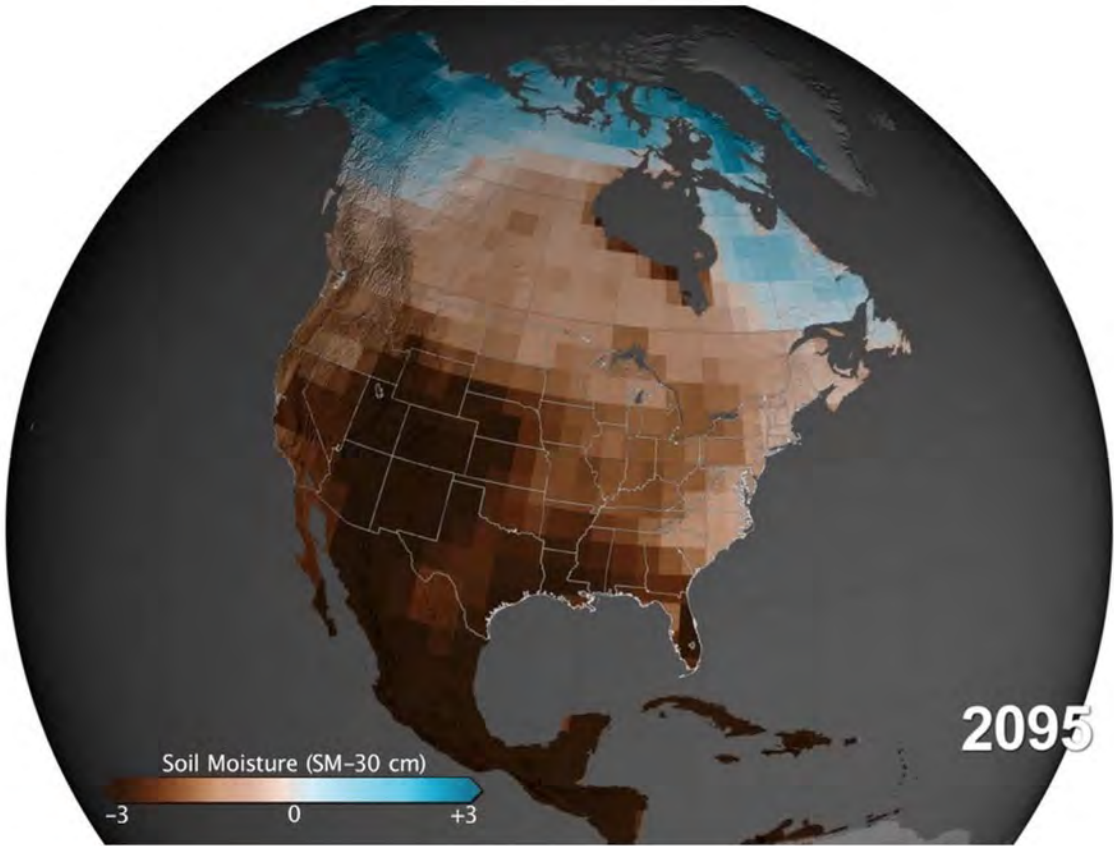
NASA: SOIL MOISTURE LEVELS, IF WE REVERSE EMISSIONS TRENDS.







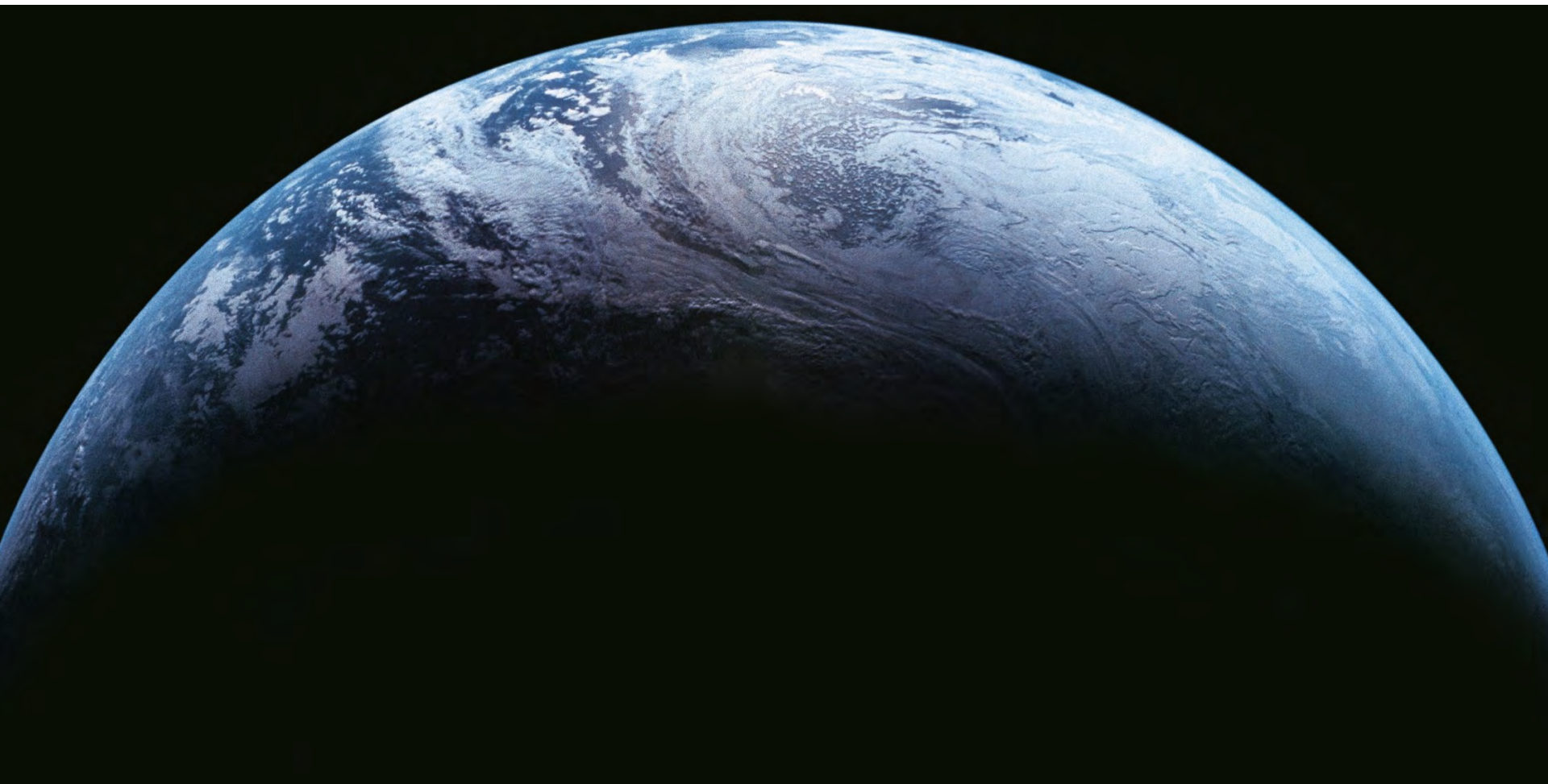
A 'megadrought' will grip U.S. in the coming decades, NASA researchers say



NASA: SOIL MOISTURE LEVELS, **IF WE DON'T REVERSE EMISSIONS TRENDS.**  
**80% CHANCE OF MEGADROUGHT** THIS CENTURY.  
DROUGHT = 3 YEARS. MEGADROUGHT = **30 YEARS.**



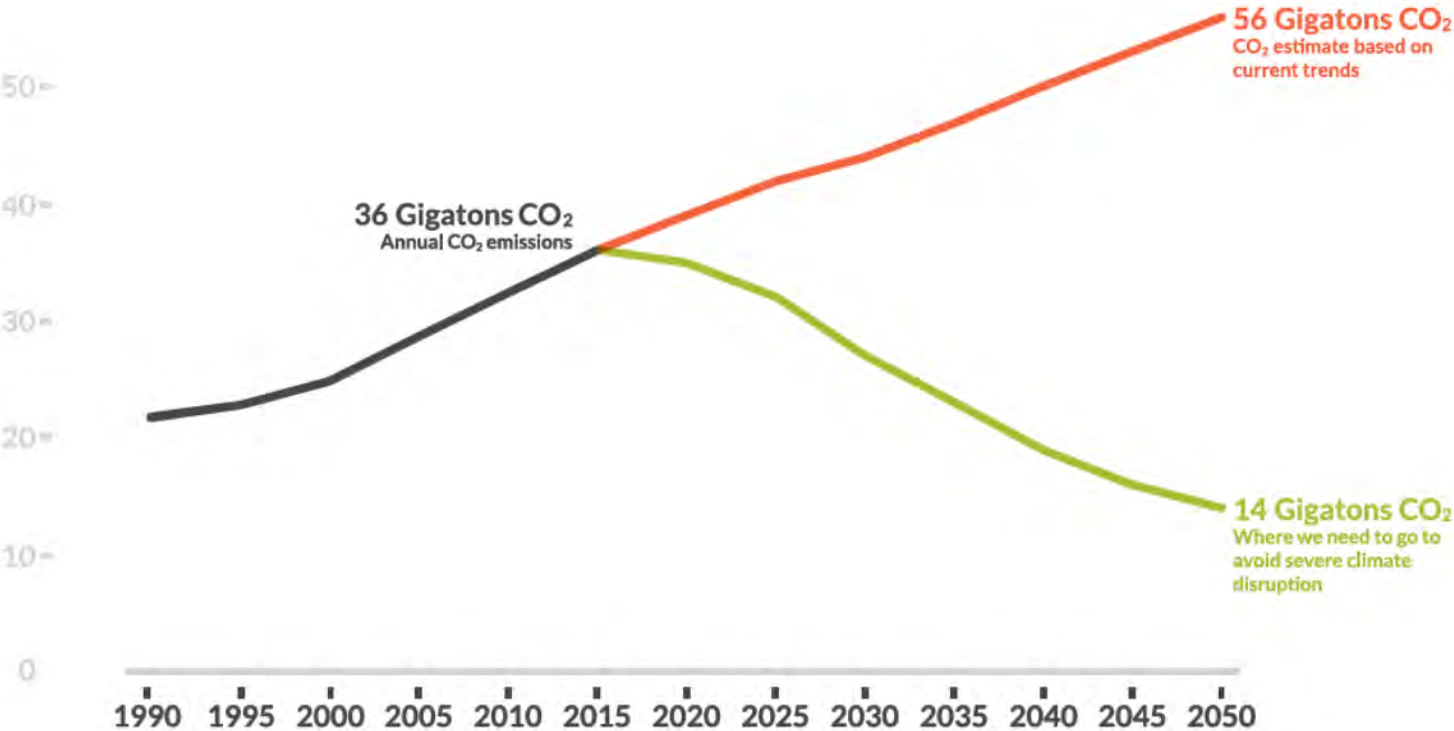
## WE NEED TO TURN THIS AROUND



1. USE ENERGY **MORE EFFICIENTLY**.
2. TRANSITION FROM FOSSIL FUELS TO **CLEAN ENERGY**.
3. IMPROVE LAND USE (**REFOREST**).
4. GEOENGINEERING? (BEWARE THE CRAZY TALK).

# GLOBAL GREENHOUSE GASSES

TO AVOID SEVERE CLIMATE  
DISRUPTION WE MUST **REDUCE**  
**GLOBAL CO<sub>2</sub> EMISSIONS 59% BY**  
**2050.**



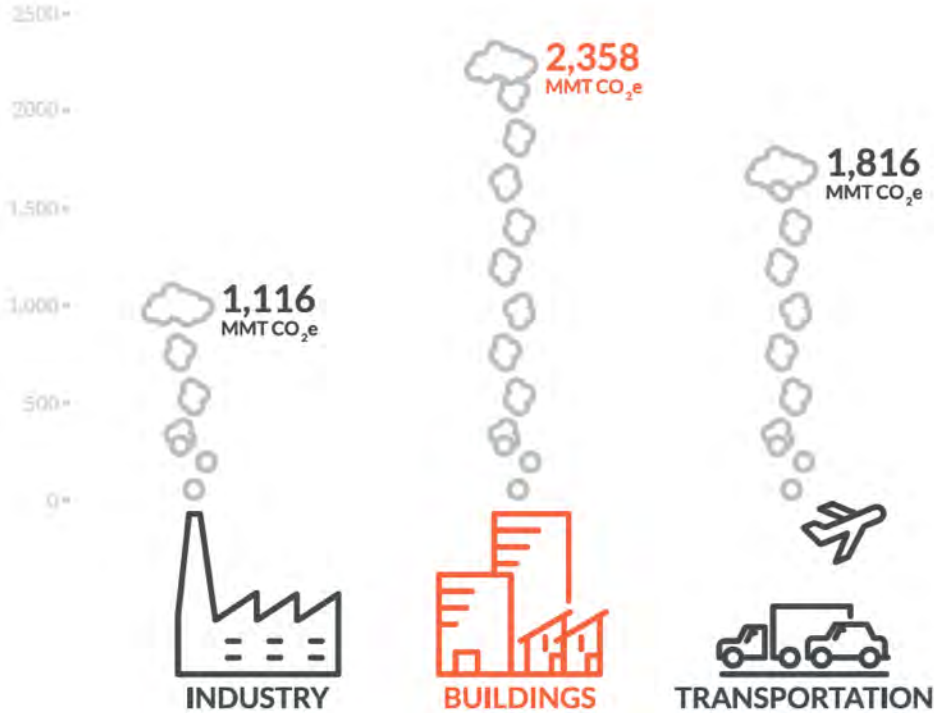
DATA SOURCE: INTERNATIONAL ENERGY AGENCY

ILLUSTRATION: © hammerandhand.com



# BUILDINGS ARE PART OF THE PROBLEM

**BUILDINGS** ARE RESPONSIBLE FOR **44.5%** OF US **CO<sub>2</sub> EMISSIONS**.



DATA SOURCE: ARCHITECTURE 2030  
ILLUSTRATION: hammerandhand.com





# BUILDINGS CAN BE PART OF THE SOLUTION

THROUGH **PASSIVE HOUSE** WE  
CAN **REDUCE HEATING & COOLING**  
ENERGY **BY 90%**.



ILLUSTRATION: hammerandhand.com

BUT WAIT...

UMM...  
YOU ARE FOOLING  
YOURSELVES.



WILLIAM STANLEY JEVONS

BUT WAIT...

**“IT IS A CONFUSION OF  
IDEAS TO SUPPOSE THAT THE  
ECONOMICAL USE OF FUEL IS  
EQUIVALENT TO DIMINISHED  
CONSUMPTION.”**



WILLIAM STANLEY JEVONS

BUT WAIT...

**“THE VERY CONTRARY  
IS THE TRUTH.”**



WILLIAM STANLEY JEVONS



**ACCORDING TO JEVONS:**

ENERGY EFFICIENCY **CAUSES MORE**  
ENERGY CONSUMPTION, NOT LESS.

**ACCORDING TO JEVONS:**

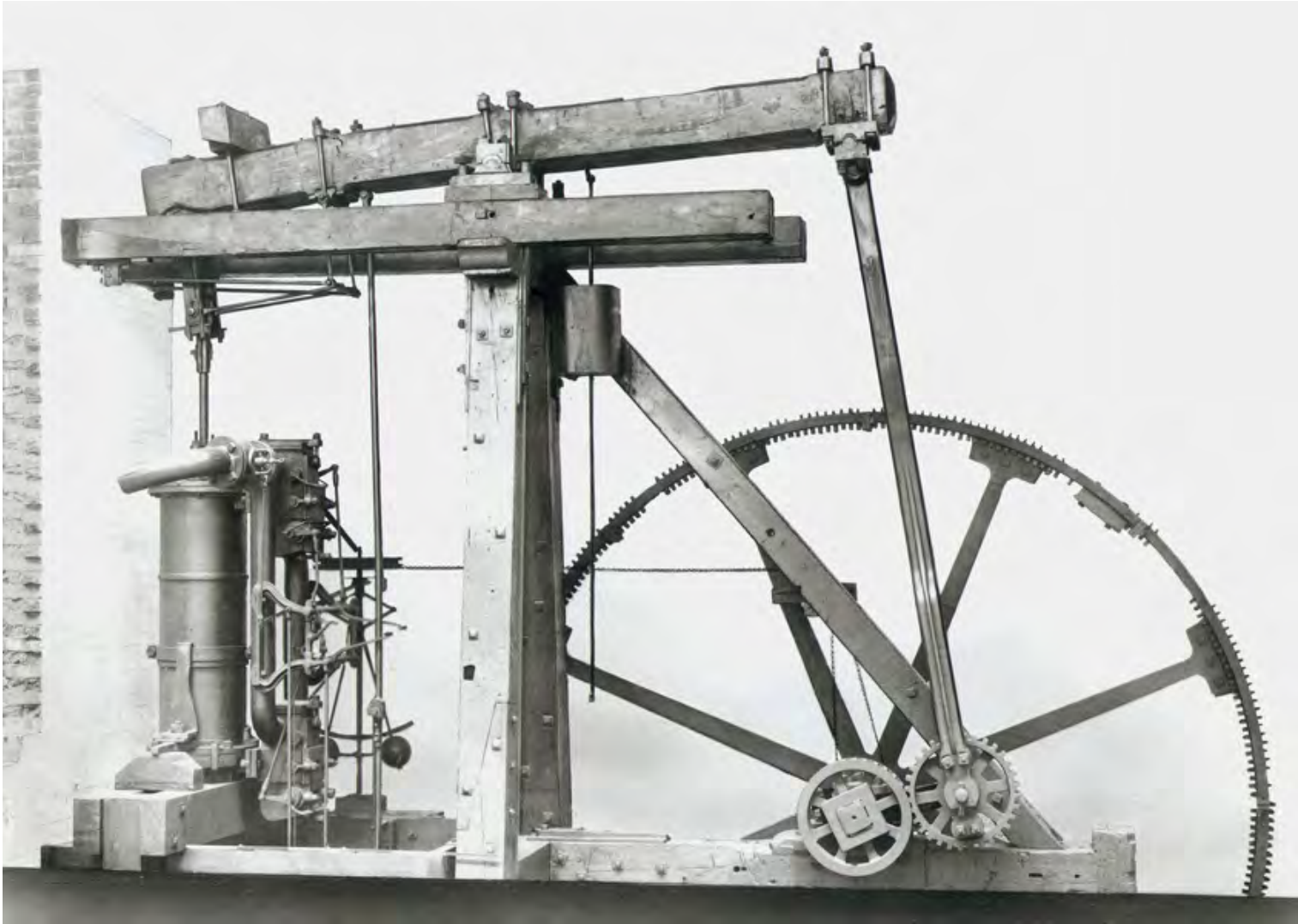
ENERGY EFFICIENCY **CAUSES MORE**  
ENERGY CONSUMPTION, NOT LESS.

True?

What does that mean for passive building?

Who stands to gain from promoting this idea?

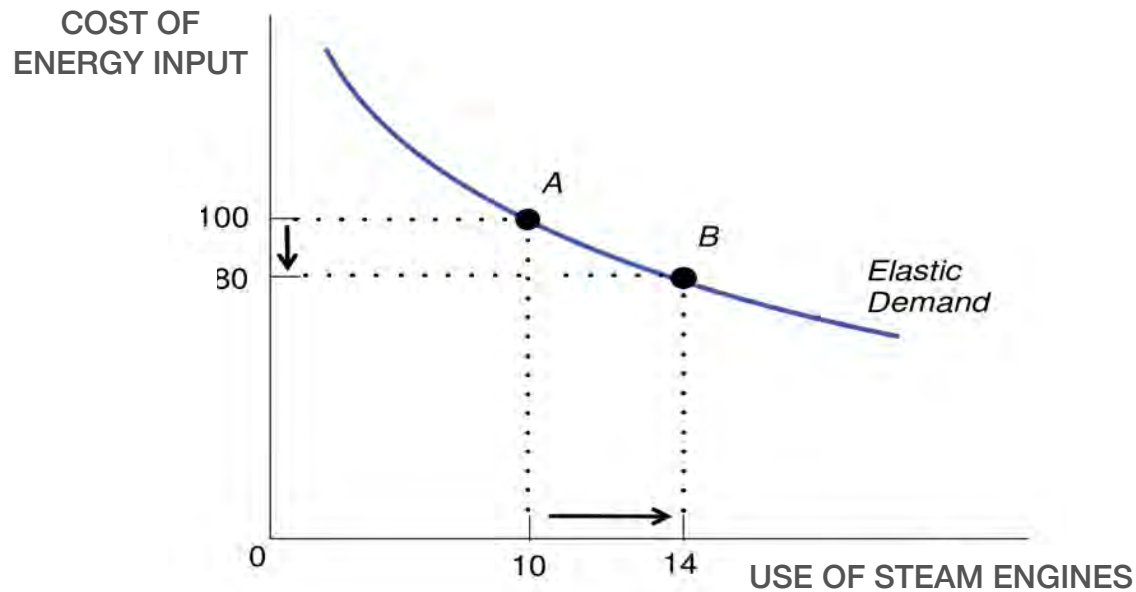
THE JEVONS PARADOX



JAMES WATT STEAM ENGINE

IMAGE: SCIENCE MUSUEM GROUP

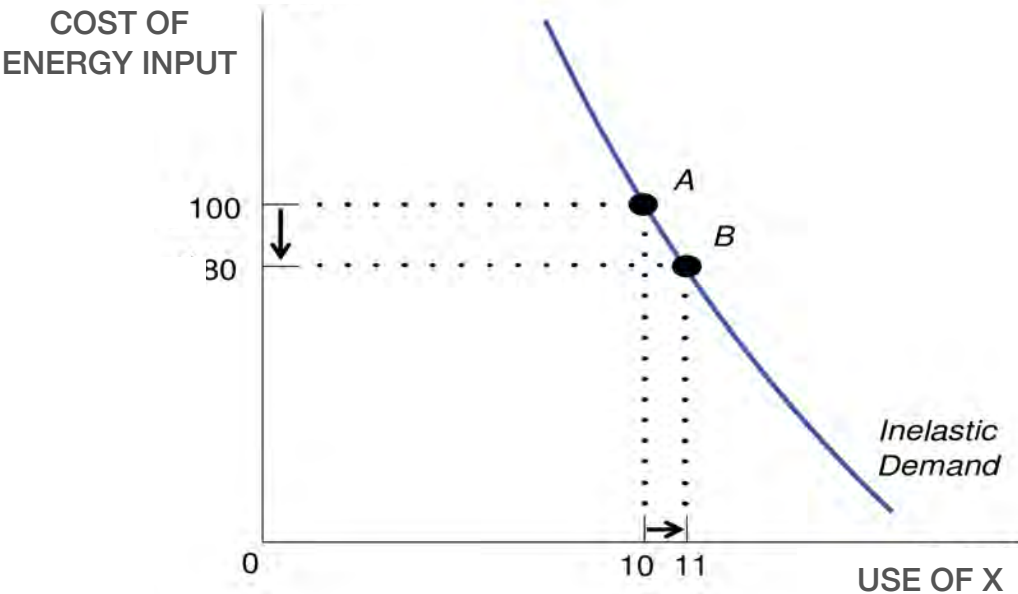
# THE JEVONS PARADOX



**JEVONS PARADOX = “BACKFIRE”**  
EFFICIENCY IS COUNTERPRODUCTIVE  
TO REDUCING CONSUMPTION

IMAGE: [https://en.wikipedia.org/wiki/Jevons\\_paradox#/media/File:ElasticDemand.svg](https://en.wikipedia.org/wiki/Jevons_paradox#/media/File:ElasticDemand.svg)

# THE JEVONS PARADOX



**REBOUND EFFECT**  
EFFICIENCY ISN'T PERFECT  
AT REDUCING CONSUMPTION

IMAGE: [https://en.wikipedia.org/wiki/Jevons\\_paradox#/media/File:InelasticDemand.svg](https://en.wikipedia.org/wiki/Jevons_paradox#/media/File:InelasticDemand.svg)





“THE **KEY TO UNDERSTANDING JEVONS** IS THAT PROCESSES, PRODUCTS, AND ACTIVITIES WHERE **ENERGY IS A VERY HIGH PART OF THE COST** – IN THIS COUNTRY, **A FEW METALS, A FEW CHEMICALS, AIR TRAVEL** – ARE THE ONLY ONES WHOSE VARIABLE COST IS VERY SENSITIVE TO ENERGY. THAT’S IT.”

- DR. LEE SCHIPPER, STANFORD UNIVERSITY

QUOTE SOURCE: New Yorker, “The Efficiency Dilemma,” by David Owen





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**SCENE & HEARD**

## Conservation Wastes Energy

Bush is right to resist the "rebound effect."

**BY KIMBERLEY A. STRASSEL**

*Thursday, May 17, 2001 12:01 a.m. EDT*

The Bush administration today unveils its energy policy, one that will rightfully put energy supply, and better ways of delivering that supply, at the center of our nation's energy efforts. The howls have already begun, with environmental groups, Democrats and a few misguided Republican "moderates" furious that conservation policies haven't been given a leading role.

For the past decade, U.S. energy policy has followed the conservationist agenda like a bible. Bill Clinton came to office promising to put policies that stifled demand for energy ahead of those that actually produced the stuff. Federal and state governments have spent hundreds of millions on tax rebates and programs that "encouraged" people to use less; consumers have shelled out as much complying with regulations that mandated greater efficiency in everything from cars to air conditioners.

Today, we see the results. Energy consumption hasn't gone down; rather, it has stubbornly risen by an average of about 1.7% a year since the early 1980s, despite the increasing weight of conservation policies. And now, after years of neglect, the supply side is a wreck. Environmental regulations have stifled exploration, as well as power-plant and refinery construction; electrical lines and gas pipes are bottlenecked. The entire West, as well as states like New York, faces energy





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COMMENTARY

## The Hidden Flaw of 'Energy Efficiency'

By Robert J. Michaels

This article appeared in [The Wall Street Journal](#) on August 21, 2012.

Mandated increases in energy efficiency — popular almost everywhere on the ideological spectrum — have been implemented around the world. Laws like the European Union's new requirement for 15% energy savings, or the U.S. Senate's proposed Clean Energy Standard Act of 2012, appear like clear winners for almost everyone. If the costs of new technologies are within reason, they promise consumers lower energy bills and producers more profit while mitigating the environmental costs of energy development and consumption.

There is just one problem: Basic economics says that the best way to promote some activity is to reduce its price. That often means efficiency requirements end up having the opposite effect than



## The Efficiency Illusion

December 21, 2010 | [Michael Shellenberger](#), [Ted Nordhaus](#), [Jesse Jenkins](#)

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If there's one thing everyone knows for certain, it's that energy efficiency reduces energy consumption. President Obama, Steven Chu, Fortune 500 chieftains, Silicon Valley VCs, the U.N. and McKinsey all say it.

Why, then, does ever-greater efficiency go hand-in-hand with ever-greater energy consumption? In this week's *New Yorker*, journalist David Owen explains this apparent paradox. The essay (excerpted below) is as fascinating as anything written by Malcolm Gladwell. And the implications for energy and climate policy are of great significance.

Energy efficiency first burst onto the scene in the U.S. after the oil shocks of the mid-seventies. That was when then-Friends of the Earth activist Amory Lovins first started claiming that we wouldn't need new nuclear power plants because increased efficiency would sufficiently reduce energy demand.

America indeed got efficiency savings -- along with higher energy demand. "Between 1984 and 2005," Owen notes.



## THE DOUBLE WIDE FRIDGE

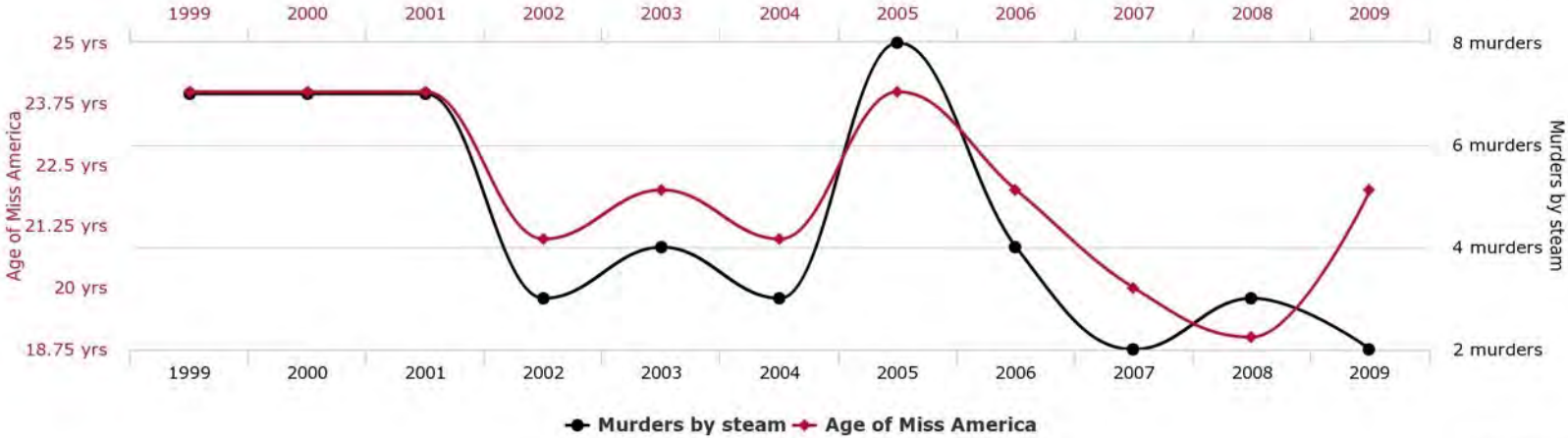


SOURCE: Pinterest

**JEVONS WOULD SAY:**  
FRIDGE EFFICIENCY **CAUSES** FRIDGE SIZE TO INCREASE.

CORRELATION ≠ CAUSATION

**AGE OF MISS AMERICA  
CORRELATES WITH  
MURDERS BY STEAM, HOT VAPORS AND HOT OBJECTS.**

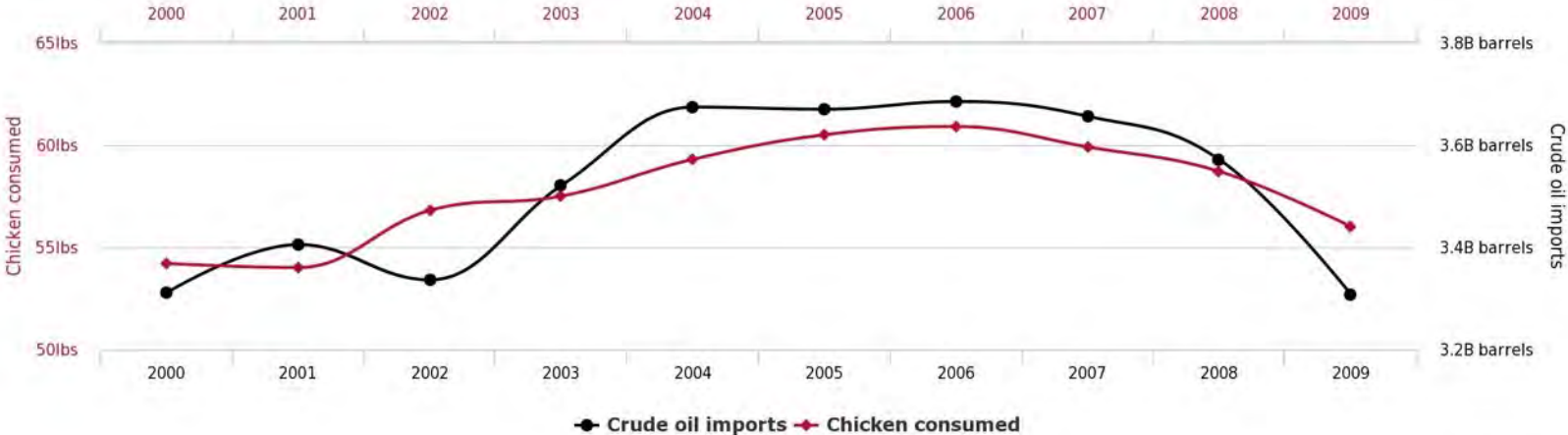


tylervigen.com  
SOURCE: Spurious Correlations



CORRELATION ≠ CAUSATION

PER CAPITA CONSUMPTION OF CHICKEN  
CORRELATES WITH  
TOTAL US CRUDE OIL IMPORTS

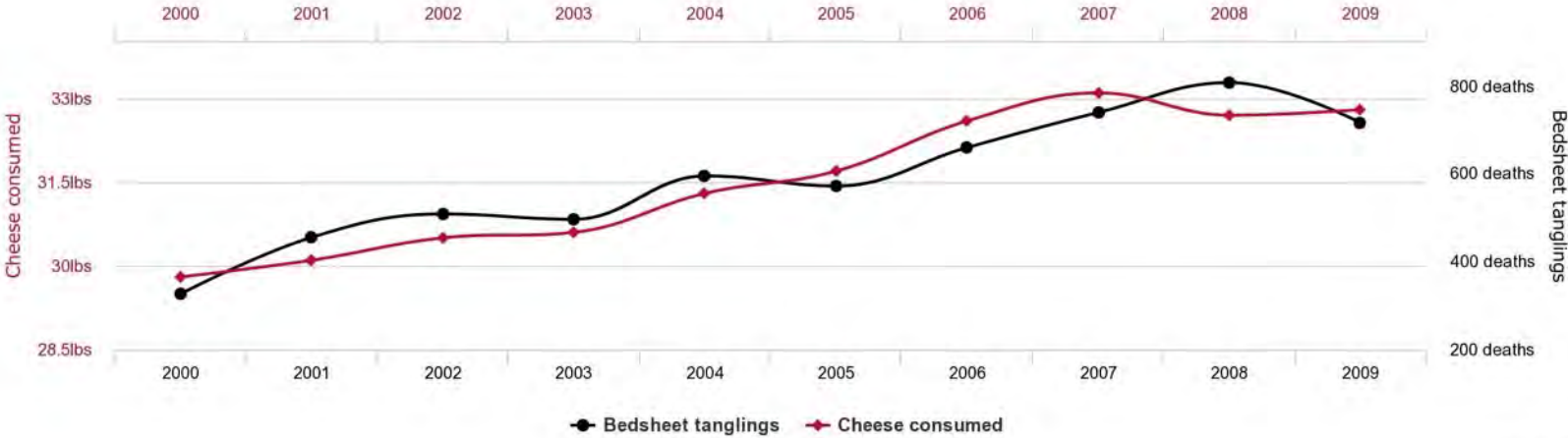


tylervigen.com  
SOURCE: Spurious Correlations



CORRELATION ≠ CAUSATION

PER CAPITA CHEESE CONSUMPTION  
CORRELATES WITH  
NUMBER OF PEOPLE WHO DIED BECOMING TANGLED IN  
THEIR BEDSHEETS



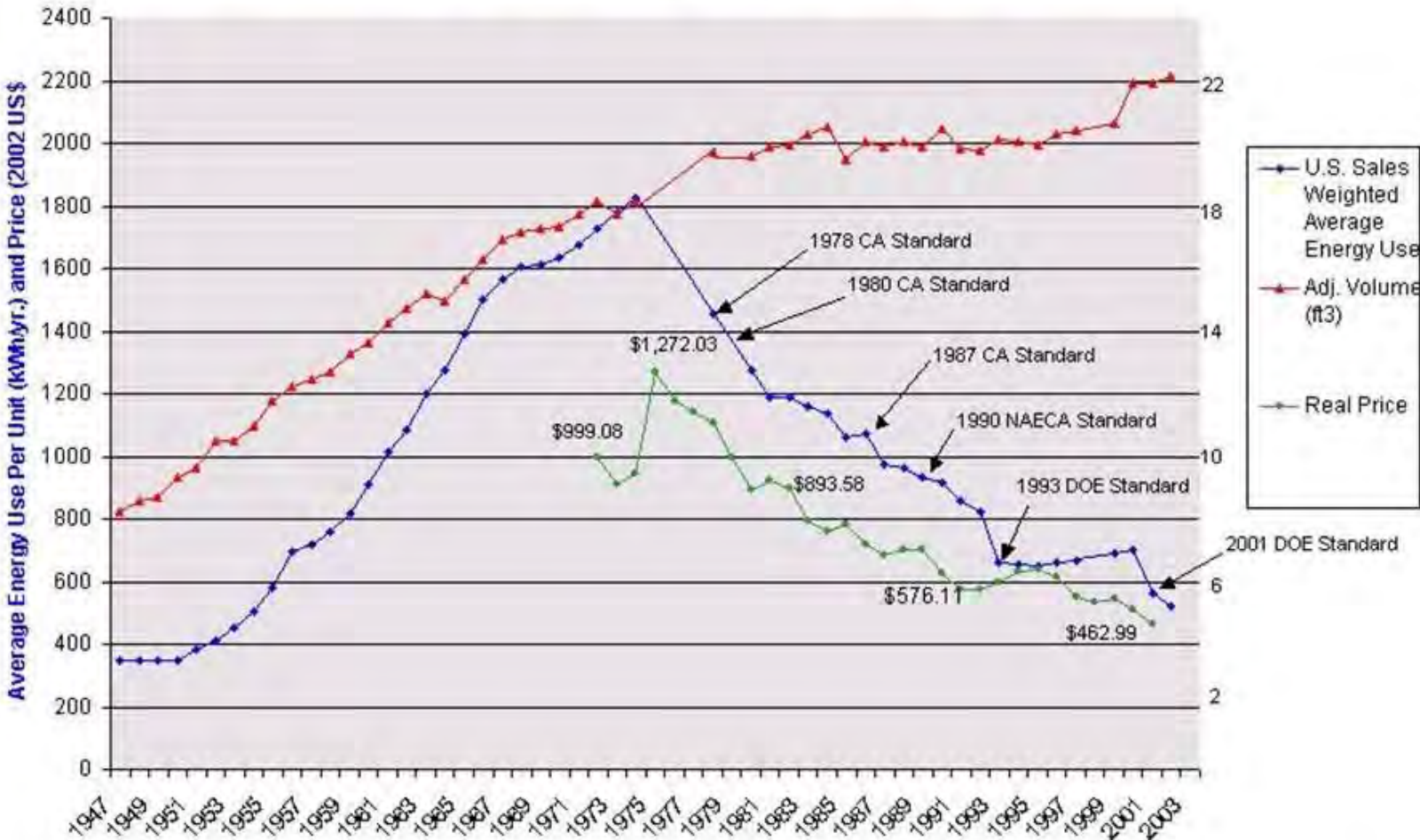
tylervigen.com  
SOURCE: Spurious Correlations





CORRELATION ≠ CAUSATION

U.S. FRIDGE ENERGY EFFICIENCY, VOLUME, AND PRICE



SOURCE: David Goldstein, NRDC



ENERGY JOURNAL SURVEY OF LITERATURE:

**10-30%** REBOUND IN **RESIDENTIAL** & **TRANSPORTATION** SECTORS

**0-20%** REBOUND IN **INDUSTRIAL** SECTOR

CONCLUSION:

ENERGY EFFICIENCY MEASURES ARE **70-100% EFFECTIVE.**

MAYBE JEVONS IS MACRO, THEN?

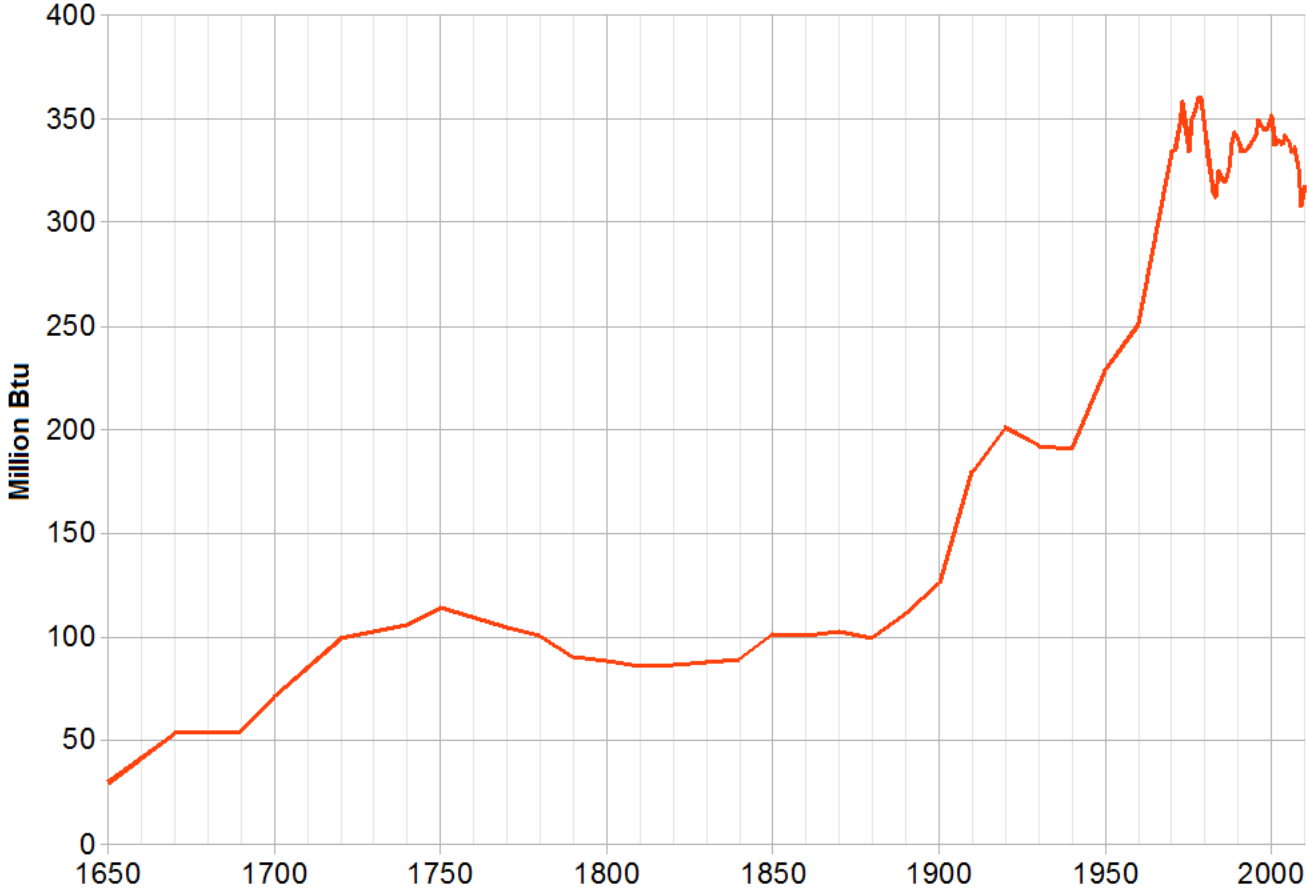


1650



2015

### United States Per Capita Energy Use



1650

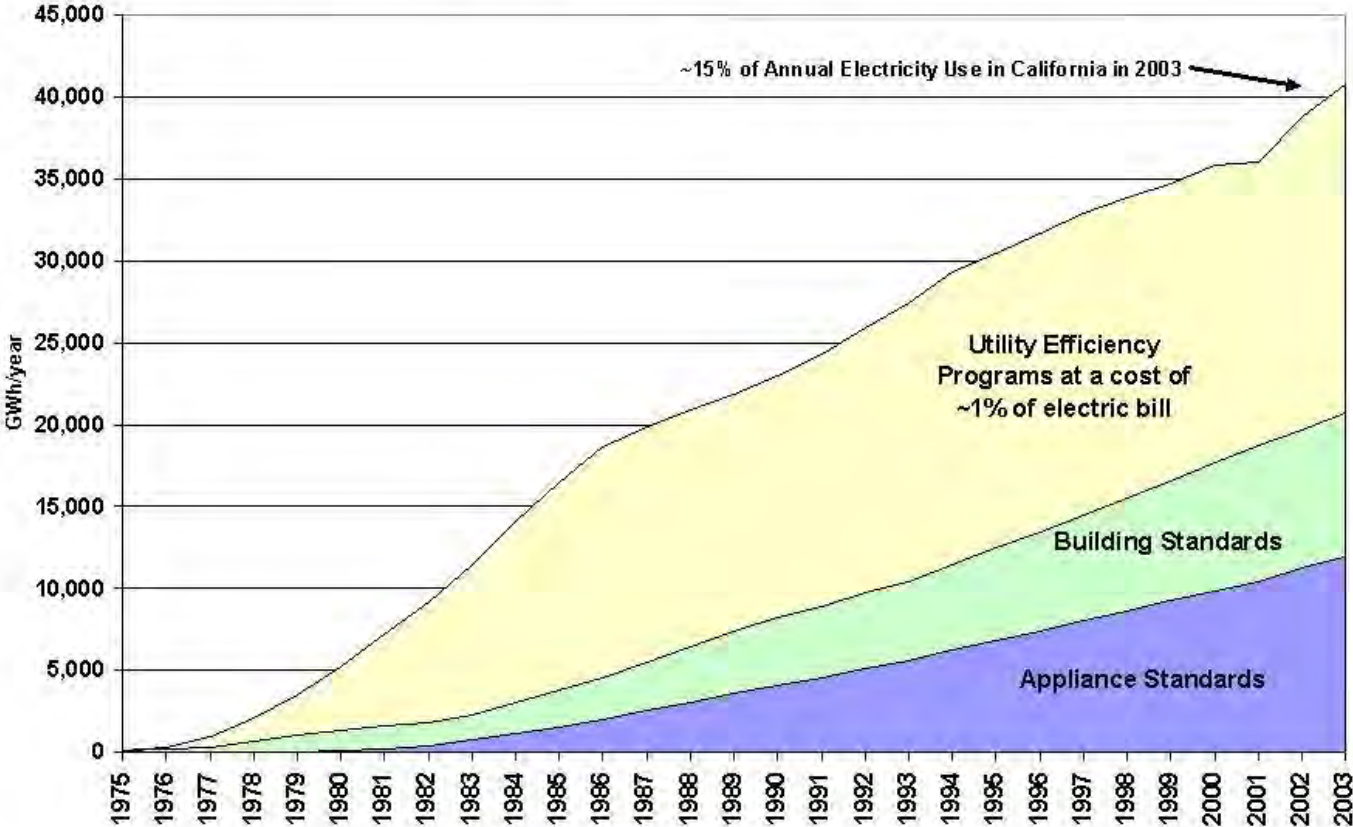
2015

IMAGE: [https://en.wikipedia.org/wiki/Energy\\_in\\_the\\_United\\_States#/media/File:United\\_States\\_per\\_capita\\_energy\\_use\\_1650-2010.png](https://en.wikipedia.org/wiki/Energy_in_the_United_States#/media/File:United_States_per_capita_energy_use_1650-2010.png)





## ANNUAL ENERGY SAVINGS FROM EFFICIENCY PROGRAMS AND STANDARDS, STATE OF CALIFORNIA

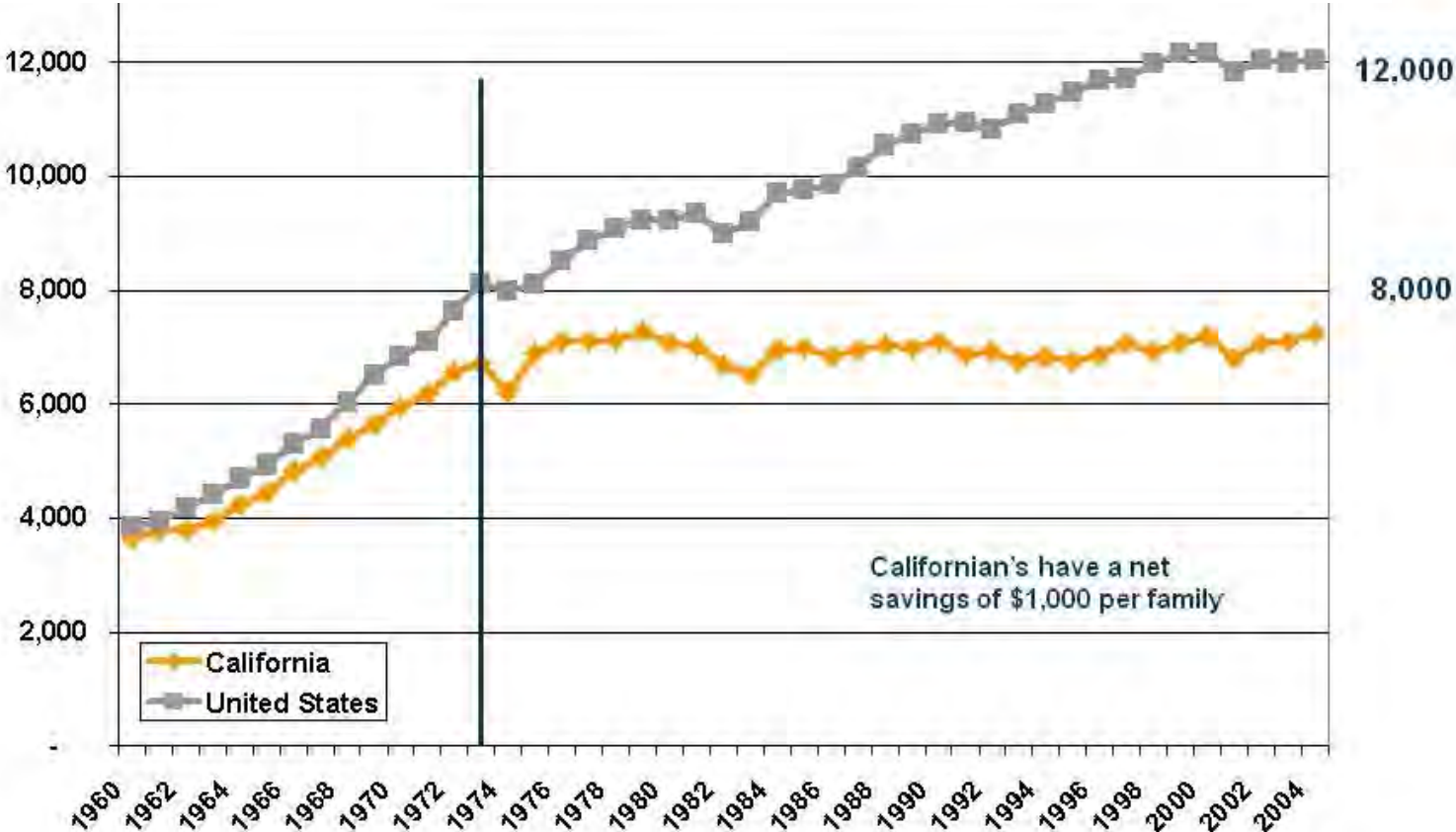


SOURCE: California Energy Standards



# DOESN'T LOOK LIKE JEVONS IS MACRO

## PER CAPITA ELECTRICITY CONSUMPTION KWH/PERSON



SOURCE: Energy Information Administration



## MAYBE JEVONS JUST DOESN'T APPLY TO OUR WORLD

---

“SOMETIMES A CONCEPT IS **BAFFLING**,  
NOT BECAUSE IT IS **PROFOUND** BUT  
**BECAUSE IT IS WRONG.**”

- DR. E.O. WILSON, HARVARD UNIVERSITY  
Quote shared by Amory Lovins in response to Jevons Paradox.



BUT SAY THE JEVONS PARADOX IS RELEVANT TODAY...

THERE'S ONE **SIMPLE CURE** FOR THE JEVONS PARADOX, AS WELL AS SMALLER EFFICIENCY REBOUNDS...

**TAX CARBON.**

THESE GUYS WANT A CARBON TAX:



BUT WAIT...

OKAY, FINE. BUT WHAT  
DIFFERENCE DOES DOES ALL  
THIS EFFICIENCY AND TAXING OF  
CARBON MAKE?

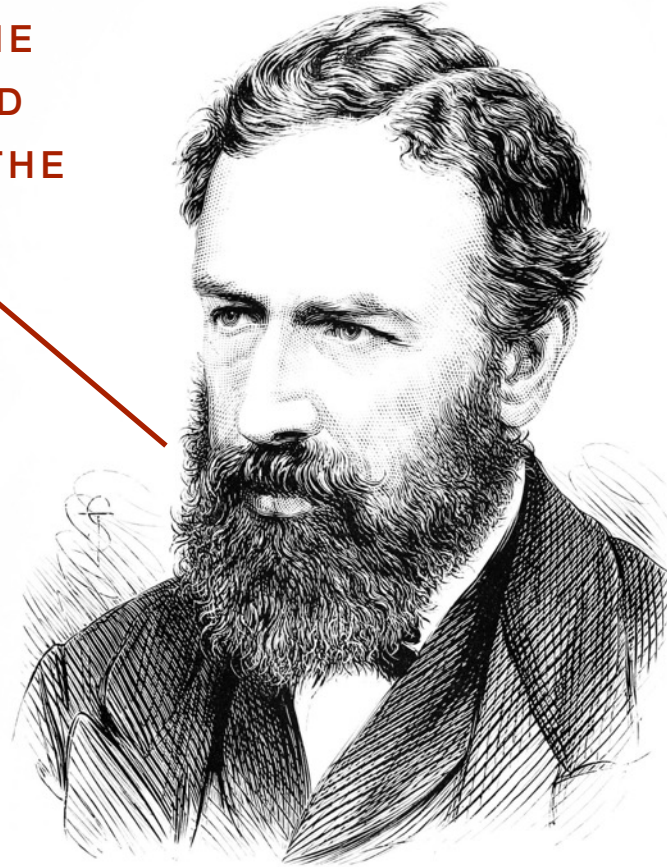


WILLIAM STANLEY JEVONS



BUT WAIT...

OIL, COAL AND GAS COMPANIES  
HAVE TOO MUCH SKIN IN THE  
GAME NOT TO EXTRACT AND  
BURN ALL FOSSIL FUELS IN THE  
GROUND.



WILLIAM STANLEY JEVONS

BUT WAIT...

ALL YOU'RE DOING  
IS DELAYING THE  
INEVITABLE.

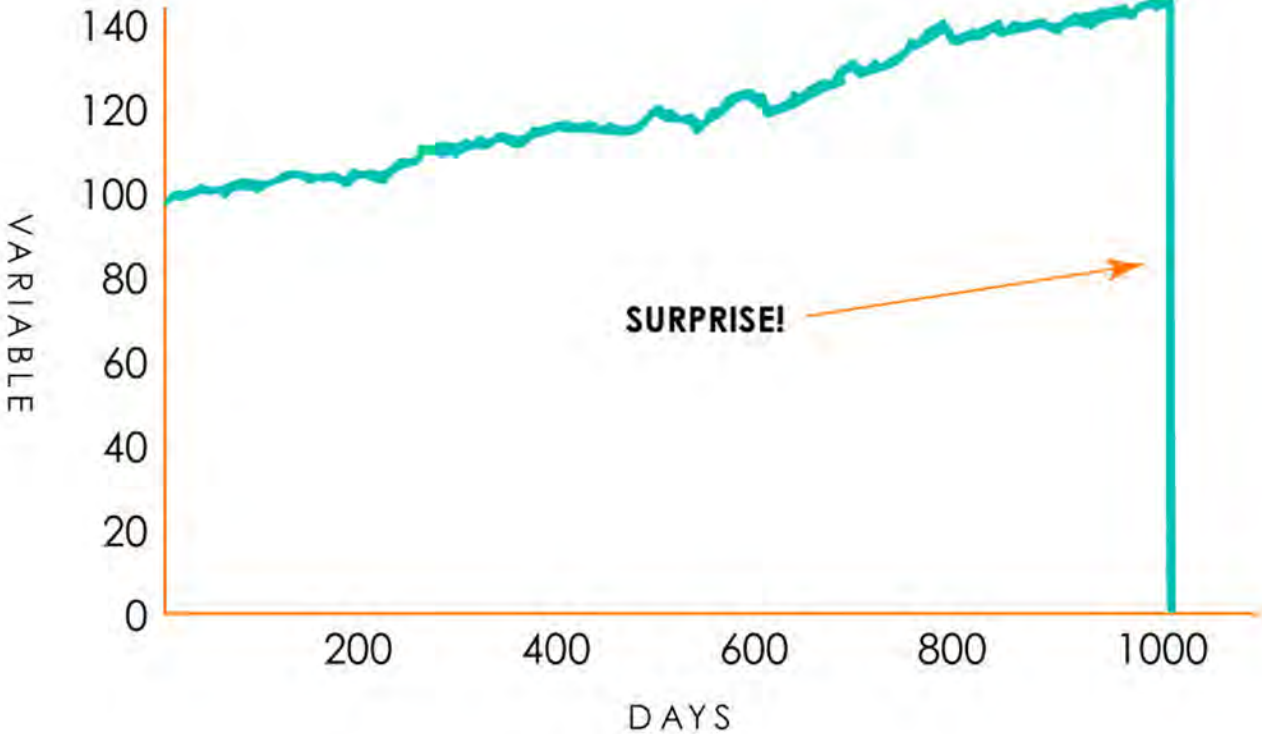


WILLIAM STANLEY JEVONS

Will we really just burn it all?

# THE BLACK SWAN EVENT

## ONE THOUSAND AND ONE DAYS IN THE LIFE OF A TURKEY



SOURCE: Nassim Nicholas Taleb's *The Black Swan*

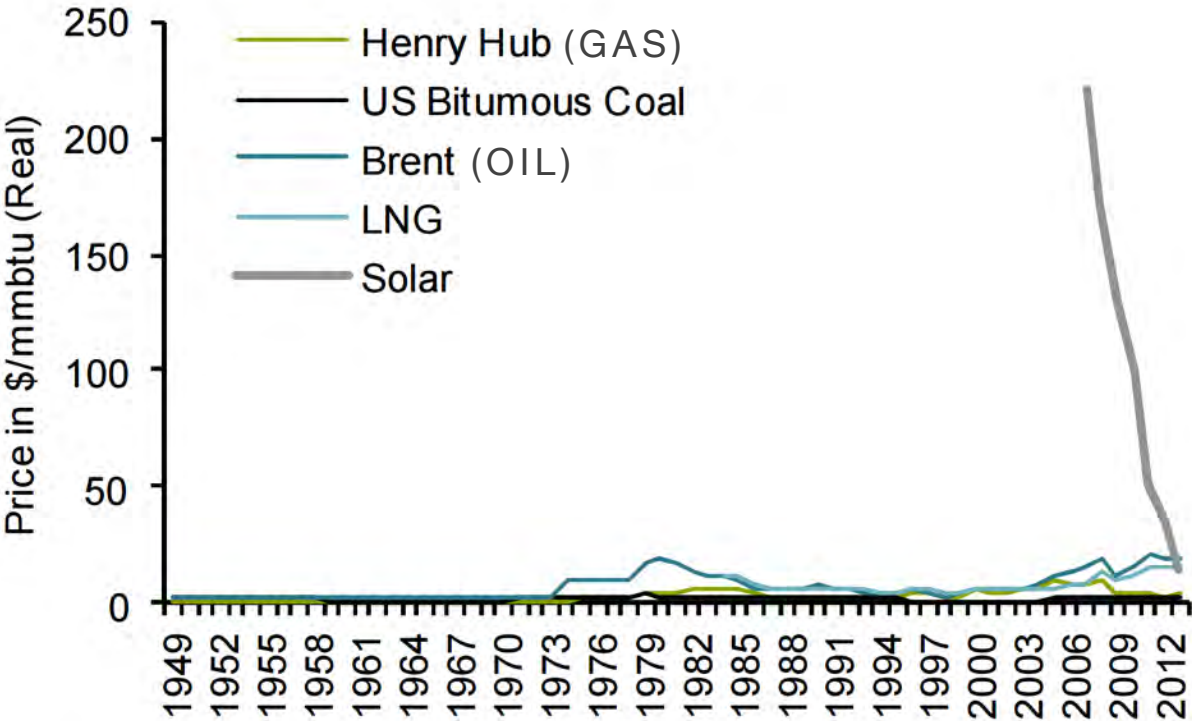


# THE SOLAR BLACK SWAN

INVESTMENT FIRM **SANFORD BERNSTEIN** (\$454 BILLION AUM)  
SEES A **SOLAR BLACK SWAN**.

“WELCOME TO THE TERRORDOME”... \$/MMBTU BY ENERGY TYPE:

---



SOURCE: EIA, CIA, World Bank, Bernstein analysis





# INNOVATION DRIVES CLEAN ENERGY COST DOWN

BECAUSE **SOLAR PV IS A TECHNOLOGY**, FALLING PRICES ARE REMINISCENT OF THE COMPUTER CHIP INDUSTRY.

**MOORE'S LAW:**  
PRICE OF **CHIP** FALLS AS THE NUMBER OF TRANSISTORS ON A CHIP DOUBLES EVERY 2 YEARS.

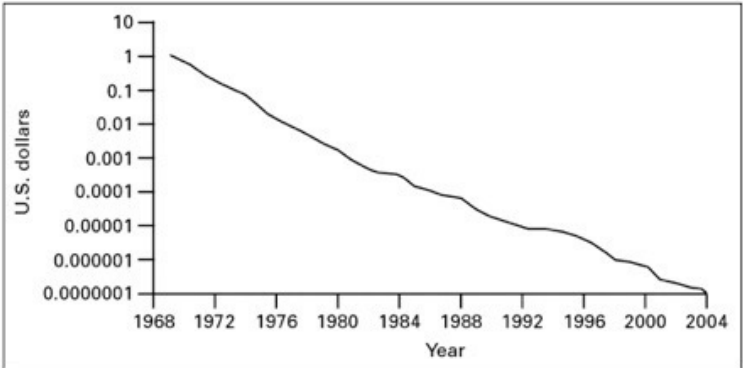


Figure 3. Average price of a transistor (1968-2004). Source: Intel/WSTS, May 2005.

SOURCE: Intel/WSTS

**SWANSON'S LAW:**  
PRICE OF **PV MODULE** FALLS BY 20% WITH EVERY DOUBLING OF GLOBAL PRODUCTION

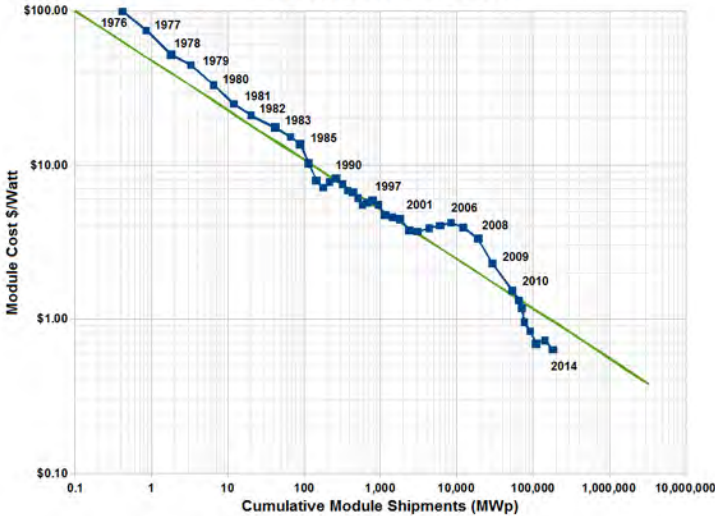
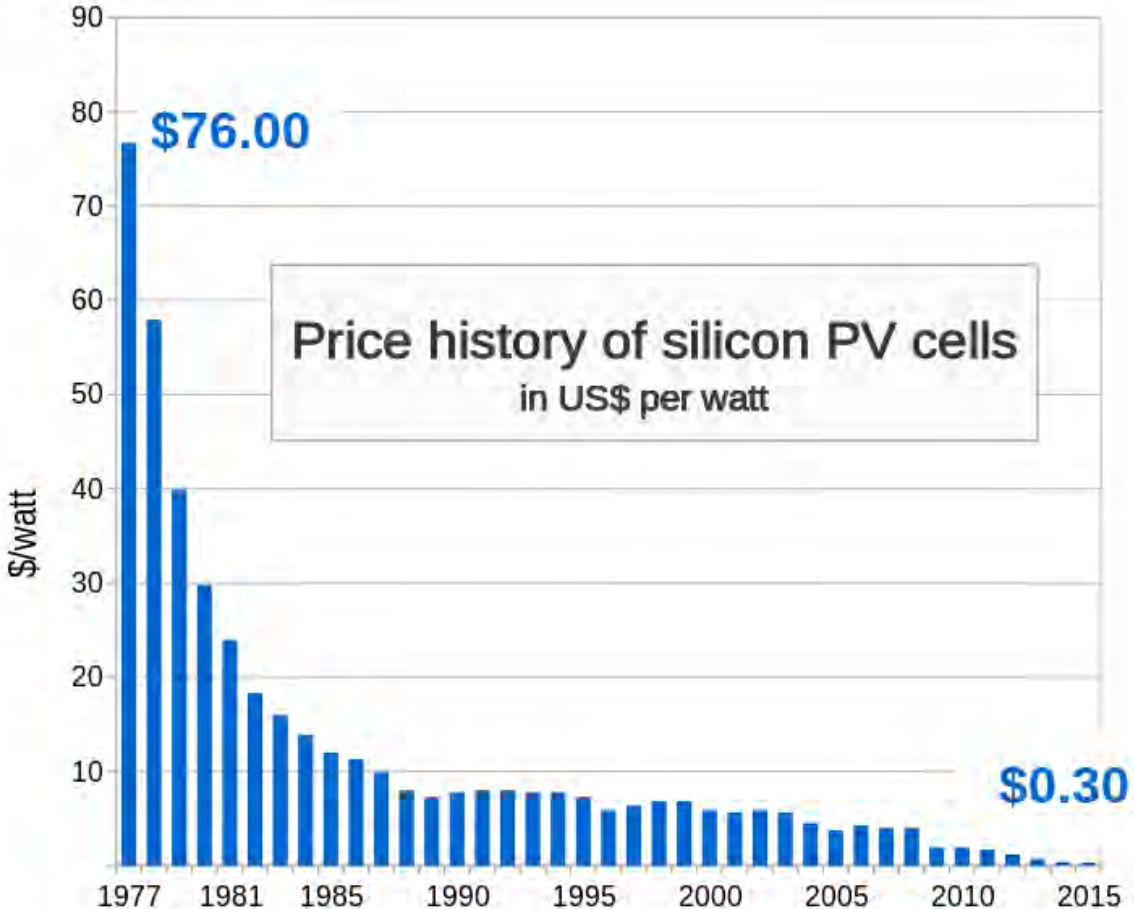


IMAGE: [https://en.wikipedia.org/wiki/Swanson%27s\\_law#/media/File:Swansons-law.png](https://en.wikipedia.org/wiki/Swanson%27s_law#/media/File:Swansons-law.png)



1977-2015: 99.6% REDUCTION IN PRICE



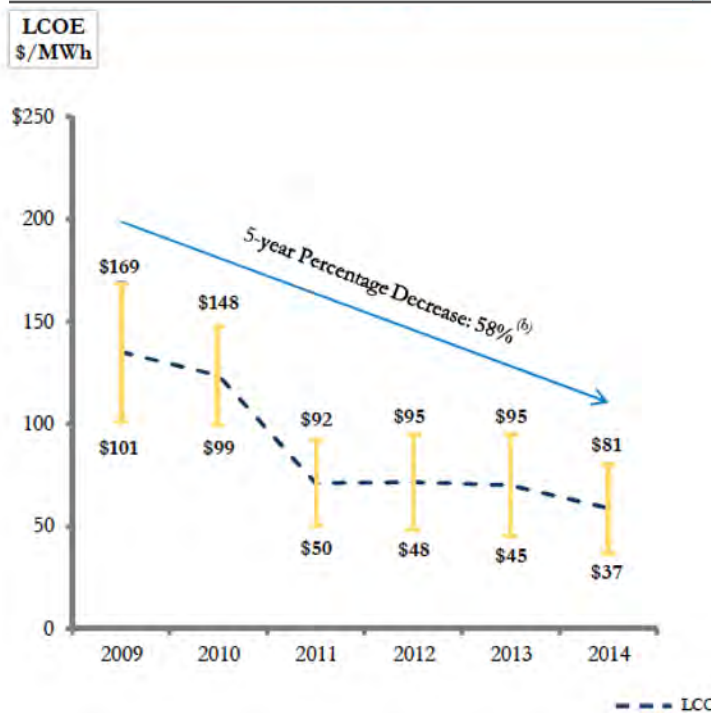
SOURCE: Bloomberg News



# IT'S NOT SLOWING, AND IT'S WIND, TOO

OVER THE **PAST 5 YEARS**, THE COST OF **WIND** POWER HAS DROPPED BY **58%** WHILE THE COST OF **SOLAR** POWER HAS DROPPED BY **78%**.

### WIND LCOE



### SOLAR PV LCOE

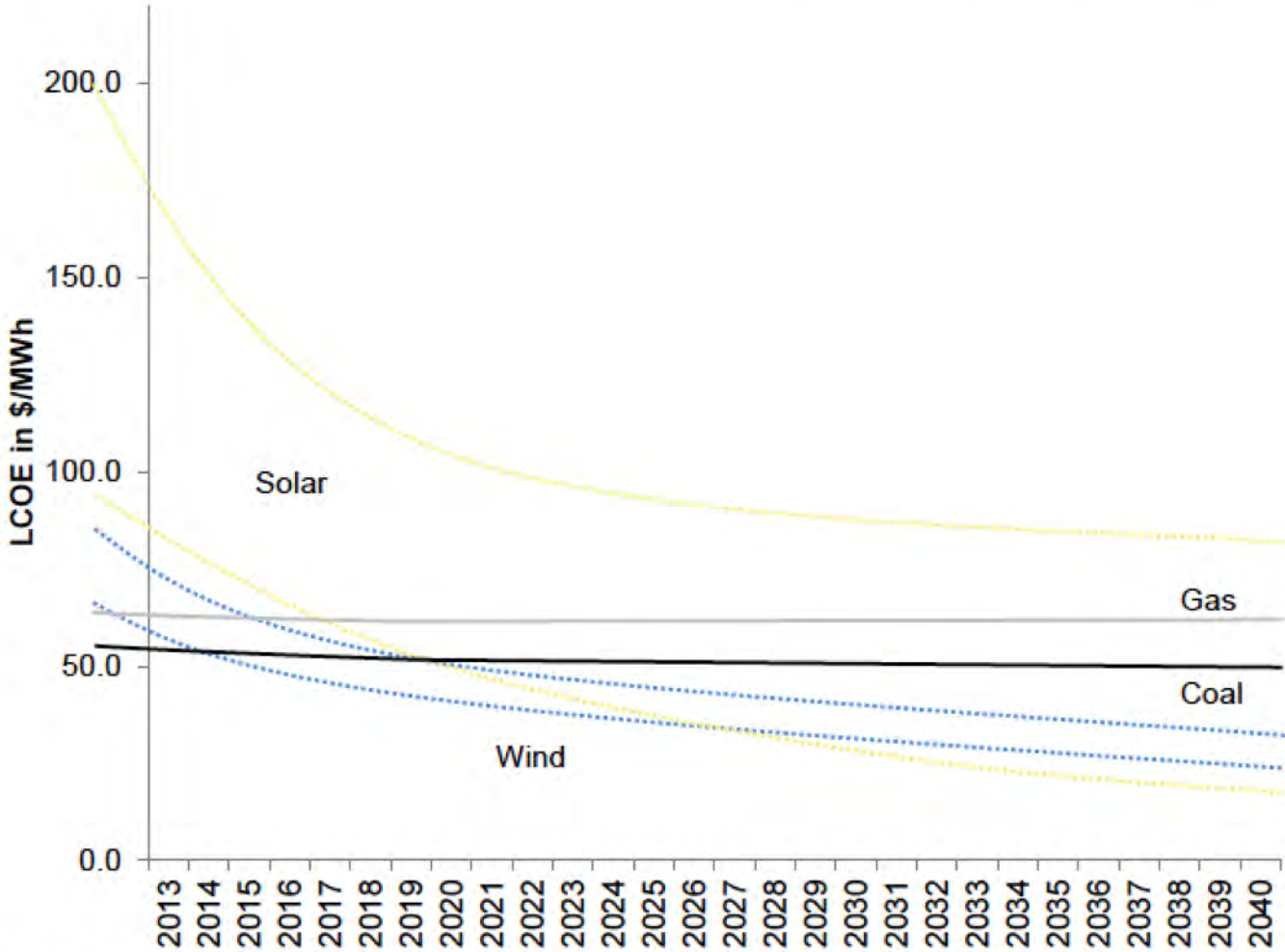


SOURCE: LAZARD'S LEVELIZED COST OF ENERGY ANALYSIS



# RENEWABLES WILL BEGIN TO INFLUENCE PRICE

Figure 41. Cost of Energy from Renewables Expected to Fall Drastically Over the Next Years



Source: Citi Research

SOURCE: CitiBank

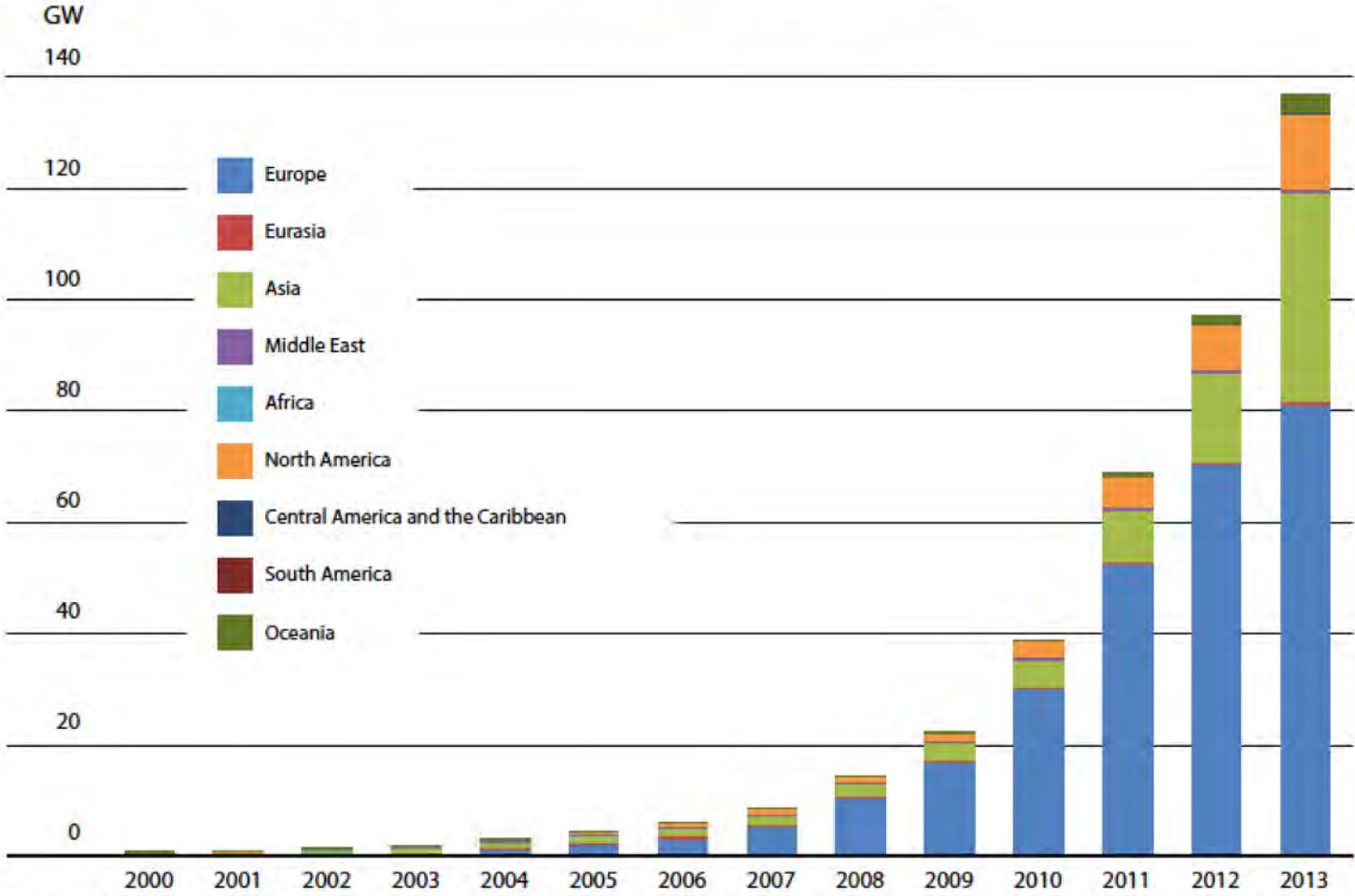


SANFORD BERNSTEIN SAYS **SOLAR WILL DRIVE FOSSIL FUEL PRICES DOWN**, BUT THAT SOLAR DEPLOYMENT WILL HAVE TO **INCREASE BY 10X** FIRST.



# RENEWABLES WILL BEGIN TO INFLUENCE PRICE

FIGURE 5.1: GLOBAL CUMULATIVE INSTALLED SOLAR PHOTOVOLTAIC CAPACITY, 2000-2013



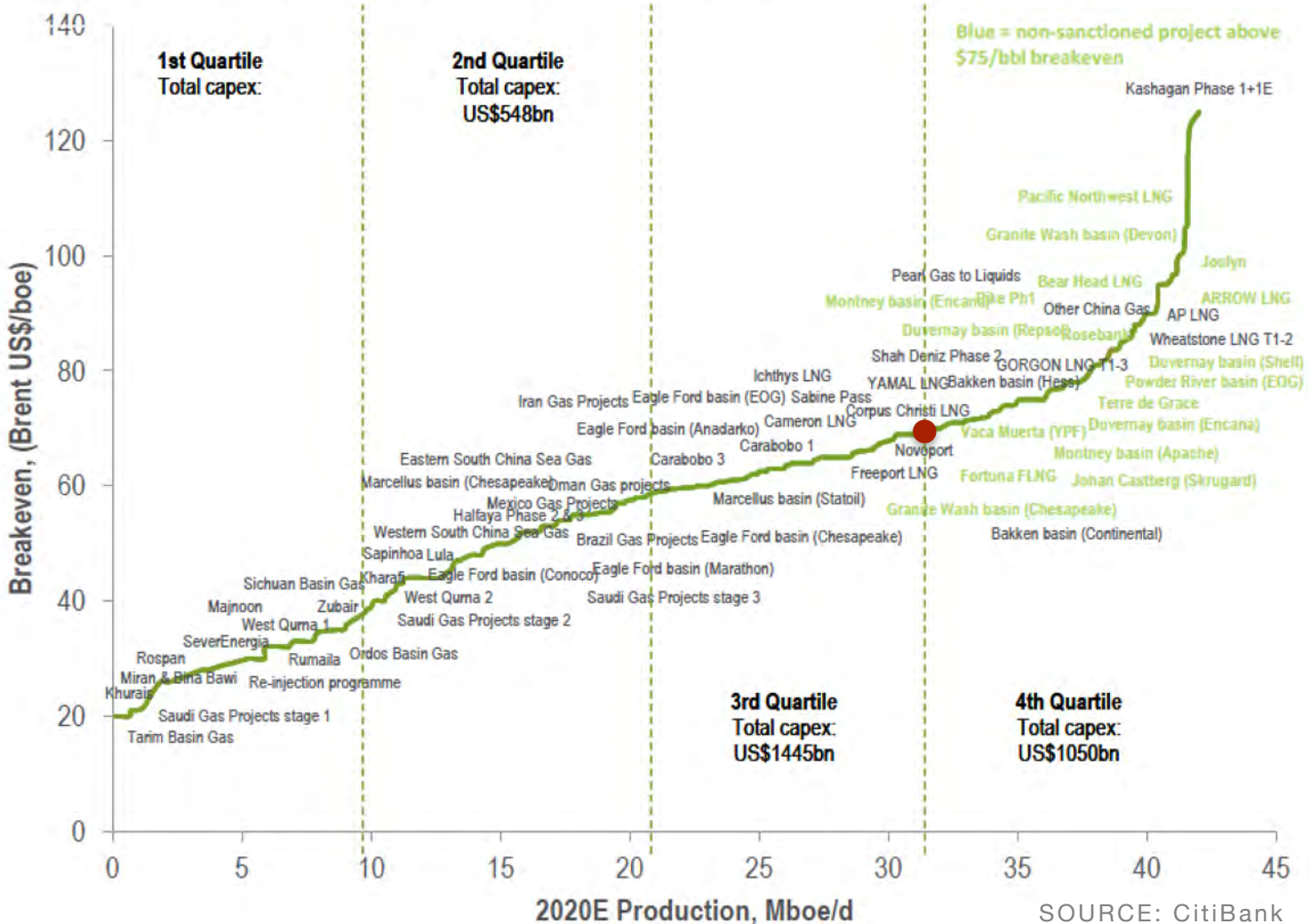
SOURCE: IRENA





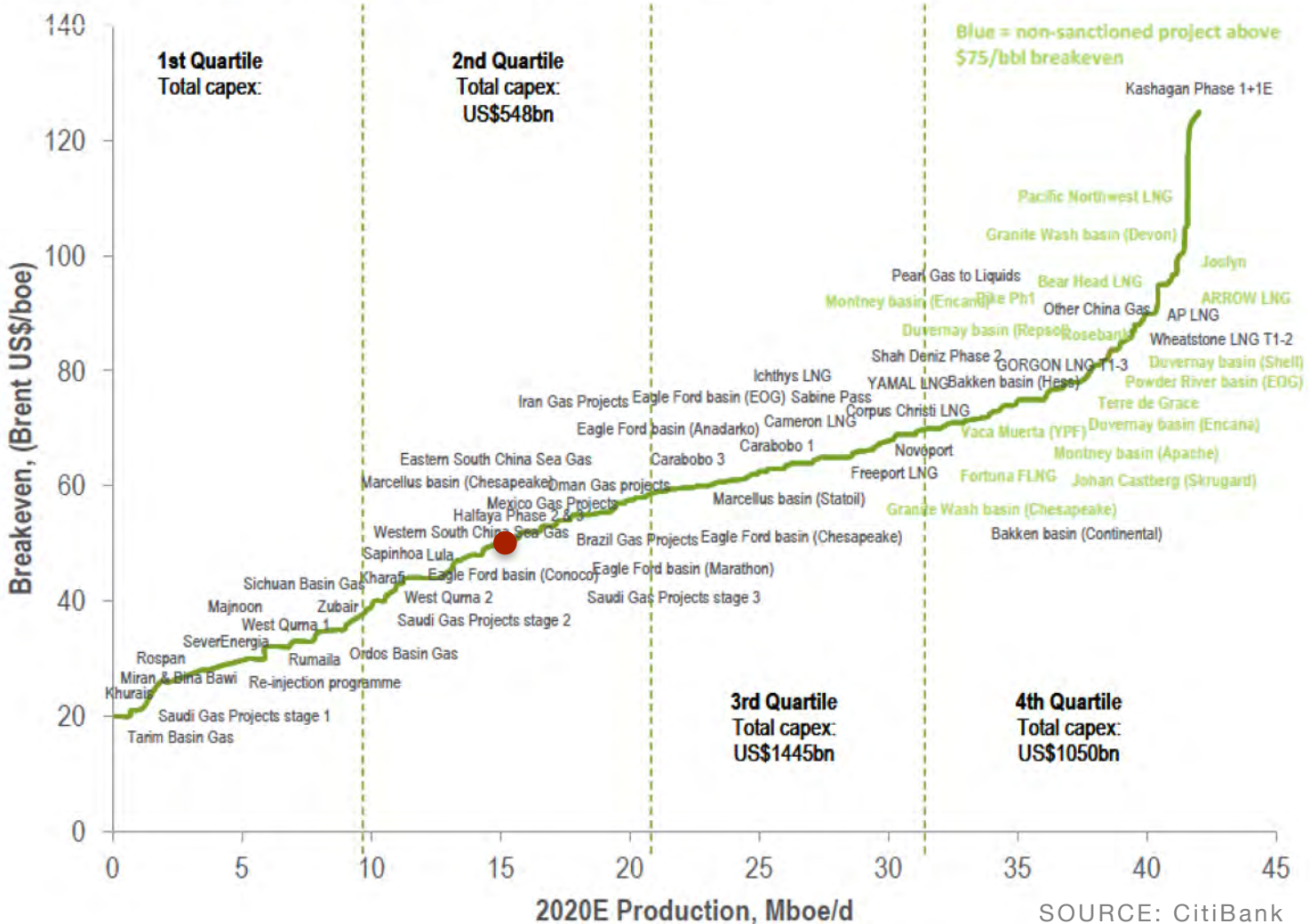
# STRANDED ASSETS AND THE COST CURVE

Figure 95. Citi's Global Oil Vision Cost Curve for Oil, Showing the 14 Projects that Remain Non-Sanctioned Above \$75/bbl



# STRANDED ASSETS AND THE COST CURVE

Figure 95. Citi's Global Oil Vision Cost Curve for Oil, Showing the 14 Projects that Remain Non-Sanctioned Above \$75/bbl



SOURCE: CitiBank





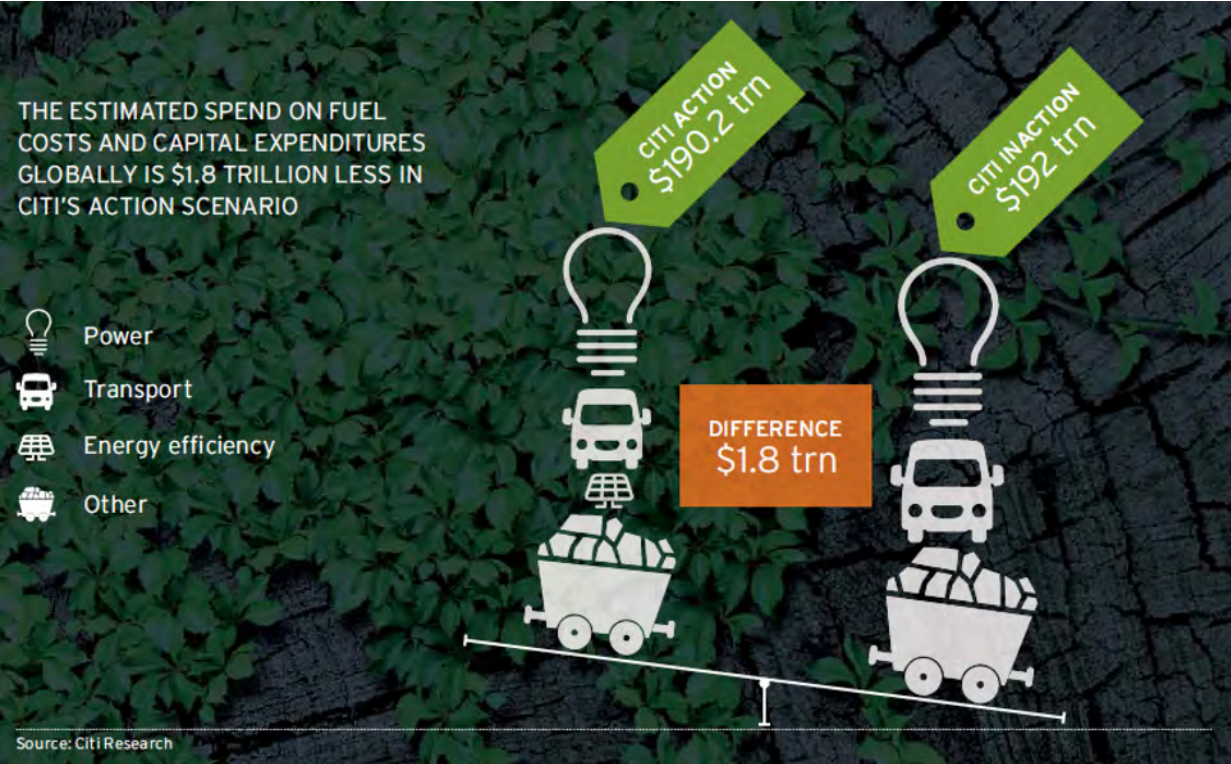


# ENERGY DARWINISM II

Why a Low Carbon Future Doesn't Have to Cost the Earth



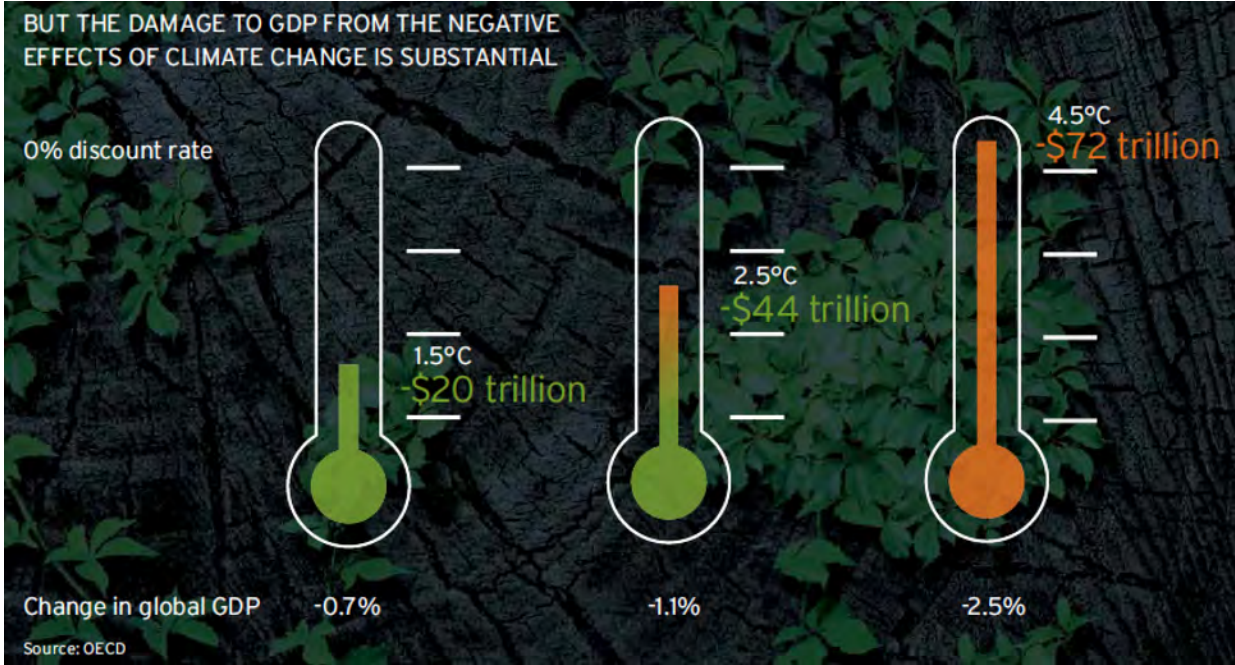
CITIBANK'S **“ACTION” SCENARIO**, AIMED AT LIMITING WARMING TO 2 DEGREES CELSIUS, **COST \$1.8 TRILLION LESS BY 2040**. THAN BUSINESS AS USUAL WARMING.



SOURCE: CitiBank



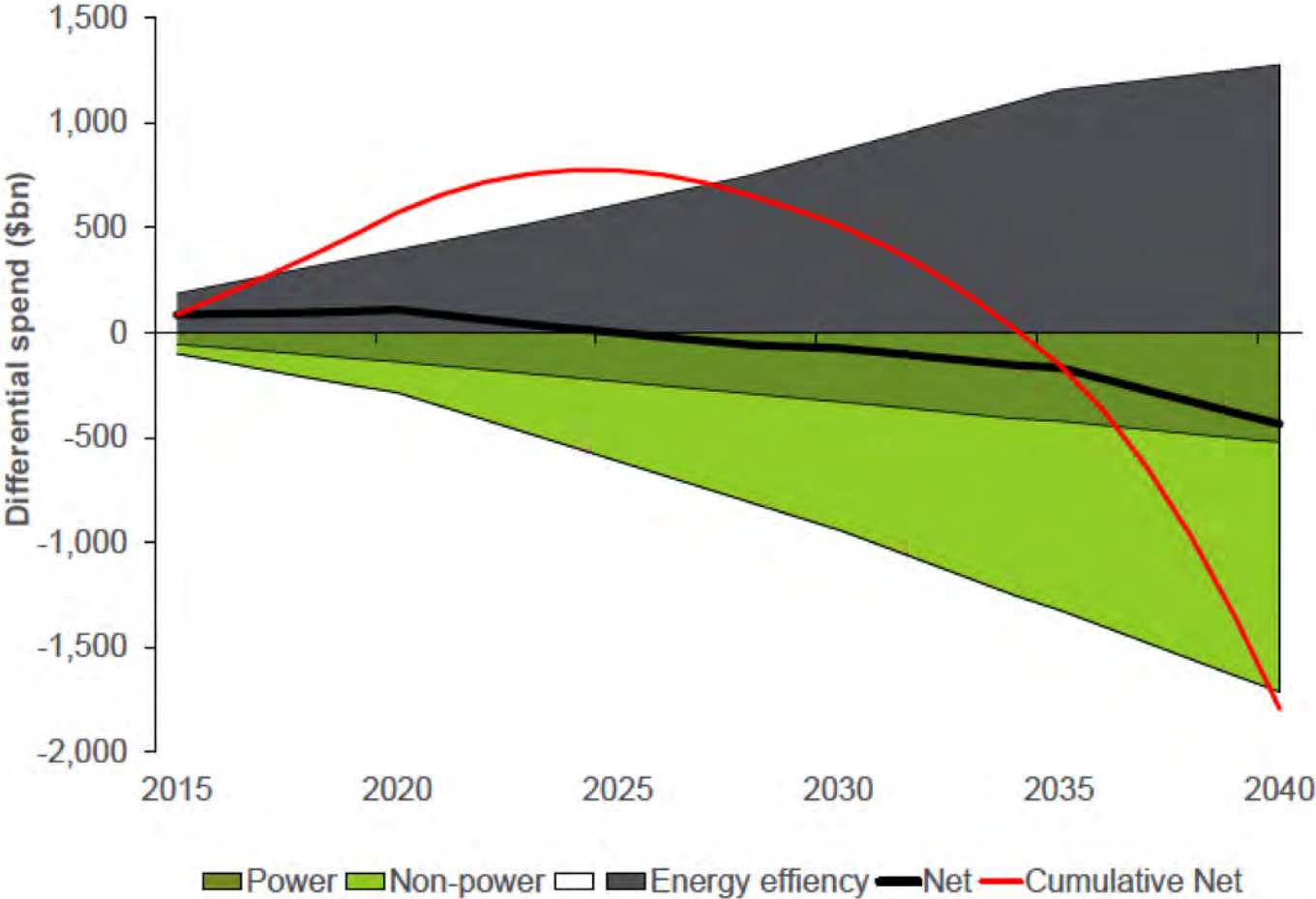
YET CONSERVATIVE ESTIMATES SUGGEST WARMING IN THE “INACTION” SCENARIO WOULD **COST \$72 TRILLION BY 2040.**



SOURCE: CitiBank



Figure 107. Net Differential Spend Between Citi's 'Action' and 'Inaction' Scenarios with Cumulative Total of Spend (Positive) or Saving (Negative)



SOURCE: CitiBank



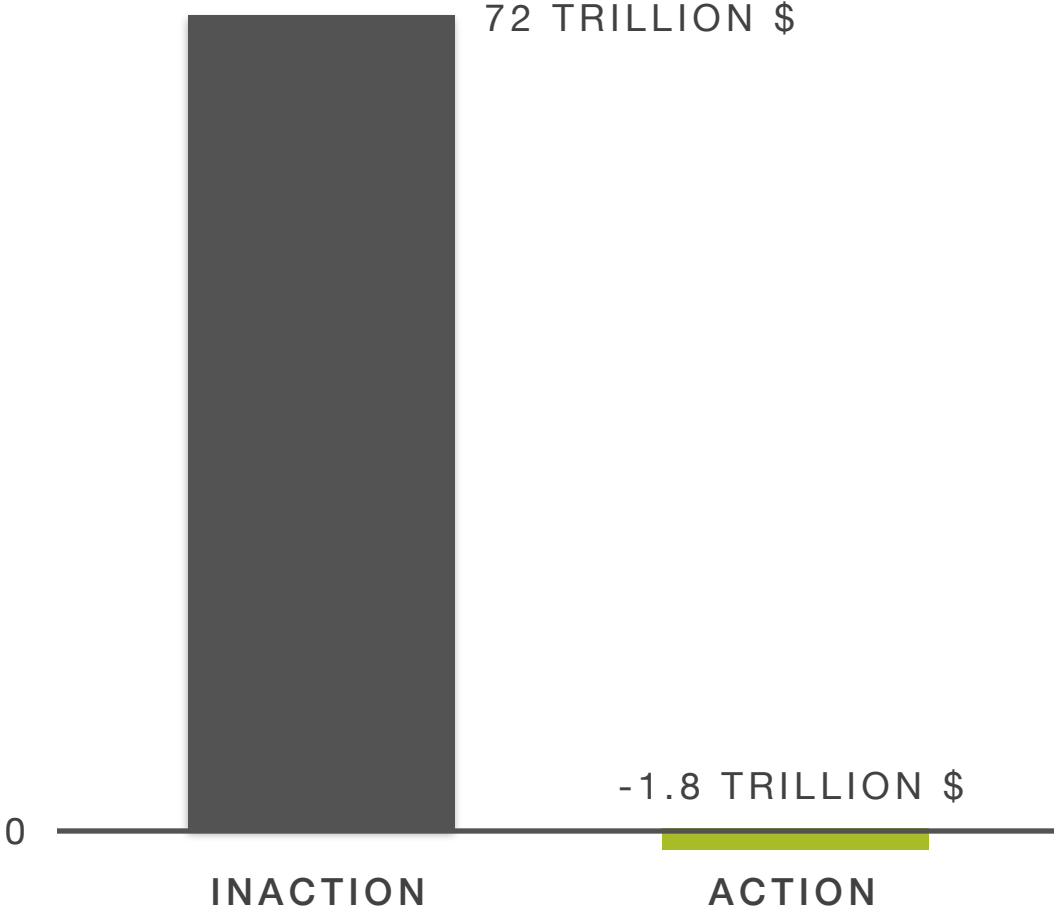
ACCORDING TO CITIBANK:

INSTITUTIONAL INVESTORS GROUP ON CLIMATE CHANGE  
\$12 TRILLION IN AUM

CARBON DISCLOSURE PROJECT - INVESTORS WITH  
\$95 TRILLION IN AUM

CLIMATE BONDS INITIATIVE - INSTITUTIONS WITH  
\$34 TRILLION IN AUM.

# THE REAL PARADOX





### **CLIMATE DENIALISM**

- BREEDS INACTION
- DISTORTS OUR UNDERSTANDING OF THE PROBLEM

### **CLIMATE DEFEATISM**

- BREEDS INACTION
- DISTORTS OUR UNDERSTANDING OF THE SOLUTIONS

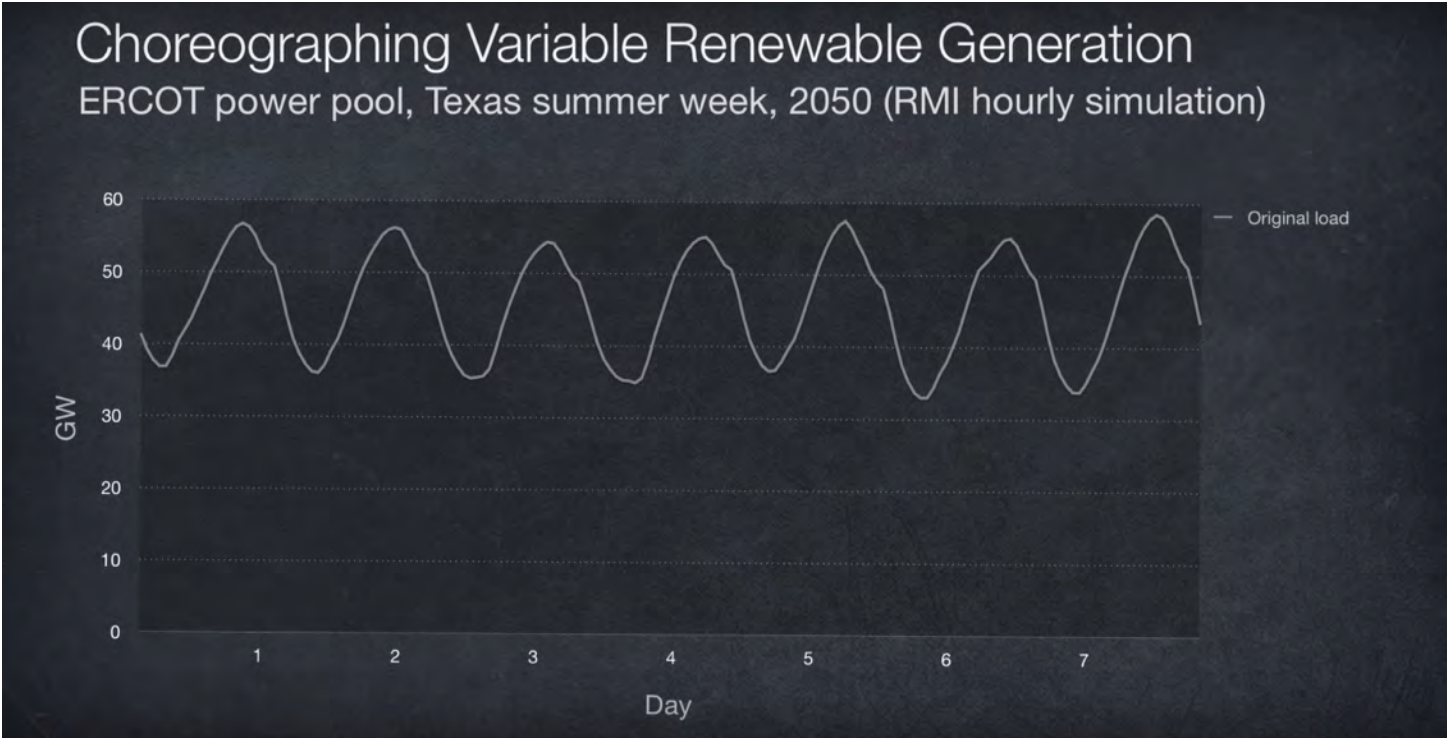
# IT'S REALLY QUITE SIMPLE



ILLUSTRATION:  hammerandhand.com

# ENERGY EFFICIENCY IS KEY

**REDUCE** ENERGY DEMAND AND **FLATTEN** PEAKS AND VALLEYS OF DEMAND

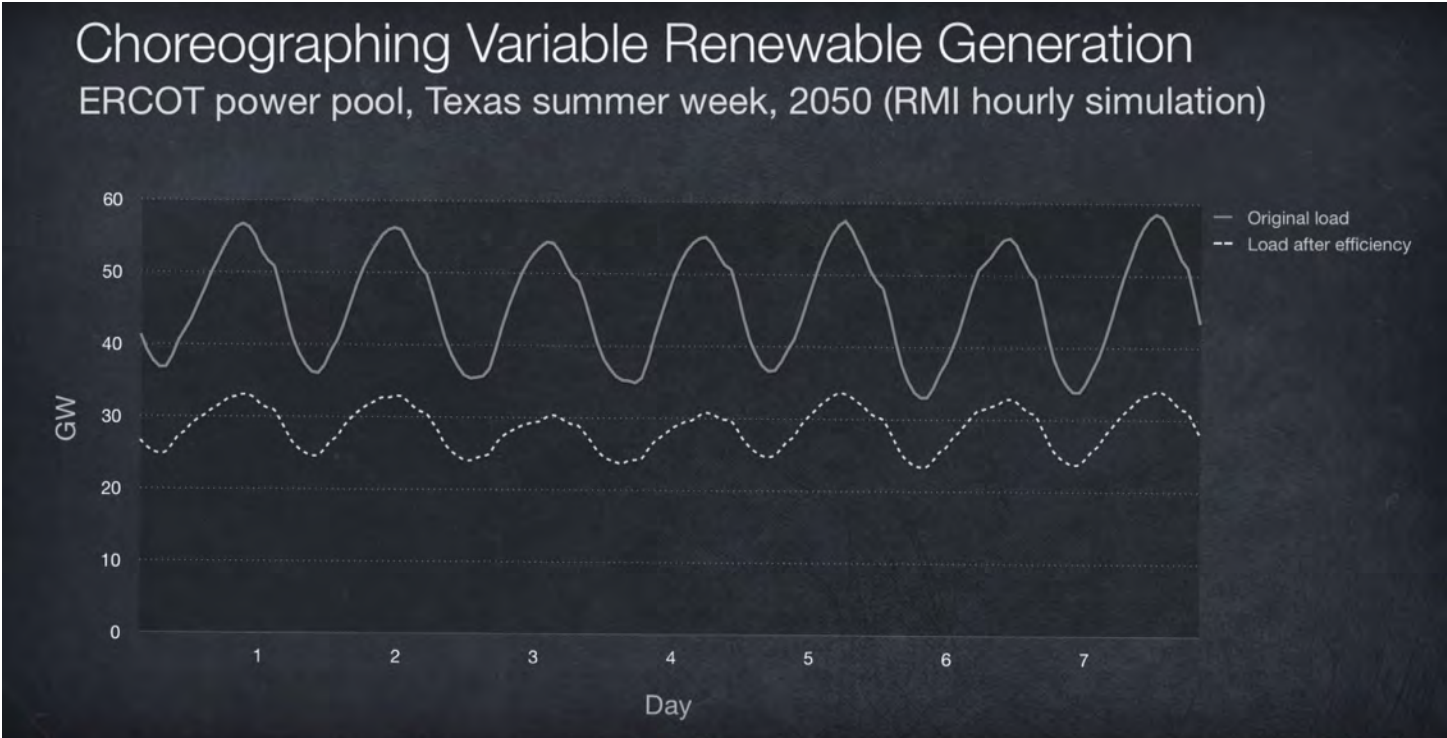


SOURCE: ROCKY MOUNTAIN INSTITUTE



# ENERGY EFFICIENCY IS KEY

**REDUCE** ENERGY DEMAND AND **FLATTEN** PEAKS AND VALLEYS OF DEMAND

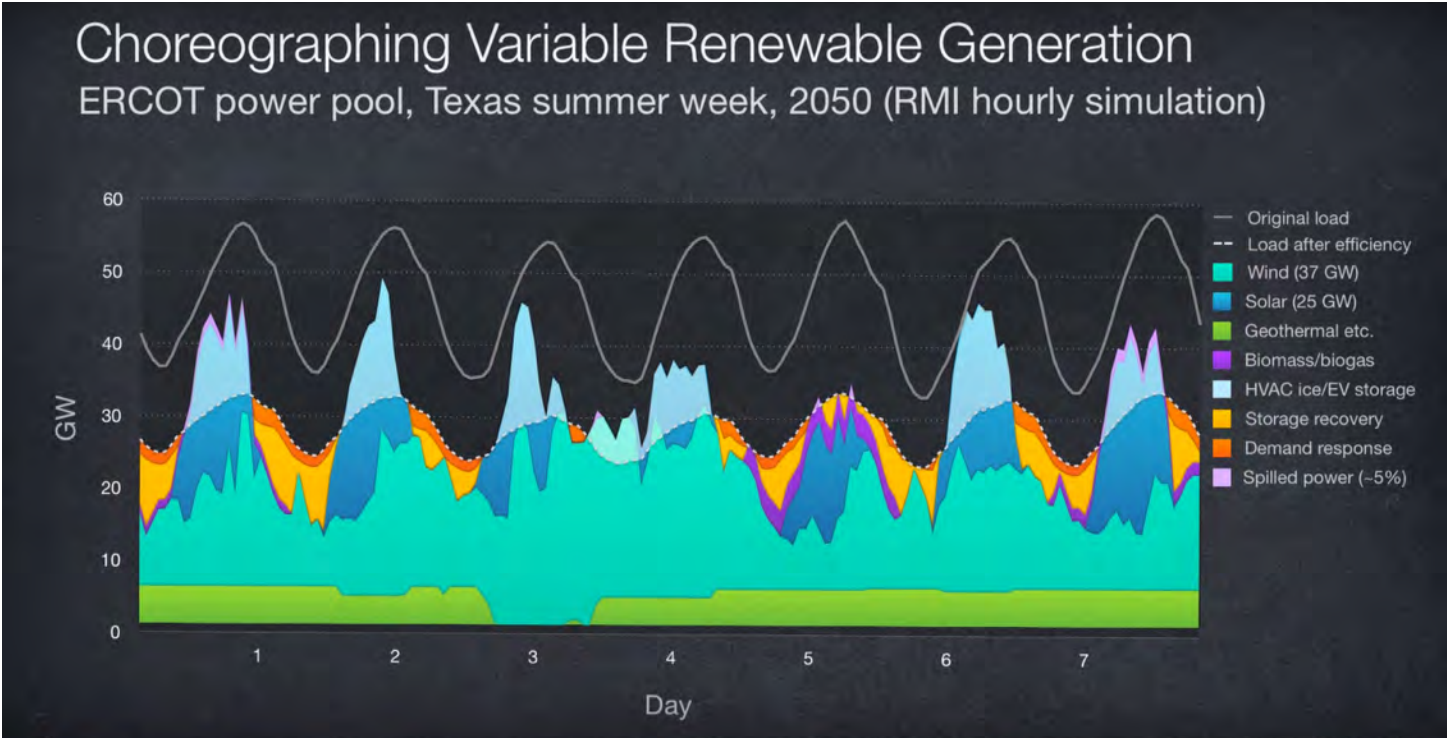


SOURCE: ROCKY MOUNTAIN INSTITUTE



# ENERGY EFFICIENCY IS KEY

**REDUCE** ENERGY DEMAND AND **FLATTEN** PEAKS AND VALLEYS OF DEMAND



SOURCE: ROCKY MOUNTAIN INSTITUTE





THANK YOU

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