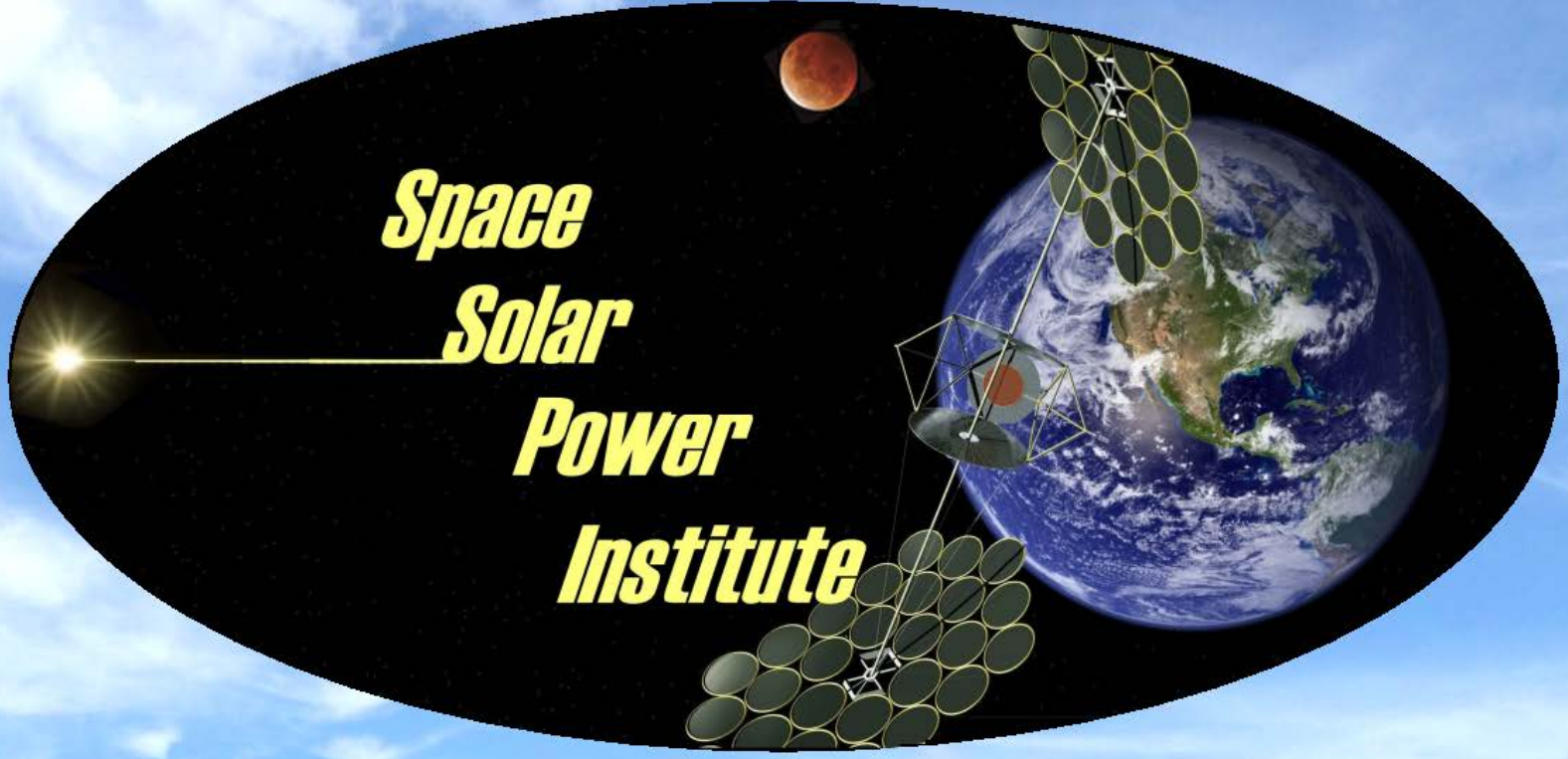


Collapsing Electric Power Grid Reliability and Economics

D. Preble

ISDC May 26, 2022

WHY SPACE SOLAR POWER(SSP)?

1. **LOW CO_2 INTENSITY**
2. ZERO FUEL COST
3. USES NO WATER
4. CLEAN, NO WASTE
5. SOLAR @ GEO COLLECTS 9.6 TIMES MORE ENERGY THAN ROOF TOP SOLAR
6. RELIABLE: 24 / 7, WEATHER INDEPENDENT
7. REDUCED LAND USE
8. UNLIMITED ENERGY

Space Solar Power Institute

The technical questions inherent in SSP were resolved forty years ago.

The economic path to SSP justification is becoming painfully and increasingly clear.

The Apollo Program ended because it could no longer be justified to the public.

What is our **justification** to taxpayers for returning to the Moon and building settlements?

Space Solar Power

Beethoven called Psalm 19 the greatest psalm:

"In the heavens God has pitched a tent for the sun.
It is like a bridegroom coming out of his chamber,
like a champion rejoicing to run his course.
It rises at one end of the heavens
and makes its circuit to the other;
nothing is deprived of its warmth. - Psalms 19:5 (NIV)

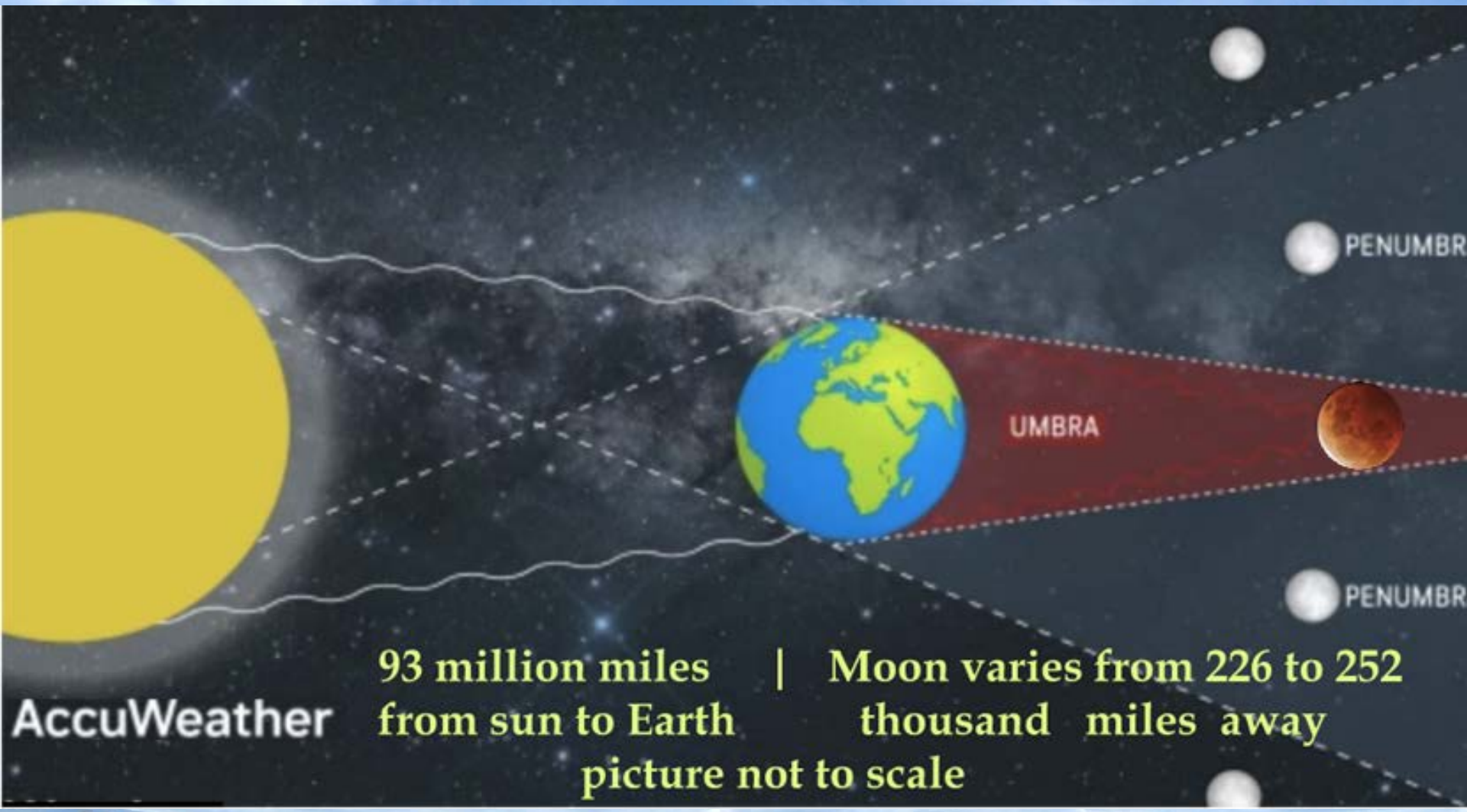
Now, with SSP, we can enjoy the sun forever ***24/7*** and 9.6 times brighter! Moon settlements can deliver parts and materials using 22 times less energy using Weak Boundary Stability Theory to deliver them to GeoSynchronous orbit, optimized during alignment that <u>occurs every lunar month:</u>

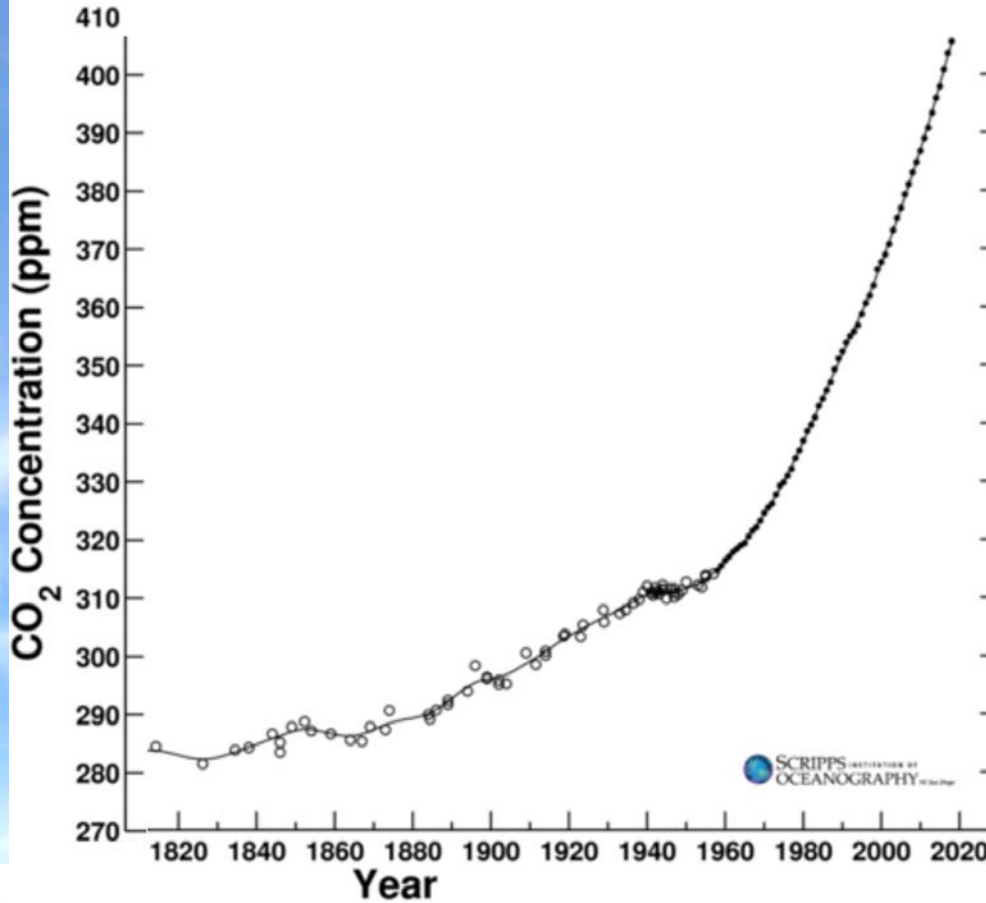
The highest priority frequency allocation

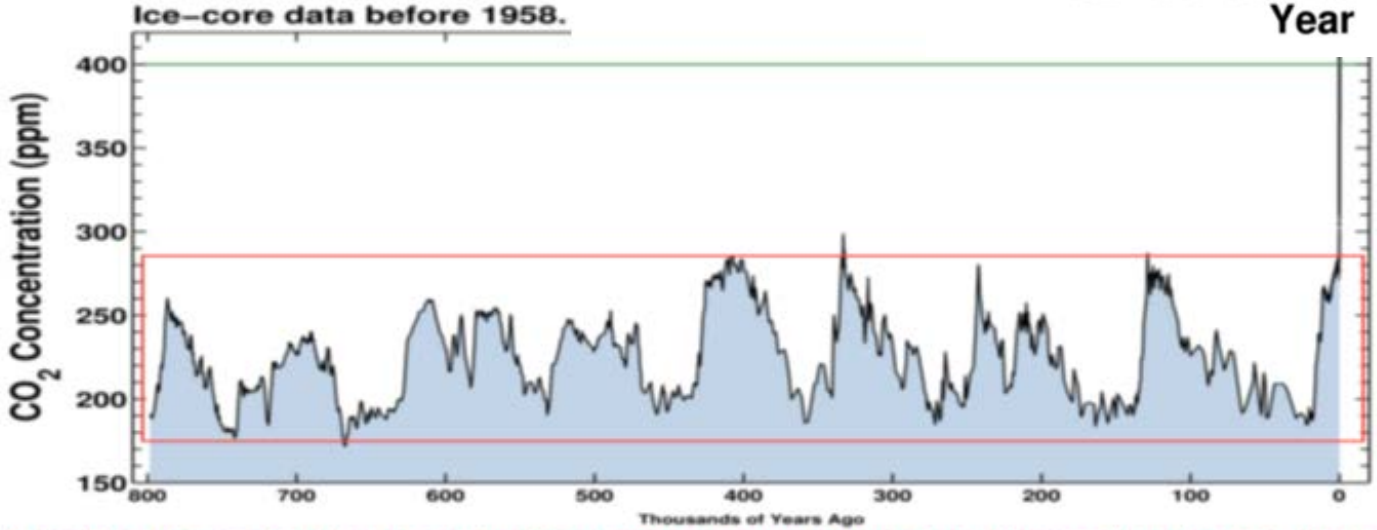
SSP requires a frequency allocation to beam power from to earth to repower our electric power grid.

Unless SSP is allocated a frequency and built, the power grid will continue declining in reliability and security and rising in cost while increasingly less reliable, less economic, more expensive, more uncertain sources are added, usually supported by burning natural gas. **How much will natural gas cost next year**? Sun power is always free.

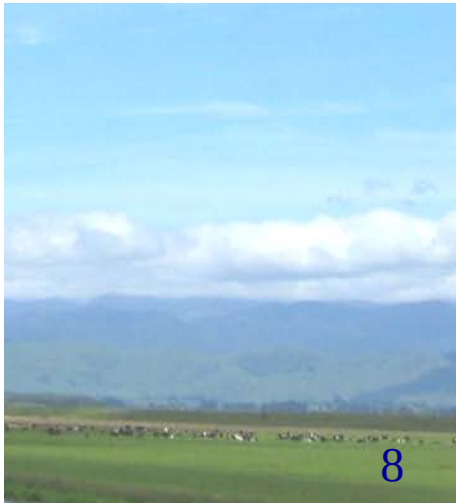
Reliable electric service is the surest sign of modern civilization. There is no higher priority frequency allocation than SSP. Cell phones, TVs, lighting, refrigeration, air conditioning; soon our cars will go depend on it. We must charter a power satellite company.


PENUMBR
UMBRA
PENUMBR
AccuWeather
93 million miles
from sun to Earth
Moon varies from 226 to 252
thousand miles away
picture not to scale

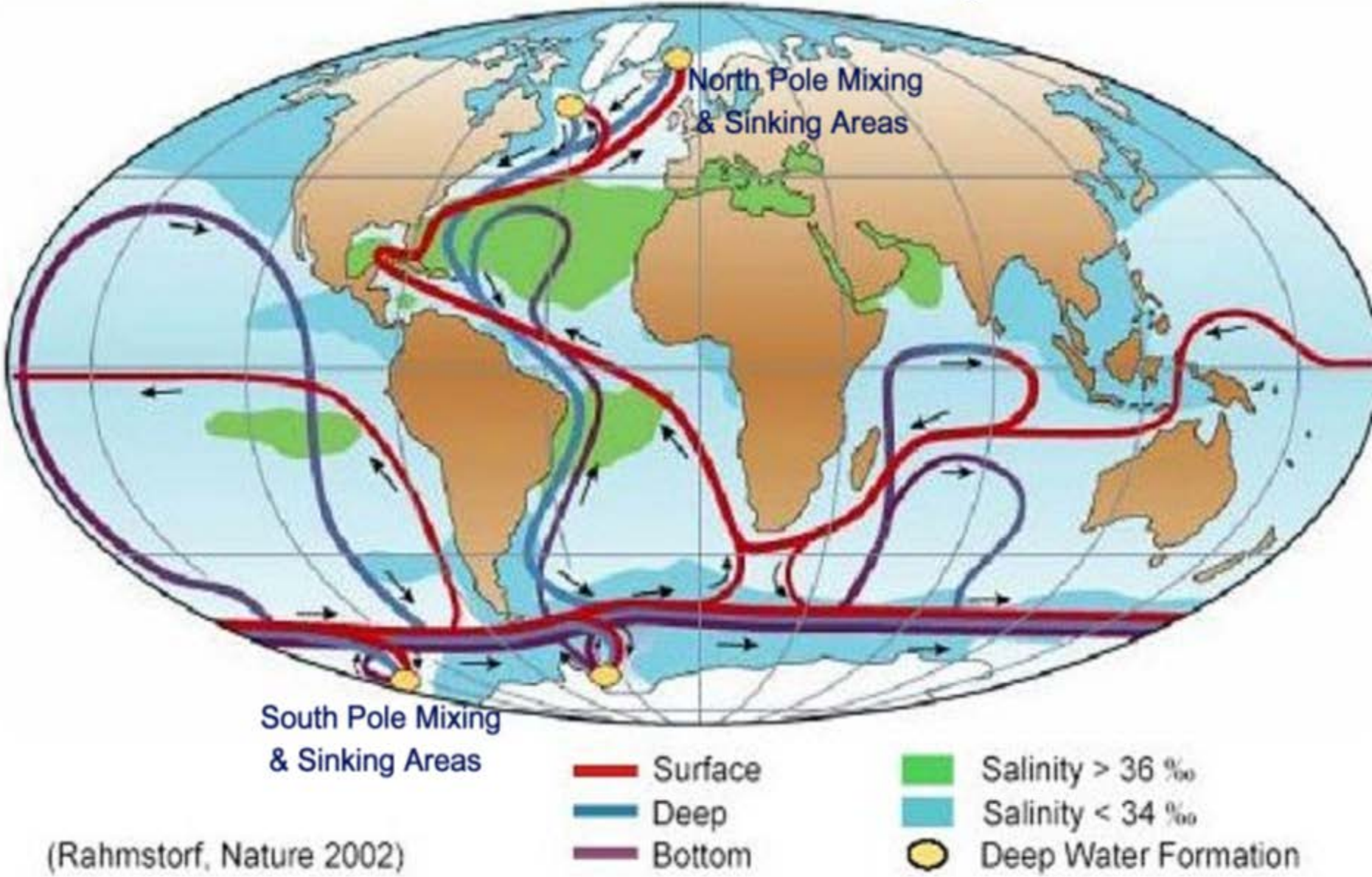




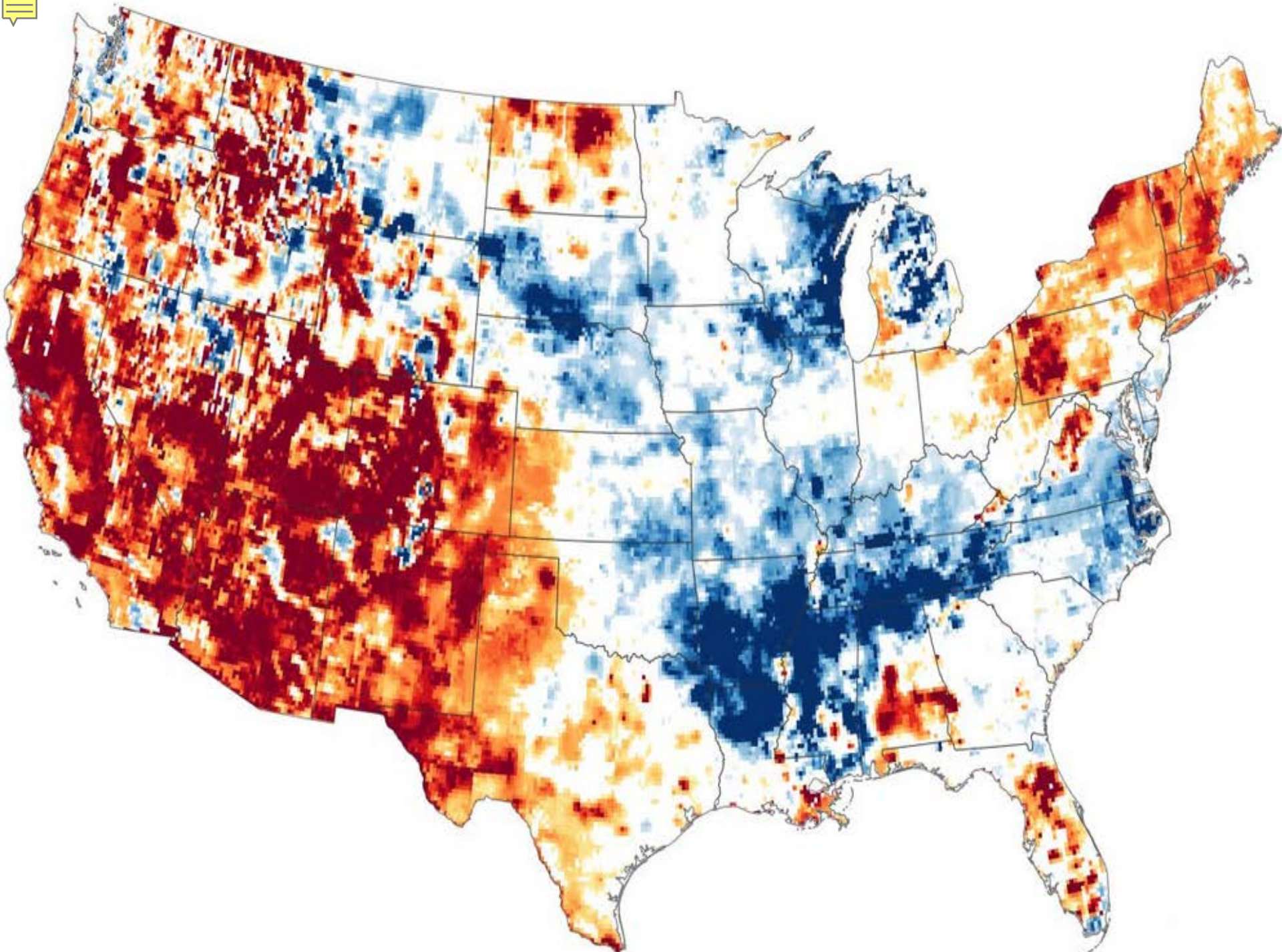
https://scripps.ucsd.edu/programs/keelingcurve/wp-content/plugins/sio-bluemoon/graphs/co2_800k.png



Great Global Conveyor



(Rahmstorf, Nature 2002)



roducts.com/safety/article/14069293/connectors-the-weak-link

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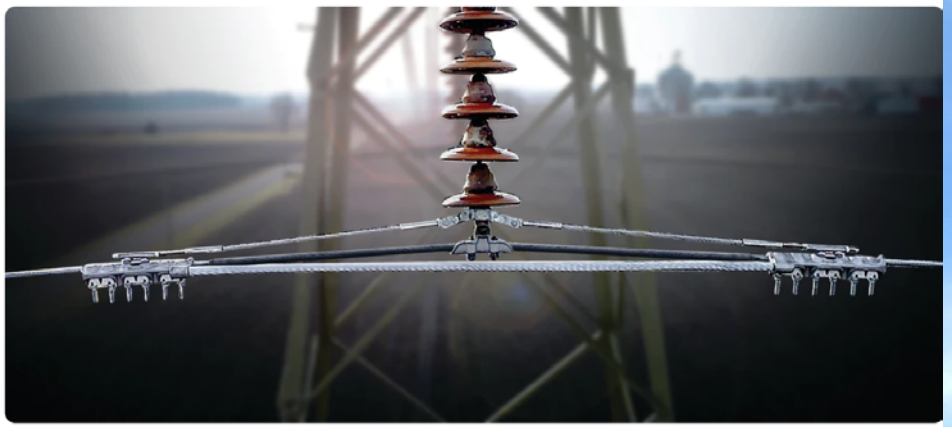
Connectors — The Weak Link

Increased operating temperatures are cause for concern

Oct 24th, 2019



When considering increased conductor temperatures, numerous issues are of concern, particularly with the dynamic effects on electrical connectors when suspended overhead aluminum conductors are operated at high temperatures, specifically above 93˚C (200˚F).

The majority of line hardware associated with suspension and support of bare aluminum overhead conductors has been designed for a maximum operating temperature for conductor of 70–75˚C. However, due to load growth and demand, as many utilities approach conductor operating temperatures of 90–95˚C and beyond on standard conductors such as aluminum conductor steel-reinforced (ACSR) and all aluminum conductor (AAC), serious questions must be answered.

Mother Nature has conveniently drawn a line in the sand for us, and the magic number is 93˚C (200˚F). This is the temperature associated with the onset of long-

PG&E, America's largest power company, emerged from Bankruptcy last summer

Aerial view of homes destroyed by the Camp fire in Paradise, California
- Justin Sullivan / Getty Images

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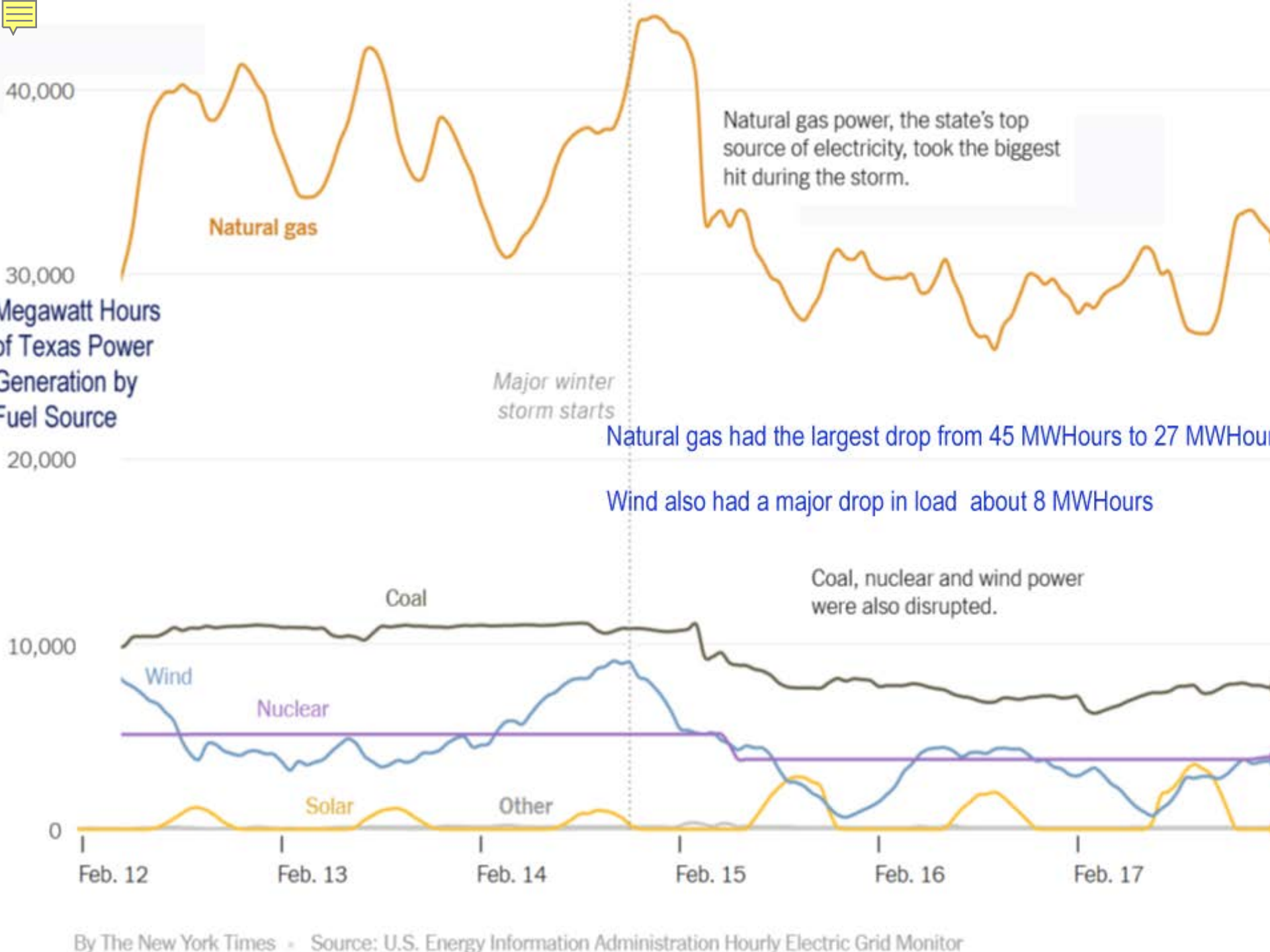
Throwing out Spoiled Meat


ABERLAIN CREEK


Space
Solar
Power
Institute

A mobile home park is covered with snow as a massive winter storm engulfed Texas, causing widespread power and water outages

Megawatt Hours
f Texas Power
Generation by
Fuel Source



Natural gas power, the state's top source of electricity, took the biggest hit during the storm.

Coal, nuclear and wind power were also disrupted.

Natural gas had the largest drop from 45 MWHours to 27 MWHou

Wind also had a major drop in load about 8 MWHours

By The New York Times · Source: U.S. Energy Information Administration Hourly Electric Grid Monitor

Texas's system operator, the Electric Reliability Council of Texas (ERCOT), was forced to order unprecedented load shedding as a last resort measure to restore frequency and protect system stability. At its peak, 52,277 MW of all types of generation within ERCOT were unavailable, or 48.6% of total installed capacity. ERCOT did this load shedding as the entire electric system was within minutes of frequency and voltage collapse, necessitating the dramatic action they took. The crisis lasted more than a week, ultimately subjecting more than 4 million Texans to localized blackouts and millions more to compounding impacts. Many municipal water systems failed. 14 million people were under boiled-water mandates. Natural gas deliveries were curtailed due to frozen infrastructure and little to no dual-fuel capability was available in Texas. Windmills froze and stopped generating. Reliable electric service is essential to support all critical infrastructures. Most tragically, hundreds of lives were lost in the Texas crisis.

Companies that collect bills from customers – merchant power companies - have no obligation in Texas to restore downed power lines, because someone else owns them. Companies that promise the lower power bills of wholesale power to customers in the hopes of gaining market share, but don't shield them from soaring prices during a blackout, have little to no stake in what happens to communities in the coming decades.

Centralized or Distributed Grid Security?

PG&E has agreed to pay **$25.5 Billion** to settle damages from thw numerous wildfires that its power lines sparked in Northern California. It was found guilty of 85 counts of felony manslaughter, including starting the Camp Fire and causing 84 deaths. PG&E is also facing rising costs for liability insurance - beyond California's new **$21 Billion utility wildfire insurance fund.**
PG&E is still investigating the origin of the 2019 Kincade Fire, which took place after the bankruptcy filing and was not accounted for in its reorganization plan. State investigators say the fire was caused by PG&E transmission lines, but the California Department of Forestry and Fire Protection's investigation report has not yet been made public. Ramsey said the Camp Fire and other incidents showed a pattern of "badly overlooked" maintenance and training practices. - "PG&E to pay over $25 billion in multiple insurance settlements", by Natalie Hanson, https://www.record-bee.com/2020/06/25/pge-to-pay-millions-in-plea-deal-over-25-billion-in-multiple-insurance-settlements/, June 25, 2020 and https://www.utilitydive.com/news/pge-faces-soaring-insurance-costs-leadership-changes-in-rest-of-2020/582655/, by Kavya Balaraman, July 31, 2020

“Serving Arizona, California and Nevada, on May 25, 2022, Lake Mead dropped to its lowest level - not seen since Hoover Dam was filling. 95% of nine Western states’ are in drought - extreme or worse. Shrinking capacity continues a 22-year megadrought that experts consider the worst in 1,200 years. California Gov. Newsom suggests his constituents voluntarily limit everyday water consumption. (Intake #1 shown)

J. Guzzardi, May 25, 2022 Longview New Journal, “Bone-dry western states can’t cope with population surges”, https://www.news-journal.com/opinion/guzzardi-bone-dry-western-states-can-t-cope-with-population-surges/article_0d06ef80-db71-11ec-bc23-53e95cd0c88f.html

Bulk Energy Storage

California's Million Solar Roof Project, can provide 9.8 Gigawatts out of California's 13 Gigawatts of Distributed Energy Source (DES) generation – when the sun is shining. California's **distribution grid must now be considered part of an immensely larger transmission grid.** Net-metered solar roof owners are now maintenance partners, although these are *operationally invisible* to grid operators. Brush & foliage monitoring, inverters, local transmission and transformers, RTUs, hardware and software cyber security,.. **Home owners are then responsible for power security.** Damaged equipment including power handling and connections that are aging and subject to derating just like bigger transmission hardware.

Backup power is needed to support this. California's ISO estimates they need 15,000 megawatts of bulk energy storage capacity. In December 2020 the U.S.'s entire large-scale bulk energy storage capacity totaled less than 2,000 megawatts. California had five hundred megawatts**.**

- "U.S. large-scale battery storage capacity", August 20, 2021, EIA, https://www.eia.gov/todayinenergy/detail.php?id=49236

Our major US power grids continue failing to respond effectively to climate change – rising CO2… CA, TX, NY, FL, etc., major power grids continue just “kicking the can down the road” to use a phrase in the bitter fight going on over New York’s race to 70% Renewable Power Standards (RPS). The major reason is because Congress has failed to charter a public-private POWER satellite company As Congress chartered COMSAT Corp in 1962 creating a public-private COMMUNICATIONS satellite company and effectively building our global COMMUNICATIONS satellite industry. They must now create a public-private POWER satellite company!!

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EPRI (Electric Power Research Institute) analysis of Biden’s energy plan projects will require a "massive transformation" of the electric sector and would triple the United States' reliance on its power grid, according to Daniel Brooks, EPRI vice president of integrated grid and energy systems. By 2050 electricity’s share of end-use energy consumption would rise from 20% now to 60%. Most of this impact would be due to growth in electric cars.

What would power this carbon-neutral economy? - ***Not pseudo-random intermittent windmills and roof-top solar***

"Atmospheric CO_2 enrichment is severely inhibiting nitrate assimilation by most plant species' shoots. Photorespiration enhances sequentially a) $NADP^+$ reduction in the chloroplast, b) malate export from the chloroplast, c) NADH availability in the cytoplasm, and d) reduction of nitrate; to nitrite, the first step of nitrate assimilation. Rising atmospheric levels of CO_2 decrease photorespiration and thereby limit shoot nitrate assimilation."

- Arnold J. Bloom, Distinguished Professor, Head Editor: Climate Change Collection, Encyclopedia of Earth 2011, research website on Elevated Carbon Dioxide, https://psfaculty.plantsciences.ucdavis.edu/Faculty/bloom/bloom.htm, http://www.climatechangecourse.org/]

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Rising Carbon Dioxide and Global Nutrition: Evidence and Action Needed

by Lewis H. Ziska

Mailman School of Public Health, Columbia University, New York, NY 10032, USA

Academic Editor: James Bunce

Plants **2022**, *11*(7), 1000; **https://doi.org/10.3390/plants11071000**

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(This article belongs to the Special Issue **The Effect of Carbon Dioxide Concentration on Plant Physiology**)

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Abstract

While the role of CO_2 as a greenhouse gas in the context of global warming is widely acknowledged, additional data from multiple sources is demonstrating that rising CO_2 of and by itself will have a tremendous effect on plant biology. This effect is widely recognized for its role in stimulating photosynthesis and growth for multiple plant species, including crops. However, CO_2 is also likely to alter plant chemistry in ways that will denigrate plant nutrition. That role is also of tremendous importance, not only from a human health viewpoint, but also from a global food–web perspective. Here, the goal is to review the current evidence, propose potential mechanistic explanations, provide an overview of critical unknowns and to elucidate a series of next steps that can address what is, overall, a critical but unappreciated aspect of anthropogenic climate change. **View Full-Text**

Keywords: **CO_2; nutrition; protein; food web; iron; zinc**

Water is 11 % hydrogen by weight and 89% oxygen by weight. Bringing hydrogen to the moon, in the form of ammonia, enables power from ultra-reliable fuel cells. Oxygen is almost a waste product from the mining and reduction of many regolith ores, such as Ilmenite (FeH_6O_3Ti). NH_3 from earth will enable power production from fuel cells, together with permanent sun for solar curtains at the lunar South Pole.

Karina von Schuckmann ((Editor)), Pierre-Yves Le Traon ((Editor)), Neville Smith (Chair) ((Review Editor)), Ananda Pascual ((Review Editor)), Samuel Djavidnia ((Review Editor)), Jean-Pierre Gattuso ((Review Editor)), Marilaure Grégoire ((Review Editor)),and 133 co-authors ***(2021) Copernicus Marine Service Ocean State Report, Issue 5***, ***Journal of Operational Oceanography,*** *14:sup1, 1-185, DOI: 10.1080/1755876X.2021.1946240* , *https://www.tandfonline.com/action/showCitFormats?doi=10.1080%2F1755876X.2021.1946240*

More references available on request.

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* "Renewable Energy Boom Risks More Blackouts Without Adequate Investment In Grid Reliability", https://www.forbes.com/sites/michaelshellenberger/2021/04/20/why-renewables-cause-blackouts-and-increase-vulnerability-to-extreme-weather/?sh=18b609a74e75

Both the heat-driven August 2020 electricity shortage in California, and the cold-driven February 2021 shortage in Texas, were caused in large part by over-reliance, not under-reliance, on weather-dependent renewables like solar panels and wind turbines. As demonstrated by the temporary freeze-up of even nuclear and fossil-fueled power plants during the Texas coldsnap, what the grid needs more reliable baseload generation — not more intermittant supplies. Without infeasibly massive investments in battery storage and other load smoothing technologies, Federal policies that force states to become more reliant on renewables will only increase the probability and frequency of blackouts.

In California, state electricity regulators over-relied on solar panels, despite warnings from the state's grid operator that doing so was dangerous, since most of the state's peak electricity use occurs during and after the sunset. "For many years we have pointed out that there was inadequate supply of electricity after solar had left its peak," said an emotional CEO of California's grid manager, CAISO, last August during the blackouts. "We told regulators over and over that more should be contracted for. That was rebuffed. And here we are."

Matthew Rozsa, “A major Pacific current system is poised to heat up — with potentially devastating repercussions”, September 30, 2021, https://www.salon.com/2021/09/30/kuroshio-current-extension-heating/

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Abstract - The Atlantic Meridional Overturning Circulation (AMOC) has been suggested to exhibit two distinct modes of operation. A collapse from the currently attained strong to the weak mode would have severe impacts on the global climate system and further multi-stable Earth system components. Observations and recently suggested fingerprints of AMOC variability indicate a gradual weakening during the last decades, but estimates of the critical transition point remain uncertain. Here, a robust and general early-warning indicator for forthcoming critical transitions is introduced. Significant early-warning signals are found in eight independent AMOC indices, based on observational sea-surface temperature and salinity data from across the Atlantic Ocean basin. These results reveal spatially consistent empirical evidence that, in the course of the last century, the AMOC may have evolved from relatively stable conditions to a point close to a critical transition.