WilderShares, LLC

Q3 WilderHill® Quarterly Report: ECO, NEX, H2X, WNX Indexes, Sept. 30, 2025

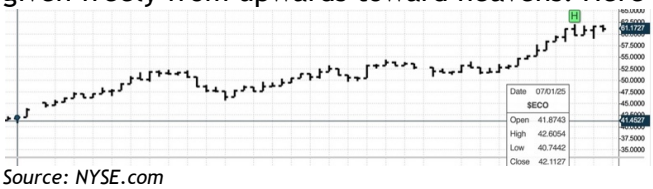
The Clean Energy Index® (ECO) began Q3 at 41.87 & ended Q3 at 60.52, so up Q3 about +45%. Since starting 2025 at 42.25, this year to date it's up +43%, with low of 28 on April 8th. Or first 2 Quarters of this president's 2nd term, from April 1, 2025, ECO is now up +83%. Persisting inflation over years had hit this interest-rate-sensitive renewables theme hard. After clean energy and thus ECO Index® had touched an earlier low in mid-2024, it rose afterward with -- or perhaps bit due to(?) the 2024 election. We'd seen in a stimulative 1st term 2017 to 2020 ECO moved dramatically: it was up +38% in 2017, down -15% in 2018, up +58% in 2019, remarkably up +203% in 2020 for about best performance of any Index/Fund, anywhere; tallied up +284% in conservative president's 1st term. Then fell 4 years of a differing president, down -30% in 2021, -46% in '22, -22% in '23, -30% in '24, so tallied was down -128%. Presently up again, 1st year of the 2nd term. Lately, 'one big bill' is pulling demand forward to 2026 -- and possibly may knock it down further out, both ways influencing clean energy.

The passive ECO Index® also can fall hard. From up near 270 in 2021 to down near 30 in 2025, the renewables' story thus ECO had plummeted by well over ~4/5ths. ECO, Global NEX, Hydrogen H2X, Wind WNX, can at times 'drop like a rock'. Jumps true, yet crashes too. Our mission is to capture & track an emerging & risky story, so crashes happen. Strong moves sharply down or maybe up at times, pervade all of clean energy; it's always been thus.

Meanwhile, traditional still-dominating fossil fuels were hit (even) harder, past 10 years. So clean energy isn't alone, and its doing 'less badly' than natural gas, a competitor in electric power. Past 10 years, a tracker for the 1st Global clean energy NEX live since 2006, is up +37%. Well-known ECO Index for clean energy, live since 2004, is coincidentally here up by +35%. For comparison, an independent natural gas index tracker (not ours since we focus instead only on clean themes) -- has fallen mightily: it is down a big -92% the past 10 years!

As clean energy so this passive ECO fell near 30, valuations discounted, much negativity priced in, some asked if this theme might possibly be troughing ahead? *Impossible to say!* And an inflection(?) up is only after a big downturn. Plus, so much in equities can be counterintuitive. For example clean energy rose hard over this conservative president's 1st term. 2nd term began initially without initial stimulus/ lower interest rates/ openness to abundant energy of all kinds, that buoyed renewables in 1st term. Yet clean energy gained 2025, and any move ahead to 'all of the above' energy strategies may be rising tide lifting all boats, renewables too if solar is seen as low-cost domestic energy freed of politics. Or not & past declines carry on! That said we emphasize as always, *past* performance *is no indication of future results.*

In sum ECO, NEX, H2X, WNX capture facets of clean energy. While energy, once mainly fossil fuels taken from deep underground, and burned -- increasingly comes from sunlight & breezes given freely from upwards toward heavens. Here's ECO to late in this last quarter:



Source: NYSE.com

One may have expected clean energy & so ECO to have fallen hard from very start of Q3 2025. After all, white house had worked closely with their party in congress on 'one big bill' signed July 4th, that aimed to hammer renewables -- while boosting conventional fossil fuels & nuclear. It pushed an odd narrative that only coal, oil, gas, nuclear are 'reliable, cheap' energy. And yet instead, as seen below, ECO & NEX *rose hard* Q3. Trackers gained over Q3 to Sept. 29: **ECO** up +47%; **NEX** up +18%; **H2X** up +10%; **WNX** up +9%. That didn't go unnoticed; last 10 days Q3 2025 trading volume in an independent ECO tracker was over $330 million.

Source: YahooFinance

Factors behind the rise include, attempts to most decimate just solar & wind in 'one big' bill, surprisingly failed last minute. Replaced by 4 years of credits. Attempts to tax just renewables failed too, last hours. Brought solar & wind demand forward near-term 2026. Plus key too is: *renewables are now so cheap, they can compete unsubsidized*. And removing the complex subsidy rules will simplify much, end uncertainty on subsidies, reduce costs. Plus, China is looking to rein in its own vast excess capacity, oversupply across new energy solar/wind, EVs. That said there's ongoing US executive branch efforts to hobble just clean solar, wind, EVs. To render even the briefly remaining US tax credits as un-attainable, so non-effective.

What had, beforehand, earlier in 2025 pushed expectations down, coiled a spring for big rises above? One was a likelihood clean energy opponents led by president & 'fiscal conservatives' (barely) in control of house & senate -- would decimate green credits. They'd drafted a harsh 'one big bill' in June. With strong chances these fervent opponents to renewables could 1st jam their moderates in house, then senate, on text singling out clean energy for acute harms. Their forces could still lose up to 3 votes in house, 3 in senate. While odds that their own party's moderates might instead upend those efforts, & slow that inertia, were not great.

Thus, a draft bill highly dis-advantageous to renewables was roughed out in the house in June. Oddly, self-professed 'fiscal conservatives' accepted their 'one big' act would blow up US debt(!); raise that debt ceiling $5 Trillion(!!); add $3.4 Trillion in deficit spending!! Far more federal outlays -- than $$ income. Their bill draft next moved to senate where it seemed sure 1) the libertarian senator from Kentucky would be 'No' on their long-principled stand on debt: this bill's gigantic deficits were not Conservative. The president briefly railed against that long-fiscally-conservative senator, who was unmoved on principle. Proposed debt, inarguable. With president's self-imposed July 4th deadline, likely just 2 senate No's (same in house), fast passage seemed likely. Hence was great surprise as senior senator from North Carolina with rare practical knowledge across all energy, announced they'd be a 2nd 'No' as well.

Senator stressed their 'No' was result of a president being "very badly-advised" on medicaid, energy. As a result, 2nd No meant just 2 moderate senators in effect could 'tag-team', since 2 additional No's would be 1 too many. Just 1 on-a-fence senator may demand enormous changes for their Yes. Conservatives, who'd wee hours before eagerly gloated they'd jam liberals on solar/wind in the house, & then senate, with fiercely anti-renewables draft text, instead found themselves jammed! They'd face a 'one big' bill's language more moderated, than what they'd hoped for. Nor could they badger this 1 North Carolina senator who knew energy economics far better than most any politician. The president wanted to conclude, sign on July 4th -- so threatened to 'primary' this 2nd senator. To hit him hard at polls. The senator retorted well then, best to find a replacement, since he'd retire, neutering that threat.

Thus when a senator of moderate, purple Maine, stated they'd be a 3rd (last possible) No, that put Alaska's senior senator in a key pivotal role. Able to make big demands in exchange for a last needed Yes. Some asks were narrow: to help its fishermen; Alaskans to do 'better' on Medicaid & SNAP as 'noncontiguous state' (blow back by parliamentarian). But nationally, Alaska's senator crucially demanded too a more moderate approach on US renewables, hence fewer clean energy cuts, a more-pro-America stance, more cheap US energy & growth in renewables. Mitigating vengeful extreme attacks. Because house/senate text must be identical, this senator 'dared' house to make any changes, send it back. For a ping-pong then back & forth, senate's resolve maybe strengthening, a revised bill moderating more. House 'fiscal conservatives'(?!) threatened an unwillingness to cave, but they caved immediately. The president, who'd hoped to proclaim a big fast victory, immediately did so. He signed 'one big' act into law. While quietly telling conservatives his administration could, & would fast mount a range of unitary new executive efforts, to hamper renewables solar & wind.

As a North Carolina 'No' had made so much possible, let's look briefly at it. The senator spoke unusually forthrightly on senate floor, pulled back curtains on 'how sausage gets made'. He stated bluntly causes for his No included: this president was being heavily misled by very poor guidance on 'one big bill': impacts would not at all be what an advisor claimed. This senator staunchly defended solar/wind tax credits in a 2022 IRA law, saying this new draft [one big] bill language 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 one 'self-described philosopher' (an advisor to oval office) and repeated that he'd had No actual experience in energy -- that he was a pro-fossil fuels & an anti-renewables 'zealot'. Versus 3 real-world business sector experts, who knew a lot about actually putting needed electrons soon on grid.

3 real-world experts all wanted far *more* renewables, including at one of the world's most sophisticated electricity buyers, which maps out its energy needs years in advance. Senator stressed draft bill as proposed, would instead gut well-laid power purchase agreements for reliable, cheap solar/wind. 'One big' bill senselessly attacked renewables. He bemoaned 'somebody had gotten cute' in text negotiations replacing deadline words 'in construction' -- with 'in service' -- which would have effect of decimating renewables. This senator with much expertise in grid baseload noted great progress in solar & wind was now teed-up. Yet instead, a white house representative with no real-world experience, did not know how to actually plan for real power needs ahead. Lamented that bill was 'half-baked' so senator was forced uniquely to vote against own party on a bill supported by an inexperienced zealot/ 'philosopher' with No Real-World Understanding of how electrons are put on grid. A video of this impassioned and unusually frank speech recently given on the US senate floor is at, https://www.dailymotion.com/video/x9m45t0

The senator rightly observed ‘best case’, due to bottlenecks, any gas turbines not already in contract, would not be ready for 5 years. Fossil fuels / nuclear can’t deliver sooner, so new electrons will Not come online fast, if renewables aren’t built. That a ‘conservative’ advisor hadn’t understood industry dynamics. Thus on 3 No’s by Kentucky, N. Carolina, Maine, a swing Alaska vote, input by key senators like of Utah & windy Iowa including a parent of PTC, thus big changes very last minute, moderated bill. Made the ‘conservatives’ fiercely anti-renewables/pro-fossils-only, howl, but they’d been jammed in senate, house. For example a prior draft would have cancelled solar/wind tax credits almost-immediately, for projects not ‘in service’, a deadline few met. Much is outside of control like Permits to put electrons on grid, taking years. That’s why the expert senator noted somebody had ‘gotten cute’ as draft text went from ‘in construction’, to must be ‘in service’. Moreover, opponents sought immediate halt to all solar/wind credits -- to prevent renewal by president or congress 4 years hence; that failed. Other draft harmful text removed too wee hours before signing. Like taxing just renewables! To forbid China-built components; notable as much solar etc still is overwhelmingly made in China. In the end, jammed, pro-fossil ‘zealots’ lost much of most extreme text final few hours, when many worst proposed penalties, got moderated.

Soft/er “or” words were added, too, so besides any impossible ‘placed in service’ deadline -- projects *alternately* may ‘begin construction’ in next 12 months, credits 4 years + beyond. On Safe Harbor rules with which solar/wind industry is familiar. Temporary grid connections, load banks. If mainly codified-criteria are met: like 5% of equipment is paid-for; work done of “significant nature” on/off-site demonstrating continuous progress. Oddly self-titled ‘fiscal-conservatives’ were ok with a $3 Trillion+ in deficits, debt; even sought *costlier* US electricity -- so long as it’s just fossil fuels or nuclear; gladly agreed to harming solar/wind. To bolster that, a July 7th Executive Order demanded federal officials “strictly enforce” in any ways paths to faster terminate subsidies for renewables. What might that mean?

The administration questioned Safe Harbor; it threated retroactivity; underscored willingness to push boundaries/norms. Also on ‘foreign entities of concern’. To empower clean energy’s foes, an Interior Dept. July memo stated renewables on federal lands/waters need an ok from Interior secretary: the memo gave 70 actions to hinder solar projects. Another concern was that a soon-coming US Treasury letter might be *Retroactive, obliterating prior better rules; ending hopes projects can begin by mid-2026. A fear too was *Treasury Dept may dis-allow a 4-year window to ‘begin construction’ on home solar: it’s satisfied if 5% of fair market value is spent. That window was expected to end for big utilities, but could it continue for residential projects, so allow 4 years for small projects where commonly availed-upon? When the Treasury Dept. issued its Letter in latter 2025, thankfully it came out as *much better* than feared. Softer, and did not contain retroactivity. Hence solar stocks jumped.

So much political had culminated in an anti-green ‘one big’ act, yet big gains in ECO, NEX, H2X, WNX immediately followed. A component in ECO mining strategic minerals rose +51% on July 10th when US invested $400 million to be biggest shareholder. China dominates in rare earths; but this US firm with a $110/kg price support for neodymium-praseodymium can start to mine & process domestically, build US end-to end critical resources supply. Will take years, but was smart, a start, reflected keen interest by Pentagon and private sector. Early July 2025 that equity was $30; days later mid-July was over $60; by late Sept. was up 5-fold year to date. A US lithium miner leapt 95% on day US may take 10% stake in it. A silicon anode maker up 14-fold, the past year to Sept 2025. For clean energy so ECO, following April 2025 low of 28, it was then rocketing up on reasons that looking back, made great sense.

Let's recall bold promises made in the presidential campaign, in 2024. With this fresh administration many months plus, in power, these can begin to be checked. Easily examined is repeated promise by this now-president, that he'd fast deliver far-cheaper electricity, and gasoline (gas) too. Justifying curiously rejecting renewables, embracing fossil fuels. Claims can start to be checked latter 2025, as 'promises kept', or not. Let's focus here on energy, as it is our work. In 2024 his often-repeated promise was: "Electricity "costs will fall ½ within 12 months of [my] taking office". At times he'd said it would fall ½ over "maximum 18 months", so let's take a charitably-longer 18 months. He'd promised too that gas would fall fast to under $2/gallon. Now, at a point beyond ½ way in, past 9+ months with his huge changes across US energy policy: has any yet happened?? Or, even started to happen?

Regrettably, no. *US electricity prices have Not (yet) dropped, even at all*. After signing his hallmark 'one big' act, US electricity costs *are since up by +6.6*% past 12 months. And likely to climb more ahead -- a lot! His act did hit cheapest electricity, solar & wind hard. Curiously it favors only the costliest 'old' electricity generation by coal, natural gas, plus nuclear. So late in 2025, we've seen US electricity costs have Not dropped, at all. Instead costs have risen! By faster than inflation, with rates being locked-in to rise much farther ahead.

Or, perhaps the president's gas price promise will yet turn out right? Drop hard fast, stay low -- that's the hard part! For price paid at pump, back in Dec. 2024, last full month of the prior president, US average was about $3.03/per gallon; US oil was then about $70/ barrel. This 'new' president promised if elected, gas will fast fall "under $2 gallon"(!). On 'unleashed' US oil abundance. So push US production up (past then-record 13.4m barrels/day, in Dec. 2024). Yet oval office lacks tools to directly change price of oil/gasoline. Note then 5 months in 2nd term, gas prices were still 'high' at $3.04 - $3.21; nowhere in US was *under* $2: cheapest was $2.71 in Mississippi on July 3rd. (The oval office curiously claimed 1st half of 2025 under $2/gallon was met, but maybe it confused gas with RBOB, a wholesale product, not retail gas). Americans see gas price up close, so it's undeniable: gas wasn't near 'a dollar something'/gallon. A prerequisite too for gas <$2/gallon is to push the US oil production up -- so price falls to or below $50/barrel & *stays there*. Yet such could make oil too unprofitable for new drilling investments to begin with. Hasn't happened anyways: last days of Q3 2025, US oil was still up around $63. Even that small fall off $70, was mainly thanks to OPEC+!

If more of cheap US solar & wind, is what will fastest best bring down US electricity prices -- yet an oval office 2025 pushed costliest fossil fuels & nuclear -- while harming renewables -- what helps to explain such counter-factual? In part that position may be out of antipathy, cultural opposition to wind/solar. Consider that in 2025 when visiting Scotland, this president helpfully explained much of his own reasoning for deeply opposing wind power. While next to the European Commission's head, the US president spoke of his views, of his own volition:

> "And the other thing I say to Europe: we will not allow a windmill to be built in the United States. They're killing us."
> "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." ….

Of minor interest, is that the assertions above are respectfully incorrect. Energy has changed greatly in a past 40 years; so much so, latter 2020s wind & solar are not costly energy; they're now mainly the cheapest. *US states with the lowest-cost electricity rely on much wind, solar. While the costliest US electricity states, rely heavily on fossil fuels.* So the 2 cheapest US states for electricity, South Dakota & Idaho, both will turn first to their ample renewables. Most wind gear in Europe/US, isn't made in China; it doesn't rust or rot in 8 years, runs 25-30+ years. Wind works very well in Germany with about the most-reliable electricity, + much renewables. Contrasts with heaviest-coal-US state W. Virginia, with *least-reliable* electricity. Note too that Iowa: the state with greatest percent wind power in 2025, got 2/3rds or 66% of its electricity from wind, 6,000 turbines, & it has cheap electricity. Plus costs there *fell* in a year to 2025. In short, respectfully, such notions re: wind & solar were maybe understandable, if formed in a different 1980s. Yet today, they're very incorrect. The 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 with whale deaths, oft caused by vessel strikes, fishing gear entanglements etc. *But everyone is entitled to their own opinion.* And this president does deserve much credit for being so frank, forthright. He speaks often of his own rather personal grievance about offshore wind: specifically, its visual impacts on golf courses. Helpfully this president has spoken often & at length since 2011 about his animosity over a 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 have however taken an opposing side; in 2025 just 2 days after his comments & on leaving Scotland, the Scottish government approved the world's largest offshore wind farm: huge 4 gigawatts (GW). To power 6 million UK homes, creating thousands of jobs, reduce electricity costs, billions of GB pounds in revenues. Bigger than anything then off China, which is saying a lot. This US president finished his own helpfully very personal, illuminating comments made of his choice, next to 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"….

His administration has hewn closely, to his views. So, it refutes renewables can *lower* costs -- instead, insists old energy is always best! US Energy Dept. even has an unprecedented(!) Coal Ad Campaign, showing a glowed-up sparkling coal lump & tagline: "She Is The Moment". Though coal is about the costliest US electricity, is definitely dirtiest, has a poor reliability. Yes, coal has some 'firmness' on its side. Unlike intermittent renewables, solar works days only, wind works only in breezes, both best with energy storage as shown ahead. Yet if sentiments wind is much too costly, and it doesn't even work, were perhaps (understandably then??) formed in a 1980s, that new Coal Ad seems from an 1880s; now counter-factual. Even a glowed-up coal lump with sparkles-photoshopped in, cannot give what this Ad implies. But it's an Ad specific to US. And whether this Ad's theme 'has legs' is yet to be seen.

2025's 'one big' act, by hiking US electricity costs, may cede leadership in AI to China ahead. Who may see it as their own good fortune that a US hit solar & wind not on economics, but cultural animosity. First 5 months 2024, China added 4x more of its 2 very-cheapest electricity sources: solar & wind -- than a US added from All Sources, all 2024. That 227 GW new solar/ wind China added in first 7 months of 2025, was 4x all US growth from all sources, all 2025. China was expanding gas, nuclear & coal capacity somewhat, but far, far more slowly than renewables. While its buildout of renewables left its coal fleet using less than ½ capacity.

Despite promises made in 2024, 7 months into 2nd presidential term, US electricity prices grew worse, from up by 5.5% at 5 months, to *up* 6.6% vs. a year prior. Up by 2x inflation. A recent analysis indicates by 2035, due to 'one big' act, Americans will pay far more for electricity annually. In the US south & Midwest $640 more/year; smaller rises in hydroelectric-heavy Washington state. *Yet all higher US electric bills!* Opposite of promises of 2024. Unavoidable, as renewables get knocked-down, costlier fossil fuels embraced. Much of it is back-loaded too, so worst impacts will be felt years later; long after this administration has ended.

Efforts are already 'blaming renewables', in anticipation of higher electricity prices. For instance, editors at Wall Street Journal long anti-renewables/ pro-fossil fuels, did an OpEd in 2025 blaming renewables[!!] for electricity price rises in Texas. Electric rates did rise in Texas by 36% for its residential power over 7 years, from an 11 cents/kilowatt-hour (kWh) 2017 -- to 14.9 cents /kWh in 2024. But, what the OpEd didn't mention, was electric rates *rose in all US states* nationally, that period. In fact rose *less* in Texas, thanks to solar/wind. Texas rates were up *less* than a US national average. Its big solar/wind helped tamp down rates.

Indeed compare Texas to 3-lower-solar & wind states: say Alabama, Mississippi, W. Virginia -- and Texas' rates rose the *least* of these 4 states! Average retail electric costs in 2025 in renewables-rich-Texas, were *below* US national average, as Texas' wind+solar grew faster than any state. What factors did in fact contribute to Texas' own price increases these 7 years? *Its huge Winter 2021 black-out on its natural gas freeze-off which incurred deaths and long-tail costs still being repaid. *Its Grid-operator must now hold back more power in reserve escalating costs. *After Russia invaded Ukraine, even its locally-produced natural gas' prices spiked in Texas so local gas-fired electricity grew more costly. Plus *Costs to add more grid transmission, yet those costs aren't unique or due just/only to growth in its solar and wind -- its own oil & gas industry is a big driver too in grid expansion. On whole the more accurate moral arguably is its ample solar/wind were helping instead to moderate, *hold down* recent Texas price rises (which were worse/ higher in most other states) those past 7 years.

Texas' approach is 'Build, Baby, Build!', and offers useful lessons. In 2023 it was America's #1 oil producing state. Made 43% of all US oil, in #1 oil-producing-nation, US. And 2023 it was biggest US wind producer by far: its wind-made electricity powered 11 million homes, 3x more wind generation, than 2nd biggest wind, California. Catching up to California in solar; a latter grew by 67% in 2020-2024, while Texas grew its solar far faster by 337%! All Texas sources compete strictly on-cost, not ideology. Texas' low-cost renewables thus 'won' / and met a noted ½ of all electricity demand in 2024. Its total clean energy output 2x that of California. So, Texans know a thing or 2 about making great cheap energy, mainly as green energy!

Crucial is that Texas is highly competitive, very pro-free-markets -- unlike California (or UK). It goes for cheapest, best energy, so renewables win. A result is Texas' retail electricity costs in 2025, were ½ that of a pricier California. On far fewer regulations than in California.

Decades of cutthroat competition, hands-off-free-markets, gave Texas low-cost electricity. Price-discovery of what's smartest, cheapest, 'best' electricity in real-time. Dynamic prices updating at 17,000 nodes, on an islanded grid. So yes, it's ironic 'big government pro-fossil fuels/& big deficits' 'fiscal conservatives' there lately aim to end such hands-off-policies. Instead, to pick winners (fossils) & hit losers (green energy). They'd *add* government, taxes on renewables. Bit of a battle going on, as oddly self-named 'fiscal conservatives', work to hinder cheaper wind / solar. Though it's starting, already, to mean costlier electricity.

In this bit like big-government states & mandates, leading to costly-power too. Progressive California has implemented renewables, but badly, for higher costs. Not prioritizing cheap power, it puts the costs of subsidies, & guaranteed 8-12% Utility returns -- on ratepayers. As first-mover, it had mandated solar early-on, when costs were 10x higher. Now is locked in-at higher costs -- though solar costs plummeted 82%, 2010 to 2025. Issues seen other places too: UK sets 1 national (high) rate based on costly option natural gas, 90% of time. Germany sets fuel mix, taxes in pursuit of social outcomes. Nothing wrong with any of these per se; but they result in costlier power in California, UK, Germany. Latter 2020s, self-described 'fiscal conservatives' in US, opposing open-competition, are likewise pushing for, in effect costly electricity ahead too by decimating renewables on ideological grounds. In this, very unlike traditional small-government, pro-free-markets conservatives Texas, Dakotas, Kansas, with cheap wind + cattle grazing underneath co-habitating nicely! Truth is open competition is best. Despite political rhetoric, *all energy* is subsidized. And truth is clean energy transition is accelerating globally at now unprecedented rates, outside of Western influence. Today some 2/3rds of the developing nations, are leapfrogging US/Europe in clean energy.

So changing US energy policy, now poses big challenges. As result of America's '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 -- vs. had that anti-renewables law never passed. Means $52 billion *less* US GDP growth. 94,000 fewer green jobs. US retail electricity costs 23% higher, on loss of cheap renewables. Industrial electricity 54% higher. All strange, as wind & solar 'just make sense'; they're conservative in truest sense. Given a freedom of choice, renewables win! Meanwhile, US competitor China jumped ahead in global green energy & EVs, yet it faces its own problems of overcapacity/oversupply. It denied permit renewal 2025 for a huge EV batteries/lithium producer; will close a lithium mine that's 6% of world supply. On this lithium stocks jumped worldwide. Lithium carbonate futures contracts on a Guangzhou exchange leapt max 8% allowed, to 81,000 yuan. Some believe China is now truly beginning to broadly pare back immense oversupply/overproduction in green-energy and EVs. To begin to address, deflation. Better match soon-reduced-supply across many green energy themes -- to demand. Allowing prices, so profitability globally, to rise. Bullish for green stocks.

Narrowly in US, eg a US biofuels name jumped 59% in one-day 2025, on strong earnings. Or broadly, solar rose fast when Treasury Dept guidance on tax credits unexpectedly left a 4-year window open if 5% is spent. Renewable foes tried to make that executive decision be, 'far worse', & retroactive. To demand physical work underway, or project be in service. But moderates had pushed back. So this guidance was a compromise between hard liners, vs. free-market moderates in senate -- all same party. Results 'better than feared', fueled rise in clean energy. Other side of risk coin, a big wind developer based in Copenhagen fell over ½ in 2025, when a stop-work order by US federal officials halted an offshore wind project in Rhode Island, partnered with US businesses. Even though the work was near-done already, 80% complete, 45 of 65 its turbines installed! Let's look closer at that federally-ordered halt to the project, since it illustrates major recent changes in US clean energy.

Nearly-complete, it was about to bring cheaper electricity to Rhode Island & Connecticut. 'Why' wind could be so helpful in lowering costs is easy. Start by knowing Rhode Island (RI) is the most reliant on natural gas for generating electricity, of any US state, at 80%. So one can guess correctly RI has had very high electricity rates: 29 cents per kilowatt/hour (kWh) in Sept. 2025, as 5th highest in US. (Very worst, Hawaii was 41 cents/kWh since it makes 2/3rds of its electricity by burning bunker oil; despite its sun, wind, wave resources, those make a tiny percent there). Bordering RI, is Connecticut (CT) & it too would benefit greatly by lowered rates once this near-operational offshore wind is energized. CT's electricity rates in 2025 were very high at 32 cents/kWh, 3rd worst in US. Its high costs were also not a surprise as CT, like RI is hugely reliant on natural gas. Few energy alternatives for either. As noted adding more natural gas-power would be too costly; anyways turbines not available until 2030s at soonest. New England's onshore natural gas transmission corridor crowded. Its few regional nuclear plants have been/ and will be retiring; any new nuclear plant likely to be frighteningly $$ billions over-budget, taking years (or decades?) extra to build. Hence, this cheaper/ better/ faster path of offshore wind should be a real solution, do-able now!

Consider this wind project was contracted to provide electricity at 9.8 cents/ kWh long-term, better than nukes or coal for 20 years. In winters, electricity by natural gas is pricier, fuel prices high. While for these 2 small states, 400 MW of 700 MW wind project to 'little Rhody' (Rhode Island), 300 MW to Connecticut is sizable. Would meet about a fifth of RI total annual electricity demand; in winters maybe fourth on less demand, strong winds. All these benefits from one offshore wind project sited 15 miles offshore so in federal waters, with big ocean space for more. (For origins of the state/federal limit 3/12 miles offshore, & the implications for US energy policy, see our book 'Listening to the Sea' (1999)). And yet this near-done wind power firmly desired by both governors, had been halted in 2025 by a US administration.

As we'll recall, in congress pro-fossil/bigger government interests opposed to renewables -- had been foiled; they'd been unwittingly *moderated* when their 'one big' bill got jammed. But by using unilateral administrative orders within the executive to decimate wind / solar -- they'd had a greater 'success' 2nd half 2025. To unambiguously decimate just renewables -- hurt them only. Bypassing more moderate traditional, free-markets conservatives in party. Side-lining congress. Ignoring facts that solar/wind are best/lower-priced pathways.

The president has spoken for years of his acute pique, against 'windmills'. Of desires to cut wind, especially offshore, & "farmer-destroying solar". 1st half 2025 that was mitigated in senate when a 'one big act' was made milder. But latter 2025 on ambitious views of executive power, expanded & unprecedented unitary claims, orders 'startling' in scope, his oft-stated grievances against wind and/solar were far more robustly acted upon. Halted even nearly-energized wind projects that would help reduce US electricity costs. Would have produced more US power, truly unleashing American energy. Actions heretofore seen as unlikely, were taken. The 2024 campaign 'braggadocio' had once been that if elected, "You will never have energy [prices] so low, as you'll have under a certain gentleman named" [his name]. And that he'd 'cut costs of US electricity in half'. Yet 2025 was seeing the opposite: US electricity *costs were swiftly rising hard,* and much faster than inflation too! Bit remarkable.

A rather intriguing question may yet be: *if* US electricity prices do go on rising, undeniably -- might the administration change course? If claims of low-price cannot persuade? If electricity costs do not fall by ½, as promised in the campaign? It's possible: US electricity may yet(?) fall, hard & soon as was repeatedly claimed. But there's also some chance they do not.

Whatever a result, one can bet fervent opposition will continue against wind/ solar. Blame laid on them for energy costs -- even as they're sizably hit late 2020's, cut back. As executive branch makes renewables' financing more risky, unappealing. Of course, there's a downside to renewables: intermittency, lack of dispatchability; they may want for storage; curtailed on impacted grids. But, all can be addressed. As is being done in many parts of the world. In sum clean energy works very well. Renewables are a vital 'arrow in the quiver' anywhere desiring new electricity supply cheap & fast. Despite that mid-2025, 5 months into president's 2nd term, $18 billion of wind & solar generation projects, were cancelled. $3.7 billion in prior awards to reduce emissions, retracted. To heighten financing risks & costs for wind & solar, perhaps an aim too. 11,000 projects for energy generation/consumption, were awaiting approval. Interconnections stalled, by an average 5 years. Opposite of in Texas, Iowa, Dakotas, Idaho, Kansas, etc etc -- with their approaches instead of 'Build, Baby, Build'!

Or contrast US policy, in 2025 -- with China. In May 2025 alone, China added 93 GW of mainly solar, wind; much less in natural gas, nuclear, coal. In 2025 it added 200+ GW in an 'all the above' path -- mostly renewables, by far. As a US in 2025 created policies to hobble its best options solar/wind. US unable to build much gas or nuclear anyways. Coal undesirable, so US *built only 63 GW all year long*. A coal plant in state of Georgia that was to be retired in 2028; was kept on & saw its costs rise from 4.6 cents / kWh in 2021 -- to 7.2 cents in 2025. A S. Carolina coal plant saw its costs go up 50%. No wonder, US electric prices are rising!

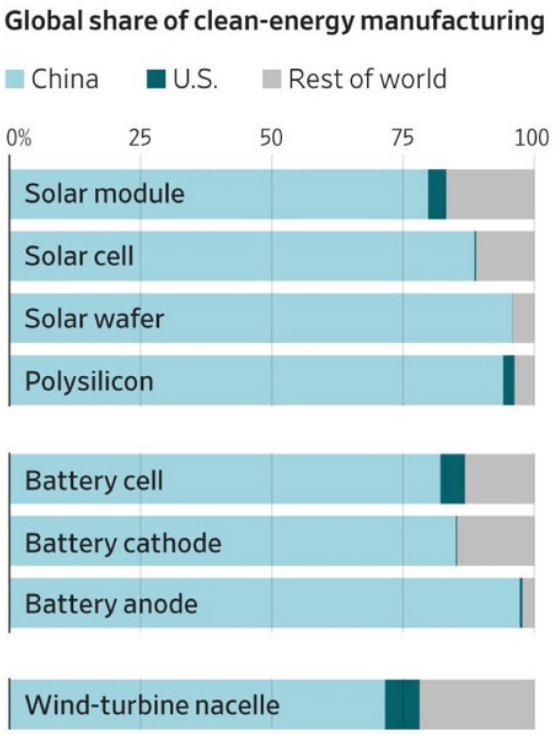
Soon it may be hard to hide the fact US electricity prices -- rather than falling dramatically, are instead rising. On less renewables / & more fossil fuels. Up faster than inflation. US gasoline prices could fall under $3 for many reasons: increasing OPEC+ production, slowing US economy etc. But it's not likely to be on an unprecedented US energy abundance, rig counts skyrocketing as repeatedly promised. Evidenced say on Labor Day 2025, America's driving holiday, when oval office & administration has had time to bring down gas prices. Was US gas as promised then under $2/gallon? No, was nearer $3! Was vastly more US oil production unleashed, far-more US-oil as promised? Again not close, but an interesting thing was happening. Facts were plain: on a prior president's Labor Day back in Sept. 2024, gas was then about $3.30/gallon. A year later in 2025 on new president -- it was $3.15/gallon, so down marginally. Only a little, a mere 15 cents/gallon. US oil production was not even up.

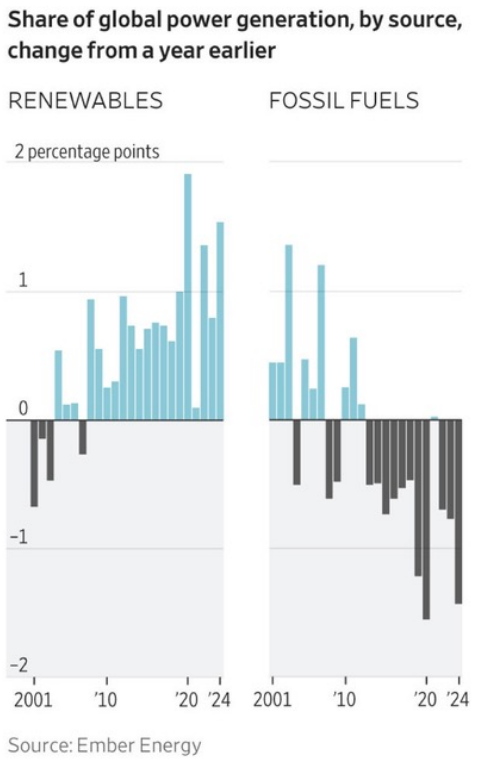
Promises had been US domestic oil production would be up hard, so gas prices way down. Yet notably, US domestic oil production was … Not hardly up at all! Labor Day 2024, it was about US 13.4 million barrels/day (b/d). By this holiday in 2025, oil production was then 13.3 million b/d, so *down!* But interesting was the white house on Labor Day 2025 made boastful claims, amplified by a favored cable news channel. They claimed the US president was already "delivering on his promises of lower" gas prices, that he was now "fully unleashing American energy dominance", and "families are saving significant money at the pump". Wasn't true. But was a bit interesting to see such assertions made, despite the energy facts.

Narratives offered by white house spokespersons and federal energy officials in 2025, included that US "lower prices are part of a trend" in this administration, "which has taken relentless action to revive America's energy capabilities and to undo a [prior president's 'restrictive'] stranglehold on American energy production." Bold claims yes, although respectfully, maybe a bit factually-challenged. That's ok: the 1st Amendment allows anyone to do bravado, to make all sorts of bold claims. The political realm (which we seek to avoid) even expects it, somewhat. But it's likely useful to be cognizant too, of the hard data and facts.

It's striking to see below at left, that US which had invented Solar Cells, & Lithium Batteries, is frankly giving up leadership in both. Like its-once-lead in electric cars. China's-enormous lead today, is now pretty eye-popping. As has been its firm decision to consistently go all in manufacturing solar/wind a past 2 decades -- today they're reaping the rewards. Likewise, in advanced batteries for storage, EVs. Their massive embrace of clean, new energy, & of EVs -- while moving away from fossil fuels -- was not based on climate, but on better economics, + jobs, better energy security. They'll also be critical growth drivers enabling cheap domestic energy, and large new energy exports. Latter-2020s their lead is widening.

Meanwhile, the world is moving massively towards just renewables in new power generation, seen in chart at right from 2001 to 2024. As it departs from costly fossil fuels. This global shift is something that the US administration in 2025, was trying desperately to deny, evade, ignore -- eg by halting open-competition from 2025. By slanting field to just fossil fuels/nuclear only. In this the US in 2025 was maybe bit like Don Quixote tilting at windmills. There's no doubt but 2025 to 2028, an administration can make life hard for renewables. On cultural antipathy. Even though solar/wind are the cheaper, better, & the more reliable options long-term:





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

As a Wall Street Journal reported Sept. 2025 this "US renewables retreat goes beyond the tax bill that is winding down more than $400 billion in estimated subsidies. Federal agencies have tightened rules for new development. The … administration recently terminated a multi-billion dollar loan guarantee for a Midwest transmission line, halted a near complete wind farm off the 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 the second quarter cancelled more green manufacturing projects than they announced for the first time on record…." This above is from the Journal's strong factual reporting, not an OpEd.

Obviously, we're fans of clean energy. Sure, we stress the weakness of intermittency, lack of dispatchability. Yet free-fuel renewables, unlike fossil fuels, are only getting cheaper, better. Growing more firm, via better storage, grid. We note too renewables reduce climate risk, improve human health, energy security -- all increasingly compelling. Right on target in latter 2020s, with solar and wind being cheap enough now, to win on their pure economics. And we're objective, factual, independent. Not partisan. Nor proponents of either party.

We simply follow the truth. So, it's interesting to observe, counter-intuitively*: the US states with greatest percentages from renewables, are often less-government, open-markets & mainly-conservative 'red states': they're also usually the states with the cheapest power!*

Consider that Sept. 2025 the states with highest percentages of electricity by renewables were: Iowa at 68% from renewables, as a red state with cheap electricity at 14 cents/kWh; South Dakota at 61% from renewables as a red state with cheap electricity at 14 cents; New Mexico at 52% renewables and since 2008 a blue state also cheap at 14 cents; Kansas at 49% renewables is a red state with cheap electricity at 14 cents; and Oklahoma, 42% renewables is a red state with cheap electricity at 13 cents. These-high-renewables states compare well, are all better than US retail average rate 17.47 cents Sept. 2025. And early 2025, the 2 very cheapest US states, North Dakota, Utah, were very renewables-rich; we'll see how/why ahead (hint: both turn to their ample renewables 1st to make electricity). Point is, these places favor hands-off, less-government, open competition; are pro-growth, building generation capacity and grid. These traits have led to: Plenty of Renewables + so Cheaper Electricity.

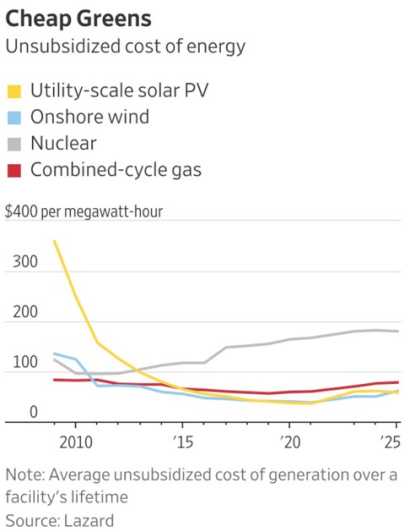
Iowa offers lessons. In 2025 a big 2/3rds or 66.7% of its electricity demand was met by wind, growing fast. Of remainder, dirty coal at 19.8% is phasing down/out long-term: the owner of its 6 coal plants announced potential retirement dates for all. Some anticipate much of this '20% hole' may be filled by more solar + storage; others expect mostly natural gas. Gas, dispatchable, was next largest component in Iowa's electricity generation at 9.8%. After that was utility-solar at just 1.8% in 2025, but new projects lately announced include an 800 MW solar-project so growing swiftly. A big 84% of Iowan land is growing crops or raising livestock; so some are concerned on conversion of farmland to solar. But, as 60% of its corn crop goes anyways to making ethanol fuel, this means it is choosing one energy or another. (Solar/EVs far more efficient). And either way, Iowa is now fast becoming a US energy powerhouse.

Countering that, is a recent 'anti-green' federal policy change to picking/harming 'losers'; to halting renewables /& open competition; and growing more US debt. When federal officials in 2025 canceled a $4.9 billion loan guarantee for huge new US Midwest grid transmission line, that's a concern. The likely effect will be to raise US costs for electricity. That big shift by 'fiscal conservatives' towards allowing more US debt, is also a broad shift standing apart from, and buffeting much. Global sovereign bonds are struggling lately, on huge new debts -- with seemingly unwillingness of nations to balance their books, to cut deficits robustly. In 2025 to early Sept., international 10-year bond yields rose as result by 0.1131 percentage points. Yet, US 10-year treasury yields that same period, *fell* by 0.3038 percentage points. Hence US 10-years inversely had gained in value, generally good for investors, broad markets. Helped by rate cut hopes, by treasuries being a global store of value/dollars, few alternatives. 2025's fall in 10-year yields, began around the time a new US treasury secretary was speaking of lower rates pathways around Feb. 19th. Such jawboning something other nations don't do. Whether the key US 10-year yield continues to decline and persists low -- is yet to be seen. The oval office targeting perhaps stable 10-year yields in the low 3%s ahead.

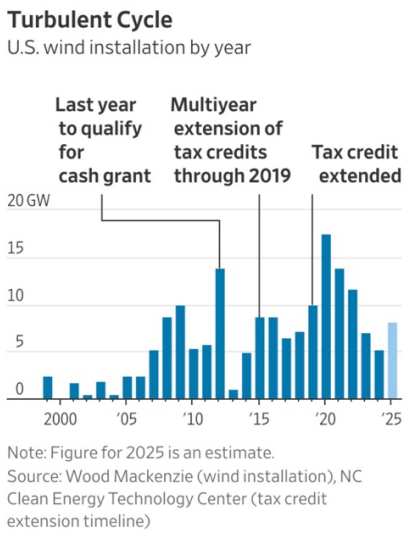
America's president again made energy news latter 2025, by opining on his social media blog, "Renewables are the scam of the century"… , "We will not approve wind or farmer-destroying solar. The days of stupidity are over in the USA!" Such statements left no doubt as to his sentiments, and made on a Wednesday, were unsurprisingly fast followed by ECO Index falling -0.96% on that day. On Thursday, it fell -0.39%. Yet on Friday, ECO Index jumped +5.48%! Notably over where it was beforehand. While this president deserves credit for being so clear about his own feelings, one may also ask: How could renewables be jumping so strongly when a president is speaking & acting vociferously against them? Broader markets rose Friday too on hopes of interest rate cuts, but ECO's rise here was very strongly outperforming.

Arguably 3 reasons for that clean energy bullishness. As well laid out in a piece in Wall Street Journal, 'Why Solar and Wind Power Can Thrive Without Subsidies'. The first is: an end to subsidies for wind in place since 1992, and solar since 2005 -- might be "an attractive entry point to this industry", for valuations here by P/E ratios etc are better than in traditional fossil fuels & nuclear trading at "steep premiums". And renewables wind/solar are no longer nascent technologies: they're able to make electricity now at low-cost vs. natural gas, *even without subsidies*. Utility-scale solar is now 84% cheaper than 16 years before, onshore wind is now 56% better. So even if tied to need for added energy storage costs, they're notably competitive now with natural gas, coal, or nuclear … without truly needing subsidies.

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



Source: Wall Street Journal



Source: Wall Street Journal

Arguably a 4th reason too is the president's broadly stimulative actions can especially boost renewables, purely on their better economics. Renewables can go up faster, are cheaper to run, & account for most new energy generation being built with good reason. Despite that president's often-expressed desires to end renewables, their economics wins-out.

Thus, was a 2025 chock full of changes & surprises, from small & narrow, to big & broad. Many actions were aimed to harm just renewables wind & solar, to make those costlier, by erecting impediments. Others tried to make fossil fuels & nuclear get cheaper, more competitive with renewables, though that's proving hard as contrary to economics. Narrowly, early 2025, one of the world's more aggressive, well-financed, technically proficient offshore wind builders (big German firm in fossil fuels too) -- decided to leave US offshore wind entirely. Its calculus was on US political realities, impossibility of getting US wind permits, high costs of materials. Thus a leader aggressive on low-carbon energy, walked away from US in 2025. Sizable volte-face, vs recently-predictable clean incentives. It's estimated that targeted, new US anti-wind policies started just since spring 2025, will erase $75 billion from investments! Amounts that would otherwise have soon flowed in for new US wind. Indeed US officials April 2025 halted a domestic $5 billion wind project in New York waters that had all its federal permits! Halt rescinded in May, after intense lobbying by state, but cost that project $955 million.

Critics of renewables felt emboldened from 2025, 'wind at their backs'. Right as a surprise blackout hit Spain & Portugal on April 28th, immediately very next day, an OpEd in Wall Street Journal (as noted anti-renewables/pro-fossil fuels), fervently *blamed it just on solar power* -- when a 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 at just ½ capacity, 10%, as it can't compete with low prices. Blackout's cause was later determined multi-factored, but was Not due to its renewables; rather it was due to its own poorly-managed grid switching off. On overvoltage, frequency oscillation, poor planning, pre-emptively-shut thermal plants, that also took 15 GW of grid's 27 GW solar, offline. Hence, the culprit was Not renewables. Rather, Spain must modernize its own grid, with eg synthetic frequency stabilization to mimic mechanical inertia @ 50 Hz -- this should be readily accomplished. Likewise fossil fuels & nuclear interests had similarly jumped to wrongly blame too, Texas wind power, when a deadly outage had also occurred in Texas in 2021: *that was determined to be due to its natural gas freezing off!* Yet narrative was fast-mounted to call its fossil fuels + nuclear '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".

Going further but with slightly Orwellian twist: a major Office of the US Energy Dept issued a banned words List in 2025 for both its internal and public-facing documents and reports: specifically it dis-allowed use of "climate change" (since implies it is a bad thing); "emissions" (as this word too implies these are bad); "clean energy" and/or "dirty energy" (as either one implies one term good, one not-so-good); "energy transition"; "Carbon/CO_2 footprint", and more. (It would have been hard to make this up). Yet even oil executives, privately, fumed a US Energy Dept in 2025 was 'only giving the Oval Office what it wanted to hear', rather than providing facts. That was as harmful for oil drillers, as it was for clean energy.

Stepping back & looking broadly at Q2 + Q3 2025 across energy & stock themes, we'd seen Oil's price did briefly fall hard, by -17% in 1st month of Q2, in April 2025. Renewables stocks fell at first too, at that time, but the latter however rebounded hard; clean energy ended April 2025 back near where it started month, and next clean facets went on jumping through Q2 and then Q3. Just April ended about levels in ECO (first down then up near nil for month); in Global clean energy NEX (similarly rebounded), and a solar equities Index theme down just a bit (-5%) for first Q2 month of April. Thus the new clean, zero-CO_2 energy transition themes (all words a US Energy Dept has now banned!) did well from start of Q2 through Q3 2025.

A -17% fall in oil in April 2025, was biggest 1-month drop in years. We discuss why ahead. And note it is unlike renewables, where the price for green electricity eg per kilowatt/hour, has fallen hard & *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 less demand, but pretty soon, may re-rise on less rigs. Or spike say on Mideast tensions. Oil moves are complex, yet comprehensible. This president's 1st term had been widely pro-energy, of all kinds. Yet it gave way to 2nd term start that first aimed to hit solar/wind, EVs. As new incentives were crafted to bolster conventional older industries oil, natural gas, coal -- plus more nuclear.

This Chart for Q2+Q3 to Sept. 29 for energy and stocks more broadly, shows 3 clean energy themes via trackers for ECO, NEX, Solar. And major US equities via a Dow theme; this has too Oil, Natural Gas. Goes April-to late-Sept. In a 1st month of April, all 6 themes fell at first. Unusually, oil was down all month for identifiable reason: fears of softer demand ahead due to tariffs. Then all rose from April 9th when a president backed-off tariffs (1st of what will be many such moves!), trade hopes. Oil briefly jumped on Mideast tensions, retreated on de-escalation. ECO rose most strongly, up 80%(!), on hopes for rate cuts, after a softening of 'anything but renewables' text. While some ECO components fell of course Q2+Q3, still an ECO component jumped 5-fold in 2nd quarter. Another was well up in last week of Q2 etc.

So here's 1st two Quarters-post re-election for Q2+Q3, an ***ECO** tracker ends at top, up **+80%.** ***Solar** **is** up **+41%,** near-tied with ***Global NEX** up **+38%;** 4th is ***Dow** up **+5%;** then conventional energy ***Oil** just down **near nil**; and at 6th / last is *Natural Gas here down by a big -39%:

Source: YahooFinance

Catalyst for fall at start of Q2 above, was 'Liberation Day' announcement on April 2nd of unexpectedly huge US tariffs worldwide. This re-elected president oft spoke of tariffs on the campaign trail, yet their ferocity, immediacy, scale in office, was a surprise. As were tariffs done 1st, *before* a stimulus. Prior to streamlining federal rules, cutting taxes, de-regulating -- as many anticipated was first order of business given 1st term in office. Especially as a core Top Aim is to swiftly *Lower* interest rates, energy costs -- raise growth. Instead, a 1st order effect of tariffs gambit can be uncertainty. A 2nd order may be less growth, weak job numbers. Backing off tariffs April 9th, markets rallied. Still, fears were of slowing ahead late in 2025 or in 2026, maybe higher prices later-on, less trade so everyone loses. Even if 'art of the deal' negotiating tactic, a feint to throw all off-balance, so-called 'reciprocal tariffs' (based instead on longstanding *trade imbalances*) were pretty unsettling worldwide.

Unlike 1st term's stimulative policies that promoted *all* energy, renewables too, instead, many actions early in a 2nd term were designed as *impediments,* to harm, to slow just solar/ wind/ EVs. De facto & de jure as 'anything but renewables'. Meanwhile, differing actions bent over backwards to help just coal, oil, gas, & nuclear. Opposite of 'all of the above' stimuli that dominated 1st term, advanced all energies -- or at worst, did no harm. Coal-use that fell in 1st term was purely on economics; when natural gas grew relatively cheap, while coal's costs 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. a once-cheap natural gas. So 4 years after that president left office early 2021 at end of a 1st term -- by 2025, fossils/nukes found it hard to compete with solar/wind. Hence to hobble, or make (now least-cost) new energy renewables more costly, became desirable to some.

A major recent US trend importantly too, is many 'red' conservative US states that do Not emphasize low-carbon or climate goals like North Dakota, Idaho, and Iowa, have been *growing their renewables hard,* and are *making electricity at* very *cheapest US rates!* Moving fast on better economics, they're building abundant wind, hydro, solar. Idaho's rooftop solar grew by 6,850% in 2014-2025, for 4th fastest expansion in US. Meanwhile states one maybe expected to be #1 in cheap renewables: California, Hawaii, instead have *Costliest* electricity: pay more for green power. Reasons include technological mandates, ossified burdensome regulations, brittle grid, unhelpful pricing mechanisms, implementation that's been poorly-done.

Renewables can make electricity at attractive low wholesale costs; yet this hasn't translated, so far, to big $$ profitability, or big profit margins. Some green equities in 2025, saw very tough moments like in US residential solar where a big US name plummeted -65% in one day; bit of solar bellwether we briefly note an issue that hit it 2025 was debt: a 'Going Concern' Letter was a huge red flag! Other side of volatility coin to upside, was a maker of robust 12 kW high voltage gallium nitride power supplies for AI hyperscalers: from $1.61/share 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 cells maker seen in 3 of our themes, ECO, NEX, and H2X, rose some 5-fold from early June to late Sept. of 2025. Or a name in zinc batteries in ECO, NEX, WNX was up 14-fold looking from early June 2024 -- to late Sept. 2025.

Yet hard down early 2025 was a maker of power silicon carbide SiC chips for renewables, EVs. On its losses & comment that 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' perhaps too weak a word: it referred ancient-Roman times to horribly 1 death of every 10 soldiers, and so a 'decimus'; the rollbacks for IRA being hashed-out in June 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) were rifted to 2 opposing camps. As if higher Energy Cost/Reliability concerns -- were somehow contrary to Climate Concerns, and visa-versa. All pretty ironic, since solar/ wind are often cheapest. And switching to renewables faster, can *save $$$, reduce* long-term energy costs. But, politics had somehow become where conservatives sided with costlier conventional energy (only) -- progressives (only) with cheaper intermittent wind & solar.

That politics grew more polarized than at decade's start, stems in part from key, important misconceptions. Narrowly for instance, a US president instructed his staff in 2025 to always use the 2 words "beautiful, clean" before "coal" -- though 'clean coal' never existed, nor can / could it ever. Yet far more consequential is the mistaken thinking, often repeated that the renewables are costlier than fossil fuels: this is No longer true! Not yet well understood, but compelling today is that the *2 Cheapest US States for Lowest-Coast Electricity, rely first & most heavily on their renewables*. America's #1 renewables-giant, Texas, has enormous clean + cheap electricity. It's cheap not 'in spite of', nor with, but *due to* wind & solar dominating its grid. Renewables now equate to = mean lower costs -- but their 'intermittency' must now be solved! We know the tariffs announced April 2025 were impactful. That clean energy has facets. Let's then see 4 green themes in a chart from April 2025 tariffs announcement, so for both Q2+Q3 2025. Here from the start of Q2, going to late in Q3 (Sept. 29th) 2025.

We see here acutely the 4 clean themes (plus 5th 'not-so-clean') swiftly plummeted April 2nd -- then rebounded from April 9th with tariffs suspended. Roughly all end here from Up +80% 'best', to a still Up +30% 'least'. So all good. Again at top is the ***ECO tracker (blue)** up **+80%**. 2nd is *Global clean energy **NEX (light blue)** up +38%. Next 3 are all roughly tied for 3rd as global *Wind WNX (orange, with a tracker in the UK so an ".L" suffix) here up +33%. Nearby it is *Hydrogen in H2X (blue, also an ".L") near same at about +32%. We also show a global 'just-cleanish' theme (is 'not so clean' as it has fossil fuels, coal, nuclear -- so is Not our's) in purple, up a middling, +33% so it is between our last two the WNX / H2X.

Start of Q2 to late Q3; 4 clean energy themes, plus a 5th alternative energy theme:

Source: YahooFinance

So 4 clean energy facets above, plus a 5th not-so-clean alternative all fell at first. Even as the world in 2024 added a record 700 GW renewables, 25% over prior year, 22nd year of expansion, this theme fell. Was bit curious too that before, 2021-2024, as renewables capacity gained -- equities here fell. Next, under a pro-fossils & nuclear president, opposed to clean energy -- ECO etc all *rose*. Fascinating. Maybe rather understandable, as discussed. Stepping back we observe too 10-year Treasury yields were very low 2.2% at start of 1st term 2017; at start of 2nd term 2025, yields were 2x, at 4.4%. In that president's 1st term, rates *fell* to 0.5% by 2020. Then after leaving office 2021 -- rates later rose to 4.5% by 2024; in those four years green equities plummeted. Still as for past 10 years, fossil fuels oft fell hardest. And key competitor natural gas had plummeted some -90% in a past 10 years, unlike clean energy.

If tariffs had been fast withdrawn, it might have been one thing. But, kept persistently high, & on key counterparties China, Europe -- then inflation may linger. Even stagflation, a worst kind of inflation(!) may later arise. Weaker jobs data too. Had tariffs been lowered say to 10% in a short window, 'trade wins' self-proclaimed, then brief weakness may have 'helped Fed' lower rates. Reducing costs of capital. But … it was not a path taken. Rather, *if* tariffs & tensions persist … interference ahead so BLS data less certain, Fed loses some independence, if Fed is 'made to' cut short term rates with prices high, on souring expectations plus $3 Trillion debt, that's not healthy. Nor is forcing change at Fed to make it compliant; 10-year treasury yields are set by markets. A Fed seeking *Job Growth & *Stable Prices, wants robust confidence. Predictability, stability. Decisions using facts-based, reliable BLS data.

If tariffs were moderated, demand can be resilient. A 'one big bill' *might* be stimulative. Yet, problems now are 1) $3 Trillion Debt(!) can't be repaid readily; and it may be unwise to seek a compliant Fed & lower rates with inflation, trying to 'inflate away' debt. 2) Act's stimulative effects are on an order of tenths of a percent; while added Debt is massive. 3) As white house & congress harms solar & wind, it makes electricity (despite contrary claims) *more expensive* ahead. All while AI, energy demand are rising. Brings us back to energy: oil. Recall that there'd been a brief oil price drop in month of April of 2025, on fears then new tariffs may hit demand. As a candidate, the president had promised repeatedly he'd bring gas down below $2/gallon within 18 months. Yes, his administration wants to, needs to bring down gas prices: that's stimulative. So it aims to *Increase US Oil Production, and *Increase US Oil Demand. But the 1st done alone, without the 2nd, will not work: Confidence in robust future demand is key, prerequisite for industry's investments into more fracking/ US oil production. Yet in April 2025 fears were US tariffs *might slow* demand growth ahead. Earlier, at start of 2025, record US oil supply had then been anticipated: 14 million barrels per day (bpd), 9.7 bpd as US shale was predicted. That 14 million bpd was based on more US fracking, and at heart that was thanks to the-then-confident predictions (before tariffs) of strengthening US growth.

Instead, on tariffs April 3rd, uncertainty spiked: expectations fell. Of maybe *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 for maybe a slowest global demand growth in 5 years. On April 9th, fears tariffs may hit demand, US WTI oil fell to $55.12/barrel. Lowest in 4 years, below breakeven for many frackers. 10-year Treasury yields jumped. Immediately, this president walked tariffs back, suspended so much for 90 days. On hopes of growth, oil jumped same day to bit 'safer' lower $60s. Still, oil in low $60s means consternation for America's shale producers, who fear a slide back to $50s. Oil down in a low $50s (along with added new $3 Trillion in US debt) could possibly lead after to cuts of say 1 million barrels/day in total US production. Unfolding swiftly in just a few brief Quarters.

Here was a rub. White house advisors, perhaps not so familiar about oil price fundamentals -- sought US gasoline prices falling <$2, oil near or under $50/barrel. But under-appreciated that in some American regions, *oil at $50 is below breakeven*. Means production shut-ins. In costly Powder River Basin, 11 of state's 15 operating rigs, tricky geology needs oil >$58/barrel to make money. In Permian, Williston at Dakotas, DJ Basin Colorado, it's cheap. In America's Permian, oil costs little to 'lift', so money can be made on oil as low as just $38/barrel. By contrast Saudis can lift oil for a few dollars/ barrel! And OPEC+ with Russia can exacerbate global low prices as once-curtailed output returns: it can kill US shale growth. A diversifying Saudi may prefer oil up in the mid-$80s (or more) to balance its books, yet if price war looms, they'll ride it out better than anyone (even oil sands) on very low-production-costs.

So could this president in 2025/2026, convince US frackers to ignore markets & grow supply, push gas under $2/gallon as promised? And keep US GDP growth 3%+? All key!! Shale producers resisted white house calls to add supply. May 2025, US rig counts fell to lowest since 2021 as confidence in demand, fell. At a big oil field services firm, counts fell to 566, or 34 below 600 a year earlier. Rigs seeking crude fell to 465, vs. 497 year earlier. Rigs in Permian to 279, vs. 312 a year prior. On stacked 25% steel tariffs (Sec. 232), pipes, rigs costs went from $15 to $19/foot in 2025; 10% more to finish a well. The president raised steel tariffs 50%! A trucking firm in frack work got just 6 jobs Jan-May 2025 -- vs. 40 in 2024, 62 in 2023. Oil prices had slumped already, so rigs were off prior 2 years; down 5% in 2024, off 20% 2023. Still, that's a normal regular kind of cycle. However, when oil drops to $50s, it can set a stage for higher prices later, on fewer rigs. So strong demand is key! Oil <$65 may mean 25 less rigs. But near $50, can mean 50-75 fewer. April 2024, 511 rigs were active in shale. A year later April 2025, was 481 active rigs. Industry must forecast many scenarios, including small business hit by Smoot-Hawley level tariffs. Hard to say if oil demand in 2026 is off by little, a lot, or more desirably, up. Plus Middle East tensions can spike oil prices too. All this as new administration sought to *grow* US oil production, by say an added 3 million barrels/day -- so go over 14 million barrels/day. Despite vast uncertainty created by its own erratic tariffs.

A white house's own *Tariffs, so uncertainty, *went Against its need for firmer Oil Demand. Erratic tariffs, based on untested, self-proclaimed, emergency powers (normally such powers reside in congress). *May* portend weaker, less demand ahead, in time fewer rigs -- inexorably later a return later to higher oil prices. That's economic cycles. Yet white house rolled out unexpectedly big tariffs -- as oil execs privately feared slowing growth. They might then wish to return capital to shareholders, to exercise spending & drilling restraint. Markets, not any president's asks, are what will most guide upcoming rig counts, oil investments.

Thus, 2025 unfolded far differently from a 'goldilocks' 2023-2024 when oil traded in a tight, stable range industry desired: $70s -- $80s. Some hoped the white house self-proclaims 'Trade Wins', reassures on GDP growth. But an underlying Gordan Knot was gas prices staying <$2/gallon/ oil near or under $50 -- is fundamentally incompatible with slowing demand. In private, oil execs understood this well: white house can open huge areas, and cut red tape -- still it can't overcome basic economics. Oil is globally traded commodity. Adding abundant supply briefly cuts US prices, at first. For gas to stay under $2/gallon, requires confidence of demand to invest. A slowing economy can mean less rigs; later higher price. We discuss ahead the 2020 oil crash that once sent gas <$2 in 2020, on very differing 'tank tops' fears.

In 2025 US markets so 'wall street' rebounded in a "V". Nadir was the president fast walking-back tariffs April 9th. Rebounding on right side, with even stronger rises in clean energy. Partly on hopes chaos pauses, markets can acclimatize to an erratic oval office, huge debt. The president briefly did 'moderate' perhaps to appease bond market vigilantes: 10-year Treasury yields had jumped 1st part of April from <4.0% -- to near 4.5%: that reflected a huge loss of confidence in US bonds, debt. In 2024 for a 1st time, the US had to spend more to service debt ($882 billion), than defense ($874 billion). Oddly for the world reserve currency, early 2025 US currency markets lost 9% -- despite high rates, like a developing nation. After April's 9th's more-stable words from oval, and rate cut hopes, Dow & especially clean energy rose both Q2 and Q3. Despite much uncertainty, including emphatically in clean energy, stocks jumped. Strongly so in clean energy. Some had hoped too there *might be a more* moderated 'big bill'; demand brought forward to 2026; deadlines become 'construction starts by' instead of 'must already in service' -- all of which had come partly to pass nicely in 2nd half of 2025.

Many critical clean energy topics were debated, decided 2025. Tightly-bound to overarching questions of which way to go on America's economy. One key question was, How, (not 'if') a 2022 IRA abhorrent to conservatives gets eviscerated. Beyond decimated. Partly to trim $3 Trillion deficits. Yet plainly too on political opposition squarely against solar, wind, EVs.

Was inconceivable then, to have crafted a genuinely 'All of the Above' energy strategy. One inclusive of *true* American energy abundance, so with solar, wind. That couldn't then be, on 1 party in power emphasizing just fossil fuels; harming renewables, unitary executive. When its goal was in picking 'winners' (fossils fuels) / harming 'losers' (renewables); when weirdly, that was counter-conservative, anti-free-markets. When the truth is more fossil fuels means = higher US electricity costs. With that act's worst impacts back-loaded, to later on.

As the 'one big' act blows-up deficits, with unpaid-for-tax-cuts, a core question today is, Can /will this all work?! Will this president's huge tariffs + tax cuts, plus bias to costliest conventional energy, fast *grow* the US economy?! Will candidate now president be right, so we'll all soon say as he claims, "Please, please, it's too much winning!". A possibility (& we sure hope so!) is Yes. *If (a big If!), if president is right,* US GDP grows 2025-2028 at 3%+, at 4% or more. Tariffs have no impacts at all. Huge jobs growth! Manufacturing moves from Asia to US! Manufacturing jobs and Markets boom! 10-year Treasuries fall from 4%s, to low 3%s. *If oval is right,* new jobs/non-farm monthly payroll is over 150,000+/month, economic growth humming -- on <2% inflation. Unemployment under 5%. *If president is right,* gas has fallen early 2026 to under $2/gallon, US oil near or under $50/barrel, oil production over 14 million barrels/day & stays there. I*f POTUS is right,* big growth prevents $3 Trillion deficits from being US debt. This is what president & congress allies stated. Anathema to some economists, yet it is one possibility. This was forcefully pushed all 2025 by president and allies.

However, another possibility to contemplate too is *'one big' act debt + tariffs + costly energy = instead may slow US GDP growth ahead. Even maybe* stagflation fear, starting with souring economy & some inflation. Reflected by say falling personal consumption expenditures 2026 (if oval office fires Bureau of Labor Statistics staff, may place 'gold standard' data in doubt). One can foresee supply disruptions *can* harm small business who can't just 'eat tariffs'. Mass deportations mean higher food, produce prices. Rather than see manufacturing jobs fast re-shoring to a US, instead China's decades of industrial policy, far lower wages, supply chains that took decades to build, resist easy US replication. US annual GDP falls, to near 2% or less. New non-farm monthly payrolls/new jobs fall <75,000/month (bad!), job markets slow. If a confidence once seen in 2024 @ 2.8% GDP growth (2.9% in 2023) stalls, *may*be harsher 2026. 10-year Treasuries see taller yields in 4%s to attract inflows; so prices decline on less confidence US will tackle debt other than by 'inflating it away'. Gas at the pump persist in $2s range, near $3/gallon -- rather than under $2 as white house promised. Worst for many, is an exploding US deficit and so debt. By self-claimed 'fiscal conservatives', in time of full employment and peacetime (normally a time for fiscal rectitude, reducing debt).

Or… maybe, stock markets boom! Rallying to new records! On stimulus & hopes for low rates. Or another possibility: uncertainty, mass deportations, slower jobs (even with market rallies) sees GDP growth middling, accepted by hardliners to 'break the back' of inflation. Welcomed 'as a feature, and not a bug' of tariffs unpredictability. To 'detoxify' what they see as public reliance on government & spending; to cut taxes & expenditures. Intent to harm renewables, subsidize fossil energy. Perhaps on 'Cultural Affinity' for older classic fuels, longing for less-constrained America of the past. Or, what's revealed ahead, may instead perhaps be some unpredictable mixture among much that's above (and more) into 2030s. Yet to unfold.

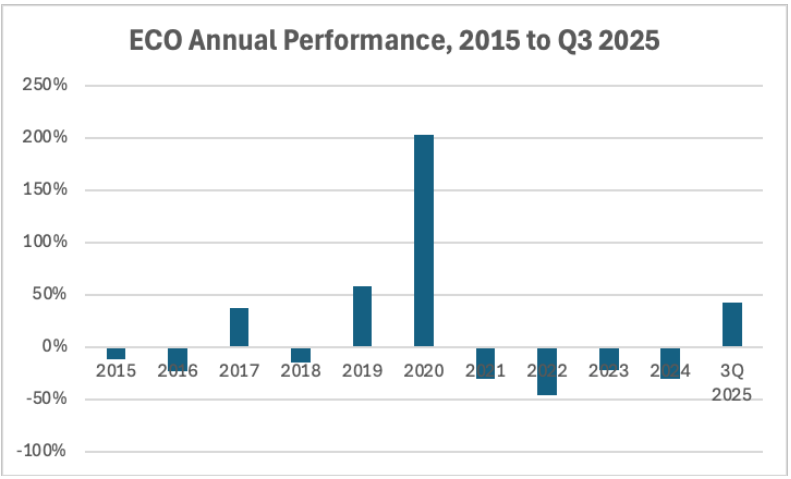
For rough analogy in physics & chemistry, the periodic table beautifully helps predict, explain how elements behave. Consider why elements in its far-left column are reactive. They have only 1 electron in outer valence shell, so 'want' to combine: Hydrogen 'wants' a 2 electrons stable pair 1st shell, so predictably forms (with oxygen) as Water. Lithium has pair of electrons in its 1st shell, but only 1 in its 2nd orbital, so is reactive. Sodium's 1 electron 3rd shell 'wants' an element with 7 valence electrons (chlorine), thus becoming table salt. That salt nicely then has 8 electrons: for a stable desirable state. Predictable, understandable.

Admittedly something of a stretch, but by an analogy, conventional fossils & nuclear favored by conservatives may be on cultural affinity: those long were US energy. Complete, Stable. Oil for at least a century, coal for much longer. Once cheap, they'd helped build America's industrial revolution. Hence an affinity for them. They're centralized, thermal, burned for heat, spins turbines, mechanical inertial force. Importantly all in contrast to renewables solar/wind that until very recently, were far too costly, impractical in 1980s, oddly different, non-thermal. They'd once only made sense with tremendous public subsidies. Given clean energy's (once super high) costs, intermittency, lack of reliability, maybe more than anything their not being longstanding part of American culture, they've not been / not yet embraced by conservatives. Clearly not in a same ideological, now-less-sensical ways that today's-costly coal, oil, gas, and nuclear, are being embraced by some 'fiscal conservatives'.

Far right column of periodic table are un-reactive 'noble' (as they stand apart) elements: Helium, Neon, Argon, Krypton: with full valence shells. Won't interact with other elements. It's a poor analogy, but until recently, there was no need to take renewables very seriously. They just had singular uses like space craft solar panels -- cost thousands of dollars per watt!! But today, solar/wind are far different from 1980s. Combined increasingly with storage, can be firm & dispatchable. So fervent opposition latter 2020s to clean energy, is not sensible on economics; yet it persists. Still, that too can change. A half-century from now, nuclear fusion power may even possibly fuse isotopes of Hydrogen (upper far left periodic table), with noble stand-alone gas Helium (at upper far right) -- making stable cheap, and safe power. With no radioactive wastes at all. Even now solar could provide US immensely more cheap power, but arguably the reasons most preventing it are cultural. From old thinking inaccurate today, given far (lower) costs of renewables, their being dispatchable with cheap new storage.

Cultural bias brings hesitancy to let go. Even of coal given traditions. Indeed 2025, federal officials actually used a rare emergency rule to block a planned US coal plant from closing. Yet closure was desired by plant's owner, grid operator, city/state; keeping it open costs ratepayers $$ tens of millions. Though a gas plant is cheaper. Maybe it's 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 to explain some, to make bit understandable aims to kill renewables. Culture changes slowly yet does change; 100 years ago it took awhile for conservative Texas ranchers to embrace bobbing oil pump jacks: they're now TX icons. A generation ahead, conservatives may look at spinning turbines, cattle grazing underneath & say 'turn, baby, turn.' Unlike 2025 when a state senator said 'a broken wind turbine blade could be hurled 4,000 miles, to kill a baby in crib'[!??]. Meanwhile, an actual concern in latter 2020s on trade uncertainty, is China may choose to use 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. Giving them leverage in trade stand-offs. It will take years for the US, like Europe, to re-build strategic minerals capacity. US & Europe were once leaders in automaking; now, given Chinese EVs, they're letting past leadership wither away.

It may be worth glancing back a moment, for any political correlation to this theme. At mid-decade 2025, a look back at ECO's Annual returns last 10 years is small food for thought. As expected we do see clean energy/ hence ECO Index, *has been/ is very* volatile. That volatility is no surprise in an emerging theme. Yet the *direction* of annual moves, is *not* what one may have expected if maybe anticipating easily-forecast directional correlation as between ECO -- and a president/party in power each of the years. Below is ECO, 2015 through Q3 2025:

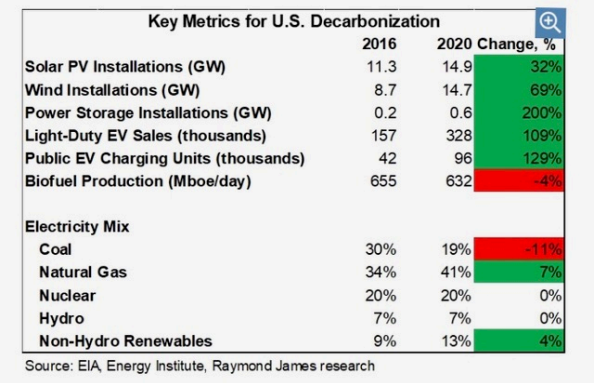


This point on direction is counterintuitive: Not what one maybe expects each of the 10 years. What surprises is during a *conservative* president, clean energy theme/so ECO, *rose* sizably. In 2017-2020, during a conservative leader's 1st term, this clean theme *strongly gained*. Tallying annual gains/losses each of 4 years it surprisingly was *up* large net +284%; as up +38% in 2017, down -15% in 2018, up +58% in 2019, up big +203 in 2020. Big gains during a conservative famously opposing 'green new scam', climate action. His 2nd term began differently, with erratic tariffs before stimulus. It's sure to unfold unpredictably, in that president's newer 2nd term, 2025 to 2028; let's watch and see what happens here ahead.

Inversely, maybe unexpectedly too, is 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 by net total -128% (tallying -30%, -46%, -22%, -30%). Not what one might have predicted! Counter to conventional wisdom yet 10 years, clean energy *rose* in a conservative president -- and *fell hard* under a liberal -- opposite direction of assumptions. But, looking at 'just' this past 10 years period ending around 2025, was perhaps too short-ish a time horizon.

Supposing was a fluke on just 1 presidential term each side, we can see earlier ~10 years too from 2005. Here we see annually 2005 to 2008, a conservative president's 2nd term ended near nil if tallying 4 years (+4% in 2005, +5% in 2006, +58% in 2007, a big -70% in 2008). Waters were muddied a bit by a Great Recession in 2008, that had dropped all hard; consider if it hadn't been for a 4th harsh year 2008, all globally down, we see a previous also conservative president would have shown (again surprisingly) big net *gains* in clean energy's theme/ so ECO in their own 2nd term in office. Lastly, in a prior liberal president's 2 terms, 2009 to 2016, we saw net -40% *loss* tallying up 8 years (+28% in 2009, -5% 2010, -51% 2011, -19% 2012, +57% 2013, -17% 2014, -11% 2015, -22% 2016). Hence the 20 years to 2025 do *Not* reflect maybe directional expectations, if one assumed green losses for conservative, gains for liberal. Facts were opposite! Resists accurate predictions, *ex ante*. Importantly too, inflation, tariffs, a heightened policymaking chaos from 2025, may also mean differing results ahead.

Doubtless 2nd term will unfold differently from 1st term. 2nd term began differently on tariffs, & new impediments designed to hit just renewables/help just fossil fuels & nuclear in 'one big bill'(!!). Yet as this president had a 1st full 4 years term in 2017-2020, one can now ask: Did decarbonizing/clean energy equities growth halt, then? No. Both in rhetoric & actions, this president long much *favors* oil, gas, carbon-laden coal, & nuclear -- and strongly *opposes* renewables, wind, solar. In 2025 the President pledged to "have a policy where no new windmills are being built"; he called climate change "the greatest con job perpetrated". And yet we saw in 2025 (like his 1st term), ECO's theme rose. We also saw earlier, that clean energy generation too grew 2017 – 2020. Solar installs were up 32%, power storage up 200%; wind installs up 69%, EV sales up 109%, EV chargers up 129% (off miniscule base). Only biofuels down then owing to overall demand destruction punishing all fuels in 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

One sees above, America's electricity mix start of 2017 was about 30% coal, 30% natural gas, 20% nuclear. Yet end of 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 as susceptible to growth, both were a static, 20%, and 7% respectively. Coal was hammered those 4 years not primarily by renewables, but plunging costs for competing nat. gas/US fracking. Start of decade 2010, a Utility executive might reasonably have aimed to add more coal power. End of decade, 2019, their fiduciary duty made coal relatively a bad bet. Not on worst pollution, but coal lost its edge vs. firm, 'less-dirty', flexible, cheaper, natural gas-fired electricity.

Decarbonization did Not pause 1st term, 2017-2020. Nor, may it now 2025-28(??): 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 is outpacing California in renewables growth. Ruby-red conservative Oklahoma is 41% wind/ solar. Iowa & Kansas lead in wind. A blue Oregon by contrast, was one of the worst-places for renewables, doing 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 an IRA's roll-out, 2/3rds of $$ at 1st went to conservative states, yet it was easy to undo in 2025. Hundreds of billions taken from EVs, DOE Loans; credits ended. It's understood: elections & 2024 Red Wave have consequences! GOP members who'd (mildly) supported IRA, rolled over for a 'one big bill' in 2025. A few senators mellowed reconciliation text. Still, many US oil executives who'd enjoyed world-record oil production in 2024, were disappointed privately 2025. They didn't want 'Drill, Baby, Drill!!' that can mean oversupply/ and so lower fossil fuel prices (oil in $50s) -- so much as a strong GDP growth to ensure ongoing firm demand for their product. New drilling areas be available, far fewer regulations, less taxes.

One place offshore wind did do well (outside China) early 2025, was Germany; it permitted new 4 GW wind; approval times got faster; a GW of wind capacity was connected to Germany's grid Q1 2025, up 40% year/year; onshore wind capacity hit 64 GW. Pro-renewables policies can help a lot!! Or, policies can hurt!! After 1,665 MW new *solar* capacity was installed there Feb. 2025 -- next month in March it dropped to 787 MW -- on new law early 2025 where solar isn't paid if electric prices go negative. Still, German solar re-gained; capacity over 100 GW. National policy can aid -- or unintentionally hinder (like US electric prices *rising* with less solar & wind ahead?). Or policy, $$$ may fail to surmount hurdles. US tried to push down coal costs 2025(!); but if by removing coal's mercury & air toxics standards -- that hits human health. Or, if rush latter 2020s to nuclear is by tech moving fast & breaking things, then that too may be ill-advised. Recently a co-founder of a nuclear startup had promised he could hold a spent fuel rod 5 minutes, with no ill-effects(!); scientists note lethal dose is in milliseconds. Cheaper, newer nuclear power *might be* great, but as always, safety must come first.

The US was trying hard from 2025 on to make a 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. Hence, the opposite of *impediments* at renewables -- federal officials announced many nuclear *incentives,* like shorter License waits of 18 months, authorizing deploying on military & energy dept. land. 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 but worryingly, dropping rules radioactive wastes must be stored sustainably. 2025 saw billions in new federal funds. 4 new executive orders relaxing the 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 yet in 2025. Nearly all US commercial reactors still are outdated 2nd generation/ gen II built long ago. Commercial fusion done 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 a hope. That *might be* great; given the capacity factor 'uptime' can be 90%+ with a firm nuclear -- vs. just 24.9% with intermittent solar, 35.4% for wind ('naked', without battery storage).

1 company did aim in 2025, to have its US commercial gen III SMR ready in 2029: we shall see! California's 1 lingering nuke in 2025, 2.2 gigawatts (GW) gen 2 helped stabilize at 60 HZ if little wind/solar, grid strained. But it's old. US & Europe slowed non-replacement new nukes; they'd been costly/risky vs. gas. But they are lately speeding up hard from 2026. As a South Korea was almost alone among OECD countries for having built a nuke on time, on budget; so of 65 reactors going up globally in 2025, most then were in Asia. Nuclear is firm, great!! But it's by far costliest option. Always far riskier, than much cheaper faster renewables.

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

Vogtle was “the most expensive power plant ever built on Earth”. Estimates (private data) of its electricity costs very-high, say 12-18 cents per kilowatt/hour (kWh) generated. Costs offset by subsidies yet were more $$ costly than China’s immense Three Gorges Dam. And it is to be dismally overtaken by a Sizewell C 3.2 GW nuke in UK where costs near-doubled since 2020 -- from estimated £20 billion -- to £38 billion /USD $51 billion in 2025. It aims to meet 7% of UK electricity demand yet is not opening until late 2030s! A future Hinckley C nuke is as bad; first estimated to cost $18 billion, it’s now far behind schedule, over budget, will not open until early 2030s and will cost at least $46 billion! That said early 2025, Georgia’s own electric rates were higher than in so many states with good wind, hydro, solar generating capacity -- like N. Dakota, Idaho, Washington State: we’ll discuss this ahead. Very high construction costs, excess delays etc help explain why nuclear as a share of electricity generation dropped worldwide from 17% mid-1990s -- to just 9.1% in 2024. New big reactors today can replace retiring ones, vs. SMRs that may hope to fall under a <cost-prohibitive $10+ billion per plant. So talk of standard modular ‘cheap’ nuclear <300 MW can be alluring. Yet reality + experience mid-202os with III gen designs shatters that. Future hyperscaler demand from AI has re-started a few old nukes. As US re-shoring after years of flat US power demand, drives hopes too for nukes in 2030s. *So, If* SMRs are safe, cheap, woohoo! An excuse for the costs so far, is each US plant is FOAK (first of a kind). Perennial hope is very standard US small reactor fast drives down costs to under say, 7 cents/kWh. Then new 3rd gen+ ‘cheaper’ SMRs may be emplaced many places in early 2030s, if they can soon finally become standardized & safe (?!?).

Reality, however so far belies that. Economics shows that big reactors are more profitable; small nukes cost *more*/kWh, with waste per kWh also worse. Models show costs/per kWh for SMRs is 50% higher than for 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 a 300% cost overrun; 2 in Russia had 400% cost overruns. Given that in the west, any new large reactor is already the most-costly way to make power at >10 cents/kWh (and 4-6 times the costs in S. Korea or China), and any small still-economically-unproven SMR, would be worse -- it’s no wonder SMRs are today 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). But 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.

Because any new nuke must compete with a natural gas plant on costs, and natural gas fuel can be at times ‘cheapish’ -- any new gen III nuclear, big or SMR, must be able to make electricity for not much over a nat. gas competitor’s 6.2 cents per kilowatt-hour (kWh). Yet even a big nuke is nowhere close! One reason why 93% of all new US electricity-generating capacity added 2025 was solar, wind, energy storage. A small % natural gas. China planned in 2025 to build more nuclear: 35 GW, so many reactors. Yet 95%+ of that 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 is a lot. Yet to put that into perspective, *China had built 350 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 the hopeful new gen III designs of that period intended to be far cheaper and so propel US nuclear ahead, instead proved too costly, especially in a west, set it farther back.

For renewables then, their *Intermittency* (sun shines at most only ½ day, wind blows only at times) means some 4x more renewables must be built, to equal = say a firm megawatt. Electrons dearly needed early evenings, yet then is no sun, wind maybe still. Batteries now only last a few hours: so Dispatchability is Crucial. Firm is important! But renewables costs nonetheless have dropped so drastically, it still can make good sense to 1st grow solar/ wind/ storage. And renewables that increasingly mean abundant electrons at/below zero wholesale costs at times, can render firm nuclear, coal, baseload gas plants that can't fast start/stop, as un-economic, terrible loss-makers. This is a crux of the matter: now at start of latter 2020s, the costliest and firm options, fossil fuels and nuclear -- cannot easily compete.

S. Korea's large firms stand out for delivering a very rare thing: reactors built almost on-time, on-budget. A first foray abroad was Barakah plant in UAE; from start 2009 to finish in 2023, $20 billion 4 reactors plant went up far faster than in a west. S. Korea has 50 years of nukes experience; in 2025 had 26 domestic reactors. Plus doesn't present national security risks for west, as does contracting with China. But all said that rare near 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 not near as cheap. US/Japan, and S. Korean firms may partner, try for 'cheap, fast' SMR prototypes in eg Canada.

So little surprise US AI, data centers needing firm power, oft look to build natural gas plants. In 2022 they once cost 'just' $800,000/MW, far less $$ than a big nuke at $16 million/MW (novel small SMRs would be more/MW)! Gas plants then made electricity for around 6 or 7 cents/kWh -- cheaper than dirtiest coal. But question of power source still has no easy answer today. For in 2022, the big 3 gas turbine makers GE Vernova, Siemens, MHI, had sold just 1 unit between them! While then 3 years later, if a new turbine wasn't already secured in 2025, then turbine shortages meant one must wait until 2030s to build. That's pushed up prices 2, 3 fold: by 2025 a new gas plant cost far more: $1.2 million/MW. Prices for natural gas fuel volatile too; as US increasingly exports LNG, gets costlier. So even 6.5 cents/kWh 'good' cost for a gas plant -- intermittent yet clean renewables on free fuel can generate for near ½ that cost/kWh or less! Thus, looking ahead, much also will come down too to how swiftly energy *storage can* advance, since new technologies here may make the intermittent solar & wind more firm and dispatchable too. There is no one, single, silver bullet in energy!

In most practical of terms, amounts spent on clean energy latter 2020s are huge, yet show the world is not (at all!!) yet solving for climate. Plus what's done is all basically 'additive' -- rather than *replacing* dirty energy. Spending needs to decarbonize is based on the science -- jaw-droppingly formidable. In 2024 the UN calculated to achieve net-zero by 2050, world's clean energy spending must be $6.5 Trillion/ per year to 2030; then $8 trillion/year to 2035! Unthinkable amounts today. Especially on a recent global backlash ('greenlash') against clean energy, & a rise of political nationalism. If science + evidence-based-concerns for our planet's future had not made climate so pressing, we all might just shrug it off & move on. Go on with a status quo burning conventional fossils, profitably. If one isn't moved by the science, that's an easiest path, and pretty near current trends. And yet the science gives us fortunately (or unfortunately?) some idea what to expect on a planet fast growing 3, or 4+ degrees C hotter. Proponents of fossil fuels may want to/like to portray themselves as having a more 'practical', serious view[!] -- yet the consequences of their thinking *may* be radical. We'll discuss in later pages what the science foresees. Yet it's also all ironic as going clean faster, though costlier upfront, will save the most $$. But taking this terrible current path 1st, is our own human nature. We'll turn next to clean energy equities now, in these latter 2020s.

Let's look briefly now at what Index components were *Most Down / & the Most up* -- YTD to around mid-2025 (to July 18th). In 4 volatile themes so US pure plays ECO; in a *global* clean energy NEX with components mainly outside US; in a global themes hydrogen H2X, and in wind energy/grid WNX. For ECO from Jan 1st to mid-2025, the components in ECO most *Down,* included in *grid & energy storage (-44%); in *US domestic solar & batteries (-43%); *inverters (-42%) fuel cells (-41%). Well *up* in ECO was one in *strategic US minerals mining (+304%); in *US silicon anode batteries (+209%); US solid-state batteries (+182%). An independent ECO tracker was up about +16% year to date (YTD) tied at 2nd among the 4 WilderHill themes.

At global new energy NEX, the components most *Down* YTD included also tightly-bunched in *batteries (-45%); *inverters (-42%); EV charging (-42%), fuel cells (-41%). Most up included in *US solid-state batteries (+182%); *electrolysis for green H2 (+113%); solar farms in Europe (+108%). Year to date an NEX tracker was nearby ECO (and H2X) at +15%. At global hydrogen H2X, the most *Down* YTD included in, *composite cylinders for hydrogen (H_2) (-62%); *in grid (-44%); and *fuel cells (-41%). Up most included in *materials for FCs (+119%); *electrolyzers (+113%); and *wind to green H2 electrolyzers (+79%). Year to date, an H2X tracker in Europe was also doing 'similar to' and so was rather nearby ECO and NEX, here at +16%.

At global WNX for wind & grid, components most *down* YTD to July 18th were tightly bunched, including, *grid & energy storage (-44%); *power converters in Taiwan (-33%); and *engineering in Europe (-28%). Most up included in *US solid-state batteries (+182%); US engineering firm (+109%); wind in Europe (+108%). Year to date to July 18th, a WNX tracker in Europe did 'best' of these 4 themes at +25%; hence WNX 'led' YTD followed by ECO/ H2X tied; and NEX slightly trailed. We note too while a US re-elected president vocally opposed wind power, that global wind installations were/are growing: 2023 hit a record, wind up +50% over 2022. Cumulative global wind capacity hit 1,021 GW, a bit like say ~1,000 nuclear reactors (though wind of course is intermittent, not at all firm). Yet on climate & CO_2 budgets, for world to stay under <2.7 degrees F/ 1.5 C heating, 1,000 GW was far from enough. Still, this narrow wind basket by Not having had over 2025, the deeper-falling themes like in solar, EVs, H_2, & fuel cells -- maybe helped WNX stay above water YTD, a relative 'winner' of the 4 themes here.

A curious fact seen 2021-2024, was as global installed new energy capacities grew & swiftly -- the equities sank, hard. Yet we see too as a once-costliest clean energy has matured, it is today *the Very Cheapest, thus is better-priced vs. traditional coal, natural gas, or nuclear -- *and though Intermittent, with storage it should grow more-firm ahead. In 2010 the levelized cost of energy (LCOE) for onshore wind had been pricey $0.11/kWh, or big 23% higher than coal/gas @ $0.09. Yet by 2024, onshore wind costs were 67% better/ lower, falling to $0.03 -- vs. fossils still @$0.10. Utility-scale solar fell more in costs, from nosebleed $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 too; storage will be key ahead for needed, firmer, solar/wind.

And as noted with ECO down near 30, some asked whether such low valuations may possibly mean troughing ahead, given deep-discounted levels? *It's impossible to say!* Yet a sheer coincidental steadiness of declines seen within 2021-2023, has ended for that period at least. And, as we emphasize, conventional energy oil, natural gas, & coal are still most dominant. *Thus, looking at say from the year 2022 -- to year 2023, world dependence on conventional energy fell by less than 0.5%, or hardly at all: it just dipped slightly from 81.9% -- to 81.5%!* What's ahead shall be interesting indeed. As clean energy may (or not!) grow, and equities (no surprise!) shall go on moving in always surprising, ever-unpredictable ways.

2025 on so now past decade's ½ way point, latter 2020s, we're seeing big changes. Globally, energy discussions have shifted sizably. From a big concern back in 2020 then over: ***How Clean*** is an electricity source -- to in latter 2020s: ***How Cheap, Firm, Reliable,*** is it today. Consider Norway's ample low-cost hydropower that long made it winner 1st half 2020s, about cheapest, yet firm/stable & reliable electricity in the OECD. While it's exporting its much pricier fossil fuel natural gas & oil to other nations. Because this cheap hydro was for decades available only to Norwegians, 'power cul de sac', prices stayed low. But huge electric interconnector cables built 2021 linking Norway, to UK -- have meant Norway's local rates, can skyrocket at times. No longer fewer buyers, it now may export electrons at super-high prices like 'Europe's green battery', but exporting only. As now higher prices hurting Norway's citizens who'd paid for those dams. If No winds in breeze-less UK, prices in Norway can spike, strangely hitting this *hydropower* nation! Big issue in Norway's 2025 election was renegotiating contracts due to 'price infection'. In 2024 with its 5 pricing zones, the rates near the connectors in Rogaland Norway leapt from <6 cents, to briefly >$1 USD (13 kr)/kilowatt-hour (kWh)! Lacking pumps, it must rely on rains, run-off; thus a 2025 drought near 20-year records, posed a question whether Norway could easily (so cheaply) power itself. That threatened then UK, Germany Denmark, who all sought to (almost-always) import Norway's green cheaper power only.

Opposite of Norway's very low-cost electricity, thanks to its surplus renewables & baseload -- is a 'losing' UK with super-pricey industrial electric rates of 46 cents per kilowatt-hour! UK's demand declines, cheap wind, were long a pincer so traditional baseload capacity was lost. Its de facto ban on & erratic support for onshore wind, permit/pricing thickets put grid in bad way. With rates set there nationally by pricey gas & it must import gas, power if intermittent winds don't blow. (Raising rates in Norway via connectors). Or, Australia's aging coal-fired fleet is today wrong-side of cost-curves, with coal now unreliable + costly. In past, UK & Oz once relied on cheaper coal & gas for power. But now, fossil fuel power is expensive! It's a topsy-turvy world. One where Cheaper Electricity now is made by renewables wind, hydro, solar. Crucial now: better grids everywhere; solving for inherent intermittency.

Take the 2 cheapest 'best' states for retail electricity in early 2025: N. Dakota (11.31 cents), and Idaho (11.34 cents). Also Washington state at cheap 12.39 cents. All 3 thanks to ample renewables. North Dakota turns 1st to its cheapest electricity sources: wind (36%), hydro (4%); they incur No resource costs; only after does it turn to stable costly 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 costly baseload gas for last 1/3rd. Washington state 1st gets 68% by hydro, 7% is intermittent wind; so 75% from 2 cheapest resources. Only after those 2 does it turn to costly firm stable gas (13%), nuclear (8%), coal (3%). Worldwide & in US, developed places with lowest-cost electricity, often rely 1st on ample and cheapest renewables!

Contrasts with costliest US state, Hawaii at 39.6 cents, or 3x the cheap states. It's clear why. Hawaii is importing/burning costly (filthy bunker) oil to meet a huge 78% of its grid demand in early 2025. That 39 cents was near retail rates in costly Germany (that has 1 pricing zone, like UK). Meanwhile in mainland America average retail was then near 15 cents. 2nd worst/costliest, 34 cents was California. Where onerous regulations require decades(!) to add capacity. It pays the 3rd highest cost in US for industrial baseload gas. Huge wildfire liabilities, myriad mandates. Importantly, California's high rates *were Not Due* to its renewables. 8 states generate a bigger share from renewables than does California, *and all those have rates below the US national average*. Old, conventional wisdom, is now wrong. The very Cheapest sources are renewables -- Costliest electricity by gas, coal, nukes. Wrong too is to assume that fossils aren't subsidized: all energy is!! Thinking can be updated latter 2020s.

Texas makes America's greatest-clean electricity, cheaply. Its 169,000 GWh clean generation in 2024 surpasses nations! By population, California is bigger place, yet it made 'only' 92,000 GWh. Industrialized Texas has more energy demand; yet its cheaper industrial electricity @ <7 cents, blew away California, that's 3x more costly. On say a not-unusual Texas winter day in 2025, wind/solar were meeting 69% of its electricity demand + growing. Of course, solar works only daytimes, wind in breezes only, they're intermittent. Latter 2020s its wind/solar are the Cheapest + often Dominant sources nowadays for Texas' own electricity.

*But, importantly: 2/3rds of Texas *capacity* is still firm, dispatchable, (often idle) non-renewables.* To see how Texas grid has evolved: in 2015 it had 251 natural-gas plants. These work-horses of dispatchable baseload could meet much demand. Yet 10 years later, in 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, not-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 new 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 in 2025. Clean energy generating capacity grew 315%. Versus natural gas capacity 'growth', of just 6%. Key reason is: electricity by solar/ wind is now THE Cheapest by far -- when the sun is shining, wind blowing. A trick now is to pair the 2 cheap renewables, with clean/better baseload recognizing climate/CO_2. Streamline permitting. Improve grids. Expand fast clean energy production / and storage greatly.

Economic allure of wind/solar is why less-regulated, market-oriented Texas, grew as it did! In 2015 gas was key to its electricity; it has a great deal, loves its 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 fast to just 3 cents/kilowatt-hour, or less!* 'Traditional energy' hence coal, or natural gas - & 2nd gen (or 3rd gen) nuclear, can never touch that.

As Texas' gas increasingly is exported, interconnected with global demand, US gas / LNG price also is rising, reflecting higher global prices fetched for product. A bit like Norway, where 'price infection' due to high UK prices paid for electrons other side of connector, drove up prices in Norway for its hydropower. As prices rise at one end, they do other end of wire too. When US converted its own LNG terminals from Importing, to instead Exporting -- US became swiftly world's #1 LNG producer. Fast went from zero exports in 2016, to just 8 years later it supplied a massive 21% of global LNG. Of course, this drove US natural gas prices higher too -- as wind and especially solar became cheapest energy, this chasm is only growing.

Unsurprisingly traditional energy is fighting back, hard. At local, state, national, global levels. After a century of making wealth, fossils are enormously influential, among most-powerful of all interests: they're winning on many fronts. So, while they've lost on low costs vs solar/wind latter 2020s, loss ever-widening, they'll highlight renewables' intermittency, lack of firmness, poor dispatchability. If 'All of the above' energy strategies fairly promote all, it's one thing. But, lately, efforts are instead directed at hobbling just, solar/wind. Attacks on renewables, EVs, specifically aim to halt clean/new energy. Sure, if one just 'overlooks' climate, then gas may be great baseload! Subsidize heavily, stress renewables' intermittency. Yet of course, that is a hugely risky 'IF bet!' And it contradicts all the science. Plus, what we're seeing are efforts, new US moves to slow, even halt just clean wind/solar alone in its tracks.

For example, Texas' legislature in 2025 considered a bill (SB 388) that would require over 50% of energy generation 2026 onwards must be by dispatchable gas, coal, or nukes only; though storage of solar/wind is normally dispatchable, it excludes that. Fossils & nukes falling behind on costs, have asked a less-regulated 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 a setback be at least >3,000 ft just for wind! While all had passed in its more conservative senate, even an oil & gas industry lobbied hard to defeat them, as Texas needs 'all the above', all new energy it could get! Those 3 failed in house, summer 2025 but they'd gotten far.

As the federal government worked to kill just solar/wind at a national level too. So besides states' efforts to hobble wind/solar, a 'surprising' effort from 2025 was to make dirty & costly coal cheaper -- 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 directly for US production, consider 2 huge subsidies to oil & gas. 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 government 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?

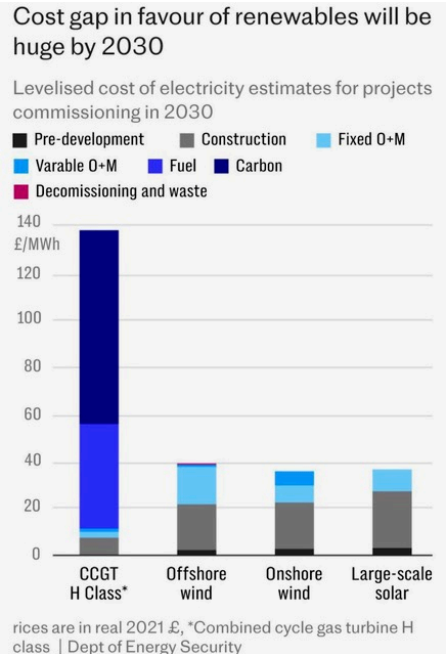
Given fossil interest narratives, one may think the very Cheapest-electricity states in US must get *All their power* purely from just natural gas, or coal -- not from renewables at all! And yet, the cheapest state: just 11.31 cents/kWh retail early 2025 was windy North Dakota. It turns 1st to its lowest-cost power, wind. Wind makes 36% of its generating capacity, which more than doubled in size 2016-2023. These gains were Not on any green ideals, nor 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 oft its 2 cheapest sources of electricity. Only after that cheap 40%, will it then use its biggest resource, firm yet dirty lignite coal for another 55% of electricity generating capacity. Then, costliest of all, is its natural gas lastly for a final 5%.

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

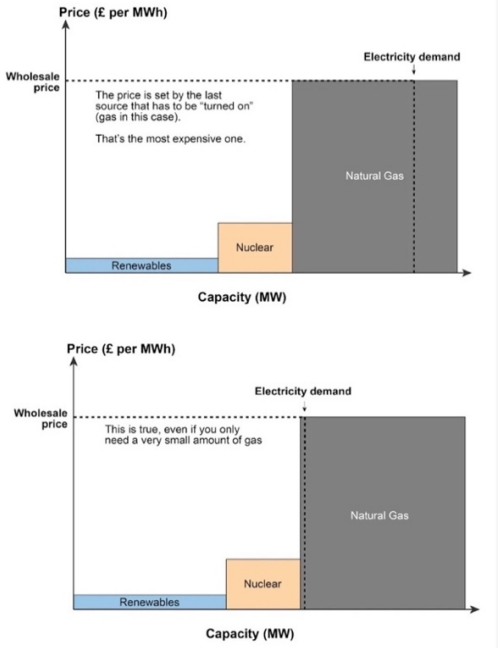
2nd lowest-priced Idaho was 11.34 cents per kWh. Does it get all electricity from fossil fuels? Again, No! For Idaho in 2023, its biggest source by far was hydro, 43%. Again renewables are Cheapest power. So, it turns 1st to low-cost 'water' (hydro), plus wind for 15% more; hence 2 renewables + a 6% 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: 'margin pricing' mechanisms commonly set electricity at higher costs. Take the UK (Great Britain), where marginal pricing means if *any* natural gas baseload is in the production mix -- true 98% of the time -- then that last most pricey gas sets wholesale price nationally. Even though costliest, last-used gas on average is only 40% of UK mix (at times 10%). In producing its 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 from natural gas, coal, nuclear -- it is costliest now latter 2020s, vs. preferably cheaper (but intermittent) renewables. It is firm, yes. And yet nowadays it's oft 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 US: a nightmare. As seen left above, a core reason for high UK electric rates is *Relying on often imported gas. Even in a modern combined cycle gas turbine, that's still costlier than wind/solar, & gap is widening. If much gas is used (right, top chart) marginal prices high; yet even if gas meets only bit of demand (right bottom), electricity *is still-highly-priced,* 'without good reason'! The UK sets one national single price, so high demand places (like London, in its south) can set that rate for rest of UK. Though wind farms in north/Scotland make cheap power (*negative* wholesale prices at times!), and a shift to regional pricing could reduce rates for citizens in windy north. Mid-2025, the UK considered but backed-off that. Had it chosen regional prices, what critics call a 'postcode lottery', cheap renewables that help now keep 'a lid' on already-costly UK rates, would have been lost for most citizens in populous south. High rates nationally would have gone up even more for most UK citizens, without that now-cheap wind.

Such regional pricing would be more like US, where 50 diverse 'regions' (50 US states) each have their own kinds of electricity production, each with varied rates. So 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. And costlier states, use much gas.* Rhode Island had a highest US gas reliance, 92% -- and 6th costliest electricity, 25 cents/kWh. For all US, natural gas made 43% of electricity on average early 2025. Even in new plants, gas-power is costly: yet gas commonly sets Retail rates. This is seminal. US retail electricity rates are set by last, 'most important' source. 2025 in gas-loving Texas, a $5 billion public fund to assist building gas plants flailed; 4.6 GW worth of proposals dropped out. Much on cost uncertainty, difficulty getting turbines. As a 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, diverse retail 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, produce. Plus, on need for grid stability, baseload has big role. Given US is so varied, recall other side of coin is the 2 costliest-electricity states. Bottom of barrel priciest Hawaii early 2025 was nosebleed 39.6 cents/kWh -- 3X that of cheap North Dakota, Idaho, Washington state. Reasons for such sad, pricey results there are clear. also pretty embarrassing for the 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, the 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 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. Heavy 1st mover costs: in free-market Iowa, wind was cheap so able to achieve 40% capacity factors, vs. California requiring solar early in 2000s that was 10x more-expensive early-on, a capacity factor 20%. *Guarantees of big returns of 8%-12% for utilities in California. Versus rural cooperatives in say, Iowa with No profit margins. *Slow/costly permitting. *California's Industrial Natural gas prices 3rd highest in US for needed baseload. *Huge wildfire costs, and *Ratepayers subsidizing too roof PV (both arguably can be partly funded statewide by taxpayers). All pushed 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% of in-state generation. Given self-inflicted foibles, for it to fast replace huge baseload gas, is no easy task. We see states with cheap electricity rely heavily on free-markets -- & on their own ample renewables. Jan. 2025 retail costs were low 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% from its wind; but on free markets, few mandates: its rate was under 13 cents in 2025. Uruguay has moved from heavy fossil fuels-reliance -- to 99% renewables, and now 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 engine 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 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 EU, it was in Agreements to export 'surplus' power to Northern nations UK, Germany, Denmark etc if latter see low winds, inadequate 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 UK, or Germany, average retail rates 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, fears in UK were of blackouts ahead, no laughing matter. In early 2025 sizably 4% of UK's electricity was from Norway hydro: that may be pared back. If no North Sea wind, 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 had issued 144 'Lack of Reserve' Alarms in Q4 2024, highest ever. Customers had to trim demand, likely means higher electric rates ahead. Many alarms were sounded too at 2 aged power stations, Bayswater, & Eraring, on coal's growing unreliability fueling old plants; one station ran only 4 weeks, over 5 months! Another station had a catastrophic explosion. On coal's many issues, electric rates Q4 2024 for national market shot up to AUD $88/MWh -- up by 83% late 2024, vs. a year prior. 14 aged baseload coal plants averaging 36 years old. A problem not just of coal: even a new grid-scale natural gas-plant, a first in 15 years in 2025, was going online 'just' 2 years late, $1 billion over budget. When Yallourn coal plant suffered breakdown in 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, more like modern baseload combined-cycle CCGT, putting CO_2 out in amounts similar to burning black coal.

Oz can have too 'dunkelflaute' times of no wind/and no sun. Early evening on 11 June 2025, so after sundown (so no solar of course!) remarkably no breezes, total demand was a 620 GWh on national electricity market. With zero solar (like every night) -- remarkably zero wind (the unusual part), only 25% could be met by its renewable hydro, just bit from batteries. That meant a very large 375 GWh had had to be met by coal, plus 91 GWh more from gas that is increasingly imported to Oz as foreign LNG -- rather than being domestic natural gas. Clearly, building much more battery and other energy storage forms 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 persisting that could be a 'disaster' for some US producers needing >$60 for wells non-low-cost Permian basin. $50 = production cuts. A 'US energy dominance' as was promised on a campaign trail -- and oil (even briefly) nearby $50 -- pretty incompatible. Or note too, rare earth elements, + graphite, magnesium etc, come from China -- supply under threat, if conflicts on Tariffs, or on Taiwan. Heavy rare earths from Myanmar; cobalt from DR Congo; insecure. Military & strategic needs for some minerals are critical, with crucial roles in new energy too. Should/can they all be sourced from US? Processed as well? Is it possible? Or, could these all come mainly from US allies?

Given president of 2025's longstanding hatred of (offshore) wind, might it be halted in a US? Even states desiring it, California, New York, Rhode Island etc etc? Should renewables be slowed, though US is moving from 20 years nil energy growth -- to energy demand for AI, data centers, re-shoring manufacturing? How big to go in US, or EU on tariffs on EVs, PV, from China? Go fast past 2nd gen -- to 3rd & 4th generation nuclear? As fights brew even on niche hydrogen (H_2); Europe 2020s was drafting rules for green H_2 nexus to renewables, to guarantee green H_2 is made when sun shines, wind blows on 'additional' green-electrons. In the US, even Exxon, Chevron, American Petroleum Institute co-signed a letter early 2025 lobbying to save IRA 45V tax credits for 'blue' H_2 made by (their) natural gas. H_2 is still very niche; just 16 million tons were made in US 2024. A H_2 by natural gas, is much cheaper @$1.50/ kilogram -- thus tough for a green H_2 costing 3x that: no one wants H_2 at such high cost!

Regardless, in 2025, EVs/PV from outside of China, a green H_2, or e-methane from anyplace -- were often too pricey. Costs matter. Fossil-players claim 'clean H_2' is made by gas-fired electricity, or RECs (renewable energy credits) by solar/wind at distant places, times. Conservatives will support it. Favor 'all of the above' strategies on abundant US shale gas; worry far less about climate risk. Many will support big Ag dairy RNG (renewable natural gas) from agriculture, or renewable natural gas from landfills or wastes. Indeed, avoiding methane spills is a way to help limit greenhouse gases. Capture carbon permanently, as in mineralized rock. Unsurprisingly France is pushing 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 a 2022 IRA, just possibly might have helped US-made solar PV to become, globally-even cheap-ish; yet changes to IRA in 2025 rendered many 2022 IRA provisions a moot point. Changes to 48E/45Y of 2025 changed a great deal. In short uncertainty reigns in clean energy so its no surprise to see huge volatility in clean energy stocks. To predict what is ahead here, regardless of election outcomes or indeed any big things (tariffs etc?!) else, is like equities in general, an ever-Impossible task. Still, some review & analysis here can be useful.

Take level & direction of Fed Rates, since these do influence clean energy's theme. Look at Federal Reserve Economic Data (FRED) for US Fed Funds Effective Rates 2020-2025. From a Fed Rate of 1.55% in Jan. 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 from a 0.08% in Jan. 2022 -- to a once-normal, yet felt high >4.5% in 2025. We saw clean equity falls, not so surprising during that spike. Central banks do have to head off inflation; just was, they'd responded much too late to gathering inflation. It resulted in a few years with some of the fastest interest rate increases seen, in well, nearly-ever.

Let consider interest rates further as they mean a lot to clean energy's (& equities) theme. Short-term rates, set by a Fed, get headlines. But crucial too are the 10-Year Treasury bonds, so-called 'notes' (as briefer in duration vs. eg, 30 year bonds): these move differently, instead are on market sentiments. They also mean a whole lot. In 2020 key '10-years' remarkably had sat <1.0% when ECO jumped +203%. But afterwards from 2021, 10-year notes then *rose* next 4 years. As a Fed finally eased short-term rates a bit in late 2024, 10-year Treasuries did *not* respond same: they at 1st rose! To psychologically key 4.50%. If they go past say >5.50% ahead, that can make far riskier equities here hard to justify. Or, if it falls under <3.5% (on strengths; not on a recession!), that may possibly re-ignite animal spirits, renew interest in potential returns at volatile themes. see eg, 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 ugly in clean … & all energy. Yet looking back to try divine a bit what's ahead -- is of little weight, in 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 only glance at such a thin-gruel bit of a past, and then try to guess (and be typically quite wrong!) about the future.

Confounding all too, is an impressive pace by which renewables are being installed, records being set for new $$$ going into wind, solar, grid, etc. Global low-carbon investing had hit $1.77 Trillion in 2023, up 17% from 2022. How can this theme's own stocks so plummet, go down for years, again over 2024, as clean energy grows globally?! We'll look at that curious fact ahead. Just brief mention here, is that as margins compress, as new energy prices fall -- profits have been hit hard. Meanwhile, longer-planning China 'ignored' overcapacity fears via unshaken policy support; it aims for ever greater market share, ever-lower prices + full employment. Unlike the West, where seeing near-term profits is a prerequisite.

US, Europe projects are pushed out too by interconnection/transmission (IX/TX) chokepoints. Demand is very strong, yet grid growth has not been enough. 2023/2024, 5-year load forecasts grew 450% from 23 GW, to 128 GW; interconnection approvals were seen to grow ~5x in 2025, good, yet not fast enough. Other issues vex west: Start/Stop inconsistent policy support like moving from US IRA tax breaks in 2024 -- to slashed in 2025 (unlike China). Ongoing scarcities in west like say, high voltage transformers, poor grid capacity, lack of domestic lithium, minerals, processing, US wind incentives in IRA cut much back in 2025, etc etc. Even with IRA slashed from 2025, a few policies may help. Or, this sector may decline not only on repeal of a once-favorable IRA -- but also on the pure economics, on bearishness, sector declines, poor prospects here. A revised vision of poor profitability. We discuss such thorny factors ahead, as may be some diverse reasons green energy dropped hard of late. Including huge broader falls in 2025 on new tariffs far larger than were expected. On draft versions of the 'one big bill' that slash incentives after 2028. And on a mountain of new US national debt.

Broadly, at least 15+ factors were at play in clean energy's bearishness in 2021-2024. *Debts were then up sharply in US, Europe, China; and *Inflation in West, as *Interest rates, cost of credit jumped; *Hopes of margin expansions/profits in PV, wind, EVs etc were dashed. The *Funds & Rules needed 'yesterday' were too slow to come from agencies. From *2023, 100+ US residential solar installers went bankrupt, 6-fold prior 3 years, US residential solar installs fell ~15% in 2024, California was down 40%-50%. *China's big Overcapacity in PV, EVs was sticky so bubble fears; as *Supply chains were clogged, despite less demand. *Big-Caps did better than Mid & Small-caps, as *Speculative disruptors faced poor sentiments especially for growth vs. value: *100+ SPACs since 2020 diluted investing. *Ongoing China/vs. Western Tensions threatened to decouple strategic green trade ahead. *Then a president's re-election to 2nd term meant IRA will be fast dismantled in 2025. *Science/efforts on climate would likely soon be silenced. Soon ahead too, tariffs, trade tensions, green energy hit in 2025.

On other hand realpolitik meant 'move fast & build things' places like Texas (and China, now designing solar PV for space!) -- were way-out-performing say California in renewables. Latter place talks of climate, but on 'Build Absolutely Nothing Anywhere Near Anybody' (BANANA) policies, less renewables get built. Decarbonizing grows faster via a new energy abundance -- than by BANANAs. Much faster progress needed in crazily-costly-electricity UK: it can make blades at Siemens plant in Hull; Vestas plant on Isle of Wight, blades exported. JDR of Britain, Sumitomo for high-voltage cables for offshore wind. Seah, steel for offshore towers.

Not yet well-understood in the west, are China's efforts from 2025 to begin to rein in excess capacity that harmed profits in EVs, PV. Like steel, limiting of capacity needed. Xi Jinping bluntly stated provincial governments are overinvesting. So nationally it has 'pledged' supply-side restrictions, amendments to a 1998 law on pricing. To strengthen price limits, cut unfair pricing behavior, curb 'involution'-style (oversupply-based) competition. Aims to curb market dominance that influences prices (sold irrationally below cost). To create accountability for price-related violations. China's overcapacity in EVs, like in PV, means Beijing has massive excess capacity, but lacks domestic demand to sop all up in key green 'emerging future industries'. Overcapacity harmed profits; by 2024, 25% of mainland China's listed firms were unprofitable -- vs. just 7% a decade prior. China ramped exports in search of demand, yet so exports deflation, hitting profits everywhere. Thus, US & Europe are now pushing back.

Or, look at wind's unique troubles, as yet another facet here. Even back before a president's animosity against wind in 2025 resulted in stop orders of 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-far-too-many tower designs, over 40+ in 2021, were cut to 9 by 2025. Rotor options cut from 15 to 4. All in hopes then 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 US / California offshore wind from 2025. Wind permits were revoked, even those already-permitted in New York, Rhode Island. Maybe Maryland too. All 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 then had been relatively-speaking, easily cheapest power. Those 2 could make electricity for around just 9 cents per kWh. That $.09/kWh cost, for coal or gas was then far cheaper than competing wind at $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's assuming one could even obtain scarce gas turbines to build. If one hadn't already secured turbines in contract in 2025, it may be early 2030s soonest before a gas-fired plant could be built, go up and online!

So mainly on huge PV supplies from China + thus 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 possibly '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.

A 3rd fossil fuel, oil, was fighting a different also losing battle over the long-term, based on physics. A fastest 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 a 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 out as 100% efficient from the go. They can, 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.

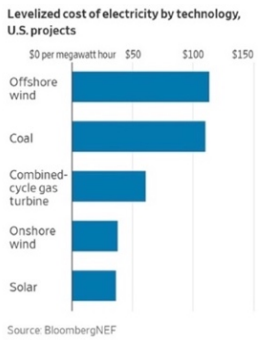
It's not-so-hard to see why fossil interests late-2020s saw threats ahead. With electrification, their goal may be as much just to ensure their products will go on seeing demand, as a past usual aim of less-regulations. A key issue for them is fast-falling costs for EVs, clean energy -- China's deflation 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 decline 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%. Zero carbon nuclear @14%. But UK was also badly de-industrializing: its costlier electricity imports were much too big @14%. Biomass 6.8%; solar 5%; hydro 2%; storage just 1.2%. Its last dirty coal-plant in Ratcliff closed 2024, coal fades from 0.6%, to nil. Yet on too-high electric rates, the UK is importing far too much electricity -- with costly natural gas (like from Norway). At issue too is its 'Contracts for Difference' (CfD): a low £44 per MWh offered for offshore wind 2023 got No takers, that 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 early 2020s -- to the 50 GW target capacity by 2030.

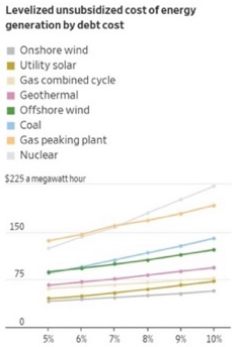
UK has suffered from stop/start support for wind, falling energy production; an old/poor grid; onerous permitting; little energy storage. For instance, on 10 Dec. 2024 forecasts were for 2 windless days: output may plummet from >7 GW to 2.2 GW. Prices rose to £175 MWh, steepest in 2 years. Meant more 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

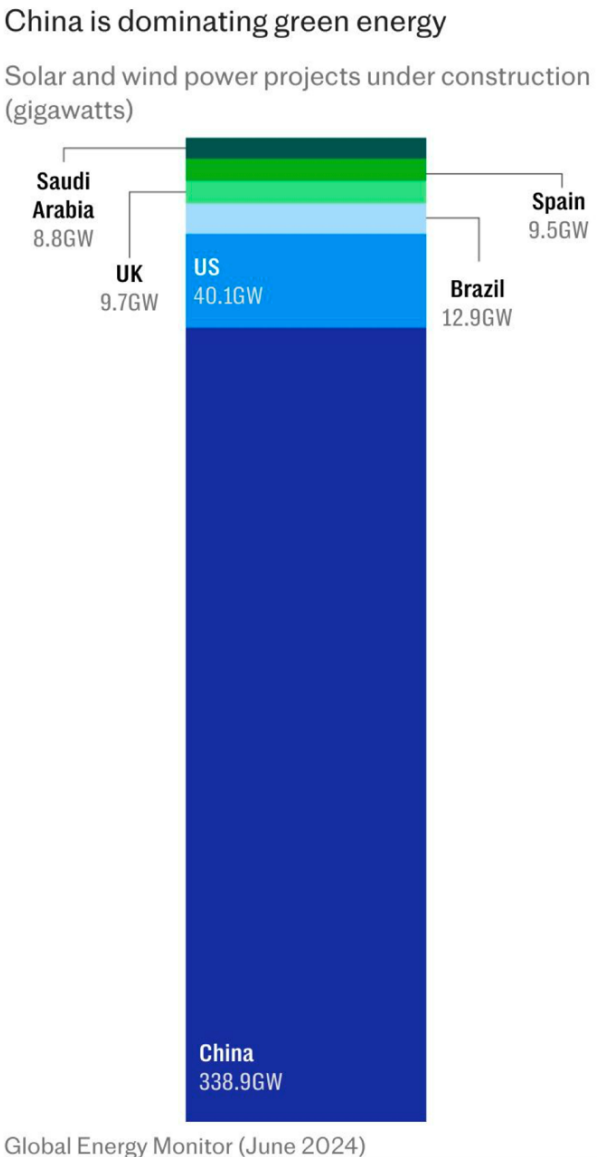


Source: Lazard, Roland Berger, WSJ.

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:



Seen at left, wealthy Saudi Arabia in 2024 poured efforts into building immense solar, given ever-unending sunshine, 'limitless' deserts, need to prepare for when oil & gas are no longer in demand. It aimed to get 50% of its electricity from renewables in just a few years (2030?). But its bar for 9 GW left at top, **in deep green,** is here thin.

Spain is much-acknowledged in Europe for growing its solar 'fast', already is leading in utility-scale solar capacity (30 GW); though wind growth there is slowing. Yet their ~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 de-industrialized, less-demand, its oft-imported, priciest gas is ill-suited for baseload. Nuclear sees immense cost over-runs, delays. And its grid charges nationally very high rates set by a priciest (often imported) LNG. De facto wind bans, with support for it in fits & starts. Much better is now needed: in its grid, to streamline permitting, more renewables, and a 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.

As one considers 338 GW going into China above 2024, 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.

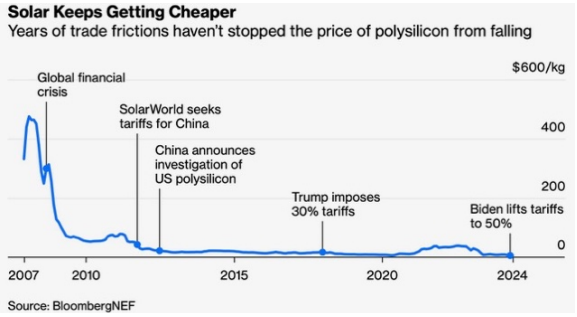
Moore's Law famously shows number of transistors placed on poly chip doubles every 2 years. Such is the room to advance on a silicon base. In China's case, it had faced around year 2000 many vulnerabilities with few oil reserves, and oil price spikes. Its government chose instead to target new poly/solar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

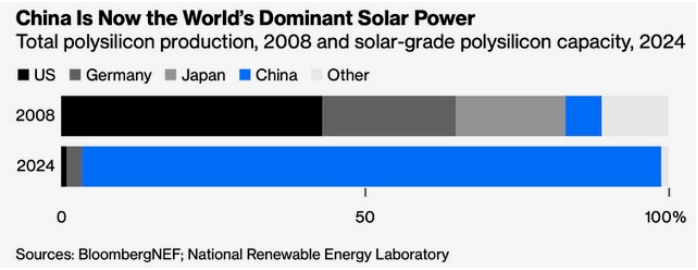
Early 2000s global poly industry grew: that US PV poly producer invested to grow capacity. By 2005 it announced plans to invest $400 million, later, another $1 billion. A lot. But consider too that near 40% of costs in making poly, is the electricity costs. Michigan is industrialized and boasts huge 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.

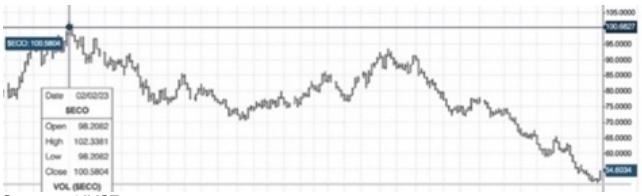
Next for data-lovers, are math parlor-tricks, a few coincidences discoverable in clean energy's story given so much data. Of mild interest only, thanks to ECO calculating live 20+ years. Take a volatile 3 down-years: 2021, 2022, 2023. Clean energy's story, tracked by passive ECO saw very 'steady' declines. 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 in a 3rd year at What would be the 2023 High in clean energy story. That high, 102.33 (intraday) was only early-ish that year: Feb. 2, 2023. Of mild (but bit more) interest: might it then be a rather symmetrical fall in clean energy's story, -50% in theme; maybe hit next nadir -½ low late in 2023 at near rounded figure of 51 (or intraday low 51.16)? A head-scratcher was how close to that, was born-out. Next page left, is theme high 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 was falling fast towards (past??) a 'conjectured' 51 low: it hit 53 on Oct 23rd; again 25th/26th. Then hit 51(.62) hard on 27th. Plummeting, felt like a 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, nearby 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 curious coincidences may be discerned in a sea of data. Next, this theme did hit a low on Nov. 1st for a 3rd time in 2023, and that 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, the short-sellers were then attacking solar, wind, EVs, fuel cells, hydrogen etc hard; one could guess a 51 might be re-tested, or soon fall into 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 did Not (yet) fall into 40s, nor bust a 'just-for-fun' conjecture of -½. Lane opened for maybe, Rate *Cut hopes* reduced concerns. Theme leapt into 60s, a big jump, yet arguably was premature, as hope in 2024 went from 4 cuts -- to maybe 2, or less. Looking back then, 2023 saw just 1 of 3 'AND' factors: a low near -50% clearly fulfilled. While a high near year start, low at end of year, or 2 of the 3 factors were Not fully-fulfilled.

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

Indeed, that past was extinguished, shattered. A 2025 high (so far) came well late, in 2nd half of year. Low for 2025 was seen (so far) very early-on, in early Q2. Hence 2025 unfolded far differently! With a new very different president, and congress & far different legislation ('one big' bill) -- with performance opposite of steady falls, declines from high at start of year, to low at end of year. Thus broke steady down trend seen 3-4 years in early 2020s. What will come in unfolding year/s shall be interesting. (A small side-question, is might sheer coincidences of pretty steady falls fulfilling all 3 'AND' factors like in 2021-2023, resume in future? Highly unlikely given how very even and steady those annual -50% falls had been)! Steadiness 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 a certainty some leaders then felt its grid was firm 2024 -- that is sure to be challenged by hurricanes, weather extremes ahead. Even in a Texas 'normal' Summer 2023, all its thermal plants had suffered from intense heat. Its fossil fuels & nukes were forced down in planned -- and unplanned maintenance. All traditional plants are impacted by such intermittency. Not what fossils/nukes want to pin on solar (that it 'won't work if cloudy or 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.

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

Bloomberg New Energy Finance (and NEF partnered with us early on in creating the NEX) has noted that end of 2020s so in just few years, the US may build 600 gigawatts (GW) new *solar, *wind, *energy storage capacity. BNEF points as new impetus to Inflation Reduction Act (IRA) discussed ahead: may go over $1 trillion plus other support. Yet there's big hurdles to 600 GW: *costs of capital, *inflation, *supply chains, *slow permitting, *antiquated grid: all impediments to growth this decade. Still leaps compared to past. It had forecast 358 GW of US solar capacity 2023-30, near 3-fold total US solar capacity seen 2022. They foresaw 137 GW new wind capacity to 2030, near 2x total wind capacity of 2022. 111 GW battery storage capacity to 2030 -- 9x gains over 2022; starting from low base yes, but growth. Fact is, US in 2020s badly lacked grid capacity for growth. So perhaps too $83 billion in grid investments; yet even that would be $172 billion short of spending needed if US is to reach 50% emission cuts by 2030. The IRA is mostly a package of tax breaks, incentives; it's NOT a strategy to decarbonize; mainly carrots, no sticks. So some green growth; but 600 GW still falls well short of achieving US targets of 50% cuts in CO_2 emissions by end of this decade.

Looked at another way, on 3 big Federal laws since 2022, US may double its recent pace of decarbonizing – to hit 4%/per year *fewer* emissions by 2030. That 4%/year of cuts, brings down emissions by 40% to 2030 -- but that rate still falls short of 50% emission cut then called for by White House. A 50% cut is what's needed to stay <2 degrees C heating, and 50% by 2030 may tee up US for net-zero 2050. But a 50% by 2030 means doubling, or 2x our fastest rates of new solar/wind to 2030. Then, growing pace more, 3.5x in 2030-2035. To achieve that pace, we'd have to act *now*, cut CO_2 not 4%/year -- but 6%/year to 2030. Then, speed up cuts even more. While not now in cards, especially after 2025 cuts to IRA, it's technically do-able. Thus, no surprise clean energy spilled into American politics 2020s. Criticisms rife. Some critiques, accurate. Such as far *more* US minerals are needed to decarbonize US & electrify -- vs. a fossil-economy; that few minerals are domestic-sourced. True too: electrifying heat will be costly, heat pumps vs. furnaces: but then, costs equalize too on efficiency. And yet many other harsh criticisms, aimed at clean energy in 2020s, were far less accurate.

For example contrary to politically-driven claims, clean energy *help to reduce* energy costs -- *renewables can be Deflationary*. An Australia that had clung to coal, resisted new energy -- is seeing change as renewables surge. PV output up year/year. With less need for costlier gas, its wholesale power prices did go to zero or negative, 12% of time; 9 am-5 pm in populous Victoria & in S. Australia, negative 55% of time. Yet, negative prices disrupt all; old-energy incentives in coal too. Power prices are set in day ahead markets next 24 hours, so if there's excess ahead, they'll bid 'negative' prices, harming themselves (harder still on nukes & coal plants that can't easily shut down). By 2025 over >40% of freestanding Australian homes had PV, >18% of electricity & it began to make sense to heat water in days on excess PV. Just as wrong too, have been critics who've claimed that EVs must-forever-be-too-costly: China has <$10k EVs with 200+ mile range. Other criticisms perplex, like skeptics who claim since climate has always changed over Earth's history, it will go on, and pro-renewables tax policies are bad: perhaps that's on mis-understanding the science. Such skeptics' arguments may in future retreat just a small bit -- but for certain not yet! Skeptics and climate deniers remain vocal in so many ways. The 2024 election results in US and red wave reflect that.

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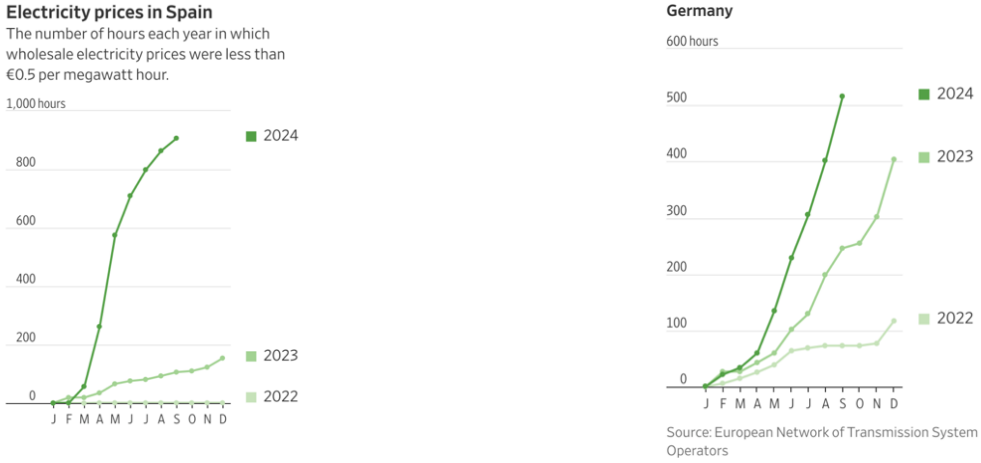
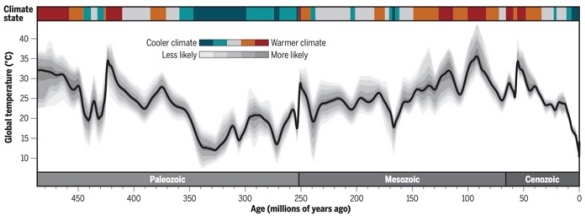
3 Charts below on newer data, are a bit startling for what they imply, what one may infer. A 1st two show how some consumers in Europe mid-2020s, lately can take advantage of (at times) negative electricity dynamic pricing. In most US (unlike EU) consumers can't access dynamic pricing. (Some US states 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 to a bigger 6%. Places with lots of renewables, can get higher/ 'better' (for consumers): was 8% in Netherlands, 11% in Finland, 12% in Spain. Also shows 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 utility-scale solar meant went negative ~20% in 2024. (A downside was 3 million megawatt hours curtailed 2024, could have powered half a million homes -- but that was on lack of energy storage). Windy Iowa US, may see wind power going 'too cheap' at times as a boon for its consumers on windy days & nights. The 2 Charts 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 a three years to late 2024:



Source for both: Wall Street Journal

Lastly, step way, way(!) back for 3rd Chart: remarkable reconstruction, newer data of Earth's surface temperatures past 485 million years 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 at a horrid 42 degrees C (107 F): life endured extremes. Refutes a natural ceiling on how hot it may get. Had it looked farther back, would have captured too a snowball Earth of the Cryogenian: happened twice 710 million to 640 million years ago, lasted 10 million years each maybe due to Earth's rings, or on less volcanic CO_2, or absorption by rocks -- so CO_2 can also go 'too low', extinction events. Over a past half-billion years, Earth's temperatures were thus 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' progress in wind & solar is ruffling some politicians' feathers but saved that grid. State is conservative, yet its private sector is growing new energy 'fast'; bit akin to a Portugal of 2023. Portugal's solar in 2023 had met 7% of demand (like then Texas), wind was 25% of electricity, about-Texas levels. Yet, they're different. Portugal's far greater hydropower met 23% of demand 2023: in 2025 it was 40%. Both Portugal & Texas were in 2023 near 7% solar/25% wind & growing. Yet in Europe natural gas is pricey, non-secure, nor-domestic, far less used vs. Texas, so by 2025, Portugal was 90% renewables! Portugal's renewables in 2023 were 61%, up from 50% in 2022. Portugal benefits greatly from hydro (unlike a flatter and arid Texas) as year to date to April 2025, Portugal's hydropower met 40%; wind met 29%; solar 8%; biomass 9%; all near 85% total. Its natural gas just 11%, and dropping. With biomass, renewables may hit near 100% early 2030s. So Portugal is growing its own clean energy much faster, and yet Texas 'wins' in context of just US, that is moving at a far-slower pace than is Europe.

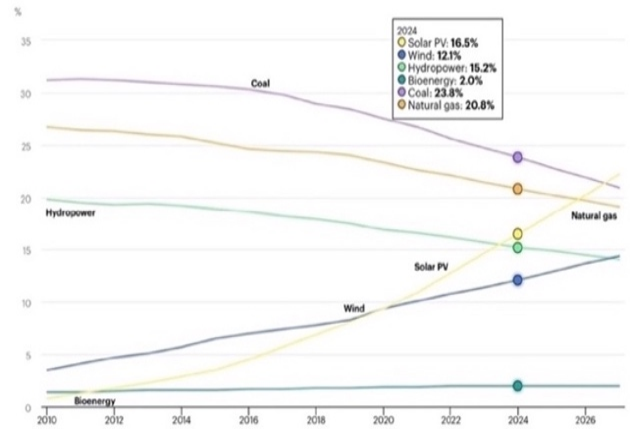
Still, via climate lens it's scary: nowhere, is clean energy going fast enough! Everywhere, sees decarbonizing setbacks. On unending human CO_2 it won't be 'just' 1.5 C hotter ahead; not-realistic. In 2023, China & Saudis refused to raise 2025 targets at a G-20 ministers meeting. China was 196% of increased emissions 2019-2022; 1/3rd of all emissions. Even per-capita, China was 3/4^{ths} of increased emissions, it ok'd 50 GW of coal: 41 GW announced, 8 GW of 'shelved' coal revived. On that coal alone, any optimism for our Earth is unfounded.

Take UK that once had led on wind, but in 2023 chose oil & gas. It sought then even if at 'net-zero' in 2050, to get 25% from oil & gas. Hopeful UK offshore wind deals were cancelled 2023 as a Party then in power, felt wind won't pencil on capital costs. Underlying was a belief that putting off climate action, was 'pragmatic'. But, *that was wrong;* renewables *are tangibly cheaper*. Spain's new solar in July 2023 met 24% of demand -- up from 16% in 2022. In Sicily, ½ excess demand on hot summer days was met by new solar. 2024 a new UK Party took power; a 1st move was to end de facto ban on new onshore wind since 2015. It faces though de-industrializing threat. A German/Spanish wind giant had giant losses, announced a €2.2 billion charge on wind turbine troubles, a net fiscal year Loss 3x that expected. Markets had valued its wind unit at €5.5 billion; after, near-zero valuation. Wind was pared back worldwide early-2020s; fell 20% 2022 from prior year; saw 32% less growth than a record 2020. Oil & gas though, were different. In 2023, 20% of oil & gas projects slated to start in 2023-28 were at Final Investment Decision stage (FID). Far better than 8% seen in offshore wind; meagre for H_2. Things after improved: a record 12.3 GW offshore wind reached FID in 2023; vs. just 0.8 GW 2022; later 8 Euro wind projects for 9.3 GW hit FID 2023. Clean H_2 saw just $10 Billion at FID stage 2020, 102 projects worldwide -- after, projects at FID rose 7-fold in value to $75 Billion, 434 projects latter 2024; 90% greater FID numbers that October 2023. For sure clean H_2 costs are still much, much too costly in 2020s, but optimists at least are hopeful for 2030s.

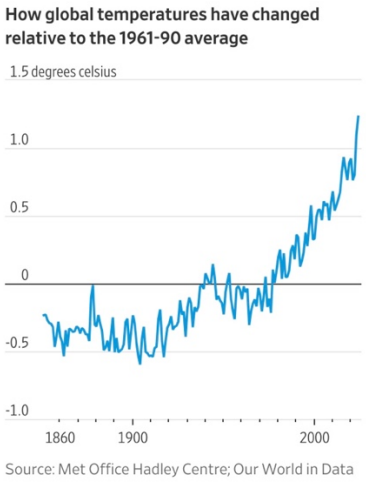
Again, big Texas in US is a case in point. Its gas plants *will* struggle, in cold/ heat extremes -- fuel costs *will* soar at times. Its Grid is far more prone to breaking down, than leaders knew in 2020s. One issue is 'firm' fossils & nuke plants will Fail: like in Texas when gas froze off 2021 and some tried to blame renewables: PR efforts scrambled to call only fossils reliable -- despite facts. Again and again gas will be straining, in hot/cold beyond that expected when thermal plants were built. *It shall happen again!* As weather extremes grow in frequency, they'll challenge thermals struggling in new-typical temps. Greatly adding PV, wind, storage, better grid will help lift teetering lines from failure; keep prices from skyrocketing. Still due to climate, without tremendous growth in solar/wind, storage, transmission, robust grid, a resiliency to help keep renewables firm & dispatchable, *that will not be near enough*.

There's bits of good news. Global solar capacity has been growing 2x every 3 years; works to 10x/per decade! 10 years ago, mid 2010s, solar was 1/10th that of mid-2020s. On 10 years of growth later was up 10-fold. Was like growing planet's nuclear plants 8-fold -- faster than building one nuclear plant in a west! Globally, nuclear divides by geography; 2024-2030 may see 55 new nuke reactors: 61 GW or ½ in China (26) -- rest in Asia & Middle East; 0 in US, 4 in Europe. Newer, safer, smaller modular nuclear reactors -- beyond 2nd gen light water reactors that typified America's nukes built to 1990s, may suddenly grow in US given needs of AI from latter 2020s. 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. 2023 was hottest Sept. then on record, not by a usual 1/10th of a degree -- but by 0.83 F! 2024 was after hottest year on record -- yet it may turn out to be one of the coolest-ever years that a young person now 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.

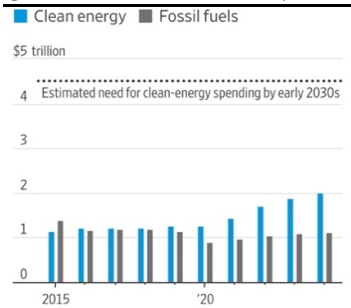


Source, left: IEA, *Share of cumulative power capacity by technology, 2010-2027.*



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's hard to capture natural gas, although an important commodity, in an Index -- that are normally are made up of equities. Gas futures too are more local than oil, location is key. And contract roll over may be a drag on Index/ETF, drift if renewed in contango. Still, for comparative purposes, we (must) use a major natural gas tracker ETF to portray it.)

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

It's significant Earth's CO_2 varied little in a past 1 million years. From 160 ppm Ice Ages (we are technically still in one with polar glaciers) -- to just 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 hard, took thousands of years. Instead, vast CO_2 spewing now in 3 centuries means huge heating is baked in. More heat, sea rises unfolding for tens of millennia+ ahead. On inertia, it may grow 'normal' that there's lethal 50+ degree C temps (122+ F) or future Arctic Circle 30+ C (86+ F). At first, briefly hellish hothouse *conditions* (masked at times by La Nina) -- then after long-hothouse *state*. We don't see how oceans already, terrifyingly, are absorbing heat. 2023 data showed 396 zeta joules of heat was absorbed from 1971 to 2018, in just 1 lifetime. That's equivalent to 25 *Billion* Hiroshima atom bombs and growing. In 2022 oceans saw an added 10 ZJ more heat than 2021, enough to boil 700 million kettles -- every second! The data indicate so much CO_2 was last seen not 1 million years ago -- but instead 14 million years ago; and we may see 600, even 800 ppm in early 2100s.

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

Hence, was remarkable that as war spiked gas prices, more coal was used. In 2020 US natural gas had cost $1.48/million BTUs; in 2022 was briefly $8.00+ or up +400%+! Then fell back hard to near $2.00 in 2024. A Europe that in 2020 was near off coal, returned to it. Short-term, coal = warmth & power. But there's a price burning carbon gathered over millions of years, and releasing it all at once. Renewables may help keep CO_2 emissions steadier (despite coal), even drop a bit latter-decade. *But, big reductions in CO_2*/GHG concentrations are needed. Necessary, with electricity made saner ways than by fossils -- or in a Zaporizhzhia nuclear plant in Ukraine near-shelling of war, with explosives stored, safety threatened(!). Tsk tsk, silly ways to boil water. Ukraine's Kakhovka dam also under threat. So too cables on sea floors carrying information globally, a backbone of internet or power that could be severed.

It's not been a straight line. Nor the same, all places. Europe, for instance in 2022 enjoyed relatively better/lower costs installing solar vs. a US. Why? For starters, Europeans didn't pay solar tariffs like US buyers had to for energy kit from China. Didn't have America's state by state added net metering (NEM) costs. Nor same restrictions on China. Plus, natural gas is a core competing fuel in Europe -- and natural gas there has been very expensive. Mid-2022 was $40+ per Mcf. So, a gas option there was often 3x more than in US -- that helped make any pro-clean energy decisions far easier in Europe. In short it was far easier & cheaper there to install new wind energy & solar in Europe -- than it was in the US in say, early 2020s.

Per IRENA data of 2021, Europe had cut its average all-in installed utility-scale solar costs, by a lot. Germany had pushed solar install costs down to $0.69/watt. Italy to $0.79, UK $0.85. Meanwhile, US was more costly 2021: $1.09/watt. Europe shaved $0.10/watt off install PV costs relative to US. Surely in a world facing unending climate crises, one may think decarbonizing fast is a priority. But No. US champions less regulatory burdens, but it lately has had higher soft costs for solar -- for design, permitting, installation -- vs. Europe's lesser burdens. If comparing like, for like, say 2 systems of similar sizes even putting aside the costs of PV hardware (lower as well in Europe), America in 2023 was much less efficient.

Step back, cost *trends* to install renewables 2020 to 2021 worldwide had as one hopes to see, Declined. More recent inflation, 2022 & 2023 hadn't shown up in those data yet. We'll see that inflation later. Yet looking 2020 to 2021 here, levelized costs of energy (LCOE) for new utility-scale solar, show electricity cost *fell* 13% in 2020/2021 to $0.048/kWh. Onshore wind, fell 15% y/over/y to $0.033 per kWh. Offshore wind, fell 13% year over year to $0.075/kWh. This is significant. Take say, Germany. It has a *potential* to raise offshore wind generating capacity to 81 GW. For rather like ~81 mid-sized current-gen nuclear reactors. Sure, wind is intermittent. Yet to a Germany facing electricity fears, that much new power can be stupendous. 10x more energy, than the 7.8 GW its operating offshore wind had then made in 1H 2022. Put in perspective, 139 billion KWh of clean energy were made by all of Germany's renewables 1H 2022, which met 49% its total electricity demand! Its onshore wind energy had made 59 billion (Bn) KWh; its solar plants made 33 Bn KWh; its biomass 24 Bn KWh; hydro made 9 Bn KWh, and its offshore wind energy had made then 12 Bn KWh.

In 2022/2023 renewables costs briefly rose, in solar/wind. Still fossil prices rose inordinately, so renewables' changes were moderated. And clean can beat fossils in unprecedented ways. Look at average fuel-only costs in gas-fired electricity (no CO_2 Fees) mid-2022: these rose to $0.23/kWh: so 23 cents per kilowatt hour wholesale cost ***for just fuel alone***. Extant, built gas plants in Europe were pricier to run -- than to build new onshore wind or solar on free fuel. When gas fuel costs in 2022 jumped briefly 540% vs. 2020, was no contest. Add carbon Fees in Europe, and 'once-cheap' (not-clean) gas-fired power went >27 cents/ kilowatt hour, 4 to 6-fold more than solar & onshore wind in 2022. No wonder renewables if competing on even-playing field, were obvious choice. Thermals coal, gas, nukes struggled to work in Summers. That said, big hydropower struggled too, given droughts at dams worldwide 2022. Big hydro may have already peaked at ~15%, it will never again be a global growth driver.

In a dozen years, 2010 to 2022, LCOE figure pretty much had said it all. For electricity made from natural gas, costs had briefly hit 23 cents/kWh for fuel-alone, 27 cents with carbon Fees like Europe. By comparison, best-case onshore wind was down near just 3 cents(!) thanks to free fuel -- a 68% cost drop since 2010! Solar PV's best cost was then near 5 cents on declines of 88%! Offshore wind, best case was just 7 cents on falls of 60%. Renewables enjoy free fuel, plus can much get cheaper over time to boot. Was / and it is, becoming No Contest.

As for Russian cheap gas once an EU's chosen path, suddenly it was red letter of shame. Went from cheap/plentiful -- to largely unwanted (yet 18.8% in 2024, after Norway's 33.6%, and ahead of US at 16.7%). A security risk. Russian gas suddenly a liability, weakness. Energy Security hawks wanted all non-Russian gas they could get, even if LNG/vessels meant more fossil infrastructure. On other hand, the Climate hawks wanted immediately to get off all that. To go directly to zero-carbon infrastructure exclusively, now. So, to keep with mainly LNG or piped natural gas, was seen by latter as mutual suicide pact. And, after US global tariffs in 2025, US gas too became a question mark. Still, both sides concurred: Germany & Europe moved from Russian gas. Emphasizes need for vastly more electricity Storage. (Electric storage can be measured as Power, so in watts -- or, as Energy, and so in watts over time -- megawatt/hours. 95% of electricity once was stored as pumped hydro: moving water between 2 elevations. On elevation difference, globally 165 GW could be stored. Or as energy, by how much water in reservoirs; in 2021, 9,000 GW/hrs or 9 TW/hrs. Anyways pumped hydro storage capacity was capped: dams can't much grow, best sites taken. Electricity storage capacity if once pumped hydro -- is not now nearly enough given intermittency & diversity of renewables. Electricity must be used at once, as made -- or be stored. So intermittent sun & wind always will demand very much storage. Maybe green hydrogen, one day as storage too. More storage & a better grid are both keys to unlocking magnitudes of clean energy growth.

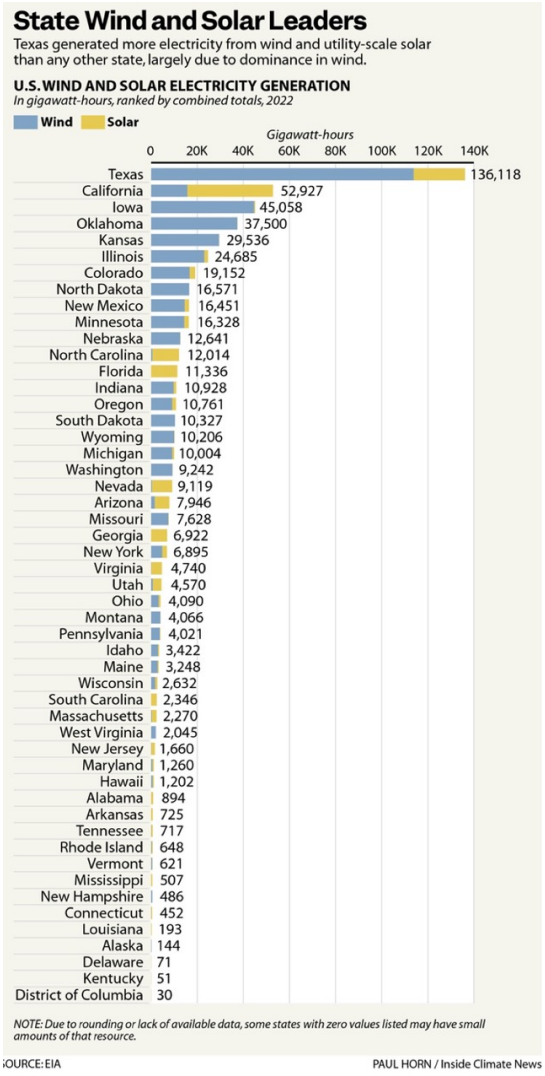
Batteries give just a short-term storage to say 4 hours. Longer-term storage options can hold electricity for days, weeks, months. Yet achieving huge-enough zero-emissions global Storage by 2040, meant new capacity of some 2.5 terawatts (TW) power, 150 TW/hrs of energy. Thus, Herculean efforts are needed, 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.

Folks are excused if they'd assumed California is America's #1 State for renewables. In fact, it's Texas. Many Texas business & local leaders embrace renewables. Yet some Texas political leaders curiously make much of their allegiance to fossils, an antipathy to renewables. Maybe as cheap renewables became a threat to gas, oil, coal, nukes; in 2022 wind & solar made 25%+ of that State's power -- at times it passed 50% of electric power in 2023 -- vs. what was just a measly 0.7% in 2002. Indeed, 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 at top:



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

A 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 might grow wind & solar generation faster? Modern grid infrastructure, using & sharing power with better resilience. 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 2022 (to Aug. 15th) at 6.8% of time -- vs. 4.6% all 2021. Wind/solar had to be curtailed (shut) at times, or it might have been worse. Fossil & nuclear interests often criticize renewables as intermittent, a 'defect' in no wind or sun -- yet they prefer 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, very cheaply/or free. Yes, some $2.5 Trillion in spending by private sector for stronger grid might indeed happen, and for many reasons.

By an 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 has lately become an expectation. 10 other outages affected over 10 million! If uninterruptable power is mission-critical, outages >8 hours more than li-ion batteries bridge. So instead of just storage, think too of fuel cells; they run unlimited long as fuel is supplied. Days, weeks, months. In 2020s, fuel 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 is more efficient, less polluting. A fuel cell is pollutant-free if using green hydrogen H_2 -- no SOx, nor NOx from burning. In such a future, green H_2 fuel may be made from wind or sun plus water, so simple using electrolyzers!

Consider more severe power outages: 3 days impacted 100 million in India on a coal shortage. 7 days out for 1 million people in Canada due to Derecho. 10 days in UK from lightning strike. On 1 day, 120 million out in Indonesia on power line disruptions. Clearly, more & bigger power grid failures lay at our collective doorsteps ahead. Attacks on grids, or on nukes. Scary, is blackouts lasting weeks, months; that may mean tens or hundreds of thousands of deaths. Longer could mean millions dead. Attempts at risky black starts, bootstrap large grids back to operation. Doesn't take much to knock out a grid: few bullets, bit of explosives, a DNS-cyberattack, even just rusty bolt cutters. First 8 months 2022, 107 physical attacks on US grid were the most seen in a decade. It's been an open secret that big, custom & critical transformers for the US grid are generally Not made in the USA; they come from China, 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; in areas for 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 to some conservatives to want a stronger grid '*now*'! Some may embrace green energy. Conservative-Iowa in 2022 got 60% of its power by wind; Kansas got near 50%; Oklahoma close. Yet their Senators opposed renewables stimulus in 2022 IRA, though they increasingly benefit from wind. Later, in 2024, IRA funds rolling out 1st went largely to few key red Swing States in '24 elections. Despite that, a hatchet was taken to the IRA in 2025. Conceivably, after 2028, a GOP Senator, House Members, may tear away from past partisan opposition to green energy. Maybe on new weather extremes, or unpalatable Russian fossils. Catalysts, or sticks that can nudge CO_2 heavy plants to retire. Once-heretical ideas like a carbon-tax, might be re-considered. Or $ Trillions spent on fossil troubles, climate disasters, or war/s fought again and again over oil & gas, may be rethought -- to reframe thinking.

As a consequential 2022 ended, much had changed. An option some had hoped to see shine -- older, traditional 2nd generation nuclear typified in an aging US nuclear power fleet built to 1990s (nuclear is Not in our Indexes) was instead hard hit by problems. One may have hoped France's shiny, 2nd-generation nuclear tech could 'ride to a rescue' 2022 on war. That the French nuclear fleet's know-how could grow output full tilt. Send more electrons to Europe, sit back pretty, be unvexed by slowing or near-cessation of Russian piped natural gas.

Instead, France 2022 was badly handicapped too, ½ its modern nuclear plants stuck offline. Not long ago they'd been *the* poster child for top-shelf Western nuclear. Proud of 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 spiffy nukes built speedily elsewhere? Don't those going up fast, on budget, mean lessons were 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 new 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 & 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.

Built nukes once set to be retired, saw closings put on hold. True, China/Asia & Russia have shown an ability to build big nuclear plants nearly on schedule, on budget. Of 31 reactors begun in 2017 to 2022, 27 were being built using standard Chinese or Russian plans. But, to contract with Russia for a new nuclear plant, now, is impossible. Left China, but future 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 on war.

A not-long-ago 2021, was wracked by record heat, drought, storms, flooding. Yet in just a few decades & maybe sooner, people may look back at 2021 with its miserable heat, floods, cold, hurricanes, rapidly disappearing sea ice, and rising seas -- as having been part of a far cooler, a more stable, and much more desirable past. One that can't ever be recovered.

Data have since made clear too, there never was any hoped-for, post-Covid, Green recovery. Clearly no post-pandemic green moves *away* from fossil fuels; CO_2 emissions first fell, then *exceeded* pre-pandemic by >5%. Got worse 2021, worse still mid-2020s. On climate, we're losing badly. Facts so far no cause for optimism. Not in this decade, nor this century.

2021 + 2022 did flesh out debate on a proposed big US climate spending plan. Outlines of that Gordian knot well known: 2 legislative bills were in play. One was a 'smaller' Infrastructure Bill supported by some conservatives, so Bipartisan yet did near *nothing* on climate -- so was not too-relevant. Less-costly of the 2, yet still $1.2 Trillion(!), it had clear 'pay-fors', revenue sources relative to the past big deficit spending/or tax cuts used by both parties.

Most of the time in politics, debate is on human-scale timeframes. There's a moderate place or stance to stake out -- a middle ground twixt 2 fiercely opposing sides. Common sense, a compromise between sharply opposing views. Singularly, for climate, the middle ground we may so instinctively seek isn't there. Punting for carrots-only, preserving fossils/no sticks, may mean Loser is our common future. A planet that centuries ahead may start to look alien. Perhaps not hyperbole to fear what's lost, was just maybe, could be more habitable future.

In politics, biggest greenhouse emitter China said it wouldn't be at COP26 in Scotland. After a prior outcry China's 5-year Plan wouldn't reduce coal sizably, they'd upped ambitious aims to peak coal sooner. But after steps away from coal -- China was hit 2021 by a severe energy crunch. It grew less certain they could keep peak pre-2030 aims. Seems on coal, little chance -- but for their huge growth of renewables. Plus, rich nations failed in their own $100 billion commitments to transfer funds & know-how to a developing world to reduce carbon emissions, so little reason developing China, India, Indonesia etc felt to offer more. Besides Russia, Brazil, Mexico didn't show at COP 2021: they likewise hardly enthused about rich-world calls there for more 'cuts' soon in carbon. Especially post-2025 as a US pulled out.

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 too, who self-proclaim virtue: a US, Japan, Germany, UK, others. Whose addictions were 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 distant 2050. All conflict with pressing CO_2 reality. On 3 reasons, an eg 2021's COP goals were small beer. 1) Rich nations 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 are mere talk, as was seen in a flailing US Congress and a disintegrated BBB/IRA; and 3) Most blatant, cuts big enough to keep to 2 degrees C heating -- let alone to 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 via 45% *fewer* emissions, a bridge much too far. Simply adding up all 2021 commitments, meant emissions if followed, would drop by oh … umm, ahem, *Nothing!* Instead, they'd go Up +14% *higher* on best commitments of 2021. Canada say, increased ambitions at COP26, yet its new '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 is ok with 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. Left 400 Bn tons by 2022, and since we spew 40 Bn tons/year, to stay under 1.5 C is Not possible; we're toast. On current trends we're passing that 'ceiling'. It's laughable then to think we'd go for years -- then, switch off say 2030 all CO_2 emissions 100% at once. In 1824, Frenchman Joseph Fourier showed how Earth is warmer, than a planet without atmosphere. In 1856 a brilliant US scientist Eunice Foote noted how CO_2 warms the 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 will heat the planet's climate. 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 power law for second, temperatures to rise as a logarithm of CO_2. In 2024, Fermi Resonance helped 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 a 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 already had 250 GW of solar power capacity, nicely 2x what was called-for in its earlier Plans. It could boast 1/3rd global solar capacity, due to its domestic China demand with reverberating benefits planet-wide. And yet.

Consider what's possible at high end. In theory if all China's areas that could easily go solar, had it. In a 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 7.5 PW/hrs of Electricity Demand (or 2x then-Total demand all energy with heat). By 2060 as solar efficiencies improve, its solar potential might rise +50% more to 150 PW/hr, when China plans for net-zero emissions. ½ its potential solar-areas already capable of PV as cheaper there in 2020, than coal. 80% of its solar areas could be cheaper than coal in 2022. As solar improves more, 2030, solar can be cheaper than coal -- across all China! It's solar costs had averaged 4.93 cents/kWh back in 2020. Costs were projected then to drop to 1.3 cents/kWh by 2030. Then solar could get cheaper still, down to 0.3 cents/kWh by 2060! If a price is put on coal pollution, say carbon tax, cost difference gets immense. And so, coal cannot compete ahead; all sides know that. But coal means 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 storage + solar can be 100% dispatchable then; by 2030 a projected 5.2 petawatt-hours of solar+storage might be available in China. All that could be cheaper than dirty coal, too -- and be near its 7.5 PW total demand.

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

Looking back a few years: it may have been lucrative to have 'gone into **Photons**' then, or solar, one 'P' (as China did). Look ahead, another P, **Protons** are riskier; energy storage & energy conversion that use protons (ions, H+) in H_2, fuel cells, *may be* propitious ahead. But that was unknowable 2000s, with huge volatility. What is certain, is 'protons' theme in 2020s *is still hugely risky*. Much more so than surer-solar. Solar is steeply cutting its costs, and on modern manufacturing gets ever cheaper, like semi chips. Energy conversion/via Protons, is different. Vexed by uncertainties, many breakthroughs still needed to harness protons (eg ions by 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, green H_2, ammonia, methanol, far more a wild card. Thus, renewables like solar/wind, with storage, may pervade ECO. Other areas may resist easy decarbonizing.

A wilder hair late 2020s, was *potential for* nuclear fusion. Put aside attention to H_2, fuel cells, PV, batteries a moment. Instead, focus here on neutrons: to fuse 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 common helium (^{4}HE). Critically a 3rd neutron is 'destroyed'; on Mr. Einstein's $E=MC^2$, mass imbalance is immense kinetic energy: 17.59 MeV mass disappears! Immense energy, no waste! But other issues like overcoming Coulomb barrier positive ways, inertial confinement at temps/pressures mimicking sun's core, mean latter half century at soonest before significant applied fusion is on grid. It's been lately said, energy-positive -- but in fact, 100x that ignition power was used by lasers -- so is yet far from it!! Next century, it *may be* a new addition. But on climate risk + energy security today, much faster growth is needed in renewables; in solar/wind, storage, geothermal too, 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 began mid-2021 as Russia suddenly exported less gas into Europe, than prior typical 80 million cubic meters (mcm)/day. Russia lowered its gas exports to Europe in July '21. Lowered again 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 piped 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; get more Norwegian gas -- and/or import lots of 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 could get in 2022, plus to build storage. Especially if colder than usual winters hit in 2020s. If sparse breezes make less wind power, nukes down on maintenance, coal emissions tough of course -- before Germany aggressively has much more renewables in 2030 -- so could get newly tight. Late-2020s could for example see less maintenance at Norway's gas platforms, pipelines, lead to a 65 mcm/day shortfall, about a 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 Zaporizhizhia nuke in Ukraine.

Sparse breezes early 2021 had hurt Europe's wind, nukes down on repairs, hydro in drought. All had meant unhappy records in 2021/22. Europe's natural gas benchmark spiked up +300%. Gas futures in Netherlands basket rose to equivalent $150/barrel for oil. Early 2022, gas rose past equivalent $500/oil barrel(!). Made Europe's gas prices then early 2022, dearest fossil by far. Ireland's electricity costs late 2021 jumped 10x in a 7-hour period on gas shortages. Gas so tight 2021 in Iberia, electricity hit $165/MWh, worst since 2002. UK electricity prices briefly rose 2x, so 7x a 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 power from France. (Watch out, undersea cables!) On good breezes like 2022, UK can produce most of its power at times from wind, very cheaply; on few breezes, UK wind's 24 GW faceplate capacity -- could fall <1 GW. Europe's gas once was cheap: it was Russian. But 2022, Russia's gas became a question-mark; might 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; with Europe using more nuclear. The calculus anyway did soon change, when Nord pipe was blown up by mystery forces. By 2023 Norway supplied 88 bcm gas to Europe or 30% of its supply; the US supplied 56 bcm or 20% of its gas thanks to a fast LNG ramp.

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

The 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, costly, interest rates matter.

All alternative energy forms (especially never-cheap nuclear!!), are impacted by interest rates. Development of nuclear, big solar, or wind, or grid etc requires big investments. So it's helped when interest rates are low (near-free-money), hurt when high. Thus sentiments matter. Valuations seen in P/E (price/earnings) ratios, what market conditions may be ahead, too. Looking forward a pessimism may arise when a metric say Cyclically-Adjusted Price Earnings (CAPE) rises to 40. This CAPE calculated since 1877, notably hit 40 in 1999 dot.com frenzy and we recall how it ended. Soon afterward S&P500 fell by -40% over 3-years in dot.com plummet. Took another 13 years for that S&P500 to once again, to re-reach prior levels.

Consider then, from 2022, high interest rates were one headwind hurting equites. Not long-before investors had got near-Zero % from bonds. So demand grew for higher-risk themes, better-returns at times. Very low real rates in 2014-2018, had meant inflation-adjusted 10-year Treasury yields were just +1.0%. On Covid, fell to *negative -1%*. As P/Es rose, from their 'common' 21 -- to a 27, CAPE went from its normal 20s -- up to a yikes 38 in late 2021.

Rate hikes were bearish for stocks. Tough too for developing renewable energy projects, or a big ticker nuclear. All fundamental points in 2020s. For Dec. 2024 CAPE had reached near 38 -- a 3rd highest point while in a bull market since 1871. Only 6 times before had CAPE gone over 30 in 153 years; and 5 of those times, Dow, S&P500, and/or Nasdaq subsequently had declined between 20% and 89%. So, a high CAPE = was maybe some reason for concern! In 2025, a newer look at CAPE did reassess it in light of just-current- components. As deleted components removed from S&P500 can skew CAPE long after removal, looking instead at only data for current components, the revised calculations since spike of 2000 -- saw CAPE in 2025 with then a smaller 2nd rise. Also had been modified on changed corporate payout policy. On this view of a 'current components' CAPE, valuations were (perhaps?) a bit less alarming.

Yet brings us though to high CAPE P/E figure seen again in Sept. 2025, at around 38. Such an elevated level is reason for concern. Compounded by the fact since April 9, 2025, stocks had been on tear upwards to then. And at a 'plain-vanilla' S&P500 P/E, we noted that on Sept 22, 2025 it passed 30, statistically-a-worrisome number for it. P/E ratio calculated on all expenses and counting official profits already in books, only. (S&P500 Index divided by GAAP net earnings as posted in the prior 4 quarters, only). Net result is that this P/E valuation too is worrying; it implies big cap stocks are now very expensive, historically. Even more worrying here in green equities, given clean energy so ECO Index has rocketed by some 60%, 70%+ to Sept. 2025, since a 28, just six months before. That bullishness at the P/Es in components, makes them very-richly-valued. Reversion to mean, down, looks notably scary.

Not to say, one foresees a fast-souring economy causing big drops. Or, inflation is next trigger, downwards. Still, if a threat is Not of 'Unprecedented' inflation, for was far higher in 1981 -- maybe it's inflation that takes root, grows hard to kill, rates higher for longer. Inflation is partly a state of mind, psychological. If expectations take root for higher rates + a stagnant / sluggish economy, it can mean stagflation; Fed tools are wickedly un-useful in recession. No central bank aims to hike rates, going into recession, economy cooling. Equity-risk premiums for riskier stocks (vs safe bonds), can makes equity decidedly unhappy place to be. 1970s-types rates were something young generations don't viscerally remember. In decade to 2022, no G7 central bank had its rates above 2.5%. But in 1990, they'd all been over 5%! High rates decidedly not a great time for volatile, high PE green themes. Can make an 'entry-point' tough; for it's impossible to consistently time markets. A CAPE near 40 also scary. But far-scarier arguably is a climate crisis, with sea-level rises too causing destruction.

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 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 gas producers did Not financially benefit. They simply didn't have product to sell in such 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 of available unfrozen gas supply as prices were then skyrocketing.

Normally gas producers sell product at around $2.50 per 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 continuously supplied gas -- to make & sell electricity were flummoxed. They'd anticipated of course an ever-ample feedstock of gas. And had 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 2022, 2023, 2024 etc smitten by diseases, wildfires, temperature extremes, blackouts, we increasingly see evidence that the global economy is a wholly owned subsidiary of the environment. Yet to notice climate, doesn't mean smoother sailing ahead; no nation has yet risen to the occasion. And for 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. In Rare earths too that in fact aren't so rare, yet are 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 used 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, 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.

Global Clean purer-play NEX – vs. competing Not-so-Clean Index theme in Big-Caps:

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 was that other Index was maybe fine choice if wanted a concentrated basket made of big caps only; narrow with little to no energy storage, no electric vehicles, no green H_2 etc. Because that other basket was so highly concentrated in big caps, skewed to a not-so-clean -- it differed very much from NEX made of clean, pure-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, the clean zero-carbon ratings in NEX are far better, and more deeply green -- than in that other 'only-cleanish' Index. NEX is also steeped in diverse new energy innovation -- so it's unlike an older GICS (Global Industry Classification System) 1999 nomenclature that put other global basket very heavily into brown, what GICS calls "Utilities". But, if one wanted only a not-so-clean, narrow concentrated, 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 most key divergence is: 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 2023 & 2024, NEX did out-perform that other 'not-so-clean' Index; the NEX is down less, -10% -- vs. other down -50% (perhaps as on times to the upside NEX may do better). Over these long periods, this key fact clearly stands out: *the Global NEX (via tracker here in gold) is very strongly is Outperforming vs.* ***other Index,*** also for a global clean energy theme **(as seen via its tracker bottom in black).** This persists for lengthy periods, whether since near tracker inception (seen here), or the past 20 years etc. This chart captures both Indexes via live trackers, for all data from start of that other Index (it went live after the NEX) with tracker so for 2009 -- to end of 2024. Interesting to see how divergent performances are, for the 2 Indexes/tracker funds. *In sum the global NEX, here in gold clearly does far 'better' -- although both end well-down here in this period:*

NEX tracker (gold) vs. not-so-clean global energy theme (black): 2009 – to end 2024:

Source: Bigcharts.com

As seen above, clean NEX has Outperformed, does some 20%+ 'better' -- *though both down*. **NEX** may go up much more strongly rising periods; yet NEX drops hard/er too in downturns. Why, perhaps? 5 factors may help explain why that other theme, is here far behind the leader **NEX** for global clean energy. Perhaps it's because 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*. *For example that other Index did much better in down years, like 2021-2024!* Also it's a good contrast -- purer vs. less-clean global energy themes! For other differences as between purer global NEX -- vs. other global energy basket, the NEX launched/went live first, 2006 -- before that other Index. Seen say early 2021, NEX had 125 components. That other global basket instead, for years since its inception, long had had only 30 components to 2021. Just 30 didn't allow real clean energy scope at all. So, wasn't possible for it to then capture stories across EVs, green hydrogen, storage etc etc.

Weighting styles, matter greatly too. That 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 a *clean* energy theme, instead in a 'cleanish' energy, 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 as small cap funds grew popular, how big inflows had made it hard for active funds generally to hold small equities. Even a $1 billion(!) market cap stock was liquidity risk from inflows. So the 'small cap' definition inched up, towards a >$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 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 obtained by Equal-weighted NEX -- vs that Market-cap weighted Index over long periods. As was observed by *The Economist*, at right in 2021, a model portfolio constructed Green Index seen here when straight Equal-Weighted, very nicely doubled; it went up swiftly from 100 to over 200 in 2020; thus went up over +100% … But its 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, is floor $1m average daily trading value (ADTV)/$750k continuing components, look at severe risk ratings, ***and*** carbon. In sum the NEX/ECO & new H2X/WNX are green, avoiding a '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.

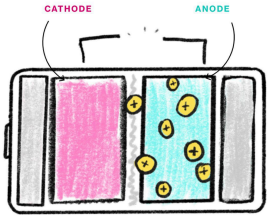
Great uncertainties abound, giving rise to volatility, tremendous risk. Myriad sub-themes *may* see advances: some incremental, some may be non-incremental, perhaps disruptive. Advanced green energy storage & batteries plainly merit focus 2020s, areas ECO & NEX have had exposure to for over 20+ years.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

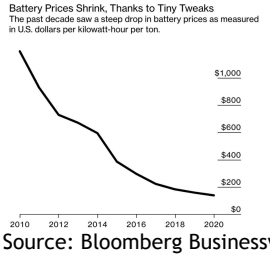
c) NMC as seen in a Nio:

Source: Bloomberg Businessweek

d) Tesla 3 has used NCA:

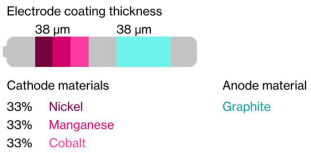
Source: Bloomberg Businessweek

Battery prices are falling hard:



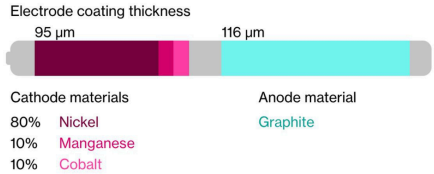
Source: Bloomberg Businessweek

NMC Composition back in 2012:



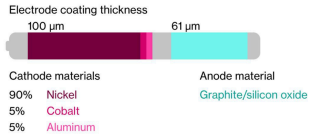
Source: Bloomberg Businessweek

Then, much Nickel, little Cobalt = thicker:



Source: Bloomberg Businessweek

NCA, light strong battery, no manganese:

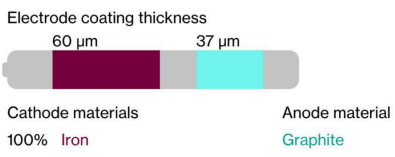


Source: Bloomberg Businessweek

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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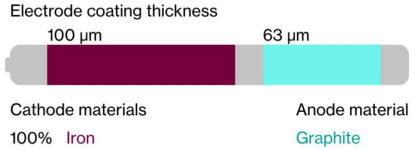
f) Modern LFP, less-energy dense:

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 showed a self-healing hierarchy of instabilities, *may* fortify separator at cathode/anode, so no puncture. Liquid electrolytes maybe replaced by a solid-state core for ultra-high current densities. With fire-safe boundary, energy/power density might 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, it 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 is so basic to our planet's backstory, it's likely life was fated to use it abundantly. A star like our Sun burns by fusion. Starting with lightest element, hydrogen -- it then fuses to a 2nd lightest helium, releasing both light/heat. Over billions of years of fusing, stars create helium atoms, and in turn fuses on towards heavier carbon, oxygen, silicon. In supergiant stars, iron is terminal stage as stars age. Given it's such 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 case). If supernova, that explosion spews immense iron, oxygen, carbon atoms etc into space. If, when gravity coalesces elements to what may become planets, asteroids etc, 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.

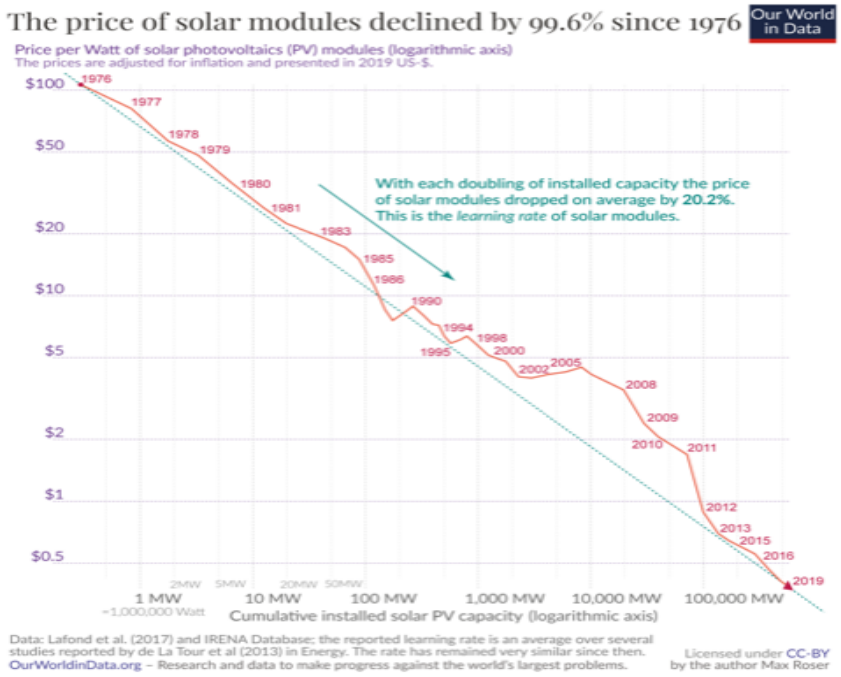
So much is possible. One interesting idea, may be iron-air batteries discharging power as they take in oxygen, making rust. In turn charging by using electricity to change back from rust to metallic iron -- releasing oxygen. On super-abundant benign iron, they may be cheaper & readily recycled. Anyway,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

Since 1984 was a period, when US technology & innovation equities had positively 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 Can In Time, Favor Elegant Clean Solutions (But Does Not Mitigate Volatility)

Burning fossil fuels to make electricity, is both extremely inelegant and dirty. Looking at the 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 US produced more oil, 13.49 million barrels/day, than any country in history! Oil then fetched high-ish 'healthy' price for producers, near $70-$75/barrel. But wasn't always so. Let's look back intriguingly to 2020, to a remarkable world oil crash. Some call that crash illogical, yet it arguably unfolded with explainable logic of its own. 4 years prior it 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 by Ides of March 2020, America's 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 <$50 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 above $30, a bare floor for many. Particularly, indebted shale producers. Oil near just $20 was maybe going lower on demand destruction. It 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. Come 2024, oil again would be in a 'desired' $60s-$90s -- with US then 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, a question was if US production increases, & maybe tariffs/trade wars too, could again impact oil prices in big new ways.

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. Was not enough fall to kill American 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. And 2025 as oil fell to low $60s/$50s (hard on producers), Middle East conflict again in June took it back up into the $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'.

Consider CO_2: A Topic Gaining Importance

For 20+ years our emphasis in Clean Energy Index® Reports has been on *Solutions*. Not, CO_2 -- nor climate *per se* -- but rather on solar, wind, EVs, storage as ecologically & economically smart paths. Climate's been a driver, yes -- but CO_2 wasn't core within Index Reports. Lately however, global heating, weather extremes are coming in as worse than what models have foreseen. In short, CO_2 might become more of tremendous risk, so let's address it directly.

For just one sample of this remarkable science here, a 2020 article in Proceedings of National Academy of Sciences warned that in a span of 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." On trends, and in particular CO_2 & population changes, a narrow temperature niche our species has long required, is projected to change more in just next 50 years, than a past six millennia! See Chi Xu, Timothy Kohler et al, *Future of the Human Climate Niche*. PNAS (4 May 2020). https://www.pnas.org/content/early/2020/04/28/1910114117

We give increasing pages here to climate & CO_2 in clean energy's story. To decarbonizing, or ugly term 'Environmental, Social & Governance' /ESG' (just 'E'). First note: CO_2 has long been a hero to our species -- in moderation. Earth without such CO_2 might have had near 0 C surface temps. Instead, it's warm thanks to CO_2 in tiny concentrations under 300 ppm. Long has meant greenhouse gases naturally gifted us average temperatures pretty ideal for us, at 58 degrees F. We'd habituated ourselves to thrive in that 'cool' for over 10 thousand years.

Late 1950s as regular CO_2 monitoring began, modern readings were already up from what had long been near 280 PPM. Like 315 PPM. By 1988, scientists became alarmed as planetary warming due to increases in CO_2 reached 350 ppm. Worriedly, a world conference held in that year called for reducing from that very high, 350 figure, downwards by -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 had only *implied cuts,* like calling for global emissions to be -20% lower in 2005. Instead, CO_2 as it turned out only grew -- going +34% *higher by 2005*. Looking back, it went on rising, another +22% higher in 2017 -- to over 425 ppm in mid-2020s. Higher than in at least a last 3 million years. Maybe the highest in last 12 million years. So merely aspirational words, absent robust actions, have woefully not achieved what's been needed for a real decarbonization, reducing grave climate risk.

Yes, 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 in 2009, but that 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 still No cause for optimism. A gathering in Glasgow 2021 meant to speed progress -- failed. 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)* be cheaper than fossil fuels (as required post a 2025 'one big act'); *that there is recognition of science; and *acceptance that decarbonizing away from fossils -- to clean paths while also creating new wealth/ new jobs -- is hardly a radical path. Instead, it seems a saner approach to our common future.

There's bits of optimism re: progress of late. Near-term to 2100s, intercomparisons of 56 climate models indicated some most awful possibilities, *may* be less likely. Barring say, feedbacks like of methane, 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. (Less than 9 F from here, as there'd been warming to mid-2020s). The models assumed higher fertility rates, widespread coal, failure on renewables; things aren't that bad. Such models may be realistic, but worst-case predictions of an unlivable 9 degrees F warming soon, hopefully very unlikely. On other, hand, studies in 2021 showed eg, the carbonate/ limestone permafrost in Siberia, if thawed, may potentially yield enormous methane, via fracturing. Methane can be *even more climate forcing than* CO_2, in the near-term.

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

Yet, lower-end of wide, 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 in 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, in 2080s or so, then decline. (CO_2 in atmosphere rises, stays high, drops only slowly as it accumulates). Coal plants would be built in Asia as they are -- but soon may be regarded as things of the past in RCP 6.0. Electric car adoptions do 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). This reflects incoming solar energy -- pushed far out of balance in our altered Earth-atmosphere system. Consequences of that, may go on as dire for our species *over centuries, millennia* ahead, yet seems about what one might 'hope for'.

Next, very, very ambitious, is a hoped-for RCP 4.5: emissions peaked in ~20 years to 2040s, then fall fast. CO_2 not long ago was stable at 280, now 425 & rising fast, rises in this view to 'just' some 650 ppm -- unlikely and has it then stopping/peaking there. Much decarbonizing is assumed to have been undertaken (far more than now planned), CO_2 in time dropping. That *may* be possible, although it's a huge stretch. And arguably highly unlikely, on CO_2 already 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. Hence operations going into 2040s and after, unless they are prematurely shuttered.

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

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

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

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

That's not alarmist. It's just where science dispassionately points us. Maybe unbearably hot -- growing hotter. Many centuries of sea level rise. It's possible that rise in just a few centuries destroys Florida, New York City, DC. Inundates much of US Eastern seaboard, the US Gulf Coast, parts of US West Coast. While indigenous peoples had long predated in today's City of St. Augustine in Florida -- if one considers it 'founded' in 1565, or 450 years ago -- then we're likely nearer end of that first US City, than to its birth. Nearer to deaths of Miami, Florida, or New York City, or New Orleans etc etc -- none having another 400 more years ahead.

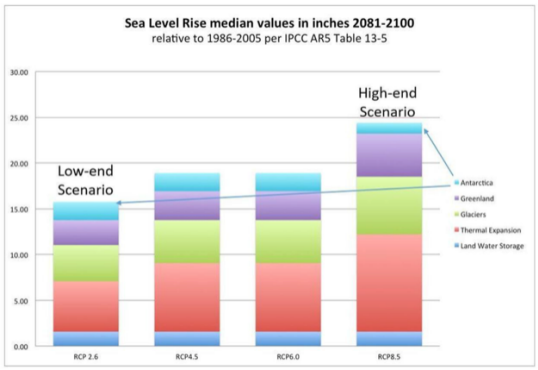
Imagine just ~70 years hence. Note then, that projections by an Intergovernmental Panel on Climate Change (IPCC) for sea level rise in year 2100, may misleading. For end of century rise may be unwinding then at far more rapid accelerating rates, than what was projected by IPCC. Getting that so wrong,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

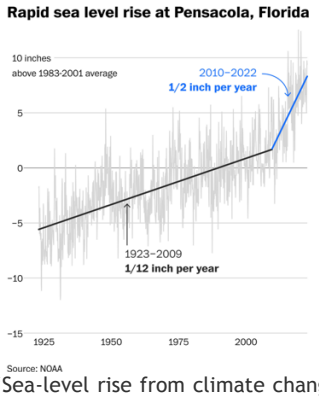
The idea that actual sea levels in 2100, could be greater than IPCC projections is well laid out in 2020 piece, 'Twenty-first century sea-level rise could exceed IPCC projections for strong-warming futures' by M. Siegert et al., One Earth (Dec. 18, 2020). Their first paragraph nicely lays out cogently clearly big ideas that scientists may now find mainstream -- yet these same thoughts should be viewed by the public, policymakers and politicians with alarm:

> 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 could possibly be 4 C hotter than today. On strong warming, seas in 2100 may be quite higher than a usually accepted IPCC range of 0.61m -1.10m, what the public thinks of as roughly 1-3 feet of rise. In particular, upper end projections are unduly taken by policymakers as maxing about 1.1 meters (3 feet) higher in ~70 years to 2100 -- and 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 may omit mechanisms -- if the machinations are hazy. Shorn of major details, these data suggest global rise may go *on, well over* 1.1 meters at 2100, above 3 ft. Difficulty modeling ice/glacier dynamics in short, potentially has left out Antarctic's contributions. It has removed complex & cascading effects. Especially in higher heat scenarios where we're trending. IPCC's higher-end curiously, indicated a *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 from Miami, or State of Florida, no doubt want it to exist centuries ahead. Same for New York City, Boston, London, Shanghai, Amsterdam, Mumbai and so on. Yet their leaders are still discounting to near-zero, staggering losses these places *may* face ahead. That's due in part, to relying on a near-term and distorting 2100 horizon.

Anything like a sea level rise that's going on potentially for 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 the ground upon which innumerable buildings sit, first as sinkholes then more 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.

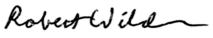
Conclusion:

The Clean Energy Index® (ECO) began Q3 at 41.87 & ended Q3 at 60.52, so up Q3 about +45%. Since starting 2025 at 42.25, this year to date it's up +43%, with low of 28 on April 8th. Or first 2 Quarters of this president's 2nd term, from April 1, 2025, ECO is now up +83%. Persisting inflation over years had hit this interest-rate-sensitive renewables theme hard. After clean energy and thus ECO Index® had touched an earlier low in mid-2024, it rose afterward with -- or perhaps bit due to(?) the 2024 election. We'd seen in a stimulative 1st term 2017 to 2020 ECO moved dramatically: it was up +38% in 2017, down -15% in 2018, up +58% in 2019, remarkably up +203% in 2020 for about best performance of any Index/Fund, anywhere; tallied up +284% in conservative president's 1st term. Then fell 4 years of a differing president, down -30% in 2021, -46% in '22, -22% in '23, -30% in '24, so tallied was down -128%. Presently up again 1st year of the 2nd term. Lately, 'one big bill' is pulling demand forward into 2026 -- and possibly may knock it down further out, both ways influencing clean energy.

There were No Deletions from ECO for a start of Q4 2025 -- and No Additions for start of Q4. At the Global Clean Energy NEX for the Latter Q3 rebalance, the Deletions were: Aker Carbon Capture, and Wolfspeed (it declared a reorganization & was removed at end of June 2025) -- and the NEX Additions for Latter Q3 were: Contemporary Amperex, and LG Energy Solution. At Hydrogen Economy H2X, the Deletions for Latter Q3 were: Aker Carbon Capture, Alfa Laval, and Wolfspeed (declared a reorganization & was removed at end of June 2025) -- and H2X Additions for Latter Q3 2025 were: Dae Myoung Energy, Taiyo Yuden. At Wind Energy WNX, the Deletion for Latter Q3 2025 was: Wolfspeed (declared a reorganization & was removed at end June 2025) -- and the WNX Addition for Latter Q3 2025 was: JL Mag Rare-Earth.

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 Q3 on 9/1/2025, or about ~4 weeks before rebalance to start Q4 2025. 62 Stocks:

Name	Weight	Name	Weight
Sunrun Inc	3.13	REX American Resources Corp	1.52
Bloom Energy Corp	2.95	Monolithic Power Systems Inc	1.50
Solid Power Inc	2.95	Hyliion Holdings Corp	1.49
SolarEdge Technologies Inc	2.48	T1 Energy Inc	1.49
NIO Inc ADR	2.29	Aspen Aerogels Inc	1.45
MP Materials Corp	2.28	Lithium Americas Corp	1.45
QuantumScape Corp	2.27	Enovix Corp	1.43
Amprius Technologies Inc	2.26	ReNew Energy Global PLC	1.42
Lithium Argentina AG	2.19	Advanced Energy Industries Inc	1.41
Ameresco Inc	2.08	XPeng Inc ADR	1.41
Joby Aviation Inc	2.01	Cadeler A/S ADR	1.40
American Superconductor	2.00	Canadian Solar Inc	1.36
Standard Lithium Ltd	1.88	MYR Group Inc	1.36
First Solar Inc	1.88	ESCO Technologies Inc	1.34
Eos Energy Enterprises Inc	1.87	Brookfield Renewable Corp	1.31
Powell Industries Inc	1.85	Quanta Services Inc	1.28
Albemarle Corp	1.84	Lifezone Metals Ltd	1.28
Bel Fuse Inc	1.80	Enphase Energy Inc	1.27
Sociedad Quimica y Minera	1.74	Tesla Inc	1.27
Sigma Lithium Corp	1.73	Rivian Automotive Inc	1.23
Plug Power Inc	1.71	EVgo Inc	1.22
Array Technologies Inc	1.69	Corteva Inc	1.19
NEXTracker Inc	1.63	Itron Inc	1.18
JinkoSolar Holding Co Ltd ADR	1.62	Universal Display Corp	1.12
Gentherm Inc	1.62	Archer Aviation Inc	1.08
Ballard Power Systems Inc	1.61	Darling Ingredients Inc	1.05
Gevo Inc	1.61	Navitas Semiconductor Corp	1.03
Shoals Technologies Group Inc	1.60	OPAL Fuels Inc	0.89
Fluence Energy Inc	1.55	Atlas Lithium Corp	0.52
Preformed Line Products Co	1.53	FuelCell Energy Inc	0.26
Niu Technologies ADR	1.53		
Ormat Technologies Inc	1.52		

Some strong representation above in *Solar, *Fuel Cells, *Batteries/Materials, and EVs.

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

INDEX (ECO) SECTOR & STOCK WEIGHTS FOR START OF Q4 2025. 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 - 13% weight (7 stocks @1.85% 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.
Nextracker, NXT. Solar trackers, optimizing PV daily performance yield.
Ormat, ORA. Geothermal, also in areas of recovering heat energy.

Energy Storage - 25% sector weight (15 stocks @1.63 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.
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, also in batteries; formerly was 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.
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.
ReNew Energy, RNW. India renewables, among largest there in solar & wind.
Sunrun, RUN. Residential solar systems, PPA, lease or purchase rooftop PV.

Cleaner Fuels – 10% sector weight (7 stocks @1.42% each)
Corteva, CTVA. Canola oil, renewable in sustainable aviation fuels (SAFs).
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)** via an independent tracker (PBD) -- on 7 August 2025, or about ~3 weeks before the next Rebalance for Latter Q3 2025. 110 stocks**:

Name	Weight	Name	Weight
QuantumScape Corp	1.74	JinkoSolar Holding Co Ltd ADR	0.92
Plug Power Inc	1.74	Flat Glass Group Co Ltd	0.91
Bloom Energy Corp	1.49	Shihlin Electric & Engineering Corp	0.91
Solaria Energia y Medio Ambiente	1.46	GS Yuasa Corp	0.91
Delta Electronics Inc	1.37	AcBel Polytech Inc	0.90
ITM Power PLC	1.22	Canadian Solar Inc	0.90
Fortune Electric Co Ltd	1.21	Toyo Tanso Co Ltd	0.89
Ceres Power Holdings PLC	1.20	ERG SpA	0.89
Green Plains Inc	1.16	NKT A/S	0.89
Doosan Fuel Cell Co Ltd	1.13	Energix-Renewable Energies Ltd	0.89
Ganfeng Lithium Group Co Ltd	1.13	Sociedad Quimica y Minera de Chile	0.89
HD Hyundai Electric Co Ltd	1.12	TSEC Corp	0.88
Prysmian SpA	1.12	Tamura Corp	0.88
Corp ACCIONA Energias Ren. SA	1.12	Signify NV	0.88
LS Electric Co Ltd	1.10	Itron Inc	0.88
Kempower Oyj	1.10	Alfen N.V.	0.88
Ballard Power Systems Inc	1.09	Hubbell Inc	0.87
Acciona SA	1.08	Verbio SE	0.86
Nordex SE	1.08	Vestas Wind Systems A/S	0.86
Nexans SA	1.08	Teco Electric and Machinery Co Ltd	0.86
Orsted AS	1.05	NEL ASA	0.86
Landis+Gyr Group AG	1.05	Tianneng Power International Ltd	0.86
Ecopro BM Co Ltd	1.04	CALB Group Co Ltd	0.85
Blue Bird Corp	1.04	Rexel SA	0.85
Samsung SDI Co Ltd	1.04	Boralex Inc	0.84
Xinyi Energy Holdings Ltd	1.04	Shoals Technologies Group Inc	0.84
NFI Group Inc	1.02	Wasion Holdings Ltd	0.84
SPIE SA	1.02	Verbund AG	0.83
Legrand SA	1.00	China Datang Corp Renewable	0.83
SES AI Corp	1.00	Terna - Rete Elettrica Nazionale	0.83
Grenergy Renovables SA	0.99	Nibe Industrier AB	0.83
Enlight Renewable Energy Ltd	0.98	Wacker Chemie AG	0.83
Core & Main Inc	0.98	FSP Technology Inc	0.82
Xinyi Solar Holdings Ltd	0.97	Allis Electric Co Ltd	0.82
Scatec ASA	0.96	RENOVA Inc	0.82
Lotte Energy Materials Corp	0.96	Mercury NZ Ltd	0.82
LS Corp	0.95	West Holdings Corp	0.81
Chung-Hsin Electric & Machinery	0.95	Motech Industries Inc	0.81
L&F Co Ltd	0.95	CS Wind Corp	0.80
NIO Inc ADR	0.94	First Solar Inc	0.80
SolarEdge Technologies Inc	0.94	Sanyo Denki Co Ltd	0.80
Elia Group SA/NV	0.94	SMA Solar Technology AG	0.78
Ormat Technologies Inc	0.93	Zhejiang Leapmotor Technology	0.77
OY Nofar Energy Ltd	0.93	Kingspan Group PLC	0.77
EDP Renovaveis SA	0.92	XPeng Inc ADR	0.76
Ta Ya Electric Wire & Cable	0.92	Sunrun Inc	0.75
		Sino-American Silicon Products	0.74

Yadea Group Holdings Ltd	0.74	BYD Co Ltd	0.64
Eos Energy Enterprises Inc	0.74	Atkore Inc	0.64
Universal Display Corp	0.73	Rivian Automotive Inc	0.63
Phihong Technology Co Ltd	0.73	ChargePoint Holdings Inc	0.62
EVgo Inc	0.71	Array Technologies Inc	0.56
Darling Ingredients Inc	0.70	Enphase Energy Inc	0.51
HA Sustainable Infrastructure	0.69		
Voltronic Power Technology	0.68		
Lucid Group Inc	0.65		

There's strong representation above from *Batteries; *Hydrogen and *Fuel Cells; *Biofuels.

**Wolfspeed declared re-organization & was removed at end of June 2025.
**Aker Carbon Capture was undergoing delisting anticipated in 2nd Half 2025.

Appendix IV:
WilderHill New Energy Global Innovation (NEX) - for Latter Q3 2025. 110 Stocks.

Name	Description	Sector	Currency	Activity
Acbel Polytech	Green energy electronics, PV & EV, power supply.	ECV	TWD	TAIWAN
Acciona SA	Sustainable infrastructure, separate is renewables.	RWD	EUR	SPAIN
Alfen NV	Electric Vehicle charging, smart grid, energy storage.	EEF	EUR	NETHER.
Allis Electric	Transformers, power transmission, smarter grid.	ECV	TWD	TAIWAN
Array Technologies	Solar, ground-mounted axis sun trackers.	RSR	USD	US
Atkore	Electrical cable, conduit systems, pre-wiring.	ECV	USD	US
Ballard Power Systems	Fuel cells, PEMs used in transportation and more.	ECV	CAD	CANADA
Bloom Energy	Stationary fuel cells, distributed but non-renewable.	ECV	USD	US
Blue Bird	Electric school buses, US size types A, C, D.	EEF	USD	US
Boralex	Renewables generation, operates wind, hydro, solar.	RWD	CAD	CANADA
BYD	Electric vehicles, advanced batteries, China based.	ENS	HKD	CHINA
CALB Group	Batteries, in electric vehicles, energy storage, grid.	ENS	HKD	CHINA
Canadian Solar	Solar, vertical integrated solar manufacturer, China.	RSR	USD	CANADA
Ceres Power	Fuel cells, high temperature steel units.	ECV	GBP	UK
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
L&F Co. Ltd.	Cathode materials, in rechargeable lithium batteries.	ENS	KRW	S. KOREA
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

110 stocks = % Weights WEIGHT EACH COMPONENT =

0.90909091

2 NEX ADDITIONS for Latter Q3 2025: Contemporary Amperex; LG Energy Solutions.
2 NEX DELETIONS for Latter Q3 2025: Aker Carbon Capture; Wolfspeed.

110 Stocks for Latter Q3 2025.		#	% Approx. Weight
Energy Conversion	ECV	26	24%
Energy Efficiency	EEF	24	22%
Energy Storage	ENS	19	17%
Renewables - Biofuels	RBB	3	3%
Renewables - Other	ROH	3	3%
Renewable - Solar	RSR	22	20%
Renewable - Wind	RWD	13	12%
		110	100%

Appendix VI:
WilderHill Hydrogen Economy Index (H2X) for Latter Q3 2025 (63 components):

NAME	Description	Sector	Activity
Arcadis NV	H2 network, Netherlands, Europe, in planning.	HI	NETHER.
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
Dae Myoung Energy	Renewables, including work in H2, and metering.	HG	S. KOREA
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
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

Renew Energy Global	Green hydrogen activity, India, Egypt, elsewhere.	GH	INDIA
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
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
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

Rebalance for Latter Q3 2025:
Deletions: Aker Carbon Capture, Alfa Laval, Wolfspeed
Adds: Dae Myoung, Taiyo Yuden

% Equal Weight each: 1.58730
63 Components % each = 1.58730

Hydrogen Index H2X Sector	#
FUEL CELLS (FC)	11
GREEN HYDROGEN (GH)	14
HYDROGEN GENERATION (HG)	11
HYDROGEN INNOVATION (HI)	10
HYDROGEN STORAGE (HS)	8
HYDROGEN in TRANSPORT. (HT)	9
	63

**Wolfspeed declared re-organization; & was removed at end of June 2025.
**Aker Carbon Capture was undergoing delisting anticipated in 2nd Half 2025.
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Appendix VII: WilderHill Wind Energy Index (WNX) for Latter Q3 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
Renew Energy Global	Utility scale wind in India, also green H2.	WF	INDIA
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
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	Strenthening 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 optimiation, efficiency EPC.	SG	USA

Rebalance for Latter Q3 2025:
Deletion: Wolfspeed
Addition: JL Mag

71 components = 1.40845% Equal Weight each

4 WilderHill Wind (WNX) Sectors	#
SMARTER GRID (SG)	22
WIND FARMS (WF)	13
WIND INNOVATION (WI)	17
WIND MATERIALS (WM)	19
Total =	71

**Wolfspeed declared re-organization & was removed at end of June 2025.

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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