



Q3 WilderHill® Quarterly Report: ECO, NEX, H2X, WNX Indexes, Sept. 30, 2026

The Clean Energy Index® ([ECO](#)) began Q3 at 82.95 & ended Q3 at 62.19, down about -25%, and year to date was down -4%. Or say in 'context of presidents' so fully 6 Quarters into new 2nd term, ECO Index® is up, +87%. We'd seen in a president's 1st term from 2017 to 2020, this Index had moved dramatically: ECO notably climbed +560%. Rose over 6-fold, ironically about the best performance of any index or fund yet during a white house highly opposed to clean energy. Fast-rising inflation, next hit this interest-rate-sensitive theme very hard; ECO then fell all 4 years of a very different (pro-clean energy) oval office 2021 through 2024. After, on return of that prior anti-renewables president to start a 2nd term, ECO once again moved up first year by +52% for 2025. We'll explain some factors behind seeming counter-intuitive moves, yet that arguably were still rather foreseeable, perhaps even a bit 'probable'.

Today's race for electrons is now on after years of slack demand. For investors, clean energy is lately seen less as a 'climate play' -- and more as a swifter-solution. Renewables can go up faster than natural gas, coal, nuclear; they're also cheaper, and 'firming-up' with new battery storage. Meanwhile ECO Index always passive, can fall hard. From up at 270 in 2021, to down at 30 early 2025, clean energy so ECO had plummeted over ~4/5^{ths}. This theme can, and will at times 'drop like a rock'. Jumps true, crashes too. Our aim is to capture a risky story where big moves down, or up, pervade clean energy's theme; it's always been so. Looking back, a first & best-known ECO Index live since 2004, is past 10 years up +50%. The first for *global* clean energy, NEX live since 2006 via its tracker is past 10 years up +52%. For comparison a natural gas futures tracker, has instead fallen mightily over past 10 years.

Times when clean energy does fall hard, valuations discounted, much negativity priced in, some ask if this theme may be troughing ahead? *Impossible to say!* And any inflection up, is after long downturns. Plus, so much here can be counter-intuitive. Like how clean energy / so ECO had jumped hard in an anti-renewables-president's 1st term. Rose again first year of a 2nd term. Any shift to free-markets, open-competition, 'all of the above' paths may be a rising tide lifting all boats, the renewables too if freed of tribal politics. Or not, & recent drops carry on! That said as always, *past performance is no indication of future results*.

Once, energy was mainly from fossil fuels taken from deep down, burned for heat. Today, sunlight & breezes give us ever-more-affordable & desirable, electricity. From clean fuels given freely, from upwards towards heavens. Here's ECO tracker in last quarter:



All 3 big energy promises made by a US president for 2025, 2026, turned out respectfully, badly wrong. As we'll see, that president's own policies made his being so far off foreseeable, even a bit-predictable (again). Reasons help illuminate how come this clean energy theme, so ECO gained sizably in first 6 full quarters of 2nd term. But, let's start with a recently volatile, sharply down Q3 2026 for ECO. Here is an independent **ECO Index tracker in blue**, **Down about -25%**; & for comparison an **S&P500**, **just up about +2%** to late in Quarter:



Source: YahooFinance

One big factor in ECO falls above, was rising inflation. War & spiking energy prices pushed costs of most everything, up. Treasuries, selling-off, sent 10-year yields from a moderate 4.0% at start of war Spring 2026 -- to tougher 5.0%+ in Fall. As conflicting-forces push clean energy in opposing ways. On one side, is cause for bearishness: Wall Street does not tolerate long periods of very-high-valuation in broader markets. And markets have seemed *over(?)*-valued on an AI stock mania valued to perfection, maybe a bubble that can/should(?) see air let out. Very bearish too is national debt now \$40 Trillion(!); deficit spending so excessive it should be brief, yet it's pursued with full-employment, and fully-intentional. By self-proclaimed 'fiscal-conservatives' (ahem), when inflation is not a targeted 2%, but is over 3%+. Making rising Treasury yields & Debt, competitive with returns on riskier equities. *Much now implies markets are over-valued, ripe to crash, as high interest rates are bearish for capital-intensive energy themes, solar & wind included.* Volatile clean energy theme might rise faster than broader markets in upturns; yet can often fall much harder here in the downturns.

Or opposing side, perhaps some reason for optimism(?) is now undeniably, renewables win on economics. In 2025 wind power hit record-low-cost: just 1 penny per kilowatt-hour (/kWh); wasn't a typical cost but it was a super-cheap electricity from free breezes. Solar hit 1 penny/kWh too for cheap electricity by free sunshine; again not typical as solar / wind early 2025 were near 3-7 cents/kWh. But *compare a low 3-7 cents cost for renewables early 2025 -- to generating electricity from costlier natural gas, or coal, or nuclear -- and solar & wind are on average the *Cheapest option*.* Built faster too. Clean can win on economics but is not firm; it must solve for intermittency. Yet a rubicon was crossed in 2020s: renewables plus batteries now make cheap electricity. Gap only irreversibly widening. No going back. On free sunlight & breezes, plus knowhow to make electricity at just 3-7 cents/per kilowatt hour in many places. Conventional-energy while firm, can never truly compete again on price.

All with a president who had promised by 2026, US electricity prices would be down by ½ -
 - who had inexplicably thought using only costlier fossil fuels will make prices plummet (!?) -
 - yet no price decline happened at all. Nor was gasoline as promised under \$2/gallon by 2026: it went from \$3.22 on inauguration day January 2025, to Not down at all, instead to nearer \$4 by Fall 2026. To put that president in a best possible light, we'll look first at just 2025, before his own war by choice in 2026, spiked prices. Explain why ECO gained 2025. Why in 6 quarters from April 2025, clean energy valuations jumped. Even as that white house strived to halt wind & solar. To stoke a more anti-renewables politics, than at decade's start.

Much stemmed from strange misconceptions deeply rooted in that white house. From its core beliefs fossil fuels are still cheapest energy. It wasn't understood within that oval office, that factually *that's Not true at all*. Tellingly, *US States with very Least-Cost Electricity now rely first, heavily on renewables*. Solar/wind giant Texas has fast-growing renewables -- and a lower-than-average cost electricity. 81% of new grid electricity in Texas 2025 was from solar + storage. 91% early 2026. In fact, conservative free-market 'red' states today have cheapest US electricity: *thanks to their more abundant low-cost renewables*. Many US states, nations too are adding renewables + storage, often seeing those costs fall. But, not yet everywhere - plus the 'intermittency' of renewables is a big issue that must soon get solved.

Here's a Chart for 5 varied clean energy themes, first 6 full quarters of a president's 2nd term; April 2025 - to late September 2026. Green energy has many facets so here's five: all are Up via trackers. At top near-tied are an independent ***ECO tracker (blue)** up about **+87%**; and **Hydrogen Index tracker** (for a narrower sub-theme, available in Europe) up some **+96%**. Next, 3rd is a **Wind Index tracker** (for a narrower sub-theme, available in Europe) up **+65%**. 4th nearby, is *Global clean energy **NEX (via tracker)** up **+56%**. Last is a 'just cleanish' **alternative energy** theme ('not so clean' as it has had much natural gas, nuclear, even coal - and top 10 is over-weighted; bottom 10 under-weighted; so not our's), up **+49%**:

From Q2 2025 -- to late Q3 (September 21st) 2026; 5 varied clean energy themes:



These clean energy gains above, were comprehensible; we'll discuss ahead.

War in 2026 became the worst oil disruption in history. Showed the risks of US fossil fuels-dependence, of energy-insecurity, when oil prices spike badly. As we'll address, that was very unlike renewables, since green electricity prices in cents per / kilowatt-hour -- can / do to contrary fall hard -- & *clean energy prices can go on dropping*. Oil by contrast can get very costly at times: sadly it can't get cheap & stay there. Instead, oil has 'floors' below which price declines can reduce rig counts. Oil prices may drop briefly; but re-rise on fewer rigs. Nor is US oil at all energy-secure. Price of oil is yes, complex, yet also comprehensible.

This Chart for Q2 2025 -- to late Q3 2026, is for energy more broadly. Thus it shows clean - & dirty energy. 2 clean themes via trackers are *ECO; & an excellent *Solar Index. Also fossil fuels *Oil, & *Natural (fossil) gas futures. Plus US equities in *S&P500 theme. Oil moves on geopolitics; like war temporarily closing the Strait of Hormuz. Even as US natural gas futures fell. Here is energy first 6 full Quarters of a president's 2nd term. At top an *Oil tracker has risen hard of late up **+98%**; nearby is *ECO tracker here again up **+87%**; *Solar next is up about **+40%**; 4th is *S&P500 more modestly up **+38%**. Last, *US Natural Gas futures, here are **down -48%** for a US natural gas futures product - that is unlike in Europe and Asia:

Start of Q2 2025 to late Q3 2026; 2 clean themes; 2 dirty themes; plus an S&P500:



Given a fierce animosity by that 2nd term-oval office to clean energy, one may have guessed stocks here, so this theme / & ECO would have fallen hard, all 2025. Instead as noted, ECO Index & tracker, jumped in 2025 to 1st half 2026. That didn't go unnoticed. In 2025/early 2026 trading volume in an ECO tracker at times was over 1 million shares/day. By July 2026 activity hit \$1 Billion for month. But by Fall 2026, inflation + 10-year Treasuries at 5%+, hit clean energy hard. Trading volumes fell fast. Confounded a white house that not long ago walked back empty threats, to which some wags joked, TACO! And if that oval (office) intended to hit China badly, force it into concessions, that oval got that badly wrong too. Instead China's big support for its own clean energy industries was paying-off very handsomely. While erratic US tariffs maybe intended as 'art of the deal' confusing feint, perhaps to try to throw China off-balance, hadn't accomplished that at all. Not a bit. As rising US inflation was biting hard, it was harming clean energy -- and all the capital-intensive energy themes as well.

3 huge mis-calculations respectfully, were made by that president early 2026. First two related, were his wrongly feeling 1) Iran wouldn't close Strait of Hormuz in response to a US attack. 2) And his misjudging that the conflict will soon be over in just "4 or 5 weeks"; his feeling US oil prices won't rise; and his 'new energy dominance' will insulate Americans from unaffordable costs of gasoline and diesel stemming from his own war of choice.

Those assumptions were a 'sucker's bet'. Surprising being so very far-off; any US president's / any leader's successes are wins for a country, so we'll root for a president. Where he went so wrong included his stating at very start that one aim was "regime change". Which changed calculus in Iran's fractured leadership; made its 1st ever-move to close the Strait, a step they'd take. If Closure worked, it could give more leverage than an atomic bomb. The US National Security Council was well-aware; but ½ its staff was removed, its advice was ignored. An insular 2nd term oval seemed to prioritize a fawning loyalty to POTUS; proceeded then more from 'gut feelings' at top, eschewed (arguably needed) expert advice. Quite different from a 1st term that had leaned to caution; with guardrails and risk-averse.

Since returning to office early 2025, this 2nd administration had promised to vastly fast grow US oil production. To add 3 million barrels per day (bpd) more US crude production -- so go from about 13.6m bpd late 2024 -- to 16.6m bpd. That oval promised 'energy dominance', believed it had oil independence. But that oval was wrong here too. After promising 'drill, baby, drill!' -- US output barely rose by Fall-2026, to just 13.9m bpd. Illusory anyways: a US was net-exporting oil: but also importing an essential, different, 8m bpd daily, as well.

As we'd predicted back in May 2026, the following was likely; not hard to foresee! There'd be a 3rd big mis-calculation: that president feeling he 'has all the cards' will first try a bombing campaign, wait out other side. He'll reject expert advice; he won't understand at first Iran can instead wait out US (and world). It'll be painful for Iran, but global oil reserve inventories will start being drawn-down. US big oil understood; the white house was warned they'll only have until the Fall or so, if Strait is fully-closed, before physical lack of gasoline, diesel, starts to bite. Oil futures may trade at more moderate prices awhile 'on paper', on optimism of a deal; but in time might rise nearer 'dated' spot prices for physical barrels. Fears of economic calamity can recede as some oil gets out. Still, that oval onboarded understanding late: they'll need to conclude a draft initial tentative outline, fast. June can be a target: that US leader likes to sign or announce agreements on major (to him) dates, and his birthday would be June 14th. Yet that pause was likely to soon fall apart. All as US magazine-depth: its munitions, bombs, missiles, will draw down faster than the oval will wish to be known.

Facts on ground can shift leverage. Perhaps 'tank bottom' fears of dwindling oil reserves, if a Strait is fully closed. In that case, aims important to Iran, may be concessions given it. Like: reparations for economic & other devastation suffered. One mechanism is maybe it aims to enforce not ship Tolls (illegal on Law of Sea maritime law) -- but Fees for Services Rendered, legal & permitted. Essentially same thing. Iran may demand hundreds of billions \$\$\$. Maybe try to re-close Strait at will; contested back & forth. Some funds held by banks, released. Iran seeks a Ceasefire in Lebanon. There'd been a 2015 Agreement for nuclear inspections to ensure no enriching uranium to weapons grade; something like it returned to (even if denied by oval). Iran keeps ability to make missiles, aid proxies. Both sides resume sporadic war, attacks. While Iran won't 'win' that war as it might claim, it's also rather fair to say in 2026 a 'US often comes in second', on errors, higher oil prices. Which has made US & global energy more costly, for not-very-good reasons. Impacting then the November of 2026 US elections which Iran and others will clearly perceive as a leverage point.

Some awful outcomes foreseeable early 2026, began unfolding that year. Saudi will pump more oil via its East-West pipeline to Red Sea. But a 746 miles-long E/W pipeline is exquisitely susceptible to attack, as are pumping stations readily taken-out by drones. Indeed it was hit by Iranian-backed militias operating in Iraq. Fast-repaired, but briefly removes some 5 million bpd of oil from global markets. Far-from the only target/s so-susceptible to attacks. Worse, other strategic vulnerabilities could be targeted ahead: like desalination plants essential for fresh water to human population. Hitting those can in weeks have alarming consequences for large populations. Early-in the war, water de-salt plants had been largely-spared by all; but it represented a deeper red-line threat. Easy-targets too would be data centers; far worse would be, cities; even targeting nuclear plants, if matters yet deteriorate more.

Saudi's multi-layered defenses strive to protect refineries like Ras Tanura. But if its 550,000 bpd is lost ahead, that may be *casus belli*, reason to further escalate. Can lead to reprisals crossing prior red lines. Like trying to take Iran's Kharg Island. A US would be reticent to cross that in 2026, since taking it requires boots on ground, significant American casualties without reason. But if there's escalation, a brute widening of war may lead to attacks destroying Kharg from air. Like attacking say an Al Udeid Base in Qatar; or Incirlik in Turkey.

Early 2026 it seemed likely the Houthis as Iran's proxy and ally, will try to close Bab el-Mandeb Strait. To gain control of south ingress/egress to Red Sea, strategic for Saudi Arabia. A worried fall of Perim/Mayyun Island to Houthis, happened. Could erratic US leadership lead to new disarray for Gulf Region's allies, among Saudi & UAE (tensions there), Qatar, Kuwait, Bahrain, Oman -- was a concern. Attacks on US bases in Bahrain: 5th Fleet HQ (put there when Soviets were assessed as more likely threat, but so near Iran, made no sense today), and US Naval Support Activity bases were likely -- and indeed heavily hit by Iran. US at first tried to keep the extent of damage quiet -- after all a US was claiming to be winning the war -- but it was soon public. As were re-supplies to USS Abraham Lincoln, flagship of US Carrier Strike Group 3, at UK Diego Garcia Base a much-publicized failure. While Iran was helped perhaps by Russian satellite intel in choosing targets for its intermediate-range missiles.

Iran could try to convince Oman to team-up, toll Strait of Hormuz. Beyond that seen at a Turkish Straits, Danish Straits, Strait of Malacca. Such tolling attempts would doubtless be rejected. But, as a practical matter, a few trucks + a few missiles can do much to threaten vessels in Hormuz. As a US president felt boxed-in by a war he'd started. He'd alienated usual US allies who were in no hurry to help 'bail him out' -- not could they do very much beyond say, protecting vessels, ports. That oval looked at some bad ideas a US oil industry loathed. Like temporarily banning diesel fuel exports. Though it would only cut diesel costs short-term, mainly in middle-US (coasts then must import *costlier* diesel from overseas); in time *less*-US-refining capacity for diesel + gasoline; it would harm sanctity of contracts, and US standing as exporter. Another poor idea yet one considered was Defense Production Act to try to boost US refineries; but they were running full-out. New refineries beyond just one on books will take years to build. Much more 'successful' were UAE-led shuttle efforts to get much more oil out via new channels hugging Oman, protected by US warships, with transfers to very large crude carriers; but that was very costly, put a much-higher-floor under oil prices. Plus it could cause Iran (in thus losing leverage) to lash out. A US Naval blockade on Iran did give latter a reason to negotiate, yet this was all a sorry situation, no great near-term solution.

While in domestic energy, US red states in that same political party with most expertise *lowering* US electricity costs -- in fact did so thanks to their *embracing more* renewables.

My, what ironies that were plain to see in 2020s. Especially in the US.

We'd seen after a nadir low hit in April 2025, ECO then rose steeply over 2025. The theme then continued rising into 2026 to end of May -- but next, on rising inflation, and capital rotating out of richly-valued technology -- clean energy fell back, hard. Still 2 narrower sub-themes within clean energy, in Hydrogen, & in Wind, did then hold-up well. To help see how that happened, let's glance briefly at Index components the *Most Down*, / & *Most up* for first 3 Quarters of 2026 (to late Sept). In 4 volatile themes YTD: so in trackers for Hydrogen (H2X) well-up about +42%; for Wind (WNX) up at +21%; for global clean energy (NEX) barely near nil at +2%; and for ECO that was also then barely near nil down some year to date.

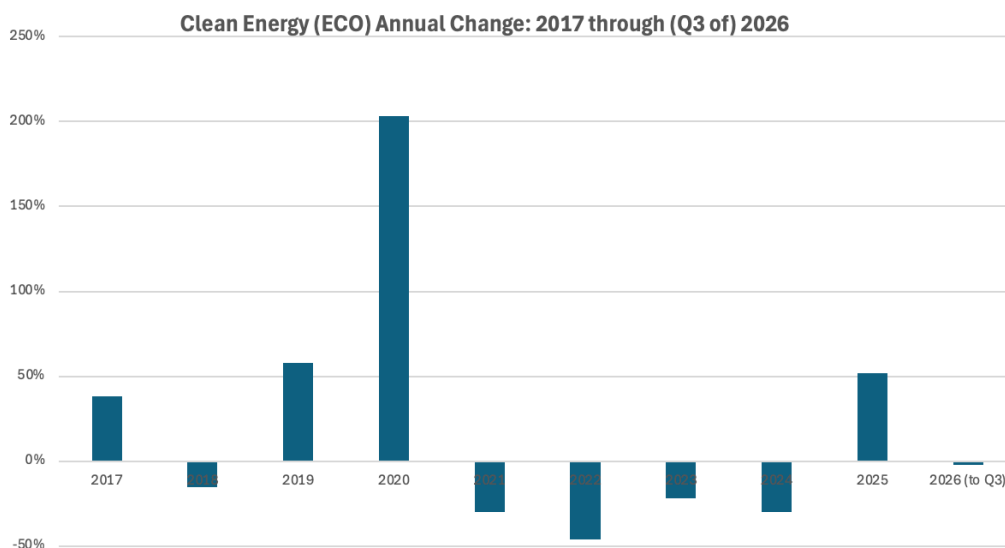
Perhaps some of this relative outperformance by Hydrogen up +42%; and Wind up +21% was as they did *not* include certain sub-themes falling hard like solar. Also components rose after years of being just perhaps, a bit 'overlooked'. At global hydrogen, H2X, components most *Down* in 2026 YTD included one in: *grid H₂ storage that was based in US (-54%); *developing green H₂, in China (-50%); *H₂, based in China (-45%); *in large-scale H₂, based in Korea (-36%). On other hand, components the most *up* here & these were up by rather a lot, had included one in: *commercial solid oxide fuel cells, in US (+206%); *electrolysis green H₂, in Japan (+183%), *fuel cells, H₂, based in Japan (+154%), *H₂ generators, in Taiwan (+124%); and *lower-carbon hydrogen via circular processes, based in Japan (+108%).

In global wind, WNX that was then up +20%, components most *Down* YTD included in: *zinc batteries on grid like for wind, based in US (-65%); *grid storage, in US (-61%); *wind generation, in China (-54%); *solid state grid storage, in US (-50%); and *wind farms, based in Germany (-28%). On other hand, the components here well up included in: *cable connectors & conductors for wind, based in Japan (+290%); *offshore wind, based in South Korea (+130%); *power measurement for wind, listed in Switzerland & operating in China (+94%); *power cables & transmission for wind, based in Japan (+70%); *heavy-duty wind cables, in Taiwan (+70%); and *wind power conversion, based in Germany (+67%).

At the Global clean energy, NEX, components most *Down* for 2026 to late Q3 included in: *lithium-metal battery development, in US (-70%); *longer-duration zinc batteries, in the US (-65%); *premium EVs, based in the US (-61%). Most *up* in global NEX included in: *fuel cells, in US (+206%); *smart grid transmission, in South Korea (+130%); *batteries, in South Korea (+101%); *fuel cells, based in the UK (+93%); *renewable biodiesel, in US (+82%). And for ECO to late Q3, the components most *Down*, included in: *zinc batteries (-65%); *battery storage (-63%); *solar, based in China (-60%); *silicon anodes (-59%); *solar trackers (-56%). Most *up*, included in: *fuel cells SOFC (+206%); *fuel cells molten carbonate (+148); *efficient linear engines (+126%); *grid transmission (+100%); and *renewable biodiesel (+82%).

Some sub-themes here like solar, that did well Spring 2025 to Spring 2026; then fell hard as interest rates rose. Others long-overlooked like H₂, rose and lingered up some. But embedded in figures above, is as the world sees once-costliest clean energy mature, it's becoming on average, *the Cheapest, Best-priced energy -- vs. costlier coal, natural gas, oil, or nuclear. And though renewables are still *Intermittent, with storage these can / will grow-firmer ahead. An ongoing huge shift. Back in 2010, the levelized cost of energy (LCOE) for onshore wind had been a pricey \$0.11/kWh; it was a big 23% *Higher* / worse than firm coal or fossil gas then @ \$0.09. By 2024, onshore wind costs were 67% *better*, falling then to \$0.03 -- vs. fossils still near @\$0.10. Utility-scale solar fell more in costs from a silly \$0.46 in 2010, 400% costlier than fossil gas / coal -- to near \$0.03 in 2024, 56% *less* than fossils. Battery costs falling fast too, and storage should become key ahead in firming solar and wind.

Returning to domestic US energy, let's glance back for a moment, see if there's any political correlation with this theme. Looking back at ECO Annual returns past 10 years. As expected, we see clean energy / so ECO is very volatile. Volatility no surprise in an emerging theme. Yet, *direction* of these Annual moves is *not* what one likely expected, if one anticipated easily-forecast directional correlation between ECO theme -- and a president & party in power each of these years. Below is ECO annually from 2017 through (most Q3) 2026:



This point on *Direction*, is counterintuitive. *Not*, as expected in each of 10 annual years. What boldly surprises, is with a *conservative* president, clean energy theme so ECO, *rose* sizably. We saw in notable 1st term 2017 to 2020, ECO Index® gained dramatically: from first day in office 2017 to last day early 2021, ECO was up by +560%, over 6-fold. About biggest gain of any Index or fund in a president's term, a white house highly skeptical of renewables. By years this was up +38% in 2017, down -15% in 2018, +58% in 2019, up +203 in 2020. Up greatly with a conservative president who railed against what he called a 'green new scam'. On his return to office 4 years after, first year of his 2nd term, 2025 rose again, from Jan. 1st at 42 -- to Dec. 31st at 64 and so was up +52%. Let's watch to see what happens ahead.

Inversely, maybe surprising as well was 4 years in between with a *liberal* president, who'd supported climate action, this clean energy theme captured by ECO, *fell very sizably in 2021 to 2024*: down -30%, -46%, -22%, -30%. Not what one might have predicted! Counter maybe to conventional wisdom, since in the 10 years clean energy *rose* with a conservative president - - and *fell* with a liberal -- opposite perhaps of presumptions. But looking at 'just' those past 10 years in going back from 2026 only, was perhaps too short-ish of a time horizon.

Maybe was just a fluke. We can look back more, a prior 10 years to 2005, so let's do it. Here annually first 2005 to 2008, an earlier prior conservative president's 2nd term had ended near nil, tallying 4 years (+4% in 2005, +5% in 2006, +58% in 2007, big -70% in 2008). Waters muddied by a Great Recession in 2008 that dropped all hard. Consider though were if not for a 4th harsh year, 2008, all globally down, that conservative president could have shown (again) net *gains* in ECO in 2nd term in office. Lastly we see a prior liberal president's 2 terms, 2009 to 2016: was a net -40% *loss* tallying annual results all 8 years. Hence a look back 2 decades from 2026, did *Not* reflect probable directional expectations, if one assumed losses in clean energy with a conservative, gains for liberal. Outcomes were opposite! Resists accurate predictions, *ex ante*. Importantly too, inflation, deficits, war, may mean quite differing results ahead.

Equity markets are fairly-efficient, forward-looking. Moving on facts, recognizes after years of flat electricity-needs, rocketing AI/data center power demand is causing upheaval. New gigawatts (GW) needed fast! Not easily met today on strained, constricted grids, nor by fossil gas burdened by large turbine shortages. Nor obviously by coal. Nor 2nd gen nuclear plants needing decades to build in a West. All reasons 90%+ of new US Utility-scale electricity generation that went up in 2025, and even more so in 2026, was from renewables.

But it's not been a straight-line. A visceral anti-renewables white house unwittingly 'helped' clean energy at first, by its war in 2026. More-secure clean energy jumped day after attack. Still, that president also had created distress-like outcomes. In 2025 despite longer-term energy-growth prospects, a big 1,891 power projects were cancelled. Of 266 GW lost, 93% was from clean energy (86 GW solar, 54 GW wind). 1st half of 2025, \$22 billion in clean energy projects were cut; that also on rises in inflation, and supply chain bottlenecks.

On rocketing demand \$6.7 Trillion in capital spending was expected by 2030 for new data centers worldwide. Yet they're increasingly-unpopular; with vast power demands, noise, pollution, extreme water-use. Their power-needs hindered by big gas turbine blade & vane bottlenecks, extreme difficulty manufacturing single-crystal castings of super-alloys. At same time more broadly, US stimulus in 2025, 2026 by an oval office & unitary executive, accommodative congress meant mountains of debt. Huge \$\$\$\$ was spent to run America's economy hot. That yanked at 2 of 3 levers to 'juice' US economy. One: by *Fiscal Policy so giant tax cuts + massive spending by an executive & congress. Latter should be a check on debt: Congress has sole Article I ability to tax & spend; in theory a guardrail on Article II executive. But a supine congress gave oval (office) immense deficit spending + tax cuts in 'one big' Act. Adding \$4 TRILLION (gulp!) in deficits over a decade! Sent US past a kinetic, debilitating \$40+ Trillion debt! GDP, so stocks can go up at first on such loose spending. But it's brief, *Not free*. A 2nd lever to run hot was pulled via deregulation. Hence scary stagflation from any policy mistakes, *might* result ahead. Could be low growth + high energy costs + persisting inflation: few gains along with vast new debt. Worst of all worlds.

A 3rd stimulative lever: *Monetary Policy, or excessively lower interest rates to run hotter - was resisted. Normally rates are set by an *independent* Federal Reserve (Fed) seeking job creation & growth, wary not to stoke inflation. Cautious to not 'over-gun engine', nor push rates too low (inflationary). That president expressly wanted a wildly-low 1% rate! But Fed at least to 2026, resisted. Rates kept neutral, resisting a 'steepening yield curve'. Though 3 votes in July 2026 to raise by 25 BPs, was most dissents since 1970 with a new Fed chair.

If fast growth by a Fed pushing super-low-interest rates down to 1% is so easy / great, why had no prior US presidents sought that to stimulate via debt, artificially low rates? Why not run huge deficits, grow US debt massively; wreck confidence in Fed independence via 1% rate, to get near-term big GDP numbers? In a nutshell because means fast-spiraling-debt. Inflation. Weakening dollar. Servicing debt crowding out all other spending. Impoverishing our future generations who must repay it -- going over >100% GDP, worse ahead than Greece, Italy. Even an aspirational 2% inflation rate, means the US dollar falls in value by 1/2 each 36 years; at 3% it is each 24 years. Maybe dollar debasement. Interest on debt has passed defense costs; the 1st time in American history. A Fed can't set 10-year yields; foreign creditors may demand Treasuries rise, costing all Americans. Dollar as world's Reserve Currency helps, but only so far. As a president + congress then ran all hot, some felt productivity gains could take care of all. For others, the issue wasn't If -- but more When debt/inflation crashes markets, & maybe economy. But let's turn our focus to new Energy paths, US energy policies.

As surprisingly-unsophisticated US energy policies 2025, 2026 pursued by then-white house raised eyebrows, US energy prices rose too. Including after its invasion of Iran done without very much serious planning beforehand. Begs the question: why had the US undertaken that war by choice in Iran in Spring 2026? Which fast led directly to Strait of Hormuz closing for first-time ever? Some suggested it was partly on oval having just come off a 'one-and-done' decapitation strike in Venezuela, in January. US leadership perhaps felt emboldened then to try by whim far-bigger regime change -- in tougher Iran. Still, other than in capturing Venezuela's leader, that prior January attack hadn't gone quite as advertised.

That surprise attack in January of 2026, had captured Venezuela's leader much for its oil - yet was done without checking first with oil executives. Its heavy high-sulfur reserves matched US Gulf refineries -- but were not then wanted by US big oil with oil in low \$60s. Turned out a mistake, foreseeable with planning. Venezuela's lack of adequate compensation to US companies for its past nationalizations, meant 'once bitten, twice shy' US big oil apart from Chevron, did not feel it had contractual certainty. So when white house last minute changed what was a closed-door private meeting with US oil execs to be instead televised live (hoping for big praises) -- the CEO of America's biggest oil firm had to state live in public, on nationalization /security / oil price risks, reserves were then "uninvestable". Embarrassing an oval (office). Yet that infrastructure needing a hundred \$\$ billion+ in costly renovations, diluents, security, made no sense to big oil execs on then-\$60s oil. The administration's allies after tried to make a case it matched US Gulf refineries, but they hardly understood \$60s oil was too low, repairs, security costs too high. So, was a non-starter to most all the oil majors at that time, with boards of directors, a memory of past expropriations.

The invasion's errors were highlighted June of 2026, as Venezuela's production of crude & other petroleum was just 1.19 million bpd: just a bit higher than 1.07 bpd of June 2025. Sure, some more crude was being sent to US Gulf Coast refineries & to Europe -- instead of to China or sold on black markets. But production was Not much up. Some rigs can come out of storage, but Venezuela with just 2 active drilling rigs, was nowhere near where it was in 1998 with 119 active rigs producing 3.4 million bpd. Results in Venezuela did not at all match a US president's odd claims next made in August 2026, that the US, & Venezuela were each making "hundreds of billions of dollars" off Venezuela's oil; that's wildly wrong. Latter 2026, a US oval announced claims to much of Venezuela's reserves, recalled ugly mix of Colonialism, Soviet-era big-government, rapacious old Belgian Congo. But bitterly opposed by most of Venezuela's people, political factions, so doubtful it lasts long. Domestic US Permian Basin draws drilling interest; but wasn't well-understood in that oval (office): tough prospects in Venezuela saw less-commercial interest, especially if oil is nearer break-even \$60s.

That Venezuela 'incursion' seemed ripped from pages of a 1980s playbook. Yet was No help start of 2026 in a world then awash in oil. Fresh off 'one and done decapitation strike', that oval next launched war in Iran late February 2026. Oil prices spiked, yet US drillers mainly stayed first on sidelines. Unsure of price in 12 months. An oval flailed, trying to force will on big oil - who was more attuned to free markets. Annoyed a US leader who wanted US gasoline under \$2, complained US big oil was 'making too much profit'; who wanted fast-drop in US average electricity costs too, down to ½ of when he'd taken office, a year prior. *Instead his odd policies were only pushing electricity costs; gasoline, diesel as well, Up hard.* To get far-more oil out of Venezuela, well over a million bpd, can take years at soonest. As an unusual oval, cabinet, small circle of advisors all prioritized loyalty to POTUS whims. Sadly hamstrung by their own mis-understandings of the free-markets. Which a senior US senator, a traditional conservative loudly had bemoaned on the US senate floor (discussed ahead).

Undeniably, US national energy policies were having *opposite* impacts of that intended. With awkward tariff outcomes backwards too from what a president wanted: China in 2025 enjoyed its first \$1 Trillion record trade *surplus*; US tariffs 'were supposed' to do opposite! That president may seek credit for a frankness about his visceral hate of wind & solar. Yet he was unwilling to see renewables are succeeding in US states, and nations. That US red states with the cheapest electricity, are much due to & thanks to ample growing renewables.

Today, it's possible to chart a course for cheaper US energy, better affordability. We've seen US electricity from big fossil / natural gas plants may cost best case, at minimum 6.5 cents+/kWh. Rose after greater demand, also a 2026 war in Middle East spiking costs in a "war by whim" without serious planning. Yet even that 6.5 cents low-floor, is rather costly, vs. clean energy. Meanwhile, building big natural gas plants can take 7 years, far longer than new solar or wind. Those big gas turbines, the labor, know-how were all stretched so a combined-cycle gas-plant not long ago at \$785/kW to build 2022, cost 3x more or \$2,400/kW just 3 years later 2025. That \$2,400 was then over 2x too expensive, vs. choosing renewables.

Once-mighty coal fell so far out of race, building new solar or wind generation with batteries even from scratch, is cheaper, smarter & better, than to just keep burning coal at all but just 1 of America's 210 mainly decades-old, many breaking soon-to-be-retired coal-fired plants! Quixotic, but in December 2025, a US energy department ordered 2 Indiana coal plants that were set to retire in late 2025 -- to instead keep operating -- March 2026 it renewed Orders. Even though the owners, & local Utilities protested as it was costing hundreds of millions of dollars, with costs mounting fast. Meant over \$100 million of new costs to invest in aged coal burners that were to be shuttered!! Operations could cost some \$1.2 million / per day. That, when many investor-owned US Utilities had sought instead to shutter coal -- and replace plants with solar/wind with storage. Or with methane / also known as natural gas.

Those oval office + federal policies were too-much-akin to Soviet-era central planning. Which also did pick & choose energy, according to motives other than economics. By sycophantic bureaucrats following erratic diktats; anyone who has visited an (ex) soviet union readily sees how & why that had deteriorated fast. Yet here in US, somehow a once-conservative 'red' party normally supporting market-economics, open competition, small government -- had fallen into a similarly sycophantic path. Costliest coal made no sense, yet was blindly followed. Federal officials made a bizarre, plaintive plea that coal will beat renewables. Yet couldn't explain how coal was needed, when fossil / natural gas was as firm and cheaper too! Plus, when solar & wind thanks to storage, were firming-up ahead.

A result: coal plants slated to close as desired by owners & Utilities, incomprehensively were forced to stay open, though costly. Far more costly than renewables+storage. Or gas. Ratepayers would pay that bill. Maybe US taxpayers; it's clear there why US electricity costs were rising! We know coal & nuclear though firm -- can't well compete on economics, vs. renewables. It's why solar or wind were #1 choice mid/latter 2020s. Firmness, now is main issue to solve. As fossils & nuclear only push electricity-costs up. Was inconceivable that white house near end of 2nd term would embrace renewables. Yet freed of that tribal politics, clean energy can win. So, as clean energy's theme grew richly-valued -- whether the green theme was over-valued(?) was a question. Might renewables continue to rise from 2026 on, despite such high inflation / US debt / high-equity-valuations, plus an American oval doing everything it could then to halt their growth? Take say, solar. What might be possible for solar growth based on physics and technology innovations, thanks to sunlight as free fuel.

Step back, and all the world's total installed solar power capacity in 2022 was 1 terawatt. Just 3 years later, in 2025, was more than 2x that, over 2 terawatts. Note then it's estimated on current trends the world may have 75 terawatts solar electricity capacity by 2050! All the world's total generating capacity in 2025 from everything, so coal, gas, nuclear, renewables etc was about 10 terawatts. Yet *China now has capacity to manufacture 1 new terawatt of solar, every year*. That will transform our world. Only makes sense: every hour our world is bathed in enough free energy by the sun to power all electricity needs for a year. And solar is now cheapest way to make electricity ever in human history. China gets it: in just 2025 it added 315 gigawatts (GW) of solar capacity -- about like 315 mid-size nuclear plants. It passed 1,700 GW installed solar capacity, about like 1,700 nuclear plants. Of course, much more energy storage is needed to make it firm, so 'dispatchable', but it's happening fast.

European Union gets it. In 2025 it passed a tipping point: EU got 30% of its electricity by solar & wind; outperforming all EU coal, oil, & gas at 29%. From 2026 on, that line crossed, renewables at #1 this gap can only widen. Plus adding in nuclear was 23% more, so the 3 (solar + wind + nuclear) had met 1/2 of demand. Yes, nuclear does face big downsides vs. renewables: nuclear is far costlier, takes far too long to build, is capital-intensive, risky -- but adds key baseload power, and it too emits no carbon dioxide (CO₂). So, an EU at 50% by solar/wind + nuclear; plus hydro/biomass for 18% more, in short meant it met 2/3rds by renewables + firm nuclear. Meanwhile, coal in the EU had fallen to a new low, of just under 10%.

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

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

For where things are headed soon: in mid-2020s US-built solar panels had cost roughly 3x more -- than super-cheap solar panels made in China. Those made in China, enjoyed vast-upstream integration; ultra-cheap cells to make those modules (also called panels); a range of subsidies/state-support; sold at a loss. China starting with a different business model, had sought immense global sales volumes for a dominant market share even if it meant no-profits, unlike the West. As a few lingering European PV makers too faced Chinese PV being sold *below* production costs. Europe doesn't impose very big Tariffs (unlike US) so China PV was sold in Europe at less than *half*, US prices. By late 2026, efforts in China to end that 'involution' (senseless profitless competition by selling green energy products below costs), had raised its solar module costs from super-low around 10 cents, in 2024 -- to 12 cents/watt.

Meanwhile other competitive not-quite-so-very-cheap panels increasingly came from India, Vietnam at near 17 cents/watt. All tough when compared to US solar manufacturing making US solar panels with less subsidies, that cost 37 cents/watt and more. That 37 cents+ for US solar was far-too-costly vs. China-solar panels that in 2024 had hit super-new lows. And was too-much of a gap as well, versus solar panels also built cheaply as in India in 2026.

In response, the US approach from late 2026/2027 was two-fold. To both 1) give modest yet notable manufacturing subsidies to domestic US solar manufacturers (called Section 45X) of 4 cents for component cells, 7 cents for finished product modules: this knocked-down costs to around 21 cents/watt for US-built panels. Not very far from non-Chinese competitors building solar pretty-cheaply like in India, Asia. And 2) US also importantly built-up newer tariff walls (called Section 232) against all non-US manufactured solar. This separate provision added a 15% tariff -- and set a floor by which imported cells cannot be sold in US for less than 22 cents/watt; and finished panels cannot be sold for less than at 38 cents/watt. Wham! This suddenly made US-built solar-prices more competitive, at least inside America.

Notably a core American EV manufacturer in 2026 set-out to build in Texas a largest-ever US solar plant, among biggest in world. Code-named Crystal Sun, to cost \$10 billion, it will manufacture both cells needed for modules to final-panels themselves. It is thus vertically integrated, which makes a great deal of sense in terms of what is needed. Given too recent pro-US antidumping and countervailing duty (called AD/CVD) and Section 232 rules.

So big picture, a global floor for very-cheapest solar was rising 2025 on China's moves to stymie manufacturers from selling at a loss (from a bottom near 10 cents in 2024). Rose to around 12 cents in 2026. With new 'anti-involution' policies, acknowledging a need for profit; to help it's own solar manufacturers but with a shake-out that was just beginning. Rest of world meantime, was catching up to China's own past-abilities to so lower its own solar costs in first-place, via greater manufacturing know-how. So, costs were converging some, up in China -- down elsewhere, towards teen cents/watt. As world minimum (China) solar floor -- rose near to mid-term. In US costs to install say home solar is dominated by far higher costs not for panels, but for example for permitting, installing, labor. So cents/per watt for the panels was a not a main issue in America, in context of total overall solar roof costs.

Meanwhile, other nations are competing ever more-strongly. India added 20.8 GW PV manufacturing capacity in 2023; rose to 65 GW. Then pace of growth only quickened. In 2025, it passed 100 GW. By mid-2026, it passed 230 GW. Just is 'nameplate' GWs -- since solar is intermittent, that 230 GW is quite different from firm, always-on generation. But when sun is shining, that's a tremendous amount of electricity from free-fuel sunlight.

China's huge spare capacity still makes growing US PV manufacturing a tough proposition without both tariffs (to raise costs of China panels), and subsidies (to lower cost of US manufacturing). US subsidies to deploy solar/wind farms had ended. But incentives to build, manufacture solar/wind in the US like 45X, remained. With US/China price wars ongoing, not only in solar. Tough pricing is seen of course in EVs too. China eyed making EVs in Mexico, Canada, maybe even right in US -- which was a chilling thought to US automakers falling farther-behind in building EVs. As China grows capacity & efficiency in search of demand. So it's important to note what China's does to quickly lower-costs, build massive capacity for new green energy technologies in the first place. All in just a few decade's time.

For scale & pace of the solar price declines, consider 2 compelling paragraphs from Raymond James of February 7, 2024, marking a milestone of just ten cent 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 China and Asia has become, as steeply falling prices inhibit competition from adding capacity. Module pricing in China mid-2024, was about just ½ that 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 some bottoming; perhaps small profits hopeful salve for wind.

In sum, amid that 2020s overcapacity, China *could* manufacture twice the number of panels being installed worldwide. As US electricity demand near-term to end of decade, was growing fast; much on AI data centers. Solar PV *may* well become the planet's single biggest source of electricity in mid-2030s. Late 2040s, solar *may* be even the biggest source for energy -- not only for electricity. And that electricity may cost just ½ of electricity today. So, the future perhaps, may be pro-renewables-biased. Still, getting past a tumultuous 2020s to see perhaps profitability later, to wring out over-capacity, is a huge obstacle. Thorny gulf to navigate, if ever! As China lets its solar pricing rise in name of what always was going to be a necessity: economic sustainability. Important since coal is now a loser; both in costs for its electricity -- and coal is a climate villain too. So China is pivoting hard from coal -- to solar.

Yet, for 'modern' US paths 2025/2026, a big top US choice then, was: coal(!). As recently as 2024, many US Utilities planned to retire ½ of America's coal-plants, by then-soon-2028 on its failing economics. Coal today doesn't have a chance. It's about 2x as expensive, as a 'less-filthy' firm, abundant fossil / natural gas. A coal plant needs hundreds of employees vs. 'just' dozens at a gas-fired plant. Coal can't dial-down output easily as renewables push electricity prices to zero, or negative! US coal plants are often 4+ decades old, see frequent breakdowns, maintenance, health costs. No new coal plants came online for years; output was flat. Yet from 2025 on whole of government powers, a white house sought startlingly inconceivable costly actions, obviously non-economic, trying to prop up dying US coal.

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

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

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

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

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

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

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

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

Something likely to be short-lived, was culture wars spilling into energy. ‘Each side’ playing to its political base. A Utah utility also in red states Wyoming & Idaho -- was encouraged to (and did) pull out of 3 blue states: Washington, Oregon, California. Latter 3 states aim to burn less coal; so differing narratives caused rift. But economics will in time, win out. For instance, a then-US administration that forced a 64 year-old coal plant to stay open in Michigan in 2025, had cost its ratepayers there an added \$259 million over ensuing year. Though the plant’s owner, the state, & energy regulators all wanted to shut it down! The administration’s order were over-ruled by courts in latter 2026. Still, that white house’s thinking to use Soviet-era-like energy diktats, can’t go on. Propping up coal is costly, so likely-to-be-short-lived.

To prioritize fossils over consumers, regrettably & foreseeably, meant higher electricity rates. And propping-up coal / while harming solar & wind, could Not cut Utility bills. Nor had a 2026 'war by choice' in Middle East, cut energy or gasoline costs. Such US policies instead hit affordability at all income levels; but mostly for low & middle-income families. Early 2026, 1 in 4 families said energy bills were unaffordable. Those making <\$30,000/year, saw % of income for home energy hit a daunting 9%. Utility bills in arrears hit \$23 billion end of 2025: heading higher. This is not a discretionary debt, it is survival debt. Costs to heat homes early winter 2026, were up 9.2%, or 3 times broader inflation. Went higher after war in 2026.

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

Bigger governmental mandates and more regulations, have Not grown clean energy faster - nor were liberal state governments able to impose more renewables. New York state in 2019 had a Climate Act calling for renewables; yet in a 7 years since, 2019-2026, 14 states added more solar/wind, than New York did. Renewables thrive in free-markets: as cheaper paths usually are solar & wind. Note too a conservative party nationally, that made much of its (fig-leaf) talk of balancing budgets, threw aside 2025/26 to run US economy hot. Self-proclaimed 'fiscal-conservatives' (ahem) voted for \$3.4 Trillion+ worth of deficits. May lead to a market rebellion: US can't borrow endlessly. Other nations too hold US bonds; seeing US wanton profligacy, they may demand higher yields on 10-year Treasuries. Of massive \$32 Trillion+ in outstanding US public debt, a sizable 1/3rd was held elsewhere, overseas. In 2025, China as 3rd biggest foreign holder of US debt net sold in every month, March to end of that year amid trade frictions. 14 years prior in 2011, all federal outlays were 'just' \$3.8 Trillion; but in 2025 it was \$7.1 Trillion, a 87% rise. For FY 2026, the US deficit alone was \$2.4 Trillion for full fiscal year, a non-pandemic record. Yet an oval office sought 50% bigger defense budget. Not just public debt is worrying: so too \$3 Trillion private credit; rules based on 'mark-to-market' which can become exceptionally volatile. A leading banker has said of hidden loans / private credit defaults, "when you see one cockroach, there are probably more".

It's not as if US energy policies 2025/26 'backfired' on that oval office. Nor that it wanted 'less of X' (less wind & solar) -- yet got more. It had desired & 'successfully' hit renewables. At issue instead, was perhaps that getting cheap + more electricity was possibly not #1 top priority. Just maybe aim was adding more fossils + nuclear, plus frankly visceral dislike for green energy. That electricity prices in 2026 hadn't dropped by ½, gas not under \$2/gallon, energy abundance not unleashed, perhaps were secondary; not as vital. Latter goals surely were hoped-for, yes; but to achieve those, would've meant very different US policies.

Consider the business model at an alternative data center builder. Rather than build as is typical, 1st the compute infrastructure, then look for power; it had flipped that on its head. It 1st found sites with very cheap ample electricity. So it's been better-prepared, given US policy mistakes that have meant tighter power, higher costs, grid constraints. Key chokepoint now in standing-up AI/data compute (or crypto mining) isn't finding chips, capital, hardware; instead, it's finding access to (cheap) electricity + a grid priority. Because so early-on it put high priority on 1st cheap, sustainable ample power + priority grid access, it pre-solved much. First-mover advantage. Avoided what competitors face today, in seeking power + grid space for ever-more-unpopular AI compute, or prior crypto-mining. Let's see what they did.

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

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

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

Was wise to choose renewables-rich North Dakota. Neighboring, also conservative, South Dakota is even farther ahead: it got 80% of its electricity by renewables in 2024: 60% wind, 21% hydro; just 19% fossil fuels (11% gas; 8% coal dropping fast). As a 2nd term oval was soon to end start of 2029, new US national leaders can draw on lessons from a painful latter 2020s. Of awful economics of just fossils & nuclear. Pressing need for smarter & cheaper electricity, thus both far more US renewables + storage *might* see renewed favor from early 2030s.

What's to be done in then-brief time to 2030 re: energy-hungry unpopular AI/data centers? For say 10% of potential 600 GW new power; that 60 GW is still a lot. Where access to rock gas is easy in so many US regions, ~½ of centers may use 'temporary, portable' gas generators, initially. Lots & lots of 'small' gas-fired units, on big turbine bottlenecks, grid constraints. Even reconditioning jet engines! A large US firm makes heaps of tractor-trailer-sized 5.7 MWe generators; put together for say, 600 MW plus fast generation. For onsite, behind-meter, bridge-to-grid, firm rock gas power even though costly. Very polluting, noisy; understandably much local opposition. Or alternatively co-locate next to extant gas plants (or nuclear) for physical direct-tie-in to avoid congestion, bypass getting onto constrained grids. Whether AI itself should instead be paused, slowed, guardrails placed on it given concerns it escapes constraints, is a serious, real, yet separate question; we look here just at energy aspects.

Clearly, energy storage must scale-faster. Yet Li-ion batteries only peak-discharge to 4 hours. So, long-duration solutions lasting 100+ hours needed to help ramp cheap solar/ wind. Firming geothermal needed too. Storage adds flexibility. Politicized (at times) opposition to sustainable energy some places, may mean hybrids: some rock / natural gas for firmness, plus solar & wind + short/long storage. Yet even then, ever-volatile rock gas is at times very costly; piped gas can be constrained, in places not-ideal. So look at hyperscaler going up in Minnesota on arguably better design. Its 1,900 green MW will lower local costs + improve reliability: as 1,400 MW of new wind, 200 MW solar; with iron-air batteries' far-longer-storage, discharge lasting not 4 hours, but for 100+ hours. Grid improvements are paid-for too. With 100+ hours of storage that bridges several nights, windless days too. Sodium-ion batteries ahead will be super-cheap, capable of 10,000 cycles, with decades of working life, thermally stable.

To instead, rely on portable rock gas power -- few renewables, is arguably a poor-work-around. Results too from grid constraints. Didn't have to be this way. China's greater GDP growth, near 5.0% -- beating US -- is partly on much-faster-renewables-growth / policies. Its big solar, EVs, batteries etc, drove over 1/3rd of that growth in 2025. 90%+ of investments; huge USD \$2.1 Trillion in economic output, 11.4% of country's GDP. New energy helped propel near 5.0% growth. Without those new energy industries, it's growth in 2025 may have been a lesser 3.5%. Its annual green industry growth accelerated too from 12% in 2024 -- to 18% in 2025. Growing faster vs. wider economy. While it did put USD \$260 billion in old dirty energy -- it put 4x that, USD \$1 Trillion in clean energy. In 2025, renewables had made up over 60% of China's total installed power generating capacity, and that figure was only growing.

Contrast that -- with a US trying to prop-up ... coal! Intent to stop new solar/wind. Late 2025 / into 2026, a US president repeatedly posted on his social media site (really), "windmills are killing all of our beautiful bald eagles!" but he mistakenly used an old 2017 photo of kestrel in Israel (not a bald eagle; they're only in North America). Doubtful bald eagles really are his concern. And a fact is, policies for more coal can't meet fast-growing US demand: US demand grew by 20 GW in winter 2026 -- vs. winter before, may soar next decade by over 220 GW. Much on AI/data compute. In a big US winter storm 2026, especially batteries (& nuclear) were heroes in Texas, where new 16.6 GW of battery capacity supplied 5 nuclear reactors' worth of electricity at crucial times. In 2021 Texas had then just under 1 GW battery storage. Policy matters. Or, consider say, quantum compute; a crypto coin and much else relies on encryption by the elliptic curve discrete logarithm problem (ECDLP). Unless US policies here are updated soon to post-quantum cryptography, then a so-called 'Q-Day' could render much current safeguards including for US energy, ineffective. In sum domestic policies can and do have impacts; it's worthwhile to pay attention to paths, the directions taken.

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

Near-term, positive effects can briefly mean a rise in *GDP, *stock markets. But also Debt. Far longer-lived, worsening problems: *Inflation; *Affordability, *Debt Reduction etc. And that administration's '3-3-3 Plan' was likely to be very very wrong: it forecasted US deficits, will: *fall* to 3% of GDP. Wildly wrong; as was a 'second 3' of their 3-3-3 Plan: it predicted US oil production would rise by 3 million barrels/day (bpd). No surprise neither happened. Deficits scarily *rose hard*, to 5.9%; worse & wrong direction, far above a 50-year average deficit of 3.8%. A 2026 attempt by Treasury to buy-back 10 years-30 years long-bonds, to lower yields, was ignored immediately by markets; \$6 billion to try that, was far too small. Had instead Plan A worked: if US manufacturing & hiring had boomed, for new \$2 Trillion+ revenues; consumer confidence jumped; if affordability, inflation was licked; industry in renaissance -- would have been great(!). His frequent promises included: US manufacturing will now be the greatest in history! He'd have vanished all inflation! That electric bills would be down by ½. That the average national US price for gasoline by 2026 would be under \$2/gallon! Wow.

Tragically, such 'expectations' were bound to be wrong. Huge tariffs won't bring back US manufacturing jobs. Deficits, went up. Nor was affordability 'solved' via far more debt. Indeed, dismal election results 2025, 2026 were a rebuke to party in power. [*Note: other party hasn't fixed issues, either!*]. That president did offer a dog's breakfast of promises: \$2,000 checks from tariffs instead of No Income Taxes. While claiming over & over America in 2026 was in a "Golden Age", "lowest inflation ever", "greatest economy we've ever had". As deficits, debt, confidence soured. Yes, US GDP at first rose; one '3' in '3-3-3' Plan. But on huge deficits, so a painful sugar-high. Still an oval showed it quietly could reassess; perhaps even change some economic policies, since its original plans had so very little success.

A review above is arguably worthwhile, for eerily-similar things were seen too, in US energy policies. Oddly an administration adhered to just costliest options, of fossil + nuclear -- while opposed cheap solar & wind. Promised to somehow(?) *cut electricity-costs*, though not possible on its policies. No surprise US electricity rates rose all 2025, higher 2026. With cheap electricity Not prioritized, it suggested an oval (office) not yet serious, could not "unleash energy abundance". Such mismatch of professed aims -- vs. undeniable results, defied logic; those oval (office) policies were all having opposite effects. Even oil industry execs 2025, 2026 vented frustrations, in private. As a leader's fixation on stopping wind -- halted permit reforms in the senate for all US energy projects. Oil execs weren't shocked gas in 2025, 2026 was far from "under \$2/gallon". As US oil production even mid-2026 was not meaningfully above late 2024. And an oval looked to Venezuela for relief, but no joy. As we'll detail, those odd US policies all 2025, 2026 were ironically, opposite of conservative, small-government, less-debt, open-to-competition 'red' US states, with the lowest-costs for electricity.

One clear metric here is *Price of Gas at the Pump. A president promised US average gas would fall under \$2/gallon in his 1st year back in office, by mid-2026. Yet, went from \$3.22 on inauguration day Jan. 2025, to not down at all, over \$3.90+ one year+ later, in March 2026. Playing with numbers a bit, a president claimed in a 2026 State of the Union, “gas prices in most states are now below \$2.30/ gallon, and some places, \$1.99/gallon.” Wasn’t true. But moved from *national* price, to gas just in few cheapest states for lowest possible figure. Even then only 2 of 50 states were barely under \$2.50. Then, took cheapest few *individual* gas stations in all US! 8 gas stations in all US just under \$2: of 150,000 stations, was 0.005% of total! To go from promising under \$2 US national gas average at pump, to claim a win on just 8 gas stations in all US, was quite a stretch. And that before war in 2026 spiked prices.

To put that president in a best possible light, we look first at 2025 -- before his ‘war by choice’ spiked energy in 2026. When campaigning, then in office, he’d seemed earnestly to believe he could push gas under \$2. His administration’s ‘3-3-3 Plan’ claimed by deregulating, they’d add *3 million barrels/per day (bpd)* to US oil production. To go from a 13.6m bpd crude of his predecessor (whom he deemed a ‘loser’) last full month of prior term -- to a big 16.6m bpd right away. Perhaps, he hoped to fast push US oil down to \$20s/barrel, for gasoline under \$2/gallon -- even though many US wells are uneconomic, below \$60 barrel. Hoping oil drillers despite free market signals for fewer rigs -- somehow boost rig counts. Then, even more remarkable: his administration was claiming they’d entirely succeeded: that US price was under \$2 per gallon in 2025. His advisors were not serving that president well. And their badly-failed ‘3-3-3 Plan’ was hardly again referred to, was not mentioned again.

Even broken down as 50 states, not one state was even near \$2 in 2025. Still an oval office in Nov. of 2025 stated [wrongly] gas “prices have plummeted to lowest in 2 decades” [not true], a “bit above \$2 now, going to approximately \$2 very soon” [didn’t happen]. Of course, no US president buys gas at the pump, so can’t readily know price in ways Americans do filling their cars. Yet, his advisors should still have told him fulsome boasts were wildly off. Gas briefly did fall under \$2, in his own 1st term: that was on a pandemic, demand collapse, ‘tank tops’ 5 years earlier, 2020. Yet he claimed in May 2025 gas “hit \$1.88 in 3 states”. In July 2025, “hit \$1.99 in 5 states”. [All incorrect; maybe grasped at just a few gas stations]. Anyways on his policies, a US could not then get US gasoline average under \$2/gallon: opening easy US tracts *might* push oil down briefly near \$50s/barrel; yet many rigs are un-economic at such prices. *And oil must fall into \$20/ barrel, for average gas under \$2.00 -- and then stay there.* But in that case, US rigs will be shut-in, rig counts fall. All well-understood by oil executives who’d privately vented 2025, then in 2026, about erratic energy policies.

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

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

2025, 2026 on everything imaginable -- plus some that hadn't been-imaginable, was tried - to stop wind & solar. For US actions off the bat, in 2025, federal officials: Declared a national emergency intended to help hasten permitting -- and yet they strangely carved out solar/wind/storage as 'not energy' (January). Froze permits for new onshore & offshore wind on public + private lands (also January). Interior deemed solar/wind "precariously inadequate" so a national security risk, on that basis, blocked new renewables deployment (in February). Removed solar/wind from cheapest & fastest energy Lists, struck off affordability agendas. Canceled an enormous 6.6 GW(!) solar project and 5 GW battery storage for 62,300 acres in Nevada desert, as on federal lands. Canceled 800-miles of 5 GW transmission that would have sent cheap wind power out from America's Midwest. These were just a few examples.

In many of its attempts to kill new wind and solar, that oval/administration lost in the courts. For instance federal law requires the US defense department complete reviews of proposed offshore wind turbines over 200 ft., within 75 days. The department instead slowed its reviews to well past that, then halted it entirely: clearly violating the law. For a second time, courts told that administration it cannot arbitrarily halt review of proposed wind projects.

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

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

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

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

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

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

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

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

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

An administration criticized Safe Harbor, threatened retroactivity. Underscored a willingness to push boundaries/norms. To empower clean energy foes, an Interior Dept memo stated renewables on federal lands/waters needed an ok from Interior secretary: gave 70 ways it may apply. Another concern was a 4-year window to 'begin construction by' on home solar might end at the end of 2025, even if 5% of fair market value is spent. That did end. The treasury department had tried to also end that major credit for big commercial and utility-scale solar, but the courts stepped-in, and overruled it: kept in the 4-year safe harbor and 5% fair market spending rules for big projects. A loss for that administration -- but a big win for building more-electricity generation for America. Still, if that administration had intended by a one big Act to 'set the table' in 2025, for 'feast of tax cuts' in 2026 -- here too it failed badly. Rather than Act putting tax cut dollars back in peoples' wallets in 2026 -- its 'war by choice' in 2026 caused oil prices to spike. Should have been an obvious predictable outcome; but time and again erratic actions were then undertaken, not-well-thought-through.

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

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

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

A 3rd name in *fuel cells was up 400%+, 5-fold 2025. Fuel cells are highly-relevant, so long in ECO theme, yet loss-makers for 20+ years! This component is a bit different; unlike needing pure hydrogen / H₂, tough for high costs etc, it uses common natural gas (methane/CH₄) fuel that's everywhere, easy to use. Rather than burn, exothermic polluting -- this instead strips CH₄ to H -- so hydrogen protons (as ions) plus electrons (electric current). Downsides include 'stacks' run hot so short life not yet much over 5+ years; efficiency not much better (yet) than natural gas plants, & costly. Still, big natural gas-fired plants take years to build; these can go up fast; stackable, less NOx pollution. AI hyper-scalers need electricity fast; they may add lots of small portable gas-burning generators, or turn here. On new deals, nimble execution, interest rates, this one, long in ECO, jumped in 2025. As another Index component also making electricity without burning, able to use a variety of fuels, pivoted from EV truck engines, and turned to data centers; it uses quiet linear approach based on Stirling cycles.

Rises seen above in 'winning' green energy equities of 2025 -- were on facts-based reasons. Based on insightful business models, each path thoughtfully laid-out. Stands in stark contrast to 'losing' political-based propositions that sought to prop-up dirty energy, even coal. Those came from a different place, politics far outside clean themes. Latter 'dirty energy' hopes arose too out of unfathomable logic. Reasons given at first blush, were their being pushed to: 1) 'slash electricity prices in half'; 2) *push gas under \$2/gallon, 3) unleash US oil abundance at record 16m bpd levels. Yet a politics-derived push that's pro-old-energy / anti-new-energy, indisputably was not-thoughtful; it was haphazardly, un-seriously conceived.

Effects of those US energy policies came fast. (We focus on energy, as it is our work). After signing a hallmark 'one big Act', US electricity costs *rose all 2025, up 6%+*. Went only higher -- by a lot! An administration's main '3-3-3 Plan' (no longer much referenced, as it failed) promised to 'unleash US energy abundance'. Claims for one 'of its 3s', was it would increase US oil production by 3 million barrels/day. Note then US production last full month of a *prior* president, was-then-record 13.6 million barrels/day (bpd) back in Dec. 2024. A full year later, on new administration, mid-2026, it was only just fractionally, barely more, 13.8 million bpd, a very small, meager rise. Hardly up at all -- let alone by huge 3 million to 16 ½m bpd. Yet, an oval office often boasted it reached amazing records, though a tiny bit higher. By playing with numbers, they could (barely) say a 'record'. But production was barely up.

National US gasoline (gas) price had dipped a bit 2025 -- mainly on overseas more pumping by OPEC+. (Price would soar of course Spring 2026 on a US war by choice), Americans see gas price up close, so undeniably it was Not near under \$2/gallon, not 'a dollar something' /gallon. Prerequisite for gas under \$2, is US oil output must go up hard, so the oil price falls to \$20s/barrel & *stays there*. Yet \$50s/barrel oil is unprofitable for many US drillers, Too low. That didn't happen anyway: 1st half 2025 US oil production *fell*: it didn't rise to over 13.6m bpd until Oct. 2025. And then went to just 13.8m bpd in mid-2026, not meaningfully more.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

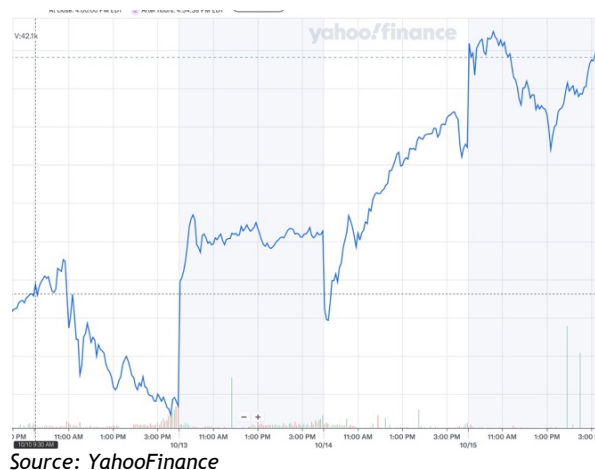
By no stretch can Saudi Arabia be deemed 'liberal'. Nor, are its policing driven by climate, or CO₂. But what they're doing just makes sense. Sell costlier oil & gas to others, and swiftly build domestic, cheap solar & wind + energy storage, grid for themselves. They're making power at smartly lower costs. Looking ahead, to when fossil fuels no longer have value. Sure, they're making clean electricity. But power is what's needed, and this is for a few cents/kWh, even with added costs for storage/ better grid to solve intermittency. Again is not a windy place -- political will is the driver. Anyplace with winds, sun can/should do as well. Norway provides cheap hydro-electricity in its north at among lowest costs in Europe -- while selling its oil & gas abroad. China in 2026, had developed Y-shaped floating wind turbines of massive 50 MW size, that 'blow away' [no pun intended] anything to date. They'll push down wind costs never-ending ways, unlike fossils. A US state of Texas, can like Saudi, have cheap clean electricity for its people + and sell pricey oil & gas if desired. A US leader might call coal, "Beautiful & Clean" [it's neither] -- but doesn't fix dismal economics. In diverse places, electricity costs are fast getting cheaper, because they're adding more renewables, including China, South Australia, Portugal, Saudi Arabia, or states in the US too, including both South & North Dakota, Texas, Kansas, Iowa, Idaho, etc etc. Explains so much at a glance.

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

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

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

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



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

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

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

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

Brings us back to a *very high* CAPE end 2025, at 39 or 40. Such elevated level we repeat is tremendous reason for concern. Especially for volatile themes, like clean energy. Or note not just 10-year smoothed CAPE -- but also 'plain' S&P500 price/earnings were up hard, as well. More commonly, P/Es in S&P500 are near say 20; yet in Sept. 2025 measured P/E ratios had hit a statistically-worrisome 30, as calculated by all expenses, counting official profits already in books only. (S&P500 Index divided by GAAP net earnings, posted in prior 4 quarters, only). Hence net result of plain P/E valuations at 30, CAPE at 39, is these *must be worrying*; implies broad markets are (too?!!)-expensively valued historically. Worrying for risky, high P/Es green-themed baskets. Compounded by fact after a nadir clean energy low April 9, 2025 at just 28, theme went up 100%+ in just 9 months to end of 2025. Plus, spiraling debt. War in 2026. Very justified, fears of Stagflation. All argues for maybe reversion to mean. Fear of big falls after frothy valuations, gains in 2025 & 2026. A frighteningly-real possibility for both broader markets (driven especially by AI valuations) and so for any clean energy theme.

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

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

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

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

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

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

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

Bit like end-results at big-government liberal blue states, like New York, also costing more. We saw New York electricity costs 2x Texas -- and it added far *less* solar/wind than did Texas. Or take California's high electricity/oil/gas costs. Not prioritizing cheap power, it's huge subsidies; 8-11%+ Utility returns on equity, harming ratepayers. A San Diego Utility sought 11.25% return in 2025! (Though a problem is its Utility assets are uncompetitive vs. cheap renewables). That first-mover state locked in some high prices; 1980 solar was \$35/watt; by 2024 it was down at 26 cents/watt(!); down 82% from 2010 - 2025. Yet some big wins too: California for instance is vastly scaling-up its batteries: helps immensely. Summer of 2020 it had under 100 MW battery storage when heat then led to rolling blackouts, a Stage 3 power emergency. Yet in hotter Summer 2026, there were No grid blackouts. The big difference? By 2026 it had over 17,000 MW of battery storage available; a bit like 17 nuke plants (vs. just one big-nuke then). By 2045 aiming to be carbon-neutral, it could add another 25,000 MW+ more batteries. As technology improves, new batteries like sodium-ion will be cheaper, safer, last-longer. Or May 2026, California was world's 1st major grid to rely all month on solar for over 50% of its electricity. Yet issues are seen in liberal places: UK sets just 1 electricity price nationally, so windy north lessens costs in populous south -- yet north pays more for it's wind-power. UK's very-high rates due to costlier rock gas, 90% of time. Or Germany sets fuel mix, higher taxes, & rates in pursuit of social outcomes. Today a liberal UK, Germany, California, are 'high price losers', where too-much rock gas hastens de-industrialization.

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

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

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

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

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

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

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

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

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

Here, at these Indexes, we're non-partisan. We'd prefer to avoid all politics. But lately was unavoidable, with impacts so relevant to the clean energy theme. In 2025 a 'one big' bill very notably was moderated last hours by just 1 vote in senate from president's own party. Less known, is that bill was nearly hit hard in house, too. Had a representative (debt-hawk) voting No, attracted 2 more No's from president's party, given the huge deficit-spending upon which that bill was based, that could have sunk it. That house member of Kentucky vexed a white house 2025, 2026 (as did state's US senator too); that the president later 'primaried' him was one barometer of how strongly that oval office controlled the party. A side note is that same house member, an engineer by training, had built a unique solar/plus battery for a home and farm power system, if interested in our own rather similar unique solar/plus battery backup system here over the past 15+ years, see: <https://www.wildershires.com/solar.php>

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

Yet whatever happens, one can bet that a visceral, not facts-based politicized opposition, continues to wind/solar. Blame put there for high US costs, even as renewables get cut. In 2025, \$18 billion in pending US wind/solar projects were cancelled. \$7.6 billion in grants to 16 states cancelled, because primarily or exclusively (admitted by the administration!) they'd go to states that voted for president's opponent. Opposite of 'Build, Baby, Build'. Instead, for renewables, it was instead only 'stop, baby, stop!! As renewables' critics wrongly fall for a 'primary energy fallacy'. They'll note that say from 2022 -- to 2023: the world dependence on 'primary energy', that is fuels for heat, fell by less than 0.5%: hardly at all. Dipped slightly from 81.9% - to 81.5%. Yet, that's such a mis-leading way to view energy: heat is Not what's usually desired! Highly inefficient! That is the primary energy fallacy; conventional energy advocates trot it out, but it does not reflect the fast-electrification of everything. Nor faster growth of renewables making electricity, cleanly. And more cheaply! A true measurement of energy progress, would substitute out -- burning for heat. Instead look at what is actually desired, and achieved far more efficiently by electricity.

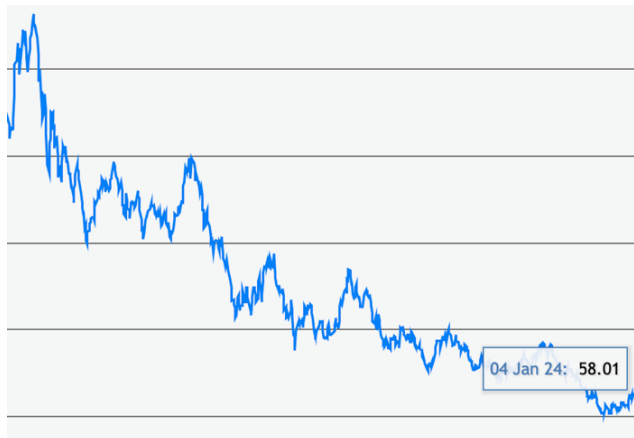
Contrast US policies in 2025 with China's true 'all the above' path, based on best options, so renewables. China planned 2025 to build more nuclear: 35 GW. That new 35 GW generating capacity planned by China, over 5 years, sounds like a lot. Yet, to put it in perspective, *China built 300+ GW of new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

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

On Labor Day Holiday in 2025, a white house made unseemly claims amplified by a favored cable news channel, boasting that US president was "delivering on his promises of lower" gas prices, he was "fully unleashing American energy dominance", "families are saving significant money at the pump". Not true. No state was even near under \$2, for the average US gas price then in 2025. Yet was interesting to see narratives by federal officials like "lower prices are part of a trend" as that administration takes "relentless action to revive America's energy capabilities and undo a [prior president's] stranglehold on American energy production." It promised US oil production was up hard, gas prices down big. Yet US domestic oil production was ... barely up! Labor Day 2024, was 13.4 million barrels/day (bpd). Same holiday 2025, US oil production 13.6 million bpd, so *hardly up!* Labor Day 2026 US gasoline set a sad new record high: over \$4 gallon (\$4.15). It was up 92 cents vs. 2 years prior, up 96 cents vs. 1 year prior! Its policies wildly off. Claiming gas had been under \$2 was bold, but respectfully, untrue. The 1st Amendment allows bluster, but one must be cognizant of truths, hard facts.

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

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



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

One mustn't read anything into it other than to confirm a great volatility, often down! Never predictive, it's ephemeral. One thing noticeable here, was an unusual steadiness, when clean energy fell 3 years - thus say, each high point -- came near-ish start of each year; low point - - was near-ish end of each year. Just for conjecture, it was bit notable after 2021 steady fall, that 2022's high proved near-immediate, at 152.87 on Jan. 3rd (154.41 intraday, on Jan 4th). A hypothetical calendar year low, if another 'exact' $-\frac{1}{2}$ down, just playing may this be near a 76.43 nadir close very late 2022. The nadir low might be, any day of a new year of course - - yet all maths were it's unlikely to be very end of year! So was interesting to see when/where 2022's nadir fell. Unsurprisingly, *not* exactly 76.43! A bit interestingly, though, on Dec. 28, 2022 the theme hit a 2022 nadir low at 76.02. As noted not so far from neat -50%, for 76.43. Just for fun, rounding off to whole numbers, both those points were near 76.

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

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

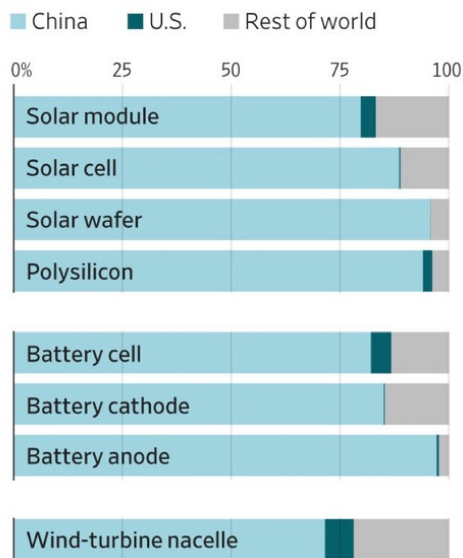
But all above is just playing with numbers, coincidences in past data. What might happen in energy next quarters to possibly herald substantive changes ahead? We know one big change, could be shift to 'All of the Above' strategies nationally. Better yet, de-politicizing clean energy. Fact is it's possible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

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

Instead it's been sad to see a US that invented Solar, Lithium Batteries, lose its lead in both. Soon in electric cars, on China's massive push. China is aligned to be the 1st Electrostate, pursuing industrial policies making it the #1 manufacturer, in solar, wind, EVs -- already reaping rewards. Next batteries, storage, grid. Their embrace of clean new energy innovation, rather than old fossils -- wasn't on climate concerns. But rather raw economics, jobs, energy security. Critical growth drivers enabling its own domestic energy production, exports sales to rise. Jan. to July of 2025, the value of these China new energy exports was a huge \$120 billion; about 50% greater than earned by Petrostate America then from its oil & gas sales. Importantly too, a green-energy China was relatively less impacted buying 40% less oil in war 2026, than would have been a decade prior on Strait of Hormuz closing. (Plus as a longtime trade ally, it could buy oil flowing via Red Sea, that was denied to most of the world).

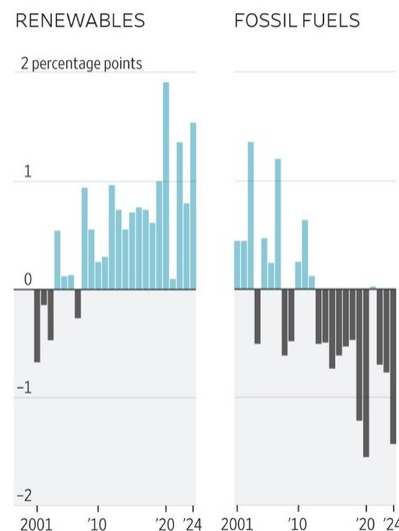
Meanwhile, world is moving massively toward renewable power generation, seen in a chart at right for 2001 to 2024. Leaving fossil fuels behind on cost. This global shift, is something a US administration from 2025, was trying desperately to deny, to evade, ignore -- eg by halting fair, open-competition.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

Global share of clean-energy manufacturing



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

Share of global power generation, by source, change from a year earlier



Source: Ember Energy

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

Obviously we're fans of clean energy. And clearly see the weaknesses of intermittency, non-dispatchability. Yet renewables, unlike fossil fuels, only get cheaper/better. Firming on new long-term 100+ hours storage, & grid. Plus renewables only help on human health, energy security, climate risks, war etc -- all increasingly compelling late 2020s. Solar/wind had grown so cheap, at 3-7 pennies/kWh in early 2025, they win on economics alone. All energy costs rose after, (odd) new policy hit renewables hardest. That said, we're objective, factual, independent in this. Never partisans or politicized. Nor, ever proponents of either party.

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

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

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

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

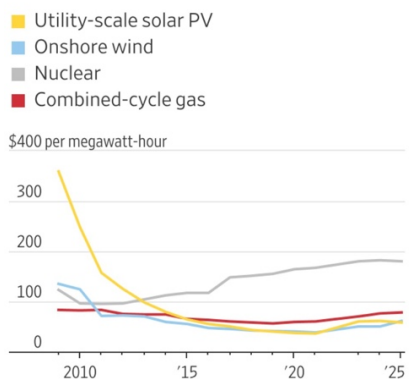
A US president repeatedly made energy news in 2025, opining [often] on his web blog, “Renewables are the scam of the century”... , “We will not approve wind or farmer-destroying solar. The days of stupidity are over in the USA!” It left no doubt as to his sentiments. Was posted on a Wednesday: unsurprisingly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

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

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

Cheap Greens

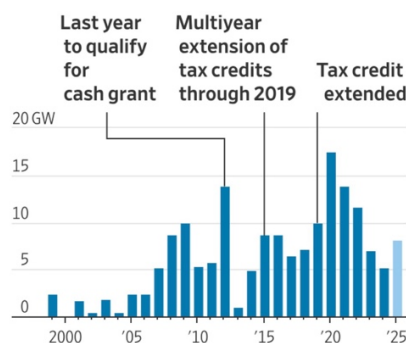
Unsubsidized cost of energy



Note: Average unsubsidized cost of generation over a facility's lifetime
Source: Lazard
Source: Wall Street Journal

Turbulent Cycle

U.S. wind installation by year



Note: Figure for 2025 is an estimate.
Source: Wood Mackenzie (wind installation), NC Clean Energy Technology Center (tax credit extension timeline)
Source: Wall Street Journal

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

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

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

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

Even further, an Orwellian twist: a major office in the US Energy Dept issued 'Banned Words List' in 2025 for internal & public-facing documents, reports. Specifically it dis-allows words "climate change" (as implies it is real and bad); "emissions" (as word implies they're bad); "clean energy" or "dirty energy" (as either implies one is good, one not); "energy transition"; "Carbon/CO₂ footprint" and more (couldn't have made this up!). Yet even oil executives privately fumed in 2025 this US Energy Dept was 'only giving the Oval Office what it wanted to hear', rather than providing facts. Seen as harmful for US oil drillers, as well.

Stepping back & looking at 2025 across energy themes, we saw Oil's price briefly fell -17% in April 2025. Renewables stocks fell at first, too, but rebounded hard. Many facets of clean energy's theme next jumped through all 2025. In other words: clean energy, zero-CO₂, new energy ideas (all words US Energy Dept banned 2025... no kidding!!) did very well in 2025. As broad S&P500 saw P/E valuations arguably become 'excessive' (mainly on a few big AI names) late in year. Then on war in spring 2026, clean energy was put in a favorable light.

Unlike a 1st term, 2017-2020 as stimulative policies promoted *All of energy*, renewables too -- instead much early 2nd term was designed as new *impediments* to harm solar/ wind/ EVs. De facto & de jure, 2025/26 was 'anything but renewables'. Meanwhile differing actions bent over backwards to help just older coal, oil, gas; plus, nuclear. Opposite of 'all of the above' that dominated 1st term, advanced all energies -- or at worst did no harm. Coal-use had fallen hard in 1st term purely on economics; natural gas grew far cheaper, while coal cost rose. Renewables got cheap, fast too -- helped by 'benign neglect' as solar/wind electricity became least-cost, best choice of all. Rapidly, clean energy soon won out vs. once-cheap natural gas. So 4 years after that president had left office in Jan. 2021 at end of his 1st term -- by 2025, fossils/nukes had found it hard to compete with solar/wind. Hence to hobble or to make (now least-cost) new renewables, more costly, from 2025/26 became desirable to some.

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

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

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

Of interest in fast-moving energy-scene 2025/26, was politics, a topic we mainly seek to avoid. Seemed almost as if key concerns about **Costs, Reliability of Energy -- and *Climate Risks --* (both valid) had rifted into opposing camps. As if Energy Costs / Reliability concerns -- were somehow contrary to Climate Concerns, and visa-versa. All pretty ironic as solar/wind are often cheapest. So switching to renewables faster, *saves \$\$\$, reduces* long-term energy costs. Yet politics somehow was conservatives sided with costly conventional energy (only) - while progressives sided (only) with the far cheaper, intermittent wind & solar.

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

Tariffs weren't modest, nor fast-ended. Problems included an ugly, massive **\$3 Trillion in Debt(!) can't be repaid readily (and is worse with many tariffs ruled unconstitutional). Unwise to try to force artificially low rates to try to 'inflate away' debt. ***'One Big' Act's stimulative effects were on order of tenths of one percent; while added massive Debt. **Also a white house & congress halting solar & wind, made electricity *more expensive*, with demand rising. Brings us back to oil. Recall its brief oil price drop April of 2025 on acute fears tariffs may hit demand. As a candidate, that president had promised repeatedly, he'd push gas down under \$2/gallon in his first year. So, his administration should want & need to bolster certainty; be stimulative (so no tariffs). To *Increase US Oil Production, also means *Increasing US Oil Demand. One, without other, will not work: Confidence in robust near-term future oil Demand, is Prerequisite for oil industry to make investments in more fracking / more rigs/ more oil production. Yet spring 2025 fears were big US tariffs would *slow* demand growth ahead. Earlier, start of 2025, US oil supply was anticipated to swiftly go up from its 13.6 -- to past 14 million barrels per day (bpd), 9.7 bpd shale. Maybe 3 million bpd more, for 16.6m bpd on crucial, stronger oil demand. At heart were then-confident-predictions (thus made before tariffs) of strengthening US growth happening right away and over 2025.

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

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

Thus white house energy policies of 2025/26, respectfully, were deeply mis-guided. As costs did Not fall by ½ for electricity; but rose, and going higher. Nor could many big US natural gas plants be brought online before 2030 as wanted: turbines not available; plus fossil gas as fuel is volatile, often costly. Coal, worse. In China coal is costly even on sparse human health, environmental standards; renewables are its cheapest/best option. Industrial electricity in some parts of China, was just 3-5 cents/kWh on massive growth in hydroelectric, wind, solar, better grid -- vs. US fossils costing twice that. Electricity in China ever-less from coal. Instead, it will face very big costs ahead in dismantling the world's largest coal infrastructure.

Or, take oil: could a president 2025/26 convince US frackers to ignore markets, grow supply & push oil into \$40s or less, gasoline under \$2/gallon as promised? With its 3-3-3 Plan, keep US GDP growth at 3%+? All key!! Shale producers resisted white house calls to add huge supply, on fears of surplus. In 2025 US rig counts had fallen to lowest since 2021, as confidence in demand fell. At a big oil services firm counts fell to 566, 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. Still, that's a normal kind of cycle. However, if oil drops into \$40s, or especially into \$30s(!) that sets stage for high prices later, on fewer rigs. Strong demand is key. All as administration sought to grow US oil production, by promised added 3 million barrels/day in its 3-3-3 Plan, to go from 13.6m in late 2024, to a new 16 ½m barrels/day in 2025/26. Despite odd *tariffs, so *uncertainty -- *working against firming oil demand. Erratic tariffs based on untested self-proclaimed, emergency powers: many arbitrary and likely to be held unconstitutional, as power of purse resides in congress. All that *may* portend less demand, ahead, so fewer rigs - - inexorably a return later to high oil prices. That's economic cycles. An oval wanted tariffs - - while oil executives privately feared slowing demand. Markets, not any US president's asks, are what most guides oil industry coming rig counts, and its shale and other investments.

2025 had unfolded far differently from a 'goldilocks' stable 2023/2024 when oil had traded in tight range industry desired: \$70s - \$80s. Some hoped a white house might self-proclaim 'Trade Wins', call it a day. But an underlying Gordian Knot was oil dropping into \$40s, gas under \$2 -- is they are fundamentally incompatible with prices, staying so low. Privately, oil execs understood it all well: a white house can encourage, open drilling areas, cut red tape -- yet it can't overcome basic economics. For gas to go low & *stay under* \$2, needs confidence of demand. So as to maintain higher rig counts and so production. A slowing economy means fewer rigs; later on, higher price. We discuss ahead a 2020 oil crash, that sent gas under \$2/gallon in 2020, on much differing fears then of demand collapse, 'tank tops'. Later went opposite way 6 years after, with a fear then of dreaded 'tank bottoms' in 2026.

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

Several big clean energy topics were debated, decided in 2025. Tightly-bound to overarching questions of which way to go on America's economy. One key question was, how (not if) an IRA of 2022, abhorrent to conservatives, gets eviscerated. Beyond decimated. Part to 'trim' \$3 Trillion debt; yet plainly too on grievances over solar, wind, EVs. Inconceivable to have then crafted a genuine 'All of the Above' energy strategy. One inclusive of *true* US energy abundance, so more solar, wind. That couldn't be, when an oval + 1 party in power wanted fossil only; a unitary executive halted renewables. It picked 'winners' (fossils), and hit 'losers' (renewables). Weirdly it pursued anti-conservative, anti-free-market policies. Though truth is: adding just fossil fuels = actually meant higher US electricity costs.

From 2025 and 'one big Act's' increasing deficits, unpaid-for-tax-cuts, a core question since is, Did it work?! Was that candidate, then president right: Are we all as he'd predicted now shouting, "Please, Please Sir, It's Too Much Winning!!". One possibility (we hope so!) is: Yes! *If (it's a big If!) that president was right, there's been huge jobs growth from 2025! Manufacturing moved from Asia, to the US! US manufacturing/jobs are now booming! 10-year Treasury Yields down from near 4% into the 1% or 2%. His Big Tariffs / Tax Cuts plus costlier energy is growing US economy! If oval office was right, new jobs/non-farm monthly payrolls from 2025 over 200,000+/month. Jobs growth humming. Inflation under 2%. Unemployment under 5%. All tariffs deemed Constitutional. If president was right, oil is now near \$40/barrel; US average gas price 2026 is below \$2/gallon. US oil production up, 16.5+ million barrels/day. If POTUS was right, US growth prevented \$3 Trillion in deficits, from being debt. All what a US president + his allies had promised. So much anathema to classical economists -- yet was say a possibility(?). Very forcefully pushed by candidate, then president, and his allies.*

However, another possibility to contemplate is: *his policies meant costlier electricity, and gasoline. More debt; there was No manufacturing / Jobs boom.* US industries not re-shored. China's decades of industrial policy, far lower wages, supply chains taking decades to build, resisted easy US replication. 10-year Treasury yields did Not fall falling: instead rose maybe near 5.0% or higher! 10-year auctions need to attract inflows, yet little confidence US will tackle debt other than 'inflate it away'. Maybe stagflation-(lite) on fears of souring economy & inflation. Affordability an issue. Non-farm payrolls jobs maybe down near 100,000/month or less(!). Hiring slowed. GDP/markets went up at first: but on painful sugar-high of US debt; private credit worsens. For say K-shaped or E-shaped economy. Falls in personal consumption expenditures (yet BLS once-gold-standard data in doubt). Many tariffs found to be Unconstitutional. Mass deportations not helpful; US food prices high. GDP/ stock markets did briefly rise near-term, then teetered on narrowness of AI gains. Much threatened by debt especially after so many tariffs unconstitutional. Gas price are high -- not at all under \$2 as a white house promised. New War/s. Scariest for many are exploding deficits, public debt, all intended by self-proclaimed 'fiscal conservatives' in robust employment, non-recession, peacetime. Normally that's a time for fiscal rectitude, to be balancing books.

GDP & stock markets can rally at first on a 'one big' stimulus, deficit spending / rate cut hopes (unmet). Or another possibility is K or E shaped economy, yields rise to 5%+ in 10 year Treasuries, yet stocks rally at first on a narrowing mania over AI. Government shutdowns grow more routine 'as a feature, not a bug' to 'detoxify' what some saw as excessive reliance on government, spending. Both tax cuts & huge expenditures. Coal, oil, gas only are advanced - - renewables are decimated on cultural affinity for fossils, longing for less-constrained America of past. Or what's is revealed ahead, perhaps might be some unpredictable mix of possibilities above (with many surprises too) in the late 2020s. All is yet to unfold.

For very rough analogy in physics & chemistry, the periodic table beautifully helps to explain, predict how elements behave. Consider, why elements in a far-left column are reactive. Each has 1 sole electron in outer valence shell: 'wants' to combine. Hydrogen for 2 electrons stable 1st shell predictably (+ oxygen) is Water. Or lithium, with pair electrons in 1st shell, has only 1 in a 2nd orbital, so is reactive. Below it, sodium, with 1 sole electron in 3rd shell, 'wants' an element with 7 valence electrons (chlorine) so it becomes table salt. (And this became a major very-cheap battery material, sodium-ion, from 2027). That salt nicely then has 8 electrons, stable so in desirable state. Predictable, understandable.

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

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

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

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

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

Source: EIA, Energy Institute, Raymond James research

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

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

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

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

Much was being tried since 2025 to make the very costliest, firm baseload power, nuclear - 'cheaper' by new gen III (3rd generation) designs. Via big reactors >1,000 MW (so 1 GW), or by trying novel small reactors under 300 MW. Opposite of *impediments*, like on renewables - federal officials gave 'nukes' *incentives*: shorter 18 months Licensing called Part 53, deploy on military & energy dept. lands, maybe higher radiation exposures, bypass some reviews etc. Trying to grow US nuke capacity 4-fold. To go from near 100 US reactors & so 100 GW in 2025 -- to 400 GW by 2050. The 3rd gen small modular reactor (SMRs) idea is getting attention & \$\$\$\$\$. A downtrodden industry's dream is cheap nukes. Yet probable result may be modular SMRs next 10 years are still too expensive, long to come online, risky. Promises recent years by SMR promoters, like low 7 cents/kWh, to be cost competitive with natural gas -- may shift to 10 cents/kWh (or more!) in getting more realistic. But new executive orders did relax Rules in hopes gen III ideas grow workable. Notion SMRs revitalize moribund US nukes was generating much talk, but sadly, not profitable SMRs yet by 2026. Near all US commercial reactors are still old, 2nd generation/ gen II built long ago. And commercial *fusion* at scale, is decades off -- 2040s at very soonest. So, what to do on US nuclear late 2020s was / & is a question. Commercial, cheap SMRs + fast-followers is a hope. *Might be* great on capacity factor uptime near 90%+ for nuclear -- vs. just 24.9% at intermittent solar, just 35.4% for wind (latter 2 'naked' with no battery storage). SMRs could be great too as zero-carbon baseload. Great as well for clean energy, if they're (likely) relatively far more costly, vs. solar or wind.

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

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

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

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

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

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

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

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

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

So little surprise the US AI centers wanting firm power fast, look to build natural gas plants. In 2022 they'd once cost 'just' \$800,000/MW, far less \$\$ than big nuclear at \$16 million/MW, novel smaller SMRs cost even more per/MW! Rock gas plants back then could make electricity for 6 or 7 cents/kWh -- cheaper than dirtiest coal. But times have changed, and 3 leading gas turbine makers: GE Vernova, Siemens, & MHI, have misread future demand; mis-matching manufacturing capacity to demand. Upshot was, if a new turbine wasn't already secured in 2025, then on turbine shortages one had to wait to 2030s to build. Pushed up costs near 2-fold. By 2025 a new gas plant might cost \$1.2 million/MW. Prices for gas fuel are volatile too; as a US increasingly exporting LNG, made it no less volatile. Even vs. a 6.5 cents/kWh, cheap gas plant -- intermittent clean renewables on free fuel might generate electricity for less! But linchpin is intermittency, so key now is how swiftly firming energy *storage can* advance. On new technologies to make intermittent solar & wind firmer, dispatchable. Geothermal can be notable too. Still, there's no one, single silver bullet answer across energy.

In practical terms, \$\$\$ spent on clean energy latter 2020s may be big, yet were not big-enough -- show world was not yet solving for climate. Plus what's done is basically additive - - rather than *replace* dirty energy, it is flopping new clean atop old. Spending the \$\$ needed, to truly decarbonize, will be jaw-droppingly formidable. In 2024 the UN calculated that to achieve net-zero by 2050, world's clean energy spending had to be \$6.5 Trillion/year to 2030; then after \$8 Trillion/year to 2035! Unthinkable amounts, today. Especially on a recent global backlash ('greenlash') against clean energy, rise of political nationalism. If evidence-based-concerns for our planet's future hadn't made climate so pressing, we might all just shrug it off, move on. Keep to the status quo of burning conventional fossils, profitably, if one isn't moved by science. Such path is uncomfortably-near our current trends. And yet science gives us fortunately, or maybe unfortunately(?), some idea of what to expect on a planet soon 4 F, or 5+ degrees F hotter. Proponents of fossil fuels often want to portray themselves as more 'practical', as the serious people in the room[!] -- yet their paths *may* be what's radical. We'll discuss in pages ahead what science foresees. All ironic too, since going clean now, faster although costlier upfront, saves most \$\$\$. Yet this terrible current path we're on today, is likely in our human nature. Let's turn to clean energy in latter 2020s.

Now past ½ way point in a decade, we're seeing big changes. Global discussions shifted from big concerns back in 2021 about, *How Clean & Low Carbon*, is each electricity source - to from 2026: *How Energy-Secure & Available* is it today. Consider Norway's main low-cost hydropower, that gave it about the world's cheapest electricity, in its north. While it exports pricey natural gas & oil to other nations. As cheap hydroelectricity in its north for decades was available only to Norwegians, a 'power cul de sac', prices were low. But, after new interconnectors linked Norway to UK/Europe -- Norway's rates at times jumped in a south.

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

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

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

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

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

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

How, why? Answer is Renewables. Clean energy grew from 168 wind /solar sites there 2015 -- to 652 wind /solar sites in Texas in 2025. Clean energy generating capacity grew 315%. Versus natural gas capacity 'growth' of just 6%. Key reason: new electricity by solar/ wind is now Cheapest by far -- when sun is shining, wind blowing. So trick now is to pair cheap renewables with storage, add clean baseload, recognize climate /CO₂. Hasten permitting. Improve America's fragile grids. Expand new energy production, storage, flexibility greatly. An economic allure of wind/solar is why a little-regulated, market-oriented Texas grew as it did! In 2015 gas was key to its electricity; has a great deal of it & loves fracked gas (especially vs. far costlier gas in Europe, Asia). Plus at times, Texas' gas can be 'cheap-ish'. *But even a 'cheapish gas', is Not Free; very different from solar/wind that are 100% forever free fuel - especially as latter costs drop to just 3, 2, 1 cent/kWh, then less!* 'Traditional energy' hence coal, or natural gas - or 3rd gen or whatever nuclear fission, can never, ever touch that.

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

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

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

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

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

Yes, renewables now enjoy *direct* subsidy levels competitive with fossils; from 2016 to 2020, 46% of US federal direct energy subsidies went to renewables. Implicit/ indirect subsidies for fossils, however, are far Bigger if one counts costs to human health, of clean-ups etc. IMF estimated those at *\$7.1 Trillion* in 2022, or 7% of GDP. For 20 years now we've written of potential big costs if Strait of Hormuz is closed between Iran/Oman. Were it shut, Brent oil could in a few months go over \$120+/barrel. When war was initiated (by choice) in 2026 that prediction proved justified. Were it not for \$\$\$\$ of US military forces, oil could go higher. Or, a Price-Anderson Act limits nuclear liability to \$10 Billion/per radioactive catastrophe; without it, US nuclear would be too risky: no new nuclear plants would even get built.

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

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

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

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

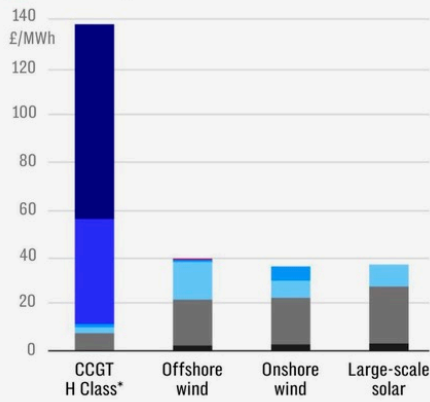
So why aren't cheap renewables, been seen to lower retail costs greatly? One reason: is rank-order 'margin pricing' mechanisms set electricity at higher costs. Take UK (Great Britain), where marginal pricing means if any natural gas baseload is used in the production mix - as is true 98% of the time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

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

Cost gap in favour of renewables will be huge by 2030

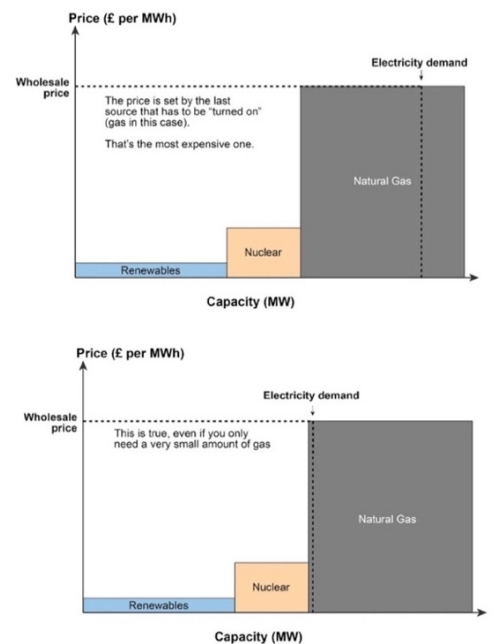
Levelised cost of electricity estimates for projects commissioning in 2030

■ Pre-development ■ Construction ■ Fixed O+M
■ Variable O+M ■ Fuel ■ Carbon
■ Decommissioning and waste



Prices are in real 2021 £, *Combined cycle gas turbine H class | Dept of Energy Security

Source: UK Dept of Energy Security



Source: Sustainability by Numbers.

UK industrial electricity costs crazily, were 45% over world average. 4x a US: so, nightmare. As seen left, above, 2 core reasons for high UK electric rates include *Reliance on natural gas, and *pricing structure. Latter means even a modern gas turbine is far-costlier than wind/solar, gap widening. If much gas is used (right top chart), marginal prices are high; yet if gas meets only tiny bit of demand (right bottom), electricity *stays-highly-priced*, ‘without good reason’! UK sets one national single price, so high-demand, industrialized, densely-settled places like around London in south, may set one steep rate for all UK. Wind farms in north/ Scotland can and do make cheaper (wholesale) power which may even go *negative* at times(!); but that is diluted, hardly passed down as low-priced UK national electricity. So a shift to regional pricing could cut local rates for its rural windy north. In 2025, the UK did consider that, but backed-off. For with regional pricing, what its critics call ‘postcode lottery’, renewables keeping ‘a lid’ on costly UK rate would no longer so help its populous south. High rates nationally, would go up even more for many UK citizens who lose cheap northern wind. The largest source of UK electricity in 2025 was its natural gas at 31.5% (up by 4.7% over 2024); so the UK was bound to have very costly-rates. Much of that gas was imported, even some electricity too.

Regional pricing is a bit like America with 50 diverse ‘regions’ (50 states). Each state has its own kinds of electricity production, varied rates. Let’s look at a US with 50 unique states, ‘de facto regional pricing’. For lessons learned. *Like that very cheapest-electricity states have abundant renewables. While costly states use much natural gas.* Rhode Island has the very highest US gas reliance at 92% -- and 6th costliest electricity, 25 cents/kWh. In all US, gas made about 43% of electricity on average 2025. Gas-fired power is costly: yet commonly sets retail rates. This is seminal. US retail electricity rates too set by last ‘most important’ source.

Since 2023, gas-loving Texas offered \$5 billion in public funds for low-interest loans to help build gas plants; in 2025 some applicants, or 4,600 MW of proposals dropped out. Partly on cost uncertainty, turbine shortages. As CEO building gas plants noted: “When you have [solar/wind] zero or negative prices for power, it’s really hard to build.” But not long after, their number of natural gas queue applicants to connect to the grid, was booming. Why?

This was due to rapid new electricity demand growth for AI/data centers. And, because best wind sites were already being used near transmission. And, as federal attacks on wind everywhere in US, had hit home, including new uncertainty on subsidies; new obstacles like what was an assumed FAA federal approval for wind towers over 200 ft, became a question mark. Faster growth of big new transmission lines was needed too, to avoid curtailment.

Let's take a look at what was happening in bellwether Texas, for US wind. Since January 2016 the tremendous growth in renewables, had meant that wind alone overtook natural gas in requests for connection to the Texas power grid. The US grid is made up basically of an Eastern segment, a Western segment, and a grid for the state of Texas that mainly uniquely has its very own grid to avoid oversight & regulation by a US national government.

Texas manages its grid via the Electricity Reliability Council of Texas (ERCOT). It is able to see what kinds of generators are growing fastest, manage them as they seek to connect. Most of those just applying to connect will not do so; in Texas it's been about 22% -- but then that was highest percentage of projects seeking connection (and that actually do so) in the US.

In recent years, 75% of generators that applied to connect are for solar, battery storage. They've made up an immense 458,000 MW in application. The rest are mostly wind, and natural gas. What had happened a past 3 years to 2026, was natural gas applications waiting to connect jumped by 400% -- from 12,500 MW in March of 2023, to over 60,000 MW in March of 2026. About 9,000 MW of growth in natural gas applications, were aided, getting low-cost loans from that Texas fund for natural gas. In that same timeframe, wind (which does not get such loans) also grew, but by 'only' 87% from about 25,000 MW, to 48,000 MW.

Driving this largely was a then-expected monster 360,000 MW demand growth coming from AI/data centers. A record peak total Texas electricity demand overall, had been a big 86,000 MW of demand seen in August of 2023. This new coming demand for just potential data centers could be 4x that. Of course, not all of those data centers will be built, but direction of demand was clear: going way up, and fast. One utility in El Paso, Texas to move fast in an 'out of the box' way, looked to scale by combining 813 smaller backup generators in a single plant!

For wind, that was a considerable climb-down in its rate of growth, relative to natural gas in Texas. When wind growth had peaked relatively-speaking there in 2018, wind generation then comprised about half of the new generation queue waiting to connect to the Texas grid. Since then, curtailment became an issue -- due to a grid that can't yet handle all of the potential growth. 3 major new 765 kilovolt transmission lines, can not come soon enough.

At that time, 2026, the US oil and gas industry was also telegraphing to markets that they should expect oil and gas prices to remain elevated, so higher for longer. Ad administration had in February of 2026, spoken of a war ('excursion') that would last only up to 6 weeks at most, then abruptly end and it expected oil & gas prices to swiftly fall to even lower than just before the war. But, that was not at all what as happening. The war, went longer.

And drillers rather than fast-ramping up rigs, drilling, instead returned cash to shareholders, bolstered balance sheets, trimmed debt. They were cautious, aware that a temporary Strait closure would soon end, and prices fall some. Permian drillers might add only some 20 to 30 rigs all year, a minor rise taking them back to levels of 2025. Certainty in greater oil and gas demand growth ahead simply wasn't there. All as electricity costs, were fast rising.

Recall America's costliest-electricity state: bottom of barrel priciest, was Hawaii in 2025 at a nosebleed 39.6 cents/kWh -- 3X vs. cheap North Dakota, Idaho, Washington state. Reasons for such sad, pricey results are clear, and pretty embarrassing for a state of Hawaii. One is Hawaii has the dirtiest, most-fossil-fuel-dependent grid, in America. Utility PR tries mightily to avoid acknowledging it; certainly doesn't fit with chamber of commerce messaging of a tropical, clean, island paradise. Yet, most of its electricity has long been made by burning (awful #2 bunker) oil; and until-recently 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 be making its firm baseload, renewables meet 100% of electricity. Instead, utility PR stresses its yet small growing renewables, says nothing of burning bunker oil. When Hawaii decided long ago fossils would make electricity, a die was cast. But had it looked first to its own wind/sun/geothermal (like Iowa, Idaho, Norway), it might today be far ahead on reliability + lower costs. Not abstract musing; 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.

Poster child for super-high-costs-of-electricity (& much else) is California. Often trotted out for misconception its high electricity rates at 34 cents per kWh, 2nd worst in US in 2025, was due to its wind, solar, hydro. *But that can't be right!* Texas' renewables make far more power than California and are a higher percentage -- yet Texas' electricity was cheap: 15.6 cents in 2025! In fact, *Texas renewables help keep costs down*: it is hard for gas/nukes to compete. Iowa has far higher % of 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, *Huge wildfire costs. *State Mandates specifying technologies. *1st mover costs. *Guarantees of big returns of 8%-12% for shareholders at utilities vs. rural cooperatives in say, Iowa with No profit margins. *Costly permitting. *California's Industrial Natural gas prices are 3rd highest in US for baseload gas. *Ratepayers subsidizing too roof PV (both arguably can be part funded statewide by larger-base taxpayers). All push retail rates extraordinarily high -- vs eg 3 bordering business-friendlier neighboring states: Oregon, Nevada, Arizona; latter were 2025 respectively 15, 13, 12 cents. As seen repeatedly, fact is that clean hydro/ solar/ wind, by contrast, are all *deflationary*; they *reduce* costs. While the reasons for California's high costs are complex, these costs can be cut -- including at its 3 very big investor owned Utilities.

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

A California that 2023 got about ½, or 54% of its electricity by renewables (32% by solar, 6% in-state wind, 10% hydro etc) aimed for 90% renewables by 2035. But 2035 was years away. In 2023 natural gas was then 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 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 and Wyoming enjoyed price *declines*. Nevada's solar & geothermal %s were like California's, but with far fewer regulations; its utility-scale solar was 56% cheaper than fossil alternatives, a retail rate just 13 cents. Oklahoma gets a good 42% by wind; on free & fair markets, few mandates: its rate was under 13 cents in 2025. Uruguay has moved from a once-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 to enjoy cheap/free onboard power off wasted braking energy -- more than made up for 2 drivetrains. Today, hybrid dual-power cars are growing faster than are just-gas-engined cars. Similarly, critics today who bemoan solar/wind as intermittent, needing storage, don't see how plummeting renewables/storage costs + ever-free fuel -- more than overcome price differentials. Solar/ wind not far-off can fall even more in wholesale costs. Say to under a penny per kWh. Fossils, nuclear fission *never* can do that! Yet 2020s saw growing pains: like 'curtailment' shutting solar/wind if making more than grid can yet handle. Better grid + storage can solve much of that. In California 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%. Then, in May of 2026 California solar plus now far more batteries set a new record, making just over 50% of the state's electricity for that entire month! Was an ideal month as neither too hot, or cold; but still.

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

But a conundrum is what of renewables' downsides. One issue lately: pricing mechanisms. In Norway's case, while Not in EU, it had agreed to export 'surplus' power to other northern nations: UK, Germany, Denmark, if latter see low winds, low power production. Norway thus exported electrons via 1,400 megawatt (MW) undersea cable since 2021. A thing is, lack of winds can make its prices (vs. normally far-pricier UK or Germany, average retail rate 39 cents) -- spike too, so local rates in southern Norway skyrocket at times by connector cables. Normally dear prices in UK, Europe on low winds, jump 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 south saw retail prices 2025 briefly go 190X that of north. Or, Norway after its 2025 election looked at reverting to prior system: to First satisfy its own demand -- rather than send electrons abroad. To do otherwise, risks internal price spikes that deny upsides of its own hydro, stoking public anger. Indeed, this was one focus of its 2025 elections. Maybe re-negotiating rates in future, or one day severing links that have sent power just one-way, to UK & Europe. Lacking pumps, its cheap hydroelectricity might be challenged in case of a severe drought.

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

UK's status is 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 down hard too. Meanwhile 2nd generation nukes were wildly costly, maintenance far worse than expected. It is placing a new emphasis now on novel 3rd generation nuclear hopes.

Meanwhile some old paths make little sense today. Take Australian coal: its national market operator issued 144 'Lack of Reserve' Alarms in Q4 2024, highest ever. Customers had then to trim demand, such likely meant higher rates ahead. Many alarms were sounded too at its 2 aged power stations, Bayswater, & Eraring, on coal's growing unreliability fueling old plants; one station ran only 4 weeks in 5 months! Another station had a catastrophic explosion. On coal's many issues, electric rates Q4 2024 on national market shot way up to AUD \$88/MWh - up by 83% late 2024 vs. a year prior. 14 aged baseload coal plants, averaged a 36 years old. Problems not just with coal: even at a new grid-scale natural gas-plant, first in 15 years in 2025, it went online 2 years late, \$1 billion over budget. When Yallourn coal plant suffered breakdown June 2025, ½ its 1,480 MW capacity was lost briefly. That forced Victoria's old, polluting short-burst open-cycle gas plants to work constantly, rather like baseload combined-cycle CCGT, but putting CO₂ out in amounts similar to burning black coal.

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

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

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

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

One president's longstanding hatred of offshore wind, solar, had forced a halt in 2025/26. Even in states desiring it, like California, New York, Rhode Island etc. Doesn't have to be. In Germany small solar panels on balconies are extremely popular, in part as they're so simple, cheap, with pay-back in 3 years. State-level regulations, had made US balcony solar illegal -- but that's starting to change: Utah now allows it -- and more US states will soon too. Could help lead to a solar blossoming. In Australia 2026, more than 1 in 3 homes have big rooftop solar; in a US, it was less than 1 in 10 in 2026. Meanwhile, fights brew too in niche areas, like new hydrogen (H₂): Europe in 2020s drafted rules for 'green H₂' by renewables, to ensure that green H₂ is made when sun shines, wind blows on 'additional' green-electrons. H₂ is still very niche; just 16 million tons were made in US 2024. H₂ by natural gas is far cheaper \$1.50/ kg -- tough for any green H₂ that costs 3x more: no one wants any H₂ at such high cost!

Costs matter. in 2025, EVs/PV made outside China, or a green H₂, or e-methane, anyplace -- were too pricey. Fossil-players claim 'clean H₂' may be made say, by gas-fired electricity, or by RECs (renewable energy credits) from solar/wind at distant places, times. Conservatives will support it. Favor such 'any of above' strategies on abundant US shale gas; will worry far less about climate risk. Many will support big Ag dairy RNG (renewable natural gas) from big agriculture; or a renewable natural gas from landfills or wastes. Indeed, avoiding methane spills is one way to help limit greenhouse gases. Capturing carbon permanently, as in mineralized rock. Unsurprisingly France too pushes turquoise low-carbon H₂ from waste heat at its ample nuclear fleet. Many, many further debates lay ahead, thus incentives will matter. For instance a 45X MPTC (Manufacturing Production Tax Credit) in an 'old' 2022 IRA, just possibly might have helped US-make solar PV to become globally-even cheap-ish; yet big changes to IRA in 2025 rendered so many of the 2022 IRA provisions, moot. Changes to 48E/45Y in 2025 changed much. In short uncertainty reigns in clean energy, so it's no surprise to see always a huge volatility in clean energy stocks. To try to predict what is ahead no matter an election's outcomes, or any other big things such as war, is just like with equities in general, an ever-Impossible task. Still some review & analysis here can be useful.

Take level & direction of Fed Rates since they influence clean energy's theme. Look at Federal Reserve Economic Data (FRED) for US Fed Funds Effective Rates 2020-2025. From a short term Fed Rate of 1.55% in 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 after -- rates leapt up from a 0.08% in Jan. 2022 -- to a once-normal yet felt high >4.5% in 2025. We saw clean equities fall unsurprisingly during that spike. Central banks do have to head off inflation; it's just they'd responded much too late to gathering inflation. Resulted in some years with some of the fastest interest rate increases seen, in well, nearly-ever.

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

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

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

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

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

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

Not yet well-understood in a west, but important are China's efforts from 2025 to try to rein in excess capacity in solar, in EVs, in batteries etc. Limit capacity ahead. It bluntly stated that provincial governments are overinvesting. So pledged national supply-side restrictions, amendments to 1998 law on pricing. To strengthen price limits, cut unfair pricing behavior, curb 'involution' (oversupply-based) irrational competition. It aims to curb dominance of prices going irrationally below-cost. Accountability for anti-involution violations. China's over-capacity in PV, EVs etc means massive excessive capabilities, but lacks domestic demand to sop it all up from key green 'emerging future industries'. Overcapacity has long harmed profits ("neijuan") in China. By 2024, 25% of mainland China listed firms were unprofitable - vs. just 7% a decade prior. China ramped exports in search of demand, exporting deflation, hitting profits everywhere. Thus a US & Europe, based on capitalism, are pushing back.

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

It's not hard to see why fossil fuel interests in 2020s were fighting so hard. Back in say 2010, coal and natural gas were then, relatively-speaking, easily the cheapest power. Those 2 could make electricity for around just 9 cents per kWh. At that \$.09/kWh cost, coal or gas was then far cheaper than competing wind as at best \$.11. Especially vs. solar's \$0.46! But by 2025, so latter 2020s, that changed dramatically. Solar/wind wholesale fell to often near 4 cents, *half the cost* vs. a natural gas plant best-case. And that was assuming one may even obtain a scarce gas turbine to build. If one hadn't already secured turbines in contract in 2025, it might be early 2030s soonest before a gas-fired plant could be built, up, and online!

Mainly on huge PV supplies from China + thus on declines in costs due to such overcapacity -- a new solar farm could go up cheaply & fast. Getting the solar PV wasn't much of an issue -- although tariffs, ensuring no forced labor, 'foreign entities of concern', getting permits, or possible 'kill switches'(!!) in China's parts, were issues. That said a new solar farm could be built at less cost, as noted than just to operate an existing coal plant! So a notable matter latter 2020s facing gas & coal -- even putting aside climate & CO₂ -- was new solar/wind though intermittent, became more economic. And this gap would only grow. Solar became cheap due to China; while in wind, Europe was building its own turbines. China's solar could bump in cost on anti-involution production cuts from 2025, but temporarily only. Meanwhile, coal & gas plants needed expensive staffs, maintenance, security, and of course to buy never-free fuel. By contrast, solar/wind need few staff. Solar maintenance may be goats to keep down grass, not much more frankly! Wind does need rather more to maintain it, but nothing like fossil fuels, nor nuclear(!). Solar/wind require little on-site security; vs. nukes that must be guarded to extreme. There's big wastes from coal plus its sizable human health impacts - vs. no such thing for renewables. So it's understood why fossils fought clean, latter 2020s. Even apart from climate concerns, fossils were/are losing badly. They can't now win on costs. And, their fuel prices never go to zero or below -- while clean is getting cheaper.

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

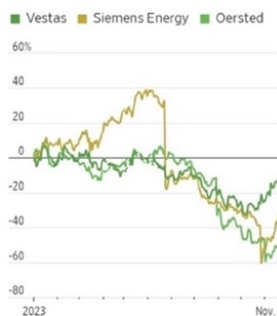
It's not-so-hard to see why fossil interests late-2020s saw threats ahead. With electrification, their goal may be as much just to ensure their products will go on seeing demand, as a past usual aim of less-regulations. A key issue for them is fast-falling costs for EVs, clean energy -- China's deflation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

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

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

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

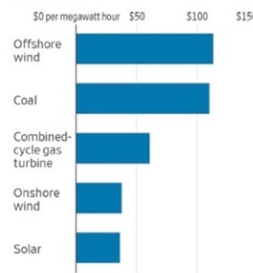
Share-price change



Source: FactSet

Source: FactSet, Wall Street J.

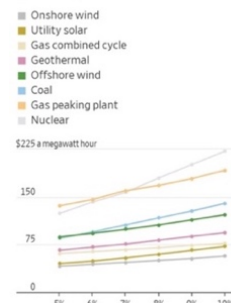
Levelized cost of electricity by technology, U.S. projects



Source: BloombergNEF

Source: Wall Street J. / Bloomberg NEF

Levelized unsubsidized cost of energy generation by debt cost



Source: Lazard, Roland Berger, WSJ.

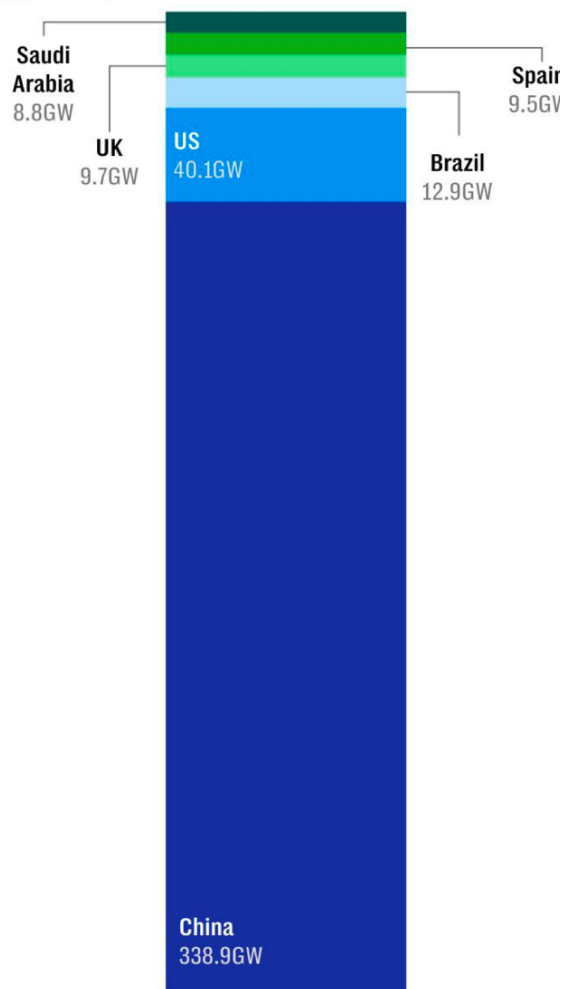
For green energy stocks, China overcapacity has been an issue. Shorn of market guardrails, of profit/loss signals of the west, profit margins were decimated worldwide. As the west in 2025 resisted buying/soaking up China's overcapacity, & began applying tariffs, results ahead could go a variety of ways, 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, 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:

China is dominating green energy

Solar and wind power projects under construction (gigawatts)



Global Energy Monitor (June 2024)

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

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

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

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

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

Poly prices in 2023 fell in China by -50%, panels -40%. Near-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. As a side-point, solar *may/should in theory* be huge: just one 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 of storage. Powerlines to move power. Of course, we would Not want to do this: solar is decentralized; we want distributed generation anyways. But it's shows the scale, with which solar gains great potency. China can do it + on PV/wind many-fold over. Nothing technically prohibitive. China may sop up its 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 solar/wind + high voltage DC transmission lines. Over 500 GW new solar/wind 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 home roof solar alone -- done without battery storage -- an unattractive economic proposition from 2024. Once a leader, prognosis there for the latter 2020s was for only maybe a shallow-ish recovery.

A longstanding US solar name issued a going concern letter; abounding uncertainty sheds some light on why solar stocks were down 2021-24; as PV installations were growing globally. 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 li-ion batteries. Note then, Fall 2024 as a huge thus China-based producer looked to shut-down a big Li mine plus production line too, global lithium stocks jumped broadly. A big question mid-2020s was, still is: how long must loss-making themes endure no-margins, before renewables, EVs, batteries, grid etc might better become profitable Perhaps some insight is found looking back in time, to see 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.

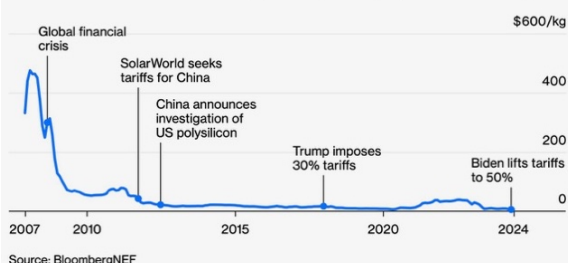
Meanwhile in China in mid-2000s, an entrepreneur seeking new business opportunities took note of Yangtze River, world's largest hydroelectric plant Three Gorges Dam. Sichuan's cheap power-generating capacity exceeding demand. On 'fat' profits being enjoyed by just a few poly producers in the West & Japan, 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 \$75, 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 once-'huge' US poly manufacturer hard. Many of China's paused domestic poly producers could re-open with new protections, return 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:

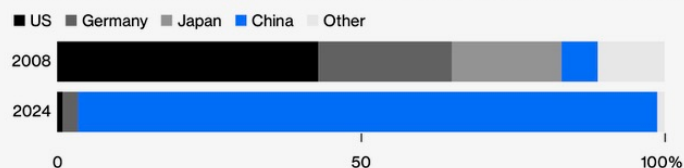
Solar Keeps Getting Cheaper

Years of trade frictions haven't stopped the price of polysilicon from falling



China Is Now the World's Dominant Solar Power

Total polysilicon production, 2008 and solar-grade polysilicon capacity, 2024



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

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

For 20 years we've looked at new energy innovations that *may* prove superior vs old energy. At disruptive ways new solar, wind, EVs, storage, hydrogen (H₂) *might* potentially make sense in their own right. We've emphasized too, clean energy stocks shall be *volatile*; *these can & will 'drop like a rock'*. We're proud as originals through our Benchmark ECO live since 2004 - Global NEX since 2006 etc, to pioneer zero-carbon themes that may help lower climate risks. Solutions that may appeal too, regardless of climate. And yet climate concerns unsurprisingly, are faster rising to fore of late. Our heating-up planet seems to now shout with undeniable scientific consensus too: risky tipping points may scarily loom, or already be at hand.

It's so significant, we'll take some precious pages here for this science. Consider: carbon dioxide (CO₂) levels now at over 425 ppm & rising fast, haven't been this high since Pliocene 2.6 million to 5.3 million years ago -- when Earth looked very different. July of 2023, & year, set planetary records, blew away a prior 16.63 degrees C (Celsius). Far more than cranking up the AC may be needed in response. 18,000 to 6,000 years ago, Earth warmed very rapidly on natural causes, discussed ahead. At times, sea levels jumped dramatically. Astoundingly by 10 ft or more per century; let's ponder that huge 'delta' / or *change* for a moment.

Sea levels in 'recent' human history were weirdly stable in geological-terms - with rises only 2 millimeters (mm)/year. As there's 25 mm to an inch, it meant a near-nothing under <1 inch per decade. But, rise is quickening. Lately a US Gulf of Mexico rose 10 mm+/per year(!), near ½ inch/year -- or 5 inches/decade. Local soil compaction, subsidence, gravity, are at play here too. Yet seas are rising non-linear ways. And implies 10 ft/century -- *could* be seen again. Especially as we push CO₂ 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 CO₂ to rise swiftly by 80 ppm. Now in one human's lifespan, CO₂ 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, shut-downs of Gulf Stream happened in past; c) Greenland & much of Arctic are projected to become 'ice-free' in this millennium -- severe impacts seem far more than just-plausible.

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

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

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

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

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

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

Bloomberg New Energy Finance (NEF partnered with us mid-2000s in creating NEX) just a few years ago noted end of 2020s so in few years, the US might build 600 gigawatts (GW) new *solar, *wind, *storage capacity. Yet BNEF based as impetus, a then-Inflation Reduction Act (IRA) that could go over \$1 trillion plus other support. Yet even hurdles then to 600 GW were still *capital costs, *inflation, *supply chains, *slow permitting, *poor grid: all impediments to growth this decade. It had forecast 358 GW of US solar capacity 2023-30, near 3-fold total US solar capacity of 2022. Foresaw maybe 137 GW wind capacity to 2030, near 2x total wind capacity of 2022. 111 GW battery storage capacity to 2030 -- 9x gains vs 2022; starting from low base, but growth. Perhaps too billions in grid investments; yet even that would be billions short of spending needed, if a US was to reach 50% emission cuts by 2030. But in 2025, all that was DOA, with end of 2022 IRA as a package of big tax breaks, incentives; NOT a strategy to decarbonize. Mainly carrots, no sticks. And even that 600 GW fell well short of achieving then-US targets of 50% cuts in CO₂ emissions by end of decade. We emphasize this, because once the IRA of 2022 was decimated in 2025 -- and 'new' administration was then doing all that it could to halt new wind & solar, such changes only took us much farther away.

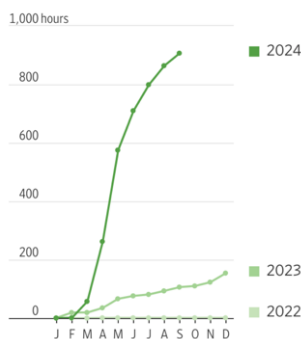
Looked at another way, on 3 then-big Federal laws extant in 2022, a US might in theory have doubled its pace of decarbonizing -- to hit 4%/per year *fewer* emissions by 2030. That could have brought down emissions 40% to 2030 -- still short of 50% emission cuts then sought, to help to stay under <2 degrees C heating. 50% by 2030 may have teed up US for net-zero 2050. But that 50% by 2030 meant doubling, or 2x our fastest rates of new solar/wind to 2030. Then, growing 3.5x in 2030-2035. To achieve that pace, we'd have had to have cut CO₂ not 4%/year -- but 6%/year to 2030. Then, speed cuts even more. *Now, none of that is in the cards!* Especially after 2025 end of the IRA. Not technically do-able. No surprise clean energy spilled into American politics 2020s. Criticisms rife. A few critiques, true. Like that strategic minerals were/are not yet domestic-sourced. Or that electrifying heat, is costly. And yet most leading criticisms & assumptions, aimed at clean energy in 2020s, were far less accurate.

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

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

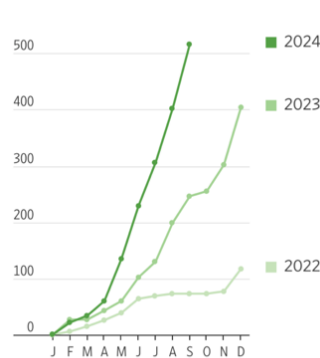
Electricity prices in Spain

The number of hours each year in which wholesale electricity prices were less than €0.5 per megawatt hour.



Germany

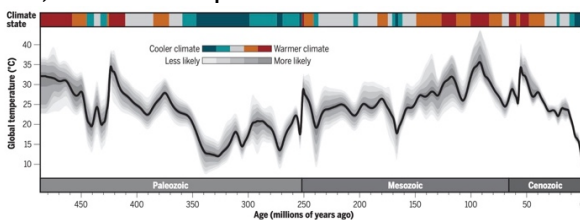
600 hours



Source: European Network of Transmission System Operators

Source for both: Wall Street Journal

Lastly, step way, way(!) back for 3rd Chart: remarkable reconstruction on data of Earth's surface temperatures past 485 million years and linking CO₂ -- to temps. Reflects too troubling sensitivity to any doubling of CO₂; at 8 degrees C avg. hotter, average tropical temperatures were higher than previously assumed, a horrid 42 degrees C (107 F): life endured extremes. Refutes a natural ceiling on how hot it 'might get'. Had it looked farther back, would have captured too a snowball Earth of Cryogenian: happened twice 710 million-640 million years ago, and lasted 10 million years each maybe with Earth rings, or less volcanic CO₂, absorption by rocks -- so CO₂ can also get much 'too low', for extinction events. Over a past half-billion years, Earth's temperatures were thus more often far hotter, than a presently 'cool' 59 F:



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

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

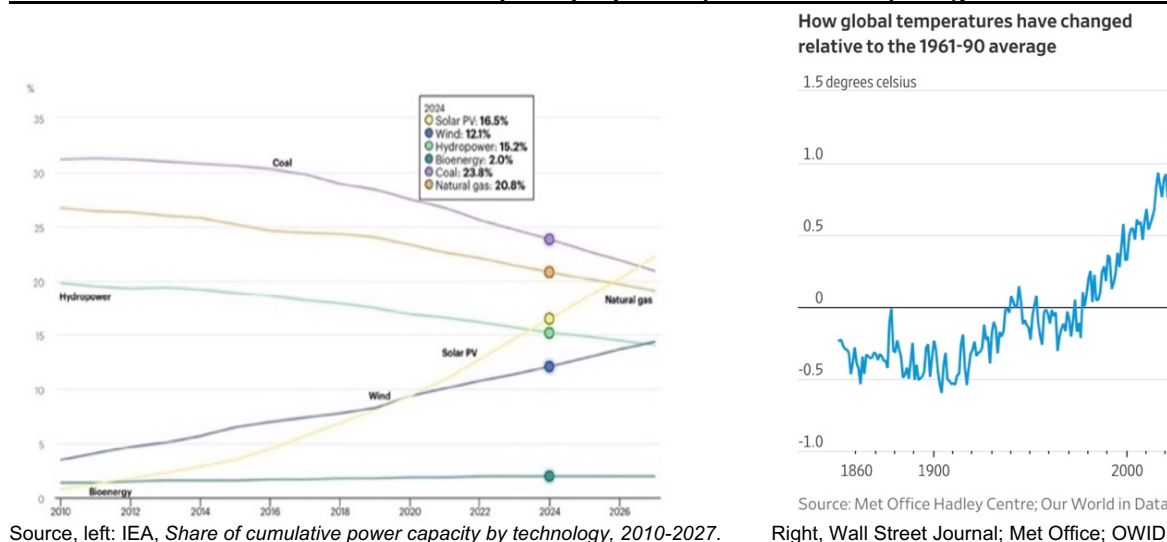
Still, via a climate lens it's scary: for nowhere, is clean energy going fast enough! Everywhere, is seeing decarbonizing setbacks. On unending CO₂ it won't be 'just' 1.5 C hotter ahead; that is not-realistic. In 2023 China & Saudis refused to raise 2025 targets at G-20 ministers meeting. China was 196% of increased emissions 2019-2022; 1/3rd of all emissions. On its vast coal alone any optimism for stability ahead in our Earth's climate, is unfounded.

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

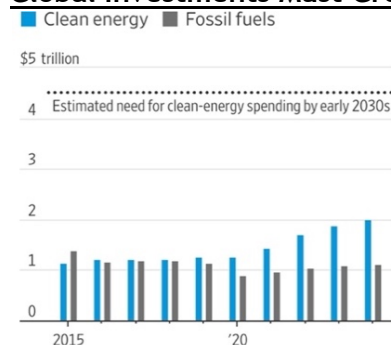
It's not as if traditional, old energy fossil fuels could have any better answer on needs for more, fast, & cheaper energy. Plus their problems are worse on so many fronts. Again, big Texas in a US is a case in point. Its gas plants there *will* struggle ahead in new colder & hotter extremes -- while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

There are bits of good news. Global solar capacity growing by 2x every 3 years; or 10x/per decade! 10 years ago in mid 2010s, solar was 1/10th of the capacity seen mid-2020s. Was like planet's nuclear plants growing 8-fold, all faster than building 1 nuclear plant in a west! Globally, nuclear is divided by geography; 2024-2030 may see 55 new nuke reactors: 61 GW, ½ in China (26), rest Asia & Middle East. Vs. 0 in US, 4 in Europe. New small nuclear reactors beyond 2nd gen reactors, past US-nukes built to 1990s may suddenly grow, given needs of AI post-2030s. However, via lens of what's needed to hold heating to 1.5 degrees C, this decade ends scarily Bust. New temperature records, eg, Sept. of 2023, a hottest Sept. then on record was not by a usual 1/10th of a degree -- but by 0.83 F! All 2024 next hottest year on record - yet it may turn out to be one of the coolest-ever years a young person today knows in their lifetime. Still, in latter 2020s natural gas is slated to be making huge gobbs of power -- despite that CO₂. 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 CO₂ /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.



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



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

Geology helps in looking at deep Past -- to go farther back than Financial Reports! CO₂ dropped hard in a last Ice Age, to 160 ppm (parts per million). Naturally Earth was once very cold at times -- very hot other times -- long before humans. Explained by fact Earth moves in predictable ways around sun, non-round, not-perfect elliptical orbits. Over tens of thousands of years our planet's moves too by 'precession'; + 'axial tilt' like top spinning on a table. 3 predictable moves explained by Milankovitch cycles, with variable/cyclic cold or warming. Meanwhile continents drifting changes Earth's surface too, impacting big ocean currents. How much land is in Northern vs. Southern hemisphere affects how much heat is absorbed -- or reflects sun's heat. Ice sheets near poles, reflect sun (cooling); dark oceans near poles absorb heat. Net results of a variable 26,000 years of precession, 41,000 year cycles in axial-tilt, plus continents drifting etc is cooling, warming. It can & does change climate by few degrees C at poles (that's a Lot!). Over time, naturally. Once renewed heating re-starts by many factors, say, CO₂ released naturally by volcanism, CO₂ by decomposing vegetation, or methane under permafrost etc, it can 'kick-start' more rapid heating via water vapor naturally in air. Water vapor is a potent greenhouse gas, can heat climates in just thousands of years.

So, it's significant Earth's CO₂ varied little a past 1 million years. From 160 ppm in Ice Ages (we are technically still in one with polar glaciers) -- to 2x that, 280 ppm at start of Industrial Revolution. To find higher ppm -- one must go back 3-4 million years to a hot Earth >420 ppm, CO₂ like today. CO₂ rising that much, naturally took thousands of years. Instead, vast CO₂ spewed now in 3 centuries means huge heating baked in. Sea rises unfolding for millennia+ ahead. On inertia, may become 'normal' that there's lethal 50+ degree C temps (122+ F), or in future Arctic Circle is over 30+ C (86+ F). At first, seeing briefly hellish hothouse *conditions* (masked at times by La Ninas) -- then hothouse *state*. We don't see how much oceans already, terrifyingly, absorb heat. 2023 data showed 396 zeta joules of heat were absorbed from 1971 to 2018, so within 1 lifetime. That's equivalent to 25 *Billion* Hiroshima atom bombs and growing. In 2022 oceans saw 10 ZJ more heat, than 2021, enough to boil 700 million kettles - - every second! These data indicate a level of CO₂ last seen not 'just' 1 million years ago -- but instead, 14 million years ago. And we could see 600 ppm, even 800 ppm in 2100s.

Hence our problem: by massively burning fossils we've put in air 'old' carbon once safely locked away millions of years. Natural Gas is 4 parts Hydrogen -- to each 1 part C carbon, thus = CH₄. This is a most hydrogen-rich/least carbon-laden fossil fuel thus is 4:1. Industry calls that 'clean' (it's Not!). Burning each molecule only bit less-horrid than is burning oil or worse coal. Take black coal, anthracite (please!): it's nearly all carbon, dense. Burning 1 ton of that poison for power puts out 4 tons CO₂ -- worse than gas(!). So coal spews 67% more CO₂ -- plus too mercury, particulates, sulphur dioxide, awful ways to make power! Young wet brown coal with impurities incredibly, is worse. Could lead to future wet-bulb global temps that kill.

Hence, was remarkable that in 2022 as war spiked gas price, more coal was used. In 2020 US natural gas had cost \$1.48/million BTUs; in 2022 briefly hit \$8.00+ up +400%+! Back near \$2.00 in 2024; then over \$4.00 at end of 2025. A Europe in 2020 nearly off coal, returned to it. Shorter-term, coal = warmth & power. But there's a price in burning carbon gathered over millions of years, released all at once. Renewables help keep CO₂ emissions flat-ish (despite coal), to drop bit latter-decade. *Yet Big reductions in CO₂/GHG concentrations are necessary* electricity made saner ways than by fossils. Or say, by a Zaporizhzhia nuclear plant being near-shelled in war, explosives stored nearby, its safety threatened(!). Tsk tsk, silly ways to boil water. Ukraine's Kakhovka dam also under threat. So too, now sea floor cables carrying both energy & information globally, a backbone that could be quickly severed.

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

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

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

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

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

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

Batteries give just 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 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 CO₂ grows worse. Yes EVs / renewables may soon help keep year over year rises to CO₂ to 'smallish', then nearer nil gains. But fossils need to Drop, Hard, fast.

Others deny the science of CO₂. 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 CO₂, 80x potency. Capping well leaks everywhere, Turkmenistan to Texas should be an obvious fix, immediately. But should a then-record 17 ppb methane increase, since grown to 1,900+ ppb levels in air be on 'natural, positive feedbacks', a global heating factor we *can't* mitigate -- then surprises may be frightening. That methane's still overlooked, in the 2020s, is of little comfort.

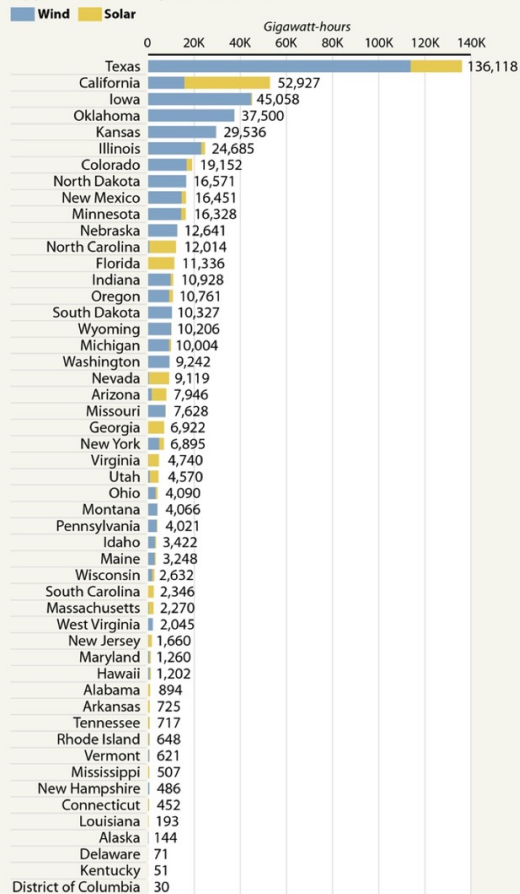
All are excused who'd assumed California is America's #1 State, for renewables. In fact, it is Texas. Many Texas business & local leaders embrace renewables. Yet some Texas political leaders curiously make much of their allegiance to fossils, and of antipathy to renewables. As cheap renewables become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

State Wind and Solar Leaders

Texas generated more electricity from wind and utility-scale solar than any other state, largely due to dominance in wind.

U.S. WIND AND SOLAR ELECTRICITY GENERATION

In gigawatt-hours, ranked by combined totals, 2022



NOTE: Due to rounding or lack of available data, some states with zero values listed may have small amounts of that resource.

SOURCE: EIA

PAUL HORN / Inside Climate News

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

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

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

By end of 2022, 31 huge grid outages had impacted 1+ million persons globally, past 4 years. Christmas 2022 a freeze hit much of US. Ukraine was hit by Russian drones. Florida hit by Hurricane -- something lately an expectation. 10 other outages, affected over 10 million! If uninterruptable power is mission-critical, outages >8 hours more than li-ion batteries bridge. So instead of just storage, think too of fuel cells; they can run unlimited as long as fuel is supplied. Days, weeks, months. In 2020s, fuel was likely natural gas, CH₄. But ahead, may be (green) H₂. Even natural gas may be less costly, less-dirty, than a diesel genset. Diesel spews 161 lbs CO₂ per MMBtu, a gas turbine is bad too @117 lbs; a fuel cell works by electrochemical reaction -- not combusting, so is more efficient, less polluting. A fuel cell is near-pollutants-free, if using green hydrogen H₂ -- no SO_x, nor NO_x from burning. In such future, green H₂ fuel may be made from the wind or sun using water, so simple when using electrolyzers!

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

Blackouts may even lead some conservatives to seek a stronger grid 'now'! Conservative-Iowa in 2022 got 60% of its power by wind; Kansas 50%; Oklahoma was close. Yet their Senators had opposed renewables in negotiating a 2022 IRA, although they increasingly benefit from wind. Later on in 2024, as IRA funds (too)slowly rolled out, monies went 1st largely to few key red Swing States. Despite that 2022's IRA, come 2025 was fast decimated. Conceivably, post-2028 elections, a few Senators/House Members may tear away from a just-partisan opposition to green energy. Maybe on weather extremes, grid failures like 1 million in US losing electricity in 2026, unpalatability of Russian fossils, on costs, they may want to fund renewables & grid -- as well as CO₂-laden fossils. Once-heretical ideas like solar/wind & better grid might be re-considered. Trillions of \$\$\$ being spent on fossil fuels, giving climate crises, wars fought over and over relating to oil & gas, may be rethought. Some thinking reframed.

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

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

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

"Over the 4 years that Hinkley Point C (HPC) has been under construction on the edge of Bristol Channel in the west of England, it has consistently been held up as an example of the industry's current problems. Nuclear energy's long-standing cost and schedule issues used to mean it was hard to compete with natural gas and coal. Now they make it hard for nuclear to compete with ever-cheapening renewable energy.

When the British Government and EDF Energy, the plant's owner, signed the relevant contracts in 2013, HPC was expected to produce a megawatt-hour for GBP £92 (then USD \$145). The same amount of energy from a new offshore wind farm was at the time expected to cost GBP £125. Nine years on, HPC is two years behind schedule and GBP £10 Billion over budget; so its power will cost more. Offshore-wind producers, for their part, are offering energy at less than GBP £50 (now USD \$60) per megawatt-hour. The cost of electricity from solar panels has fallen yet further."

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

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

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

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

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

Anyway, most all nations were & are carbon-addicted, despite flowery words to contrary. Not just a usual China, India, Russia, Saudi Arabia, Qatar -- rich G-20 polluters who self-proclaim virtue too: US, Japan, Germany, UK, others. Whose addictions were/are at odds with prettier promises at G-20 events & climate conferences. Private industry gives more of same. State-owned fossil firms, offer vague promises, glossy blue hydrogen ads, talk of distant 'carbon neutrality' in say a far-distant 2050. All conflicting with pressing CO₂ reality. For instance eg a 2021's COP goals were small beer: 1) Rich nation big 'commitments' of \$100 Billion/year to developing nations were easier to mouth in a Paris Agreement -- than actually to mobilize at COP; 2) Global carbon rules mere talk, as seen in flailing US Congress and disintegrated BBB/ IRA; and 3) Most blatantly cuts big enough to keep to 2 degrees C heating -- let alone 1.5 C -- were obviously far deeper, than what nations were prepared to offer. Commitments made far short of a 2 degrees C ceiling; to say nothing of 1.5 C necessitating 45% *fewer* emissions, a bridge much too far. Simply adding up all say, 2021 commitments, meant then global emissions if followed would drop by oh ... umm, ahem, *Nothing!* Instead, they'd go Up +14% *higher* on best commitments 2021. Canada increased ambitions at COP26, yet 'tougher' goals were so lax, they'd still be in line with 4 degrees C of further heating.

Physics & chemistry can show us the total carbon budget: how much emissions on 50% chance to not go past 1.5 degrees C. That's 2,890 Bn tons of CO₂ -- but we'd emitted 2,390 Bn tons by 2019. So, spewing now @40 Bn tons/year -- to stay <1.5 C is Not possible; we're toast; current trends pass that ceiling. It's laughable to think we'll go for years -- then, switch off in 2030 all CO₂ emissions 100% at once. In 1824, Frenchman Joseph Fourier showed how Earth is warmer, than a planet of no atmosphere. In 1856 brilliant US scientist Eunice Foote saw CO₂ warms inside of a jar; she predicted CO₂ can cause climate change, a century & half ago. John Tyndall in 1860s correctly showed how CO₂, water vapor, methane will warm a planet. Over a century ago, Svante Arrhenius & Arvid Hogbom of Sweden determined Why then-forecasted 3 degrees+ C rise in global warming results from each 3/2 rise of CO₂. That ratio has since been refined, but principle roughly the same, more heating at poles, than at equator. Linear increase in CO₂ -- means a logarithmic rise in radiative forcing. In 2024, Fermi resonance helped explain in new ways the quantum aspects of heating; the CO₂ excites in vibrational coupling, broad spectrum either side of 15 microns wavelengths.

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

Consider what might be possible at a high end. If in theory all China's areas that can go solar, had it. A sparsely-populated northwest (most folks are in southeast), a 'technical potential' of all solar in 2020 was 100 petawatt-hours. That was 13x all China's then total of 7.5 PW/hrs of Electricity Demand (or 2x then-Total demand if all energy with heat). By 2060 as solar efficiencies improve, its solar potential might rise say +50% more, to 150 PW/hr, when China plans for net-zero emissions. 1/2 its potential solar-areas capable of PV were then-cheaper by 2020, than coal. 80% of its solar areas could be cheaper than coal in 2022.

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

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

Looking back a few years: it could have been lucrative to have ‘gone into **Photons**’ then, solar, one ‘P’ (as China did). Look ahead, another P, **Protons** are riskier; energy storage & energy conversion using protons (ions, H⁺) in H₂, fuel cells, *may be* propitious ahead. But that was unknowable 2000s, on huge volatility. What is certain, is ‘protons’ theme in 2020s *is still hugely risky*. Much more so than surer-solar. Solar has steeply cut costs, on manufacturing it gets ever cheaper, like semi chips. Energy conversion/via Protons, is different. Vexed by uncertainties, many breakthroughs still needed to harness protons (eg, ions via fuel cells) -- unlike photons/solar as PV costs fell. Unlike battery-making too, where persistent cost reductions of roughly 6-8%/year have been helpful. Instead, Protons in 2020s as via fuel cells, like green H₂, ammonia, methanol, far more a wild card. Thus, renewables like solar/wind, with storage, may go on pervading ECO. Other areas, may resist so easily decarbonizing.

A wilder idea late 2020s, was a *potential* for nuclear fusion. Put aside attention to H₂, fuel cells, PV, batteries a moment. Instead, focus here on neutrons: fusing 2 isotopes of hydrogen, deuterium (²H as in seawater, 1 neutron) -- with tritium (³H on 2 neutrons bred by lithium) -- to create 2 neutrons of common helium (⁴HE). Critically a 3rd neutron is ‘destroyed’; on Mr. Einstein’s $E=MC^2$, a mass imbalance is immense kinetic energy: 17.5 MeV mass disappears! Immense energy, no waste! But other issues: overcoming Coulomb barrier in positive ways, an inertial confinement at temps/pressures mimicking sun’s core, mean latter half century at soonest before significant applied fusion is on grid. It was lately called “energy-positive” - - but in fact, 100x ignition power was used by lasers -- so yet far from it!! Latter this century it *may be* an addition. But on climate risk + energy security today, much faster growth is needed in renewables; solar/wind, storage, geothermal across the 2030s, ‘40s, 50s, etc.

All as input costs for growing clean energy have soared. Supply chains stretched. Inflation was much more than a ‘transitory’ as at first was curiously said by Fed. Steeply rising input costs, were/are thorny for clean energy. Went from ‘just in time delivery’, to ‘what if’ worries. Take solar. If US, Europe, & Japan are to wrest back manufacturing leadership that had shifted to China in 2010s (we recall 20 years ago Japan, US, Europe dominated PV making; China was near zero) -- then Big changes are needed fast. Confinement needed too. Not just physical like ²H/³H 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 green changes lay ahead, like say, perovskites for better/cheap PV.

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

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

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

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

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

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

In US, one solar deployment target was that 45% of electricity should be from PV by 2045. From a science/climate standpoint, this wasn't only possible, was maybe *required* on 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 then *double* solar each year, 30 GW more installed in US in each year 2022 to 2025. Then rise 4-fold/year. To a freshened 60 GW new US installed solar installed, each and every year, from 2025 through 2030. As we say, that did not happen. Especially as solar was hit by US policies in an administration in 2025. Still, by 2035 on climate crisis, US could need 1,000 GW of renewable power on grid! By 2050 a new 1,600 GW of solar on US zero-carbon grid! So, more solar -- than generated by all sources including fossils/nukes in 2021. To further Decarbonize heat, too, meant 3,000 GW more clean energy by 2050. Greening US transportation, buildings, manufacturing, industry. Zero-carbon power to cover every GW of electricity, plus each BTU of needed heat.

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

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

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

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

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

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

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

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

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

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

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

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

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

More **storage** suggested, too 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 of the AMOC/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 Gulf stream's heat conveyor fail, science is unsure if a Frozen Europe? Or, a Baked one? But impossible, is no change at all! It's a difference engine yet again -- and here in our natural world. A Gulf Stream slowed as meltwaters dilute salinity, or an Antarctic overturning current, would hit ocean currents worldwide. So we all lose. Smarter paths present in myriad ways as *more renewables, energy storage & better grid*. In *short greater Clean Energy and decarbonization* -- is where attention ought turn.

In a 2025, then 2026 etc smitten by storms, wildfires, temperature extremes, blackouts etc, we increasingly see the global economy is a wholly owned subsidiary of the environment. Yet no nation has yet risen to the occasion. And for a host of reasons volatile ECO, NEX, H2X, WNX will surely fall at times, *hard!* Each nation has its own issues... just one problem as a practical domestic matter, has been America lags behind badly in producing lithium, nickel. Rare earths too that in fact aren't rare, yet needed in motors, turbines & strategic uses. As a Senator observed in 2021, "We don't produce any of the rare earth minerals, or very, very, very little of any rare earth minerals that it takes to make a battery. We depend on other sources of the world ... that we seem to want to be out of sight, out of mind, and we just say, 'Well, we have an electric vehicle.'" Or take nickel in batteries, electric cars, grid. In 2022, nickel had spiked briefly on a classic short squeeze going then from \$20k -- to \$100k/ton.

This 'ain't our first Rodeo' seeing US fall badly behind, when it needn't have done so. We saw solar manufacturing decamp from Japan/US/Germany -- to China 2 decades ago - then to SE Asia: Vietnam, Malaysia, Thailand. By 2020, 3 biggest PV makers HQ'd in China. It's seemingly happening again in crucial batteries, EVs. Such needn't occur. But a US does not have a similar industrial 'green-focused' policy. In 2021 a US had only 3 big battery factories. Tesla's Gigafactories pointed a way, yet we may still see, say, only 10 big US battery factories 2030; should be many more. Meanwhile, these 'US factories' may be S. Korean etc-owned factories, just in US. By 2030 so in less than ~5 years, China is smartly on track to have 140 big battery factories! Europe maybe 17 big factories. On projected US EV demand, it should be 20+ US battery factories in 2030. Not inspiring, 2021 saw only half, 10 were on track, maybe. They should have been in planning 2021, construction 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, social impacts -- all to be handled solemnly. Ideals like 'green lithium' are tough, but a 'greener' lithium from hot briny waters & zero-carbon geothermal power is preferable 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 an and all mining. Meanwhile, some disturbed places are more amenable. Places like West Virginia welcome sourcing minerals from ample disturbed sites, and extant waste piles of old mines -- creating good jobs.

Other efforts, unfortunately, may aim to help dirty energy. For what ‘carbon intensity’ wickedly may do, in propping up fossils, is lend them a fig leaf. It sounds quantitative, yet may let polluting firms claim to be ‘greening’ in going from oil -- to gas. Sadly, clever marketing, may enable fossil firms an entry into ‘kind of clean’ (really brown) basket ‘green’ funds. On ill-conceived notions like ‘revenues’ /per ton of CO₂ -- that makes carbon ‘intensity’ slippery indeed. So subtle, it’s pernicious. Consider a startup solar firm, tiny CO₂ emissions, negative revenues; it won’t score well ‘carbon intensity’ on few sales. By contrast, a huge fossil firm massively growing its brown fossil gas sales, gobs of revenues, scoring well. Awful CO₂ eclipsed by swelling profits, for better CO₂ ‘intensity’ scores. Something’s patently wrong with that picture. For how a passive clean Index performs, return to Weighting Methodologies. Interestingly, we saw that *equal-weighted* NEX can outperform since inception -- vs. a *market cap* weighted Index. For equal-weighting’s benefits, consider the Chart below:

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



Source: The Economist (2021)

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

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

Unfortunately, the [green] 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: It’s dismaying to see big oil & coal names in any ‘green’ fund, especially in clean energy Indexes or funds. Beyond this, Europe SFDR/BMR aimed to help address that. And in NEX/H2X/WNX, a floor is \$1m average daily trading value (ADTV)/\$750k continuing components; a look at risk ratings, *and* carbon.

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, H₂ & fuel cells, as seen in other clean energy baskets too. And fast-moving Europe *may* seek more H₂. Continental Europe lacks its own gas reserves (it's no Texas). Was long over-dependent on Russia. Post-2022 it seeks green H₂ 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 H₂ feedstock a 'green ammonia' -- or methanol/CH₃OH (but not from fossil fuel gas; that's greenwash). Europe potentially *may* latter 2020s become a green H₂ leader. And China may ramp nuclear -- even sadly as it only reduced its coal use a bit (if at all) mid-2020s.

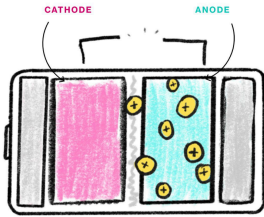
Great uncertainties abound, giving rise to volatility, tremendous risk. Myriad sub-themes *may* see advances: some incremental, some may be non-incremental, perhaps disruptive. Advanced green energy storage & batteries plainly merit focus 2020s, areas ECO & NEX have had exposure to for over 20+ years. 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 (li-ion), has constellation of materials, besides lithium. Like, say Iron, Nickel, Manganese. Much effort in having less/or no cobalt. While different chemistries each favor varied characteristics, all batteries basically, consist of a *Cathode, *Anode, *Separator, *Electrolyte. Anode was largely settled, as graphite, maybe silicon -- maybe say nickel niobate. But that's changing too in a shift away from nickel, cobalt; like a lithium manganese rich (LMR) design promoted by US/ South Korea of late.

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

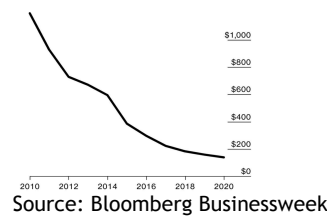
a) 4 basic battery parts:



Source: Bloomberg Businessweek

Battery prices are falling hard:

Battery Prices Shrink, Thanks to Tiny Tweaks
The past decade saw a steep drop in battery prices as measured in U.S. dollars per kilowatt-hour per ton.



Source: Bloomberg Businessweek

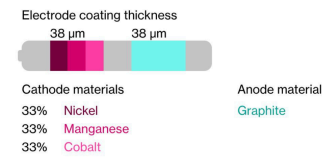
b) Nickel Manganese Cobalt (NMC) in a Zoe:

Renault Zoe



Source: Bloomberg Businessweek

NMC Composition back in 2012:



Source: Bloomberg Businessweek

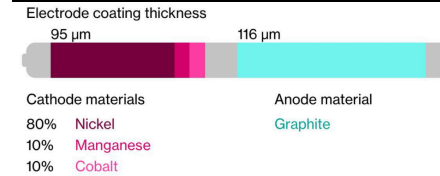
c) NMC as seen in a Nio:

Nio ES6



Source: Bloomberg Businessweek

Then, Nickel, little Cobalt = thicker:



Source: Bloomberg Businessweek

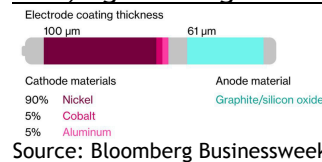
d) Tesla 3 has used NCA:

Tesla Model 3



Source: Bloomberg Businessweek

NCA, light strong battery, no manganese:



Source: Bloomberg Businessweek

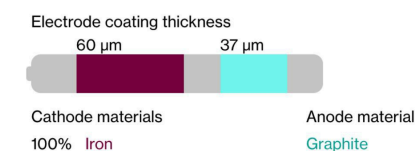
Popular was NCA, or NCM with 8:1:1 ratio of Nickel, Cobalt, Manganese. So, a 'lithium' battery may be much nickel by weight. LFP's cheap iron & phosphate eliminates vexed cobalt, costly nickel. So LFP is gaining. Especially low-cost use. Heavier LFP iron once hadn't performance of NCA, but it's safer & 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 on a 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 low-cost iron:

Electric Buses



Source: Bloomberg Businessweek



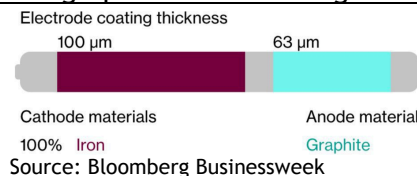
f) Modern LFP, less-energy dense:

BYD Han



Source: Bloomberg Businessweek

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



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 early 2020s since 'dendrites' can penetrate electrolyte. But newer-generation solid-state batteries tantalize. Drumbeat of wistful ever-on horizon solid-state battery hope, long so-elusive, *may* be getting closer. Possibilities of non-incremental advances towards (quasi or fully) solid-state batteries from latter 2020s decade makes one hopeful.

Research shows liquid electrolytes may be replaced by solid-state core for ultra-high current densities. A lithium metal anode with say, $\text{LiNi}_{0.8}\text{Mn}_{0.1}\text{Co}_{0.1}\text{O}_2$ 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 500 charge / discharge cycles meant acceptably a 100,000 mile lifetime in electric car battery. After, pack may have 2nd life uses like stationary storage @ 80% as acceptable. Instead, 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 (we recall building radios with these early 1970s) -- to far superior solid-state transistors (in late 1970s). Solid-state *may* be game-changing in batteries. Or, not happen. Or sodium-ion batteries from latter 2020s that are super cheap, under \$40 per kWh, made of all-abundant materials. Starting cheaper than LFP, but over 10,000 cycles means decades of calendar life, stable, thermally-safe. Less-energy dense than lithium, but great for smaller more affordable city EVs, and far more.

Other ideas may include a dual battery incorporating both LFP for everyday shorter drives and more costly nickel-manganese: lesser cycles yet 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 but which are massive, so just for say, grid-storage. 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, 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. 4th most common element in Earth's crust, it's likely that our planet's core is mostly iron. Being so abundant on Earth, in our solar system too, one hopes (like H_2) to find many uses in energy. So ubiquitous & benign, it's been adopted by life over millions of years. Iron unsurprisingly, is essential to life. 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.

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

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

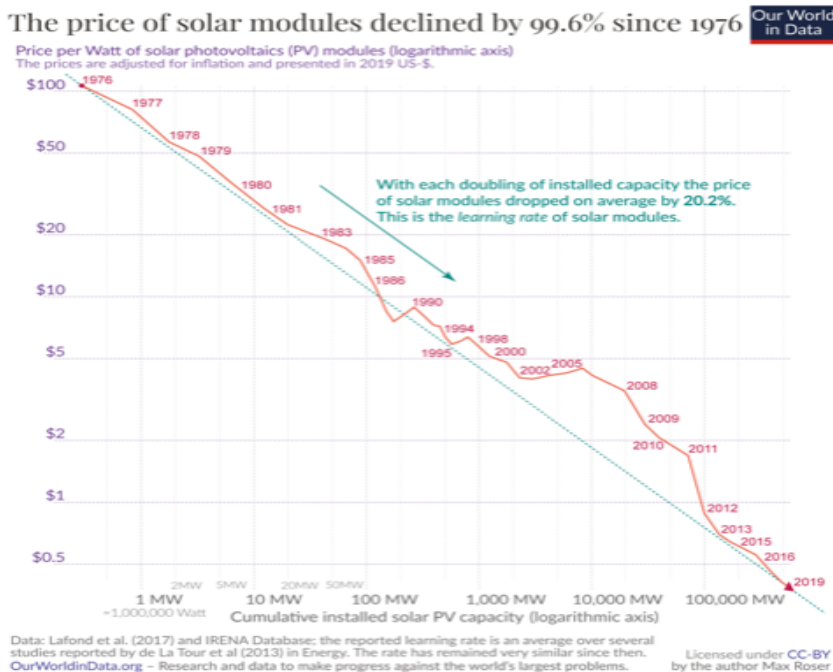
So much is possible. One interesting idea, may be iron-air batteries discharging power as they take in oxygen, making rust. In turn charging by using electricity to change back from rust to metallic iron -- releasing oxygen. On super-abundant benign iron, they may be cheaper & readily recycled. Anyway,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

Expect battery technology advances, help from AI. Fundamentally differing from a greenwash that only dresses up carbon, in spiff-names. Beware of greenwash, perpetuating dirty. Please be aware too, some phrases can mislead just a bit. As noted, a lower 'carbon intensity' isn't actually same as actual low-CO₂ -- but instead, is based on a rather duplicitous profitability. Or, say strongly-scoring E Pillar 'ESG' number -- doesn't correlate necessarily with low-CO₂. 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 create credits -- but ugly offsets still traded). Often artful dodging in 'net zero', 'sequestration' '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, H₂ is nearer to economic on gas' spikes. It would be very risky to suppose this, but just maybe, perhaps, green H₂ *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, CO₂ 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 stock market and her firms domiciled 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%. (April 2025 it stood again not greatly higher, at 8,275).

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

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

As a market cap weighted Index, it *could* have adjusted for awful returns in CO₂ heavy oil. As once-big firms declined, lower prominence, that could let fast-growing small firms instead take leadership positions. But, a problem here has been, that the rest of that Index is literally 100 largest firms, and similarly they've been in slower areas too like mining (was 8 names in 2021, but had earlier been 12), in retail, tobacco. Not in innovation or technology. Therefore, it's not been so similar to say, S&P500 (that added eg, an EV maker). And surely 'ye olde' FTSE was not at all similar to an innovation-heavy US Index, like say popular NASDAQ 100.

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

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

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

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

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

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

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

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

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

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

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

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

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

May 2020 front-month WTI contracts would expire late-April. So, if -25% less demand was not met by production cuts, fears grew of 'tank tops' as in landlocked Cushing, Oklahoma. The 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 in \$20s showed US/global oil markets in distress. Even a more global benchmark, the costlier North Sea Brent crude briefly dropped down in \$20s late April. Not zero, yet oil in \$20s meant production cuts worldwide. Perhaps 1 million oil patch jobs lost, expertise may potentially disappear. Rig counts may fast drop, wells shut-in, bankruptcies. Maybe forcing some US shale producers to shut in, to inflict pain was perhaps an initial aim of some non-US producers like 2015. But this time, oil's ramp in supply had begun, just before pandemic's demand destruction. That on Covid, made disorderly consequences greater than was initially expected. Oil in 2024 could again be in 'desired' roughly \$60s-\$80s -- with US biggest oil producer in world. But that outcome of course was unknown to oil industry, back in panicky 2020/2021. Later in 2025, a question was if new US tariffs & trade wars could again impact oil prices in big new ways. Then, war in 2026 sent oil spiking the other direction.

A 2015 strategy of opening spigots, to stifle competition, had failed in a thriving oil-hungry world; the impacts were then muted. Oil fell to \$50, briefly. Yet excess was absorbed. Wasn't enough fall to kill US shale. Their playbook may have been in a world awash in oil, 2020, that only very-lowest-cost conventional producers could survive. So, later on, they might raise prices, after-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. Unlike clean energy, oil choke points can hit hard: ~20% of oil trade passes at a Strait of Hormuz (attacked in 2026); a Ras Tanura Refinery is key too. 75% of China's imports pass a Strait of Malaga. There's Suez Canal. Bab El-Mandeb strait. Or Taiwan Strait is obvious geopolitical risk. So too a Panama Canal facing drought on low water levels, climate risks.

Thus in 2020 on a pandemic + on tank tops fears, oil went briefly under <\$20. Quickly reviving economies & getting oil demand back, was essential. Oil-exporting nations may ideally want crude prices in \$90s to \$110s. To let them better balance their own books, national budgets. But regaining firm demand, came first. Proposed conventional oil projects anyway often uneconomic, without oil at least \$50s. Plus for some nations it's vital to realize, sell crude when richly valued. Vast underground reserves held too long, look increasingly like maybe stranded assets one day. As such, wary of sharply diminishing value on CO₂ / fresh climate concerns -- or electrification. Ascent of electric vehicles. And changing oil economics. For example, industry faced opposite -- dreaded 'tank bottom' fears six years later in 2026.

Globally, back then, industry faced pressing fears Spring 2020: of Inland wells for instance without a port or storage nearby, or distribution pipelines -- having to sell its excess crude at unthinkable 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 benchmark due to landlocked Cushing fears, proved not as 'useful' as the benchmark for Brent Sea Crude (that stayed positive with \$20 bottom then) -- or even Oil Indexes like in the UAE.

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

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

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

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

Yet in 2022 much was changed: oil & especially gas took on new directions. Russia shut supply, for one thing. Before, renewables were rather unaffected by oil & gas. But with oil/ gas pricey, growing clean energy/storage was an aim. Small electricity storage capacity was once simple, if little was needed; push water high, release it for power; plus 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'.

CO₂ Gaining Importance -- While Renewables Are Now The Cheapest Energy Of All

For 20+ years, our Clean Energy Index® Reports have been looking at smarter new *Solutions*. Not just problems of CO₂ & climate *per se* -- but solar, wind, batteries, as more elegant ideas. This was logical even start of 2020s, when having the better economics wasn't yet a primary engine for clean energy. Lately, however, the renewables have become very cheapest energy path. This fundamentally will not be reversed. Means going forward, renewables now as both *zero-CO₂, and with *best economics, can help make clean energy even-more compelling.

In short, CO₂/climate is a tremendous risk to humanity; meanwhile the least-costly & best solutions on energy -- renewables, can now make the most sense anyways. None too soon.

Consider a scientific report which warns in just a “coming 50 years, 1 to 3 billion people are projected to be left outside climate conditions that have served humanity well over past 6,000 years.” In particular, on CO₂ & population changes, a narrow temperature niche our species required, is projected to change more in just next 50 years, than past 6 millennia.

CO₂ has long been hero to our species -- and indeed all present forms of life, in moderation. Earth without such a CO₂ level might have had near 0 C surface temp. Instead, it's ‘just right’ thanks to CO₂ in tiny concentrations under 300 ppm. Greenhouse gases naturally presented over thousands of years, have mean average temperatures are pretty ideal for us, at a 58 degrees F. We'd habituated ourselves to thrive in such ‘cool’ for over 10 thousand years.

Late 1950s when regular CO₂ monitoring began, modern readings were already up from what was long near 280 PPM. Nearer 315 PPM. By 1988, scientists became alarmed as planetary warming due to increases in CO₂ had reached 350 ppm. Worriedly, a world conference held in that year called for reducing from very high, 350 figure, downwards -20%, by 2005.

By 1992, a global compact was reached. Signed in Rio, a UN Framework Convention on Climate Change lacked specific cuts. Looking back, a nebulous agreement to try to act was real failure -- nowhere close to task. CO₂ continued rising sharply. For Rio only *implied cuts*, like calling for global emissions to be -20% lower in 2005. Instead, CO₂ as it turned out, still only grew -- going +34% *higher by 2005*. Looking back, it went on rising, by another +22% higher in 2017 -- to over 425 ppm mid-2020s. Higher than in a last 3 million years. Maybe highest in last 12 million years. So, merely aspirational words, absent robust actions, have woefully not achieved what's needed for real decarbonization, to cut grave climate risk.

More specific ‘cuts’ were laid out 5 years after in a 1997 Kyoto Agreement on climate. Yet CO₂ went on rising, more sharply. A mockery of CO₂ action. International agreements were again tried 2009, but Copenhagen event failed. CO₂ levels continued increasing, temperatures spiking. A 2015 Paris Agreement was roughly more of same. CO₂ still a fast uphill scary climb. By 2020, only 3 countries had met early Paris terms: Marshall Islands, Suriname, & Norway which made up only 0.1% of emissions globally. In short there's still No cause for optimism. A gathering in Glasgow 2021 meant to speed progress -- failed. In 2025 the US once-again pulled out of Paris Climate Convention, for a 2nd time. The truth is, despite flowery words, there's been woefully little action. In sum commitment Isn't there. That's why it's arguably crucial to see *clean energy (at times *unsubsidized*) has become cheaper than fossil fuels (subsidized massively worldwide). Yet still little *recognition of the science; or *acceptance that decarbonizing away from fossils -- to clean paths while also creating new wealth/ new jobs - is hardly a radical path. Instead delay, willful ignorance is accepted here.

There's some bits of optimism. Near-term to 2100s, intercomparisons of 56 climate models indicated some most-awful possibilities, *may* be less likely. Barring say feedbacks of methane, of clathrates, water vapor, permafrost, & hoping for no other mal-contributions, then models' scariest ~9 degrees F by 2100s *may be* less likely on recent understanding. Prior models had assumed higher fertility rates, more use of coal, fewer renewables; things aren't that bad. So worst-case predictions of an entirely-unlivable 9 degrees F warming, hopefully become highly unlikely. On the other, hand, studies still do show that eg, the carbonate/ limestone permafrost in Siberia, were it to thaw, might potentially yield enormous methane release via fracturing. Methane can be *even more climate forcing than CO₂*, in the near-term.

Yet if we deem high end, Representative Concentration Pathway (RCP) 8.5 as unlikely, heavy CO₂ emissions there improbable -- then we should also regard a lowest RCP 2.6 too, as unrealistic. It assumes a widespread embrace of renewables already far greater than is seen, and No coal (ha ha ha). Neither, especially the latter, was close to accurate latter-2020s.

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

Next 'lower' RCP 6.0 seems rather closer to where we're trending -- on today's present (in)action. It foresees roughly near 5 ½ degrees F warming by 2100s. Under it global emissions peak some 60 years out, 2080s or so, then decline. (CO₂ in the atmosphere rises, stays high, drops only slowly as accumulates). Coal plants built in Asia as they are -- but those soon may be regarded as things of the past in RCP 6.0. Electric car adoptions globally accelerate.

It assumes a CO₂ equivalent to about 850 ppm, or about 2x now. For data nerds like ourselves, translates to radiative forcing of 6.0 Wm² post 2100, or 6 watts/square meter in RCP 6.0. (RCP 8.5 translates to 8.5 Wm²). For incoming solar energy, pushed far out of balance in our altered Earth-atmosphere system. Consequences of that, may go on to be dire for our species but over centuries, millennia ahead. Yet it seems about what one 'might hope for'.

Next is a very, very ambitious hoped-for RCP 4.5: emissions peak ~20 years so 2040s, then fall fast. CO₂ not long ago was a stable 280, now 425 & rising fast; it rises in this view to 'just' some 650 ppm -- unlikely but has it then stopping/peaking there. Much decarbonizing is assumed to have been undertaken (far more than is now planned), CO₂ in time is dropping. That *may* be possible, although it's a huge stretch. And arguably highly unlikely, on CO₂ now some 50% greater than near 280 ppm, pre-industrial, rising fast. The 4.5 is very improbable, as hundreds of coal plants are being built now in 2020s, each with a life of 20 years or more. Possibly operating into the 2040s, even after, unless they are prematurely shuttered.

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

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

Imagine a few years hence. Europe using low-cost solar from Asia, wind, & vast new energy storage, became the 1st to reach 100% net carbon free power, or be at least carbon-neutral, latter 2030s. The US afterwards. Much of world later got there ~2050s. Electric vehicles scaled faster than expected! Green H₂ long-much-too-costly, came to industry, richer nations grew climate neutral in 2060s. China too got there by 2070, meeting targets. Rest of world in 2080s although with much fudging like including on 'sequestration' and other claims. Earth still has some thriving forests, oceans are partially-healthy, with some left CO₂ 'natural sinks'.

That modestly-ambitious timeline, is absolutely Do-able! Unfortunately, the science also implies on inertia in CO₂ -- this scenario destroys global low-lying megacities due to sea-level rise, climate crises. Blew right past 2 C Paris goal (says nothing of a dead 1.5 C aspiration) -- and has soon put us unbearably onto a 5 C, or even 6+ C degrees hotter world. Oceans may be at the start of a long-collapse. The AMOC / Gulf Stream may be degrading-fast.

That's not alarmist. It's just where science dispassionately points. Maybe unbearable heat -- and growing hotter. Centuries of sea level rise; possible centuries of rise is ending Florida, New York City, DC. Inundating much of US Eastern seaboard, US Gulf Coast, parts of US West Coast. While indigenous peoples long predate today's St. Augustine, Florida -- if one considers it 'founded' in 1565 -- we're likely nearer end of the first US City, than birth. Near death of Guangzhou, Mumbai, Shanghai, Bangkok etc -- none have 450 more years ahead.

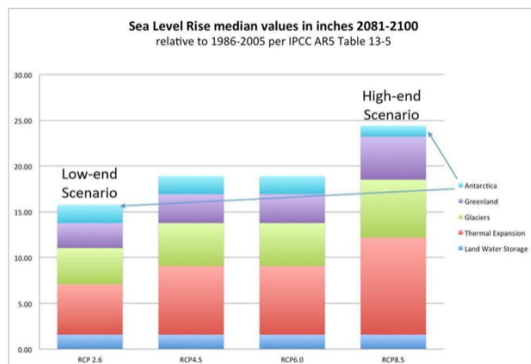
Imagine just ~70 years hence. Note then projections by Intergovernmental Panel on Climate Change (IPCC) for sea level rise in year 2100, may be misleading. For that end of century rise may be unwinding at far more rapid accelerating rates, than was projected by IPCC. Getting that so wrong, has meant that a lax policy today has allowed for too much CO₂, methane, and inertial heat to build unduly. Which can then neither be halted, nor at all unwound.

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

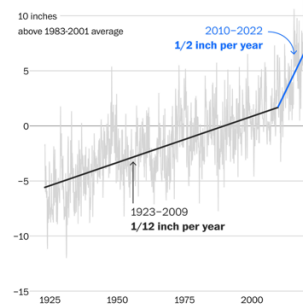
Since around 1850, the concentration of atmospheric CO₂ has risen from ~280 to over 415 parts per million (ppm), resulting in a global mean temperature rise of ~0.9 C -- 1.2 C. Even if human-caused emissions are reduced to net zero by 2050, global temperatures may rise to more than 1.5 C above their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

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

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



Rapid sea level rise at 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 CO₂ 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 CO₂. 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 CO₂ 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 CO₂, methane, other greenhouse gases at rates never seen before. Global reshaping is what we're talking about. So put aside for a moment, noisy political debate. Ignore too other impacts, say new diseases, the storms, famines, droughts, tornadoes, collapsing ecosystems. Follow-on impacts that spread like ripples on a pond. Earthquakes that may follow unburdened melting glaciers, that can affect distant tectonic plates. Just focusing on impacts of seas rising, is enough.

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

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

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

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

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

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

These data show a 'recent' rising warming which started from 20 millennia ago, had crucially brought the Earth out of its last ice age. Air temperatures sharply rose over a period from last ice age, to roughly the steadier-modern-climate that commenced some 11 millennia ago. From that point, on, both CO₂ 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 CO₂, 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 CO₂ may be steadied -- even if humanity takes determined actions to slow CO₂ rises worldwide and decrease emissions. This thorny fact is not widely appreciated nor understood.

Combine CO₂ 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 CO₂ 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 CO₂ 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 CO₂ changes naturally took thousands of years to occur. To slowly rise or fall. By contrast in a single human lifetime now, we're exploding CO₂ 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 CO₂ out of atmosphere over very long periods of time, via Earth's natural 'rock thermostat'. Specifically, CO₂ 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 CO₂ -- 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 CO₂ 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 CO₂ 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 CO₂ 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. Prizes given for clever ways to pull CO₂ from air, or incentivizing better, not-bitter, action ahead. Perhaps CO₂ 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 CO₂. That can be a lot on 30 billion metric tons pumped into air each year. Like abalone that makes shells from CO₂ 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 CO₂ 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 gave scenarios for rise this century, straightforward 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 CO₂ scenario: little rise. It assumed strong actions would be taken later in this century to reduce CO₂ 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 CO₂, 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 CO₂.

CO₂ 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 CO₂ 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(!) shaping continents as 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 CO₂. 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 CO₂ 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 CO₂ 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 CO₂, 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 CO₂ 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 82.95 & ended Q3 at 62.19, down about -25%, and year to date was down -4%. Or say in 'context of presidents' so fully 6 Quarters into new 2nd term, ECO Index® is up, +87%. We'd seen in a president's 1st term from 2017 to 2020, this Index had moved dramatically: ECO notably climbed +560%. Rose over 6-fold, ironically about the best performance of any index or fund yet during a white house highly opposed to clean energy. Fast-rising inflation, next hit this interest-rate-sensitive theme very hard; ECO then fell all 4 years of a very different (pro-clean energy) oval office 2021 through 2024. After, on return of that prior anti-renewables president to start a 2nd term, ECO once again moved up first year by +52% for 2025. We'll explain some factors behind seeming counter-intuitive moves, yet that arguably were still rather foreseeable, perhaps even a bit 'probable'.

The Deletions from ECO for start of Q4 2026, were: Atlas Lithium, AXIA, and SES Corp -- the Additions to start Q4 were: Factorial Energy, Wolfsped, and Xanadu. At Global NEX for the Latter Q3 rebalance, Deletions were: Atkore, Phihong, and TSEC -- and NEX Additions were: CNGR, Rigetti, Wolfsped. At Hydrogen H2X, Deletions for Latter Q3 2026 were: SungEel, Thyssen. Nucera -- and H2X Additions for Latter Q3 were: NanoFilm. At Wind Energy WNX, the Deletions for Latter Q3 2026 were: Atkore -- WNX Additions for Latter Q3 were: none.

As always, we welcome your thoughts and suggestions.

Sincerely,

Robert Wilder

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Disclaimer: The following is a reminder from the friendly folks at WilderHill® who worry about liability. Performance figures represent past performance only, no guarantee of future results. Views expressed are not investment advice and should not be considered as predictive in nature. Positions in ECO Index®, NEX, Hydrogen H2X, Wind WNX can & do change. Discussions of past performance do not guarantee, and are not indicative of, future performance. These Indexes aim to capture volatile, risky sectors & so are volatile, risky too, and subject to well above-average changes in valuation. While these materials are intended to provide very general information, nothing is offered as investment advice: it is believed mainly reliable, but we do not warrant completeness, timeliness, or accuracy. Clean Energy Index® (ECO) is published & owned by WilderShares®. The WilderHill: New Energy Global Innovation (NEX), Hydrogen Economy (W2X), Wind Energy (WNX) Indexes are all owned by WilderHill New Energy Finance; no financial instruments or products based on them are sponsored or sold by these entities, and they make no representation regarding advisability of investing in product(s). Marks to WilderHill®, Clean Energy Index®, ECO Index®, and WilderShares® are registered property; all rights reserved.

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

INDEX (ECO) SECTOR & STOCK WEIGHTS FOR START OF Q4 2026. 72 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 - 14% weight (8 stocks @1.68% each + 1 *banded)

Array Technologies, ARRY. Solar, tracker mounts follow sun through day
Cadeler A/S, CDLR. Offshore wind, vessels for installation / maintenance.
Canadian Solar, CSIQ. Solar, vertical integrated solar manufacturer, China.
First Solar, FSLR. Thin film solar, US based, CdTe low-cost alternative.
JinkoSolar, JKS. Solar, wafers through solar modules, China-based OEM.
Nextpower, NXT. Solar trackers, optimizing PV daily performance yield.
Ormat, ORA. Geothermal, US, also in areas of recovering heat energy.
T1 Energy, TE. Solar manufacturing, also makes batteries, based in US.
**Toyo Solar*, TOYO. Solar PV, built in Japan, also in US; non-China PV.

Energy Storage - 18% sector weight (13 stocks @1.38 each)

Albermarle, ALB. Lithium, specialty materials in batteries energy storage.
Amprius Technologies, AMPX. Silicon anode batteries, greater energy density.
Chemical & Mining of Chile, SQM. Lithium, large producer in energy storage.
Enovix, ENVX. Silicon-anodes, 3D for improving new lithium-ion batteries.
Factorial Energy, FAC. Solid-state batteries, quasi, & all-solid-state, AI use.
loneer, IONR. Lithium, boron miner, for batteries, from US domestic sites.
Lithium Americas, LAC. Lithium, deposits in the State of Nevada in US.
Lithium Argentina AG, LAR. Lithium deposits in Argentina; has China nexus.
Quantumscape, QS. Battery, solid state lithium-metal, dense fast charge.
Sigma Lithium, SGML. Lithium, in planning & pre-construction, Brazil.
Solid Power, SLDP. Solid electrolyte battery, Earth-abundant materials.
Standard Lithium, SLI. Lithium, from brine in U.S., vs. traditional ponds.
Tesla, TSLA. Electric vehicles, EVs, storage, advanced energy systems.

Power Delivery & Conservation - 20% sector (14 stocks @1.35% each + 2 *banded)

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, NVT. Gallium Nitride GaN, high voltage in AI, EVs.
Nio Inc, NIO. EVs, China-based maker premium vehicles, battery as service.
**Niu Technologies*, NIU. Electric scooters, motorcycles, mopeds, bicycles.
Preformed Line Products, PLPC. Grid products & transmission OEM, solar.
Rivian, RIVN. Electric vehicles, trucks and commercial fleets, charging.
Shoals, SHLS. Solar, for electric balance of system, wiring, combiners.
**Tigo Energy*, TYGO. Solar, software & power electronics hardware.
Universal Display, OLED. Organic light emitting diodes, efficient displays.
Wolfspeed, WOLF. Electrification of all, Silicon Carbide SiC, MOSFETs.
Xpeng, XPEV. Electric vehicles, new mobility, swappable battery, China.

Energy Conversion - 20% sector weight (14 stocks @1.42% each)

Advanced Energy, AEIS. Power condition: inverters, thin film deposition.
Archer Aviation, ACHR. Electrifying aircraft, vertical takeoff & landing.
Ballard Power, BLPD. Mid-size fuel cells; PEM such as in transportation.
Bel Fuse, BELFB. Transformers, power supplies, circuit protection, AC/DC.
Beta Technologies, BETA. Electric aircraft, VTOL/CTOL low operating cost.
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.
Lifeline Metals, LZM. Low-carbon battery metals, Nickel no smelting.
MP Materials, MP. Rare Earths, domestic U.S. source Neodymium, NdPr.
Plug Power, PLUG. Fuel cells, also electrolyzers to generate H2 on-site.
SolarEdge Technologies, SEDG. Inverters, solar optimizers, inverters.
USA Rare Earths, USAR. Rare Earths, domestic US-magnets supply chain.

Greener Utilities - 18% sector weight (13 stocks @1.38% each)

American Superconductor, AMSC. Wind, grid conditioning; superconductors.
Brookfield Renewable, BEPC. Renewables hydro, wind, solar; energy storage.
D-Wave, QBTS. Quantum compute, optimizing use of renewables on the grid.
Energy Vault, NRGV. Utility-scale energy storage; shorter & longer duration.
Eos Energy, EOSE. Zinc batteries, a safer li-ion alternative, longer-duration.
Fervo, FRVO. Geothermal, using enhanced recovery for a firm renewable.
Fluence, FLNC. Battery storage, for renewables and digital applications.
IonQ, IONQ. Quantum compute, for Virtual Power Plants (VPPs), efficiency.
Powell Industries, POWL. Switchgear, controllers, & power generation.
Quanta Services, PWR. Infrastructure, modernizes grid, power transmission.
Solv Energy, MWH. Large-scale solar power + battery storage, Utility EPC.
Sunrun, RUN. Residential solar systems, PPA, lease or purchase rooftop PV.
Xanadu Quantum, XNDU. Quantum compute, efficient batteries/PV/grids.

Cleaner Fuels - 10% sector weight (7 stocks @1.42% each)

Bloom Energy, BE. Stationary fuel cells, not-yet cleanest/renewable fuels.
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.
Hyllion, HYLN. Enabling variety of fuels, in more efficient linear engine.
Opal Fuels, OPAL. Renewable natural gas, RNG, CH4 at landfills, dairies.
Rex, REX. Biofuels, adding CCS sequestration, But Not advanced biofuels.

**Axia: was removed infra-Q3 2026.

Appendix II:
WilderHill New Energy Global Innovation (NEX) - for Latter Q3 2026. 110 Stocks.

<u>Name</u>	<u>Description</u>	<u>Sector</u>	<u>Currency</u>	<u>Activity</u>
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
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
BYD	Electric vehicles, advanced batteries, China based.	ENS	HKD	CHINA
CALB Group	Batteries, in electric vehicles, energy storage, grid.	ENS	HKD	CHINA
Canadian Solar	Solar, vertical integrated solar manufacturer, China.	RSR	USD	CANADA
Ceres Power	Fuel cells, high temperature steel units.	ECV	GBP	UK
China Datang Renewable	Wind, among largest listed wind operators in China.	RWD	HKD	CHINA
Chung-Hsin Electric Mach.	Fuel cells, H2 dispenser, micro-grid maker, Taiwan.	ECV	TWD	TAIWAN
CNGR Advanced Materials	Cathode materials and precursors for new energy batteries.	ENS	HKD	CHINA
Contemporary Amperex Tech.	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
Ganfeng Lithium	Lithium, produces compounds, metals, for batteries.	ENS	HKD	CHINA
Green Plains	Biorefining, lower-carbon fuels, renewable SAFs.	RBB	USD	US
Greenergy Renovables SA	Solar & storage, integrated project developer.	RSR	EUR	SPAIN
GS Yuasa	Battery technologies, also lithium for EVs, Japan.	ENS	JPY	JAPAN
Hainan Drinda	Solar PV, China & overseas; also perovskite batteries.	RSR	HKD	CHINA
Hannon Armstrong	Energy efficiency, capital & finance for infrastructure.	EEF	USD	US
HD Hyundai Electric	Transformers, circuit breakers, smart ships.	EEF	KRW	S. KOREA
Hubbell Inc.	Electrical equipment, grid infrastructure, utilities.	EEF	USD	US
ITM Power plc	Fuel cells, uses PEM technology; also hydrogen.	ECV	GBP	UK
Itron	Meters, Utility energy monitor, measuring & manage.	EEF	USD	US
J&V Energy Technology	Solar, wind, and power storage.	RWD	TWD	TAIWAN

JinkoSolar	Solar, wafers through solar modules, China OEM.	RSR	USD	CHINA
Kempower Oyj	Fast chargers, EVs, cars, trucks, aircraft, vessels.	EEF	EUR	FINLAND
Kingspan Group plc	Efficient Buildings, insulation, conservation, Ireland.	EEF	EUR	IRELAND
Landis+Gyr Group AG	Advanced meters, modernizing grid, Switzerland.	EEF	CHF	SWITZER.
Legrand SA	Electrical, energy & digital infrastructure in buildings.	ECV	EUR	FRANCE
LG Energy Solution	Batteries, in EVs, energy storage, S Korea,	ENS	KRW	S. KOREA
Littelfuse Inc	Electronic components, transformers.	EEF	USD	US
Lotte Energy Materials	Rechargeable battery materials, elecfoils in batteries.	ENS	KRW	S. KOREA
LS Corp.	Cables, wind power transmission over distances.	RWD	KRW	S. KOREA
LS Electric	Smart grid power transmission, wind, solar, storage.	ENS	KRW	S. KOREA
Lucid	Electric Vehicles, premium, higher-voltage, range.	EEF	USD	US
Mercury NZ	Clean power, 100% renewable hydro, geothermal.	ROH	NZD	NEW ZEA.
Motech	Solar, cells and modules manufacturing.	RSR	TWD	TAIWAN
Nexans SA	Cables, for grid power infrastructure.	EEF	EUR	FRANCE
NFI Group	Fuel cell and electric drivetrains, for large buses.	EEF	CAD	CANADA
Nibe Industrier AB	Heating, cooling, sustainable technologies, Sweden.	EEF	SEK	SWEDEN
Nio	Electric Vehicles, design, manufacture, premium EVs.	ENS	USD	CHINA
NKT A/S	AC/DC cables, grid infrastructure improvements.	EEF	DKK	DENMARK
Nordex SE	Wind turbines, based in Germany/Europe, worldwide.	RWD	EUR	GERMANY
OCI Holdings Co Ltd	Solar, polysilicon, modules, expanding in Texas.	RSR	KRW	S. KOREA
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
Plug Power	Small fuel cells, e.g. in forklifts; drop in replacements.	ECV	USD	US
Prysmian SpA	Cables, renewable power transmission, global.	EEF	EUR	ITALY
Quantumscape	Lithium metal batteries, solid state, quicker charge.	ENS	USD	US
Renova	Wind, Solar, Biomass, power generation in Asia.	RWD	JPY	JAPAN
Rept Battero	Lithium ion batteries, energy storage.	ENS	HKD	CHINA
Rexel SA	Electric conversion systems, energy storage, cables.	ECV	EUR	FRANCE
Rigetti Computing Inc	Quantum computing to optimize grid, batteries, solar, CCS.	EEF	USD	US
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
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
Wolfspeed Inc	Silicon carbide, better efficiencies fuel cell vehicles.	EEF	USD	US
Xinyi Energy	Solar Farms, near 50 farms also floating, in China.	RSR	HKD	CHINA
Xinyi Solar Holdings	Solar, ultra-clear glass products, China.	RSR	HKD	CHINA
Xpeng Motors	Electric Vehicles, internet and autonomous features.	ENS	USD	CHINA
Yadea Group	Electric scooters and motorcycles, electric bikes.	EEF	HKD	CHINA
Zhejiang Leapmotor	Electric vehicles, internet connectivity, China.	ENS	HKD	CHINA

For Rebalance in Latter Q3 2026:

Deletions: Atkore, Phihong Technology, TSEC Corp

Additions: CNGR Advanced Materials, Rigetti Computing, Wolfspeed

110 stocks = % Weights

WEIGHT EACH COMPONENT =

0.90909091

110 Stocks for Latter Q3 2026.		#	% Approx. Weight
Energy Conversion	ECV	22	20%
Energy Efficiency	EEF	26	24%
Energy Storage	ENS	20	18%
Renewables - Biofuels	RBB	3	3%
Renewables - Other	ROH	3	3%
Renewable - Solar	RSR	23	21%
Renewable - Wind	RWD	13	12%
		110	100%

Appendix III: WilderHill Hydrogen Economy Index (H2X) for Latter Q3 2026 (64 components):

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

Sanyo Denki Co. Ltd.	Cooling units for fuel cells, renewables inverters.	FC	JAPAN
Scatec ASA	Green Hydrogen produced by solar power.	GH	NORWAY
Schneider Electric SE	Gas analysis, automation for advanced H2 storage.	HS	FRANCE
Screen Holdings	Membranes for fuel cells.	FC	JAPAN
Sensata Technologies	Sensors, inverters, contactors, etc. for fuel cells.	FC	USA
Sensirion Holdings	Sensors for fuel cells.	FC	SWITZER.
SGL Carbon SE	Carbon fibers, gaskets, and sealing for hydrogen tanks.	HS	GERMANY
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
Spie SA	Hydrogen in mobility, H2 production, distribution.	HT	FRANCE
Sumitomo Metal Mining	Non-ferrous metals and solid state batteries.	FC	JAPAN
Taiyo Yuden	SOFC fuel cells-metal supported, capacitors, H2 fuels.	HT	JAPAN
Takaoka Toko	Power to gas for production/storage of H2.	HG	JAPAN
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
Wacker Chemie AG	Green H2 from water using renewables, into methanol.	GH	GERMANY
Weichai Power	Hydrogen uses in forklifts, fuel cell buses, Asia.	GT	CHINA
Yara International	Green ammonia, H2 catapult aims for H2 <\$2/kg.	GH	NORWAY

For Rebalance in Latter Q3 2026:

Deletions for Latter Q3 2026: SungEel HiTech Ltd, Thyssenkrupp Nucera

Addition for Latter Q3 2026: NanoFilm Technologies

Equal Weight = 100/64= 1.56250% each.

<u>WilderHill Hydrogen Index Sectors</u>	<u>#</u>
FUEL CELLS (FC)=	16
GREEN HYDROGEN (GH)=	10
HYDROGEN GENERATION (HG)=	12
HYDROGEN INNOVATION (HI)=	8
HYDROGEN STORAGE (HS)=	9
HYDROGEN in TRANSPORT (HT)=	9
Total Constituents =	64

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Appendix IV: WilderHill Wind Energy Index (WNX) for Latter Q3 2026 (70 components):

<u>Name</u>	<u>Description</u>	<u>Sector</u>	<u>Activity</u>
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.
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
Daihen	Transformers, power distribution, inverters.	SG	JAPAN
DEME Group NV	Offshore wind infrastructure, undersea cable.	WI	BELGIUM
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	NEW ZEALAND
Mersen SA	Carbon brushes in wind power, & graphite.	WM	FRANCE
Nexans SA	Subsea cables for offshore wind farms.	SG	FRANCE
NKT A/S	High voltage DC offshore wind, cables.	SG	DENMARK
Nordex SE	One of world's largest wind turbine makers.	WI	GERMANY
Orsted A/S	Renewable energy - transitioned from fossils.	WI	DENMARK
Osaki Electric	Smart meters and switchgear for grid.	SG	JAPAN
Prysmian SpA	Cables for new offshore wind and grid.	SG	ITALY
Quantumscape	Solid state batteries, lithium, grid storage.	SG	USA
Renova Inc	Independent renewable power producer.	WF	JAPAN
Rexel SA	Smart electrical systems, energy efficiency.	WM	FRANCE
Scatec ASA	Wind farm, new 5 GW, green H2, ammonia.	WF	NORWAY
Schneider Electric	Advanced grid, wind energy management.	SG	FRANCE

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

For Rebalance in Latter Q3 2026:

Deletions for Latter Q3 2026: Atkore.

Additions for Latter Q3 2026: None.

Equal Weight = $100/70 = 1.4286\%$ each.

<u>WilderHill Wind Sectors</u>	<u>#</u>
SMARTER GRID (SG)=	22
WIND FARMS (WF)=	11
WIND INNOVATION (WI)=	17
<u>WIND MATERIALS (WM)=</u>	<u>20</u>
Total Constituents =	70

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://wildershires.com> - or <https://cleanenergyindex.com>

For 1990s antecedents in an original, Wilder-hill Hydrogen Fuel Cell Index, see <http://h2fuelcells.org>
