



350

NEW MEXICO

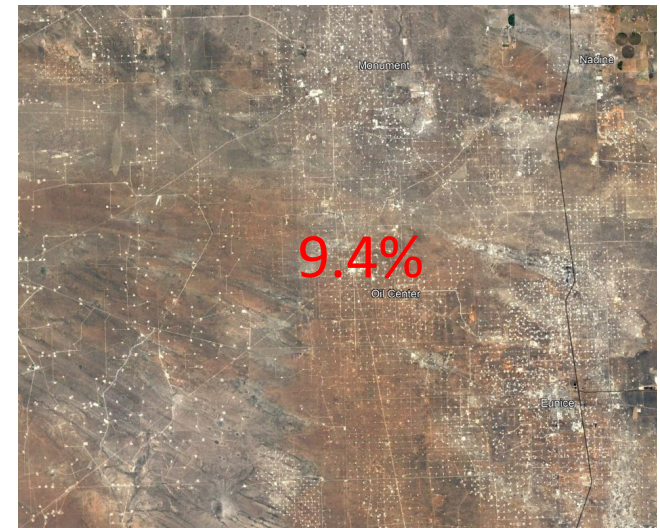
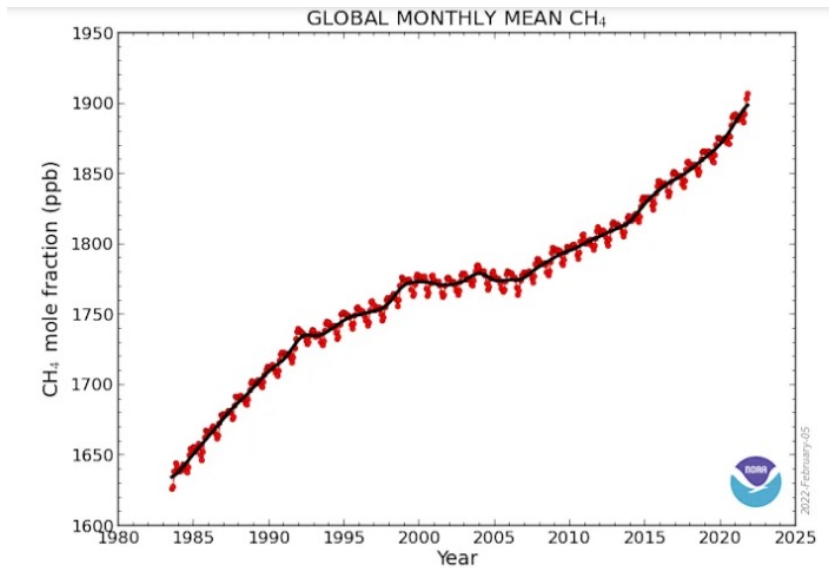
A New Mexico chapter of 350.org



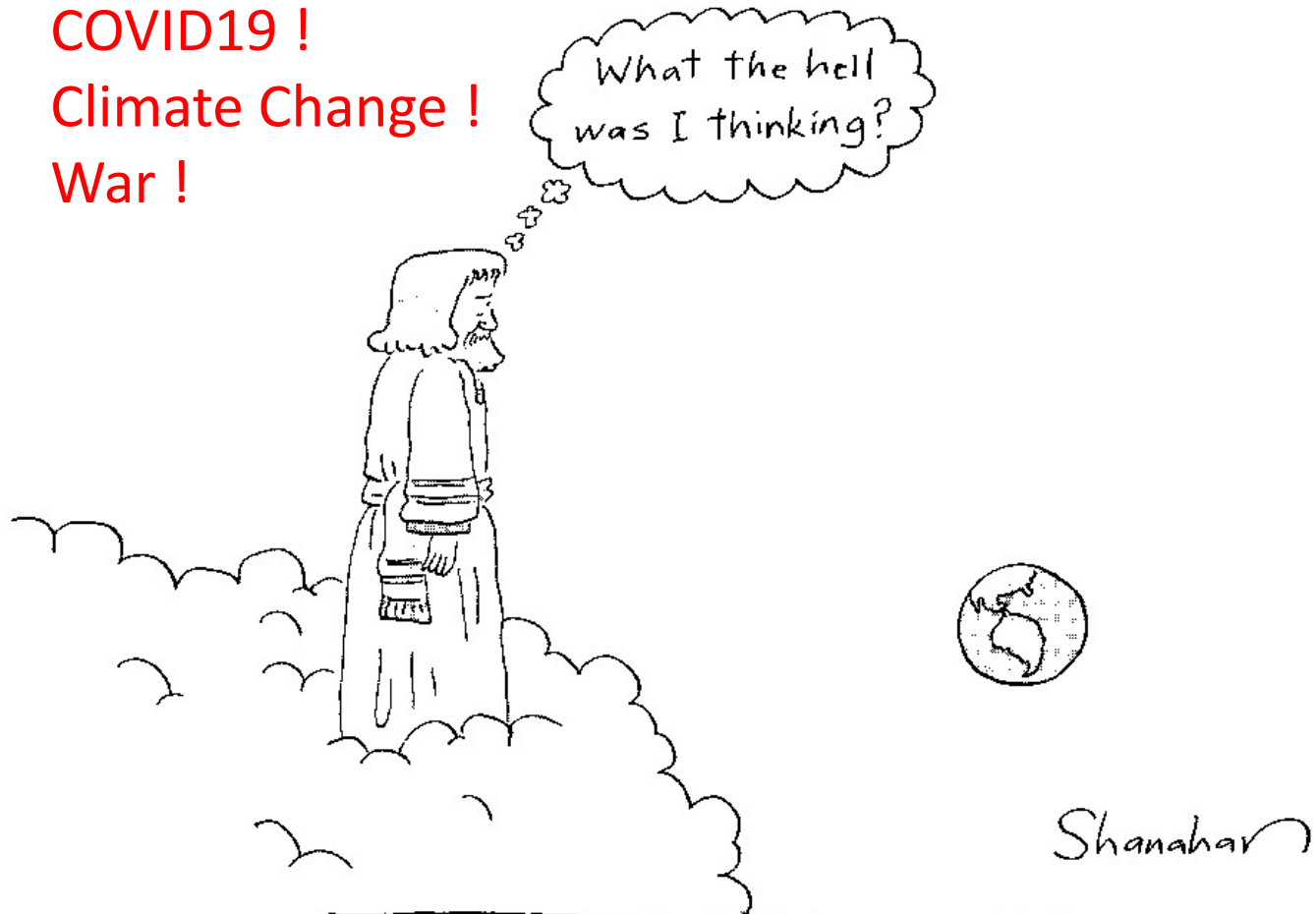
Methane: Climate Change, Energy Transition, Geopolitical Cudgel

A.R. Ingraffea, Ph.D., P.E.

March 28, 2022



COVID19 !
Climate Change !
War !



CREATOR'S REMORSE

• •

From The New Yorker, Sept. 29, 2014

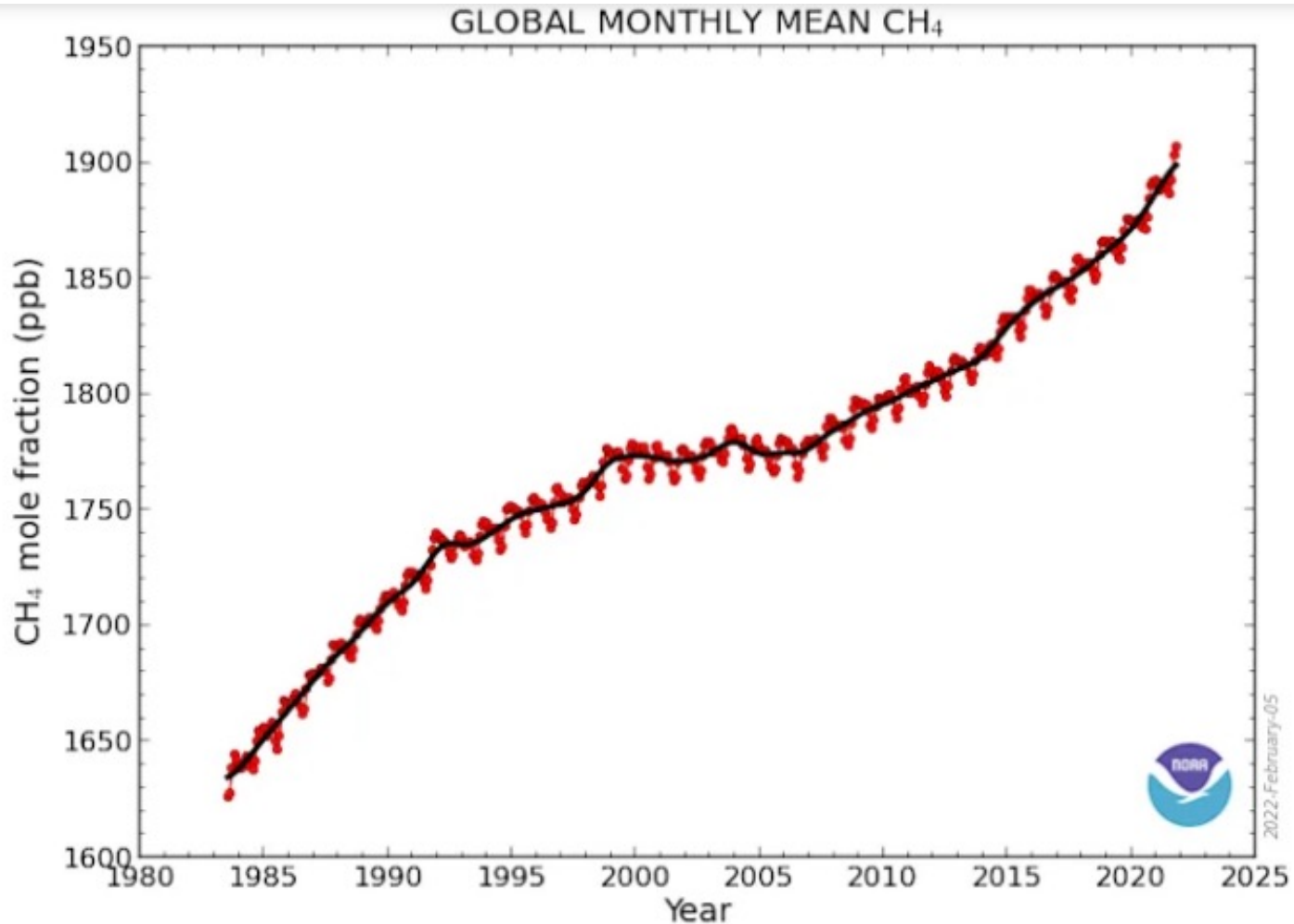
Methane, CH₄, Fossil Gas: Its Role In...

... **Climate Change: A Major Driver**

... The Energy Transition: Major Impediment

... Geopolitics: What a Mess!!!

Atmospheric Methane Concentration Continues to Rise at an Increasing Rate



Why Is Controlling Methane (CH₄) Emission So Important?

Because the IPCC says so,

“IPCC’s Assessment Report highlights the urgency of sharp reductions in methane”

David McCabe, Clean Air Task Force

“Methane is the #2 driver of climate change. Get to know the Methane molecule, it’s ruining our world.”

Project Canary

GWP

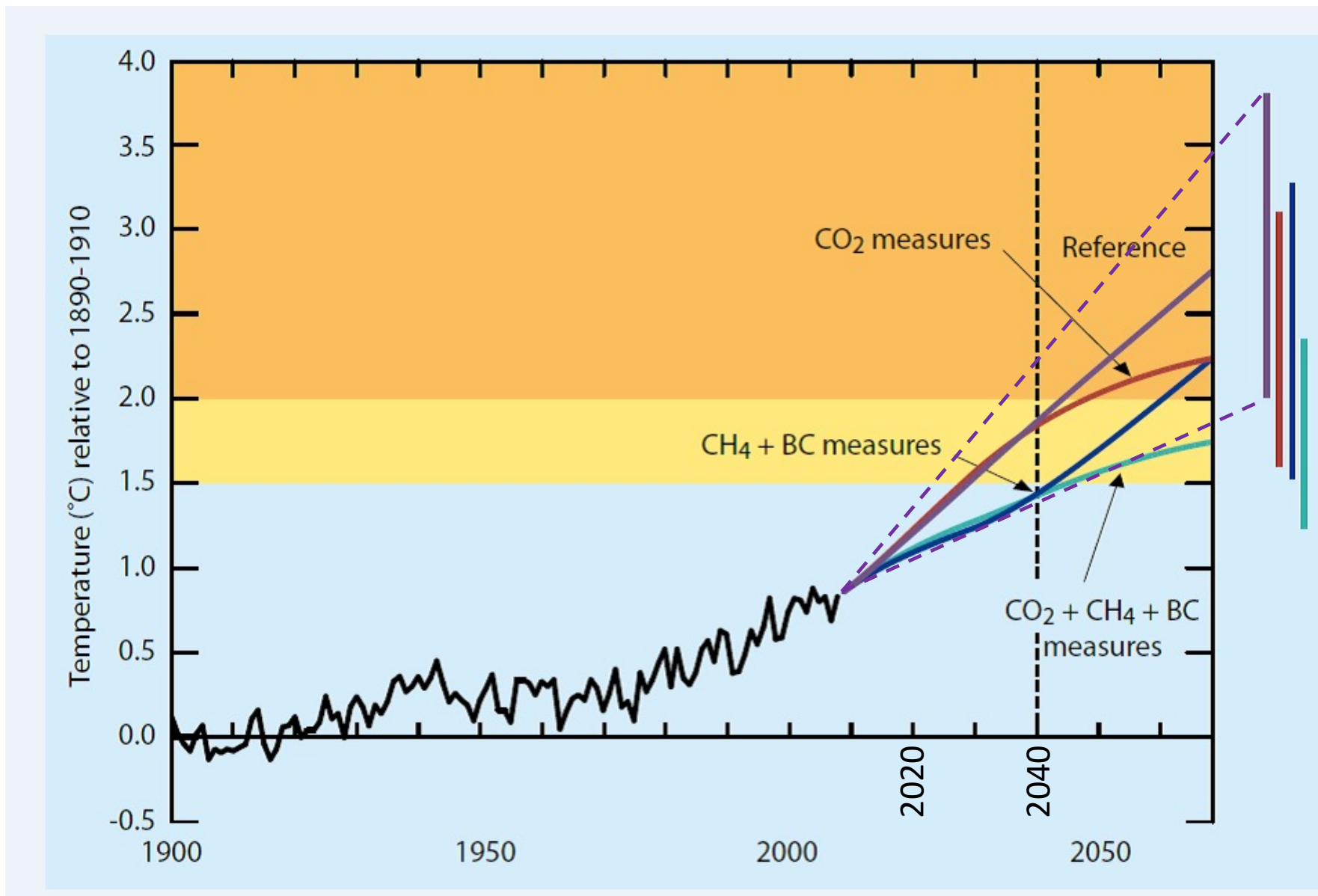
Halting the Vast Release of Methane Is Critical for Climate, U.N. Says

A major United Nations report will declare that slashing emissions of methane, the main component of natural gas, is far more vital than previously thought.

New York Times

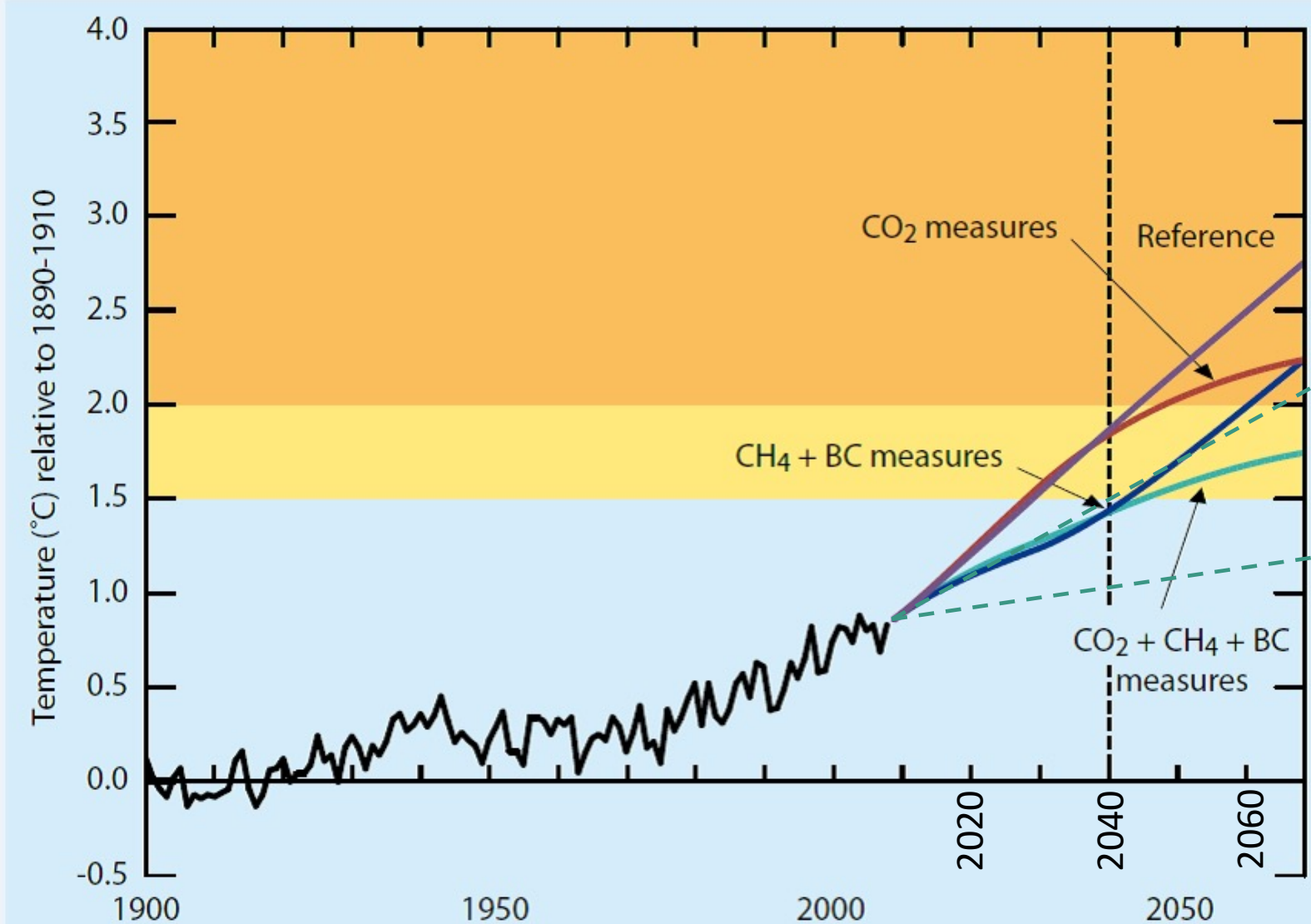
1
36
298
23,500

Why Is Controlling Methane (CH₄) Emission So Important?



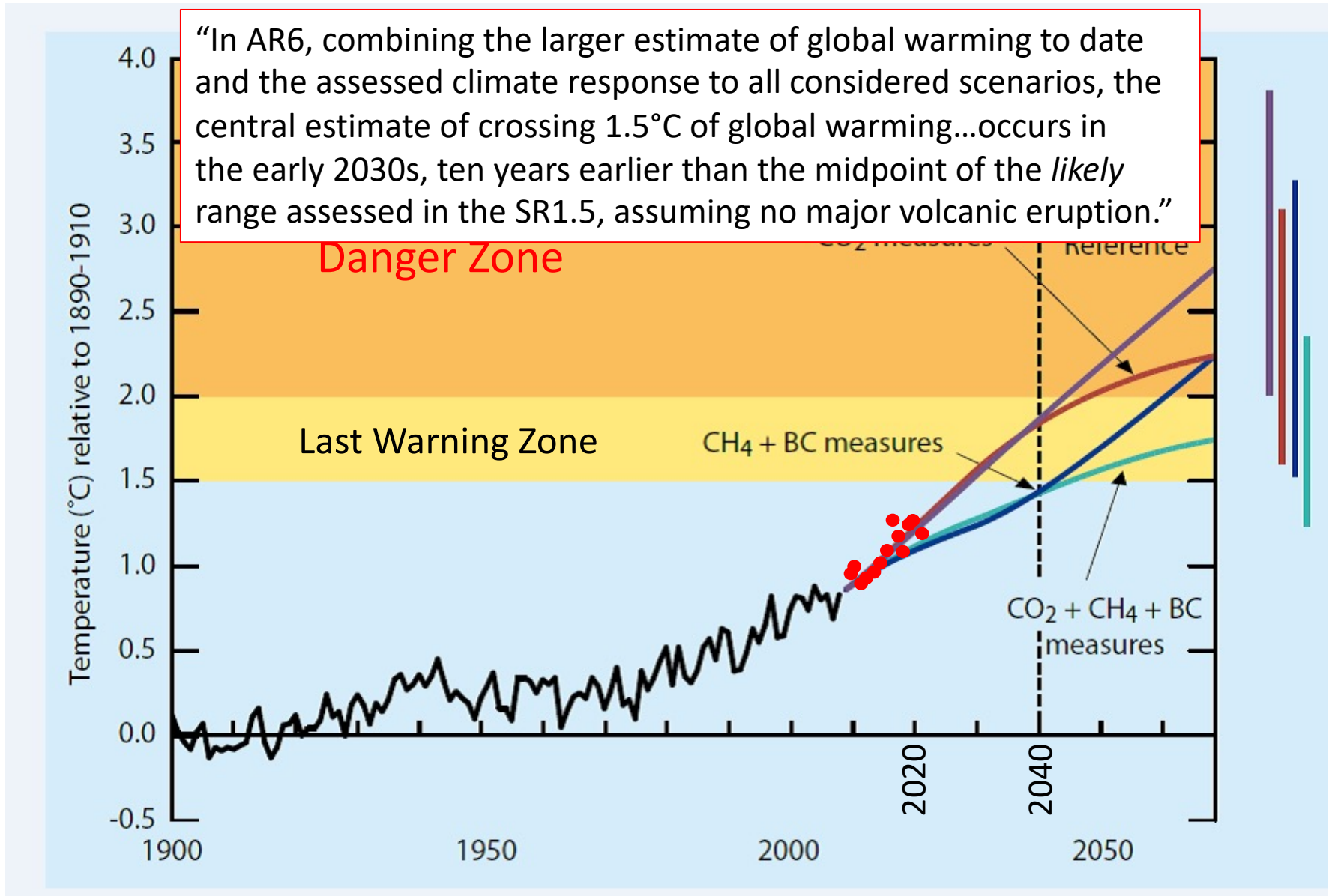
Shindell, et al. *Science* **335**, 183 (2012)

Why Is Controlling Methane (CH₄) Emission So Important?



Shindell, et al. *Science* **335**, 183 (2012)

Why Is Controlling Methane (CH₄) Emission So Important?



Shindell, *et al. Science* **335**, 183 (2012)

<https://data.giss.nasa.gov/gistemp/graphs/>

Methane and the greenhouse-gas footprint of natural gas from shale formations*

Robert W. Howarth · Renee Santoro ·
Anthony Ingraffea

“Natural gas is composed largely of methane, and 3.6% to 7.9% of the methane from shale-gas production escapes to the atmosphere in venting and leaks over the lifetime of a well.”

This in the era of the “bridge fuel” meme from the big green NGO’s and Obama’s SOTU address, “We have a supply of *natural gas* that can last America nearly *100 years...*”

The White House Judged Our Work Not “Credible”

“There were numerous studies on fugitive emissions of methane. There was a **very famous Cornell report** which we looked at and decided was not as credible as...**well we didn't think it was credible**, I'll just put it that way and it was over estimating fugitive emissions.”

Former U.S. Energy Secretary Steven Chu
Sept. 17, 2013 while giving a speech at
America's Natural Gas Alliance Think About
Energy Summit, Columbus, Ohio

We Were Correct, and Conservative

Comprehensive aerial survey quantifies high methane emissions from the New Mexico Permian Basin*

“The fact that a large sample size is required to characterize the heavy tail of the distribution emphasizes the importance of capturing low-probability, high-consequence events through basin-wide surveys when estimating regional O&G methane emissions.”

Declining methane emissions and steady, high leakage rates observed over multiple years in a western US oil/gas production basin**

“As a percentage of gas production, however, emissions remained steady over the same years, **at ~ 6–8%, among the highest in the U.S.**”

**Lin *et al.* NATURE, 2021

*Chen *et al.* ES&T, 2022

Some of Many Methane Emission Sources

- Compressor station blowdowns
- Pipeline blowdowns
- Leaking wells
- Intermittent flaring

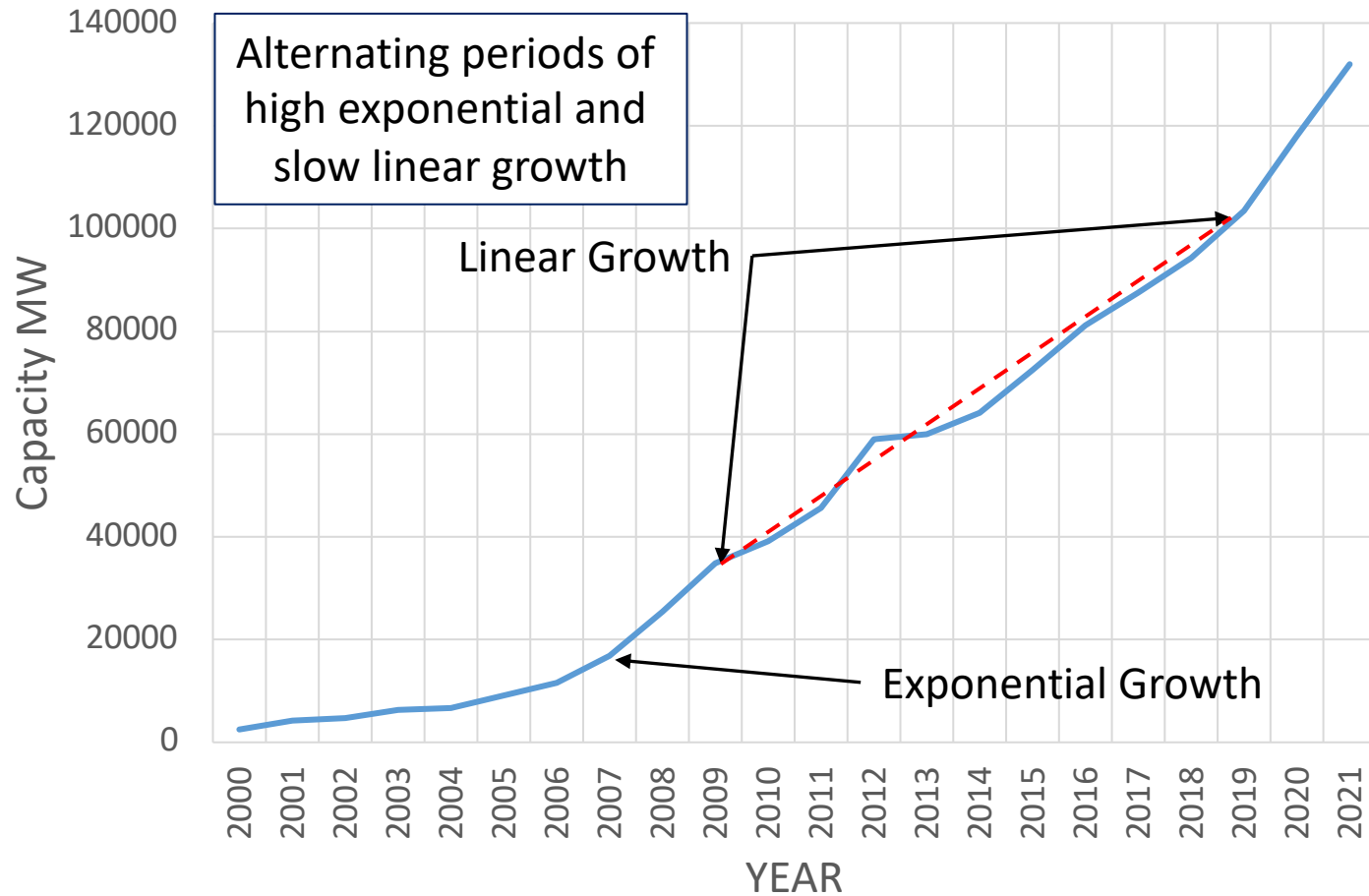
Methane, CH₄, Fossil Gas: Its Role In...

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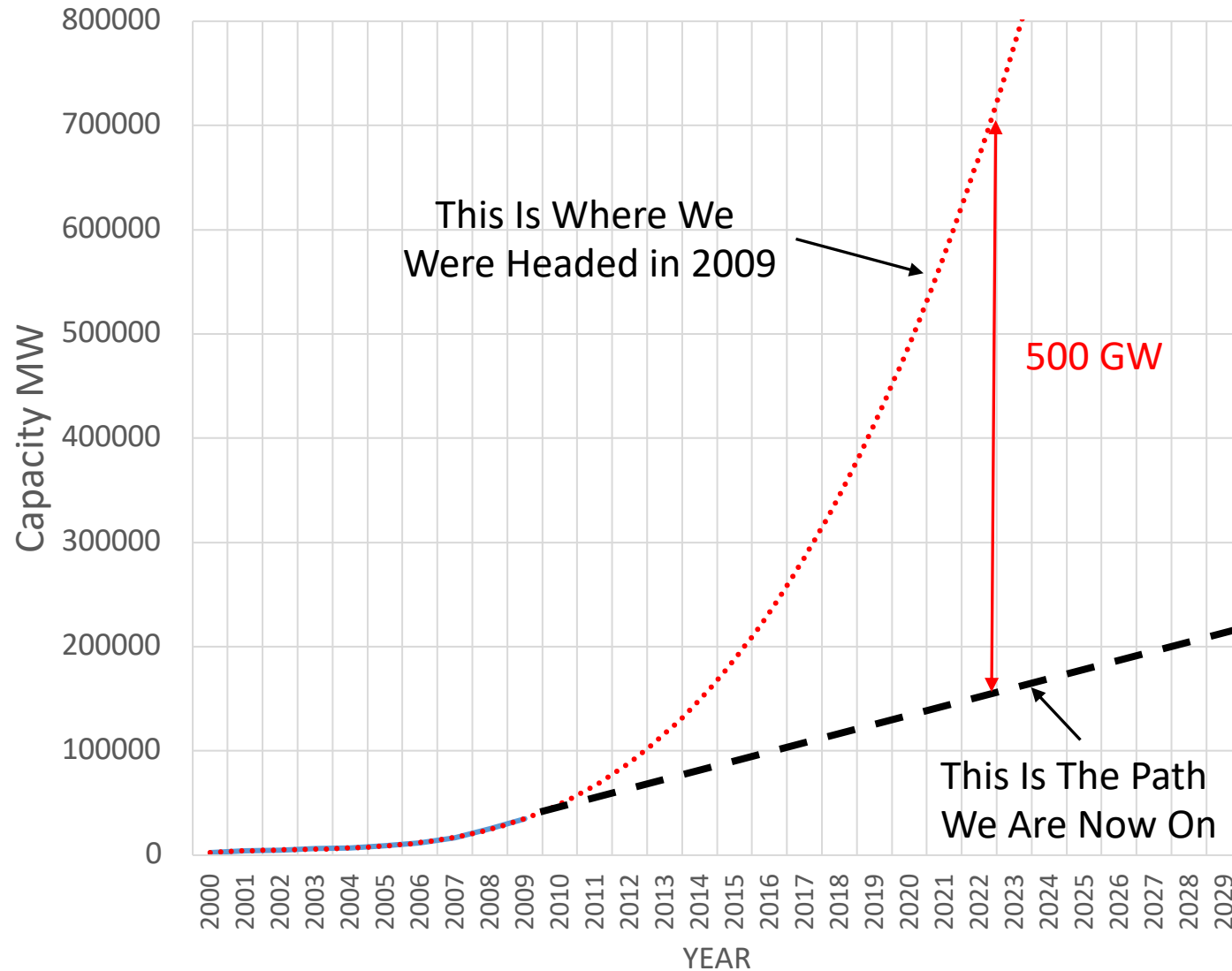
... Geopolitics:

History of U.S. Wind Energy Capacity, Electricity Sector

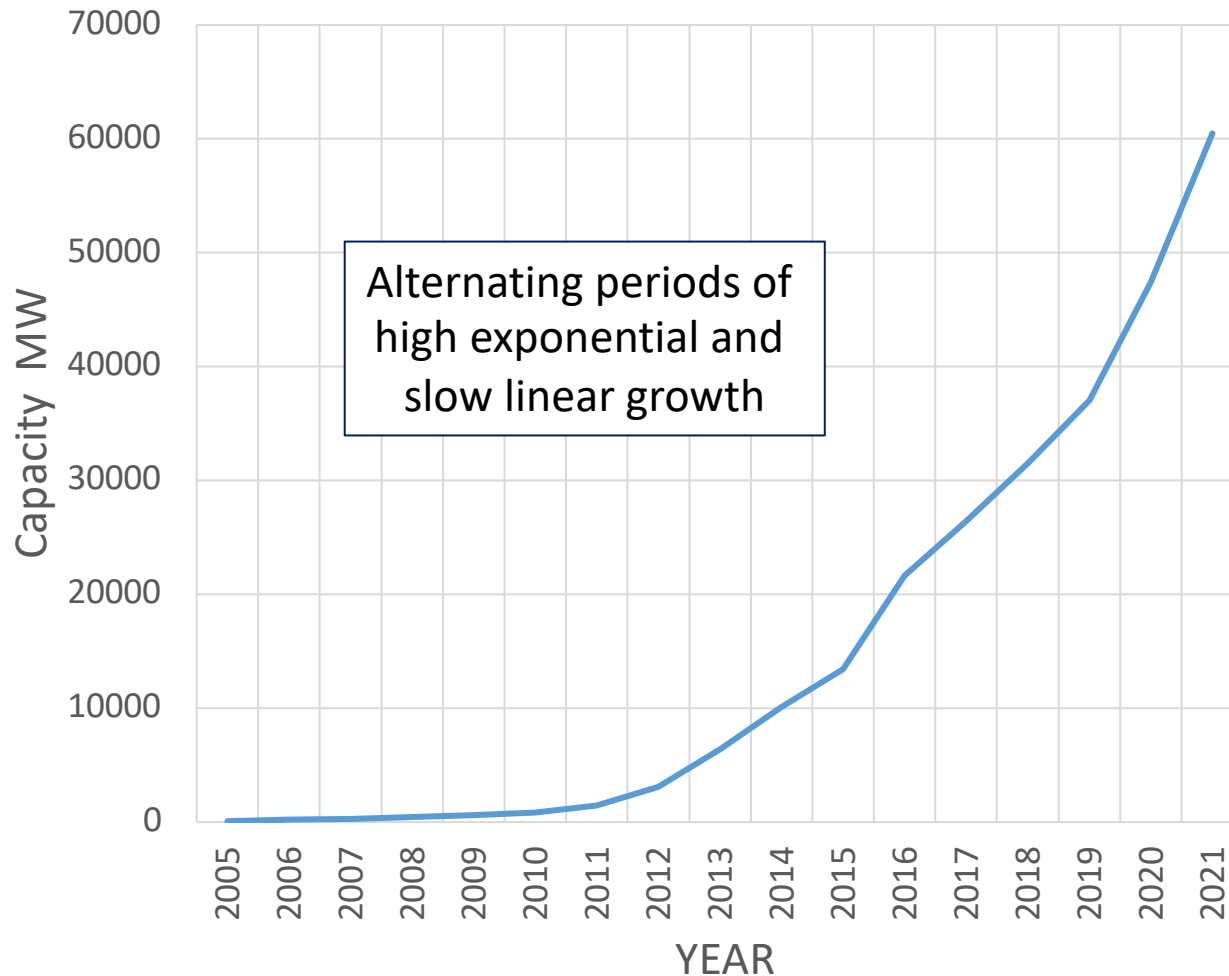


https://www.eia.gov/outlooks/steo/data/browser/#/?v=25&f=A&s=&start=1997&end=2023&id=&mchart=0&ctype=linechart&linechart=BMEPCAP_US

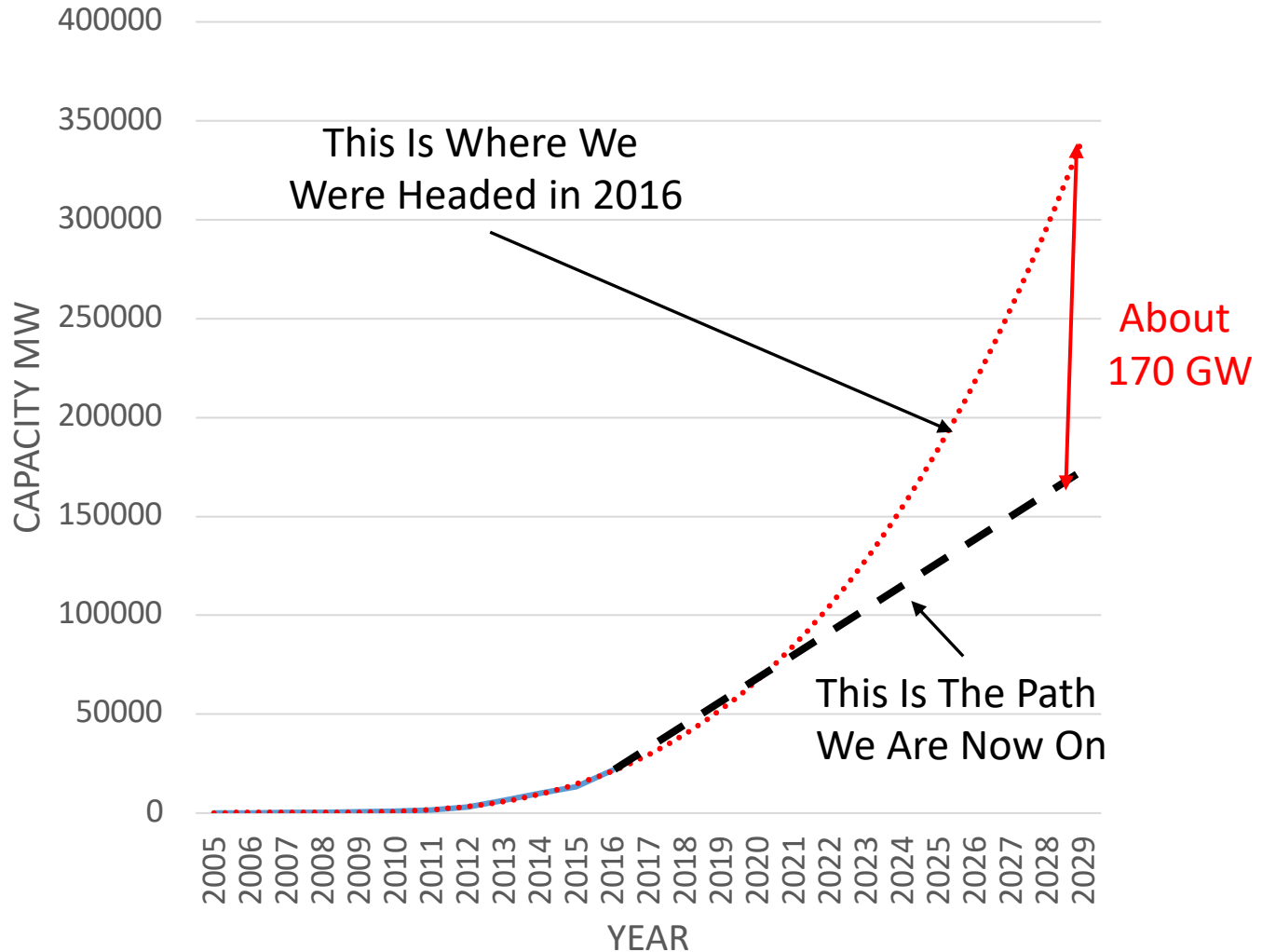
What Might Have Been...



History of U.S. Solar Energy Capacity, Electricity Sector



What Might Have Been...



Methane, CH₄, Fossil Gas: Its Role In...

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... **Geopolitics: What a Mess!!**

To the 2011 Oil Council: “Shale won’t last, Arctic drilling needed now.”



Rex Tillerson, EXXON CEO

<http://bigstory.ap.org/article/d4aa1d761b244c4a97a6370e8a1106f7/oil-council-shale-wont-last-arctic-drilling-needed-now>

“...Arctic drilling needed now.”



"Russia is one of the world leaders in gas, oil and petroleum product exports, and contributes significantly to ensuring global and regional energy security. We value our deserved reputation as a trustworthy and responsible partner in energy resource markets." Rex Tillerson, 2011

Rex Tillerson, CEO of EXXON (L), Vladimir Putin, unknown, and President and Management Board Chairman (R) Igor Sechin, Rosneft, a Russian state-owned multinational petrochemical company.

Photo Credit: [Russian Presidential Press and Information Office](#)

Do You Want Energy Security?

Appoint Putin's Business Partner as
your Secretary of State?

Rex Tillerson,
CEO of EXXON



“Exxon’s [landmark](#) 2011 joint venture with Kremlin-controlled [Rosneft](#) calls for upwards of **\$500 billion in investment** over the coming decades. The companies are planning an offshore drilling campaign in Russia’s frozen Chukchi Sea, Laptev Sea and Kara Sea, as well as the **Black Sea.**”

<http://www.forbes.com/sites/christopherhelman/2014/03/20/will-exxons-bromance-with-the-kremlin-help-keep-putin-in-check/>

Bros. (Credit: ALEXEY DRUZHININ/AFP/Getty Image)



Fracking Is a Powerful Weapon Against Russia

The technology can increase the total supply of oil and keep a lid on prices.

By Karl W. Smith

February 24, 2022, 3:00 PM EST

Fracking may be America's most powerful weapon against Russian aggression.

<https://www.bloomberg.com/opinion/articles/2022-02-24/war-in-ukraine-u-s-fracking-is-a-powerful-weapon-against-russia>

Granholm Urges US Producers to Hike Supply

Copyright © 2022 [Energy Intelligence Group](#)

Granholm said the Biden administration had pressed domestic oil producers to increase supply and that “there is a response by the oil and gas market.” On the meeting's opening day, Granholm said the government told American energy companies to increase production “where and whenever they can, right now” and that the U.S. was doing its utmost to offer liquefied natural gas to countries seeking to wean themselves off Russian supplies.

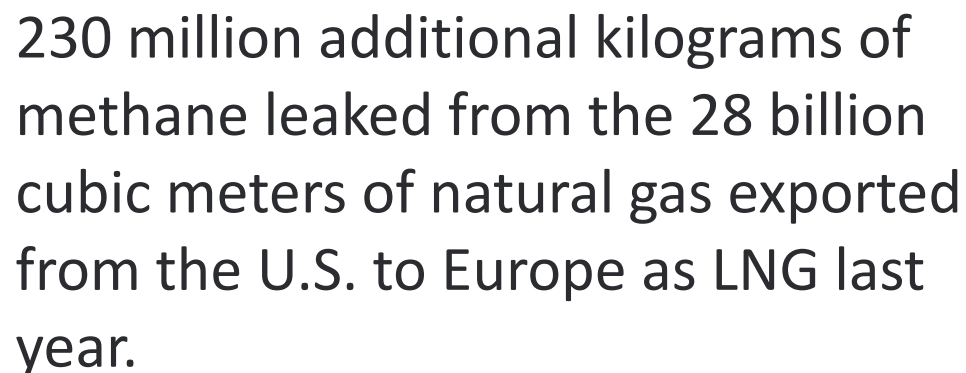
“We’re exporting every molecule ... of natural gas that can be liquefied at a terminal that exists,” Granholm said.



US Energy Secretary Jennifer Granholm on Tuesday called on US oil producers to increase their output, urging them to get “rig counts up,” as the Biden administration continues to fine tune its messaging while navigating the political perils of high fuel prices.

Methane Emissions from U.S. LNG Supply Chain

"A 2019 study performed by the National Energy Technology Laboratory in the United States investigated life-cycle GHG emissions from U.S. LNG exports. With calculations based on the most likely routes for production, transport, and usage, the study estimated that methane emissions would account for **9% (using GWP100; 19% using GWP20)** percent of a cradle-to-delivery GHG footprint of an LNG export.“*



230 million additional kilograms of methane leaked from the 28 billion cubic meters of natural gas exported from the U.S. to Europe as LNG last year.

* **“Methane emissions from LNG”**
Prepared by **Carbon Limits AS, Oslo, Norway**
September 2021.

U.S. Proved Reserves of Oil and Fossil Gas

	Crude Oil billion barrels	Wet Natural Gas trillion cubic feet
U.S. proved reserves at December 31, 2019	44.2	495.4
Total discoveries	3.0	39.8
Net revisions	-8.8	-98.2
Net Adjustments, Sales, Acquisitions	1.2	73.4
Production	-3.8	-37.1
Net changes to U.S. proved reserves	-8.4	-22.1
U.S. proved reserves at December 31, 2020	35.8	473.3
Percent change in U.S. proved reserves	-19.0%	-4.5%

5 year supply →

← 15 year supply

“Supply” is for current U.S. consumption rate,
not including exports or unproven reserves!

SUMMARY

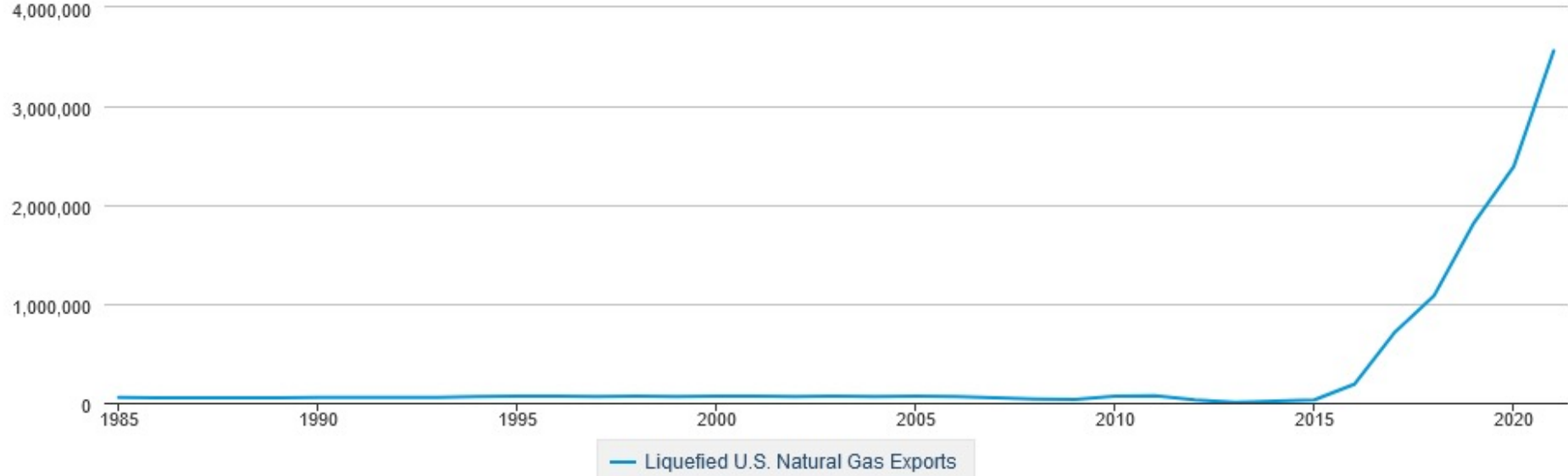
- Decreasing methane emissions the only short-term approach available to avoid 2° C.
- The oil/gas industry pulling out all the stops to stay alive.
- True energy independence means a clean renewables transition: all countries own their own sunshine, wind, water.

Backup Slides

Liquefied U.S. Natural Gas Exports

DOWNLOAD

Million Cubic Feet



Source: U.S. Energy Information Administration

<https://www.eia.gov/dnav/ng/hist/n9133us2A.htm>

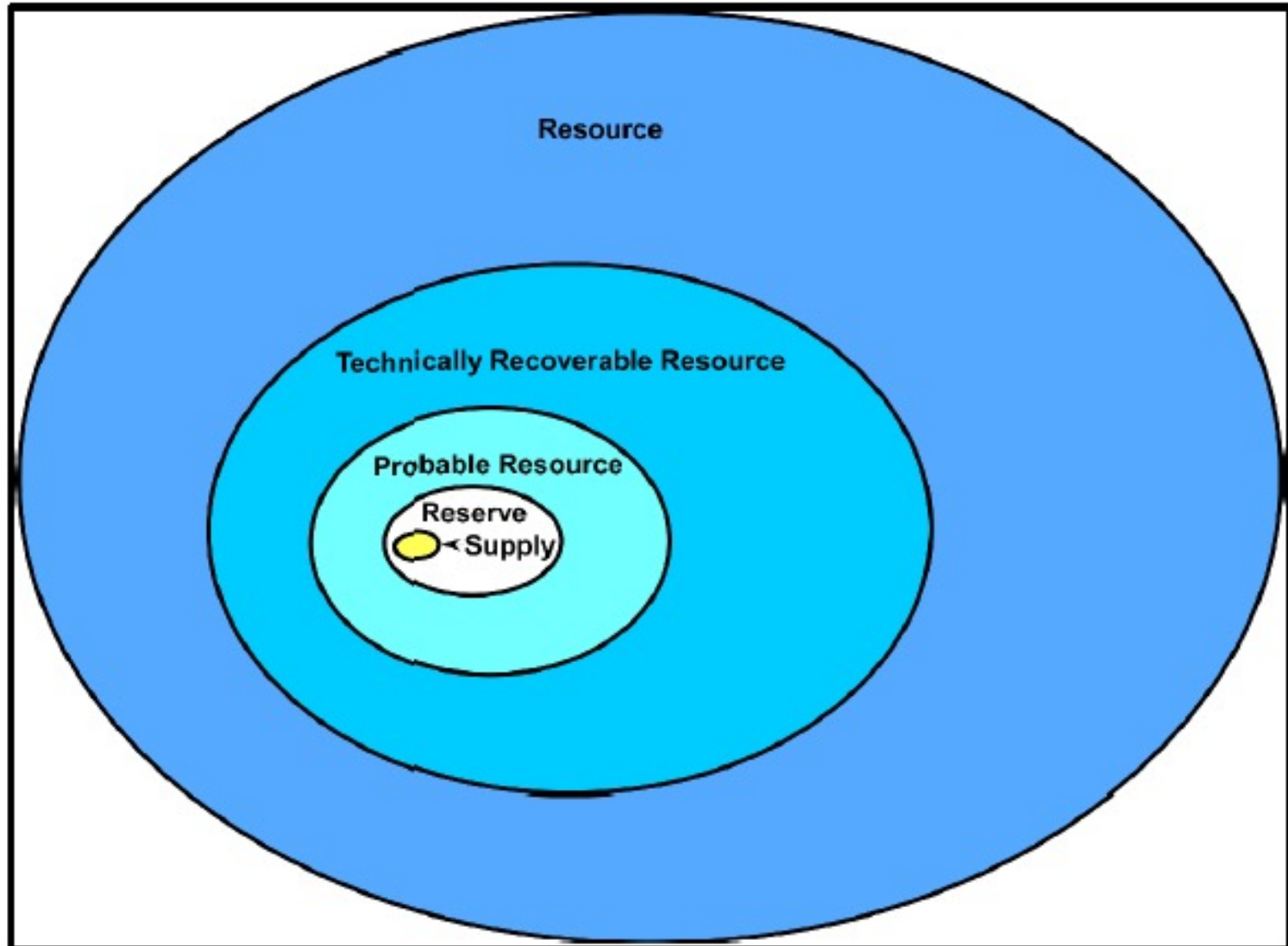
Shell Sees LNG Demand Climbing By 90% Over Next 20 Years



Global liquefied natural gas demand is set to surge by 90 percent by 2040 compared to 2021 to exceed 700 million tons annually in two decades, as LNG and gas will continue to play an important role in energy supply, Shell, one of the top LNG traders, [said](#) in its annual industry outlook on Monday.

[Shell Sees LNG Demand Climbing By 90% Over Next 20 Years \(yahoo.com\)](#)

Measurements and Estimates of Gas and Oil Supplies



Time Horizon for Global Warming Potential: 100 years or???

In 2011, we warned:

“...we evaluated both 20- and 100-year integrated time frames for methane. Both time frames are important, but the decadal scale is critical, given the urgent need to avoid climate-system tipping points.”

In 2022, others are finally getting the point:

“To best align emission metrics with the Paris Agreement 1.5 °C goal, we recommend a 24 year time horizon...”

Global temperature goals should determine the time horizons for greenhouse gas emission metrics

Abernethy, Jackson 2022 *Environ. Res. Lett.* 17 024019

#	Country	Oil Reserves (barrels) in 2016	World Share
1	<u>Venezuela</u>	299,953,000,000	18.2%
2	<u>Saudi Arabia</u>	266,578,000,000	16.2%
3	<u>Canada</u>	170,863,000,000	10.4%
4	<u>Iran</u>	157,530,000,000	9.5%
5	<u>Iraq</u>	143,069,000,000	8.7%
6	<u>Kuwait</u>	101,500,000,000	6.1%
7	<u>United Arab Emirates</u>	97,800,000,000	5.9%
8	<u>Russia</u>	80,000,000,000	4.8%
9	<u>Libya</u>	48,363,000,000	2.9%
10	<u>Nigeria</u>	37,070,000,000	2.2%
11	<u>United States</u>	35,230,000,000	2.1%

<https://www.worldometers.info/oil/>

#	Country	Gas Reserves (MMcf)	World Share
1	<u>Russia</u>	1,688,228,000	24.3%
2	<u>Iran</u>	1,201,382,000	17.3%
3	<u>Qatar</u>	871,585,000	12.5%
4	<u>United States</u>	368,704,000	5.3%
5	<u>Saudi Arabia</u>	294,205,000	4.2%
6	<u>Turkmenistan</u>	265,000,000	3.8%
7	<u>United Arab Emirates</u>	215,098,000	3.1%
8	<u>Venezuela</u>	197,087,000	2.8%
9	<u>Nigeria</u>	180,490,000	2.6%
10	<u>China</u>	163,959,000	2.4%

<https://www.worldometers.info/gas/>

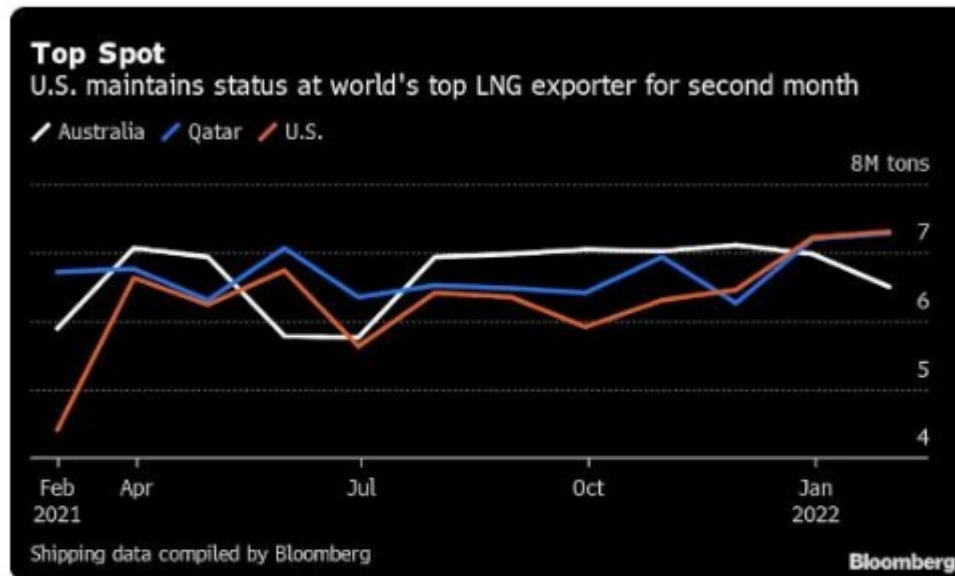
Wow, That Much, Eh?

“Oil and gas companies face **\$275K** in fines for not reporting methane pollution in New Mexico

*Fossil fuel companies are required to report their air pollution emissions to the State, or risk **hefty** penalties.”*

<https://www.currentargus.com/story/news/2022/03/17/new-mexico-oil-gas-companies-fined-methane-violations-air-pollution/6999036001/>

The latest numbers available from November 2021 show that LNG exports now constitute 9.7 percent of all U.S. marketed production. As recently as November 2015 those exports constituted a tiny 13/100ths of a percent of total domestic production. The raw numbers show an increase from a little under 3 billion cubic feet of LNG exports for November 2015 to 306 billion for November 2021



U.S. LNG exports hit a record 7.3 million tons in January, taking the No. 1 spot away from Middle Eastern powerhouse Qatar for a second time since December. Europe, which is facing low winter inventories and high natural gas prices due to tensions between Russia and Ukraine, was a top destination for U.S. cargoes last month.

<https://finance.yahoo.com/news/u-holds-world-top-lng-154325424.html>

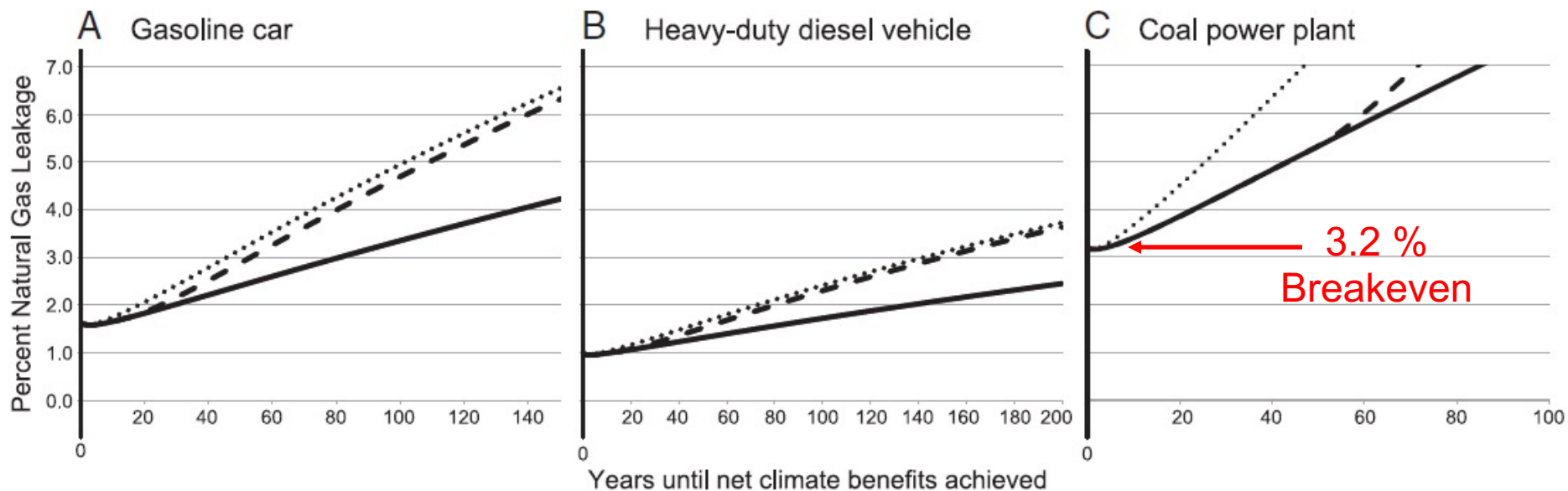
“Evolution Well Services this month announced it contracted with Permian Basin operators to employ electric hydraulic fracturing equipment by the end of 2022, powered by natural gas rather than the traditional diesel engines.”

[New Mexico to seek federal funds for cleaning up abandoned oil and gas wells](#)

<https://www.yahoo.com/news/study-permian-basin-super-emitters-193201176.html>

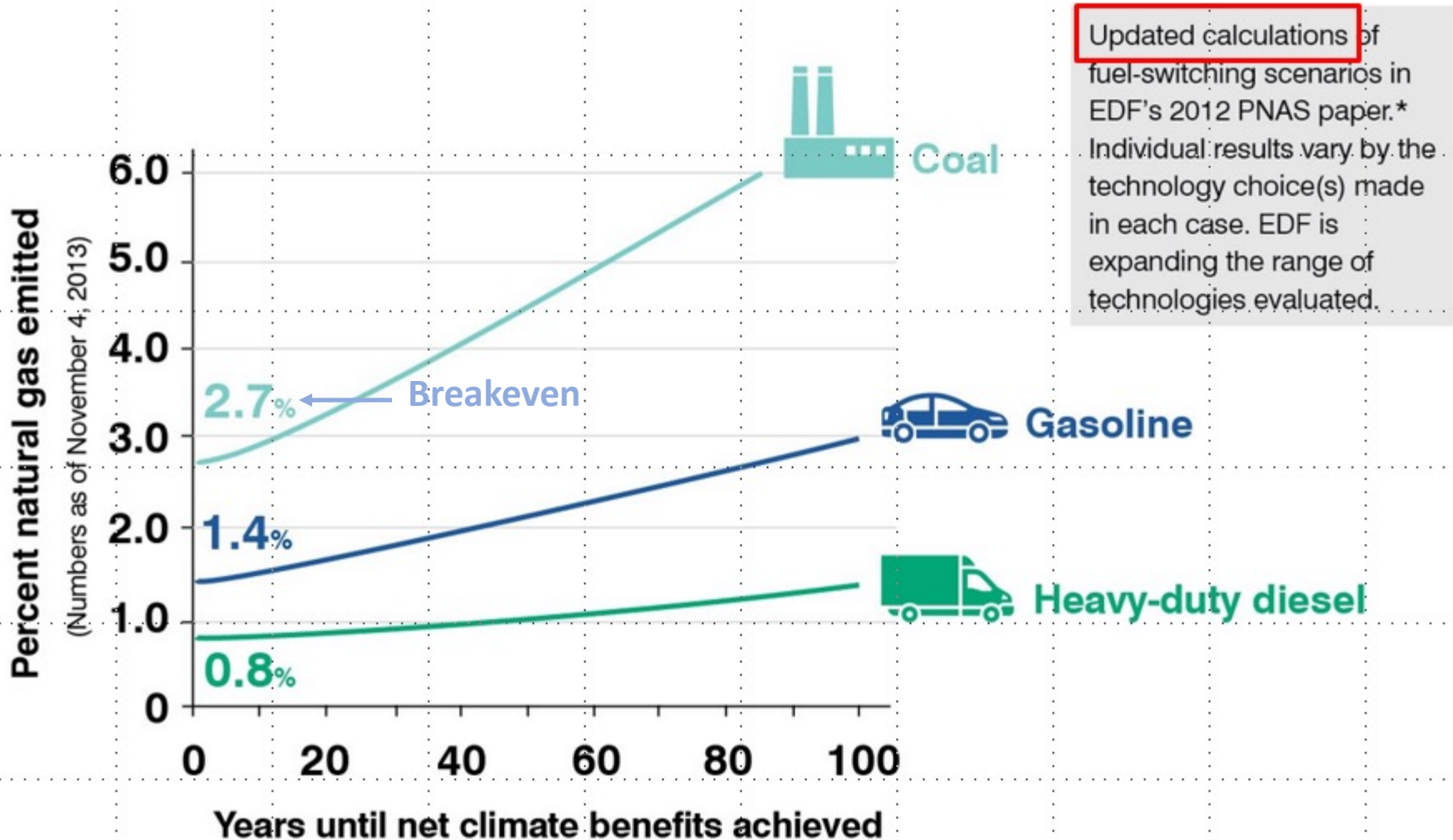
Climate Benefit from Natural Gas ?

EDF Round 1, 2012



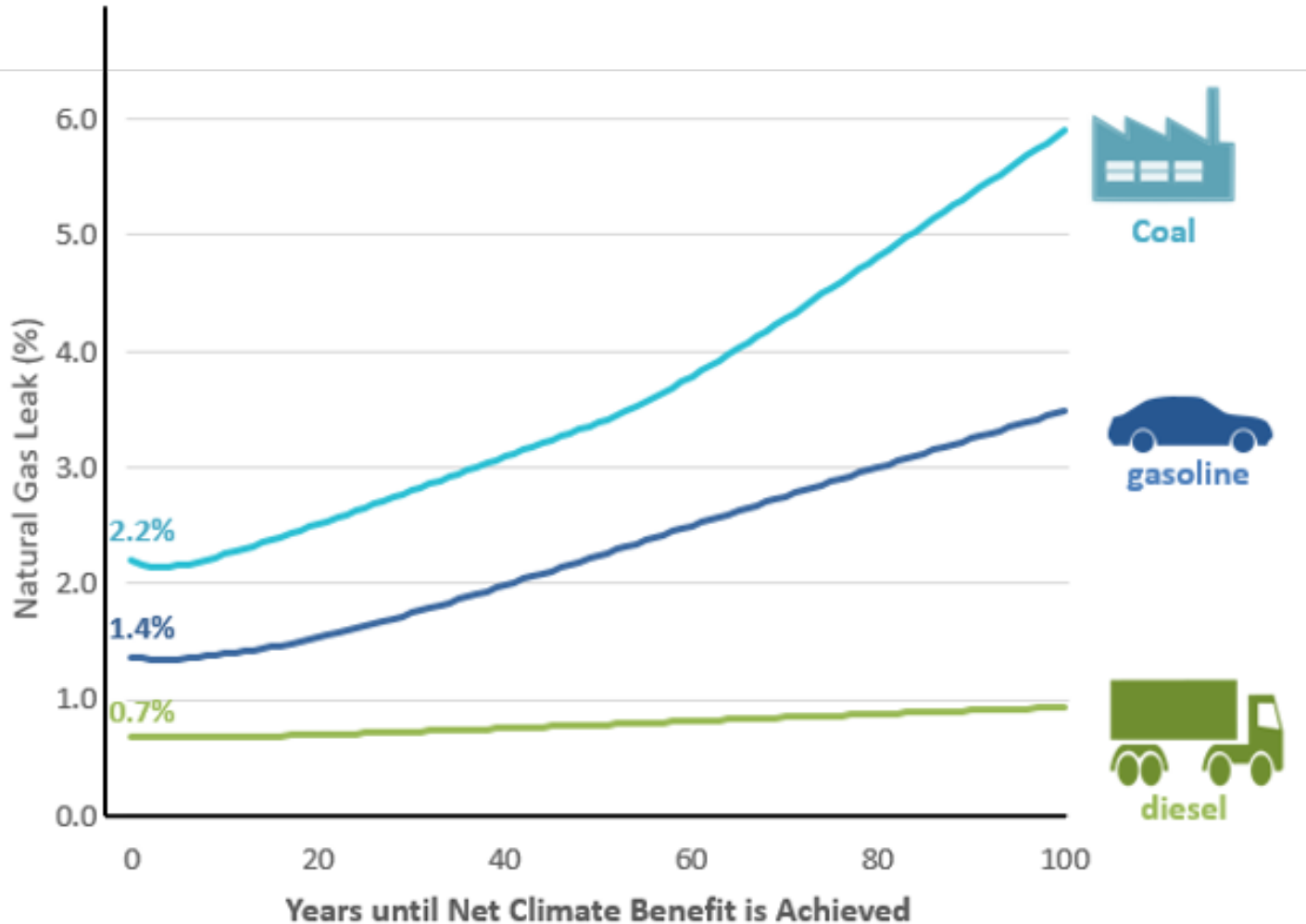
Alvarez et al.: www.pnas.org/cgi/doi/10.1073/pnas.1202407109

Climate Benefit from Natural Gas ? EDF Round 2, 2013



Climate Benefit from Natural Gas ?

“EDF” Round 3, 2018



Alvarez *et al.* Assessment of methane emissions from U.S. oil and gas supply chain. *Science* 186-188 (2018).

Etminan *et al.* Radiative forcing of carbon dioxide, methane, and nitrous oxide: A significant revision of the methane radiative forcing. *Geophys. Res. Lett.* 43, 12614–12623 (2016).