

Energy Year

2018

In Review

Special year-end issue, published by:



**AMERICAN
ENERGY
SOCIETY**

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A look back at the 2018 Energy Hunger Games

The story of energy in 2018 is not about the rise and fall and rise again of gasoline prices, or slumping investment in renewables, or the geopolitical turmoil that disrupted oil markets, or the unrelenting decline of coal, or ...? Rather, it is about the arc of innovation that is providing more affordable electricity for more people than ever before.



Innovation continues to drive the cost of electricity and power closer and closer to zero. The scale and consequence of this market revolution is unimaginable. Never in human history have so many people gained access to energy at such a fast rate: 262,600 people "discover" electricity every single day. And yet, never before in human history have so many people - 1.2 billion - lacked reliable access to any electricity at all. The difference between energy "haves" and "have-nots" has never been greater.

Not only were the energy "haves" and "have-nots" competing this year, but all power sources were vying for a larger slice of the market, too. These sources are not distributed equally across the globe. China has a lot of low-quality coal. Saudi Arabia has massive reserves of oil. The US Midwest has incredible wind resources. Canada has ample hydropower. Germany imports a third of its electricity from other countries, including coal. The gasoline in a 3 Series BMW in Beijing probably found its origin in the Middle East, but heat for its garage probably came from the Permian Basin in Texas.

The invisible hand of the marketplace allocates power to the highest bidders, which meant that new innovations in 2018 made power generally cheaper. But, the benefit of lower prices did not reach people who could not bid. The developed world consumed far more than its share. The Energy Hunger Games of 2018 was, quite simply, a competition for access to power - a few billion people had access to cheaper power, and about 1.2 billion did not.

In the years ahead, new innovations will continue to drive energy prices down. But will the market mechanisms finally create more equitable distribution? Will new and more aggressive policies force greater equity? Or, will the climate change so dramatically that it makes the Energy Hunger Games of 2018 look tame by comparison.

Energy access: the good, the bad, and the ugly

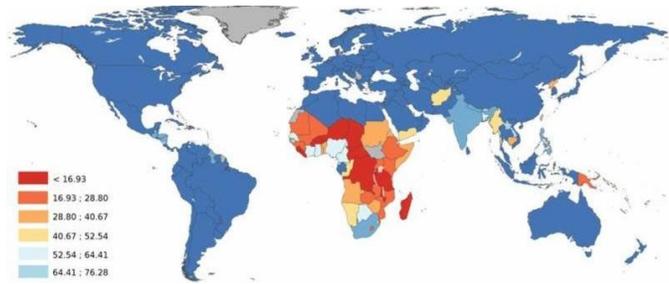
Energy access - the good

- 1800 - a laborer had to toil for six hours to earn enough money to pay for a candle that burned for one hour.
- 1880 - a person would work 15 minutes to burn a kerosene lamp for an hour.
- 1950 - 8 seconds of work was enough to pay for an hour of light from an incandescent bulb.
- 1994 - a laborer worked for one-half-second for an hour of light from a compact fluorescent (CFL) bulb.
- 2018 - the cost for light generated from an LED light bulb is 20% more efficient than a CFL bulb of just a few years prior.



Energy access - the bad

Meanwhile, 500 million people in sub-Saharan Africa have no access to electricity (right: access to electricity, as a % of population).

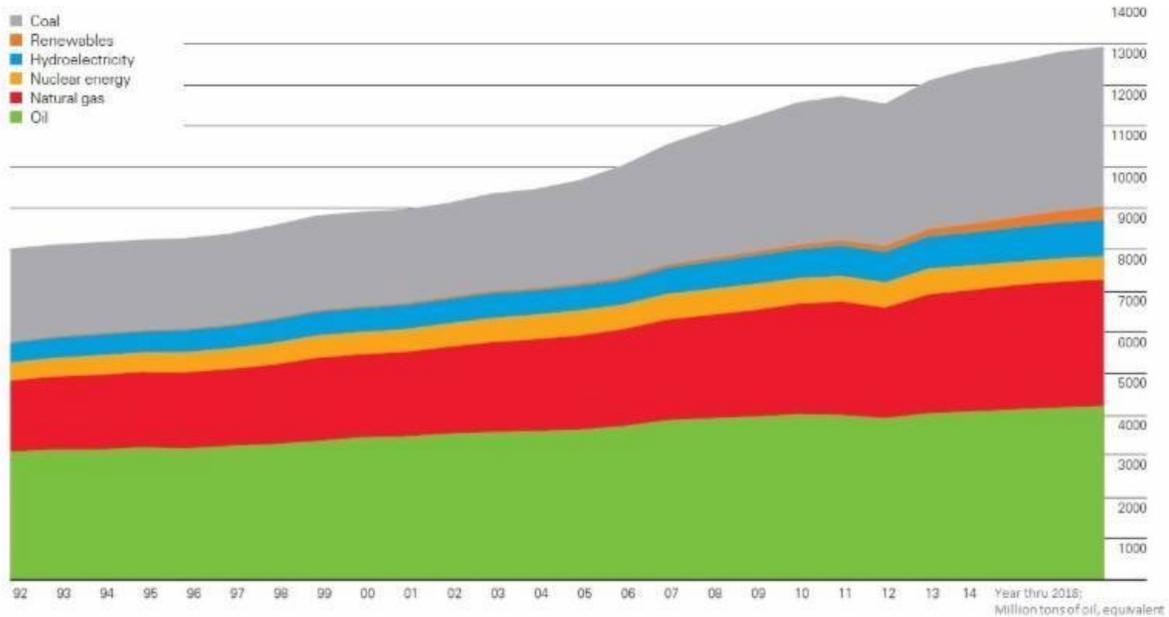


Energy access - the ugly

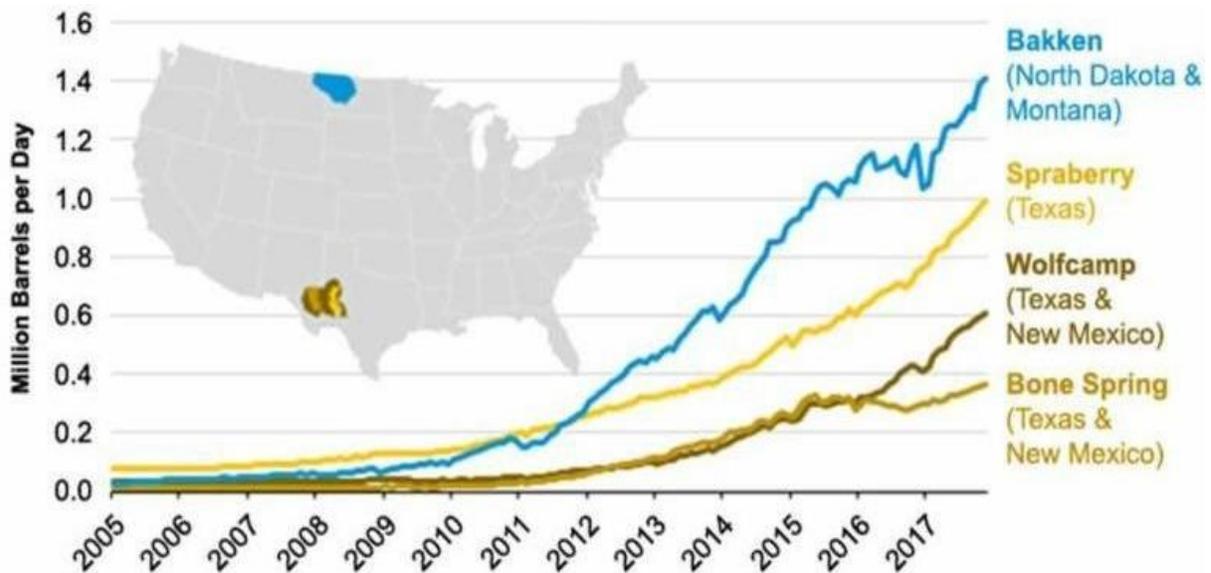
While the average household in developed parts of the world uses 900 kilowatt-hours of electricity per month, the typical household in underdeveloped regions uses just 3 kilowatt-hours of electricity per month - a 300X difference.

Three Epic Energy Stories in 2018 ... as told in slides

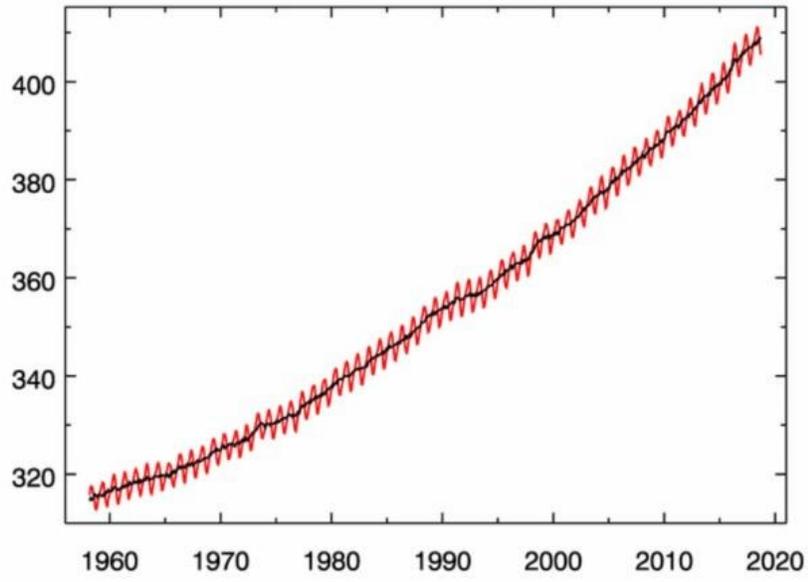
> The world is still consuming about the same amount, or more, of all types of energy:



> The unconventional shale revolution has just begun.
(Note: the US is now producing more than 11 million barrels of oil per day.)



> In 2018, the concentration of carbon dioxide in the atmosphere continued to climb uninterrupted. Note: CO₂ is the primary driver of greenhouse gas emission, and there are now about 420 parts per million (ppm) in the atmosphere (below).



Awards

2018 AES Energy Writer of the Year

Nathaniel Rich is the AES Energy Writer of the Year, the premier literary award for energy. Mr. Rich is recognized for his article, "[Losing Earth](#): The Decade We Almost Stopped Climate Change" (New York Times Magazine, August 1, 2018).

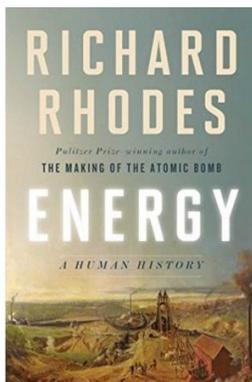


Past winners of the award include:

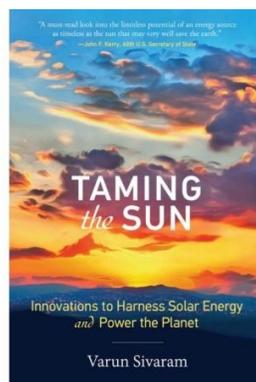
- [Meghan O'Sullivan](#) (2017), for her book, *Windfall: How the New Energy Abundance Upends Global Politics and Strengthens America's Power*.
- [Mark Mills](#) (2016), for his article, *Shale 2.0*.
- [Coral Davenport](#) (2015), for her influential series of posts on Twitter about energy and environmental policy.

Other AES Energy Awards

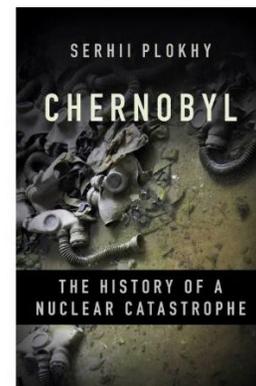
> Nominees for **Energy Book Award** (*winner below*):



Energy: A Human History
by Richard Rhodes



Taming the Sun
by Varun Sivaram



Chernobyl
by Serhii Plokhii

> Nominees for the **Energy Person of the Year** (*winner below*):

- *Jerry Brown*, Governor of California. He closed the year hosting the Global Climate Action Summit in San Francisco (attended by 1,000,000+) and then stewarded ambitious energy and environment bills into law.
- *Bill Gates*, among many other projects, founding investor of the Breakthrough Energy Group. This visionary venture fund is leading next-generation energy innovation (aka "Energy 2.0") by doubling the length of the typical venture investment time-frame, from a 3-year ROI to a 7+ years' time-scale.
- *Narendra Modi*, Prime Minister of India. India's energy consumption is growing at 4.2% a year - faster than that of all the major economies in the world. No one is having more influence than PM Modi.
- *Mary Nichols*, Chairwoman of the California Air Resources Board. If California is the last bastion in the global battle to stabilize the climate, as the head of the board, the 73-year-old Nichols is arguably California's most powerful weapon.
- *Donald Trump*, President - United States. The President's policies have helped make the US energy sector the biggest player on the world stage.

> Nominees for **best article in Energy Today** (*winner below*):

- [95 and Still King: The Story of John B. Goodenough](#)
- [What Will We Do With All Those Solar Panels When Their Useful Life is Over?](#)
- [We Made Plastic. We Depend on It. Now We're Drowning in It.](#)

> Nominees for the **best Hollywood movie in 2018**, with "energy" or "environment" as a sub-theme (*winner below*):

- [Avengers: Infinity War](#) - The Avengers attempt to stop Thanos from obtaining Infinity Stones, an all-powerful source of energy.
- [Black Panther](#) - T'Challa has enhanced speed, strength, night vision, and healing ability from a plant that gives him exceptional energy; also, vibranium is a metal that provides the power source to fuel Wakandan's life.
- [The Clover Paradox](#) - Scientists test a device to solve an energy crisis and end up with a dark alternate reality.
- [Jurassic World: Fallen Kingdom](#) - When a dormant volcano begins roaring to life, the remaining dinosaurs (fossil fuels) need to be rescued from extinction.
- [Mission Impossible: Fallout](#) - The finest action film since 2015's Mad Max, Tom Cruise is tasked with recovering a trio of energy-rich plutonium cores.

> Nominees for **best Indie-movie** (documentary or drama) 2018, with "energy" or "environment" as a sub-theme (*winner below*):

- [24 Frames](#) - this experimental documentary features twenty-four scenes - i.e., animals running, clouds rolling, smoke billowing, etc. - that situate viewers in trance-like thought about the changing climate.
- [Annihilation](#) - one of the best sci-fi films in years. Biologist (Natalie Portman) discovers a mystery about nature's endless cycles of synthesis and mutation that eventually create something wholly, frighteningly unique.
- [The Game Changers](#) - James Wilks (elite special forces trainer and winner of The Ultimate Fighter) travels the world on a quest for the truth behind the world's most dangerous myth: that meat is necessary for protein, strength and optimal health. (Note: winner of the Environmental Film Festival documentary award.)
- [Leave No Trace](#) - a suspenseful story about a father and daughter illegally living off the grid in the national forest of the Pacific Northwest.

Energy Award Winners:

- *Book:* [Energy: A Human History](#), by Rhodes - A meticulously researched examination of energy transitions in the context of current challenges
- *Person:* Jerry Brown - Governor Brown has enjoyed multiple turns in the national spotlight, but 2018 was perhaps the high-point of a long political career.
- *Article in Energy Today:* [We Made Plastic](#).
- *Hollywood movie:* [Black Panther](#)
- *Indie-movie:* [Annihilation](#)



Signals & Noise

An end-of-year favorite, a few AES expert Members were asked to identify an overlooked energy development ("signal") and an over-emphasized topic ("noise").

[Sally Benson](#), Professor of energy engineering at Stanford University, co-director of the [Precourt Institute for Energy](#):

- *Signal*: Ambitious efforts to decarbonize the energy system
- *Noise*: Roof-top solar

[Matt Chester](#), Energy Analyst, and Editor of Chester Energy and Policy:

- *Signal*: States adopting California's more stringent automobile emission standards
- *Noise*: Rollback of federal vehicle emission standards

[Jim Claunch, Jr.](#), Vice President of Operational Excellence, [Equinor](#) (formerly Statoil):

- *Signal*: Corporate leadership that uses technology to transform individual work habits and broader corporate culture
- *Noise*: Technology-centric solutions

[Hal Harvey](#), CEO of Energy Innovation:

- *Signal*: Policies that decarbonize the energy sector and increase energy efficiency
- *Noise*: Symbolic gestures like divesting from fossil fuels

[Tracey Holloway](#), Professor, Energy Analysis and Policy Graduate Program, [Nelson Institute](#) for Environmental Studies, University of Wisconsin, Madison:

- *Signal*: Public health "co-benefits" of low-carbon energy due to improved air quality
- *Noise*: Outdoor air purifiers (or any technology that removes pollution from the air)

[AG Kawamura](#), Member, President Donald Trump's Agricultural Advisory Committee and former Secretary of the California Department of Food and Agriculture:

- *Signal*: Sustainable water infrastructure
- *Noise*: Endless conversations about drought and no real effort to solve the problem

[Arun Majumdar](#), Founding Director of ARPA-e, current Co-Director of the Precourt Institute for Energy at Stanford University:

- *Signal*: Record regional high temperatures that have a devastating impact on human life
- *Noise*: Average global temperature rise ("averages" don't convey extreme conditions)

[Nancy Pfund](#), Founder and Managing Partner of DBL Partners and #17 on FORTUNE's Top 25 Eco-Innovators:

- *Signal*: More wind and solar built in the developing world this year than new fossil
- *Noise*: "I am not a scientist" as an excuse for making uninformed decisions about climate change

[Patrick J. McCloskey](#), Director of Research and Publications, [University of Mary](#) (Bismarck, North Dakota):

- *Signal*: Politics and railways - natural gas producers and politicians in North Dakota would like to send natural gas by rail in large quantities to the West Coast for export, but since those states are controlled by the Democratic Party, this plan might entail heading north into Canada to Vancouver
- *Noise*: Oil price volatility - oil prices will bounce up and down, but American shale producers will remain nimble and issues such as the trade war with China and OPEC production levels will be Pound non-factors over the long run

[Deanna Zhang](#), Associate, Energy Technology, Investment Banking division of Tudor, Pickering, Holt & Co:

- *Signal*: Oil and gas efficiency gains through automation

Noise: Digitization-driven corporate reorganizations (or, "make or break" adoption of AI and machine learning - "it's sort of a tie")

The Lighter Side of Energy: 18 "Awards" for 2018

The "Worst title for a program" award:

[DAYS](#) - Duration Addition to electricitY Storage. (Note: this ARPA-e sponsored program that supports storage research is still *not the all-time worst acronym*. That award goes to US President Jimmy Carter's inspired call for public mobilization in pursuit of energy independence: **Moral Equivalent Of War** ... aka "[MEOW](#).")

The "Zero-Sum" award:

*3rd place: **Electric vehicles**.* About half of the electric vehicles in the US and 2/3rds in China draw power from coal.

*2nd place: **Blockchain**.* Digital applications that run on blockchain make energy transactions more efficient but require massive amounts of energy to operate (blockchain uses about the same amount of energy as Ireland).

*1st place: **Air conditioners**.* Air conditioners save lives from the conditions they are helping create. (Note: air conditioners are being installed around the world at a rate of about 1.3 every second.)

The "Don't Give Up" award - the most promising energy technologies in development (from the portfolio of investments by [Breakthrough Energy Ventures](#), the venture fund for LP's Bill Gates, Jeff Bezos, Meg Whitman, Mark Zuckerberg....):

Geothermal

Small modular nuclear reactors

Fusion nuclear power

Carbon capture

Meat-substitutes

Battery storage

Photosynthesis (Mother Nature apparently developed an inefficient system)

Geoengineering

The "Duh" award:

In a [report](#) from *Protect Our Winters*, researchers found "a direct connection between low snow cover and fewer jobs in US ski towns."

The biggest "[Tragedy of the Commons](#)":

[Ocean garbage gyres](#).

The energy story that got more attention than it deserved:

Tracking Scott Pruitt's demise as EPA Administrator. Given the ethical issues that followed Scott Pruitt everywhere, it is probably safe to say that he was ill-suited for public service on a national stage. But the unrelenting expose went overboard. For instance, the *Washington Post's* syndicated daily publication "Energy 202" dedicated front-page headline coverage to

the Administrator's demise for 57 consecutive days and turned its own obsession into a topic-specific byline: "Drip. Drip. Drip."

The energy story that deserved more attention:

The inability of the Congress to pass meaningful energy-policy. The last time the US Congress passed major environmental legislation was in the 1970s, which means that presidents have had to use old statutes to address new challenges (such as global warming). Furthermore, the protracted legislative stalemate between Republicans and Democrats has given the courts an increasingly critical role in trying to interpret how far those obsolete laws reach.

The "I wouldn't want to be in his shoes" award:

2nd place: President Donald Trump. The E15 ethanol mandate (which requires 15% ethanol blends in gasoline) puts the President between two powerful constituent groups: the oil industry and the Farm Belt. Oil refineries want out of a costly requirement to blend ethanol into the gasoline they produce; corn growers say the requirement diversifies the US fuel supply and insist that Mr. Trump fulfill his promise to protect the ethanol mandate. Making matters harder, Trump's ethanol requirements will have to survive an inevitable challenge in the Supreme Court; ironically, Justice Kavanaugh wrote the [dissenting opinion](#) against the E15 mandate.

1st place: US DoE Secretary Rick Perry. The White House gave Sec. Perry his marching orders: "prepare immediate steps" to bail out economically struggling coal and nuclear power plants. However, the proposal is overwhelmingly [opposed](#) by virtually everyone else, including FERC. And yet, this flawed policy still won't [die](#).

The "Data don't lie" award:

Oil is the world's biggest traded commodity, [bigger](#) than all the minerals and metals combined, bigger than agriculture. Petroleum fuels 95% of the machines used to move all people and all goods for all purposes, trade included.

The "And I'm supposed to be angry?" award:

Some residents around Brooklyn's heavily polluted Gowanus Canal are [angry](#) because removal of the tar-like toxins from the canal has led to gentrification (the former Superfund site now has high-end restaurants, dense housing, and other businesses).

The "How is it possible that we can invent quantum computing, autonomous vehicles and artificial intelligence, but we can't figure out ___?" award:

2nd place: No one has been able to figure out what caused a cloud of radioactive pollution that spread over Eastern Europe. Experts who investigated the incident have determined that "there is not enough information to pinpoint the source or origin."

1st place: The GAO discovered that ARPA-e [didn't receive](#) \$91 million of its legally appropriated 2018 budget, and no one knows why, or where it went.

The Hypocrisy award:

2nd place: In 2014, Narendra Modi ran for Prime Minister of India promising a strong commitment to providing electricity for all of rural India - about 38 million people in more than 18,000 villages. However, the government deems a village “electrified” if only [10%](#) of its households and public places (schools, hospitals, etc.) have electricity. As the program nears its end, **32 million of 38 million people still do not have electricity, and yet the government is claiming success.** (Note: coal provides about 75% of all of India's electricity.)

1st place: Of the hundreds of companies in the US that have pledged to reduce greenhouse gas emissions - across all industries, from agriculture to finance - **only [36%](#) have set a formal deadline for action.**

The Hypocrisy award II, EU edition:

2nd place: More than nine countries and a dozen cities in Europe have announced they are going to ban internal combustion engines or diesel-powered vehicles (including Paris, Madrid, Athens, Norway, France the United Kingdom); however, **none have passed a law prohibiting anything.**

1st place: Despite *Energiewende* policies that require rapid transition to renewable energy, Germany is [bulldozing](#) centuries-old villages (such as the medieval village of Pödelwitz) to make way for brown coal mines — one of the dirtiest and cheapest fossil fuels.

The “You can't make this stuff up” award (Russia sweeps the category):

3rd place: A Russian energy-components manufacturing company is packaging its product with President Trump's [image](#) on the label and a seal that reads: “Approved by Donald Trump, 45th President of the United States.”

2nd place: In retaliation against sanctions imposed by the Trump administration, a Russian company that makes [sewage](#) pump equipment delayed delivery of an order placed by the US National Mall and Memorial Parks headquarters.

1st place: Russia-based cyber-terror attacks on the Russian energy sector are out of control. For instance, there is evidence that [Russian military intelligence](#) is conducting "malicious" cyber attacks on Russian energy companies like Gazprom, ransomware attacks targeting Russian utilities, and denial-of-service attacks on smaller Russian private energy companies. Meanwhile, civilian Russian hackers (like Fancy Bear) hacked the Russian military hackers.

The "Disingenuous" award (China sweeps the category):

3rd place: There are at least [three factories](#) in China that are producing the banned industrial gas Trichlorofluoromethane (CFC-11) even though the world banned the production of the highly toxic compound under the Montreal Protocol in 1987.

2nd place: China claims that it has cancelled more than 100 coal plants across 13 provinces. In some cases it has, and in some cases it has simply replaced older, dirtier coal plants with newer less-dirty ones. And sometimes the claims are completely [false](#) .

1st place: China announced that it met its 2020 carbon goals three years ahead of schedule, but their system [of self-evaluation](#) only measured emissions from the power sector and did not include the transportation, agriculture or manufacturing sectors.

The "How in the world did they get elected" award (the US sweeps the category):

2nd place: Senator James Lankford from Oklahoma said that meteorologists that give daily weather reports are "[propagandizing](#)" the news.

1st place: Alabama US Representative Mo Brooks claimed that [rocks](#) tumbling into the ocean were the cause of rising sea levels along the Alabama coast. (FYI - Alabama's shoreline along the Gulf of Mexico stretches for 60 miles.)

"This is a bad idea" award:

3rd place: Nuclear power is virtually the only energy source that is not receiving significant private investment.

2nd place: Eddy-Lea Energy Alliance, a coalition of counties in central Texas announced they would build an underground storage site that would temporarily house [waste](#) from the nation's nuclear reactors. Seems reasonable. Except that this region is in the heart of the Permian Basin fracking boom and has experienced a substantial increase in earthquakes.

1st place: The American economy is driven by a powerful network of billions of "smart" connected devices, from minuscule sensors to massive industrial machines, from autonomous vehicles to smart water meters. Yet, how "smart" is smart if these devices aren't protected from cyberattacks? There are literally millions of cyber-attacks every day.

The "Wow, just ... wow" award:

When Scott Pruitt selected a special desk that he wanted for his office, a staffer noticed a warning label that the desk contained formaldehyde, which is classified as a carcinogen by the EPA. No one on Administrator Pruitt's staff knew what to do, so acting deputy chief of staff Reginald Allen emailed the EPA Chemical Office: "Sorry to bother you with this but we need some help. The [desk](#) the Administrator wants for his office from Amazon has a California Proposition 65 warning. What I am asking is this desk safe for the Administrator even though it has formaldehyde?" (Note: The month before, Pruitt's staff had blocked a public report on the health dangers of formaldehyde.)

The impossible you-are-going-to-fail trick-question energy quiz

Zoology: **Which animal is bigger?**

- a. unicorn
- b. whale
- c. elephant
- d. dusky gopher frog

Answer - c. "[elephant](#)". A "unicorn" is a billion dollar company, the "whale" is the massive offshore hydrocarbon basin in the Gulf of Mexico, and the 1 cm "frog" was powerful enough to divide the US Supreme Court; but the "elephant" describes super-massive hydrocarbon basins that hold 500 million barrels of oil or more; an elephant has been spotted offshore of the Nigeria/Angola coast.

Math: **Calculate the social cost of carbon:**

Answer - To solve this complex and multi-layered mathematical problem, first calculate how much carbon emissions for the last 300 years (the life-span of carbon in the atmosphere) have affected temperature, rainfall, sea level rise, corn yields, mortality, energy costs, water consumption, etc., as well as species migration, the consequence of melting glaciers, the consequence of violent conflict, etc. Then, calculate how these changes have affected the thousands of decisions made by 7.6 billion humans as well as the behavior of gazillions of plants and animals every single day. And take into account these calculations in the context of the planet-scale earth system.

Extra credit: Be precise - rough estimates will be categorically rejected by [denialists](#).

Economics: **What is the economic value of solar and wind employing 3x more people in the US than coal and natural gas combined?**

Answer - Be careful because this statistic can be turned on its head. Coal and natural gas workers provide about 15x more energy-intensity than wind and solar combined.

Vocabulary: **Define the word "capacity" as used in the energy sector.**

Answer - There are many ways to use or misuse the term. For instance, on average, the capacity of a wind farm operating at 100% is very different from its capacity factor of 34% (meaning, wind farms generate energy for about 1/3 of a full day). Solar panels also generate a lot of power at full capacity, but the capacity factor for solar photovoltaics that track the sun is 10% in the UK, 19% in the US, and 24% in Chile's Atacama Desert (the highest rating for any solar in the world). By comparison, coal plants have a 40% capacity factor and nuclear about double that.

A Few Final Thoughts About Energy, 2018

> Thought-leaders forecast the long-term future of energy and the environment:

- "Evolution," by Mark Cuban – we already have the necessary technological innovations; now it's just about implementation and iteration.
- "Revolution," by Bill Gates - we need breakthrough discoveries that will leapfrog the status quo.
- "Evacuation," by Steven Chu (Nobel Prize winner; former-Secretary of the DoE) - the changing climate is going to lead to mass migration around the world.

> **Stop saying "smart-___"**. We have smart- grid, meters, data, cars, sensors, thermostats, batteries, cities... What do we call the next generation of innovations? "Smarter-?" Or should the next generation call this generation "dumb?"

> **Rex Tillerson deserves better** ... but maybe he's happier now?

> **"All of the above" is not an energy policy or strategy - it's a cop-out.** Not all sources and uses of energy are created equal. Some are better than others. Eventually, you have to make choices ... and then live with the consequences. And maybe "price" should not be the only or primary factor.

> Four of the world's five largest economic regions (that account for 75% of global GDP) — Europe, China, India, Japan and North America — *import* oil. Of these, **only North America exports oil.**

> **Let's be honest:** The odds of keeping global warming under 2 degrees Celsius (3.6 F) are 1:20. If by some miracle we are able to stay under this threshold, we will "only" have to negotiate the extinction of the world's tropical reefs, sea-level rise of several feet, and the abandonment of the Persian Gulf - long-term disaster is the best-case scenario. Three-degree Celsius warming (or 5 degrees Fahrenheit) - *the more realistic outcome* - is a prescription for short-term disaster: forests in the Arctic and the loss of most coastal cities. The consequence of four-degree warming is catastrophic.

> **Looking ahead to 2019:** Though responding to a different but equally enormous challenge, Dr. Martin Luther King may have offered some advice for the present existential crisis caused by the changing climate: "*what can be done can be undone.*" Perhaps these words can inspire us to consider a radical proposition: it is time to work with and alongside Big Oil - on a grand scale. No other industry has the supply-chain, engineering-capacity, financial capital, and global presence in place to combat the crisis "*with the fierce urgency of now.*" The industry may have been the primary source of the greenhouse gas emissions that are causing the global climate to change, but now it is time to think of this same

industry as the best hope to provide solutions that offer humanity its last chance to protect the world in its present condition.

> **And one last thought for 2018:** *Mother Nature always bats last.*

Thank you for another great year

With greatest appreciation ...

Katy
Stacy
Zack
Bryan Pollard
Sally and Arun
Jane
Diana and Kirsten
David, Peter and Randi
Gro, Katja, Anne
Matt
Ted
Of course, Heidi Hackford, Ph.D.

Jeff Cornelius
Ahsan Ali
Jacque Martin
Ian Forraker
Bob O'Conner
Greg Miller
Don Cuffel
Scott Magargee
Greg Allen
Beth Duff Brown
Definitely, all Members of AES
And to our children, and for them, too.

Note: Eric J. Vettel, Ph.D., President and Editor of American Energy Society, is available for speaking engagements. Please [contact us](#) with questions or to schedule an event.



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