Climate Change Dispatch

August 14, 2023

Climate Beliefs Can't Change The Power Of Power Density

 In an August 7 article, *New York Times* columnist Paul Krugman claimed that "technological progress in renewable energy has made it possible to envisage major reductions in emissions at little or no cost in terms of economic growth and living standards."

He continued, writing that last year's Inflation Reduction Act "consisted almost entirely of carrots — tax credits and subsidies for green energy. [emphasis, links added]

Yet thanks to the revolution in renewable technology, energy experts believe that this all-gain-no-pain approach will have major effects in reducing greenhouse gas emissions."

That last line included a link to an analysis done by academics at Princeton University. They claim that massive deployments of wind and solar energy — **deployments that would require covering state-sized tracts of land with wind turbines and solar panels** and doubling or tripling the size of our high-voltage transmission system — could result in significant cuts in emissions.

Krugman went on to claim that "**the climate war is now part of the culture war**" and that "right-wingers" are "rejecting the science in part because they dislike science in general." All of this, he avers, is part of a years-long conspiracy to prevent action on climate that's being led by "fossil-fueled think tanks."

Before going further, it must be noted that in his piece, "Climate Is Now A Culture War Issue," **Krugman failed to mention** the disgraceful role that two **richly funded climate NGOs played in *increasing New York's reliance on fossil fuels*.**

Not a word about former New York governor Andrew Cuomo and how he and his co-conspirators at Riverkeeper and Natural Resources Defense Council [NRDC] forced the **premature closure of the nuclear reactors at the Indian Point Energy Center** in 2021, a move that resulted in **increased generation from natural gas-fired power plants** and **a huge jump in the state's greenhouse gas emissions**. (It must also be noted that presidential hopeful Robert F. Kennedy Jr. was a key player in Riverkeeper's push to shutter Indian Point.)

Nor did Krugman mention that **Riverkeeper and NRDC callously cheered the closure of the plant** in the pages of the *New York Times*.

But I digress.

None of the claims in Krugman's August 7 column are new. For years, academics from elite universities, climate activists, leaders of the anti-industry industry, and legacy media outlets (and the *New York Times* in particular) have been **peddling shopworn claims about "all-gain-no-pain" renewables.**

You've no doubt heard them: renewables are cheap and getting cheaper, wind and solar energy are the future, and the main reason that conservatives and knuckle-dragging rural landowners are opposing massive renewable projects all across America is that they don't understand "science."

That's the spin. Here's the reality: **the conspiracy against wind and solar is one of basic math and simple physics.** It's not conservatives who are wrong on "science," **it's liberals like Krugman and his myriad allies** in the climate claque **who refuse to recognize** (or even discuss) the **physical limits on our energy and power networks**.

The shape and size of our energy systems are not being determined by political beliefs about climate change. Instead, those systems are ruled by the Iron Law of Power Density which says: **the lower the power density, the greater the resource intensity**. This can easily be seen in the graphic above.

It includes a screen grab from a 2021 International Energy Agency report on the mineral intensity of various methods of electricity generation. The **mineral intensity of offshore wind**, including huge amounts of copper and zinc, **is shocking**: roughly 15,400 kilograms per megawatt of generation capacity. That is roughly **13 times more than** the amount **needed for natural gas-fired generation** (1,148 kg) and **six times more than** what's needed for a **coal plant** (2,479 kg).

The Iron Law of Power Density explains why Siemens Energy just reported a $2.4 billion loss on its wind business in the latest quarter. It explains why **offshore wind projects in the U.S. and Europe are being canceled left and right**. It also explains why, all around the world, rural

communities and landowners are **fighting back against the landscape-blighting encroachment of massive wind and solar projects.**

But I'm getting ahead of myself.

Power density is perhaps the most important, and least understood, metric in physics. …

Before going further, a quick primer: **energy and power are commonly confused**, even by people who work in the energy sector. Remember: **energy and power are not the same thing**.

Energy (measured in joules, or BTUs) is the ability to do work. Power (measured in watts, or horsepower) is the rate at which work gets done. As I have said many times, we don't care about energy. **What we want is power.** That is, we don't care what form of energy (oil, sun, coal, or gas) that's being used to power our car, run our television, or cook our quinoa, **we only care that we have the power needed to do the work at hand.**

Put another way, **energy is useless if we can't make it flow.** And the more we can make energy flow, the more power we can produce and therefore, the more work we can do.

Writer and polymath Vaclav Smil calls power density the "key analytical variable to evaluate all important biospheric and anthropogenic energy flows." So, again, **what is it?**

Power density is the **measure of energy flow** that can be harnessed from a given area, volume, or mass. Power density is a measure of how many watts we can get per square meter, liter, or kilogram from a given source. This article focuses on areal power density. **Proving why low-power-density sources are the wrong choice** for modern society takes **only a modicum of effort.**

Let's start by looking at corn ethanol and other biofuels, which have a **power density of about 0.1 watts per square meter**. Counteracting that paltry power density requires lots of other resources, including fertilizer, diesel fuel, water, and staggering amounts of land.

In 2021, Dave Merrill, a reporter and data analyst at Bloomberg, reported that "Two-thirds of America's total energy footprint is **devoted to transportation fuels produced from crops**, primarily corn grown for ethanol. It requires **more land than all other power sources combined.**"

Merrill determined that **biofuels require the cultivation of about 80,000 square miles of cropland**. As can be seen in the graphic above, that's **an area bigger than the state of Nebraska.**

Corn ethanol, wind, and solar are not only dependent on the weather but they **are also cursed with low power density.** (About 1 watts per square meter for wind and ten watts per square meter for solar.) That means that like ethanol, they too require vast amounts of land.

They also require **vast amounts of copper, zinc, molybdenum, silicon, and rare earth elements like neodymium**. With inflation hitting commodities of all kinds, the mineral intensity of wind and solar is **hitting the bottom lines of the big renewable companies**.

These power density numbers are derived from several sources. The shale gas figures are for a multi-well drilling pad in the Marcellus shale and come from data provided by the Bureau of Economic Geology at the University of Texas. The nuclear number of 2,000 watts per square meter is the power density of the now-closed Indian Point Energy Center. The Rolls-Royce SMR figure is the expected power density of the reactor now being developed.

Indeed, late last year, Siemens Energy, which produces wind turbines, announced a big drop in its expected profits. During a TV appearance, the CEO of Siemens Energy, Christian Bruch, confirmed the Iron Law of Power Density. Bruch said:

"Never forget, renewables like wind roughly, roughly, need 10 times the material [compared to]… what conventional technologies need…So if you have problems on the supply chain, it hits … wind extremely hard, and this is what we see." Bruch also said there is "still a way to go" in the maturation of the wind industry and that there are problems with distributing "risk along the supply chain in a world which is much more volatile, much more difficult, much more multilateral than before." He continued, saying "if we don't resolve it as an industry…we'll fail with the energy transition."

If your power plant requires ten times more material inputs than other forms of power generation, it's readily apparent why **Siemens and other companies in the wind business are getting blown away**.

Last year, GE's renewable business lost $2.2 billion. That loss was blamed on "inflation and supply chain pressures." The company has cut its onshore wind turbine workforce by 20% and according to Reuters, **the last time GE's renewable business made a profit was in 2020.**

Since Bruch's TV appearance, the **problems at Siemens Energy have worsened.** Last week, the German company announced it lost $2.4 billion on its wind business in the latest quarter and it expects to lose $4.9 billion in 2023 due to **costly fixes it will have to make to wind turbines it has sold.**

What happened? In the ongoing effort to wring more electricity from the diffused energy in wind, Siemens has made bigger and bigger machines with longer and longer blades. In doing so, **they made the turbines more fragile and thus more likely to break**. On August 7, *the same day Krugman's column was published* in the *Times*, Reuters reported that in addition to the multi-billion-dollar loss, the company…:

…also cut its sales outlook, and issued a new, lower profit outlook after withdrawing it in the wake of the disclosed issues, which include wrinkles in rotor blades and faulty gears at its newer onshore turbines. The equipment and service provider to the power industry said only some of the 2,900 turbines of its most recent 4.X and 5.X models in the field were affected by the problems, but declined to provide a specific number.

The **same issues are happening in the offshore wind sector**. Over the past few weeks, several projects have been canceled. Spanish utility Iberdrola agreed to pay fines to **cancel a contract for an offshore project in Massachusetts**, and Danish company **Orsted had its offshore project in Rhode Island scuttled due to soaring costs**. Meanwhile, an **offshore project in Britain was canceled** by Sweden's Vattenfall. …

The other key facet of the Iron Law of Power Density, of course, is land use. The only way to substantially increase the production of wind and solar energy is by **seizing more and more land** (or ocean) so they can be **covered with more and more steel, concrete, copper, and silicon**.

As I reported in these pages on August 4, in "Massive Riots, Renewable Resentments," the backlash against the encroachment of large wind and solar projects is real, it's global, and **it's growing**. As can be seen in the Renewable Rejection Database, the total number of rejections and restrictions on wind and solar in the U.S. now totals 575.

Krugman didn't bother to mention land use in his article. That's not surprising. The *New York Times* has steadfastly refused to cover the land-use conflicts in New York even though it is arguably the **epicenter of the backlash against large-scale renewables**.

The Renewable Rejection Database contains 66 rejections or restrictions of renewables in New York since 2015. Indeed, the **backlash in the state has been so stout** that the potentates in **Albany passed a measure** known as Article 94c that **gives state officials the authority to override local zoning laws** and **force communities to accept renewable projects they don't want.**

Of course, **these facts don't fit the narrative** that Krugman and others are pushing. So they go unreported and unmentioned in the pages of the *Times*.