WilderShares, LLC

Q1 WilderHill® Quarterly Report: ECO, NEX, H2X, WNX Indexes, March 31, 2026

The Clean Energy Index® (ECO) began Q1 at 64.44 & ended Q1 at 66.67, up +3%. In say 'context of presidents' so now 4 full Quarters into 2nd term, ECO is here up by a neat: +100%. Inflation hit this interest-rate-sensitive theme, hard. After clean energy thus ECO Index® touched a low mid-2024, it afterwards gained some, despite -- or perhaps bit due(?) to a 2024 election. We'd seen in a stimulative 1st term from 2017 to 2020, ECO moved dramatically: +38% in 2017, -15% in 2018, +58% in 2019, remarkably up +203% in 2020, about best for any index or fund, anywhere. Tallied it was +284% gain ironically for a 1st term of a white house highly skeptical of green energy. Then, ECO fell all 4 years during a very differing presidency in 2021-2024, declines those 4 years of -30%, -46%, -22%, -30%; tallied it was down -128%. Now with a prior president returned for their 2nd term, ECO was again well up here by +52% for 2025, while events have pulled demand forward -- and just possibly may knock it down ahead.

Although passive, ECO Index® falls hard. From near 270 early 2021, to down by 30 early 2025, renewables theme so ECO, plummeted over ~4/5ths. ECO, NEX, H2X, WNX all can 'drop like a rock'. Jumps true, crashes too. Our mission is to capture a risky story. So, strong moves down, or maybe up at times too can pervade clean energy's theme; it's always been thus.

Meanwhile, a race for more electrons is on after years of slack demand. Look back at say a past 10 years, and ECO is doing 'less badly' than natural gas, a main competitor for generating electric power. ECO live since 2004, the best-known for clean energy is past 10 years up +48%. The first Global clean energy NEX, live since 2006, is by its tracker past 10 years up +60%. For comparison a natural gas futures Index (not ours, as we focus instead only on clean themes) -- has fallen mightily: down -89% a past 10 years. After war in Spring 2026, energy-secure solar & wind are gaining great interest, also for their low-costs too -- versus oil, gas, coal.

When clean energy's theme has fallen hard, valuations discounted, much negativity priced in, some asked if this theme might be troughing ahead? *Impossible to say!* And an inflection up, is only after a very long downturn. Plus, so much here is counterintuitive. Like how clean energy, so ECO jumped over an anti-renewables-president's 1st term. Their 2nd term began without an initial openness to energy of all kinds that may buoy renewables, yet clean energy rose again for 2025. Any shift ahead towards 'all of the above' US energy strategies may be a rising tide lifting all boats, renewables too if freed of politics. Or not, & past drops carry on! That said, we note as always that, *past performance is no indication of future results*.

Our Indexes reveal facets of clean energy. Meanwhile energy once mainly by old fossil fuels dug from deep underground, their prices spiking at times on geopolitical risks & chokepoints, then imperfectly burned -- is increasingly from abundant sun & breezes coming to us securely and affordably from up towards heavens. Here's ECO tracker to late last quarter:

Source: YahooFinance.com

All 3 of the big energy promises made by a US president for 2025 into 2026, have turned out respectfully, to be very wrong. As we'll see that president's own policies, (once again) had made his being incorrect, very foreseeable, predictable. Reasons why, will help illuminate how clean energy's theme, so ECO, gained sizably +100% first 4 full quarters of a 2nd term. But let's start with a recent volatile Q1 2026; 1st Quarter. Here is an independent **ECO Index tracker in blue, up +3%** & for comparison, an S&P500, down about -4% for the Quarter:

Source: YahooFinance

Strongly-conflicting-forces pertinent to clean energy, yet moving opposite ways, clash of late. One side, a cause for bearishness is that Wall Street does not tolerate extended periods of extremely-high-valuations in broad markets. Note then US stock markets are highly (maybe, much over?)-valued. Let's start with the high valuations. Worsened by AI stock mania valued to perfection. Maybe in a bubble that can/ (should?!) see some air let out. As S&P500 Price/Earnings (P/E) ratios become excessive, klaxons blare, red lights flash. As we'll show, a 'CAPE' hit levels late in 2025 seen just 5 prior instances in 153 years, after which US stocks *crashed* at times by -20% to -89%. With valuations late 2025 then mainly on 6 AI names, in an S&P500 alarmingly outpacing rest of an 'S&P 494' (some air let out lately). Thus, much here indicates *broad markets lately might be hugely over-valued, ripe for a plummet: this must be regarded as a high possibility*. Note too, volatile clean energy which may rise faster than broader markets, typically also falls far harder in downturns. After an April of 2025 low 28 in clean energy's theme, ECO fast gained over +100% in 3, & 4 quarters since that nadir. Then came war in 2026. All argues for maybe some reversion to mean downwards in S&P500. And bigger falls especially here, in this always-risky, and ever-volatile, clean energy theme.

Or opposing side, perhaps reason for possibly optimism(?!) is today undeniably, renewables are now the winners on economics. *In 2025 wind power hit a record-low-global cost in highly supportive conditions, of one penny per kilowatt-hour(/kWh)*; was not average nor typical, but very cheap electricity by free breezes. *Solar, hit 1 penny/kWh* too for cheap electricity by free sunshine; again not typical: both may be say, more-typical 3-5 cents/kWh. But when compared to generating electricity from a firm, yet costlier natural gas, or coal, or nuclear -- renewables solar & wind are the *Cheapest option*. Hence among good reasons for clean energy's so ECO's rise over 2025, one is economics. A rubicon was crossed: solar / wind from after early-2020s is now the cheapest electricity. Gap is only widening, irreversible. Never to reverse. On sun / breezes free fuel, the manufacturing knowhow for 3-5 pennies/per kilowatt hour electricity in supportive places, old-energy can never compete again on price.

Despite a president then promising: US Electricity prices would by now be down hard, by ½ -- or inexplicably that *adding* costlier fossil fuels would somehow make these prices drop(!?) -- didn't happen at all. Nor, has *Gas at pump fallen, as promised, to under $2/gallon: it went from $3.22 inauguration day Jan. 2025, to Not down at all, over $3.90+ in March 2026. To put that president in best possible light, we look first at 2025, before war by choice, spiked prices. Still reasons for these incongruities help explain ECO's big gains in 2025. Why, in a 1st full four quarters, from April 1, 2025, clean energy was up hard, +100%. As a white house adamantly tried to halt wind/solar, stoke a far more anti-renewables politics than at decade's start.

Arguably, much stems from misconceptions in that white house, core belief that fossil fuels are the cheapest energy. It was not, & still is not understood in that oval office, that factually, *it's Not true*. Tellingly, the *US States with Lowest-Cost Electricity rely 1st & heavily on their ample renewables*. Solar/Wind giant Texas has fastest-growing US renewables + cheaper-than-average electricity. 81% of new electricity in Texas 2025 was solar. Conservative, free-market 'red' states understand this: they have cheapest US electricity -- thanks to abundant lower-cost renewables. While liberal 'blue' states like New York, often have much fossil fuels, so costly power: New York 2019 to 2025, grew *less* solar/wind than Texas did in just 2024/25! In so many states, in countries too, adding cheapest power, thus renewables + storage = means falling costs. But clearly not yet everywhere -- plus 'intermittency' must be solved.

Let's see a Chart for clean energy themes, first 4 full quarters of a president's 2nd term so April 2025 – to end March 2026. We know this theme has many facets; so here's 4 clean themes (plus a 5th 'not-so-clean') all well Up via trackers -- from Up +100% as 'best' by ECO tracker; to a +60% 'least up'. Top is an independent ***ECO tracker (blue)** up **+100%**. Then 2nd is global ***Hydrogen H2X (purple,** tracker in UK so ".L") up near **+69%**. 3rd is *Global clean energy **NEX (light blue)** up **+65%,** & global *Wind WNX (teal, also an .L) up +58%. Also shown is a global 'cleanish' theme ('not so clean' as it has coal, nuclear -- so Not our's), last yellow, +58%:
Start Q2 of 2025 to end of Q1 (March 31) 2026; 4 clean energy themes, plus a 5th theme:

Source: YahooFinance

These 4 clean facets, plus a 'not-so-clean one', had all fallen, earlier-on, before April 2025 -- invisible here since to left of chart. After a president walked back 1st suggested tariffs (1st retraction of what would be many) in mid-April 2025, was bit fascinating to see year unfold. Up +52% for 2025, was bit like 1st term, when a same ardent-pro-fossil fuels president, likewise opposed clean energy. Yet looking-back, it was comprehensible, as we'll discuss ahead.

Equity markets are fairly-objective, are efficient, definitely forward-looking: move on facts. After years of flat electricity-use, rocketing energy demand for data centers & AI compute, is causing upheaval. Gigawatts (GW) needed fast! Not easily met by a strained, old grid. Nor by conventional natural gas unable to grow as fast as is needed. Nor obviously by coal. Nor, by new nuclear plants taking 10+ years to go up in west. Natural gas is firm, abundant in US, production is up on demand; yet burdened by geopolitical risks unending price volatility, equipment shortages, much more. All reasons why 90%+ of new US Utility-scale electricity generation in 2025 was just by renewables; in 2026 it was near 98% from renewables.

But not all is in a straight-line. A white house viscerally-against renewables, ironically helped them, with its "war of choice" in Spring 2026. ECO Index noticeably jumped the very next day. Still, that president did create 'distressed-like outcomes' all 2025, for renewables projects. Despite their prospects for longer-term growth, in 2025 a big 1,891 total power projects were cancelled. Of 266 GW lost: 93% was clean energy (86 GW solar, 54 GW wind). First half 2025, over $22 billion in clean energy projects were cancelled or cut-back; that also was on new policy uncertainty; inflation; rising interest rates, supply chain bottlenecks.

Other side of coin though, is broadening US stimulus. An oval office/unitary executive, plus accommodative congress all stimulating by mountains of debt; huge $$$$$ spent to run America's economy hot. Yanking 2 of 3 levers to 'juice' US economy. By: *Fiscal Policy, so giant tax cuts + massive spending; needs both executive & congress: latter normally check on debt. Congress has the sole Article I ability to tax/spend, in theory a guardrail on Article II executive powers. But a supine congress gave an oval (office) immense deficit spending + tax cuts in 2025, in 'one big' Act. For 2026, was $500 Billion in debt. For 2027 was $635 Billion. $2+ TRILLION (gulp) debt over a decade(!). Yes, GDP growth & stock markets then can go up, temporarily, on loose spending fiscal policy. But it's brief, not free; already fast sent total US debt past a kinetic, debilitating $38+ Trillion. And a 2nd lever to run hot, by *Credit Policy was yanked hard too, with massive efforts as well pushing widespread Deregulation.

But a 3rd stimulative lever: *Monetary Policy, excessively lowering interest rates, to run hot -- saw resistance. Normally, rates are set by *independent* Federal Reserve (Fed) seeking jobs creation & growth, wary not to stoke inflation. Cautious to not 'over-gun engine', not push rates too low (inflationary). Yet attempts were made to wrest that caution from Fed. A US president expressly sought a super-low 1% rate! Could mean 'steepening yield curve', for long-terms rates are set by markets. But that Fed, at least to early 2026, had resisted. Rates were then kept near 3.5%, then roughly neutral, neither very restrictive nor stimulative.

If fast growth by super-low-interest rates near 1% can be so easy / so great, why had no prior US presidents gone to lengths to stimulate via debt & artificially low rates? Why not just run huge deficits, grow US debts massively; wreck Fed's independence by such low 1% rates, to get near-term strong GDP numbers? In a nutshell because it means spiraling-debt. Inflation. Weakening dollar. Servicing debt could crowd out all other spending. Impoverishing our future generations who must repay (going >100% GDP, to get worse ahead than Greece, or Italy). Even aspirational 2% inflation means the US dollar falls in value by ½, each 36 years; at 3%, each 24 years. Maybe dollar debasement. Interest on debt passing defense spending, 1st time in American history. Fed can't set 10-year yields; so foreign creditors may demand these rise, costing all Americans as dollar loses value. Being world Reserve Currency helps, but only so far. As a president, + congress aimed to run all hot, some felt would be positive, productivity takes care of all. For others, issue wasn't If -- but When runaway debt/inflation may crash markets & economy. But let's turn our focus to new Energy paths, policies.

As unsophisticated energy policies of 2025, carried on into 2026, advice given within the white house raised eyebrows. Like to capture Venezuela's leader for its poor, sour, 'oil' -- without checking first with US oil executives, experts, to confirm viscous, hard to process reserves were then wanted by big US oil companies. They were not. So, when a white house last minute changed what was to be a closed-door private meeting with oil executives, to instead be televised live (hoping to hear loud praises) -- the CEO of America's biggest oil company had to proclaim on camera, correctly, that on nationalization/ security/ economic risks, those reserves were "uninvestable". Embarrassing an oval office who called it 'too cute'. Yet facts were clear: hard-to-refine, tar-like 'oil' reserves akin to Canada's tar sands, needing tens of $$ billions infrastructure renovations, diluents, heavy security, all with oil prices then in low $60s, made no sense. An administration's allies then tried to make a case viscous 'oil' was great for US Gulf refineries, but facts were: $60s oil too low, repairs & security costs too high, a non-starter for oil majors with boards of directors. It should have been factored, before invasion. Indeed 2 auctions that month for tracts in ANWR, & Colorado yielded zero bids, a failure. Permian does draw interest. But what wasn't yet well-understood in an oval (office), was tough areas were attracting little-interest with oil then near a break-even low $60s.

That 'incursion' seemed hatched in, ripped from pages of a 1980s playbook. Yet of no help in a 2026 world then awash in oil. Counterproductive even. 2nd term administration flailed some, trying to force its will on big oil firms most attentive to free markets. Annoying a president who'd hoped to see far-cheaper US gas, by then; who wanted US average electricity costs down to be ½ when he'd taken office, a year prior. (*Instead, his policies unwittingly pushed electricity costs, higher)*. Advisors seemed hamstrung by repeated mis-understandings, or were frustrated by today's free-market-facts. Something a leading conservative US senator had bemoaned on senate floor (discussed ahead). Undeniably, US energy policies had opposite impacts of what was intended. Seen too in tariffs; China in 2025 saw its first $1 Trillion record trade surplus; tariffs were 'supposed' to have the Opposite effect. That president deserves credit for being frank, open about his own visceral dislike for wind & solar. Yet he seemed unwilling to hear how renewables now are succeeding in US states, nations. The US red states with cheapest electricity, are thanks to their big & faster-growing solar, wind, storage.

Today, it's possible to chart a course for cheaper US energy, for better affordability. We know electricity from big natural gas plants, will cost best case, minimum 6.5 cents+/kWh. More after-a 2026 "war by choice" in Middle East spiked oil & gas; some called that "war by whim", given a lack of serious planning for outcomes. Yet even that 6.5 cents is too costly, vs. clean energy. Meanwhile, building big natural gas plants can take 7 years, so far longer than solar or wind. The big gas turbines, labor, know-how all stretched thin, so a combined cycle gas-plant that not long ago cost $785/kW to build in 2022, cost 3x more, $2,400/kW just 3 years later in 2025. That $2,400 is 2x, even 3x times too expensive, vs. choosing renewables. To compete today, a gas-fired plant should cost under $1,000 kW. Meanwhile once-mighty coal is so far out of the race, that building new solar or wind with batteries today from scratch, will be cheaper, smarter & better, than to just keep burning coal at all but just 1 of America's 210 decades-old, breaking, and hoping-soon-to-be-retired coal-fired power plants!

We know fossils & nuclear -- can't well compete on economics, vs. renewables. It is why solar or wind is #1 choice latter 2020s. Pricing advantage now seminal. Since fossil & nuclear only push electricity-costs up, it's conceivable a white house, just perhaps(??) begins to rethink … *possibly* allow (quietly) some renewables. Free of politics, clean energy wins. Hence a clash of late. If clean energy grows in-value -- whether it's over(?!)-valued, is a key question.

Step back, and all the world's total installed solar power capacity in 2022, was 1 terawatt. Just 3 years later in 2025, it was more than 2x, over 2 terawatts. Note then it's estimated on current trends the world may have 75 terawatts solar electricity capacity by 2050! All the world's total generating capacity in 2025, from everything, so coal, gas, nuclear, renewables etc was about 10 terawatts. Yet *China now has capacity to manufacture 1 new terawatt of solar, every year*. That will transform our world. Only makes sense: every hour our world is bathed in enough free energy from sun to power all electricity needs for a year. And solar is now cheapest way to make electricity ever in human history. China gets it: in just 2025 it added 240 gigawatts (GW) of solar capacity -- about like 240 mid-size nuclear plants. It passed 1,700 GW installed solar capacity, about like 1,700 nuclear plants. Of course, much more energy storage is needed to make all this firm, dispatchable, but it's happening fast.

European Union gets it. In 2025 it passed a tipping point: EU got 30% of its electricity by solar & wind; outperformed all EU coal, oil, & gas at 29%. From 2026 on, that line crossed, renewables #1, this gap can only widen. Plus add nuclear too was 23% more power, so 3 (solar + wind + nuclear) had met ½ of demand. Yes, nuclear does face big downsides vs. renewables: nuclear is far costlier, takes far too long to build, is capital-intensive, risky -- but adds key baseload power, and it too emits no carbon dioxide (CO_2). So, an EU at its 50% by solar/wind + nuclear; plus hydro/biomass for 18% more, in short meant it met 2/3rds by renewables + firm nuclear. Meanwhile, coal in the EU had fallen to a new low, of just under 10%.

Saudi Arabia, famously long a Petrostate, relied 99% on fossils for electricity, until recently -- now gets it, too. It is targeting 50%+ of its electricity to come by solar & wind in 2030! Hence is turning very fast to make electricity cheap, by domestic sustainable energy & storage. Fastest solar growth in human history. Or look at Europe's north: Norway is an oil & gas powerhouse, yet already meets 98% of its own electricity demands by cheap hydro & wind. Its costlier fossil fuels, instead, are exported (as Saudi wants to do). Sanely it makes world-beating-low-cost electricity just by renewables. About cheapest in Europe. Or a bit ironically, take Texas in US: America's #1 oil & gas producer. Yet met 40% of electricity demand in 2025 by its big, fast-growing solar & wind. In Oct. 2025 conservative 'red' Texas generated over 1/4th of America's total wind power. Texas' growing renewables recently saved it $28 billion. Were New York to develop ample offshore wind resources too, it could likewise save Billions. Something US federal policymakers didn't understand. In 2026 US officials paid a European energy firm near $1 Billion to cancel wind lease & plans off New York -- and instead build oil & gas(!) in US! To instead export out US gas as LNG; though it will do absolutely nothing to reduce US prices. Made no sense on economics, or for improving US energy affordability.

For a contrary energy path, consider #1 competitor, China. It massively, overwhelmingly, purposefully, is now the renewables leader. In 2025 its solar & wind under construction was over 2x the rest of world, combined. Crucial since cheap/abundant energy & AI/data center growth -- are linked, each influences the other. A huge power gap separates China / vs. US: though economic competitors, this gap is only getting bigger, worse. In 2024 China made over 2x the electricity of US; soon 3-fold. An AI center being built say in Virginia in US (greatest data centers concentration in world) pays high & rising electricity rates. While a data center in China with its renewables (maybe subsidies too) may pay ½ that cost for electricity. China's renewables + storage mean its power is cheap and is getting cheaper + and more abundant. That's a huge AI competitive advantage for China. By 2030, China with vast renewables & power transmission will have 400 GW of *spare capacity*. 3x rest of world's AI electricity demand. Meanwhile the US faces a *shortfall of 44 GW* by 2028. Today this widening US vs. China 'electron gap', is rightly worrying America's political & AI leaders greatly.

For ‘new’ US paths 2025/26, a big top US choice now, is coal(!!). Yet as recently as 2024, the US Utilities had planned to retire ½ of America’s coal-plants, by very-soon-2028, due to its failing economics. Coal today doesn’t have a chance. It’s about 2x as expensive, as ‘less-filthy’, firm, abundant, natural gas. A coal plant needs hundreds of employees vs. ‘just’ dozens at a gas-fired plant. Coal can’t slow output easily when renewables push electricity prices to zero, or negative! US coal plants are often 4+ decades old, see frequent breakdowns, maintenance, health costs etc. No new coal plants came online for years; output flat. Yet from 2025, with whole of government plans, a white house tried ‘startlingly inconceivable in being so non-economic’ costly new actions in trying to prop up dying US coal.

Even interventions, federal decrees, to *force* loss-making US coal plants, to stay open. Against all wishes of plant owners, Utilities, local & state governments! Federal emergency Orders kept open 5 of 11 plants slated to shutter, renewed each 90 days. On top of $6 billion already spent to keep coal going 2021 to 2024. Forcing all fossil plants slated to shut 2025-28 to stay open, can cost $6 billion more. Pretty startling, as local Ratepayers bear immoderately higher electricity costs; they want unprofitable plants to close, or switch to gas. A Colorado co-op was unsure how to seek cost-recovery for federal mandate to keep its old coal plant open, on costs of maintenance. EPA ‘helped’ an administration prop-coal-up; it repealed limits on mercury; rolled back rules on toxic air & water pollution. Extended deadlines to require coal ash must be dumped in lined pits’, so kept 11 coal plants from shuttering.

Key problem for an administration ‘pushing on a string’ was it’s all uneconomic. Late 2025 it held largest coal auction in decades; yet that 167 million tons coal got … just 1 Bid, valued coal under a penny per ton! Less than one, one-hundredth winning bid 2012. It hoped in 2025 for 3 more coal projects, yet all collapsed. On no new US coal-fired plants, ‘thermal’ coal was comatose, like ‘met’ coal for heat in steel manufacturing. Renewables now make more electricity in the US, than coal. And US natural gas is cheaper, less-polluting; plus the markets to export US coal had died; Indonesia’s coal is cheaper. Felt like maybe just an old cultural affinity for coal, a nostalgia held it up. A 1st term president, then pro-free markets, let coal fall hard. But 2nd term was different; pro-big-government, political appeals to its base, & this time it was rather untethered from open, free-markets & energy realities.

So much 2025/2026 had tried to prop-up US coal. Yet proved feckless, ineffective at best. Coal importantly *can’t* make US electricity more affordable / nor add far greater energy. Yet the consequences of so going backwards this way, are serious. Meanwhile unserious actions include a president mandating his staff call coal, “beautiful clean” [it’s neither]. An oval office wanting Defense Dept. to buy coal-fired electricity, though costlier. Interior creating a comic mascot, “Coalie”. Energy Dept. launching an unprecedented Coal Ad Campaign(!) of glowed-up sparkling coal lump with big stars photoshopped & tagline: “She Is The Moment”. Energy Dept. office banning basic key words that could cast coal/gas/oil in poor light, bans on words including: “emissions”, “clean energy”, “dirty energy”, “climate change”.

In 2026, a US leader speaking to world leaders at Davos, doubled-down on his thoughts on (coal-competitor) wind power. His words were remarkable. Not just in being strikingly, not factual; he was also taking US down a costly energy cul-de-sac of just coal, oil, gas, & nuclear. While damaging clean energy. In a few short years that remarkable energy path may be re-thought. So strangely, maybe was a bit bullish. Wind & solar were being decimated, yet in facts-based forward-looking markets, just possibly opportunities may arise in maybe wrong-footed(?) sentiments, actions. Perhaps worth a moment to consider those Davos words.

Such bold thoughts on wind power by a US leader at Davos were respectfully, remarkably, incorrect (something most in a room then understood). Yet this US leader quotably stated, *"China makes almost all the windmills, and yet I haven't been able to find any of the windmills in China. Did you ever think of that? [China sells] them for a fortune. They sell them to stupid people that buy them, but they don't use them themselves …. By the way, only stupid people buy them …. Every time that [blade] goes around, you lose $1,000."*

Let's just briefly consider facts on wind power, China. Contrary to a claim China doesn't have, or use "windmills" -- its wind generation in 2024 was huge 40% of all global wind power. It had giant 159 GW of wind power (more than US nuclear power fleet at 100 GW) & it had 180 GW solar in construction too: 2x rest of world combined. World's largest wind farm in Gansu is well-known, huge, visible from space: working since 2009 with now 7,000 turbines; once done will be 20 GW so like 20 nuclear plants(!) for 15 million homes. China has now enormous 20 MW offshore turbines, each one so big, can power 40,000 homes for a year. In 2025, China's wind & solar met 26% of electricity demand, a new record. Thanks to renewables, its low residential rates were often just 4 - 8 cents per kilowatt/hour (averaging 7.6 cents). Far better than US residential rates, near 17 cents. Or, than the EU with its big taxes, so 27 cents rates. Hence that US leader's words on 'windmills', were respectfully, rather wrong.

Europe responded quickly. Days after his return to a US, 9 European countries: Germany, Norway, France, Ireland, Belgium, Luxembourg, Netherlands, plus UK, agreed to build huge 100 gigawatts (GW) of joint offshore wind. About like all generating capacity of America's total nuclear fleet at 100 GW (though nuclear is firm, dispatchable … is far costlier than wind). Nine European countries aim for an enormous 300 GW from renewables by 2050. Not-so-subtle rebuke to a person repeatedly calling wind 'stupid', for 'losers'. Some in Europe making much clean energy, joked the animosity was a case of 'windmill derangement syndrome'.

US saw only setbacks trying against all evidence, to kill Europe's long affinity for wind & solar. Setbacks too in pushing its own US exports of natural gas LNG -- following US comments on Greenland that broke norms. US hoped a new 'Vertical Corridor' would soon move US LNG shipped to Greece, northwards into Central Europe for in an American ambassador's words, "energy dominance". Yet auction was a total flop: of a big 71 gigawatt-hours pipeline capacity offered, under 1/10th of one percent got booked. A later LNG auction got zero, no bids. Why? Reasons given by Greece, included erratic US tariffs; also white house breaking post-war alliances in Europe. After a US leader's comments in Davos on 'taking' Greenland, it was felt by some not a time to safely invest in US LNG. Little EU appetite then to exchange a past reliance on Russian piped gas -- with a new dependence on LNG from suddenly unreliable US. Despite an ambassador's links to oval office. There were / are limits to what any US leader can do, especially if facts run far to contrary. As a new 'sell America' trade arose, rupture led some 'middle countries' to look at energy path apart not just from Russia & from China -- but also from once-closely-aligned, once-pro-free-trade (lately much less so) US.

A pattern in 2026, yet one likely to be short-lived, was culture wars spilling into energy. 'Each side' then playing to its political base. A Utah utility also in 2 red states, Wyoming & Idaho -- was being encouraged to (and did) pull out of 3 blue states: Washington, Oregon, California. Latter 3 states aim to burn less coal; so differing narratives caused rift. But the economics will, in time, win out. For instance, a then-US administration forcing old coal plants to stay open in Michigan 2025, cost ratepayers there added $80 million first 4 months of year. That can't go on. Propping up coal is costly, & likely-to-be-short-lived. Demands for cheaper, smarter & abundant US electricity, will bring a shift to open, free-markets thinking.

Prioritizing US fossils over consumers, regrettably yet foreseeably meant high electric rates. While propping-up coal / harming solar & wind, did Not cut Utility bills. Nor had a 2026 'war by choice' in Middle East, cut energy, gasoline costs. Such US policies instead hit affordability at all income levels; but mostly for low & middle-income families. In 2026, 1 in 4 families said energy bills were unaffordable. Those making <$30,000/year, saw % of income for home energy reach a daunting 9.9%. Utility bills in arrears rose to $23 billion end of 2025: may go to $28 billion end 2026. Not a discretionary debt, is survival debt. Costs to heat homes early winter 2026, were up by 9.2%, 3x inflation. Then, went only higher, after war in 2026.

Such backwards results for affordability were foreseeable, on energy policies of 2025/2026. Solutions ahead, happily, are non-partisan, obvious, uncomplicated. They include to prioritize instead (like done ironically in many conservative, 'red' states): free open markets for cheap energy. Undo any mandates for costliest gas, nuclear, or propping-up coal -- and instead, embrace All of the Above energy strategies. Build long-term energy storage. Create resilient modern grids. Streamline Permitting. Remove roadblocks on solar/wind/storage/grid, to fast lower costs. Add firm geothermal. All compelling, and non-partisan. Nor has either one political party had all the answers; as we've observed, conservative open-markets red states often have the most-clean energy + the cheapest electricity (despite characterizations to contrary by then-white house). Problems not on Revenues-side -- but Spending-side: mistakes seen at both political parties. A big-government liberal state promised eg 'high speed rail' from San Diego to San Francisco, to cost $9.95 billion & be completed by 2020; yet it hardly had gotten underway in 2026, despite having spent already, over $14 billion. Both parties clearly and far-too-often, have been guilty of overspending, falling-into excessive debt.

As bigger government mandates + regulations have not grown new clean energy the fastest -- not have liberal state governments been able to ordain renewables. New York state's 2019 Climate Act calls for more renewables; yet in 7 years since then, 2019-2026, 14 states added more solar/wind, than New York did. Renewables thrive in free-markets: cheapest paths usually are solar & wind. Note too, that a conservative US party that long made much of its (fig-leaf) talk of balancing budgets, threw all that aside 2025/26 to run US economy hot. Self-proclaimed 'fiscal-conservatives' (ahem) voted in $3.4 Trillion+ worth of deficits. May lead to market rebellion: US can't borrow endlessly. Other nations too hold US bonds; seeing wanton profligacy, may demand high yields on 10-year Treasuries. Of massive $30 Trillion in outstanding US public debt, a sizable 1/3rd is held elsewhere overseas. In 2025, China as 3rd biggest foreign holder of US debt, net sold every month from March to end of year amid trade frictions. US deficit first 3 months fiscal 2026, $601 billion; $2.4 Trillion full fiscal year for a non-pandemic record; 14 years earlier all federal outlays were $3.8 Trillion; FY 2026, at $7.1 Trillion, a 87% rise, yet an oval office sought 50% bigger defense budget. Not just public debt is worrying: so too is $3 Trillion private credit; rules there are based on 'mark-to-market', which can become exceptionally volatile. A leading banker has said of hidden loans / private credit defaults, "when you see one cockroach, there are probably more".

It's not as if US energy policies 2025/26 'backfired' on an oval office. Not that it wanted 'less of X' (less wind & solar) -- yet got more. It had desired to & it 'successfully' hit renewables. At issue instead was perhaps cheap + more energy, was possibly not a #1 top priority. Just maybe an aim was adding more fossils/nuclear, plus frankly visceral dislike for green energy. That electricity prices in 2026 hadn't dropped by ½, gasoline was not under $2/gallon, energy abundance not unleashed, perhaps secondary; not as vital. Latter goals surely were hoped-for, yes; but to achieve those, would've meant *very* different US policies.

Consider the business model approach of an alternative data center builder. Rather than was typical, 1st build compute infrastructure & then look for power; it flipped that on its head, by 1st finding just sites with cheapest, ample electricity. So it's now better-prepared, given US policy mistakes that have lately meant tighter power, higher costs, grid constraints. A core chokepoint now for standing-up AI/data compute, isn't finding chips, capital, or hardware; instead, it's finding access to (cheap) electricity + grid priority. Because so early-on it had put a top priority on 1st cheap, sustainable ample power + priority grid access, it solved much. First-mover advantage. It avoided what so many competitors are now facing today. trying to find needed power + grid space for AI/compute. Let's see what they did.

They began fundamentally, by locating 1st in places with abundant & very-cheap electricity -- hence regions powered-mainly by renewables. (Cold places too saving rig cooling costs). One US site was in North Dakota with 30 MW (megawatts) of available grid; 100 MW ahead by updates, 300 MW total capacity. N. Dakota is a conservative state with much renewables; it has the cheapest electricity in America. Thanks to its very ample renewables, N. Dakota turns 1st to its own cheapest electricity sources, so to its wind power (36%) & hydroelectric (4%); these incur No resource costs. Only after, does it turn to costlier baseload lignite coal (55%), natural gas (5%). Like everywhere N. Dakota has had inflation in 5 years to 2025. Like in its transmission since transformer costs rose 100%; aluminum/copper wiring costs up 50%; what was $400,000/mile cost for new transmission line, became $2 million/mile. Its electricity generation in part from traditional fossil fuels, which had cost $800/kilowatt there, in 2021 -- had become $2,700/KW by end 2025. Still, North Dakota's cost-rises were at lower-end; it has cheapest electricity much thanks to ample renewables (and almost no natural gas).

That builder has another data center in Norway, accessing its hydropower for electricity costs of just 4.5 cents per kilowatt/hour. Far cheaper than US, since the nation avoids using costly natural gas, coal, nuclear. It is sited in northern Norway's NO4 power region, so not impacted by connectors to Europe, that may spike prices. Grid improvements may mean it can access 110 MW of cheap renewables; total capacity may reach 315 MW. And a Finland site has both grid access + sizable electricity supplies by hydro, & nuclear; along with fast growing wind and solar. Latter site might potentially access a big 1 gigawatt (GW) on the grid ahead.

In short, by 1st siting its data centers amid abundant cheap renewables + grid access, it enjoys power near low 4.5 cents per kWh. Contrast that, with data centers in the US with commercial electricity costs around 12.5 cents/kWh late 2025. (Residential rates worse, averaging 17.7 cents). Such low 4.5 cents with grid access too, is now big advantage for AI/data compute. Research shows 70% of grid access requests are withdrawn, on constraints. In 2026, due to tight capacity, 30%-50% of data compute sites may thus co-locate near natural gas plants, a costly way to bypass slow grid access, get power/firmness. Just 12 months prior early 2025, only a small minority of data centers were so vexed by power/grid. It is easy to forecast such power + backup trends, only push up 'gas burn rates'; worsen scarcity, grid issues, raise wholesale and so commercial / retail electricity prices. Worse, after war in 2026.

It was thus wise to site in a renewables-rich, North Dakota. Neighboring South Dakota, another conservative state, got notably 80% of its electricity by renewables in 2024 as 60% wind, 21% hydro; just 19% fossil fuels (11% gas; 8% coal dropping fast). In sum, 2028 is not far off and it shall mean a new white house. Likely, abruptly new energy paths starting 2029. Given lessons learned too on the painful economics & constraints of fossil fuels & nuclear. On needing more / cheaper electricity, it's possible US renewables + storage *may* find stronger new favor.

What can energy-hungry AI/data centers do now in few short years to 2030? Say, as 10% of maybe potential 600 GW new US power is built. That 60 GW is still a Lot; places gas access is easy like Texas, Pennsylvania regions, ~½ of centers may use 'temporary, portable' natural gas generators initially. Lots & lots of 'small' gas-fired units, on shortages of big gas turbines, grid constraints. Some even are reconditioning jet engines! A large US firm is making heaps of tractor-trailer-sized 5.7 MWe generators; bigger 16 MWe units too; a customer might want, say, 40+ to make 600 MW plus; as fast mobile generators. Onsite, behind-the-meter, bridge-to-grid, plus maybe fuel cells, for firm natural gas power, though costly. Yet very polluting, noisy; understandably seeing much local opposition. Or alternatively say co-locate centers next to big gas plants (or nuclear) for physical direct-tie-in that avoids congestion hurdles, bypasses getting onto constrained grids. Whether AI itself should instead be slowed, guardrails put on it is a serious yet separate question; we're looking here just at energy aspects.

Clearly, energy storage must scale-fast. Yet Li-ion batteries only discharge to 4 hours; so longer-duration solutions lasting 100+ hours are needed to help ramp cheap solar/ wind. Firming geothermal, is needed too. And if data centers bring capacity, added storage can add flexibility. Politicized opposition to sustainable energy, in some places may mean hybrids: much natural gas for firmness, plus solar & wind + short/long storage. Yet even then, prices for ever-volatile natural gas is at times costly; piped gas constrained, in places, not-ideal. So look at say a hyperscaler going up in Minnesota on arguably better design. Its 1,900 green MW will lower local costs + improve reliability: 1,400 MW new wind, 200 MW solar; with iron-air batteries' far-longer-storage lasting not just 4 hours, but 100+ hours. Grid improvements paid-for too; while that 100+ hours of storage can bridge several nights, windless days too.

To instead rely so on portable gas power / with only few renewables, is a work-around. Result too of grid constraints. Didn't have to be this way. China's far-greater GDP growth near 5.0% -- beating US -- is partly on its much-faster-renewables-growth / green policies. Its big solar, EVs, batteries etc, drove over 1/3rd of that growth in 2025. 90%+ of investments; huge USD $2.1 Trillion in economic output, 11.4% of country's GDP. New energy helped propel near 5.0% growth; without new energy industries, it's growth in 2025 would have been lesser 3.5%. Its annual green industry growth is accelerating too from 12% in 2024 -- to 18% in 2025. Growing faster vs. wider economy. While it did put USD $260 billion into old, dirty energy industries -- it put 4x that, USD $1 Trillion in clean energy. In 2025, renewables made up over 60% of China's total installed power generating capacity, growing. Importantly new energy is a major GDP growth generator, also providing it cheap, expanding domestic power.

Contrast all that -- with a US trying to prop-up … coal! Intent to stop any new solar/wind. Late 2025/into 2026 a US president repeatedly posted on social media "windmills are killing all of our beautiful bald eagles!" but mistakenly used an old 2017 photo of kestrel in Israel (not a bald eagle; they're in North America). Doubtful bald eagles really are his concern. And a fact is, coal can't meet fast-growing US demand: US demand grew by 20 GW, winter 2026 -- vs. a winter before. May soar next decade by over 220 GW. Much on AI/data compute. In a massive US winter storm 2026, especially battery storage (& nuclear) were heroes in Texas, where new 16.6 GW of battery capacity supplied 5 nuclear reactors' worth of electricity at crucial times. (In 2021, Texas had then had under 1 GW battery storage). With Renewables and Transmission fast growing more robust. It meant in a 2026 storm, wires (Distribution) was what then most went down on ice and winds. Far 'better' than in 2021, when so much Generation froze-off: natural gas mainly, but also coal, & renewables. In sum energy policies have impacts; it's worthwhile to pay attention to paths, directions being taken.

We do glance at presidents as simply relevant to clean energy's theme, though perhaps not in a direction one expected. From 2025 start of a recent leader's 2nd term, his initial Plan A re-directed the US economy in unprecedented ways. His new Plan in 3 parts, first focused on *Huge Tariffs aiming to bring in $1 Trillion+ [*though promised jumps in US jobs, re-shoring & manufacturing haven't happened*]; tariffs proclaimed at will on social media went around the congress where the power to tax originates. His Plan A also assumed too, swift and *Enormous Cuts to Government Personnel & Spending; anticipated easy gains; $2 Trillion more revenues & savings [*that didn't happen: total government spending, actually went … Up!*]. It expected that slashing regulations would be entirely just stimulative, $3 Trillion from tariffs + spending cuts + growth. Expected deficit spending to 'pay for itself' via new growth, allowing his 3rd *Huge Tax Cuts, in 'one big Act'. Envisioned fantastic new tariff Revenues + *less Debt*. Which might even eliminate a need ahead for any US income taxes. That was original Plan A.

Near-term, positive effects can briefly mean a rise in *GDP/*stock markets. But debt too, that's far longer-lived, so worsening problems: negatives for *Jobs, *Hiring, *Affordability, *Debt Reduction etc etc. And that administration's '3-3-3 Plan' likely also to be *very* wrong: it forecast US deficits would -- *fall,* to 3% of GDP. Likely to be wildly off, too, was a 'second 3' of their 3-3-3 Plan: predicting US oil production rises 3 million barrels/day (bpd). No surprise neither was happening. Instead, US oil production did not jump. US deficits scarily *rose hard* to 5.9%; worse & wrong direction, over 50-year average deficit of 3.8%. Sure, had the Plan worked: had US jobs & hiring boomed; brought in $2 Trillion+ in revenues; consumer confidence jumped; had affordability & inflation been licked; a manufacturing renaissance -- would have been great(!!). The candidate promised manufacturing now would be greatest ever seen in US history; he'd have vanished all inflation from US, that electric bills are down by ½; average US price paid at pump for gasoline in 2026 is now under $2/gallon.

Tragically, such 'expectations' in retrospect weren't likely. Manufacturing jobs never shot up. Deficits were not Down. Nor was affordability 'solved', by debt-fuel. Indeed, dismal election results in 2025 were rebuke to party in power. *[Note: other party hasn't fixed issues, either!].* That president late 2025 did offer a dog's breakfast of promises: $2,000 checks on tariffs instead of No Income Taxes. While claiming over & over, America in 2026 has "lowest inflation ever", and "greatest economy we've ever had". All as jobs, deficits, debt, consumer confidence, etc soured fast. Yes, the US GDP at first rose! Last '3' in '3-3-3' Plan, but on huge deficits, painful sugar-high. Still white house showed late 2025 it quietly could reassess; perhaps even change Economics policies, as its original plans saw very little success.

A review above is arguably worthwhile, for eerily-similar things were seen too, in US Energy policies. Oddly an administration adhered to just the costliest options: fossil fuels + nuclear -- while opposed cheap solar & wind. Promised it somehow(?) *cuts* electricity-costs, though that's impossible on its policies. No surprise US electricity rates rose throughout 2025. Went higher in 2026. As cheaper electricity was Not prioritized, it suggests an oval office not yet serious. Not 'unleashing energy abundance'. Such mismatch of professed aims -- vs. obvious results, defied logic; those oval (office) policies were all having opposite effects. Even oil industry executives through 2025 vented frustrations, in private. That continued in 2026 when a leader's fixation to stopping wind -- halted streamlining/permit reforms for all US energy projects. Oil execs weren't shocked US gas all 2025 was far from "under $2/gallon". That US oil production early 2026 was not meaningfully above late 2024. As we'll detail, those very odd US policies 2025 into 2026 were ironically, opposite of conservative, small-government, less-debt, open-to-competition 'red' US states, with the best & lowest-cost electricity.

One clear metric is *Price of Gas at the Pump. A president promised US average gas would fall under $2/gallon his 1st year back in office. Yet, went from a $3.22 on his inauguration day Jan. 2025, to not down at all, over $3.90+ one year+ later, in March 2026. Yet (playing with numbers, a bit), a president still claimed in 2026 State of the Union, "gas prices in most states are now below $2.30/ gallon, and some places, $1.99/gallon." By switching from *national* price, he might look at gas just in a few, cheapest states, for lowest possible figure. Yet even then only 2 of 50 states were barely under $2.50. Then, took cheapest few *individual* gas stations, in all US! Was 4 gas stations just under $2: of 150,000 stations, was 0.003% of total! To go from promising under $2 US national average gas at pump, to claiming a win based on just 4 gas stations in all US, was quite a stretch. And before war 2026; gas after, spiked.

To put that president in a best possible light, we look here first at 2025 -- before his 'war by choice' spiked energy in 2026. When campaigning, then in office, he'd seemed earnestly to believe he could push gas under $2. His administration's '3-3-3 Plan' claimed by deregulating they'd add *3 million barrels/per day (bpd)* to US oil production. So go from a 13.6m bpd crude oil of his predecessor (whom he deemed a 'loser') last full month of prior term -- to a big 16.6m bpd right away. Perhaps, he hoped to fast push US oil down, to under $40 barrel -- even though many US wells are uneconomic, below $60 barrel. That oil drillers despite free market signals, for less rig counts, as prices fall -- somehow boost rig counts. Then, even more remarkable: his administration claimed that they'd entirely succeeded: that US price was under $2 per gallon in 2025. His advisors, doing so, were not serving that president well. And their badly-failed '3-3-3 Plan' was hardly again referred to, was not mentioned again.

Even broken down, as 50 states, not one state came near $2 in 2025. Still an oval office Nov. of 2025 stated [wrongly], gas "prices have plummeted to lowest in 2 decades" [not true], a "bit above $2 now, going to approximately $2 very soon" [didn't happen]. Of course, no US president buys his/her as at pump. so a president can't readily know gas prices in a way Americans do filling their car. Arguably, his advisors should have informed him repeated fulsome boasts were wildly off. Gas briefly had once fallen under $2, but that was in his own 1st term(!), and was on Covid demand collapse 5 years earlier in 2020. Yet he claimed May 2025, gas "hit $1.88 in 3 states". In July 2025, "hit $1.99 in 5 states". [All incorrect; maybe was grasping at just a few stations]. Anyways on his policies, a US could not then get there any way, shape, form: opening easy US tracts *might* push oil down briefly to $50s/ barrel; yet many shale rigs un-economic at such prices. *And oil must fall below $40/ barrel, for average gas to go under $2.00.* But then US rigs shut-in, rig counts fall. All well-understood by oil executives who'd privately vented 2025, then on war 2026, about erratic energy policies.

Or, consider respectfully, another repeated claim, that he'd "Unleash American energy" for a "golden era of American energy dominance". Like so many of his aims, it too was laudable. Yet again, his contrary policies had / & continue having opposite effects. Right off bat, start of 2025, his administration did everything imaginable to halt wind & solar energy. Once-fast-growing US renewables were hobbled, so impossible to unleash a US "energy dominance". Doubly-so, as his administration policies also foreseeably failed to raise crude oil production, any meaningful way all 2025. Certainly not by a targeted, 3 million barrels/day. Diesel, the backbone for trucking so much in the US, hit an inflation-inducing, $5+/gallon in 2026.

All, as far-better energy solutions in conservative small-government 'red' states, open to fair competition, could be a blueprint. They have both low-cost energy & renewables. Yet instead, big-government mandates, costly requirements was forcing coal plants to stay open. US policy allowing for only coal, natural gas, oil, & nuclear; that was all pretty tough to believe.

2025 on, everything imaginable -- plus some that hadn't before-been-imaginable, was tried -- to stop wind & solar. For US actions off the bat in 2025, federal officials: Declared national emergency intended to help hasten permitting -- yet they strangely carved out solar/ wind/storage as 'not energy' (January). Froze permits for new onshore & offshore wind on public + private lands (also January). Interior deemed solar/wind "precariously inadequate" so a national security risk, on that basis, blocked new renewables deployment (in February). Removed solar/wind from cheapest & fastest energy Lists, struck off affordability agendas. Canceled an enormous 6.6 GW(!) solar project and 5 GW battery storage for 62,300 acres in Nevada desert, as on federal lands. Canceled 800-miles of 5 GW transmission that would have sent cheap wind power out from America's Midwest. These were just a few examples.

Might such odd ideas be quietly softened ahead?? Given notably, such poor energy paths weren't costless. They're pushing Up electricity costs fast -- and if US is to build AI, grow jobs, re-shore industry -- energy costs *must instead come down*. By 2024, renewables were cheaper than all fossil fuels, or nuclear, over 90% of time -- gap widening! So there's a limit to what a president can do to harm wind/solar. Softening may mean (*shh, quietly) moving away from just fossils. Yet that administration by Emergency orders mandated 9+ coal-plants must stay open (owners wanted to close!!) costing $615,000/day. Forcing all fossil burners to stay open, may cost consumers $3 billion by end of 2028. 2 plants in Colorado, Indiana shut/broken, were ordered to restart costing $$$$. Forcing uneconomic coal to stay open, cannot possibly help consumers. High electricity-costs may require a rethink. Would be a real change, though. In Dec. 2025 the Energy Secretary announced he was looking at keeping America's Back-up Generators at big box stores etc running 24/7, for 35 GW. Put aside for a moment it's the most-*In*efficient way to make electricity imaginable. Note it would instantly be also **The Most-Costly-Possible* Way to make electricity!* Non-sensical if seeking cheaper electricity. But tellingly if an aim is to use only, diesel, gas, & propane fuels -- no matter higher costs (and halt renewables, no matter what), it was only way to 'justify' that.

Given the oval office antipathy to green energy, one may have guessed clean energy's theme/ so stocks, and thus ECO, fell hard in 2025. Instead as noted, ECO Index & tracker jumped in that year. Didn't go unnoticed. 1st month of Q4 2025, October, trading volumes in independent ECO tracker were significant at near $1 Billion that month. Feb. + March 2026, ECO went sideways; yet tracker trading volumes were over a million shares/day, over a dozen+ days.

What had, earlier-on in 2025 pushed expectations down, 'coiled a spring' for big rises? One, was likelihood clean energy opponents in oval office & self-proclaimed 'fiscal conservatives' (barely) in control of house & senate -- could decimate green energy. They'd drafted in Spring of 2025, a harsh 'one big bill', with real chance these fervent opponents to renewables could jam moderates in house, then in senate, with text singling out clean options for acute harms. They could still lose up to 3 votes in house, 3 in senate. While odds their conservative party's own moderates might upend such efforts, so slow that inertia, were not great.

As draft text hurting solar/wind was worked-up in house where spending bills begin, oddly self-proclaimed 'fiscal conservatives'(!?) knew their 'one big' bill would blow up the debt. Raise debt ceiling by $5 Trillion! In short time 7% deficits, $3.4 Trillion deficit spending! Yes 'juicing' stocks/GDP, but was a deficits/debt-bomb. As draft went to senate, it seemed sure Kentucky's libertarian senator is a 'No' given his stand on debt: it wasn't Conservative. That proposed new debt was inarguable. On a president's self-imposed July 4th 2025 signing date, and likely just 2 total senate No's (same as in house), its passage seemed likely.

Hence it was pivotal when North Carolina's senior senator, with rare deep energy knowledge, announced he'd be a new 2nd 'No' too. Senator stressed his No was on a president then "very badly-advised" on energy, health care. As a result, just 2 moderate senators could in effect then 'tag-team'; 2 more No's is one too many. So, 1 on-fence senator could demand enormous changes, in exchange for a Yes. Conservatives who'd wee hours before eagerly gloated they'd jam liberals on solar/wind in house, then senate, on fiercely anti-renewables draft text, instead found themselves jammed! They'd face a 'one big' bill more moderated, than what they'd hoped for. Nor could they badger this one N. Carolina senator who knew energy far, far better than most any politician. The president wanted to sign it on a July 4 -- so threatened to 'primary' that senator in 2026. Hit him hard at polls. That senator retorted well then, best to look for his replacement for he'd just retire, neutering such threat.

With a moderate senator from purplish-Maine as 3rd & last possible No, it put Alaska's senior senator in key pivotal role. Able to make big demands, in exchange for last needed Yes. Some asks were narrow: help its fishermen; for Alaskans to do better on Medicaid & SNAP as a 'noncontiguous state' (blow back by parliamentarian). But notably, Alaska's senator crucially demanded a far more moderate approach on renewables, hence fewer clean energy cuts, a more-pro-American stance, more cheap US energy & so growth still in renewables. Mitigating vengeful extreme attacks. Because both house/senate text must be identical, this senator rather 'dared' the house to make any change, send it back. Ping-pong back & forth, senate's resolve maybe strengthening, a revised bill moderated more. House 'fiscal conservatives'(?!) at first threatened their unwillingness to cave, but caved immediately. And thus a president who'd hoped to proclaim big fast victory, immediately did so. Signed 'one big' Act into law. While quietly also telling conservatives that his administration can & would fast undertake a range of unitary executive actions, to hamper just clean renewables solar & wind.

Since that North Carolina 'No' made much possible, let's look briefly at it. This senator spoke unusually forthrightly on senate floor, pulling back curtains on 'how sausage is made'. He stated bluntly, the president was heavily misled by poor guidance on 'one big bill': impacts would not at all be what an advisor claimed. Senator staunchly defended solar/wind tax credits in 2022 IRA, said new 'one big' draft bill was "another classic example of think tanks & people that hadn't worked a day in business, setting policy in white house, without a clue about what they're potentially doing to our grid!" He described his discussions with that 'self-described philosopher' (advisor to oval office) & repeated, he had No experience in energy -- he was a pro-fossil fuels / & anti-renewables 'zealot'. Versus 3 real-world business experts, who all knew about actually fast-putting needed electrons & batteries on better grid.

3 real-world experts all had wanted far *more* renewables, better grid, including one of the world's most sophisticated electricity buyers that maps out energy needs years in advance. Senator stressed proposed draft would instead gut power purchase agreements for reliable, cheap solar/wind. Attacking renewables & grid was senseless. He bemoaned 'somebody had gotten cute' too in negotiations replacing deadline text words requiring 'in construction' -- with 'in service' -- to effectively decimate new renewables. This senator with much expertise in grid baseload energy noted so much progress for solar & wind was now teed-up. Yet instead, a white house representative lacked experience, didn't know how to actually-plan-for power ahead. Lamented the draft was still 'half-baked', so this loyal-senator was forced to vote against his party on a bill backed by inexperienced zealot/ 'philosopher' with No Real-World Understanding of generating electrons. A video of this impassioned unusually frank and pivotal speech as was recently delivered on the US senate floor, can be seen at, https://www.dailymotion.com/video/x9m45t0

Senator noted how even best case, due to supply bottlenecks, big gas turbines not already in contract won't be ready for ~5 years. Since fossil fuels & nukes can't deliver soon, electrons won't come fast, if renewables aren't built. Yet a 'conservative' (not really) advisor, hadn't understood that. So, on 3 No's from Kentucky, N. Carolina, Maine, 1 swing Alaska vote, input by key senators from Utah & windy Iowa including a parent of PTC, big changes last minute moderated that bill. Made 'conservatives' fiercely anti-renewables/ pro-fossils-only howl, but they'd been jammed in senate, house. For example, a prior draft would have cancelled all solar/wind tax credits on projects not 'in service', a deadline few met. Much is outside of control, like Permits needed to put electrons on grid, taking years. It's why a senator noted somebody 'got cute' as draft went from 'in construction by', to must be 'in service by'. Moreover opponents sought immediate halt to all solar/wind credits to prevent renewal by new president or congress 4 years hence; it failed. Other draft harmful text was removed wee hours before signing. Like taxing renewables! Or to forbid Chinese components, notable as solar (sadly) is overwhelmingly still made just in Asia. In end jammed, pro-fossil 'zealots' lost much extremist text final few hours, when worst proposed penalties, got moderated.

Softer "or" words got added in too, so besides impractical, 'be placed in service' deadlines -- projects *alternately* may 'begin construction' next 12 months; credits then go 4 years + beyond. On Safe Harbor rules with which industry is familiar. Temporary grid connections, load banks. Helpful criteria like if 5% of equipment if paid-for; or if work done of a "significant nature" on /or off-site demonstrating continuous progress. Oddly, the self-titled 'fiscal-conservatives' were fine adding $3+ Trillion in deficits, huge debt; they even sought too a *costlier* US electricity -- so long as will be fossil fuels/ or nuclear; glad if harms solar/ wind. To bolster that, a July 7th Executive Order demanded that federal officials "strictly enforce" new paths that may terminate subsidies for renewables. Concerns arose over that.

An administration criticized Safe Harbor, it threated retroactivity. Underscored a willingness to push boundaries/norms. To empower clean energy foes, an Interior Dept memo stated renewables on federal lands/waters needed an ok from Interior secretary: gave 70 ways to hinder it. Another concern was a soon-coming US Treasury letter might be *Retroactive, so obliterate prior better rules; end hopes projects can begin by 2026. A fear too was *Treasury may dis-allow a 4-year window to 'begin construction' on home solar even if 5% of fair market value is spent. Window was expected to close on big solar; but might it continue for home rooftop solar? When the US Treasury Dept. did issue a Letter, latter 2025, thankfully it was *much better* than feared. Solar stocks jumped. Still, if that administration had intended by this 'one big Act' to 'set the table' in 2025, for 'a feast of tax cuts' in 2026 -- it failed badly. Rather than Act putting tax cut dollars back in peoples' wallets in 2026 -- its 'war by choice' in 2026 caused oil & gas prices to spike. Should have been an obvious, predictable outcome; but time and again, erratic actions were undertaken, not-well-thought-through.

Much politicized/anti-green, culminated in 2025's 'one big' act. Yet ECO, NEX, H2X, WNX, gains followed. An ECO component in strategic minerals, rose +51% on July 10th as US invested $400 million to be biggest shareholder. China dominates in rare earths; but this firm with new $110/kg price support in neodymium-praseodymium can start to mine & process domestically, to start US end-to end critical supply. Will take years but a start, reflects keen interest by Pentagon and private sector. Early July 2025 that equity was $30; just days later in mid-July it was over $60; later was up 5-fold year to date. Or, a US lithium miner leapt 95%, as the US may take 10% stake in it. A silicon anode maker was up 14-fold in a past year to Sept. 2025. So, for clean energy theme, thus for ECO, after an April 2025 nadir low close at 28, it gained 120% over next 6 months, for reasons that looking back, made sense.

Looking back at clean energy/ECO in 2025, many components stood out by impressive gains. How these good gainers were added into this passive ECO Index, so very many years ago -- is maybe of interest to folks outside of energy, so worth mention. One, a component in *lithium rose up 200%+ in 2025: ECO has always had deep exposure to lithium/battery materials since Index inception over 20+ years ago. For how lithium was understood early-on as likely to be critical in green energy ahead, just consider physics & chemistry. Left column, 2nd row of periodic table, lithium (Li) is importantly the 1st so lightest metal, with its just 3 electrons (2 inner orbital, 1 valence) atomic number 3. Three protons, 4 neutrons, so super-light, less dense than water. With just one outer shell electron, LI is very reactive. Hence it 'wants' to either add an electron -- or most relevant here, this atom readily can lose single-electron to become an ion, which we all know as it then becomes Li+ ion (lithium-ion). Li key traits being very lightweight, very reactive, energy-dense, made it likely core to batteries ahead. State of the art battery tech back in 2000, was chemistries were far too heavy (lead-acid), memory effects (nickel cadmium), simply not as energy dense as needed for expected new electric vehicles. Hence lithium was a key 'better-metal'. Foreseeably fated to fill gaps. Plus policy factors. US & Canada years ago had let their crucial lithium sources shift overseas; went to Australia, Chile, even China. Precious few suppliers left in Americas, they could see far-better valuations. As happened 2025. In essence recognizing physics, and policy mistakes, one could foresee lithium firms in a US, or in Americas, might rise possibly quite hard.

Or take *rare earths metals & a 2nd component, also long in passive ECO, here up 300%. The rare earths Lanthanide group is made up of 15 / 17 elements, and in fact are not rare at all -- but difficult to purify. Vital to powerful magnets and motors: they've long been relevant to, so part of this clean energy theme. Yet US (like Europe) had let rare earths production move past 4 decades almost-entirely to Asia/China. Though critical in electric vehicles, in motors, wind turbines, more. Neodymium say, atomic number 60, in iron/boron in magnets can lift 1,000x its weight. To replace that neodymium, with US-source iron-nitride will take years. In sum rare earths were very relevant to, long in ECO. While moves (up) in these very volatile ECO components in Li, and in rare earths, as seen in 2025 were not entirely surprising.

A 3rd name in *fuel cells was up 400%+, 5-fold 2025. Fuel cells are highly-relevant to so long in ECO theme, yet loss-makers for 20+ years! This component is a bit different; unlike needing pure hydrogen / H_2, tough for high costs etc, it uses common natural gas (methane/CH_4) fuel that's everywhere, easy to use. Rather than burn, exothermic polluting -- this instead strips CH_4 to H -- so hydrogen protons (again ions) plus electrons (electric current). Downsides include 'stacks' run hot so short life not yet much over 5+ years; efficiency not much better (yet) than natural gas plants, & costly. Still, big natural gas-fired plants take years to build; these can go up fast; stackable, less NOx pollution. AI hyper-scalers needing electricity now, fast, may add lots & lots of small portable gas-burning generators, and/or turn here. On deal announcements, nimble execution, falling rates, this one long in ECO, jumped in 2025.

Rises above in 'winning' green energy equities of 2025 -- were for facts-based reasons. Based on insightful business models, each path thoughtfully laid-out. Stands in stark contrast to 'losing' policy propositions that more broadly sought to expand, to prop-up dirty energy; they came from a different place, politics, far outside clean themes. Latter 'dirty energy' hopes arose out of more politically-based goals. Which seemed at first blush, to be most pushed by: 1) 'slash electricity prices in half'; 2) *push gas under $2/gallon, 3) unleash US oil abundance at record 16m bpd levels. That politics-derived push mainly pro-old-energy / anti-new energy, arguably was not-very-thoughtful; was haphazardly, un-seriously conceived.

Effects of new US energy policies came fast. (We focus on energy, as it is our work). After signing hallmark 'one big Act', US electricity costs *rose all 2025, up 6*%+. Went only higher -- by a lot! An administration's original '3-3-3 Plan' (no longer much referenced, as it failed) promised to 'unleash US energy abundance'. Claim for one 'of the 3s', was it would increase US oil production, by 3 million barrels/day. Note then US production last full month of a *prior* president, was-then-record 13.6 million barrels/day (bpd) back in Dec. 2024. A full year later, on new administration, early in 2026, it was only just fractionally, barely more, 13.7 million bpd, a very small, meager rise. Hardly up at all -- let alone by huge 3 million to 16 ½m bpd. Yet, an oval office often boasted it reached amazing records, though a tiny bit higher. By playing with numbers, they could (barely) say a 'record'. But production was barely up.

National US gasoline (gas) price had dipped a bit 2025 -- mainly on overseas more pumping by OPEC+. (Price would soar of course Spring 2026 on a US war by choice), Americans see gas price up close, so undeniably it was Not near under $2/gallon, not 'a dollar something'/gallon. Prerequisite for under $2, is US oil output must go up hard so oil falls under $40/barrel & *stays there*. Yet even $50/barrel oil is unprofitable for many US drillers, it's too low. That didn't happen anyway: 1st half 2025 US oil production *fell*: it didn't rise back to 13.6m bpd until Oct. 2025. Then was just 13.7m bpd early 2026, not meaningfully more.

Respectfully, president was quite confused too on key US electricity generating capacity: in a speech Dec. 2025 he said, "within the next 12 months, we will have opened 1,600 new electrical generating plants, a record". That was impossible, wildly(!) off: permits take years, so we'd know if was even a fraction of that. Maybe he'd mixed up "1,600" with just **1* natural gas plant coming online 2026, 'near-ish' 1,158 MW. But just 1 new plant, is absurdly far from *1,600 new plants 2026!* Almost all new generating capacity in 2026, was just solar, batteries, wind. Only about 6.3 GW of new gas plant capacity was coming all 2026. 3.3 GW of combined cycle, and combustion turbines 2.8 GW. Yet a '1,600 new electrical plants in 2026' was from a speech so signed-off too by US Energy Dept. perhaps fearing to correct an oval office.

That oval office, did make subtle meaningful changes Dec. 2025, for price at pump. Rather than go on insisting US gas average now "under $2.00" -- for a 1st time, changed to "in some states". And to "under $2.50". These ways, a white house could walk back its claims; cover tracks; maybe point ahead to cheapest gas states, like just say, Arkansas, or Oklahoma.

Yet if more of cheapest US solar & wind is what can fastest push down US electricity prices -- and an oval office was adding only costliest fossil fuels & nuclear /and hitting renewables -- what helps explain this counter-factual? In part it seems out of deep antipathy, a personal visceral 'dislike' for wind & solar. Consider in 2025 visiting Scotland, the president helpfully explained much of his own reasoning for deeply opposing wind power. While next to a European Commission head, that US president spoke of his views, of his own volition:

> "And the other thing I say to Europe: we will not allow a windmill to be built in the United States." "They're killing the beauty of our scenery, our valleys, our beautiful plains — and I'm not talking about airplanes. I'm talking about beautiful plains, beautiful areas in the United States, and you look up and you see windmills all over the place. It's a horrible thing. It's the most expensive form of energy. It's no good. They're made in China, almost all of them…. "When they start to rust and rot in eight years, you can't really turn them off, you can't bury them" …. "The whole thing is a con job. It's very expensive. And in all fairness, Germany tried it, and wind doesn't work. You need subsidy for wind. Energy should not need subsidy." ….

It's fascinating that all assertions above, are respectfully so wrong. Energy changed greatly a past 40 years; so much so, latter 2020s, wind & solar are not costly energy; they're *now the cheapest*. US states with very lowest-cost-electricity, rely on much hydro, wind, or solar. The very cheapest electricity states: N. Dakota & Idaho turn 1st to ample renewables. While very costliest electricity states all rely heavily on fossil fuels. Plus, most wind gear in Europe/US isn't made in China; it doesn't rust or rot in 8 years, runs 25+ years. Wind works reliably-well in Germany with its growing renewables. Contrast that with a most-coal-dependent-state, W. Virginia: it has *least-reliable* electricity. Iowa by contrast, had highest % wind power in 2025, got 2/3rds, 66% of its electric power by wind: 6,000 turbines + cheap electricity; plus costs there *fell* in a year to 2025. In short, respectfully, such wrong notions above on wind/ solar were maybe understandable, if they'd been formed in a far different 1980s. Now in a 2020s they'd become bluntly, rather enormously incorrect. That president then went on,

> "But more important than that, is it ruins the landscape. …. "You know you have a certain place in Massachusetts area, that over the last 20 years had one or two whales wash ashore, and over past short period of time, they had 18, ok? Because it's driving them loco, it's driving them crazy. Now, windmills will not come, it's not going to happen in the United States." …

Science hasn't found any correlation of offshore wind to whale deaths, often caused by vessel strikes, fishing gear entanglements. *But everyone is entitled to their own opinion*. And that president deserves much credit too, for being so frank, forthright. He oft speaks of his own personal grievances on offshore wind: specifically, visual impacts on his own golf courses. Helpfully that president has spoken at length since 2011 of his animosity over sight of offshore wind from his golf courses near Aberdeen Scotland, Doonbeg, Ireland. He's sued, & lost, claimed it ruins his views. Local/national governments there however take an opposing side; in 2025 just 2 days after the comments & leaving Scotland, the Scottish government approved world's largest offshore wind farm: huge 4 gigawatts (GW). To power 6 million UK homes, for thousands of jobs, lower electricity costs, billions of GB pounds in revenues. Bigger than anything then off of China, saying a lot. Then a US president who's claimed 'wind power noise causes cancer', finished his own helpfully personal illuminating comments made of his choice. Next to the head of the European Commission, explaining further his own thoughts:

> "Today I'm playing the best course I think, in the world, Turnberry. Even though I own it, it's probably the best course in the world. And I look over the horizon and I see 9 windmills, … and I said Isn't that a shame! What a shame! You have the same thing all over Europe. …. "Some of the countries prohibit it, but people oughta know, these windmills are very destructive. … "These are people that, they almost want to harm the country" … "It's the worst form of energy, the most expensive form of energy"….

His administration has hewed closely to his views, as a leader famously brooking no dissent. His US Energy Dept launched an unprecedented Coal Ad Campaign(!) with glowed-up sparkling coal lump & tagline: "She Is The Moment". His Interior Dept's "Coalie" cartoon mascot. Even though coal makes US electricity costlier, hurts affordability, is very dirty, has poor reliability. Coal does have firmness, unlike intermittent solar, wind; so latter 2 are best with storage & more robust grid. Yet if sentiments by a president that solar/wind are the most costly; don't even work, were thus maybe formed in 1980s, that Coal Ad seemed from a 1880s; now grossly counter-factual. Even a glowed-up lump, photoshop sparkles can't give what Ad implies. But it's an Ad very specific to US. And whether the Coal Ads 'have legs' is yet to be seen.

Conceivably, might an administration from 2026, alter its direction a bit? For how badly a white house 'pushed on a string' all 2025 on hopes adding fossil fuels will cut US electricity costs(!?), consider facts. These will bedevil fossils all late 2020s. The fact is, any new US natural gas plant + fuel, is now far costlier than solar/wind. Gas-fired power, very best case, costs at least 6.5+ cents/kilowatt-hour (kWh). More, after war in Middle East in 2026, even if that gas is produced/ & consumed entirely in US: prices are based on global markets. Plus US gas is exported as LNG; buyers in Europe/Asia pay more. Alternatively, there's nuclear power. Yet big nuke reactors in west, every single case, went far over-budget. Small modular reactors lately enjoy 'hype-cycle' subsidies; yet small US reactors work now in theory, only; a few commercial-experiments worldwide are far from on-time, on-budget. Even then power $/per kWh is priced above big nukes, themselves too costly at over 10 cents/kWh! So, one can only hope there's truly better solutions ahead, that nuke costs & safety improve in 2030s.

Among non-renewable energy options, this leaves only: coal. Yet in no way can coal *ever* cut US electricity costs. Even in China where some coal capacity is still built, China turns 1st to its own renewables as cheapest; China ½ half of 2025 installed more new solar capacity, 210 gigawatts -- than all 153 GW installed solar capacity in entire US. While China's coal plants often run at just 50% or less capacity. Coal is too costly even in China, though its pollution / human health standards are far more lax, than in west. With US coal fast declining today, a focus is Not on when new US coal plants get built -- but when last are retired. Yet a 2nd term administration tried to promote & revive US coal. Late 2025 it held as noted the largest coal auction in decades. Huge 167 million tons Montana coal got as noted … just 1 Bid. A silly $187,000 valuing coal under a penny per ton! Back in 2012, winning bid was $1.10/ton, 100x more. Reasons for such abysmal 2025 auction were plain. *Coal-fired US electricity is now too costly*. Last US coal plant went into service decade+ ago -- none since. Yes, as candidate, then once in office, a president often spoke of "unleashing American energy", he pantomimed "digging coal" -- but the economics are undeniable. An administration in 2025 had to halt its planned 441 million tons coal auction in Wyoming, stating *"While we'd hoped for stronger participation, this postponed … coal lease sale in Wyoming underscores lasting damage from [a prior] administration's decades-long 'war on coal' which aimed to dismantle domestic production, shake investor confidence in the industry."* US BLM staff even further wrote [perhaps bit unconvincingly]: *"under this new president [BLM is] restoring trust between government and industry as part of a broader push for American Energy Dominance."*

An alternative, sobering analysis is while a 2nd term administration may blame awful bids on "lingering impacts" of [prior president's so-called] 'war on coal', fact is coal-fired electric generation was already very hard down. Fell 3.5%/year in a prior presidency. But earlier, was it had already dropped 9.5%/year in this same conservative-president's own 1st term! Latter analysis observes that *"Coal simply can no longer compete with other energy sources like natural gas. Did BLM really expect enthusiastic bidding for the property? Do they really believe in the 'war on coal'? If publicly solicited bids don't represent market value, what does?"* They noted, *"energy business, we would argue, is in the midst of a wave of creative destruction, as new energy technologies supplant old ones.* [The president's] *energy policy seems to be a combination of determined opposition to new ideas, and ineffective support for the old. We asked a Washington insider to explain what theme dominates the administration's energy policy. He was puzzled, then said, 'Possibly a visceral hatred of renewable energy except for geothermal.' Is that the basis for an investable energy policy?"*

Arguably all these latter compelling points, are today food for thought.

To clinch how electricity costs may best be-lowered, let's see where they're cheap. At places all potential energy paths are allowed, with smart policies, what's best? We know on sheer efficiencies, that solar & wind, though intermittent -- beat fossils on cost. Thanks to free sun & breezes as fuel, renewables manufacturing scaling, a missing link of storage-coming-down fast in cost for dispatchable power, gap is only widening. Recall too: 2025 set world-record for low-cost wind: 1.338 pennies/per kilowatt-hour (kWh) in not-windy, but highly-supportive Saudi Arabia. Or note Norway is 98% powered by renewables. Portugal is 68% renewables. China is now 40%+ clean energy & growing fast, A big state of South Australia start of 2026 met 84% of its electricity demand by solar/wind; most of any major grid and may reach 100% end of 2027: because of it wholesale electricity costs in Q4 2025 -- were 30% cheaper than one year prior. Or, in a US, that South Dakota already is 80%+ renewables. Iowa is 60% wind. All Very Different places! Yet all see electricity getting cheaper with -- or really because of -- their abundant renewables. There's far windier places than Saudi Arabia; like a midwestern US, a northern UK, or coasts around the world etc, that could match incredible-low wind costs too, if given also such strongly supportive policies. Saudi Arabia is now deploying its solar at faster pace than any country anytime in human history: it will be going over 50%+ soon.

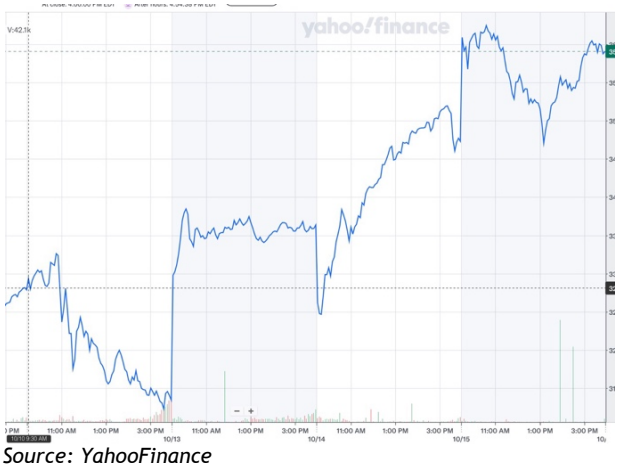
By no stretch can Saudi Arabia be deemed 'liberal'. Nor, are its policing driven by climate, or CO_2. But what they're doing just makes sense. Sell costlier oil & gas to others, and swiftly build domestic, cheap solar & wind + energy storage, grid for themselves. They're making power at smartly lower costs. Looking ahead, to when fossil fuels no longer have value. Sure, they're making clean electricity. But power is what's needed, and this is for a few cents/kWh, even with added costs for storage/ better grid to solve intermittency. Again is not a windy place -- political will is the driver. Anyplace with winds, sun can/should do as well. Norway provides citizens cheap hydro-electricity among lowest costs in Europe -- while selling its own oil & gas abroad. China in 2026, had developed new Y-shaped floating wind turbines of massive 50 MW size, that 'blows away' [no pun intended] anything to date. They'll push down wind costs never-ending ways, unlike fossils. A US state of Texas, can like Saudi, have cheap clean electricity for its people + and sell pricey oil & gas if desired. A US leader might call coal, "Beautiful & Clean" [it's neither] -- but doesn't fix dismal economics. In diverse places, electricity costs are fast getting cheaper, because they're adding more renewables, including China, South Australia, Portugal, Saudi Arabia, or states in the US too, including both South & North Dakota, Texas, Kansas, Iowa, Idaho, etc etc. Explains so much at a glance.

Saudi Arabia's record wind & solar near penny/kWh in 2025, handily beat all -- even typical solar/wind costs nearer 3 – 5 cents/kWh, are still cheap. Saudi Arabia is hugely-sunny, yes; yet so too is a southwestern US. Saudi is building storage & better grid at florid pace for power that's firm, dispatchable, reliable. (Contrasts with a West Virginia in US; most coal-dependent US state, it has very *un*reliable power, yet fossil-interests often claim to win on reliability). If strong support builds fast for solar, wind, grid & storage in US, it too can be a 'Saudi Arabia of renewables'. Instead, the Saudis long known as the 'Saudi Arabia of oil', are fast-becoming, err, 'Saudi Arabia of renewables' too. While a US curiously raced 2025/26 to prop up coal, to allow only fossil fuels/nuclear -- while harming its best resources, solar/wind(!). One day, this weird interregnum may be looked back on as a time when America lost her way. A pejorative joke may be, it's 'America of renewables', meant as folly. Arguably such US path makes no rational sense, but for those watching US energy markets, carefully, moves by an oval office also maybe conveyed short-term especially-risky 'odd-predictability'. Opportunity too, just perhaps, in volatile brief timeframes. For in markets (even wrong) unusual decisions, may be noted & acted-upon, if guessed in advance, though always very risky.

Mainly we look here at clean energy/moves in mid-term time-scales: weeks, months, or few years. But let's just briefly look at a scale of hours to few days, say in a mid-October 2025, for moments of heightened markets (& clean energy) equity activity. Say just after Thursday, October 9th as China stated it may expand rare earth export controls for 5 elements on banned list -- in a tit-for-tat the US fast added port levies on China's ships. Next morning, US stocks first moved languidly; but by mid-day an angered president said he'd add 100% tariffs on China, go from 40% -- to 140%! Friday afternoon headlines shouted the 'US-China Trade War Is Back!', and broad markets fell late-day. Dow was down -1.9%, S&P500 -2.7%, Nasdaq down -3.5%. In late-Friday's trading, $2 Trillion was wiped off the value of US stocks.

Index trackers may see sparser trading late on Fridays. Yet on that late Friday, volumes were substantial; at say an ECO tracker volumes on Friday were heavy at $100 million+. Much was selling of course; US markets tanked on amped-up US-China trade frictions. Bearish, so reason for many to sell! But not all was selling; there was also some buying late Friday; just maybe some had a contrarian very risky idea…(?) perhaps they guessed (riskily!) a president's words were bluster; he might swiftly walk it back, again. If so, then perhaps very volatile themes too (like ECO) that fell late Friday, *might possibly* reverse next trading day. Perhaps rebound at Monday's opening if a president fast backed-off threats next hours. Markets work because they're efficient. Not always by 'ignoring' politics; may also capitalize on it, or on politicians even if (or when) they're seen as 'predictably' walking-back items. Including here.

Note then, hours later, on Sunday a president indeed posted far more conciliatory words. He backed-off, writing "Don't worry about China, it will all be fine!". His Veep also softened on Sunday talk shows: so S&P500 futures rose then sharply, anticipating Monday's open. Volatile ECO / tracker that had dropped late Friday, rose +7.6% on Monday October 13th. Some a bit jokingly proclaimed 'TACO Monday', but whiplash was interesting. Monday rebound saw near $100 million volume in an independent ECO tracker. Tues./Wed., theme rose on dovish Fed comments; then fell Thursday, and Friday by -3.5% (volatile, up Monday +3.6%). All set amid broadening concerns over excess valuations in S&P, thus maybe falls soon in broad markets -- so in clean energy too. Below are 4 days for clean energy/ECO, amidst broader worries:



Source: YahooFinance

Reasons for broader bearishness included: **US Debt** spiraling on 'one big Act': US Debt may surpass even Greece, Italy by 2030(!); **P/E Ratios 'too high'**; so a **Collapse, Currency Debasement** is possible; **Trade War, High Tariffs, also vexing** along with **weakening Dollar**; **Inflation** and maybe **Stagflation-(lite)**; **Poor Jobs numbers** in a souring economy; **Promises to Re-Shore US Jobs/ US Industry** prove empty, **like promises of Unleashing US Energy Abundance. US electric rates rising -- not falling, as promised;** US energy production hardly up, though promised. Scary time!

In November, ECO rose unusually, +10% mid-Friday to early Monday, as government shutdown ended. Then, sideways Q4 2025. But let's return to usual time-frames of weeks/months/ years. And reasons Not for gains, but instead just perhaps, for soon much Bigger Declines.

Compared to April in 2025 when broad markets so ECO were down -- by late that year, after big gains, a fear was equities were too-frothy. Sentiments matter. Including if stocks are 'too-richly-valued' in an S&P500. With reason: warnings ought to ring out if a metric like (S&P500) Shiller Cyclically-Adjusted Price/ Earnings, or CAPE, spikes up to rare high 30s. CAPE calculated since 1877 had spiked in such 'warning' in 1929, eve of Great Depression. Later scarily hit 40 in 1999 on eve of dot.com bust; we know how that frenzy ended; S&P500 fell by -40% in a 3-year plummet; took 13 years to again re-reach prior levels. Note then a CAPE hit mid-30s late 2021 then paused. Historically a high CAPE near 35 (normally near 17), has often given way to lower future returns, to follow. Late 2025 a few mega-cap AI names had pushed CAPE very high (maybe a bubble?); such a high CAPE is regarded as bearish.

As CAPE hit 39 late in October 2025, alarm bells seem to blare, warning lights flash! Was 2nd highest in bull market since 1871. Only 6 times before had CAPE neared such in 153 years, and in 5 of those times, a Dow, S&P500, or Nasdaq subsequently declined from -20% to -89%. So, such high CAPE = should arguably ring klaxons, that broad markets can plummet! *On that 'nosebleed-high' CAPE at a 39 late in October 2025, it indicates broader stocks might be remarkably, hugely over-valued: ripe for a crash, so this must be regarded as a high-possibility*. An echo of an "irrational exuberance", called-out by a prior Fed Chair. We'd emphasize too that in very volatile baskets, like here for renewable energy, equities can and do typically crash far, far harder down, than the large caps in broad markets. All adds to fears of maybe big regression back to mean, given very frothy P/Es seen at end of 2025.

Brings us back to a *very high* CAPE of late-October 2025, at 39. Such elevated level we repeat is tremendous reason for concern. Especially for volatile themes like clean energy. Or note not just 10-year smoothed CAPE -- but also 'plain' S&P500 price/earnings were up hard, as well. More commonly, P/Es in S&P500 are near say 20; yet in Sept. 2025 measured P/E ratios had hit a statistically-worrisome 30, as calculated by all expenses, counting official profits already in books only. (S&P500 Index divided by GAAP net earnings, posted in prior 4 quarters, only). Hence net result of plain P/E valuations at 30, CAPE at 39, is these *must be worrying;* implies broad markets are (too?!!)-expensively valued historically. Worrying for risky, high P/Es green-themed baskets. Compounded by fact after a nadir clean energy low April 9, 2025 at just 28, theme went up 100%+ in just 9 months to end of 2025. Plus, spiraling debt. War. Could Inflation be contained, & fears of Stagflation.. All argues for maybe reversion to mean. Fear of big falls after frothy valuations gains 2025. Was/is a frighteningly-likely possibility for both broader markets (driven especially by AI valuations) and any clean energy theme.

One can't know, one can't foresee if it's say, fast-souring confidence that triggers a drop. Or massive US & private debts being recognized. Or slowing GDP, Jobs growth, AI bubble burst. Or war, & energy crises. Or if threat is not un-precedented inflation, for was higher in 1981 -- maybe inflation takes root, harder to kill, rates high for longer. Inflation is partly a state of mind, psychological. If expectations are high rates + stagnating economy, can be stagflation-(lite). Currency debasement. Fed tools wickedly un-useful then. No central bank wants to hike rates going into recession. Equity-risk premiums in much riskier stocks, vs. 'safer' bonds (though yields may rise fast) make stocks too an unhappy place. 1970s rates something a young generation doesn't recall; in decade to 2022, no G7 central bank had rates over 2.5%. But in 1990, they'd All been over 5%+! High rates decidedly awful for volatile PE themes. A president once proudly calling himself, "King of Debt". A CAPE at 39, may be scary. Yet scarier, may be true climate crises; weather extremes where 'center cannot hold, rising seas in mid/latter this century, and next … all set amidst far-worse global indebtedness.

Now & into next decade, America's 'one big Act' by hiking US electricity costs, arguably may ceding its leadership on AI ahead to China. Which is aligning itself to become the world's first Electrostate. Who sees it as their own good fortune, the US is aligning itself as last-remaining Petrostate, halting its own wind and solar. Not on economics, but a cultural animosity. Everyone is entitled to their opinions; yet if offshore wind is indeed hit all over the US on one person's feelings, one individual's emotions, not on reason -- despite lower costs undoubtedly favoring solar & wind, that fact respectfully, is worth serious re/consideration.

Fast-improving economics of clean energy – now only makes old coal, gas, and oil, look worse. Already, in building the 1st Electrostate, China in 2026 was far less impacted by spiking costs of oil, and natural gas, thanks to its huge embrace of renewables and energy storage. First 5 months of 2024, China had added 4x more of its 2 cheapest electricity sources: solar & wind -- than US had added from All Sources, all 2024. The 227 GW of new solar/wind China added in just first 7 months of 2025, was 4x all US growth from all energy sources all 2025. China yes, is expanding gas, nuclear, coal capacity some too -- but far more slowly vs. renewables.

Analysis shows by 2035 on 'one big' Act, Americans may pay far more for electricity annually. In US South, & Midwest, $640 more/year; up less in hydropower-rich Washington state; yet *all places in US, higher electric bills!* Opposite of promises. Unavoidable, if renewables are cut. Efforts have begun to blame renewables, anticipating high electric rates. Wall Street Journal, long anti-renewables /pro-fossil fuels, did an OpEd in 2025 blaming renewables[!!] for electricity price rises in Texas. Yes, electric rates rose in Texas by 36% for residential power in 7 years, from 11 cents/kilowatt-hour (kWh) in 2017 -- to 14.9 cents/ kWh in 2024. But, what that OpEd didn't mention, was electric rates *rose in all US states,* nationwide, in that period. In fact, they rose *less* in Texas, thanks to its solar/wind. Texas rates were up *less* than the US national average. Its big solar/wind helped to tamp down increases.

Compare Texas, to 3-lesser-solar & wind states: Alabama, Mississippi, W. Virginia -- & we see Texas' rates rose *least* of these 4 states! Average retail electric costs 2025 in renewables-rich-Texas were *below* US national average; Texas wind+solar grew faster than any state. Factors contributing to Texas' price rise the 7 years included *Winter 2021 natural gas freeze-off that resulted in terrible deaths, long-tail costs still being repaid. Its Grid must now hold more in reserve, escalating costs. *Post-invasion of Ukraine, even local-produced natural gas prices spiked in Texas so gas-fired electricity is costlier. Plus, there's *Costs in adding grid transmission, yet those aren't unique or just solar/wind growth -- its oil & gas industry too is a big driver in grid expansion. On the whole, a more accurate view is that its ample solar/wind have helped to *hold down* Texas price rises (was worse/ higher in most other states) in those 7 years. First 8 months of 2024, Texas added more solar -- than 39 states ever installed!

Texas' 'Build, Baby, Build!' energy paths suggest useful lessons. In 2023 it was America's #1 oil producing state; 43% of US oil in the #1 oil-producing-nation. In 2023 it was also the biggest US wind-producing state too, by far. Its electricity by wind powered 11 million homes, 3x greater generation than a 2nd biggest wind state, California. Catching too, California in solar: latter grew 67% in 2020-20; while Texas solar grew 337%! All options in Texas compete nicely on-lowest-costs, not on ideology. In Texas low-cost renewables met ½ of demand in 2024; its total clean/green energy output was 2x more than California. So, Texans know a thing or two about making cheap energy, that's mainly green! Key, Texas is competitive; pro fair & free-markets -- far more so than California (or UK). It goes for cheap best energy, so renewables win. A result is Texas' retail electricity costs in 2025, were about ½ that of pricey California (much less too than a UK). On far fewer regulations than say, in California, or UK.

Decades of cutthroat competition, plus hands-off free & open markets, gave Texas cheap electricity. Price-discovery of what's best/cheapest in real-time, dynamic updates at 17,000 nodes islanded grid. It's ironic then, self-proclaimed 'fiscal conservatives'(!?) who now want fossils/ nuclear only, would *end* hands-off-policies. Would pick 'winner' fossils / nuclear -- and harm cheap green energy. A battle is going on: as self-labeled 'fiscal conservatives' who ironically reject true fiscal-conservatism -- oddly want only, costly fossil & nuke power.

Bit like an inverse, how big-government, liberal blue states, such as New York, also end-up costing more. We saw New York charges twice as much for electricity as Texas -- and added far less solar/wind than did Texas. Or take California with high electricity/oil/gas costs. Not prioritizing cheapest power, it allows huge subsidies like 8-11%+ Utility returns on equity, harming ratepayers. A San Diego Utility sought 11.25% return in 2025! (Although real problem, is Utility assets are uncompetitive vs. cheaper renewables). A first-mover, state mandated solar early on at higher costs; locked in some high prices; in 1980 solar was $35/watt; by 2024 was 26 cents/watt(!); plummeted 82% from 2010 - 2025. Issues seen other liberal places, too. UK sets 1 electricity price nationally, so windier north helps lessen costs in a populous south -- yet north pays a lot for wind-power. UK's very-high rates are due to costly natural gas 90% of the time. Or, Germany sets its fuel mix, higher taxes, rates in pursuit of social outcomes. Today liberal UK, Germany, California are 'price losers'; rely too much on natural gas, poor cost-structures, costly power hastens de-industrialization. Self-labeled 'fiscal conservatives' in US lately also would be price-losers. They'd replace open-competition, with fossils/nukes only. Decimate US renewables on ideological grounds. Though we know the states/nations with cheapest power, embrace free markets. Today even Saudi Arabia that relied on oil, until recently, is now growing solar faster than anywhere, any time in history. With a firming storage, better grid. Natural gas will be used less & less ahead, mainly just as backup.

New US energy policy poses huge challenges. As a result of America's recent 'one big Act', 77 GW of anticipated electricity generation (a bit like 77 nuclear reactors, though not firm) -- *will Not get built* in US from 2025 – 2035. Versus had that anti-renewables law, never passed. $52 billion *less* US GDP growth. 94,000 *fewer* green jobs. *US retail electricity costs 25% higher,* on that loss of cheaper renewables. *Industrial electricity: 54% higher*. All strange, as wind & solar 'just make sense'; conservative in truest sense. Given freedom of choice, renewables win. Meanwhile, US competitor China has jumped ahead in global green energy & EVs, yet faces its own problems of overcapacity, oversupply. It denied permit renewal for huge batteries/lithium producer; halted a lithium mine, 6% of world supply. Thus, lithium stocks jumped worldwide. Lithium carbonate futures on a Guangzhou exchange leapt the max 8%, to 81,000 yuan. Some believe China from 2025 has begun to broadly pare back its immense oversupply, overproduction, in green new energy and EVs. Is addressing its deflation.

US solar grew 2025, like when bullish Treasury Dept guidance for tax credits, left a 4-year window open. Renewables' foes had tried hard to make that 'far worse', & retroactive. Tried to demand work must be already underway, project in service. But moderates pushed back. So, guidance was a compromise between hard liners, vs. free-market moderates in senate, all in same political party. Results 'better than feared', fueling some rise in clean energy. Other side of coin, was eg a wind developer based in Copenhagen that fell ½ in 2025 as stop-work order from US federal officials 1st halted its Revolution Wind offshore project with US businesses in Rhode Island. Though that project was near-done, 80% complete, 45 of 65 turbines installed! Let's look closer at that bizarre 1st federally-ordered halt in 2025 at a near-done major wind project, for it illustrates odd recent changes in US energy policy.

New offshore wind was about to bring Rhode Island, & Connecticut cheaper power. 'Why' wind power can be so helpful in lowering costs there, is easy. Start by knowing Rhode Island (RI) is more reliant on natural gas to generate electricity, than any other US state: 80%. So, one can guess: RI has very high electricity costs: 29 cents per/kilowatt-hour (kWh). In Sept. 2025, 5th highest in US. (Very worst Hawaii is 41 cents/kWh; 2/3rds of its electricity by burning (ugh!!) bunker oil; despite sun, wind, wave resources that are tiny percent there). Bordering RI is Connecticut (CT); it too would benefit by lower rates once this near-operating offshore wind farm is energized; CT's electricity rates 2025 were a very high: 32 cents/kWh, 3rd worst in US. Its high cost also no surprise, for CT, like RI, is also very reliant on natural gas. Few energy alternatives at either. As noted, to add natural gas-power would be costly; anyways big gas turbines not much available until 2030 at soonest. And, New England's onshore natural gas transmission corridor is crowded. Plus its few regional nuclear plants have been / & are retiring ahead; and any new nuclear plant would likely, frighteningly go $$ billions over-budget, take years (decades?) longer to build. Hence, this cheaper/ better/ faster, offshore wind + batteries near-its-start-up, was a scalable economic solution do-able right now!

Offshore wind was about to make RI/CT electricity at 9.8 cents/kWh. Its immature stech there, far more costly vs. Saudi wind at 1.3 cents; but quite attractive vs all else: about ½ the cost of gas-fired electricity at peak demand. Far better than fossils; going for 25+ years. For 2 small states this 400 MW to 'little Rhody', 300 MW to Connecticut/CT were sizable wins. Could meet 1/5th of total RI annual electricity demand; in winters maybe 1/4th on less demand, stronger winds. Big benefits from 1 wind project 15 miles offshore in federal waters, space for far more wind turbines. (For origins of state/federal 3-mile division, 12 mile sea & the implications for US energy policy, see our book 'Listening to the Sea' (1999). And yet this near-ready wind project so desired by both governors, was halted twice(!) in 2025/ and again in 2026, by an administration aggressively-anti-renewables. Hating all offshore wind.

We recall how those who'd halt US wind -- were foiled in the senate, June 2025. Unwittingly were *moderated* when a draft 'one big' bill, was jammed. But now, acting on just unilateral administrative orders in the executive, renewables could be decimated -- with far greater 'success' from 2025. Unambiguously, by focusing just on renewables -- hurting them only. Bypassing more traditional free-market conservatives in their party. Side-lining a congress. Ignoring the better economics of solar & wind, blind to their low-priced paths.

That president for decades had spoken of his pique against 'windmills'. Of his deep desires to halt wind, "farmer-destroying solar". 1st half 2025, he'd been foiled in congress, when a 'one big act' was made milder. But from latter 2025, with his ambitious views of executive power, expansive & unprecedented unitary claims, orders startling in scope, grievances towards wind & solar were far more robustly acted upon. Halts to many near-energized wind sites, though those would have helped to cut US electricity costs. Though would have produced American energy, cheaply. As actions once seen as very unlikely, were undertaken. Despite too, his very to the contrary 'braggadocio' like if elected, "you'll never have energy [prices] so low, as you'll have under a certain gentleman named" [his name]. Yet 2025 unfolded entirely opposite of seeing cheaper, more abundant, affordable US energy: all bit remarkable.

Late 2025 an administration went deeper into realm of 'this hadn't really been conceivable before', as it halted all 5 major, in-construction offshore wind sites on US east coast. Those were going to add a huge 5.8 GW dearly-needed generating capacity; some even started-up! About to make abundant very cheap electricity from frequent free sea breezes.

In announcing halt, a white house took care to again vent a president's deep, decades-long resentments; again calling renewables "scam of the century", a worn talking point (though very wrong). Those 5 sites would have generated enough electricity to now power 2.5 million homes. Electrons dearly-needed too for AI/data centers, sprouting like in Virginia, highest-concentration of data centers anywhere. US data centers were instead making do, like with dozens & dozens of say 5.3 MWe or 16 MWe portable gas generators though costly, noisy, polluting. It was 2nd halt to Revolution Wind off Rhode Island; after courts had struck down a prior, 1st halt. But an administration after that went wider, deeper. It ordered halts too at Empire Wind off New York, also a costly, 2nd halt; his administration previously allowed it in exchange for a natural gas pipeline in New York state, but in poor faith went back on that. Also it halted 3 other near-complete/needed wind projects at Coastal Virginia, Sunrise wind at New York, and Vineyard Wind off New England where of a big 800 MW of near-finished capacity, about 70 percent of it, or 572 MW of wind turbines were already operating. Those repeated halts would later, each be overturned by the Courts. Losses for administration.

Such efforts of course, make US electricity price rises, worse. Negatively impact reliability, affordability. But such concerns seemed not a priority for that white house. Operator of the 13-states grid from Virginia to Illinois, saw auction reserve power prices, spike. No other outcome could be expected. Connecticut's Governor stated that halt "is blowing a hole in our efforts to bring down the cost of electricity". 4 Governors jointly wrote this newest wind halt "defies logic, will hurt our bid for energy independence, will drive up costs…". Even in a president's own party, feelings were increasingly upset outside/beyond a white house. One deeply-impacted house member warned, this halt is "disastrous" for energy security, for local economy, military readiness. Another member of his party, who'd even chaired Federal Energy Regulatory Commission during that president's own first term, stated that the halt "sets a terrible precedent at a time when we need every available electron". And that "I find this to be incredibly reckless". For, "how are we going to support all the data centers? I was critical of the [prior president's] administration, for targeting fossil fuels. I am critical of this administration [in 2025] for targeting clean energy. Now more than ever, we need it all".

Here, at these Indexes, we're non-partisan. And we'd much prefer to avoid looking at politics at all. But lately was unavoidable, with changes so relevant, key to clean energy theme. In 2025 a 'one big' bill very notably, was moderated last hours by just one vote in the senate from president's own party. Less known, is that bill was nearly hit as hard, by same party too, in the house. Had a representative (debt-hawk) voting No, attracted 2 more No's from the president's party, given the enormous deficit-spending upon which that bill was based, could have sunk it. That house member of Kentucky, vexed that white house all of 2025 (as did that state's US senator too); whether the member is 'primaried' is one barometer of how forcefully new policies can go on. Adding debt, too. A side note is that same house member, an engineer by training, had built a unique custom solar/plus battery home and farm power system, one not very unlike our's here; if interested in our own unique solar/plus battery backup system here the past 15+ years, see: https://www.wildershares.com/solar.php

A rather intriguing question now might be: *if* US electricity prices keep on rising undeniably -- might a few in president's party press again for new course on clean energy; even for say, a partial acceptance of it? Might that administration itself, alter course of its accord? After say, 2+ years of rising electricity/oil bills, & war, if promises don't persuade as in past? It is conceivable US electricity rate rises, might slow, if say, US growth slows. Or, if forecasted big AI demand boom, doesn't materialize. But, for US electricity costs to fall hard soon, by a big ½ as was repeatedly promised: there's vanishingly little to zero chance of that.

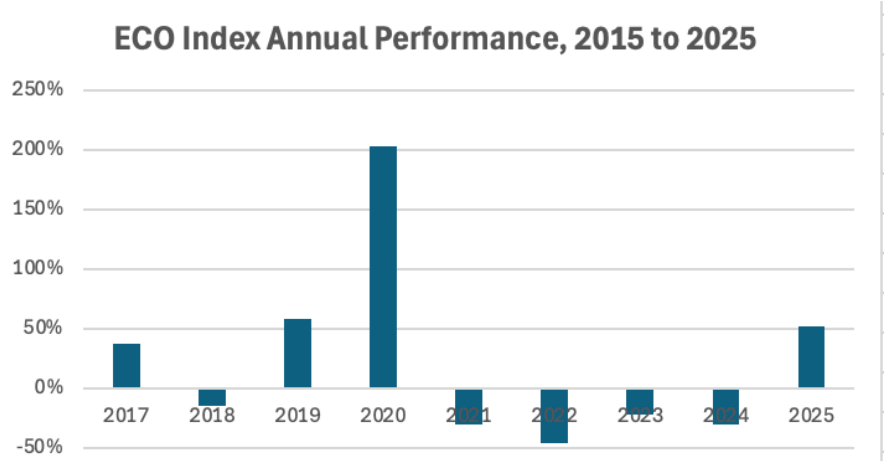
Yet whatever happens, one can bet that a visceral (not facts-based) politicized opposition, continues to wind/solar. Blame put there for high US costs, even as renewables get cut. As opponents go on trying to make financing renewables, unappealing. There's issues of intermittency, dispatchability, curtailment on burdened grids, but all those can be addressed. In supportive places, wind / solar may near 1 cent/kWh. Renewables can/should be a vital arrow in the quiver, anyplace wanting cheaper electricity -- even an oil kingdom. Despite that in 2025, $18 billion in pending US wind/solar projects were cancelled. $7.6 billion in grants to 16 states cancelled, primarily or exclusively (as admitted by the administration!) they'd go to states that voted for a president's opponent. Some 11,000 US generation/ consumption projects sat awaiting approval. Interconnections stalled average of 5 years. Opposite of 'Build, Baby, Build'. Instead, for renewables, it was instead only 'stop, baby, stop!!

Contrast US policies in 2025 with China's true 'all the above' path, based on best options, so renewables. China planned 2025 to build more nuclear: 35 GW. That new 35 GW generating capacity planned by China, over 5 years, sounds like a lot. Yet, to put it in perspective, *China built 300+ GW of new solar /wind in just 2024 alone!!* From 2010 to 2024, its electricity production grew by more than rest of world combined. By 2024 China was making 2x more electricity, than a US. A new AI/ data center in say Virginia in US, might pay say 7-10 cents/per kWh, less than in much of Europe. Yet a data center in China, may pay just 3-5 cents/kWh in places, near ½ the US. Is a huge AI competitive advantage for China, with far-faster buildout of big hydro, wind, solar, storage, modern grid, transmission. Solar/wind is sprouting up for instance in Mongolia, in a landscape bit similar to rural Texas. By 2030 China's vast renewables & power transmission will have 400 GW *spare* capacity. 3x rest of the world's AI/ data center electric demand. While a US faces maybe a 44 GW shortfall by 2028. This 'electron gap' as between the US vs. China, did in 2026 (rightly) worry America's AI leaders greatly.

As a US in 2025 purposely hobbled its own best paths, solar/wind. US *built only 63 GW total energy, all year long*. 1 costly US coal plant in Georgia set to retire / 2 in Indiana, forced by federal officials to stay open! Though uneconomic. On a federal law, meant for emergencies like in a hurricane, when high costs can be acceptable. A South Carolina coal plant costs, up 50%. No wonder US power prices are rising! China's AI chips are less advanced, but gaps in electricity costs are so big, it allows China to use 2x more chips. Impossible now to hide it: US electricity prices rather than down in 2025 by ½, were instead up. Due to less renewables / more fossils, went Up faster than inflation. When oval office claimed average US gas prices were under $2/gallon, that was a bit silly. But an interesting thing was happening.

Interestingly a white house on Labor Day holiday 2025 had made boastful claims amplified by a favored cable news channel, that a US president was "delivering on his promises of lower" gas prices, "fully unleashing American energy dominance", "families are saving significant money at the pump". Wasn't true. Average US gas price in 2026 was still near $3 -- no state under $2. Yet was interesting to see curious narratives by white house & federal officials 2025 like "lower prices are part of a trend" as this administration takes "relentless action to revive America's energy capabilities and undo a [prior president's 'restrictive'] stranglehold on American energy production." Another promise was US oil production will be up very hard, so gas prices down big. Yet notably US domestic oil production was at first … not up! Labor Day in 2024, 13.4 million barrels/day (bpd). Same holiday in 2025, US oil production 13.3 million bpd, so *down!* Rose only slightly end of year. US gas average was far from <$2/gallon, so claims of under $2 bold, yet respectfully factually-challenged. 1st Amendment allows bluster. Still, it is useful to be cognizant of truths, and at times, pretty-surprising hard facts.

It may be worth glancing back for a moment too, for any political correlation with this theme. Latter-decade, a look back at ECO's Annual returns last 10 years is small food for thought. As expected we can see clean energy / and hence the ECO Index *has been & is very* volatile. Such volatility no surprise in an emerging theme. Yet a *direction* of annual moves is *not* what one may have expected if anticipating easily-forecast direction correlation as between ECO -- and president/party in power each of the years. Below is ECO for 2015 through 2025:



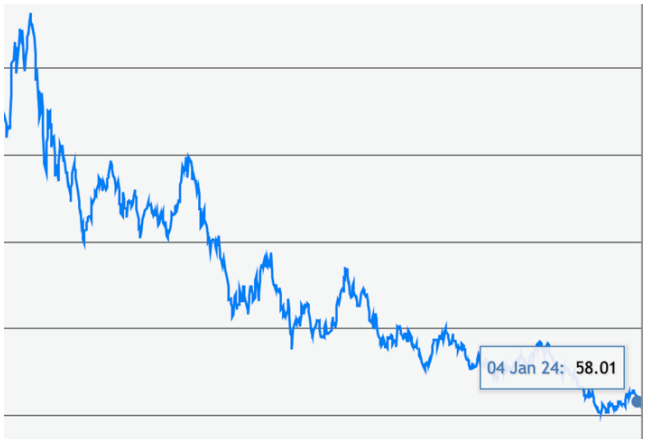
The point on Direction is counterintuitive. *Was not* maybe expected, each of 10 years. What boldly surprises, is during a *conservative* president, this clean energy theme/so ECO *rose* up, sizably. In 2017-2020 so in a conservative's 1st term, this theme *strongly gained*. Tallying annual gains minus losses, each of 4 years, was surprisingly *up* sizably net +284%. Up +38% in 2017, down -15% in 2018, up +58% in 2019, up +203 in 2020. Up big during a conservative who tried to halt a 'green new scam'. 2nd term began differently yet 2025 rose too from Dec. 31, 2024 close at 42.25 -- to Dec. 31, 2025 close at 64.44, up +52%. Rather like in 2019 when that 3rd year of a 1st term it rose from a Dec. 31, 2018 close at not-very-different 44.76 -- to Dec. 31, 2019 close at 70.74; up then +58% for rather similar % rises those 2 years. Things are sure to unfold unpredictably over a 2nd term 2025 to 2028; so let's watch what happens ahead.

Inversely, maybe unexpected as well, was under a *liberal* president who'd supported climate action, this same clean energy theme captured by ECO, *fell very sizably 4 years 2021 to 2024:* for a net -128% (tallying -30%, -46%, -22%, -30%). Not what one might have predicted! Counter to conventional wisdom, yet in these 10 years clean energy *rose* in a conservative president -- and *fell hard* during a liberal -- opposite perhaps of presumptions. But, looking at 'just' those past 10 years going to about 2025, was perhaps too short-ish of a time horizon.

Maybe was just a fluke. We can look back more to a prior ~10 years since 2005; let's do it. Here, annually 2005 to 2008, a prior conservative president's 2nd term had ended near nil, tallying 4 years (+4% in 2005, +5% in 2006, +58% in 2007, a big -70% in 2008). Waters were muddied by a Great Recession in 2008, that dropped all hard. Consider then if not for for the 4th harsh year 2008, all globally down, then prior also conservative president would show (again surprisingly) big net *gains* in clean energy's theme / so ECO in their 2nd term in office. Lastly we can see a prior liberal president's 2 terms, 2009 to 2016: was a net -40% *loss* tallying 8 years (+28% in 2009, -5% in 2010, -51% in 2011, -19% in 2012, up +57% in 2013, -17% in 2014, -11% in 2015, -22% in 2016). Hence all 20 years to end 2025 did *Not* reflect likely directional expectations, if one assumed losses for conservative party, & gains for liberal. Outcomes were rather opposite! Resists accurate predictions, *ex ante*. Importantly too ongoing inflation, big debt, and yet more policymaking chaos from 2026, might mean differing results ahead.

Next for data-lovers are just math parlor-tricks, only a few coincidences discoverable in clean energy's story given ample data. Of mild interest only, thanks to ECO calculating live 20+ years. Here for a volatile 3 down-years in 2021, 2022, 2023; we saw clean energy's story tracked by passive ECO had very 'steady' declines then; so steady, 1) Each year's High was early-ish in 2021, '22, '23 -- AND it 2) Was followed by nadir Low very late in calendar year; AND 3) coincidentally too steadiness of falls took each year's nadir low down by near -½.

ALL 3 Factors were reflected in 2021; an 286.89 intraday high was Feb. 10, 2021 -- AND fell to nadir intraday low late that year on Dec. 29, 2021; AND that 142.39 low was down by a near-neat -½ (by -49.6%). Next, 2022, green energy's story fell a 2nd time again from high early-on that year -- AND to a low very late in year, AND by near -½ at nadir. The high was very 1st day of 2022 at 152.87 -- AND nadir low was last day of 2022 -- AND bit interestingly down near -50% (-49.7%) to 76.02. Such -50% fall in this passive story was just by chance, seen looking *backwards* only, on rich data. Still 2 not-imprecise consecutive drops near -50%. Here are these 3 years from 2021 to 2023, when falls were surprisingly, steady & consistent. That all ended late 2023, so is now over, but here's a visual for the brief, steady fall then:



3 steady falls near -50% in the 3 years for clean energy's theme, were mere coincidences in data-rich past. Meaningless, looking forward. At times infra-year; other times start of year -- sometimes intraday, other times at closing values. Can't ever be used to predict a future, but can show *how volatile this theme is,* fell -50%, even after 2020, a big-up year! But one cannot use brief coincidence to forecast, it is NOT predictive. Only bit of fun on so many data points. As Mark Twain humorously put it, "Lies, Damn Lies, and Statistics". Just playing with data.

One mustn't read anything into it other than to confirm a great volatility, often down! Never predictive, it's ephemeral. One thing noticeable here, was an unusual steadiness, when clean energy fell 3 years – thus say, each high point -- came near-ish start of each year; low point -- was near-ish end of each year. Just for conjecture, it was bit notable after 2021 steady fall, that 2022's high proved near-immediate, at 152.87 on Jan. 3rd (154.41 intraday, on Jan 4th). A hypothetical calendar year low, if another 'exact' -½ down, just playing may this be near a 76.43 nadir close very late 2022. The nadir low might be, any day of a new year of course -- yet all maths were it's unlikely to be very end of year! So was interesting to see when/where 2022's nadir fell. Unsurprisingly, *not* exactly 76.43! A bit interestingly, though, on Dec. 28, 2022 the theme hit a 2022 nadir low at 76.02. As noted not so far from neat -50%, for 76.43. Just for fun, rounding off to whole numbers, both those points were near 76.

Of mild interest, we did wonder for a 3rd year, what/when/where, 2023's high/low might be in clean energy's story. Intraday high came early-ish in year on Feb. 2, 2023, at 102.33. Might there be a rather steady fall next for 2023 in clean energy's story, so down -50%; AND maybe ALSO hit a nadir end 2023, near an intraday low say of 51.16? A coincidence was how rather close to 51, was born-out. ECO is just passive: we are mere observers; and yet coincidences can be discerned in a sea of data. That theme's low was not end of year, but Nov. 1st, 2023, at 50.61. Looking back, 2023 saw just 1 of 3 'AND' factors: low near -50%, fairly fulfilled. High only near-ish start, low only near-ish end of year, so 2 coincidences completely Failed. Then 2024 anyways ended short coincidences. After literally a high on 1st day of year at 62.38 (intraday), neither nadir late in year -- NOR down –50% (near 31.19) were met in 2023. So a past brief conjecture trio of the three: *early-year highs/ *AND a late-in-year lows/ *AND at neat -50% down, no longer applied. Prior brief steadiness extinguished. Shattered. Thereafter all unfolded far different ways. A brief-steady gait broke apart. For ample past ECO data, calculating 20+ years, see New York Stock Exchange, https://www.nyse.com/quote/index/ECO

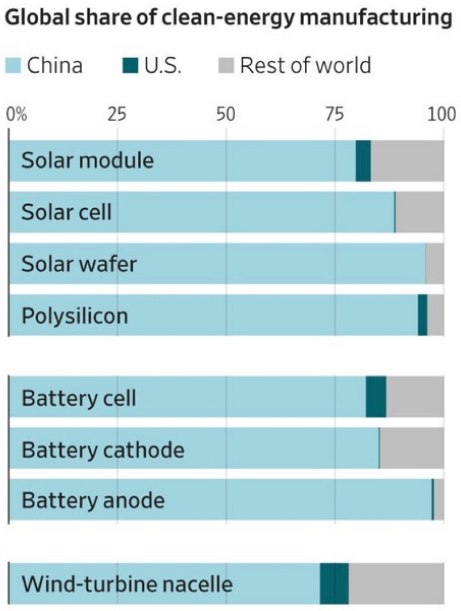
Before leaving a side-topic of coincidences: after an April 2025 nadir low, we saw by mere chance a rather-steady gain that lasted ~10 months. Viewing not via ECO valuation metrics -- but instead (changing a bit) tracker values, we saw after an April 8, 2025 tracker nadir close at 13.42 (28.26 in Index), it moved rather-steadily (up) next 10 months. A few times fell some below just rough 'steady gait' -- yet briefly snapped back a couple times. That fell apart; was ended by March 2026 as ECO went sideways/down. For sure after "war by choice" March 2026, and erratic theme moves, any brief steadiness, down or up, had completely evaporated.

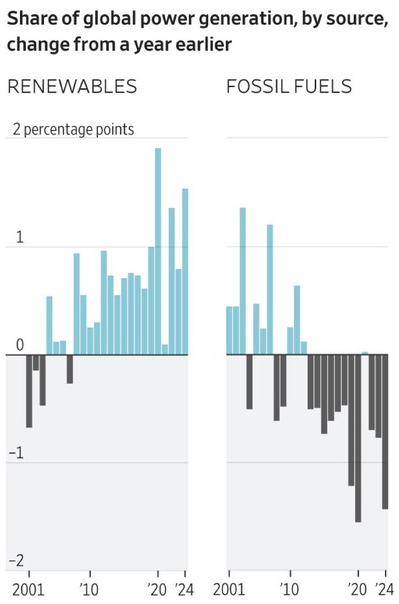
But all above is just playing with numbers, coincidences in past data. What might happen in energy next quarters to possibly herald substantive changes ahead? We know one big change, could be shift to 'All of the Above' strategies nationally. Better yet, de-politicizing clean energy. Fact is it's possible to energize all US by a combination of Big solar in US Southwest; Wind turbines in central Plains & off East Coast plus other windy American places; with long-duration Storage. Baseload. Fast-ramp firm geothermal. Solve over time for US electricity. All while making US energy cheaper, more reliable to boot. Means overcoming however partisanship, political dogmas. Embracing instead, abundance. After war in the Middle East in Spring of 2026, and hence the big price spikes in oil -- and in natural gas outside the US that followed, it's clear solar & wind better favor American independence, security, freedom, liberty. Better than oil & gas ever could. And this applies to any nation as well.

Small steps might happen, sooner; a federal opposition to solar might begin to thaw; projects for solar in US approved; (onshore) wind too. Renewables' superiority as cheaper energy is hard to ignore. Small steps possible by states too; like allowing simple Solar Balconies which pay for themselves in 3 years; if governments get out of the way. Such can energize people to enjoy solar's benefits. Unhelpfully what we've had instead is 'cold war' on clean energy / climate. 2 entrenched, opposed ideologies. Conservatives are assumed to side with fossils & nukes. Liberals assumed to side with solar, wind. Impasse with institutionalized trench lines. For an out, one may think of at how cultural impasse -- was addressed by changing definitions. China's new leader in 1980s re-defined staid doctrines, towards far-different "poverty is not socialism". Towards "doesn't matter whether cat is black or white, as long as it catches mice", and a widely-attributed, "to get rich is glorious". China's decarbonizing since has been more pervasive, effective (and self-enriching) than any international pact. Kissinger & Nixon, two old cold-warriors by going to China, broke stasis. Now a few prominent US conservatives talking about renewables and climate solutions in serious ways, could also mean a lot.

Instead it's been saddening to see a US that invented Solar Cells, and Lithium Batteries, lose its lead in both. Soon again in electric cars, on China's-massive push. China is aligning itself to be the 1st Electrostate, pursuing industrial policies making it the #1 manufacturer, in solar, wind, EVs -- and already is reaping rewards. Next, in batteries, storage, grid. Their embrace of clean new energy innovation, rather than old fossil fuels -- wasn't on climate concerns. But rather raw economics, jobs, energy security. Critical growth drivers enabling its own domestic energy production, green tech exports sales to rise. From January to July of 2025, the value of these China new energy exports was a huge $120 billion; that figure was about 50% greater than was earned by Petrostate America that period from its oil & gas sales. Importantly too, China was relatively less hurt by loss of oil & gas in war 2026, than would have been a decade prior on closure of Strait of Hormuz. Sun/winds don't pass any Strait.

Meanwhile, world is moving massively toward renewable power generation, seen in a chart at right for 2001 to 2024. Leaving fossil fuels behind on cost. This global shift, is something a US administration from 2025, was trying desperately to deny, to evade, ignore -- eg by halting fair, open-competition. By slanting field to just more fossil fuels/nuclear only. In this a US was maybe bit like Don Quixote tilting at windmills. There's no doubt but 2025 to 2028, an oval can make life hard for its renewables. Out of a cultural antipathy. Even though globally, solar/wind are now obviously the cheapest, better, most sensible options long-term:





Source: Bloomberg NEF/& above/right: Wall Street Journal

As a Wall Street Journal reported Sept. 2025, such "US renewables retreat goes beyond the ['one big'] tax bill winding down more than $400 billion in estimated subsidies. Federal agencies have tightened rules for development. The … administration recently terminated a multi-billion-dollar loan guarantee for Midwest transmission line, halted a near complete wind farm off coast of Rhode Island, and cancelled $3.7 billion of funding for technologies that could reduce industrial emissions. The whiplash has hit investment. Companies in 2nd quarter cancelled more green manufacturing projects than they announced for first time on record …." This above is from the Journal's strong factual reporting, not on an OpEd side.

Obviously we're fans of clean energy. And we clearly see the weaknesses in an intermittency, non-dispatchability. And yet renewables, unlike fossil fuels, only get cheaper/better. Firming on new long-term 100+ hours storage, & grid. Plus renewables only help on human health, energy security, climate risks, war etc -- all increasingly compelling late 2020s. Solar/wind now so cheap, at 3-5 pennies/kWh, they'll win on economics alone. We're objective, factual, independent in this. Never partisans or politicized. Nor, ever proponents of either party.

We follow the truth. So say again, that counter-intuitively, US states with most renewables & that favor smaller-government, less-debt, free/fair markets -- are often conservative/ moderate 'red states': they're also happily the US states with the very cheapest power.

In September 2025, states with highest percentages cleaner electricity, included South Dakota at 80%+ renewables, which is a red state with cheap home electricity at 14 cents; Iowa at 68% from renewables that's a red state with cheap electricity at 14 cents/kWh; New Mexico at 52% renewables yet since 2008 a blue state at 14 cents; Kansas at 49% renewables is a red state with cheap electricity at 14 cents; and Oklahoma at 42% renewables is red state with cheap electricity at 13 cents. These-highest-renewables states all compared favorably vs. the US retail average of 17.47 cents in Sept. 2025. The 2 very cheapest US states in late 2025 were North Dakota & Idaho: both renewables-rich (hint: both turn first to ample renewables / use relatively little natural gas). Point is the states favoring hands-off smaller-government, less-debt, open to all competition, pro-growth, building greater capacity grid -- repeatedly are 'red' states and each has an ample amount of Renewables = so Cheap Electricity.

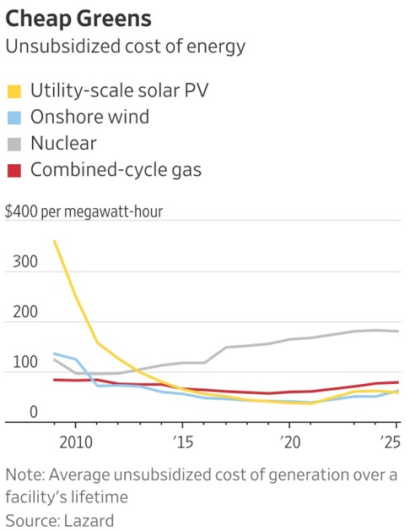
Iowa offers lessons. In 2025 a big 2/3rds or 66% of its electricity demand was met by wind. Growing. Of a remainder, coal was 19.8% there but was phasing down/out long-term: owner of its 6 coal plants announced possible retirements at all. Some anticipate much of '20% hole' may be filled by more solar + storage; others, expect more natural gas. Gas, dispatchable, was next largest part of Iowa's electricity generation at smallish 9.8%. After that, utility-solar just 1.8% in 2025, but new projects lately announced include an 800 MW solar-project so growing. A big 84% of Iowa land is in growing crops, raising livestock, so some are concerned on converting farmland to solar. But, as 60% of that corn crop goes anyway to making ethanol fuel, it means choosing one energy form, or another. (Solar/EVs are the far more efficient way). Either way, Iowa has been fast becoming a US energy powerhouse.

Countering from 2025 are new federal policies that harm 'losing' renewables. Anti, open-competition. Federal officials in 2025 stopped a $4.9 billion loan guarantee that would have built a huge US Midwest grid transmission line; it's a concern as a likely effect will be to *raise* US electricity costs. Worrying, that so-called 'fiscal conservatives' now favor more US debt; that too is a big change buffeting much. Globally too, sovereign bonds are struggling lately on national debts, unwillingness of rich nations to balance books, cut deficits. In 2025 to early September of that year, internationally, 10-year bond yields *rose* (due to debts etc) by 0.1131 percentage points. And yet, US 10-year Treasury yields same period fell bit surprisingly by 0.3038 percentage points. 10-year yields dropping generally are good for investors, markets. Helping rate cut hopes, Dollar as reserve currency, Treasuries as global store of value/dollars (few alternatives). That 2025 fall in 10-year yields had commenced around a time a new US treasury secretary spoke of lower rate pathways, from Feb. 19th. Such jawboning is something other nations don't do. But whether key US 10-year yields can decline and then persist low -- is a seminal point, yet to be seen. An oval office in 2025 and then 2026 targeted, aimed for stable 10-year yields to be in a (very, very) ambitious range under 3% (even 1%!) ahead.

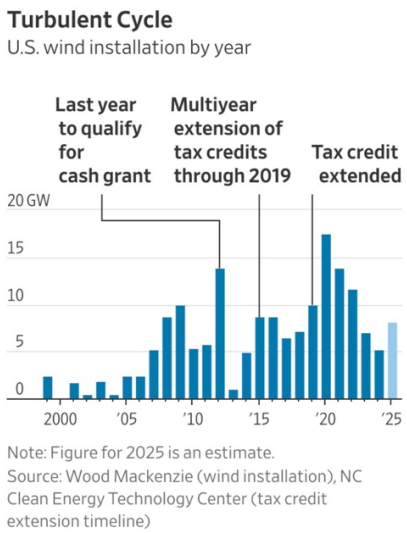
A US president repeatedly made energy news in 2025, opining [often] on his social media blog, "Renewables are the scam of the century"… , "We will not approve wind or farmer-destroying solar. The days of stupidity are over in the USA!" It left no doubt as to his sentiments. Was posted on a Wednesday: unsurprisingly perhaps ECO Index fell -0.96% that day. And Thursday it fell -0.39%. Yet on Friday, ECO jumped +5.48%. Notably above where was beforehand. While that president deserved credit being so frank about his own feelings, one might ask: How can renewables jump strongly, if a US president is speaking so vociferously against them? Broader markets rose Friday too on hopes of interest rate cuts -- but this ECO rise was even stronger, and 'out-performed' broad markets. Side note too, is that president's social media posts(!?) weren't sparing, rare, or moderate; just one night in Dec. 2025 he posted 160 times!!

3 arguable causes for maybe clean energy bullishness were well laid out in Wall Street Journal, 'Why Solar and Wind Power Can Thrive Without Subsidies'. A first is ending subsidies for wind in place since 1992, for solar since 2005 -- might now be "an attractive entry point to this industry" as valuations in P/Es etc are better than in traditional fossil fuels & nuclear trading at more "steep premiums". Renewables wind/solar are not now nascent technologies: they're able to make electricity at lower-cost vs. natural gas, *even without subsidies*. Utility-scale solar has become 84% cheaper than it was 16 years before, onshore wind is 56% better. Even with some need to add energy storage for firming, they're notably competitive now with natural gas, coal, or nuclear … 'naked', at last without truly needing subsidies.

2nd, subsidies were so complicated to use, tough to monetize, to end them *may help reduce costs!* By not hiring an "army of lawyers & project finance specialists", costs fall. Importantly too, it 3rd brings "more stability to an industry that has seen boom & bust cycles at the whims of congress". The above 3 points are all notable. Useful to point out too, that they come from the Reporting side of the Journal which is objective and facts-based; that differs from an Editorial side's deeply-politicized viewpoints. There's a longstanding divide between an objective reporting from facts-based articles side -- vs. bias in its OpEd editorials:



Source: Wall Street Journal



Source: Wall Street Journal

Arguably a 4th reason too is a president's stimulus (although don by huge deficits) can boost renewables, purely on economics. As renewables are built fastest. Are cheapest to run. So, account for almost all new energy generation now being built with good reason. Despite often-expressed desires by a president to halt the renewables, their economics now win-out.

2025 was chock full of changes & surprises, from small & narrow, to big & broad. Many actions undertaken aiming to harm wind & solar, to make them costlier, by impediments. Others tried to make fossils & nuclear cheaper, so nearer competitive with renewables, though it proved far harder as contrary to economics. Narrowly, early 2025 one of world's more aggressive, well-financed, technically proficient offshore wind builders (big German firm in fossils too) -- left US offshore wind entirely. Its calculus was on new US political realities, impossibility of getting US wind permits, materials costs. Thus a low-carbon leader walked away from US very early 2025. Their decision turned out prescient. It's estimated targeted US *anti-wind* policies started just 2025, will soon erase $75 billion of investments! Amounts that would otherwise have flowed in for US wind. Indeed, US officials in April 2025 halted [their 1st time] $5 billion Empire Wind in New York waters with all federal permits. Halt was rescinded in May on intense state lobbying, but cost that project $955 million. In Dec. 2025, all US offshore wind was halted. By a president who'd sued & lost a decade ago over what he often claimed were 'windmills ruining' his views from his own golf courses in Scotland. A deep grievance.

Critics of renewables felt emboldened from 2025, 'wind at their backs'. As a surprise blackout hit Spain & Portugal on April 28th, immediately very next day an OpEd in Wall Street Journal (as noted anti-renewables/pro-fossil fuels) ardently *blamed all just on solar power* -- when its cause had Not Yet Been Determined! Unencumbered by truth of what happened, even its title was slanted: "How Lights Went Out in Spain: Country Flew Too Close to the Sun - Which is to say it Relied Too Heavily On Unreliable Solar". Spain moments before was making electricity at *negative price* €-1/MWh on free fuels: 55% solar, 11% wind, 10% hydro; it was exporting 5 GW. Nuclear, at just ½ capacity, or 10% as it can't compete with low prices.

Blackout's cause was later determined multi-factored, but was Not due to renewables; rather it was due to its own poorly-managed grid switching off. Mainly on overvoltage, frequency oscillation, poorly-timed maintenance, it pre-emptively-it-shut thermal plants; that took 15 GW of grid's 27 GW solar, offline. 2 oscillations began in Spain, 1st for 5 seconds, a 3rd caused the link to France to sever. Hence culprit was Not renewables. Rather, Spain must modernize its own grid, with eg synthetic frequency stabilization to mimic mechanical inertia @ 50 Hz -- this can/should be readily accomplished. Likewise, pro-fossil & nuclear interests similarly jumped to fast, wrongly blame wind power in US State of Texas, on deadly outage in 2021: *it was later determined due to its natural gas freezing off!* Yet a narrative was fast-mounted to call fossil fuels + nuclear as 'the only reliable power' -- when truth was the opposite! As Twain said, "A lie can travel halfway around the world while truth is lacing up its boots".

Even further, an Orwellian twist: a major office in the US Energy Dept issued 'Banned Words List' in 2025 for internal & public-facing documents, reports. Specifically it dis-allows words "climate change" (as implies it is real and bad); "emissions" (as word implies they're bad); "clean energy" or "dirty energy" (as either implies one is good, one not); "energy transition"; "Carbon/CO_2 footprint" and more (couldn't have made this up!). Yet even oil executives privately fumed in 2025 this US Energy Dept was 'only giving the Oval Office what it wanted to hear', rather than providing facts. Seen as harmful for US oil drillers, as well.

Stepping back & looking at 2025 across energy themes, we'd seen Oil's price briefly fell -17% in April of 2025. Renewables stocks fell at first, too, but rebounded hard; clean energy ended April 2025 back where started that month. Many facets of clean energy theme next jumped Q2/Q3/Q4 of 2025. In other words: clean energy, zero-CO_2, new energy technologies (all words a US Energy Dept banned 2025… no kidding!!) did very well in Q2-Q4 2025. Yet broad S&P500 saw P/E valuations arguably become 'excessive' (mainly on AI) late in year.

Oil's -17% fall in April 2025, was then a biggest 1-month oil drop in years. We address why. And note it is unlike renewables, where price for green electricity in cents per /kilowatt-hour has fallen hard -- & *it can go on dropping*. Instead, oil may see 'floors', below which further declines impact rig counts, so oil may re-rise. Oil price may briefly drop on many factors; but soon may re-rise if less rigs. Or it can spike up like on Mideast war like in Spring 2026. Potentially lingers high; no energy-security. Oil's moves are complex, yet comprehensible.

This Chart for Q2 2025 – to end Q1 2026 -- for energy / stocks broadly, has 2 clean themes via trackers, for *ECO, & an excellent *Solar Index. And major US equities in *S&P500 theme; and *Oil, *Natural Gas. For April 2025 -- to end of March 2026. Here, all 5 themes fell at first. Unusually, oil was down all April for reasons including fears of softer growth due to chaotic tariffs. Then, all rose from mid-April, as that president in 2025 backed-off tariffs (1st walk-back of many ahead). Oil also moves big on geopolitical risks here. ECO rose here the most strongly, up 101%(!), like after a softening of 'anything but renewables' in one big' bill.

And a big event too, was that oval office launching its 'way by choice' Spring 2026. So, here's that 4 full Quarters of a president Q2 2025 to end Q1 2026. An ***ECO tracker** ends at top here up **+100%** (from that Index close at 33.10 on March 31, 2025 – to its close at 66.67 on March 31, 2026, it had doubled). *Solar next up about +79%; 3rd and seen after large jump is an ***Oil** tracker up about **+70%;** next 4th is the *S&P500 up much more modestly +17%; last is ***US Natural Gas futures,** though we note natural gas jumped by more in Asia/Europe:

Source: YahooFinance

We've noted how one catalyst at far left above was after Liberation Day tariffs, worldwide -- their walk-back. What some wags, call, TACO. On a campaign trail, that candidate often spoke of tariffs: yet their ferocity, immediacy, and scale, was a surprise. If an oval office was betting early in 2025, that China would be hit hard, its exports suffer, forced into concessions, that oval got this as well, very badly wrong: when it came to those tariffs, arguably it was the US that blinked. While China's tremendous steady support given its own clean new energy industrial policies, were paying-handsomely. If America's erratic tariffs were 'art of the deal' negotiating tactic, confusing feint to throw world off-balance, so-called 'reciprocal tariffs' (actually based on longstanding normal trade imbalances) hadn't accomplished that. Likewise a US 'war by choice' a year later in Spring 2026, did not lower energy prices, either.

Unlike a 1st term, when stimulative policies had promoted *All of* energy, so renewables too -- instead much early in 2nd term was designed as *impediments* to harm solar/ wind/ EVs. De facto & de jure, 2025/26 was 'anything but renewables'. Meanwhile differing actions bent over backwards to help just older coal, oil, gas; plus, nuclear. Opposite of 'all of the above' that dominated 1st term, advanced all energies -- or at worst did no harm. Coal-use had fallen hard in 1st term purely on economics; natural gas grew far cheaper, while coal cost rose. Renewables got cheap, fast too -- helped by 'benign neglect' as solar/wind electricity became least-cost, best choice of all. Rapidly, clean energy soon won out vs. once-cheap natural gas. So 4 years after that president had left office in Jan. 2021 at end of his 1st term -- by 2025, fossils/nukes had found it hard to compete with solar/wind. Hence to hobble or to make (now least-cost) new renewables, more costly, from 2025/26 became desirable to some.

An important US trend is many US 'red' conservative states that don't emphasize low-carbon like North Dakota, Idaho, Texas, Iowa, are *growing their own renewables hard,* and *making electricity at* very *cheapest US rates!* Moving fastest due to better green energy's economics; they're building abundant wind, hydro, solar. Idaho's rooftop solar grew 6,850% in 2014-2025, the 4th fastest US expansion. Meanwhile states one might have expected to be near 100% renewables: California, Hawaii, instead have fossil fuels + the *Costliest* electricity: paying most for power. Reasons include excessive mandates, excessive fire risks, ossified regulations, brittle grid, unhelpful electricity pricing mechanisms, and poorer implementation.

That renewables can make electricity at attractive-low wholesale costs, hasn't translated so far to big $$ profitability, profit margins. Some green equities 2025 saw very tough moments like in US residential solar where one big US name plummeted -65% in one day; bit of solar bellwether we briefly note an issue that had hit it 2025 was debt: a 'Going Concern' Letter was a huge red flag! Other side of a volatility coin to upside, was a maker of robust 12 kW high voltage gallium nitride power supplies for AI hyperscalers: from at $1.61/share as seen in early-April, its stock leapt to $6.50 in late May; that longtime ECO component jumped by 4-fold in first 2 months of 2nd Quarter; then rose higher in June to briefly over $8.50: up 5-fold within just Q2 of 2025. Or a fuel cell maker in 3 themes, so ECO, NEX, H2X rose some 5-fold too from early June to late Sept. of 2025. Or a name in zinc batteries in ECO, NEX, WNX was up 14-fold if looked at from early June 2024 -- to late Sept. 2025.

Hard down early 2025 was a maker of power silicon carbide SiC chips for renewables, EVs. On losses, comment a hopeful $1 billion tax credits in a CHIPS act, may not be forthcoming. On debt, that troubled US chip maker filed for reorganization. Much more broadly, while it was uncertain all 1st half 2025 *how* cuts might unfold to a 2022 Inflation Reduction Act (IRA), it was clear this IRA was *sure* to be *decimated* soon by the oval office, house & senate. 'Decimated' is perhaps too weak a word: it referred ancient-Roman times to horribly 1 death of every 10 soldiers, and so a 'decimus'; these rollbacks for IRA being hashed-out in June of 2025 were far more than a 10% figure. They unfolded fast from July 2025.

Of interest in fast-moving energy-scene in 2025, was politics, a topic we mainly seek to avoid. Seemed almost as if key concerns about *Costs, Reliability of Energy -- and *Climate Risks -- (both valid) had rifted into opposing camps. As if higher Energy Costs / Reliability concerns -- were somehow contrary to Climate Concerns, and visa-versa. All pretty ironic as solar/wind are often cheapest. So switching to renewables faster, *saves $$$, reduces* long-term energy costs. Yet politics somehow was conservatives sided with costly conventional energy (only) -- while progressives sided (only) with the far cheaper, intermittent wind & solar.

Tariffs raise revenues, but their *uncertainty* costs a US economy. Plus lacked constitutional basis; likely to be overruled by US Supreme Court: taxes can only be levied by the congress. *If* they'd been small, fast withdrawn, it's one thing. But, they were high, and erratic, on key counterparties like Asia, Europe, Americas -- with inflation that can linger. Can bring stagflation-(lite), worst kind of inflation(!) may arise. Had 'wins' been fast self-proclaimed, tariffs ended, the short weakness may have 'helped Fed' lower rates. Cut costs of capital. But … it was not path taken. Rather, was chaos & debt. Interference so BLS data are less certain. Fed unhealthily pushed to cut short term rates, even on sticky inflation. $3 Trillion+ in new debt. 10-year yields much above a targeted 1.0%, 2%, or 3%. While a Fed if forced to let inflation run hot, is deprived of credibility, predictability, stability, even reliable data.

Tariffs weren't modest, nor fast-ended. Problems included an ugly, massive **$3 Trillion in Debt(!) can't be repaid readily (and is worse with many tariffs ruled unconstitutional). Unwise to try to force artificially low rates to try to 'inflate away' debt. **'One Big' Act's stimulative effects were on order of tenths of one percent; while added Debt massive. **Also a white house & congress halting solar & wind, made electricity *more expensive*, with demand rising. Brings us back to oil. Recall its brief oil price drop April of 2025 on acute fears tariffs may hit demand. As a candidate, that president had promised repeatedly, he'd push gas down under $2/gallon in his first year. So, his administration should want & need to bolster certainty; be stimulative (so no tariffs). To *Increase US Oil Production, also means *Increasing US Oil Demand. One, without other, will not work: Confidence in robust near-term future oil Demand, is Prerequisite for oil industry to make investments in more fracking / more rigs/ more oil production. Yet spring 2025 fears were big US tariffs would *slow* demand growth ahead. Earlier, at start of 2025, US oil supply was anticipated to swiftly go up from a 13.5 -- to past 14 million barrels per day (bpd), 9.7 bpd shale. Maybe even 3 million bpd more, for 16m bpd on crucial, stronger oil demand. At heart were then-confident-predictions (thus made before tariffs) of strengthening US growth happening right away and over 2025.

Instead on tariffs from April 3rd, uncertainty spiked: expectations fell. For *less*-demand. America's EIA fast cut its US forecasts by 100,000 bpd. Europe's IEA cut its forecast US oil production growth by 490,000 bpd, figures revised down at near-slowest global demand growth in 5 years. On April 9th fear on demand, US WTI oil fell to $55.12/barrel. Lowest in 4 years, below breakeven for many frackers. 10-year Treasury yields jumped. Immediately, that president walked tariffs back, suspended much for 90 days. On hopes, oil jumped same day to bit 'safer' low $60s. Still, oil in $50s to low $60s means consternation for America's shale producers, who fear a slide near-$50. Oil down at $50 (with added $3 Trillion in US debt), could soon afterwards lead to cuts of say 1 million barrels/day in total US production. Supply losses unfolding swiftly after that, over just a few Quarters, for soon much higher prices.

Here's the rub. White house advisors, perhaps not very familiar with oil price fundamentals -- needed oil to fall under $40/barrel, For US gas prices to thus fall <$2. But they'd under-appreciated in 2025 that in many American regions, *oil at $50 is already below breakeven*. For production shut-ins. In Powder River Basin, 11 of state's 15 operating rigs, tricky geology needs oil over >$58/barrel to make money. Sure, in a Permian, Williston at Dakotas, DJ Basin Colorado, it's cheap. US Permian oil costs little to 'lift', money made there at $38/barrel. By contrast Saudis can lift oil for just a few dollars/ barrel! OPEC+ can send global prices down by resuming curtailed output: lower gas costs but hitting US shale growth. A diversifying Saudi Arabia may prefer oil $80s+ plus, to help balance books. Yet if price war looms, they'll ride out lows better than anyone. Better than even oil sands, given lowest-production-costs.

Thus white house energy policies of 2025, respectfully, were deeply mis-guided. Costs did Not fall by ½ for electricity; but rose and going higher. Nor could many big US natural gas plants be brought online before 2030: turbines not available; plus natural gas as fuel is volatile, often costly. Coal is worse. In China coal is costly even with sparse human health, environmental standards; renewables are its cheapest/best option. Industrial electricity in some parts of China, was just 3-5 cents/kWh on massive growth in hydroelectric, wind, solar, better grid -- vs. US costing twice that. Electricity in China comes ever-less from coal. Instead, it faces costly burdens ahead of dismantling the world's largest coal infrastructure.

Or, take oil: could a president 2025/26 convince US frackers to ignore markets, grow supply & push oil under $40, gasoline under $2/gallon as promised? With its 3-3-3 Plan, keep US GDP growth 3%+? All key!! Shale producers resisted white house calls to add huge supply, on fears of surplus. 2025 US rig counts fell to lowest since 2021, as confidence in demand fell. At a big oil services firm counts fell to 566, or 34 below 600 a year earlier. Rigs seeking crude fell to 465, vs. 497 year earlier. Rigs in Permian to 279, vs. 312 a year prior. On stacked 25% steel tariffs (Sec. 232) pipe costs went from $15, to $19/foot in 2025. Oil prices slumping, rigs off prior 2 years; down 5% in 2024, off 20% 2023. Still, that's a normal kind of cycle. However, if oil drops near $50, or $40(!!) it sets stage for high prices later, on fewer rigs. Strong demand is key. All as administration sought to *grow* US oil production, by promised added 3 million barrels/day in its 3-3-3 Plan, to go from 13.6m, to 16 ½m barrels/day. Despite odd *tariffs so *uncertainty -- *working against need for firm oil demand. Erratic tariffs based on untested self-proclaimed, emergency powers: many arbitrary and likely to be held unconstitutional, as power of purse resides in congress. All that *may* portend less demand, ahead, so fewer rigs -- inexorably a return later to high oil prices. That's economic cycles. An oval wanted tariffs -- while oil executives, privately feared slowing demand. Markets, not any US president's asks, are what most guides oil industry coming rig counts, and its shale and other investments.

Thus 2025 had unfolded far different from a 'goldilocks' stable 2023-2024 when oil traded in tight range industry desired: $70s - $80s. Some hoped a white house might self-proclaim its 'Trade Wins', call it a day. But underlying Gordan Knot was US oil under $40, for gasoline under $2 -- is fundamentally incompatible with staying so low. Privately, oil execs understood all well: a white house can encourage, open drilling areas, cut red tape – yet can't overcome basic economics. For gas to get & stay under $2, requires confidence of demand. A slowing economy means fewer rigs; later high price. We discuss ahead a 2020 oil crash that once sent gas under $2 in 2020, yet it was on much differing fears of demand collapse, 'tank tops'.

In 2025 stock markets/wall street saw a "V" rebound. To left-side, a fall due to tariffs. Nadir was a president walking-back tariffs in April. Then at right-side, strong rises in clean energy too. Partly on hopes white house chaos is paused; markets acclimatize to erratic oval & debt. An oval office had walked back partly to appease bond market vigilantes: 10-year Treasury yields jumped April from under 4.0% -- to near 4.5% reflecting huge loss of confidence in US, new debt. 2024 for the 1st time, the US had to spend more to service its debt ($882 billion) -- than on defense ($874 billion). Oddly for world's reserve currency, in early 2025 these US currency markets lost 9% -- despite high rates, a bit like a developing nation. After April 9th, on more-stable words from an oval (office), rate cut hopes, an S&P500 + especially clean energy rose Q2-Q4. Despite uncertainty, including for sure in clean energy, stocks jumped. Strongly so, in clean energy. Some had hoped in late spring, a draft 'one big bill' might get moderated; its deadline shift to 'start construction by' instead of 'be already in service by' -- which came to pass nicely early 2nd half 2025. Bullish times then April to end of 2025.

Several big clean energy topics were debated, decided in 2025. Tightly-bound to overarching questions of which way to go on America's economy. One key question was, how (not if) an IRA of 2022 abhorrent to conservatives gets eviscerated. Beyond decimated. Partly to 'trim' $3 Trillion debt. Yet plainly too on pure grievances about solar, wind, EVs. Thus inconceivable then, to have crafted a genuine 'All of the Above' energy strategy. One inclusive with a *true* US energy abundance, hence more solar, wind. That couldn't be, as an oval + 1 party in power wanted fossil only; and a unitary executive to halt renewables. Pick 'winners' (fossils fuels), and hit 'losers' (renewables). Weirdly it embraced anti-conservative, anti-free-markets. Though truth is, adding just fossil fuels = actually has meant higher US electricity costs.

As 2025's 'one big Act' blows-up deficits, with unpaid-for-tax-cuts, a core question is, Can / Will this all work?! Was that candidate, then president right: Are we all as he'd predicted now shouting, "Please, Please Sir, It's Too Much Winning!!". One possibility (we'd hope so!) is: Yes! *If so (a big If!) a president was right, there's now huge jobs growth 2026!* Manufacturing has moved from Asia, to US! US manufacturing and jobs are now booming! 10-year Treasury Yields down from 4%s into 2s%. His Big Tariffs, Tax Cuts (& Debt) plus costlier energy are now *growing* US economy! *If oval office was right,* new jobs/non-farm monthly payrolls 2026 are over 200,000+/month. Jobs growth is humming. Inflation under 2%. Unemployment under 5%. All tariffs were deemed Constitutional. *If president is right,* oil is now under $40/barrel; US average gas price 2026 below $2/gallon. US oil production up at 15+ million barrels/day. I*f POTUS was right,* US growth has prevented $3 Trillion in deficits from being new debt. All that a US president + his allies, promised. Much was anathema to classical economists -- yet was say, a possibility. Very forcefully pushed by candidate, then president, and his allies.

However, another possibility to contemplate, is *were seeing bigger debt + tariffs + costlier energy; these haven't brought a manufacturing + Jobs boom.* US industries not re-shored. China's decades of industrial policy, its far lower wages, supply chains that took decades to build, resist US replication. Affordability is still an issue. Non-farm payrolls/jobs maybe down near 100,000/month or less(!), hiring slowed. GDP/markets went up at first: but on painful sugar-high, huge US debts; private credit worsens. All unsustainable; 10-year Treasury yields resist falling: need to attract inflows, yet less confidence US will tackle debt other than 'inflating it away'. Maybe stagflation-(lite) on fears of souring economy & inflation. For say K-shaped or E-shaped economy. Falls in personal consumption expenditures (yet Bureau of Labor Statistics' once-gold-standard data in doubt). Many tariffs deemed Unconstitutional (as happened in 2026, to no one's surprise). Mass deportations, US food prices high. GDP/ stock markets did briefly rise nearer-term, yet teeter on narrow AI gains. Much threatened by debt (especially after many tariffs deemed unconstitutional). Gas price high -- not at all under $2 as a white house promised. Wars. Scary too for many, exploding deficits, public debt. Private credit weakening too. All by self-proclaimed 'fiscal conservatives' in robust employment, non-recession, peacetime. Normally the time for fiscal rectitude, balancing books.

Or… maybe GDP/stock markets rally at first, on 'one big' stimulus, deficit spending/ low rate hopes (although unmet). Or another possibility, is a K or E shaped economy on slowing jobs -- yet stocks rally, accepted by hardliners to 'break the back' of inflation. Government shutdowns get routine 'a feature not a bug' to 'detoxify' what some saw as excessive reliance on government, spending. Both tax cuts & huge expenditures. Coal, oil & gas are supported -- yet renewables decimated on 'cultural affinity' for old fuels, longing for less-constrained America of past. Or, what's is revealed ahead, perhaps might be unpredictable mix of several possibilities above (with many surprises too) into late 2020s. All is yet to unfold.

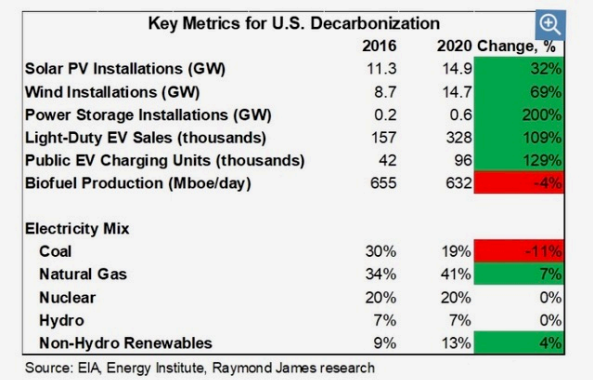
For very rough analogy in physics & chemistry, the periodic table beautifully helps to explain, predict how elements behave. Consider, why elements in a far-left column are reactive. Each has 1 sole electron in outer valence shell: 'wants' to combine. Hydrogen for 2 electrons in a stable 1st shell to predictably form (+ oxygen) Water. Or lithium, with pair of electrons in a 1st shell, has only 1 in 2nd orbital, so is reactive. Below it, sodium, with 1 sole electron in 3rd shell, 'wants' an element with 7 valence electrons (chlorine) so it becomes table salt. That salt nicely then has 8 electrons, stable so in desirable state. Predictable, understandable.

Admittedly something of a stretch, but by an analogy, conventional fossil fuels favored by conservatives may be on a cultural affinity: they long made US energy. Complete, Stable. Oil for at least a century, coal for much longer. Once cheapest, they'd helped build America's industrial revolution. Hence an affinity for them. They're centralized, thermal, burned for heat to spin turbines, mechanical inertial force. In stark contrast to renewables solar/ wind, which until recently were too costly, unreliable, impractical in a 1980s, oddly non-thermal. So they'd once only made sense as a niche, on tremendous public $$$ subsidies. Given clean energy's (once super-high) costs, intermittency, lack of reliability, maybe more than anything else their not being longstanding part of American culture, they'd not been / are not yet embraced by conservatives. Clearly not in a same ideological, non-sensical ways that today's-costly coal, oil, gas, and nuclear are embraced by self-styled 'fiscal conservatives'.

Far right column in that table are un-reactive 'noble' (they stand apart) elements: Helium, Neon, Argon, Krypton: with full valence shells. So won't interact with other elements. It's a poor analogy, but until recently, there'd been no need to take renewables seriously. They'd just had singular uses like in space craft solar panels -- thousands of dollars per watt!! But today, solar/wind are far different from a 1980s. Combined ever more with storage, can be firming & dispatchable. So that fervent opposition in the 2020s to clean energy, clearly isn't sensible now on economics; yet it persists. Still, it too can change. A half-century from now, nuclear fusion power may possibly fuse isotopes of Hydrogen (upper far left periodic table) + a noble stand-alone Helium (upper far right) -- for stable cheap, and safe power. No radioactive wastes at all. Even now, solar/wind could provide the US immense cheap power, but arguably reasons most preventing it, are cultural. On old thinking, inaccurate today (given far lower costs of renewables), that has painted them as too costly, non-dispatchable.

A cultural bias brings hesitancy to let go. Even of coal, on traditions. In 2025 federal officials actually invoked a rare emergency rule to block a planned US coal plant, from closing. Yet that closure was desired by plant's owner, grid operator, city/state; keeping it open costs ratepayers $$ tens of millions. Though gas instead is cheaper. Maybe it's a cultural affinity. To force coal plant to stay open, certainly is Not based on economics, nor local desires, nor free markets; but maybe culture helps explain some, make a bit understandable those aims to kill renewables. Culture changes slowly, yet does change; 100 years ago, it took awhile for conservative Texans to embrace bobbing oil pump jacks: they're now a Texas icon. Just a generation ahead, conservatives may look out at spinning turbines, cattle grazing underneath & say 'turn, baby, turn.' Unlike 2025 when a TX state senator said 'a broken wind turbine blade can be hurled 4,000 miles, to kill a baby in crib'[!??]. Meanwhile, actual concerns in latter 2020s include trade uncertainty, China may use its strategic lead in minerals & processing. China has 93% of rare earths, 97% of graphite, 68% of lithium; it could slow-walk export permissions, ban exports. For leverage in trade stand-offs. It will take years for a US, like Europe, to re-build strategic minerals capacity. The US & Europe once leaders in car making; but now on Chinese EVs they're letting that past leadership wither away.

Doubtless a president's 2nd term may unfold differently from 1st term. This 2nd term began with tariffs, impediments to hit renewables / help just fossils & nuclear. Yet that president also did have a prior, 4 years in 2017-2020, so one should ask: Did decarbonizing/clean energy equities growth, halt then? No. Both in rhetoric & actions, that president has long *favored* oil, gas, coal, & nuclear -- and long *opposed* wind, solar. Late 2024, he'd stated [factually ahem, wrongly] that wind "is the most expensive energy there is. You cannot get more expensive." In 2025, he'd pledged to "have a policy where no new windmills are being built". He's called climate "the greatest con job perpetrated"; yet we saw too in 2025, ECO's theme rose. In his 1st term, clean energy generation itself grew 2017 – 2020: solar installs up 32%, power storage up 200%; wind installs up 69%, EV sales up 109%, EV chargers up 129% (off miniscule base). Only biofuels were down on demand destruction in a punishing Covid-19:



Key Metrics for U.S. Decarbonization	2016	2020	Change, %
Solar PV Installations (GW)	11.3	14.9	32%
Wind Installations (GW)	8.7	14.7	69%
Power Storage Installations (GW)	0.2	0.6	200%
Light-Duty EV Sales (thousands)	157	328	109%
Public EV Charging Units (thousands)	42	96	129%
Biofuel Production (Mboe/day)	655	632	-4%
Electricity Mix			
Coal	30%	19%	-11%
Natural Gas	34%	41%	7%
Nuclear	20%	20%	0%
Hydro	7%	7%	0%
Non-Hydro Renewables	9%	13%	4%

Source: EIA, Energy Institute, Raymond James research

We saw America's electricity mix at start of 2017 was then about 30% coal, 30% natural gas, 20% nuclear. End of that president's 1st term, coal in 2020 was down hard to 19%, gas was up near 40%. Nuclear, *hugely* expensive in a west -- and big hydro not susceptible to growth, were both static, 20%, and 7% respectively. Coal was hammered those 4 years not primarily by renewables, but plunging costs for competing nat. gas/fracking. Start of decade in 2010, a Utility executive might reasonably have aimed to add coal power. End of decade, 2019, their fiduciary duty had made coal relatively a bad bet. Not on worst pollution, but as coal lost its edge vs. also firm yet 'less-dirty' flexible, cheaper natural gas-fired electricity.

Decarbonization did Not pause in 1st term, 2017-2020. Nor, may it 2025-2028(??): still-critical too are innumerable state-level policies, private-sector goals etc all advancing green energy. No doubt renewables will be hit hard. Yet crucial today is better economics of green power. Conservative US States reflect it: rock-ribbed conservative Texas far outpacing California in renewables growth. Ruby-red conservative Oklahoma 41% wind/ solar. Iowa & Kansas lead in wind. While deep-blue Oregon by contrast is one of the worst-places to grow renewables as it did little to improve its grid: of 469 large renewables projects that applied to connect to grid 2015-2024, just one 1 was approved by Bonneville Authority. Washington state, also blue, 'liberal' was dead-last worst of 50 states in 2025; pretty anti-abundance. Globally one expects a liberal Europe to lead; instead, its start/ stop policies are a problem. Dirty-coal China is by far the world's green manufacturing Leader -- even with its supply chains saturated.

On IRA's slow roll-out, 2/3rds of $$ went 1st to conservative states; yet was fast undone in 2025. Hundreds of billions halted. It's understood: the elections / 2024 Red Wave have consequences! GOP members who'd (mildly) supported IRA, rolled over for 'one big bill' in 2025. A few senators mellowed reconciliation text. Still, many US oil execs who enjoyed world-record oil production in 2024, were disappointed, privately all 2025. They didn't want 'Drill, Baby, Drill!!' given oversupply/ low prices/ oil near $50 -- so much as firm GDP growth, stable ongoing oil demand, easing drilling with far fewer regulations, less taxes.

A place offshore wind did well (outside China) in tough early 2025, was Germany; it permitted new 4 GW wind; approval times quickened; GW wind capacity was connected to grid Q1 2025, up 40% year/year. Pro-renewables policies help, a lot!! Or, policies can hurt!! After a 1,665 MW of new *solar* capacity was installed there in Feb. of 2025 -- next month, March it dropped to 787 MW -- on a new law 2025 whereby solar isn't paid if electric prices go negative. Still German solar fast re-gained, capacity >100 GW. National policy can aid -- or 'unintentionally' can hinder (like US electric prices *rising on* less solar & wind). Or, new policy even with lots of $$$ may fail to surmount hurdles. US tried to push coal-costs down 2025/ 2026, but to cut coal's mercury & air toxic standards – will hit human health. Or, a rush latter 2020s into small new nuclear coming from 'move fast & break things, tech bros', may be ill-advised. Recently a co-founder of a nuclear startup promised he could hold a spent fuel rod "for 5 minutes" with no ill-effects(!); as scientists note, a lethal dose is actually in milliseconds.

Much was being tried since 2025 to make the very costliest of firm baseload power, nuclear -- 'cheaper' by new gen III (3rd generation) designs. Via big reactors >1,000 MW (so 1 GW), or by trying novel small reactors under 300 MW. Opposite of *impediments,* like on renewables -- federal officials gave 'nukes' *incentives*: shorter 18 months Licensing, deploy on military & energy dept lands, maybe higher radiation exposures, bypass NRC reviews etc, all trying to grow US nuke capacity 4-fold. Try to get a US from about 100 reactors & so 100 GW in 2025 -- to 400 GW by 2050. Thus the 3rd gen small modular reactor (SMRs) idea gets attention & $$$$. A downtrodden industry's dream is cheap nukes. Yet probable result may be modular SMRs prove next 10 years still too expensive, too long to come online, too risky. Promises recent years by SMR promoters, like low 7 cents/kWh, to be cost competitive with nat. gas -- may move to 10 cents/kWh (or more!) as they get more realistic. But new executive orders did relax Rules in hopes gen III ideas grow workable. Notion SMRs will revitalize moribund US nukes was generating much talk, but sadly, no SMR power yet by 2026. Near all US commercial reactors are still old, 2nd generation/ gen II built long ago. And commercial *fusion* at scale, is decades off -- 2040s at very soonest. So, what to do on US nuclear late 2020s was / & is a question. Commercial, cheap SMRs + fast-followers is a hope. It *might be* great on a capacity factor uptime near 90%+ at nuclear -- vs. just 24.9% at intermittent solar, just 35.4% for wind (latter 2 'naked', with no battery storage). SMRs would be great too as zero-carbon baseload. Great as well for clean energy, being they're relatively far more costly, vs. solar or wind.

A company aimed to have a US commercial, gen III SMR up in 2029: we'll see! California has long had a sole lingering 2.2 GW big gen 2 nuke helping stabilize a fragile grid. But it's old. And US/Western Europe aren't building many new nukes, other than as replacements; they've been too costly, too risky vs. gas. Yet Asia and Russia, are a different story. South Korea is almost alone among OECD countries having built a nuke on time, on budget; of 65 reactors going up globally 2025, most were in Asia. Yes, nuclear *could be* great!! But it's still far & away, costliest path. Far riskier too than much cheaper, faster, always safe, renewables.

US experience is instructive. Only 1 big new US nuke was 'successfully' built in last 3 decades: Vogtle II in Georgia, a gen 3. Breathtakingly over-budget, its 2 reactors took far longer than promised. Cost, was wildly, $35 billion! Enormous $16 million per megawatt capacity, and so *far more* $$$ than even natural gas. Hence far more expensive than lowest-cost, fast-built electricity-generating options by solar, wind, battery storage. Georgia's ratepayers ended up paying $1,000 per person for it even before opening. Will pay $7 billion+ ahead in overruns that bankrupted its builder. So the Utility hopes to recoup a litany of ugly costs. Its early-promises to be cheap, new, US gen III nuclear built on-time and on-budget, were folly.

Vogtle was “the most expensive power plant ever built on Earth”. Estimates (private data) of its electricity costs very-high, say 12-18+ cents per/kilowatt-hour (kWh) generated. Offset by subsidies, yet more costly than China’s giant Three Gorges Dam. Yet dismally, overtaken now by Sizewell C 3.2 GW nuke in UK whose costs near-doubled since 2020 -- from estimated £20 billion -- to £38 billion/ or USD $51 billion in 2025. Aims to meet 7% of UK electric demand; yet not opening until late 2030s! A future Hinckley C nuke is as bad; 1st set to cost $18 billion, it’s now so far behind schedule, over budget, won’t open until 2030s and costing at least… $46 billion!! With Vogtle in operation, Georgia’s power rates in 2025 were higher than so many states on clean wind, hydro, solar power -- like N. Dakota, Idaho, Washington State: we’ll discuss ahead. Awful construction/labor costs, excess delays etc etc help explain why nuclear as a share of electricity generation dropped worldwide, from 17% in mid-1990s -- to just 9.1% in 2024. New, big reactors may replace retiring ones, with proven designs; vs. hopes tiny new SMRs fall under a <cost-prohibitive $10+ billion per plant. Talk of standard modular ‘cheap’ reactors <300 MW can be alluring. Yet reality + experience, 2020s with gen III designs shatters. Hyperscaling new AI demand, has re-started a few of the older nukes. As hopes for US to re-shore industry after years of flat power demand, drive hopes for nukes in 2030s. *So, If* SMRs become Safe, fast & cheap, wonderful!!! An excuse at US nukes has so far been, FOAK (first of a kind). Perennial hope is standardizing small reactor designs fast drives down costs to say, 7 cents/kWh to be competitive. So 3rd gen+ ‘cheaper’ SMRs can be emplaced at many sites early 2030s. Standardized/proven, and be firm & dispatchable, cheap, & #1 key Safe(?!).

Reality, however, so far belies that. Economics shows big reactors are more profitable; small nukes cost *more*/kWh, waste per kWh also worse. Models show cost/per kWh for SMRs is 50% higher than big reactors. So little surprise globally, only 3 SMRs were operating 2025, all built by state-owned enterprises, cost overruns ‘accepted’. China had 1 SMR with 300% cost overrun; 2 in Russia had 400% cost overruns. In a west any new big reactor is already the very-most-costly way to make power, well >10 cents/kWh, 6 times build costs of S. Korea, China. So, note, small still-economically-unproven SMRs may be even ‘worse’ -- it’s no wonder SMRs are today pre-named “the most expensive possible energy source”. When a US private company did lately try building a 1st new domestic SMR, costs jumped >$20 million/megawatt, absurdly expensive, worse than Vogtle(!): it was cancelled in 2023. Or a recent attempt at a 375 MW natrium reactor saw costs soar to $10 billion, or $30 million/MW making it absurdly more costly than Vogtle (near 2x more). Canada aims by 2030 for a CAD $7.8 billion 300 MW test SMR; will see if it’s anywhere near on-time, on-budget. And #1 key: is it Safe!??

Because any new nuke must compete with natural gas plants, on cost, and natural gas fuel is at times ‘cheapish’ -- a new gen III nuclear big or SMR, must be able to make electricity for not much over competitor natural gas @ ~6.5 cents per /kilowatt-hour (kWh). Yet even a big nuke comes nowhere close! Reason why some 98% of all new US electric-generating capacity added in 2026 was solar, wind, batteries. Only a small % was even natural gas. China planned in 2025 to build more nuclear: 35 GW so more reactors. Yet 95%+ of it would be as big reactors, each over 1,100 MW (1.1 GW). With just 1% of that to be the smaller new 3rd gen SMRs.

Yes, a 35 GW new generating capacity planned by China, over 5 years seems a lot. Yet to put that into perspective, *China had built 300+ GW of new solar/wind, in just 2024 alone!!*

So US administration was trying from 2025 to bolster gen III big reactors + SMRs for firm power -- yet hopeful new gen III designs, intended to be far cheaper, propel US nukes ahead instead proving costly especially in the west. More’s the pity; nuclear could help clean energy.

The *Intermittency* of solar (sun shines only ½ the day), and wind (blows only at times) means maybe some 4x more renewables may be built, to equal = say 1 firm megawatt. Electrons dearly needed early evenings, so always after sunset, may be windless. Most batteries now only last a few hours. So Dispatchability is Crucial. Firm key! Yet renewables' cost nonetheless has dropped so drastically, it still makes great sense to 1st grow solar/wind/ with storage. Renewables making abundant electrons, can cost near-zero, less at times. So can render firm old coal, baseload gas plants, even nuclear that can't fast start/stop, as un-economic, terrible loss-makers at times. This is a crux of matter latter 2020s: fossil fuels & nuclear: firm and yet costliest options -- cannot easily compete at times now with ultra-cheap clean energy.

S. Korea stands out, having delivered a rare thing: reactors built nearly on-time, on-budget. Their first foray abroad was Barakah plant in UAE; from start 2009 to finish in 2023, that $20 billion 4 reactors plant went up far faster than in west. S. Korea has 50 years of nuclear experience; in 2025 it had 26 domestic reactors. Plus it doesn't present national security risks to a west, like contracting with China. But, all in, that rare nearly on-time/on-budget plant used very cheap imported labor in a Middle East. Plants in US, or Europe, can't do same. Czech Republic may desire GWs of firm nuke power; but its labor force is not nearly as cheap. US/Japan & S. Korean firms may partner, try 'cheap, fast' SMR prototypes in eg Canada.

So little surprise US AI centers wanting firm power may often look to build natural gas plants. In 2022 they'd once cost 'just' $800,000/MW, far less $$ than a big nuke at $16 million/MW (novel small SMRs cost even more per/MW)! Gas plants back then could made electricity for 6 or 7 cents/kWh -- cheaper than dirtiest coal. But times have sure changed. In 2022, the big 3 gas turbine makers: GE Vernova, Siemens, & MHI, had all sold just 1 unit between them! After, manufacturing capacity was lost. So 3 years later, if a new turbine wasn't already secured in 2025, turbine shortages meant one must wait to 2030s to build. Pushed up prices near 2-fold. By 2025 a new gas plant cost far more: $1.2 million/MW. Prices for natural gas as fuel are volatile too; as US increasingly exports LNG, is no less volatile. Yet even vs. say, 6.5 cents/kWh 'cheap'-gas plant -- intermittent clean renewables on free fuel may generate at ½ that cost or less! Look ahead and one linchpin is how swiftly energy *storage, can* advance. New technologies that make intermittent solar & wind more firm, dispatchable. Geothermal advances will be notable too. Still there's no one, single silver bullet answer across energy!

In practical terms, the $$$ spent on clean energy latter 2020s may be big, yet they show the world is not yet solving for climate. Plus, what is being done is still, all, basically additive -- rather than *replacing* dirty energy, it is flopping new clean atop old. Spending the $$ needed, to decarbonize, is jaw-droppingly formidable. In 2024 the UN calculated that to achieve net-zero by 2050, world clean energy spending must be $6.5 Trillion/ per year to 2030; then after $8 Trillion/year to 2035! Unthinkable amounts today. Especially on a recent global backlash ('greenlash') against clean energy, rise of political nationalism. If evidence-based-concerns for our planet's future hadn't made climate so pressing, we'd just shrug it all off, move on. Keep to a status quo of burning conventional fossils, profitably, if one isn't moved by science. Such an easy path is pretty-near our current trends. And yet, science gives us fortunately, or maybe unfortunately(?) some idea of what to expect on a planet 3, or 4+ degrees C hotter. Proponents of fossil fuels often want / like to portray themselves as more 'practical', the more serious[!] -- yet consequences of their thinking *may* be what's radical. We discuss in pages ahead, what science foresees. It's all ironic too, since going clean now, faster, though costlier upfront, saves most $$. And yet a terrible current path we're on today is likely in our human nature. Let's return to clean energy equities now, in latter 2020s.

We saw after a nadir low 28 in April 2025, ECO theme rose steeply and ended well up for that year, 2025. To help explain how this happened, let's look briefly at what Index components then were *Most Down, / & Most up* for all 2025 (to Dec. 20th). In these 4 volatile themes, in ECO; in global clean NEX for stocks mainly outside US; in hydrogen H2X; wind energy WNX. For ECO from Jan 1st to late Dec. (20th) 2025, components most *Down,* included in: *thermal-insulating aerogels (-75%). *solar inverters (-52%); *battery metals (-43%). But what stood-out was that 14 ECO components showed triple digit gains. Of 62 Index components total, this meant near 1/4th of components were up over 100%. 14 most *up* in ECO, all over 100%, were in *fuel cells (+300%), *lithium (+250%), *domestic US rare earths (+246%), *silicon anode batteries (+233%), *zinc-based long-storage batteries (+169%), US solar (+149%), **solid-state batteries (+148%), *solar trackers (+143%), *solar panels (+120%), solid electrolyte batteries (+120%), *power supply chips (+119%), *solar inverters (+114%), *electronics (+113%), *lithium mining (+107%). And a few still more were well up too at just under then, +100% gains.

At the Global clean energy NEX, components most *Down* for all 2025 to late Dec. included in *EV chargers (-65%), *EVs (-61%), *backup power, based in Taiwan (-48%), *wind, based in Denmark (-26%), *solar, in Taiwan (-25%). Most up in global NEX, included a *fuel cell maker also in ECO (+300%), plus components just here in *power transmission, based in South Korea (+193%), *energy storage (+169%), *wind power, in Germany (+157%), *lithium, based in China (+157%). In global hydrogen H2X most *Down* YTD included *composite cylinders for H_2 (-83%), *electric meters, based in Switzerland (-61%), *separator films, S. Korea (-39%). Up the most included that one in fuel cells also in ECO (+300%), and just here, *H_2 electrolyzers (+155%), solid oxide fuel cells & electrolyzers, in Taiwan (+112%), and *fuel cells, S. Korea (+88%).

At global WNX for wind, most *down* in 2025 included in *power measurements, based in Switzerland (-61%), *wind lubricants (-45%), *wind farms based in Germany (-30%), *wind installation vessels (-27%). Most up included in *power transmission, based in S. Korea (+193%), *wind power, based in Germany (+157%), *wind & solar, based n Spain (+155%), *power transmission, based in Japan (+154%), and *rare earth in turbines (+136%). So, despite US, wind globally has continued to grow. Back in 2023, world hit a record with wind then up +50% over 2022, a cumulative global wind capacity hitting 1,021 GW, or a bit like say ~1,000 nuclear reactors (though wind of course is ever-intermittent, not firm). Yet on CO_2 budget, for our world to stay under <2.7 degrees F/ 1.5 C heating, that 1,000 GW was far from enough.

Embedded in figures above, we've seen that as once-costly clean energy matured, it is now *the Very Cheapest, the Best-priced vs. traditional coal, natural gas, or nuclear. And though *Intermittent, with storage it can/will grow-firmer ahead. In 2010 levelized cost of energy (LCOE) for onshore wind had been a pricey $0.11/kWh, a big 23% Higher/worse than coal/gas @ $0.09. Yet, by 2024, onshore wind costs were 67% *better* / lower falling to $0.03 -- vs. fossils still near @$0.10. Utility-scale solar fell even more in costs, from silly $0.46 in 2010 or 400% costlier than conventional gas/coal -- to near $0.03 in 2024, 56% *less* than fossils. Battery costs are falling fast too; storage will be key ahead for needed firming solar/wind.

And yet, the older energy by gas, coal, nuclear, still dominate. *Look at say from year 2022 -- to year 2023: world dependence on conventional energy fell by less than 0.5%: hardly at all! Dipped slightly from 81.9% - to 81.5%!* What's ahead is unknown, yet of such importance. It's certain equities here shall move in surprising, ever-unpredictable ways. Yet we're mindful too that after big rises seen like in 2025, that by late that year, stock markets had then grown (too?!?) richly-valued. For sure, many components in clean themes saw lofty valuations.

Now past decade's ½ way point, we're seeing big changes. Global discussions shifting sizably. From big concerns back in 2021 about, ***How Clean, Low Carbon,*** is each electricity source -- to from 2026: ***How Energy-Secure, Available,*** is it today. Consider Norway's ample low-cost hydropower that gave it about cheapest, yet firm reliable electricity in OECD. While it exports its pricey natural gas, & oil to other nations. Because cheap hydroelectricity in its north was for decades available only to Norwegians, 'power cul de sac', prices were low. But, after interconnectors were built 2021 linking Norway to UK -- Norway's rates at times jumped.

No longer just a few power buyers, it could export electrons at high prices; like a 'green battery'. Those high prices hurt Norway's citizens, who'd paid for its dams. Ironically if no winds in a UK, prices in Norway might spike, oddly hitting this *hydropower-rich* nation. An issue in Norway's 2025 election was renegotiating with UK, on 'price infection'. With 5 pricing zones, rates near its connector in Rogaland, Norway had leapt in 2024 from <6 cents, to briefly over >$1 USD (13 kr)/kilowatt-hour (kWh)! Lacking pumps, its dams rely on rains, run-off, so in 2025 a drought had also posed issues of whether Norway can so cheaply go on powering itself. Any new cap in turn might threaten UK; Germany, Denmark a bit, they seek (almost-always just getting) imports of green and far-cheaper power, from Norway.

Opposite of Norway's very low-cost electricity thanks to its surplus of renewables/baseload -- is 'losing' UK with super-pricey industrial electricity, 46 cents/kilowatt-hour! UK's falling demand, plus cheap wind power, long were a pincer, so baseload capacity was lost. Its de facto ban on, & erratic support for onshore wind, grid permit thickets, put it in a bad way. One national electricity rate is set by priciest gas, while it imports gas, & power too if the winds don't blow (can raise rates too, in Norway). Recently a typical UK household paid about $1,500/year for electricity; a US household using 3x electricity paid about $1,700. Or take Australia's aged coal fleet wrong-side of cost-curves too. Its coal is unreliable + costly. In past UK & Oz had relied on cheap coal. But now, fossils are most expensive! It's topsy-turvy. Where cheapest electricity globally is renewables, like near a penny for solar/wind in Saudi Arabia. Better grids, everywhere, now crucial. As is storage, to solve an inherent intermittency.

The 2 cheapest, so 'best' US states for retail electricity in 2025 were N. Dakota (11.31 cents), and Idaho (11.34 cents). Also, Washington state is cheap at 12.39 cents. All 3, thanks to ample renewables. North Dakota turns 1st to its cheapest electricity: wind (36%) & hydro (4%); these incur No resource costs. Only after does it turn to costlier baseload: lignite coal (55%), used little gas (5%). Idaho relies 1st on cheap hydropower (43%), wind (15%), solar (6%) -- only after does it turn if needed to costlier baseload gas for last 1/3rd. Washington state 1st gets a 68% by hydro, 7% by wind; so 75% is by 2 cheapest resources. Only after those 2 does it turn to costlier, firming gas (13%), nuclear (8%), coal (3%). Worldwide & in US, developed places with the very lowest-cost electricity, very often rely 1st on ample and cheaper renewables!

Contrasts with costliest US state, Hawaii at 39.6 cents, so 3x the cheap states. It's clear why. Hawaii imported & burned costly filthy bunker oil to meet a huge 78% of grid demand 2025. That 39 cents was near retail rates in costly Germany (1 pricing zone, like UK). Meanwhile in mainland US, average retail was then near 15 cents. 2nd worst/costliest 34 cents California, has onerous regulations. Require decades(!) to add capacity. It pays 3rd highest US prices for industrial baseload gas. Has huge wildfire liabilities, myriad mandates. Note, California's high rates *were Not Due* to its renewables. 8 states make a bigger share from renewables than California, *and they all have rates below a US national average*. Old conventional wisdom is today, wrong. Cheapest sources are renewables – Costliest, natural gas, coal, nukes.

Texas makes-the-most-clean-electricity in US: its 169,000 GWh of clean generation in 2024 surpassed nations! California is bigger by population, and yet made 'only' 92,000 GWh. Industrialized Texas has huge energy demand and meets that by cheap industrial electricity under 7 cents, which blew away California that's 3x more costly. A not-unusual Texas winter day in 2025, Texas wind/solar met 69% of electricity demand + growing. Of course, its solar works only daytimes; wind breezes only, they're intermittent. That said in latter 2020s, its wind & solar were the Cheapest + often the dominant sources for Texas' own electricity.

*Yes notably, 2/3rds of Texas *capacity* is still in firm, dispatchable, (often idled) non-renewables.* To see how Texas grid has evolved: in 2015 it had 251 natural-gas plants. These work-horses of dispatchable baseload could meet much demand. Yet 10 years later, 2025 with far greater electricity demand vs. 2015 -- it had near-same 264 gas-plants. Baseload does need to gets cleaner; one sees why there's calls for new small modular nuke reactors. ***If,*** they can be made safer/better/cheaper than today's gen II (2nd gen) nuke technology. Gas power was cheaper than nukes @ 'just' 7 - 9 cents in 2025, and gas can be built faster than nukes (if gas turbines/ parts are available) -- yet as noted, that gas capacity grew by a puny 6%.

How, why? Answer is Renewables. Clean energy grew from 168 wind /solar sites there 2015 -- to 652 wind /solar sites in Texas in 2025. Clean energy generating capacity grew 315%. Versus natural gas capacity 'growth' of just 6%. Key reason: new electricity by solar/ wind is now Cheapest by far -- when sun is shining, wind blowing. So trick now is to pair cheap renewables with storage, add clean baseload, recognize climate /CO_2. Hasten permitting. Improve America's fragile grids. Expand new energy production, storage, flexibility greatly. An economic allure of wind/solar is why a little-regulated, market-oriented Texas grew as it did! In 2015 gas was key to its electricity; has a great deal of it & loves fracked gas (especially vs. far costlier gas in Europe, Asia). Plus at times, Texas' gas can be 'cheap-ish'. *But even a 'cheapish gas', is Not Free; very different from solar/wind that are 100% forever free fuel -- especially as latter costs drop to just 3, 2, 1 cent/kWh, then less!* 'Traditional energy' hence coal, or natural gas - or 3rd gen or whatever nuclear fission, can never, ever touch that.

As Texas' nat. gas is increasingly exported, interconnected to global demand, US gas / LNG price may rise reflecting high global prices fetched for product. A bit like Norway's 'price infection', as high UK prices paid for electrons other side of connector, drove up prices for Norway's power. As prices rise one end, they do other end too. When a US converted its own LNG terminals from just Importing, to instead Exporting -- it swiftly world's #1 LNG producer. Fast went from zero exports in 2016, to 8 years later supplying massive 21% of global LNG. One argument is those exports can drive US natural gas prices higher. Another, is that nat. gas priced mid-$4 range in 2010 (pre-exports), would be $6.70/MMBtu in 2026 adjusted for inflation. So a post-exports nat. gas price around $3/MMBtu in 2026, implies US exports did not raise price of nat. gas. It is though, surely volatile. And is costlier than solar/wind.

Unsurprisingly, traditional energy is fighting back at all levels. After a century making wealth, fossils are among the most-powerful of interests, so winning on many fronts. While they've lost on costs vs solar/wind, loss widening, they're highlighting renewables' intermittency, lack of firmness, poor dispatchability. Still, on 'All of the above' energy strategies, the fossils and nuclear, lose. Hence efforts to hobble solar/wind, EVs. 'IF one just overlooks climate', gas might make-up most baseload! Subsidize it heavily, stress renewables are intermittent. Yet that hugely risky bet, contradicts science. But, we are seeing such growing efforts, bold moves by states etc to slow, or even to halt just clean wind/solar alone in its tracks.

For example, a Texas' legislature 2025 considered a bill (SB 388) to require over 50% of energy generation 2026 onwards, must be by dispatchable gas, coal, or nukes, only; though storage of solar/wind is normally dispatchable, it excluded that. Fossils & nukes falling behind on costs have asked a less-regulated, pro-free markets Texas, to put its thumb on these scales -- against clean! Another bill would require renewables alone, must get PUC Permits. Or, while oil wells in Texas must be at least >200 ft from property lines; another bill would make setbacks over 3,000 ft for wind! While all passed in a conservative senate, even oil lobbied to defeat them; Texas needs 'all the above' energies. Defeated, but bills had gotten far.

Besides states' efforts to hobble wind/solar -- big efforts from 2025/26 tried to make dirty coal, cheaper -- by cutting Federal Health regulations. In 2025, federal officials exempted 47 coal companies from mercury, air toxics standards, eg particulates. Coal is too costly; just moving/burning heavy coal makes it costlier than renewables: so paring health/environment rules Not enough. Yet, to allow more harms for human health, should be a non-starter. Even in China with its far sparser health protections, coal is too pricey; at a baseline USD 5.0 cents (RMB 0.38), coal is costlier than renewables -- even in China! Plus there's no 'clean coal'. We see too on US politics, an old -- yet still wrong argument again being trotted-out too: it claims US oil & gas are Unsubsidized; that only the renewables solar/ wind are subsidized. *Yet that's just wrong too: all energy is in fact heavily subsidized.* Consider tax breaks given just US oil & gas; enormous $35 billion in direct subsidies is continuing there (and only growing).

Of 10 big tax favors given directly for US oil & gas production, consider 2 huge subsidies. One, "intangible drilling costs" is a massive subsidy in US Tax Code since 1913 that lets fossil firms annually write off 80% of costs of drilling, wages, surveys, before producing any oil. Another huge fossil subsidy over a century old, is a "depletion allowance" that lets fossil firms deduct a big 15% of taxable income. In 2025, profitable US oil & gas got $1.7 billion in subsidies on intangible drilling costs that year alone; next 10 years, they'll get $9.7 billion. Depletion allowance gives $15.6 billion more, in subsidies too. It's little wonder oil & gas companies spend millions on lobbying to preserve tax breaks; these subsidies are worth billions to them. But, hush, don't use wretched word, 'subsidies'. Public relations efforts have long strived to portray oil/gas (even coal!) in a 'Marlboro Man' rough & tumble way. One that takes its own risks, neither seeks/ nor does it get any governmental support. They've gone out of their way to avoid any 'subsidies' label for $$$ given them. But truth, is well, the truth.

Yes, renewables now enjoy *direct* subsidy levels competitive with fossils; from 2016 to 2020, 46% of US federal direct energy subsidies went to renewables. Implicit/ indirect subsidies for fossils, however, are far Bigger if one counts costs to human health, of clean-ups etc. IMF estimated those at *$7.1 Trillion* in 2022, or 7% of GDP. For 20 years now we've raised potential indirect costs if Strait of Hormuz is closed between Iran/Oman. Were it shut, we've long projected oil could in weeks go to $140+/barrel. When war broke out spring 2026, that prediction proved justified. Were it not for $$$$ of US military forces, oil may go higher. Or, a Price-Anderson Act limits nuclear plant liability to $10 Billion/per radioactive catastrophe; without it, US nuclear would be too risky: no new nuclear plants would even get built.

Hence, it's important to state plainly: in fact, all kinds of energy -- oil, gas, coal & nuclear -- and all renewables too, are ALL subsidized. While we're clearing energy misconceptions, let's return to America's 2 lowest-priced 'electricity-winning' states in 2025: what were their main sources for electricity? Was electricity in 2 cheapest states, sourced purely from 'super-cheap' fossil fuels -- as fossil interests and advertising might have one believe?

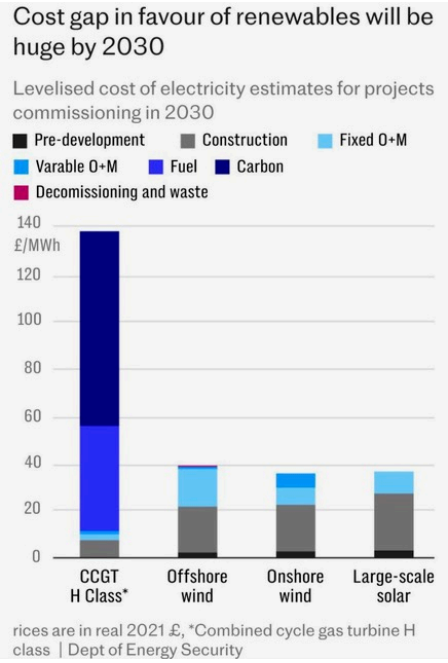
Given narratives from fossil-interests, one might think very Cheapest-US-electricity states get *All their power* just by natural gas, coal, nuclear -- not on renewables at all! And yet very cheapest state, just 11.31 cents/kWh retail early 2025 was windy North Dakota. It turns 1st to its lowest-cost resource wind (35%) that more than doubled 2016-2023, and hydro (5%). Those gains were Not on green ideals, or climate-concerns, but because frankly its abundant winds make cheapest power. With cheap, firming resource, hydropower. Hence note 2 renewables are often its 2 cheapest sources of electricity. Only after that cheapest 40%, will it then use biggest, firm resource, dirty lignite coal for another 55% electric generating capacity. As important as what it burns -- is what it avoids burning: costly natural gas is just 5%.

Hence America's very lowest-priced state 1) embraces cheap wind that's ½ the cost of coal; 2) and its lignite coal is abundant, although costly on health, + environmental regulations -- yet importantly is firming on intermittency of wind/solar. Together they're cheap thanks to its *renewables lowering coal's costs (avoids natural gas). Does Not face *climate/or wildfire risks; a *sparce population lets it export power, to Canada. In sum its renewables are used 1st for a big 40% & growing -- while coal is falling fast. (South Dakota is 80%+ renewables)

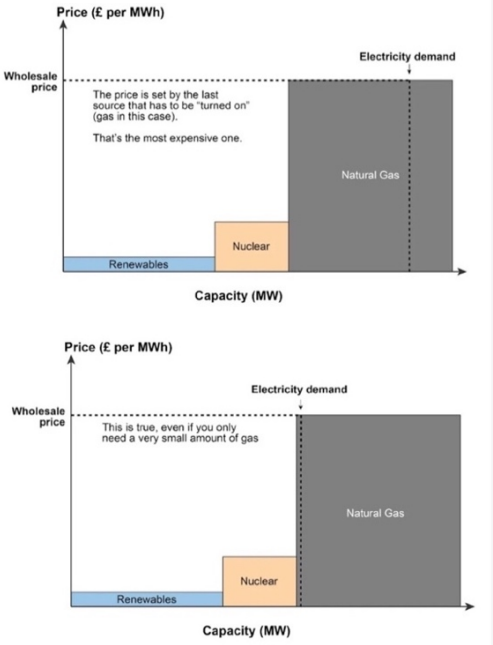
2nd lowest-priced Idaho, was 11.34 cents per kWh. Does it get electricity just from fossil fuels? Again, No! For Idaho in 2023 its biggest source by far was hydro, 43%. Again renewables are Cheapest power. So, it turns 1st to low-cost 'water' (hydro), plus wind for 15% more; hence 2 renewables + 6% solar make 65%, 2/3rds clean met demand. Wind/solar are intermittent, hydro stable but less than fully firm; thus, turns after these to costly firm fossils: natural gas is notably 1/3rd in low-cost Idaho. A lesson again is abundant renewables are key to low-cost electricity. A 3rd very low-cost state, Washington was 12.39 cents retail early 2025: it gets 68% electricity from hydro, another 7% from wind: hence 2 renewables make 75% of its supply. For importantly baseload, it also gets 25% of electricity from firm but far more costly fossil gas at 13%, nuclear at 8%, coal at 3%. Hence these 3 low-cost US states notably all rely very-heavily, sizably on renewables: much wind, hydro. They're growing more solar too.

So why aren't cheap renewables, been seen to lower retail costs greatly? One reason: is rank-order 'margin pricing' mechanisms set electricity at higher costs. Take UK (Great Britain), where marginal pricing means if *any* natural gas baseload is used in the production mix – as is true 98% of the time – then that last, most pricey gas sets wholesale price nationally. Even though costliest last-used gas is on average only 40% of UK mix (at times 10%). In making electricity, cheap sources (renewables) are used first. Then, next-cheapest, firm dirty resources, etc. *But retail customers do Not see benefits of cheap solar/wind, almost no operating costs. Instead, the UK wholesale rate is set by last and so the costliest source.*

Baseload thermal power relies on heat/ steam, whether it's by natural gas, coal or nuclear -- it is the costliest now latter 2020s, vs. preferably cheaper (but intermittent) renewables. It is firm, yes. Yet nowadays it's often cheaper to build new wind, or solar farm from scratch -- than go on fueling an existing coal plant! As seen next in a gas-heavy UK ahead in 2030 (left) this price gap grows tremendous. Traditional natural gas electricity is near: 14 pence/ kWh -- versus *Offshore wind, *Onshore wind, *Large-scale Solar at 1/3rd that price, costing only about 4 pence/kWh. Even rather pro-nuclear Nordic countries found in 2025 that to add new nuclear plants (that can't even come online 'til latter 2030s soonest) will be uneconomic: they've thus decided to instead extend life of their few existing plants. Renewables can make cheaper wholesale power, yet on marginal pricing, retail consumers will not see that:



Source: UK Dept of Energy Security



Source: Sustainability by Numbers.

UK industrial electricity costs are crazily 45% over the world average, 4x the US: a nightmare. As seen left, above, a core reason for high UK electric rates is its *Reliance on oft-imported gas. Even a modern gas turbine is still far-costlier than wind/solar, & gap is widening. If much gas is used (right top chart), marginal prices are high; yet if gas meets only tiny bit of demand (right bottom), electricity *still-is-highly-priced,* 'without good reason'! The UK sets one national single price, so high demand places (like London in south) can set rate for rest of UK. Though wind farms in north/Scotland make cheap power (or *negative* wholesale prices at times!); a shift to regional pricing can cut rates for citizens in windy north. In 2025, the UK did consider it but backed-off. With regional prices, what critics call 'postcode lottery', cheap renewables keeping 'a lid' on already-costly UK rates, would be less useful for populous south. And high rates nationally, would go up even more for many UK citizens without cheap northern wind. Still, consider that in 2025, Saudi Arabia (with less winds) set global low-price record: just a penny/kWh! Wind/solar could be made for 3-5 cents/kWh with serious support.

Regional pricing in UK, could be more like a US, with 50 diverse 'regions' (50 states) each having their own kinds of electricity production, each with varied rates. Let's look at US with 50 unique states, a 'de facto regional pricing'. For lessons learned. *Like that very cheapest-electricity states have abundant renewables. Costlier states, use much gas.* Rhode Island had a highest US gas reliance, 92% -- and a 6th costliest electricity, 25 cents/kWh. For all US, gas made 43% of electricity on average 2025. Even new gas-fired power is costly: yet gas commonly sets Retail rates. This is seminal. US retail electricity rates are set by last, 'most important' source. In 2025 in gas-loving Texas, a $5 billion public fund to assist building gas plants flailed; 4.6 GW worth of proposals dropped out. On cost uncertainty, difficulty getting turbines. CEO of a large firm building gas plants noted: "When you have [solar/wind at] zero or negative prices for power, it's really hard to build." Note too, rates in 50 states are some places high, others low. As consumers who pay retail, don't see wholesale, at times negative prices at which wind, solar, hydro can produce. Plus on need for grid stability, baseload has big role. Recall the 2 costliest-electricity states: bottom of barrel priciest Hawaii in 2025 was nosebleed 39.6 cents/kWh -- 3X cheap North Dakota, Idaho, Washington state. Reasons for such sad, pricey results are clear and are pretty embarrassing for a state of Hawaii.

Foremost/worst is Hawaii, with dirtiest, most-fossil-fuel-dependent grid, in America. Utility PR tries mightily to avoid acknowledging this; certainly doesn't fit with chamber of commerce messaging of a tropical, clean, island paradise. Yet, most of its electricity was long made by burning (awful #2 bunker) oil; until-recently, imported coal(!). Most states long ago dropped oil-fired electricity after the oil crises 1973/1978. Yet Hawaii burns oil (coal too 'til recently), hidden from tourists, pollutants dissipated by ocean breezes. This on islands blessed by abundant sun, winds, waves. Geothermal could making its firm baseload, so renewables 100% of electricity needs. Instead, utility PR stresses its yet small growing renewables, says nothing of burning bunker oil. When Hawaii decided long ago fossils would make electricity, die was cast. Had it looked first to its own wind/sun/geothermal (like Iowa, Idaho, Norway), it might today be far ahead on reliability + lower costs. It's not abstract musings; a local cooperative in pristine Kauai long ago went hard & fast into solar; it now sees rates much lower/better than those from Hawaii Electric, plus with electricity that is over 2X as clean.

A next poster child for super-high-electricity (& other) costs is California. Often trotted out for misconception its high electricity rates at 34 cents per kWh, so 2nd worst in US early 2025, are due to its wind, solar, hydro. *But that can't be right!* Texas' renewables make far more power than California, and are a higher % -- yet Texas' electricity is cheap: 15.6 cents early 2025! In fact, *Texas renewables keep costs down:* it is hard for gas/nukes to compete. Iowa has a far higher % made by renewables at 65% -- while its electric rates are less than ½ that of California. So, California's own very high costs, can't be due to its solar/wind.

Instead more accurately, a few factors help explain California's 2nd worst US prices including, *State Mandates specifying technologies. *Huge wildfire costs. *1st mover costs (in more free-market Iowa wind as cheapest resource 'naturally' achieved 40% capacity factor vs. California requiring solar early-in 2000s that was then 10x more-expensive early, capacity factor 20%). *Guarantees of big returns of 8%-12% for shareholders at utilities in California; vs. rural cooperatives in say, Iowa with No profit margins. *Slower/more costly permitting. *California's Industrial Natural gas prices are 3rd highest in US for its needed baseload gas. And *Ratepayers subsidizing too roof PV (both arguably can be partly funded statewide by larger-base taxpayers). All push retail rates extraordinarily high -- vs eg 3 bordering business-friendlier neighboring states: Oregon, Nevada, Arizona; the latter were in 2025 respectively 15, 13, 12 cents. As is seen repeatedly, the fact is that clean hydro/ solar/ wind, by contrast, are all *deflationary;* they *reduce* costs. While the reasons for California's high costs are complex, these costs can be cut -- including at its 3 very big investor owned Utilities.

There 3 big Utilities aim to recoup costs of wildfires, accidents from ratepayers, while also giving big, sure 8%-12% returns on equity to shareholders on capital investments. California is vast geographically, but a very conservative Texas in 2023, made by far most Wind power: 115,000 gigawatt-hours (GWh). Other US wind power leading states are conservative too: Iowa (42,000 GWh), Oklahoma (38,000 GWh), Kansas (27,000 GWh). One keeps seeing this, of 12 states with the most 'WWS' (Wind, Water/hydro, Solar) by percentage Oct. 1, 2023 to Sept. 30, 2024 -- 6 were among 10 lowest-retail electricity price states early 2024. Low-priced states overlap on a map, with abundant wind & hydro power. At the other end, a costly Maine with instead very high industrial natural gas prices (especially during a disaster recovery) -- had near the highest electric rates. California's industrial gas costs likewise, are very high: 2x the US average price. Ratepayers there do subsidize socially-sought-after goals like assistance on power for its poor (can be addressed by the much bigger taxpayers pool). In sim it was fated to have costlier rates, than in the states pursuing none of the traits.

A California that in 2023 got about ½, or 54% of its electricity by renewables (32% by solar, 6% in-state wind, 10% hydro etc) aimed for 90% renewables by 2035. But, 2035 is years away. In 2023 natural gas was still huge 39% of in-state generation. Given self-inflicted foibles, for it to fast replace huge baseload gas, is no easy task. We see states with cheap electricity rely heavily on free-markets -- & on their own ample renewables. Jan. 2025 retail costs were lowest in renewables-heavy Utah (11.4 cents), Arkansas (11.8 cents), Nebraska (12.1 cents). Wind-endowed-Kansas, Wyoming, enjoyed price *declines*. Nevada's solar & geothermal %s are like California's, but with utility-scale solar, and far fewer regulations (and utility-scale solar 56% cheaper than fossil alternatives), rate just 13 cents. Oklahoma gets a good 42% by wind; on free & fair markets, few mandates: its rate under 13 cents in 2025. Uruguay has moved from heavy fossil fuels-reliance -- to 99% renewables, and now to greatly reduced costs.

When a first hybrid car arrived, the Prius, critics long held it having 2 drivetrains (both one gasoline, & one electric) -- meant sure failure: either make a cheap gas engined car, or costly EV they cried. What they didn't foresee, was enjoying 'cheap/free onboard power off wasted braking energy' -- would more than make up for having 2 drivetrains. Today new hybrid dual-power cars are growing faster than gas-engine cars. Similarly, critics today who bemoan solar/wind as ever-intermittent, needing storage, perhaps don't see plummeted renewables costs + ever-free fuel -- *may* more than overcome a price differential ahead. Solar/ wind might, not far-off, fall even more in wholesale costs. Say two pennies. Fossils, 2nd generation nuclear *never* can do that! Yet 2020s sees growing pains: 'curtailment' that shuts solar/wind if making more than grid can yet handle. Better grid + storage can solve much. In California late winter-early summer 2024, 100% of demand was met by green sources up to 10 hours, 98 of 116 days, a record. Zero blackouts. Solar output up 31% vs 2023, wind up 8%. Battery capacity up 2x. But, what of baseload vital & still necessary, during the other hours!??

Globally, wealthy places see bit of a similar conundrum. Those with ample renewables, say a pretty stable Hydro, often have best/lowest electricity rates. Norway's 1,700 hydropower plants mainly in its north form 88% of electricity production capacity; it also has 65 large wind farms too for 11% more electricity. Some 99% of demand thus met by cheapest sources: both renewables. Costlier, polluting thermal plants that burn gas, coal, or biomass met just 1.5%. In 1990s/2000s, it had healthy total domestic capacity surplus. Hence Norwegians long (on no drought) had enjoyed an ample, reliable, firm, very cheap clean domestic power.

But, what of renewables' downsides. One issue lately: pricing mechanisms. In Norway's case, while Not in an EU, it was in Agreements to export 'surplus' power to Northern nations UK, Germany, Denmark if latter see low winds, so low power production. Norway has exported electrons via 1,400 megawatt (MW) undersea cable since 2021. A thing is, lack of winds can make prices (vs. normally far-pricier in UK or Germany, average retail rate a high 39 cents) -- spike so local rates in southern Norway have skyrocketed at times near connector cables. Normally dear prices in UK, in Europe on low winds spike rates extraordinarily in Norway too near export points. Drought ahead, could be awful. Sweden as well makes cheap hydropower in its far north, while demand is mainly in south; as an internal matter, Gothenburg in its own south saw retail prices 2025 briefly go 190X that in north. Hence vs. an EU, Norway may after its 2025 election, revert to prior system First satisfy its own demand -- rather than send electrons abroad. To do otherwise, risks price spikes that deny upsides of its own hydro, stoking public anger. Indeed this was a focus of Fall 2025 elections. They might well renegotiate rates in future, or may one day sever links that send power to UK & Europe. Lacking pumps, that cheap hydroelectricity can be challenged in severe drought.

It's easy to see why national sovereignty, costs, liberty, can be pivotal in elections. Norway's ruling coalition had collapsed 2025 in fury when once-cheap rates jumped. Meanwhile other end of cable, UK fears were of blackouts ahead, no laughing matter. In early 2025 sizably 4% of UK's electricity was from Norway hydro: it may be pared back. If no North Sea wind, then UK rates jump, so too prices some Norwegians pay for home-grown hydro electricity: recently those jumped 20-fold in parts of Norway in just 1 week. In 2025, a 12,000 turbines UK wind fleet on brief windless/gloomy 'dunkelflaute' (dark doldrums) saw collapsed output; instead of making 10 GW like a typical day, was just 120 MW, 0.5% of normal output. Like 30 turbines on a windy day, when instead it could make a huge 23 GW, cheaply! So consider impacts both sides of connectors. Especially at an increasingly-energy-starved UK in latter 2020s.

UK's status far different from energy-*exporting* Norway long making hydro electricity cheaply, while selling far pricier oil & gas to UK, Europe. A UK scarily is instead *Importing* fossil fuel + electricity. In 2019 UK had to import £19 billion/year worth of energy & fuels; by 2024, was £41 billion/year. Norway sent UK, $1 billion of electrons 2024. Every year since a 1st connector opened 1986, UK has imported French electricity; industrial power there costs far less too, 16 cents. (A brief exception was 2022 when France's nuclear fleet saw troubles but since, UK resumed as Importer). Gas still generates so much UK electricity, and UK gets 41% of that gas from Norway, a nearer gas source than Qatar, from whom UK sources 14% of gas. But a point is, the UK today is problematically not in any electricity surplus. Nor broad domestic energy surplus (oil/gas too) by any means. While UK support for its own wind, is in fits & starts, uneven. Plus, given long-falling energy demand there -- its gas-baseload capacity is now down hard too. Meanwhile its 2nd generation nukes were wildly costly, maintenance far worse than expected. It is placing a new emphasis now on novel 3rd generation nuclear hopes.

Meanwhile some old paths make little sense today. Take Australian coal: its national market operator issued 144 'Lack of Reserve' Alarms in Q4 2024, highest ever. Customers had then to trim demand, such likely meant higher rates ahead. Many alarms were sounded too at its 2 aged power stations, Bayswater, & Eraring, on coal's growing unreliability fueling old plants; one station ran only 4 weeks in 5 months! Another station had a catastrophic explosion. On coal's many issues, electric rates Q4 2024 on national market shot way up to AUD $88/MWh -- up by 83% late 2024 vs. a year prior. 14 aged baseload coal plants, averaged a 36 years old. Problems not just with coal: even at a new grid-scale natural gas-plant, first in 15 years in 2025, it went online 2 years late, $1 billion over budget. When Yallourn coal plant suffered breakdown June 2025, ½ its 1,480 MW capacity was lost briefly. That forced Victoria's old, polluting short-burst open-cycle gas plants to work constantly, rather like baseload combined-cycle CCGT, but putting CO_2 out in amounts similar to burning black coal.

Oz can have too its 'dunkelflaute' times of no wind/and no sun. Over 48 hours with under 15% of generating capacity. Early evening on 11 June 2025, so post-sundown (no solar of course!) notably zero breeze, total demand was a 620 GWh on national electricity market. With zero solar (as every night) -- remarkably zero wind (unusual part), only 25% could be met by its renewable hydro, just bit from batteries. That meant a very large 375 GWh had to be met by coal, plus 91 GWh more from gas increasingly imported to Oz as foreign LNG -- rather than domestic natural gas. Far more battery & energy storage is crucial, needed fast.

Let's return now to clean energy trends in a US. And to US equities, domestic issues in latter 2020s that lately impact themes. Especially given some pretty surprising developments being seen this 2nd half of decade, regarding policy, politics and clean energy themes.

Control of Congress is vital; House where spending bills originate -- & Senate with tall 60 votes needed (50 on reconciliation). Much nitty-gritty is determined here. Yet regardless of 2024's red wave, not all (clean) energy must mean partisan battles; good ideas can be found despite politics. For instance, more grid capacity is vital for added solar, wind, and storage -- just as it is for more natural gas & coal fired-power, plus adding more nuclear power, too. So note, grids can be bettered without new poles, pylons. Extant cables are often made of heavy steel cores surrounded by thin aluminum conducting electrons. Replacing old wires with light carbon fiber/thick conductor wires carries more power: this is 'reconductoring'. In California, the widespread switch to such cables could better transmission capacity some 4-fold by 2035. Or importantly, just federal streamlining of permitting for all, could be very Big Deal.

Other aspects were maybe not what oil industry expected from re-elected president. April 2025 oil briefly fell to mid-$50s/barrel; if persistent, that could be a 'disaster' for some US producers needing over $60, outside of low-cost Permian basin. $50 means = production cuts. A 'US energy dominance' promised on campaign trail – and US oil (even briefly) under $40 -- are pretty incompatible. Or note too, rare earth elements, + graphite, magnesium etc, come from China -- that supply under threat on conflict over Tariffs, or Taiwan. Heavy rare earths from Myanmar; cobalt from DR Congo; both insecure. Military & strategic needs for some minerals is critical, crucial roles too in new energy. Should/ even can all be sourced in US? Processed as well? Is that possible? Or could these come mainly from US plus its allies?

One president's longstanding hatred of offshore wind and solar, had forced a halt in 2025/26. Even in states desiring it, like California, New York, Rhode Island etc. Doesn't have to be. In Germany small solar panels on balconies are extremely popular, in part as they're so simple, cheap, with pay-back in 3 years. State-level regulations, had made US balcony solar illegal -- but that's starting to change: Utah now allows it -- and more US states will soon too. Could help lead to a solar blossoming. In Australia 2026, more than 1 in 3 homes have big rooftop solar; in a US, it was less than 1 in 10 in 2026. Meanwhile, fights brew too in niche areas, like new hydrogen (H_2): Europe in 2020s drafted rules for 'green H_2' by renewables, to ensure that green H_2 is made when sun shines, wind blows on 'additional' green-electrons. H_2 is still very niche; just 16 million tons were made in US 2024. H_2 by natural gas is far cheaper $1.50/ kg -- tough for any green H_2 that costs 3x more: no one wants any H_2 at such high cost!

Costs matter. in 2025, EVs/PV made outside China, or a green H_2, or e-methane, anyplace -- were too pricey. Fossil-players claim 'clean H_2' may be made say, by gas-fired electricity, or by RECs (renewable energy credits) from solar/wind at distant places, times. Conservatives will support it. Favor such 'any of above' strategies on abundant US shale gas; will worry far less about climate risk. Many will support big Ag dairy RNG (renewable natural gas) from big agriculture; or a renewable natural gas from landfills or wastes. Indeed, avoiding methane spills is one way to help limit greenhouse gases. Capturing carbon permanently, as in mineralized rock. Unsurprisingly France too pushes turquoise low-carbon H_2 from waste heat at its ample nuclear fleet. Many, many further debates lay ahead, thus incentives will matter. For instance a 45X MPTC (Manufacturing Production Tax Credit) in an 'old' 2022 IRA, just possibly might have helped US-make solar PV to become globally-even cheap-ish; yet big changes to IRA in 2025 rendered so many of the 2022 IRA provisions, moot. Changes to 48E/45Y in 2025 changed much. In short uncertainty reigns in clean energy, so it's no surprise to see always a huge volatility in clean energy stocks. To try to predict what is ahead no matter an election's outcomes, or any other big things such as war, is just like with equities in general, an ever-Impossible task. Still some review & analysis here can be useful.

Take level & direction of Fed Rates since they influence clean energy's theme. Look at Federal Reserve Economic Data (FRED) for US Fed Funds Effective Rates 2020-2025. From a short term Fed Rate of 1.55% in January 2020, it fell to (free money!!) just 0.09% in Dec. 2020. Such low rates boosted longer-cycle renewables: Thanks, Central Banks+ no inflation! But afterwards -- rates leapt up from a 0.08% in Jan. 2022 -- to a once-normal yet felt high >4.5% in 2025. We saw clean equities fall then unsurprisingly during that spike. Central banks do have to head off inflation; it just was they'd responded much too late to gathering inflation. Resulted in some years with some of the fastest interest rate increases seen, in well, nearly-ever.

Let consider interest rates further, as means a lot to clean energy (& to equities here). Short-term rates as set by the Fed, get headlines. Crucial too are 10-Year Treasury bonds, so-called 10-year 'notes' (as brief duration vs. 30-year bonds). These not set by Fed, instead move on market sentiments. These also are hugely important. In 2020, these '10-years' remarkably had sat under <1.0%, as ECO jumped +203%. But afterwards from 2021, 10-years *rose,* next 4 years. When Fed finally eased short-term rates a bit late in 2024, 10-year Treasuries did *not* respond same: they at 1st, rose! To a psychologically key 4.50%. If they go up past say >5.50% in future that can make far riskier equities like here, hard to justify. Or, if falls under say <3.5% (on strength; not recession!), may possibly re-ignite animal spirits, renewing interest in potentially volatile themes. For 10-years, see: https://finance.yahoo.com/quote/%5ETNX

A year 2024 that had ended with ECO well down, elongated big steady falls of 2021, '22, '23. Charts were then ugly in clean … & all energy. Yet looking back to try divine what's ahead -- is of little weight, if trying to see forward! Just some musing, playing with numbers. Finding coincidences by looking back on joys of ample data over 20+ years. There's no way to surmise from just these past data, what may yet be ahead. One might glance at such thin-gruel of past, and (only) then try to guess and will be typically quite wrong(!) about the future.

Confounding all too, is an impressive pace by which renewables are installed, records being set as new $$$ goes into wind, solar, grid. Global low-carbon investing had hit $1.77 Trillion in 2023, up 17% from 2022. How could this theme's stocks so plummet, down years like 2021 through 2024, as clean energy grows globally?! We'll look at that curious fact ahead. Just brief mention here, is that as margins compress, and as new energy pricing goes on falling -- profits have also been hit hard. Meanwhile a long-planning China 'ignored' overcapacity, with unshaken policy support. It has aimed for ever greater market share, ever-lower prices + full employment. Unlike in the West where seeing nearer-term profitability is prerequisite.

US, & European projects are being pushed out too, lately, by interconnection/transmission (IX/TX) chokepoints. Demand is very strong, yet grid growth not enough. In 2023/2024, 5-year load forecasts foresaw 450% growth from 23 GW to 128 GW; interconnection approvals to grow ~5x, yet not fast enough. Still it was slowed by policy from 2025. Other issues vex a west: Start/Stop inconsistent support like going from a US IRA's tax breaks 2024 -- to slashed 2025 (unlike China). Or ongoing scarcities in west like high voltage transformers, poor grid capacity, little domestic lithium, minerals, processing, US wind incentives halted 2025 etc. Even with IRA slashed from 2025, better economics of renewables means much. Still, even solar & wind may be severely stunted, even halted, on irrational, non-sensical federal actions like allowing only a more costly energy, are embraced. Or desiring more national Debt. Sounds crazy, to Add to a mountain of US national debt, at 125%+ of GDP in 2026. Something a conservative party had once-sought to avoid, when it was characterized by fiscal-rectitude, by preference for smaller-government. But those priorities have lately been dramatically overturned.

The mountain of US debt already a problem 2024, grew far worse as self-proclaimed 'fiscal conservatives' aimed to add vastly more deficit spending from 2025. Once they passed a 'one big' Act predicated on $$$ Trillions in debt, the International Monetary Fund estimated new US government Deficit will (intentionally!) be over 7% of GDP every single year to 2029! Debt reaching 143% by end of this decade. For comparison, Greece & Italy long-ridiculed for their own past profligate spending (to which they would plead guilty as it makes them 'poor men' in Europe with a dismal future) -- will see their debt as percent of GDP overtaken by the US the end of decade. What a sad metric for US to lose on. Wasn't always so. After WWII, thanks to spending care, US debt fell from >100% in 1946, to under 25% in 1974. More recently, from high 48% of GDP in 1994, it fell to 31% in 2001. Postwar growth isn't available now to cover a multitude of spending sins. Today when a party in power sought to spend $ billions to keep coal plants open (against wishes of owners & all else), to force Americans to face/pay unaffordable electric bills out of desires just to harm cheaper renewables, truth must be out. Let free and open-markets, true competition work, and the best-solutions will follow.

Indeed, realpolitik is seeing 'move fast & build things' places like Texas, Iowa, or the Dakotas -- or Saudi Arabia, or China (now designing solar PV for space!) -- way-out-perform in applied renewables growth. Decarbonizing does well on energy abundance. And faster progress is clearly needed on crazy-costly, unaffordable electric-bills. These could come down fast. With the causes of these rising electricity costs now clear, and solutions, one can only hope.

Not yet well-understood in a west, but important too are China's efforts in 2025 began to try to rein in excess capacity in solar, EVs etc. Limit capacity ahead. It bluntly stated provincial governments are overinvesting. So nationally it 'pledges' new supply-side restrictions, amendments to a 1998 law on pricing. To strengthen price limits, cut unfair pricing behavior, curb 'involution' (oversupply-based) competition. It aims to curb market dominance that influences prices, by selling irrationally at below cost. Accountability for price violations. China's overcapacity in EVs, and PV, means Beijing has massive excessive capacity, but it lacks domestic demand to sop all up in key green 'emerging future industries'. Overcapacity has long harmed profits. By 2024, 25% of mainland China's listed firms became unprofitable -- vs. just 7% a decade prior. China has ramped exports in search of demand, so is exporting deflation, hitting profits everywhere. Thus, US & Europe are now pushing back.

Or, look at wind's unique troubles as another facet here. Those existed before a president's animosity against wind from 2025, with stop orders on New York, Rhode Island projects. Even before that, in 2023 a big wind name had made headlines when it abandoned contracts for 2 wind farms off New Jersey, US. Why? Wind manufacturers were then *losing* $$ on each giant offshore turbine delivered. A contract to supply turbines for a 1st New Jersey wind farm that was negotiated 3 years prior, meant it was delivering units at a loss, after prices jumped 40%. Thus a $1.5 billion deal obligating turbines/towers, was putting it ever-deeper in a hole. First step if digging oneself into a hole, is stop-digging! Q3 2023's losses had slowed to -7.6%, off scarier -26% year before. A large emblematic firm took a $500 million charge to repair & maintain its turbine fleet; focus on few proven 'workhorse' designs. Once-too-many tower designs at over 40+ in 2021, were cut to 9 by 2025. Rotor options cut from 15 to 4. All in hopes that profit margins might, *possibly,* begin to emerge many years ahead. 2024 had seen a glimmer of hope for maybe infant wind off California. But then, re-election of a president animatedly hostile to wind, strangled California & all US offshore wind from 2025. Wind projects revoked, even those already-permitted in New York, Rhode Island, Maryland. All had clouded matters enormously when it came to new US offshore wind near-term.

It's not hard to see why fossil fuel interests in 2020s were fighting so hard. Back in say 2010, coal and natural gas were then, relatively-speaking, easily the cheapest power. Those 2 could make electricity for around just 9 cents per kWh. At that $.09/kWh cost, coal or gas was then far cheaper than competing wind as at best $0.11. Especially vs. solar's $0.46! But by 2025, so latter 2020s, that changed dramatically. Solar/wind wholesale fell to often near 4 cents, *half the cost* vs. a natural gas plant best-case. And that was assuming one may even obtain a scarce gas turbine to build. If one hadn't already secured turbines in contract in 2025, it might be early 2030s soonest before a gas-fired plant could be built, up, and online!

Mainly on huge PV supplies from China + thus on declines in costs due to such overcapacity -- a new solar farm could go up cheaply & fast. Getting the solar PV wasn't much of an issue -- although tariffs, ensuring no forced labor, 'foreign entities of concern', getting permits, or possible 'kill switches'(?!!) in China's parts, were issues. That said a new solar farm could be built at less cost, as noted than just to operate an existing coal plant! So a notable matter latter 2020s facing gas & coal -- even putting aside climate & CO_2 -- was new solar/wind though intermittent, became more economic. And this gap would only grow. Solar became cheap due to China; while in wind, Europe was building its own turbines. China's solar could bump in cost on anti-involution production cuts from 2025, but temporarily only. Meanwhile, coal & gas plants needed expensive staffs, maintenance, security, and of course to buy never-free fuel. By contrast, solar/wind need few staff. Solar maintenance may be goats to keep down grass, not much more frankly! Wind does need rather more to maintain it, but nothing like fossil fuels, nor nuclear(!). Solar/wind require little on-site security; vs. nukes that must be guarded to extreme. There's big wastes from coal plus its sizable human health impacts -- vs. no such thing for renewables. So it's understood why fossils fought clean, latter 2020s. Even apart from climate concerns, fossils were/are losing badly. They can't now win on costs. And, their fuel prices never go to zero or below -- while clean is getting cheaper.

3rd fossil fuel, oil, was fighting a different also losing battle over a long-term, based on its physics. A fast gasoline car, say Ferrari like any 'gasser', faces a conundrum; to go from idle stop, its petrol engine first has tiny torque. Baby-like pulling power. That's why all gas-cars (gassers) have gears/transmissions. To get engine speeds up, first gear is needed, it can only propel to low top speed; so 2nd gear is needed, then 3rd gear, 4th for highway speeds etc. Meanwhile instead, electric motors in all EVs start as 100% efficient from the go. They can, and will soon readily outpower all. Shall soon win-out vs. even 'baddest' gasser Ferrari's.

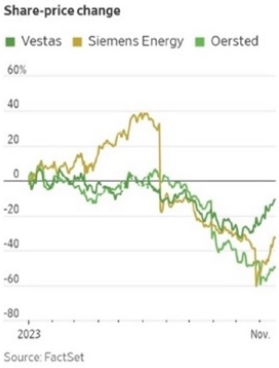
A recent US response is to keep EVs out, via big tariffs, Yet China's cars are fast getting cheaper, faster, better than cars made in west. And Europe, Latin America, Middle East, rest of world is seeing a deluge of brand new electric cars from China. There's little rest of the world can do (but for US-like moat, tariffs) to stymie China tidal wave of new EVs. That change, will increasingly hit global demand for oil, long fuel of choice for cars, buses, trucks. Electrification may in time then hit aviation, shipping. Physics plainly favors more efficient and torquey-EV-motors, clearly very much so over inefficient, fuel/air combustion.

It's not-so-hard to see why fossil interests late-2020s saw threats ahead. With electrification, their goal may be as much just to ensure their products will go on seeing demand, as a past usual aim of less-regulations. A key issue for them is fast-falling costs for EVs, clean energy -- China's deflation not helping. Perhaps China's recent aim of thinning overcapacity will help. By bringing near term price rises for EVs, and PV. But that's temporary, transitory. Plus it is impossible as always, to predict with any certainty, what comes out ahead.

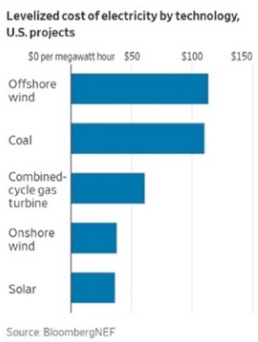
Green energy themed-baskets like ours saw elongated 4 full years of declines 2021 to 2024. Partly, on wind: an American firm in 2024 dropped 2 offshore wind contracts in Maryland USA, on low offtake offers. Or look at Great Britain/UK, a past leader at times in wind. For all 2024, for its 1st time, wind was #1 in its energy mix @30%. More so than natural gas @26%. Or nuclear @14%. But UK was also badly de-industrialized: its costly electricity imports were much too big @14%. Better biomass was 6.8%; solar 5%; hydro 2%; storage just 1.2%. Its last dirty coal-plant in Ratcliff closed 2024, coal fading from 0.6%, to nil. Yet on too-high electric rates, UK was importing far too much electricity -- and natural gas (like from Norway). At issue too is its 'Contracts for Difference' (CfD): a low £44 per MWh offered for offshore wind in 2023 got No takers, auction flopped. Post 2024 elections, the CfD budget was raised >50% to £1.5 Billion, offshore wind offer £73/GWh. Offshore wind bids then were 3,367 MW, 9.6 GW total CfDs awarded latter 2024. But more is needed if UK is to raise wind capacity by 4-fold. To go soon from a 13 GW seen in early 2020s -- to 50 GW target capacity by 2030.

UK has suffered from stop/start support for wind, falling energy production; an old/poor grid; onerous permitting; little energy storage. For instance, on 10 Dec. 2024 forecasts were for 2 windless days: output may plummet from >7 GW to 2.2 GW. Prices rose to £175 MWh, steepest in 2 years. Meant more costly gas had to be burned. Needed: more energy production overall in UK. Plus storage capacity and a stronger UK grid: an end to sending overseas billions of its £ pounds for energy imports; or its curtailment costs. Imbalance remains a huge issue.

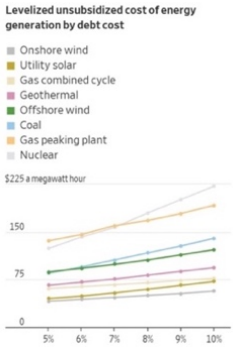
EU too is far from its 2030 targets. Cash-strapped Germany stepped up especially in 2025. Yet China has led in wind by far, and growing -- unlike a declining west. By 2024, 3 biggest global wind makers by market share were all Chinese: Goldwind (installed 20 GW), Envision (13 GW), Mingyang (12 GW). Wind grew 12% year/year on China domestic demand; fell 9% in the west; a story as seen in solar, EVs, batteries etc. In solar, German support helped to see 124 new PV projects, 1,600 GW capacity: solar prices 2024 fell to USD $0.056 (EUR 0.051) per kWh, better/lower than prior USD 7 cents. In a US with immature offshore wind supply chains, things were sanguine as a president aimed to shutter wind permits in federal areas 2025-2028. Still extant onshore wind & PV were 2 cheapest-US options, considering energy costs vs. debt. Clearly far better vs. 2 costliest options: nuclear & gas peakers. As coal/ offshore wind sat in a middle on costs. Hence the 3 relative best US winners were *Utility-scale solar; *Onshore wind; and *Baseload power if via-cheapish natural gas at CCGT combined cycle plants:



Source: FactSet, Wall Street J.



Source: Wall Street J./ Bloomberg NEF

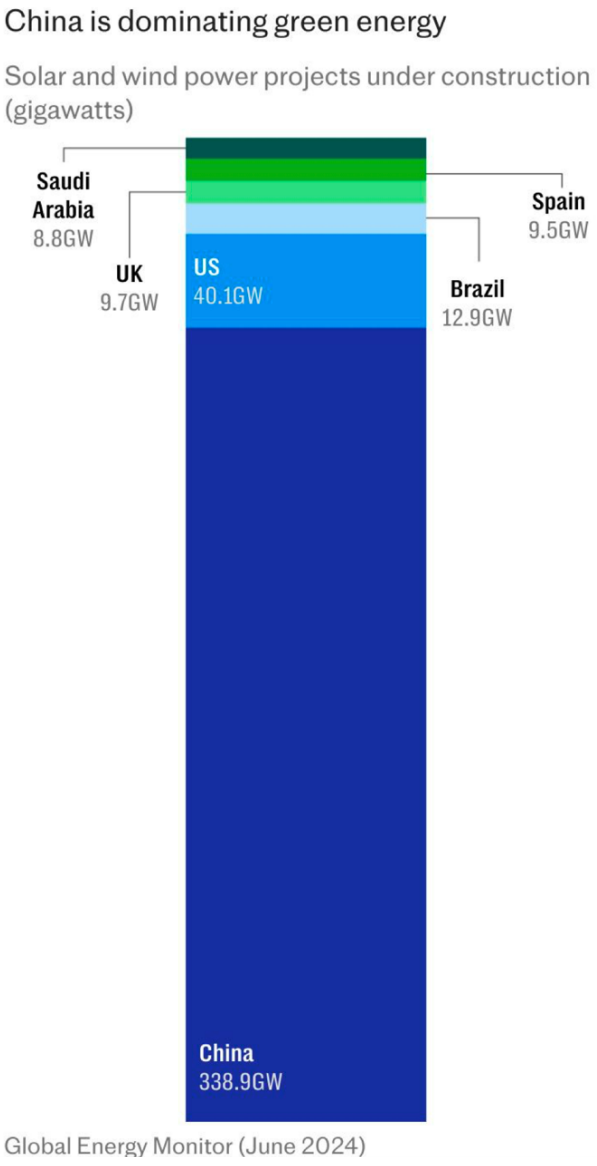


Source: Lazard, Roland Berger, WSJ.

For green energy stocks, China overcapacity has been an issue. Shorn of market guardrails, of profit/loss signals of the west, profit margins were decimated worldwide. As the west in 2025 resisted buying/soaking up China's overcapacity, & began applying tariffs, results ahead could go a variety of ways, many impactful. And the degree to which China has been / & it is still now outspending the whole rest of the world on clean energy, is gob-smacking.

Here is global construction seen June 2024 in renewable solar & wind: it's obvious how China leads the world. Had this chart included its efforts worldwide as well in electric vehicles too, in batteries, storage, grid etc -- this huge lead by China, would be more jaw-dropping. Folks in a west may talk about their 'massive efforts' going into renewables 2024 in US -- or Europe -- but this recent **2024 lead by China in deep blue below,** puts it all into perspective!

Take US record growth 2024 under an IRA and an encouraging white house. New US solar grew then by upper 30 GW in 2024, beat prior record 2023, with big gains in Texas. (Battery storage roughly doubled too although not in chart). Yet, America's 'big' ~**40 GW total construction, mainly in solar / (and some in slower) wind below** was 'near-nothing' vs. China:



Top, at left, wealthy Saudi Arabia is now putting immense efforts into building solar & wind, given limitless blessings. And on a keen need to prepare for when oil & gas are no longer sellable. It aims for 50% of electricity from renewables in just a few years (2030?). Yet its bar with a 9 GW left at top, **in deep green,** is thin (vs China).

Spain is much-acknowledged in Europe for growing its solar, 'fast', and already leads in utility-scale solar capacity (30 GW); though its wind growth there is slower. Yet that ~9.5 GW total construction, left in green, is just visible as a thin here too.

UK has left centuries of coal; great! But so sadly is de-industrialized on less-demand, and oft-imported pricey gas ill-suited for baseload. Nuclear sees immense cost over-runs, delays. And its grid charges nationally very high rates set by priciest (imported) LNG. Has de facto wind bans, support for it is in fits & starts. Much better is needed: in its grid, to streamline its permitting, more renewables, and for more low-carbon baseload; this 9.7 GW is a start.

Brazil was adding a record of 13 GW new renewables capacity in 2024, almost all solar & wind. And yet, this 'huge' amount at left, light blue, seems like a rounding-error -- versus growth in China.

Consider the 338 GW going in, in China above 2024 and their seriousness is undeniable.

Poly prices in 2023 fell in China by -50%, panels by -40%. Was nearly-impossible for anyone in Europe, or America trying to compete. China's glut thorny even to its own solar-makers! Its state-guided economy sought full employment, ever-lower prices, market share. In 2022 with China 90% of world spending on clean energy, a bewildering array of firms still sought to make more PV there, so extant China firms halted expansion. 70 listed firms tried to move into PV -- from dairy farming, fish feeds, jewelry, real estate, chemicals etc... (Bit of story seen before, Toyota of Japan started in weaving looms). A Chinese poly leader defied oversupply; it aimed to *add* 575,000 tons capacity, beyond 200,000 tons needed by market. After China's oversupply shakeout 2010-13, and 2018-20, fears were a 3rd wave; China prices falling to maybe record lows well under <USD $6/kg. China global poly share rising to 90%. Yes, non-China poly could command *somewhat* higher prices, given overseas aims of domestic product. But at such a big and widening gap, these cost differences were getting 'ridiculous'...

As PV profits collapsed, margins contracted, solar was challenged. Finished China PV was *sold* in Europe at near ½ cost of *producing* panels in Europe. Few winners. China 2024 looked to lift a 5% cap on curtailments -- for more green energy. In a side-point, solar *may/should in theory* be huge: a square 100 miles x 100 miles solar in southwestern US deserts, in theory, *could* make all America's electricity. 0.06% of US continental land for 4 million GWH. Of course intermittent as solar, so add 1x1 mile batteries. Add another 1x1 square mile of storage via green hydrogen, or ammonia, e-methanol. Powerlines to move power, IX/TX more space. But it's viable, goes past thermal coal, gas, nuclear. China can do it + on PV/wind many-fold over. Nothing technically prohibitive. China may sop up its own excess capacity on PV made + used in vast interior Gobi, western deserts. Consider in 2024, electric power made there equaled ½ of all US generating capacity. 500 GW in northwest China, 5 inland provinces and Xinjiang plus a 100 GW more in Gobi = 600 GW growing fast. Most new energy built in northwestern China is now solar/wind + high voltage DC transmission lines. Over 500 GW new solar/wind were planned in China, perhaps hundreds renewables mega-bases. Kubuqi desert energy base may be 16 GW when done. As India builds too. Dwarfing anything in a US! There's immense renewables mega-base potential ahead in China deserts. As well, ahead in India too. A type of Kardashev Scale reflecting civilization's progress, underscoring potential.

Ironic economically since solar stocks fell 2021-2024 partly on overcapacity. China production targeted ~750 GW, yet its demand was ~550 GW. US faced 100+ bankruptcies in a downturn. An analyst felt it may get worse: 500 US residential PV installation firms in trouble; an estimate in 2024 was that of 5,000 US solar installers, some 10%-15% may disappear. And California by its own hand, scenario NEM 3.0; ½ its residential PV installers may not make it. California's NEM 3.0 as noted ahead means a Golden State looked at maybe a huge 50% plummet in its residential PV installations! New rules there had made homes roof PV alone -- without battery storage -- an unattractive economic proposition from 2024. Once a leader, prognosis there for 2025 was for only maybe a shallow recovery. Maybe a stronger 2026 … Yet a time of rather dismal profits for rooftop solar PV then, in once-proud California.

A longstanding US solar name issued a going concern letter. Abounding uncertainty sheds some light on why solar stocks were down 4 years 2021-24; as PV installations were in a real sense growing globally. On possibility of some 'right-sizing', perhaps prospects *may* improve ahead for green energy profits. For instance, late 2022 to mid-2024, pricing for lithium carbonate had collapsed from $84,000/ton - to $10,000/ton; Li is key for EV li-ion batteries. Note then, that in Fall 2024, when a huge and thus China-based producer looked to shut-down one of its Li mines, plus a production line too, global lithium stocks then jumped broadly.

A last few lingering European PV makers, faced Chinese PV sold *below* production costs. Europe doesn't impose Tariffs (unlike US) so China PV was sold at *half* US prices. Downstream, in Europe, many installers opposed adding tariffs: they wanted cheap panels. India too added 20.8 GW PV manufacturing capacity, 65 GW. That spare capacity dims any prospects to grow PV manufacturing in EU, US. Price wars in EVs too, and China eyed making EVs in Mexico -- chilling industry. As China grows capacity & efficiency, in search of demand. *In 2023, China installed an immense 216 GW of solar. It was more than a US which had invented PV and that installed a record for-it 19.6 GW of utility-scale PV in 2023, had ever installed to date!*

For scale & pace of solar pricing declines, consider 2 compelling paragraphs from Raymond James of February 7, 2024, marking a milestone of just ten cents per watt PV modules:

> "Welcome to the world of $0.10/watt solar PV modules... this milestone, reached today in the benchmark price data, has been a long time coming! There is no clearer case study of clean tech commoditization than this. While there is nothing "magic" about $0.10 or any other price point, it is a symbolic milestone and an illustration of just how far the solar value chain has come with regard to cost reduction." ….
>
> "Let's first review some history. In 2008, just before the global financial crisis, crystalline module pricing (we are using PVinsights data as the global benchmark) was $3.00. By 2012, it was $1.00 – a drop of 67% over four years. After another four years, with a more moderate 50% drop, it was $0.50. As shown … declines continued until … $0.16 in 2020, when COVID-era inflation and supply chain complications spurred a two-year period of rising prices that peaked at $0.22 in 2022. This was followed by an extremely steep drop of 45% in 2023, with the year ending at $0.11, en route to $0.10 as of today. Putting everything together, modules are 97% cheaper [in early 2024] compared to 2008. Can you think of any other physical product, energy-related or otherwise, whose price is down 97% over the past 16 years?"

Above excerpt makes clear how relentless, ruthless solar manufacturing in or beyond Asia -- had become! Yes, steeply falling prices were & are conducive to adding solar capacity. Module pricing in mid-2024 was about just ½ that of March 2023. All as wind too, faced its own issues: inflation in materials & labor, warranty claims, inadequate off-take prices -- all hurt. Bit of hope was maybe of some bottoming; perhaps small profits a hoped-for salve for wind.

All amid PV overcapacity mid-2020s; China *could* manufacture twice the number of PV panels being placed worldwide. Yes, near-term to end of decade, US electricity demand may grow to be 10% be from AI, data centers. Solar PV *may* well become planet's single biggest source of electricity mid-2030s. Then 2040s solar may be *the* biggest source of energy -- not only of electricity. And that electricity might cost just ½ the cheapest electric power today. So, the future, just perhaps, may be rather pro-renewables-biased. Still, getting past a tumultuous mid-2020s to reach perhaps profitability later, wring out over-capacity, has been & still is a huge obstacle. Thorny gulf to navigate, if ever! Hence a big question mid-2020s was & still is: how long must loss-making themes endure dismal margins, before unsubsidized renewables, EVs, batteries, grid etc might better become profitable …. Perhaps some insight may be found first by looking back in time, to how we got to this point today.

To start, how could a US that had invented this practical silicon solar cell, have lost its big poly-making industry-lead to China? Even briefly told, this is illuminating. Bell Labs in 1954 created a modern solar cell; commercial versions soon arose but PV costs meant it was used only for-space @$1,785/watt. Costs began to drop as new ways to make 'poly' more cheaply were found: it's also key in making microcomputer chips. Know-how to melt sand at sufficiently high purities for necessary elemental silicon, polysilicon -- was held by just a few big, staid poly (chip) leaders in a US, Japan, Germany. They mainly made highly-refined poly for chips; by 1976 poly for solar cells globally was a tiny subset, miniscule at <500 kW. Rejected poly just from making chips was enough to satisfy all PV demand. Even years later, in 2010, the world's then-biggest solar poly producer still mainly made computer chips; it was based in Michigan US, and it supplied about 1/4th of the world's solar-grade poly.

15 years later, mid-2020s all had changed. China by then was making >90% of the solar poly -- as US/ Japan/ Europe were all-but-out. Why? While blame is oft put on China's subsidized loans, government incentives stimulating green manufacturing, IP theft, few environmental regulations, super-cheap labor and land -- a case may also be made it was due too to 'normal' aggressive, private investing by its own entrepreneurs convinced of solar's future. Plus importing least-cost practices, & on its super-cheap electricity. That said all would lead soon to it dominating poly/PV worldwide, leaving just husks of collapsed firms outside China.

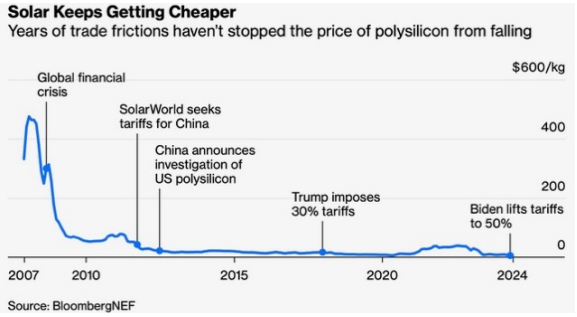
Moore's Law famously shows number of transistors placed on poly chip doubles every 2 years. Such is the room to advance on a silicon base. In China's case, it had faced around year 2000 many vulnerabilities with few oil reserves, and oil price spikes. Its government chose instead to target new poly/solar manufacturing, to maybe begat a new poly & solar PV-boom there. Until then, poly rejected in chip making (needing highest quality, defects <1 part in 10 trillion) was enough to supply PV cells, only needing defects <1 part in 100 million. But early 2000s, seeing opportunity, entrepreneurs in China began focusing on making their own solar poly, & then modules, in fast growing amounts -- hence at ever-cheaper-costs per watt.

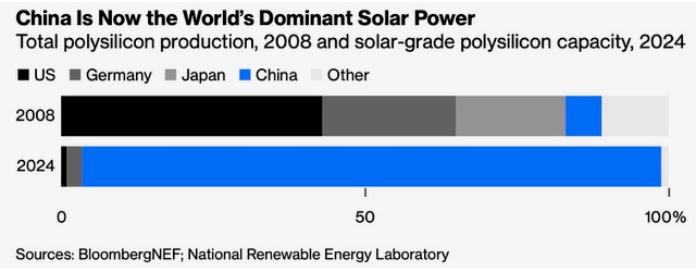
Early 2000s global poly industry grew: that US PV poly producer invested to grow capacity. By 2005 it announced plans to invest $400 million, later, another $1 billion. A lot. But consider too that near 40% of costs in making poly, is the electricity costs. Michigan is industrialized and boasts huge GM & Ford factories, yet electricity consumption by this one poly producer had made it The Biggest Consumer in the State. Cheap hydro power like in Washington State once attracted aluminum producers to it who could then make airplanes. But Michigan, did not have super cheap power. Mid-2000s just 10 sites in US, Japan, Europe made nearly all the poly for computer chips (so for solar panels too). And they all were run by just 7 companies, so obviously the few were not seeking to do it as very-cheaply as possible.

Meanwhile in China in mid-2000s, an entrepreneur seeking new business opportunities took note of Yangtze River, world's largest hydroelectric plant Three Gorges Dam. Sichuan's cheap power-generating capacity exceeding demand. On 'fat' profits being enjoyed by just a few poly producers in the West & Japan, he invested $428 million into a plant dedicated to making cheaper solar poly. Many other investors in China saw this, did likewise believing they too could make poly for PV cheaper than US, Japan, Europe. Noting too China's sparse protections of its environment, workers rights, also meant 'cheaper' growth. It ignited and swiftly led to overcapacity: by 2008 China's new poly industry had 20,000 tons poly producing capacity, 80,000 more in construction -- versus solar poly demand that year just 4,000 tons! Capacity for making that into completed PV panels so using that poly, was only beginning.

On a 2009 financial crisis, governments everywhere had reigned in PV subsidies. China's poly, burdened by huge overcapacity and dependent on export-led growth, crashed. Manufacturers began selling poly at any price. Spot PV poly in China in 2009 briefly fell near $15, far cheaper than producing it elsewhere. After rising back up, later again crashed: Aug. to Dec. 2011, China spot poly fell from $50/kg to $25. Again undercutting that biggest US (chips) poly producer. Around then, a German manufacturer with poly plants in Oregon asked the US to impose duties on Chinese poly, arguing it was being dumped at below cost. That was granted, and China responded by imposing its own tariffs in 2013 on US-made poly. Those hit the once-'huge' US poly manufacturer hard. Many of China's paused domestic poly producers could re-open and with new protections, they returned to producing in ever-greater quantities.

In 2020s new Chinese poly producers sprang up especially where electricity was super-cheap. Like near Hydro dams, or by abundant solar & wind power made very very cheaply. In Sichuan, in Yunnan -- and/or Mongolia with so much sun & wind (but also its filthy coal). In 2024 poly prices had fallen further, to just $6; so after brief bump early-2020s, that had resumed falling. One can see in a chart below at left, the huge drop in poly prices since 2009 but for brief rise in early 2020s. At right we see China starting near-zero, came to dominate poly globally: this has been an eye-opening change since 2003 and one that we've witnessed:





2024, one single China-based producer had capacity to make 480,000 tons of poly/per year and it looked to double again. Versus a once-biggest US producer of poly -- that could then make 'just' 30,000 tons/year. To put this in perspective, that 480,000 tons of poly/year was enough to build solar panels that could power UK & Ireland for a year, or Mexico for a year. As sun rises anew each morning, these panels will go on making power, lasting decades. (Our rooftop panels here have powered our building reliably for 2 decades+ now). So compared to oil & gas, a gallon or a BTU of which can be used only once -- over their lifetimes: these solar panels will provide nearly 5 times as much useful energy to our planet, as all oil & gas reserves of an Exxon Mobil. A gasoline gallon is energy dense but combusted, used once in propulsion; that spent energy then becomes useless. A solar panel keeps working, renewably! But perhaps a most helpful fact in Chinese solar startups' growth, was certainty of China's support for green energy & solar. The West by contrast, oft pulls back support (like 2025); so what once was its thriving early solar-lead years ago, later disappeared. A lesson in there somewhere.

We may see it repeated late 2020s, in AI. Invented in US, energy-intensive, a search on ChatGPT may use 10x standard google. Data centers were 4% of US electricity demand 2024 -- it may grow near 10% demand 2030. For US to retain its leadership, nearly 50 GW of new electricity generating capacity may be needed by 2030; 7 hyperscalers each may need 5 GW soon as 2030. Yet US power late 2020s, >$100/MWh. By contrast China aims to be *the leading* AI superpower by 2030, it's building 11 nuclear plants costing $31 billion, has 155 AI-related projects. Huge State Support. So it may happen in AI too: China might swiftly overtake US, unless action on both AI and US energy is undertaken fast. But that's another story.

For 20 years we've looked at new energy innovations that *may* prove superior vs old energy. At disruptive ways new solar, wind, EVs, storage, hydrogen (H_2) *might* potentially make sense in their own right. We've emphasized too, clean energy stocks shall be *volatile; these can & will 'drop like a rock'*. We're proud as originals through our Benchmark ECO live since 2004 -- Global NEX since 2006 etc, to pioneer zero-carbon themes that may help lower climate risks. Solutions that may appeal too, regardless of climate. And yet climate concerns unsurprisingly, are faster rising to fore of late. Our heating-up planet seems to now shout with undeniable scientific consensus too: risky tipping points may scarily loom, or already be at hand.

It's so significant, we'll take some precious pages here for this science. Consider: carbon dioxide (CO_2) levels now at over 425 ppm & rising fast, haven't been this high since Pliocene 2.6 million to 5.3 million years ago -- when Earth looked very different. July of 2023, & year, set planetary records, blew away a prior 16.63 degrees C (Celsius). Far more than cranking up the AC may be needed in response. 18,000 to 6,000 years ago, Earth warmed very rapidly on natural causes, discussed ahead. At times, sea levels jumped dramatically. Astoundingly by 10 ft or more per century; let's ponder that huge 'delta'/ or *change* for a moment.

Sea levels in 'recent' human history were weirdly stable in geological-terms – with rises only 2 millimeters (mm)/year. As there's 25 mm to an inch, it meant a near-nothing under <1 inch per decade. But, rise is quickening. Lately a US Gulf of Mexico rose 10 mm+/per year(!), near ½ inch/year -- or 5 inches/decade. Local soil compaction, subsidence, gravity, are at play here too. Yet seas are rising non-linear ways. And implies 10 ft/century -- *could* be seen again. Especially as we push CO_2 up at new rates 100-times that which once-unfolded over many thousands of years. When leaving depths of a last Ice age, it took 'only' 6,000 years for CO_2 to rise swiftly by 80 ppm. Now in one human's lifespan, CO_2 is shoved up over just decades -- by more ppm! Sea levels this century and next, may soon be a top-level concern.

As late-night ads shout, 'but wait, there's more!'. Melting ice in Greenland & Arctic may spill freshwater lens atop North Atlantic, lowering salinity. Pausing key thermohaline circulation – the deep ocean currents like blood coursing in our bodies. If 'AMOC' slows, it could end the Gulf Stream; 2023 models raised concerns it potentially may happen in this century, or next. Such would be catastrophic; temperatures might immediately swing some 18 to 30 degrees F or more. Given the data indicate that: a) It's already slowing; b) Slowing and shut-downs of Gulf Stream have happened in past; and c) Greenland & much of Arctic are projected to become 'ice-free' in this millennium -- severe impacts seem far more than just-plausible.

Just following the science: nothing political. Pleasant European climes we've long known, warmed by a Gulf Stream at high latitudes -- otherwise frozen -- may end. Perhaps loss of not only Europe's benign temps, but habitability. Rises on US Eastern seaboard. But there's more. A 'river' high in atmosphere too, the Jet Stream is driven by sharp contrasts (a delta) between equatorial/ vs. polar temps. Lately it's faltering -- may weaken, change. It has long kept arctic air far up north; instability in it too, may mean extreme weather. Climate whiplash. The blazing hot summer -- and freezing winter seen in 2021 -- may soon seem like a year of nicely mild temperatures. A past we can only hope for again. Hence, concerns this is *Not* a 'new normal' -- but maybe, just a beginning. Start of long, drastic changes. Extremes that can't be unwound. Putting massive greenhouse gases in air -- *may* mean no happy ending. However, there's cheaper, sensible, saner pathways -- and decarbonization is indeed one emphasis throughout our Indexes. Let's briefly look then at some ways that clean energy innovations in say, Summer of 2023 recently aided a great, Lone Star State of Texas.

A bitter freeze had hit Texas in Feb. of 2021, and that famously took down its grid for days. Misery, deaths resulted. We'll examine that in detail ahead (including a false claim it was due to frozen wind power -- when in fact natural gas freezing off was lion's share of fault). But let's turn first, to more recent baking Summer of 2023 as Texas saw record High temps. Here clearly, zero-carbon renewables solar & wind were heroes -- plus nuclear; the 3 kept on electricity in June and July 2023 -- power flowing, firm, and without huge prices spikes.

Fortunately for it, Texas had already begun better positioning itself a few years prior. So it then had a 16 GW (gigawatts) of solar power deployable by June 2023 -- it was a bit like 16 nuclear plants, although not-as-firm. This 16 GW was 8x vs. puny 2 GW solar it'd had in 2019. As baking heat arrived June 2023, temps soared: what helped its grid? Operate no anomaly, prices fairly-low, instead of spiking as thermal plants went offline, unable to handle heat/less maintenance? Notably in intense heat June 28th & 29th, renewable solar/wind, plus nuclear -- met 55% of power demand. At peak demand so early evenings, renewables -- plus nukes, met near 50% of electricity demand. Solar worked well as intended daylight. Wind performed well, oft best nighttime. But, needed now, is far more energy *Storage*. It has only begun to grow to help further smooth out intermittency. Of 700 MW of new energy storage that went in across all the US in a 1st Quarter of 2023, 70% of that went into just Texas.

Despite love for oil/gas felt by some of its leaders, Texas blew away all other US states in recent gains in solar & wind. Gains needed: Texas now sees hot & cold extremes its old energy systems Were Not Built For. Indeed in 2023 it installed *another* 7 GW utility-scale PV; no other US state was close. Aimed for 25 GW utility-scale solar capacity in 2026: enough to energize 10 million Texas homes. For comparison when peak demand had hit in July of 2022, a then 59% of its demand was met by gas; next coal was 15%; just 10% was solar, 9% wind. Yet a next year, July 2023 on a new record 83,414 MW demand, 57% was met by gas; while solar was a better 2nd at 14%; edged out coal 14%; wind 9% (calm day, would be more if windy), 6% nukes. So on 25+ GW new solar + much more wind, far more storage can't come soon enough! Despite certainty some leaders had felt its grid was firm 2025 -- that is sure to be challenged by hurricanes, weather extremes ahead. Even in a Texas 'normal' Summer like 2023, all thermal plants had suffered from an intense heat. Its fossil fuels & nuclear forced down for planned -- and unplanned maintenance. All traditional plants are impacted by intermittency. Not what fossils/nukes want to pin on solar (that it 'won't work if cloudy or at night') or pin on wind ('only works if breezy') -- *thermal plants can't handle these new weather 'normal' extremes.* Thermals are at whims too of fuel costs. Contrast that with solar, wind that work in more stable ways -- and enjoy ever 'free fuel' to boot. It's estimated Texas' renewables had saved its consumers over a billion $ dollars during a 2023 heatwave. Money its citizens didn't need to send senselessly (as they had done in 2021) towards spiking energy costs.

In Summer 2023, extreme heat became too much. Aug. 6th power prices skyrocketed 800% from $275, to $2,500/MWh. Just 1.6 GW spare capacity left 6 pm sunset, as demand peaked at 84.4 GW -- new State record. Emergency cooling centers were set up. Renewables propped up its fossils-grid, kept prices lower thanks to sun/wind -- but could only do so much. Sept. emergency saw just 500 MW left! Or, Derecho winds in a Spring may bring 100+ MPH winds. So, a need for far more PV/wind + storage is crystal clear. 150 years ago, it was humorously said 'everyone talks about the weather, but nobody does anything about it.' Well, in a cruel irony we all may be doing something about it now, unalterably. Normally, a rise of ocean temps of a 10th of a degree is notable: seas require far more heat to rise than air. Yet in North Atlantic off Newfoundland, Summer 2023, sea surface temps reached 9-18 degrees Fahrenheit (5–10 degrees C) above normal: beyond even many of the most extreme climate models.

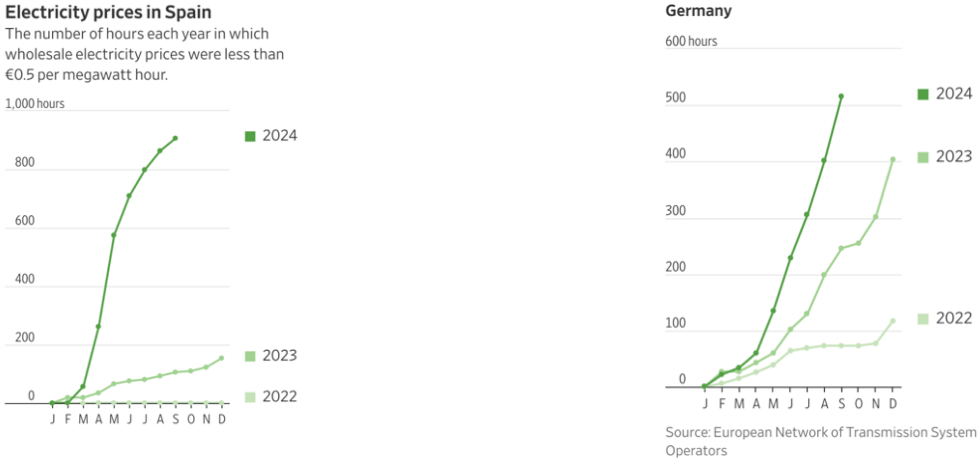
In Florida Keys, sea temps in 2023 went >100 degrees F, hot tub temps. Yes, was in shallow waters, less open ocean flushing, seagrass dark bottom absorbs heat … but still. Antarctic sea ice lately is not rebuilding like normal in winters -- worrying scientists who fear tipping points, a collapse in sea ice extent. Fears too of a slowing of Antarctic's key overturning current, which keeps stable, 'normal', very basic planetary systems upon which we all depend.

Bloomberg New Energy Finance (NEF partnered with us mid-2000s in creating NEX) just a few years ago noted end of 2020s so in few years, the US might build 600 gigawatts (GW) new *solar, *wind, *storage capacity. Yet BNEF based as impetus, a then-Inflation Reduction Act (IRA) that could go over $1 trillion plus other support. Yet even hurdles then to 600 GW were still *capital costs, *inflation, *supply chains, *slow permitting, *poor grid: all impediments to growth this decade. It had forecast 358 GW of US solar capacity 2023-30, near 3-fold total US solar capacity of 2022. Foresaw maybe 137 GW wind capacity to 2030, near 2x total wind capacity of 2022. 111 GW battery storage capacity to 2030 -- 9x gains vs 2022; starting from low base, but growth. Perhaps too billions in grid investments; yet even that would be billions short of spending needed, if a US was to reach 50% emission cuts by 2030. But in 2025, all that was DOA, with end of 2022 IRA as a package of big tax breaks, incentives; NOT a strategy to decarbonize. Mainly carrots, no sticks. And even that 600 GW fell well short of achieving then-US targets of 50% cuts in CO_2 emissions by end of decade. We emphasize this, because once the IRA of 2022 was decimated in 2025 -- and 'new' administration was then doing all that it could to halt new wind & solar, such changes only took us much farther away.

Looked at another way, on 3 then-big Federal laws extant in 2022, a US might in theory have doubled its pace of decarbonizing -- to hit 4%/per year *fewer* emissions by 2030. That could have brought down emissions 40% to 2030 -- still short of 50% emission cuts then sought, to help to stay under <2 degrees C heating. 50% by 2030 may have teed up US for net-zero 2050. But that 50% by 2030 meant doubling, or 2x our fastest rates of new solar/wind to 2030. Then, growing 3.5x in 2030-2035. To achieve that pace, we'd have had to have cut CO_2 not 4%/year -- but 6%/year to 2030. Then, speed cuts even more. *Now, none of that is in the cards!* Especially after 2025 end of the IRA. Not technically do-able. No surprise clean energy spilled into American politics 2020s. Criticisms rife. A few critiques, true. Like that strategic minerals were/are not yet domestic-sourced. Or that electrifying heat, is costly. And yet most leading criticisms & assumptions, aimed at clean energy in 2020s, were far less accurate.

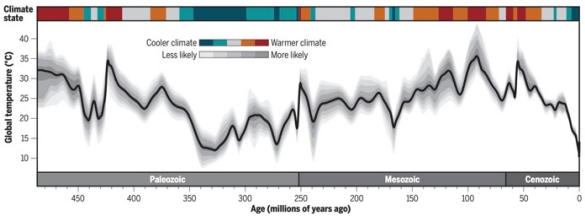
For example, contrary to political-drawn-beliefs, fact is: clean energy can *cut* energy costs -- *renewables can be Deflationary*. But that doesn't just flow to lower costs. Australia had clung to coal -- it saw changes as renewables surged. PV output up year/year. With less need for costly gas, *wholesale* power prices went zero/negative 12% of time; 9 am-5 pm in populous Victoria & in S. Australia, negative 55% of time. BUT, that grew the need for more storage. And negative price disrupts old-energy coal. Power prices are set in day ahead markets next 24 hours, so if excess ahead, they'll bid 'negative' prices, harming themselves (hard on nukes & coal plants that can't easily shut down). By 2025 over >40% of freestanding Australian homes had PV, but this only exacerbated the importance of dispatchability. Just as wrong, too, have been critics who've claimed that EVs must-forever-be-much-too-costly: China now has <$10k EVs with a 200+ mile range. Other criticisms perplex, like skeptics claiming that since climate has always changed through Earth's history, pro-renewables policies must be bad: that perhaps in on a mis-understanding of science. Skeptics' arguments may in future retreat a small bit, as seas rise -- but certainly have not yet! Skeptics and climate deniers remain vocal so many ways. Elections late 2020s shall be interesting for what they decide, portend.

The 3 Charts below on newer data are a bit startling for what they imply, what one may infer. 1st two show that some consumers in Europe mid-2020s, lately can take advantage (at times) of negative electricity dynamic pricing. In US (unlike EU) consumers can't access dynamic pricing. (Some US states may rethink & might allow some retail access too). In Europe in 2022, prices went below zero only a tiny 0.3% of time. That rose to 2.2% in 2023. In 2024 bigger 6%. Places with lots of renewables, can get higher/'better' (for consumers): 8% in Netherlands, 11% in Finland, 12% in Spain. Also for what may come to US, if rules are relaxed. In US 2023, just 21% of electricity generation was made by renewables -- EU was clearly ahead then: 44% in 2023 -- yet some US regions may see changes, if negative dynamic pricing is allowed. Southern California wholesale prices went <zero only 5% of time 2023; but a boom in utility-scale solar meant they went negative ~20% in 2024. (A downside was 3 million megawatt hours expensively curtailed/wasted 2024, could have powered half a million homes -- but that was on lack of energy storage). A windy Iowa US, may see wind power go 'too cheap' at times as a boon for consumers on windy days & nights. Chart for Spain left about to go over 1,000 hours -- and for a Germany right, to go over 600 hours -- show remarkable growth in their negative pricing that came about in just three years to late 2024:



Source for both: Wall Street Journal

Lastly, step way, way(!) back for 3rd Chart: remarkable reconstruction on data of Earth's surface temperatures past 485 million years and linking CO_2 -- to temps. Reflects too troubling sensitivity to any doubling of CO_2; at 8 degrees C avg. hotter, average tropical temperatures were higher than previously assumed, a horrid 42 degrees C (107 F): life endured extremes. Refutes a natural ceiling on how hot it 'might get'. Had it looked farther back, would have captured too a snowball Earth of Cryogenian: happened twice 710 million-640 million years ago, and lasted 10 million years each maybe with Earth rings, or less volcanic CO_2, absorption by rocks -- so CO_2 can also get much 'too low', for extinction events. Over a past half-billion years, Earth's temperatures were thus more often far hotter, than a presently 'cool' 59 F:



Source: Judd et al, A 485-Million Year History of Earth's Surface temperature. Science 385 (2024).

Texas' wind & solar has ruffled some politicians feathers, but saved its grid. A conservative state, yet its private sector is growing new energy 'fast'. A bit akin to Portugal in 2023, where solar then met 7% of demand (then like Texas); wind then 25% of electricity demand also like Texas levels. So, Portugal, & Texas in 2023, were near 7% solar & 25% wind & growing. But they're different too. In Europe natural gas is pricey, unsecure nor-domestic, so far less used. Hence Portugal's focus is renewables! Portugal's renewables met 68% of demand 2025, up fast from a 61% in 2023, or 50% in 2022. Portugal benefits more greatly too from hydro (unlike flat arid Texas). Portugal hydropower met 23% of demand in 2023, hit 27% in 2025. In say an April of 2025, Portugal hydropower met 40%; wind 29%; solar 8%; biomass 9%; all in near 85%. While natural gas was just 11% and dropping. Portugal's renewables may hit near 95%+ by 2030. Portugal is thus growing clean energy much faster than in Texas. Yet in context of just the US, Texas 'wins' among the 50 states, although moving at slower pace than Europe.

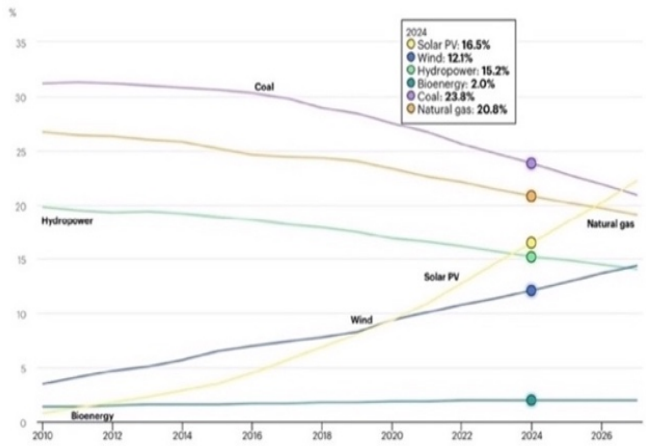
Still, via a climate lens it's scary: for nowhere, is clean energy going fast enough! Everywhere, is seeing decarbonizing setbacks. On unending CO_2 it won't be 'just' 1.5 C hotter ahead; that is not-realistic. In 2023 China & Saudis refused to raise 2025 targets at G-20 ministers meeting. China was 196% of increased emissions 2019-2022; 1/3rd of all emissions. On its vast new coal capacity alone any optimism for stability ahead in our Earth's climate, is unfounded.

Take a UK that once led on wind but in 2023, chose oil/gas; so much so, even if reaching 'net-zero' in 2050, it still planned to get 25% of its energy from oil & gas. UK offshore wind deals were cancelled in 2023 as a Party then in power, felt wind won't pencil on capital costs. Underlying all was a belief putting off action on climate was 'pragmatic'. But, *that's wrong;* renewables *can be tangibly cheaper*. However, China with its much-longer term commitments to solar, wind, weathered that storm far-better. It may potentially gain most from wind growth ahead, even in Europe. Outside of China for instance, a German/Spanish Euro wind giant saw losses early 2020s; it took €2.2 billion charge on wind turbine troubles, net fiscal year loss was 3x more than expected. In that tough time as wind pared back worldwide early-2020s; it fell 20% in 2022 from prior year; saw 32% less growth, than in its record 2020. By contrast, China over those lean years provided ongoing support to its wind manufacturers. That led them to reduce costs of their wind turbines from $1,200/kilowatt in 2019, to some $400/kilowatt in 2026. That remarkable 2/3rds cost reduction for wind gear from China, means they are now sizably cheaper than home-built equipment in Europe costing $1,000/KW. While the UK in 2026 had some 3,000 wind turbines offshore -- thousands more were planned. Meanwhile the low-costs of China-manufactured gear was becoming-tough to beat.

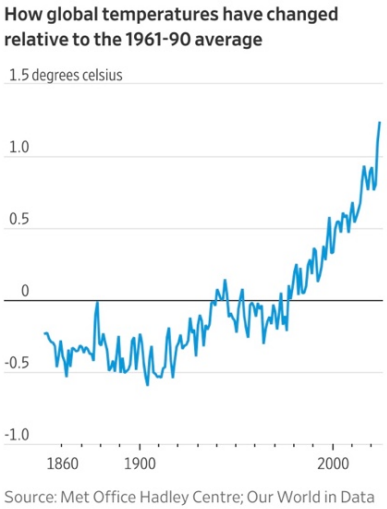
It's not as if traditional, old energy fossil fuels could have any better answer on needs for more, fast, & cheaper energy. Plus their problems are worse on so many fronts. Again, big Texas in a US is a case in point. Its gas plants there *will* struggle ahead in new colder & hotter extremes -- while its fuel costs *will* soar at times. Its Grid is going to be far more prone to breaking, than even its leaders knew in an early 2020s. This issue to be increasingly evident ahead, is its 'firm' fossils & nuke plants will Fail: like in Texas when its gas froze off 2021 and some interests tried to blame renewables: PR efforts had scrambled to call only fossils 'reliable' -- despite the facts. Again and again, gas (and nukes) will strain in hot/cold beyond expected when thermal plants were built. *It shall happen again!* As weather extremes grow in frequency, they'll challenge thermals struggling in 'newly-normal' temps. Greatly adding PV, wind, storage, better grid, will help lift teetering systems from failure; keep prices from skyrocketing. Still without tremendous new growth in solar/wind, storage, transmission, grid, & resiliency to help keep renewables firm & dispatchable, *it will not be near enough*.

There are bits of good news. Global solar capacity growing by 2x every 3 years; or 10x/per decade! 10 years ago in mid 2010s, solar was 1/10th of the capacity seen mid-2020s. Was like planet's nuclear plants growing 8-fold, all faster than building 1 nuclear plant in a west! Globally, nuclear is divided by geography; 2024-2030 may see 55 new nuke reactors: 61 GW, ½ in China (26), rest Asia & Middle East. Vs. 0 in US, 4 in Europe. New small nuclear reactors beyond 2nd gen reactors, past US-nukes built to 1990s may suddenly grow, given needs of AI post-2030s. However, via lens of what's needed to hold heating to 1.5 degrees C, this decade ends scarily Bust. New temperature records, eg, Sept. of 2023, a hottest Sept. then on record was not by a usual 1/10th of a degree -- but by 0.83 F! All 2024 next hottest year on record -- yet it may turn out to be one of the coolest-ever years a young person today knows in their lifetime. Still, in latter 2020s natural gas is slated to be making huge gobs of power -- despite that CO_2. Global coal to be still abundant 2027. Some green growth but spending projected Nowhere near $4.5 Trillion in 2030. Instead, all overshadowed by inertia of big dirty energy, that made huge 45% of electricity in 2024; coal was 23%, natural gas 22%. Fossils will be still core 2027. On climate science, on CO_2 /greenhouse gases, the 2020s will end a Bust for all -- with world temps going well over 1.5 C degrees heating:

Left: Share of Cumulative Power Capacity By Tech, 2010 - 2027; Right: Global Temps.

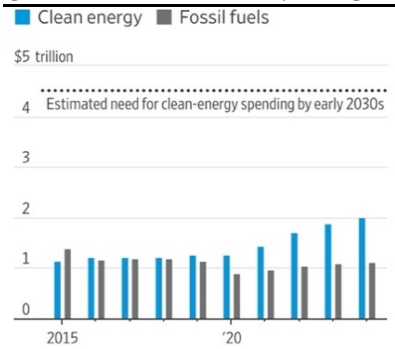


Source, left: IEA, *Share of cumulative power capacity by technology, 2010-2027*.



Right, Wall Street Journal; Met Office; OWID.

Global Investments Must Grow Significantly -- To Keep Heating Under 1.5 Degrees C:



Source, chart at left: IEA, Wall Street Journal; 2024 figures estimates.

(Side note: it is hard to capture natural gas, although an important commodity, in an Index -- these are normally made of equities. Gas futures too are more local than oil, location is key. Contracts rolling over may be a drag too on Index/ETF, drift if renewing in contango. Still for comparative purposes, we use a major natural gas futures tracker, to portray it.)

Bit of geology helps here looking at deep Past – to go farther back than Financial Reports! CO_2 dropped hard in a last Ice Age, to 160 ppm (parts per million). Naturally Earth was once very cold at times -- very hot other times -- long before humans. Explained by fact Earth moves in predictable ways around sun, non-round, not-perfect elliptical orbits. Over tens of thousands of years our planet's moves too by 'precession'; + 'axial tilt' like top spinning on a table. 3 predictable moves explained by Milankovitch cycles, with variable/cyclic cold or warming. Meanwhile continents drifting changes Earth's surface too, impacting big ocean currents. How much land is in Northern vs. Southern hemisphere affects how much heat is absorbed -- or reflects sun's heat. Ice sheets near poles, reflect sun (cooling); dark oceans near poles absorb heat. Net results of a variable 26,000 years of precession, 41,000 year cycles in axial-tilt, plus continents drifting etc is cooling, warming. It can & does change climate by few degrees C at poles (that's a Lot!). Over time, naturally. Once renewed heating re-starts by many factors, say, CO_2 released naturally by volcanism, CO_2 by decomposing vegetation, or methane under permafrost etc, it can 'kick-start' more rapid heating via water vapor naturally in air. Water vapor is a potent greenhouse gas, can heat climates in just thousands of years.

So, it's significant Earth's CO_2 varied little a past 1 million years. From 160 ppm in Ice Ages (we are technically still in one with polar glaciers) -- to 2x that, 280 ppm at start of Industrial Revolution. To find higher ppm -- one must go back 3-4 million years to a hot Earth >420 ppm, CO_2 like today. CO_2 rising that much, naturally took thousands of years. Instead, vast CO_2 spewed now in 3 centuries means huge heating baked in. Sea rises unfolding for millennia+ ahead. On inertia, may become 'normal' that there's lethal 50+ degree C temps (122+ F), or in future Arctic Circle is over 30+ C (86+ F). At first, seeing briefly hellish hothouse *conditions* (masked at times by La Ninas) -- then hothouse *state*. We don't see how much oceans already, terrifyingly, absorb heat. 2023 data showed 396 zeta joules of heat were absorbed from 1971 to 2018, so within 1 lifetime. That's equivalent to 25 *Billion* Hiroshima atom bombs and growing. In 2022 oceans saw 10 ZJ more heat, than 2021, enough to boil 700 million kettles -- every second! These data indicate a level of CO_2 last seen not 'just' 1 million years ago -- but instead, 14 million years ago. And we could see 600 ppm, even 800 ppm in 2100s.

Hence our problem: by massively burning fossil fuels, we've put in air 'old' carbon once safely locked away millions of years. Natural Gas is 4 parts Hydrogen -- to each 1 part C carbon, thus = CH_4. This is a most hydrogen-rich/least carbon-laden fossil fuel thus is 4:1. Industry calls that 'clean' (it's Not!). Burning each molecule only bit less-horrid than is burning oil or worse coal. Take black coal, anthracite (please!): it's nearly all carbon, dense. Burning 1 ton of that poison for power puts out 4 tons CO_2 -- worse than gas(!). So coal spews 67% more CO_2 -- plus too mercury, particulates, sulphur dioxide, awful ways to make power! Young wet brown coal with impurities incredibly, is worse. Could lead to future wet-bulb global temps that kill.

Hence, was remarkable that in 2022 as war spiked gas price, more coal was used. In 2020 US natural gas had cost $1.48/million BTUs; in 2022 briefly hit $8.00+ up +400%+! Back near $2.00 in 2024; then over $4.00 at end of 2025. A Europe in 2020 nearly off coal, returned to it. Shorter-term, coal = warmth & power. But there's a price in burning carbon gathered over millions of years, released all at once. Renewables help keep CO_2 emissions flat-ish (despite coal), to drop bit latter-decade. *Yet Big reductions in CO_2*/GHG concentrations are necessary electricity made saner ways than by fossils. Or say, by a Zaporizhzhia nuclear plant being near-shelled in war, explosives stored nearby, its safety threatened(!). Tsk tsk, silly ways to boil water. Ukraine's Kakhovka dam also under threat. So too, now sea floor cables carrying both energy & information globally, a backbone that could be quickly severed.

It's not a straight line of growth. Nor same all places. Europe for instance in 2022, enjoyed relatively better/lower costs for installed solar -- vs. a US. Why? For starters Europeans don't pay solar tariffs, unlike US buyers of Asian panels. Don't have America's state by state net metering (NEM) costs. Nor restrictions on China. Plus natural gas is core fuel, in Europe too -- yet gas there is very expensive. In 2022 hit $40+ per Mcf. So gas there's often 2-3x the US -- which helps make clean energy decisions far easier in Europe. In short was easier & cheaper to install new wind & solar in Europe -- than it was / or is in the US say, mid 2020s.

Per IRENA data, back in 2021, Europe had cut average all-in installed utility-scale solar costs, a lot. Germany had pushed solar install costs down to $0.69/watt. Italy $0.79, UK $0.85. Meanwhile, a US was far more costly 2021: $1.09/watt. Europe shaved $0.10/watt off install PV relative to US. Surely in a world facing climate crises, one may think decarbonizing has some priority. But No. A US may champion fewer regulatory burdens, but when comes to renewables, it has higher soft costs -- like in the solar design, in permitting and installation -- vs. Europe's lesser burdens. Comparing like for like in 2 similar systems & putting aside costs for PV hardware (lower as well in Europe) -- America in mid-2020s was much *less* efficient.

Look back at say, 2020 to 2021: Levelized Costs of Energy / or LCOE for new US utility-scale solar costs did fa*ll* 13% in 2020-21 to $0.048/kWh. Onshore wind, fell 15% y/over/y to $0.033 per kWh. Offshore wind, fell 13% year/year to $0.075/kWh. Getting that cheap, was notable. In say, Germany, it has *potential* to raise offshore wind generating capacity to 81 GW. Rather like ~81 nuclear reactors. To a Germany facing electricity fears that could be stupendous. 10x more energy, than a 7.8 GW its operating offshore wind had made back in 1H 2022.

Let's stay with 'LCOE' for a moment. Critics of renewables like to point to LCOE figures, which greatly now favor clean energy, as misleading. Some critics point-out that LCOE does Not include externalities, costs of lesser Dispatchability; Curtailment -- which is partly right. Mid-2020s renewables' variability meant a great deal of firm backup was needed, like if wind isn't blowing at night. Or if 'too many' electrons by renewables are generated, then they may have to be expensively shut/curtailed. But, both of issues are now being addressed by ever-cheaper energy storage: short-term batteries and longer-term technologies. And by better grids to address curtailment. Yet critics add new transmission costs, onto renewables only -- ignoring that wires are needed for fossils and nukes too. Critics then artificially increase LCOE costs for wind/solar by 2-fold, 3-fold or more(!), claiming they're adjustments. For example they'll come up with wild (highly-dubious) assertions, like that renewables in New England would 'cost a range anywhere from 6 to 12 times existing natural gas'. We saw in 2026, that a US cabinet member seized on that range, yet repeated just the very-highest-end, to claim mistakenly 'wind energy is 12x more costly than natural gas'. That was very wrong.

Such sorts of mathematical gymnastics are often a source of some bizarre charges seen today, for costs of clean energy. Critics may bend facts, reality -- to fit a politically-driven narrative that favors fossil fuels. Equity markets put a lie to that. Given cheap renewables, competing at times without subsidies, are the obvious choice. (Though we note in regards to an even-playing field; that all fossil fuels all subsidized; nuclear is enormously so). Lately, in just years since 2010, LCOE has pretty much said it all. For electricity made by natural gas, costs had briefly hit a war-high on fuel-costs; but even after brief peak/decline they remain sticky high. By comparison onshore wind costs only falling: down to 3 cents in say 2022 as 68% cost drop; afterwards, they fell even more. Solar was down 88% in 2022; like wind, it went to penny in Saudi Arabia in 2025! Renewables, given with free fuel, plus notably necessary accompanying Storage getting only-cheaper over time to boot, this has become on costs, no contest.

With war cheap Russia's gas, once-so-key for EU energy, suddenly was a red letter of shame. Went from cheap/plentiful -- to unwanted. From meeting 18.8% of demand 2024, to on war -- that gas suddenly was a liability, weakness. Energy Security hawks wanted all non-Russian gas they can get, including LNG vessels; hence new gas infrastructure. On the other hand, Climate hawks wanted immediately to get off all that. To go directly to new zero-carbon infrastructure, exclusively, now. Building just LNG or piped natural gas, was seen by latter as mutual suicide pact. After US tariffs 2025, even 'stable' US gas supply became a question mark. Still, both sides concurred that: Germany & Europe needed to move off from Russian gas. Emphasizing a need for vastly more electricity Storage. (Electric storage can be measured as Power, so in watts -- or as Energy and so this being watts over time -- megawatt/hours. 95% of electricity once was stored as a pumped hydro: moving water between 2 elevations, on such difference, global 165 GW could be stored. Or as energy, how much water is in reservoirs; in 2021, was 9,000 GW/hrs or 9 TW/hrs. Anyways pumped hydro storage capacity was capped: dams can't grow, best sites taken. Electric storage capacity once pumped hydro -- is not anywhere-near enough now, on the intermittency of renewables. Electricity must be immediately used once made -- or be stored. So an intermittent sun & wind always will demand far greater storage. Better storage, & grid both keys to unlocking clean energy.

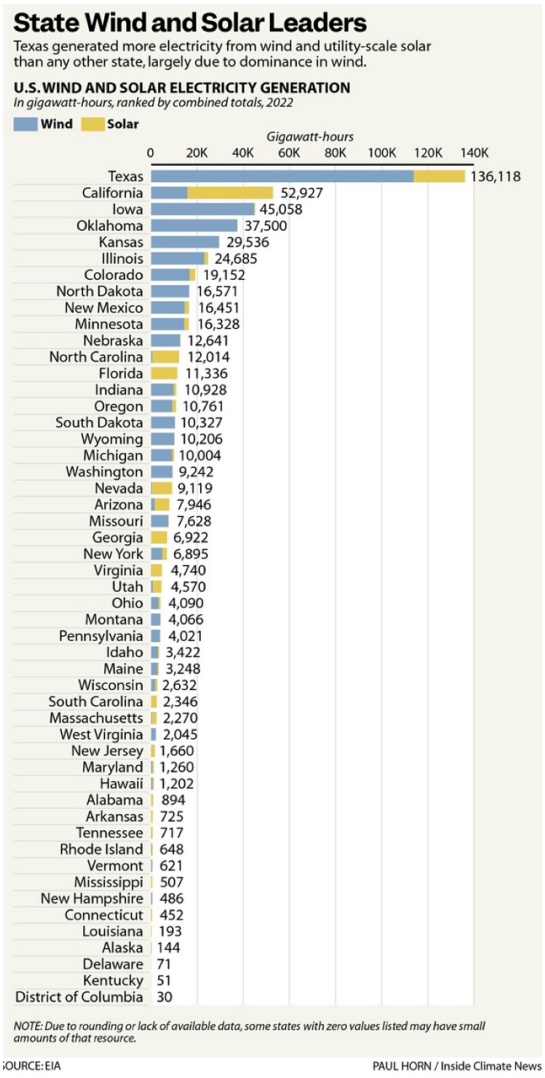
Batteries give just a short-term storage to say 4 hours. Longer-term storage options can hold electricity for days, weeks, months. Yet achieving huge-enough zero-emissions global Storage by 2040, meant new capacity of some 2.5 terawatts (TW) power, 150 TW/hrs of energy. Thus, Herculean efforts are needed, fast. But outside of pumped hydro, little capacity existed. Consider: if all non-pumped-hydro base storage then extant in 2020 were grown 20-fold, from 2020 to 2030, then that would only come to 1 TW/hr. Just 150th the projected energy storage capacity *need* of 150 TW/hrs. No doubt, new non-hydro technology will appear, and can advance\e the curve in unexpected ways. But, this new 2.5 TW sought is quite an ask!

Some rely on hope. Hope say, energy crises in late 2020s/and 30s aren't as bad as in 1970s. Yet may be worse ahead. Two 1970s crises were both on oil. Now, 2020s/30s, they're partly about oil -- and vital natural gas too -- even nuclear-fuel-cycle. And demand pushing up prices is for ugly coal too, as CO_2 grows worse. Yes EVs / renewables may soon help keep year over year rises to CO_2 to 'smallish', then nearer nil gains. But fossils need to Drop, Hard, fast.

Others deny the science of CO_2. Yet given big consequences if they're wrong -- and science shouts that Wrong they are -- that's a slender reed on which to hang all one's hopes. In 2022, a major world leader had maybe intended perhaps to stoke conflicts among Europe's elites. To start an invasion to re-claim past territories, re-open old energy rivalries. Divide EU/ West. Tear down NATO, EU elites, promote global populism. As a key gas supplier to Europe, had wherewithal to withhold that gas, and daily we were reminded of horrors of war. Yet Europe moved surprisingly fast off their gas -- as other things were going on early/mid-2020s too.

They included 'bad' surprises not-covered in media. Like methane concentrations in air that 2022 inexplicably went far higher than expected/projected. If on anthropogenic causes, say leaky gas pipes, sabotage, it's one thing. Or agricultural practices too may be addressed. Yet methane's a very-potent greenhouse gas. More short-term than discussed CO_2, 80x potency. Capping well leaks everywhere, Turkmenistan to Texas should be an obvious fix, immediately. But should a then-record 17 ppb methane increase, since grown to 1,900+ ppb levels in air be on 'natural, positive feedbacks', a global heating factor we *can't* mitigate -- then surprises may be frightening. That methane's still overlooked, in the 2020s, is of little comfort.

All are excused who'd assumed California is America's #1 State, for renewables. In fact, it is Texas. Many Texas business & local leaders embrace renewables. Yet some Texas political leaders curiously make much of their allegiance to fossils, and of antipathy to renewables. As cheap renewables become a threat to gas, oil, coal, nukes; in 2022 wind & solar had made 25%+ of that State's power -- yet at times it passed 50% of electric power in 2023 -- vs. what was a measly 0.7% in 2002. A slew of anti-renewables Bills curiously were introduced in 2023/2025 -- trying to reverse clean energy growth. Here at left, one sees America's highest vs. lowest states ranked for renewables wind/solar in 2022, many Red states were at top:



Source: Energy Information Agency (EIA), Inside Climate News

136,118 gigawatt-hours of green power was made in Texas 2022 by wind, utility-scale solar (above); yet its electric power needs were so huge, renewables still had only met 34% of that Texas total electricity demand. Adding in zero-carbon nuclear, & hydropower too, meant Texas led the nation by making a big 180,000 gigawatt-hours of zero-carbon electricity. That's all nice, but its coal & natural gas capacities were still very big there -- and lately feeling threatened, given how cheap renewables had become. In 2023, then 2025 a raft of Bills were introduced in Texas' Legislature to stop renewables. Nationally too, renewables & nuclear had gotten to where, in 2022, ~40% of US electricity was being met by zero-carbon sources. That was some ~22% met by renewables, and ~18% met by nuclear power.

What can help to grow wind & solar generation faster? Modern grid infrastructure is key. This means big changes akin to building Interstate Highways in 1950s. So far, instead, it's been just patchy repairs, few big upgrades, catch as catch can. Grid bottlenecks led to wholesale electricity prices going negative in 2022 (to Aug. 15th) 6.8% of the time -- vs. 4.6% all 2021. Wind/solar curtailed/shut at times or could have been worse. Fossil & nuclear interests, often criticize renewables as intermittent, as a 'defect' -- yet they don't so discuss when sun/wind flip-side are abundant. Then, firm coal/nukes -- not nimble, unable to start/stop, must stay-on as prices drop near zero -- even negative! On May 7, 2022, a Texas coal plant saw prices briefly fall to -$8,977, negative per megawatt/hr; *paying* users to take power! 'Firm' can be a liability if renewables can & do make power at times cheaply/or free. Yes, $2.5 Trillion in spending by the private sector for a stronger grid might happen, for many reasons.

By end of 2022, 31 huge grid outages had impacted 1+ million persons globally, past 4 years. Christmas 2022 a freeze hit much of US. Ukraine was hit by Russian drones. Florida hit by Hurricane -- something lately an expectation. 10 other outages, affected over 10 million! If uninterruptable power is mission-critical, outages >8 hours more than li-ion batteries bridge. So instead of just storage, think too of fuel cells; they can run unlimited as long as fuel is supplied. Days, weeks, months. In 2020s, fuel was likely natural gas, CH_4. But ahead, may be (green) H_2. Even natural gas may be less costly, less-dirty, than a diesel genset. Diesel spews 161 lbs CO_2 per MMBtu, a gas turbine is bad too @117 lbs; a fuel cell works by electrochemical reaction -- not combusting, so is more efficient, less polluting. A fuel cell is near-pollutants-free, if using green hydrogen H_2 -- no SOx, nor NOx from burning. In such future, green H_2 fuel may be made from the wind or sun using water, so simple when using electrolyzers!

More severe power outages included: 3 days impacting 100 million in India on a coal shortage. 7 days out for 1 million in Canada due to a Derecho. 10 days in UK from lightning strike. On 1 day, 120 million out in Indonesia on power line disruptions. Clearly, more power grid failures lay at our collective doorsteps ahead. Attacks on grids, on power. Scary is any blackout lasting weeks or months; may mean tens or hundreds of thousands of deaths. Longer could mean, millions dead. Attempts at black starts to bootstrap large grids back into operation. Doesn't take much to knock out a grid: few bullets, bit of explosives, cyberattack, just a rusty bolt cutter. First 8 months 2022, 107 physical attacks on US grid were most seen in a decade. It's been an open secret, big custom critical transformers for US grid are mainly Not made in USA; come from China, or India -- and there's insufficient backups if 'taken out'. Destroy just 9 key electric substations + few key transformer manufacturers -- and that can decimate a US power grid largely made up of 3 parts; over areas up to a year. Given sleeping vulnerabilities -- potential for widespread deaths, the case for better grid needs to be considered.

Blackouts may even lead some conservatives to seek a stronger grid '*now*'! Conservative-Iowa in 2022 got 60% of its power by wind; Kansas 50%; Oklahoma was close. Yet their Senators had opposed renewables in negotiating a 2022 IRA, although they increasingly benefit from wind. Later on in 2024, as IRA funds (too)slowly rolled out, monies went 1st largely to few key red Swing States. Despite that 2022's IRA, come 2025 was fast decimated. Conceivably, post-2028 elections, a few Senators/House Members may tear away from a just-partisan opposition to green energy. Maybe on weather extremes, grid failures like 1 million in US losing electricity in 2026, unpalatability of Russian fossils, on costs, they may want to fund renewables & grid -- as well as CO_2-laden fossils. Once-heretical ideas like solar/wind & better grid might be re-considered. Trillions of $$$ being spent on fossil fuels, giving climate crises, wars fought over and over relating to oil & gas, may be rethought. Some thinking reframed.

When a consequential 2022 ended, much had changed. A path some had hoped to see shine -- traditional nuclear like in an aging US nuclear power fleet built up to a 1990s (nuclear is Not in our Indexes) was instead hard hit by problems. Or some had hoped that France's shinier 2nd-generation nuclear tech ideas could fast 'ride to a rescue' in 2022 on war. That the French nuclear fleet know-how, could re-grow output at full tilt. Sending electrons across a Europe that sits pretty, unvexed by slowing or near-cessation of Russian piped natural gas.

Instead, France 2022 was badly handicapped, too; ½ its modern nuclear plants stuck offline. Not long ago, they'd been *the* poster child for top-shelf Western nuclear. Proud of her sovereign nuclear abilities, the highest-percentage nuclear in world, without mega-disasters of Chernobyl or Fukishima. But instead, France in 2022 was hit by massive-forced power cuts. 12 of her 56 reactors stuck offline, a 27% year over year output drop to power levels ~30 years ago. Taxpayer subsidized, yet high electricity costs seemed to vex in perpetuity. Power cuts 2022 took La Belle France to under <300 terawatt/hours. All with consequences for Europe, which struggled at first then to find enough fossil fuels-fired electric power.

Not yet well-known, then, was France's nuclear plants had been acutely hit by unexpectedly bad corrosion issues, maintenance needing time to sort. Only could hope 30 GW is back online fast. And that focus on nuclear unhelpfully also held back renewables; in 2022 they'd only met 9% of demand (vs. 25% in UK). France looked to nationalize her debt-laden private nuke champion -- then did so. Plus, problems rife too at big Hinkley Point C nuke plant going up in Britain. Predictably far behind-schedule, far over-budget -- yet a biggest modern nuclear plant going up then in the West. In the words of The Economist (June 25, 2022):

> "Over the 4 years that Hinkley Point C (HPC) has been under construction on the edge of Bristol Channel in the west of England, it has consistently been held up as an example of the industry's current problems. Nuclear energy's long-standing cost and schedule issues used to mean it was hard to compete with natural gas and coal. Now they make it hard for nuclear to compete with ever-cheapening renewable energy.
>
> When the British Government and EDF Energy, the plant's owner, signed the relevant contracts in 2013, HPC was expected to produce a megawatt-hour for GBP £92 (then USD $145). The same amount of energy from a new offshore wind farm was at the time expected to cost GBP £125. Nine years on, HPC is two years behind schedule and GBP £10 Billion over budget; so its power will cost more. Offshore-wind producers, for their part, are offering energy at less than GBP £50 (now USD $60) per megawatt-hour. The cost of electricity from solar panels has fallen yet further." ….

What of spiff nukes built more speedily, in Asia? Don't those going up faster, on budget, mean lessons were all learned in colossal mistakes like Hinkley? After all, nuclear-proponents talk of lessons learned. Yes, but not in a West. Take America's attempts to do nuclear cheaply, in Vogtle Units 3 & 4 in Georgia -- 1st US fission nuke in 3 decades. Begun 2009 on understood Westinghouse designs, costs were to be $14 Billion & be done by 2017. But, instead, it drove Westinghouse bankrupt. By 2018 costs were re-estimated $25 Billion. Then 2021 costs re, re-estimated $28 Billion; operation only began 2024 @$35 billion -- crazy *$17 billion over-budget!* France's 'new' Flamanville from 2007 was a decade+ behind schedule, hundreds of re-welds in 2022 cost € billions. Germany might close nukes. And the Olkiluoto nuke in Finland set to open in 2009, had only begun its regular output 'just' 18 years late, in 2023. Now latter 2020s, a new president and much bullishness around nukes, it has seen an upsurge. *Built* nukes, once set to be retired, saw their closings put on hold. True, China/Asia & Russia have shown an ability to build big nuclear plants nearly on schedule, on budget unlike a West). Of 31 reactors begun in 2017 to 2022, 27 were being built on standard Chinese or Russian plans. But, to contract with Russia for a new nuclear plant, is impossible. Left China, but contracts with it too, question marks for the West. Maybe, South Korea, or ??? Point was & is: there's No Easy Simple Energy Answers! Plus, much had changed dramatically after war in Ukraine.

A not-so-long-ago-world, of 2021, was wracked by record heat, drought, storms, floods. Yet in a few decades or sooner, people may look back at 2021 with its miserable heat, floods, cold, hurricanes, rapidly disappearing sea ice, and rising seas -- as being part of a far cooler, far more stable, and a much more desirable past. One that cannot ever be recovered.

Almost always in politics, debate is on human-scaled timeframes. A moderate place, or stance to stake out is on human-time-scales, a middle ground 'twixt even fiercely opposing, mostly-local sides. Without temporal reverberations either, that impact the planet. Common sense compromise can sure be found amid sharply opposing views. So, a middle ground is available. The practical finish-line exists and finding it, we can mostly 'satisfice' diverse parties. Such compromise does not reverberate for centuries or even many, many millennia ahead.

Singularly on climate though, such middle ground we instinctively seek, probably isn't there. Just politically punting on this topic like done in eg a 2022 IRA law so became a carrots-only bundle of tax credits for renewables-only, that preserved all fossils fuels / with no sticks, was a compromise. One that could be/ and so it was easily taken. Later in mid-2020s, the other political side favoring pro-fossil fuels, next dismantled those green tax credits with fury over how cheap renewables had become, an impossible competition. That framing by both sides -- ignored climate science. Science very strongly indicates that on both paths (especially the latter), our common future is a Loser. This planet centuries ahead may start to look alien. Not the past bright blue & white marble seen from space, but a green & hazy one. Perhaps it is not a hyperbole to fear what's being lost, just maybe, could be more habitable future.

In politics this decade has seen staggered progress, yet more frequently steps backwards. The world's biggest greenhouse emitter, China, said it wouldn't even be at a COP26 in Scotland. After an outcry on China's 5-year Plan not reducing coal sizably, they upped the ambitions to reach peak coal, sooner. But after some steps away from coal -- China was hit by energy crunch + Covid. Plus rich nations too failed their own $100 billion commitments to transfer funds & know-how to a developing world, so little reason developing China, India, Indonesia etc felt to offer more. Russia, Brazil, Mexico didn't show up at COP 2021: they likewise hardly were enthused about rich-world calls for more 'cuts' soon in carbon. Especially after the US in 2025 again pulled out of the Paris Climate Treaty; then the COP held in Brazil.

Anyway, most all nations were & are carbon-addicted, despite flowery words to contrary. Not just a usual China, India, Russia, Saudi Arabia, Qatar -- rich G-20 polluters who self-proclaim virtue too: US, Japan, Germany, UK, others. Whose addictions were/are at odds with prettier promises at G-20 events & climate conferences. Private industry gives more of same. State-owned fossil firms, offer vague promises, glossy blue hydrogen ads, talk of distant 'carbon neutrality' in say a far-distant 2050. All conflicting with pressing CO_2 reality. For instance eg a 2021's COP goals were small beer: 1) Rich nation big 'commitments' of $100 Billion/year to developing nations were easier to mouth in a Paris Agreement -- than actually to mobilize at COP; 2) Global carbon rules mere talk, as seen in flailing US Congress and disintegrated BBB/ IRA; and 3) Most blatantly cuts big enough to keep to 2 degrees C heating -- let alone 1.5 C -- were obviously far deeper, than what nations were prepared to offer. Commitments made far short of a 2 degrees C ceiling; to say nothing of 1.5 C necessitating 45% *fewer* emissions, a bridge much too far. Simply adding up all say, 2021 commitments, meant then global emissions if followed would drop by oh … umm, ahem, *Nothing!* Instead, they'd go Up +14% *higher* on best commitments 2021. Canada say, increased ambitions at COP26, yet 'tougher' goals were so lax, that they'd still be in line with 4 degrees C of further heating.

Physics & chemistry can show us the total carbon budget: how much emissions on 50% chance to not go past 1.5 degrees C. That's 2,890 Bn tons of CO_2 -- but we'd emitted 2,390 Bn tons by 2019. So, spewing now @40 Bn tons/year -- to stay <1.5 C is Not possible; we're toast; current trends pass that ceiling. It's laughable to think we'll go for years -- then, switch off in 2030 all CO_2 emissions 100% at once. In 1824, Frenchman Joseph Fourier showed how Earth is warmer, than a planet of no atmosphere. In 1856 brilliant US scientist Eunice Foote saw CO_2 warms inside of a jar; she predicted CO_2 can cause climate change, a century & half ago. John Tyndall in 1860s correctly showed how CO_2, water vapor, methane will warm a planet. Over a century ago, Svante Arrhenius & Arvid Hogbom of Sweden determined Why then-forecasted 3 degrees+ C rise in global warming results from each 3/2 rise of CO_2. That ratio has since been refined, but principle is roughly same, more heating at poles, than at equator. A linear increase first of CO_2 -- means by a power law for second, that temperatures to rise as a logarithm of CO_2. In 2024, Fermi resonance helped explain Quantum aspects of heating; the CO_2 exciting a broad spectrum at either side of 15 microns wavelengths.

As for what's possible, think of carbon & solutions linchpin, China. So wedded to coal it hadn't talked at COP26 of a coal 'phase-out' -- but 'phase-down.' Yet its advances in solar power are immense. China, more than any can make vast solar growth happen. Reminiscent of US mobilizing 1941 for war. By 2021 China had already 250 GW solar power capacity, nicely 2x what was called-for in its earlier Plans. It could boast 1/3rd of global solar capacity, due to domestic China and global uses, with reverberating benefits planet-wide. And yet.

Consider what might be possible at a high end. If in theory all China's areas that can go solar, had it. A sparsely-populated northwest (most folks are in southeast), a 'technical potential' of all solar in 2020 was 100 petawatt-hours. That was 13x all China's then total of 7.5 PW/hrs of Electricity Demand (or 2x then-Total demand if all energy with heat). By 2060 as solar efficiencies improve, its solar potential might rise say +50% more, to 150 PW/hr, when China plans for net-zero emissions. ½ its potential solar-areas already capable of PV were then-cheaper by 2020, than coal. 80% of its solar areas, could be cheaper than coal in 2022.

As solar improves more, in 2030 solar can be cheaper than coal everywhere across all China! Its cost had averaged a 4.93 cents/kWh back in 2020. Projected then to drop to 1.3 cents/kWh by 2030 (has beat that). Then go cheaper still, down to 0.3 cents/kWh by 2060! If a price is put on coal pollution, say a carbon tax, cost difference gets immense. So, coal can't compete ahead; all sides know that. But coal does mean jobs; it's firm, dispatchable uninterruptible -- a vast domestic power source if needed. Solar, hobbled by intermittency, dearly needs energy storage to be firm. Put together, better advanced long-term storage + solar can be dispatchable; by 2030 a projected 5.2 petawatt-hours of solar+storage might be available in China. All cheaper than dirty coal too -- and to be nearer its 7.5 PW total demand.

By 2060 solar+storage could make 7.2 petawatt-hours, so 1/2 of China's electricity demand. Compliment it with huge wind and a firm better dispatchable geothermal to meet all needs -- alongside maybe nuclear too (fusion? -- better than fission)! Yet put aside unknown fusion -- think of challenges in ramping proven renewables. Battery designs, if needing say, cobalt -- may hoover up 36% of world known cobalt reserves -- on past battery designs. So, on better batteries, hence not needing cobalt, discussed ahead it gets easier. Even lithium needs may then be 'only' 8% of global reserves. Hence greener, alternative technologies grow crucial -- myriad ideas may blossom. Material domestic availability is important; so too cost, efficiency that may also impact choices such as needing less of bottlenecked materials.

Looking back a few years: it could have been lucrative to have 'gone into **Photons**' then, solar, one 'P' (as China did). Look ahead, another P, **Protons** are riskier; energy storage & energy conversion using protons (ions, H+) in H_2, fuel cells, *may be* propitious ahead. But that was unknowable 2000s, on huge volatility. What is certain, is 'protons' theme in 2020s *is still hugely risky*. Much more so than surer-solar. Solar has steeply cut costs, on manufacturing it gets ever cheaper, like semi chips. Energy conversion/via Protons, is different. Vexed by uncertainties, many breakthroughs still needed to harness protons (eg, ions via fuel cells) -- unlike photons/solar as PV costs fell. Unlike battery-making too, where persistent cost reductions of roughly 6-8%/year have been helpful. Instead, Protons in 2020s as via fuel cells, like green H_2, ammonia, methanol, far more a wild card. Thus, renewables like solar/wind, with storage, may go on pervading ECO. Other areas, may resist so easily decarbonizing.

A wilder idea late 2020s, was a *potential for* nuclear fusion. Put aside attention to H_2, fuel cells, PV, batteries a moment. Instead, focus here on neutrons: fusing 2 isotopes of hydrogen, deuterium (^{2}H as in seawater, 2 neutrons) -- with tritium (^{3}H on 3 neutrons bred by lithium) -- and it creates 2 neutrons of common helium (^{4}HE). Critically a 3rd neutron is 'destroyed'; on Mr. Einstein's $E=MC^2$, a mass imbalance is immense kinetic energy: 17.5 MeV mass disappears! Immense energy, no waste! But other issues: overcoming Coulomb barrier in positive ways, an inertial confinement at temps/pressures mimicking sun's core, mean latter half century at soonest before significant applied fusion is on grid. It was lately called "energy-positive" -- but in fact, 100x ignition power was used by lasers -- so is yet far from it!! Latter this century it *may be* an addition. But on climate risk + energy security today, much faster growth is needed in renewables; solar/wind, storage, geothermal across the 2030s, '40s, 50s, etc.

All as input costs for growing clean energy have soared. Supply chains stretched. Inflation was much more than a 'transitory' as at first was curiously said by Fed. Steeply rising input costs, were/are thorny for clean energy. Went from 'just in time delivery', to 'what if' worries. Take solar. If US, Europe, & Japan are to wrest back manufacturing leadership that had shifted to China in 2010s (we recall 20 years ago Japan, US, Europe dominated PV making; China was near zero) -- then Big changes are needed fast. Confinement needed too. Not just physical like ^{2}H/^{3}H DT fusion ignition -- but of price rises like 2021 as Europe's wholesale PV prices that inflated +19%. Panel prices in 2021 were up 50% euro cents/kW vs. 2020, poly prices spiked 4x from 2020 to 2021. If the US is to grow its own solar from meeting a meager 3% of its demand in 2021 -- to meeting 50%+ by 2050, then hurdles loom large. Poly is discussed ahead. But there's other key input materials in the manufacturing of solar PV.

To fast ramp solar PV, start with costlier, thorniest inputs. Take pricey silver in making PV panels, ripe for change as conductor in PV. How better to reduce, or better yet to replace dear silver with plentiful copper. Panels in 2021 had devoured 20% of global industrial, silver supply. In inflationary times, silver can be 15% total costs of a solar cell. *May* be worse on 'slugflation' (sluggish growth + inflation), or stagflation! So, to grow solar even more swiftly, think then of displacing that silver, since it's such vexing $$ constraint.

For comparisons sake, back in 2021 silver had cost $750,000/ton -- vs. copper @$9,000/ton -- even after copper's price increases. But obstacles to switching include copper oxidizing; it's not easily used in PV cells. So, an advance could be to make copper better than silver. Testing new solar cell with copper did find efficiencies, 25.5%. Whether large-scale PV manufacturing can use copper ahead in place of silver, is to be seen. But it's clear that many other, diverse sorts of greener changes lay ahead, like say, perovskites for better/cheap PV.

For now, natural gas storage & LNG may have big roles. Like cold European Winters. An issue began mid-2021, as Russia suddenly exported less gas into Europe, than prior typical 80 million cubic meters (mcm)/day. Russia lowered its gas exports to Europe in July '21. Lowered again Aug '21. Gas levels were already low in UK & globally too. Why? Covid supply cuts + weather volatility had cut supplies worldwide. US hurricanes compounded that. Net/net on sharp losses of supply, & less storage -- natural gas prices jumped. Europe doesn't frack, has few domestic gas suppliers, so long (over)relied on cheap Russian gas. As natural gas costs spiked, so too did electricity prices skyrocket 2021. Asia is hungry for that gas as well, so eye-watering-high electricity costs in 2021 and 2022 had at first hit a then-prostate Europe.

It was suggested tight gas exports 2021 from Russia, was maybe to help it win ok for Nord Stream 2 pipeline to Germany. Or, to prepare to stifle Europe's gas 2022. Europeans for their part wanted uncontracted, cheap spot gas. Alternatives were few; more Norwegian gas -- and/or import liquid LNG by ship -- though latter means competing with a voracious Asia so high prices. And Germany (then) lacked LNG terminals. Europe needed all gas it can get, plus to build storage. Especially if colder than usual winters hit latter 2020s. If sparse breezes make less wind power, nukes down on maintenance, coal emissions tough -- before Germany aggressively has more renewables in 2030 -- can get tight. Late-2020s could for example see less maintenance at Norway's gas platforms, pipelines, lead to a 65 mcm/day shortfall, about 1/3rd of UK gas demand. To be a worry if cold snaps, low wind, or harm comes to Sudzha gas compressor in Kursk. Or even meltdown at nearly-shelled Zaporizhizhia nuke in Ukraine.

Sparse breezes early 2021 hurt Europe's wind, nukes were down on repairs, hydro in drought. All meant unhappy records in 2021/22. Europe's natural gas benchmark spiked up +300%. Nat. Gas futures in Netherlands basket rose to equivalent $150/barrel for oil. Early 2022, nat. gas rose past equivalent $500/barrel, oil(!). Made European nat. gas prices early 2022, a dearest fossil by far. Ireland's electricity costs late 2021 jumped 10x in a 7-hour period on nat. gas shortages. Nat. Gas so tight 2021 in Iberia, electricity hit $165/MWh, worst since 2002. UK electricity prices briefly rose to 7x year prior; next day UK power hit $395/MWh. UK imported 7.5% of its power from France, as an undersea cable loss knocked out 2 GWs from France. (Watch out, undersea cables!) On good breezes like 2022, UK can produce most electricity at times from wind, cheaply; on few breezes, UK wind's 24 GW faceplate capacity -- can fall <1 GW. Europe's nat. gas once was cheap, Russian. But 2022, Russia's gas became a question-mark; may Nord II not open -- Nord I cease? If so meant replacing piped 150 billion cubic meters (bcm) -- with LNG by ships from US, Qatar, Algeria etc from 2022. Might mean >15 bcm is US LNG; Europe using more nuclear. Calculus anyway did soon change, when Nord pipe was blown up by mystery forces. By 2023 Norway was supplying 88 bcm gas to Europe, or 30% of its supply; the US was supplying 56 bcm, or 20% of its gas thanks to very fast LNG ramp.

Past simmering European fears of Russian gas, were waved off by how bloody cheap it was; 40% of Europe's gas, more to Germany. Until war. To win approval for a new Nord 2, or to soften targets was maybe in part behind Russia's cuts; to divide Europe, or prepare for war. Paradigms shifted on fears Russia may invade Ukraine -- as it did. All that as China, Japan, S. Korea too wanting LNG pushed prices on war >$15/per million BTUs. US nat. gas rose too as all is interconnected, from $2 mm/BTUs -- to $5 briefly, unheard of in US fracked-shale era. Europe's Winter gas demand competes vs JKM (Japan-Korea Market); this meant Europe had to fill storage fast. That + a mildish 2023/24/25 helped. But all was scarier on war. Europe's storage reached >95%; but would have to refill quickly ahead for hot Summers, maybe freezing Winters say late 2020's etc. All as US nat. gas shortage was rather short in early 2025.

An early 2020s had thrust Europe's debilitating over-reliance on Russia gas, in sobering light. LNG was stepped up swiftly yet underscored immediate need for more renewables fast. GWs *more* solar/wind quickly -- plus battery storage firm power. LNG infrastructure, storage up -- but better clean power wasn't yet big or firm enough. As Europe tried to wean off coal, some places off older nukes -- other places were expanding to new nukes; competing with renewables for finance. Wind & solar early/mid-2020s were in an awkward stage. Growing yes, but not yet near-big-enough to be the Hero. In 2020, renewables had met only 20% of Europe's electricity demand, nowhere near enough to overcome gas troubles … yet…

Plus, solar prices *rose* 1st Quarter 2022 vs. 1st Quarter 2021, year over year residential, commercial, utility-scale: not seen since analysts started measuring in solar in 2014. Inflation wasn't just in solar of course (nor wind) but until lately 'unheard of' here. Causes like fast-rising costs for aluminum & steel in solar frames, mounts. High silver costs in PV cells (seen again in 2026!). Pricier special PV panel glass. Freight costs for shipping PV product. Labor up for assembling despite mechanizing. Polysilicon from sand, a key building block, saw big cost increases (before falling again). Europe's PV prices 2021 rose 16% over 2020. Increased costs for inputs in 2021, also reverberated in 2022, 2023. Accelerated demand for clean energy that pushed things higher -- was also hit by project cancellations (and inflation) as well.

In US, one solar deployment target was 45% of electricity should be from PV by 2045. From a science/climate standpoint, this wasn't only possible, it was maybe *required* given carbon budget. Yet such a ramp would be unprecedented. In 2014 the US had got <1% of its electric power from solar. By 2021, it was near 3%; 15 gigawatts (GW) was deployed in that year. To ramp from there, fast enough to hit 45%, would mean US must *double* solar each year, 30 GW more installed in US in each year 2022 to 2025. Then rise 4-fold/year over. To a freshened 60 GW of new installed solar installed, each and every year, from 2025 through 2030.

By 2035 on climate crisis, US could need 1,000 GW of renewable power on grid! By 2050 a new 1,600 GW of solar on US zero-carbon grid! So, more from solar -- than generated from all sources including fossils/nukes in 2021. To further Decarbonize heat too meant 3,000 GW more clean energy by 2050. Greening US transportation, buildings, manufacturing, industry. Zero-carbon power to cover every GW of electricity, plus each BTU of needed heat.

What is each 1 GW like? For comparison, 1 GW can power 750,000 US homes; roughly like a mid-sized (albeit there firm always on) 2nd gen nuclear fission reactor. With proper support, solar & wind, yes, can grow very fast -- with battery/storage to make that firm power. Or they may stumble & fall, if future, like a 'One Big' Act of 2025, decimated a 2022 IRA. Partly shows why there's such huge volatility here. And why across the Atlantic, small modular reactors are being looked at in a UK for low-carbon nuclear -- if its 7 big nuclear plants are cut back. Though those big reactors had made 17% of UK's costly power 2021, new 'smaller' gen IV small modular reactors (SMRs) may be seen in a standardized design emerging in say, China, or France. Rather than building each reactor from scratch FOAK, as US chose to do.

But can nukes also be made 100% safe? Less costly, sure -- but no-risk, too?!? In 2020s nuclear state of the art, that answer's murky, dubious/or no at best. Hence questions do swirl around advancing past current 2nd generation fission nukes late 2020s, get to SMRs 2030s, perhaps in theory to safer fusion system tests late 2030s. Yes, we see China, Germany, S. Korea, UK, US & others searching for firm baseload power. Especially on demand ramping late 2020s for new energy, given artificial intelligence (AI). And here high interest rates matter much.

In a foreshadowing on climate, disaster had hit Texas in 2021 as a freeze took down its electric grid. That blackout also showcased battles going on in a public square. What does it take to build a reliable grid? Just more fossils & nukes? Or renewables too, better storage, add geothermal? Natural gas has dominated, yes -- yet lately finds itself on back heels. Case in point, amid crisis was an argument hastily put out during a blackout that it was all the fault of clean energy -- due to Texas' *wind* turbines freezing up! Whether promoted by uninformed, or politically motivated opponents -- that false tale was widely circulated especially in a few media outlets. Photo image was spread of a helicopter with vat, hovering over a frozen wind turbine -- claiming was a current Texas pic of flailing attempts to drop chemicals to unfreeze stuck turbines. They'd claimed this was proof wind was the ***main, only cause*** of terrible deadly grid outages, during a freezing Winter week late February 2021 in Texas.

Was that really so? Let's start with that frozen wind turbine photo shown on TV to so many. In fact, it was an old 2013 photo by a Swiss helicopter company testing hot water drops from a boiler truck (no chemicals) in Sweden -- for a turbine lacking usual de-icing features. That compelling photo was shown at a 2015 conference -- but made for a powerful, fictional 2021 false meme/narrative. This meme was shared widely by a publicist, websites, etc: it was memorable, but clearly untrue. It stoked misinformation, was seized on by wind's opponents as 'proof' of wind's failures. The truth in Texas was very different -- but facts only arrived weeks later, after this memorable photo & its tall tale were long-played out.

Let's dig a bit into what really caused that awful Winter 2021 grid-collapse disaster in Texas. To begin, Texas' electricity grid early in 2021 was Not mainly powered (yet) by renewables; but instead by natural gas. 52% of its grid power was from natural gas in 2020 – vs. about 39% gas for all grids on gas nationwide. What was/is key is how well Forecast/Actual energy Supply -- matched Demand. That week, the Electricity Reliability Council of Texas (ERCOT) had expected 82 gigawatts (GW) of power to be available. The most expected supply percentage expected was to be by natural gas. That was huge projected 50 GW availability.

A review of just what in fact happened on Monday February 15th -- to Wednesday Feb 17th 2021 is laid out in Texas Monthly (3/3/21). As recounted there, the key problem was losing a massive, unexpected 20 GW of natural gas-fired electric power, due to hard freeze. Reasons included an inability of power plants to even obtain gas, & some plants that got it, weren't winterized to operate in such conditions: gas lines froze. So regardless of how much gas was 'given', much of that fuel couldn't be utilized, many gas plants couldn't make electric power. To be sure some amount of wind energy did go offline. From peak-pre-freeze -- to worst on Feb. 15th, wind had dropped 8 GW. But importantly, such low wind output had been forecast for that time of year: dead Winter is regularly near wind lows. ERCOT's own models expected a puny 1.89 GW from wind. Thus, as wind output did hit 0.65 GW nadir, that wasn't very far off 2021 forecasted models. (Wind soon spools up enormously in the early Spring months).

Some power plants couldn't find enough natural gas fuel, at any price, anywhere. While early wrong criticisms were leveled against wind by the Governor & Texas Railroad Commission -- they'd barked up the wrong tree. As that fascinating image/tale of helicopter hovering high bestride a frozen wind 'Texas' turbine, only confused matters. Was just Kabuki theater, a one-time narrative for opponents to rail against clean energy. Like a 2023 photo of a melted traffic light circulated online, captioned it was taken then in Texas heat; actually was from Italy a year prior, when a motorscooter had caught fire underneath that traffic light.

A relatively small underperformance then in wind, vs. expectations, was narrower than coal. Latter was off by a larger 5 GW from where it 'should have been' in freeze. Even supposedly unflappable current-generation II nuclear, was down some, like wind -- off 0.7 GW. In all, 55% of *unplanned* capacity outage was due to natural gas. At worst, 22% was wind. 18% was coal, plus, nuke losses. Thus, each source of electricity was hit. Truth is wind's shortages were smaller (near the least) among all disruptions in that crisis freeze over 3 vexing days.

Key shortfall was in natural gas. It suddenly fell short, by hugely 20 GW less than expected -- a gap 16 GW lower than lowest-end case models by ERCOT! How/Why? Texas is a global hub for shale gas drilling! But as temperatures froze, about a third of its own gas production 'froze off' Normally it's a warmish to hot place; much equipment is left unweatherized, so tanks to divert the oil from water & from gas, during a deep freeze, became solidly blocked off.

If not frozen, could have spooled up enough to 'oversupply' gas-fired electricity to a tune of 45 GW - 50 GW. Much more than enough to make up for losses elsewhere. As laid out in that article, many nat. gas producers did Not financially benefit. They simply didn't have product to sell in acute shortage. Worse, some couldn't meet their contracted gas obligations for volumes promised. So, some were forced -- along with other gas producers/users to compete for meager amounts available unfrozen gas supply as prices were then skyrocketing.

Normally nat. gas producers sell product around $2.50/million British Thermal Units (BTUs). But contractually obligated to supply gas that they couldn't provide, instead some had to buy (to provide elsewhere) gas at ridiculous prices like over >$200/BTU. On Exchanges, where gas prices hadn't gone up to $200 they'd had to add a digit. Nearby in wealthy Dallas, the price of natural gas in the heart of a super-gas-abundant Texas(!) suddenly went to $1,000.

Power plants needing continuous natural gas -- to make & sell electricity, were flummoxed. They'd anticipated of course an ever-ample feedstock of nat. gas. And expected wholesale power rates around $24 per megawatt-hour. As gas was unavailable on freezing temperatures, chaos sandwiched them between needing to find gas right away any price, prices they charged shot up for each MWh -- from $24, to in some cases a really crazy $9,000/MWh! Reminiscent of the crazy gas pricing seen at first seen in Europe in 2022, with the start of war in Ukraine. In Texas, power producers who needed gas to make electricity, competed with gas producers needing it to meet contracted obligations of available unfrozen supplies. All got hurt. That gas trading expert well describes how differences in trading normally are in 1 penny amounts. Then instead, they were dealing with absurd gaps of $50+ 'deltas' in gas prices.

In retrospect, to see how to do all better next time, lessons can be drawn. Lesson #1 is *more* natural gas would Not have solved anything. But *winterizing -- or better yet, *weathering for bitter Cold -- and hot Summers too in key gas facilities & infrastructure can make a difference. Texas has a history of preferring light regulatory touch in electricity supply; natural gas is less burdened. But this arguably is a matter of public safety. Plus, more unregulated power markets, like this one, as it turned out were perhaps surprisingly not always cheapest. Cold wasn't at fault, *per se*. Plenty of gas infrastructure works in deep-freezing places, where facilities are built with freezes in mind. Winterizing 1 well may cost $100K. As only 0.06% of annual Texas gas production may freeze off in a year, few are winterized. There are 100,000 Permian Basin wells, 250,000 active in State, many marginal of little consequence. Hence there needs to be some balancing. Or, the State could continue hands-off, and just blame renewables like before (though next blackout its true fault will be better known).

More *storage* suggested, too, yet of *natural gas*. In Texas' crisis, *gas Storage* was a Hero. It didn't freeze like gas *production*. Another idea, *winterize key power plants; a multi-billion-dollar nuclear plant down on a pump freezing was cheap to prevent in first place, no-brainer. Ensure *critical infrastructure gets power in crisis. Harder to address is drought. Thermal coal, gas, and even nuclear may *have to* shut on low water -- not only the hydropower dams.

If it feels like we're playing with a teetering system bound for scrap ahead, you're probably right. What it shows, too, is what really went wrong in a 2021 Texas crisis. It wasn't loss of wind! Wind turbines can readily be winterized; it adds 10% to turbine costs but is done 'round the world. Wind energy works fine in the Arctic, in US Upper Midwest, places like Nordics far colder than Texas; in fact, wind prefers colder, heavier breezes. (Natural gas too prefers cool days, but no claims to contrary were made about gas -- as were for wind!). After Texas' freeze it later came to light a blitz campaign was fast mounted to call renewables 'unreliable' -- to deem fossils 'reliable energy'. Even though natural *gas was the most to blame in 2021.*

Texas' disaster bad as it was, was minutes from being far worse -- if frequency stability were lost. It did fall from 60 hertz -- to critical 59.25 -- nearly crashing the whole system. Had transformers caught fire, or high voltage lines been destroyed, it could have been weeks, months -- not days with no power! We don't realize how dependent we are on electricity 'til it's gone'. Only by shedding 7,500 MW of demand (effectively turned off ~1 in every 8 homes in State), were they able to take a first emergency step. That was twice a 2011 emergency shedding that lasted 8 hours, 4x longer than a blackout of 2006. There were 3 emergency load sheds/ rolling blackouts – still, crucial frequency stability had nearly been lost in 2021.

It boils down to: How ready are we for changing climate? Honestly, not at all. Summer 2023 Texas then saw unprecedented heat -- and some power was lost. Or a key oil pipeline from Texas to US East Coast, if severed -- could paralyze Southeastern US gasoline supply. Glance at a weather app like Ventusky: it shows swirling arctic polar vortexes in Winters. Bitter arctic air drops to nearish population centers, yet it remains North of US, Europe, Asia. We're saved by the Jet Stream's wind patterns. Yet, those too can change. Sudden stratospheric warming high in atmosphere can weaken this 'fence' protecting us. Doesn't take much to envision on the climate Jet Stream shifting, wavering, weakening: a bitter cold arctic air moving farther south. While that may not sound so harsh to hear, consequences would be. Or floods, longer droughts too from air that's warmer, so holding more moisture for occasional bomb cyclones. Those increasingly imperil big thermal coal, gas, nuclear plants, dams. Terms like 'Climate Change', 'Global Warming' – might be too benign for what can be Calamities. Better, may be 'Climate Crisis', 'Global Heating', 'Broiling' -- even a 'Global Weirding' should centuries follow of blazing Planet. Perhaps uninhabitable equator, with temps not too apart from very 'Hot Poles'. Getting there may not be slow, nor incremental. It may be in non-linear ways. Not pleasant. Not a desirable pleasant warming, made up of gradual gentle change only.

An ending Gulf Stream *can* paradoxically mean centuries+ of bitter change -- colder or hotter. Look westward -- or eastward away from North Atlantic warmed by Gulf Stream -- and it's soon frozen. Should the Gulf stream's heat conveyor fail, science is unsure if a Frozen Europe? Or, a Baked one? But impossible will be, no change at all! It's a difference engine yet again -- and here in our natural world. A Gulf Stream slowed or stopped as meltwaters dilute salinity, and/or in Antarctic overturning current, would hit ocean currents worldwide. So we all lose. Solutions present in myriad ways but clearly *more renewables, energy storage & better grid, in short greater Clean Energy and decarbonization* -- is where attention ought turn.

Useful *Non*-Correlation between our clean WilderHill Indexes -- versus Fossil Fuels

ECO/NEX/H2X/WNX – have shown a good *non*-Correlation vs all fossil fuel energies. What an example of diversification! There may be differences, at times, eg when clean alone, gains. Or, times clean *falls* hard -- when fossils are up at times like in a last decade. Yes, they all are *energy* themes -- yet clean marches to distinctly different drummer vs. coal, oil, gas. Take say a vantagepoint at start of this decade and look back from there: an interesting thing happened. Dirty energy in few years to 2020 was worst performing sector of S&P500 in 4 of a prior 6 years; and it was down -30% in 2020 -- when clean energy roared. (In S&P500, 'energy' mainly still is fossil fuels). Then in a sharp turnaround, fossils jumped 2021, after doldrums. The past several years were notable for all kinds of energy, so look a bit more closely.

Consider what transpired, as a Covid crash first hit everything hard in 2020. At first it dropped markets worldwide, to a then nadir March 2020. Thin slice of S&P500 in energy (so mainly dirty fossils) was strongly down by -51% in Q1 2020 -- while the whole S&P500 was down then 'only' by -19%. Partly that gap was due to a 500 Index's market cap weighting methodology. Just 1 very big component in the market cap weighted S&P500, say an Apple, may potentially be heftier than all its then-2020 dirty fossil fuel energy names & weightings, combined!

That major Index is slowly' greening', albeit at snail's pace. A key electric car firm was added to 500 in 2020 -- already America's 4th biggest company -- and curiously was listed in the 500 as 'consumer discretionary'. A solar inverter firm was only added in 2021. For all energy in general, as we'd noted back in 2020, (dirty) energy then was just 2.5% of S&P500 but it once was far bigger there: it was 7% in 2015, 11% in 2010; 16% in 2008. In 1980, this dirty energy was 7 of S&P's top 10 by market cap, 25%! By contrast in 2020, 28% was in tech, up from 18% in 2010. Some observers late 2020 had hoped the EV maker's addition to 500 might have come earlier-in 2020, to be 1.4% of the Index. That would have been significant for the $4 Trillion in trackers. But it was then passed over, and was added only afterwards for Q4 2020.

Drilling deeper, let's consider oil & gas behemoth Exxon. In 2020 the Dow Jones Industrials announced it was dropping Exxon from its leading ~30-stocks Dow basket. Why? Apple was splitting 4-1 and a *price-weighted* Dow Average needed component/s to better keep up with other baskets. (Dow had sizably lagged performance then). So new representation was chosen -- but not from fossils. Instead, they added in 2020, 3 tech-heavy names. Dow Industrials dropped Exxon that various incarnations was in since 1928; long-serving component, no more. Only Chevron in oil stayed. (Due to prior few years perhaps, as dirty energy had then fallen -- yet it would soon rise big in 2021 as energy became bigger slice of S&P500 after 9 of its 11 sectors fell, and energy gained +14.3% in eg Sept 2021; in retrospect then Dow maybe should have kept fossil fuel names -- which really later jumped up 2021-2024; then fell 2025).

The make-up of Indexing baskets matters. As battles quietly going on, can influence hundreds, thousands of Billions of $ dollars. Back in 2018-2020, a then-Administration's Dept. of Labor on ERISA wanted to know of 'discernable trends' in how retirement funds were invested in energy (FAB 2018-1). There'd been sizable outflows from fossils -- to green energy themes. It's been reported fossil industry/climate skeptics were an impetus trying to slow inflows to 'ESG' (Environment, Social, Governance) -- better thought of, as decarbonization theme. They perhaps hoped to see 'non-pecuniary' goals like climate change, get subverted. A new Administration in 2021, explicitly pointed to green themes as important. Still, it's useful to recall how a stealthy attack occurred (and failed) against clean energy 2018-2020. Especially after re-election to a 2nd term in 2024, and stronger moves against new energy in 2025.

The real-world Returns for clean energy in a 2018-2020 window were Up, hundreds of percent, hardly 'non-pecuniary'! ECO was up +300%, when traditional Indexes were up more modestly +85% (NASDAQ), +40% (S&P500), +25% (Dow). Fossil gas was then *Down* -60% yet would spike -- then fall. Interestingly too fossil gas vs. clean energy *both* non-correlated with broad Indexes last decade. So maybe was No surprise to see billions of dollars flowed to 'ESG' (again an awful term!), it broke records as green assets in 2020 were up 2x vs. 2019, to $246 billion in 2021. Decarbonizing may grow yes, *but will surely be hugely volatile too, oft down*. And yet. Attention to climate (IB 2015) saw 'unworthy' Federal attack 2018-2020 reportedly by fossil interests and skeptics on ERISA. At State-levels too. In 2022, Texas moved to divest from funds it felt had somehow 'boycotted' oil -- if new energy was just in their name (like NEX)!

Of note is Texas' war on what it considered fossil-boycotting by big global Banks, could cost its Taxpayers a Huge $22 billion! Research shows a Texas community wanting to issue 30 year Municipal Bonds, went with an attractive winning bid of 4.0808433% by a major multinational investment Bank. But State of Texas halted the deal; it claimed that big Bank was 'boycotting' fossil fuels. That Bank responded they were not 'boycotting' fossils -- they had $33.5 Billion invested in fossils! They were simply aiming to Reduce Their Carbon Footprint via green new energy too. Yet Texas' leaders blocked the deal. As a result, studies in 2024 showed Texans as a result paid a much higher 0.41 percentage points interest rate for Bonds -- it can cost its taxpayers a Huge $22.5 Billion over 30 years! Talk about cutting off their noses to spite their face! Or hoist by their own petard! Yes, 'ESG' (an ugly term!) however is different -- from our focus on Clean Energy/decarbonizing, these 2 not to be conflated. In sum if proposed rules/attacks like by Texas are to prevent look at climate risk by deeming it 'non-pecuniary', then that's a bit curious given quite glaring Performance facts, like say in this window:

<u>In 2018-2020 a Clean/Climate theme (top) -- then Left Traditional Fossil Fuels far behind:</u>

Source: finance.yahoo.com

It's an artificially narrow window above, and clean energy plummets after from 2021 to 2015 (fossils too plummeted 2025 with announcement of tariffs). Yet makes a point in highlighting differences vs. fossils. March 2020 to March 2021, ECO had ranged 46 to 286, rising 6-fold. Global NEX ranged 150 to 630, up 4-fold. Then crashed. By 2025, down in 20s! Doubtless future big plummets like 2021-25 lay ahead. In 2021, China has aimed to go from 11% solar / wind -- to 16% by 2025. Wind developers jumped on expiring subsidies -- put in 72 GW of wind 2020, 3x that of 2019 (solar up 60%). But because their fund for subsidies early 2021 hit cumulative 320 Billion yuan (USD $50 Billion) shortfall, it briefly proposed to write-off some sums. In response a big wind developer's stock fell -30% in 4 days, soon rebounding, once that proposal was dropped. Point is regardless of ongoing volatility, decarbonization has begun figuring into finance. And the this theme can plummet like 2021-2025 (or maybe rise at times, too).

In a 2023, 2024, 2025 etc smitten by storms, wildfires, temperature extremes, blackouts etc, we increasingly see evidence a global economy is wholly owned subsidiary of the environment. Yet no nation has yet risen to the occasion. And for a host of reasons volatile ECO, NEX, H2X, WNX will surely fall at times, *hard!* Each nation has its own issues… just one problem as a practical domestic matter, has been America lags behind badly in producing lithium, nickel. Rare earths too that in fact aren't rare, yet needed in motors, turbines & strategic uses. As a Senator observed in 2021, "We don't produce any of the rare earth minerals, or very, very, very little of any rare earth minerals that it takes to make a battery. We depend on other sources of the world … that we seem to want to be out of sight, out of mind, and we just say, 'Well, we have an electric vehicle." Or take nickel in batteries, electric cars, grid. In 2022, nickel had spiked briefly on a classic short squeeze going then from $20k -- to $100k/ton.

This 'ain't our first Rodeo' seeing US fall badly behind, when it needn't have done so. We saw solar manufacturing decamp from Japan/US/Germany -- to China 2 decades ago – then to SE Asia: Vietnam, Malaysia, Thailand. By 2020, 3 biggest PV makers HQ'd in China. It's seemingly happening again in crucial batteries, EVs. Such needn't occur. But a US does not have a similar industrial 'green-focused' policy. in 2021 a US had only 3 big battery factories. Tesla's Gigafactories pointed a way, yet we may still see, say, only 10 big US battery factories 2030; should be many more. Meanwhile, these 'US factories' may be S. Korean etc-owned factories, just in US. By 2030 so in less than ~5 years, China is smartly on track to have 140 big battery factories! Europe maybe 17 big factories. On projected US EV demand, it should be 20+ US battery factories in 2030. Not inspiring, 2021 saw only half, 10 were on track, maybe. They should have been in planning 2021, their construction already have begun back in 2023. And in 2025 the US looked at tariffs that would rise hundreds of % on solar from SE Asia's solar; but that itself would not directly aid US solar manufacturing, in the way China has done.

So, US is far behind China in green manufacturing, even behind a more committed Europe. If the US had expected 200+ electric & hybrid car models 2024, it should have been producing far more rare earths minerals for motors. Rare earths in quantity for wind turbines too. Lithium for batteries is a different beast; rather abundant in Earth's crust, not to be confused with rare earths (also, not rare). Rare earths are used eg for magnets to generate electricity in spinning wind turbines, or to take amps of (clean) electricity & to convert that into lovely electro-motive power pushing new EVs, trains, aircraft, large ships at sea, etc.

As said by Mr. Nikola Tesla regarding his amazing discoveries, as later applied in potent magnets, wind turbines, AC electric motors, *"I would not give my rotating field discovery for a thousand inventions, however valuable… A thousand years hence, the telephone and the motion picture camera may be obsolete, but the principle of the rotating magnetic field will remain a vital, living thing for all time to come."* Unlike more pedestrian parlour tricks by comparison, these rotating fields of rare earths are awesome; make possible unmatched blue-sky advances. Myriad powerful technologies today harness these fields to work their magic.

For all that, mining clearly means a range of harsh environmental, and social impacts -- all to be handled solemnly. Ideals like 'green lithium' are tough, but at least a 'greener' lithium from hot briny waters & zero-carbon geothermal power better than water-intense evaporative ponds and sulfur. So too is avoiding mining's bankruptcies upending cleanup. Ecologically sensitive places surely must be always protected from any, and all mining. Meanwhile, some disturbed places more amenable. Places like West Virginia welcome sourcing minerals from ample disturbed sites, and extant waste piles of old mines -- creating good jobs.

The Global Clean purer-play NEX – vs. a competing yet Not-so-Clean Big-Cap Theme:

Consider next many big differences as between Global NEX with its trackers in US & Europe -- vs. a differing, competing, global 'just-cleanish' energy Index also with US, Europe trackers. That other, global Index has several characteristics that has set it well apart from NEX. One, long has been that other Index was a fine choice if wanted a concentrated basket made of big caps only; very narrow, little to no energy storage, no electric vehicles, no green H_2 etc. Because that other basket was so highly concentrated, & big caps, skewed to not-so-clean -- it differed very much from NEX made of clean, purer-plays in diverse solar, wind, EVs, energy storage, H_2, etc. And if theme went down -- that big-cap other Index was oft down less; versus cleaner, purer-plays NEX often down more. There's also several more contrasts too.

For example, clean zero-carbon ratings in the NEX were far better, and more deeply green -- than in that other 'only-cleanish' Index. NEX is steeped in diverse new energy innovation -- so it's unlike an older GICS (Global Industry Classification System) 1999 nomenclature that had put other global basket very heavily into a brown, what GICS calls "Utilities". But, if one wanted only a not-so-clean, a narrowly concentrated and mega-caps basket, more liquid on big names, little energy storage, or EVs -- then that other basket was surely a fine choice.

Yet consider too the key divergence has been in: Performance. Briefer periods, the NEX vs. other Index trade leadership back & forth a bit. Short-horizons 1 Index may lag other sizably. Other time frames, are oft a wash, no clear leader. In say up markets like, 2019/2020, volatile NEX far out-performed that other 'not-so-clean' Index. Or down down markets like 2022/2023 the NEX was down far, far harder than that other. Yet long periods, eg, Since Inception of that less-clean Index, this key fact clearly stands out: *our Global NEX (via tracker here in green) very strongly Outperforms vs. that other Global theme (seen via a tracker at bottom in blue).* This fact persists lengthy periods, whether say, from inception (seen here), or past 20 years etc. This chart captures both Indexes via trackers, since the start of that other Index (it went live after NEX) via trackers so from 2008 -- to late 2025. Interesting to see how divergent performances are, for 2 Indexes/trackers. *In sum global NEX here in green clearly is doing far 'better' -- although both have ended well-down here over this period:*

The NEX tracker (in green) -- vs. not-so-clean global energy (blue): 2008 – to late 2025:

Source: Yahoo Finance

As seen above, clean NEX Outperformed as far better … *though both down*. (Short periods they can be quite similar). **NEX** may go up more strongly rising periods; NEX down harder in downturns. Why? 5 factors may help explain why the other theme, is here far behind **NEX** for global clean energy. Perhaps it's been because that other non-NEX basket long was/ or is:

* Heavily Restricted to (not-as-clean) just bigger-caps -- so far fewer themes & stocks;
* Was Heavily concentrated in top 10; had been 30 names total (much more post-2021);
* Heavily skewed by having to use a modified-market capitalization style and weightings;
* Was unable to hold so many stories: it eg long missed across storage, EVs, H2, grid, etc;
* Less Diversified across stories/ nations -- & it also has relatively dirty themes represented.

Nothing wrong with that other theme *per se*. *As noted that other Index did much better in down years, like 2022/2023!* And it's a good contrast -- of purer vs. less-clean global energy themes! For other differences as between a purer global NEX -- vs. other global energy basket, NEX launched/went live first, 2006, before that other Index. Seen say in early 2021, NEX had 125 components. That other global basket instead, for years since its inception, long had only 30 components, up to 2021. Just 30 hadn't allowed real clean energy scope at all. So, wasn't possible for it then to really capture stories across EVs, green hydrogen, storage etc etc.

Weighting styles matter greatly too. Other basket used market cap weights modified by 4.5% cap, at times exceeded. Generally, at any rate, just 10 names in that other tracker might earlier make up ~half its total Index weight!! In truth global clean energy reflects far more than just 10 names, of course. Concentrating that way meant biggest few, might push up fast if momentum narrowly did well -- or might pull down. Shorter periods, say past 1 or 5 years -- these 2 Indexes can trade leadership back & forth -- but long periods, NEX has done significantly better. Equal weighted NEX, eg early 2021 had far greater 125 names so far wider reach. And helpful NEX equal weighting let more & smaller names be heard: each has a voice. With No Overweighted Top 10. Given such huge performance gap long periods, it seems equal weighting may allow passive NEX (& tracker) to better capture far more -- especially small & mid cap inherently clean purer plays. *Please note though: neither approach is 'right': they're simply 2 very differing methodologies*. 2 varied ways for global clean stories to be captured. That other concentrated only 'cleanish' style allowed few-clean names, biased towards big caps -- while NEX notably has always been purer, cleaner, more equal, wider-ranging.

As a practical matter that other Index's tracker helpfully has a notably low expense ratio -- though at times it's swamped by performance difference. Its heavy-trading gives liquidity. Overall then, 2 takes on a fast-growing theme. Equal weight NEX truer to clean -- vs. a big cap less-clean other skewed to Top Ten & brown Utilities. Quite useful in real world having 2 such differing benchmarks for an-emerging global story. But, that other Index also did face vexing issues given how it was first designed/built. One arguably was excess concentration. Its tracker faced real liquidity risks, given that design. As growing sums flowed in, AUM, a few concentrated names in a tracker there might overwhelmed even 'mid-sized' big stocks. That in turn, might *distort share price/s, and/or *take far too many days for its tracker to 'fill' at the rebalance given regular let alone above-average trading $ values, or ADTV.

After doing public consultations in 2021, that other Index made numerous understandable changes for Q2 2021 & going forward. From a fixed 30 only components, it added at first very big 52 more -- and it could go towards 100+, total unlimited. With no ceiling, it was again becoming bit more like the NEX; this made sense given new energy's a growing story ahead. Such could allow too, for that other Index to better reflect an evolving story over time.

However, problematically, that other could & did then add *Non-Pure-plays -- outside of clean energy*. Less closely adhering to *clean* energy theme, instead in a 'cleanish' energy, as less pure. A huge difference from 2021, vs. purer NEX. That other Index might have in it, fossil fuel/ natural gas, or nuclear; it changed after 2021 since can be bigger yet browner, while big-caps mean it may decline less in down markets -- perhaps move up less in rising ones.

Mid-2021 that other global Index could & did hold non-clean names. Just 3 examples were 1) that other Index added at a big 5% weight in 2021 a utility getting only 8% of its earnings from renewables; fracking natural gas on near-enough pipe to go New York to Paris & back, can't be clean nor sustainable for decades at soonest. 2) They also added another dirty energy name too, that also can't be in NEX as it's heavily in natural gas and in nuclear too; so not eligible for NEX that's instead for global *clean* energy. 3) That other Index added too another utility also ineligible for clean NEX as it generates electricity from oil, even burning diesel (among last US Utilities to do so)! In 2020 only 35% of that utility's power was from renewables though its in a region blessed with sunshine & wind. Later that other Index did another market consultation to allow more changes, but notably, it explicitly still allowed in much gas(!) just weighted bit less. It kept unfortunate 'Carbon Intensity' score metric. That faulty metric allows inclusion of dirtiest fossil fuels by distorted false numeracy. *Clearly fossil fuels and certainly coal, don't belong in a green energy basket. Nor* should they be in a global *Clean Energy* theme. So, that other Index though it fixed some distortions, arguably made changes post-2021 that allowed itself to become maybe, dirtier. Did so again 2022, more gas & nuclear names -- thus arguably only sort of, kind of, in global 'clean-ish' energy.

We recall years ago, when small cap funds grew popular, how big inflows made it hard for active funds generally to hold small equities. Even a $1 billion(!) market cap stock faced liquidity risk, from inflows. So the 'small cap' definition inched up, towards >$2 billion floor or more(!) to accommodate growth. Some definitions got thin, diluted from target concept -- not pure. A ramification of fast-rising popularity of 'small caps', was it got harder to hold equities outside of big, as inflows grew in active Funds -- and passive Indexes. Consider then green thinking today. Green 'words' may see tremendous interest. There's an upswing of activity. In 'net creations' especially for ETFs in decarbonizing themes. Yet one result may be as investors open their Prospectus to see Holdings, what's in funds, they're very surprised by what's inside! Confounding, is many so-called 'ESG' funds that hold coal, oil companies! Perhaps names steeped-in-nuclear. That clearly should & must be fixed. Greater truth and an understanding of green aims arguably ought to prohibit any questionable inclusions.

Arguably, a priority should be to stay true to clean/green. Not be pushed into brown energy. Otherwise, prior focus on good targets like robust zero/low-carbon may drift off-theme. How in the world, can coal, oil be included in a true green (or less-green 'ESG') basket?!! Or, make a claim of 'ESG'??? They can't. But an unfortunate way is via a 'carbon-intensity' metric. It allows a big fossil producer, say on *Revenues* of say 70% oil & 30% natural gas -- to massively ramp its gas to say be 60% natural gas, 30% oil, 10% biofuels -- and claim clean'! CH_4 /natural gas spews a bit less CO_2 per kWh -- vs. oil or coal -- with $$ profits from gas really the dynamic. Nothing zero-carbon of course, but 'carbon-intensity' schemes can lend false numeracy via profits, a seeming quantitative rigor, when the opposite is true. Left side of that equation is correct: carbon footprint can be measured in tons of CO_2 as Scope 1, 2, 3. But right side of equation, 'intensity' grafts 'value', revenues in Dollars, Renminbi, Euros. *Yet air cares not a whit 'how profitably' each CO_2 molecule was made* -- more *revenues* - or less! But sadly, the (ahem, intended) upshot is that dirty fossils and companies can get a free pass.

What 'carbon intensity' wickedly does, is lend fossils a fig leaf. Sounding quantitative, yet it lets polluting firms claim 'green' going from oil -- to gas. Sadly, clever marketing, enables fossil firms entry into 'kind of clean' (really brown) basket 'ESG' funds. On ill-conceived notions like 'revenues'/per ton of CO_2 -- that makes carbon 'intensity' slippery indeed. So subtle, it's pernicious. Consider a startup solar firm, tiny CO_2 emissions, negative revenues; it won't score well 'carbon intensity' on few sales. By contrast, a huge fossil firm massively growing brown gas sales, gobs of revenues, scores well. Awful CO_2 eclipsed by swelling profits, for better CO_2 'intensity' scores. Something's patently wrong with that picture.

For how a passive clean Index performs, return to Weighting Methodologies. Interestingly, we saw that the *equal-weighted* NEX has far outperformed since inception -- vs. that other *market cap* weighted Index. For equal-weighting's benefits, consider the Chart below:

Much better real-world results are seen, right, with an Equal-weighting 'green index' (like NEX) -- vs Market-cap weighting over long periods. As was observed by *The Economist*, at right in 2021, a model portfolio constructed for their 'green index' seen here as straight Equal-Weighted, very nicely doubled; it went up swiftly from 100 to over 200 in 2020; thus went up over +100% … But a Market cap weighted version, instead went up much less, from 100 to about 160, or 'just' +60%. In their 'Climate Finance: The Green Meme' (May 22, 2021) they reported:

Source: The Economist (2021)

> *"Since the start of 2020 our portfolio when companies are equally weighted has more than doubled; [but] when firms are weighted by market capitalization, our portfolio has jumped by more than half. The reason for that difference is that many green firms are small -- their median market capitalization is about $6 billion -- and the tiddlers have gone up the most. The smallest 25% of firms have risen by an average 152% since Jan. 2020. Firms that derive a greater share off their revenue from green activity, such as EV-makers and fuel-cell companies, have also outperformed. Greenest 25% of firms saw their share prices rise 110%."*

Describing how 2020s inflows are increasingly into green & 'ESG' themes, they state:

> *Unfortunately, the [ESG] boom has been accompanied by rampant 'greenwashing.' This week the Economist crunches the numbers on the world's 20 biggest ESG funds. On average, each of them holds investments in 17 fossil-fuel producers. Six have invested in ExxonMobil, America's biggest oil firm. Two own stakes in Saudi Aramco, the world's biggest oil producer. One fund holds a Chinese coal-mining company.…*

The Economist makes 2 very good relevant points above: 1) It's dismaying to see big oil & coal names in any 'ESG' fund, especially 2) global in clean energy Indexes or funds. Beyond this, Europe SFDR/BMR aims to help rectify that. And in NEX/H2X/WNX, floor is $1m average daily trading value (ADTV)/$750k continuing components, looks at severe risk ratings, ***and*** carbon. In sum the NEX/ECO & new H2X/WNX are green, avoiding 'greenwashing' pitfall.

Of minor note, is sharp thematic volatility seen here, isn't necessarily due to *Global* aspects. Consider say, a *global* NEX -- vs a *US-listings only* ECO. These 2 have industry's longest track records (20+ years, 18+ years) -- so put aside a moment that separate, other, global Index. Glancing just at NEX/ECO, a few thoughts come to mind. One is US-listings-only ECO basket *can* be hugely volatile too. Seen head-to-head, day to day eg first 6 weeks of 2021, an NEX tracker saw a sizable 14 days with + or -3% or more daily change/day to March 15. Yet US-listings-only ECO tracker, saw even more: fully 24 days with sizable + or - 3% change/day.

So, *global* does not necessarily = volatile. But new tech & innovation themes, may somewhat. There's risks in new energy solar, wind, EVs, H_2 & fuel cells, as seen in other clean energy baskets too. And fast-moving Europe *may* seek more H_2. Continental Europe lacks its own gas reserves (it's no Texas). Was long over-dependent on Russia. Post-2022 it seeks green H_2 on security, climate concerns too. Says nothing of how equities may perform (maybe *down* like in 2021, or up like 2020). Just reflects a very risky, volatile theme, always uncertain. Whether it is domestic US listings -- or listings worldwide in clean/new energy innovation.

Of interest is 2021, the International Renewable Energy Agency wrote, not $10 Trillion (Tn) -- nor $100 Tn -- but a startling $131 *Trillion* might be needed in clean energy by 2050 to avoid heating over >1.5 degrees C. So more than $100 Trillion has been suggested. Gas use had spiked in Europe 2022 on horrific war; yet gas use *may* peak late years this decade. In its place, electrolyzer capacity for green hydrogen *may* go from puny 0.3 GW 2020 -- to say 5,000 GW. With H_2 feedstock a 'green ammonia' -- or methanol/CH_3OH (but not from fossil fuel gas; that's greenwash). Europe potentially *may* latter 2020s become a green H_2 leader. And China may ramp nuclear -- even sadly as it only reduced its coal use a bit (if at all) mid-2020s.

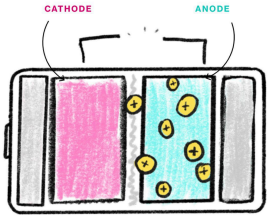
Great uncertainties abound, giving rise to volatility, tremendous risk. Myriad sub-themes *may* see advances: some incremental, some may be non-incremental, perhaps disruptive. Advanced green energy storage & batteries plainly merit focus 2020s, areas ECO & NEX have had exposure to for over 20+ years. New attention also for Hydrogen Economy, Wind Energy. As China continues to be a major presence across all these themes in the 2020s.

Energy storage, is a big deal, world fast needs far better, cheaper, and much more batteries. A fine piece in Bloomberg Businessweek was useful, well-illustrated ('The Hidden Science Making Batteries Better, Cheaper and Everywhere.' April 27, 2021; we side note Bloomberg New Energy Finance was an early partner here in the global NEX Index). Excerpting from their useful, nicely-visual piece, we relay several good illustrations from it below.

First what's called a 'lithium-ion' battery has constellation of materials, besides lithium. Like, say Iron, Nickel, Manganese. There's much effort in having less/or no cobalt. While different chemistries each favor varied characteristics, all batteries basically, consist of a *Cathode, *Anode, *Separator, *Electrolyte. The anode was largely settled, as graphite, maybe silicon -- maybe say nickel niobate (NiNb2O6). But that's changing too in shifts away from nickel, cobalt; like a lithium manganese rich (LMR) design promoted by US/ South Korea of late.

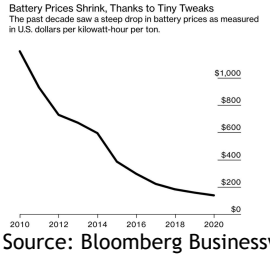
A few chemistries dominate at Cathode. Particular traits/materials are selected for strengths favored: batteries are in fact named for cathode materials. Traits balanced can be: cost, energy density, weight, calendar longevity, cycle life, fast charging ability, temp range etc. Favoring one trait, seeking say a better energy density, might come at the cost or trade-off of eg, reduced cycle life. Or higher performance may be traded away -- to get cheaper, although heavier with a less potent material like iron (although this changing too).

a) 4 basic battery parts:



Source: Bloomberg Businessweek

Battery prices are falling hard:

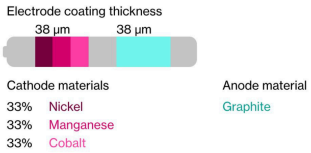


Source: Bloomberg Businessweek

b) Nickel Manganese Cobalt (NMC) in a Zoe:

Source: Bloomberg Businessweek

NMC Composition back in 2012:

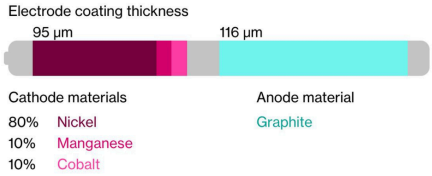


Source: Bloomberg Businessweek

c) NMC as seen in a Nio:

Source: Bloomberg Businessweek

Then, much Nickel, little Cobalt = thicker:

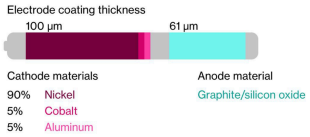


Source: Bloomberg Businessweek

d) Tesla 3 has used NCA:

Source: Bloomberg Businessweek

NCA, light strong battery, no manganese:

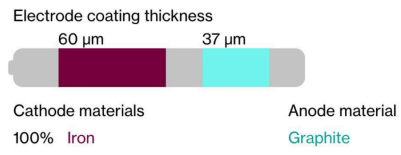


Source: Bloomberg Businessweek

Popular was NCA, or NCM with 8:1:1 ratio of Nickel, Cobalt, Manganese. So, a 'lithium' battery may be much nickel by weight. LFP's cheap iron & phosphate eliminates vexed cobalt, costly nickel. So LFP is gaining. Especially low-cost use. Heavier LFP iron once hadn't performance of NCA, but it's safer & LFP is improving fast. (We'd had an early electric bike here 2001, LFP chemistry). Its market share went from 6% in 2020, to 30% in 2022. LFP may be in buses as its ~30% lesser range and big weight are non-issues; cheap, it maybe went <$100kWh(!) back in 2021 in China. In price-conscious EVs, it can be charged more fully to 100%, less fire risk. Consider in 2022 pricing wars had meant 80 pounds of nickel in NCA electric car battery, added $1,750 in costs. Concerns over Russian nickel, in short squeeze had sent its price from $10,000/ton -- to $30,000/ton -- then briefly on short squeeze to $100,000/ton(!). Hence attention at novel new LFP anodes that may let iron perform at near nickel levels.

e) Electric Buses using LFP lower-cost iron:

Source: Bloomberg Businessweek

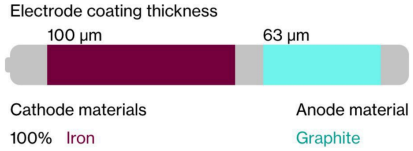


---

f) Modern LFP, less-energy dense:

Source: Bloomberg Businessweek

Thicker Electrode is less costly using iron – and graphite in anode might be replaced:



Source: Bloomberg Businessweek

Efforts ongoing for all: better cathodes/anodes/electrolytes in cell phones, ebikes, EVs etc. Depending say, if energy density -- or lower cost is desired, it's certain all will keep evolving, improvements ahead. At one world-class top EV maker, iron in early 2020s had let it improve profit margins sizably -- over spiffy/costlier NCA (nickel, cobalt aluminum) performance cells. A huge LFP supplier in China (where else?) seeing great competition, gives some leverage to the many EV makers that may consider yet more low-cost, good new iron LFP options.

Figuring out how to add a bit more silicon at anode, without swelling, has promise. Farther ahead exciting metallic lithium batteries could be -- should be -- very impressive. Here fire risk was untenable in early 2020s since 'dendrites' can penetrate electrolyte. But newer-generation solid-state batteries tantalize. The drumbeat of wistful ever-on horizon solid-state batteries hopes, long so-elusive, *may* be getting closer. Possibilities of non-incremental advances towards solid-state batteries later in this decade may make one hopeful.

Research shows self-healing hierarchy of instabilities, *may* fortify cathode/ anode separator, so no puncture. Liquid electrolytes maybe replaced by a solid-state core for ultra-high current densities. On fire-safe boundary like lithium oxychloride (Li3OCl) energy density may improve, shorten charging times dramatically. Lithium metal anode with $LiNi_{0.8}Mn_{0.1}Co_{0.1}O_2$ cathode showed 82% capacity retention @ 10,000 cycles! Not long ago a standard was 80% capacity @500 cycles, after which a Li-ion battery was 'dead' if for EV purposes. So early EVs once had 200-mile range, as on 500 charge/discharge cycles that range meant acceptably a 100,000 mile electric car battery. After, pack may have 2nd life uses like stationary storage @ 80% as acceptable. Instead, up to 10,000 cycles may be possible on solid-state batteries, *perhaps* in production latter 2020s. Designed with help of AI(?). That may be like going from vacuum tubes (and we recall building radios with these early 1970s) -- to using far superior solid-state transistors (in late 1970s). Solid-state *might* be game-changing in batteries. Or, not happen.

New ideas may include a dual battery that incorporates both LFP for everyday shorter drives and more costly nickel-manganese: lesser cycles that can go farther if longer range is needed. Or sulfur batteries, this molecule maybe hosting more than lithium; or bipolar designs that end a need for casings; Near term may make sense to shift from nickel -- to iron in batteries. Making batteries from abundant, cheap iron is good strategy. Unlike nickel -- iron is non-toxic, benign. Iron's the most abundant metal. Not on Earth in pure elemental state, in a sense it's a bit like H_2 (a reactive energy carrier, the latter in water, hydrocarbons, carbohydrates). Pure, elemental iron is only found newly arrived from outside our planet, like in meteorites. Once on Earth, iron rapidly corrodes in air: it rusts. The 4th most common element in Earth's crust, it's likely that our planet's core is mostly iron. Being so abundant on Earth, and in our solar system too, one hopes (like H_2) to find many uses in energy. So ubiquitous & benign, it has been adopted by life, adapted to for over millions of years. Iron unsurprisingly, is essential to life. It's vital for instance in plants -- making their chlorophyll needed to survive. Animals depend on iron too, for carrying oxygen via hemoglobin in bloodstreams, that makes blood red. Maybe AI can help apply it in newer batteries, with better cathodes/anodes!

Iron's so basic to our own planet's backstory, it seems likely that life was fated to use it abundantly. A star like our Sun burns by fusion. Starts on lightest element, hydrogen -- it fuses to a 2nd lightest helium, releasing both light/heat. Over billions of years of fusing, stars create helium atoms, in turn fuses on towards heavier carbon, oxygen, silicon. In supergiant stars, iron is terminal stage as stars age. A stable atom, once a star's core becomes iron, it begins to die (giving life in turn, after death). Reaching terminal iron core, no further energy can be released by fusion -- for that would take up energy. More energy would be required, than released, so may go supernova (or small brown dwarf in our star's case). If supernova, that explosion spews immense iron, oxygen, carbon atoms etc into space. If gravity coalesces elements to what may become planets, asteroids etc, then that iron is easily found.

So iron is, quite literally, everywhere! We see it in Mars' red-tint from iron. Iron deserves our thanks for Earth's vital magnetic core, that molten core gives a magnetic shield protecting life from intense solar radiation that otherwise kills. Miners already are looking at making a new 'green' iron ore for steel. Or in a 'two-fer', maybe using it for batteries too. Maybe new gigawatts of green electrolyzer capacity, with Europe & Asia (not yet a US) leading.

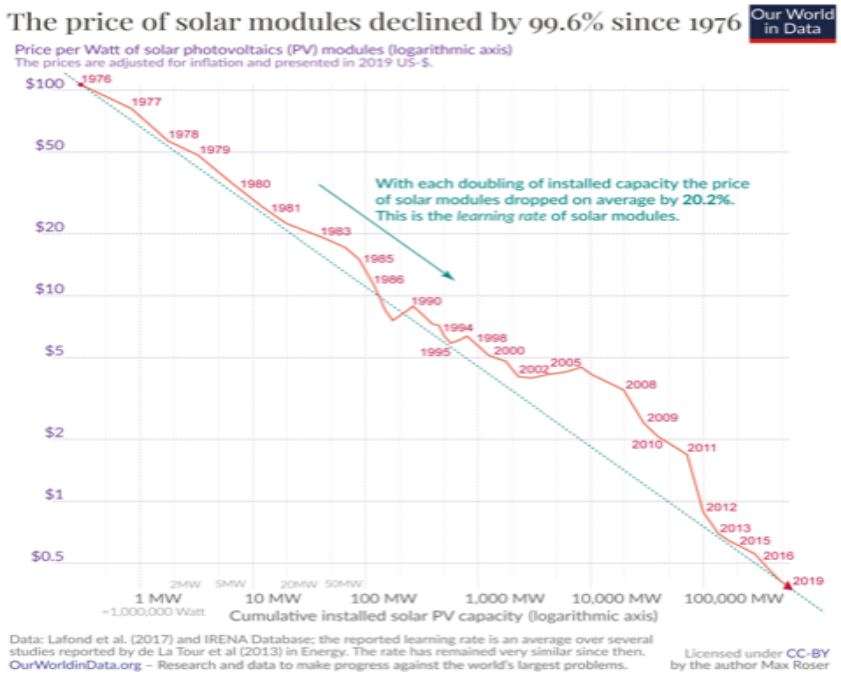
So much is possible. One interesting idea, may be iron-air batteries discharging power as they take in oxygen, making rust. In turn charging by using electricity to change back from rust to metallic iron -- releasing oxygen. On super-abundant benign iron, they may be cheaper & readily recycled. Anyway, recyclability of lithium-ion batteries is an area too where so much progress is needed. Of interest perhaps ahead, zinc-ion batteries resist degrading. Or a zinc anode. If we reverse engineer, Design for X with benign, abundant, low-cost, eco-friendlier materials prioritized, that helps win a storage game especially in big ramp up.

Expect battery technology advances, help from AI. Fundamentally differing from a greenwash that only dresses up carbon, in spiff-names. Beware of greenwash, perpetuating dirty. Please be aware too, some phrases can mislead just a bit. As noted, a lower 'carbon intensity' isn't actually same as actual low-CO_2 -- but instead, is based on a rather duplicitous profitability. Or, say strongly-scoring E Pillar 'ESG' number -- doesn't correlate necessarily with low-CO_2. An oil & gas producer may 'lower emissions', meaning in its own operations (scope 1) only -- ignoring scope 3 emissions; or it may regard that efficiency as responsibility of buyers. Or 'carbon credits', or 'offsets' game true emissions reductions. For example 2000 to 2008, some 12.4 million offsets were created in 3 dirty projects growing oil extraction(!) -- sold as supposed carbon offsets (that process thankfully no longer can creates credits -- but the ugly offsets still traded). Often artful dodging, like 'net zero', 'sequestration' or 'offsets' coupled with distant promises of 2050 -- that divert from true goals: real decarbonization now.

Lest that disappoint, an optimist might suppose that gaslighting, greenwash, dissembling, are perhaps last gasps of a waning industry. That the fossil interests see writing on the walls. That solar & Wind, vs older fossil fuels -- like faster driving EVs, vs gassers -- arguably can be recognized as a superior technology -- and gets better from here! That green maybe has 'won' in one sense, if given enough time. Next decades are just fill in the blanks. That late this century, if that is 'mid-term', perhaps incumbent natural gas no longer can compete with batteries + other storage. That maybe, H_2 is nearer to economic on gas' spikes. It would be very risky to suppose this, but just maybe, perhaps, green H_2 *might* even become cheap, provide industrial heat. As always these are very risky ideas. Declines in volatile baskets that capture evolving themes. And yet, on climate, CO_2 already >425 ppm, we likely are too late. Even an innovative-rich 21st century, this scenario misses the carbon-budget ceiling.

It's important that renewables solar, wind, geothermal notably enjoy *zero fuel costs. Relatively-speaking *close to zero* operating costs. How hard for fossil fuels & nuclear to compete with that! Only by amortizing sunk costs at already-built coal, gas, & nuke plants, can they reduce costs significantly as extant plants age-out. Comparing like for like, new solar/ and wind are simply more affordable on levelized costs -- than new dirty plants.

To trace cost drops, 1 early super-pricey solar cost-point shows: in 1956 solar had cost $1,865/per watt(!). So just one 300-watt solar panel today, installed theoretically on a roof, could have cost $500,000+! Of course, it was unaffordable back then. Applied in niche ways like space applications, solar kept getting better. Prices fell very fast. *So, with solar power, costs are all about Technology*. Like modern chips in computers, we've grown far better at cramming lots of performance in, ever more cheaply. It's a virtuous circle that goes like this, Ever Greater Deployments = Prices Falling More = Newly Competitive; fresh markets open up = Demand increases again, more. Repeat that, over and over and over again!



Source: Roser, Why Did Renewables Become So Cheap So Fast? Our World in Data (Dec. 2020).

Solar prices thus fell enormously -99.6% since 1976(!) on technology. In 2022 US tariffs on PV made in China were temporarily stopped so enters US freer, cheaper still. Fossils -- by contrast -- are Not all about technology; they may be doomed in long-term even apart from carbon. Costs declines in wind too make it impossible for dirty to catch up. How can coal, oil, or gas hope to keep up for decades with this lovely curve? They can't if economics is a metric.

But fossils have immense inertia, influence, capital, and lobbying to keep deploying it. No doubt they will continue -- especially natural gas given it is still dirty, but the least so. Able to provide firm baseload, and can be sourced from stable, friendly nations in the west. Thus not go gently into that good night. Also, carbon-free nuclear has a very notable role yet too in energy transition. In sum, it's no wonder solar & wind power make up most power plants newly built today -- along with growing new storage. In green baskets, storage too is crucial. Consider: how specifically an Index is constructed, the constituents that can fill it, and the substantive direction that it aims for, are as we'll next address -- all very significant.

Very meaningful are initial choices made for an Index theme. They shape it, & that vision in turn can impact performance mightily, later-on. So passive baskets can be molded at theme's creation. Let's look at a well-known 'FTSE 100'. Based in UK, often called the 'Footsie', this Financial Times Stock Exchange Index is 100 large blue-chip firms on London Stock Exchange. Bit of a prosperity gauge for UK's economy, it's among the most widely used, short-hand measures for how well Britain's own stock market and her firms domiciled there are doing.

Consider then that when the Market Value of just 1 US company, Apple, overtook all market cap weighted FTSE 100 in late 2020, that was bit of a shocker. Some 40 years since FTSE 100 was created in 1984, some thoughts now come to mind as to its vision & construction. To be sure, there's been *some* growth in that basket's returns over a past 4 decades.

But it's not been huge. Initially its 100 companies in 1984 had a market value near £100 billion -- and that Index began at 1,000. By end of January 2021, it stood around 6,400; an annual gain over 37 years of just +5.1% -- or up +7.6% annually, including via net shares issuance. This (not so great) return was Not by straight climb. As noted in MoneyWeek, it had earlier on peaked in 1999 at 6,930. Later, it passed that in 2016, and did so again in 2018 to 7,877. But Jan. 2021 at 6,400, it stood out as only +11% higher than where it had been 15 years prior. In March 2022 it was at 7,500, so up a mere +3% from where it had been 5 years prior. It would hit 8,000, in Feb. 2023. But a stronger, better growth rate had been seen from 1984 to 2005 when it had a much better return compound average growth +12.5% (real terms +8.5%). Then 2005 through 2020, an annual growth rate was much slower, at only 2% better than inflation that then was at +4.7%. (Later, in April 2025, it stood again not greatly higher, at 8,275).

From 1984, was a time-period when US technology & innovation equities boomed.

What can account for a lugubrious showing by FTSE 100? One factor is its big components at start had included BP, in oil & gas. Recall how poorly US oil & gas energy companies fared say in S&P500 for years. Terribly, is how they'd acquitted themselves 2008 - to end 2020! It's not been just about BP, per se, but maybe partly then was bit about oil & gas in that regard.

As a market cap weighted Index, it *could* have adjusted for awful returns in CO_2 heavy oil. As once-big firms declined, lower prominence, that could let fast-growing small firms instead take leadership positions. But, a problem here has been, that the rest of that Index is literally 100 largest firms, and similarly they've been in slower areas too like mining (was 8 names in 2021, but had earlier been 12), in retail, tobacco. Not in innovation or technology. Therefore, it's not been so similar to say, S&P500 (that added eg, an EV maker). And surely 'ye olde' FTSE was not at all similar to an innovation-heavy US Index, like say popular NASDAQ 100.

There's been some names in FTSE related to health/biotechnology. Some in tech. And based in real property. But, in recent years to for instance 2024, FTSE 100 returns clearly lagged far behind Wall Street/US broader Index baskets like NASDAQ. And while ECO & global NEX did absolutely crush FTSE around the clean energy gains of 2019/2020, a huge volatility in NEX, ECO, also meant they can/ and have fallen well below FTSE like in 2021-25 down years.

In sum, an Index's theme, its rules, construction, & goals, like it's definition can and do vitally shape the theme. They matter, hugely. Let's look next at a recent past, maybe possibilities ahead in a world fast changing. In the context too, of science, and what's possible in energy. Science does not mitigate the huge volatility here at all; but it can helpfully inform.

Physics In Time Favors Elegant Clean Solutions (But Does Not Mitigate Volatility)

Burning fossil fuels to make electricity, is both extremely inelegant and dirty. Looking at world as it is, and what's needed, can reveal possibly better paths ahead. For instance, consider electric vehicles; Carnot's Limit helps to explain why electric cars were/are destined to outdo traditional 'gassers'. Today's gassers are inefficient, sadly archaic at best. Diesel fuel or gasoline-burning heat engine cars/trucks only can reach silly theoretical bests, near a 40% efficiency. More typically, car engines are sadly near 20% efficient(!). Huge, heavy SUVs anchored down by non-torquey gasoline heat engines, are relegated to stay so slow, they may suffer from oft silly model differentiation being like on their number of cupholders.

Unsurprisingly 2020s is seeing outpouring of fresh-faced electric vehicles globally. Equity markets in 2010s, had under-appreciated what new lithium-ion batteries -- lashed to efficient (>90%) torquey AC motors, could do. Next up is better, cheaper batteries after 20+ years of non-linear enhancements. But EVs are also bound near-term to often be too-costly, premium products in the first decades. As a consequence there's often big volatility (down / up too) -- with strong *non*-correlation between EV equity pure plays -- vs. broader markets.

Not yet sufficiently looked at, may be huge potential in Geothermal. Maybe utilize lithium-rich hot brine both for firm clean power, & 'lower-carbon lithium'. Ultra-deep, geothermal -- might be done from anyplace on earth! And US big oil names could lead here. For example, Salton Sea in California hosts Geothermal resources; it might produce both a firm baseload -- and lithium needed for extraordinary number of EVs to be built in the US. Could mean good new jobs. So, one must ask, Why Not!?? If one looks with a scientific eye, at energy, today -- at how it is harnessed, and how it is put to use, then new ideas reveal themselves.

Or, consider, big thermal power plants today. And what Mr. Carnot observed back in 1800s. Today's sad, natural gas turbine plants oft only reach efficiencies in 40%s. 'Cutting-edge' combined cycle gas power plants, bump up against theoretical efficiencies in 60%s. How silly! How ineffective, what a plainly dottery old way of achieving electric power generation! As we'd learned 100 years ago from Mr. Einstein, later in quantum science, flat to increasing entropy (disorder) gives Time -- a second law of thermodynamics -- and Time moves in one direction (centered on basic C, velocity of light). Notable too is time's arrow, and what we've learned in the past (like how to make PV ever-cheaper), generally isn't unlearned.

In work for which Mr. Einstein earned his Nobel Prize, we saw light acts as both wave + particle in discrete quanta; we've learned to harness photons in solar PV better over 50+ years. Researching wavelengths, newer solar panels will enjoy maximum efficiencies higher still, vs. silly old heat engines. And since fuel (sunlight) is free, that doesn't so much matter! On time's arrow, gifted by entropy, we've learned how to harness Mr. Sun's free photon packets, at ever-lower, better, less costs per watt. Unlike fossil fuels, there's learning curve ahead. Profoundly it shall push hard and ever-downwards on solar costs, at times very rapidly.

It goes deeper. For years, a Newtonian Physics seemed to explain 99% of a world around us. We'd thus built entire industries, societies; fortunes around it. Nothing in our human-made world could approach C, the velocity of light. And its approximations of the real world actually had served us well enough -- and yet, in some ways Newton was actually really quite wrong. In a metaphor, fossils served us well for centuries. We learned, advanced within their limits, their constraints were accepted (like we've accepted pollution, inefficiencies). But science has taught us too, that the fossils' pollution is actually, accelerating climate risk.

Why a Major Oil Price Crash Happened in 2020 -- followed by Oil Price Rise After

A US in December 2024 was producing more oil, 13.6 million barrels/day, than any country in history! Its oil was then fetching a high-ish 'healthy' price for producers, near $70/barrel. But let's look back, intriguingly to 2020, and remarkably a world oil crash. Some called that crash 'illogical', yet it arguably unfolded with explainable logic of its own. That 4 years prior event began when oil *Demand* collapsed at onslaught of Covid early 2020. Businesses froze globally. Quickly, surplus oil began backing up worldwide, as expected in Q1 2020 Report. That Demand Destruction swiftly grew so large, that where to store all 'excess' oil was a robust question -- especially given oil 'prices' in artificial sense, unsurprisingly soon went briefly negative.

At start of 2020 the world was producing 100 million barrels/day, so-matching needs. Demand & production were expected to (only) grow. Indeed, in only 2 of a prior 35 years had demand for oil to then dipped -- only a brief bit. Yet suddenly from March 2020, monster demand collapse from Covid loomed large; perhaps down -25% or more. Normally on slight slackening in demand for whatever reason, supply can be slightly curtailed. Excess stored, mopped up. But instead Saudi Arabia & Russia had *ramped* production up, wrestling for market control. On an important day March 9th, crude prices plummeted -30%: greatest one-day 'fall off cliff' in oil of roughly past 30 years. In March, US benchmark West Texas Intermediate (WTI) crude fell -60%, for an historic drop, from $60 down to $20. One big factor was Saudi/Russia ramp; also *Demand was* dropping tremendously by -25% or more as world economies gummed up.

A fear then, was Ides of March 2020, US crude price might yet drop even under $20/ barrel, absent intervention. There might then be 1.8 billion surplus barrels of crude, yet 'only' 1.6 billion of tanks storage capacity. Oil under $40 vexes, under $30 threatens America's oil industry, both shale & conventional. Producers from tiny to huge are a diverse lot, yet all felt pain. Texas in 2020 had 174,000 wells of most any imaginable kind -- some so curious as to be hard to believe. Latter Q1 2020, the White House embarked on unusual path for any American president. It tried to rally nations to *raise* crude prices. A hope among many in industry was to get prices up well above $30, a bare floor for many. Particularly, indebted shale producers. Oil near just $30 was maybe going lower on demand destruction. Could go briefly (in markets) near zero in theory maybe on volatile futures contracts trading. Storage was filling, nearer 'tank tops' and so fixes were badly needed as a bridge until activity bounces back.

E.g. May 2020 front-month WTI contracts would expire late-April. So, if a -25% less demand was not met by production cuts, fears grew of 'tank tops' as in landlocked Cushing, Oklahoma. May contracts would need to be unwound fast, by traders with neither a desire, nor capacity to take crude delivery; it pushed front-end WTI oil briefly under zero, some -$37 by April 20th. That brief (artificial) move in finance, wasn't really a great surprise! Not too much should be read into such an 'artificial' -$37 close. Contracts many months out were less distorted. But WTI oil near $20, showed US/global oil markets in distress. Even a better global benchmark, the costlier North Sea Brent crude briefly dropped down near $20 by late April. Not near zero, yet oil @$20 meant production cuts worldwide. Perhaps 1 million oil patch jobs lost, expertise may potentially disappear. Rig counts may fast drop, wells shut-in, bankruptcies -- some wells perhaps might not be (expensively) re-started. Maybe forcing some US shale producers to shut in, pain perhaps was an initial aim, like 2015. But this time, oil's ramp in supply began, just before pandemic's demand destruction. That on Covid, made disorderly consequences greater than was initially expected. Oil in 2023/2024 could again rise to 'desired' $60s-$80s -- with a US the biggest oil producer in the world! But that all of course was unknown to oil industry, back in a panicky 2020/2021. And later from 2025 on, a new question was if new US tariffs/ plus as result maybe trade wars too, could again impact oil prices in big new ways.

A 2014-16 strategy of opening spigots, to stifle competition, had failed in a thriving oil-hungry world; impacts were then muted. Oil fell to $50, briefly. Yet the excess was absorbed. Wasn't enough fall to kill US shale. Their playbook may have been that in a world awash in oil, in 2020, that only the very-lowest-cost conventional producers could survive. Later on, to raise prices, post-shale bankruptcies. It's long said 'the cure for cheap oil, is cheap oil' -- as seen again & again. More market-share re-captured by those lifting oil the most cheaply -- by conventional means. If competing shale capacity is gutted, 'too-low' prices of $20-$30 might disappear. Very unlike in clean energy where low prices can go lower & lower, without a floor of oil. And unlike clean energy, oil choke points can hit hard: ~20% of all oil trade passes at a Strait of Hormuz (attacked in 2026); Ras Tanura Refinery. 75% of China energy imports passes Strait of Malaga. Suez Canal. Bab El-Mandeb strait. Or Taiwan Strait is obvious geopolitical risk. So too Panama Canal facing drought on low water levels, climate risks.

Thus in 2020 on a pandemic + on tank tops, oil went under <$20. Quickly reviving economies & getting oil demand back, essential. Oil-rich nations may ideally want crude prices nearer $80 - $110. To let them better balance their own books, national budgets. But regaining firm demand came first. Proposed conventional oil projects were anyway oft uneconomic, without oil at least >$50. Plus for some nations it's vital to realize crude when richly valued. Vast underground reserves held too long, look increasingly like maybe stranded assets one day. As such they may be wary of sharply diminishing value on CO_2 / fresh climate concerns -- or electrification. Ascent of electric vehicles, changed economics. Meanwhile, US oil firms that might want oil prices around $80, soon faced some production ramps from 2025.

Globally back then industry faced pressing fears in Spring 2020: Of Inland wells for instance without a Port or storage nearby, nor distribution pipelines -- so having to sell excess crude at unthinkably low-prices. Lacking close off-takers might mean dreaded tank tops. In Canada for instance, inland wells far from its ports were lifting heavy crude that's then hard to move; suddenly, mounting product upended all, raised fears of runaway cratering. Vast demand destruction further benighted industry's evaporating storage, changing everything. This was the 'logic' behind the oil industry's (real) fears and crisis back then in Spring 2020.

So, April 2020, OPEC+ with Russia, agreed to production cuts of 10 million barrels/day. With 25 or 30 million barrels of demand gone -- the cuts could have been more. Saudis in agreeing to cuts understandably felt fellow producers should do so too, reducing their own production. And Russia, understandably felt US by only 'organically' cutting -- that is, just producing less on low prices -- rather than cutting capacity, was as different as width can be from length. Given global demand was so much lower, the situation was vexing for oil everywhere.

But the U.S. can't cut production by diktat. Anti-cartel laws mean apart from say, a Texas Railroad Commission (rather like a mini-OPEC, since long before OPEC) ordering rare cuts in proration, it's not an option. So, with wink and nod, Saudi & Russia agreed to 10 million cut. Even that unprecedented big move was just a (necessary) patch-up fix. Yet it made headlines. Concerns held by some technical oil-watchers, was it was 2x smaller than hoped-for. And didn't start until May 2020 -- so made possible the April 2020 scenario when lower-grade crude went narrowly, briefly cost-negative, at less than zero. Even at desirable light sweet crude, cuts of 10 million barrels/day did Not match up exactly to ~25 million barrels/day suddenly no longer needed. But, it was hoped demand would rebound hard in 2021. And WTI Index due to landlocked Cushing fears, proved not as 'useful' as the Index for Brent Sea Crude (that stayed positive with $20 bottom then) -- or even Oil Indexes like in the UAE.

It was about getting past an immediate crisis, re-starting oil demand in 2021. Crude might then rise organically -- on demand rebirth or even inevitable heat waves or cold snaps stoking demand. Free markets are how the US and its prices work, rather than by fiat, so paths were envisioned to stimulate rebound. If US States soon re-opened. If Covid is increasingly endemic more like seasonal virus even if immunity is conferred only for one flu season, if effective vaccines arrive, or better yet, if robust vaccines for Covid ably can treat new variants too, there were thus hopes for some return to demand rebound towards normalcy.

A fascinating side effect of plunging oil was that old-school coal -- long the cheapest energy although still dirtiest -- briefly in 2020 became relatively costly. Fracking pushed down natural gas / oil prices strongly. Natural gas, at -90% cheaper, became in 2020 very attractive for making power. Unsurprisingly and one after another, US coal-fired power plants closed.

Thus, when benchmark Brent crude fell Q1 2020 to $26/barrel, with Australian coal at $57/metric ton or roughly equivalent by analysis to like $27 oil, broadly-speaking, crude oil was cheaper than coal. True: coal / oil don't directly compete. Thermal coal is burned in power plants -- unlike crude oil used for gasoline, heavy oil for asphalt etc. Levelized costs (+ fuel) for solar & wind had fallen too, so were relatively attractive -- vs old coal.

In retrospect, that very cheap oil wouldn't last. Surest path to oil rebound from 2021, was if economies revived, demand returned. Production cuts help too to eat up slack. Oil's crash uncomfortably did get near upending more in an oil patch. A key hub, Cushing's 4 huge tanks nervously grew full-ish. Pipelines to forward crude had slowed, to be like storage that could have meant a kind of oil constipation, backed-up to producer. Had 5,500 miles of pipes for refined product from Gulf Coast to mid-Atlantic stopped accepting gasoline, no contracted-off-taker, a scary April 2020 might have yielded a much different 2021. As many in oil patch fervently hoped, global oil demand rebounded latter 2020. On fast-reviving economies, production cuts largely complied with, even as Iran pumped. So, a 2020 that had begun with oil tops on peoples' lips, gave way in 2021 to tops a non-issue. On war 2022 demand surged -- or at least, prior oil surpluses no longer a concern. In 2025 oil fell to low $60s/ then $50s (hard on producers), Middle East conflicts at times took it back up briefly into $70s.

Yet in 2022 much was changed: oil & especially gas took on new directions. Russia shut supply, for one thing. Before, renewables were rather unaffected by oil & gas. But with oil/ gas pricey, growing clean energy/storage was an aim. Small electricity storage capacity was once simple, if eg little was needed; push water high, release it for power; plus some batteries. But early 2020s, looked different. Vastly more storage needed, so far more batteries, and infrastructure for innovative storage, grid etc. For immense scale of what's sought, consider Texas. In 2019 it had just 5.5 GW of solar, that met only 1.35% of State electricity demand; wind power met healthier 17.5%. Its 5.5 GW of solar 2019 was a start. Were Texas a nation, that PV would have ranked 5th -- after a China (30 GW), EU (16 GW), all US (13.3 GW), Japan (7 GW) -- ahead of say Vietnam at 4.8 GW of PV in 2019. By 2022, Texas' wind + solar was over >35% of its needed power at 27 GW. And was growing faster yet in latter-2020s.

The US like all others, are nowhere near finish line. Very generally, one could think of US needs ahead, as like 20x the renewables capacity that was once extant in the early 2020s. More too, is needed for industrial processes, like green heat in steel & cement. Tremendous increases in solar capacity then plus new wind capacity too. Big say 1,300 MW (1.3 GW) Texas solar farm that went online in 2023, was just a start. Far more energy storage is needed too from scratch. Enormous new needs ahead, not readily measured even 'x-fold'.

CO_2 Gaining Importance -- While Renewables Are Now The Cheapest Energy Of All

For 20+ years, our Clean Energy Index® Reports have been looking at smarter new *Solutions*. Not just problems of CO_2 & climate *per se* -- but solar, wind, batteries, as more elegant ideas. This was logical even start of 2020s, when having the better economics wasn't yet a primary engine for clean energy. Lately, however, the renewables have become very cheapest energy path. This fundamentally will not be reversed. Means going forward, renewables now as both *zero-CO_2, and with *best economics, can help make clean energy even-more compelling.

In short, CO_2/climate is a tremendous risk to humanity; meanwhile the least-costly & best solutions on energy -- renewables, can now make the most sense anyways. None too soon.

Consider a scientific report which warns in just a "coming 50 years, 1 to 3 billion people are projected to be left outside climate conditions that have served humanity well over past 6,000 years." In particular, on CO_2 & population changes, a narrow temperature niche our species required, is projected to change more in just next 50 years, than past 6 millennia.

CO_2 has long been a hero to our species -- and indeed all present forms of life, in moderation. Earth without such a CO_2 level might have had near 0 C surface temp. Instead, it's 'just right' thanks to CO_2 in tiny concentrations under 300 ppm. Greenhouse gases naturally presented over thousands of years, have mean average temperatures are pretty ideal for us, at a 58 degrees F. We'd habituated ourselves to thrive in such 'cool' for over 10 thousand years.

Late 1950s when regular CO_2 monitoring began, modern readings were already up from what was long near 280 PPM. Nearer 315 PPM. By 1988, scientists became alarmed as planetary warming due to increases in CO_2 had reached 350 ppm. Worriedly, a world conference held in that year called for reducing from very high, 350 figure, downwards -20%, by 2005.

By 1992, a global compact was reached. Signed in Rio, a UN Framework Convention on Climate Change lacked specific cuts. Looking back, a nebulous agreement to try to act was real failure -- nowhere close to task. CO_2 continued rising sharply. For Rio only *implied cuts,* like calling for global emissions to be -20% lower in 2005. Instead, CO_2 as it turned out, still only grew -- going +34% *higher by 2005*. Looking back, it went on rising, by another +22% higher in 2017 -- to over 425 ppm mid-2020s. Higher than in a last 3 million years. Maybe highest in last 12 million years. So, merely aspirational words, absent robust actions, have woefully not achieved what's been needed for real decarbonization, to reduce grave climate risk.

More specific 'cuts' were laid out 5 years after in a 1997 Kyoto Agreement on climate. Yet CO_2 went on rising, more sharply. A mockery of CO_2 action. International agreements were again tried 2009, but Copenhagen event failed. CO_2 levels continued increasing, temperatures spiking. A 2015 Paris Agreement was roughly more of same. CO_2 still a fast uphill scary climb. By 2020, only 3 countries had met early Paris terms: Marshall Islands, Suriname, & Norway which made up only 0.1% of emissions globally. In short there's still No cause for optimism. A gathering in Glasgow 2021 meant to speed progress -- failed. In 2025 the US once-again pulled out of the Paris Climate Convention, for a 2nd time. The truth is, despite flowery words, there's been woefully little action. In sum commitment Isn't there. That's why it's arguably crucial to see *clean energy (*unsubsidized)* has become cheaper than fossil fuels (as required post a 2025 'one big act'). Yet still little *recognition of science; or *acceptance that decarbonizing away from fossils -- to clean paths while also creating new wealth/ new jobs -- is hardly a radical path. Instead, delay and willful ignorance is the word here.

There's some bits of optimism. Near-term to 2100s, intercomparisons of 56 climate models indicated some most-awful possibilities, *may* be less likely. Barring say feedbacks of methane, of clathrates, water vapor, permafrost, & hoping for no other mal-contributions, then models' scariest ~9 degrees F by 2100s *may be* less likely on recent understanding. Prior models had assumed higher fertility rates, more use of coal, fewer renewables; things aren't that bad. So worst-case predictions of an entirely-unlivable 9 degrees F warming, hopefully become highly unlikely. On the other, hand, studies still do show that eg, the carbonate/ limestone permafrost in Siberia, were it to thaw, might potentially yield enormous methane relaese via fracturing. Methane can be *even more climate forcing than CO_2*, in the near-term.

Yet if we deem high end, Representative Concentration Pathway (RCP) 8.5 as unlikely, heavy CO_2 emissions there improbable -- then we should also regard a lowest RCP 2.6 too, as unrealistic. It assumes a widespread embrace of renewables already far greater than is seen, and No coal (ha ha ha). Neither, especially the latter, was close to accurate latter-2020s.

Yet, lower-end of an heavy-emissions RCP 8.5 band, seems scarily still feasible. It foresees arguably, a catastrophic rise near 7 degrees F as possible, as soon as 2100s. Even 'lower-end' RCP 8.5 possibilities ought to concern nations & leaders, greatly. RCP 8.5 is one factor in predictions of a massive loss of the inhabitable human climate niche in the 2100s.

Next 'lower' RCP 6.0 seems rather closer to where we're trending -- on today's present (in)action. It foresees roughly near 5 ½ degrees F warming by 2100s. Under it global emissions peak some 60 years out, 2080s or so, then decline. (CO_2 in the atmosphere rises, stays high, drops only slowly as accumulates). Coal plants built in Asia as they are -- but those soon may be regarded as things of the past in RCP 6.0. Electric car adoptions globally accelerate.

It assumes a CO_2 equivalent to about 850 ppm, or about 2x now. For data nerds like ourselves, translates to radiative forcing of 6.0 Wm^2 post 2100, or 6 watts/square meter in RCP 6.0. (RCP 8.5 translates to 8.5 Wm^2). For incoming solar energy, pushed far out of balance in our altered Earth-atmosphere system. Consequences of that, may go on to be dire for our species but over centuries, millennia ahead. Yet it seems to be about what one, 'might hope for'.

Next is a very, very ambitious hoped-for RCP 4.5: emissions peak ~20 years so 2040s, then fall fast. CO_2 not long ago was a stable 280, now 425 & rising fast; it rises in this view to 'just' some 650 ppm -- unlikely but has it then stopping/peaking there. Much decarbonizing is assumed to have been undertaken (far more than is now planned), CO_2 in time is dropping. That *may* be possible, although it's a huge stretch. And arguably highly unlikely, on CO_2 now some 50% greater than near 280 ppm, pre-industrial, rising fast. The 4.5 is very improbable, as hundreds of coal plants are being built now in 2020s, each with a life of 20 years or more. Possibly operating into the 2040s, even after, unless they are prematurely shuttered.

With renewables making only some 25% of electricity many places though growing; coal is burned still including in industry; cars using oil – an ambitious RCP 4.5 with 'only' horrid 2.7 C or 4.9 F of heating is perhaps an unlikely bet. Worse, likely. That said, to 'unexpectedly' see ice sheets destabilize, heatwaves, floods, tornadoes, droughts, *may* catalyze action. Sudden, scary events may yet hasten faster action on climate. Models too inevitably grow more complex. Until recently, they'd ignored say, ice sheet destabilization. But if a big pulse of melting occurs, if change is visibly underway, skeptics may melt away too. Especially as clean energy is becoming *the most economical choice*, while creating jobs to boot.

A Decarbonized Power Grid by 2040s, Climate Neutral World by 2080

Imagine years hence. Europe & US using low-cost solar made in Asia, wind power & vast new energy storage, became the 1st to reach 100% net carbon free power latter 2030s. Much of world later got there ~2050. Electric vehicles scaled faster than expected! Green H_2 came to industry, richer nations grew climate neutral by 2060. China on much new nuclear too got there by 2070, meeting targets. Rest of world by 2080 though with much fudging like on 'sequestration' claims. Earth still has thriving forests, oceans, and CO_2 'natural sinks'.

That moderately ambitious timeline, is absolutely Do-able! Unfortunately, the science also implies on inertia in CO_2 -- this scenario destroys global low-lying megacities due to sea-level rise, climate crises. Blew right past the 2 C Paris goal (say nothing of dead 1.5 C aspiration) -- and it has soon put us unbearably onto a 5 C, or even 6+ C degrees hotter world.

That's not alarmist. It's just where science dispassionately points. Maybe to unbearably hot -- and growing hotter. Centuries of sea level rise; it's possible just centuries of rise destroys Florida, New York City, DC. Inundates much of US Eastern seaboard, US Gulf Coast, parts of US West Coast. While indigenous peoples there long predated today's City of St. Augustine in Florida -- if one considers it 'founded' in 1565, or 450 years ago -- we're likely nearer end of that first US City, than its birth. Nearer to a death of Miami, or New York City, or New Orleans, Guangzhou, Mumbai, Shanghai, Bangkok etc etc -- none having 450+ more years ahead.

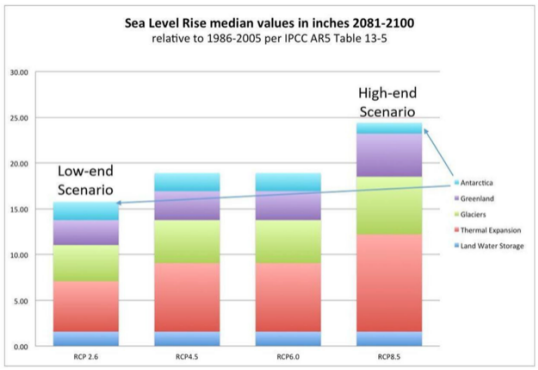
Imagine just ~70 years hence. Note then projections by Intergovernmental Panel on Climate Change (IPCC) for sea level rise in year 2100, may be misleading. For an end of century rise may be unwinding then at far more rapid accelerating rates, than was projected by IPCC. Getting that so wrong, has meant that a lax policy today allows for too much CO_2, methane, inertial heat to build unduly. Which can then neither be halted, nor unwound.

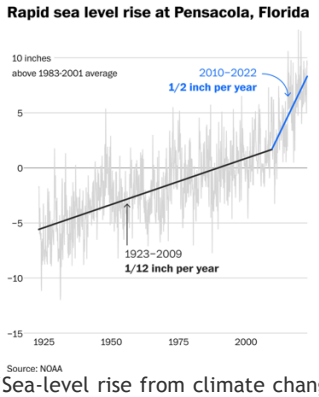
This idea that actual sea levels in 2100, could be greater than IPCC projections is well laid out in 2020 piece, 'Twenty-first century sea-level rise could exceed IPCC projections for strong-warming futures'. Their first paragraph nicely lays out very cogently and clearly, big ideas that today scientists now find mainstream. Yet their same thoughts should be viewed by the public, by policymakers and politicians with alarm given their gravity:

> Since around 1850, the concentration of atmospheric CO2 has risen from ~280 to over 415 parts per million (ppm), resulting in a global mean temperature rise of ~0.9 C -- 1.2 C. Even if human-caused emissions are reduced to net zero by 2050, global temperatures may rise to more than 1.5 C above their pre-1850 levels. Global CO2 emissions are still on the rise, however albeit with a slight coronavirus disease (COVID-19) dip, and analyses of current policies suggest that greenhouse gas emissions will continue on an upward trajectory over the coming decades. This keeps strong warming futures, which exceed 4 C by the end of the century and continued warming thereafter, well within the realm of the possible.

Wow, near-term end of century may possibly be 4 C hotter than today. On strong warming, seas in 2100 may be quite higher than usually accepted IPCC range of 0.61m -1.10m, what public thinks of as roughly 1-3 feet of rise. In particular, upper end projections are unduly being taken by policymakers as maxing about 1.1 meters (3 feet) higher in ~70 years to 2100 -- yet that's in fact **not a** true ceiling at all. Moreover, they could be rising then, fast.

Uncertainty cloaks Antarctica's immense dynamics. Computer models can omit mechanisms -- if machinations are hazy. Shorn of major details, these data suggest global rise may go *on at well over* 1.1 meters at 2100, above 3 ft. Difficulty modeling ice/glacier dynamics in short, potentially left out Antarctic contributions. It removed complex & cascading effects. Especially in higher heat scenarios where we're trending. IPCC higher-end curiously, indicated *least* rise from Antarctica, even RCP8.5 high heat scenario in IPCC AR5 (at left). A 2024 piece in Science by Judd, Tierney, implies greater climate sensitivity -- than has been modelled. Here's a Gulf of Mexico 10 mm/year from 2010-2022 seen in Pensacola, Florida:





Source for chart at left: J. Englander. See also, J. Berandelli, 'Sea-level rise from climate change could exceed the high-end projections, scientists warn'. CBS News. Dec. 23, 2020. Chart at right for sudden rise of 10 mm/year 2010 -2022: NOAA 2023.

Next few centuries have to be deeply concerning. Scientists understand a crucial fraction of airborne carbon already emitted in the industrial revolution, plus this century and likely next, can persist for thousands of years. In short, the CO_2 released in a relatively brief window from just 150 years ago, to mere 1-2 centuries ahead, even if emissions are drawn-down next few decades, may have committed the world to inertia of hugely rising seas. Impacts ahead from that unstoppably rising rate, going on for maybe centuries, perhaps for millennia.

Science suggests many tens of feet of rise is possible on CO_2. Accelerating rise, maybe locked-in perhaps going on for thousands of years. Past rises long ago seem to have happened in non-linear ways, at times moving quickly. A meltwater pulse on CO_2 coming from natural causes, at rates less than now, caused seas to rise between 50 ft and 80 ft, in just 400 -- 500 years.

That's to say, massive ice sheets having once retreated very swiftly before, might do so again. Especially as 'we engage in pulling all kinds of climate levers' releasing CO_2, methane, other greenhouse gases at rates never seen before. Global reshaping is what we're talking about. So put aside for a moment, noisy political debate. Ignore too other impacts, say new diseases, the storms, famines, droughts, tornadoes, collapsing ecosystems. Follow-on impacts that spread like ripples on a pond. Earthquakes that may follow unburdened melting glaciers, that can affect distant tectonic plates. Just focusing on impacts of seas rising, is enough.

Climate & ocean inertia is something we've written about (such as, Scientific American, Oct. 19, 2016): observing for example how problematic models project scenarios of climate change forecast only to year 2100. At times just to 2050. As a result, public discussions have been mostly framed as "X degrees warming", & "Y feet sea level rise" just to end of century only. That year 2100 end-point has accidentally but notably limited our thinking. It causes us to miss striking impacts that may go far beyond -- because of that artificial, near time horizon.
https://blogs.scientificamerican.com/guest-blog/exposed-the-climate-fallacy-of-2100/

Politicians of Miami, or State of Florida, no doubt want their homes to exist centuries ahead. Same for New York City, Boston, London, Shanghai, Amsterdam, Mumbai and so on. Yet their leaders are still discounting to nearly-zero, the staggering losses these places *may* face ahead. That's due in part, to relying on a near-term and distorting field of a 2100 horizon.

Anything like sea level rise going on potentially for many centuries, or thousands of years, essentially means "forever" on our human time scales. These new data imply we're possibly creating a kind of forever legacy, one that potentially can't be forgotten nor fixed, no matter how far ahead we conceive of humanity. Flooding -- not just at coasts, but eroding ground upon which innumerable buildings sit, first as sinkholes then dissolving near coasts.

And so, we do ourselves a dread disservice by consistently framing just very near-term 2100 as essentially last, final year of impacts. We think in blinkered ways decades out, while our foot is pressing hard on heating's accelerator, with serious impacts maybe millennia out.

How, then, can we think about climate and seas in truer, science-based time frames?

One way is to address sea level rise over the longer term, from a scientific perspective.

These data show a 'recent' rising warming which started from 20 millennia ago, had crucially brought the Earth out of its last ice age. Air temperatures sharply rose over a period from last ice age, to roughly the steadier-modern-climate that commenced some 11 millennia ago. From that point, on, both CO_2 levels and air temperatures then sharply leveled off.

Sea levels that had started 400 feet lower than today, didn't stop rising at temps leveled however. They *continued rising long past air temperatures had reached their plateau*, rising another 8,000 years, so climbed another 150 feet -- to today's height. Oceans thus did not achieve now-current state we all know as modern coasts, maps, 'til roughly 3,000 years ago.

This mere sliver, in geological time, of climate stability over a past 11 or so millennia had dearly helped human societies and cultures to flourish. But a lesson ought to be, seas are acutely sensitive to CO_2, and temperatures. They can have inertia that lags carbon cycle, climate systems. That means that today's oceans *could* go on rising for very long periods after CO_2 may be steadied -- even if humanity takes determined actions to slow CO_2 rises worldwide and decrease emissions. This thorny fact is not widely appreciated nor understood.

Combine CO_2 persistence with inertia of seas, and *potentially* it can mean sea rise *goes on* for a millennium, or for millennia+, though that's 'unimaginable' to many. Despite our hubris, there's no off switch to halting seas. No matter how much in the future we may wish it.

Opportunity to go on ignoring such a plausible dynamic according to accepted science, grows vanishingly small. There's already been in 2020s, flashes of near 1.5 degree C increases in global temperatures of late. That rate of change alone, seems close to what were the greatest natural variations within this time frame to have occurred over the past 10,000 years.

So current rates of change ought be very concerning. It took a long time -- from 21 millennia ago, to 12 millennia ago, for atmospheric CO_2 levels to jump by 80 parts per million. Go from ~190 to 270 ppm. In that span, global temperatures rose on average hugely, by 7 degrees F. We're on track to maybe repeat that increase (or more) -- over far far briefer period.

For where we're going on CO_2 already at 425+ ppm & rising fast, think first: the Pliocene. Earth 3-5 million years ago once had a forested arctic: we might reach Pliocene temps 'soon'. Of course, it'll take a lot longer for flora & fauna to react, reach equilibrium. Means vast changes ahead with mass-extinctions. Those hotter temps happened million of years before we humans evolved in a once-comfortable 230 ppm world. Could get hotter still, like Miocene: 400-600 ppm when coasts today were submerged. Interestingly at 'just' a 400 ppm Pliocene, Greenland's ice sheet was gone on only 'modest' warming. And millions of years ago, those CO_2 changes naturally took thousands of years to occur. To slowly rise or fall. By contrast in a single human lifetime now, we're exploding CO_2 by astounding 100 ppm+(!). So, plants & animals only begin to react. Cascading extinctions unavoidable. It's Not Only Fact of Great Change -- but rather also The Extreme Pace of Such Change that's bound to be deadly.

Before a Miocene of 5-23 million years ago, much before a Pliocene 3-5 million years ago -- were long periods -- millions of years where a hot Earth cooled before humans appeared. PPMs/ temps fell, down from Miocene's 400-600 ppm (at times 2,000 ppm from volcanoes). Cooling eventually gave way to hospitable carbon levels, temps we could evolve in nearer 230 ppm. Key then, was our planet's ability to pull CO_2 out of atmosphere over very long periods of time, via Earth's natural 'rock thermostat'. Specifically, CO_2 was absorbed as by rocks, but only over many millions of years. Taken up too as by calcium carbonate in oceans.

Long cooling post-Pliocene lowered CO_2 -- let glaciers form. Today's flora & fauna evolved over a hospitable, cool Earth we'd known recently. Again, millions of years needed to go from that hot Pliocene. That's now being explosively undone. In just 250 years of fossil fuels, we're dramatically destroying cool. Vanquishing glaciers. Ending ice sheets that required a vast, vast cold period to form in first place. There's no reverse switch. Hence this may become (or probably already is) a climate crisis; maybe an emergency tougher to fix.

Trying to pull CO_2 from air & oceans may soon be touted by some, as a necessity. Even though a bargain with the Devil, consequences unforeseen, likely disastrous. Differs from renewables that better prevent harm in the first place. Of course, such 'pulling CO_2 out,' mustn't be done in ways extending fossil fuels. And mustn't be done say, by treating the oceans like an open sewer, injecting carbon there like we've been abused the air for centuries.

Rather as noted, any direct capture or sequestration should best *Remove CO_2 from air & seas *Permanently, in *Practical, Economic Ways Scaling to Gigatons, carbon made *Benign & Stable, done in ways *Carbon Negative -- not merely carbon neutral. If meeting those criteria such technologies *may* conceivably be included say, in Indexes. Yet in early 2000s, no such technologies existed. None: safe, ecologically benign, nor scalable: basic requirements.

Conceivably, innovations may arise. New Prizes given for clever ways to pull CO_2 from air, or incentivizing better, not-bitter, action ahead. Perhaps CO_2 may be turned to carbonates, to benign solids such as building materials stable for many thousands of years. Perhaps 2 pounds of carbonates for every pound of CO_2. That can be a lot on 30 billion metric tons pumped into air each year. Like abalone that makes shells from CO_2 on dissolved mineral ions in seawater. But this would have to be safe, fast, require very little energy, be ecologically benign, no easy task! Or in a single step a non-thermal plasma conversion of CO_2 at room temps and say, at 15 PSI pressure, rather than requiring 500 degrees F and over 150 PSI. This is a riddle that may not soon be solved. And so, it's likely then that climate impacts may be baked in.
What does all this mean, for sea level rise on current trends?

An international panel back in 2013 had given scenarios for rise this century, straightforwardly on expansion due to warming oceans. Back then, they'd only allowed for small influence from runoff due to marine ice-sheet instability, MISI, primarily on assumption that Antarctic ice sheets were too stable, too vast to irreversibly shrink during this century. That report had an optimistic low-end CO_2 scenario: little rise. It assumed strong actions would be taken later in this century to reduce CO_2 emissions, predicated estimated just 1 foot of rise (0.3 to 0.6 meters) by 2100. A high-end estimate on current trends, with little action this century to reduce CO_2, foresaw about 3.5 feet of rise at 2100, rate increasing rapidly one third - to over half an inch (8 to 16 mm)/year last 2 decades this century. Such rate later on in this century, could be up to 10 times what was the 20th century average rise. But it still does Not start to approach what had occurred around end of the Ice Age, when seas rose rapidly.

Since that report, we saw a regional jump in Gulf of Mexico of over 10 mm/year, 5 inches from just 2010-2022 in Pensacola Florida; it may be due to thermal expansion in hotter Gulf or slowing maybe of Gulf Stream. While globally, newer papers on ice-sheet dynamics show prior understanding was incomplete; MISI mechanisms may be much more extensive in the Antarctic. The enormous Pine Island Glacier in Antarctica, for example, looks to be thinning, retreating at quickening rate. Like cork in a champagne bottle, it holds back far greater rise. Mechanisms in newer models show mass loss by unstable retreat may potentially become significant, sooner than expected. Some early collapse maybe starting at Thwaites Glacier. Unexpected collapse of say Antarctic marine ice sheets could cause previous upper estimates of sea rise, to be well-exceeded, not long after (before?) end of century. Although timescales are profoundly uncertain, rapid rises *may* occur in relatively short period ahead, say over two to nine centuries. Or as Gulf of Mexico 2010 to mid-2020s indicates with rises seen half an inch per year albeit on different mechanisms, like ocean currents, we are in for surprises.

A subsequent paper shows marine Ice Cliffs may be become instable too, MICI a mechanism for more rapid retreat through 2100 -- certainly after artificial 'terminal years'. Numerous more papers lately showing sea levels could start to rise much more than was forecast in prior lower-end scenarios. These data imply more than 40 feet of rise may potentially come just from Antarctica in half-millennium to 2500, in accord with higher-end scenarios for CO_2.

CO_2 can/will make a complete failure of efforts to pour $ billions, $ Trillions into armoring coastlines. One can imagine enormously long expensive walls, say 10 feet high, topped in a couple centuries. One can't even imagine bigger seawalls able to handle what may be oceans going up 50 feet, 100+ feet higher and rising without pause. The point here is 2100 shouldn't be regarded as a terminal year. Nor, 1-3 ft of sea rise. To do so, is just folly, wrong-thinking. Life goes on, people do not end there, it's one year in an artefact human calendar: the world's seas will not suddenly halt rising then. Things may be wee bit better -- or wee bit worse at times due to heating next centuries; maybe a whole lot worse threatening survival of human civilizations: but it's pretty certain that on a hot Earth they won't get a whole lot better.

Scientists are natural skeptics, not prone to dramatizing their findings. But cause for abundant hope is fading. That ought to stretch our thinking. Listening to the Sea, and so to science, ought adjust our thinking about what's wise. Paleoclimate records indicate that in meltwater periods, or termination of glacial period, seas perhaps rose at astounding rates 10 feet per century and more. There's no reason to say it can't happen again. Or rise by faster rates to 220 ft max height ahead. Given aggressive CO_2 trends, that must be considered.

Keep in mind what such big rates, scales of change, may mean. A difference of 'just' 7 degrees F had separated our recent "ideal" climate for us -- from an extreme ice age. In a refresher, the Ice Age not that long ago had ice sheets over Canada, Northern US, Europe, Asia. The US Great Lakes were born of great sheets retreating. Meltwater retreat shaped Long Island NY, Cape Cod MA. Huge impacts were thus wrought by just a 7 degrees F 'delta'. Ice had stood a mile tall over some of North America(!) making continental shapes that we know today.

Just imagine then, another 7 degrees F change -- but instead -- of global *heating*. Certainly, that will alter land, seas, & ecology in scales, ways hard to fathom. Looking back to Earth's record it's conceivable on a temperature rise of "only" 2 to 5 degrees F, seas could rise fast in non-linear ways, say going 15 to 65 feet higher. Drowning so much today, like great State of Florida. In a thought experiment, 5 degrees F of warming is imaginable, on current CO_2. So, it is reasonable to see seas fast going up 60+ feet higher. No seawall could stop that. It renders the shapes of whole countries as we know them, today, a distant memory.

Mechanisms by which it happens easy to fathom. Greenland's ice sheet has stored up 'only' 22 feet of potential sea level rise, may melt over say 10 millennia. However, Antarctic ice sheets store much, much more: 150 ft. of potential rise. In past years East Antarctic ice sheet annually gained some 175 trillion pounds of thin new ice (precipitation). But West Antarctic annually lost much more, 275 trillion pounds of critical ice. Plus, Greenland has averaged 600 trillion pounds of ice of late lost yearly, like 10 billion trucks a year carting ice away.

On CO_2 and inertia, we're heading to conditions unknown in human history. Earth will exhibit changed states that only can be guessed at. For instance ice melt makes Earth slightly alter movement on its polar axis. Length of days changing, as ice melt redistributes water mass towards a bulging equator. So too groundwater withdraw. Small changes in Earth's spin may not seem troubling, yet show magnitude of changes from tiny CO_2 molecules. A key Gulf Stream long keeping N. Europe far warmer, than 'it otherwise would be', may be slowing.

A century, or even a few decades from now, science strongly implies people may look back on a recent 2021 with then-record-breaking heat, irony of flood & droughts, bitter cold snaps, rapidly disappearing sea ice, gradual rising seas -- as being a cooler, far more desirable past. One that can 'never' be recovered. When seas rising by 2 inches per decade (faster in 2021, than 50 years prior) were *then, so much less than soon ahead.* If irreversible ice collapses in Greenland, and Antarctic, far more rapid rises shall happen -- making that better past a memory. With both jet stream & gulf stream. It's impossible to say just when such things will occur. But given fast rising heat, and ever-more CO_2, it is certain change will happen.

Growing clean energy capacities in 2020s 'felt' like progress; it was also more than many were prepared to give. Maybe it felt too like green energy was replacing dirty fossils fast enough -- though it wasn't: not on the science, physical CO_2 budget of burning fossils. Dollars in 2022 IRA seemed huge -- yet decimated by a 2025 'one big' act. And dwarfed by scale of efforts needed: $100 Trillion spending worldwide. The science says we're (likely) in for unbearably hot future. Killing much Life. Maybe in under some thousands of years, impossible to know -- yet ending us. End of our cultures, societies, maybe our species. All for silly reasons, really. On no good reason, we've chosen not to go clean, fast. Of course no doubt, the future is uncertain. Solutions costly. Yet climate may mean catastrophic change. Maybe in most everything, everywhere, all at once. Our rampage of oil, coal may be a mutual suicide pact, for we know probable outcomes. It's as if we're determined to wage an intended war on all other life on this planet -- making it a bit harder to cheer our own species on.

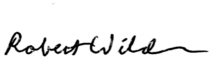
Conclusion:

The Clean Energy Index® (ECO) began Q1 at 64.44 & ended Q1 at 66.67, up +3%. In say 'context of presidents' so now 4 full Quarters into 2nd term, ECO is here up a neat +100%. Inflation hit this interest-rate-sensitive theme, hard. After clean energy thus ECO Index® had touched a low mid-2024, it afterwards gained some, despite -- or perhaps bit due(?) to a 2024 election. We'd seen in a stimulative 1st term from 2017 to 2020, ECO moved dramatically: +38% in 2017, -15% in 2018, +58% in 2019, remarkably up +203% in 2020, about best for any index or fund, anywhere. Tallied it was +284% gain ironically for a 1st term of a white house highly skeptical of green energy. Then, ECO fell all 4 years during a very differing presidency from 2021-2024, declines those 4 years of -30%, -46%, -22%, -30%; tallied it was down -128%. Now with a prior president returned for their 2nd term, ECO was again well up here by +52% for 2025, while events have pulled demand forward -- and just possibly may knock it down ahead.

There were no Deletions from ECO for start of Q2 2026 -- and the Additions to start Q2 were: Beta Technologies, D-Wave Quantum, Ioneer, IonQ, Solv, USA Rare Earths. At the Global Clean Energy NEX Index, for Latter Q1 rebalance, the Deletions were: Chargepoint, and Nel ASA -- and NEX Additions were: Rept Battero, J&V, Hainan Drinda. At Hydrogen Economy H2X, the Deletions for Latter Q1 2026 were: Nel ASA, and Littelfuse -- and H2X Additions for Latter Q1 2026 were: AGC, Sensata Technologies, Takaoka Toko. At Wind Energy WNX, there were no Deletions for Latter Q1 2026 -- and WNX Addition for Latter Q1 2026 was, Osaki Electric.

As always, we welcome your thoughts and suggestions.

Sincerely,



Rob Wilder
rwilder@wildershares.com

Appendix I, ECO Index for the Start of the New Quarter:

INDEX (ECO) SECTOR & STOCK WEIGHTS FOR START OF Q2 2026. 68 STOCKS.
Each stock freely floats according to its share price after rebalance.
*Stocks below $200 million in size at rebalance are *banded with a 0.50% weight.

Renewable Energy Harvesting - 12% weight (8 stocks @1.50% each)
Array Technologies, ARRY. Solar, tracker mounts follow sun through the day
Cadeler A/S, CDLR. Offshore wind, vessels for installation / maintenance.
Canadian Solar, CSIQ. Solar, vertical integrated solar manufacturer, China.
First Solar, FSLR. Thin film solar, US based, CdTe low-cost alternative.
JinkoSolar, JKS. Solar, wafers through solar modules, China-based OEM.
Nextpower, NXT. Solar trackers, optimizing PV daily performance yield.
Ormat, ORA. Geothermal, US, also in areas of recovering heat energy.
T1 Energy, TE. Solar manufacturing, also makes batteries, based in US.

Energy Storage - 20% sector weight (13 stocks @1.50 each + 1 *banded)
Albermarle, ALB. Lithium, specialty materials in batteries energy storage.
Amprius Technologies, AMPX. Silicon anode batteries, greater energy density.
**Atlas Lithium,* ATLX. Lithium, battery metals nickel, rare earths, graphite.
Chemical & Mining of Chile, SQM. Lithium, large producer in energy storage.
Enovix, ENVX. Silicon-anodes, 3D for improving new lithium-ion batteries.
Ioneer, IONR. Lithium, boron miner, for batteries, from US domestic sites.
Lithium Americas, LAC. Lithium, deposits in the State of Nevada in US.
Lithium Argentina AG, LAR. Lithium deposits in Argentina; has China nexus.
Quantumscape, QS. Battery, solid state lithium-metal energy dense fast charge.
SES, SES. Lithium metal, battery technologies with use of AI enhancement.
Sigma Lithium, SGML. Lithium, in planning & pre-construction, sites, Brazil.
Solid Power, SLDP. Solid electrolyte battery, Earth-abundant materials.
Standard Lithium, SLI. Lithium, from brine in U.S., vs. traditional ponds.
Tesla, TSLA. Electric vehicles, EVs, storage, advanced energy systems.

Power Delivery & Conservation - 21% sector (14 stocks @1.50% each)
Ameresco, AMRC. Energy saving efficiencies, net zero, decarbonization.
Aspen Aerogels, ASPN. Aerogels, fire retardant in batteries, EVs, insulates.
EVgo, EVGO. EV Charging, DC fast-charging Networks, renewable power.
Itron, ITRI. Meters, utility energy monitoring, measurement, management.
Monolithic Power, MPWR. Chipmaker, better efficient power management.
MYR Group, MYRG. Grid transmission, distribution aids solar & wind farms.
Navitas Semiconductor, NVTS. Gallium Nitride GaN, high voltage in AI, EVs.
Nio Inc, NIO. EVs, China-based maker premium vehicles, battery as service.
Niu Technologies, NIU. Electric scooters, motorcycles, mopeds, bicycles.
Preformed Line Products, PLPC. Grid products & transmission OEM, solar.
Rivian, RIVN. Electric vehicles, trucks and commercial fleets, charging.
Shoals, SHLS. Solar, for electric balance of system, wiring, combiners.
Universal Display, OLED. Organic light emitting diodes, efficient displays.
Xpeng, XPEV. Electric vehicles, new mobility, swappable battery, China.

Energy Conversion - 22% sector weight (15 stocks @1.46% each)
Advanced Energy, AEIS. Power condition: inverters, thin film deposition.
Archer Aviation, ACHR. Electrifying aircraft, vertical takeoff & landing.
Ballard Power, BLDP. Mid-size fuel cells; PEM such as in transportation.
Bel Fuse, BELFB. Transformers, power supplies, circuit protection, AC/DC.
Beta Technologies, BETA. Electric aircraft, VTOL/CTOL low operating cost.
Bloom Energy, BE. Stationary fuel cells, not-yet cleanest/renewable fuels.
Enphase, ENPH. Microinverters, also energy storage systems and software.
ESCO Technologies, ESE. Power management, shielding, controls, testing.
Gentherm, THRM. Thermoelectrics, heat energy, battery management.
Joby Aviation, JOBY. Electric aircraft, cleaner, more energy efficient.
Lifezone Metals, LZM. Low-carbon battery metals, Nickel no smelting.
MP Materials, MP. Rare Earths, domestic U.S. source Neodymium, NdPr.
Plug Power, PLUG. Fuel cells, also electrolyzers to generate H2 on-site.
SolarEdge Technologies, SEDG. Inverters, solar optimizers, inverters.
USA Rare Earths, USAR. Rare Earths, domestic US-magnets supply chain.

Greener Utilities – 16% sector weight (11 stocks @1.45% each)
American Superconductor, AMSC. Wind, grid conditioning; superconductors.
Brookfield Renewable, BEPC. Renewables hydro, wind, solar; energy storage.
D-Wave, QBTS. Quantum compute, optimizing use of renewables on the grid.
Energy Vault, NRGV. Utility-scale energy storage; shorter & longer duration.
Eos Energy, EOSE. Zinc batteries, a safer li-ion alternative, longer-duration.
Fluence, FLNC. Battery storage, for renewables and digital applications.
IonQ, IONQ. Quantum compute, for Virtual Power Plants (VPPs), efficiency.
Powell Industries, POWL. Switchgear, controllers, & power generation.
Quanta Services, PWR. Infrastructure, modernizes grid, power transmission.
Solv Energy, MWH. Large-scale solar power + battery storage, Utility EPC.
Sunrun, RUN. Residential solar systems, PPA, lease or purchase rooftop PV.

Cleaner Fuels – 9% sector weight (6 stocks @1.50% each)
Darling Ingredients, DAR. Renewable biodiesel, sustainable aviation fuels.
FuelCell Energy, FCEL. High temperature fuel cells, uses variety of fuels.
Gevo, GEVO. Biofuels, decarbonizing chemicals, new aviation fuels, RNG.
Hyliion, HYLN. Enables use of a variety of fuels, efficient linear engine.
Opal Fuels, OPAL. Renewable natural gas RNG, CH4 from landfills, dairies.
Rex, REX. Biofuels, adding CCS sequestration, But Not advanced biofuels.

Appendix II:
WilderHill New Energy Global Innovation (NEX) - for Latter Q1 2026. 110 Stocks.

Name	Description	Sector	Currency	Activity
Acbel Polytech	Green energy electronics, PV & EV, power supply.	ECV	TWD	TAIWAN
Acciona SA	Sustainable infrastructure, separate is renewables.	RWD	EUR	SPAIN
Alfen NV	Electric Vehicle charging, smart grid, energy storage.	EEF	EUR	NETHER.
Allis Electric	Transformers, power transmission, smarter grid.	ECV	TWD	TAIWAN
Array Technologies	Solar, ground-mounted axis sun trackers.	RSR	USD	US
Atkore	Electrical cable, conduit systems, pre-wiring.	ECV	USD	US
Ballard Power Systems	Fuel cells, PEMs used in transportation and more.	ECV	CAD	CANADA
Bloom Energy	Stationary fuel cells, distributed but non-renewable.	ECV	USD	US
Blue Bird	Electric school buses, US size types A, C, D.	EEF	USD	US
Boralex	Renewables generation, operates wind, hydro, solar.	RWD	CAD	CANADA
BYD	Electric vehicles, advanced batteries, China based.	ENS	HKD	CHINA
CALB Group	Batteries, in electric vehicles, energy storage, grid.	ENS	HKD	CHINA
Canadian Solar	Solar, vertical integrated solar manufacturer, China.	RSR	USD	CANADA
Ceres Power	Fuel cells, high temperature steel units.	ECV	GBP	UK
China Datang Renewable	Wind, among largest listed wind operators in China.	RWD	HKD	CHINA
Chung-Hsin Electric Mach.	Fuel cells, H2 dispenser, micro-grid maker, Taiwan.	ECV	TWD	TAIWAN
Contemporary Amperex	Batteries, in EVs, energy storage, China-based.	ENS	HKD	CHINA
Core & Main	Electrical metering, power utilities upgrading.	EEF	USD	US
Corporacion Acciona En.	Renewables, one of world's biggest, wind, solar etc.	RWD	EUR	SPAIN
CS Wind	Wind energy, both onshore and also offshore.	RWD	KRW	S. KOREA
Darling Ingredients	Renewable diesel, sustainable aviation fuels.	RBB	USD	US
Delta Electronics	Power systems, EV chargers, fuel cell development.	ECV	TWD	TAIWAN
Doosan Fuel Cell	Fuel cells, high temperature and hydrogen, S. Korea.	ECV	KRW	S. KOREA
Ecopro BM	Battery materials, cathode and precursor for Li-ion.	ENS	KRW	S. KOREA
EDP Renovaveis SA	Wind power, among the largest producers, Iberia.	RWD	EUR	SPAIN
Elia Group SA	Smarter grid, high voltage transmission Europe.	EEF	EUR	EUROPE
Energix Renewable En.	Wind & solar, producer Poland, US, Israel, elsewhere.	RWD	ILS	ISRAEL
Enlight Renewable	Solar & wind, clean energy storage infrastructure.	RSR	ILS	ISRAEL
Enphase	Inverters, micro-products for solar panels, storage.	RSR	USD	US
Eos Energy	Zinc batteries, longer-duration and safer than li-ion.	ENS	USD	US
ERG SpA	Power provider, from wind, solar, hydroelectric.	RWD	EUR	ITALY
EVgo	EV charging, an early leader in fast charging.	EEF	USD	US
First Solar	Thin film solar, CdTe low-cost alternate to polysilicon.	RSR	USD	US
Flat Glass Group	PV panel glass, solar engineering & construction	RSR	HKD	CHINA
Fortune Electric	Transformers for power transmission, switchgear.	ECV	TWD	TAIWAN
FSP Technology	Power supplies, inverters, and microgrids.	ECV	TWD	TAIWAN
Ganfeng Lithium	Lithium, produces compounds, metals, for batteries.	ENS	HKD	CHINA
Green Plains	Biorefining, lower-carbon fuels, renewable SAFs.	RBB	USD	US
Grenergy Renovables SA	Solar & storage, integrated project developer.	RSR	EUR	SPAIN
GS Yuasa	Battery technologies, also lithium for EVs, Japan.	ENS	JPY	JAPAN
Hainan Drinda	Research, development, and production of pv modules.	RSR	HKD	CHINA
Hannon Armstrong	Energy efficiency, capital & finance for infrastructure.	EEF	USD	US
HD Hyundai Electric	Transformers, circuit breakers, smart ships.	EEF	KRW	S. KOREA
Hubbell Inc.	Electrical equipment, grid infrastructure, utilities.	EEF	USD	US
ITM Power plc	Fuel cells, uses PEM technology; also hydrogen.	ECV	GBP	UK

Itron	Meters, Utility energy monitor, measuring & manage.	EEF	USD	US
J&V Energy	Solar, wind, and power storage	RWD	TWD	TAIWAN
JinkoSolar	Solar, wafers through solar modules, China OEM.	RSR	USD	CHINA
Kempower Oyj	Fast chargers, EVs, cars, trucks, aircraft, vessels.	EEF	EUR	FINLAND
Kingspan Group plc	Efficient Buildings, insulation, conservation, Ireland.	EEF	EUR	IRELAND
Landis+Gyr Group AG	Advanced meters, modernizing grid, Switzerland.	EEF	CHF	SWITZER.
Legrand SA	Electrical, energy & digital infrastructure in buildings.	ECV	EUR	FRANCE
LG Energy Solution	Batteries, in EVs, energy storage, S Korea,	ENS	KRW	S. KOREA
Lotte Energy Materials	Rechargeable battery materials, elecfoils in batteries.	ENS	KRW	S. KOREA
LS Corp.	Cables, wind power transmission over distances.	RWD	KRW	S. KOREA
LS Electric	Smart grid power transmission, wind, solar, storage.	ENS	KRW	S. KOREA
Lucid	Electric Vehicles, premium, higher-voltage, range.	EEF	USD	US
Mercury NZ	Clean power, 100% renewable hydro, geothermal.	ROH	NZD	NEW ZEA.
Motech	Solar, cells and modules manufacturing.	RSR	TWD	TAIWAN
Nexans SA	Cables, for grid power infrastructure.	EEF	EUR	FRANCE
NFI Group	Fuel cell and electric drivetrains, for large buses.	EEF	CAD	CANADA
Nibe Industrier AB	Heating, cooling, sustainable technologies, Sweden.	EEF	SEK	SWEDEN
Nio	Electric Vehicles, design, manufacture, premium EVs.	ENS	USD	CHINA
NKT A/S	AC/DC cables, grid infrastructure improvements.	EEF	DKK	DENMARK
Nordex SE	Wind turbines, based in Germany/Europe, worldwide.	RWD	EUR	GERMANY
Ormat	Geothermal, works too in recovered heat energy.	ROH	USD	US
Orsted A/S	Sustainable wind, also biomass, thermal, Denmark.	RWD	DKK	DENMARK
OY Nofar Energy	Solar, ground, floating and rooftops, battery storage.	RSR	ILS	ISRAEL
Phihong Technology	EV chargers AC & DC, power supplies, Taiwan.	ECV	TWD	TAIWAN
Plug Power	Small fuel cells, e.g. in forklifts; drop in replacements.	ECV	USD	US
Prysmian SpA	Cables, renewable power transmission, global.	EEF	EUR	ITALY
Quantumscape	Lithium metal batteries, solid state, quicker charge.	ENS	USD	US
Renova	Wind, Solar, Biomass, power generation in Asia.	RWD	JPY	JAPAN
Rept Battero	Lithium ion batteries, energy storage	ENS	HKD	CHINA
Rexel SA	Electric conversion systems, energy storage, cables.	ECV	EUR	FRANCE
Rivian	Electric trucks and vehicles, fast charging network.	ENS	USD	US
Samsung SDI	Batteries, innovative energy storage, EVs, S. Korea.	ENS	KRW	S. KOREA
Sanyo Denki	Power supply, cooling systems, solar management.	ECV	JPY	JAPAN
Scatec ASA	Solar, hydro, wind, storage, green methanol, global.	RSR	NOK	NORWAY
SES AI	Lithium-metal batteries, in EVs, eVTOLs.	ENS	USD	US
Shihlin Electric	Grid transformers, EV powertrains, motors, chargers.	ECV	TWD	TAIWAN
Shoals Technologies	Solar, electric balance of system, wiring, combiners.	RSR	USD	US
Signify NV	Lighting, systems increasing efficiency, Netherlands.	EEF	EUR	NETHER.
Sino-American Silicon	Solar, semi-conductor silicon wafer materials, Taiwan.	RSR	TWD	TAIWAN
SMA Solar Technologies	Inverters for solar, industrial scale storage, Germany.	RSR	EUR	GERMANY
Sociedad Quimica Chile	Lithium, a key element in advanced batteries, Chile.	ENS	USD	CHILE
SolarEdge	Inverters, panel-solar optimizers, micro-inverters.	RSR	USD	US
Solaria Energia	Solar, renewable power generation, Iberia.	RSR	EUR	SPAIN
Spie SA	Energy sustainability, decarbonization, design, build.	ECV	EUR	FRANCE
Sunrun	Residential solar, leases, PPA or purchase PV.	RSR	USD	US
Ta Ya Electric Wire	Power cables, wires, magnet wires, Taiwan.	ECV	TWD	TAIWAN
Tamura	Transformers, battery chargers, power modules.	ECV	JPY	JAPAN
TECO Electric Machinery	EV motors, wind converters, in electrifying all.	ECV	TWD	TAIWAN

Terna Rete SpA	Transmission of electricity, increasingly is renewables.	EEF	EUR	ITALY
Tianneng Power	Hydrogen fuel cells, batteries for wind and solar.	ECV	HKD	CHINA
Toyo Tanso	Graphite, used in solar, wind, H2, LEDs, SiC, more.	ECV	JPY	JAPAN
TSEC Corp.	Solar cells and modules, high efficiency PERC.	RSR	TWD	TAIWAN
Universal Display	Organic light emitting diodes, efficient displays.	EEF	USD	US
Verbio Vereinigte BioEn.	Biofuels, manufacturer supplier to Germany, Europe.	RBB	EUR	GERMANY
Verbund AG	Electricity supplier, hydro, a large provider for Austria.	ROH	EUR	AUSTRIA
Vestas Wind Systems A/S	Wind, turbine manufacturing & services, Denmark.	RWD	DKK	DENMARK
Voltronic Power	Power conversion, solar inverters, EV charging.	ECV	TWD	TAIWAN
Wacker Chemie AG	Solar polysilicon maker, a leader in Europe.	RSR	EUR	GERMANY
Wasion Holdings	Advanced metering, electrical and fluids.	EEF	HKD	CHINA
West Holdings	Solar, Japan-focused residential, commercial PV.	RSR	JPY	JAPAN
Xinyi Energy	Solar Farms, near 50 farms also floating, in China.	RSR	HKD	CHINA
Xinyi Solar Holdings	Solar, ultra-clear glass products, China.	RSR	HKD	CHINA
Xpeng Motors	Electric Vehicles, internet and autonomous features.	ENS	USD	CHINA
Yadea Group	Electric scooters and motorcycles, electric bikes.	EEF	HKD	CHINA
Zhejiang Leapmotor	Electric vehicles, internet connectivity, China.	ENS	HKD	CHINA

For Rebalance in Latter Q1 2026:
Deletions: ChargePoint, Nel asa
Additions: Rept Battero, J&V Energy, Hainan Drinda New Energy Technology

110 stocks = % Weights WEIGHT EACH COMPONENT =

0.90909091

110 Stocks for Latter Q1 2026.		#	% Approx. Weight
Energy Conversion	ECV	25	23%
Energy Efficiency	EEF	23	21%
Energy Storage	ENS	19	17%
Renewables - Biofuels	RBB	3	3%
Renewables - Other	ROH	3	3%
Renewable - Solar	RSR	23	21%
Renewable - Wind	RWD	14	13%
		110	100%

Appendix III: WilderHill Hydrogen Economy Index (H2X) for Latter Q1 2026 (65 components):

NAME	Description	Sector	Activity
AGC Inc	Fluoropolymer ion exchange membrane	HG	JAPAN
Asahi Kasei	Alkaline water electrolyzers, supplier of all components.	GH	JAPAN
Ballard Power Systems Inc	Fuel cells, H2 in buses, trucks, trains, backup power etc.	HT	CANADA
Belden	DC power from fuel cells, or intermittent wind & solar.	FC	USA
Bloom Energy Corp	Fuel cells, high temps can use variety of fuel sources.	FC	USA
Ceres Power Holdings PLC	Fuel cells, high SOFC temperature allows variety of fuels.	FC	UK
China Datang Renewables	Wind & hydro in China, that's developing H2 projects.	HG	CHINA
Chung-Hsin Electric	Fuel cells. Hydrogen, methanol reformers.	HG	TAIWAN
Corp. Acciona Energias Renov.	Green H2, new GreenH2Chain to ensure green H2 origins.	HI	SPAIN
Delta Electronics	Solid oxide fuel cells development, also electrolyzers.	FC	TAIWAN
DEME Group NV	Offshore energy infrastructure, green hydrogen.	HT	BELGIUM
Doosan Fuel Cell	Fuel cells, high temperature for a variety of fuels.	FC	S. KOREA
Energy Vault Holdings	H2-Vault Hydrogen Storage Tech	HS	USA
Evonik Industries AG	Chemicals, H2 carriers, membranes for eletrolysis, FCs.	HG	GERMANY
Fluence Energy	Energy storage software, hardware for green H2 on grid.	HI	USA
Furuya Metal	Electrolysis, green H2, iridium coating for electrodes.	HG	JAPAN
Hanwha Solutions	H2 storage, refueling vehicles, drones, aerospace.	HS	S. KOREA
Hexagon Composites	Hydrogen storage, also RNG, composite tanks.	HS	NORWAY
Hyosung Advanced Materials	Advanced composite materials for hydrogen tanks.	HS	S. KOREA
Hyster-Yale	Lift trucks, powered cleanly by hydrogen fuel cells.	HT	USA
Industrie De Nora SpA	Green hydrogen, by alkaline water electrolysis.	GH	ITALY
Infineon Technologies	Power electronics, in green hydrogen, wind, solar.	GH	GERMANY
ITM Power PLC	Fuel cells, PEM; electrolyzer manufacturing green H2.	GH	UK
Johnson Matthey	Catalyst-coated membranes, in fuel cells, electrolyzers.	FC	UK
Kaori Heat	Hydrogen (H2) generators, methanol fuel cells (FCs).	FC	TAIWAN
Kolon Industries	Membranes, fuel cell PEMs, MEA commercialization.	HI	S. KOREA
Kyocera	Solid oxide fuel cells (SOFC) stack development.	FC	JAPAN
LEM Holding	Power measurements, better fuel cell efficiencies.	FC	CHINA
Lotte Fine Chemical	Green hydrogen, production launch, ammonia.	GH	S. KOREA
Nexans SA	Cables, can carry both H2 + electricity, H2 pipelines.	HT	FRANCE
NFI Group	Hydrogen fuel cell electric power in buses,	HT	CANADA
Nippon Sanso Holdings	Hydrogen fuel, carried via ammonia for fuel cells.	HS	JAPAN
Nordex SE	Green H2, in a JV for electolyzers	HG	GERMANY
OCI N.V.	Green Ammonia, building up from biogas, hydrogen.	HG	NETHER.
Opmobility SE	H2 and fuel cell technologies in automobiles, trains.	HT	FRANCE
Orsted A/S	Green hydrogen directly from wind power, early stage.	GH	DENMARK
Plug Power Inc	Green hydrogen, and fuel cell systems in development.	HI	USA
Renesas Electronics	Hydrogen gas sensors, power controller systems.	HG	JAPAN
Resonac Holdings Corp	Lower-CO2 hydrogen from used plastics; graphite uses.	HI	JAPAN
Salzgitter AG	Steel, exploring new green H2 uses, SALCOS.	HI	GERMANY
Sanyo Denki Co. ltd.	Cooling units for fuel cells, renewables inverters.	FC	JAPAN

Scatec ASA	Green Hydrogen produced by solar power.	GH	NORWAY
Schneider Electric SE	Gas analysis, automation for advanced H2 storage.	HS	FRANCE
Screen Holdings	Membranes for fuel cells	FC	JAPAN
Sensata Technologies	Sensors, inverters, contactors, etc. for fuel cells	FC	USA
Sensirion Holdings	Sensors for fuel cells	FC	SWITZER.
SK IE Technology	Large plants for liquification of blue hydrogen.	HG	S. KOREA
SKF AB	Advanced bearings, for H2 by compressed transmission.	HS	SWEDEN
SMA Solar Technology	Electrolyzer converters, green H2 from renewables.	GH	GERMANY
Solvay SA	Advanced materials, membranes & polymers for H2.	HI	BELGIUM
SungEel HiTech	Recycling platinum from fuel cell spent catalysts.	HI	S. KOREA
Spie SA	Hydrogen in mobility, H2 production, distribution.	HT	FRANCE
Sumitomo Metal Mining	Non-ferrous metals and solid state batteries	FC	JAPAN
Taiyo Yuden	SOFC fuel cells-metal supported, capacitors, H2 fuels.	HT	JAPAN
Takaoka Toko	Power to gas for production/storage of H2	HG	JAPAN
Thyssenkrupp Nucera	Electrolyzers, a purer play in hydrogen generation.	GH	GERMANY
Tianneng Power	Hydrogen, fuel cells, Li-ion and other batteries.	FC	CHINA
Toray Industries	Membranes for H2 purification, generation, fuel cells.	HI	JAPAN
Toyo Tanso	Graphite, nanotubes H2 storage, brushes in wind.	HS	JAPAN
Umicore SA	Catalysts and materials, green H2 production, FCs.	HG	BELGIUM
Verbio Vereinigte Bioenergie AG	H2 from biomethane, biofuels, agriculture.	HG	GERMANY
W-Scope	Water electrolysis, by anion exchange membranes.	GH	S. KOREA
Wacker Chemie AG	Green H2 from water using renewables, into methanol.	GH	GERMANY
Weichai Power	Hydrogen uses in forklifts, fuel cell buses, Asia.	GT	CHINA
Yara International	Green ammonia, H2 catapult aims for H2 <$2/kg.	GH	NORWAY

Rebalance in Latter Q1 2026:
Deletion: Nel Asa, Littelfuse
Additions: AGC Inc, Sensata Technologies, Takaoka Toko

% Equal Weight each: 1.53846
65 Components % each = 1.53846

Hydrogen Index H2X Sector	#
FUEL CELLS (FC)	15
GREEN HYDROGEN (GH)	12
HYDROGEN GENERATION (HG)	12
HYDROGEN INNOVATION (HI)	9
HYDROGEN STORAGE (HS)	8
HYDROGEN in TRANSPORT. (HT)	9
	65

==========

Appendix IV: WilderHill Wind Energy Index (WNX) for Latter Q1 2026 (72 components):

Name	Description	Sector	Activity
Acciona	Sustainability infrastructure, engineering.	SG	SPAIN
Alfen NV	Smart power grid, energy storage systems.	SG	NETHER.
Allis Electric	Transformers in grid, switchgear, inverters.	SG	TAIWAN
Arcadis NV	Engineering, EPC, develops wind projects.	WI	NETHER.
Atkore	Conduit, cables, electrification assemblies.	SG	USA
Belden	Wind cables, turbine data communications.	WM	USA
Boralex Inc	Development and operation of wind farms.	WF	CANADA
Cadeler A/S	Offshore wind construction, maintenance.	WF	DENMARK
China Datang Corp Renewable	Among largest listed wind operators in China.	WF	CHINA
Corporacion Acciona Energias	Wind, global energy exclusively renewables.	WI	SPAIN
CS Wind	Wind power, both onshore, and also offshore.	WF	S. KOREA
DEME Group NV	Offshore wind infrastructure, undersea cable.	WI	BELGIUM
Daihen	Transformers, power distribution, inverters.	SG	JAPAN
EDP Renovaveis SA	Wind, among the world's largest generators.	WI	PORTUGAL
Elia Group SA	High voltage power transmission, Europe/UK.	SG	BELGIUM
Energiekontor AG	Wind farms developer and operator, solar too.	WF	GERMANY
Energix Renewable	Wind, solar, independent power producer.	WF	ISRAEL
Enlight Renewable Energy Ltd	Builds and operates wind, also solar sites.	WF	ISRAEL
Eos Energy	Zinc batteries, safer alternative to Li-ion.	SG	USA
ERG SpA	Wind, going from fossils to clean renewables.	WF	ITALY
Fluence	Energy storage, using intermittent wind in grid.	SG	USA
Fortune Electric	Wind power transmission, grid transformers.	WI	TAIWAN
Fujikura	Power cables, overhead transmission lines.	WM	JAPAN
Furukawa Electric	Cable connectors, electrical conductors.	WM	JAPAN
Grenergy Renovables	Wind, development, construction, operation.	WF	SPAIN
HD Hyundai Electric	Power transformers, circuit breakers for grid.	WM	S. KOREA
Hubbell	Electrical gear, modernizes grid, utilities.	SG	USA
Hydro One	Electricity transmission, distribution, Ontario.	SG	CANADA
IMCD NV	Wind lubricants, 100% recycled blade foam.	WM	NETHER.
Infineon Tech AG	Converters and inverters, wind power systems.	WM	GERMANY
JL Mag Rare Earth	Rare Earths, NdFeB permanent magnets, China.	WM	CHINA
Landis&Gyr	Smart Grid management, advanced meters.	WM	SWITZER.
LEM Holding	Power measurement, transducers, wind, grid.	WI	CHINA
LG Energy Solution	Batteries, ESS for strengthening the grid.	SG	S. KOREA
Littelfuse	Wind controls, sensors, circuit protection.	WM	USA
LS Electric	Offshore wind power, transformers & grid.	WI	S. KOREA
Meridian Energy Ltd	Wind, hydropower, Utility in New Zealand.	WF	NEW ZEALAND
Mersen SA	Carbon brushes in wind power, & graphite.	WM	FRANCE
Nexans SA	Subsea cables for offshore wind farms.	SG	FRANCE
NKT A/S	High voltage DC offshore wind, cables.	SG	DENMARK
Nordex SE	One of world's largest wind turbine makers.	WI	GERMANY
Orsted A/S	Renewable energy - transitioned from fossils.	WI	DENMARK
Osaki Electric	Smart meters and switchgear for grid.	SG	JAPAN
Prysmian SpA	Cables for new offshore wind and grid.	SG	ITALY
Quantumscape	Solid state batteries, lithium, grid storage.	SG	USA
Renova Inc	Independent renewable power producer.	WF	JAPAN
Rexel SA	Smart electrical systems, energy efficiency.	WM	FRANCE

Scatec ASA	Wind farm, new 5 GW, green H2, ammonia.	WF	NORWAY
Schneider Electric	Advanced grid, wind energy management.	SG	FRANCE
Shihlin Electric	Heavy transformers for grid, EV charging.	WI	TAIWAN
Sinbon Electronics	Heavy duty wind connectors, cables, grid.	WM	TAIWAN
SKF AB	Wind gear rolling bearing, seals, mechatronics.	WM	SWEDEN
SMA Solar Technology	Wind power conversion; green H2 from wind.	SG	GERMANY
Spie SA	Energy infrastructure sustainability, Europe.	SG	FRANCE
SSAB AB	Green steel development, in wind towers.	WM	SWEDEN
Sumitomo Electric	Power cables for offshore wind, grid, SiC.	WM	JAPAN
Ta Ya Electric Wire	Power cables, wires, magnetic wires, grid.	SG	TAIWAN
Taihan Electric Wire	Submarine cables wind, solar; high voltage.	WI	S. KOREA
TECO Electric & Machinery	Turbines for wind energy, and EV motors.	WM	TAIWAN
Terna Rete	Europe's largest independent grid operator.	SG	ITALY
Timken	Engineered bearings, friction management.	WI	USA
TKH Group NV	Power cables for offshore and onshore wind.	WM	NETHER.
Tocalo Co. Ltd.	Advanced surface coatings in wind, lubricity.	WI	JAPAN
Toray Industries	Carbon fiber for wind turbine blades.	WI	JAPAN
Toyo Tanso	Graphite, nanotubes, in wind, H2 storage.	WM	JAPAN
Vaisala Oyj	Weather intelligence, wind forecasting.	WI	FINLAND
Valmont	Strengthening grid, for more wind & solar.	SG	USA
Vestas Wind Systems A/S	One of first, largest, wind turbine makers.	WI	DENMARK
Voltronic Power	Power converters, inverters, energy storage.	WM	TAIWAN
Wasion Holdings	Advanced metering, energy distribution.	SG	CHINA
WESCO International	Utility electric for grid, assists renewables.	WM	USA
Willdan Group	Engineering, grid optimization, efficiency EPC.	SG	USA

Rebalance for Latter Q1 2026:
Deletions: None
Addition: Osaki Electric

72 components = 1.3889% Equal Weight each

4 WilderHill Wind (WNX) Sectors	#
SMARTER GRID (SG)	23
WIND FARMS (WF)	12
WIND INNOVATION (WI)	17
WIND MATERIALS (WM)	20
Total =	72

Disclosure: from the 1990s the co-founder and manager of the ECO Index began to sell personal holdings pertinent to any polluting fossil fuels - and to buy/hold instead equities in this clean energy space due to personal convictions and over strong concerns about climate change crisis; some of these may be in the ECO Index and they are all held very-long-term only.

ECO rebalances quarterly at the end of each March, June, September, December.
NEX/H2X/WNX rebalance quarterly at the end of each February, May, August, November.
For more on all 4 WilderHill Indexes, see: https://wildershares.com – or https://cleanenergyindex.com
For 1990s antecedents in an original Wilder-hill Hydrogen Fuel Cell Index, see http://h2fuelcells.org