

The Progressive Case for Nuclear Energy





HOW WILL WE POWER OUR HIGH ENERGY WORLD RELIABLY . . .



WITHOUT THIS?

THIS IS BAKERSFIELD, CALIFORNIA, WHERE OIL DRILLING HAS BEEN A WAY OF LIFE FOR MORE THAN A CENTURY¹.

¹ Read more about the sad history of Bakersfield. All references are listed on page 59.



EMISSIONS FROM DRILLING, FRACKING, MINING AND BURNING FOSSIL FUELS IS CAUSING OUR CLIMATE TO HEAT UP

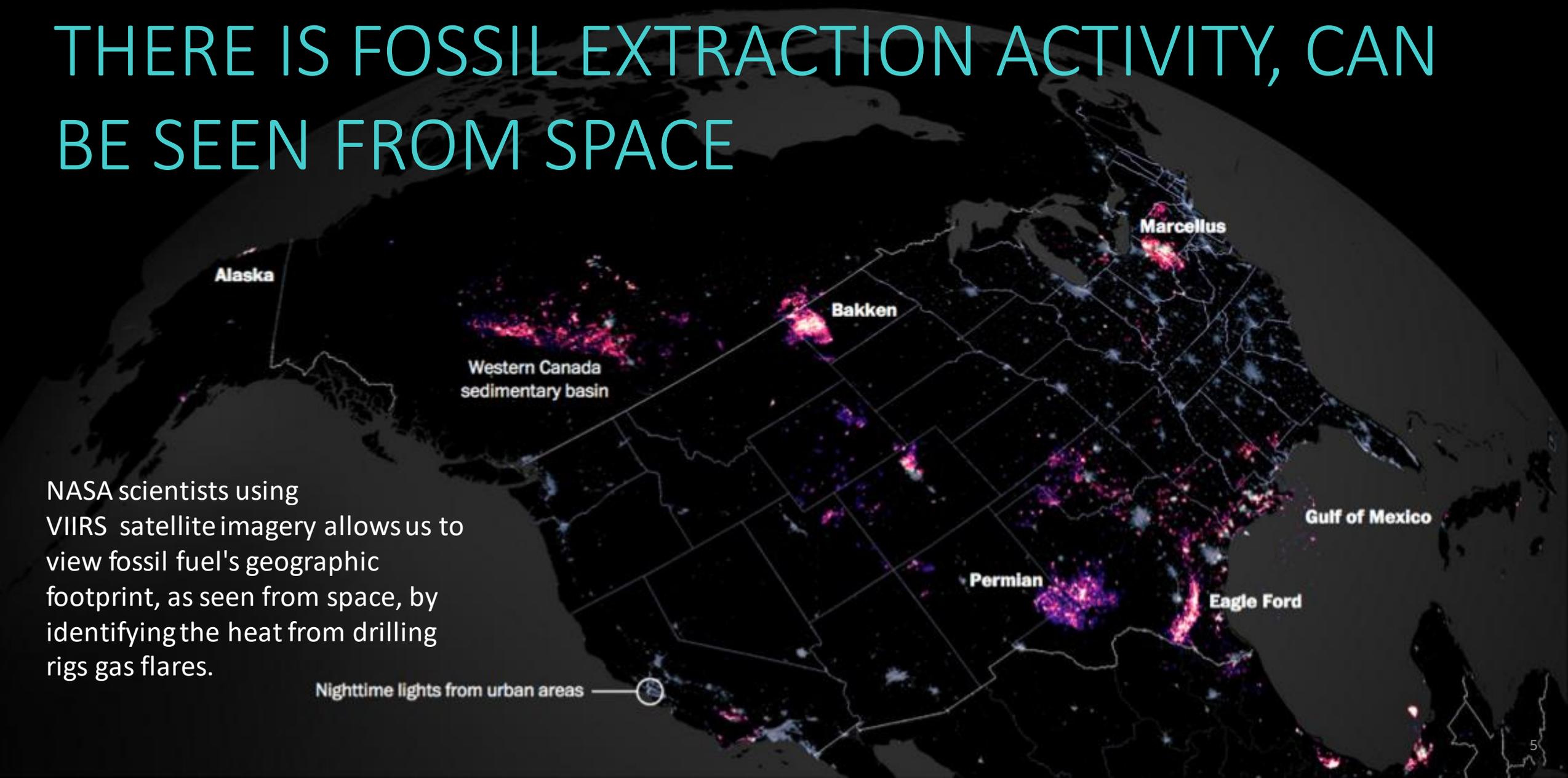
Fossil fuels still provide 80% of all energy used by humans around the globe. Their emission exceed 35 billion tons (gigatons) of CO₂ & methane (CH₄) every year. Estimates put accumulated CO₂ at well over 1,000 gigatons.

METHANE FLARES, SO PREVALENT WHERE THERE IS FOSSIL EXTRACTION ACTIVITY, CAN BE SEEN FROM SPACE



NASA scientists using VIIRS satellite imagery allows us to view fossil fuel's geographic footprint, as seen from space, by identifying the heat from drilling rigs gas flares.

Nighttime lights from urban areas 

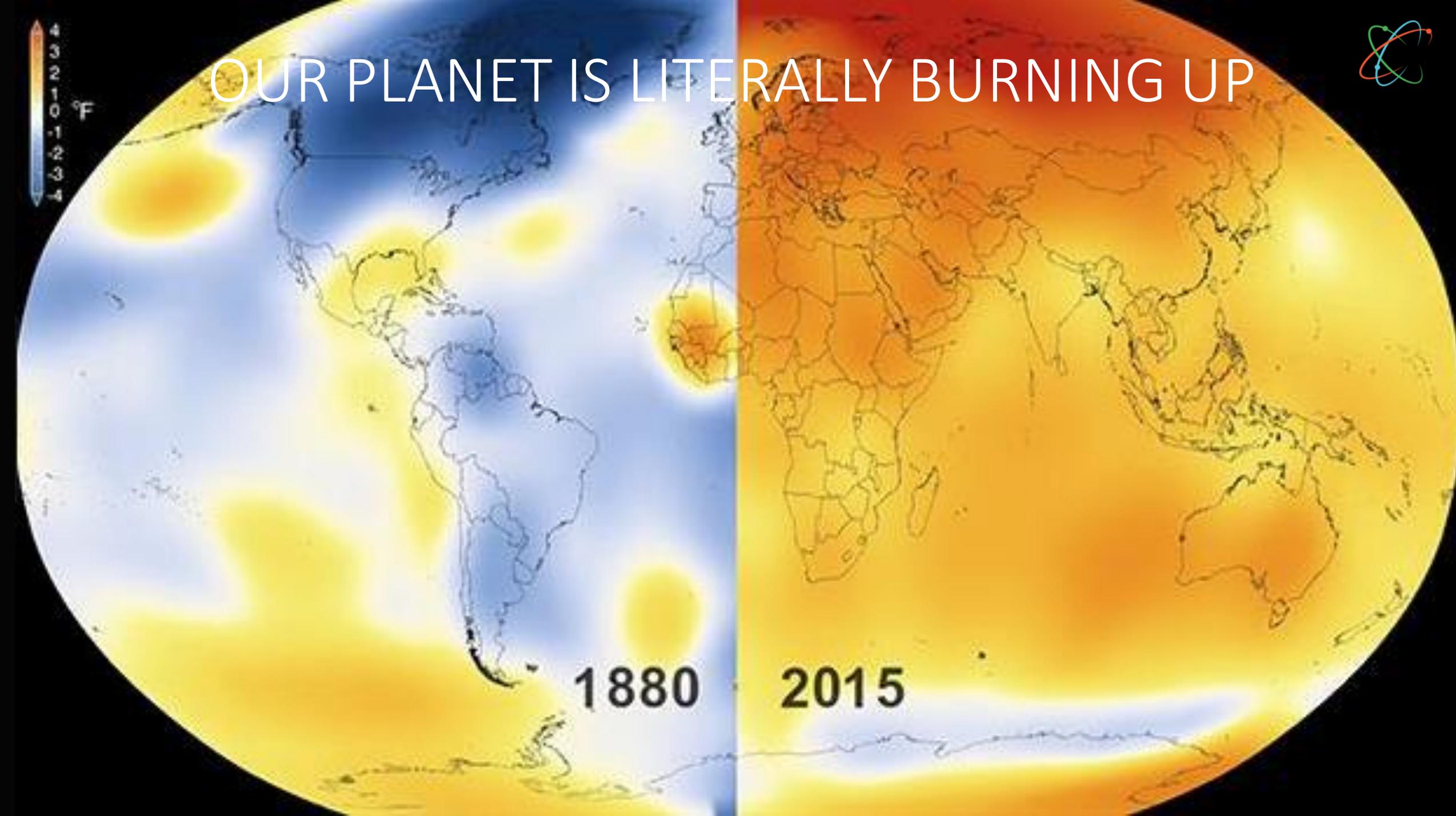


OUR PLANET IS LITERALLY BURNING UP



1880

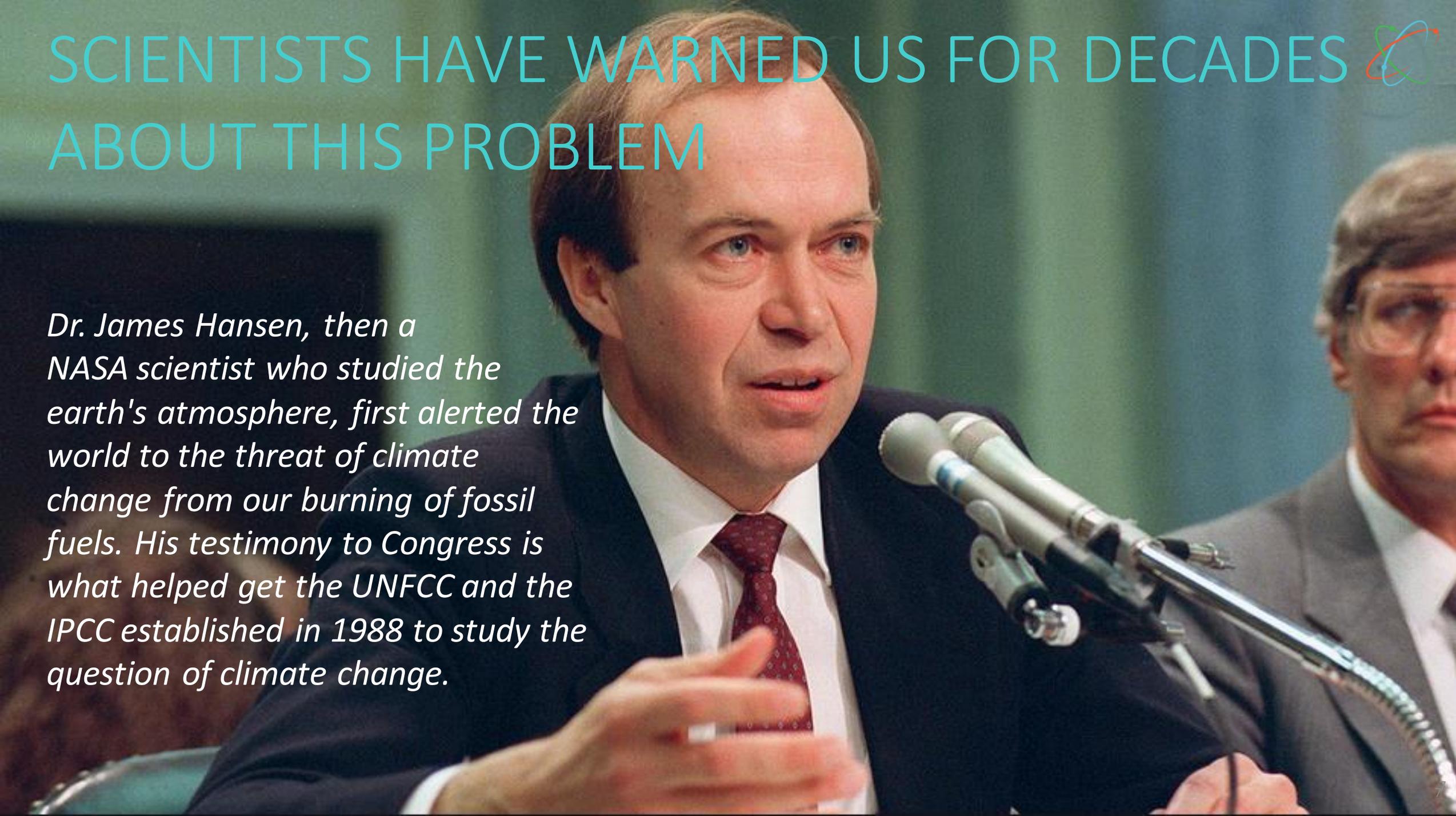
2015



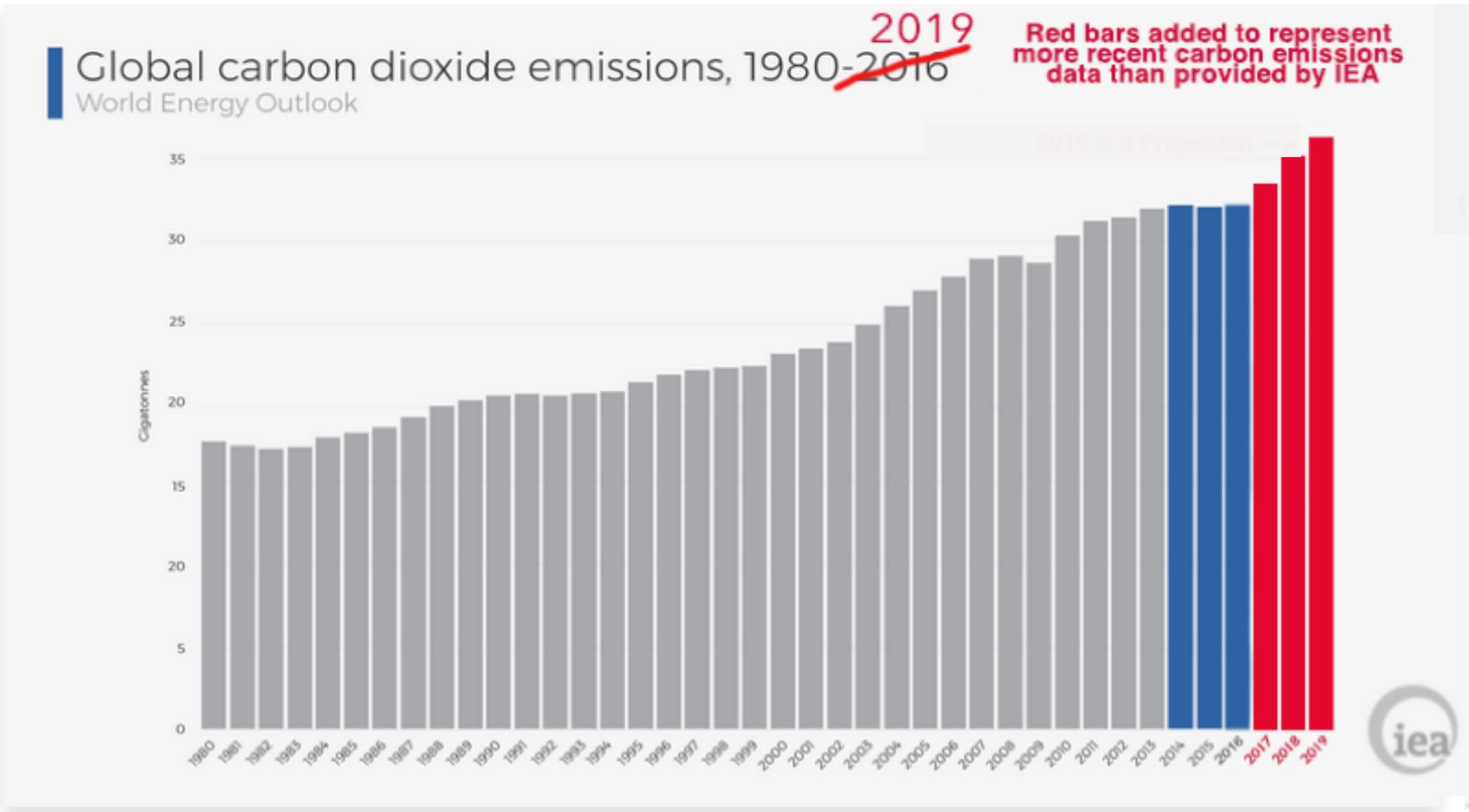
SCIENTISTS HAVE WARNED US FOR DECADES ABOUT THIS PROBLEM



Dr. James Hansen, then a NASA scientist who studied the earth's atmosphere, first alerted the world to the threat of climate change from our burning of fossil fuels. His testimony to Congress is what helped get the UNFCCC and the IPCC established in 1988 to study the question of climate change.

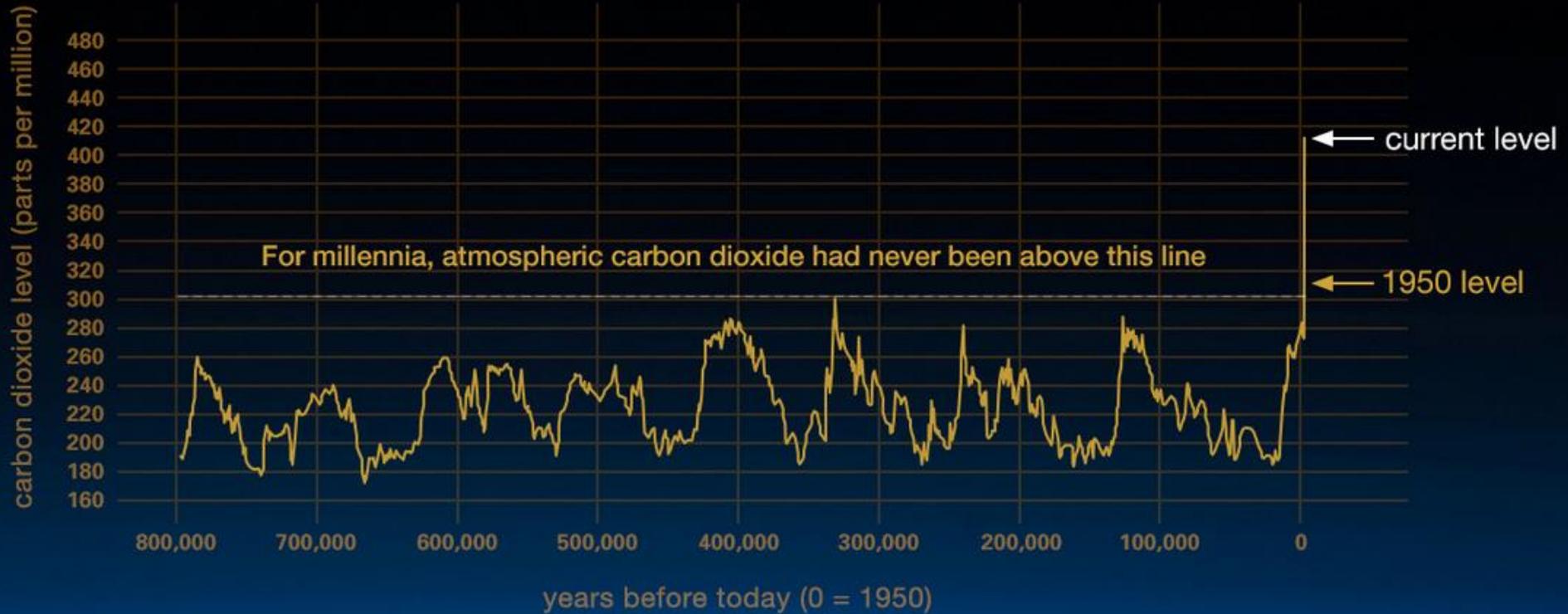


BUT, WE HAVE YET TO REDUCE CO₂ EMISSIONS

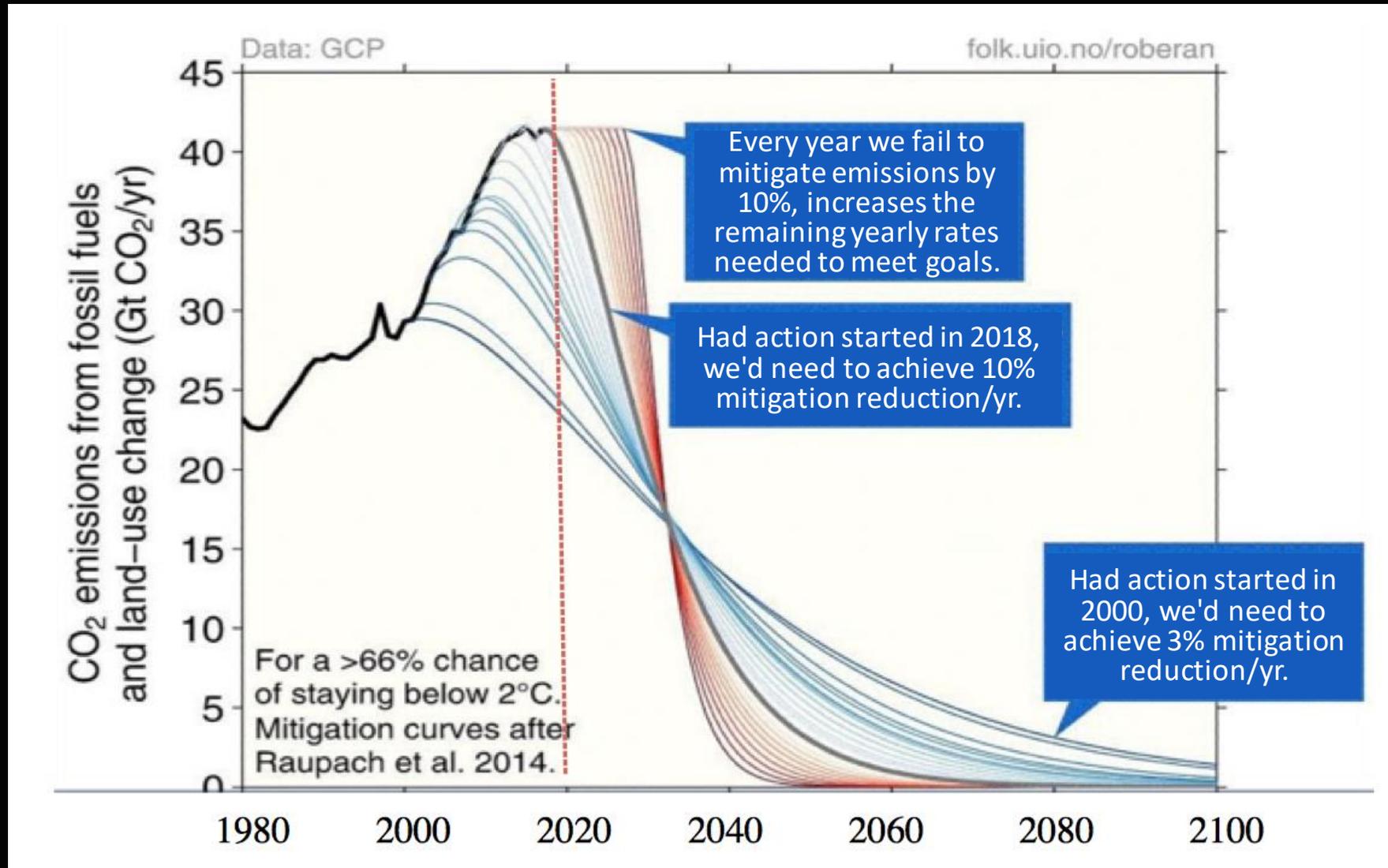


* Due to the pandemic, many experts believe that 2020 emissions will show a decline but not because of structural or lasting changes to our use of energy.

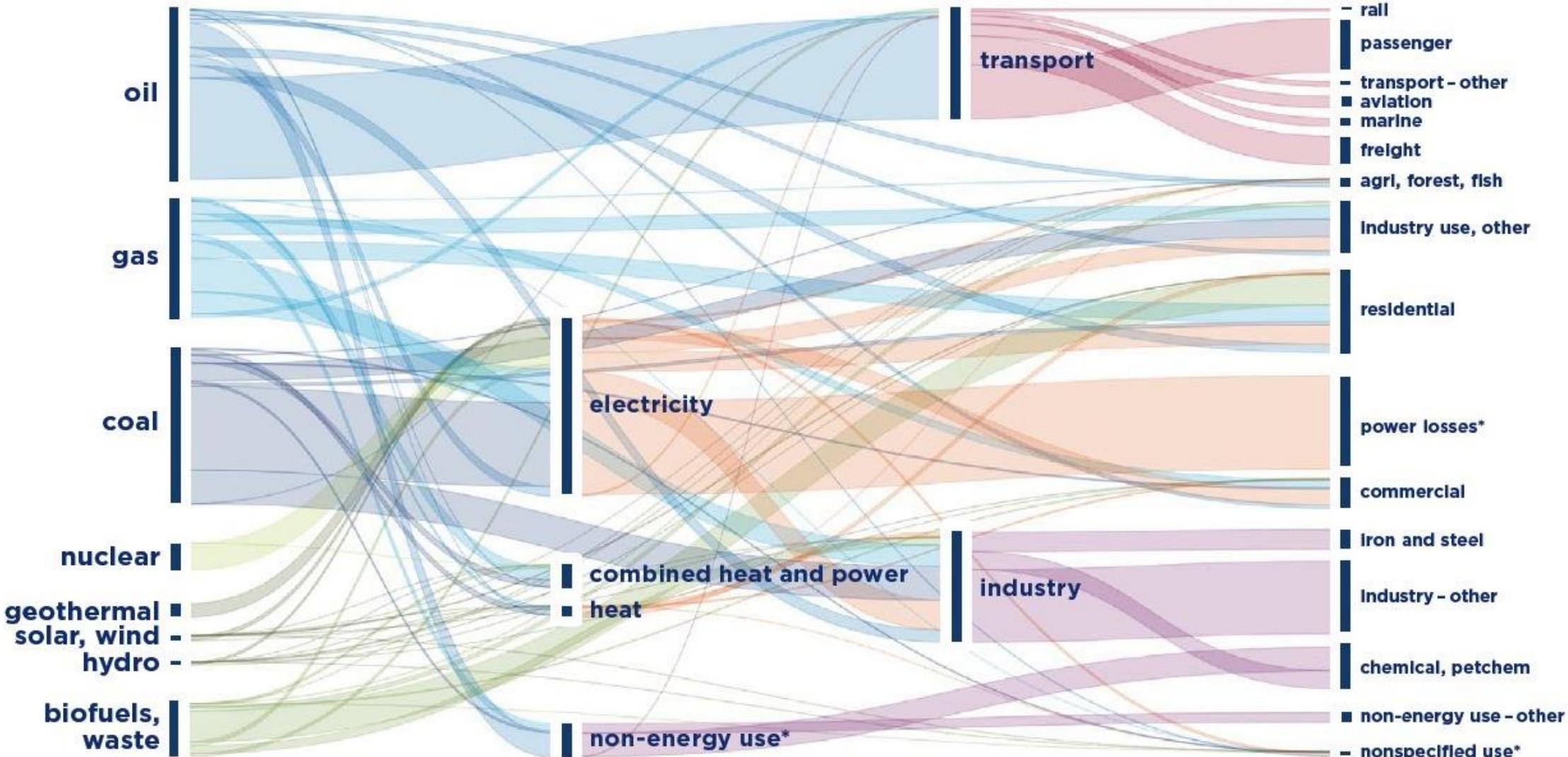
PUSHING CO₂ LEVELS TO UNNATURAL HEIGHTS



WE NOW NEED RAPID ACTION TO AVOID DISASTER



BUT ENERGY USE IS VERY COMPLICATED



We Americans are dependent on our cheap, gas-guzzling conveniences, so there has been broad reluctance to risk taking the kinds of tough policy actions that could increase prices at the pump.





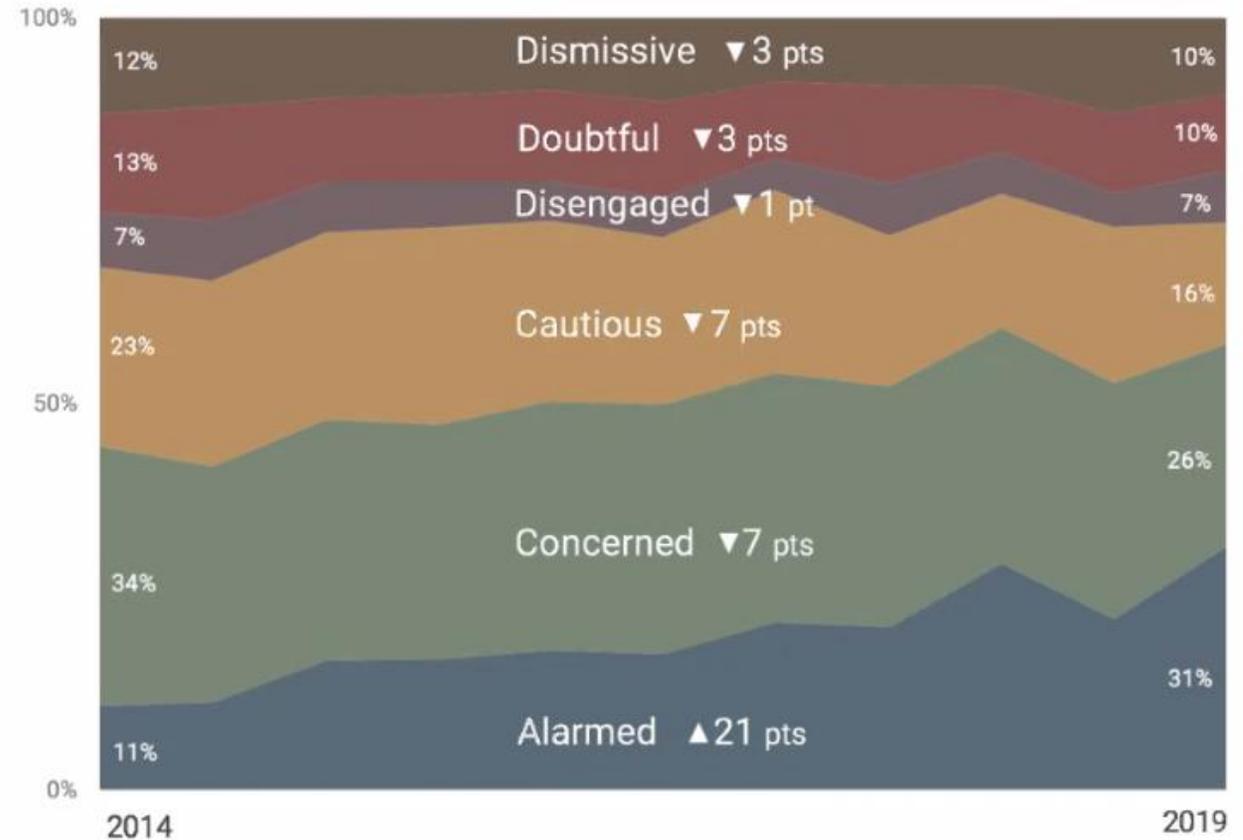
But increasingly,  consequences from our heating planet are causing other kinds of pain. Americans are paying the costs of climate shifts from floods, fires, drought, hurricanes and more, so attitudes are on the move across the US and the world.

THE PUBLIC IS FINALLY FAVORING ACTION



Decades of delay in addressing emissions were the result of public skepticism about climate change, the result of campaigns waged by the fossil fuel industry, questioning the science and impugning scientists. Even after investigative journalists discovered that Exxon knew about global warming in the 1970s, Exxon and other companies continued to fund misinformation.² This has cost us dearly in terms of time and we will need to take more dramatic measures to cut emissions more steeply in the coming years. This adds considerably to the mounting pressure to protect existing nuclear power and expand the base of nuclear use around the world.

Global Warming's Six Americas: Five-year Trend



Data from 11 national surveys ($N = 13,854$) from Oct. 2014 to Nov. 2019. Difference scores are calculated before rounding (example: $12.3\% - 9.7\% = 2.6\%$ which, after rounding, would appear in the figure as $12\% - 10\% = 3\%$).

EVIDENCE THAT EXXON KNEW

Exxon

PROPRIETARY INFORMATION

For Authorized Company Use Only

Petroleum Department

Engineering

79PE 554

October 16, 1979

E X X O N R E S E A R C H A N D E N G I N E E R I N G C O M P A N Y

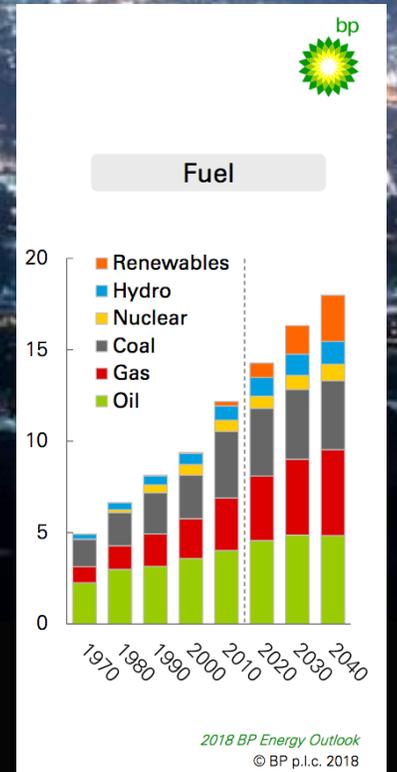
CONTROLLING THE CO₂ CONCENTRATION IN THE ATMOSPHERE

The CO₂ concentration in the atmosphere has increased since the beginning of the world industrialization. It is now 15% greater than it was in 1850 and the rate of CO₂ release from anthropogenic sources appears to be doubling every 15 years. The most widely held theory is that:

- The increase is due to fossil fuel combustion
- Increasing CO₂ concentration will cause a warming of the earth's surface
- The present trend of fossil fuel consumption will cause dramatic environmental effects before the year 2050.

(Read the full investigative report at [Inside Climate News](#)² and about the litigation that has resulted.³)

SO, HOW CAN WE POWER OUR HIGH ENERGY LIFESTYLES WITHOUT USING FOSSIL FUELS?



Fossil fuels still comprise the vast majority of our energy.⁴



SOME WANT TO BELIEVE THAT
RENEWABLES CAN REPLACE FOSSIL
FUELS BY THEMSELVES





BUT SCIENTISTS SAY OTHERWISE . . .

*“Nuclear power paves the only
viable path forward on climate
change.”⁵*

*—The same Dr. James Hansen,
now working and teaching at Columbia's
Earth Institute, considered the world's
foremost climate scientist.*





WHY DO EXPERTS CALL FOR USE OF ALL AVAILABLE TYPES OF CLEAN ENERGY, INCLUDING NUCLEAR POWER?





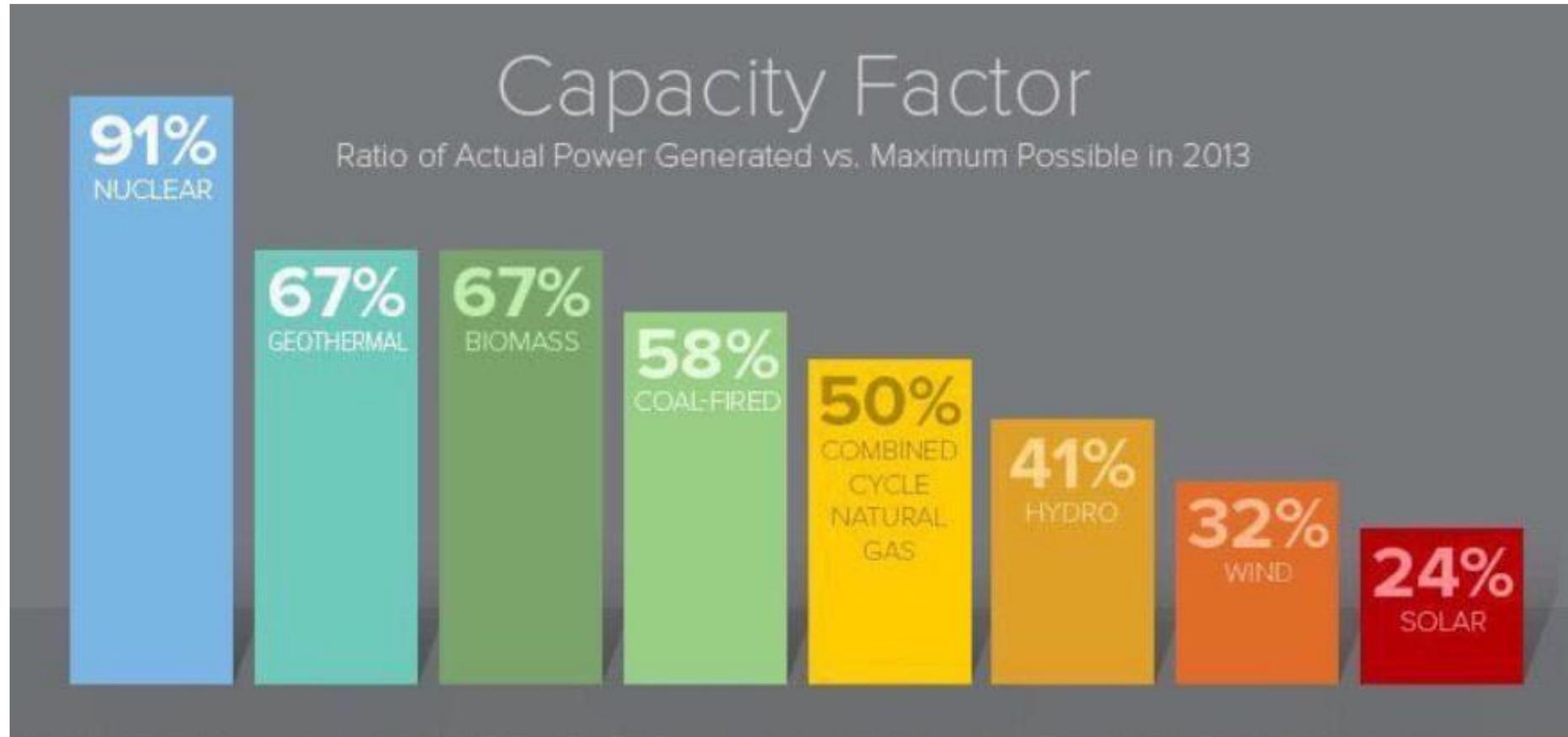
WE ONLY HAVE A FEW CLEAN ENERGY OPTIONS

CARBON EMISSIONS PER kWh



Carbon Emissions per Kilowatt uses lifecycle analysis to create a measurement of CO₂ for each generated kWh of energy. This readily shows the comparative emissions for all types of energy. All energy has some emissions but only a few have low enough CO₂ emissions that it would not be detrimental to our climate if we used these a lot.

NUCLEAR IS THE WORKHORSE OF CLEAN ENERGY, GOING 24x7x365

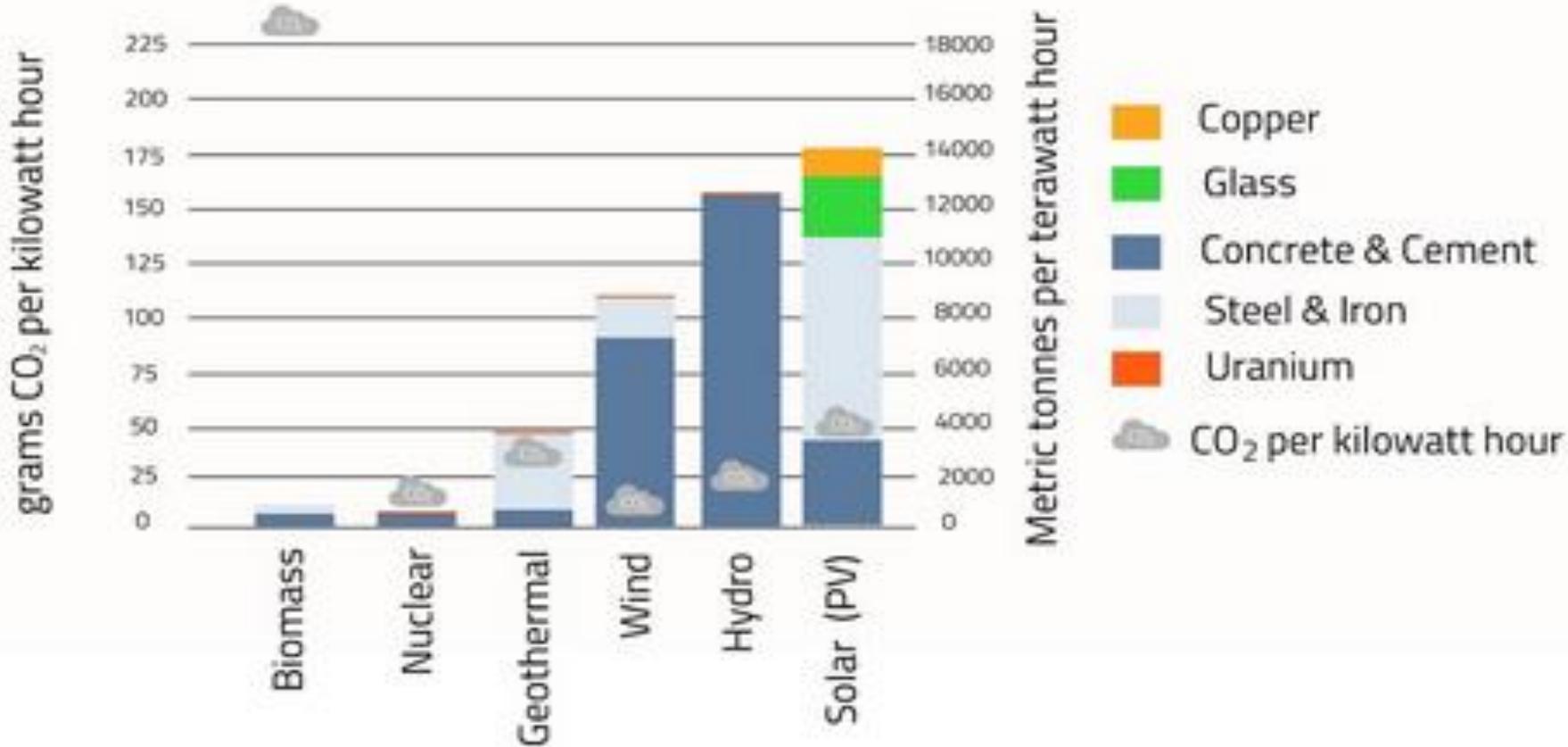


Source: Nuclear Energy Institute. US Nuclear Power Plant Statistics. <http://www.nei.org/Knowledge-Center/Nuclear-Statistics/US-Nuclear-Power-Plants/US-Capacity-Factors-by-Fuel-Type>

NUCLEAR USES LESS RAW MATERIALS

MATERIAL INPUTS AND LIFECYCLE GREENHOUSE GAS EMISSIONS PER UNIT OF ENERGY

Sources : US DOE QTR 2015, WNA, IPCC 2014



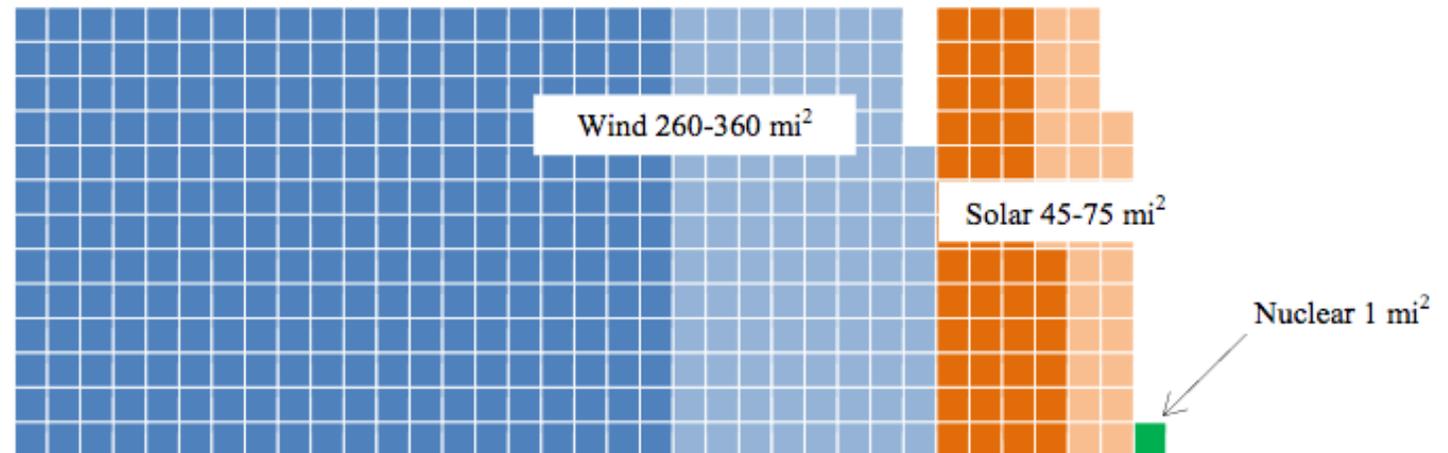
AND USES MUCH LESS LAND PER MW (WHICH IS GOOD FOR NATURE)



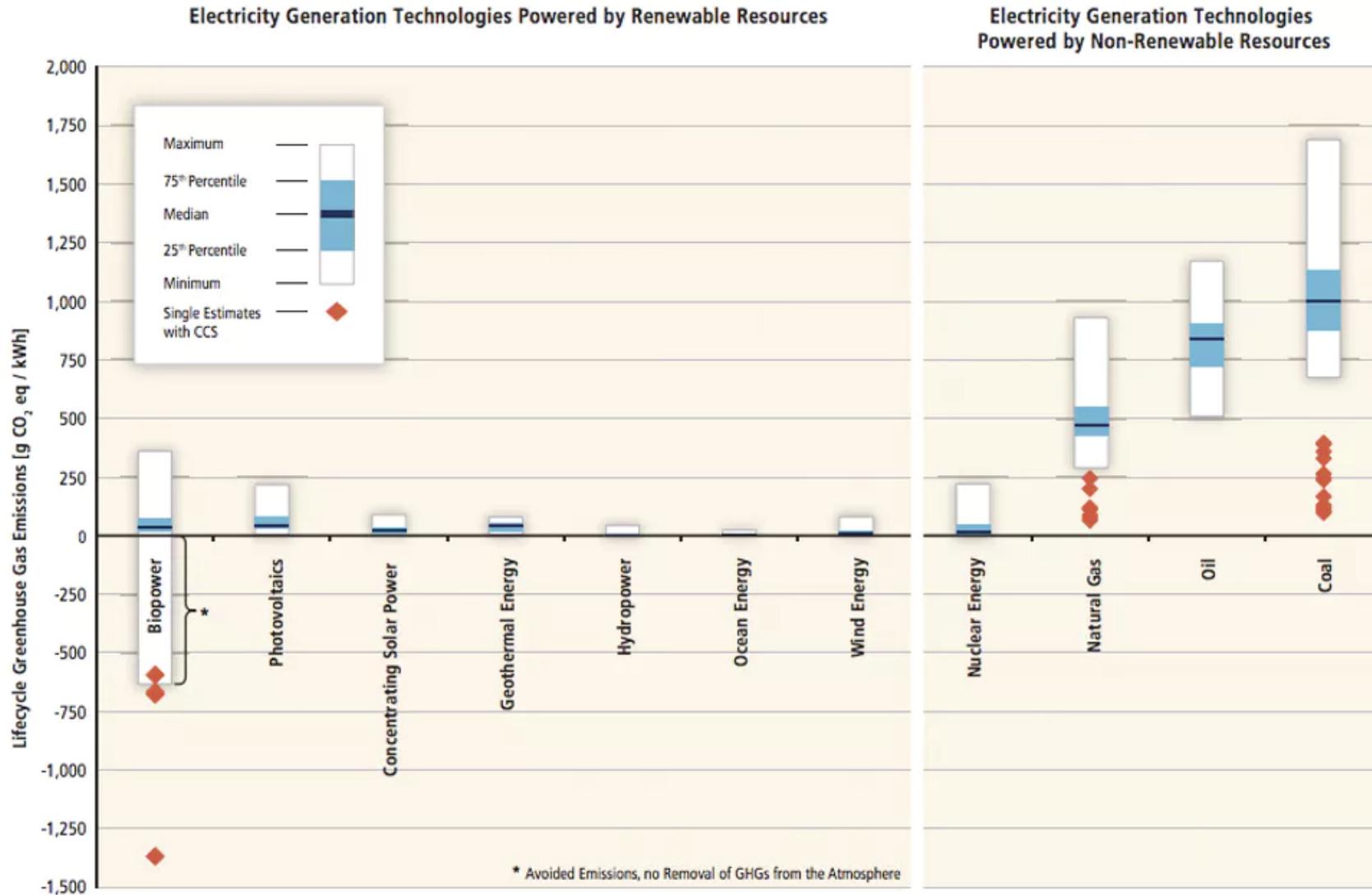
Capacity Factor is the term used to explain the percentage of a year that the energy plant actually produces energy. A Megawatt (MW) is an amount of energy. This chart shows that if a wind plant operates at the high end of the range (47% of the time) then that plant (located in a high wind area) would need 260 square miles (dark blue) in order to generate the same power as a 1,000 MW nuclear power plant that occupies 1 square mile, running 90% of the time.

Technology	Capacity Factor, %	Square Miles Needed for 1,000 MW
Wind	32-47	260-360
Solar	17-28	45-75
Nuclear	90	1.3

The table summarizes the approximate land required by wind and solar technologies to match the electricity produced annually by a 1,000-MW nuclear power plant.



NUCLEAR LIFECYCLE CO₂ IS LOW

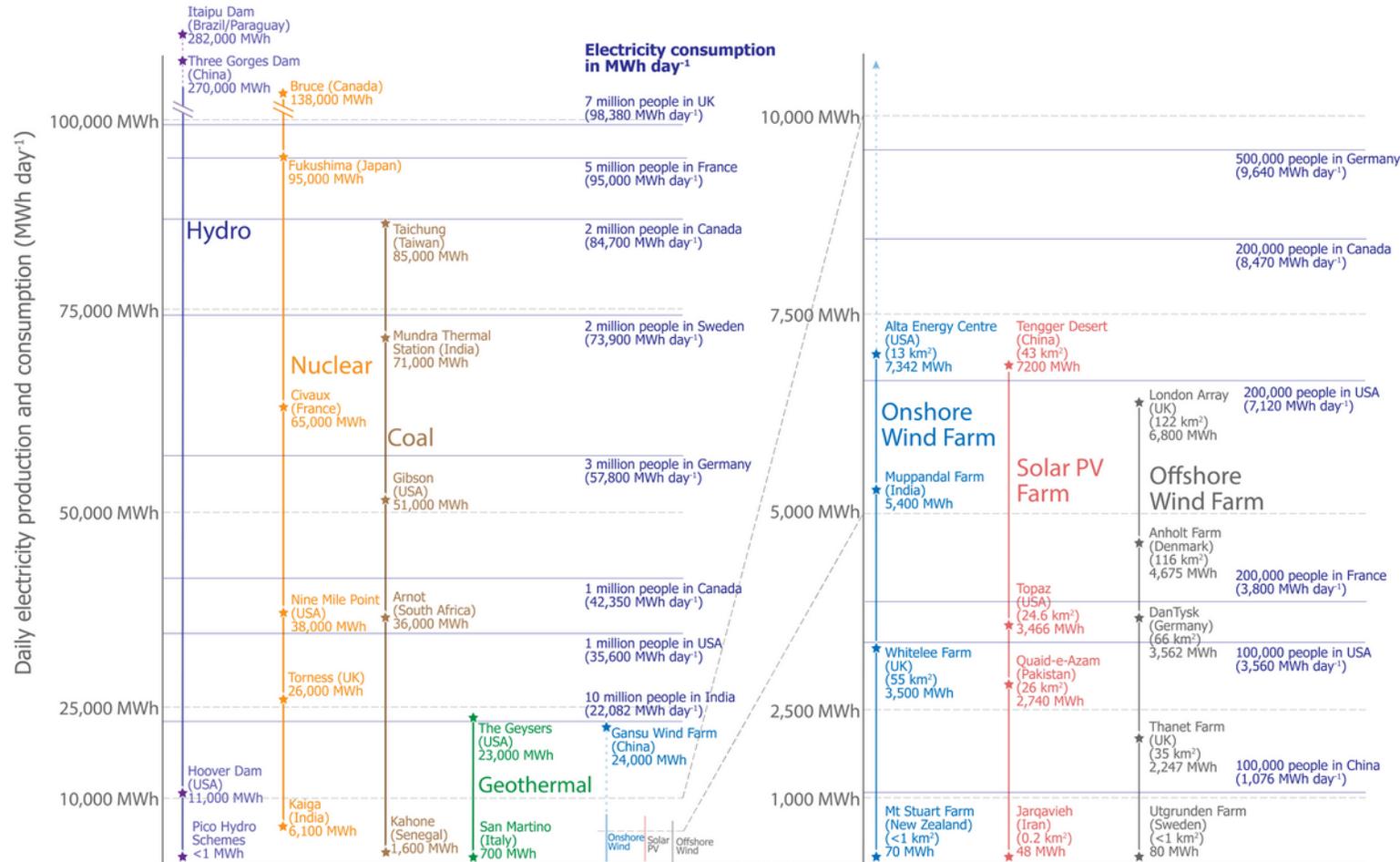


Lifecycle GHG Emissions refer to the measurement of emissions associated with building the plant and processing the fuel. Wind and sunshine may be free but there is energy and CO₂ embedded in the fabrication of these technologies, which require energy and raw materials in order to build the plant. Lifecycle analyses take all of these operations into account to compare the emissions across differing technologies.

BUT POWER GENERATION IS HIGH

A sense of scale for electrical energy production and consumption

Daily production by electricity source is shown by vertical lines (|) – the line shows the range from the smallest to the largest power plants of a given type. Some specific power plants are shown with stars (★). Typical levels of electricity consumption are shown by horizontal lines (–).



Understanding the scale of energy generation is not easy for most people.

It is important to note that the entire right side of this chart is a magnification of the last three bars on the lower right side of left half of this chart.

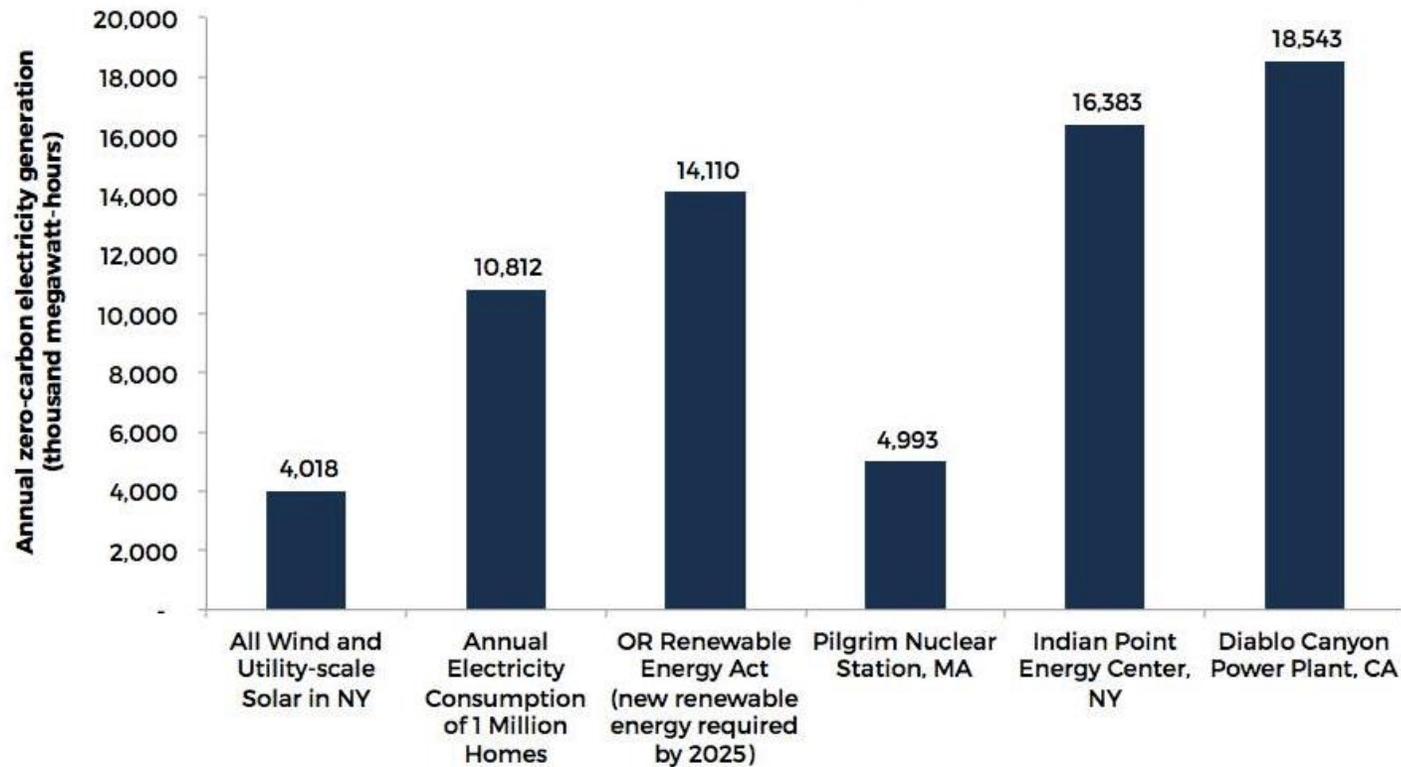
Details on sources for this infographic can be found at OurWorldInData.org/scale-for-electricity At OurWorldInData.org you also find more research and visualizations on this topic.

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NUCLEAR GENERATION ADDS GRID STABILITY



**Putting Nuclear Power Plant Retirements in Perspective:
Annual Carbon-free Electricity Generation**



Data sources: New York utility-scale solar and wind from EIA form 923 for Nov 2015–Oct 2016 (most recent 12 months available)

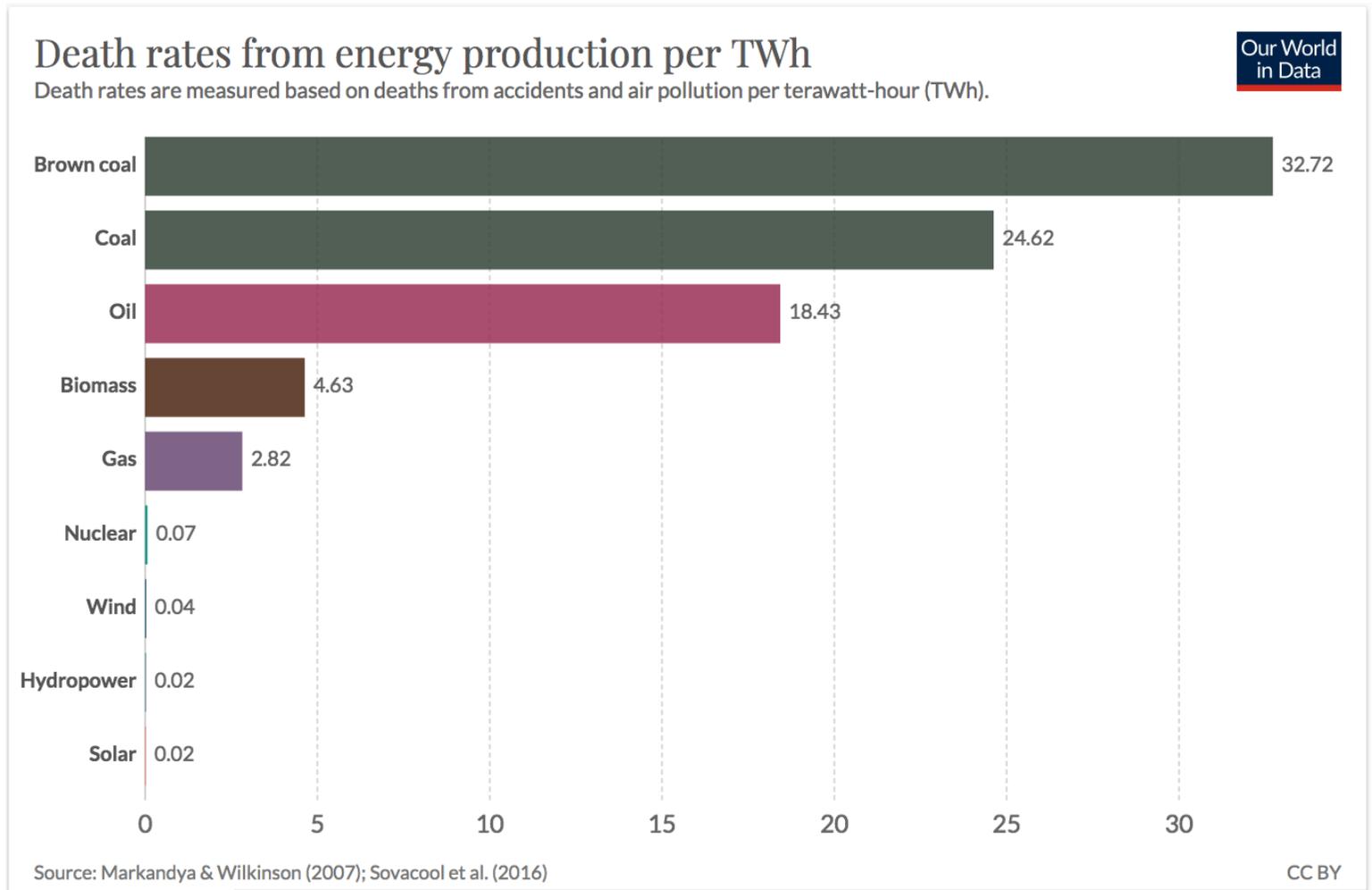
Oregon Renewable Energy Act estimated 2025 requirements from Database of State Incentives for Renewable Energy (DSIRE)

Indian Point, Diablo Canyon and Pilgrim annual generation from IAEA PRIS database for calendar year 2015 (most recent 12 months available)

Annual average U.S. household electricity consumption from EIA

Ancillary Services is a way of describing benefits that come from having nuclear on the grid and covers a wide array of characteristics that are mostly available to "thermal" sources of energy (i.e. generation that comes from creating heat). Nuclear is the only provider of ancillary services, other than fossil fuels, so getting rid of fossils and nuclear would cause the grid a lot of additional problems.

BEST OF ALL
NUCLEAR IS
ACTUALLY
ONE OF THE
SAFEST TYPES
OF ENERGY⁶



Nuclear has over 60 years of operating history, disproving the claim that it is dangerous. Hannah Ritchie and Max Roser, statisticians at Our World in Data, are some of the most highly respected number crunchers. Even the very worst nuclear accident, at Chernobyl, as scary as that accident was, killed only 31 people directly. Epidemiologic assumptions about thousands of other deaths have not been realized.

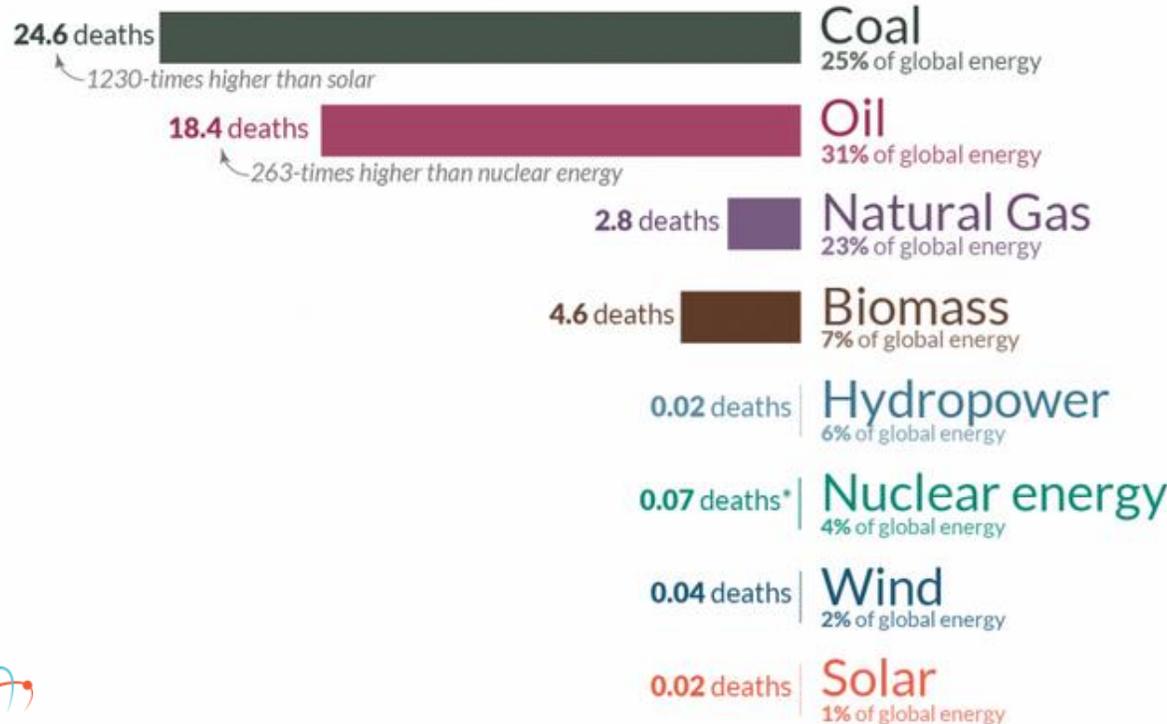
AS WELL AS ONE OF THE CLEANEST

Our World
in Data

What are the **safest** and **cleanest** sources of energy?

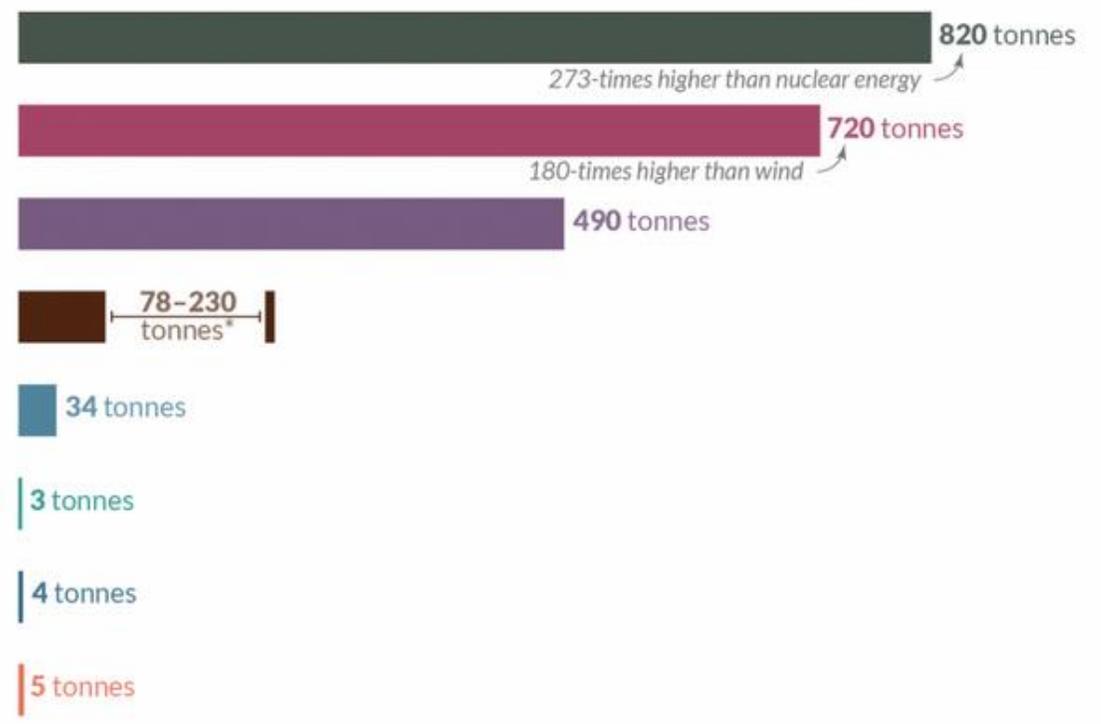
Death rate from accidents and air pollution

Measured as deaths per terawatt-hour of energy production.
1 terawatt-hour is the annual energy consumption of 27,000 people in the EU.



Greenhouse gas emissions

Measured in emissions of CO₂-equivalents per gigawatt-hour of electricity over the lifecycle of the power plant.
1 gigawatt-hour is the annual electricity consumption of 160 people in the EU.



NUCLEAR IS
CREDITED
WITH SAVING
LIVES, SINCE
IT DISPLACES
FOSSIL FUELS
AND EMITS NO
TOXIC AIR⁷



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Published: 29 May 2013

Environment

Nuclear power saves lives

Nature 497, 539(2013) | [Cite this article](#)

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Highly read on pubs.acs.org 20 April–20 May

Nuclear power might have prevented almost two million air-pollution-related deaths around the world, an analysis of historical data suggests.

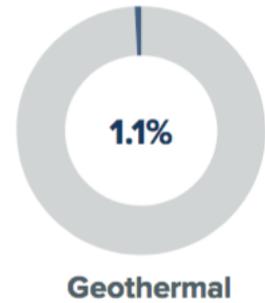
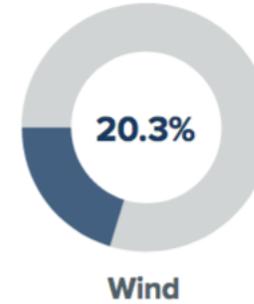
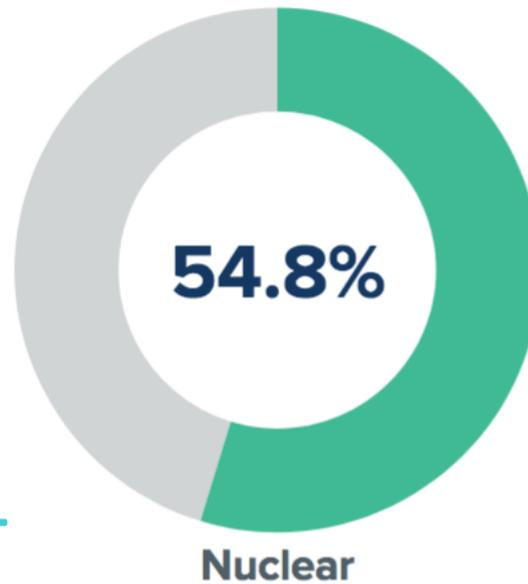
Former NASA scientist James Hansen, who left the agency in early April to devote his time to climate activism, and Pushker Kharecha at the NASA Goddard Institute for Space Studies in New York estimate that nuclear power has prevented some 1.84 million deaths that would have occurred had that power been generated by burning fossil fuels. This equates to 370 times more lives saved than have been lost to radiation poisoning or occupational accidents in nuclear power plants over the past 40 years or so. In addition, the power generated by the technology has prevented 64 gigatonnes of carbon-dioxide-equivalent greenhouse-gas emissions, which would have accompanied the burning of fossil fuels, from entering the atmosphere.

IN FACT, NUCLEAR GENERATES MORE CARBON-FREE ENERGY THAN ALL RENEWABLE TECHNOLOGIES COMBINED, BUT MOST PEOPLE DON'T REALIZE IT

THE NUCLEAR ADVANTAGE

2019 U.S. Carbon-Free Electricity Fuel Shares

Nuclear power is responsible for more carbon-free electricity than all other sources combined.



PLUS, NUCLEAR IS BETTER ABLE TO WITHSTAND EXTREME WEATHER

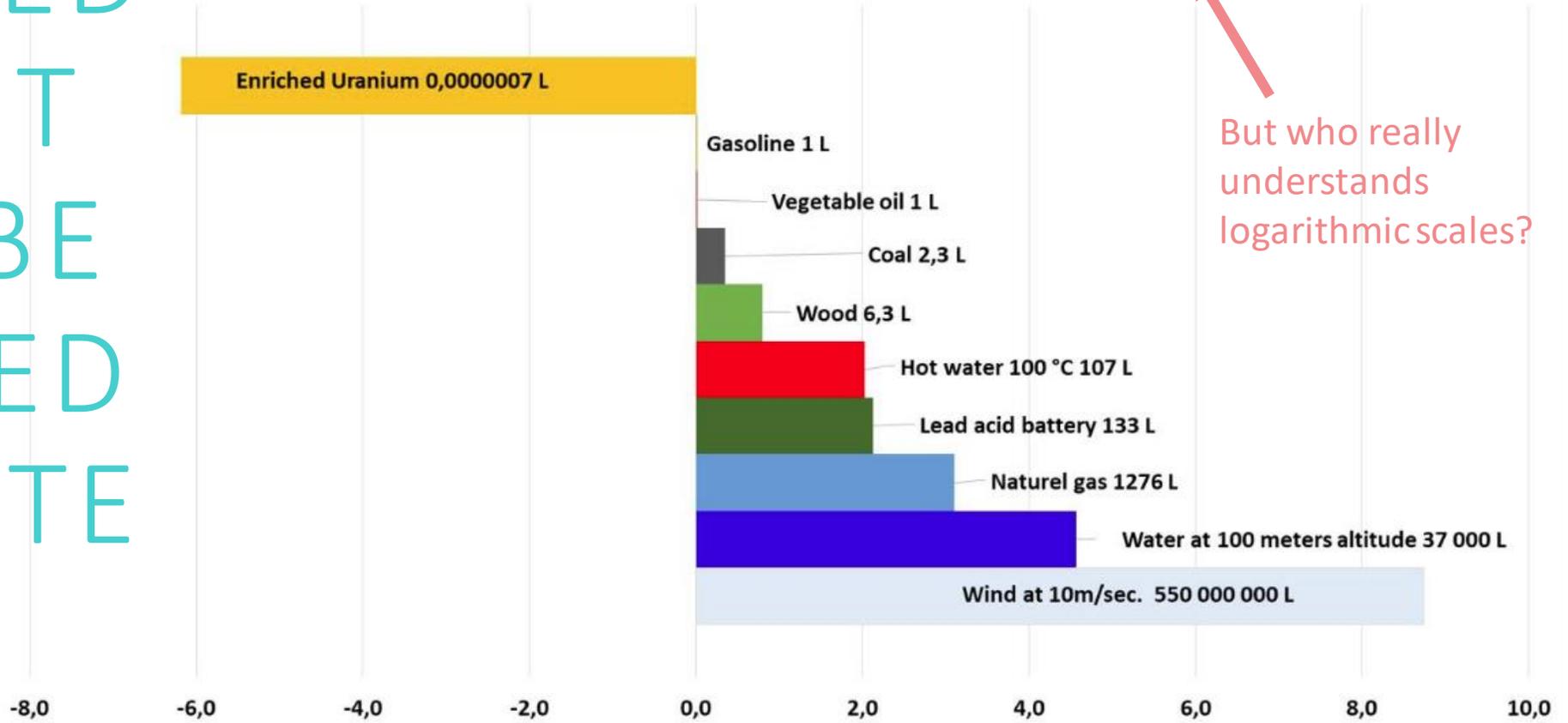


Weather Extremes and unpredictable weather shifts, as a function of our changed climate, create additional and sometimes catastrophic risks for wind and solar, which must operate out in the open air.

Nuclear does not have this degree of vulnerability to weather shifts. Additionally, having a more diverse set of energy options decreases the overall risk profile of the grid, much like portfolio diversification.

NUCLEAR FUEL IS EXCEPTIONALLY ENERGY DENSE, SO VERY LITTLE IS NEEDED AND IT CAN BE STORED ON SITE

Volume containing the same energy as one liter gasoline (logarithmic scale) *Pierre Arthuis*



One uranium fuel pellet contains as much energy as...

And prevents the emissions of...

1 ton of coal

149 gallons of oil

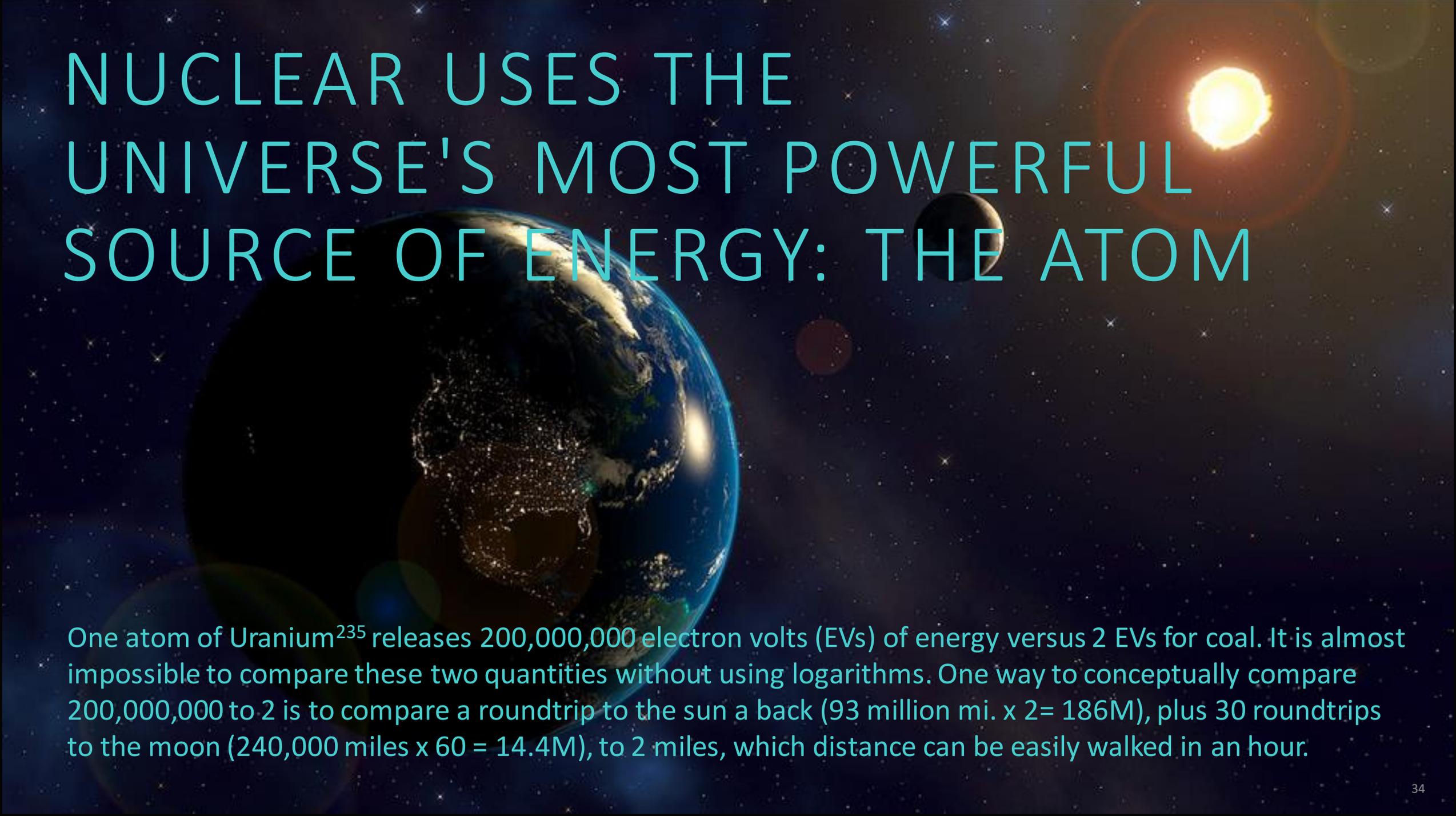
17,000 ft³ of natural gas



2.9 tons of CO₂

1.6 tons of CO₂

1 ton of CO₂



NUCLEAR USES THE UNIVERSE'S MOST POWERFUL SOURCE OF ENERGY: THE ATOM

One atom of Uranium²³⁵ releases 200,000,000 electron volts (EVs) of energy versus 2 EVs for coal. It is almost impossible to compare these two quantities without using logarithms. One way to conceptually compare 200,000,000 to 2 is to compare a roundtrip to the sun a back (93 million mi. x 2 = 186M), plus 30 roundtrips to the moon (240,000 miles x 60 = 14.4M), to 2 miles, which distance can be easily walked in an hour.

BUT WHAT ABOUT THE WASTE?



(This is what anti-nuclear activists want people to think happens with the waste.)

NUCLEAR WASTE IS SAFELY STORED.
NEXT-GEN REACTOR DESIGNS WILL
REUSE WASTE AS VALUABLE FUEL



(Despite the popular obsession about waste, no one has ever been hurt or killed by nuclear energy waste.)



Rendering of Oklo's proposed "Aurora" power plant. Image courtesy of Oklo

WASTE NOT WATT NOT

The power plant of the future could run on nuclear waste

By [Nathanael Johnson](#) on Feb 20, 2020

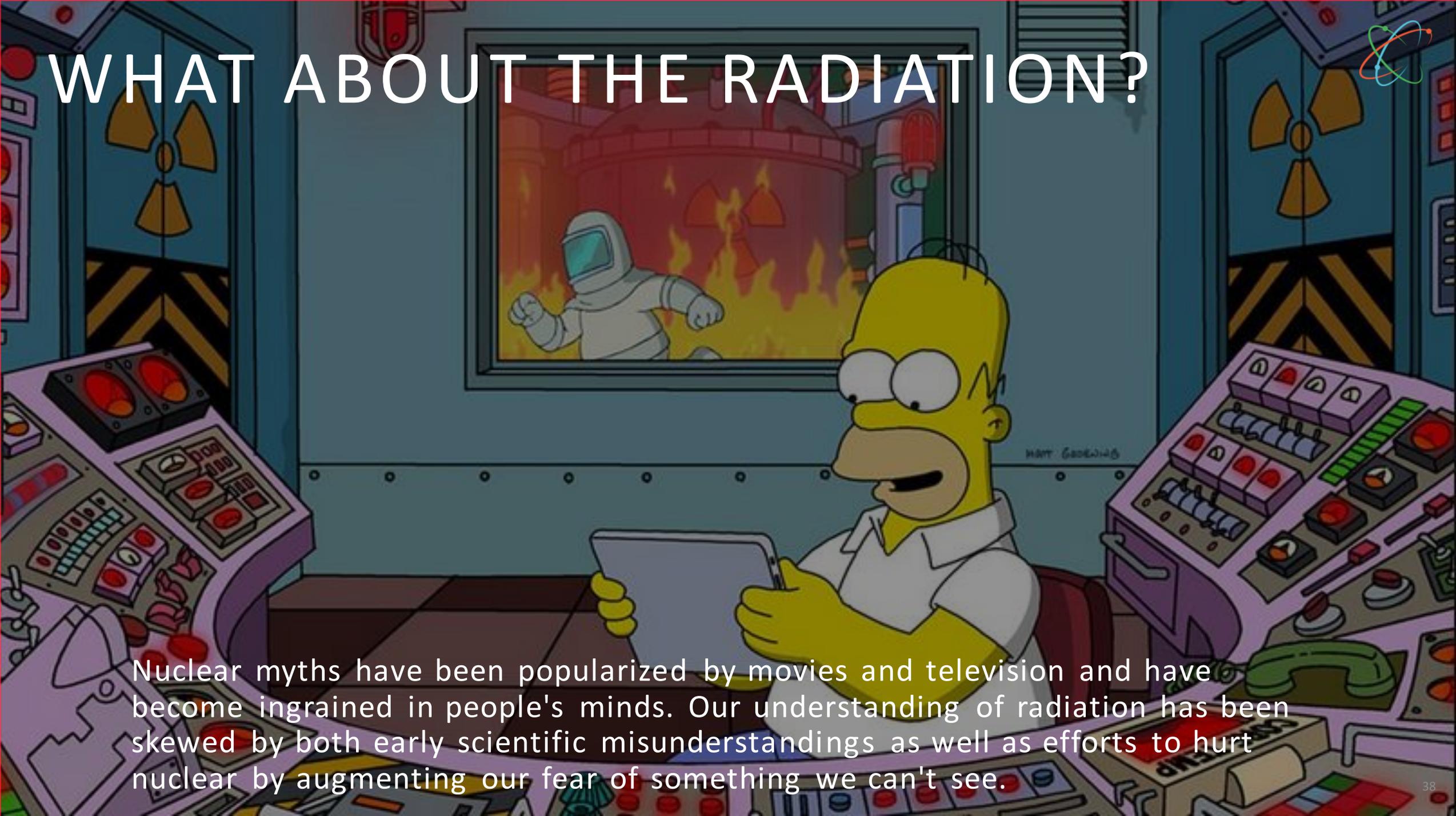


WASTE NOT WATT NOT

Oklo, one of the first of the next-gen designs to re-imagine nuclear power, has already received approval to run their test design using nuclear waste as fuel.

It turns out that nuclear waste is not really "waste," it is largely unused fuel plus a very small fraction of miscellaneous fission products, many of which have commercial value. Rather than paying good money to store this for centuries, there are groups looking to recycle this waste, use the unfissioned uranium for fuel and use the fissioned materials for a range of other industrial purposes. A much smaller fraction of what is currently stored really has no current commercial value, the rest does.

WHAT ABOUT THE RADIATION?



Nuclear myths have been popularized by movies and television and have become ingrained in people's minds. Our understanding of radiation has been skewed by both early scientific misunderstandings as well as efforts to hurt nuclear by augmenting our fear of something we can't see.

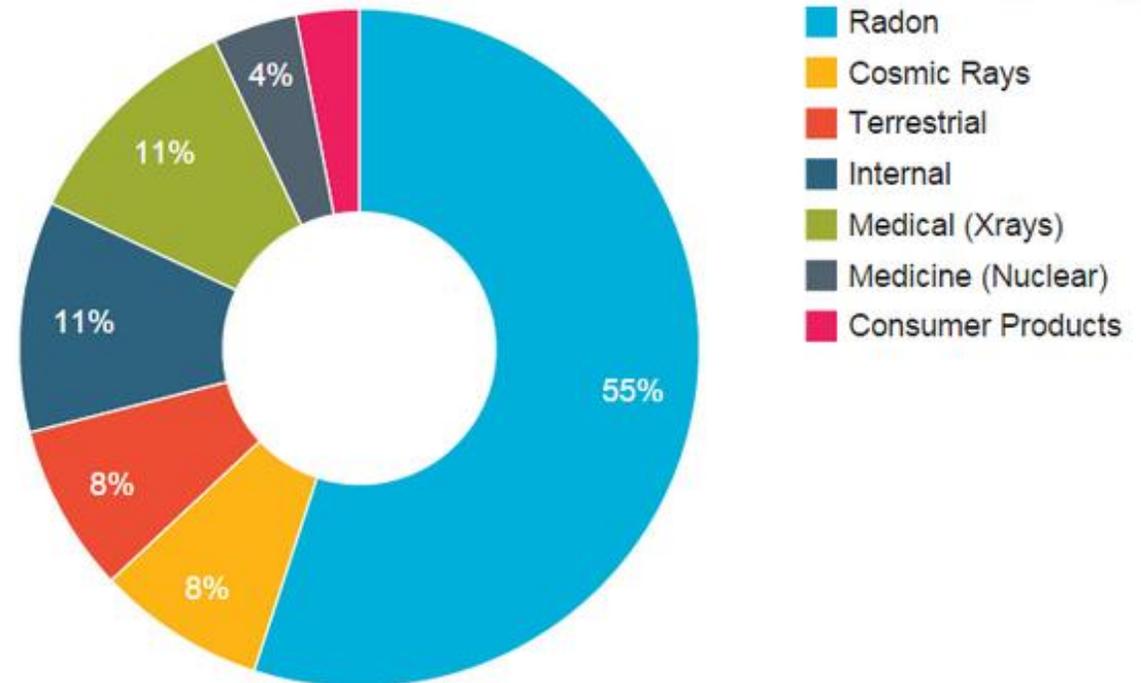
RADIATION IS ALL AROUND US AND, AT NORMAL LOW LEVELS, IS NATURAL AND HEALTHY



Neither nuclear energy nor nuclear waste even make it onto the chart of sources of most of our exposure to radiation over our lifetimes.

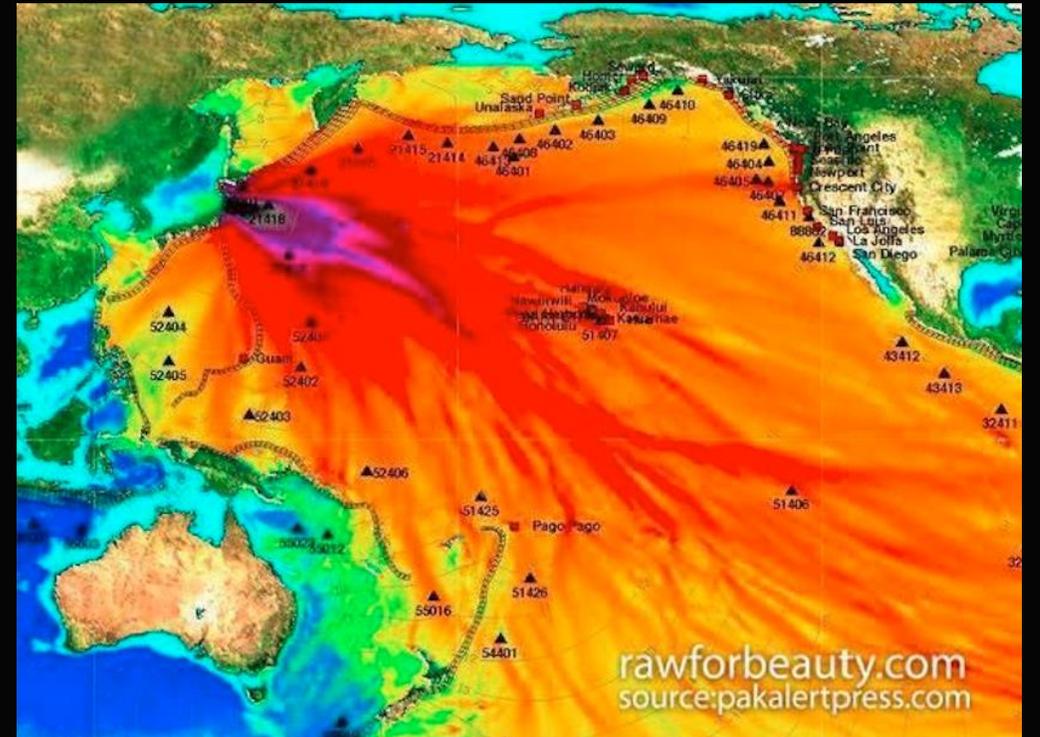
The initial scientific assumption, deemed the "Linear Non-Threshold Theory" that there is no safe dose of radiation has been found to be incorrect. Radiation operates more like temperature: there is range in which life thrives, above that or below that, can be dangerous.

Typical Dose to US Residents



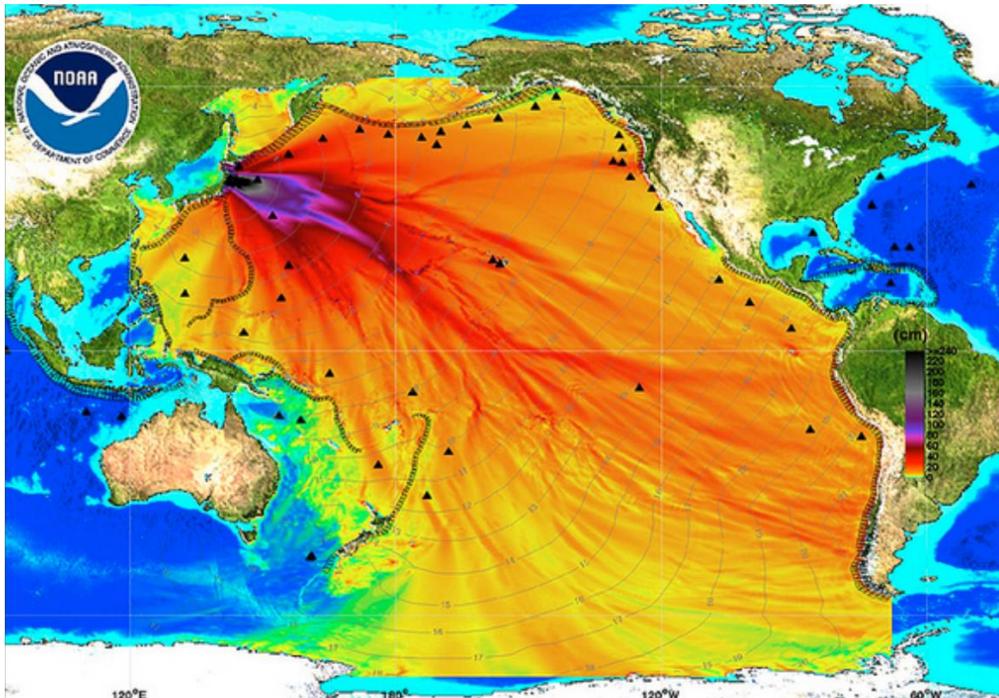


RADIATION FEARMONGERING IS PERVASIVE



Holy Fukushima – Radiation From Japan Is Already Killing North Americans

IT IS EASY TO SCARE PEOPLE WITH WITH FAKE IMAGES: HARDER TO GET THEM LOSE THEIR FEAR



Original image: from the National Oceanic and Atmospheric Administration, which issued this image as an alert to coastal communities to indicate wave height of the tsunami that resulted from the earthquake that struck right near Japan. The tsunami swept some 15,000 people into the sea at Fukushima. The nuclear power plant had its meltdown three days later but that accident killed 0 people. Nevertheless, this graphic map was deliberately altered by numerous groups, which removed the NOAA logo and added alarming text or symbols that made it appear to be showing radiation.



BIG OIL

Paid for by The American Petroleum Institute
1220 L Street, NW
Washington, DC 20005-4070

PPSRT STD
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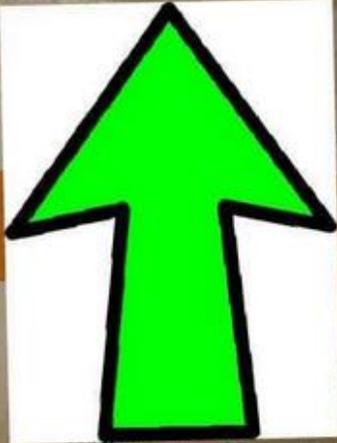
Say No to Nuclear Bailouts

Bailing out the nuclear industry means higher energy rates for consumers like you. These billion dollar companies don't need bailouts, they need to compete with other energy companies on a level playing field.

➔ GET INVOLVED! ➔

TWITTER: @NoNukeBailout
NO NUCLEAR BAILOUT
FACEBOOK: facebook.com/nonukebailout

ten them competition and lower prices are good for Pennsylvania. A bailout for the billion dollar nuclear industry just won't work.



**FUNDING THE FAUX-GREEN
ANTI-NUCLEAR MOVEMENT
SINCE THE DAWN OF NUCLEAR POWER**

FOSSIL FUELS have been found to have funded and supported many of the campaigns and much of the fake news about nuclear energy, nuclear waste and radiation that keeps people being afraid and opposed. They have used the same playbook as they ran with climate change, to "protect" their franchise.



THE AMERICAN PETROLEUM INST. EVEN BOASTS ABOUT IT . . .

Only nuclear can compete as firm, baseload energy with fossil fuels and they know it. API routinely throws millions of dollars into campaigns that appear to reflect public sentiments opposing nuclear power. This image came from a presentation by API boasting about how well it was able to influence lawmakers to believe that the public didn't want to protect their nuclear power. It spent \$16 million opposing two state initiatives.

MOBILIZED API ASSETS

To show state legislators and public service commissioners that voters did not support nuclear subsidies, API relied on its robust mobilization infrastructure and relationships in each state to quickly deploy an aggressive education and activation campaign that included:

Energy Citizens/Energy Nation

- High volume letters to legislators
- Legislator intercepts
- Door to door canvassing
- Digital and on the ground influencer network
- Personal letters to legislators
- Employee toolkits for coalition members and API member companies

Microtargets

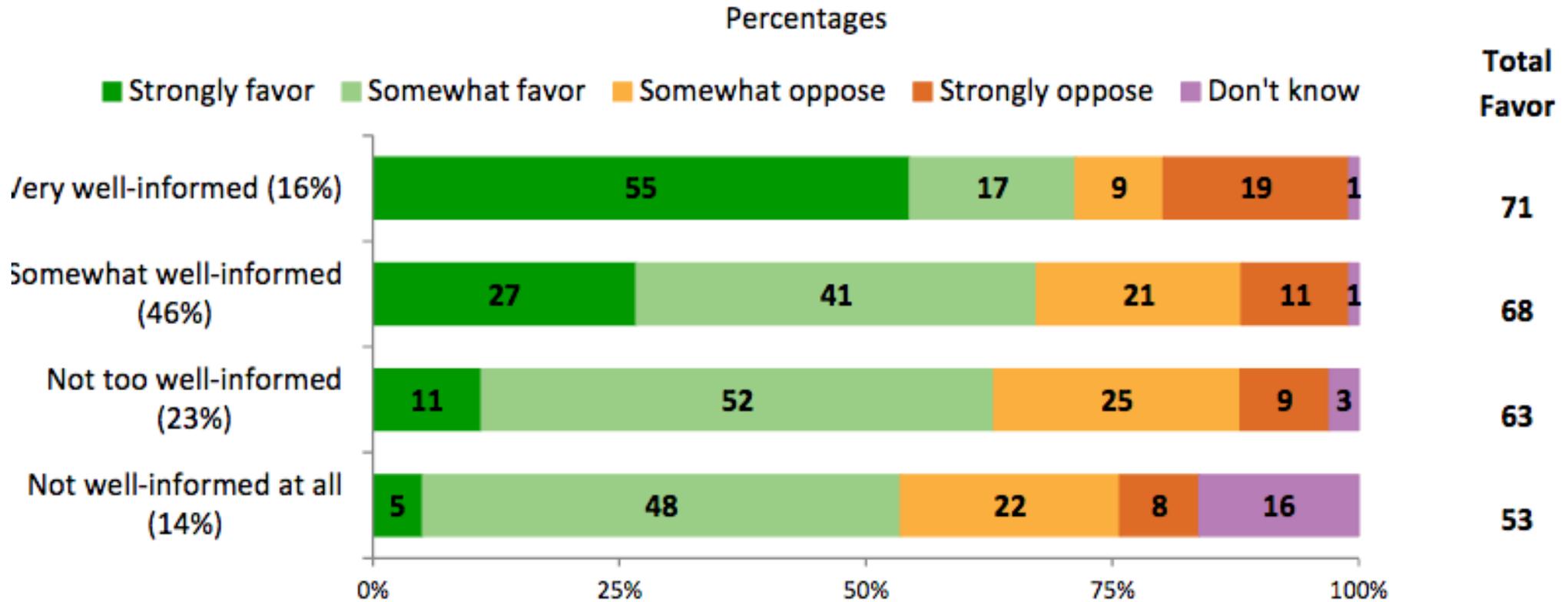
- Intensive education and activation mail and phone campaign
- Educational robo-calls
- Patch through calls to legislators

Energy Forums

- Third party group education and engagement
- Key influencer engagement to make an impact on target legislators
- Legislator intercepts
- Non-traditional audiences to act as community spokespeople



THE MORE YOU KNOW, HOWEVER, THE MORE YOU FAVOR NUCLEAR



FACT-BASED KNOWLEDGE IS KEY



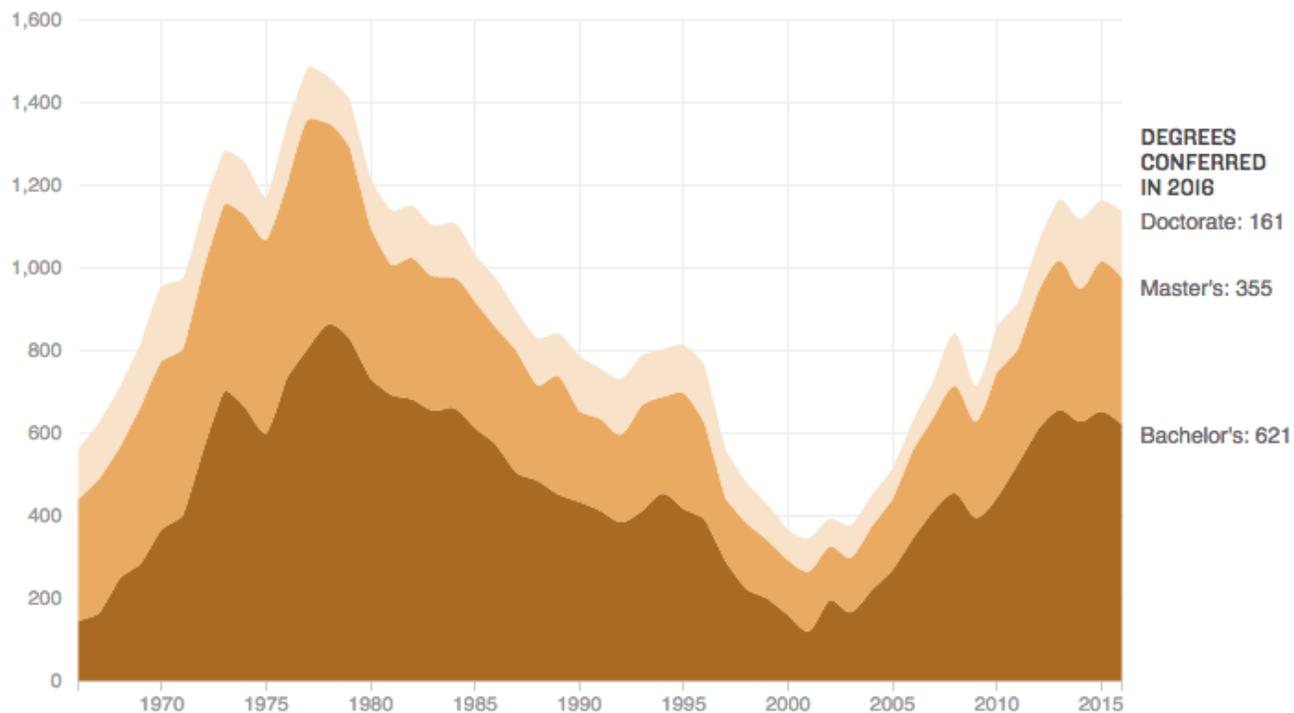
“To solve the climate problem, policy must be based on facts and not prejudice. Alongside renewables, Nuclear will make the difference between the world missing crucial climate targets or achieving them.”

From “**Nuclear power paves the only viable path forward on climate change**, an open letter by James Hansen, Kerry Emanuel, Ken Caldeira and Tom Wigley, printed in *The Guardian*, December 3, 2015. (See Appendix for References.)

YOUNG PEOPLE ARE AHEAD OF US

Nuclear Engineering Programs Have Rebounded Since 2001

Degrees conferred in programs that offer majors in nuclear engineering or equivalent coursework (1966-2016)



Notes: Dates shown reflect the end of the academic year

Source: Oak Ridge Institute for Science and Education: Nuclear Engineering Enrollments and Degrees Survey

Credit: Alyson Hurt/NPR



Developing leaders to energize the future of nuclear.

North American Young Generation in Nuclear (NAYGN) provides opportunities for a young generation of nuclear enthusiasts to develop leadership and professional skills, create life-long connections, engage and inform the public, and inspire today's nuclear technology professionals to meet the challenges of the 21st century.

Nuclear Engineering and related fields attracts some of the smartest students and offer some of the best paying jobs, while directly addressing climate change. The photo is a gathering of NAYGN.

YOUNG PEOPLE WANT SOLUTIONS



Environmental demonstrators in support of nuclear and against the closure of nuclear power plants.

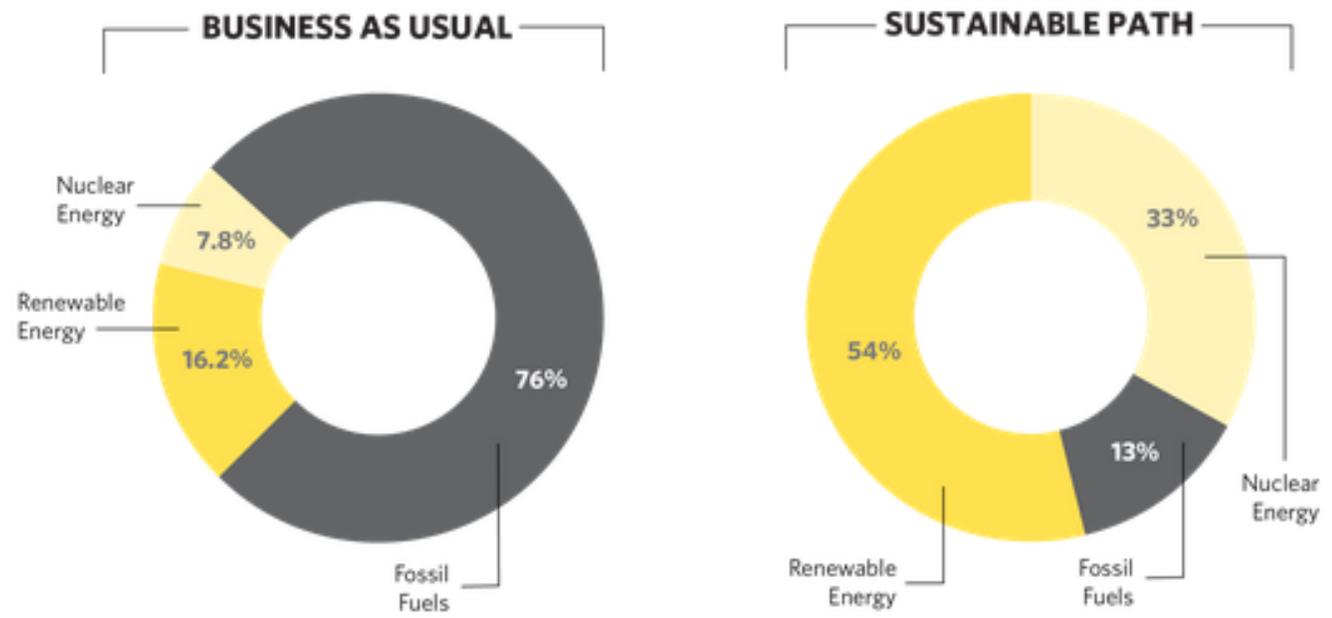
CONSERVATIONISTS RECOGNIZE THAT NUCLEAR CONSERVES LAND



The Nature Conservancy issued this graphic in their Sustainability Report. In it they call for the use of nuclear power to grow from 7.8% of total energy to 33% of total energy (greater than 300% growth). By doing so, they show that they care a lot about the severe impacts to nature of building wind and solar everywhere, which requires cutting down forests and developing many of our remaining natural areas.⁹

A Changing Energy Portfolio

In order to both meet increased energy demand and keep the climate in safe boundaries, we'll need to alter our energy makeup to curtail emissions of carbon and other harmful chemicals.



FORMERLY ANTI-NUCLEAR GROUPS FACE A DILEMMA: NUKES ARE KEY!

The Union of Concerned Scientists, which has long taken a harsh stance on nuclear power, has reversed their opposition to nuclear because to fail to do so would be denying the science.¹⁰ This group has a lot of internal controversy but they had the courage to finally reverse their position, which many of the mainstream environmental groups have not done, even though they know they should.



[BLOG] UNION OF CONCERNED SCIENTISTS



Why We’re Taking a Hard Look at Nuclear Power Plant Closures

KEN KIMMELL, FORMER PRESIDENT | NOVEMBER 8, 2018, 12:01 AM EST

Like 2.5K Tweet SHARE

Last month the Intergovernmental Panel on Climate Change (IPCC) issued a sobering report. Based on the most up-to-date scientific evidence, the report warns that we are rapidly losing any appreciable chance of meeting the Paris climate agreement goal of keeping temperature increases to “well below” 2 degrees Celsius above pre-industrial levels.



This post is a part of a series on [The Nuclear Power Dilemma](#)

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KEN KIMMELL was president of the Union of Concerned Scientists.

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- Energy
- Food and Agriculture
- Global Warming
- Nuclear Power

CLIMATE & ITS SOLUTIONS HURT



Many Republicans have had been unwilling to acknowledge climate change as a result of fears about government taxation, regulation and big government. But all too similarly, progressives have been unwilling to acknowledge nuclear's past excellent performance and the critical role nuclear power needs to play in solving climate, because of their fears of big industry, deep science and nuclear's associations with military efforts and bombs.

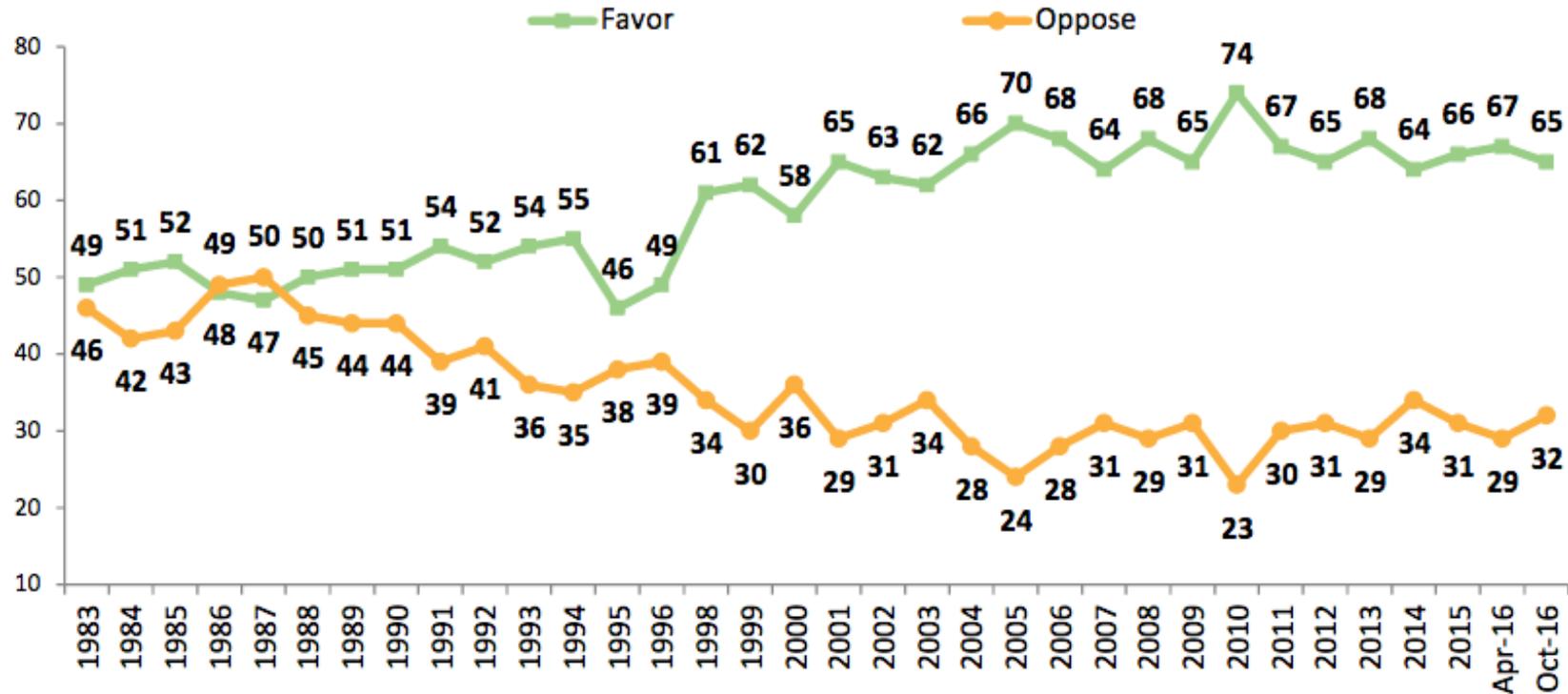
Both these attitudes have slowed and hurt our ability to address climate change effectively.

FORTUNATELY, ATTITUDES ARE SHIFTING



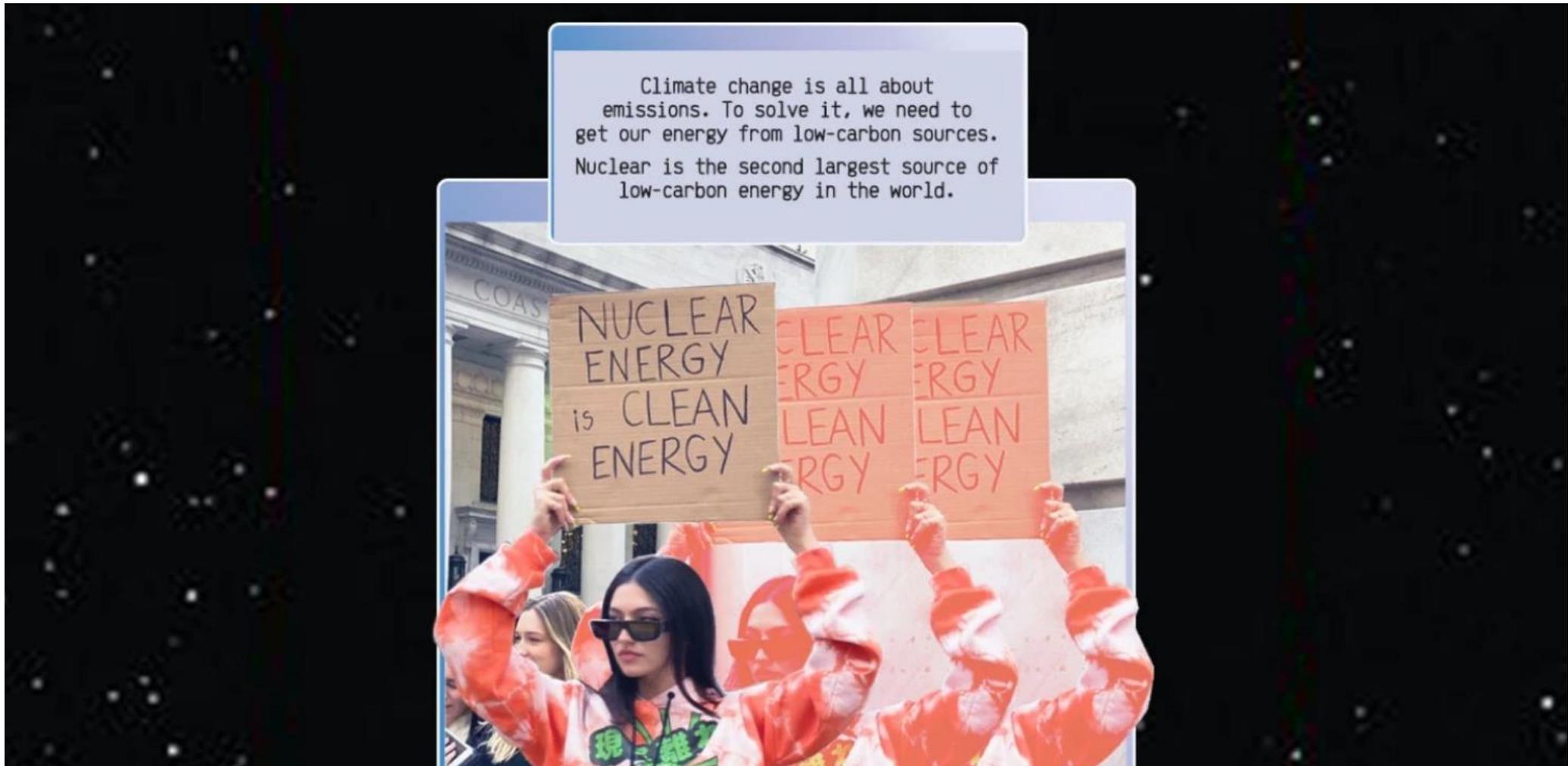
Trend 1983-2016: Annual Averages Until 2016
Percent Who Favor and Oppose Nuclear Energy

“Overall, do you strongly favor, somewhat favor, somewhat oppose, or strongly oppose the use of nuclear energy as one of the ways to provide electricity in the United States?”

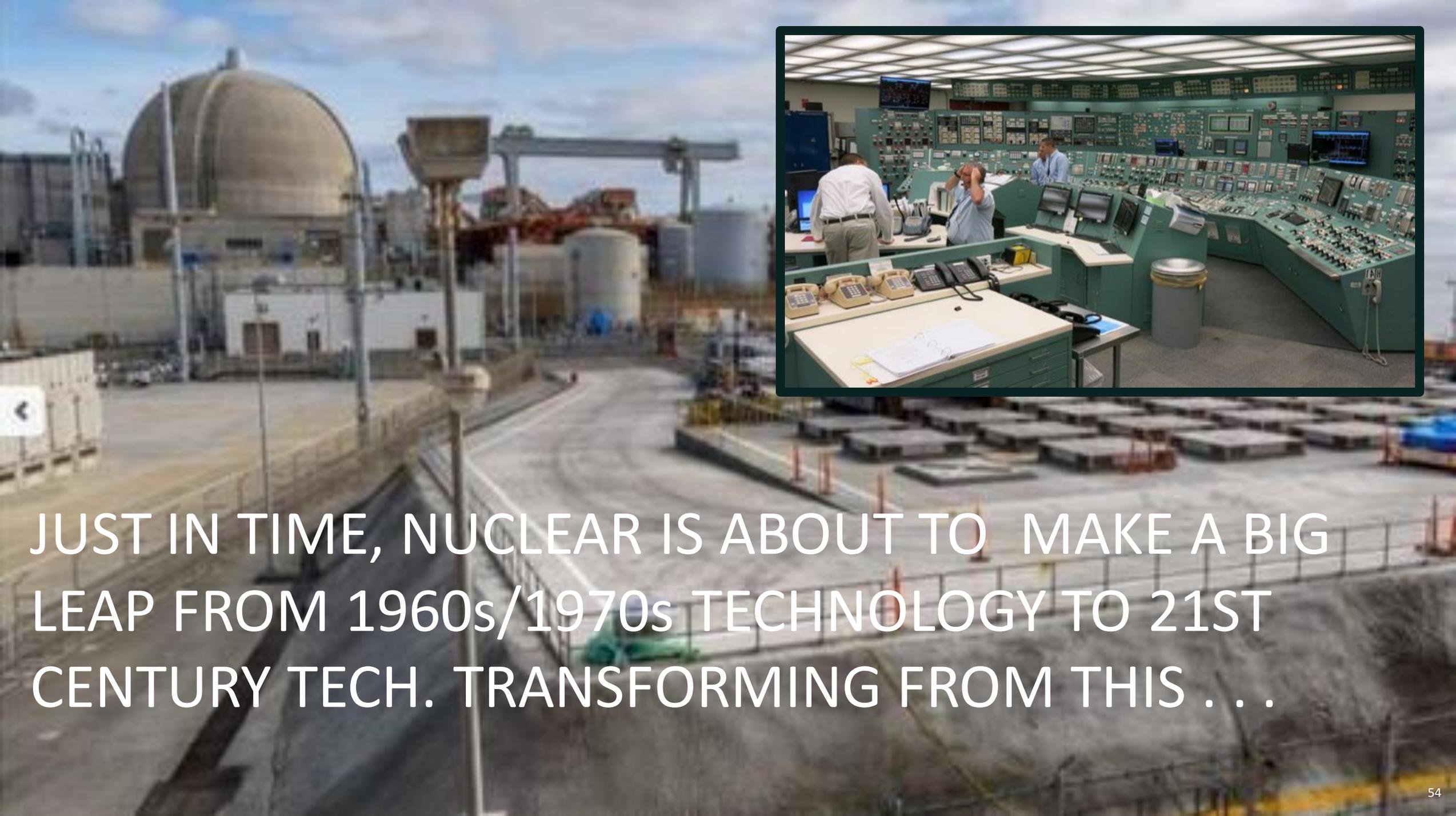


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NUCLEAR HAS COOL INFLUENCERS



This is Isabella Boemeke, a Brazilian model who uses TikTok to bring pronuclear issues to the masses.



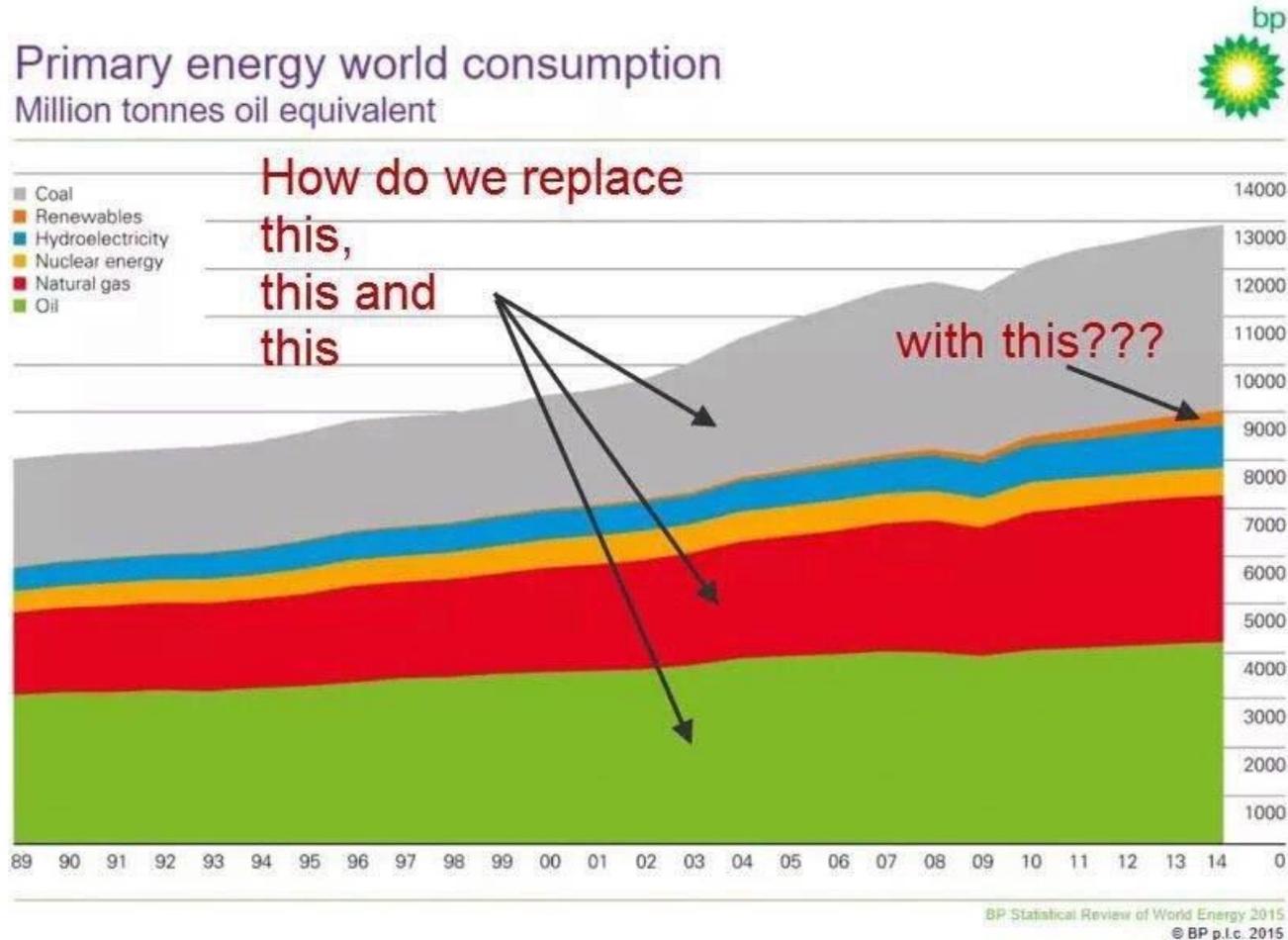
JUST IN TIME, NUCLEAR IS ABOUT TO MAKE A BIG LEAP FROM 1960s/1970s TECHNOLOGY TO 21ST CENTURY TECH. TRANSFORMING FROM THIS . . .



...INTO THIS!

IMPROVING FUNCTIONALITY AND
SOLVING FOR TODAY'S GRID NEEDS

WE FACE A HERCULEAN CHALLENGE, WHICH NUCLEAR MAKES EASIER



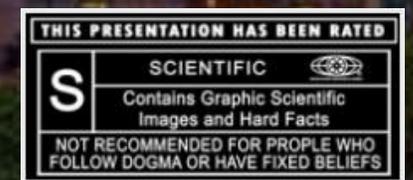
The Race to Commercialize Advanced Nuclear designs is on.

The need for nuclear energy globally is enormous. Russia, China, India, S.Korea, Canada and the US are all competing to commercialize the right designs in order to set the proper standards and control the international market. If the U.S. fails to win this development race, nuclear energy won't go away, it just means that Russia or China will be the ones to supply this technology to the rest of the world.

PROGRESSIVES WHO CARE ABOUT THE
PLANET, SHOULD HELP NUCLEAR BE
THE BEST IT CAN BE—FOR THE BENEFIT
OF OUR CHILDREN



SO WE CAN POWER OUR
WORLD WITHOUT
DESTROYING IT.





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Nucleation Capital is a venture capital fund focused on investing in the technologies that will enable us to dramatically reduce and manage our emissions. Learn more at nucleationcapital.com

