WilderShares, LLC

Q4 WilderHill® Quarterly Report: ECO, NEX, H2X, WNX Indexes, Dec. 31, 2025

The Clean Energy Index® (ECO) began Q4 at 60.52 & ended Q4 at 64.44, up +6%. For all 2025, ECO was up +52%. Or in say the 'context of presidents' so 3 full Quarters into a 2nd term, ECO is up +95%. Persisting inflation had hit this interest-rate-sensitive theme hard. After clean energy and so ECO Index® had touched a low around middle of 2024, it later gained despite -- or perhaps a bit due(?) to a 2024 election. We'd seen in stimulative 1st term 2017 to 2020, ECO moved dramatically up +38% in 2017, down -15% in 2018, up +58% in 2019, remarkably up +203% in 2020 for about best performance of any Index or fund anywhere. Tallied was a total gain of +284%, ironically in the 1st term of a white house highly skeptical of green energy. Afterwards, ECO fell all 4 years of a very differing presidency, first down -30% in 2021, then declines next 3 years by -46%, -22%, -30%; tallied was down by -128%. The 'one big Act' is lately pulling demand forward -- and just possibly may knock it down further ahead.

Although passive, the ECO Index® can also fall hard. From up near 270 early in 2021, to down near 30 early in 2025, this renewables story so ECO had plummeted by over ~4/5ths. ECO, NEX, H2X, WNX can all 'drop like a rock'. Jumps true, yet crashes too. Note then end of 2025, broader stock market valuations were lofty, that in downturns green themes can fall by more. Yet our mission is to capture & track a risky story so crashes happen. Strong moves down, maybe up at times pervade clean energy's theme, so tracker too; has always been thus.

The global race for more electrons is now on, after years of slack demand. For past 10 years, ECO is doing 'less badly' than is natural gas, a key competitor for generating electric power. So last 10 years ECO Index, live since 2004 & the best-known clean energy theme, is up +44%. The 1st Global clean energy index, NEX live since 2006, seen via its tracker is up nearby +51%. For comparison, an independent natural gas futures tracker (not ours, as we focus instead only on clean themes) -- has fallen mightily: it is down a big -90% the past 10 years.

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

In sum our Indexes capture facets of clean energy. And energy, once mainly fossil fuels taken from deep down underground, and burned -- increasingly comes now by abundant sunlight & breezes, free from up towards heavens. Here's ECO tracker to late last quarter:

Source: YahooFinance.com

3 big promises made by a president on energy for 2025 turned out, respectfully, very wrong. Reasons why, help illuminate why the clean energy theme, so ECO, gained sizably that year. But let's start with a recent Q4 2025; last 4th Quarter ECO went sideways, up & down with sizable *Volatility. Over first 50 trading days, so from October to late-December (10th) 2025 -- we saw 29 days (or more than half) went sizably either down / or up at least 2 percent. Here's **ECO tracker in blue** (+11%) & in comparison S&P500 (+4%) in Q4 to late-Dec. (28th):

Source: YahooFinance

Two strongly-conflicting-forces, pertinent to clean energy yet moving opposite ways, clashed late 2025. One a good cause for Bearishness: US stocks arguably grew highly (over?)-valued. Made worse by AI stock mania, valued to perfection, likely a bubble that can/ should(?!) see air let out. Broadly, as S&P500 Price/Earnings (P/E) ratios grew excessive, klaxons blare, red lights flash. As we'll show, a 'CAPE' ratio had hit levels late 2025 seen only a few instances in 153 years, after which US stocks *crashed* some -20% to -89%. Much on just 6 AI stocks in an S&P500 alarmingly outpacing rest of an 'S&P 494' (some air was let out late year). Thus, much indicates *broader markets now are hugely over-valued, ripe for a plummet: this must be regarded as high-possibility. Note then too, volatile clean energy theme which can rise faster than broader markets, typically falls much, much harder in downturns.* And after an April 2025 nadir low at 28 seen in clean energy's theme, ECO gained 120%+ in 6 months. Then went volatile sideways in late 2025. All argues for maybe some reversion to mean ahead in S&P500. And hence for bigger falls especially here, in a more-volatile green energy theme.

Or opposing side & perhaps a good reason for possible optimism(?!) is that now undeniably, renewables are the winners on economics. *In 2025 wind power worldwide hit a record-low price of just one penny per kilowatt-hour (/kWh)* for cheap electricity by vast free breezes. *Solar power many places also 1 penny/kWh* for cheap electricity by vast free sunshine. When compared to traditional electricity by any fossil fuels, or nuclear -- clean renewables are now *The cheapest option*. In America, electricity by a new natural gas plant, best case, costs at least 6.5 cents+/kWh. Coal often worse. So much so, building new solar/wind from scratch -- is cheaper than to just keep a coal plant going on fuel, operating costs! Nuclear most costly of all, is worse than a natural gas that takes 7 years on average to build, more too than coal. In sum the 3 can't compete today on the economics vs. renewables. Even with energy storage needed to make renewables more 'firm', dispatchable, solar/wind are #1 clear choice today. This key advantage is now seminal. As fossil fuels/nuclear can only push up the costs for US electricity, a white house *may* begin(?) to soften its stance, add (shhh, quietly): renewables. If freed of politics, clean energy then wins. Hence a clashing of late. Clean energy's theme grew better-valued -- whether it's today far over(!?!)-valued, is a key question.

Despite frequently promising electricity costs will soon fall (or that they're already down?!?), hasn't happened at all. Reasons for incongruity help explain this theme's gains 2025. Why, first 3 full quarters from April 1, 2025, clean energy stocks were up, so strongly. While a white house & administration adamantly sought to halt new wind & solar. Stoking politics far more polarized & anti-renewables, than at decade's start. Arguably so much stems from a core repeated misconception, their belief fossil fuels are still the very cheapest energy. It was not / and is not well understood in an oval office, that factually, *this is No longer true*. Tellingly, today, *US States with very Lowest-Cost Electricity all rely first & heavily on their renewables*. Renewables now mean lowest-priced electricity. America's own wind & solar giant, Texas for example, has clean + cheap electricity. Not 'in spite of', 'or even with', but *due to* wind/solar dominating its grid. Globally too greater renewables plus storage often equates now to = lowering costs. But clearly not everywhere -- plus their 'intermittency' must be solved.

Let's turn to a Chart for clean energy themes in the first 3 full quarters of a president's 2nd term, so from April 2025 – to late December. We know this theme has many facets; so here's 4 themes, Q2 to late Q4 (Dec. 28th) 2025. All 4 clean themes (plus 5th 'not-so-clean') are well Up via trackers -- from roughly Up +101% as 'best' (ECO tracker), to +44% 'least up'. Very top is an independent ***ECO tracker (blue)** up **+101%**. 2nd is *Global clean energy NEX (light blue) up +52%. Next roughly tied for 3rd is global *Hydrogen H2X (yellow, tracker in the UK so ".L") up +48%, & a global *Wind WNX (purple, with tracker in UK so ".L" suffix) up +46%. Also shown is a global 'cleanish' theme ('not so clean', since it has had fossil fuels, coal, even nuclear -- so it is Not our's) in grey at 'bottom', although it is still up by a middling, +44%.

Start Q2 to late Q4 (Dec. 28th); 4 clean energy themes, plus 5th an alt. energy theme:

Source: YahooFinance

All 4 clean energy facets above, plus a 5th not-as-clean had long fallen, earlier -- prior to April 2025. (Invisible here as to left of chart). Even when world had in 2024, added a record 700 GW of renewables, 25% greater than prior year, a 22nd year of expansion, these themes' *stocks* had fallen hard in a prior 4 years. From 2021 - to April 2025, as global renewables capacities were growing -- these *stock themes* nonetheless fell. Then, after a 2nd term president walked back startlingly-big tariffs from April 2025, a noticeable rise was seen from far left in chart. Arguably fascinating too was temporally, the rise occurred from near-start of 2nd term *during* an ardently pro-fossil fuels president ferociously opposing clean energy -- as ECO and others here rose hard over 2025. Yet it's rather comprehensible, too, as we'll discuss ahead.

We'll glance at presidents too, as simply relevant to clean energy's theme. Although probably not in a direction one expected. Stepping back, we saw at start of a conservative leader's 2nd term, his initial Plan A for 2025 began re-directing the US economy in unprecedented ways. In 3 parts his Plan A first deployed *Huge Tariffs, aiming to bring in over $1 Trillion+ [*results have been a fraction so far*]; to do so without raising prices, inflation(?!). Tariffs proclaimed by ad hoc social website posts, bypassing congress where power to tax, originates. His Plan A also aimed also make *Enormous Cuts to Government Personnel, & to Spending; it assumed easy gains too of another $1-2 Trillion in revenue and savings [*didn't happen either; spending actually went … Up!*]. Presumed easy cuts, without major harm. Hoped slashing US regulations would be only & entirely stimulative, helped by over $2 Trillion+ from tariffs + spending cuts + growth. Promised too to bring in tens of $$ Trillions+ of new investments, huge gains in US manufacturing, hiring. Big deficit spending that pays for itself, allowing *Tremendous Tax Cuts in 'one big act'. Envisioned fantastic revenues + *less Debt*. Possibly eliminate need ahead for US income taxes. That was an original Plan A, at least at the very start of 2025.

Had it worked: if US jobs & hiring is booming, $2 Trillion+ in revenue; consumer confidence jumping; affordability & inflation licked, that would have been one thing. If US manufacturing is re-shoring, now in a renaissance. His promises were that US companies, jobs will be now growing like never before in American history. That he alone can and will have vanished all inflation from electricity, from gas prices at the pump, from food, and more by 2026.

Tragically, such expectations were in retrospect never likely. Such policies haven't grown jobs. Ended debt, solved affordability. Indeed, dismal election results November 2025 were a clear rebuke to party in power. Promised waves of reshoring, US manufacturing, hiring, hadn't happened. Prices were not down, hard. So, a president late 2025 tried a pivot. Threw out a dog's breakfast of ideas like $2,000 checks from tariffs (which brought far less than $1 Trillion), rather than No more Income Taxes. While claiming over & over America now has "lowest inflation ever", "greatest economy we've ever had". Cut tariffs on beef, coffee, fruit. Yet key data for Jobs, Deficits, Debt, Consumer Confidence were bad & souring fast. GDP was nicely up, but done by huge deficit-spending stimulus, meaning far greater debt ahead. Notably white house did show late 2025 it could (quietly) reassess; so perhaps it might try to change course on Economics, as original plans were seeing no success.

This review above is arguably worthwhile, as eerily-similar things are seen in US energy today. Oddly, that administration still adheres to most-costly of all options, fossil fuels & nuclear -- while opposing cheapest solar & wind. Repeatedly it's still promising to (somehow??) *lower* US electricity-costs, although that's 'impossible' on slowest-to-come-online: natural gas & nuclear. It was no surprise, then, US electricity rates went on rising throughout all 2025. Only now going higher. Rather than already down very hard by early 2026, as was promised.

A top priority should indeed be cheaper US electricity, so this suggests an oval office not yet serious. Nor "unleashing a US energy abundance". This mismatch, between newest policies -- and clear results, defies logic. A conundrum now is oval office policies continue to have an opposite effect. Even oil industry executives in 2025 vented their frustrations (in private). No shock US gas (gasoline) prices ended 2025, not "under $2/gallon". Or US oil production Dec. 2025, was not meaningfully above Dec. 2024. As we'll detail, a white house thinking in 2025 -- was opposite (ironically) of small-government, less-debt, open-to-competition 'red' US states, that have best lowest-electricity rates. We saw a white house late in 2025 was quietly looking at perhaps moving away from its costly, failed Economics policy. Just maybe, just perhaps(??) it may quietly reassess, possibly rethink too its costly failed Energy policies.

Respectfully, US energy policies in 2025 were unfortunately based on core misconceptions of how energy markets work. Saddled them, with issues of seriousness, implementation, even competence. For example, 'merit-order' electricity markets of US, & Europe favor cheaper energy 1st: so, prices go lower as more renewables are available. Last generator dispatched (so most expensive) determines price. How then may 2025's mistaken energy choices be fixed ahead? As a candidate then president, this American leader repeatedly, memorably, boldly promised to "slash electricity costs in half within 12 months". Yet his policies in 2025 instead had opposite effect; so, to now drop by ½, if unchanged, is *impossible*. ('Impossible' a strong word, yet apt here). Yes, achieving *Cheaper electricity* is crucial -- but he's being very poorly advised on how to do so -- for clearly very cheapest US states for electricity, all rely 1st on their own ample renewables. They all make large & fast-growing amounts of clean energy, Go 1st to their ample wind / hydro / solar. Only after may they turn to costly natural gas or coal or nuclear. Fossil fuels do offer firm (always-on) power, at times important. But daytimes, or windy times, renewables deliver abundant, lower-priced energy. That can be firmed with more energy storage, better grid. A decreasing need for firm (costlier) gas.

Yet as a president had very thing in 2025, halted cheapest once-fast-growing wind & solar -- US electricity prices were bound to rise. Which they did … by a lot. Up by more than inflation. Not down since it means adding renewables, like states with lowest-cost power all heavy into renewables. Inversely, US states with most expensive electricity all rely heavily on fossil fuels; plus often have harmful cost structures, poor execution, higher natural gas prices, wildfire, and other risks, making them more expensive. We've seen too that this president has very helpfully, long made his own grievance towards renewables abundantly clear, notably his feeling offshore wind harms views from his golf courses. Yet here too, he's being poorly-served by his own advisors. Who should present facts, 2020s. Like that (once) far-higher costs / unreliability of solar & wind he cites, real issues in 1980s, no longer apply 2020s. Instead, even oil industry executives privately were complaining that his own US Energy Dept was now 'only giving the oval office what it wanted to hear', rather than providing the facts.

That president also repeatedly promised he'd fast push "gasoline below $2/gallon". Was he right at least here; had his policies reached that key goal by now?! Sadly, not close. Average US price for gasoline (gas) as he took office was about $3.07/gallon in January 2025. As we'll discuss, many forces affect price of gas consumers pay at the pump: US rig counts, $ shale investments, expected oil demand near term, intent to return capital to shareholders vs. more drilling, overseas OPEC+ production levels etc etc. That said this promise was/ and still is, nowhere near right. End of 2025, average US price at pump was still absurdly far from under $2 gallon! Barely under $3/gallon. And small price drop anyways was much due to resumed output overseas, greater production after a curtailment was ended by OPEC+.

Yet remarkably, that white house claimed in 2025 that average US gas price was already as promised, under $2/gallon. While some spokespersons were half-hearted, as no US state average was near $2 in 2025, the president himself was full-hearted in his own boasts. Like Nov. 2025 that gas "prices have plummeted to lowest in 2 decades", or a "bit above $2 right now for gas going to approximately $2 very soon". Of course, no US president buys his/her as at pump, so a president may not readily know US retail gas price (in way Americans do filling their cars). His appointees too like vice-president, cabinet members all echoed his wrong boasts in fulsome ways. But it just wasn't so. Arguably those around a president should inform him his claims were wildly off. Actually, at times early Jan. 2025 so in a prior administration (one clearly not favored by him), gas had recently cost less. And briefly it was actually under $2 in his own 1st term(!), during the pandemic some 5 years earlier in 2020.

Even broken down as 50 states, *none* were near $2 in 2025. Yet he claimed May of 2025, gas "hit $1.88 in 3 states". July 2025 "hit $1.99 in 5 states". Aug. 2025, US gas was "below $2 some places". All mistaken. Still affordability Is crucial: with gas so high, one hopes average price goes under $2/gallon; understandable. Yet on white house policies, it wouldn't go under $2 average in 2025, in any way, shape, form. Reasons include oil industry requires robust oil demand to raise rig counts & production. Opening tracts *can* push oil down briefly near $50/barrel; yet many US shale rigs are un-economic at such low prices. *And oil must fall below $40/ barrel, for gas under $2*. Yet US rigs are then shut-in, rig counts fall. All well-understood by oil execs who privately vented across 2025 about poor US energy policies.

Or consider respectfully, another repeated claim, that he'd fast "Unleash American energy" in a "golden era of American energy dominance". Like many aims, it is laudable. Yet again, contrary to his policies which had / & continue to have, opposite effects. Right off the bat in 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". What's needed instead, are truly 'all-of-the above' energy strategies. Yet likeliest outcome of 2025/2026 policies was / & is *more expensive* US electricity. Unable to grow supply now as fast as AI demands. Consumers hit by ongoing sticky gas prices. US oil production not meaningfully greater, than at end of last administration. No "unleashed energy abundance". Even US natural gas prices sticky on more LNG exported abroad. All making America's own dirtier energy portrait latter 2020s, ironically now worse: *less affordable*, *more* brittle.

Obvious solutions can be seen in US conservative small-government red states, open to fair competition, as a blueprint. They have low-cost energy & much renewables. Or for example, look globally: in 2020 a lead-oil-exporting nation got near-zero electricity by renewables. Then, it opened up to solar/wind. By 2025 it had set world records for making very cheapest wind & solar electricity ever, 1 penny per kWh! In just 5 years, they're aiming to soon make over 50%+ of their electricity by renewables. The fastest growth of solar in human history.

Meanwhile a US 2025 had tried every step imaginable, some not so-imaginable, to stop solar & wind. For actions right off the bat 2025 by federal officials hitting at new US wind/solar: Declared a national emergency to help hasten permits -- except strangely carved out solar/ wind/ storage as 'not energy' (January). Froze permits for new onshore & offshore wind on public + private lands (also Jan.). Interior Dept Order deemed solar/wind as "precariously inadequate", a national security risk and on that basis it blocked renewables deployment (in February). Revoked Rules & Orders if pro-renewables, or they refer to climate (also in Feb.). Removed solar/wind from cheapest & fastest energy Lists so struck off affordability agendas. Halted an already-permitted New York Empire offshore wind project so costing $$$ millions. Canceled an enormous 6.6 GW(!) solar project with 5 GW battery storage on 62,300 acres of Nevada desert because it was sited on federal lands. New 'foreign entity of concern' rules were drafted to stop solar/wind credits. Signed 'one big Act' to greatly reduce US solar/wind and raise electricity prices. Canceled an 800-miles 5 GW transmission line that would have sent cheap wind power from America's Midwest. These above are but a few examples.

The administrative actions in 2025 also included things 'one could not have made up'. Like in an Orwellian twist, a core Office in the US Energy Dept. issued a novel 'Banned words List' for internal & public-facing documents. It dis-allowed the use of obvious keywords such as "climate change" (since this term implies that the concept is real, and that it's a bad thing); and "emissions" (since it too implies these are bad); even the use of either "clean energy" or "dirty energy" (since either implies one term is good, other not-so-good). Not kidding.

Might such policies just perhaps, quietly be softened ahead?? Notably those energy paths are not costless. They're now pushing Up electricity costs fast -- and if America is to build AI, grow jobs, re-shore industry -- then energy costs must come down. By 2024, renewables were already cheaper, than even least-cost fossil fuels or nuclear over 90% of time -- gap widening! So there's a limit to what politics can do in harming renewables. Hence a softening may mean (*shh, quietly so they don't admit to being wrong), moving away from fossil-fuels-only. Yet that administration eg by Emergency orders in 2025, even mandated coal-plants Must stay open (that all wanted closed!!) costing $615,000/day. *Economics* made hundreds of US coal plants shutter. Trying to force some US fossil generators to stay open, can cost US consumers $3 billion/year. On painful high electricity-costs, economics may force possibly, a rethink. Would be abrupt change though. In Dec. 2025, US Energy Secretary announced he was looking at keeping America's Back-up Generators at big box stores etc running constantly 24/7, for giant 35 GW. Put aside for a moment it would be polluting, most-*In*efficient way to make electricity imaginable. Note it would also instantly be: **The Most-Costly-Possible* Way to make electricity!* Non-sensical, if one seeks cheap electricity. But, tellingly, if an aim is to use only diesel, natural gas, propane fuels-- no matter higher costs (and to halt renewables, no matter what), that's only way to 'justify' such idea. No wonder new US energy policies in 2025/2026 were widely seen as non-serious. Raising questions too then of competence.

So one may have thus expected clean energy stocks, so ECO to have fallen hard all 2025. Instead, as noted, ECO Index & so a tracker jumped over 6 months from April 2025 low. That didn't go unnoticed. 1st month of Q4 2025, just for October trading volumes in an independent ECO tracker were significant, near $1 Billion. Next month, Nov. 2025, despite Thanksgiving day stock market closure & one less day in the month, that approached $1 Billion.

Factors in theme's rise, maybe included, oval office tries to decimate solar/wind in 'one big' bill surprisingly failed last hours. Replaced by 4 years of credits. Attempts to tax just renewables, failed too(!) in last hours. Plus, core is: *renewables now have the very best / lowest costs, even unsubsidized*. And removing complex subsidy rules now isn't fatal: can simplify much, end uncertainty, reduce costs. Plus, China is starting to rein in its excess capacity, oversupply. That said, an US executive branch worked to hobble solar, wind, EVs. To render even brief US green incentives moot, make them un-attainable so non-effective.

What, beforehand early-on in 2025 had pushed expectations down, coiled a spring for big rises mid-year? One was likelihood clean energy opponents led by oval office & self-proclaimed 'fiscal conservatives' (barely) in control of house & senate -- could decimate green credits. They'd drafted a harsh 'one big bill' to June, real chance fervent opponents of renewables could 1st jam moderates in house, then 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 own party's own moderates might upend such efforts, and slow that inertia, were not great.

As a draft highly dis-advantaging solar/wind was worked-up in house, where spending bills begin, those oddly self-proclaimed 'fiscal conservatives'(!?) knew 'one big' bill will blow up US debt. Raise debt ceiling by $5 Trillion! 7% deficits, $3.4 Trillion deficit spending! Yes, it will 'juice' stocks, but as a 'deficits /debt-bomb'. As the draft moved to senate, seemed sure 1) Kentucky's libertarian senator would be a 'No' given long-principled stand against debt: bill's deficits weren't at all Conservative. So president briefly railed against senator, who was unmoved: proposed debt inarguable. On a president's self-imposed July 4th signing deadline, and likely just 2 total senate No's (same as in house), its passage seemed likely.

Hence it was pivotal as North Carolina's senior senator with rare deep knowledge of energy, announced they'd be a new 2nd 'No' as well. Senator stressed their No was on that president being "very badly-advised" on energy, health care. As a result, just 2 moderate senators can in effect 'tag-team'; 2 more No's, would be one too many. 1 on-fence senator could demand enormous changes in exchange for their Yes. Conservatives, who'd wee hours before eagerly gloated they'd jam liberals on solar/wind in house, then in 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 better than most any politician. The president wanted to conclude & sign July 4 -- so he threatened to 'primary' that 2nd senator. Hit him hard at polls. That senator retorted well then, best to look for his replacement since he'd just retire, neutering such threat.

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

As that North Carolina 'No' had made so 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 the new 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'. Vs 3 real-world business experts, who all knew about actually fast-putting more needed electrons & batteries on better grid.

The 3 real-world experts all wanting far *more* renewables, better grid, included 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. So, attacking renewables/grid was senseless. He bemoaned 'somebody had gotten cute' too in negotiations replacing deadline text wording requiring 'in construction' -- with 'in service' -- as it can effectively decimate new renewables. This senator with much expertise in grid baseload energy noted so much progress in solar & wind was now teed-up. Yet instead, white house representative lacked experience, didn't know how to actually-plan-for power ahead. Lamented that the draft was still 'half-baked', so this loyal-senator was forced to vote against party on a bill backed by an inexperienced zealot/ 'philosopher' with No Real-World Understanding of generating electrons. A video of this impassioned unusually frank pivotal speech as recently delivered on the US senate floor, can be seen at, https://www.dailymotion.com/video/x9m45t0

This senator noted how even best case due to supply bottlenecks, any gas turbines not already in contract, would not be ready for ~5 years. So fossil fuels & nuclear can't deliver soon; hence electrons can't be online fast if renewables aren't built. Yet 'conservative' (not really) advisor hadn't understood this. Thus on the 3 No's from Kentucky, N. Carolina, Maine, a swing Alaska vote, input of key senators from Utah & windy Iowa including a parent of PTC, many big changes last minute moderated that bill. It made 'conservatives' fiercely anti-renewable/ pro-fossil-only howl, but they'd been jammed in senate, house. For example, a prior draft would have cancelled all solar/wind tax credits immediately, for projects not 'in service', a deadline few met. Much is outside control, like Permits to put electrons on America's fragile grid, taking years. That's why the expert senator noted somebody 'got cute' as draft text went from 'in construction', 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 A Tax on renewables! Or to forbid China-built components, notable as solar (sadly) is overwhelmingly still made just in China/Asia. In end jammed, pro-fossil 'zealots' lost much of most extremist text in final few hours, when many of their worst proposed penalties, got moderated.

Softer "or" words added too, so besides those impractical, 'be placed in service' deadlines -- projects *alternately* could '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 just 5% of equipment if paid-for; or work is done of a "significant nature" on/off-site demonstrating continuous progress. Oddly those self-titled 'fiscal-conservatives' were fine adding $3 Trillion+ in deficits, huge new debt; they even sought too a *costlier* US electricity -- so long as it's fossil fuels/ or nuclear; gladly if harms solar/ wind. To bolster that, a July 7th Executive Order demanded federal officials "strictly enforce" new paths that terminate subsidies for renewables. Concerns arose over that.

That administration questioned Safe Harbor; threated retroactivity; underscored willingness to push boundaries/norms. New 'foreign entities of concern'. To empower clean energy foes, an Interior Dept July memo stated renewables on federal lands/waters needed an ok from the Interior secretary: it gave 70 ways to hinder solar projects. Another concern, soon-coming US Treasury letter might be *Retroactive, so obliterate prior better rules; end hopes projects can begin by mid-2026. A fear too was *Treasury Dept may dis-allow 4-year window to 'begin construction' on home solar if 5% of fair market value is spent. Yes, that window was expected to close for big utility solar projects; but might it continue for home rooftop solar, allow 4 years for smaller projects that commonly avail upon that? When a US Treasury Dept. did issue a Letter latter 2025, thankfully it came out *much better* than feared. Language was softer than feared and did not contain retroactivity. Hence solar stocks then did jump.

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

Looking back at clean energy /so ECO's gain all 2025, many of its components stood out with impressive gains. How these gainers in passive ECO Index, were included so many years ago -- is maybe not so apparent to folks outside energy, so worth a mention. One, a component in *lithium was up 200%+ in 2025: ECO's always had deep exposure to lithium/battery materials since Index inception over 20+ years ago. For how lithium was understood so early on as likely to be critical for green energy ahead, just consider physics & chemistry. Left column in second row of the periodic table, lithium is importantly the 1st and so lightest metal, with 3 electrons (2 inner orbital, 1 valence) at atomic number 3. Just 3 protons, 4 neutrons, super-light, less dense than water. And with just one outer shell electron, it's of course very reactive. Thus it 'wants' to either add an electron -- or most relevant here, this atom readily loses that single-electron to become an ion, which we all know of as it becomes Li+ ion (lithium-ion).

Li key traits as very lightweight, very reactive, very energy-dense, made it likely core to new batteries ahead. State of art battery tech back in 2000, was chemistries then were far too heavy (lead-acid), memory effects (nickel cadmium), or simply not as energy dense as will be needed for expected new electric vehicles. Hence lithium posed as a 'better-metal', was foreseeably fated to fill gaps in new battery technologies in development. Plus, there's newer policy factors too. US & Canada years ago had let their few crucial lithium sources shift to overseas; production moved to Australia, Chile, even China. That meant that the precious few American suppliers left could grow fast, see far-better valuations. As happened in 2025. In essence by recognizing physics, and policy mistakes too, one wasn't so surprised when domestic US lithium stocks, or even those from the Americas rose quite hard of late.

Or take *rare earths metals, and a 2nd component long in passive ECO, here up 300%. These rare earths Lanthanide group is made up of 15 / 17 elements that in fact are not rare at all -- but difficult to purify. Vital to most-powerful magnets, motors: they've long been very relevant to, so part of this clean energy theme. Note then a 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. Yet only suppliers now are overseas. Neodymium, say, at atomic number 60, with iron/boron in magnets lifts 1,000x its weight. To replace that neodymium, with a US-sourced iron-nitride will take years. As geopolitical risks spiked, it too meant price manipulations inhibit competitors. So, a new US industrial policy support could move markets. In sum rare earths were very relevant to, long part of ECO too in passively capturing clean energy. So when this longtime component also jumped in 2025, exact catalyst itself was not so-pertinent; but it was foreseeable, as was impact on ECO.

A 3rd name, in *fuel cells was up 400%+, 5-fold 2025. Fuel cells are highly-relevant to, so in theme, yet they've also been loss-makers for 20+ years! This component is a bit different; unlike needing a pure hydrogen /H_2 fuel, thorny given high cost of H_2 that's a problem today -- it is designed to use natural gas (methane/CH_4) fuel that's everywhere, easy to use. Rather than burning gas so an exothermic, polluting combustion -- this instead strips that CH_4 to H -- so hydrogen protons (again ions): with electrons for desired electric current. But downsides include 'stacks' must run hot so a short life not yet much over 5+ years; efficiency not much better (yet) than natural gas plants, & costly. Still, it can go up faster than gas plants; is stackable, less NOx pollution. So, AI hyper-scalers seeking electricity quickly, can turn here. On new Deal Announcements, nimble execution, falling rates, this 3rd in ECO, since listing in 2018, jumped 2025. The above 3 'winning' energy names all in ECO -- were in stark contrast to 3 'losing' energy concepts seen 2025, all far outside of ECO. Let's consider those next.

Recall big energy promises a candidate, then president, had made. With his administration now a year+ in, they should be checked. Easily examined are his repeated promises to have 1) 'slashed electricity costs by 2026 by at least 50%'. 2) *gasoline prices 'under $2/gallon'. Such promises can be easily-graded as kept, or not. Let's focus on energy, as it is our work. His frequent promise "electricity costs will fall by ½ within 12 months of [my] taking office", clearly failed. At times he also said "maximum 18 months" so we'll charitably take a longer view and re-look mid-2026. Still, by end of 2025 after his big changes, were electricity costs down by ½? Was gas under $2? Had an era of US 'energy abundance', been 'unleashed'??

Regrettably not at all. As noted US electricity prices didn't fall, at all. After signing a hallmark 'one big' Act, US electricity costs *rose all 2025, went up some 6*%+. Likely, climbing ahead -- a lot! Was his frequent promise that US gas is now under $2, right?!? Under $2, prices staying low, hardest part?! No, not close. On price at the pump, average gasoline (gas) price was $3.07/gallon in January 2025. US oil production was 13.6 million barrels/day (bpd) Dec. 2024. An oval office lacks tools to directly set gas prices. Yet by Dec. 2025, gas was hardly changed, around $2.90. (Maybe he somehow confused gas & RBOB, wholesale product, not retail gas). Americans see gas up close, so undeniably it's Not 'a dollar something'/gallon. Prerequisite too for under $2 gas is US oil output risen hard, so oil falls under $40/barrel, *stays there*. Yet even $50 oil is unprofitable for many US drillers. Hadn't happened anyway: in 1st half 2025 US oil production *fell*: did not rise back to 13.6m bpd until Oct. 2025. By Dec. 2025 hardly up: 13.8m bpd, so even here his policies failed. Respectfully, confusion was seen again in a speech Dec. 2025 where he said: "within the next 12 months, we will have opened 1,600 new electrical generating plants, a record". That's wildly(!) off: he maybe mixed things up, as *3* new natural gas plants were coming online ahead to make near 1,600 MW (1.6 GW) each; a 1st online 2026 but other 2 after 2029 soonest. Just 1 plant, is absurdly different from *opening 1,600 new natural gas plants in 2026!* Takes on average 5-7 years to go up; only 3.34 GW or just a few big natural gas plants opening all 2026. Once, a bit over 100 natural gas plants were hoped for by 2030; but that was now unlikely on higher costs for turbines, fuel.

He did make a subtle yet meaningful change Dec. 2025 re: price at the pump. Rather than go on insisting US average is now "under $2" -- a 1st time ever he changed it to "in some states". And made it "under $2.50". In this way white house can walk back a seminal claim; cover its tracks, and maybe it will point ahead to a bit closer, cheapest gas, Arkansas, Oklahoma.

Yet if more cheapest US solar and wind is what will fastest push down US electricity prices – and an oval office was pushing only costlier fossil fuels & nuclear /while hitting renewables -- what helps explain this counter-factual? In part seems to be out of a deep antipathy for, an individual's visceral hatred of wind & solar. Consider in 2025, visiting Scotland the president helpfully explained much of his own reasoning for deeply opposing wind power. While next to European Commission head, that US president spoke about 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 the assertions above, respectfully, are so very incorrect. Energy has changed greatly in a past 40 years; so much so, latter 2020s wind & solar are not costly energy; they're *now the cheapest*. US states with lowest-cost electricity, rely on wind, solar. The 2 cheapest electricity states: S. Dakota & Idaho turn 1st to ample renewables. While costliest US electricity states rely heavily on fossil fuels. Plus, most wind gear in Europe/US isn't made in China; doesn't rust or rot in 8 years, it runs 25+ years. Wind works reliably-well in Germany with its growing renewables. Contrast that with most-coal-dependent-US state, W. Virginia, with *least-reliable* electricity. A state of Iowa had the greatest percent wind power in 2025, got 2/3rds or 66% of its electric power by wind: 6,000 turbines & cheap electricity; plus its costs there *fell* in year to 2025. In short respectfully, such wrong notions above of wind/ solar were maybe understandable, if they'd been formed in a far, far different 1980s. Yet now in 2020s they'd become, bluntly, enormously incorrect. That president 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, or fishing gear entanglements. *But everyone is entitled to their own opinion.* And that president deserves much credit for being so frank, forthright. He oft speaks of his own personal grievances on offshore wind: specifically, the visual impacts on his golf courses. Helpfully that president has spoken at length since 2011 about his animosity over the sight of offshore wind from his golf courses near Aberdeen Scotland, Doonbeg, Ireland. He's sued, & lost, claimed it ruins views. Local/national governments there however take an opposite side; in 2025 just 2 days after his comments & after leaving Scotland, the Scottish government approved the world's largest offshore wind farm: huge 4 gigawatts (GW). To power 6 million UK homes, for thousands of jobs, reducing electricity costs, billions of GB pounds in revenues. Bigger than anything then off China, saying a lot. That US president (who's claimed 'wind power noise causes cancer') finished his own helpfully personal, illuminating comments of his choice by 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 oughtta 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"….

That administration hewed closely to his views, a president who famously brooks no dissent. Thus, it denied renewables *lower* costs -- instead it has insisted old energy is best(?!) His US Energy Dept launched an unprecedented Coal Ad Campaign(!) with a glowed-up sparkling coal lump & tagline: "She Is The Moment". Though coal is costly US electricity, definitely dirty, poor reliability. Coal has some 'firmness' unlike intermittent solar, working days only, or wind only in breezes; so latter are best with growing storage and better grid. Yet if sentiments by a president that wind is costly, or doesn't work were maybe (understandably then??) formed in a 1980s, this Coal Ad seemed from an 1880s; now grossly counter-factual. Even a glowed-up lump with big sparkles-photoshopped in, can't give what that Ad implied. But it's an Ad very specific to a US. And whether the Coal Ad's theme 'has legs' is yet to be seen.

Conceivably, might that administration latter 2020s, possibly alter direction? For how badly white house 'pushed on a string' all 2025, in hopes & claims to add fossil fuels & nuclear cuts US electric costs(!?), consider facts. These will bedevil fossils all latter 2020s. The fact is any new US natural gas-plant + its fuel, is now far costlier than solar/wind. Gas-fired power, very best case, costs at least 6.5 to 8.5+ cents/kilowatt-hour (kWh). Even if turbines are found & on shortages, it's unlikely before 2030. Plus US nat. gas as fuel, is increasingly exported as LNG, so pricey as buyers in Europe/Asia pay more. Alternatively, there's nuclear power. Yet big nuke reactors in a west every single case go far over-budget. Small modular reactors lately enjoy 'hype-cycle' subsidies. Yet smaller US reactors today exist in theory only; a few commercial-experiments worldwide have been far from on-time, on-budget. Even their power $/per kWh will be priced above big nukes, themselves too costly at over 10 cents/kWh! So, on nuke costs & safety, one can only hope there's new solutions ahead there late 2030s.

Among non-renewable energy options, this leaves only: coal. Yet in no way can coal *ever* reduce US electricity costs. Even in China where coal capacity is still being built, China turns 1st to its own renewables as cheapest; so its coal plants run at just 50% or less capacity. Hence coal is too costly even in China, though its pollution / and its human health standards are far more lax, than in a west. Look at US coal in fast decline today & focus is Not whether new coal plants can soon be built -- but rather on when last existing ones will be retired.

And yet this 2nd term administration hoped to promote, revive US coal. Late in 2025 It held largest coal auction in decades. Huge 167 million tons Montana coal got … just 1 Bid only. For a silly $187,000, valued coal under a penny per ton! Back in 2012 that area's winning bid was $1.10/ton, 100x more. Reasons for 2025's abysmal auction were plain. *Coal-fired US electricity is now uneconomic, too costly.* A last US coal plant went in service decade+ ago -- none since. Lone bidder in 2025 noted so many coal plants will go offline next 2 decades. Yes as both a candidate, and then in oval office, he'd often spoken of "unleashing American energy", pantomimed "digging coal", but the economics are undeniable. His administration in 2025 halted a planned 441 million tons 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 wrote [perhaps a 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, more sobering analysis, is while 2nd term administration may blame awful bids on "lingering impacts" of [prior president's so-called] 'war on coal', fact is, coal for electric generation was already very hard down. Fell 3.5%/year in prior presidency. But earlier, was already down 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 note *"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 these latter compelling points, are today food for thought.

To clinch how electricity rates may best be-lowered, let's see where they're now, cheapest. Places all potential energy paths are allowed, with smart policies, what's best? We know on sheer efficiencies, solar/wind -- beat fossil fuels on low-cost. Thanks to sun & breezes as free fuel, solar & wind manufacturing scaling-up globally, missing link storage-down fast in cost as dispatchable power, this gap is only widening. Recall too, 2025 set a new world-record for low cost wind power: just 1.338 pennies/per kilowatt-hour (kWh) in not-very-windy, Saudi Arabia. Or note China, Norway, Saudi Arabia, plus Iowa, Kansas, Texas are all Very Different places! Yet they all have cheap power on their renewables. There are far windier places, than a Saudi Arabia -- like say midwestern United States, or a northern UK, or so many coastlines around the world. So many places to match incredible-low wind costs of 1 cent per kWh too, if given very strong policy support. From a recent-near-zero renewables there, Saudi Arabia is deploying its solar at a faster pace than any country, anywhere, any time in history. They're aiming to quickly see over 50%+ of their electricity come from new renewables + storage.

By no stretch, can Saudi Arabia be deemed 'liberal'. Nor its policy driven by climate or CO_2. But what they're doing, just makes sense. Sell a costlier oil to others, while swiftly building immense domestic, cheap solar, wind, energy storage, & grid for themselves, they're making power at smart low costs. Looking ahead, to beyond when fossil fuels no longer have value. Sure, they're making nicely clean electricity. But power is what's needed, and at just about 1 cent/kWh, even with added costs for storage/ better grid to solve intermittency, its public and industries will enjoy remarkably green + cheapest-rates. Again, not such a windy place -- political will is the driver. Anyplace with ample winds can/should do it as well. For instance, Norway provides citizens cheap green electricity among lowest costs in Europe | while selling its oil & gas abroad. China in 2026, developed new Y-shaped floating wind turbines of massive 50 MW size, 'blowing away' [no pun intended] anything to date. They'll push down wind costs in never-ending ways (unlike fossils). A US state of Texas, could, like Saudis, have cheap clean electricity for its own people | and sell pricey oil & gas if desired. Oddly, a US president can demand coal be called "Beautiful & Clean" by his staff [he really did although it's neither!) -- but doesn't fix dismal economics of coal. There is such diversity of places where electricity costs are now low, & getting cheaper thanks to more renewables, including China, Portugal, Saudi Arabia, like in US a North Dakota, Iowa, Idaho etc. Explaining much, at a glance.

Saudi Arabia's wind at 1.3 cent/kWh in 2025, handily beat out natural gas, coal, or nuclear -- only-option as good & cheap is another renewable on efficiencies & free fuel too: Solar at 1.097 penny/kWh. Yes, Saudi Arabia's a hugely-sunny place. Yet so too is southwestern US. Saudi is building vast new energy storage & better grid at florid pace, for power firm & dispatchable. Not hit by weather vagaries; bad weather hits all fossil fuels (West Virginia, the most coal-dependent US state, has highly *un*reliable power, lacks 'firmness' yet fossil-interests claim they win on this). If support as strong fast-builds solar, wind, grid & storage in America, it too could be a 'Saudi Arabia of renewables'. Instead, Saudis long known as the 'Saudi Arabia of oil', are fast-becoming, err, 'Saudi Arabia of renewables' too. While a US curiously was racing in latter 2020s towards sadly costlier energy. Allowing only worst fossil fuels/nuclear -- while *harming best resources, solar/wind(!)*. One day this weird interregnum of today may be looked back upon as a time America lost her way. Led obviously to-costlier electricity. A pejorative joke may be, it's the 'America of renewables', meant as folly. Arguably this US path makes no rational sense. But, for those watching US energy markets carefully, such white house moves may also convey a short-term, especially-risky yet 'odd-predictability'. Opportunity just maybe in brief timeframes. For in equity markets, consistent (even when wrong) odd decisions may be noticed & acted-on, if guessed in advance.

Mainly we look at clean energy/stocks in mid-term time-scales; weeks or months to few years. But let's just briefly look at scale of hours to few days, say in mid-October 2025, for moments of heightened broad markets & clean energy activity. Say just after Thursday, October 9th when China stated it might expand rare earth export controls for 5 elements, on a bans list -- and in 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 US president said he'd add huge 100% tariffs on China, going from 40% -- to 140%! On that Friday afternoon's headlines shouted 'US-China Trade War Back!', broad markets fell all late-day. Dow was down -1.9%, S&P500 -2.7%, Nasdaq -3.5%. In late-Friday's trading, $2 Trillion was wiped off the value of US stocks.

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

Note then, hours later, on Sunday that 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 sharply, anticipating Monday's open. Volatile ECO and a tracker that 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 on Thursday, and on Friday by -3.5% (volatile, up Monday +3.6%). All set amid broadening concerns over excess valuations in the S&P, with falls in broader markets -- so here too in clean energy. Below are 4 days in ECO amid strong reasons for declines, given excessive big cap stock valuations, frothiness, maybe big & broad crash soon ahead:

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** possible; **Trade War, High Tariffs also vexing,** China's negotiator called 'unhinged'; **Inflation,** maybe a Stagflation-(lite); **Poor New Jobs numbers** in souring economy; **Promises to Re-Shore US Jobs/Industry** proving empty, **like promises of Unleashed 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 in Q4. But let's return to usual time-frames of weeks/months to a few years. And reasons Not for gains, but instead just perhaps, for bigger Declines.

Compared to April 2025, when broad markets & ECO had all been down -- later in same year after huge gains, a new fear was/is equities were far-too-frothy. Sentiments matter. Including stocks are too-richly-valued in S&P500. With reason: warnings ought to ring out when a metric like (S&P500) Shiller Cyclically-Adjusted Price/ Earnings, or CAPE, spikes to rare high 30s. CAPE calculated since 1877 had spiked in a warning 1929, eve of Great Depression. Later it scarily hit 40 in 1999 on eve of dot.com bust; we know how that frenzy ended; S&P500 then fell -40% in a 3-year plummet, took 13 years for it to again re-reach prior levels. Note then a CAPE hit (yikes) mid-30s late 2021, paused. Historically a high CAPE over 35 has after given way to lower future returns, that often follow. In 2025 just a few mega-cap AI names had mainly blown up CAPE (a likely bubble?), yet a *low* CAPE # is what would be bullish.

As CAPE hit a 39 late October 2025, alarm bells seemed to blare, warning lights flash! Was 2nd highest in a 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 the big broader markets can plummet! *On that 'nosebleed-high' CAPE at 39, late 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*. In an echo of "irrational exuberance"; Fed Chair in latter 2025 said of excess valuations (less colourfully) that "by many measures… equity prices are fairly highly valued". We'd emphasize too in very volatile baskets like here, renewable & green energy stocks can and will typically fall in crash far, far harder than large caps or broad markets. All adding to fears of maybe a big regression back to mean, given frothy P/Es seen late in 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 in clean energy. Or note too 'plain' S&P500 price/earnings (P/Es) were up hard as well. More commonly, P/Es in S&P500 are near say 21; yet in Sept. 2025 measured P/E ratios had hit a statistically-worrisome 30, as calculated by all expenses and 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 here for the very risky equities high P/Es green themed baskets. Compounded by fact after recent nadir clean energy low April 9, 2025 at just 28, green stocks then went up 120%+ in just 6 months to October 2025. All argues for maybe reversion to mean. Big falls after frothy valuations gains mid-2025. Was/is a frighteningly-likely probability for the risen broader markets (driven by AI there), and for any clean energy theme.

One cannot know, can't foresee, if it's say fast-souring economy that triggers drops. Or big US debt. Or, hiring seizes up. Or say more-narrowly an AI bubble bursting triggers it. Or, if threat is Not of 'Unprecedented' inflation, since was higher in 1981 -- maybe inflation let run hot, taking root, hard to kill, rates higher for longer. Inflation is partly a state of mind, psychological. If expectations take root of high rates+ stagnating economy, maybe stagflation-(lite); currency debasement; Fed tools wickedly un-useful then. No central bank wants to hike rates going into a recession. And equity-risk premiums in risky stocks (vs. safer bonds) make equities decidedly an unhappy place. 1970s rates are something a young generation doesn't viscerally recall; in a decade to 2022, no G7 central bank rates were over 2.5%. But in 1990, they'd all been over 5%+! High rates are decidedly awful for volatile, high PE themes. With a president latter 2020s who's proudly called himself the "King of Debt"! So 39 CAPE was/is scary. Yet scarier may be climate crises, new real-world weather extremes, destruction, rising seas this latter and the next century … all set amidst far greater global indebtedness.

America's 'one big Act' by hiking its electricity costs, may cede AI leadership ahead, to China. Who sees it as their own good fortune the US halted its own wind, solar too, not on economics, but *cultural animosity. That a US halted its offshore wind on a person's *feelings about views from his golf courses, having sued and lost: hatred that's 'visceral' thus based on emotions -- not on facts and reason. When facts now favor wind, so a 3rd reason, and it is facts-based: *these far better economics today of solar/wind -- now make coal, natural gas, and nuclear -- look bad. First 5 months 2024 China added 4x more of its 2 cheapest electricity sources: solar & wind -- than a US added from All Sources, all 2024. The 227 GW of new solar/wind that China added just first 7 months of 2025, was 4x all US growth, from all sources all 2025. China also expanded its gas, nuclear, coal capacity some too -- but far, far more slowly vs. renewables. A cheaper clean energy buildout, left pricey coal struggling, at <½ capacity.

Despite a US president's promises, electricity prices rose, got worse. Up by 5% to mid-2025 -- then went *up* by over 6%+ late in 2025, vs. a year prior. 2x worse than inflation. Analysis shows by 2035 due to 'one big' Act, Americans will pay far more for electricity annually. In a US South, & in Midwest, $640 more/year; up smaller in a hydropower-rich Washington state. *Yet, all places in US will see higher electric bills!* Opposite of the promises. Unavoidable, as renewables are cut. Efforts have begun to blame renewables, anticipating high electric rates. The 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, that period. In fact rose *less* in Texas, thanks to its solar/wind. Texas rates were up *less* than a US national average. Its big solar/wind helped to tamp down increases.

Indeed, compare Texas to 3-lesser-solar & wind states: an Alabama, Mississippi, W. Virginia -- & we see Texas' rates rose the *least* of these 4 states! Average retail electric costs 2025 in a renewables-rich-Texas were *below* US national average; Texas wind+solar grew faster than any state. Factors contributing to Texas' price rise those 7 years included *Winter 2021 black-out on its nat. gas freezing-offs resulted in terrible deaths, long-tail costs still being repaid. Its Grid must now hold back power 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 they 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 *hold down* Texas price rises (was worse/ higher in most other states) those 7 years. In first 8 months of 2024, for example, Texas added more solar power -- than 39 other states had ever installed! Its price wasn't near a very low, one penny/kWh like in Saudi Arabia, but they've proven very low costs are viable.

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

Decades of cutthroat competition, hands-off free markets, gave Texas cheaper electricity. Price-discovery of what's best, cheapest real-time. Dynamic updates at 17,000 nodes islanded grid. It's ironic then, self-proclaimed 'fiscal conservatives'(!?) seeking fossil fuels/ nuclear, only -- want to *end* such hands-off-policies. Instead to pick 'winners' (just fossils/nukes) -- & to hit 'losers' green energy. A battle is going on as oddly self-labeled 'fiscal conservatives', chase obviously costlier electricity for Texas. In 2026 they even fought against a new solar manufacturing plant (+ jobs) in Texas -- although it would mean fast-cheaper power.

A bit like how big-government, liberal places, also end-up costing more. Take California in implementing renewables poorly, at high cost. Not prioritizing cheap power, it allows huge subsidies like 8-11%+ Utility returns on equity: harms ratepayers. A San Diego Utility sought 11.25% return in 2025! A first-mover, the state mandated solar early, when costs were 10x higher; locking in high prices -- that plummeted 82% in 2010 to 2025. Issues elsewhere too. A liberal UK sets 1 electricity price nationally, so windier north cuts cost for a populous south -- with north rates far more than wind-power costs. And UK's extreme-high rates based on costly natural gas, 90% of time. Germany sets fuel mix, high taxes/rates in pursuit of social outcomes. Today liberal UK, Germany, California, are 'price losers'; much reliance on natural gas, poor implementation, so costly power hastening scary de-industrialization. Yet joining in as 'new price losers' are self-described US 'fiscal conservatives' who in 2025/2026 re-shaped US policy. Replaced open-competition, with just fossil fuels/nukes only. Worked to decimate US renewables, on ideological grounds. Though we know states/nations with cheapest power, 'price winners' embrace free markets, lowest-cost paths. Today even a Saudi Arabia that relied only on oil & gas until recently, is now growing solar faster than anywhere, any time in history. With a firming storage, better grid, so natural gas needed less & less ahead just as backup. A bit like US red-states that prioritized their 1st cheapest power and free-markets, now have more renewables, cheapest rates: Iowa, Kansas, Idaho, Dakotas, Texas etc.

So now, US energy policy poses huge challenges. As a result of America's new 'one big Act', 77 GW of anticipated electricity generation (bit like 77 nuclear reactors, although 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 23% higher*, on loss of cheaper renewables. *Industrial electricity: 54% higher*. All strange, as wind & solar 'just make sense'; they're conservative in truest sense. Given freedom of choice, renewables would win. Meanwhile, US competitor China jumped ahead in global green energy & EVs, yet faces its own problems of overcapacity, oversupply. It denied permit renewal 2025 for huge batteries/lithium producer; halted a lithium mine, 6% of world supply. Thus, lithium stocks jumped worldwide. Lithium carbonate futures contracts on a Guangzhou exchange leapt max 8%, to 81,000 yuan. Some believe China from 2025 is beginning to broadly pare back its immense oversupply, overproduction in green new energy and EVs. Addressing deflation.

US solar grew in 2025, like on a bullish Treasury Dept guidance for tax credits that left a 4-year window open, if 5% is spent. Renewables' foes had tried to make it both 'far worse', & retroactive. To demand work have been 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 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 federal-ordered halt in 2025 at near-done major wind project, since it illustrates odd recent changes in US energy policy.

New offshore wind was about to bring Rhode Island & Connecticut, cheaper power. 'Why' wind could be so helpful in lowering costs, is easy. Start by knowing Rhode Island (RI) is more reliant on natural gas to generate its electricity, than any US state, 80%. So, one could guess, correctly, RI has very high electricity costs: 29 cents per/kilowatt-hour (kWh). In Sept. 2025, 5th highest in US. (Very worst is Hawaii at 41 cents/kWh; 2/3rds of its electricity is by burning (ugh!!) bunker oil; despite its sun, wind, wave resources, those are a tiny percent there). Bordering RI, is Connecticut (CT); it would benefit by lower rates too as 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, as 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 gas turbines not available until 2030s at soonest. New England's (onshore) natural gas transmission corridor is crowded. Plus its few regional nuclear plants have been / & are retiring ahead; and a new nuclear plant most likely would frighteningly go $$ billions over-budget, take years (decades?) extra to build. Hence, this cheaper/ better/ faster offshore wind + batteries nearly-started-up, is a scalable economic solution do-able now!

Offshore wind was about to make RI/CT electricity at 9.8 cents/kWh long-term. It's immature there, so far more costly vs. say Saudi Arabia's (onshore) wind at super-cheap 1.3 cents; but is quite attractive vs all else in US. Far better than gas, coal, nukes; nicely goes 25+ years. For 2 small states, a 400 MW to 'little Rhody', 300 MW to Connecticut/CT were sizable wins. To meet about 1/5th of total RI annual electricity demand; winters maybe better 1/4th given 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 limit, at 3 and 12 miles offshore & implications for US energy policy, see our book 'Listening to the Sea' (1999)). And yet this near-ready, cheap wind project much desired by both governors, was halted [now twice!] late 2025 by an administration so aggressively-anti-renewables in its 2nd term.

We recall how fossil interests maybe seeking 'less-competition', ardently anti-solar & wind -- had been foiled in June 2025. Unwittingly *moderated* when a draft 'one big' bill, got jammed. But now, on just unilateral administrative orders, renewables could be decimated -- with far greater 'success' from latter-2025. Unambiguous, by focusing just on renewables -- hurting them only. Bypassing more traditional, free-market conservatives in their party. Side-lining congress. Ignoring economics of solar & wind as now the lowest-priced paths.

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

Yet late 2025 his administration went deep into realm of 'this hadn't really been conceivable' before, when it halted all 5 major, in-construction offshore wind sites on US east coast. These were about to add a huge 5.8 GW dearly-needed generating capacity; some already started! Were about to make abundant and vital very cheap electricity by frequent sea breezes.

On that announced halt, the white house took care to again vent that president's deeply-held and decades-nursed resentments; again calling renewables the "scam of the century", his well-worn talking point [though very wrong on both wind & solar]. The 5 sites would have generated enough electricity to very soon power 2.5 million homes. Electrons dearly-needed for AI/data centers sprouting in Virginia hosting most concentrated data centers anywhere. Was 2nd big halt to Revolution Wind off Rhode Island; courts had struck down a 1st halt. Now, his administration went wider, further. Halts were ordered too for Empire Wind off New York (it too was costly 2nd halt; his administration previously allowed it to proceed in exchange for a natural gas New York pipeline ok, but now in bad faith it went back on that). It also then halted 3 other near-completed & needed projects: at Coastal Virginia, Sunrise wind off New York, and at Vineyard Wind off New England where of a big 800 MW of near-finished capacity, about 70 percent of that or 572 MW of its wind turbines were already operating.

Such halts shall of course, make electricity price rises worse. Negatively impact reliability, affordability -- but such concerns seemed not a priority for that white house. An operator of 13-states grid from Virginia to Illinois saw auction reserve power prices, spike. No other outcome can be expected. Connecticut's Governor, stated this halt "is blowing a hole in our efforts to bring down the cost of electricity". All 4 Governors jointly wrote that 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 beyond the white house. One deeply-impacted house member warned a halt will be "disastrous" for energy security, local economy, military readiness. Another member of the same party, who'd even chaired the Federal Energy Regulatory Commission during that president's own first term, stated that this 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] administration for targeting fossil fuels. I am critical of this administration for targeting clean energy. Now more than ever we need it all".

Here, at these Indexes, we'd much prefer to avoid discussing politics, at all. But lately it had become unavoidable, as relevant & key to the clean energy theme. In 2025 a 'one big' bill had very notably been moderated, in last hours by just one vote in senate from president's own party. Less known is that that bill was nearly hit hard, as well, in the house. Had a single representative (a debt-hawk) voting No, attracted 2 more No's from the president's party, given enormous deficit-spending on which bill was based, that could have sunk it. This house member from Kentucky consistently vexed white house all year (like the state's US senator); whether that member is 'primaried' is one barometer of how forcefully an administration can go on adding huge debt. Blocking clean energy, like SPEED bill negotiations on permitting. A side note: that house member, an engineer, has built a unique custom solar/battery power system, not unlike our's here; if interested in our solar/battery system here over the past 15+ years, see: https://www.wildershares.com/solar.php

A rather intriguing question now might be: *if* US electricity prices keep on undeniably rising -- might a few in president's own party start to press for a new course on clean energy, even say, some partial acceptance? Might even administration itself alter course of its accord? After say 2 years of still rising electric bills, if its promises don't persuade as they did in past? It is conceivable US electricity rates may slow 2025's fast ascent if for instance US growth slows. Or if forecasted AI demand boom, doesn't materialize. But as for US electricity costs falling soon by big ½, as repeatedly promised: there's vanishingly little to zero chance of that.

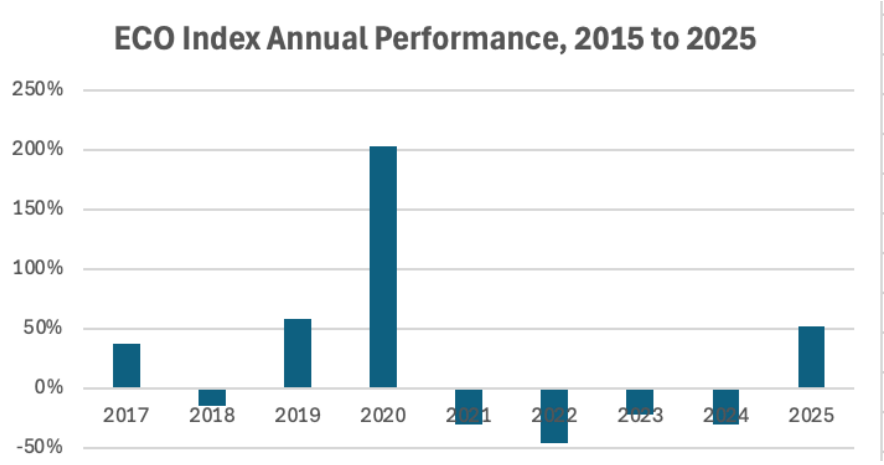
Whatever happens, one can bet a politicized, visceral (not facts-based) opposition continues to wind/solar. Blame laid on them for high costs, even as renewables get cut. Opponents will try to make financing renewables, unappealing. Of course there's issues of intermittency, dispatchability, curtailed on burdened grids. But all can be addressed. As done in supportive places, so wind / solar can be 1 cent/kWh. In sum 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; an $3.7 billion awarded to cut US emissions, was retracted. Perhaps to worsen financing risks, too. 11,000 US generation/ consumption projects sat awaiting approval. Interconnections stalled average 5 years. Opposite of a 'Build, Baby, Build'. For renewables, it was instead only 'stop baby, stop!!

Contrast such US policies 2025 -- with China's true 'all the above' path, based on its best options, so renewables. China planned in 2025 to build nuclear: 35 GW. That 35 GW of 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. An AI/ data center in say, Virginia in US, might pay 7 to 10 cents/per kWh, much less than in Europe. Yet a data center in China, might pay just 3-5 cents/kWh in some places, about ½ the US. Huge AI competitive advantage for China, with far-faster buildout of big hydro, wind, solar, storage, modern grid, transmission. Sprouting up for instance in Mongolia, with a landscape similar to rural Texas. By 2030, China's vast new renewables & power transmission will have 400 GW *spare* capacity. 3x rest of the world's AI/ data center electric demand. While US faces maybe a 44 GW shortfall by 2028. This 'electron gap' between US vs. China was in 2026 (rightly) worrying America's AI leaders greatly.

As a US in 2025 purposely hobbled best paths solar/wind, the US *built only 63 GW total energy, all year long*. A costly US coal plant in Georgia set to retire in 2028, and two in Indiana, were forced by federal officials to stay open! Though uneconomic. A South Carolina coal plant cost rose 50%. No wonder US power prices are rising! China's AI chips are less advanced, but such gap in electricity costs is too big; allows China to use double the chips. Impossible now to hide it: US electricity prices rather than having fallen in 2025 by ½, instead rose. On less renewables / more fossils, they're Up, faster than inflation. Oval office claims average US gas was now under $2/gallon were a bit silly too. But an interesting thing was happening.

Interestingly that white house on Labor Day holiday 2025 made boastful claims amplified by favored cable news channel that the US president was already "delivering on his promises of lower" gas prices, "fully unleashing American energy dominance", and "families are saving significant money at the pump". Wasn't true. Average US gas price in January of 2025 was as noted $3.07; by late 2025 was still near that -- nowhere near under $2. Yet was interesting to see curious narratives by white house & federal officials all 2025 such as, "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 would by now be up hard, so gas prices would thus be down big. Yet notably, US domestic oil production was at first … not up! Labor Day in 2024, it was US 13.4 million barrels/day (bpd). On same holiday in 2025, US oil production was 13.3 million bpd, so *down!* Rose only slightly, near end of year. Gas of course was far from <$2/gallon, so claims gas was under $2 were bold, yet respectfully factually-challenged. The 1st Amendment allows bluster. Still, it is useful to be cognizant of truths, and at times-pretty-surprising hard facts. Even if truth is opposite of what one assumes.

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:



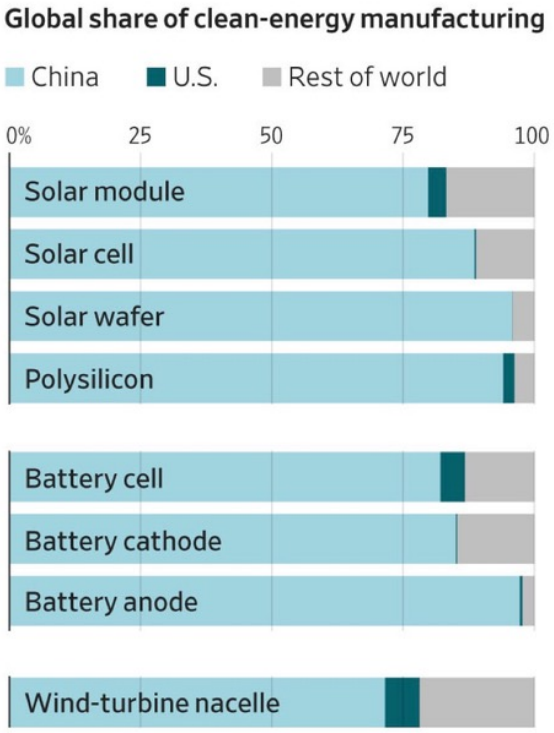
The point on Direction is counterintuitive. *Not* maybe expected, each of 10 years. What boldly surprises, is during a *conservative* president, this clean energy theme/so ECO *rose* up, sizably. In 2017-2020 so in a conservative's 1st term, this theme *strongly gained*. Tallying annual gains minus losses, each of 4 years, was surprisingly *up* very sizable 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 2019 when 3rd year of his 1st term it rose from a Dec. 31, 2018 close at a not-hugely-different 44.76 -- to Dec. 31, 2019 close at 70.74; up +58% though their rises differed those 2 years). Things are sure to unfold unpredictably over a 2nd term 2025 to 2028; so let's watch what happens ahead.

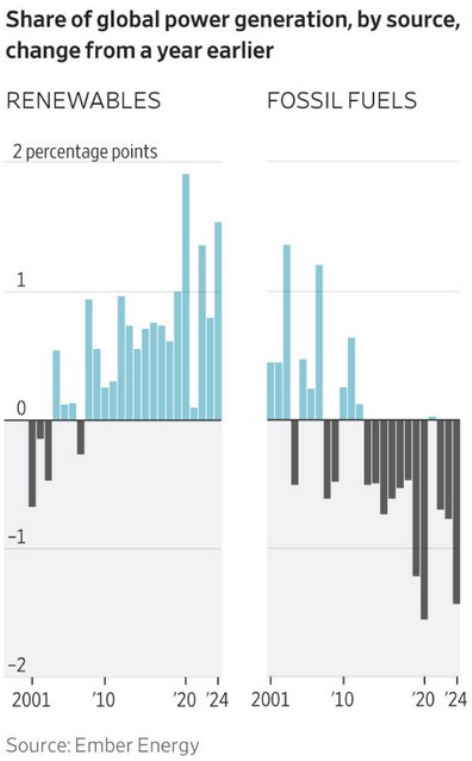
Inversely, maybe unexpected as well, was under a *liberal* president who'd supported climate action, this same clean energy theme captured by ECO, *fell very sizably 4 years 2021 to 2024:* for a net -128% (tallying -30%, -46%, -22%, -30%). Not what one might have predicted! Counter to conventional wisdom, 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 just a fluke. As we can look back more/see 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.

It was sad to watch a US that had invented Solar Cells, & Lithium Batteries, give up leadership in both. Now seen again with US-once-leadership in electric cars, falling to China's-massive push. On China's industrial policy to be #1 manufacturer for solar/ wind, and now EVs a past 3+ decades -- today they're reaping rewards. Soon ahead in batteries in storage, grid. Their embrace of clean new energy innovation, EVs and moving away from old energy fossil fuels -- wasn't based on acute climate concerns, but on economics, jobs, energy security. These are becoming critical growth drivers enabling both its domestic energy production, and green energy products export and sales. Latter-2020s their lead has been only widening.

Meanwhile the world is moving massively toward renewable power generation seen in a chart at right for 2001 to 2024. Leaving fossil fuels, on costs. This global shift is something a US administration from 2025, was trying desperately to deny, 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 in 2025 to 2028, the US can make life harder for its own 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 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 second 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. Yes, we note the big weaknesses of intermittency, non-dispatchability. And yet, renewables, unlike fossil fuels, are only getting now cheaper/better. While also firming up with better storage & grid. We note too, renewables only help on human health, energy security, climate risk -- all increasingly compelling latter 2020s. With solar/wind seen now so cheap, about 1 penny/kWh, they'll win on economics alone. We're objective, factual, independent about this. Never partisan. Nor proponents of either party.

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

In September 2025, the states with highest percentages of electricity by renewables were: Iowa at 68% from renewables, a red state with cheap home electricity at 14 cents/kWh; South Dakota at 61% from renewables, again a red state with cheap electricity at 14 cents; New Mexico at 52% renewables though since 2008 a blue state 14 cents; Kansas at 49% renewables, a red state with cheap electricity at 14 cents; and Oklahoma at 42% renewables, a red state with cheap electricity at 13 cents. These-highest-renewables states all compare favorably vs. a US retail average of 17.47 cents in Sept. 2025. And the 2 very cheapest US states late 2025 were North Dakota, & Idaho: both renewables-rich (hint: both turn first to their very ample renewables for electricity). Point is, such places favor hands-off smaller-government, less-debt, are fair and open to all competition, pro-growth, building greater capacity grid. Such traits repeatedly lead to their having Plenty of Renewables = so Cheap Electricity.

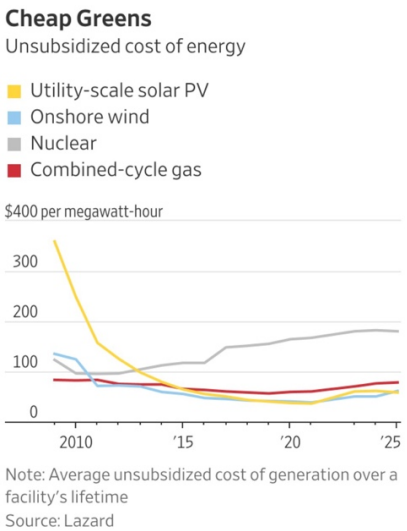
Iowa offers lessons. In 2025 a big 2/3rds or 66% of its electricity demand was met by wind. Growing fast. Of remainder, coal was 19.8% but phasing down/out long-term: the owner of its 6 coal plants announced possible retirement dates for all. Some anticipate much of the '20% hole' may be filled by more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

Countering from 2025, are federal policies harming 'losers', halting renewables. Anti-open-competition, more-US debt. When federal officials 2025 stopped a $4.9 billion loan guarantee that would have built a huge US Midwest grid transmission line, that's a concern as a likely effect will be to *raise* US electricity cost. Worryingly, so-called 'fiscal conservatives' now are favoring ever-more US debt; that's a big change buffeting much. Globally, sovereign bonds are struggling lately on national debts, an unwillingness of rich nations to balance books, cut deficits robustly. In 2025 to early September, internationally, 10-year bond yields *rose* (due to debts etc) by 0.1131 percentage points. Yet, US 10-year Treasury yields in same period fell bit surprisingly by 0.3038 percentage points. 10-year yield drops generally good for investors and markets. Helped by rate cut hopes, Dollar as reserve currency, Treasuries a global store of value/dollars (few alternatives). That 2025 fall in 10-year yields 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 these key US 10-year yields can continue to decline, and then persist low -- is yet to be seen. The oval office in 2025 targeted, aimed for a stable 10-year yield around an ambitious low-3%-range ahead.

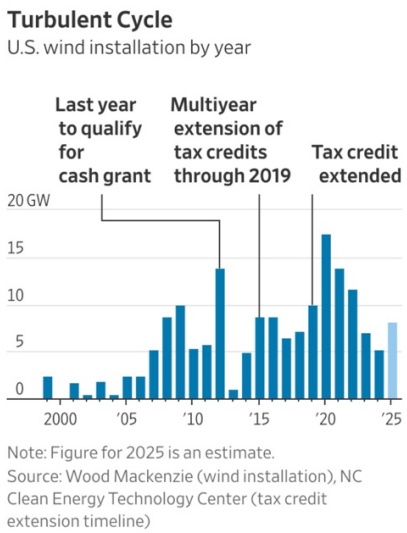
Yet that US president again made energy news 2025, opining [again] on his social media blog, "Renewables are the scam of the century"… , "We will not approve wind or farmer-destroying solar. The days of stupidity are over in the USA!" Such left no doubt as to his own sentiments. Posted on a Wednesday,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

3 arguable causes for some 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, solar since 2005 -- might now be "an attractive entry point to this industry", as valuations here 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 … and 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 aimed to harm just wind & solar, to make them costlier, by erecting impediments. Others tried to make fossils & nuclear cheaper, so nearer to competitive with renewables, though that's proving far harder as contrary to economics. Narrowly, early 2025 one of world's more aggressive, well-financed, technically proficient offshore wind builders (a big German firm in fossil fuels 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 to 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 [1st time] $5 billion Empire Wind in New York waters with all federal permits; halt rescinded in May after intense state lobbying, but it had cost that project $955 million. In Dec. 2025, all US offshore wind was halted. Actions that were attributed to a president who had sued & lost a decade ago over what he often claimed were the 'windmills ruining his views' from his golf courses in Scotland; a deep grievance that president has spoken about often since.

Critics of all renewables felt emboldened from 2025, 'wind at their backs'. When 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. Nuclear was 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 was due to its own poorly-managed grid switching off. On overvoltage, frequency oscillation, poor planning, pre-emptively-it-shut thermal plants; that took 15 GW of grid's 27 GW solar, offline. 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 had similarly jumped to fast wrongly blame wind power in US State of Texas, right as a deadly outage occurred 2021: *it was later determined due to its natural gas freezing off!* Yet a narrative was fastest-mounted by some to call its 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 with an Orwellian twist: a major office in the US Energy Dept issued a 'Banned Words List' in 2025 for internal & public-facing documents, reports. Specifically it dis-allows words "climate change" (as implies is real, and bad); "emissions" (as word implies they're bad); "clean energy" or "dirty energy" (as either one 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 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 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 /Q3 2025. Yet broad S&P500 grew to P/E valuations that arguably were 'excessive' (mainly on AI) late in year.

Oil had seen a -17% fall in April 2025, biggest 1-month oil drop in years. We'll discuss 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 diverse factors; but pretty-soon may re-rise if less rigs. Or, can spike on Mideast tensions. Oil's moves are complex, yet comprehensible. That president's 1st term was pro-energy of all kinds. Gave way to 2nd term that at first, aimed to hit solar/wind, EVs. Incentives were crafted to bolster just the conventional older energy, oil, natural gas, and coal -- plus as well, more nuclear.

This Chart for Q2-late Q4 (Dec. 28th) 2025 -- 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 for *Oil, *Natural Gas. April-to late-Dec. (28th) 2025. All 5 themes fell at first. Unusually, oil was down all April for acute reasons including fears of softer growth due to tariffs. Then all rose from April 9th, as that president backed-off tariffs (a 1st walk-back of many ahead!). Oil did briefly jump on Mideast tension, then it retreated on de-escalation. ECO rose here the most strongly, up 101%(!), like after a softening of 'anything but renewables' in one big' bill. While some ECO components fell here, of course, notably many were up; one ECO component jumped 5-fold in a 2nd quarter 2025. Others well up especially during Q2, and Q3 etc.

So here's 3 full Quarters of new president, Q2 to late Q4, an ***ECO tracker** ends top up **+101%.** *Solar is next up +63%, 3rd is *S&P500 here up +24% to late December; 4th is conventional older energy so an ***Oil** tracker down **-8%**; last a *Natural Gas futures tracker down a big -39%:

Source: YahooFinance

Catalyst for early Q2 fall above, was 'Liberation Day' announcement April 2nd of unexpectedly huge US tariffs worldwide. On a campaign trail, that candidate often spoke of tariffs: yet their ferocity, immediacy, and scale in office, was a surprise. As were big tariffs done 1st, *before* stimulus. Prior to streamlining federal rules, or to cutting taxes, or to de-regulating -- as many anticipated first order of business given 1st term in office. If an oval office bet early in 2025 was that China would be hit hard, its exports suffer, forced into concessions, the oval got that bet wrong: first year of tariffs, arguably it was a US that blinked. While China's tremendous & steady support given its own clean new energy industrial policies, were paying-off handsomely. Even if America's erratic tariffs were an 'art of the deal' kind of negotiating tactic, a confusing feint to throw the whole world off-balance, so-called 'reciprocal tariffs' (actually based on longstanding normal trade imbalances) were unsettling worldwide.

Unlike a 1st term's stimulative policies, that had promoted *all of* energy, so renewables too -- instead much early in a 2nd term was designed as *impediments* to harm solar/ wind/ EVs. De facto & de jure 2025 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-cheaper natural gas. So 4 years after that president had left office in Jan. 2021 at the end of his 1st term -- by 2025, fossils/nukes found it hard to compete with solar/wind. Hence to hobble or to make (now least-cost) new renewables more costly, from 2025 became desirable to some.

Yet an important US trend is many US 'red' conservative states that don't emphasize low-carbon per se, like North Dakota, Idaho, Texas, Iowa, are *growing their own renewables hard,* and *making electricity at the* very *cheapest US rates!* Moving fastest all due to better green energy economics, as 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 maybe expected to be just renewables: California, Hawaii, instead have much fossil fuels + *Costliest* electricity: paying most for power. Reasons include technical mandates, ossified burdensome regulations, brittle grid, unhelpful electricity pricing mechanisms, and poorer implementation.

That renewables often make electricity at attractively-low wholesale cost, 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.

While 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 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 can raise revenues for government, but their *uncertainty* was/is hugely costly for US economy. And lack constitutional basis: as taxes are only to be levied by congress. *If* they'd been fast withdrawn, it's one thing. But they'd stayed high, erratic, on key counterparties China and Europe -- for inflation that can linger. Even a stagflation-(lite), worst kind of inflation(!) may arise. Were tariffs briefly at a 10% max & ended, trade 'wins' self-proclaimed, short weakness may have 'helped Fed' lower rates. Cut costs of capital. But … that was not a path taken. Rather, was big tariffs, chaos, & debt. Interference so BLS data are less certain. Fed unhealthily losing some independence, pushed to cut short term rates even on souring expectations and $3 Trillion in new debt. 10-year yields sticky, above targeted 2.0%. While a Fed letting inflation maybe run hot, was deprived of predictability, stability, reliable data.

If tariffs were modest, fast ended, demand can be resilient. Yet problems include a massive **$3 Trillion in Debt(!); it can't be repaid readily, & unwisely distorting to seek a compliant Fed, with artificially low rates to try to 'inflate away' debt. **That Act's stimulative effects are on order of tenths of one percent; while added Debt is massive. **A white house & congress that halted solar & wind is making electricity *more expensive*, though demand is rising. Brings us back to to oil. Recall a brief price drop in oil back in April of 2025, due to acute fears that erratic tariffs could hit demand. As a candidate, that president had promised repeatedly he'd fast bring gas under $2/gallon in his first year. So his administration should fast want to, need to bring down oil/gasoline prices: be stimulative. Must *Increase US Oil Production, also thus *Increase US Oil Demand. One, done without other, will not work: Confidence in robust near-term future oil Demand, is prerequisite for oil industry to make investments in more fracking / rigs/ US oil production. Yet in a spring 2025 fears were of course that US tariffs would *slow* demand growth ahead. Earlier on, at start of 2025, US oil supply had been anticipated to swiftly go well up over 14 million barrels per day (bpd), 9.7 bpd shale. That 14+ million bpd based on crucially, stronger oil demand. At heart then-confident-predictions (thus made before tariffs) of stable, fast strengthening US growth happening right away in 2025.

Instead on tariffs April 3rd, uncertainty spiked: expectations fell. Of *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 go to under $40/barrel, For US gas prices to fall <$2. But they'd under-appreciated in many American regions, *oil at $50 is already below breakeven*. For production shut-ins. In a costly Powder River Basin with 11 of state's 15 operating rigs, tricky geology needs oil >$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 $38/barrel. By contrast Saudis can lift oil for just a few dollars/ barrel! OPEC+ with Russia, can send global prices down by resuming curtailed output: hitting US shale growth. A diversifying Saudi Arabia may prefer oil up in $80s+ plus, to help balance books. Yet if price war does loom, they'll ride it out better than anyone. Better than even the oil sands, on lowest-production-costs.

Thus, were white house energy policies all 2025, respectfully, deeply mis-guided. Costs were Not down ½ for electricity; but up, and bound to rise. Nor many big US natural gas plants to be brought online before 2030: turbines not available; plus nat. gas as fuel is costly as US is an LNG exporter. 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 power, wind/ solar, grid -- vs. US costing twice that. Electricity in China, is coming less & less, from coal. Which faces a costly burden of dismantling the world's very largest coal infrastructure.

Or, there's oil: could a president in 2025/26 convince US frackers to ignore markets, grow supply, push oil under $40, gasoline under $2 as promised? Keep US GDP growth 4%+? All key!! Shale producers resisted white house calls to add huge supply, on fears of surplus. May 2025 US rig counts had fallen to lowest since 2021, as confidence in demand fell. At a big oil services firm counts fell to 566, so 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, so rigs were off prior 2 years; down 5% in 2024, off 20% 2023. Still, that's a normal kind of cycle. However, if oil drops below $50, or near to $40(!!) it sets a stage for higher prices later, on fewer rigs. Strong demand is key. All as administration sought to *grow* US oil production, say by an added 3 million barrels/day – to go from 13.6m to well over say 16m barrels/day. Despite its own *tariffs uncertainty -- *which went against its need for stable firm oil demand. Erratic tariffs based on untested, self-proclaimed, emergency powers: normally a power of the purse resides instead in congress. All that *may* portend less demand ahead, in time less rigs -- inexorably a return then later to higher oil prices. That's economic cycles. As white house rolled out tariffs -- oil executives privately feared slowing demand. Markets, not any US president's asks, are what most guides oil industry coming rig counts for shale and other investments.

Thus 2025 had unfolded far differently from a 'goldilocks' 2023-2024 when oil traded in tight stable 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. In private oil execs understood all well: a white house can open up drilling areas, cut red tape – yet it can't overcome basic economics. For gas to get & stay under $2, requires confidence of demand. A slowing economy means fewer rigs; later a higher price. We discuss ahead a 2020 oil crash that once had sent gas under $2 in 2020, yet that was on much differing fears of demand collapse, 'tank tops'.

For 2025 stock markets/wall street saw a "V" rebound. To left-side, a fall due to tariffs. Nadir was a president walking-back tariffs on April 9th. Then right-side, strong rises, in clean energy too. Partly on hopes white house chaos is paused; markets acclimatize to an erratic oval & debt. An oval office walk back partly to appease bond market vigilantes: 10-year Treasury yields jumped April from under 4.0% -- to near 4.5%; reflected huge loss of confidence in US, new debt. In 2024 for a 1st time, the US had to spend more to service its debt ($882 billion) -- than on defense ($874 billion). Oddly for the world's reserve currency, in early 2025 the 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, S&P500 + especially clean energy rose in Q2/Q3. Despite uncertainty, including emphatically 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 shifted to 'start construction by', instead of 'already in service by' -- which came to pass nicely early-in 2nd half 2025. Bullish times then during 2025.

Some 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 more solar, wind, EVs. Thus it was inconceivable then to have crafted a genuine 'All of the Above' energy strategy. One inclusive of *true* US energy abundance, so with solar, wind. Couldn't be as 1 party in power wanted fossil fuels only; unitary executive; to halt renewables. A goal to pick 'winners' (fossils fuels), and hit 'losers' (renewables). Weirdly by taking anti-conservative, anti-free-markets paths. Though the truth is, adding just fossil fuels = actually means higher US electricity costs. Plus some costliest, worst-impacts from 2025's 'one big, act, were back-loaded to later-on.

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

However, another possibility to contemplate is instead *'one big Act' + debt + tariffs + costlier energy haven't brought a new Jobs boom*. Nor, Asia's manufacturing re-shoring to US. China's decades of industrial policy, far lower wages, supply chains that took decades to build resist easy US replication. Affordability too is hit. Non-farm payrolls are maybe nearer just 100,000/month, new jobs hiring slowed. GDP up, as it gets a sugar-stimulus, but big new debts. That's not sustainable; so 10-year Treasuries resist falling; near 4% is needed to attract inflows on less confidence US tackles debt other than 'inflating it away'. Maybe a stagflation-(lite) on fears of souring economy & sticky inflation. K-shaped economy. Fall in personal consumption expenditures (oval firing Bureau of Labor Statistics staff puts gold standard data in doubt). Perhaps, supply disruptions too harm small business who can't 'just eat tariffs'. Tariffs may be deemed Unconstitutional. Mass deportations, so high produce prices. Stock markets rise up yet on narrowing AI gains; debt is a sugar-high, so bubble fears. Gas at pump persists in say, mid $2s/gallon -- not under a $2 as white house had promised. Worse for many, is exploding deficit, debt. By self-proclaimed 'fiscal conservatives' during full employment, in non-recession, peacetime. Normally prime time for fiscal rectitude, reducing debt.

Or… maybe stock markets boom and rally on 'one big' stimulus, deficit spending/ low rate hopes (although based on debt). Or another possibility, is a K shaped economy with slowing new jobs -- yet stocks rally, GDP growth advances; accepted by hardliners to 'break the back' of inflation. Government shutdowns accepted 'as a feature, not a bug' to 'detoxify' what some see as excessive reliance on government & spending. Aims to cut taxes & expenditures, halt renewables, subsidize fossils, perhaps on a 'cultural affinity' for older fuels, longing for less-constrained America of past. Or, what's revealed ahead perhaps may be unpredictable mix of much above (with many surprises too) into late 2020s. All yet to unfold.

For a rough analogy in physics & chemistry, the periodic table beautifully helps to explain, to predict how elements will 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 stable 1st shell to predictably form (+ oxygen) Water. Or lithium, with pair of electrons 1st shell, has only 1 in 2nd orbital, so it's reactive. Or 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 a 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 were 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 president's 2nd term may unfold differently from 1st term. This 2nd term began new via tariffs, impediments to hit renewables / help just fossil fuels & nuclear. Yet that president also did have a prior, 4 years 2in 017-2020, so one can 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 in 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. Like his 1st term as 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 about 30% coal, 30% natural gas, 20% nuclear. Yet 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 its worst pollution, but as coal lost its edge vs. also firm yet 'less-dirty' flexible, cheaper natural gas-fired electricity.

Decarbonization did Not pause 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 this: rock-ribbed conservative Texas far outpaces California in renewables growth. Ruby-red conservative Oklahoma, is 41% wind/ solar. Iowa & Kansas lead in wind. A deeply blue Oregon, by contrast, was one of the worst-places for renewables, as it did little to improve its own grid: of 469 large renewables projects that applied to connect to its grid 2015-2024, just one 1 was approved by Bonneville Authority. Globally one expects a liberal Europe to lead; instead, its start/ stop policies are a problem. So dirty-coal China is world's solar/wind/ EVs manufacturing Leader -- even with its supply chains saturated.

On IRA slow roll-out, 2/3rds of $$ had 1st gone to conservative states, it was fast undone 2025. Hundreds of billions taken out. It's understood: 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'd enjoyed a world-record oil production in 2024, were disappointed, privately, over 2025. They didn't want 'Drill, Baby, Drill!!' so oversupply/low prices (oil near $40) -- so much as stronger GDP growth to ensure ongoing product demand. Easier drilling areas, far fewer regulations, less taxes.

One place offshore wind did do well (outside China) in tough early 2025, was Germany; it permitted new 4 GW wind; approval times got faster; a GW of wind capacity was connected to it's grid Q1 2025, up 40% year/year. Pro-renewables policies can 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 in 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 over 100 GW. National policy can aid -- or 'unintentionally' hinder (like US electric prices *rising*, due to less solar & wind ahead?). Or new policy, and even lots of $$$ may fail to surmount hurdles. US tried to push coal-costs down in 2025/26(!) but if by removing coal's mercury & air toxics standards -- that hits human health. Or if a rush latter 2020s to nuclear is from 'move fast & break things tech bros', that may be ill-advised. Recently a co-founder of a nuclear startup promised he can hold a spent fuel rod "for 5 minutes" with no ill-effects(!); scientists noted a lethal dose is in milliseconds. Cheaper, new nuclear power *may be* great, but safety must come first.

The US was trying hard, from 2025 on, to make costliest baseload electricity of all, nuclear -- cheaper with new gen III (3rd generation) designs. Via big reactors >1,000 MW /1 GW, or by trying novel small reactors <300 MW. Given opposite of many *impediments* for renewables -- federal officials announced many nuclear *incentives,* like shorter License wait of 18 months, authorizing deploying on military & energy dept lands. May allow higher radiation exposures, bypass NRC reviews, try to grow US nuclear capacity 4-fold. To go from its 100 GW, in 2025 -- to 400 GW by 2050. On new policies so 3rd gen small modular reactors (SMRs) got attention & $$$$$. That downtrodden industry's dream is gen III SMRs = 'cheap' nukes (nuclear). Even California's legislature considered a bill for SMRs, worryingly, dropping rules that radioactive wastes must be stored sustainably. 2025 saw billions in new federal funds. 4 new executive orders relaxing Rules, in hopes new gen III (still an airy idea) -- is workable. Notions of SMRs revitalizing moribund US nukes was generating much talk but sadly, no SMR power in 2025. Nearly all US commercial reactors still are outdated 2nd generation/ gen II built long ago. Commercial fusion at scale is decades off -- 2040s soonest. So, what to do on US nuclear late 2020s was/is a question. Commercial cheap SMRs + with fast-followers is one hope. That *might be* great; given the capacity factor 'uptime' can be 90%+ with a firm nuclear plant -- vs. just 24.9% with an intermittent solar, 35.4% for wind (latter 2 'naked', no battery storage).

1 company has aimed to have a US commercial gen III SMR up in 2029: we'll see! California had a sole lingering 2.2 gigawatts gen 2 nuke mid-2020s; it helped stabilize a fragile grid. But, it's old. And US/Europe are not building many nukes other than as replacements; they're too costly, and too risky vs. gas. Asia, Russia are a different story. While South Korea has been almost alone among the OECD countries in having built a nuke on time, and on budget; of 65 reactors going up globally in 2025, most were in Asia. Yes, nuclear is firm, great!! But it's far and away the costliest path. Far riskier too than cheaper, faster, safe renewables.

US experience is instructive. Only 1 big new US nuke was built, started last 3 decades: Vogtle II in Georgia, a gen 3. Breathtakingly over-budget its 2 reactors took far longer than was promised. Cost wildly $35 billion! Enormous $16 million per megawatt capacity, so was far more $$$ than natural gas. Hence far more expensive than today's best, low-cost electricity-generating options: solar, wind, battery storage. Georgia's ratepayers ended up paying $1,000 each for this plant even before it opened. Ahead they'll repay $7 billion+ more in the cost overruns that bankrupted its builder; its ratepayers will go on paying additional $200+/year so the Utility can hope to recoup litany of expenses. Its early-promises cheap new US gen III nuclear power would be built, on-time and on-budget, were all purely folly.

Vogtle was “the most expensive power plant ever built on Earth”. Estimates (private data) of its electricity costs are very-high, say 12-18 cents per/kilowatt-hour (kWh) generated. Offset by subsidies yet more costly than China’s immense Three Gorges Dam. Yet, dismally overtaken by a 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. It aims to meet 7% of UK electricity demand yet now not opening until late 2030s! A future Hinckley C nuke is as bad; 1st to cost $18 billion, it’s now so far behind schedule, over budget, will not open ‘til early 2030s and cost at least $46 billion!! And once-built, Georgia’s own electric rates in 2025 were higher than in so many states going with clean wind, hydro, solar generation -- like N. Dakota, Idaho, Washington State: we’ll discuss this ahead. Such high construction costs, excess delays etc help explain why nuclear as a share of electricity generation had dropped worldwide, from 17% in mid-1990s -- to just 9.1% in 2024. New big reactors today can replace retiring ones on proven designs, vs. hopes tiny SMRs may fall under <cost-prohibitive $10+ billion per plant. Talk of standardized modular ‘cheap’ reactors <300 MW can be alluring. Yet reality + experience mid-2020s on III gen designs shatters. Future hyperscaler AI demand has re-started a few old nukes. US re-shoring(?) too after years of flat power demand, can drive hopes for nukes in 2030s. *So, If* SMRs are Safe/ & cheap, woohoo! An excuse for the costs at each US nuke has been, FOAK (first of a kind). Perennial hope: a standard US small reactor design fast drives down costs under say, 7 cents/kWh. So new 3rd gen+ ‘cheaper’ SMRs are emplaced at many sites early 2030s. If they soon, finally become Standardized/Cheap & key: Safe (?!?).

Reality, however, so far belies that. Economics shows the 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 the west, any new large reactor is already the very-most-costly way to make power at >10 cents/kWh, 6 times build costs of S. Korea, China. So note, small still-economically-unproven SMRs would be worse -- so it’s no wonder SMRs are today pre-named as “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, so $30 million/MW making it absurdly more costly than Vogtle (near 2x more). Canada aims for in 2030 a CAD $7.8 billion 300 MW test SMR; will see if it’s done anywhere near to on-time, on-budget. And key: is it Safe!??

Because any new nuke must compete with natural gas plants on costs, 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 a natural gas competitor’s ~6.5 cents per /kilowatt-hour (kWh). Yet even a big nuke is nowhere close! So, reason why 93% of all new US electricity-generating capacity added in 2025 was solar, wind, energy storage. Only a small % was natural gas. China planned in 2025 to build more nuclear: 35 GW, so many reactors. Yet 95%+ of it would be big reactors, with each over 1,100 MW (1.1 GW) in size. Just 1% would be smaller new 3rd gen SMRs.

Yes, too, 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!!*

A US administration tried from 2025 to bolster gen III, big reactors/ SMRs for firm baseload -- yet hopeful new gen III designs that were intended to be far cheaper, to propel US nuclear ahead, instead proved too costly in that year, at least especially in the west.

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

S. Korea does stand out having delivered a very rare thing: reactors built near on-time, on-budget. Their first foray abroad was Barakah plant in UAE; from start 2009 to finish 2023, that $20 billion 4 reactors plant went up far faster than in the west. S. Korea has 50 years nuke experience; in 2025 it had 26 domestic reactors. Plus it doesn't present national security risks to west, like contracting with China. But, all in, that rare nearly on-time/on-budget plant used very cheap imported labor in 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 then could made electricity for around 6 or 7 cents/kWh -- cheaper than dirtiest coal. But there's still has no easy answer today. In 2022, the big 3 gas turbine makers: GE Vernova, Siemens, & MHI, had sold just 1 unit between them! After, manufacturing capacity was lost. So 3 years later if a new turbine wasn't already secured by 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, it gets costlier. Yet even if vs. a 6.5 cents/kWh 'cheap'-gas plant -- intermittent clean renewables with free fuel may generate at ½ that cost or less! Look ahead then, and much will come down to how swiftly new energy *storage can* advance. For new technologies here can make intermittent solar & wind more firm, dispatchable. There's still no one, single silver bullet, answer across energy!

In practical terms, amounts 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.

After a nadir low 28, in April 2025, ECO theme rose steeply 120%+ next 6 months to Oct. 2025. Ended well up for year 2025. To help explain how this happened, let's look briefly at what Index components were *Most Down* / & *Most up* in all 2025 (to Dec. 20th). In 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 a decade's ½ way point, we're seeing big changes. Globally, energy discussions have shifted sizably. From big concerns back in 2020 then for, ***How Clean*** is an electricity source -- to latter 2020s: ***How Cheap, Firm, & Reliable*** is it today. Consider Norway's ample low-cost hydropower that gave it about cheapest, yet most firm & reliable electricity in OECD. While exporting pricey natural gas & oil to other nations. Because cheap hydroelectricity in its north was decades available only to Norwegians, a 'power cul de sac', prices were low. But after interconnectors were built 2021, linking Norway to UK -- Norway's local rates might jump.

No longer with few buyers, it could export the electrons at high prices; like a 'green battery'. Those high prices hurt Norway's citizens, who'd paid for its dams. Ironically then on no winds in a UK, prices in Norway may spike oddly hitting this *hydropower-rich* nation! A big issue in Norway's 2025 election, was renegotiating with UK/Europe 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 must rely on rains, run-off, so in 2025 a drought also posed issue of whether Norway can so easily /cheaply go on powering itself. That in turn may threaten a bit UK; Germany, Denmark, who seek (almost-always just to receive) imports of that 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 falling demand, plus its cheap wind power, long were a pincer, so baseload capacity was lost. Its de facto ban on & erratic support for onshore wind, grid permitting thickets, put it in a bad way. 1 national rate set by priciest gas, while imports gas & power too if intermittent winds don't blow (raising rates too, in Norway). Recently a typical UK household paid about $1,500/year for electricity; a US household using 3x that electricity paid about $1,700. Or take Australia's aged coal fleet wrong-side of cost-curves, too. Its coal is now 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 by renewables, like 1 penny 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%), 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% intermittent wind; so 75% by 2 cheapest resources. Only after those 2 does it turn to more costly firm stable gas (13%), nuclear (8%), coal (3%). Worldwide & 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 are natural gas, coal, nukes.

Texas is greatest-clean-electricity producer in US: 169,000 GWh clean cheap generation in 2024 surpassed nations! By population, California is bigger yet it made 'only' 92,000 GWh. Industrialized Texas' huge energy demand is met by cheap industrial electricity @<7 cents, which blew away a California that's 3x more costly. On a not-unusual Texas winter day 2025, its wind/solar met 69% of its electricity demand + growing. Of course, that solar works only in daytimes, wind in breezes only, so they're intermittent. That said in latter 2020s, its wind & solar are the Cheapest + often Dominant sources today for Texas' own electricity.

*But, importantly: 2/3rds of Texas *capacity* is still firm, dispatchable, (often idled) non-renewables.* To see how Texas grid so evolved: in 2015 it had 251 natural-gas plants. These work-horses of dispatchable baseload could meet much demand. Yet 10 years later, 2025 on far greater electricity demand vs. 2015 -- had near-same 264 gas-plants. As baseload 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 costly, non-secure gen II (2nd gen) nuke technology. Gas power was far cheaper than nukes @ 'just' 7 - 9 cents in 2025, is built faster than nukes (if gas turbines/ parts are available) -- yet as noted that gas capacity grew by a puny 6%.

How, why? The answer is, Renewables. Clean grew from 168 wind/solar farms there in 2015 -- to 652 wind/ solar farms in Texas, 2025. Clean energy generating capacity grew 315%. Versus natural gas capacity 'growth' of just 6%. Key reason is: new electricity by solar/ wind is now The Cheapest by far -- when sun is shining, wind blowing. So trick now is to pair 2 cheap renewables, with a clean baseload, recognizing climate/CO_2. To streamline permitting. To improve America's fragile grids. Expand fast clean energy production & storage greatly.

Economic allure of wind/solar, is why 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' gas increasingly gets exported, interconnected to global demand, US natural gas / LNG price also has risen reflecting higher 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 hydropower. As prices rise at one end, they do other end too. When a US converted its own LNG terminals from just Importing, to instead much Exporting -- US became swiftly world's #1 LNG producer. Fast it went from zero exports in 2016, to 8 years later was supplying a massive 21% of global LNG. So that drove the US natural gas prices higher too. Even as wind and solar become ever-cheaper energy, this price-chasm will only grow.

Unsurprisingly, traditional energy is fighting back hard. At local, state, national, global levels. After a century making wealth, fossils are enormously influential, among the most-powerful of interests, so they're winning on many fronts. While they've lost on costs vs solar/wind, loss widening, they're now highlighting the renewables' intermittency, lack of firmness, poor dispatchability. If 'All of the above' energy strategies promoted all, it would be thing. But they'd lose; so lately, efforts hobble solar/wind. Big attacks on renewables, EVs specifically to halt clean energy. Sure, 'IF one just overlooks climate', then gas might be all baseload! Subsidize it heavily, and stress renewables are intermittent. It's a hugely risky, 'IF bet!' Contradicts all the science. But, we are seeing such fast-growing efforts of late, bold moves by US states now to slow, or even halt just clean wind/solar alone in its tracks.

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

As federal officials worked to kill just solar/wind at national level too. So, besides states' efforts to hobble wind/solar, a big effort from 2025 was to make dirty & costly coal, cheap -- by cutting federal Health regulations. In 2025, federal officials exempted 47 coal companies from mercury, air toxics standards like particulates. Coal's still too costly; just moving/burning coal makes it costlier than renewables: so paring health/environment rules Not enough. Yet, to allow more harms to human health, should be a non-starter. Even in China with far sparser health protections, coal is pricier; baseline USD 5.0 cents (RMB 0.38), coal costlier than renewables -- even in China! Plus, there's no 'clean coal'. We see too on recent US politics & fossil momentum, an old -- yet still wrong argument is again being trotted-out too: it claims traditional US oil & gas are all Unsubsidized; and that only the renewables solar/wind are subsidized. *Yet that's just wrong too: all energy in fact is heavily subsidized*. Consider tax breaks given just US oil & gas. Despite attempts to end ongoing fossil fuel breaks, an enormous $35 billion in direct subsidies continues on (and 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" so fossil firms can deduct a big 15% of their 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; the subsidies are worth billions to them. But, hush, don't use that 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 gets any governmental support. They've gone out of their way to avoid a 'subsidies' label for $$$ given them. But truth, is well, the truth.

Renewables enjoy subsidy levels competitive now with fossils; 2016 to 2020, about 46% of US federal energy subsidies went to renewables. Yet direct subsidies, only. Implicit subsidies to polluting fossils are Far Bigger, when one counts costs to human health, clean-ups etc. IMF estimates those were *$7.1 Trillion* in 2022, or 7% of GDP. Or US Military keeping oil flowing in Strait of Hormuz between Iran/Oman; were it shut, oil could go >$300/barrel. Or Price-Anderson Act limits nuke industry liability to $10 Billion/ radioactive catastrophe; without it, current II gen US nuclear would be too risky, no new nuclear plants would get built.

Hence it's important to state it 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?

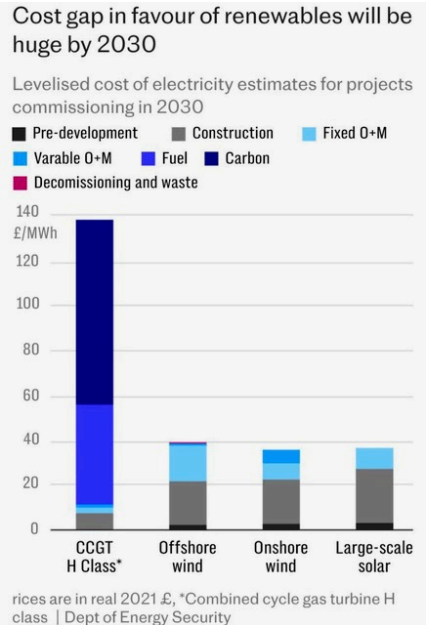
Given narratives from fossil-interests, one might think very Cheapest-US-electricity states must get *All of their power* purely by natural gas, coal, nuclear -- not on renewables at all! And yet very cheapest state, just 11.31 cents/kWh retail early 2025 was windy North Dakota. Turning 1st to its lowest-cost power, wind. Wind makes 36% of its generating capacity, which more than doubled in size 2016-2023. Those gains were Not on any green ideals, or climate-concerns, but because frankly its abundant winds make cheapest power. Along with wind to 1st meet demand, it turns first also to another cheap source hydropower for 4% more. Hence note 2 renewables are often its 2 cheapest sources of electricity. Only after that cheapest 40%, will it then use its biggest resource, firm dirty lignite coal for another 55% electric generating capacity. Then goes lastly to costliest of all, its natural gas lastly for final 5%.

Hence at America's very lowest-priced state, 1) cheap wind costs are ½ or less that of coal; 2) its own lignite coal is abundant though costly on human health +environment regulations -- yet important baseload to mitigate intermittency of wind/solar; 3) all is cheap thanks to its *renewables lowering fossils' costs. It does Not face *big climate/or wildfire risks; *sparce population lets it export power to other states & Canada. In sum its renewables are now its 1st and big 40% of power & growing -- while its own fossils only after are 60% and falling.

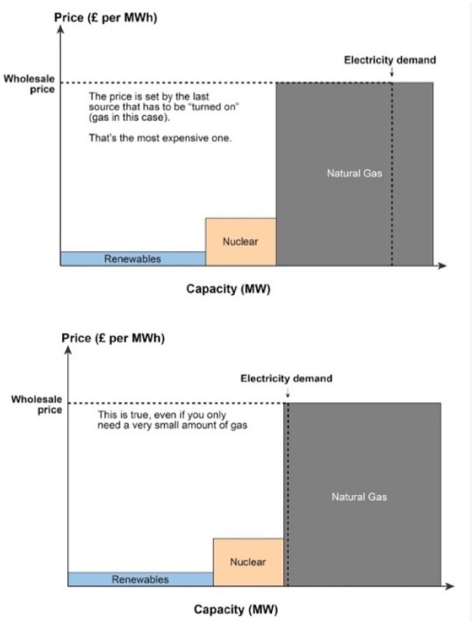
2nd lowest-priced Idaho was 11.34 cents per kWh. Does it get all electricity from fossil fuels? Again, No! For Idaho in 2023 its biggest source by far was hydro, 43%. Again renewables are Cheapest power. So, it turns 1st to low-cost 'water' (hydro), plus wind for 15% more; hence 2 renewables + a 6% solar make 65%, 2/3rds clean meeting demand. Wind/solar intermittent, hydro is stable but less than fully firm; thus, it 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% is from wind: hence 2 renewables make 75% of its supply. For important baseload it also gets 25% of electricity from firm but far more costly fossil gas at 13%, nuclear at 8%, coal at 3%. Hence the 3 low-cost US states notably all rely very-heavily, sizably on renewables: wind, hydro. Will include more solar ahead too.

So why haven't the cheap renewables, been seen to lower retail costs greatly? One reason: rank-order 'margin pricing' mechanisms set electricity at high costs. Take UK (Great Britain), where marginal pricing means if *any* natural gas baseload is in the production mix – it's true 98% of the time -- 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, with 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% more than world average, 4x a US: 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, & that gap is widening. If much gas is used (right top chart) marginal prices high; yet when gas meets only a 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', cheapest renewables now keeping 'a lid' on already-costly UK rates, would be less useful for populous south. And high rates nationally, would have gone up even more for the many UK citizens without nearby cheap wind. Still, consider that in 2025, Saudi Arabia (with less winds) set new global low-price record: just 1.338 cents/kWh! UK could in theory, move to emulate that! Saudi solar was producing for just 1.097 pennies/kWh, all thanks to serious support.

A regional pricing in a 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, is Hawaii which has the 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-electric (& 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 wait, that can't be right!* Texas' renewables make far more power than California, and are now a high % -- 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 its 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. Its heavy 1st mover costs: in a free-market Iowa, wind was the cheapest resource and so able to 'naturally' achieve 40% capacity factors, vs. a California requiring solar early-on in 2000s that was then 10x more-expensive early-on, a capacity factor 20%. *Guarantees of big returns of 8%-12% for shareholders in the utilities in California. Versus rural cooperatives in say, Iowa with No profit margins. *Slow/costly permitting. *California's Industrial Natural gas prices are 3rd highest in US for needed baseload gas. *Huge wildfire costs, 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 seen repeatedly, the fact is that clean hydro/ solar/ wind by contrast, are *deflationary;* they *reduce* costs. While reasons for California's high costs are complex, these can be cut especially at its 3 big investor owned Utilities.

The 3 big Utilities aim to recoup costs of wildfires, gas accidents from ratepayers, while also providing 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 leader states are conservative too: Iowa (42,000 GWh), Oklahoma (38,000 GWh), Kansas (27,000 GWh). As further evidence, of 12 states with most 'WWS' (Wind, Water/hydro, Solar) by percentage Oct. 1, 2023 to Sept. 30, 2024 -- six were among 10 lowest-retail electricity price states early 2024. Low-priced states overlap on a map, with abundant wind & hydro power. South Dakota, Montana, Iowa, got at times 110%, 87%, 79% of their electricity by clean energy, mainly wind, hydro. At other end, a costly Maine with instead very high industrial natural gas prices (over disaster recovery) -- had high electric rates. California's industrial gas costs at 2x US average price, ratepayers subsidizing socially-sought-after goals (can be addressed by the much bigger taxpayers pool), it was fated to have costlier rates than most states pursuing none of the traits.

A California that in 2023 got about ½, 54% of its electricity by renewables (32% solar, 6% in-state wind, 10% hydro etc) aims for 90% renewables by 2035. But that 2035 is years away. In 2023 natural gas was still a huge 39% for 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 must burn gas, coal, or biomass met 1.5%. In 1990s/2000s, it had had healthy total domestic capacity surplus. Hence Norwegians long had (on no drought) 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?

On a president's longstanding hatred of offshore wind it was forced to a halt in US, 2025. Even in states desiring it, California, New York, Rhode Island, etc etc. It doesn't have to be. In Germany small solar panels on balconies are extremely popular, in part because they are legal, simple, very cheap. In US, state-level regulations had made such balcony solar illegal -- but state-level changes starting in Utah makes it viable. It can lead to a blossoming like in Australia where in 2026 more than 1 in 3 homes, have rooftop solar. In a US, was less than 1 in 10 had rooftop solar in 2026. Yet Utah late 2025 made solar tougher. As fights brew too say on niche hydrogen (H_2): Europe in 2020s drafted rules for green H_2 by renewables, to ensure 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 a 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 from anyplace -- were too pricey. Fossil-players claim a cheap '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 is pushing a turquoise low-carbon H_2 from waste heat in 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 2022 IRA provisions moot point. Changes to 48E/45Y of 2025 changed a great deal. In short uncertainty reigns in clean energy, so it's no surprise to see huge volatility in clean energy stocks. To try to predict what is ahead here, no matter the election outcomes, or indeed any other big things (tariffs etc?!), 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 had changed dramatically. Solar/wind had fallen to often near 4 cents, or *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.

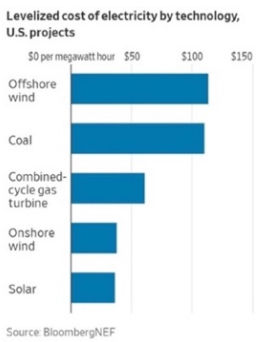
It's not-so-hard to see why fossil interests late-2020s saw threats ahead. With electrification, their goal may be as much just to ensure their products will go on seeing demand, as a past usual aim of less-regulations. A key issue for them is fast-falling costs for EVs, clean energy -- China's deflation 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.

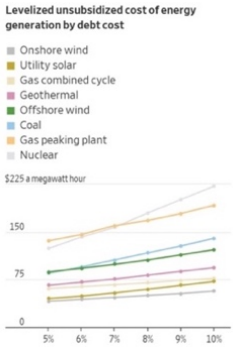
UK has suffered from stop/start support for wind, falling energy production; an old/poor grid; onerous permitting; little energy storage. For instance, on 10 Dec. 2024 forecasts were for 2 windless days: output may plummet from >7 GW to 2.2 GW. Prices rose to £175 MWh, steepest in 2 years. Meant more 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, offshore wind supply chains immature, things were sanguine on a president aiming to shutter wind permits in federal areas 2025-2028. Still extant onshore wind & PV were its 2 cheapest-US options, considering energy costs vs. debt. Clearly far better vs. 2 costliest options: nuclear & gas peaker plants. As coal/ offshore wind sat in middle on costs. Hence 3 relative best US winners were *Utility-scale solar; *Onshore wind; and *Baseload power if via-cheapish natural gas at modern combined cycle plants:

Source: FactSet, Wall Street J.



Source: Wall Street J./ Bloomberg NEF

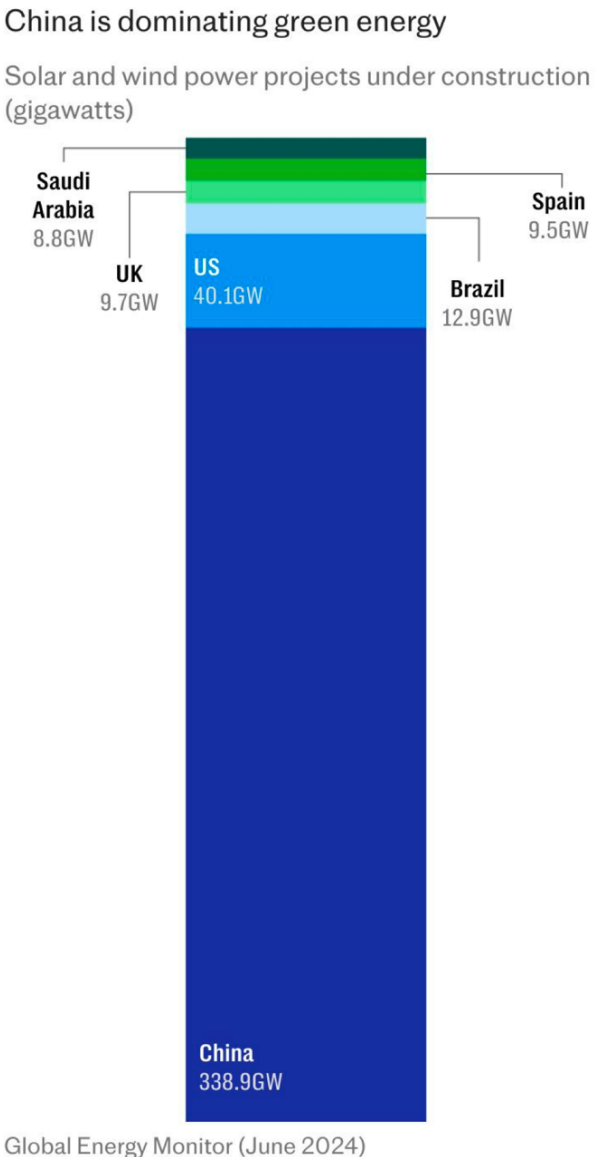


Source: Lazard, Roland Berger, WSJ.

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.

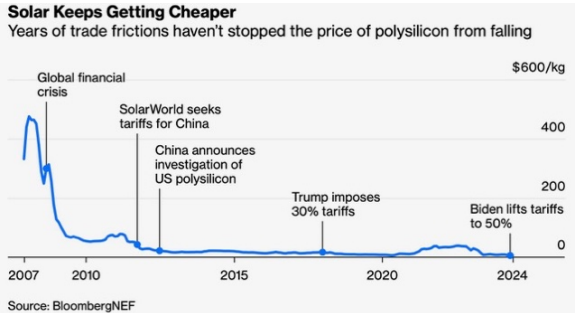
Moore's Law famously shows number of transistors placed on poly chip doubles every 2 years. Such is the room to advance on a silicon base. In China's case, it had faced around year 2000 many vulnerabilities with few oil reserves, and oil price spikes. Its government chose instead to target new poly/solar 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.

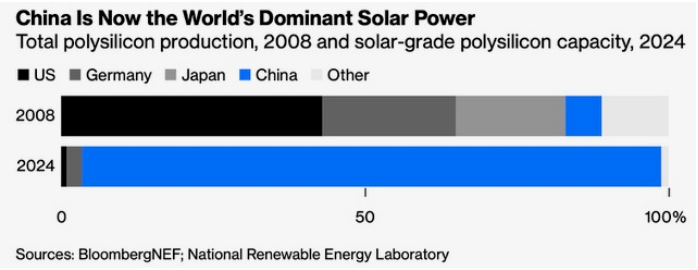
Early 2000s global poly industry grew: that US PV poly producer invested to grow capacity. By 2005 it announced plans to invest $400 million, later, another $1 billion. A lot. But consider too that near 40% of costs in making poly, is the electricity costs. Michigan is industrialized and boasts huge 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 the US, & energy-intensive, a search on ChatGPT may use 10x standard google. Data centers were 4% of US electricity demand 2024 -- that 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; if 7 hyperscalers (AI users) each may need 5 GW soon as 2030. Yet 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 may swiftly overtake US, unless action on both AI and US energy is undertaken fast. But that's another story.

Some tailwinds *may* help clean energy: *Old fossil Utility-power is getting far costlier; *US electricity Demand from 2025 is beating records. As *Heating & transport get electrified, *new AI, re-shoring US chip makers mean GWs of demand: gas plants to supply juice could be a pricier 7-9+ cents per kWh; *Nukes in West typically end up as far more time/$$. A US that once spent $400 billion annually on oil imports, was by 2024 the World's Biggest Oil Producer (70% by shale) & Gas (80% from shale) thanks to fracking revolution! And yet, in the US natural gas only met a steady 43% of electricity demand in 2024. *Nuclear costly in West, met a static 19% of electricity '23, '24, '25. *As costlier coal's share fell from 20% in 2022 to 17% in '23, to 15% in '24, 14% in '25. Coal's role in US electricity by 2023 was just ½ vs. a decade prior (mostly replaced by gas). Meanwhile, electricity by new wind, hydro, solar *rose* from 21% in 2023, to 23% in 2024, to 25% in 2025. Some growth, yes, but Not nearly fast enough.

Sec. 45(X, V, Z) tax credits had helped build US solar, wind in 2024: but were restrained by a re-elected president hostile to IRA in 2025. For US makers too of wind, PV, inverters etc, much is commoditized. Hard to differentiate premium brands. In 2024 the biggest PV maker in China so world, asked its own government to bar competitors from selling PV below cost; sub-par failing panels give its solar a bad name. All part of China's moves to rein-in big over-capacity with an anti-involution campaign from 2025 to pare back excess supply, poor-quality. Aims to address 'irrational competition', for better profitability; it *may* be bullish for equities, if it comes to pass. Hence latter-2020s can be an interesting time. One may look around & see if overcapacity & better margins are better-addressed. Equities, as ever being forward-looking, may seek to anticipate profitability -- and *might* move ahead of that.

In other news, $7 billion had been slated ahead in federal funding for 7 US hydrogen hubs, but dramatically cut from-2025; the fossil H_2 survives. Like an Appalachia hub's maybe $925 million on natural gas -- for so-called 'blue' H_2 that isn't truly clean. Or Gulf Coast $1.2 billion partly natural gas to H_2 so not truly clean -- both in red-states. A blue state California's $1.2 billion was to be for renewable H_2. America Heartland $925 million was to decarbonize agriculture fertilizer-use. Atlantic was $750 million for H_2 by renewables, but also from nuclear. Midwest was for steel, glass, power production, also sustainable in aviation fuels at $1 billion. Pacific Northwest electrolysis for clean H_2 was $1 billion. Of course, green, locally clean-H_2 using 'additionality' from new renewables solar/wind -- is in theory best. Made from an additional clean power+H_2 -- matching hours sun shines, or wind blows. But in 2025, the more important factors seemed to be maybe whether a hub was in red-states region; whether H2 was tied to fossil fuels, something novel that the oil industry was supporting.

Fossil interests are clearly growing. A COP28 Climate Conference late 2023 choreographed a shiny (oily) veneer of success. It highlighted global Agreement for 3x renewables by end of decade: nothing wrong there! The petrostate heading it was smart, put that 3x in front. But what they did Not highlight, was also worth considering. Fossil representatives had dominated COP28 like never before, at ~4 times the number of attendees vs. Egypt a year before. Its 2,400 people was greater than any Country's Delegation, save Brazil. Quietly they'd put the *Petro-states' interests as a main centerpiece -- eg citing 'carbon capture' that can allow oil/gas, and coal to go on decades to come -- while also *Removing teeth from final language. COP Drafts went from "phase out" of fossils -- to softer "transition away from". Some silliness like "responsible yachting". Worse was wording to 'accelerate' [so-called] 'carbon capture and storage'. COP28 end-product was deemed 'devastating', 'dangerous' by many climate scientists, who often used much saltier language. In sum the fossil-focused nations viewed this COPs 'favorable' result as significant success, indeed they Voted for its outcome.

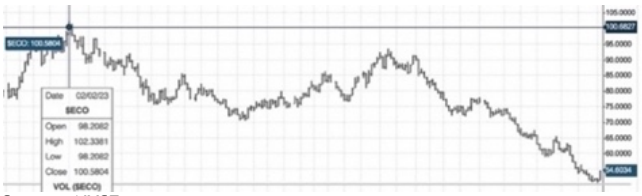
Next for data-lovers, are math parlor-tricks, a few coincidences discoverable in clean energy's story given so much data. Of mild interest only, thanks to ECO calculating live 20+ years. Take a volatile 3 down-years: 2021, 2022, 2023. Clean energy's story, tracked by passive ECO saw very 'steady' declines. So steady 1) Each year's high had come early on in 2021, 2022, 2023 -- AND 2) Followed by nadir Low, very late in each calendar year; AND 3) coincidentally too steadiness of falls took each year's nadir low down -½. For ALL Three Factors. Thus was 2021 286.89 intraday high on Feb. 10, 2021 -- AND fell to nadir intraday low very late in that year on December 29, 2021, AND that 142.39 low had dropped by a near 'neat' -½ (-49.6%).

Then, in 2022, green energy's story fell a 2nd time again from the high early on in that year -- AND to low very late in year, AND by near -½ at nadir. From a 1st day 2022 high at 152.87 -- AND nadir low that year on last day of 2022 -- AND a bit interestingly near -50% (-49.7%) to 76.02. Such a 2nd, -50% fall in this passive story again by chance only, seen looking *backwards* on rich data. Still 2 non-imprecise consecutive steady drops -50%. Looking for coincidences say Q1 2022, it also fell near, say, 100-resistance level 4 times. Or, early 2023 it initially fell repeatedly to a 70; of course, later that year it obliterated that fully-random, 70 value.

A few falls by near -50% in clean energy, so ECO, were mere coincidences in a data-rich past. Meaningless looking forward. Sometimes, was infra-year only; other times only start of year -- sometimes intraday, other times, at closing values. Can't be used to predict future, but do show *how volatile this theme is,* falling -50% early, even in a 2020 big up year! Or take a non-calendar 12 months say, end Q1 2021 -- to end Q1 2022. Meaningless as non-calendar period, yet went roughly 200-100, from April 2021 at 205.65 close -- to 2 lows Jan. 27th & Feb 23rd. Just noting again not far off -50% from round 205 -- to 102. War sparked a brief +40% rally in better solutions here, then fell back. But, to so cherry-pick from data, especially infra-year or day, is NOT predictive. Only bit of fun given so many data points. As Mark Twain humorously put it, "Lies, Damn Lies, and Statistics". Just playing with ample data, thousands of data points here. More importantly, this brief bit of fun is of no real help when looking forward.

Thus, one mustn't read too much into it, other than to confirm great volatility, often down! Like Jan. 2022 this passive theme fell by near neat -30% in blow-out. Or down -20% Jan. 2024. Never predictive, it's ephemeral. Maybe points a bit to 'enter on dips, sell on rips'! One thing noticeable here was a sheer steadiness as clean energy fell these years -- so 2022's high point/ and a start of year -- were nearly the same; 2022's low point/and end of year also near same. Just for giggles, conjecture, we'd seen 2022's high close was 152.87 Jan. 3rd (154.41 intraday Jan 4th), so hypothetical calendar year's low, if another 'exact' -½ down, just playing might be near a 76.43 nadir close very late 2022. Nadir low any day of year, is possible of course -- yet all the maths were it's very unlikely to be at very end of year! So was interesting to see when/where 2022's nadir did fall. Not surprisingly, *not* exactly 76.43! Interestingly, though, on Dec. 28, 2022 this theme did hit a 2022 nadir low of 76.02. As noted not so far off a 'neat' -50% nadir of 76.43. Just for fun, in rounding to whole numbers, both were near to 76.

Hence for fun we'd looked a 3rd year at What may be a 2023 high in clean energy story. That 102.33 (intraday) high was early-ish in year: Feb. 2, 2023. Of mild (but bit more) interest: might it then see a rather symmetrical fall in clean energy's story, -50% in theme; maybe hit its next nadir –½ late in 2023, near rounded figure of 51 (or intraday low 51.16)? Bit of a head-scratcher was how close to that was born-out. Next page is the green theme high on Feb. 2 -- as ECO hit a rounded 102(.33) high intraday. AND far right, bottom one sees a rounded 51, then-low 1st touched on later'ish' on Nov. 1st -- so near a roughly -50% conjecture:



Source: NYSE.com

Oct. 2023 this theme had been falling fast towards (past??) a 'conjectured' 51 low: it hit 53 on Oct 23rd; again 25th/26th. Then 51(.62) hard on 27th. Plummeting, felt like rounded 51 (as floor) might be about to be decidedly breached -- so proven quite-wrong in that 3rd year! And yet. End of October clean energy's theme fast bottomed, near a conjectured 51 (-50%) -- touched again Oct. 30th. On November 1st it touched (only) tad lower, 3rd time low so far: still rounded 51. If this low were to hold as nadir all 2023 -- then near -50% conjecture might be born out, though Not coming very End of Year. ECO is just a passive theme, yet coincidences may be discerned (for fun) given a sea of data. Next this theme did hit a low on Nov. 1st for a 3rd time in 2023, and it was barely still at an intraday low of rounded off 51 (50.61).

On Nov. 2nd this theme rose somewhat, laying-in 51 as something of a resistance-level. Just modest chance this low could possibly stand as the nadir for year… rounded 51 (50.61) nearly 'as surmised/ conjectured'. But on other hand, short-sellers were then attacking solar, wind, EVs, fuel cells, hydrogen etc hard; one could guess 51 might be re-tested, or soon fall to 40s. Indeed 10 days later, it touched rounded 51 a 4th time. A fuel cell name raised doubts as going concern, solar trackers were crashing, EVs hammered. In this environment was no surprise to see this theme again touch that round 51 low (50.65 intraday) on Friday, Nov. 10th at left. It touched it a 5th time at about 51 (just barely so, at 50.52) at right Nov. 13th:

And then, it held. So, 2023 had Not (yet) fallen into 40s, nor bust a 'just-for-fun' conjecture of -½. Lane open for maybe Rate *Cut hopes,* reduced concerns. Theme leapt into 60s, a big jump, yet arguably premature, as hopes in 2024 went from 4 cuts -- to 3, maybe 2, or less. Looking back then, 2023 saw just 1 of 3 'AND' factors: low near -50% clearly fulfilled. While a high near year start, low at end of year, or 2 of 3 other factors were Not fully-fulfilled.

Next, 2024's high literally came 1st day of year at 62.38 (intraday); so bit interesting to see if a nadir also might come very late in year -- AND down –50% (to near 31.19). Such did Not happen: low was on Sept. 10th well before year end @ 36, so not conjectured -50% (or 31). Then after a president's re-election, story fell to a 28 nadir in April 2025; with erratic trade threats, chaotic policies, that broke earlier steadiness of declines. By 2025, that trio of *early-in-year highs/ *AND late-in-year lows/ *AND -50% as a conjecture, no longer applied.

Indeed, that prior steadiness (and all down) was by now extinguished, shattered. The 2025 high came well late in 2nd half of that year. The low for 2025 was seen very early-on, so opposite, in April/early Q2. Hence 2025 unfolded far differently! Very different president, congress, & far different legislation ('one big' bill) -- performance opposite of steady falls, just declines from a high at start of year, to low at end of year. Thus broke a steady down trend over 3 years earlier 2020s. What will come next, in unfolding year/s shall be interesting. (A small side-question, is whether such sheer coincidences of pretty steady falls fulfilling all 3 'AND' factors like was seen in 2021-2023, might resume in future? Highly unlikely given how even, steady those annual -50% falls had been)! Steadiness has ended, for near-term at least. For ample past ECO data see, https://www.nyse.com/quote/index/ECO

For 20 years we've looked at new energy innovations, that *may* be superior vs old energy. At ways disruptive 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 -- and Global NEX since 2006 etc to pioneer zero-carbon themes to help avoid climate risks. As solutions that may appeal regardless of climate. And yet climate concerns unsurprisingly, rise to the fore of late. Our heating-up planet seems to shout along with undeniable scientific consensus: risky tipping points may scarily loom, or be already now at hand.

It's so significant, we'll take some precious pages here for this science. Consider: carbon dioxide (CO_2) levels now 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, like that year, set planetary records, blew away a prior 16.63 degrees C (Celsius). Far more than cranking 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.

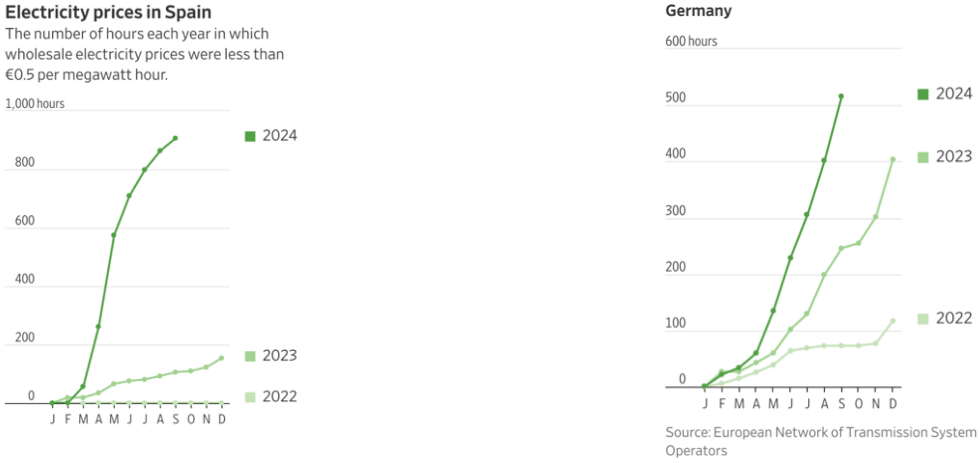
In Florida Keys, sea temps in 2023 went >100 degrees F, hot tub temps. Yes, was in shallow waters, less open ocean flushing, seagrass dark bottom absorbs heat … but still. Antarctic sea ice lately is not rebuilding like normal in winters -- worrying scientists who fear tipping points, a collapse in sea 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.

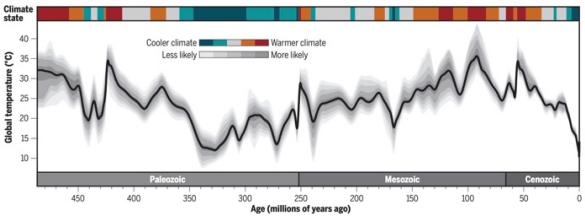
For example, contrary to political-drawn-beliefs, fact is: clean energy can *cut* energy costs -- *renewables can be Deflationary*. But that doesn't just flow to lower costs. Australia had clung to coal -- it saw changes as renewables surged. PV output up year/year. With less need for costly gas, *wholesale* 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 growth ruffles some politicians feathers but saved its grid. A conservative state, yet its private sector is growing new energy 'fast'. And a bit akin to Portugal in 2023, where solar had met 7% of demand (then like Texas); wind then 25% of electricity demand also like Texas levels. So, Portugal & Texas in 2023, were alike 7% solar/25% wind & growing. But they're different too. In Europe natural gas is pricey, not-secure or-domestic, so far less used. Hence Portugal's focus is renewables! Portugal's renewables met 71% in 2024, up fast from a 61% in 2023, from 50% in 2022. Portugal benefits more greatly from hydro (unlike flat, arid Texas). Portugal hydropower at 23% of demand in 2023 -- was 40% by 2025. In say an April of 2025, Portugal's hydropower met 40%; wind 29%; solar 8%; biomass 9%; so all in near 85% total. While natural gas was just 11% and dropping. Portugal's renewables may hit near 95%+ by 2030. Portugal is thus growing its clean energy much faster. Yet in context of just a US, Texas 'wins' among the 50 states, though it's moving at far-slower pace than Europe.

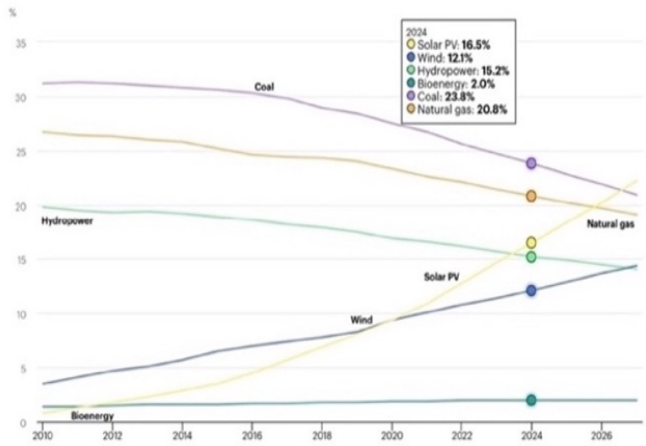
Still, via a climate lens it's scary: for nowhere, is clean energy going fast enough! Everywhere, is seeing decarbonizing setbacks. On unending CO_2 it won't be 'just' 1.5 C hotter ahead; that is not-realistic. In 2023 China & Saudis refused to raise 2025 targets at G-20 ministers meeting. China was 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.

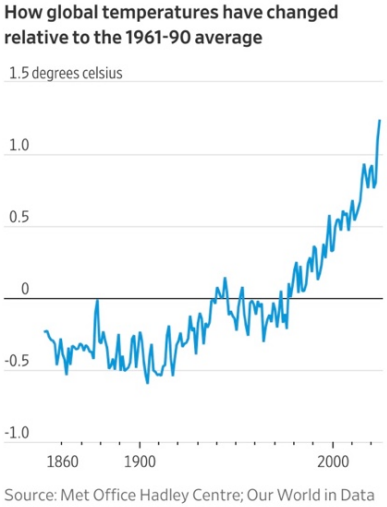
It's not as if traditional, old energy fossil fuels could have any better answer on needs for more, fast, & cheaper energy. Plus their problems are worse on so many fronts. Again, big Texas in a US is a case in point. Its gas plants there *will* struggle ahead in new colder & hotter extremes -- while 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 has been growing by 2x every 3 years; or 10x/per decade! 10 years ago, mid 2010s, solar was 1/10th capacity of mid-2020s. Was like planet's nuclear plants grew 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 with ½ in China (26) -- rest Asia & Middle East. Vs. 0 in US, and 4 in Europe. New small nuclear reactors beyond 2nd gen reactors typifying American 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 was next hottest year on record -- yet may turn out to be one of the coolest-ever years a young person today will know 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.

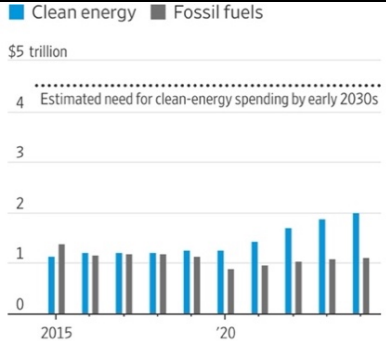


Source, left: IEA, *Share of cumulative power capacity by technology, 2010-2027.*



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.

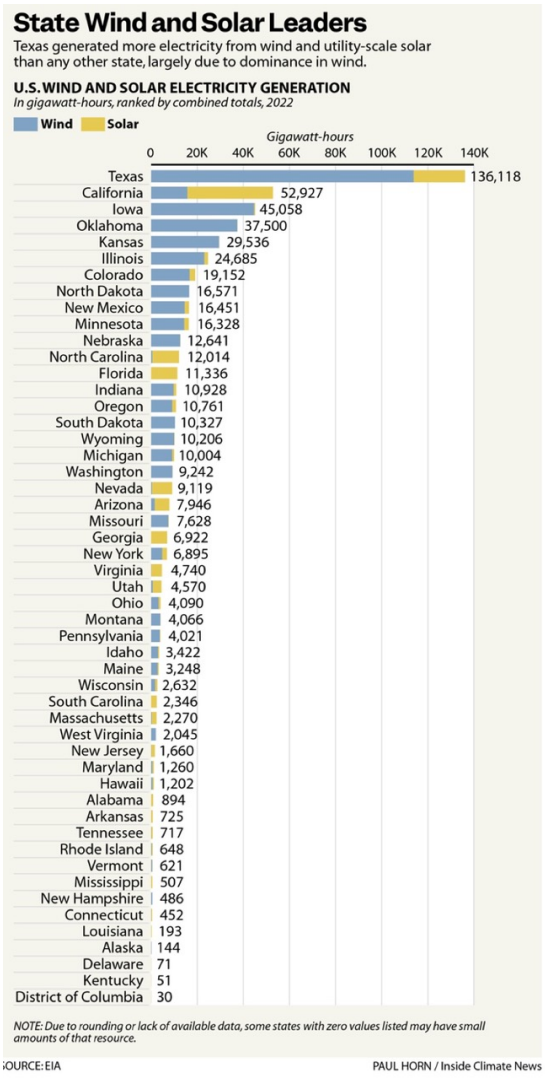
Batteries give just a short-term storage to say 4 hours. Longer-term storage options can hold electricity for days, weeks, months. Yet achieving huge-enough zero-emissions global Storage by 2040, meant new capacity of some 2.5 terawatts (TW) power, 150 TW/hrs of energy. Thus, Herculean efforts are needed, 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. 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) at 6.8% of time -- vs. 4.6% all 2021. Wind/solar curtailed (shut) at times, or might have been worse. Fossil & nuclear interests oft criticize renewables as intermittent, a 'defect' -- yet they want Not to 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 very cheaply/or free. Yes, some $2.5 Trillion in spending by private sector for 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 that's lately become an expectation. 10 other outages affected over 10 million! If uninterruptable power is mission-critical, outages >8 hours is more than li-ion batteries bridge. So instead of just storage, think too of fuel cells; they run unlimited, as long as fuel is supplied. Days, weeks, months. In 2020s, fuel was likely natural gas, CH_4. But ahead, it 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 more efficient, less polluting. A fuel cell is pollutant-free if using green hydrogen H_2 -- no SOx, nor NOx from burning. In such future, green H_2 fuel may be made from wind or sun plus water, simply by using electrolyzers!

More severe power outages included: 3 days impacting 100 million in India on a coal shortage. 7 days out, hit 1 million people in Canada due to Derecho. 10 days in UK from lightning strike. On 1 day, 120 million out in Indonesia out on power line disruptions. Clearly, more & bigger power grid failures lay at our collective doorsteps ahead. Attacks on grids, on power. Scary is any blackout lasting weeks or months; it 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: a few bullets, a bit of explosives, a DNS-cyberattack, even 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 that big custom critical, transformers for US grid are generally Not made in the USA; they come from China, or India -- and there's insufficient backups if they're fast 'taken out'. Destroy just 9 key grid electrical substations + a few key transformer manufacturers -- and that can decimate a US power grid largely made up of 3 parts; over areas for up to a year. Given such sleeping vulnerabilities -- and a potential for widespread deaths in the USA -- more needs to be considered.

Blackouts may lead some conservatives, towards a stronger grid '*now*'! Some to embrace green energy. Conservative-Iowa in 2022 got 60% of its power by wind; Kansas 50%; Oklahoma was close. Yet their Senators had opposed renewables in a 2022 IRA, though they increasingly benefit from wind. Later on, 2024, as IRA funds slowly rolled out, went 1st largely to few key red Swing States before 2024 elections. Despite that, IRA in 2025 was decimated. Conceivably, post-2028 elections, a few Senators, House Members may tear away from partisan opposition to green energy. Maybe on new weather extremes, unpalatable Russian fossils, or on costs, they might nudge CO_2-laden fossil plants to retire. Once-heretical ideas, like a carbon-tax might be re-considered. Trillions $$$ spent on fossil fuels, giving us climate crises, wars fought over and over which relate to oil & gas, may be rethought. Some thinking reframed.

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

Instead, France 2022 was badly handicapped, too; with ½ of 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, highest-percent 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 were stuck offline, 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 had taken 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 that 2021 with its miserable heat, floods, cold, hurricanes, rapidly disappearing sea ice, and rising seas -- as being part of a far cooler, more stable, and a much more desirable past. One that cannot ever be recovered.

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

Singularly here on climate, 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, 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 over China's 5-year Plan not reducing coal sizably, they upped their 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 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 give us a 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 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 how CO_2 warms inside of a jar; she predicted CO_2 can cause climate change -- century & half ago. John Tyndall in 1860s correctly showed how CO_2, water vapor, methane warm planet. Over a century ago, Svante Arrhenius & Arvid Hogbom of Sweden determined Why then-forecasted 3 degrees+ C rise in global warming will result from each 3/2 rise of CO_2. That ratio has since been refined, but principle is roughly same, with still more heating at poles than at equator. A linear increase first of CO_2 -- means by a power law for second, temperatures to rise as a logarithm of CO_2. In 2024, Fermi resonance helped to explain Quantum aspects of this heating; with the CO_2 exciting a broad spectrum at either side of 15 microns wavelengths.

As for what's possible, think of carbon linchpin, China. So wedded to coal it hadn't talked at COP26 of a coal 'phase-out' -- but of 'phase-down.' Yet its possibilities for 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 had 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 high end. If in theory, all China's areas that could go solar, had it. In its sparse-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 there 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 (it beat that). Then to 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 is 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 have big roles. Like if cold European Winters. An issue begun mid-2021 when 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 in 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 win OK for a 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 stepping 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 too off older nukes -- many places were expanding to new nukes; competing some with renewables for finance. Wind & solar 2020s were in an awkward stage. Growing yes, but not yet near-big-enough to be a Hero. In 2020, renewables had met only 20% of Europe's electricity demand, was nowhere near enough to overcome gas troubles … yet…

Plus solar prices *rose* in 1st Quarter of 2022 over 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. Pricier special PV panel glass. Freight costs for shipping PV product. Labor up for assembling despite mechanizing operations. Polysilicon from sand, a key building block, saw big cost increases then (before falling again). Europe's PV prices 2021 rose by 16% over 2020. Increased costs for inputs in 2021 had 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 that 45% 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* its solar each year, 30 GW more installed in US 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 a 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 -- along with battery/storage to make that firm power. Or they may stumble & fall, if future big bills like BBB with draft $ Trillions, again and again fail. Partly too 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 China, or France. Rather than build each reactor from scratch, as the US chose to do.

But can nukes also be made 100% safe? Less costly, sure -- but less risky too?!? In a 2020s on a nuclear state of art, that answer's murky, dubious at best. Hence questions do swirl around advancing past current 2nd generation fission nukes latter 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 did hit Texas in 2021 when a freeze took down its electrical 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, also? Natural gas has dominated, yes -- yet lately finds itself on back heels. Case in point, amidst that 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 by 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 above 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 off 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. its expectations, was narrower than at coal. Latter was off 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 like H2X/WNX – have shown a good *non*-Correlation vs all the 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.

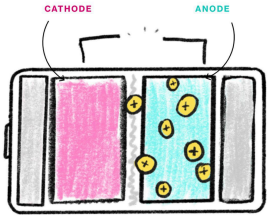
Great uncertainties abound, giving rise to volatility, tremendous risk. Myriad sub-themes *may* see advances: some incremental, some may be non-incremental, perhaps disruptive. Advanced green energy storage & batteries plainly merit focus 2020s, areas ECO & NEX have had exposure to for over 20+ years. 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 moving to little/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/Koreans in 2025.

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

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

Source: Bloomberg Businessweek

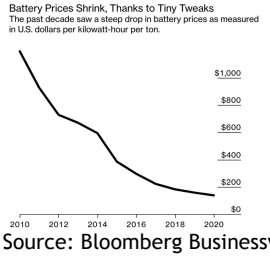
c) NMC as seen in a Nio:

Source: Bloomberg Businessweek

d) Tesla 3 has used NCA:

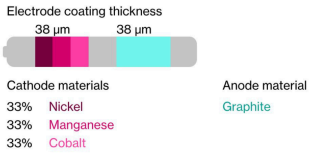
Source: Bloomberg Businessweek

Battery prices are falling hard:



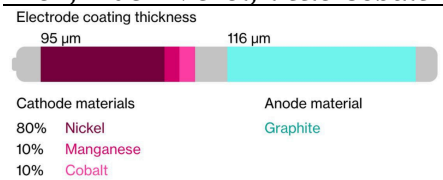
Source: Bloomberg Businessweek

NMC Composition back in 2012:



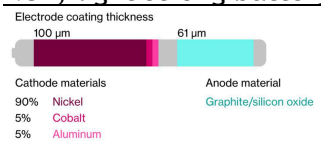
Source: Bloomberg Businessweek

Then, much Nickel, little Cobalt = thicker:



Source: Bloomberg Businessweek

NCA, light strong battery, no manganese:

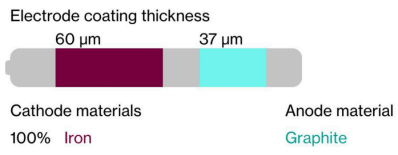


Source: Bloomberg Businessweek

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



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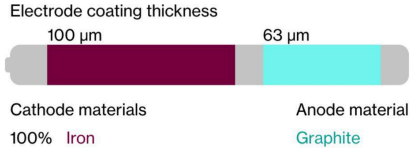
f) Modern LFP, less-energy dense:

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.

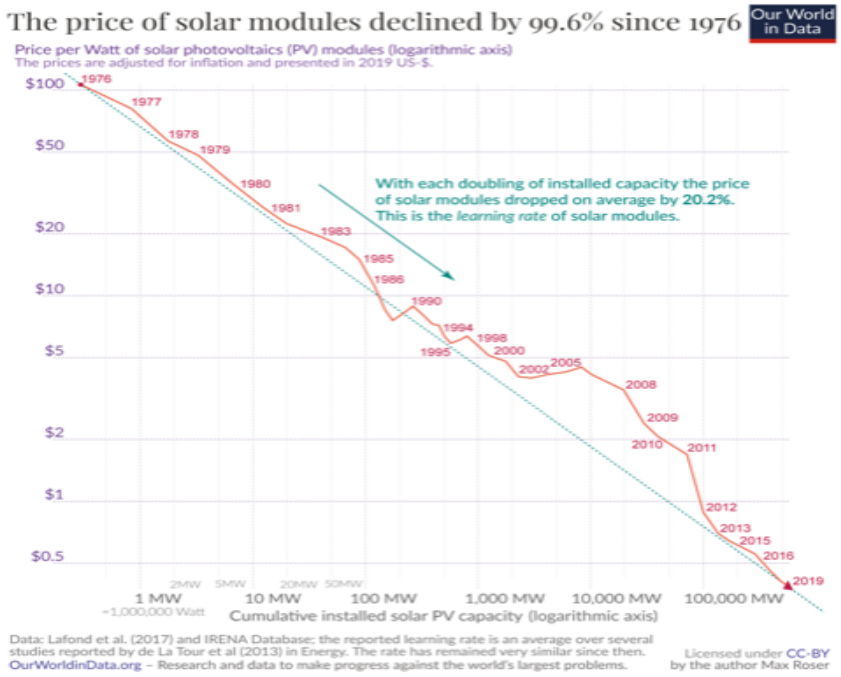
So much is possible. One interesting idea, may be iron-air batteries discharging power as they take in oxygen, making rust. In turn charging by using electricity to change back from rust to metallic iron -- releasing oxygen. On super-abundant benign iron, they may be cheaper & readily recycled. Anyway, 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 Can Favor 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

Dec. 2024, the US produced more oil at 13.6 million barrels/day, than any country in history! Oil then fetched high-ish 'healthy' price for producers, near $70/barrel. But isn't always so. Let's look back, intriguingly to 2020, and a remarkable world oil crash. Some called that crash 'illogical', yet it arguably unfolded with explainable logic of its own. 4 years prior began as oil *Demand* collapsed at onslaught of Covid early 2020. Businesses froze globally. Quickly, surplus oil began backing up worldwide, we'd forecast it here in Q1 2020 Report. That Demand Destruction swiftly grew so large, where to store all that 'excess' oil was a robust question -- especially as 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 then in a thriving oil-hungry world; impacts were muted. Oil did drop to $50, briefly. Yet excess was absorbed. Wasn't enough fall to kill US shale; shale reserves can fast bounce-back, putting something of a high upper cap on prices producers fetch. Their playbook may have been that in a world awash in oil, in 2020, that only 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's choke points can hit oil hard eg Strait of Hormuz: ~25% of all oil trade passes it; or Strait of Malaga: about 75% of China's energy imports pass it; or a Suez Canal, or Bab El-Mandeb strait; or Taiwan Strait as obvious geopolitical threat, or Panama Canal that's facing drought so low water levels on climate risk.

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.

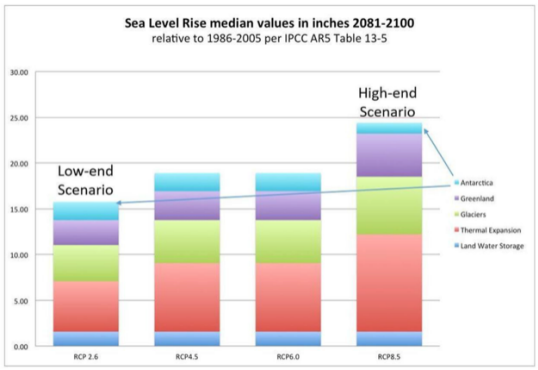
Imagine just ~70 years hence. Note then projections by Intergovernmental Panel on Climate Change (IPCC) for sea level rise in year 2100, may be misleading. For an end of century rise may be unwinding then at far more rapid accelerating rates, than was projected by IPCC. Getting that so wrong, has meant 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.

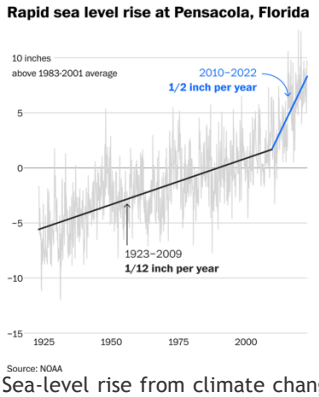
This idea that actual sea levels in 2100, could be greater than IPCC projections is well laid out in 2020 piece, 'Twenty-first century sea-level rise could exceed IPCC projections for strong-warming futures'. Their first paragraph nicely lays out very cogently and clearly, big ideas that today scientists 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.

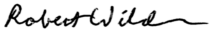
Conclusion:

The Clean Energy Index® (ECO) began Q4 at 60.52 & ended Q4 at 64.44, up +6%. For all 2025, ECO was up +52%. Or in say the 'context of presidents' so 3 full Quarters into a 2nd term, ECO is up +95%. Persisting inflation had hit this interest-rate-sensitive theme hard. After clean energy and so ECO Index® had touched a low around middle of 2024, it later gained despite -- or perhaps a bit due(?) to a 2024 election. We'd seen in stimulative 1st term 2017 to 2020, ECO moved dramatically up +38% in 2017, down -15% in 2018, up +58% in 2019, remarkably up +203% in 2020 for about best performance of any Index or fund anywhere. Tallied was a total gain of +284%, ironically in the 1st term of a white house highly skeptical of green energy. Afterwards, ECO fell all 4 years of a very differing presidency, first down -30% in 2021, then declines next 3 years by -46%, -22%, -30%; tallied was down by -128%. The 'one big Act' is lately pulling demand forward -- and just possibly may knock it down further ahead.

There were 2 Deletions from ECO for a start of Q1 2026: ReNew Energy Global, and Corteva -- and the 2 Additions for start of Q4 were: Energy Vault, SES AI. At the Global Clean Energy NEX for Latter Q4 rebalance, the 1 Deletion there was: L&F -- there were no NEX Additions. At Hydrogen Economy H2X, the Deletions for Latter Q4 were: Arcadis, Dae Myoung, ReNew Energy -- and H2X Additions for Latter Q4 2025 were: Energy Vault, Screen Holdings, Sensirion, Sumitomo Metal Mining. At Wind Energy WNX, the Deletion for Latter Q4 2025 was: ReNew Energy Global -- and the WNX Addition for Latter Q4 2025 was: TKH Group.

As always, we welcome your thoughts and suggestions.

Sincerely,



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Appendix I: ECO Index (via independent tracker PBW) components in descending % order in Q4 on 11/15/2025, or about ~6 weeks before rebalance to start Q1 2026. 62 Stocks:

Name	Weight	Bel Fuse Inc	1.5%
Canadian Solar Inc	4.0%	Ameresco Inc	1.5%
T1 Energy Inc	2.7%	Preformed Line Products Co	1.5%
Fluence Energy Inc	2.4%	Amprius Technologies Inc	1.5%
Eos Energy Enterprises Inc	2.3%	Darling Ingredients Inc	1.5%
Albemarle Corp	2.2%	Sigma Lithium Corp	1.5%
Lithium Americas Corp	2.2%	REX American Resources	1.5%
Nextpower Inc	2.1%	SolarEdge Technologies Inc	1.5%
First Solar Inc	2.1%	ReNew Energy Global PLC	1.5%
Ormat Technologies Inc	2.1%	Plug Power Inc	1.5%
Solid Power Inc	2.0%	Tesla Inc	1.4%
Lithium Argentina AG	2.0%	Joby Aviation Inc	1.4%
XPeng Inc	1.9%	NIO Inc	1.4%
Sociedad Quimica y Minera	1.9%	Niu Technologies	1.4%
Brookfield Renewable Corp	1.9%	Gevo Inc	1.4%
Bloom Energy Corp	1.9%	OPAL Fuels Inc	1.3%
JinkoSolar Holding Co Ltd	1.8%	Corteva Inc	1.3%
MYR Group Inc	1.8%	Archer Aviation Inc	1.3%
Advanced Energy Industries	1.8%	Universal Display Corp	1.3%
Navitas Semiconductor Corp	1.7%	Itron Inc	1.2%
Ballard Power Systems Inc	1.7%	MP Materials Corp	1.2%
Shoals Technologies Group	1.7%	Enovix Corp	1.2%
Rivian Automotive Inc	1.7%	Lifezone Metals Ltd	1.2%
Quanta Services Inc	1.7%	Enphase Energy Inc	1.1%
Powell Industries Inc	1.7%	Hyliion Holdings Corp	1.1%
Sunrun Inc	1.7%	EVgo Inc	1.0%
Array Technologies Inc	1.6%	FuelCell Energy Inc	1.0%
Gentherm Inc	1.6%	American Superconductor	0.8%
QuantumScape Corp	1.6%	Aspen Aerogels Inc	0.7%
Standard Lithium Ltd	1.6%	Atlas Lithium Corp	0.4%
Cadeler A/S	1.6%		
ESCO Technologies Inc	1.6%		
Monolithic Power Systems Inc	1.6%		

Some strong representation above in *Solar, *Batteries/Storage/Lithium Materials, and Geothermal.

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

INDEX (ECO) SECTOR & STOCK WEIGHTS FOR START OF Q1 2026. 62 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 (7 stocks @1.71% 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, CdTe low-cost alternate to polysilicon.
JinkoSolar, JKS. Solar, wafers through solar modules, China-based OEM.
Nextpower, NXT. Solar trackers, optimizing PV daily performance yield.
Ormat, ORA. Geothermal, also in areas of recovering heat energy.

Energy Storage - 26% sector weight (16 stocks @1.59 each + 1 *banded)
Albermarle, ALB. Lithium, specialty materials in batteries for 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.
Lithium Americas, LAC. Lithium, deposits in the State of Nevada in US.
Lithium Argentina AG, LAR. Lithium deposits in Argentina; has China nexus.
Nio Inc, NIO. EVs, China-based maker of premium vehicles, battery as service.
Quantumscape, QS. Battery, solid state lithium-metal energy dense fast charge.
Rivian, RIVN. Electric vehicles, trucks and commercial fleets, charging.
SES, SES. Lithium metal, battery technologies with use of AI enhancement.
Sigma Lithium, SGML. Lithium, in planning & pre-construction, sites in Brazil.
Solid Power, SLDP. Solid electrolyte battery, Earth-abundant materials.
Standard Lithium, SLI. Lithium, from brine in U.S., vs. traditional ponds.
T1 Energy (TE). Solar manufacturing in US, also in batteries; formerly Freyr.
Tesla, TSLA. Electric vehicles, pure-play across EVs, advanced energy storage.
Xpeng, XPEV. Electric vehicles, advanced mobility, swappable battery, China.

Power Delivery & Conservation - 18% sector (11 stocks @1.63% 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.
Niu Technologies, NIU. Electric scooters, motorcycles, mopeds, bicycles.
Preformed Line Products, PLPC. Grid products & transmission OEM, solar.
Shoals, SHLS. Solar, for electric balance of system, wiring, combiners.
Universal Display, OLED. Organic light emitting diodes, efficient displays.

Energy Conversion - 21% sector weight (13 stocks @1.61% 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.
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.

Greener Utilities – 13% sector weight (8 stocks @1.62% each)
American Superconductor, AMSC. Wind, grid conditioning; superconductors.
Brookfield Renewable, BEPC. Renewables hydro, wind, solar; energy storage.
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.
Powell Industries, POWL. Switchgear, controllers, & power generation.
Quanta Services, PWR. Infrastructure, modernizes grid, power transmission.
Sunrun, RUN. Residential solar systems, PPA, lease or purchase rooftop PV.

Cleaner Fuels – 10% sector weight (6 stocks @1.66% 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 III:
WilderHill New Energy Global Innovation (NEX) - for Latter Q4 2025. 109 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
Chargepoint	EV charging, an early leader with global presence.	EEF	USD	US
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
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
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
Nel ASA	Hydrogen, in fuel cell vehicles, renewably, Norway.	ECV	NOK	NORWAY
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
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

109 stocks = % Weights WEIGHT EACH COMPONENT =

0.91743119

1 NEX DELETION for Latter Q4 2025: L&F Co

109 Stocks Latter Q4 2025.		#	% Approx. Weight
Energy Conversion	ECV	26	24%
Energy Efficiency	EEF	24	22%
Energy Storage	ENS	18	17%
Renewables - Biofuels	RBB	3	3%
Renewables - Other	ROH	3	3%
Renewable - Solar	RSR	22	20%
Renewable - Wind	RWD	13	12%
		109	100%

Appendix IV:
WilderHill Hydrogen Economy Index (H2X) for Latter Q4 2025 (64 components):

NAME	Description	Sector	Activity
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
Littelfuse	Hydrogen & fuel cell sensors, temperature probes.	HS	USA
Lotte Fine Chemical	Green hydrogen, production launch, ammonia.	GH	S. KOREA
Nel ASA	Electrolysis for H2 from water, using alkaline and PEM.	GH	NORWAY
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
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
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

For Rebalance in Latter Q4 2025:
Deletions: Arcadis, Dae Myoung, Renew Energy Global
Additions: Energy Vault, Screen Holdings, Sensirion, Sumitomo Metal Mining

% Equal Weight each component: 1.56250
64 Components % each = 1.56250

Hydrogen Index H2X Sector	#
FUEL CELLS (FC)	14
GREEN HYDROGEN (GH)	13
HYDROGEN GENERATION (HG)	10
HYDROGEN INNOVATION (HI)	9
HYDROGEN STORAGE (HS)	9
HYDROGEN in TRANSPORT. (HT)	9
	64

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Appendix V: WilderHill Wind Energy Index (WNX) for Latter Q4 2025 (71 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 strenghtening 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	N. 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
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 Q4 2025:
Deletion: Renew Energy Global
Addition: TKH Group

71 components = 1.40845% Equal Weight each

4 WilderHill Wind (WNX) Sectors	#
SMARTER GRID (SG)	22
WIND FARMS (WF)	12
WIND INNOVATION (WI)	17
WIND MATERIALS (WM)	20
Total =	71

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

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