WilderShares, LLC

Q1 2021 Quarterly Report: WilderHill Clean Energy Index®, March 31, 2021

The Clean Energy Index® (ECO) started 1st Quarter & 2021 near 215, and it ended Q1 around 200, down roughly -7%. After +205% gains 2020 when this decarbonization story rose 6-fold, for a best performance of most any Index or Fund anywhere, a sell-off was maybe overdue. Thus, it wasn't so surprising especially after seeing ECO Index® drop by one-half in Feb/March of 2020 – to see it drop hard within Q1 by one-third February/March 2021 from 280 to 180. Volatility is partly due to big, pro-clean energy policies increasingly now happening for this theme worldwide. Since start of 2017 when ECO was at 38, it's now up +410%.

As we emphasize, ECO, global NEX, & OCEAN themes passively capture volatile risky themes, so can & will at times 'drop like a rock'. Big gains may occur, bigger drops too. Yet fresh attention *may* continue to be paid here; solar is about to become the lowest & best-priced electricity *anywhere, anytime in history*. Potentially, this may mean vast new demand ahead from US, Europe, and Asia. As infrastructure and good jobs, equity & social justice – overlap with climate change solutions - there may be moves ahead. Not just in solar, perhaps too in offshore & onshore wind, batteries, energy storage, electric vehicles, new green hydrogen, fuel cells, ESG, and the deep decarbonization of everything – unlike anything before.

Last 5 years, original Benchmark ECO Index® live since 2004 and 1st for climate solutions is up +400% to early-March. This over a period when any energy gains likely stand out. For in the same 5 years, CO_2-heavy oil & gas are down by some -50%, and the last 10 years the fossils are down -80%. That starkly contrasts with decarbonization as longtime organizing theme here in key ECO, NEX, & OCEAN, which have showed clearly strongest returns in energy.

And the New Energy Global Innovation Index (NEX) for *worldwide* clean energy story is up +200% last 5 years, also starkly beating fossil fuels. ECO & NEX outperformed too vs. another global clean energy Index most every sizable period: past 1, 5, 10 years, since inception etc; very differing weightings & fewer components in that other may help explain this divergence. As for Trackers, we note a new fund is available in Europe (GCLE; London Exchange) for NEX. In sum, volatile risky WilderHill themes have outperformed past several years. And energy, long dirty and dug deep underground – increasingly comes to us all in innovative and disruptive ways - cleanly, renewably and more desirably from up towards Heavens.

The Clean Energy Index® (ECO) live since 2004, is the first capturing the significant clean energy portrait. ECO Index® has the longest record, is a Benchmark, and has well outperformed coal, oil & gas. Along with global NEX, & OCEAN, they offer climate change solutions: solar, wind, electric vehicles, batteries, hydrogen, fuel cells, and decarbonization of everything. Highly-respected, WilderHill Indexes are volatile & innovative - with noted performances and non-correlation to fossil fuels. Plus, they deliver transparency, diversification and modern ESG thinking that can help diversify a model portfolio.

Source: NYSE.com

Recent: Q1 and 2021

Fascinating and ever-unfolding, clean energy in stock markets is seen in ECO, NEX, OCEAN. Below, most granular, is Q1 2021 to late-March. All 3 WilderHill themes had at first gained in January; ECO, NEX, OCEAN first up +22%, +10%, +10%, outperforming an S&P500. After highs early-February – all 3 started falling very hard; ending January + February +5%, -3%, +2% YTD, near an S&P500. (OCEAN Index isn't shown simply as no tracker just yet). In March that plunge was deepening – crashing, like in Q1 2020. Interestingly though, this time fossil fuels were *gaining* very strongly Q1 2021 – by coming off their deep lows. Past many years, our 3 green themes had usually done (far) better than the fossil fuels; that has changed in this latter Q1. Here oil & gas - admittedly coming off their own dismal deep lows, clearly jumped.

Fossil fuels having fallen dramatically for years, Q1 was quite a change. Oil for instance had dropped historically hard in 2020, on a Demand Collapse due to pandemic. The world's oil industry needs oil prices at least over >$50s, over >$60s. Nearer to ~$50/barrel punishes indebted shale producers. Oil near $50 foretells much misery ahead for producers, even for whole countries relying on reserves. Equities are inherently forward-looking, so oil's vexed theme 2020 hadn't seemed an attractive destination for capital. But following big supply cuts to be discussed ahead, both oil and natural gas gained unusually well early 2021. Higher prices in Q1 for gas, however, might in time make clean energy yet even more competitive.

A key point, to be repeated, is *Costs for solar/wind electricity, by contrast, can go very low at times, naturally*. This variability is a characteristic, indeed a core trait of the renewables. Oil, instead, faces its 'make or break' price floors, beneath which industries suffer. Past oil busts meant near-term lost capacity, collapsing jobs, non-producing wells shut in, price hikes. In 2020, oil didn't enjoy a firm floor; tough reserves maybe stranded assets. Thus, in 2020 **Demand destruction** had been key, with renewables, maybe electric cars accelerating:

Q1 2021 to late-March:

Source: finance.yahoo.com

'Happily', for Oil it did rebound Q1 back to the $60s. But that was on very big self-induced supply cuts by Saudi Arabia/OPEC, plus hopes of renewed demand in latter 2021. Otherwise, were 100m barrels/day still supplied, it would have kept that market in collapse. Coal (no longer tracked by an ETF) lags badly: no new US coal plants are built - regardless of who sits in the Oval Office. Coal's dismal US economics swamp even the firmest political will, thus US producers look overseas to where coal is still being burned: Asia has the world appetite 2021. Yet the fact that America's own domestic coal had once been the last century's cheapest, dirtiest, most stable source of electricity, suddenly is no longer much in its favor.

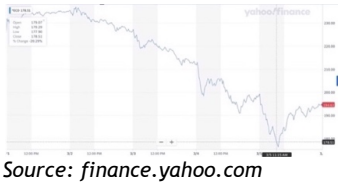
Mid-Q1 start of latest plummet, a question arose: might this plunging clean energy/ECO take a harsh backslash shape down only, for an "\", or maybe an "L" shape (down, then sideways)? Or, all Q1 given January's rise, maybe a bounce late March in "N" shape? For 3 reasons, latter Q1 might see headwinds: *No clarity yet on Prospects for the Climate Bill passing Q3/Q4 2021; *China's 5-year plan might push bigger green actions to later this decade post-2025; and *Europe if seeing a pause, may not lead as strongly starting up in 2021 as recently hoped.

To those 3, add 2 more: *underlying stocks hit Very High P/E multiples late January, and *Inflation risk. Perhaps just bit of soft ceiling? Rather than an upwards-sloping "N" late in Q1, maybe a downwards sloping "N" or "M"? Hopes for stimulus Climate Bill, succor. If optimistic, a linchpin Infrastructure & Climate package *may* perhaps support richer Price targets (the "P" in P/Es) in Q2 or after, if there's upwardly moving Earnings estimates. In meantime a plunge ironically was seen mid-Q1 across all growth stories over a possibly stronger economy ahead. Given fears of inflation with the Fed willingly running hot over normal 2% inflation targets. Thus, capital, unsurprisingly late in Q1, reflexively was shifting from growth stories - to value. Yet that's also a bit ironic. Longer term, volatile growth stories may again re-attract capital, if/when traders get re-accustomed to seeing higher more 'typical' interest rates.

In growth-based clean stories, little or no dividends, no positive "E" earnings yet (indeed far from it) – matters swung very bearish. Global new energy innovation NEX, like US listed ECO, fell hard - as one could expect in February/March on that big macro-picture. Such classic sell-off was maybe overdue: NEX & ECO had recently risen 4x & 6x fold in under 1 year.

As noted, February/March 2020, ECO Index® had crashed then by 1/2. So in plunging Q1 2021, it wasn't surprising to see ECO fall by 1/3rd in Feb./March 2021 – from 280 to 180, and to see NEX go down nearly 1/3rd from 630 to 450. Certainly, they can drop (much) harder yet in 2021; down ½ takes ECO to 140, NEX down to 315. 2020 gains as this decarbonization story jumped, means that such levels were seen not very long ago: ECO was at 140 recently as Nov 2020 - and NEX was at 315 as recently as September 2020. So such drops easily be imagined.

On the other hand, March 5th stood out as *maybe* bit of brief pause mid-Q1. ECO began that day at 201, fell hard in morning -11% to nadir about 180. Given ECO was at 280 one month before; this 180 reflected indeed a fall of near exactly one-third – very hard & fast. This clean story at times certainly drops like a rock. To wit here's 5-days illustrating left-side fast drop from 238 down to about 180. Sharply down about 1/4th - over just 5 brief days(!):



Source: finance.yahoo.com

NEX began that day at 480 and fell to 450 for perhaps bit of mid-Q1 low that week; NEX was lately 630 so down 1/3rd would take it to low 400s; instead falling to ~450 was about -30% off. OCEAN hit 370s – had been 450 a month prior; no components in OCEAN fell as big as in ECO/NEX. Latter biggest declining components were: Beam, Renesola, Fisker, Ameresco, Ayro (all were US-listed, so could be in both themes). 2 days later, March 9th the 5 jumped as ECO shifted briefly from 178 to 200. Late March ECO back to 200 was bit of an "L" shape for latter Q1; or an "inverted V" with downwards-sloping end for all Q1. Q2 may fall harder. Or rise. If P/Es are a metric (useful) & Price targets high late January, then the prospects for passage – or failure of Climate Bill in Q3/Q4 - plus China & Europe – may soon be impactful.

Beyond a narrow Q1, let's turn to some factors for broader 2020 gains in ECO, NEX, OCEAN. Given the 3 Indexes stood out in 2020 as top performers worldwide, 1 up +203%: why did they do so 'well' over 2020? Several factors, enumerated next, may add a bit of colour.

One may be, *Decarbonization as an organizing principle has set us apart. Another may be, *Market Inefficiencies: our Indexes have held many mid & small caps not so well known to mainstream analysts; fewer analysts in cutting-edge innovations like lilliputian electric cars, Li-ion, hydrogen fuel cells, solar IP – could add sizable pricing inefficiencies. On fewer experts in zero-CO_2 (and those that are, do excellent work!), a flood of new attention & price discovery, 'animal spirits' in tow yields scope for gains. A 3rd factor, may be all-too human: *Disbelief! Difference of opinion is what makes a market; deep skepticism here - even shorting - vs +12,000% gains in an equity are impactful. Our thematic focus on clean new energy has been very consistent for 15+ years; that it's now becoming well favored is good fortune.

We'd seen a bit similar in ECO, 2004–2007. Green energy, long unknown came acutely in the spotlight – with sharp rises in tiny solar firms, electric car startups, new li-ion batteries, storage, H_2 & fuel cells. Stubborn-held (dis)beliefs maybe broke down even perhaps just a bit - or not. Views often heard in 2004 included Electric cars could *never* be as fast as 'real cars'; couldn't ever reach 200 miles range, nor be as pretty nor fun to drive. Views were oft stated that solar & wind weren't real - vs. 'always cheaper' coal & gas. Future earnings estimates, based on short-term valuations, resisted penciling anew. Important: valuations then were still based here *on only 'future promise' in 2007. Clean energy then was still much too costly*. All then crashed on global overcapacity and being just 'promise only' around 2008-2016.

So re-think 2020s what's maybe possible this decade; it *might be* more promising. Possibly, 5-million-mile batteries; whole regions competing in building renewables & new electric cars; solar-electricity costs falling to <penny a kilowatt/hour, perhaps cheap green hydrogen – all may cause new looks at valuations. Closing past equity inefficiencies. To more accurately see truer prospects ahead is never a bad thing, disruptions to narrow gaps is an engine of growth. Clean & new displaces dirty & old. Over & over so many ways, closing gaps from 'state A' – to 'state B' – can propel. This force occurs from quantum-level scales, on up to our own macro and visible, and up further to our own small solar system and local galaxy.

Or think financial sphere. Melt-ups redux. In ECO Index® there were 10 Gaining components all up by over +1,000% on past 52-weeks lows from March 2020 - to March 3, 2021:

Blink:	**+2,628%**	**Renesola:**	**+1,470%**
Nio:	**+1,868%**	**SPI Energy**	**+1,356%**
Plug:	**+1,624%**	**Sunpower**	**+1,148%**
Arcimoto:	**+1,618%**	**Workhorse**	**+1,034%**
FuelCell:	**+1,476%**	**Daqo**	**+1,031%**

10 components in any Index theme with Gains +1,000% from 52-week lows (even +2,600%!) - is perhaps a bit remarkable. Perhaps this helped explain ECO's rise by 6-fold+ of late.

Note here too *Speed by which clean energy is getting to be the least-cost option, *Force, by which governments embrace zero-carbon mandates, & maybe biggest item, *Climate Change. It's this last factor: how much CO_2 can we afford, that's new to our species. Maybe most vital limit of all. 2050 goals, are meaningless. Instead, what *needs* be done to decarbonize, Now?! All squarely within our theme. These may help to explain jumps here 2020.

The Good

Or for fun, let's call factors behind change, or 'delta' here the Good, the Bad, and the Ugly. A Good reason for delta past 2020 clearly was ***Huge Cost Reductions** in clean energy. Solar is now **least-cost electricity* in much of the world; onshore wind too. Solar will soon be the *cheapest electricity in history!* Unimaginable, inconceivable, for many people a decade ago. Model projections often foresaw fossils, instead, as definitely lowest cost in 2021.

A 2nd reason for 2020 delta, ***unprecedented commitments*** by the 3 biggest economic blocs, US, Europe, China. Late 2020, China made statements on decarbonizing not well appreciated in the West. President Xi Jinping announced China's aim to become "carbon neutral" by 2060, Peak carbon by 2030. Devil would be in the details, to be fleshed out after Spring 2021 as the seminal new 14th 5 Year Plan publicly would get released to much anticipation.

Would that mean all greenhouse gases? Methane/CH_4, HFCs for 'climate neutral' - or just CO_2? How much (disagreeably) might current carbon capture & storage (CCS) tech play a role, so CO_2 is only temporarily stored? Monoculture reforesting? Slight of hand, 'carbon intensity', CO_2 as per unit of GDP growth? All that can distort true numbers around 'net-zero'.

So it was a Big disappointment when the 5 year Plan was preliminarily released March 2021, and it did Not take big steps early to end coal. The world needs coal to peak by 2025, so for biggest user China to commit to peak-coal first half of decade. It did not! Instead, it sees CO_2 peaking only later on post-2025, presumed steeper CO_2 cuts then. Draw down, latter decade. In a fudge, oceans & land maybe 'nature-based solutions', CO_2 sinks. A lugubrious inertia-bound bureaucracy isn't likely to jump though to draw down coal, jobs in it so dominant. That push post-2025, ought to have been resisted. Huge CO_2 sinks for example can fast be sources, even an Amazon. *Instead, Renewables were always the answer*. Glinda the Good Witch knew that Dorothy's ruby-red slippers could fast take her home. But Dorothy first followed the yellow-brick road, to learn confidence in that. China's own ruby red/gold solution, its clean new energy can replace coal, now - and are already be its 1st and best choice 2021-2025.

Changes 2020s were modelled by Tsinghua University, for China to hit net-zero CO_2 by 2050, all greenhouse gases 2060. It requires giant declines of coal for electricity - and for heat – plummeting from >70% – to <5%. To instead more slowly cut coal pre-2025, requires far sharper cuts to 2030. Far better to have Aggressively Started Decarbonizing, Now. A more immediate straight pathway would have been so preferable to so many, worldwide. China instead will ramp up nuclear first, rising upwards from 46 plants that made 50 GW in 2021.

Regardless, China's new energy costs may top $15 trillion! A greater spend than contemplated by Europe, or US: re-allocations to its economy. Most ambitious Plan the world has ever seen. Say, 10+fold fast increases in solar, 7+fold in wind. (Maybe 10x-100x more solar manufacturing capacity?). Tremendous ramps in storage – new technologies too like maybe green hydrogen for zero-CO_2 high heat for steel and cement. These changes shall still be colossal.

Consider batteries: both for electric vehicles & for energy storage. Apart from Tesla to 2021, China is seizing opportunities, like Japan, South Korea, and Taiwan. About 1 million EVs were sold in China in 2019: 54% of world total, 3 times 2nd place US. And growing faster: new EV growth in China could surpass 25%/year, to 4+ million EVs in 2025. Maybe a reason for 2020 delta upswings in ECO/NEX/OCEAN! Demand has helped push battery costs down 80% in 8 years, maybe ahead to <$100/kWh by 2023. Battery demand may grow 5-fold.

America's leader Tesla had 2020 about 35 (gigawatt/hours) GWh lithium-ion battery capacity, maybe soon 100 GWh 2022; it aims for 3,000 GWh (or 3 TWh) by 2030. That 3 TWh, give or take, is about all world battery manufacturing capacity in 2020. Change is happening! So rising demand is another reason for valuation delta here in 2020. To make all vehicles electric, may need >10,000 GWh new battery manufacturing(!) each year next 15 years. Twice that+ for all energy storage. Better batteries, storage innovations for renewables to replace fossils. Beyond lithium-ion much new may be ahead: solid-state batteries with faster charging; Zinc deeply discharging on less thermal management and better longevity and cheaper to boot, new flow batteries on grid that may fundamentally resist degrading, etc.

China's early focus on batteries proved fruitful for it. 2020 it had 80% world refining material capacity: could manufacture 77% of battery cells, 60% of components, had 72 GWh of battery demand; no one was close! Europe's attachment to dirty diesel once held it back, no more. EV incentives there are moving it forward. Late 2020 Europe's EV/hybrid numbers (>300,000 Q4) were pulling ahead of the US. A century ago, Des Moines Iowa was an early world capitol for electric cars. 30,000 EVs were registered in US in 1912. They let that world-lead slip away, something China, and lately Europe too seems very intent not to let happen to it.

All this opportunity = new green jobs. China recognizing this, has its foot on the accelerator. It persists in coal; in 2020 China made 53% of global coal power, much more than 44% in 2015. Yet other side of ledger is also much clean new energy growth. 2019 China added 30 gigawatts (GW) solar, 26 GW wind. Generating capacity solar/wind >204 GW/ 210 GW respectively. 2020 China added 48 GW more solar, 72 GW more wind; plans maybe for >50 GW more solar & wind, each and every year. Yet hopes for >100 GW/year were dashed early 2021 on a latest NEA draft @60 GW. And yet. Some *Climate models given CO_2 levels >400 ppm, call for 10x-100x that: thousands of GW global solar/wind ahead - due here on climatic concerns.

Or look West to aims of faster-moving Europe; the new European Climate Law is enormous. It lays out being carbon neutral by too distant 2050, yet to be 55% there *this decade* by 2030. Little-discussed in US (like China's 5 Year Plan), it is still seminal. To be fleshed out in 2021, is the first legally-binding net zero Plan of the Big 3. Perhaps 2030 targeting 60 GW offshore wind for 5-fold increase from 2020, 300 GW by 2050. All that is better than now-unhelpful CCS. Plus, unlike China - Europe is beginning vitally a start *now* - quickly, not years ahead. (China's growth to be fastest in the world, in green areas to which it does commit).

It's voluminous, Europe Decarbonizing not only its energy - whole industries, infrastructure, water, agriculture, buildings etc; all subject to consideration and change. Broadly EU Green Deal may soon mean carbon tariffs, and/or carbon taxes, trillions of Euros spending, carbon border adjustment mechanisms on 'embedded carbon' impacting trading nations. Likewise, details being fleshed out now may soon be the start of a Newly Decarbonizing world.

The US has ample news coverage of what the President may do. Actions include whole government approaches, strong unitary executive, green good-paying jobs with focus on areas hard hit by coal, oil & gas losses. Tougher is a firm carbon tax, a national renewables standard, even ending fossil fuel tax breaks - although watch for it and a focus on tax breaks instead for clean power, alternative fuels, and efficiency. Upstream, thin-margin solar & battery manufacturing is still Asia-based now (Europe growing). But very low-cost PV can help to fast electrify all US – better yet if there's no embedded coal/carbon. In the US, much new EV charging, Building Back Better – with good paying jobs in grid, transmission weatherization, distribution etc. Arguably pretty Good reasons indeed for upwards volatility in 2020.

The Bad

Maybe there's 'bad' factors too for spikes in 2020. Bad, if in a sense some ideas to a few observers, didn't yet warrant such exuberance. Hydrogen (H_2) & fuel cells in 2020s - come to mind. Not that they won't one day, possibly sooner than expected - be key too. It's more that in 2020, they perhaps hadn't yet justified hype – not until breakthroughs come to pass. But then this is a passive Index – not actively managing by predictions in/out. They are included – and notably hydrogen fuel cells had quite 'outperformed' in 2020. Yet that H_2 still is brown, burdened by sparse CO_2 avoided and low efficiency, yet H_2 may grow increasingly relevant. When still from 'rock gas' (drilling) – it has been inextricably tied to fossil fossils - not worthy as a solution. Like 'blue' H_2 tied to fossil fuels, it only passes a low bar. Big Oil dipping a toe in H_2 may see a 'blue H_2' chimera in their fossils - but a unlike renewable clean green hydrogen - neither the blue H_2 nor the classic brown/grey H_2 are clean and renewable.

Far better, is the *green hydrogen* that's renewably & cleanly made as from solar or wind. Spain hopes for 9 billion euros in green H_2 investments. France aims for 2 billion euros on green H_2. Germany looking at 9 billion euros by 2030. A Catapult plan aims for 25 GW green H_2, at <$2 per kilogram. Saudi Arabia is considering new 4 GW of solar & wind for it. Different, is capturing a potent methane gas (CH_4) now spilling from landfills, dairies, agriculture wastes - and making H_2 from it with clean power - or upgrading to 'renewable natural gas'. Or a step further, to make drop-in replacement low-carbon liquid fuels. Latter not immensely scalable, but it is renewably made – and displaces now-spilling CH_4 - in a mid-way bridge.

Green H_2 by contrast, is immensely scalable. On growing speculation it's more plausible than before. Demand for green H_2 *could*… *maybe* grow enormously: >$70 billion by 2030. Europe might see €200–€500 billion+ invested by 2050 – in theory. Big oil's deep engineering bench may tout H_2. Or green ammonia (H_2+Nitrogen=NH_3) - gas or liquid easier to handle than H_2, on site as by offshore wind. (A blue ammonia, undesirably, comes from fossil gas). Visuals of wind/solar making a green H_2 - or a green NH_3 - in place of oil is prettier future than past.

The rub though is cost. H_2 affinity to react, means much solar/wind is needed for electrolysis to split water. Green H_2 2020, was far too costly, vs brown H_2 from steam reforming fossil gas - itself too costly in its own right. An inflection may be: 1) Solar/wind costs down enormously; and 2) green H_2 for <$2/kg by 2030, even <$1/kg perhaps sooner. Profoundly, in that case, no longer 20+ years in future. On a carbon tax of say $50-60/tCO2, clean H_2 *could* make steel, or cement, or power ships, ports, planes and more. Manufacturers having reduced H_2 costs by 80% in 3 years. <$2/kg is now targeted, and even cheaper may yet arrive in new ways.

Still was just dreams in 2020. Green H_2 costs x-times too high everywhere, & seldom available anywhere. 42 hydrogen stations in ambitious California 2020 – vs. 22,000 electric outlets for charging. Worse: inefficiencies. Compared to batteries, H_2 loses ~half from water – to H / O, then more loss from H – to electricity at fuel cell. A case can arise, *if* cheap solar/ wind+green H_2 'time shifts' intermittent renewables; holy grail = abundant firm power & heat as needed. Nearer term, green H_2 could displace rock gas <15% to not embrittle steel. Renewable natural gas albeit limited, is drop in. Capturing potent uncapped GHG methane – upgrading it on clean power to renewable natural gas, or 'turquoise hydrogen'. Better making green H_2 - and truly sequestering the C in stable form. Renewable natural gas is just on defense for climate risk. Not great, but it is something. In sum a promise of H_2 & fuel cells is partly why a clean sector had jumped so in 2020, as equities are forward-looking. The case for green H_2 in 2021 - is still far hazier than it is for solar, wind, electric cars. That said, green H_2 once just conceivable, *may be* plausible and reaching <$2/kg - *if* renewables can deliver cheap power.

The Ugly

The *Ugly* factors are tangential – but can highlight how better are green energy solutions. Take an unpretty state of the art of CO_2 Direct Air Capture (DAC). So energy intensive now, it's a non-starter: more power generating more CO_2 & so on. But… if DAC gets economically sensible + very low-energy to use – that could be huge. Less fetching to the eye, yet much-touted by fossil fuel industries, is Carbon Capture & Sequestration (CCS). CCS might extend fossil fuels use by decades. It could push say, captured CO_2 gas back underground to briefly produce yet more oil. If so then a question must be asked: Why??!! When getting at & burning *less* oil & gas is where we ought to now be fast-headed, in the first place?

There's matters too won't discuss - like what if CO_2 leaks in centuries, or less?? At Lake Nyos in Africa a 'burp' of CO_2 killed a thousand people. Hence, stable CO_2 storage or mineralization is needed, inert, safe, permanent. Since solar is cheaper than coal, sans sequestration, to add costly CCS onto coal is No Answer. Capturing the gas + pumping it underground, renders coal 4x too costly! It's why we've seen 'clean coal' in ads only – but never for real.

To be compelling, DAC or CCS must *Remove CO_2 from air & seas, *Permanently, that Carbon *Benign & Stable, *in Practical Economic Ways Scalable to Gigatons, and be *Carbon Negative – not just carbon neutral. A current impotence here so far boosts green equities.

Even Uglier is 'Geoengineering' (Seriously, try to dim our planet's air or dump CO_2 massively into deep oceans without knowing effects??!). Such of course should be rejected. Even that hydra-headed monster - is overshadowed by climate change's now immediate threat. In the 2020s climate change is fundamentally altering our once-cool planet. This last specter so real it concentrates the mind, on how to sensibly avoid CO_2 in the first place.

Difference Between 'State A' and 'State B' may help account for volatility here

Recall how closing gaps, like progressing beyond past (wrong) views about what's possible – helped propel clean equities up 2017-2020. Twenty years ago, conventional wisdom saw EVs, and solar & wind as costly toys seated at the kids' table. They weren't heard. Rather than 'listening to the sea', thinking holistically – early electric cars were dismissed as slow golf carts to be vexed by the smallest hills, their range forever 'known' as sad joke.

How wrong! From those 'facts' of 20 years ago – sleek electric cars have grown vastly better: they were fated to do so! Foreseeing such fate could make fortunes. Closing gaps between state "A" (old belief) – and "B" (physics) – is seen in oft disruptive innovations. That, produces useful work. Clearly it can go on for a 'delta' in equity valuations – maybe 'alpha' in financial terms. Seeing at times these gaps even a little early-on, may deliver potentially ahead.

It's very non-linear. In tremendous falls back in 2008/2009, green themes plummeted (And they certainly could do so ahead again in 2021). Back then a dozen years ago, profit margins went non-existent, staying down for years. There's a non-Euclidian curved geometry to real world. Like disjointedly compressing margins, few true straight lines. Solar margins in time becalmed a bit; we learned how to make solar *least-cost electricity in history!* Learned cost-reductions led to virtuous circles. Electric cars got better most every way. Think of heat engines, unfathomably still all around us: spark plugs' explosions pushing pistons for power. Coal making electricity by heat difference, like nuclear = world's costliest boiling water. Delta is in hot vs. cool. What's needed is a difference of state, (temperature) gap between "A" vs "B". Innovation's fate is to produce a difference over time, a bit like nature itself.

Mr. Babbage captured value in his difference engine. Mr. Turing's work led to computers; but that was purely mathematics. Here, nothing's certain. Razor-thin margins in solar may crash. Equities again may plummet boom/bust like a bear a decade ago. Or, growth *may be* possible here on new demand – affordability – and top issue of all perhaps: physical CO_2 limits.

Return to a factor so significant it stands alone, *sui generis*: Climate Change. Potentially, it may devastate humanity, whole societies and cultures. It's perhaps even an existential threat. One not yet well enough understood. Tipping points, feedbacks, methane bursts, clathrates, GHGs, new things that can't be unwound. No matter how hard we humans might beg, bargain with, or badger nature. On most topics, scientists counsel calm. Soothingly, they'll remind us things aren't as bad, nor as extreme, as the non-scientific laypersons paint them.

Not so, climate. Singularly, researchers here are shouting. Perhaps it's Conservative then to heed the scientific consensus – Radical to reject it. This may ahead hit not in spirit of gladly looking towards smarter solutions, nor boldly advancing our better natures. Instead, it may mean hastily saving what may still be saved: remember Summers lasting only 3 months? Sandy Beaches? Winters? Coral Reefs? How better to prevent this becoming a future we needlessly bequeath. Especially as Sustainable, No Regrets paths make us healthier, happier, richer, safer, more secure. Saving us from spending spiraling blood & treasure, bearing disease and despair. It may mean our intentionally saying ahead: Prevention Rather than Cure.

NEX/ECO/OCEAN may capture & track some action here. Towards decarbonization, electrifying transport, lower-carbon fuels, more efficient heating, cooling, green industry, agriculture etc. Some delta may emerge, areas of particular strength, themes, or regions. In meantime consider 14 volatile upside constituents in NEX mid-Q1 most up last 52-weeks. In a Q4 2020 Report we'd looked at biggest gains in NEX components then. Let's again do this Q1: following are 14 biggest gainers. (6 more could be been in the top gainers last 52-weeks but they've just come into NEX new for the start of Q2 2021, so are not shown here).

Late January 2021, NEX was near steep highs, figures then were much higher; so we'd avoided looking earlier. Instead, here they are in early March when NEX components like most growth & innovation equities globally, were instead in steep falls. Hence these % up figures are moderated, by looking here March 3rd amidst a then so far -25% YTD plummet. Here much like ECO's story where we noted biggest gains over +1,000% from their own lows in the last 52 weeks to early March 2021, there's very rich gains globally too. These 14 NEX components in Q1 showed greatest gains all over +600% from their own 52-week lows:

Nio:	**+1,868%**	**CS Wind:**	**+ 920%**
Plug:	**+1,624%**	**Bloom:**	**+ 787%**
FuelCell:	**+1,476%**	**Lithium Am.**	**+ 763%**
Renesola:	**+1,470%**	**McPhy:**	**+ 651%**
Doosan	**+1,465%**	**Enphase:**	**+ 649%**
Sunpower:	**+1,148%**	**Flat Glass:**	**+ 627%**
Daqo:	**+1,031%**	**Sunrun**	**+ 622%**

In sum, 2020 concluded with large gains in all 3 Index themes. Then, Q1 2021 next saw a correction of a neat 1/3rd with lows dropping down to 180 in ECO, 450 in NEX, 370s in OCEAN. That bottom held firm through Q1, perhaps partly on sizable hopes that a Climate Bill could pass in 2021. Should that Bill fail this year – then arguably all 3 Indexes could plummet farther, swiftly. Alternatively, should a Climate Bill pass, one might imagine these themes rising.

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14 components in NEX or any Index theme with Gains over +600% from past 52-week lows, may again be a bit remarkable. Maybe helps explain a big NEX 4-fold rise from March 2020 to January 2021. And an unsurprising crash by (so far) 1/3rd in February/March 2021.

Above gainers are remarkably diverse. Some are in new energy innovation that's scalable and 'on offense' against climate change – like solar & wind. Names solar upstream, include from poly and ingot/wafer/panel manufacturing, to downstream, inverters, sales, and installation. There's advanced Li-ion batteries and materials. Plus, much in speculative hydrogen & fuel cells where new energy reflects a variety of dynamics.

There's 'defense' too on climate. Smaller steps, extant infrastructure. Capturing methane – otherwise indifferently released in air like a sewer. Renewable natural gas fitting existing systems; it becomes CO_2 once-combusted, but less potent greenhouse gas. There's lower CO_2 or better, negative-CO_2 liquids from renewables such as aviation fuel, gasoline, diesel.

Past equity gains like 2020, do not foreshadow gains ahead. Indeed rises may auger sharp/er declines ahead. Regression to mean; nothing is certain. Or they *may* point to fresh paths. Once upon a time, fossil fuels were all we had. They magnified what we could by many-fold. Yet we can't let past long dominance by once-magic fossils, now waning - convince us what's bad today for fast-fading coal, oil, gas - is bad for humanity. Arguably we'll all be far braver and wiser to set out for more sustainable and sunlit uplands: this choice is seminal.

20 years ago, it was even less clear what paths might lead us to greener sunlit uplands. Solar perhaps, but on which technologies? Wind, sure, but which companies successful, which ones standing? Electric vehicles: who knew how soon until they succeeded, which gargantuan few best? Might a green hydrogen ever come to be? If so, might fuel cells ever become robust & low-cost? All obvious questions – no obvious answers. Questions ahead barely imaginable now like which electric jets will prevail, what among H_2 & electric ships, what DAC will be green? May safe and scalable sequestration render carbon inert, like rock? Or will clean energy fail?! So much lays ahead this decade. Most of it open to debate. Inherently unknowable. Much we recall is like at end of last century, only 20+ years ago before a current early 2020s.

Passively pooling clean energy technologies into a Basket or Index made great sense then – & does now. Mitigating against individual risk was compelling; probably even more so now! One can't know which component/s across fast-changing solar, wind, green H_2, fuel cells, electric vehicles, decarbonizing and much more(!) may survive ahead. Which equities, or technologies all-risky – shall fail -which may even thrive. This key vexed question always bedevils – and it makes the passive Index basket approach like here in an ECO/NEX/OCEAN compelling.

A differing beast, is short-term volatility. We say with confidence: oil prices will unexpectedly jump at times. Coal, oil & gas perhaps are in long-term decline, but events happen like attacks on infrastructure, blazingly hot days, bitter cold snaps all overthrowing and decimating energy delivery. To not weatherize against extreme heat & cold – despite robust climate change - means price jumps in oil & gas shall happen. Unpredictability is very predictable in that sense. Stratospheric heating due to global warming, may be detected one month, so weakening a jet stream allowing super cold vortex arctic air to dip South freezing energy infrastructure weeks later. A slowing Gulf Stream might freeze Europe in time. Oil & gas may be in lugubrious decline long-term – yet we'll see many upwards price spikes along the way.

In what may foreshadow escalating weather extremes ahead, a disaster hit Texas early 2021 as a freeze took its electrical grid down. That recent blackout showcases too battles acutely going on right now, over what makes for a better, stronger grid going forward.

In midst of that crisis, an argument was hastily made that the State blackout was due mainly to clean energy, to wind turbines freezing! Whether promoted by the uninformed, or by politically motivated critics of renewables – that tale was widely circulated especially among some media outlets. An image was quickly spread of a helicopter with vat hovering above a frozen wind turbine – accompanied by statements this was a current photo of flailing attempts then in Texas to use chemicals to try to unfreeze wind power. They claimed this as proof that wind power was the main cause of terrible grid outages in a freezing early 2021 Texas.

Was that really what happened? Let's start with the frozen wind turbine image so many saw. In fact, that's an old 2013 photo from a Swiss helicopter company, demonstrating a test using hot water from boilers (no chemicals) in Sweden – on a turbine lacking usual de-icing features. That compelling image presented at a 2015 Conference – was lifted in 2021 for a powerful, colorful fictional story. That meme shared widely by a publicist, a website, and others was indeed memorable, but not true. Yet it definitely stoked misinformation and was seized upon by wind-opponents as 'proof' of Texas' failures of wind power. The truth was quite different but only arrived later, as this memorable photo & tall tale were already played up.

Let's dig a bit into what really caused the awful Winter freeze grid-collapse disaster in Texas. First, to begin with the Texas electricity grid is not mainly powered (yet) by renewables; but instead by natural gas. A greater 52% of its grid power was running off natural gas in 2020 – vs. about 39% on gas nationwide. What's important, is how well the *forecasted* levels of energy Supply – match Demand. During this week it was expected by the Electricity Reliability Council of Texas (or ERCOT) that 82 gigawatts (GW) of power would be available in Winter. Greatest percentage of that expected was natural gas: a projected 50 GW availability.

An excellent review of just what happened this Monday February 15th – to Wednesday Feb 17th is laid out in Texas Monthly (3/3/21). As it recounts, the key problem was fast losing a massive 20 GW of expected natural gas-fired electrical generating plant power, due to hard freeze. Reasons included inability to obtain gas; also, some power plants weren't winterized to operate in such conditions as lines for their natural gas froze. So regardless of how much gas they were being 'given', it couldn't be utilized so they couldn't make electric power.

Many plants did not - or could not find enough natural gas available at any price, anywhere. While much early criticisms were leveled against wind power by the Governor – and by the Texas Railroad Commission – they clearly were barking up the wrong tree. That fascinating image and fun tale of helicopters hovering bestride frozen wind nacelle only confused the issue. But it did make fascinating theater for Texas' political opponents of clean power.

To be sure some wind power went offline. From peak before freeze to worst of it on February 15th, was a drop in wind of 8 GW. But importantly a low wind output was always forecast for this time of year: Winter is regularly a low for wind power. ERCOT's models expected just a puny 1.89 GW from wind. Then, when wind's output went as low as to a 0.65 GW nadir, that wasn't far off forecast models. (Wind spools up enormously later months).

Moreover, relatively small underperformance vs expectations for wind, was narrower than coal: latter was off much larger 5 GW from where it 'should have been' due to freeze. Even supposedly unflappable nuclear was down by roughly a like amount to wind – off 0.7 GW.

So each source of electrical power was hit. Truth was, wind power shortages were but a tiny fraction (about the smallest of all!) for what was going on those 3 thorny days.

Core to this shortfall was natural gas suddenly unable to supply a huge 20 GW expected – which was 16 GW lower than the very lowest-end case modeled by ERCOT. How, Why? Texas is a global hub of shale gas drilling! But when temperatures froze, about a third of its gas production 'froze off' Normally it's a warm or hot place; much equipment wasn't weatherized and the tanks that divert oil, water, and gas became solidly blocked off.

If unfrozen, they could have spooled up enough to 'oversupply' natural gas-fired electricity to tune of 45 GW. More than enough to make up for all losses elsewhere. As is laid out in that piece, many gas producers did Not financially benefit. They simply didn't have the product to sell in this acute shortage. Worse, they couldn't meet their own contractual gas obligations for volumes promised. So some were forced – like other gas producers – to suddenly compete for meager amounts of available unfrozen gas supply while prices were skyrocketing.

Normal days, gas producers might sell their product around $2.50 per million British Thermal Units (BTUs). Contractually obligated to supply gas which they couldn't, instead they had to buy (to in turn give elsewhere) at ridiculous prices like $200/BTU. On a trading Exchange where gas prices hadn't gone to $200, they had to add a digit; near wealthy Dallas the price of natural gas (right in heart of super-gas-abundant Texas!) suddenly went to $1,000.

Power plants need continuously supplied gas – to sell electricity: so they were flummoxed. They'd anticipated of course ever-ample feedstock gas. And expecting to hit the normal wholesale power rates of $24 per megawatt-hour. But because gas was unavailable due to the freezing temperatures, in the chaos of needing to find gas right away at any price, their prices that they charged shot up for each MWH – from $24, to in some cases a crazy $9,000!

Power producers needing gas to make electricity, were competing with gas producers needing to meet contracted obligations for available unfrozen supplies. All getting hurt. That piece by gas trading expert describes how differences in trading normally would be just concerning one penny amounts; instead, they were about gaps of $50 & $100 'deltas' in gas prices.

In retrospect, better understanding about how to do better can be drawn out. One lesson is that drilling for *more* natural gas would have solved nothing. But winterizing - or better yet weathering for Summers too key gas facilities & infrastructure can make a difference. Texas has a long history preferring a very light regulatory touch to its electricity supply. Its natural gas even less burdened by regulation. But this arguably may be a matter of public safety. (Plus the unregulated power markets as it turns out, may not always be cheaper).

Cold wasn't at fault, per se. Plenty of gas infrastructure works well deep freezing places, because the facilities have been built with freezes in mind. Because winterizing just one well might cost $100K, and just 0.06% of annual Texas gas production may freeze off in a year, not all need be winterized. There are 100,000 wells in Permian Basin, 250,000 active wells in the State with so many just marginal and of little consequence. There needs to be a balancing. Or, the State might continue being fully hands-off, like before (with consequences).

A suggestion made in that piece, is much more storage capacity for natural gas. In that recent crisis gas Storage was relative hero; it didn't freeze off in ways gas production did. Another better way is to winterize all big electricity generating plants. Having a multi-billion-dollar nuclear power station go offline, because a simple outside water pump froze (something very inexpensive to prevent in the first place) is a no-brainer to fix. And making sure for instance there's no passive withholding by producers like say taking a generator down in discretionary way for inspections during a critical period. Lastly, put the needed gas facilities on a critical infrastructure list, so they still are receiving electrical power and can produce in a crisis can help make sure more power does not go down again in a vicious cycle.

If most all the last paragraph above about saving natural gas feels like playing around at edges of a teetering system, one bound for scrap heap next few decades, it's probably true. And what is shows too, is what actually went wrong in a February 2021 Texas grid crisis. It wasn't due to a small loss of wind! Moreover, wind turbines can certainly be winterized; it may add 5%-10% to cost per turbine, but is readily done around the world. Wind works fine in the Arctic circle, or say in an US Upper Midwest far colder than Texas. (The same for natural gas, but no claims to contrary were made about gas – like they were for wind power!)

Consider too that Texas' disaster, bad as it was, was minutes away from being far worse had frequency stability been lost. Had grid transformers caught fire, high voltage lines destroyed, it would have been months, not days of no power. We don't realize how dependent we are on electric power until it's gone. Lack of infrastructure resilience is a very big deal.

It boils down to: How ready we are for a changing climate? Not at all.

Glance at a weather app like Ventusky; it shows a swirling arctic polar vortex each Winter. Bitter arctic air dropping at times Winters towards population centers, yet remaining just North of the US, of Europe, of Asia. We're saved by historic wind patterns. But those could change. Sudden stratospheric warming for instance, high in atmosphere might weaken this 'fence' protecting us. It doesn't take a great deal of change to envision jet stream shifting, wavering, weakening, so the bitter arctic cold descends rather farther Southwards. While that may not sound especially harsh, to the ear, the consequences surely would be.

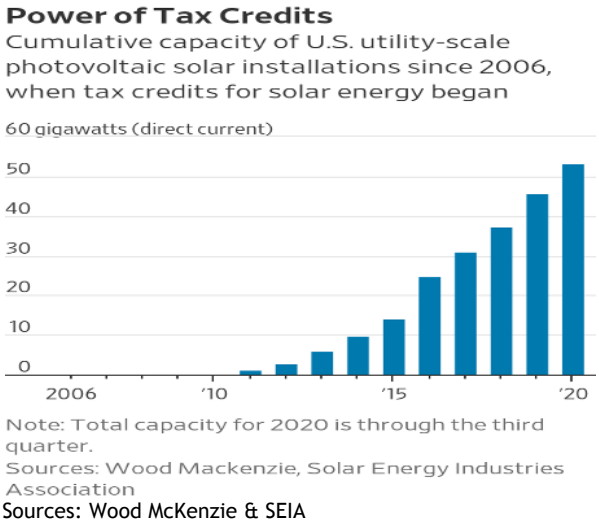
Perhaps 'Climate Change' like 'Global Warming' is too benign a phrase for maybe calamity. 'Global Weirding' may be better, or 'Global Heating', or 'Climate Crisis'. Change going for decades, centuries, or longer ending with a much hotter Planet, Equator not far differing from very warm Poles. That does Not mean that getting there, is incremental. That we will experience linear, straight nice warming along the way, gradual gentle changes only.

A slowing Gulf Stream could paradoxically a mean bitter cold. Trace a finger on a globe from lovely British Isles and Northern Europe, westward or eastward: it quickly becomes a frozen barren place away from North Atlantic warming by the Gulf Stream. Should global heating cause that warm Gulf current to cease, the freeze can end so much that we know today.

In Texas 2021, more Storage (of gas) was needed to make essential power. Instead with renewables like solar and wind, it's the storage of electricity itself that's now needed. Making electric power is sure to grow far easier & cheaper ahead, thanks to clean, better renewables. Storing that power, somehow, is where we also need to greatly focus and grow. That can and will be done myriad ways: but Storage, is clearly where much attention is needed.

So what to do, 2021? Changing tack let's briefly look at possible Tax incentives for greater energy storage. Back in 2020, proposed tax changes for storage had passed in the House – but not in the Senate, nor were they supported by a President opposing all green themes. In 2021, things became very different. Budget-reconciliation in Senate allows for a simple 51 votes, so consider that the tax credits that once earlier had been so crucial to starting up solar – could once again become similarly vital to storage starting 2021.

It's a chicken and egg problem. Solar once had required both ever-cheaper solar panels – & favorable initial tax policy, to light the fuse, to prime the pump. Both needed. This chart shows how fast solar then grew, partly thanks to solar tax credits post-2006. Solar stands now much more on its own – but like all energy, the early tax policy here had mattered:



Sources: Wood McKenzie & SEIA

Tax credits for Storage have required links to solar - so of little help. Unleash storage by allowing investment tax credits or better yet, cash for it alone, and much can change. In 2020 there was just puny megawatts of deployed storage – we need hundreds, thousands of gigawatts. No doubt we'll scale storage with right policy. Repeating for batteries & all storage - what has so recently happened for fast-growing solar – would be of great benefit to all.

Just one example: tax policy could help bring about new green 'zero-CO_2' lithium in making batteries, that's cheaper to boot. Places naturally hot lithium brine occurs, geothermal from that hot water means power – and lithium hydroxide. All without wasting water and freed from intensive evaporative ponds like lithium today (also no sulfur). Co-locate battery & EV makers there – like building poly plants nearby solar panel makers - and decarbonization as organizing principle promotes *both* lower-costs & better zero-CO_2 solutions.

Tax changes possible 2021 may be huge. Desirably they might extend solar ITC credit for 5, or 10 years at 30%, direct pay option @85%, storage standing alone, adding 10% credit where construction jobs satisfy specific labor goals. Wind PTC extended at 60%, far better than prior annual threats of PTC termination; an ITC @85% for parties not able to avail of Tax Credits (like cash option 2009). 10% added credit with Labor Dept targets met as on prevailing wages. 44 current tax benefits replaced by 3 for clean power, transportation fuels, energy efficiency. All done before or in Q3 or Q4. Equity & inclusion, rural job programs, environmental justice, all have got to be important top line priorities in new energy public policy.

2020, 2019 and these Last Few Years:

Look briefly at past 12 months to March 2021, and here ECO is up +250%; NEX is up some +150%: both far outdid fossil fuels - and major broad Indexes like an S&P500 and Nasdaq too. The Chart next page for these 12 months shows clean energy ECO/NEX sharply up. There's also a useful, vivid non-correlation ECO/NEX often shows vs dirty energy. What a fine example of diversification! While oil & gas stories were in free fall 2020, sharply rising early 2021 - clean energy seen in ECO & NEX marched to a distinctly-different drummer.

Or step outside that chart. Note from a 2020 vantagepoint, dirty energy was then single worst performing sector of S&P500 in 4 of past 6 years; down -30% in 2020 as clean roared up. (In an S&P500, 'energy' is still mainly considered fossil fuels). 2020 and the past few years, have been remarkable - and seminal in energy – so we'll discuss this important period.

Consider for instance what was transpiring in an S&P500 as Covid crash hit everything hard. It dropped markets around the world, and ECO/NEX/OCEAN to a nadir mid-March 2020. Here a little slice of S&P500 within energy (fossil fuels) was off by -51% in Q1 2020, when overall the S&P500 was then down 'only' -19%. Partly that was due to that 500 Index weighting methodology: just 1 big component in an S&P500 that's based as it is on market capitalization weighting, might be potentially heftier than all fossil fuels combined.

That's slowly greening, at a snail pace. An electric car maker was added to the 500 in 2020 – though by brought in so late it was then the 4th biggest US company – regarded curiously as in 'consumer discretionary'. Enphase was added early 2021. As for energy, in general, we noted in 1H 2020 that (dirty) energy made just 2.5% of S&P500. Once it was a far bigger 7% in 2015, 11% in 2010; 16% in 2008; back in 1980 dirty energy was 7 of the S&P's top 10 by market cap, over 25%! By contrast the 18% technology stocks in 2010, grew to 28% by 2020. Technology rose in the 500 . Some observers had even earlier hoped that the big EV maker's addition might have come earlier, by Q3 to be 1.4% of that Index. That would have been significant, given ~$4 trillion in trackers. But it was passed over, and only added in Q4.

For further insight, let's consider say the oil & gas behemoth, Exxon. In 2020, Dow Jones Index announced it was dropping Exxon from its leading 30-stock Dow basket. Why? Apple was splitting 4-1; so a price-weighted Dow needed to find component/s to add to keep up with other baskets. (Dow significantly lagged performance of late). New representation was chosen - but Not from anything old-style dirty energy like oil. Instead, it was adding 3 technology-heavy names. So Dow deleted an Exxon in various incarnations present since 1928. Once longest-serving component of Dow, no more. Only Chevron, among oil, stayed. Reflecting last decade, dirty energy has fallen fast – perhaps indicating too what's maybe ahead.

The make-up of financial baskets matters. Battles are quietly going on, influencing hundreds of billions of dollars+. Back in 2018-2020, a then-Administration using Department of Labor ERISA law, wanted to know if there were 'discernable trends' in how retirement funds were being invested in energy (FAB 2018-1). There'd been sizable outflows out of fossil fuels – into sustainable energy themes. It's been reported fossil-fuel industry, & conservative climate skeptics were an impetus, trying to slow inflows into ESG (Environmental, Social, Governance) investing. They'd perhaps hoped to see 'non-pecuniary' goals like addressing climate change, get subverted. A new Administration 2021 doubtless changed past Labor Dept aims: still it's useful to remember how a stealthy attack recently occurred against clean 2016-2020.

And Real-World Returns for clean energy the last years, have hardly been 'non-pecuniary'! See this Past 12 months chart: the 2 strongest performers again are ECO & NEX via trackers, very nicely non-correlated with all. ECO/NEX positive over +250% & +150% to mid-March 2021. (OCEAN up +130%, no tracker for it quite yet). Thus, they did far better than old energy – that is instead *down* -15% (oil) and -30% (gas). Better too than an S&P500 or Dow, those two up 'only' +60% for comparison bogeys. So maybe no surprise at all to see billions of dollars flowing into ESG 2020, breaking all 2019 records. 2020 more than doubled 2019 inflows, reaching $50+ billion. ESG made up more than ¼ of inflows to stock and bond funds that year. So as ESG thinking has outperformed, in 2020, its winning attention to climate change (IB 2015-1) was also under attack 2018-2020, reportedly by fossil fuels interests under ERISA.

So if proposed rules 2018-2020 sought to prevent a look at climate solutions, for being deemed 'non-pecuniary', that's a bit curious given these glaring Performance facts:
Past 12 months to early-March 2021:

Source: finance.yahoo.com

In a past 12-month window to March 2021, ECO went from 46 to 286 – rising more than 6-fold. Global NEX went from 150 to 630 – rising over 4-fold. Like nothing in old energy. Such changes could mean much interest in EVs, solar, storage, wind – even hydrogen & fuel cells. Far-thinkers deeply involved saw much delta like ECO, NEX, OCEAN. As was said of the gains by one brilliant man, "How strange…. Well, back to work". Climate change and decarbonizing have begun to figure more prominently - tied to green sustainable solutions, with good reason. In 2020/Q1 2021 smitten by diseases, wildfires, temperature extremes and blackouts, increasingly we saw mounting evidence the economy is a wholly-owned subsidiary of the environment. On the other hand, if a US Infrastructure & Climate Bill does Not pass this Q3 or Q4 2021, if that floor gets yanked away – then ECO could fall *much* farther ahead!

But things are changing; even the petroleum lobbying group is calling for carbon to be at issue. We have begun to see deep interconnectedness linking fossil fuels - to climate. Oil plays a role. Note then, 2020 saw oil's prices distort the other way: falling -70%, *Downwards*. In that year oil futures fell tremendously (even negative) rebounding a year later, 2021. A few words about that unique oil index & tracker. Very unlike ECO/NEX/OCEAN, that oil Index is instead based on a commodity - rather than equities. 'Worse', was based on far front-end oil futures, pricing in turn influenced by tracker that can't take physical possession of oil. It's constrained by known rules, subject to pricing attack. So when nearest front-end month contracts 'broke' into contango Spring 2020, that oil index went extremely down. Nearest monthly prices unlike more stable futures 12 months out (better reflecting physical oil). We'll discuss oil farther ahead, but a point is that oil in 2020 vastly fell – rebounding only in Q1 2021 back up around $60s/barrel WTI. By contrast, green themes here like solar have moved very, very differently. And the prognosis for clean/green, is far different.

Drivers instead for Solar's useful consolidation & growth 2020, included eg: a US solar maker sold its operations & management arm to another O&M. A dedicated solar name split in two; once-vertical-integrated it had made solar panels – and installed/serviced them. Splitting with a spin allowed parent to refocus downstream in residential & commercial North America. It's a big solar market (albeit thin margins) plus the storage permits premium branding, distributed generation, and it can get bigger. That's in-country work that can't be outsourced, nor done overseas by cheaper or commoditized competitors based elsewhere.

This shines a light on tightening solar margins, downstream as well – consolidations here too. Post-spin parent *may* see better valuations in a heating-up space. US installs already are rising fast. A separate, 2nd merger latter 2020 brought 2 leading US solar installers together as one behemoth. From 2021 the 2nd installer *may* see more robust valuations, comparable to the 'new' standalone downstream parent; everyone seeking lower-cost access to capital.

Meanwhile, upstream, the spunoff maker of premium PV enjoyed China patent protection & pricing power early 2021 (2-4 cents/Watt commercial; ~4-8 c/W residential). But margin pressures are unrelenting, some manufacturing moving from China - to Malaysia, Philippines, Mexico etc. There's huge commoditization: PV upstream ('just get good panels least cost') with module pricing down ~80% since 2012. Module capacity may grow another >60%, from ~210 GW in 2019 to 340 GW in 2022! Meanwhile downstream parent using PV from its spinoff brand leader to advantage, may hurdle thin margins globally. It will be interesting to see how both do as their performances unfold. Solar panel maker - and that in solar sales.

Thus a roller-coaster 2020 was exhausting & thrilling. Last year's stock chart was remarkable; the world hadn't seen anything like it. Nor such divergence between zero-carbon (far up!) - vs dirty (far down!). Hence 90 dense pages in these Reports. Overshadowing all 2020 of course was the Covid pandemic. Job losses skyrocketed on Great Lockdown/s. Markets cratered in most themes hard 2020 – they may do so again ahead. Oil imploded to places not seen in 100 years, then a bounce. New attention late in 2019 for climate change, and for clean energy solutions – initially derailed by pandemic – again had resurging late 2020 & early 2021.

Moving on let's consider a longer, Past 5 years. Fossil fuels stand out here for declines (fast rising recently) so an interesting shift emerges in a 5-year chart. Until a few years ago, a last 5-year period for ECO was generally well down. Breaking that end of 2019, ECO left a long spell negative for past 5 years. Suddenly, sharply, clean energy shifted past 5 years up positive, returning +50%. 1st half 2020 the divide grew starker, ECO up over +50%, as dirty fell yet more. End of 2020, an even more striking divergence. Clean up +300%, with all strong across green energy themes - vs. the dirty themes then down -30 to -70% or worse.

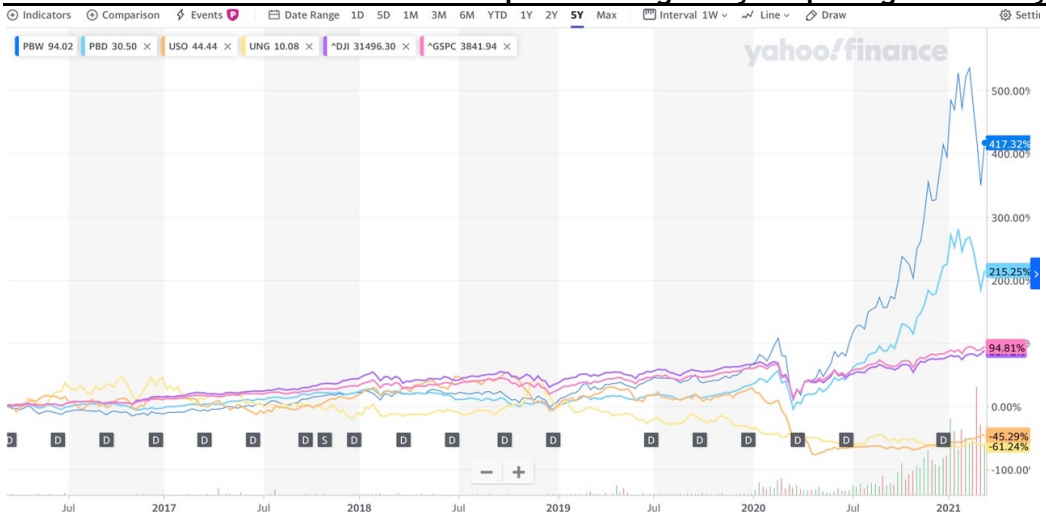
Due to declines in 2016, as 2021 scrolls forward, past 5 years by mathematical coincidence can improve further ahead – even if ECO/NEX are flat 2021. Should ECO/NEX happen to even gain some 2021, then past 5 years chart could really rise. That's simply a mathematical fluke, without much significance; just please do be aware of it. 5 years captures a small sliver of time. Corrections happen, trees don't grow to the sky. And temporal slices are snapshots; eg by end of 2019, a past 1-year ECO already was up sizably by +59% - so perhaps a big drop wasn't very 'surprising' Q1 2020 - like again Q1 2021. And clean energy's theme, once long *down* past 5 years in prior Reports of 2010s, shifted. The once previously-monolithic 2010s: 'All of energy (clean too) was far down' - lately has been changing, a lot.

Striking below in this 5-year Chart is a) clean energy ECO/NEX leaves 3 Down years 2014-2016; and b) 4 very positive up years 2017-2020. These gains in ECO, NEX, OCEAN are big in both absolute ways – and relative to major Indexes as well. With clean up +400% here, it left dirty fuels / and major Indexes 'in the dust'. Past 5 years then ECO tracker is strongest of all stories here up +400%; 2nd best global new energy NEX up +200%. There's then a huge gap after these two highest themes – with next performances being the comparison 'bogeys' Dow and S&P500 at +90% and +95% up. Normally anything near +100% over 5 years is a 'Win'. So in an absolute sense, they did do well. Just when relative to clean energy and decarbonization characterizing ECO/NEX/OCEAN, have the major Indexes foundered.

That separate, good independent global clean energy Index not ours, also trailed ECO/NEX here; that other global clean energy theme underperformed vs NEX most every sizable period last 1, 5, 10, 12 years, since inception etc. It and two other relevant Index themes, an excellent solar-only story, and an active-managed alternative energy mutual fund, will be seen in charts ahead for their stories past 10 years, 12+ years, plus. Those three there replace Dow, S&P500, and all country world theme for visual clarity in Charts.

Clean plunges at times: *a plummet ahead in 2021 will Not be surprising!* On the other hand, clean's gains *may* also outpace broad Indexes up. Consider August 2020: Dow then gained +7%, its 7th best August since 1984; S&P500 up +7% for its 8th best August since 1986. Meanwhile that month ECO was up August by +20%, the NEX was up +15%, & OCEAN was up +12% (nor were those greatest monthly gains in 2020: November and then December saw more).

ECO/NEX trackers vs. varied other clean & fossil fuels themes over Rolling Past 5 years, 2016 to early March 2021. Once was a 'very tough' past 5 years for all energy - is here Differentiated – Clean ECO/NEX at top are both greatly outpacing all of Dirty energy:



Source: finance.yahoo.com

Next is a past 10 years rolling, lately positive for clean. Until recently the clean energy story last 10 years was a relative 'dog' (our apologies to all dogs). What's changed? From a strict charting sense, it's partly due to leaving behind what were steep declines long ago late 2000s/ start of 2010s. Those were final legs in a steep plunge then in renewables. So including any bit of those years, had bent performance downwards. Clean then relatively outperformed vs. dirty at times; still - clean also had plunged then too, and that warrants attention. Thus seen next is a rolling chart for a rough past 10 years from 2011 - to start of 2021.

Past 10 years, now global NEX is up the most by +90%, while ECO is +75%. This period starts leaving behind a Great Recession that thunderously dropped all 2008-2012. That had put in bottoms for many *non-energy* stories some moving well up afterwards. But not so energy: that got hit harder, going on longer. As seen here, especially among these dirtiest themes, much energy went on falling after into the 2010s, with no immediate rebounding up.

The 2010s decade was rough as well on clean energy. This story is well captured by ECO/NEX, so note ECO tracker start of 2010 was 55, and ended 2019 at 34 or well down. Global NEX tracker in 2010 was at 16, it ended 2019 at 14, also down. Early 2020s so far looks to be very volatile, & also different. Clean energy vs. dirty energy is diverging – lately happily, by a lot! Long-term, clean energy's back history still is immersed in that period, given a key decade when China's new manufacturers of solar, wind, etc scaled up big and drove down costs. That would come to accelerate solar & wind installations, but it also crushed margins.

Solar was more stable in 2020, moving past overcapacity & commoditization's thin margins. Globally, NEX is here positive past 10 years, as noted up +90%. ECO is positive too about +75% for 10 years to early 2021. Then a big gap down, to next again that separate global clean energy Index (not ours) telling a quite more concentrated story; it is up (only) +20%. An excellent, focused solar-only story here is near nil, tied with an active-managed alternative energy fund. Meanwhile oil & gas plumb depths very far down some -80% to -90%. A tale of two cities: Big Declines Dirty energy – vs Clean Well-Up. That's been trending for some time. Recent Q1 2021 gains in oil and gas *might* create a new narrative, if they can persist.

Likely in this decade is solar + electric cars increasingly converge. We wrote about this idea 10 years ago for example in Solarsense: The Economic Case for Dumping Gasoline Car and Powering Your Car by the Sun' (2011) and in 'Driving on Sunshine'. Looking at the chart below, a passive Solar basket was down last 10 years, but it's far better since lows from last decade. A trailing active-fund shows yet again, that it's always tough to beat passive Indexes.

Highest is Global NEX, then ECO. They far outperform vs. other energy themes here – and yet trail behind broad Indexes not seen like an S&P500. On the other hand, clean ECO & NEX clearly did 'best' last 10 years – vs. the other energy stories. As time rolls on past those earlier, tough years, it *could* begin perhaps telling a quite different story. And how new energy NEX was created and assembled, a 'backroom matter', has been consequential

Rolling Past 10 Years from early 2011 to early 2021:

Source: yahoofinance.com

Let's here consider some key differences between global NEX now with a tracker too in Europe (GCLE; London) – vs. a good, concentrated independent Index also in clean energy worldwide. That other global Index has also had several characteristics usefully setting it apart from NEX. One contrast, is that other Index had arguably been a better choice if one sought a concentrated approach, excluding much exposure in electric vehicles, fuel cells, hydrogen and more. Because that other basket has been so very concentrated, it differed. The NEX by contrast has always embraced a greater representation across new energy innovation in eg: solar, EVs, hydrogen, fuel cells, wind etc etc. But there's many more contrasts, too.

NEX being in innovation, it also contrasts vs. classifications of an old CIGS (Global Industry Classification Systems) nomenclature from 1999. One result has been the other global clean energy basket has fallen more heavily in what old-style CIGS refers to as so-called "Utilities". To underscore: if one had been aiming for a very heavy concentration just within big names, to have fewer themes/countries - then that other basket was maybe a better choice.

Consider their Key divergence, has been in Performance. Brief periods, NEX vs. other Index traded leadership back & forth a bit. Short-time-horizons that other Index often lags the NEX, other shorter times it may even lead for brief periods. Brief time frames, mostly a wash.

But for most all long periods an interesting fact stands out: Global NEX **(in gold ahead)** has well Outperformed that other independent global clean energy theme **(in bold ahead).** This Stands for most all lengthy periods: past 1, 5, 10, 12+ years, since inception etc. Look over years, and clearly NEX has Outperformed significantly by some 50%+. Why might that be?

4 factors help explain why that other, separate, global theme has trailed so behind the NEX for global clean energy. Perhaps it's because that other non-NEX basket has been:

* So heavily Restricted to bigger-caps – thus having fewer themes and stocks;
* Very concentrated at the top, and only 30 (although with far more is ahead?);
* Heavily skewed by using the modified-market capitalization, with 4.5% or 8% cap;
* Unable to hold many stories - like in storage, alternative fuels, efficiency, and grid;
* Much less Diversified across clean stories, nations - with fewer (more ahead??) sectors.

Nothing is wrong with that *per se*. And means a good contrast between 2 clean energy themes. For other differences as between global NEX – vs. that other global clean energy basket, the NEX launched/and went live first in 2006 – well before that other Index. In recent Q2 the NEX has 125 components; and often has had roughly about ~100 or so. That other basket instead, for years has had just 30 components: arguably just 30 meant limited view of clean energy; it isn't possible to capture many growing stories in EVs, nor hydrogen, fuel cells etc.

Weighting styles matter much. That other basket sorted by market capitalization has been modified by a 4.5% cap. At times that 4.5% gets far exceeded like Q1 2021: a top name organically went well past the limit. Generally at any rate just a top 10 names in that other tracker, might reach upwards to become nearly half (or more) of its total Index weight!

In actuality, global clean energy pure play names are far, far more than 10. So concentrating that way means a big few may push it up if momentum narrowly does well - or they can pull that Index down harder like March 2021. As seen in performances last 1 year, 5 years, 10 years plus, while that other Index - and the NEX differed at times trading leadership back and forth - over most all longer periods, the NEX has done very, very significantly better.

NEX by equal weighting its larger 125 (more and growing) components Q2, has a wider reach. And helpfully, its equal weight style allows more components to be included and to be heard; each has 'a voice' in global clean energy innovation. Given such a big difference in performance, it seems an upside to equal weighting *may be* to allow passive NEX (& tracker) to better capture far more here. Reflecting more diversity of stories globally, in solar, wind, electric vehicles, batteries, storage, green hydrogen, fuel cells, decarbonization, etc etc.

Neither approach is 'right': t*hey're simply differing methodologies*. Varied ways, worldwide for clean energy stories to be captured. One has been very concentrated – one wide-ranging.

Both have trackers listed in US & in Europe. That other basket as a practical matter has a moderately lower expense ratio in funds (though swamped by performance difference). And heavy-traded funds helpfully mean liquidity. Overall, 2 differing takes on this growing theme. Equal weighting vs. Market cap skewing towards Top few, for a variety of choice. So it's been quite useful in real world ways in having 2 differing baskets for this fast-emerging story.

To those interested in more technical aspects of global clean energy & Indexing, we take a short look next at some practical topics. For folks who eyes glaze at the thought, we'd suggest please skipping to a section ahead – to page 25 for Rolling Charts vs. Fixed charts.

One possible technical matter, is bit akin to years back when small caps grew very popular. New inflows then, meant it was harder for active fund managers to have smaller equities, say <$400 million market cap. They meant liquidity risk. Definitions of 'small cap' inched up, maybe to be even <$1 billion market capitalization, to accommodate sudden growth.

A ramification of fast-rising popularity then, was it got harder to capture small caps as inflows grew. Whether in active managed Funds – or passive Indexes. Consider then, ESG thinking and greener goals saw tremendous fresh interest 2020. There was an upswing of activity, of 'net creations' especially in ETFs with focus on ESG themes. That interest grew to nearly be one-quarter net creations in equity ETFs over 2020, especially late in year. Much interest in ESG was aimed at cleaner/ non-fossil fuel themed baskets. Such levels of interest in ESG were unprecedented. Importantly, they also pushed underlying equities themselves organically up, maybe to Price Targets 'nearer perfection'. Multiples grew to be very high late January 2021. So high one *could well imagine* falls, on "P" (price targets) so above past P/E. multiples.

January 2021 saw rampant exuberance for green themes. Swift inflows to underlying equities could cause impacts. The fast rise of *hopes* was driving up stocks, increasingly challenging justifications to somehow also rise, despite what's seen on the ground. Thorny here, was to see green themes get priced nearer perfection. In such cases moderately troubling news could cause a harder-levered contraction. If say, Inflation fears grow, a diminishment of future earnings' value even far off in time could be impactful for growth themes today.

Separately, fast-rising P/Es, weightings + new interest, may mean liquidity risk for trackers. Somewhat confoundingly if interest grows swiftly, small caps may rise more swiftly. And in a highly-endowed tracker, adding or removing a component might require 20+ days to fill, carrying technical aspects; that reweighting period may also be depressive for a component dropping from recently higher weight. Adding big but less-pure plays on liquidity concerns, for more average volume overall, is no answer. Suffice it to say with fast inflows+high tracker volumes, it may be relatively tough to capture smaller and even mid-size pure plays.

Side note: volatility here wasn't particularly due to a *global* nature of this theme. Compare *global* NEX basket - with say, a basket of *US-listings*. Well-known Global NEX in Q2 2021 has a good 125 Components. Contrast with the well-known ECO Index of just US listed equities; latter 66 components in Q2 were half as many. These 2 Indexes have longest track records in the industry (each over 15+ years) - so put aside a moment that other, separate good global clean energy Index. Glancing at NEX/ECO, a few thoughts arise regarding volatility.

One a narrower basket; US listings here *may* at times be quite volatile. Mathematically this makes sense. More variety is available to a global theme vs. US listings only. And surely both themes in emerging innovation will likely be much more volatile - vs. a Big Cap, say S&P500. Head-to-head, day to day, first 6 weeks of 2021, NEX tracker saw a sizable 14 days of 3% or more change per day to March 15; yet ECO's tracker saw 24 days of 3%+ of change/day. ECO with just US listings, and a low cap floor will at times be very volatile. Global basket NEX has a wider range of possible nations, and of stories, and it has 2x higher minimum cap floor.

So global theme doesn't itself mean volatility. But 'new energy' or 'innovation' themes, can. In Q2 the NEX has its volatile hydrogen & fuel cell names (like other clean energy baskets). Europe greening its industry *may* move fast into H_2; there's several names here in Q2 2021. Continental Europe lacks great natural gas infrastructure (unlike say a Texas), it must import gas (from say Russia); there may be some relatively innovative attempts there in H_2. Says nothing about how those very volatile equities may perform (down like latter Q1, or up) – just may reflect Europe's interest of late in riskier innovative energy possibilities here.

In March, the International Renewable Energy Agency reported a startling $131 *Trillion* might be needed for clean energy by 2050 to avoid going over >1.5 degrees C. Coal & oil then virtually might go away, natural gas peaks in 2025. Electrolyzer capacity globally from a puny 0.3 GW – may go to 5,000 GW. Green H_2 may be feedstock for green ammonia, green methanol (CH_3OH) as liquid fuel. Europe importantly, might be a world leader here. China maybe faster growing its nuclear power - while only more slowly reducing its coal use to 2025.

Turn back to the 2 baskets for Global clean/new energy. For their components, 1st here is top in NEX seen via tracker January 2021. Next page is that other new/global clean energy basket, via its tracker. They've somewhat matched performances in shorter times – but longer terms, the NEX has been far outperforming. First here's the <u>NEX Top 30 Components:</u>

ReneSola - 3.1%	Eos Energy - 1.2%	Sunrun – 1.0%
Lithium America - 1.8%	Flat Glass Ltd. - 1.1%	Boralex – 1.0%
Plug Power - 1.7%	Bloom Energy - 1.1%	NEL ASA – 1.0%
FuelCell Energy - 1.6%	TPI Composites - 1.1%	Samsung SDI – 1.0%
Ballard Power – 1.4%	Canadian Solar - 1.1%	NIO Inc ADR – 1.0%
SunPower - 1.4%	Xebec Adsorpt. - 1.1%	Azure Power Ltd – 1.0%
ITM Power PLC - 1.2%	PowerCell Sweden – 1.1%	Xinyi Solar Ltd – 1.0%
Maxeon Solar - 1.2%	VERBIO BioEnergie – 1.0%	Ceres Power PLC – 1.0%
Ganfeng Lithium - 1.2%	Xinjiang Goldwind – 1.0%	
Daqo New Energy - 1.2%	Renewable Energy – 1.0%	
GreenPower - 1.2%	BYD Ltd – 1.0%	

A few thoughts on the above January 24 data, *These Top 30 are rather nearer equal-weighted (starting each Quarter straight equal weighted then moving up/down on their own actions); *They're capturing a very wide variety of Stories as well as also of Nations & Exchanges; and *This is only a top 30 of over 100+ components Q1 – better capturing global developments.

NEX above, reflects Solar; Lithium, Batteries; Hydrogen; Fuel Cells; Electric Vehicles; Wind; Renewable Biofuels etc. Plus, these top 30 components together above are still <1/3rd of all components, nicely representing some 40% of the total NEX Index weighting overall.

Next briefly, here's All 30 of that good, but Other global basket in Q1 (seen by tracker):

Plug Power – 10.4%	Orsted – 3.7%	Sunnova Energy – 2.2%
Enphase Energy – 5.6%	Ormat Tech 3.6%	Companhia Energetica – 2.1%
Meridian Energy – 4.7%	Scatec Solar – 3.6%	Doosan Fuel Cell - 2.1%
Verbund AG 4.7%	Sunrun – 3.2%	Solaria Energia – 1.9%
Siemens Gamesa – 4.2%	Boralex – 3.1%	PowerCell Sweden – 1.9%
Xinyi Solar Holdings – 4.1%	Solaredge Tech. – 3.0%	Renewable Energy – 1.8%
Daqo New Energy – 4.0%	Innergex Renewable – 2.5%	Companhia Paranae. – 1.1%
Vestas Wind – 3.9%	Canadian Solar 2.5%	Enlight Renewable – 0.3%
Contact Energy – 3.9%	Neoen SA – 2.4%	
First Solar – 3.8%	Encavis AG - 2.4%	
EDP Renovaveis – 3.8%	Atlantica Sustainable – 2.3%	

In Q1 2021 all 30 components in that other tracker stand out a few ways vs. the NEX: Their *Weighting percentages are much higher especially in the Top 10 getting near 50% of total; *The other Basket seems to mainly exclude Electric Vehicles; it has *Much Less exposure above overall to Hydrogen, Fuel Cells (much just 1 equity at top) so the above is top heavy. Given their far different basket sizes Q1 (102 in NEX vs 30 in other) almost every component in that other, concentrated Index above – is also found in bigger NEX. Yet less than 1/3rd of the components in NEX Index in Q1 - might also be found in that other Index.

Given the 2 Indexes have been calculating live many years, we've been able to see a very wide performance difference. Somewhat interesting, is *Why*. Clearly over time the better performing NEX tracker (next page, in gold) is doing much better Up some +45%, vs. that other tracker that's Down some -35%. One difference is the variety & number of countries in each. Another big difference is Weighting; that other tracker Q1 (Jan. 24) has just 2 countries for nearly 50%: the US (36%) and China (11%) made up nearly half of that Index by weight.

4 other countries nicely added roughly 7% each there: New Zealand, Denmark, Spain, Canada. About 8 more countries form the rest, under 5% each. So a big difference Q1 2021 was in Weightings: just 2 countries made up near half that other Index, 12 more most its other half, then a few other nations. Total was concentrated 30 components, about 14 countries for overall that global green energy theme. Heavily skewed at top. To repeat that's one approach to this Global theme; these are mainly just differences as to flavor.

NEX differently rebalances 2x as often, Quarterly. That other, semi-annually. Early in 2021 the top 2 NEX countries were US (28%) & China (14%) – for less weight at top (42%). That allows for more components, and more weights from other nations in other 58%. And it allows for more components overall too within US & China: arguably useful given the diversity here.

NEX thus = greater range: 102 components, and better yet 125 in Q2. The Q1, then smaller basket of just 102 was in US (30), China (11), Germany (7), Canada (7), Spain (6), S. Korea (4), UK (4), Taiwan (3), New Zealand (3), France (3), Japan (3), Sweden (3), Denmark (3), Norway (2), Switzerland (2), Italy (3), Netherlands (2), Ireland (1), Finland (1). Again, many more components, themes, nations, relatively more stories here in NEX. Had the 2 Indexes closely traded leadership, then these differences might not have much mattered.

But performance of the 2 Indexes plainly has favored NEX tracker (gold) by some +50% or more since inception. Thus NEX is far higher than the other **global clean energy theme (bold).** That metric on which they starkly differ, weighting – is worth a moment's discussion. Whether equal weight for NEX – is 'better' here for new energy - than market cap can't really be said (yet). Much ink is spilled over this in broader Indexes. Probably simplest is to say some periods equal-weight does better – other periods market capitalization does better. Neither is predictable – each identifiable only in hindsight. When gains are in just a few big names, market cap can lead; when speedy growth is broader it favors equal-weight. Thus, at times, one approach could do better – at other times the other – seen in hindsight only.

But with its much broader range, performance has much favored NEX, while liquidity risk in that other grew prominent. Thus it was no surprise when that other good Index proposed early 2021 to go from 30 - to 35; then aimed for 100 components! That can help alleviate liquidity concerns. But its new profile might have large conglomerates, non-pure plays, only partly in clean energy: that would take it away from clean energy. So too, 'carbon intensity' that may mean allowing in natural gas. Probably, it will aim to catch up some to NEX on performance – though that will be tougher. That other basket may modify its 4.5% cap to address small components over-weighting; 'helping' some, though it concentrates more in Top 10. Perhaps Quarterly rebalancing, again more like NEX. Changes can address concentration & liquidity; may make it a bit more akin to broader NEX: that could make good sense. But if adding non-pure plays, just for their big size, that may nudge that basket from this clean theme.

Lastly here's global clean energy as captured by the 2 Indexes via live trackers for the past 12 years to January 2021. It's interesting to see performances of the 2 Indexes/ tracker funds. In sum the global NEX tracker (in gold) has long clearly shown a much better performance in capturing this global clean energy story worldwide:

Source: Bigcharts.com

Moving on, one last point about Charts. A small problem with *rolling* Charts, past 1 year, 5 years, 10 years etc, is in a few years they *may* show Very strong returns here for ECO & NEX. Once charts leave huge fall 2008-2012, and tough energy times 2014-2016, then relative drops removed, both ECO/NEX *may* show far greater relative gains. For that reason a view is needed with ECO's especially huge declines in 2008/2009 preserved: hence this Chart below. From fixed 2008 it looks onward. Long-running ECO + tracker might have begun in 2005, yet other trackers didn't commence until later – so earliest feasible start was mid-2008.

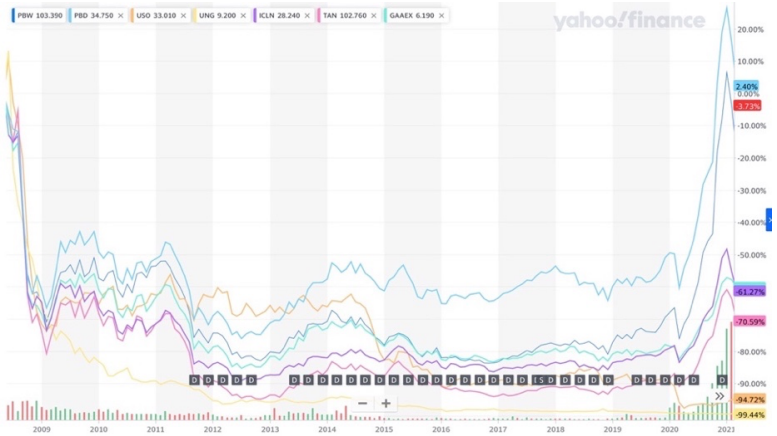
Over what's now 12+ years & growing, this *non-rolling* chart shows very Big energy declines. Unsurprisingly, fossil fuels again lag green sizably. But relative to a rolling 10 years, above, one difference increasingly stands-out; the global crash 2009, brightly highlighted, is forever preserved. What energy might perhaps do ahead, will doubtless be of interest as 2020s scroll forward. Yet what was once viewed as tough times all energy – last 12+ years - *may* instead ahead show as mainly very tough for the fossil fuels, only … Or perhaps, Not!

Look far back, and we'd also note that an ECO predecessor, the WilderHill Hydrogen Fuel Cell Index, had calculated 1999-2007. Given this chart below picks up 2008, we've uniquely been capturing Hydrogen & Fuel Cells themes more than 20 years: since 1999! For latter H_2, visit our 20+ year-old 'cousin site', The Hydrogen Fuel Institute, http://h2fuelcells.org

This chart preserves as in amber big drops in energy after steeply rising early-2000s. From about 2008 when many trackers were just commencing near peaks, all soon plunged. That 2008/2009 crisis hit countless themes globally. Yet a bog & a deep mire since here, has stretched across both clean and dirty energy and it is brightly preserved below forever.

Starting from bottom are fossil fuels, oil and gas down here some -95%. Next 'above' is solar off -70%. Then an independent, other global clean energy basket off -60%, that theme fell hard and and with just 30 components it differed greatly vs. NEX. Tied with it is an actively managed alternative energy mutual fund. 'Above' those all and steeply rising yet still near nil after dramatic falls in 2008/2009 is ECO at about -4%. Clearly 'highest' among energy baskets is global NEX though only near nil at +2%. Broad Indexes outside energy (not seen here) did *far* 'better' yet differ sizably: energy is a sliver there. Plus since 2017, all of clean energy has shown some up volatility too, which *may* yet change many things ahead:

Roughly Last 12 ½ Years starting from a Fixed June 1, 2008 to early 2021:



Source: yahoofinance.com

In 2020 side note, a big clean energy plummet Spring 2020 left only 1 ECO component positive at bottom, March 18, 2020. That inflection was a bit memorable: ECO had opened at 51.88, it fell to intra-day low 45.85 losing -12.57%, closing at 47.37. So this basket had dropped by over ½ in early 2020 from a 93.65 high intraday Feb. 20 (close of 92.53): in just weeks, ECO strongly plummeted by over -50%!! World markets were crashing too amidst fears of a 2nd Depression like unemployment. All seemed to be on the brink that moment.

Lest over-emphasizing negatives, spotlighting falls in Q1 2021, or long ago in prior decades - there's also sharp rises here at times too, like 2003-2006, or recently 2017-2020. For example, ECO components jumped over 3 days in 2020 from March 24th nadir for a sharp +25% rebound. Volatility from those lows had pushed ECO upwards some +15% in hours.

After closing 2020 under 50 on March 23 at 48.75 on fears of 25% unemployment & a Depression the Index reached 55.87 on March 24, closing at 55.74 on hopes of $2 Trillion stimulus. Focused green support wasn't expected in a new stimulus in 2020; as expected, help didn't come – as it was opposed politically. Yet clean energy was growing cost-competitive - even *without* subsidies ahead (unlike fossil fuels and nuclear, so needing continued support).

So gains *may* happen in a volatile clean energy theme. At times, alongside broad markets, perhaps on greater volatility. Consider say April 6th to 10th in 2020: in 1 week S&P 500 & Dow rose some +12%, the biggest 1-week S&P gain since 1974, and the 7th largest for Dow. While both ECO & NEX can at times plummet; here they rose in even more volatile upside: ECO rose +19%, while volatile NEX gained over +12%. Broadly these were rising themes.

Compared to a market cap Index, just one stock in ECO/NEX won't have so great an impact. Recall for a moment that other, cap-weighted basket for the global clean energy Index: there just 1 component in fuel cells had become 9.7% of it in Q1. When that hit a sharp downturn March, it pulled that other Index down by a sizable amount. Not so much, in the NEX/ECO.

Hydrogen fuel cells have 2 decades+ of high volatility. They may fall – or rise hard, no doubt. Ability to one day make green H_2 at scale is uncertain, needing breakthroughs first in cost-reduction, in production, transmission & storage. Meanwhile fuel cells for electricity from that green H_2 needs breakthroughs to be cost-competitive, and durable too. Green hydrogen and fuel cells then are mainly really on 'hope' now; not yet on the cusp at start of 2021.

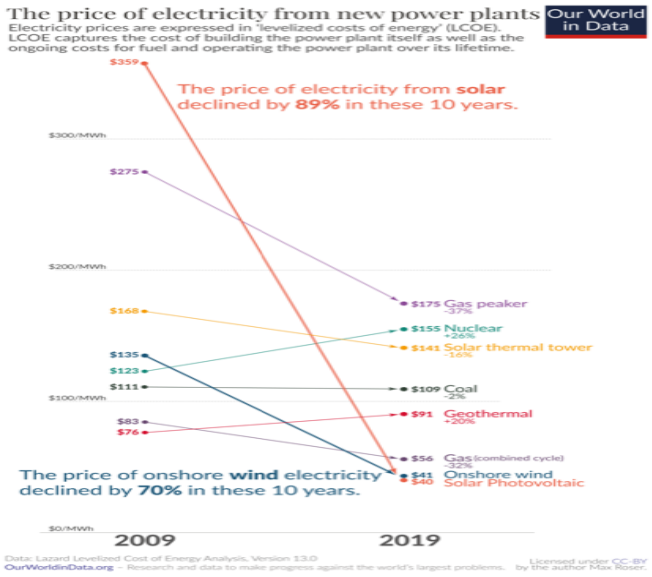
Solar & wind, are different. They'll more likely grow strongly, vs. a far less certain green H_2. That said, there's in 2021 growing interest in H_2 - and easier to transport green ammonia (H_2+nitrogen) gas, or green methanol liquid – both moving hydrogen like an energy currency. Where super-hot furnace temperatures are needed, to make steel, cement, aluminum etc, clean electricity from solar PV/wind can't normally accomplish it. But adding a, step could. With electrolysis by super-cheap green electrons, green H_2 from water (H_2O) – can make high temperatures. One firm is looking at a >90% efficient electrolysis, no membrane needed, <$1/kg! Green ammonia gas, or green methanol liquid (neither blue) as energy carrier.

Applications immediately show themselves if green hydrogen is under <$1. Making say sponge-iron for steel produces 7% of carbon dioxide emissions globally. It is 10% of the CO_2 emitted by Sweden. A green H_2 test project in Sweden, aims to release only 25 kilograms CO_2 per metric ton of steel – vs. 1.6 tons today. Here the affordable green hydrogen ideal has been long-held; ECO, NEX, OCEAN and an earlier WilderHill Hydrogen Fuel Cell Index (by 'Hill') have each had H_2 & fuel cells since latter first inception 20+ years ago, late 1990s.

Flip side of America's growth from zilch in 2010 - is that where we stand on renewables now, is *Awful*. In 2020 US offshore wind 'should already' have been hundreds of GWs; instead it was near non-existent. Solar in 2020 was only 3.4%, wind was 8.1% of US electricity. Yet solar & wind could, should be soon meeting 100% of electricity. Today, electric propulsion for cars, trucks, ships, jets is instead tiny rounding error. So it may feel we've come a ways 2021 – but only given how pathetically we began. The World Economic Forum observed using 'Our World in Data' (OWiD) figures, that polluting fossil fuels in 2019 still were making fully 79% of energy production worldwide. Unsurprisingly that was due to their besting so long on costs relatively speaking, and on firmness, all the clean alternatives. Not much longer.

Solar is forecast to wallop dirty ahead, given a price plummet of 89% last 10 years. Costs of solar, like wind & storage, continued dropping hard 2020. Coal, oil, gas suddenly are becoming instead the relatively costlier - they always must pay for fuels. They are always bound to be expensive: to operate, they must pollute, and seem powerless to reduce their cost follies much further. Unsustainably they're creating 87% of global emissions of CO_2. Estimates are their air pollution alone has been causing 3.6 million deaths every year, which is 6-fold more than all the annual war deaths, terrorist attacks, and murders combined!!

This Report may focus on power, but energy is a broad topic including heat and other uses. Coal, most harmful energy source, still generates 37% of our electricity and with it most CO2. Natural gas, 2nd, makes 24% of our power while also generating overall much CO_2. Coal's costs were mainly flat the last decade, while gas costs dropped sizably due to fracking – those costs turning back up in Q1 2021. Yet the changes there are dwarfed by wondrous-solar: costs down by -89% and by onshore wind where costs are down -70% as seen here:



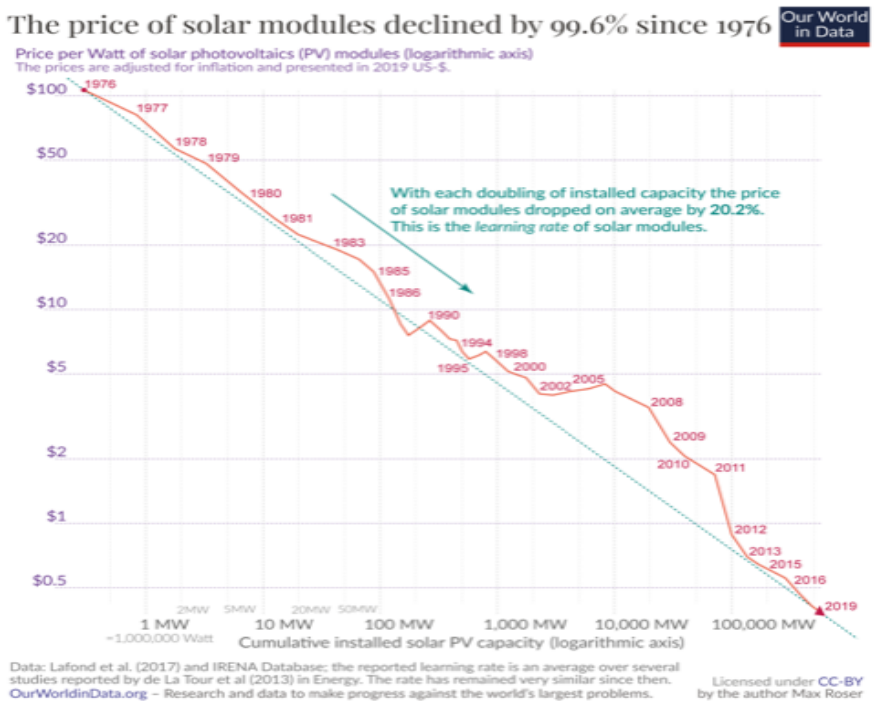
Source: Roser, Why Did Renewables Become So Cheap So Fast? Our World in Data (Dec. 2020).

So fossil fuels & nuclear poorly situated in 2020s for making electric power. Think about it: they are vexed by *ever high costs of Fuel & their Wastes (nukes must store for centuries, millennia after shut-down!), by *High Operating Costs with hundreds+ of employees, and those costs can't/won't decline. At every non-standardized US nuclear, each new plant costs yet *more* to build(!) – that's the exact opposite of better solar/wind.

At a coal plant, fuel costs may eat up 40% total operating costs. Natural gas fuel costs did decline last 10 years, but is Not a long-term trend, not in Q1 2021, nor going far lower.

By contrast, renewables solar & wind enjoy *zero costs for fuel. Relatively-speaking *close to zero Operating Costs. How horrible it must be for fossil fuels & nuclear to compete with that! Only by amortizing sunk costs at now-built coal, gas, and nuclear, can they reduce costs significantly until extant plants age-out. If comparing like for like, then new renewable solar/wind are simply much more affordable on levelized costs – so better than the rest.

That OWID Report identified an early solar cost in 1956, $1,865/per watt(!). So just 1 typical 300-watt solar panel today, installed on a person's rooftop would cost over $500,000 at that rate. Of course that was unaffordable back then. Valued nonetheless for space applications, solar went on getting better, prices coming down very fast. *Thus with solar, it's all about Technology*. Similar to integrated circuit chips in computers, we grow much better quickly at cramming in lots of performance ever more cheaply. It's a virtuous circle, similar to computer chips which enjoy ever greater new deployments = prices falling more = more competitive new markets = and so demand increases: repeat that over and over and over!



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

Solar module prices fell so enormously -99.6% since 1976(!) because it's all about Technology. And the Executive Branch may reduce or repeal existing tariffs, so China PV becomes cheaper. Fossil fuels – by contrast - are Not all about technology; they may be doomed. Declines seen above like in wind power, are impossible for dirty to try to catch. How can coal, oil, even gas hope to keep up for decades with this learning curve in solar? They can't, if economics is sole metric. But fossils have great inertia, much influence, capital, lobbying, and will deploy it (more on that later). No doubt they won't go gently into that good night. Still no wonder solar & wind make up most new power construction. Now energy storage is becoming much needed too along with policy changes. In a clean energy index, storage has to be significant.

How meaningful are initial choices made by Indexes. Construction & vision early on impacts later performance. Definitions passively, yet literally – shape mind's eye of a basket.

Take well-known FTSE 100. It's widely known in Europe, oft called Footsie' and this Financial Times Stock Exchange Index is made of the 100 largest ('blue chip') firms listed on the London Stock Exchange. Bit of a prosperity gauge of the UK economy, it's the most widely used measure of how well the British stock market and firms domiciled there are doing.

So when the value of just 1 single US company, Apple, overtook value of that entire market cap weighted FTSE 100 Index late 2020, that was bit of a shocker. Nearing 40 years since FTSE was created 1984, some thoughts come to mind about its construction. To be sure, there's been 'some' growth as seen in that important basket's annual returns.

But not much, really. Initially its 100 companies first had a market value about £100 billion – the Index set at starting 1,000. By end of January 2021, it stood around 6,400. That was an annual gain over 37 years of just 5.1% (or 7.6% annually including net share issuance).

Even this (not great) was No straight climb. As noted in MoneyWeek (2021), it had peaked 1999 at 6,930. Later, it passed that 2016, next peaking 2018, at 7,877. But by end of January 2021, that 6,400 stood out as only 11% higher than where it had been some 15 years prior.

Much stronger growth was seen 1984 through 2005. It thus once showed better returns, compound average growth of 12.5% (in real terms 8.5%). But then 2005 through January 2021, annual growth rate has become much slower and is only 2% ahead of inflation at 4.7%.

This over a period lately when the US technology & innovation equities positively boomed.

What factors account for such lugubrious showing by the FTSE? Consider its biggest component at start was BP – an oil & gas company. Recall how poorly US oil & gas 'energy' companies fared too within say, an S&P500 past many years. Terribly, is how they acquitted themselves. Hence it's not about BP, per se, but rather maybe partly about oil & gas in that regard.

Being a market cap weighted Index, it should automatically adjust for awful returns in CO_2 heavy old school oil & gas. Once-big firms decline, losing Index prominence, that allows much faster-growing smaller firms to take up the leadership positions. Problem is rest of that Index by definition (remember, literally the 100 largest firms listed) have similarly been in slower areas like mining (now 8, but had been 12), in retail, or tobacco. Not in innovation or technology. It's thus not so similar to an S&P500 (only recently adding its first EV maker). And surely is not at all similar to innovation-heavy Index like say, popular Nasdaq 100.

What's been in the FTSE 100? Royal Dutch Shell is still near top. Of 277 past components in FTSE 100, many have been retail, like Boots (health & beauty retailer), or in energy like BOC (now part of Linde). Banks, once UK giants of FTSE, faded. British American Tobacco, and Imperial, both tobacco – do not enjoy (thank goodness) huge prospects like tech/innovation.

There has been health care related to biotechnology like AstraZeneca, some technology like Aveva in IT, or Rightmove for online web-based real property. But over the last 15 years and obviously in past 5 years to 2021, these FTSE 100 returns have clearly lagged the major Wall Street / US broader Index baskets like the S&P500 or Nasdaq 100. And FTSE 100 has absolutely been crushed by our trackers for global/ clean new energy NEX Index, and ECO Index.

As pointed out in Money Week, part of FTSE 100's issue is absence of organic growth among its components. Sage plc has grown its enterprise software, as Next plc did clothing retail. But much also entered top 100 by mergers and acquisitions – that's not a good long-term ramp for growth. The innovation & technology thesis in a Nasdaq 100, a similar Nasdaq Composite - or an S&P500 are different. They noted that the S&P had 19 technology stocks in 2005 – while FTSE 100 had only 1. In 2020s, more technology names joined FTSE 100 than before. Still by contrast, US Indexes reflect considerably more tech themes. The mid cap and smaller cap FTSE 250 enjoys more momentum and more innovation-equities, than the FTSE 100. Seeing this chart below – clearly the performance farthest at bottom these past 5 years is FTSE 100 in light blue that's 'up' little this period (to mid-February 2021) some +11%.

Next up mid-cap FTSE 250 in purple does sizably better, +30%. A technology-rich barometer, S&P500 in pink doubled here. Tech-and-innovation-heavy Nasdaq composite in gold is far up, at 200%. The **NEX Index in blue** is up +275%. To be sure, innovation and technology themes are very risky: at times they'll drop hard & fast. While a conservative theme is less risky, over recent periods at least technology and thematic areas (like new energy innovation) has outperformed by far. So much so, one must be very wary of a bubble here – and recall too the NEX - like ECO & OCEAN - can and will at times 'drop like a rock'. Here it is:

Past 5 years to mid-Q1 2021; FTSE 100 at bottom pink, **S&P500** middle, and **NEX** at top:

Source:YahooFinance.com

With hindsight one can obtain better performance than a FTSE 100 recently in UK markets. One might for instance rely on a differing, mid-and smaller cap FTSE 250. In some ways the 250 is similar to 100 – other ways is quite different. As name implies it's the top 250 by market cap also listed in London. From 1985 through January 2021, it has returned a more significant +8.5%, putting is well ahead of the large cap 100 (that's been up 3.6% less, per year).

Of course, all identifiable in hindsight only. It's impossible to say beforehand what Indexes, like which companies, will do well ahead. Some factors may perhaps be mildly notable, like say less emphasis on older themes of the past. (Though conservative is better in down years). A potential pool of components tending to skew towards some tech and innovation. In the FTSE 100 older style energy is rather large at 9% and there's mining (materials) 13% - so together 22%. By contrast in US those two are 5% of market; in Europe they are 10%. In the US, technology makes up 28%, healthcare 14% of the S&P500; and in a Europe-wide Index (ex-UK) roughly 10% and 16%. By contrast they're just 1.3% and 10% in the UK. In sum the rules and construction of an Index can be thought of as shaping the theme; they really matter. Next, let's look at some possibilities ahead in a world that's fast changing.

Recent Past under Covid-19 – & perhaps some possibilities ahead:

The President + bare Senate majority are now historic for clean energy. Possibly impacting this decade. Consider our future: young voters rightly demand a far more sustainable, equitable, clean zero-carbon future than what us 'oldies' ever contemplated.

A glimpse of what may be sought 2021+ after is seen in a 500 page Select House Committee on the Climate Crisis Report from Summer of 2020 and that's increasingly relevant today, https://climatecrisis.house.gov/sites/climatecrisis.house.gov/files/Climate%20Crisis%20Action%20Plan.pdf This is worth a look for voluminous changes contemplated. Not near all will be accomplished, and more aggressive goals may be dashed on rocks of reality (consider Manchin, Sinema). Yet any real steps begun early in this decade for decarbonization will be a huge change.

This Plan is no small beer. It's far more ambitious & aggressive than was contemplated back early 2020. With a new White House + a Senate, this decade **may** be unlike anything in clean energy. "Transformative" is a big word - yet it could be, along with ambitious Europe & China. Still, bear in mind if expectations get too ahead of reality – eg an unmoored *hype* like before in hydrogen fuel cells (since called 'fool cells' by many) – big drops may be more likely. Plus, expectations may shatter when big changes like a strong national renewable energy standard, or carbon tax - require legislation & Senate - home to compromise, inertia, realpolitik.

Consider as well, how little was truly done for US clean energy in mid-2020. Summer of 2020, federal pandemic aid for fossil fuel-heavy sectors reached some $68 billion; yet much of that went to prop up airlines. By contrast $27 billion went to only slightly, green-related areas mainly well outside clean energy. (To be sure this will change soon in the 2020s).

More directly fossil interests got $3 billion in forgivable small businesses loans back mid-2020. Contrasts with little support specific to clean energy. Impossible to know if we're in calm before another pandemic wave 2021 and after. But, solar has re-gained momentum, Utility scale up some 43% in 2020 to 19 GW. Costs dropped 5%-8%, as many big installers re-reached pre-Covid expected levels. Early 2021, even US residential solar grew by 25%-30% in 2021 YoY! Europe expected to do well too, plus on fewer inverter supply challenges.

Back in early 2020, big offshore wind globally did especially well - despite Covid-19. In fact, first 6 months of that year were best yet recorded for offshore wind! First part of 2020 more investments went into new offshore wind, $35 billion, than all 2019. This tripled the world's figure first half of 2019. Major offshore wind array decisions in 1H 2020 had included a new 1.5 GW Vattenfall project off The Netherlands and it was largest to date at $3.9 billion; a new 1.1 GW SSE Seagreen offshore farm in the U.K. for about $3.8 billion; a 600 MW Changfang Xidao project offshore Taiwan at $3.6 billion; and some 17 coming installations being financed by China such as 600 MW Guandong Yudean that will cost $1.8 billion.

One big driver lately was huge declines in offshore wind costs – plus looming subsidy cliffs. Unlike solar based so strongly in semiconductors (like cramming ever more memory capacity into semi chips), wind is more about advances like in heavy fabrication, and ever-bigger blade designs. Since 2012, levelized offshore wind costs dropped 67%. Unlike onshore-based wind rubbing up against limited availability, oceans are immense, often windy spaces for placing massive turbines far from view. Big wind farms have been providing desirable, reliable, returns on capital. Thus, renewables investments here rose 1st half 2020 to $132 billion, vs first half 2019 at $125 billion. Much of that offshore wind fast growing worldwide.

Even with Covid-19, 3 nations had experienced especially strong new renewables investments in part thanks to their offshore wind early 2020. China was up some +40% over 2019; France had tripled, and The Netherlands gained by 2.5 fold in 1H 2020 - vs 1H in the prior year.

Let's take a look at one particular offshore wind development early 2021 that stood out. This was oil giant BP's winning bid, £924 million for the option to develop 2 offshore wind sites off North West England and Wales. Their winning Bid in 2021 has said a lot of things.

One is that BP even with its big money is a bit late to the party. Their bid was well outside norms in wind now. Their bid with German partner Energie Baden-Wuerttemberg, EnBW meant in essence they'll pay the British Crown Estate £231 million per year, over 5 years for each of 2 sites, at end of which they'll decide whether to proceed. This comes to paying about £150,000 per megawatt/per year. Compare that with a quite lower £93,000 MW/year paid by a differing winning bid to Crown ocean property by Cobra Instalaciones y Servicios alongside their British new homegrown offshore venture, Flotation Energy.

That well surpasses too £83,000 MW/year paid by a joint venture of Total & Macquarie to another site. And it's more than the £89,000 MW/year & £76,000 MW/year in 2 bids won by the big German company RWE for big wind farms at Dogger Bank.

It hammers a 2nd telling point: BP rather late to offshore wind bidding is paying higher prices. In a sense, its hand was forced: it promised to go carbon neutral by 2050. But there's a cost to coming late. Its shareholders have seen very high-percentage returns it once earned from older oil exploration & production. So BP may feel some considerable pressure to earn something like high 8%-10% returns fairly 'risk-free', from its coming offshore wind farms.

Problem is, paying so much at start makes it hard to reap higher returns later. Arguably 10% returns are a tough target anytime, especially aiming for no-risk. Consider too their oil & gas has shown poor returns for years. US behemoths like an ExxonMobil have shrunk considerably. At levels of 1 person, a 23-year-old oil roughneck once could earn $100K+ working just part year: but that bubble's gone. Today, a wind technician can make good salary with experience, but it's hard to imagine an industry matching $$/and Benefits fossil fuels paid. Unionization rates dipped everywhere, including in some parts of fossil fuels production. But areas there like pipefitters, rates are relatively higher and with that better Wages and Benefits.

This is still a province of business ventures. Fortunes favoring the bold. Greatest returns in new energy innovation perhaps more likely to be enjoyed by first-moving risk-takers. Otherwise, lumbering fossil fuel giants, or supermajors following others' leads, may instead experience lower returns nearer say 5% - than perhaps hoped-for near risk-free 8-10%.

Thus a number of serious bidders lost to BP. Shell for instance offered nowhere close. Yet with offshore wind, Europe's supermajors BP, Total, & Shell may be at last be starting to genuinely transform into 'energy companies' (not merely greenwashing) That puts them well ahead of US oil supermajors. A good example is Orsted of Denmark. It robustly divested out of old oil & gas to focus on green energy. Leader Orsted, even a more slowly-changing BP, Shell, or Total of Europe – all contrast sharply with American Big Oil. US oil may yet cling to 'sequestrating carbon', perhaps hopeful marketing – soldiering on with old fossil fuel-centered business models. All a non-starter as seen in their market cap trends.

Consider Raymond James data on renewable/clean tech investments at the large cap oil & gas companies. They show that of 7 Big Oil firms committing to net-zero emissions in 2040 to 2050 - fully 6 are based in Europe. For the top 7 from Big Oil, their name/country (and estimated % of capital expenditures on clean energy) figures in 2020 were: Repsol, in Spain (26%), Total, France (15%), Equinor, Norway (13%), Eni, Italy (10%), Royal Dutch Shell, Netherlands (7%), BP, United Kingdom (4%), and Occidental, USA (2% to 3%).

4% cap ex spending at BP for renewables and clean tech may not be terribly inspiring. Yet ExxonMobil in US is spending much less, under 1%; same with Chevron. And Big Oil hadn't even made the net-zero pledges until 2018. 2021, the pace is quickening a bit. Partnerships, acquisitions, and activity by Big Oil in Europe shows biofuels, biomass, wind, solar, hydrogen leading – plus as one might expect much too around varied treatment of carbon.

Backdrop to it all (except recent gains on output cuts by OPEC), is that Big Oil & Gas valuations mainly have declined last 1 year, past 5 years etc. That's important: perhaps the more those past-fossil-behemoths resist change, the more they *may* head towards smaller market caps. Those most wedded to the highest-CO_2 models – may possibly (Ahem, no polite way of saying this): move towards Irrelevance 20 years from now. Like coal, and steam before it.

Take for instance the last 1 year to mid-Q1 2021. Here's **BP, blue**, a Big Oil example at bottom is down about -45%. (It did rise on announcement of its billion £ wind project). A bit above it, though also negative is carbon-heavy **ExxonMobil, in gold,** off about -15%. In contrast, Orsted, in light blue (once in oil & gas, but sold it and instead is embracing clean renewables like offshore wind) is up +40%. And a tracker for decarbonizing **global new energy innovation Index (NEX), in orange**, is at the top here up some +140%.

Source: GoogleFinance

Denmark's Orsted is rather posterchild for a once past oil & gas firm, transitioning quickly to clean new energy - successfully, growing & becoming more profitable to boot. Not half steps, nor dithering as in 'carbon sequestration' to prolong fossils. Orsted robustly launched itself into wind, solar, bioenergy. The benefits are shown in rising market capitalization (above), increasing strongly - even as BP & Exxon declined. Benefits can also be underscored in Scope 1, 2, 3 rankings ahead for emissions. Scope 1 & 2 mean direct & indirect emissions by a company's own operations; those may be reduced while a firm goes on selling fossil fuel products. So Big Oil could stay put in fossil fuel lane, while reducing Scope 1 or 2.

But Scope 3 refers to customers' carbon footprint using its product/s; hence only a green transition (like at Orsted) to clean sustainable energy will satisfy this measure. If US Big Oil is determined to stay in dirty energy, perhaps with facile CO_2 accounting like 'carbon offsets', marketing and the like, then Scope 3 concerns will still grow ever-tougher.

Big Oil Europe's moves in offshore wind – far ahead of Big Oil US – reflect Europe's differing views. A European BP, Shell, Total are right to do so: wind is far greener than dirty oil & gas. All of Big oil has cash, experience, engineering knowhow – as with BP partnering with Equinor of Norway for US wind. What's also needed now, besides wind - floating or otherwise – and right in Big Oil's wheelhouse, is magnitudes more energy Storage. Big oil could accelerate storage like pumped air in existing caverns (Not a carbon sequestration!); or using weights for gravity storage, or geothermal. As noted, undertake geothermal at lithium-rich hot waters and get both firm clean power – and zero-carbon Li-ion for batteries. That zero CO_2 green lithium could replace rock mining, and water-intensive evaporative ponds using sulfur.

Lessons learned by the UK in ocean wind can assist the US. Infrastructure like undersea cables, facilitating offtake of power in the first-place. In this like much else, the US has badly trailed behind the UK in offshore wind policy. Start of 2021 there's 'just' 10 GW in UK which still ranks it as a world-leader. Now UK aims to quadruple it this decade to 40 GW offshore wind - enough to power so many homes yet they could do much more. The US by contrast early 2021, had pathetically close to zero offshore wind, despite the entire country's vast shores!

Data from excellent Bloomberg New Energy Finance, BNEF (our long-time prior NEX partner) - and the US National Renewable Energy Lab, 2021, shows how badly America lags Europe and China on offshore wind. We could use the same innovations – GE Haliade 12 MW, Siemens 14 MW, Vestas 15 MW huge wind turbines - so consider one obstacle is US regulations. All of America in early 2021 had but 2 small offshore wind farms at work, one a tiny 30 MW site so equivalent to just 2½ turbines! That will change – but much too slowly.

Breaking down that US Pipeline, initially there's Project Planning stage (developer or Agency initiates site control), then Site Control (lease/contract), Permitting (building plan+ offtake agreement), then Approval (regulatory OK), Financial Close (sponsor investment), next Construction (build initiated), and Operating. This doesn't include myriad lawsuits in the way, political opposition, sparse infrastructure to offtake power, all halting offshore wind before it begins. Perhaps little wonder, it has been utterly absent so far from US shores.

What's changing like 'pig in a python' are projects bulging near start. Projects in site control and offtake stage have increased +200% from a small base in 2018/2019. Start of 2021 some 28 GW various US projects are mostly early development stages. Seen like slices of pie, now-installed US wind is hardly visible: 30 MW, or 0.1% of the 28 GW ahead, a tiny 12 MW in final approval. But a new 6 GW of coming US wind is advancing towards permit offtake stage, 22%. It's a big ocean; some 60% of the 28 GW pipeline or 17 GW, is still in earlier lease area/site control step. There's several years yet to go, but it is at least some small progress.

US states farthest along early 2021, all in Site Control/Permitting were Massachusetts with 8 GW to come; New Jersey 4 GW perhaps ahead; New York 3 GW; North Carolina 3 GW; and Virginia 2 GW. Only one State has offshore wind at final Construction; this is Virginia's 12 MW now energized. Overall, the US is 'progressing' far too slowly, many years to unfold.

Confoundingly of 11 States in wind pipeline 2021, all but 2: East Coast. Despite Pacific Ocean presenting great wind resources! Some on Texas Coast too. One may have guessed there'd already be tens of gigawatts - yet only California & Hawaii have potential projects, mere 1 GW in planning. Much still needed like submerged power cabling. That said BNEF raised its estimated US offshore wind projections by +70%, from 11 GW by 2030 estimated back in 2018 – to greater 19 GW by 2030 proffered just a year later in 2019. And again growing.

For Global Indexes NEX and OCEAN – and ECO too, there may be interesting changes in offshore wind technology ahead relevant possibly to all 3 themes. For the scope of change, consider first what's been seen in offshore wind prior to/up to 2019. Then what *may* come post-2021, next 5 years 2021–2025. Much change might be seen, especially in the latter years.

Up to 2019 global cumulative offshore wind capacity reached 27 GW. But it was concentrated in a few places: UK, Germany, China, Denmark, Belgium, Netherlands. Moreover in the year 2019, just 5 nations accounted for 99% of new installations. Fast-growing China then led, swiftly adding nearly half (47%) of all the new global capacity in that year 2019.

A decade before, UK steadier growth had built the most installed offshore wind: 8 GW. Germany started later, and grew faster. China most recently, has had the sharpest ramp. Taking China, Europe & US, the world pipeline for all estimated offshore wind 1990 to 2038 goes from 27 GW operating 2020 – fast up to 230 GW projected ahead. China especially goes from just 10 GW wind in construction 2019, to soon leading the globe in offshore wind.

More granular facts get interesting; starting about 2024, the US may be a significant player. Here what grows significant are *floating* offshore wind platforms. US offshore wind attached to seafloor is entirely still East Coast, where a trailing edge margin means shallow waters. Deep US West Coast waters would mean operating perhaps in waters 1,000 meters or more.

Hence floating platforms, tethered ahead to seafloor may be a game-changer for ocean wind. Here the US may actually hold its own, significant change vs. Europe - and vs. Asia. In this new arena Asia - and US - & Europe - each make up about 1/3rd of the floating pipeline. A 25 MW test, Float Atlantic in Europe became operational in 2020 and proved the potential. It's very early days, yet Asia's leadership for a floating wind pipeline isn't China, nor Japan - but instead South Korea (1.7 GW) and Taiwan (1 GW). Also, UK, France and Spain have proposed most so far in Europe, and each of them already have operating floating test units.

A startling change is US ambitions, with 2.3 GW proposed pipeline. Here, Castle Wind off California is large at 1 GW; it might go in deep 900 meter waters. Interestingly all 7 proposed US projects use a steel semi-submersible platform. That's the easiest of various 3 main types of floating substructures. With a shallow draft they may be built by docks, towed out without heavy lift install vessels. That design now makes up 89% of substructures where the choice is made. And note for fixed wind, new huge 12-15 MW wind turbines, the number of vessels able to install nacelle mass >500 tonnes, hub height >100 meters & rotor diameter 200 meters(!) becomes vanishingly small. Specialized vessels (WTIVs) for offshore wind must be constructed for monopile wind affixed to seafloor; for jackup depths >50 meters. New vessels & port infrastructure is needed from scratch for hopeful growth of fixed & floating wind ahead.

Crucial to all offshore wind is pricing. Like solar, it is falling dramatically – with onshore wind costing modestly more than solar. Yet these renewables are all highly favorable - vs. costly nuclear, coal, gas – as old energy is unable to compete on price declines of their own.

In Europe, levelized offshore wind costs already fell from about 18 cents/kWh, to 9 cents. US offshore wind was around 9 cents in 2020; Mayflower Wind off Massachusetts in US is one the world's best-priced ocean wind projects at 6.9 cents, plus US tax changes 2021 made it better. Floating wind too, looks likely to fall to about 6 cents in the years ahead as well.

Once offshore wind better such toe-hold, regulatory issues better understood, fixed & floating wind may have far greater presence. Late 2020, America's 1st offshore floating wind project began. Meanwhile, in China, it is seeing much faster growth in its offshore wind. Solar too, is advancing there. China confounded early 2020 expectations for slowing solar manufacturing due to Covid: instead, its solar manufacturing gained speed. First half of 2020 China had produced 59 GW of solar panels, that was about 15% greater than in 1H 2019.

Europe has had decarbonizing gains in solar & wind. First half 2020 the EU made more power renewably – than from fossil fuels. Note nations there with **more* renewables - have enjoyed **cheaper** electricity prices – obliterating a 'higher cost' argument oft leveled against green. Despite critics' dings that renewables 'suffer' from intermittency, there was strong electricity supply 2020 & Q1 2021 in Europe (unlike big power interruptions in California, Texas).

1st half 2020 among 27 EU members, wind, solar, hydro & bioenergy made 40% of electricity overall – fossil fuels, 34%. Latter April to June, renewables made 44%. Austria then made 93% mainly using its hydro from renewables, Portugal made 67%, and Germany 54%.

In Denmark wind & solar alone made 64% of its electricity; Ireland 49%; and Germany 42%. In absolute terms, Germany has continued building its enormous growing fleet of renewables - and achieving big moves from coal. Its wholesale electricity prices are *down* to near just 3 cents per kilowatt/hour (kWh). By contrast at neighboring coal-dependent Poland, the wholesale electricity costs from its dirty coal are higher - more near 5 cents kWh.

So Wind & solar are growing – from one perspective. From 13% EU electricity in 2016, to 22% 1H 2020. Yet from more pressing perspective there's a long, long way to go given CO_2. Greater renewables, more flexibility, ability to export excess power, transmission, batteries All are Faster Needed! US has made less progress. Renewables just 18% of US electricity generated 2019, fossils 62%. Recall again how the European nations with *more* renewables, oft see *lower* *Wholesale* electricity costs, rewarding green areas. The EU chooses to add more Taxes, rendering its Retail power costs higher than the US – but that's a differing matter.

In a surprise late 2020 the US House/Senate extended a 26% ITC tax credit by 2 years for solar & fuel cells; PTC of $0.15/kWh for wind 1 year. Hoped for 'in lieu' cash from Treasury didn't materialize. Batteries alone wouldn't yet get a credit unless bundled with solar. Nor was a $7,500 credit re-extended for GM or Tesla cars. But 2021 looks to be better. In 2020, consolidations continued, solar went on maturing. One big residential solar installer bought another, for hopeful economies. A China-based solar maker sought dual equity listings on US & on China Exchanges, another in 2020 moved towards dual listings, then a 3rd too. All with intent to unlock low-cost capital for faster growth; those were 'grown-ups' moves in solar – a commodity business where low price is all. A long way from few small solar listings possible for ECO and for global new energy NEX we well recall back in 2006 or 2007, even 2010.

Data and facts reveal an energy landscape changing so fast, it's challenging 'all we know' about energy. Clean energy overtaking fossil fuels on price. Even more compellingly, clean energy – *Without Any Subsidies – becoming more affordable than fossil fuels & nuclear!!* Economics more than anything, changes everything. Carbon awareness is still lacking. Economics is thus vital – and trending smartly. Especially given coal, oil, and nuclear shrivel without their more highly-needed subsidies. Not our Grandparent's energy world.

While staid coal prices have hovered for years - renewables (and gas) got more affordable – thus renewables plus natural gas suddenly became leaders. Especially on 2020 demand loss: Utilities turned 1st to their lowest-cost sources. Those were renewables on free sun & wind - plus natural gas. Coal's out in the cold. Gas is big, capable, flexible. Fracking brought it fuel price collapse - some price spikes seen since in 2021. Relatively visible equity gains in oil, gas in 2021 from off of 2020 lows have been 'cute' - but lacked prospects for sustainable decades of strong returns ahead – especially versus clean decarbonization themes today.

So green themes flowered lately, key cases like never before. Consider for instance Electric Vehicles. Here, Carnot's Limit helps explain why new electric cars are destined to outdo old-school oily 'gassers'. Today's very best gassers are inefficient, sadly archaic at very best. Their diesel or gasoline heat engines in cars & trucks only let them reach theoretical bests near 40% efficiencies. More typical car heat engines sadly just 20% efficient(!). Gigantic heavy SUVs anchored further by lacking-in-torque heat engines, are relegated to be so very slow and suffer from often silly model differentiation like on the number of cupholders.

Not-surprisingly early 2020s enjoyed an outpouring of fresh-faced electric vehicles globally. Equity markets long under-appreciated what lithium-ion batteries lashed to efficient (>90%) torquey AC motors could do, improving swiftly yet on better, cheaper batteries. Past 20 years has been non-linear enhancement. So as a consequence, there's oft been much volatility (up) – with a strong non-correlation between EV equity pure plays - vs. the broader markets.

Or consider sadly, big thermal power plants today – vs. what Mr. Carnot observed in 1800s. Today's sad natural gas turbine steam plants reach efficiencies in the 40s%. 'Cutting-edge' combined cycle gas power plants bump up against theoretical efficiencies in 60s%. How silly! How ineffective, what plainly dottery way to achieve needed electric power generation!

As we learned 100 years ago from Mr. Einstein, and in later quantum work, flat to increasing entropy (disorder) gives us Time – a second law of thermodynamics – and Time moves one direction (centered on basic C, velocity of light). What's notable is that on time's arrow, given entropy, it means that what we've learned in past, generally isn't unlearned.

In work for which Mr. Einstein earned his Nobel Prize, we saw light acts as wave + particle in discrete quanta; we've learned to harness photons in solar panels made ever better in 50+ years. On research in wavelengths, new solar panels may enjoy maximum efficiency ceilings far higher still, vs. silly heat engines. And since fuel (sunlight) is free, doesn't much matter! On time's arrow, gifted by entropy, we've learned well how to harness Mr. Sun's free photon 'packets' at ever-lower, better costs per watt. Unlike fossil fuels, there's a learning curve here that is profoundly pushing only-downwards on solar costs, often very rapidly.

It goes deeper. For centuries Newtonian Physics well enough explained 99.99% of world around us. We built entire industries, societies, made fortunes based around it. Nothing in our own human-made world could approach C, velocity of light. And yet approximations for how the world really worked that served well enough – were actually quite, quite wrong.

In a metaphor, fossil fuels served us for centuries. We 'learned' in their limits, constraints that we still accept today. Yet much we 'know' about energy is actually wrong. For instance, we've long accepted that electricity generation – has to closely match demand. Given great costs of power plants, for avoiding waste we'd never build something that's 'too big'.

Yet like Newtonian Physics, what's long 'known' misleads. Making semiconductors nano-scale, rockets into space, we've learned quantum strangeness - and made use of that. Smallest scale to Earth around us, space/time, gravity are different from common Newtonian suppositions. Better still, weirdly different Quantum theory at first so bizarre to us, has increasingly explained reality in new understanding – that weirdness being usefully-harnessed.

It's essential eg in cell phones, GPS, Lasers, MRI Imaging, LEDs. Even ubiquitous computers rely on quantum effects not-heretofore known prior centuries. Revolutionary ideas like the superposition of objects in two or more states at the same time. An Einstein-Podoleky-Rosen paradox where 2 entangled particles though far distant from one another seem linked in real-time so appearing to share information inconceivably at faster than light. (Entanglement and Copenhagen interpretation have solved that latter thorny quantum puzzle). We've progressed as we learn. Space isn't a complete vacuum; virtual particles may briefly snap in and out of existence. Photons act in 4 possible ways, 2 actually observed, other 2 options simply cancelling each other out – in wonderful Feynman Rules of probability weirdly, profoundly deterministic - in what's called the Hong-Ou-Mandel effect. (If interested, see e.g. the Quantum Centre at the UK University of Sheffield, https://www.youtube.com/watch?v=ld2r2IMt4vg).

A point being that in clean energy too, we're learning bizarre novelties, some at first strange. Novel ideas that might be embraced ahead in modern energy technologies – given *this is how the world actually works.* A few sacred old ideas maybe thrown out. It's progress! Jarring yes, but leverage in how we can advance – including new energy innovation. Especially as we're moving ever-nearer towards zero CO_2 and softer, more natural energy paths.

Lashing lithium batteries to AC motors, new electric cars were one recent example of this. So too, solar panels. Or a novel way of thinking about solar energy: to far Oversize solar farms may actually save money. This might seem weirdly brain-spinning idea, oversizing solar.

Yet consider that if solar PV becomes super-low cost, over-sizing may more than compensate vs. more costly added storage. 'Wasting' that solar – given the fuel is free – may have not be the issue or penalty we felt in over-sizing any coal or gas plant. Moreover that solar power may in time be shared widely via grid, or surplus be green H_2. Ever over-size a nuclear plant? 'Fuggetabouddit'!! That would be so costly, inflexible, those vexed wastes stored for centuries or millennia, that it's been cul-de-sac of an idea for any fossil fuels or nuclear.

Yet intriguing, if solar grows super inexpensive. Electricity usually must be used immediately when generated – so we've learned to avoid it. But in a new world, to possibly waste some solar via overcapacity on sunniest days, might obviate need for (costlier) storage. Nothing like oversupplying dirty-brown electrons which has carried all kinds of downsides. If free and abundant renewable electricity is provided by intermittency, then the green H_2 & inefficient fuel cells once staggeringly 'foolish' 20 years ago, might just begin to make some sense.

Leaving these academic musings aside, let's return to decarbonizing now. ECO/NEX/OCEAN saw equity gains in 2020 - dirty oil, gas & coal flailed by comparison. Clean energy clearly 'beat' brown energy then. In a recent turn, clean energy bested major bogeys too in 2020. Yet solar, even with all its green credentials, like anything else may suffer unneeded potential undesirable risks. We'll address sadly a political risk next, that's so unnecessary of late; a possibility of unneeded/unwanted forced labor within one unique region.

An issue lately brought to light is allegations of forced labor in Xinjiang Uighur Autonomous Region of desert in northwestern China. Of note here, Xinjiang as a major source for silicon used in manufacturing solar panels: processed polysilicon is used in solar made worldwide, including in the US. 'Poly' prices have plummeted over many years, to where it's become a cheap commodity. 3/4s of 2021 global PV polysilicon supply came from China – and of that coming from China, fully >½ of it was coming in 2020 from that unique Xinjiang region.

There's currently no evidence that any forced labor is involved in silicon manufacturing. But, this matter is clearly grave enough to be looked at very carefully; it's extremely serious.

5 companies were lately noted by a consulting firm for having Xinjiang-region supplied content. 3 aren't in any of our Indexes. But 2 do have US listed shares and they are widely found in many US and global clean energy Indexes including ECO & NEX – they also are in a great many active funds. One is in 135 mutual funds, the other in 165 mutual funds. Indeed, one is a leading component by weight in a separate good global clean energy Index (not ours) & tracker. So this issue warrants attention. (None of those 5 are in the OCEAN Index).

What's tough is there's no independent confirmation, one way or another. Solar companies themselves strongly deny any connection. Plus there's zero need for forced labor. In the US, the Solar Energy Industries Assn. is seeking to ensure there's no forced labor any part of the solar chain. SEIA aims for a protocol to ensure zero raw materials onwards contain it.

Nonetheless one company named was downgraded to a Neutral rating on that possibility; again no evidence, but without clarity, the US Congress or Executive may soon act given this gravity. At present the 2 solar firms emphatically state they condemn forced labor, do not use it in their factories; it is called "morally repugnant", and that they have "zero-tolerance" for forced labor both in their Xinjiang factories and across the supply chain. While the US has not (yet) 'called out' the solar manufacturers in Xinjiang, clearly the notion of even-possible abusive labor rightly raises warning flags. That Report's source was right to point global attention here. Just the possibility of it, has to be of great concern.

Side-note separate issue, China's mining Rare Earth minerals was raised by that source elsewhere – but for far different reasons. (Besides too mining's myriad ecological challenges). Instead, given the vital role Rare Earth's have across clean energy's spectrum in solar, wind, electric vehicles, batteries etc, another of its reports looks at dominance of China in mining strategic rare Earths. The US imports over 80% of needed rare Earths from China including for defense systems. That dominance could well provide China great tactical or strategic advantages and leverage as clean new energy innovation gains steam. It also greatly impacts the oceans, http://fullmeasure.news/news/shows/the-battle-below

In conclusion, for Xinjiang the burden of proof for its products (solar, wind, even textiles etc) – may be that a Non-existence of forced labor must be shown. Clearly if evidence arises, that's enough to lead to changes in an Index. It's an unnecessary, unwanted risk, an issue to be watched closely, with moral implications as well. It's possible that all suppliers and all products from Xinjiang may face a burden of proving No forced labor. Some firms may relocate away from that cheap electricity region. Others may move their listings off US exchanges, onto China Exchanges only. Perhaps a new 3rd party Independent Audit Verification: there's no call for such unacceptable practices to ever seep into a solar supply chain.

Moving on let's see where PV poly solar supply more generally stands 2021. We've cited at times reports as from Raymond James, Roth, Piper, etc; this time we'll utilize a good recent report from Roth Capital on: 'Sustainability, The Solar Snapshot: Some Perspective on Module Input Cost Inflation' (2021) – along with a good 2nd Roth Report from March 2021.

They note rising solar demand & capacity constraints are lately pushing poly prices upwards. Q3/Q4 2020, poly was priced at $10.68/kg, then $11.52/kg. Poly then went past RMB 100/kg (1 Renminbi=$0.15 USD) to $14/kg ex-VAT. They saw a low probability risk that solar poly reached 150 RMB Spring 2021; it hit RMB 120/kg. So wafer suppliers needing to ensure enough poly supply, turn to longer term contracts. A major supplier was almost fully booked through 2022, demand heavy into 2023, 2024. Raising added capital via a China (STAR) listing in 2021, it may add capacity of 40, 80, or 100 MT. Given demand strong, their costs flat to down a bit latter 2021, there's scope maybe for margin expansion. Growth might occur in Inner Mongolia & Yunnan; if prices rise quickly, that draws in idled Tier 2 suppliers. Generally, 1st half 2021 saw rising demand for PV, and pricier solar glass, silver, freight too. US Utility scale solar pricing was expected at around 25-27 cents/watt; closer to 29 cents/watt in 2nd half 2021.

A solar situation 10 years ago was so different! Then, the pricing in 2010 for *finished* modules was near $2.00/watt. Costs have dropped so hard; from that $2.00/watt for modules in 2010 - falling last 10 years to just 0.20/watt by 2021! Poly commonly is a key input in solar panels so its costs are critical. PV poly in 2010 had cost some $55/kg, that spiked some on a shortage in 2011 going to $80/kg. But after that, it mainly has dropped considerably lower. By early 2021 poly was down to around $11/kg. Perhaps brief rises ahead at times on demand, after $10/kg in 2020 – but it's still far less costly nowadays, allowing much cheaper solar.

Back when poly was very costly, different materials and designs were tried to avoid it. Over time poly supply re-located to China, lowest-cost regions co-locating with PV manufacturers. Increasingly too, PV became an automated process - especially panel manufacturing. In future poly & solar makers may co-locate say Europe, or North Africa, or Middle East. On automated processes, a renewables-powered Middle East could export say Green Hydrogen, zero-carbon green ammonia, methanol. PV too made from super-abundant sunshine and sands. Making it again a leading energy exporter worldwide - not of oil – but of zero-CO_2 green power!

By 2021, much world poly supply came from Northwestern China. It wasn't always thus. Here we'll look back, at excerpts from our 2005 WilderHill ECO Index Report detailing notable poly shortages then, then as surplus polysilicon sourced from US semiconductor manufacturing: https://wildershares.com/pdf/Quarterly%20Report.2005%20Q1Q2.pdf

> *Moving to solar, which is a major component of the WilderHill Clean Energy Index (ECO), there's some interesting news here. In the course of Q1/Q2 2005 (especially before, in Q4 2004) the market capitalization of Index component Evergreen Solar (ESLR) rose notably. Some general and technical factors may have contributed to this. One cause is their sales increased rather a lot, especially in Europe (ESLR sells 2/3 of its modules in Europe) – and Evergreen simply participated in this growth like other pure- play solar PV makers.*
>
> *A 2nd factor unique to Evergreen, is that its special string ribbon process makes laser-cut silicon wafers from Gemini II furnaces half thickness of competitors, under 150 micrometers. A result is only 1/3 as much silicon needed for their PV wafers processed into solar cells and panels. ESLR estimates they can produce 2x as many wafers/ton of silicon, as competitors.*

This is an issue in the solar industry globally now, because of shortages in the silicon that's needed to grow new facilities and production lines. Like when there's an absence of the tax credit for wind power, or when poor transmission capacity slows wind power growth, the lack of silicon has been an unneeded obstacle that's now hindering PV.

With ribbon capability and desiring to open a European facility, ESLR contemplated whether to build a factory there, or to find a partner in Germany. It chose the latter. In Q1/Q2 they announced a new joint venture with a large German solar PV maker Q-Cells AG. This potentially combines scaling-up skills, and module efficiencies (suited to high latitude sites) of Q-Cells, with more efficient silicon manufacturing of ESLR.

Interestingly for the Index, ESLR share price had already risen fast and reached such weight (6%) in a Quarter within ECO, there was some concern an inevitable regression to the mean and price correction at ESLR, may unduly impact the whole Index. However this highlights another facet to Indexing: all components must be left to reach their own level, without Index managers trying to guess an exact time to sell and so reduce position in that stock. Indeed rebalancing ECO each Quarter and a 4% cap helps prevent undue influence from any individual stock, which might otherwise reach double- digit weight in the Index. Ultimately, passive-management tends to perform well.

In our case, a different frustration felt in 2004 & 2005 was over an inability to include stocks listed outside the U.S., particularly German solar PV makers. Because ECO Index Rules require component stocks be listed on major U.S. markets (NYSE, AMEX, NASDAQ) and adequate volume, we were prevented from holding them a time German solar was thriving. For instance Solar World AG is expanding wafer capacity from 120 MW to 150 MW. Solar-Fabrik AG went from 17 MW, to 40 MW of capacity. Alfasolar Gmbh was 4.5 MW in 2004 and aims to expand to 20 MW (if it gets silicon supply). Heckert Solar GmbH made 5 MW in 2004, and aims to grow to 2x that in 2005 (with enough silicon). Well-known Q-Cells grew from 48 MW of capacity in 2003, to 150 MW capacity 2004 (its production too was limited by silicon supply). Despite shortages, stock performance of European PV makers was remarkable 2004-2005.

*Silicon shortage *may* possibly mean some opportunity. One component, Energy Conversion Devices (ENER) makes thin-film solar PV modules made of amorphous silicon that allows more panels despite shortages faced by others (but overall profitability has been an issue); their subsidiary, United Solar Ovonics, seeks to expand capacity. As noted, ESLR is robustly growing; they're planning 40-50 MW more capacity with Q-Cells venture to perhaps start producing 2006. A Belgian company Photovoltech makes both regular cells and fascinating cells with backside-contacts only; this importantly allows high efficiencies (>17%) since contacts on the front of panels are absent. That permits more sunlight/photons to directly reach each cell. For 2006, they'd like to increase their PV manufacturing capacity to 75-85 MW.*

Silicon shortages now vexing PV makers may be rather short-lived, perhaps a few years. The PV industry normally buys surplus silicon from semi manufacturers: they produce roughly 30,000 tonnes/year. In 2004, however, 1/3 of supply went into producing a surprising 1 GW of solar PV. Tight markets weren't foreseen, by the few producers of high-purity-grade silicon. This situation is a bit ironic since silicon is widely on Earth, and surely can be remedied ….

That, was then: back in 2005. At any rate it is perhaps interesting to recall that poly/PV situation, back 15+ years ago. Things are very different start of 2020s. Having recalled that time in energy, let's now look forward on various fronts of the coming 2020s next.

We avoid politics. So just a side-note that zero hope had existed 2020 for US green energy stimulus. 180 lawmakers had sent a Letter to House Leadership asking for direct relief given 600,000 clean energy jobs lost in pandemic. But the calculus for any direct green funding – even far short of that being vetted in Europe – wasn't aligned in 2020. Senate leadership was squarely opposed, plus this was a non-starter in the White House. But that - was then.

Musing in 2021 on new dynamics, one little noticed but potential big change may happen soon in an Office of Information and Regulatory Affairs (OIRA) in OMB. On his first day 2021, the new President directed that OIRA reviews should now promote the: "public health and safety, economic growth, social welfare, racial justice, environmental stewardship, human dignity, equity, and the interests of future generations." Including environmental justice is very welcomed. Goes beyond a (blinkered) cost-benefit analysis that had allowed horrific pollution in communities of color; this is a step forward. Plus removes from fossil fuel interests' quiver, poisoned arrow of "externalities" that has long discounted/promoted pollution.

Backdrops changing too. We'd predicted back in March 2020 at start of Coronavirus, that a then beginning pandemic – could become endemic. Becoming background threat like the flu – maybe evolving in variants going ahead. Especially given places & people sans vaccination, acting as reservoirs, as well as an ongoing spread among mammals etc.

There's some positive change. From a politics that was anti-science, proven so wrong on Covid (and arguably climate). A more recent embrace of science is much the better for it. Public opinion polling strongly supporting new emphasis on facts. Including on climate change, where science-based perspectives are starting to become embraced. Change may yet go deeper; $2 trillion and more *might* be spent on climate solutions. Infrastructure improvements that are deeply green. US large utility-scale solar, for example, could early on grow >100 GW/year. Battery storage could fast grow >40 GW/year; in time approaching today's installed electric generating capacity. Maybe a world flowering of new green growth. A robust carbon tax may arguably be the simplest direct way to get there, though politics continues to get in the way. But countless obstacles are ahead. So think about very low hanging fruit.

Cheap batteries are a hardy perennial – lodestones to improve intermittent renewables & EVs. Battery capacity may soon go from <300 Wh/kg to >400 Wh/kg. "Made in U.S.A." can & must = good-paying jobs. Solar manufacturing capacity ought to fast go to the 100s+ of GW/yr. Scary climate scenarios show a striking need for some 7 *TW* of solar PV globally, fast.

So green stimulus is needed 2021 and there's precedent. 2009 ARRA boosted climate-friendly sectors by $90 billion of $800 billion. That helped triple U.S. solar/wind installs, grew U.S. clean energy jobs from a few hundred thousand, to 3+ million. In 2021 in Europe a Green Deal - and maybe carbon tax are being shaped. The 2020 US CARES Act had boosted carbon-heavy, older industries – a new package that's in focus April 2021 will potentially be far greener. Giving us great cost reductions, unlike in oil or coal. For as renewables *achieve cost declines, they hold onto & grow farther still;* they're stickier, sustainable and welcome.

In this decade, a laggard US *may* pivot towards carbon free grid, saving money to boot. It's now feasible! We'll look at freshening possibilities next. This *may* be a transformative decade in the US, in Europe, and Asia. Let's start with the US, to envision the possibilities by 2035. These lately go far, far beyond what even lately was thought possible.

Where is the US power grid now? What will it take to get to zero carbon? Let's take a look using recent 2019 data from the US Energy Information Administration.

Electricity generation in 2019 accounted for a large part (though not all) US CO_2 emissions; it made 4,127 terawatt/hours of electricity. Most of that power, 38% was made by natural gas plants; another 23% came from coal; 19% from nuclear; 7% from wind, 7% was hydropower; only about 2% came from solar, while 2% was from miscellaneous other sources.

As noted coal waned under Covid over 2020/2021. Given natural gas and renewables became cheapest and best power - an outsized reduction in CO_2 resulted just from simply shuttering some very polluting coal plants in US (and Europe). But that's been only a blip.

Numbers above show what a huge slog is ahead to get to a zero-CO_2 American grid. That said, on pure economics of it all, to start early/now & to go hard actually is the most profitable. Nuclear can't offer much help; unlike solar & wind each year getting cheaper & better – US nuclear instead is going up in price. Nuclear plants once built for 'just' <$7 or $8 billion each. Now, two ridiculously-costly plants going up in Georgia cost $25 billion+! Their inflexibility, once touted as an asset, instead has been flipped to be a liability vs. renewables.

Getting to US zero CO_2 here means eliminating in 15 years, 668 coal plants, and most of 6,080 gas-fired plants. While fast-ramping solar/wind, with 15% faceplate capacity – but making just 9% of US energy (2019) because they're intermittent on non-windy days, solar at night.

So we start 2020 from just 104 gigawatts wind power, just 36 gigawatts of solar. Plus 12 GW more wind and another 16 GW solar built 2021. At such a recent slow rate of growth, with 50% faceplate capacities, we would not get to achieving US 100% renewables until 2070.

That's far, far too late given CO_2. So instead, triple the 2021 growth in renewables. Back of napkin we'd need to replace 791 gigawatts of fossil power generation, to be 100% clean by 2035. For rough $ cost estimate, a new 1,500 MW (1.5 GW) of wind power in Oklahoma costs $2 billion. That leads to a figure of about $1 trillion to replace US fossil fuel power – something over twice that to account for the intermittency (resolved too by new storage).

Renewables are getting constantly cheaper – so this actual figure likely less. And renewables enjoy free fuel, so as next several pages show – this actually leads to an outcome of Americans paying *less* for their power in 2035 – than they did 2021! From there savings snowball. Factor in the reduced hospitalizations, cleaner air, better health - and it gets only better!

It's been assumed this requires (an unwanted) top-down *diktat* from government. But fast solar and wind growth in Texas – vs. slower rates in more heavily-regulated California - suggests opening markets to competition can spur on renewables. After all, it's estimated US solar and wind can naturally make up some 55% by 2035 just based on their better price alone. Adding wonkier mechanisms, like tech-neutral 'clean tax cuts' – 'Clean Asset Bonds & Loans', or a carbon tax - can doubtless help get us to 100% with not much help needed.

Because this seems to (and does) fly in face of what we've 'known' in energy last half-century - like that intermittency is a grave problem vs firm power, and solar/wind are too costly – we'll take some pages ahead to outline a different US scenario next 15 years.

1st assume the science is correct. If so, we all must act far, far faster – to cut CO_2 emissions in ½ by 2030, to hit 'only' 1.5 degrees C ravaging warming. Yet we're nowhere near 50% cuts! Actual global trends from 2021 still go weakly languidly decades before really decarbonizing. That gives us much too hot a world, as genuine zero-CO_2 goals are realized far too late.

If is action is desired soon, note plunging solar, wind, & energy storage costs *immediately changes everything*. A US grid with 90% (in our case, 100%) less CO_2 is not only feasible, it can be reached in 15 years – on *cheaper* electricity. Competing analyses had differed on last pieces of 100% zero-carbon puzzle. Yet models often *agreed* on 90% – (we're using 100% as a goal), so a 2020 Report blueprinting how to get there from U.C. Berkeley is important. Also a December 2020 Report, Larson et al, 'Net-Zero America: Potential Pathways, Infrastructure and Impacts' by the Andlinger Center and High Meadows Environmental Institute. With more Reports coming. But we'll cite here this 2020 Report from U.C. Berkeley.

It shows how carbon-free can be achieved swiftly in 15 years to 2035. Retail electricity costs in 2035 should be 10% less for consumers than today. Past assumptions thus got it wrong on how hard it is (can be done) - and how costly (saves money) on a cleaner U.S. path.

Remarkably zero CO_2 is a 'no-regrets' path sensible in its own right, better than status-quo, No New Policy. A "2035 Report: Plummeting Solar, Wind, and Battery Costs Can Accelerate Our Clean Electricity Future" (2020), https://www.2035report.com – offers new conclusions that interestingly differ sharply from reports of just 8-10 years ago. Those had once foreseen carbon-free electricity as adding many new costs. Instead, it now portrays how today:

> "Given the plummeting costs of clean energy technologies, the United States could reach 90 percent zero-carbon electricity by 2035, maintain reliability, while *lowering* customer electricity bills from today's levels, on the path to 100 percent zero-carbon by 2045. To reach 90 percent, this infrastructure build-out would productively put about $1.7 trillion dollars in investment to use over the next 15 years, supporting about 530,000 more jobs each year and avoiding at least $1.2 trillion in cumulative health and environmental damages. And it would reduce economy-wide greenhouse gas emissions (GHGs) by 27 percent by 2035.
>
> Building a reliable 90 percent zero carbon electricity system is a huge opportunity for economic recovery – a fantastic way to invest in a healthier economy and support new jobs, without raising electricity bills. But America's current electricity policy framework is not on track to deliver this economic opportunity."

The study allows using all known 'zero-carbon' generation options. As expected, a focus is on cleanest: solar, wind, energy storage. Yet a baseload with hydro, geothermal, biomass, and even nuclear may be permitted. (And in theory, fossil fuel with carbon capture/ sequestration – but least-cost models do not include any new nuclear, or sequestration). In contrast to this Zero Carbon path, the No New Policy merely is state & federal trends status-quo. That latter model reaches only 55% clean by 2035 so would fall way far short of what's required. Crucially this better clean plan means reliable, firm power fully dispatchable, as needed. It meets all demands in every hour of each day. There's no compromise on performance.

To reach a zero-carbon target by 2035, annual U.S. deployment of U.S. solar & wind has to first double each year in 2020s, then triple historical bests early 2030s. This rises up hard from roughly 15 GW of solar installed 2016, and from a 13 GW of wind installed in 2012.

Big US energy generation growth has happened; natural gas grew 65 GW in 2002. Now, what's needed, has changed: *energy storage* is the 3rd leg of a crucial triad to solve intermittency of renewables: storage deployment needs to grow by 25% each year. Starting from a measly 523 megawatts in 2019, it should grow immensely through the 2020s to 2035.

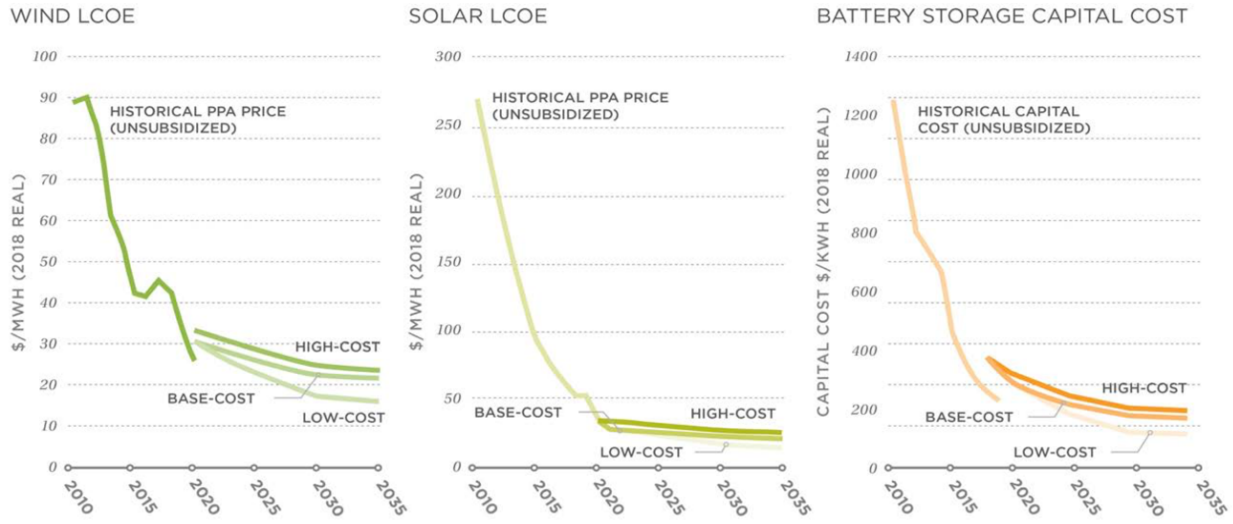
Happily, only modest new transmission or spur lines are needed to interconnect expanding clean power, so a less pressing need for costly, slow-to-build intergenerational lines. No tough overturning grid infrastructure, requiring longer lead times. But what changes, is composition of both generation and storage over this now here & fast-arriving 15 years.

First off, all U.S. coal plants will need to be permanently shuttered by 2035 under this plan. Places like California, it's already done. Extant coal elsewhere generally has been running for many years now, so 15 added years in this Plan leaves time to recoup capital investments. It is doubtful coal owners would want to burn much longer, given the higher costs and liabilities vs. clean power – but recouping those costs is addressed in this Report.

Second, *no new* U.S. natural gas fired plants are built. Existing gas plants and those going up now can remain; they'll play a decreasing role though in grid stability as new storage grows. Again, capital investments are recouped this period – ending with a zero-carbon grid. Currently there's about 540 GW of gas capacity operating in the U.S.; in this Plan 361 GW of that dispatchable natural gas is kept to 2035, another 90 GW in reserve for reliability. Natural gas meanwhile is used for only generally 10% of generation – going down to zero.

As gas-plants pay for fuel, the reduction helps achieve wholesale electricity costs 2035, *10% less* than now. In low solar & wind generation periods, gas does have a key backup role – but utilization rates of only 10%. The Plan suggests a federal 'clean' (carbon-free) standard of 55% by 2025, 75% by 2030, 90% by 2035; and 100% by 2045. In past when renewables were much more costly, than the fossil fuels, such standard was not yet embraced.

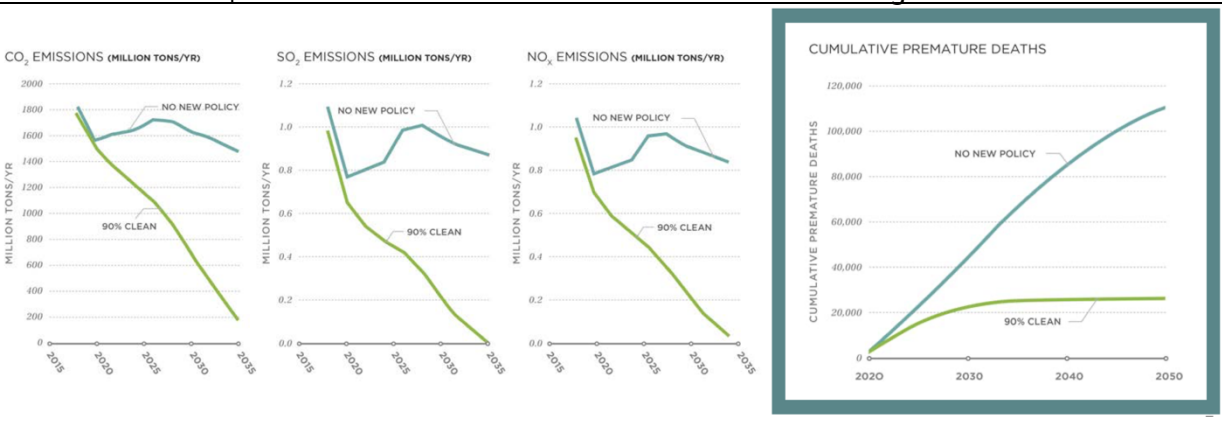
<u>Dramatic Declines in Costs Have Arrived 2020 Far Sooner than Expected:</u>



Source: 2035 Report: *Plummeting Solar, Wind, and Battery Costs Can Accelerate our Clean Electricity Future*, slides (June 2020).

Relative to a currently trending status-quo No New Policy, this 2035 Plan would instead slash CO_2 emissions from energy generation by a whopping 88% by 2035. As a direct human health consideration, that reduces human exposure to the polluting fine particulates (PM 2.5) and Nitrogen Oxides (NOX) & Sulfur Dioxides (SOX) emissions by 96% and 99% respectively. The clean Plan separately also saves over $1 Trillion in health and environmental costs(!).

2035 Plan Avoids $1 Trillion in Human Health + Environmental Damages vs. Business as Usual:



Source: 2035 Report: *Plummeting Solar, Wind, and Battery Costs Can Accelerate our Clean Electricity Future*, slides (June 2020).

So 3 fundamental points are: it's *feasible, *saves money, *and lowers climate risks to boot. Getting there means constructing 70 GW of new solar & wind capacity a year on average, for 1,100 GW total by 2035. Contrary to conventional wisdom, renewables can go in most of the country. The public may assume solar needs warmest climates, but in fact solar power does quite well thank you in freezing temps – working even say, at Poles or literally in space.

Electricity in this model is made by solar for less than 3.5 cents per kilowatt/hour (kWh) in the places shown here in yellow/green: thus most of the U.S. Wind power similarly is made at less than 3.5 cents kWh in much of the country, shared widely via grid etc or stored. Such zero-carbon renewable energy prices are, remarkably, less than any of fossil fuels. (And one wonders in 2021, if even this projection is off; 2035 renewables being much cheaper!)

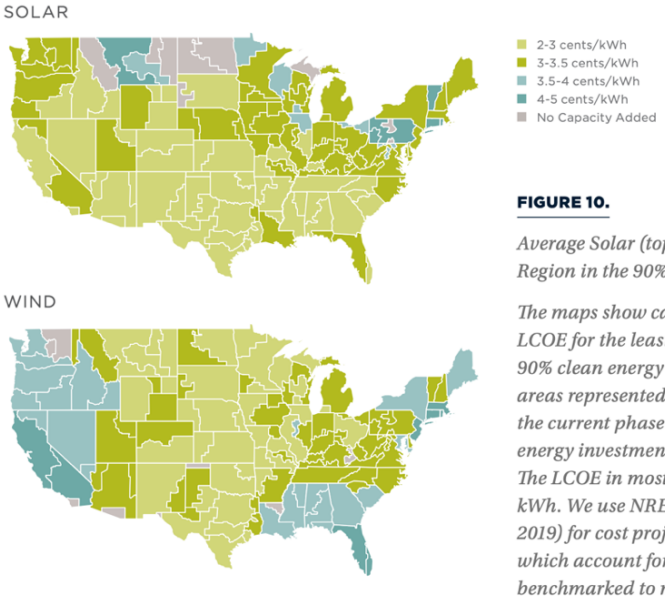


FIGURE 10.

Average Solar (top) and Wind (bottom) LCOE by Region in the 90% Clean Case in 2035

The maps show capacity-weighted average LCOE for the least-cost portfolio to meet the 90% clean energy target for the 134 balancing areas represented in ReEDS. LCOE includes the current phase-out of the federal renewable energy investment and production tax credits. The LCOE in most zones is lower than 3.5 cents/kWh. We use NREL's 2019 ATB Mid-Case (NREL 2019) for cost projections with some modifications, which account for the cost reductions already benchmarked to recent PPA pricing.

Source: 2035 Report: *Plummeting Solar, Wind, and Battery Costs Can Accelerate our Clean Electricity Future.* (June 2020).

Relative to a No New Policy case, this Clean Plan can create 500,000 new jobs/per year. From 2020 to 2035 this is a cumulative 29 million job-years. Many new jobs can & should be located near closing fossil fuel power plants; better jobs building solar, wind, storage going in where fossils shutter. Jobs to be front-loaded & prolific in construction - not so much later operations since neither fuels, nor much maintenance is required. It's surely crucial to assist local communities too once dependent on coal; shoring up pensions, healthcare, jobs & training programs in a move to green energy. A recent Survey (World Economic Forum, Fall 2020) laid out goals of a *Just Transition* - more than half favored working in renewables.

So if to keep below 'only' 1.5 degrees C warming in the 2018 IPCC Report, global emissions have to be halved by 2030. This green Plan alone isn't near enough; it means a 27% reduction in CO_2 from U.S. electricity generation. It doesn't give U.S. -50% by 2030, nor globally, but there'll be (one hopes) big reductions too in industry, buildings, etc. And under this Plan's glidepath, finishing up with a roughly 100% CO_2-free grid 2035 could be compelling.

Delivering *less-costly* power in 2035 that's also *cleaner* – wasn't regarded as feasible before - studies done a dozen years ago, even 8 years ago, didn't foresee how drastically solar, wind & storage costs would fall. Now that they have, modeling far-less-costly electric power may be undertaken. This lets us see how storage is key for non-firm nature of renewables.

Dependability in modeling for this Plan defined as at minimum meeting all power demand needs, every hour of the year. Hourly operations were simulated in America's power system over 60,000 hours. This was done for every hour, across 7 weather years. In each one of these hours, sufficient power was assessed as meeting all of the demand in every one of the 134 regional zones of the model. Ramp rates and minimum generation levels were included for more than 15,000 individual electricity generators, and 310 transmission lines.

A crucial ingredient in making all possible, is how far storage costs have dropped – and will do so ahead. 2035 models seminally found adding 600 GWh (150 GW for 4 hours) short-term battery storage, cost-effectively can achieve a 90% zero-carbon grid goal. 20% of daily electricity demand is then met by storage. (Limitations to computer models keep battery storage capabilities envisioned to this 4-hour window). Real world data in Appendixes, show how hard it had been 2020 for California to meet 50,000 MW of demand; storage is key.

Renewables are oft criticized, because their faceplate installed capacity must be built out to so many times what's needed - compared to firm, always-on power because of intermittency & variability. That's portrayed as liability vs. nuclear, coal, and natural gas. And means aiming for a huge 100-fold more PV faceplate capacity by 2035. But it's just a characteristic.

Over 7 weather years modeled, in normal conditions, wind, solar, battery storage generally, regularly provide 70% of annual generation; hydropower & nuclear provide 20%. But when there's very low generation by renewables solar/wind – and/or unusually very high demand, existing natural gas plants, hydro, and nuclear together with batteries can in cost-effective fashion interim compensate for mismatch and are able to meet needs. Natural gas-plants still will only contribute around 10% of annual electricity generation these bridge years.

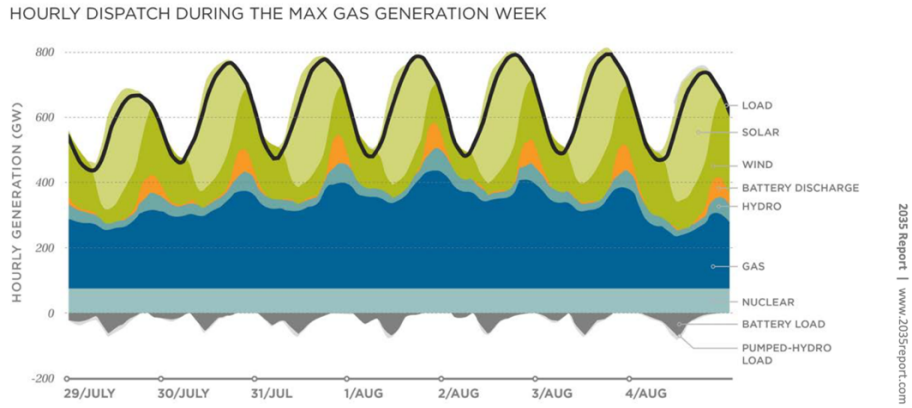
This Plan is so different from what's seen today, one may naturally ask: How is this done? We know solar is binary: every day it makes zero power all night long. So what happens as high demand in evening hours – overlaps with little wind – drastically curtailing output?

Let's start with a tough-case; no-solar evening hour, little wind as well. Total solar & wind generation are 94% below rated capacity, a mere puff of wind somewhere in grid - when an enormous 1,220 GW of rated capacity - is making only 75 GW actual generation.

That's 80% below annual average yearly output for combined solar/wind generation. Over 7 weather years modeled, such very toughest hour/s come on August 1st, with the largest gap between green power (solar, wind, storage) – and dirty generation to compensate.

8 pm Eastern time (evening, no wind or solar) the very greatest natural gas capacity needed to meet demand, would be 360 GW. Intermittent solar + wind are making little, despite far higher nameplate capacity. With total demand of 735 GW, immediate dispatch need is met partly by 2 other zero-carbon sources, hydropower & nuclear – and 80 GW battery discharge – and by noted by 360 GW of natural gas capacity. That's in a worst-case scenario.

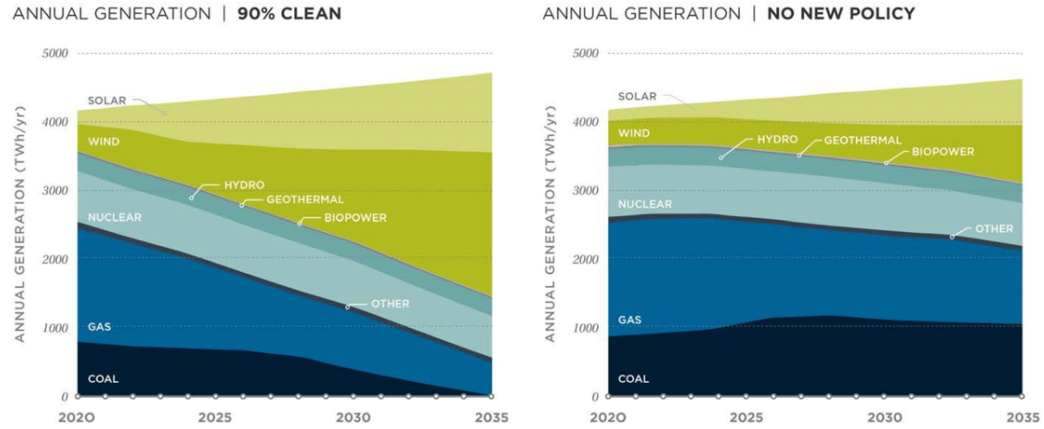
A Worst-Case Generation Period for Renewables: Still Moving Off of Fossil Fuels/Nuclear:



Source: 2035 Report: *Plummeting Solar, Wind, and Battery Costs Can Accelerate our Clean Electricity Future*, slides (June 2020).

Over 7 weather years, highest demand hour for natural gas baseload is always August, on least wind and at nighttime so zero solar. But gas-fired power needs over 300 GW are still kept here to below 45 hours per year. In sum, decarbonization progress is suddenly real.

A 2035 Grid Mainly Solar/Wind/Storage, at Less Cost – than Coal/Gas/and Nuclear:



Source: 2035 Report: *Plummeting Solar, Wind, and Battery Costs Can Accelerate our Clean Electricity Future*, slides (June 2020).

Capital required is some $1.7 Trillion of new clean energy investment. An enormous sum, though akin to COVID stimulus rounds, with enormous positive, lasting benefits.

A No-Regrets path not only lowers consumer electricity costs, it improves human health and reduces damages - *without* considering climate change. Especially if one considers impacts of say, sea-level rise over centuries and maybe millennia ahead – advantages can be compelling. (We briefly discuss some potential impacts of eg sea level rise ahead).

Economics of retiring all existing U.S. fossil fuel power plants 2035, is far less onerous than one might have guessed. A 2020 piece in Science, calculates more than 70% of 2019 extant fossil fuel plants will have reached their end of lifetimes before 2035, see Grubert, "Fossil Electricity Retirement Deadlines for a Just Transition" Science 1171 (Dec. 4, 2020).

So a tired argument that clean is too costly, on stranded assets of coal and gas plants that have not yet recouped all their sunk costs – is much less relevant. And from 2021, no fossil plants need to be built anyway in light of cheaper storage + clean renewables.

Given renewables' intermittency and great range of outputs, there's another side to this coin: they at times generate Far MORE power than immediately usable. At times electric power prices will go Negative. *It's not a disaster for clean energy - like it was for fossil fuels* when oil prices went negative – everything possible then done to get oil prices back up 2020. Instead, it's here a *feature* of the clean renewables system – one that really ought to be taken advantage of. Happily there's many ways to do so ahead. Batteries sensible & on track: maybe soon single-crystal cathodes, perhaps silicon nanowire anodes, vanadium flow etc.

A 2035 Plan gets so much solar & wind built, 14% 'surplus' renewable power is curtailed/ shut at times. Consider then it being stored in so many new ways. Hydrogen (H_2) for instance. That *still requires breakthroughs* to be cost-effective. Physics presupposes if one made electricity, used immediately, makes little sense to lose efficiency via electrolysis to convert water into hydrogen for long-term storage. And one incurs further loses again, converting hydrogen or green ammonia/methanol back into electricity later via fuel cells, or combusting it.

But a unique situation may present itself: free green electricity that alters this equation. If sun shining & wind turbines spinning offer excess power, it must be used or sadly curtailed as prices go negative. This is a case for green H_2 made renewably, no CO_2. Clean zero-carbon hydrogen - unlike H_2 from natural gas/CH_4 is costly, yet has been mused about for decades. For example, http://h2fuelcells.org; or in a piece from 20+ years ago, see e.g. R. Wilder, 'We Need Clean Hydrogen Soon'. Engineering News Record. 244/59 (May 8, 2000); also: Wilder, 'Develop Eco-Industrial Parks'. ENR (June 7, 1999). In Europe, standard dirty 'grey' H_2 from gas may cost around $1.5/kilo, while far better clean green H_2 might cost more than 3, 4, 5 times that. Plus vast hype about hydrogen has clearly spiked up of late in 2021.

Hydrogen is fiendishly difficult to handle, it's unwieldy, an uneconomic energy carrier, a tiny molecule vexing to store, transport, embrittling steel, and it is now tied to dirty fuels. Pile uneconomic H_2 atop uneconomic fuel cells, especially if solar & wind are now least-cost power - and no wonder many aptly call these 'fool cells" – and makes a case too for a passive basket, like an Index. So there's been hype about green H_2, as energy carrier that's a ways off. But… if green electricity is ahead 'free' – or better yet if one is paid to split water for green H_2 – it's a new ballgame. Sunny, windier hours excess power for green H_2 can time shift to windless nights. It could then be used to create high temperatures too like in making steel and cement. In sum, on political will plus - abundant renewables and negative prices - *and with needed breakthroughs yet in both H_2 & fuel cells*, much *may* be possible.

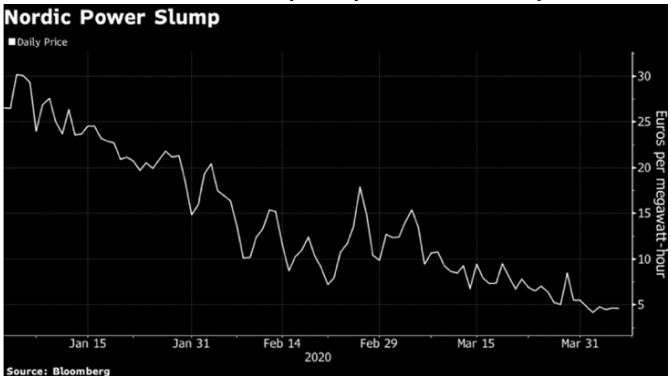
Moving on, recall *applied* clean energy 2020 when renewables prices can, and did fall swiftly – happening good snowballing ways (unlike oil). Start then 1st with Solar Power costs hitting a Record 2020 Low cost of *only 1.35 cents per kilowatt/hour* at a big 1.5 gigawatt solar farm going up in Abu Dhabi! True, it's in excellent solar circumstances, desert for instance. But there's great deserts in Western U.S., and arid regions in Southern Europe too, and 1.35 cents is cheaper than any new coal power, today, tomorrow, or ever. New solar power for a penny is less pricey than new natural gas. Frankly, no new fossil plant comes close.

As a practical matter, consider 2 renewables when joining together in a world-leader, say Sweden. There clean energy tells a bit of a startling story. Especially as more renewables get built, as is happening, interesting synergistic eco-possibilities may be repeated. So consider how April 2020 when Sweden's then-largest onshore wind farm opened, right away it changed context for inflexible nuclear plants – given how wind (just like hydro, solar, geothermal) can in good circumstances, heartily underprice costly non-renewable, firm, nuclear. That wind farm owned by a Dutch Pension Fund consists of 80 large turbines each rated 3.6 MW, for together near 300 MW of installed capacity expected to annually make 900 GWh. That's big – but certainly not huge. see https://www.vasavind.se/askalen-eng.aspx

And wind isn't only big renewable operating there. Sweden already has hydropower plants, so it's harnessing water in addition to its wind. Indeed most all places could use myriad untapped renewables even if they're inexplicably ignored; blowing winds onshore and/or offshore, often good sunlight for solar power, geothermal potential, run of river small hydro that ecologically could be much better than non-scalable big-hydroelectric etc etc.

So Sweden already has hydropower for significant power. And very rapidly, indeed just 1 day after this wind farm opened with hydropower too already making abundant cheap power, then 2 units at a big costly nuclear plant north of Stockholm had to ratchet down to just 50% power production. With 2 other units at an older nuke plant also shut due to a national shift away from nuclear, these two renewables were obviously fast becoming impactful.

If it happens that wind farms are capitalizing on windy days – plus good hydropower conditions – then together they may make good use of all 'free'. Such increasingly crowds out fixed fossil fuels & nuclear plants that must pay much for fuel and operations. An upshot was Sweden's electricity prices start of April 2020 were hitting welcome new Lows. Note too wind in Sweden like in Norway, the frozen Arctic, Minnesota etc works great in freezing areas; putting the lie to opponents who wrongly claimed (when Texas froze in 2021) that renewables can't work in cold (there it was lack of weatherization in natural gas, coal, wind, even nuclear that shut down much power. Future fleets of electric cars – with Vehicle to Grid (V2G) could use their cars to store/sell cheap surplus electricity too, released as needed for profit into the grid.



Source: Bloomberg, 'Giant Wind Park Starting Up is Another Blow to Nuclear Industry', Apr. 8, 2020.

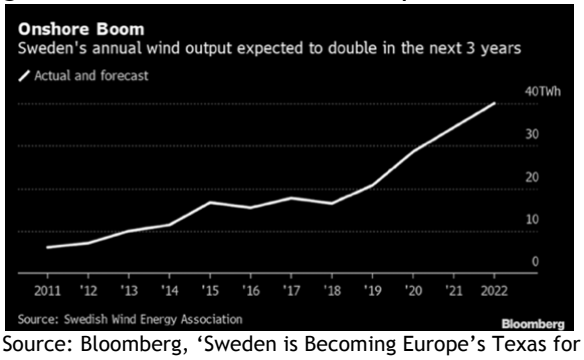
So yes, of course renewables are intermittent. There's not always blowing wind, nor seasonal rains for hydro. At times other renewables may be tapped. For instance new geothermal might possibly grow more common as firm power. Especially if oil rig counts drop, then geothermal may become much more attractive. Idled oil drilling capability could be harnessed, helping accelerate geothermal as baseload power. Capital is what's needed; geothermal needs deeper wells, and wider bore holes; it's costly upfront vs solar or wind.

US big Oil hadn't before looked much at big renewables projects. But if oil is near $50s/barrel, renewable projects could rival $$ returns in a new oil field. Geothermal is too costly now – maybe 3x or 4x more-than wind/solar. But geothermal is firm power and the build-out utilizes skills well-understood in oil/gas: how to drill holes deeply into the ground. In time geothermal might thus grow more affordable. This is especially relevant say in California, where major ~10% firm power is supplied by 1 nuclear plant – that's soon to be removed.

So natural situations in Sweden are exacerbated in good ways when windy days coincide with high-hydropower output. Charts from Bloomberg New Energy Finance (BNEF, prior longtime partner on the global new energy innovation NEX) illustrate nicely how daily wholesale power costs in Sweden had been driven down "naturally" by hydro/wind to lowest-ever. In Spring 2020 electric power day-ahead pricing fell by half. For comparison, to get to just break-even before profit, that region's nuclear plants need a much higher price floor. Costly-nuclear faces a thorny pricing dilemma given how low renewables *can* go. Especially if a region combines natural resources, say rain, and wind, and maybe with solar power too.

To local industries seeking low-price power, big hydro is welcome. Sweden's mills, smelters, miners, aluminum manufacturers are energy-sensitive. Big hydro is a static source, potential capped, limited to big dam-able areas with huge ecological burdens. So recently wind power has entered in a major way. A BNEF article aptly called "Sweden is Becoming Europe's Texas for Wind Power" - shows how Sweden, a bit like Texas, is in midst of a wind boom.

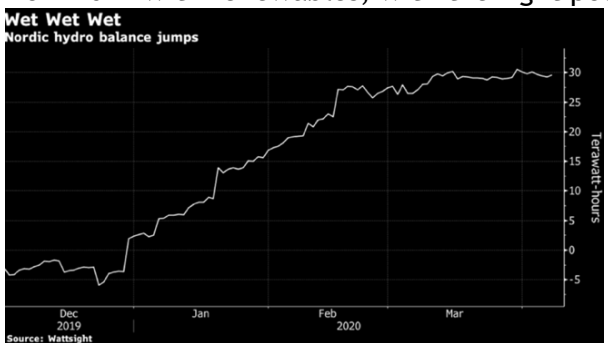
Indeed Texas may have added 2020 as much new wind faceplate capacity, as past 5 years. Solar there is jumping from 3,800 MW to 21,000 MW in 2023. This US renewables leader has 29,000 MW solar & wind; large-solar may soon beat 13,000 MW in California. Texas' ERCOT queue 2020 had 77,000 MW contemplated; that's 13,000 MW each of solar/wind in its queue, a portion of which may be possibly built. Little wonder when wind power in Texas can be generated as low as 2.6 cents per kWh in 2020. Here's booming Wind in Sweden:



Source: Bloomberg, 'Sweden is Becoming Europe's Texas for Wind Power', Nov. 25, 2019.

Because wind, solar, hydro enjoy free fuel, they can get *very* inexpensive (painful to a Utility, bonanza to off-takers) in abundant times. Combine hydro with abundant wind, & solar, and benefits snowball. Clean power potentially gets very inexpensive (below zero!). Given fast-declining costs, it's credible China reaches peak CO_2 soon (1st half this decade best).

More dauting than recent Sweden, is China's newest aim "carbon neutrality" (if not tougher "climate neutrality") by 2060. Costly nuclear ramps there a lot (maybe too 'ugly' CCS) – while better, green energy storage must as well rocket up greatly. Intermittency always an issue. Solar yields zero at night, predictably; less forecastably, it drops hard on clouds. Wind is best windy days obviously. Hydropower too requires dimpled landscape, snow/rain; some seasons there's less precipitation (run of river micro-hydro ecologically far less burdensome than big hydro). We are in the very early innings, and there's to be one hopes fantastic progress ahead from 2021 with renewables, with the right policy, like we've seen of late in Sweden:



Source: Bloomberg, 'Giant Wind Park Starting Up is Another Blow to Nuclear Industry', Apr. 8, 2020.

As for the US, it's making some progress – and thankfully beyond big hydro. A decade ago, renewables made up just 10% of US electric power in 2010 – much of that from big hydro. Despite vexed ecological impacts and limited room for growth in hydro. Somewhat noteworthy then, is US renewables' slice grew to near 20% end of 2020 - thanks mainly to rises in now far more scalable, greener solar and wind which still have enormous room to grow.

End of last decade US installed solar capacity rose to just ~100 GW. (A gigawatt may be thought of as ~roughly one nuclear reactor output – yet solar intermittent, unlike nuclear, coal, natural gas). By 2020, solar & wind did rise from near zero to 10% of US electric power. Hopeful – yet underwhelming: we need 10x that! Note how growth happened. Partly by China pushing down solar costs via consolidation. World's biggest solar firm 2017 went bust. Some 180 solar companies died 2016-2020. In 2010, 1,000 employees at a China solar plant made 350 MW of product; in 2020, the 1,000 people made 6,000 MW. Price per watt in solar manufacturing crashed -90% that decade. Partly too it was on a US 2009 meltdown. American jobs were lost at rates of half a million per month; stocks and housing cratered. In response the $800 billion stimulus American Recovery and Reinvestment Act (ARRA) gave that crucial $90 billion then for clean energy, electric vehicles, energy efficient infrastructure etc.

At that time, 2008, solar made up only 0.1 percent of America's electricity(!). Wind less than 1 percent. So they were vanishingly small within the total U.S. energy mix. The ARRA sought to change all that while creating good jobs and growth. It contained a then-large $25 billion for renewables, another $20 billion for energy efficiency, there was $18 billion for transit, $10 billion for improving the grid, and more for other varied green programs.

Tax credits were unusable to many in that tough time, so happily became liquid cash payouts. Developers were allowed as much as 30% of project costs, instead of as tax credits. 2009 stimulus helped prime a pump that next decade for growth since. Also of help, at start of that decade was a US SunShot Initiative, which reached its end goal early helping make solar much more competitive vs. dominant dirty energy. Consider that in a decade since Recovery Act, the U.S. solar power generation capacity has since grown by 48-fold, though starting from a very tiny base. Wind generation capacity had grown 4-fold plus.

Of key importance was China's strong entry in solar & wind arenas. Seeking market share in a big way, it began pushing down price per kilowatt - dramatically. That put many established firms out of business, in Japan, Germany, US and elsewhere. Profit margins dried up. So many legacy firms couldn't keep up. Chinese firms enjoyed low costs of capital, cheap labor, often free land, less environmental regulations. Local governments there were glad to see big employment gains these factories brought. Solar costs, pricing & margins plummeted.

Germany did ramp installations in 2010s. 2012 alone it placed 7.6 GW of solar panels. It with other European nations like Denmark also embraced wind power. Thus by 2013, subsidized wind power reached cost-competitiveness in many places, with coal & gas. Where winds are plentiful, the equation grows *very* favorable; America's Midwest saw power auctions for just 2.5 cents per kilowatt/hour (kWh) in some bids for wind power, making it best choice.

Mid-decade especially on wind, a marker was hit 2015 when more renewables were installed, 150 GW – than all fossil fuels plants added that year. Diverse kinds of renewable energy were growing common in Europe & US. Various clean energy put together good days, began to briefly even meet 100% of demand on occasion. Thus in 2016 all Portugal ran just on its renewable sources alone - solar, wind, big hydropower for some 4 straight days.

Seen by generation type, renewables were pulling ahead of nukes. In a first in a long industrial history, U.K. made more renewable power in 2019 – than fossil fuels combined. Not-sunny it still made clear renewables work: wind, hydro, & solar etc (plus not-green biomass). On April 20, 2020 solar made 9.7 megawatts, meeting 1/3rd of its power demand; a one-off, and 10 times what it normally produces in a day there. Yet what a change; in 2010 its dirty fossil fuels met ¾ of demand, 10 times the renewables. Renewables since jumped to 40% by 2020 and gaining since. And U.K. coal-fired power fell from 70% in 1990, to under 4%. Coal ending in the U.K. by 2025. The E.U. aims for climate neutrality by 2050 – more likely sooner.

Global annual solar panel production changed enormously from a once-puny 15 GW 2010. Yet, as emphasized a key issue for many renewables (except geothermal and hydro) is now their intermittency. That's held them back - but needn't do so ahead. Like overcoming high early costs of solar & wind – a need for firm power spotlights batteries & energy storage. Intermittency's an issue. *Yet it can surely be overcome*. Coordinating renewables in grid, maybe innovations like flow batteries, carbon taxes, even green H_2 as energy carrier (with breakthroughs) - may ascend one day. We *can do much* to advance renewables.

Asia made a commitment to advancing batteries years ago. Lately Europe is trying to catch up in EVs, batteries, for new leadership in technology & manufacturing. Decarbonizing everything can move all things forward. Yet inexplicably, the US ceded ground early on as in energy storage and batteries. And China, having once missed out on early prowess in making 'regular' gasoline powered cars – now seems determined not to make a same mistake twice with coming electric vehicles. Essentially EVs are a big battery surrounded by 4 wheels, China may soon 'own' much EV space. Innovation in various storage/batteries will be part & parcel of advancing renewables worldwide, beginning right now start of this new decade.

There are practical issues. A Great Lockdown 2020 at first slashed jobs in US clean energy - as in other industries and nations. March 2020, 100,000 new unemployment claims were filed in the US clean energy space. According to the group E2, these included 69,800 job loss claims in energy efficiency, another 16,500 in renewable energy, 12,300 from clean vehicles, and 7,700 jobs lost in grid, storage, and cleaner fuels. It looked very bad Spring 2020.

Early 2020 there was perhaps some 600,000 clean energy jobs lost in the US. Yet as will be discussed, far greater losses have been seen over years in coal, and oil. There, things are far worse. Coal now is a shadow of its former heft – due to mechanization by that industry itself – and not due to any clean companies. Here, in clean energy, there'd been waning consumer confidence Q1 2020 meaning residential solar cancellations, a caution at Utilities, auctions halted on fresh wind/solar projects. That said, Q3 / Q4 2020 grew better fast - and far side after this pandemic – that, if reached, could bring more green activity.

One useful change could be for Utility procurement processes to better consider all potential power sources – including green alternatives. The fact that wind and solar power are already often heaps better than coal – is accepted in many places – but not yet everywhere. When vertically-integrated Utilities tilt procurement to fossil fuels, to the status quo and their own bottom-lines, that means an excess of power generation – rather than desirably leaner cleaner competition, a keener look at the climate impacts, and truly lowest-cost power.

Places that have decoupled Utility's revenue - from amount of power produced – bottom lines may better advance real efficiencies and lower system costs. 'Steel for fuel' swaps reward operational savings from 'steel' (new wind & solar farms) - over uneconomic older fuel-intensive fossil fuels generation. Without total re/views, encumbered inertia and old-ways of thinking can allow more-costly fossil fuels and heavy CO_2 to unduly linger.

Change is happening so fast, young-ish decisionmakers who 'knew' in 2000 that 'Renewables were the most-costly' – are startled by this change. It's something of a wonder: in not even a decade 2010 to 2018, Utility-scale Solar Power capacity grew amazingly 30x, a 30-fold scaling-up to swiftly reach over 60 GW. It looked to potentially double again in another 5 years (although perhaps not quite as fast due to pandemic). Yet we need far more!

In clean technology, cost reductions once learned – like green capacity once built – will not forgotten or lost. New solar, or wind that's sited in favorable circumstances, often now makes electricity in the most economical way of all as noted. Two-thirds of the world now sees well-sited solar and wind generation as the very *least expensive* forms of new power!

According to ever useful Lazard Reports, clean renewables have come under half the cost of nuclear power (and nukes will still have centuries of costly toxic waste to dispose of). Thusly are renewables clearly preferable to once-cheap King coal. Lower than 'cheap' new natural gas. Issues are now shifting to energy *storage* – last piece in the firm power picture.

What's key to consider here, is *levelized costs* of energy - that is, all in including fuel costs. End of day, fossil fuels increasingly struggle with this fact of 'free' solar/wind. Especially as solar & wind only get cheaper. Take solar cells, built soon using more wavelengths. On group III-V semiconducting materials, more solar output is captured than cells today. Concentrate that sun further, with mirrors, and it may then be possible ahead for innovative solar cells to capture 400 times more solar power over an equivalent surface area!

Consider Perovskites since we are in the early PV innings technologically speaking. These solar materials with crystal lattice structure are nicely cheap and abundant; they could become some 50% more efficient than solar cells today. Able to capture low light, too, they might open entirely new possibilities over years ahead. Solar getting (much) cheaper still. But as we emphasize, clean energy in 2021 is still so weak, nowhere close to what's needed.

In reality the Paris Accord's so-called targets are not close to being met, even though the US returned into that Treaty 2021. Rising CO_2 hit new records in 2018, 2019, 2020, 2021 etc etc. The peak in global CO_2/ greenhouse gases aren't expected any soon-year. Not by 2025, 2026, nor 2030 – this despite flowery aspirational words to the contrary aiming for 'just' 1.5 or even 2 degrees C of warming ahead. Blowing past the hopes of Paris is already a certainty.

2020 brought some inspiring wins at margins. Scotland met 97% of its electric needs by renewables; though heating & transportation have a ways to go. First half 2020 Ireland's slice of electricity made from wind surpassed all sources including natural gas; wind met 43% of Ireland's demand – vs. 41% met by natural gas. Spain, looking to its natural blessings turned on Europe's then largest solar farm, 500 megawatts (MW) of power for 250,000 people. In May of that year a bigger 690 megawatt US solar farm was approved in Nevada for as many people (since Americans consume more); notably it includes 380 MW of battery storage.

But things are bleak on CO_2. Coal remains worst carbon source, hundreds of new coal plants being built 2021 across Asia. In China and in India, coal is still a cheap and leading main fuel given lax rules. Given that laxness, coal power can cost some 30% less than renewables. Solar & wind are growing cheaper in China, maybe they will beat coal 2026 in wealthier regions. That said China had still remained in 2018 heavily dependent on coal (and on big hydro) for some 83% of its electricity mix - vs. growing wind and solar but that were still only 7%.

By 2019, coal capacity in China had grown a staggering 37 GW, "more than the whole world" - for while coal was being shut other places like in Europe, U.K., and US - enough permits had been granted in China to potentially expand coal by about another 25% more.

Early 2020, China had already permitted, or it had under construction, an enormous 135 GW of new coal capacity; that's about half the entire built U.S. coal fleet capacity.

Besides the coal going up in China & in India, wealthy-Japan is set to burn coal for decades. Look at Japan in 2020: in 5 years it might build to 22 new coal plants, up to 17 locations. If all get built, they'll emit nearly roughly as much new CO_2, as all new cars sold in the US, annually. Even Germany was getting ~33% of its electricity from coal. While renewables are over 40% there, it ok'd one (final) coal plant in 2020. Many plans in Europe to shut coal are being brought forward, shuttering sooner in pandemic – but that's not happening everywhere. It's all a tremendous current to swim against - if one aims not just to *slow the rates of growth* of emissions – but absolutely to *Cut* the total CO_2 concentrations in the atmosphere.

There's a Paris Agreement. Yet wealthy Japan set itself a very low bar, aiming for a meager 26% less greenhouse gases by 2030, than 2013. Even that's merely a goal. Coal makes up one third of Japan's power, and by 2030 it expects coal to still be ¼. Renewables, 10% of its power in 2010, in 2018 only made up 17% and much of that was from big hydro. In sharp contrast, France expects to fully shut all its coal plants by 2022 (though by leaning on its nukes)

Japan's course is uninspiring. While clean renewables could become the cheapest power there by 2025, it's standing by coal. Unsurprisingly after a horrific nuclear accident, nuclear fell there from some 1/3rd of its power, to under 4%. Yet fossil fuels instead grew to 4/5ths today. And its renewables are dominated by non-optimal, big hydropower. Plus it is exporting bad practices; only China gives more finance for coal plants overseas. There's airy talk of course, of so-called 'clean coal', yet always off in future for a concept that's never been real.

In US, demand for thermal coal itself is dropping. 2019 it was 556 million tones, less in 2020; Europe has declined to some 534 million tons and is dropping too - especially with renewables becoming least-cost, best option. Yet necessarily measured against declining numbers, are increases in Asia – China alone last year used around 3.6 billion tons thermal coal: their figure is growing; it accounts for half world demand/ consumption. India used 946 million tons thermal coal and it too is adding coal power plants. So while the US and Europe are decreasing coal burning, closing 22 gigawatts of coal power – that's swamped by the maybe 49 gigawatts of brand new coal plants across Asia-Pacific.

Europe carbon credit costs jumped 70% from March 2020 lows, to August 2020– reaching $30 a metric ton - which hit dirty coal very hard. And while price of thermal coal for burning in power plants dipped 2% to $50/ton, that was overwhelmed by a 60% decline in natural gas to $1.50 per million BTUs – making gas a winner (though hiccupping on shuttered oil wells).

Germany's Utilities can even *lose* money selling coal-fired electricity. Natural gas on the other hand, is relatively bit less filthy, needs fewer carbon credits, and more profitable for Utilities. So for them it's a mixed bag. But for the Earth and future, all fossils must go, coal first.

It makes sense: global average solar costs in 2019 were 6.8 cents per kWh; onshore wind just 5 cents per kWh. Average solar costs continue to fall; soon maybe under 3 cents. So beyond China & India (less burdened by environmental health and safety rules letting coal become cheap), renewables are making great progress. Ironically China's advances make renewables far cheaper today. Beyond a Petrostate, it may be in future be an 'Electrostate'.

Confronting all, is that Earth doesn't care about renewables' strong growth at first from zilch. And we oughtn't pretend impacts on us alone, are all that matters. As air-breathing mammals, we see only these terrestrial impacts. That's a mistake. Earth's surface is mainly covered by seas: their health declining fast. Skeptics questioning CO_2 and warming air, have no ground on which to stand with ocean acidification. For oceans' CO_2 uptake is undeniable; rising CO_2 concentrations doubtless equal acidifying seas. Devastating harms thus ahead for reefs, for kelp forests, fish populations, shellfish, marine mammals, more. Marine life, once weakened by acidification, then stands a lesser chance of surviving marine heat waves.

Ways shellfish, for example, calcify to grow shells from surrounding seawater are understood. Hence it's perplexing that we know acidification lowers pH, no doubt enfeebling the species essential to ecosystems, *yet we care not a bit*. Shells getting too thin, accreting calcium from seawater gets too difficult – likely meaning tipping points, catastrophic collapses. Naturally perturbated places with more 'acidic' waters like those nearby volcanic seeps, both fish and habitats are now negatively impacted by CO_2 levels only a little above that today.

And there's warming. Post-2050 deep seas might warm at rates maybe 7x those now – a climate velocity sure to overthrow life evolved in very stable deep thermal settings. There will be tipping points, complex & cascading losses. In sum, renewables are vital. We perceive of clean energy – and oceans - as being quite separate, when they're intimately linked.

Since the industrial revolution, ~1,700 gigatons of CO_2 ($GtCO_2$) has been put in air, leaving room for ~200 Gt more before we may go over 1.5 C warming. Releasing 40 $GtCO_2$ /year now, means we may have <5 years to 2025 at today's rates, before we're in big trouble.

That's why distant vague promises about 2050 are absurd. Reducing now is vital.

We know from scientific perspectives major threats to oceans include: climate change due to CO_2 & greenhouse gases, overfishing, non-point source pollution, habitat destruction, acidification etc – all harmful to marine biological diversity. Each presents a daunting problem to overcome. Each so locked-in. Difficult to resolve, to protect the oceans.

Seemingly the most intractable, most vexed, and hardest of all to remedy: is CO_2 & climate. So it's surprising: the solution here economically/ecologically sensible – saves money!

This key answer of course is clean renewable power. Solar shining brightly, another option blowing just overhead, wind's story. The question is, how to get there, given inertia? What will it take to instead power the entire world, off of mainly clean solar and wind power?

Seen another way - given new guardrails imposed by CO_2: how much solar is needed fast to reach the Paris Climate Accord's Goal of achieving under 1.5 degrees C of global warming?

In short solar manufacturing capacity worldwide, was in 2020 less than $1/10^{th}$, maybe $1/100^{th}$ where we need to be in building PV panels fast enough. In 2020 we'd made a little over 100 GW/year. (Still, better than a 0.250 GW in 2010!). We've seen PV manufacturing become a low-margin commodity business. After a decade of consolidations wringing out excess costs/capacity, solar 2020 was profitable. 2021 cheaper all the while growing.

2021 stood roughly ~9 of 10 panels being made in China/Asia. Now the planet's biggest solar production plant is going up in Anhui Province, China: it may have capacity to make 60 GW new PV modules by end of 2023, each & every year. But given economics, it's in 4 phases to $2.5 billion. From a standpoint of where we need to be on CO_2 in 2035, it's a (small) start. It's a beginning… yet wildly small if we're to make ~60% total global electricity from solar.

Consider: without vastly ramping on current trends, global capacity is just ~400 GW/year ahead of PV. Incrementally that increases global PV installed capacity; it grows but far, far too slowly. On those economics, it's taking too many decades to get to that 60%.

Given where we should be on CO_2, the past PV overcapacity, overexpansion are less at issue. Solar *needed to become* world's cheapest energy! It has. Now arguably we'll need Policy Changes that can allow much fasted ramping. It's a hand that CO_2 has forced on us all.

On carbon we stand 2021 nowhere near enough installed solar, nor manufacturing capacity to vastly ramp new PV fast enough to 2025. Policy changes are needed. In 2020 China had world's most existing installed solar capacity at just over 200 GW; European Union was 2^{nd} and was growing at over 130 GW; US was third with just over 75 GW etc.

From so little installed solar capacity – PV manufacturing capabilities would get far bigger, fast to hit 60% of world electricity generation. Given climate, ramping *might* get underway in early 2020s to get us where we need to be 2035. Europe may lead soon on this.

So consider a 2020 Report from Solar Power Europe, and the LUT University: "100% Renewable Europe: How to Make Europe's Energy System Climate-Neutral Before 2050" (2020). https://www.solarpowereurope.org/wp-content/uploads/2020/05/SolarPower-Europe-LUT_100-percent-Renewable-Europe_Summary-for-Policymakers_mr.pdf

They make many important observations and reach notable conclusions.

Almost every sentence in their initial paragraph was unimaginable, a decade ago:

> "It's possible for the EU to become fully climate neutral by 2040, complying with the ambitious 1,5 C Paris Climate Target, and without any tricks, like carbon sinks, but just by going 100% renewable. ….
> … Solar PV and wind represent the two main pillars of the energy transition, supplying over 90% of power demand in the long run. …
> Clearly the transition to a climate-neutral energy system comes at a cost; however, perhaps surprisingly, moving slowly does not make it any less costly. The most cost-effective way of achieving climate neutrality by 2050 is a 100% renewable energy system. According to the modelling in this study, total cost of achieving 100% by 2050 is 6% lower than the cost of inadequate action in the less ambitious … scenario, which only reaches 62% renewables by 2050, thus missing both the targets of the European Green Deal and the Paris Agreement.

There's several points above, challenging conventional wisdom and worth unpacking. Start with the latter: moving more quickly towards decarbonizing costs *Less $,* than the status-quo of incremental additions of solar & wind. Partly on renewables being cheaper; their 'Leaders' scenario shows greenhouse emissions fall 60% (from 1990) to 2030 in 10 years – reaching zero 2040 (a decade ahead of 2050). By contrast an incrementalism on past conventional wisdom has Europe reaching only 53% emissions reduction by 2030. And this Solar Power Report here assumes absence of nuclear power, not due to risks, but on its high costs.

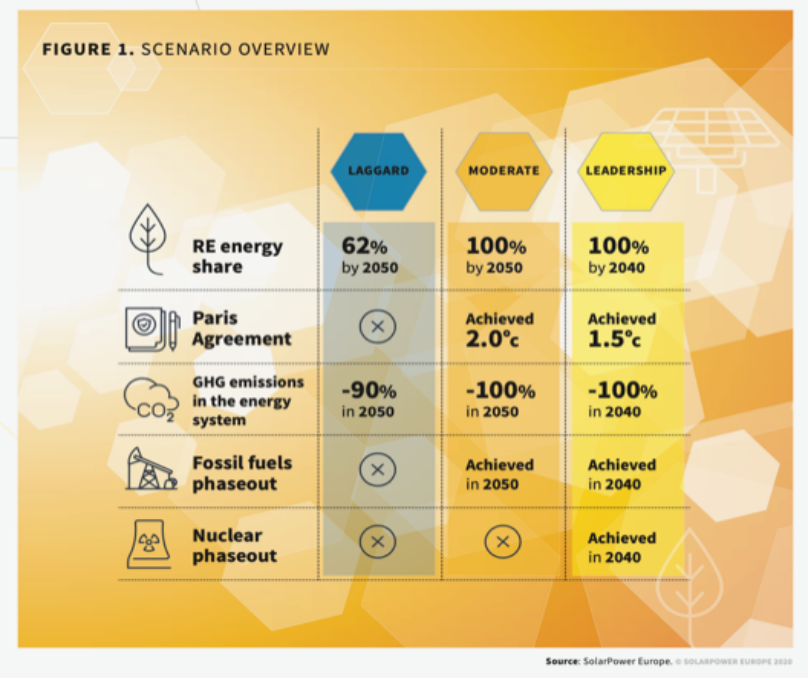
This Report recommends policy makers immediately begin by creating a new framework targeting installed 7 TW of solar power – and 1.7 TW of wind reached well before 2040.

That involves 2 factors: starting the upswing now soon as possible – and growing PV manufacturing abilities harder and faster. Given the CO_2 pressing issue, we may need to build 100 factories worldwide, each one capable of make ~60 GW of PV like that factory going up in 4 stages in China. Ramping up to around that 7 TW of solar 2040(!). Clearly this is possible. Raw materials can ramp fast – we'll also doubtless find ways to make PV much more cheaply, efficiently. The US in World War II had ramped greatly its weapons and materiel. Only this time it's the whole world to our own rescue. CO_2 was rising 1 ppm/year at a first Earth Day, lately scarily, by 2.5+ ppm/year. That number is only growing, accelerating.

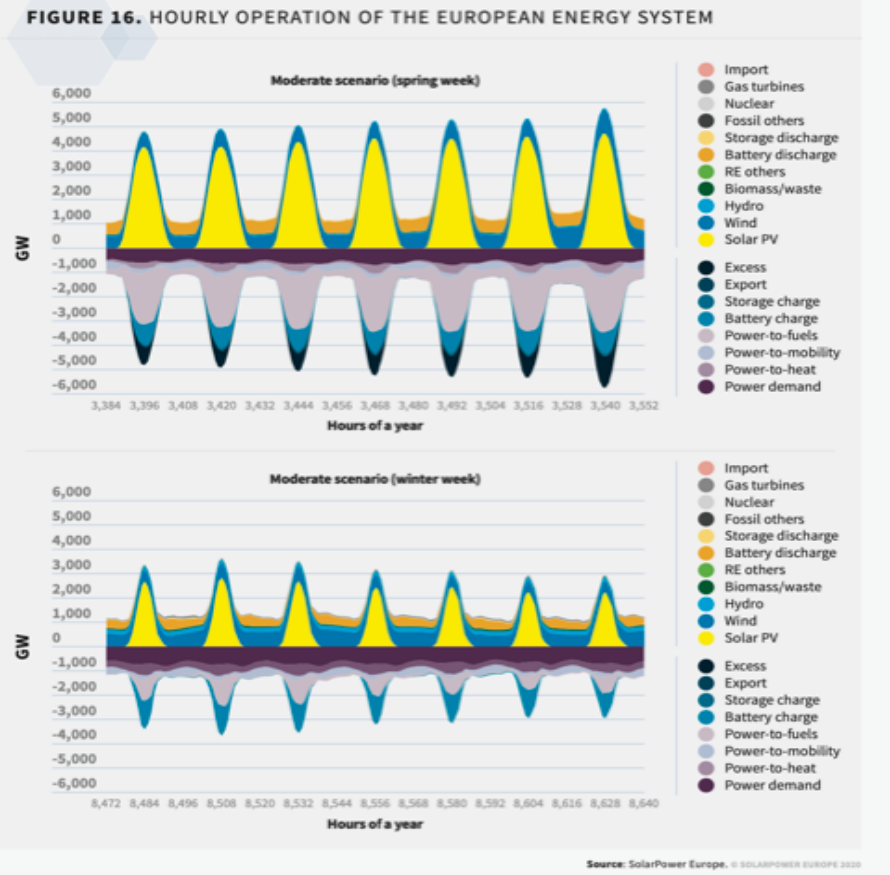
Their 2 good scenarios present a more Moderate level – and a Leadership level going quicker. Former achieves only the 2.0 degrees of warming goal under Paris, the latter achieves the more robust better 1.5 degrees goal. Again, it's a matter of when ramp begins, and angle of departure. But interestingly the stronger the action, the more $$ is saved over time!

Moderate approach does not achieve 100% renewables until 2050. By contrast the Leadership gets to 100%, 10 years sooner in 2040. Better to move fast. Under it, Southern Europe is making vast amounts of mainly solar power in e.g. Spain, Italy; & Eastwards. While the Northern & Western Europe region mainly uses wind, given natural resources in Denmark, Norway, Sweden, Finland, etc. Similar under both Moderate and Leadership scenarios.

Seminally, Europe can have enough renewables to power entire needs by 2040. Electrification of everything. About 63% is solar overall, 30% is wind on a Leadership path. And as for costs, Moderate path costs less over time than Laggard, while the Leadership beats Moderate. Unlike a game of rock, paper, scissors – in this right Policy Framework there is a winner.



Source: Solar Power Europe 2020.



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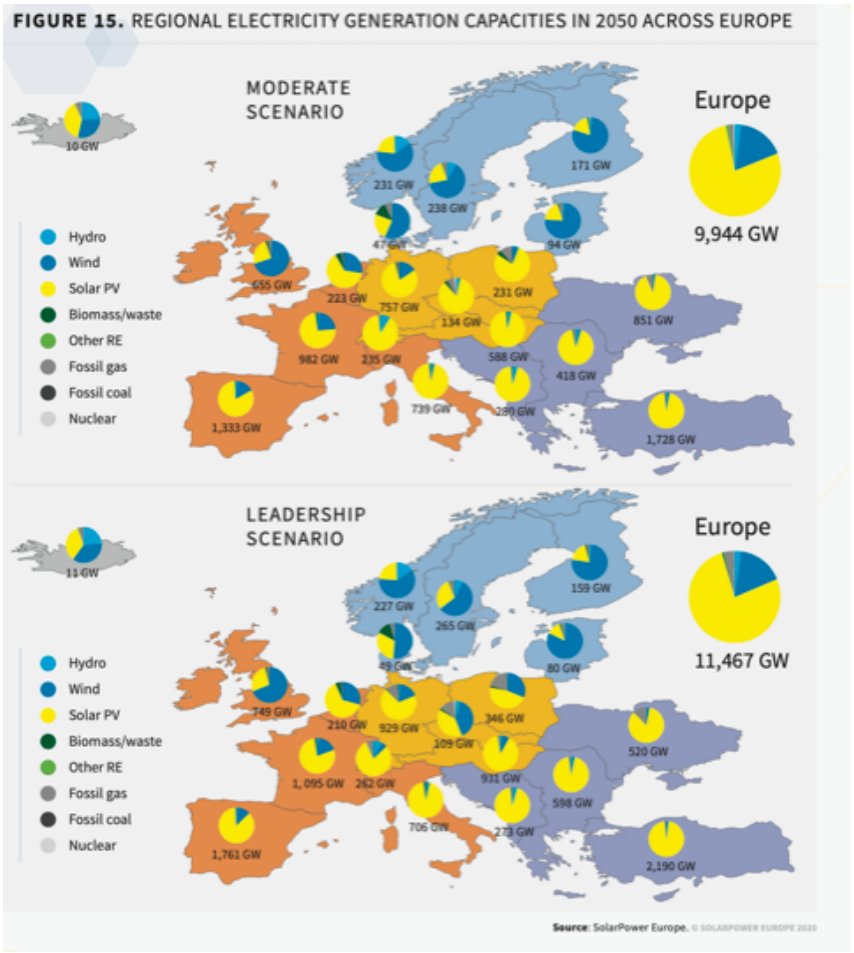

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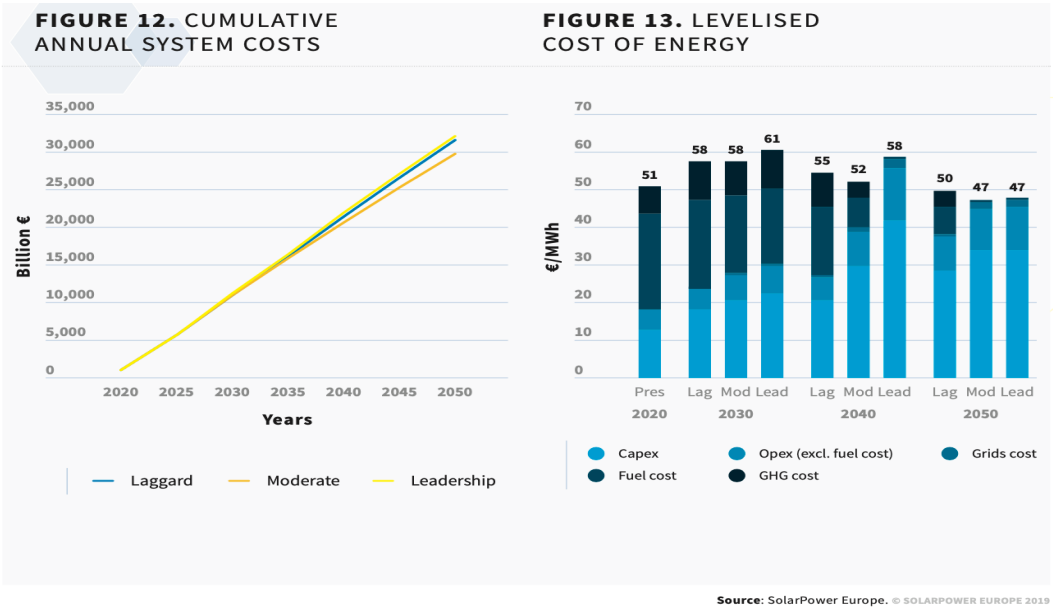


Source: Solar Power Europe 2020.

What may lay ahead for solar 2020s? From equities standpoint as always: Nothing's certain. Notably there were far fewer Analysts last decade in clean/sustainable/decarbonization, than areas like oil & gas. That may change ahead! Over 15 years plus we've at times cited excellent Raymond James reports etc. Here similarly is a brief excerpt too from a very good report by Philip Shen et. al. Roth Capital Partners, from Solar Snapshot (Dec. 24, 2020):

ROTH: "Key Themes for 2021

2020 was just the beginning: Look for the multiple expansion across our sector to continue in 2021.

1. **Despite the recent Covid-19 surge, we continue to expect strong global demand in 2021.**
2. **ITC/PTC extension reduces 2021 pull-in of U.S. demand, but supports higher medium-term growth.**
3. **We expect the cost of solar ABS financing to continue to decline.**
4. **Rising input costs could remain a challenge.**
5. ….

1. 2020 was just the beginning: Look for the multiple expansion across our sector to continue in 2021.

- **Look for a greater mix of unsubsidized economic solar projects to support improving revenue visibility, increasing earnings quality, and multiple expansion.** …. While the U.S. is clearly a subsidized market, by H2'21 China should be largely unsubsidized. Many other countries around the world have been and are starting to see meaningful solar demand not based on subsidies.
- **Our tag line for this mega-trend is "the wholesale transformation of the power industry from the inside out."** With this and other energy transition mega-trends, we expect more capital to continue to flow into renewables from ESG, energy funds, retail, etc. …. All in, we expect the positive sentiment and momentum in our sector to continue until we get a narrative break. And we currently don't see anything meaningful on the horizon.
- **We recently saw another wave of announcements for PPAs linked to large scale solar projects across the globe.** … unsubsidized solar demonstrated increasing momentum with a number of PPAs signed in countries such as Germany, U.S., Egypt, Italy, Philippines, France and South Africa. Amazon, McDonalds, and Coca-Cola were among offtakers for this wave of PPAs.
- **The European corporate PPA market could be set for an influx of new generation capacity.** ….

2. We expect strong demand globally in 2021 as the solar industry continues to navigate well through the recent Covid-19 surge.

- **Global demand outlook: It's still very much about China.** …. Grid parity projects in China generally need module prices of RMB ~1.45/W (~19.5c/W) or lower, but prices are currently ~1.65/W RMB (~22-23c/W USD). If prices drop faster than expected to ~19.5c/W, 2021 demand could move toward the higher end of the range. Notably, a speech by Xi Jinping earlier in December seemed to drive increasing confidence that annual demand in China could eventually reach 70-75GW. That said, few specific policy details were provided, and we maintain a bit more conservative view. Ultimately, we believe module prices will be key and despite the recent raw material cost increases, substantial capacity expansion could put downward pressure on module ASPs.
- **We continue to see 25-30% growth for U.S. resi in 2021.** The extension of the 26% ITC for two years, once official, removes the potential rush of demand ahead of what was an ITC step down at Year End 2021 ….
- **Restrictions in Europe may have only a modest impact on solar installs.** Checks … before the more severe shutdowns — suggested that increased Covid-19 restrictions in Europe should have only a modest impact on resi solar installations. One contact is seeing record bookings and expects 30% YoY growth in December in the EU, though Spain and France could be somewhat weaker than other regions in Europe. It appears the strength is due in part to the success of online/virtual sales practices, which were implemented even before Covid-19. Another suggested that the lockdown in the Netherlands is not preventing solar installations, though some may be taking an early break for the holidays. Notably, our checks were done prior to the latest UK lockdown announcement, but after the announcement of the five week lockdown in the Netherlands, effective 12/15 until at least 1/19. This will be important to continue monitoring to see if the narrative shifts or even breaks.

….

Given how renewables, above, uniquely thrive on ever-lower prices – let's contrast that next by looking instead at **Oil** over a remarkable Spring of 2020. Oil moves *very differently*.

Major Crash of Oil in Spring 2020

Intriguingly 2020 brought a maybe once-in-lifetime oil crash. While some have called that oil crash completely illogical, it had arguably unfolded with rather explainable logic of its own. To start with, Oil Demand collapsed on Covid-19. Businesses froze globally. Very quickly, surplus oil began backing up worldwide, as we'd forecast here March in the Q1 2020 Report. Demand destruction swiftly grew so large, as anticipated, where to store oil had by late April, become a real question (especially when narrowly oil prices as expected, went negative).

Start of 2020 the world was producing 100 million barrels/day, well-matching rising needs. Demand and production were then expected to (only) grow. Indeed only in 2 of last 35 years, had the demand for oil dipped – and even then for only a brief bit. Yet suddenly, in March, a monster demand collapse due to Covid loomed large of perhaps some -25% or more.

Normally on slightly slackening demand for whatever reason, supply can be slightly curtailed. Excess stored and soon mopped up. But instead, Saudi Arabia & Russia had *ramped* production up wrestling for market control. One an important day, March 9th, crude prices plummeted by -30%: the greatest one-day 'fall off the cliff' in oil for roughly the past 30 years.

March U.S. benchmark West Texas Intermediate (WTI) crude fell by -60% in an historic drop, from $60 to $20. A big factor was that Saudi/Russia ramp; but greater was that *demand* was dropping tremendously by -25% or more as world economies halted. A fear come Ides of March was America's crude might yet drop well under $20/barrel absent intervention; there may be 1.8 billion surplus barrels of crude, yet 'only' 1.6 billion of storage capacity.

Pricing under $50, so at $30 is a threat to America's oil industry, both shale & conventional producers. Tiny to huge, they are a diverse lot and all felt pain. Texas 2020 had some 174,000 wells of most every imaginable kind of rig – some so curious as to be hard to believe. Latter Q1 then the White House embarked on an unusual path for an American President. It tried to rally nations to *raise* crude prices. A hope among many in industry was to get prices up above at least $30, a barest floor for many. Particularly, indebted shale producers. But oil then near just $20 at that point was likely going lower due to demand destruction. It could go briefly below zero some places, or maybe on volatile futures contracts trading. Storage was filling, nearer tank tops, 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 is not met by great production cuts, fears grew of 'tank tops' like in landlocked Cushing, OK USA. The May contracts would need to be unwound fast by traders with neither desire, nor capacity to take crude delivery; it pushed front-end WTI oil briefly under zero, to some -$37 by April 20th. That temporary artificial move, as a matter of finance wasn't really a great surprise at all! Not too much should be read into -$37 close. Contracts many months out were a less distorted picture of physical crude, than May contracts expiring as storage evaporated. But WTI oil near $20 still showed oil markets were in distress. Even better global benchmark, costlier North Sea Brent crude briefly dropped down to near $20 by late April – but never near zero.

Oil near $20 furthermore meant production changes worldwide. Perhaps 1 million oil patch jobs & expertise might potentially disappear. Rig counts were fast dropping, capacity tightening, wells shut-in, bankruptcies – many wells perhaps never (expensively) re-started. Maybe forcing U.S. shale producers to shut in, was perhaps an initial aim, like 2015. But this time, oil's ramp in supply had begun just before pandemic's sudden demand destruction. That on Covid, made disorderly consequences greater than maybe initially expected.

Perhaps all put-down to timing. 2014-2016, opening spigots failed because in a thriving well-lubed oil hungry world, impacts were muted. Oil had then dropped near $50 briefly. Excesses soon were absorbed, not enough to kill off America's shale boom. And that shale which did bounce-back strongly, put something of a cap on prices WTI oil might soon fetch.

A playbook might have been, a world awash in oil can mean low-cost conventional producers later may raise prices, post shale bankruptcies. It's long been said that the cure for cheap oil, is cheap oil – as seen again & again. A more commanding market-share could then be re-captured by those able to lift oil from ground most cheaply by conventional means. Once competing shale capacity was well-gutted, low-prices might disappear. (That's all very unlike clean energy where lower prices go lower still, without the floor seen in oil and coal).

On a pandemic + tank tops and oil unexpectedly under $20, quickly reviving economies & demand getting oil back up was essential. Oil-wealthy nations might ideally seek higher crude prices nearer $80 - $100. Such in theory allows them to better balance their own books and their national budgets. But now, regaining firm oil demand came first. Proposed conventional big new projects are anyways often uneconomic, without oil at least well above $40s/$50s.

Plus for nations it's important to realize crude's intrinsic vitality, while its still richly valued. Vast underground reserves held too long, look increasingly like maybe stranded assets. Those assets might in time become of sharply diminishing value, whether due to CO_2/ climate change concerns, or perhaps an ascent of electric vehicles, or simply changed economics.

Globally then oil industry was facing pressing fears in April: Inland wells for instance without a Port or storage nearby, nor distribution pipelines - might sell crude for unthinkably low-prices. Lacking close off-takers, could mean dreaded tank tops. In Canada for instance the inland wells far from ports were lifting heavy crude that's difficult to move; suddenly, mounting product had upended all, raising fears of runaway cratering. Vast demand destruction was further benighted by the industry's fast evaporating total storage, and that was changing everything. This was a 'logic' of oil fear and crisis as it were Spring 2020.

So it was April 2020 that OPEC+ with Russia agreed to production cut of 10 million barrels/day. With 25, even 30 million barrels of demand gone – cuts really 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 the US by 'organically' cutting – that is, just by producing less on low prices – rather than cutting capacity, was as different as width from length. Given global demand was so much lower, the situation was vexing for oil.

But the U.S. can't cut production by diktat. Anti-cartel laws meant apart from say, a Texas Railroad Commission (rather like mini-OPEC, long before OPEC) ordering rare cuts as proration, it's not an option. So with wink and nod, Saudi & Russia agreed to a 10 million cut. Even that unprecedented big move, was just a (necessary) patch-up fix. It made headlines. Concerns among technical oil-watchers were it was 2x or 3x smaller than hoped-for. Plus it didn't start until May 2020 so was pretty-much no surprise in April when local lower-grade crude went cost-negative, less than zero. Even for desirable light sweet crude grades, cutting 10 million barrels/day did Not match up exactly, to perhaps 25 million barrels/day suddenly no longer being needed. But it was expected that demand would rebound some by 2021. And the WTI Index with landlocked Cushing fears, proved to be not as useful as the Indexes like Brent Sea Crude (staying positive with $20 bottom) – and new Oil Indexes like in UAE.

It was about making it past an immediate crisis, to re-starting oil demand 2021. Crude might then rise organically – like especially on say inevitable the heat waves or even cold snaps. Free markets are how U.S. oil prices work, rather than by fiat, and paths were envisioned to stimulate that rebounding. If say US States begin re-opening in 2021, Covid-19 increasingly is endemic more like a seasonal virus; if immunity gets conferred even if only for a season; if effective vaccines arrive even if for latest season, or better yet robust vaccine for Covid-19 treats new variants too, there were thus hopes for some return to demand normalcy.

A fascinating side effect of plunging oil was that coal – long dirtiest cheapest energy – still dirtiest – had just become most costly. Fracking long ago had pushed down natural gas prices wildly, seen in charts above. Natural gas -90% cheaper became very attractive for making power and unsurprisingly, one after another U.S. coal power plants had closed.

Thus when benchmark Brent crude fell in Q1 2020 to around $26/barrel, Australian coal sitting at $57 /metric ton, roughly equivalent by analysis to $27 oil, broadly-speaking crude went cheaper than coal. True coal vs. oil don't directly compete. Thermal coal is burned in power plants – unlike light sweet crude for gasoline, heavy sour in asphalt. Natural gas alone wasn't taking market from coal. As levelized solar & wind costs fell, they became attractive vs old coal. In sum, dirty was becoming much less desirable, and relatively costly too.

Surest path to oil rebounding is that economies revive, demand returns, and production cuts linger to eat up slack. Oil's fail had drawn uncomfortably near, which might have upended more in the oil patch. A key hub, Cushing's 4 huge tanks nervously filled. Pipelines that normally forward crude, had slowed more to like storage: that could have meant a kind of oil constipation backing-up to producer. Had 5,500 miles of pipes sending refined product Gulf Coast to mid-Atlantic stopped accepting gasoline, no contracted-buyers as product off-takers, a fascinating and scary April, might have yielded to a much different June 2020.

Then as many hoped, oil prices rebounded June to $40s.That was mainly on partially reviving economies, as well as production cuts by OPEC+ largely complied with (Iran pumped rather freely). A Q2 2020 that began with oil on everyone's lips, ended with oil largely unnoticed to end of Q4 – or at least not so pressing concern as other matters at the fore.

Throughout, clean energy was hardly (in energy) affected by oil's demand crisis. Instead, to grow it and energy storage fast enough, was a much different issue. Storing electricity is simple if little is needed; push water or weights high, release when power is needed, inject air into caverns etc. Vast amounts needed, means may mean '5 million mile batteries', infrastructure for innovative flow batteries, H2, etc etc. For immense scale of what's needed, consider Texas. 2019 it had 5.5 GW of solar, still only 1.35% of State's electricity supply; a healthier 17.5% from wind power. That 5.5 GW of solar 2019 was only a start. Nonetheless, were Texas a nation it have ranked 5th after China (30 GW), EU (16 GW), whole US (13.3 GW), Japan (7 GW) – ahead of say, the nation of Vietnam which had 4.8 GW in 2019.

Very generally let's think of fast needing 12x - 20x times more renewables capacity than now, given the need to also convert industrial processes like steel and cement to green energy. Roughly a dozen-fold increase in solar capacity - and wind capacity. A 1,300 MW (1.3 GW) Texas solar farm coming online 2023 is just a start. Far more energy storage needed too, here starting from scratch: it's so enormous, the needs are not measurable by 'x-fold'.

Beyond oil's ride down 2020, another big trend stands out in evolving energy landscape: *Coal lost a huge slice of US energy pie last 10 years*. As Yogi Berra said, "It's tough to make predictions, especially about the future" – so let's glance backwards at this now-seminal shift. It's movement away from coal in the US and in Europe that's far underway.

In 2005, little thought was given notions the US coal could soon see dramatic losses. At that time 'King coal' had made up some 50% of US electric power generation. Minor early gains (small in absolute terms, big percentages) had just started in solar & wind – in gas more so – but those hit coal only incrementally, taking coal 'down' only a bit to 45% by 2010. After 2010, US coal dropped hard, down from about ½ to <¼ of American power generation. Renewables by 2020 were (only) near 20% and rising, natural gas near 40%. Why, is easy. Fracking's revolution pushed down natural gas costs tremendously. In a power plant with 30+ year-life, natural gas doesn't suffer opprobrium vexing coal. Gas embraced by industry is an easy choice. Dispatchable, firm, less-dirty, stable priced, it's widely unquestioned.

What's perhaps more interesting now, is a bigger change just beginning to unfold as clean renewables become the best bet. Now Energy Storage from 2021 is fulcrum to really advance low-cost renewables. Even in a tough 2020 period. In fact it was then **due to, because of** tough conditions then, given solar & wind, and gas as cheap fuels, that coal was jettisoned. Prospects for inflexible big nuclear had dimmed considerably as well.

For retail power consumers, how electricity is delivered matters. Recall nimble Texas: some things there it does well, with far lighter regulations. There's much more competition; wind power can be plentiful at night costing under 9 cents/kWh. Texas residential power rates can be some 37% less than California, its commercial & industrial rates about 50% less. Other things are not as good there; Texas still makes ~20% of its power by (ugh) burning coal, and around half from natural gas. Wind is growing, fast, but is around yet a 20% figure, like coal. And lacking interconnections to the Eastern and Western grids, it is somewhat islanded.

By contrast California is more regulated, its power much more costly. In San Diego for example on time of use, nighttime is great for electric car charging – similar to Texas; but then San Diego fast jumps up to a more costly 29 cents for much of the day – and may leap to 50 cents late afternoon. Costs near 35 cents/kWh partly due to little competition and much regulation. And California imports much CO_2-laden yet badly needed brown power especially in heat waves roiling a West. Lacking in energy storage, facing wildfires, 2020 saw rolling blackouts in the Golden State. Texas, also lacking storage, was hit by blackouts due to cold 2021.

In past, Texas wasn't thought of as Clean Energy incubator, nor innovator. Oil & gas, sure. But Texas is open to energy innovations – with less regulations, more flexibility vs. California. On the other hand, Texas is quite vulnerable to climate change. CO_2 *may* cause sudden heating in the stratosphere, weakening a polar vortex boundary over Arctic; ironically global warming *might* then mean bitterly cold Arctic air reaching riefly to say, Texas. Record cold snaps once regarded as only every 100 years, may need to be regarded as every 20, even 10 years. Weather extremes trying fossil fuel infrastructure. Un-weatherized natural gas then exposed; wind turbines too. Blackouts and grid outages due to severe cold, or heat. Lacking grid interconnections, no demand response only heightens the matter. Renewables like wind aren't to Blame for the blackouts, though green critics doubtless try. Instead, new wind power may arise like in Iowa that once was an EV capitol. In Oklahoma, Kansas, Illinois. Offshore Great Lakes, East West Texas coasts maybe offshore wind powerhouses. Importantly with equity, inclusion, environmental justice all while building back better.

Consider CO_2: A Topic Gaining Importance

For 20 years our emphasis at benchmark Clean Energy Index® has been *Solutions*. Not just on CO_2 nor Climate Change *per se* – but in helping to move forward solar, wind, electric cars: new path both ecologically & economically better. Warming's threat is a core driver - but that CO_2 hasn't been a focus of Reports. Lately, however climate's impacts are nearer worst ends of what models foresaw. In short: CO_2 matters increasingly, so let's address it here.

In an acute example of this science, a recent article in the Proceedings of National Academy of Sciences warns that in a span of just a "coming 50 years, 1 to 3 billion people are projected to be left outside the climate conditions that have served humanity well over the past 6,000 years." On current trends of CO_2 and population, a narrow temperature niche our species has long required, is projected to change more in just next 50 years, than past long six millennia! See Chi Xu, Timothy Kohler et al, *Future of the Human Climate Niche*. PNAS (4 May 2020). https://www.pnas.org/content/early/2020/04/28/1910114117

Hence this Report's brief excursion here into climate as relevant to clean energy's story. And consideration too of Environmental, Social & Governance/ ESG factors (especially 'E'). First note: CO_2 is a hero to our species – in moderation. Earth without its CO_2 may have had frozen zero degree C surface temperatures. Instead, warming thanks to small CO_2 concentrations well under 400 ppm, greenhouse gases naturally gifted us surface temperatures near ideal for us, 59 degrees F. We'd habituated to that in hundreds/tens of thousands of years.

In the late 1950s when regular CO_2 monitoring began, modern readings had already risen from what had long been around 280 PPM, to 315 PPM. By 1988, scientists became alarmed by planetary warming as that increasing CO_2 then reached 350. Worried, a world conference held in that year called for reducing from that high 350 figure, downwards -20% by 2005.

In 1992 a global compact was reached. Signed in Rio this U.N. Framework Convention on Climate Change lacked specific cuts. Looking back that nebulous agreement to try to act was a real failure – nowhere close to task. CO_2 continued on rising sharply. Rio only implied *cuts,* like calling for global emissions to be -20% lower in 2005 – yet instead, CO_2 as it turned out instead grew - going +34% *higher by 2005*. Looking back, it went on rising another +22% higher by 2017 - to over 400 ppm in 2020s, higher than at least the last 3 million years, maybe highest of the last 12 million years. So merely aspirational words, absent real acceptance and robust action has woefully not achieved what's been needed on decarbonization for climate.

Yes, specific cuts were laid out 5 years after, in a 1997 Kyoto Agreement on climate. Yet CO_2 went on rising, even more sharply. It's been a mockery of 'acting' on CO_2. International agreement was again tried, in 2009; that Copenhagen event also failed. CO_2 levels continued increasing, temperatures spiking up. In 2015 a Paris Agreement was roughly more of the same, CO_2 is still on a fast uphill, scary climb. By 2020, only 3 countries had met early target Paris terms: the Marshall Islands, Suriname, & Norway which made up only 0.1% of emissions globally. So there's No cause for optimism. A gathering in Glasgow 2021 was meant to take stock of progress – yet truth is despite the flowery words, there's been woefully none.

In sum commitment Isn't There. That's why it's now crucial that 1) clean energy's costs beat, *unsubsidized,* fossil fuels; 2) there's a growing recognition of science, first from Europe, and 3) since COVID-19's crashing oil demand, the idea of decarbonizing away from dirty fossils – into cleaner paths while creating jobs – is more approachable worldwide.

Looking near-term decades ahead to early 2100, there's some good news. Intercomparisons of some 56 climate models, indicates most awful possibilities *may* be perhaps a bit less likely. Barring say methane feedbacks, underseas clathrates, water vapor, or permafrost, and hoping for no other major contributions, then of models, the scariest rises near 9 degrees F by 2100 *may be* less likely on current understanding. (Less than 9 F from 2021, since there's already been some warming to now). Those models assume high fertility, widespread coal still worldwide, and failure to strongly embrace renewables. Such models may be rather more unlikely at their highest/ worst-case ends predicting (unbearable) 9 degrees F warming.

Yet if we regard that highest end Representative Concentration Pathway (RCP) unlikely, heavy CO_2 emissions in so-called RCP 8.5 – then we should also regard lowest RCP 2.6 as even more unrealistic. It assumes widespread vigorous embrace of renewables that's already far greater than seen, and No coal; neither (especially the latter) is close to accurate in 2020.

And a low-end of that wide band heavy-emissions RCP 8.5 band, seems scarily still feasible. That foresees arguably catastrophic rise of near 7 degrees F possible, soon as 2100s. Even say 'low-end' RCP 8.5 possibilities ought to concern nations & political leaders greatly. RCP 8.5 was one basis for predictions (above) of the mass loss of inhabitable climate by 2100.

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

That assumes a CO_2 equivalent to about 850 ppm, about 2x now. For data nerds like ourselves, this translates to radiative forcing of 6.0 Wm^2 post 2100, 6 watts/square meter for RCP 6.0. (RCP 8.5 translates for example to 8.5 Wm^2). This reflects influence of how altered incoming solar energy vs. outgoing balance is in our Earth-atmosphere system. Consequences of that may be dire for our species over centuries ahead seems about what one may 'hope for'.

Next, better, very ambitious is most hoped for RCP 4.5: emissions peak in about 20 years near 2040, then fall fast. Thus CO_2 not long ago stable near 280, now >400 & rising fast, under this scenario only goes on to 'just' some 650 – unlikely stopping. Strong decarbonization is assumed here undertaken, now, with CO_2 slowly dropping. That *might* be possible, although it's a huge stretch to be sure. And very unlikely given the present. CO_2 is already some 50% greater than roughly 278 ppm pre-industrial era; and rising fast. Especially improbable, since hundreds of new coal plants are *being built, right now* in 2021. Each has working lives 20 years or more, hence shall be operating in 2040s and after, unless they are prematurely shuttered.

Renewables still make up only some 20% of electricity in many nations (although growing), coal is still burned widely, cars mainly oil-powered: ambitious RCP 4.5 is a very unlikely bet. That said 'unexpected' events like ice sheets destabilizing, might catalyze stronger action. COVID-19 plus say, sudden scary events, could hasten strong and real action on climate.

Climate models, inevitably, are getting more complicated. Until recently they'd ignored e.g. ice sheet destabilization, seas melting glaciers from below. Yet if a big pulse of change gets visibly underway, then skeptics may melt away too. Especially when clean energy is the *most economical choice*, it creates jobs, it alone can go unsubsidized, and may save us.

Inertia, Even on Decarbonized Power Grid 2040, Climate Neutral World by 2070

Lastly let's imagine decades hence. Europe & US were aided by low-cost solar from China, cheap renewables, energy storage, and on great efforts,they 1st reached 100% carbon free power in 15 years by 2035. Rest of world got there 2050. Electric cars scaled immensely, faster than was expected! Green H_2 to fore in industry. Richest nations climate neutral by 2050. China, on much nuclear, got there by 2060, meeting its targets. Rest of world by 2070 although with much fudging like CCS, and in hoping Earth's 'natural sinks' remain so.

That timeline, fairly ambitious, is absolutely do-able. Unfortunately, mainstream science also indicates inertia in this CO_2 scenario may thus destroy much of the world's low-lying lands & megacities due to sea-level rise from climate change. It blows past a 2 C Paris goals (to say nothing of 1.5 C) and could land us all unbearably at 5 or 6+ degrees C hotter.

That's not alarmist. It's where science dispassionately points us. Maybe unbearably hotter - yet growing. Decades, centuries or more of sea level rise. It's possible such rise can in just a few centuries mean destruction of Florida, and New York City. Inundating large parts of the US Eastern seaboard, US Gulf Coast, parts of the US West Coast. Indigenous peoples had once lived around what's the City of St. Augustine, Florida, a City 'founded' in 1565, about 440 years ago. Yet we may be past half-way point of that City, or say, lovely Jupiter, Florida, Miami, or New Orleans etc - none of them having a further 400 years ahead.

Let's begin just 80 years hence. Some aspects of what's projected by UN Intergovernmental Panel on Climate Change (IPCC) about sea level rise, in 2100, may be just a bit misleading. End of century, rise may be unwinding at more rapidly accelerating rates, than what's been regarded as projected by the IPCC. Getting this wrong, now, policy may allow too much CO_2 and so an inertia building unduly. Something that can't then be halted, nor unwound.

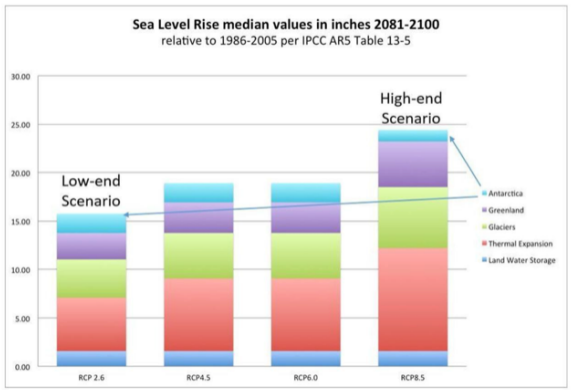
That actual sea levels seen 2100, could be greater than IPCC projections is well laid out in the 2020 piece, 'Twenty-first century sea-level rise could exceed IPCC projections for strong-warming futures' by M. Siegert et al., One Earth, 3 (Dec. 18, 2020).
https://doi.org/10.1016/j.oneear.2020.11.002

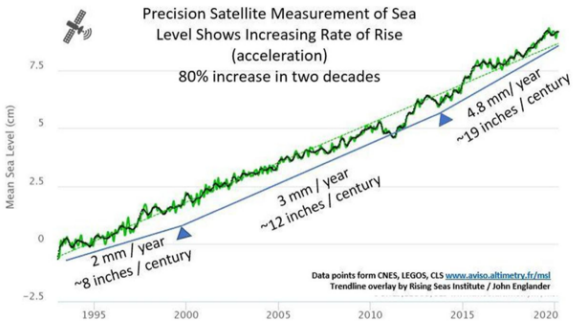
Their first paragraph nicely lays out in cogent clear words what scientists may find mainstream – yet these same thoughts ought to be viewed by a wider public with alarm:

> Since around 1850, the concentration of atmospheric CO2 has risen from ~280 to over 415 parts per million (ppm), resulting in a global mean temperature rise of ~0.9 C – 1.2 C. Even if human-caused emissions are reduced to net zero by 2050, global temperatures may rise to more than 1.5 C above their pre-1850 levels. Global CO2 emissions are still on the rise, however albeit with a slight coronavirus disease (COVID-10) 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.

Near-term, end of century on strong warming, seas soon in 2100 may be quite higher than a usually accepted IPCC range of 0.61m -1.10m, or what public calls roughly 1-3 feet. In particular, upper end projections are unduly taken by laypersons as maxing out at about 1.1 meter (~3 feet) – yet that's in fact not true ceiling at all. It could be much higher.

Because uncertainty cloaks immense Antarctic dynamics, computer models exclude unclear mechanisms - potential rise there is hazy. Shorn of important details, an absence of certainty here strongly suggests rise *may max out at more than* 1.10 meters, >roughly 3 ft. Difficulty in modeling aspects of ice sheet / glacier dynamics in a nutshell, potentially has left possibly greater Antarctica contributions out. That foreshortens complex & cascading rise potentially as a major factor. Especially in the higher heat scenarios, where we seem to be trending in comparing recent models to reality. Yet IPCC high-end curiously indicates eg the least rise is coming from Antarctica, even in the RCP8.5 highest heat scenario IPCC AR5:





Source for both charts: J. Englander. See also, J. Berandelli, 'Sea-level rise from climate change could exceed the high-end projections, scientists warn'. CBS News. December 23, 2020.

Centuries and millennia ahead are of greater concern. Scientists understand a crucial fraction of airborne carbon already emitted from the industrial revolution, plus from this century (and perhaps next) can persist for thousands of years. In short CO_2 released from a relatively brief window extending from just 150 years ago, to a mere 1-2 centuries ahead, even if emissions are halted in 5 decades ahead, may have committed the world to great inertia seen in oceans. Impacts from rising seas, going on for maybe centuries, even perhaps many millennia.

Science suggests many tens of feet of rise, or more are possible on CO_2. An accelerating rise, maybe getting locked-in, perhaps going for thousands of years. Past rise seemingly happened in non-linear ways, at times quickly. A meltwater pulse due to the CO_2 from natural causes, at rates less than now, caused seas to rise between 50 ft and 80 ft in just 400 - 500 years.

That is to say, massive ice sheets having once retreated very swiftly before, could do so again. Especially as we're engaging in pulling all kinds of climate levers, releasing CO_2 and potent other greenhouse gases at rates not seen before. Global reshaping is what we're talking about. So put aside for a moment, noisy political debate. Ignore too the other impacts, say, new diseases, storms, famines, droughts, collapsing ecosystems, follow-on consequences spreading beyond like ripples on a pond. Just impacts of seas rising, alone, is enough.

Climate & ocean inertia is something that we've written about - see eg Scientific American, Oct. 19, 2016 - observing for example how problematically models projecting scenarios of climate change forecast only out to a year 2100, at times just to 2050. As a result the public discussions have been mostly framed as "X degrees of warming" or "Y feet of sea level rise" just to end of century, only. We've accidentally but notably limited our thinking, causing us to miss striking impacts that may go on & on, beyond an artificial, specific time horizon. https://blogs.scientificamerican.com/guest-blog/exposed-the-climate-fallacy-of-2100/

No doubt the great citizens in and politicians representing Miami, and State of Florida intend for these places to exist beyond a few centuries. Same for New York City, Boston, Washington D.C., London, Shanghai, Amsterdam, Mumbai and so on. Yet leaders oft discount the staggering losses these places *may* face ahead. That's due to a 2100 horizon.

Anything like sea level rise going potentially for centuries, or thousands of years, essentially means "forever" on human time scales. These new data imply that 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. In short inertia of our actions in a few decades, lingers.

And so we do ourselves a dread disservice by consistently framing just very near-term 2100 as essentially last, final year of impacts. We're thinking in blinkered way decades out, while our foot presses hard on warming 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 and from a scientific perspective.

The data show how in recent past, a major rise in CO_2 and warming starting from 20 millennia crucially ago had brought Earth out of a last ice age. Air temperatures continued to rise over a period from that Ice Age, to the roughly modern climate that began some 11 millennia ago. From that point, onward, both CO_2 levels and air temperatures sharply leveled off.

Sea levels, which were initially 400 feet lower than today, did not stop rising, however. They *continued rising long past when air temperatures reached their plateau*, rising for another 8,000 years, climbing another 150 feet to today's height. Oceans did not achieve the near-current state we all know as modern coasts and maps, until roughly 3,000 years ago.

This mere sliver (in geologic time) of climate stability lasting past 10 or so millennia, dearly helped human societies and cultures to flourish. But a lesson ought to be that the seas are acutely sensitive to CO_2, and temperatures, and they can have inertia lagging the carbon cycle and climate systems. That means today's oceans *could* go on rising for very long periods after CO_2 might be steadied—even if humanity takes determined actions to slow rising CO_2 worldwide, and then decrease emissions. This thorny fact is not widely appreciated.

Combine that CO_2 persistence with an inertia of seas, and it *could potentially* mean that sea rise *might go on* for a millennium, or more - the unimaginable. Despite our hubris, there's no easy off switch to halt rising seas. No matter how much future societies may wish it to end.

Opportunity for us all to go on ignoring this possible dynamic, according to accepted science, is growing vanishingly small. There's already been well-accepted over 1.5 degrees C increase in global temperatures of late. That rate of change, alone, seems to come close to what have been the greatest natural variations that have occurred over the previous 10,000 years.

So current rates of change are very concerning. It had taken a long period from some 21 millennia to 12 millennia ago, for atmospheric CO_2 levels to jump by 80 parts per million - from about 190 to 270 ppm. Over that span global temperatures rose an average 7 degrees F. We're on track to maybe repeat that kind of increase over a far, far shorter period.

So what does all this mean for sea level rise?

An international panel in 2013 had given scenarios for rise in this century mainly based on a straightforward expansion of warming oceans. They had only allowed then for a small influence from marine ice-sheet instability, known as MISI, primarily on the assumption that Antarctic ice sheets were too stable and vast to irreversibly shrink during this century.

The report presented an optimistic lower-end CO_2 scenario that assumed strong actions would be taken later on in this century to reduce CO_2 emissions, and predicted on that an estimated just 1 foot of rise (0.3 to 0.6 meters) by 2100. The high-end estimate, based on current trends continuing and little strong action this century to reduce CO_2, led to about 3.5 feet of rise by 2100, with the rate increasing rapidly to between one third to over half of an inch (8 to 16 millimeters) per year, during the last two decades of this century. Such a rate just under a century hence, could be up to 10 times the 20th century average rise and it might possibly start to approach what had occurred around end of the Ice Age, when seas rose rapidly.

In years since that major report, several newer papers on ice-sheet dynamics have shown our prior understanding was incomplete, and that MISI mechanisms may be much more extensive across the Antarctic. The enormous Pine Island Glacier in Antarctica, for example, looks to be currently thinning and retreating at quickening rate. Like a cork in a champagne bottle, it holds back much greater rise. Mechanisms in newer models show mass loss by unstable retreat may potentially become significant, sooner than expected. Some early collapse may be starting perhaps at Thwaites Glacier now. Unexpected collapse of the Antarctic marine ice sheet could cause previous upper estimates of sea level rise to be exceeded, not long after the end of this century. Although the timescales are profoundly uncertain, much more rapid collapse *could* occur possibly in a relatively short time period of say, two to nine centuries.

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

Consider: likely CO_2 can make a complete failure of pouring billions or trillions of dollars into armoring coastlines. One can imagine enormously long and expensive walls, say 10 feet high, being topped in just a century or two. One can't even imagine bigger seawalls able to handle what could become oceans going 50 feet higher and rising without pause.

The point here is that 2100 shouldn't be regarded as a terminal year. Nor 3.5 ft of sea rise. To do so, is folly; it's wrong-thinking. Life goes on, people do not end there, it's but a year on an artefact human calendar: the world's seas will not suddenly halt their rising then.

Scientists are natural skeptics, not prone to dramatize their findings. But cause for abundant hope is fading. That ought to stretch our thinking. Listening to the sea, and to science, ought to adjust our thinking about what's wise. Paleoclimate records indicate that in periods of meltwater, or termination of last 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 still rise by yet (much) faster rates ahead. Given aggressive CO_2 trends, it must be considered.

Keep in mind what big rates and big scales of change may mean. A difference of 7 degrees F has separated today's "ideal" climate - from extreme conditions of an ice age. In a refresher, the Ice Age had built up ice sheets over Canada, New England, North Midwest US, Northern Europe, Northern Asia. Great Lakes were born of sheets retreating. Meltwater retreat made Long Island, NY, & Cape Cod. Huge impacts thus wrought by a 7 degrees F 'delta': ice stood two miles tall over some of North America, shaping whole continents we know today.

Just imagine if there's another 7 degrees F of global warming, ahead. Certainly, it would alter land, sea & ecology in scales and ways hard to fathom. Looking back to Earth's more distant past, it's conceivable on a temperature rise "only" 2 to 5 degrees F warmer, seas could rise in non-linear ways say, say 15 to 65 feet, a level drowning much today like Florida. In a thought experiment adding 5 degrees F warming is very imaginable on trends of increasing CO_2. So it is reasonable to imagine seas 60 feet higher. No seawall could ever stop that. It renders the shape of many whole countries as we know them, today, a distant memory.

Mechanisms by which this happens are easy to fathom. Greenland's ice sheet stores 'only' 22 feet of potential sea level rise, possibly ongoing some 10 millennia. However, Antarctic ice sheets store much more: 150 feet of potential rise in that same time frame. Ironically, over a past dozen+ years, the East Antarctic ice sheet annually gained some 175 trillion pounds of thin new ice (precipitation). But West Antarctic annually has lost much more, some 275 trillion pounds of critical ice. Plus Greenland has averaged 600 trillion pounds of ice lost yearly, which is equivalent to 10 billion trucks a year carting ice away to melt in the sea.

With CO_2 plus inertia, we may be heading beyond conditions known in human history. Earth may begin to exhibit changes of states that only can be guessed at. A new study for instance, shows net melting is causing Earth to slightly change how it moves on its polar axis. Days are getting just very slightly longer, as ice melts at poles and redistributes mass as water towards a bulging equator. Very tiny change in Earth's spin may not seem (at first) troubling, yet it helps to show magnitude of changes possible from CO_2. Or the Gulf Stream that has made Northern Europe far warmer than 'it should be', appears to already be slowing significantly.

Just a century from now, perhaps even only decades hence, the science implies people may look back on our current era - with its record-breaking high temperatures year after year and storms, or bitter cold snaps, rapid disappearance of Arctic sea ice, gradually rising sea levels - as part of a much cooler far more desirable past. One that can never be recovered.

A tiny sea level change we're accustomed to now - rising only a little over 1 inch per decade and considerably faster than 50 years ago - might jump to many inches per decade. That ramp could just be beginning. Early maybe irreversible glacial collapse in Greenland and Antarctica indicate that *considerably more rapid rise might possibly* be in store. The issue is that it's impossible to say exactly when, or even if, this might even occur. A delta could be huge.

Based on what we'd been prepared to give before, 2020s may feel like progress. Clean energy 'fast' (not really) replacing fossil fuels. But based on the CO2 budget, even 'ambitious' action places us in a maybe unbearably hot future, fast-rising seas or worse. Once we got our energy from beneath our feet, underground. That it was high-carbon was not viewed as a problem. Thankfully modern clean energy increasingly is from up above towards the Heavens. It renewably shines on our faces, and cleanly blows across our cheeks, in ways sustainable, desirable, economic, and arguably a better future if we can make it …

Conclusion:

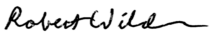
The Clean Energy Index® (ECO) started out 1st Quarter & 2021 near 215, and ended Q1 around 200, down roughly -7%. After +205% gains 2020 when this decarbonization story rose 6-fold, for a best performance of most any Index or Fund anywhere, a sell-off was maybe overdue. Thus it wasn't so surprising, especially after seeing ECO Index® drop by one-half in Feb/March of 2020 – to see it dropping hard Q1 by one-third February/March 2021 from 280 to 180. Volatility is also partly due to big, pro-clean energy policies increasingly now happening for this theme worldwide. Since start of 2017 when ECO was then at 38, it's now up +410%.

There was a classic sharp sell-off in Q1; ECO & NEX each dropped by around one-third. Last 5 years the Benchmark ECO Index® live since 2004 and 1st for climate solutions is up +400% over a time when *any* energy gains are arguably notable. The same 5 years, CO_2-laden energy themes are far negative, with oil & gas far down -50%. Both ECO/NEX have outperformed too, versus a good but separate & concentrated independent global clean energy Index.

There are many new & relevant equities of late. No ECO Deletions for start of Q2; the 10 Additions to ECO for Q2 were: Advent, Aemetis, Canoo, Chargepoint, Gevo, MP Materials, Piedmont Lithium, Romeo, Shoals, Sunworks. At Global NEX, 2 Deletions for Q2 were Albioma, Veeco; the 25 Additions were: Aemetis (US), AFC Energy (UK), Aker Offshore Wind (Norway), Arise (Sweden), Canoo (US), Cell Impact (Sweden), Chargepoint (US), EcoPro BM (S. Korea), Everfuel (Denmark/Norway), Gencell (Israel), Gevo (US), Greenlane Renewables (Canada), Hexagon Purus (Norway), Hydrogen Refueling (France), HydrogenPro (Norway), Invinity (UK), Montauk Renewables (US), MP Materials (US), Piedmont Lithium (US), Powerhouse (UK), Proton Motor (UK), SFC Energy (Germany), Shoals (US), Sunworks (US), Voltalia (France).

As always, we welcome your thoughts and suggestions.

Sincerely,



Rob Wilder
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Appendix I:

ECO Index (via independent tracker PBW) Descending Weights latter-Q1 on 3/14/2021, or about ~2 weeks before rebalance to start Q2 2021, 56 Stocks:

Name	Symbol	Weight %
Daqo New Energy Corp ADR	DQ	3.49
ReneSola Ltd ADR	SOL	3.35
Lithium Americas Corp	LAC	2.70
Arcimoto Inc	FUV	2.49
Fisker Inc	FSR	2.49
FuelCell Energy Inc	FCEL	2.46
Quanta Services Inc	PWR	2.26
Sociedad Quimica y Minera Chile	SQM	2.25
GreenPower Motor Co Inc	GP	2.24
Plug Power Inc	PLUG	2.21
MYR Group Inc	MYRG	2.21
Maxeon Solar Technologies Ltd	MAXN	2.15
Willdan Group Inc	WLDN	2.11
Ormat Technologies Inc	ORA	2.05
SunPower Corp	SPWR	2.05
Gentherm Inc	THRM	2.01
Albemarle Corp	ALB	1.99
Tesla Inc	TSLA	1.98
Livent Corp	LTHM	1.95
NIO Inc ADR	NIO	1.88
Ballard Power Systems Inc	BLDP	1.87
Eos Energy Enterprises Inc	EOSE	1.87
American Superconductor Corp	AMSC	1.86
Kandi Technologies Group Inc	KNDI	1.86
TPI Composites Inc	TPIC	1.85
ESCO Technologies Inc	ESE	1.83
Itron Inc	ITRI	1.82
Advanced Energy Industries Inc	AEIS	1.79
Cree Inc	CREE	1.78
Canadian Solar Inc	CSIQ	1.77
Ameresco Inc	AMRC	1.74
Universal Display Corp	OLED	1.72
Woodward Inc	WWD	1.66
Azure Power Global Ltd	AZRE	1.65
Infrastructure and Energy Alter.	IEA	1.65
First Solar Inc	FSLR	1.62

Bloom Energy Corp	BE	1.61
Renewable Energy Group Inc	REGI	1.61
XPeng Inc ADR	XPEV	1.59
Array Technologies Inc	ARRY	1.59
Sunnova Energy International Inc	NOVA	1.57
Sunrun Inc	RUN	1.53
ElectraMeccanica Vehicles Corp	SOLO	1.52
Enphase Energy Inc	ENPH	1.51
SolarEdge Technologies Inc	SEDG	1.50
Air Products and Chemicals Inc	APD	1.47
Beam Global	BEEM	1.47
Blink Charging Co	BLNK	1.44
Workhorse Group Inc	WKHS	1.39
JinkoSolar Holding Co Ltd ADR	JKS	1.39
Lordstown Motors Corp	RIDE	1.29
QuantumScape Corp	QS	0.96
AYRO Inc	AYRO	0.55
SPI Energy Co Ltd	SPI	0.49
Broadwind Inc	BWEN	0.46
Flux Power Holdings Inc	FLUX	0.44

There's strong representation at top in *Solar, *Electric Vehicles, *Lithium/Batteries, and Hydrogen Fuel Cells.

Starting March 2021: Effective First Quarter 2021, quarterly Rebalance announcements for WilderHill Clean Energy Index (ECO) occur after close on the sixth index business day prior to last index business day of month - March, June, September, December: announcements are made by the New York Stock Exchange. (Later posted on our site only in new month).

Applied Renewables I: In 2020 State Flex alert California's Energy *Cushion fell near-zero!*

Demand in a Heat Wave on Sept. 7, 2020 nearly Exceeded All Available Capacity 53,347 MW – Forecast Afternoon Peak Demand hitting 44,074 MW (and was 48,522 MW day before)! That left almost no cushion against Blackouts; yet 53,000 MW+ Demand is foreseeable. Emergency steps, only, got supply just >50,000 MW. Far more Renewables + energy Storage needed asap. Rather than Natural Gas (less effective in heatwaves) or electricity Imports making more CO2 – climate demands CO_2 go towards zero. O too much carbon-power still comes from Gas, and from neighboring States likewise in dire straits during big dome heat waves. Solar can help to right matters vs gas and carbon-heavy imports - but only in daylight and it's still too small. Far more Renewable Solar/Wind, plus Batteries and Energy Storage, must play far larger roles ahead to grow clean supply. Texas, by contrast less regulated, is growing renewables faster – but it sorely lacks in needed Weatherization of its existing energy assets, and needs more Storage too as seen in February 2021 on a blackout disaster due to lost natural gas!!

See: CAISO.com – Sept 7, 2020 at 1:50 pm. See caiso.com/TodaysOutlook/Pages/supply.html

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

INDEX (ECO) SECTOR & STOCK WEIGHTS FOR START OF Q2 2021. 66 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 - 19% weight (10 stocks @1.80% each +2 *banded)
Array Technologies, ARRY. Solar, tracker mounts follow sun through the day
Azure Power Global, AZRE. Solar, India; aims for very low-cost green energy.
**Broadwind,* BWEN. Wind, steel towers, gearing fabrication, and solar arrays.
Canadian Solar, CSIQ. Solar, vertically integrated solar manufacturer, China.
Daqo New Energy, DQ. Solar, polysilicon/wafer manufacturer; China-based.
First Solar, FSLR. Thin film solar, CdTe a low-cost alternate to polysilicon.
JinkoSolar, JKS. Solar, wafers through solar modules, China-based OEM.
Maxeon, MAXN. Solar, efficient PV panels after spinoff from Sunpower.
Ormat, ORA. Geothermal, also in areas of recovering heat energy.
Renesola, SOL. Solar, project development and operations, China & globally.
**SPI Energy,* SPI. Solar and EVs, develops solar projects, subsidiary is in EVs.
TPI Composites, TPIC. Wind Blades; also light-weighting for transportation.

Energy Storage - 25% sector weight (15 stocks @1.63% each +1 *banded)
Albermarle, ALB. Lithium, specialty materials in batteries for energy storage.
Chemical & Mining of Chile, SQM. Lithium, large producer for energy storage.
Eos, EOSE. Zinc grid batteries, 100% depth discharge, longer-life, is not li-ion.
**Flux Power,* FLUX. Batteries, lithium-ion packs for fork lifts, stackers.
GreenPower Motor, GP. Large EV, electric transit buses, transit, school buses.
Kandi, KNDI. EVs, inexpensive small cars early-stage, battery exchange, China.
Lithium Americas, LAC. Lithium, deposits in State of Nevada U.S. & Argentina.
Livent, LTHM. Lithium, and compounds used in batteries for energy storage.
Lordstown Motors, RIDE. Electric commercial pickup trucks, American startup.
NIO Inc, NIO. EVs, China-based startup premium vehicles, battery as a service.
Piedmont Lithium, PLL. Lithium, US domestic source battery-grade lithium.
Quantumscape, QS. Battery, solid state lithium-metal energy dense fast charge.
Romeo, RMO. Battery packs, designs & builds energy systems and snap in use.
Tesla, TSLA. Electric vehicles, pure-play across EVs, advanced energy storage.
Workhorse, WKHS. Electric Vehicles, large electric delivery trucks, early-stage.
Xpeng, XPEV. Electric vehicles, advanced mobility, swappable batteries, China.

Power Delivery & Conservation - 23% sector (16 stocks @1.43% each)
Ameresco, AMRC. Energy saving efficiencies, net zero CO_2, decarbonization.
American Superconductor, AMSC. Wind, grid conditioning; superconductors.
Arcimoto, FUV. EVs, smaller very low-cost 3 wheeled electric vehicles.
Ayro, AYRO. EVs, compact fleet vehicles university & corporate campuses.
Blink Charging, BLNK. EV Charging, among bigger EV charging networks in U.S.
Canoo, GOEV. Electric delivery vehicles, configurable may be multipurposed.
Chargepoint, CHPT. EV Charging, global including for fleets and businesses.
Electrameccanica Vehicles, SOLO. EVs, 3 wheeled and custom electric vehicles.
Fisker, FSR. EV crossover SUV, is assembled by contract manufacturer.
Infrastructure and Energy, IEA. Renewables, power generation to delivery.
Itron, ITRI. Meters, utility energy monitoring, measurement & management.

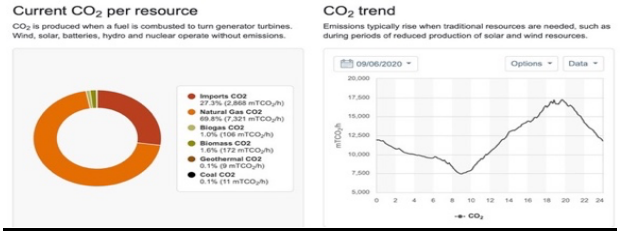
MYR Group, MYRG. Grid transmission and distribution, for solar & wind farms.
Quanta Services, PWR. Infrastructure, modernizing grid & power transmission.
Shoals, SHLS. Solar, electrical balance of system (EBOS), wiring, combiners.
Universal Display, OLED. Organic light emitting diodes, efficient displays.
Willdan, WLDN. Efficiency, in distributed energy, renewables, engineering.

Energy Conversion - 19% sector weight (13 stocks @1.46% each)
Advanced Energy, AEIS. Power conditioning: inverters, thin film deposition.
Advent, ADN. Fuel cells, high temperature so fuel-flexible for diverse uses.
Ballard Power, BLDP. Mid-size fuel cells; PEM FCs as in transportation.
Bloom Energy, BE. Stationary fuel cells, not-yet cleanest/renewable fuels.
Cree, CREE. Power electronics, electrifying EV power, SiC, converters.
Enphase, ENPH. Microinverters, also energy storage systems and software.
ESCO Technologies, ESE. Power management, shielding, controls, testing.
FuelCell Energy, FCEL. Stationary fuel cells, distributed power generation.
Gentherm, THRM. Thermoelectrics, heat energy, battery management.
MP Materials, MP. Rare Earths, US domestic source of Neodymium, NdPr etc.
Plug Power, PLUG. Small fuel cells, for eg forklifts; drop in replacements.
SolarEdge Technologies, SEDG. Inverters, solar optimizers, inverters.
Woodward, WWD. Converters, controls for wind power, energy storage.

Greener Utilities – 8% sector weight (5 stocks @1.60% each)
Beam, BEEM. EV Charging, rapidly deployable portable PV powered utility.
Sunnova, NOVA. Solar provider, operating fleet for residential, plus storage.
SunPower, SPWR. Solar system provider, storage and distributed generation.
Sunrun, RUN. Residential solar systems, lease, PPA or purchase rooftop PV.
Sunworks, SUNW. Solar installations, 1-stop for commercial and residential.

Cleaner Fuels – 6% sector weight (4 stocks @1.50% each)
Aemetis, AMTX. Biofuels, renewable jet fuels, hydrogen, low-carbon diesel.
Air Products & Chemicals, APD. Hydrogen, projects for green hydrogen (H_2).
Gevo, GEVO. Biofuels, lower carbon liquid fuels from renewable sources.
Renewable Energy Group, REGI. Biodiesel, natural fats, grease to biofuels.

Practical Issues in Renewables II: In a California Flex Alert, CO_2 Emissions were Allowed to Spike to get Supply High as Possible >50,000 MW to meet demand. Natural gas+peaker plants all maxed at 100%, no maintenance, more (dirty) imports from out of State. Demand in California eg in a Heat Wave, Sept. 5, 2020 outstripped normal capacity. Demand not yet at peak in late-day, wind nominal, solar power troublingly about to fall hard. California's Demand History shows that Renewables+Batteries must grow very, very fast as huge energy efficiency strides already made – and California is now adding more electric vehicles swiftly creating more demand - with Demand already at times over 50,000 MW:



Source: CAISO.com - Sept. 6/7, 2020 at 2:30 p.m.

Appendix III: **WilderHill New Energy Global Innovation (NEX)** descending weights late-Q1 via independent tracker (PBD) 3/14/21, ~2 weeks before Rebalance to start Q2 2021. 102 stocks:

Name	Symbol	Weight %
FuelCell Energy Inc	FCEL	1.95
ReneSola Ltd ADR	SOL	1.81
Lithium Americas Corp	LAC	1.68
Plug Power Inc	PLUG	1.50
Daqo New Energy Corp ADR	DQ	1.49
Fisker Inc	FSR	1.36
GreenPower Motor Co Inc	GP	1.35
SunPower Corp	SPWR	1.31
Maxeon Solar Technologies Ltd	MAXN	1.23
Ballard Power Systems Inc	BLDP	1.22
Ganfeng Lithium Co Ltd	1772 HK	1.20
Iljin Materials Co Ltd	020150 KS	1.18
Eos Energy Enterprises Inc	EOSE	1.18
ITM Power PLC	ITM LN	1.17
Grenergy Renovables SA	GRE	1.14
Veeco Instruments Inc	VECO	1.11
Arcosa Inc	ACA	1.11
Sociedad Quimica y Minera Chile	SQM	1.10
Tilt Renewables Ltd	TLT	1.10
Cree Inc	CREE	1.10
Willdan Group Inc	WLDN	1.10
American Superconductor Corp	AMSC	1.07
Samsung SDI Co Ltd	006400 KS	1.06
VERBIO Vereinigte BioEnergie AG	VBK	1.06
Signify NV	LIGHT	1.06
Xinjiang Goldwind Science	2208 HK	1.04
Flat Glass Group Co Ltd	6865 HK	1.04
Livent Corp	LTHM	1.04
Bloom Energy Corp	BE	1.03
Renewable Energy Group Inc	REGI	1.03
Acciona SA	ANA	1.02
Novozymes A/S	NZYMB DC	1.02
TPI Composites Inc	TPIC	1.01
Motech Industries Inc	6244 TT	1.00
Itron Inc	ITRI	0.99
Canadian Solar Inc	CSIQ	0.99
TransAlta Renewables Inc	RNW	0.99

Ormat Technologies Inc	ORA	0.98
Nordex SE	NDX1	0.98
Xinyi Solar Holdings Ltd	968 HK	0.97
Boralex Inc	BLX	0.97
2G Energy AG	2GB	0.97
Ceres Power Holdings PLC	CWR LN	0.96
BYD Co Ltd	1211 HK	0.96
Falck Renewables SpA	FKR	0.96
GS Yuasa Corp	6674 JP	0.96
Eolus Vind AB	EOLUB SS	0.95
Kingspan Group PLC	KSP	0.95
Nibe Industrier AB	NIBEB SS	0.95
Sunnova Energy International	NOVA	0.94
United Renewable Energy	3576 TT	0.93
Enlight Renewable Energy Ltd	ENLT	0.93
Siemens Gamesa Renewable	SGRE	0.92
NIO Inc ADR	NIO	0.92
Ameresco Inc	AMRC	0.92
Koninklijke DSM NV	DSM	0.92
Verbund AG	VER AV	0.92
Sunrun Inc	RUN	0.91
Enphase Energy Inc	ENPH	0.91
Hannon Armstrong Sustainable	HASI	0.91
CS Wind Corp	112610 KS	0.90
Renewables Infrastructure	TRIG LN	0.90
CropEnergies AG	CE2	0.90
Greencoat UK Wind PLC/Funds	UKW LN	0.90
Gurit Holding AG	GUR SW	0.88
PowerCell Sweden AB	PCELL SS	0.88
SMA Solar Technology AG	S92	0.88
NEL ASA	NEL	0.88
Alfen Beheer BV	ALFEN	0.87
Terna Rete Elettrica Nazionale SpA	TRN	0.87
Mercury NZ Ltd	MCY	0.87
Sino-American Silicon Products	5483 TT	0.87
Encavis AG	ECV	0.86
PNE AG	PNE3	0.86
Albioma SA	ABIO FP	0.86
Xinyi Energy Holdings Ltd	3868 HK	0.86
SolarEdge Technologies Inc	SEDG	0.85

Caverion Oyj	CAV1V FH	0.84
QuantumScape Corp	QS	0.84
McPhy Energy SA	MCPHY FP	0.84
Universal Display Corp	OLED	0.84
RENOVA Inc	9519 JP	0.83
Prysmian SpA	PRY	0.83
Azure Power Global Ltd	AZRE	0.83
Scatec ASA	SCATC	0.82
Landis+Gyr Group AG	LAND SW	0.81
First Solar Inc	FSLR	0.81
Innergex Renewable Energy Inc	INE	0.81
Vestas Wind Systems A/S	VWS DC	0.81
EDP Renovaveis SA	EDPR	0.81
Solaria Energia y Medio	SLR	0.80
Meridian Energy Ltd	MEL	0.80
Orsted AS	ORSTED DC	0.79
Array Technologies Inc	ARRY	0.77
West Holdings Corp	1407 JP	0.77
Doosan Fuel Cell Co Ltd	336260 KS	0.75
Neoen SA	NEOEN FP	0.75
JinkoSolar Holding Co Ltd ADR	JKS	0.73
Xebec Adsorption Inc	XBC	0.69
Lordstown Motors Corp	RIDE	0.69
XPeng Inc ADR	XPEV	0.67
Solarpack Corp Tecnologica SA	SPK	0.67

Among best performers in NEX in this period above, there's again clear representation from *Electric Vehicles, *Batteries/Energy Storage, *Solar Power, *Hydrogen & Fuel Cells.

Appendix IV:

WilderHill New Energy Global Innovation (NEX) - for start of Q2 2021. 125 Stocks.

Also NEX Index Composition is at, https://www.solactive.com/indices/?se=1&index=US96811Y1029

Name	Description	Sector	Currency	Activity
2G Energy AG	Hydrogen, biogas, and combined heat and power.	ECV	EUR	GERMANY
Acciona	Operates Wind, Solar/thermal, Hydro, Biomass plants.	RWD	EUR	SPAIN
Aemetis	Biofuel, renewable jet fuel, hydrogen, low-carbon diesel.	RBB	USD	US
AFC Energy	Fuel cells, alkaline has greater H2 fuels tolerance.	ECV	GBP	UK
Aker Offshore Wind	Offshore wind, new floating deepwater technologies.	RWD	NOK	NORWAY
Alfen NV	Electric Vehicle charging, smart grid, energy storage.	EEF	EUR	NETHERLANDS
Ameresco	Energy savings, performance contracts, renewables.	EEF	USD	US

American Superconductor	Wind turbines, and grid power trnsmission.	RWD	USD	US
Arcosa	Wind tower structures, grid power and infrastructure.	RWD	USD	US
Arise AB	Wind Farms onshore, owns own, develops for others.	RWD	SEK	SWEDEN
Array Technologies	Solar, ground-mounted axis sun trackers.	RSR	USD	US
Azure Power Global	Solar, India, aims to offer lowest-cost electricity.	RSR	USD	INDIA
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
Boralex	Renewables generation, operates wind, hydro, solar.	RWD	CAD	CANADA
BYD Co.	Electric vehicles, batteries, rail, and more.	ENS	HKD	CHINA
Canadian Solar	Solar, vertically integrated solar manufacturer, China.	RSR	USD	CANADA
Canoo	Electric delivery vehicles, configurable, multipurpose.	EEF	USD	US
Caverion OYJ	Energy efficiency, buildings, infrastructure, Europe.	EEF	EUR	FINLAND
Cell Impact AB	Fuel Cells, stamped bipolar, PEM flow field plates.	ECV	SEK	SWEDEN
Ceres Power	Fuel cells, high temperature steel units.	ECV	GBP	UK
Chargepoint	EV charging, an early leader with global presence.	EEF	USD	US
Cree Inc.	Power electronics, electrifying powertrains, SiC, GaN.	EEF	USD	US
CropEnergies AG	Bioethanol, from cereals and sugarbeet, Germany.	RBB	EUR	GERMANY
CS Wind	Wind power, both onshore, and also offshore.	RWD	KRW	S. KOREA
Daqo New Energy	Solar, high-purity polysilicon for solar wafers, China.	RSR	USD	CHINA
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 largest producers in world, Iberia.	RWD	EUR	SPAIN
Encavis AG	Solar, large solar park operator, also wind, Germany.	RSR	EUR	GERMANY
Enlight Renewable	Solar & wind power, clean energy storage & infrastructure.	RSR	ILS	ISRAEL
Enphase	Inverters, micro-products for solar panels, storage.	RSR	USD	US
Eolus Vind	Wind power, also consulting services for wind.	RWD	SEK	SWEDEN
Eos Energy	Batteries, zinc chemistry for stationary grid storage.	ENS	USD	US
Everfuel A/S	Hydrogen electrolyzers, fueling vehicles, trains, ships.	ECV	NOK	DENMARK
Falck Renewables SpA	Renewable wind, biomass, WtE, solar, Europe.	RWD	EUR	ITALY
First Solar	Thin film solar, CdTe low-cost alternate to polysilicon.	RSR	USD	US
Flat Glass Group	PV panel glass, solar plants engineering & construction	RSR	HKD	CHINA
FuelCell Energy	Fuel cells, high temperature and hydrogen.	ECV	USD	US
Fisker	Electric cars, electric SUVs, with contract manufacturer.	ENS	USD	US
Ganfeng Lithium	Lithium, production of compounds, metals, for batteries.	ENS	HKD	CHINA
GenCell Ltd.	Fuel cells, hydrogen from ammonia, remote power.	ECV	ILS	ISRAEL
Gevo	Biofuels, lower carbon liquid fuels, renewable sources.	RBB	USD	US
Greencoat UK Wind plc	Infrastructure fund, invested in U.K. wind power assets.	RWD	GBP	UK
Greenlane Renewables	Renewable natural gas, lower-carbon liquid fuels.	RBB	CAD	CANADA
GreenPower Motor	Electric vehicles, transit, school and charter buses.	ENS	USD	CANADA
Grenergy Renovables SA	Solar projects, and wind, batteries, Spain, Latin America.	RSR	EUR	SPAIN

GS Yuasa	Battery technologies, also lithium for EVs, Japan.	ENS	JPY	JAPAN
Gurit Holding AG	Composite Materials in wind, lightens cars, planes.	RWD	CHF	SWITZERLAND
Hannon Armstrong	Energy efficiency, capital & finance for infrastructure.	EEF	USD	US
Hexagon Purus AS	Hydrogen storage, whole systems for FC vehicles.	ENS	NOK	NORWAY
HydrogenPro	Hydrogen, electrolysis from solar and wind power.	ECV	NOK	NORWAY
Hydrogen Refueling	Hydrogen refueling, turnkey systems for heavy trucks.	ENS	EUR	FRANCE
Iljin Materials	Rechargeable battery materials, elecfoils for batteries..	ENS	KRW	S. KOREA
Innergex Renewable	Renewable power, run-of-river hydro, wind, solar.	ROH	CAD	CANADA
Invinity Energy Systems	Flow battery, stationary, vanadium liquid electrolyte.	ENS	GBP	UK
ITM Power plc	Fuel cells, uses PEM technology; also hydrogen.	ECV	GBP	UK
Itron	Meters, Utility energy monitor, measuring & manage.	EEF	USD	US
JinkoSolar	Solar, wafers through solar modules, China OEM.	RSR	USD	CHINA
Kingspan Group plc	Efficient Buildings, insulation for conservation, Ireland.	EEF	EUR	IRELAND
Landis+Gyr Group AG	Advanced meters, modernizing grid, Switzerland.	EEF	CHF	SWITZERLAND
Lithium Americas	Lithium, projects in Nevada USA, and in Argentina.	ENS	USD	US
Livent	Lithium, production of compounds, batteries.	ENS	USD	US
Lordstown Motors	Electric Vehicles, pickup trucks, telematics.	ENS	USD	US
Maxeon Solar	Solar panel manufacturer, a spinoff from Sunpower.	RSR	USD	US
McPhy Energy	Hydrogen, electrolyzers using water, H2 storage.	ECV	EUR	FRANCE
Mercury NZ	Clean power, 100% renewable hydro, geothermal.	ROH	NZD	NEW ZEALAND
Meridian Energy	Hydroelectric power stations, some wind, New Zealand.	ROH	NZD	NEW ZEALAND
Montauk Renewables	Biofuels, methane capture, RNG, electrical generation	RBB	USD	US
Motech	Solar, cells and modules manufacturing.	RSR	TWD	TAIWAN
MP Materials	Rare Earths, US sourced strategic Neodymium, NdPr.	ECV	USD	US
Nel ASA	Hydrogen, in fuel cell vehicles, renewably, Norway.	ECV	NOK	NORWAY
Neoen SA	Renewable energy, mainly in solar, some wind.	RSR	EUR	FRANCE
Nibe Industrier AB	Heating & cooling, sustainable technologies, Sweden.	EEF	SEK	SWEDEN
Nio	Electric Vehicles, design, manufacture, premium EVs.	ENS	USD	CHINA
Nordex SE	Wind turbines, based in Germany/Europe, worldwide.	RWD	EUR	GERMANY
Novozymes A/S	Biofuels, enzymes used in partnerships, Denmark.	RBB	DKK	DENMARK
Ormat	Geothermal, works too in recovered heat energy.	ROH	USD	US
Orsted A/S	Sustainable wind, also biomass, thermal, Denmark.	RWD	DKK	DENMARK
Piedmont Lithium	Lithium, US-based source for battery-grade lithium.	ENS	USD	US
Plug Power	Small fuel cells, e.g. in forklifts; drop in replacements.	ECV	USD	US
PNE AG	Wind Farms, both onshore & offshore; also hydrogen.	RWD	EUR	GERMANY
Powercell Sweden	Fuel cells, transportation, marine, stationary uses.	ECV	SEK	SWEDEN
Powerhouse Energy	Non-recyclable wastes, to syngas & hydrogen.	ECV	GBP	UK
Proton Motor Power	Fuel cells, hydrogen systems and H2 storage.	ECV	GBP	UK
Prysmian SpA	Cables, renewable power transmission, global.	EEF	EUR	ITALY
Quantumscape	Lithium metal batteries, solid state, quicker charge.	ENS	USD	US

ReneSola	Solar, project developer and operator, worldwide.	RSR	USD	CHINA
Renewable Energy Group	Biodiesel, natural fats, oils, grease to biofuels.	RBB	USD	US
Renewables Infras.	Wind Farm & Solar Park revenues assets, U.K.	RWD	GBP	UK
Renova	Wind, Solar, Biomass, power generation in Asia.	RWD	JPY	JAPAN
Royal DSM	Biofuels, reduction of CO2 and methane emissions.	RBB	EUR	NETHERLANDS
Samsung SDI	Batteries, innovative energy storage, EVs, South Korea.	ENS	KRW	S. KOREA
Scatec ASA	Solar power, develops, owns and operates worldwide.	RSR	NOK	NORWAY
SFC Energy AG	Fuel cells, direct methanol (DMFC) technology.	ECV	EUR	GERMANY
Shoals Technologies	Solar, electric balance of system, wiring, combiners.	RSR	USD	US
Siemens Gamesa	Wind, onshore & offshore, turbines, gearboxes, Spain	RWD	EUR	SPAIN
Signify NV	Lighting, systems increasing efficiency, Netherlands.	EEF	EUR	NETHERLANDS
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-level solar optimizers, micro-inverters.	RSR	USD	US
Solaria Energia	Solar, renewable power generation, Iberia.	RSR	EUR	SPAIN
Solarpack Corporacion	Solar plants, engineering and operations, globally.	RSR	EUR	SPAIN
Sunnova	Residential solar and energy storage installation.	RSR	USD	US
SunPower	Solar, efficient PV panels with rear-contact cells.	RSR	USD	US
Sunrun	Residential solar, leasing, PPA or purchase rooftop PV.	RSR	USD	US
Sunworks	Solar installations, 1-stop for commercial & residential.	RSR	USD	US
Terna SpA	Transmission of electricity, increasingly is renewables.	EEF	EUR	ITALY
Tilt Renewables	Wind Farms, Australia and New Zealand, some solar.	RWD	NZD	NEW ZEALAND
TPI Composites	Wind Blades; also light-weighting for transportation.	RWD	USD	US
TransAlta Renewables	Renewables, operating wind power, some hydro.	RWD	CAD	CANADA
United Renewable Energy	Solar, also energy storage, hydrogen and fuel cells.	RSR	TWD	TAIWAN
Universal Display	Organic light emitting diodes, efficient displays.	EEF	USD	US
Verbio Vereinigte BioEn.	Biofuels, manufacturer supplier to Germany, Europe.	RBB	EUR	GERMANY
Verbund AG	Electricity supplier, hydro, a large provider for Austria.	ROH	EUR	AUSTRIA
Vestas Wind Systems A/S	Wind, wind turbine manufacturing & services, Denmark.	RWD	DKK	DENMARK
Voltalia SA	Renewables, biomass, wind, solar, also carbon credits.	RBB	EUR	FRANCE
West Holdings	Solar, Japan-focused residential and commercial PV.	RSR	JPY	JAPAN
Willdan Group	Energy efficiency in infrastructure, engineering.	EEF	USD	US
Xebec Adsorption	Gases for new renewable energies, hydrogen.	RBB	CAD	CANADA
Xinjiang Goldwind	Wind, large turbine manufacturer, China.	RWD	HKD	CHINA
Xinyi Energy Holdings	Solar Farms, a spin-off from Xinyi solar glass, 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

NEX in Q2 2021 WEIGHT EACH COMPONENT = 0.80000%

125 stocks/100 = 0.800000

25 NEX ADDITIONS for Q2 2021: AMTX.OQ, AFEN.L, AOW-ME.OL, ARISE.ST, GOEV.OQ, CIb.ST, CHPT.N, 247540.KQ, EFUEL-ME.OL, GNCL.TA, GEVO.OQ, GRN.TO, HPUR-ME.OL, ALHRS.PA, HYPRO-ME.OL, IES.L, MNTK.OQ, MP.N, PLL.OQ, PHEG.L, PPS.L, F3CG.DE, SHLS.OQ, SUNW.OQ, VLTSA.PA.

2 NEX DELETIONS for Q2 2021: ABIO.PA, VECO.OQ

NEX SECTOR WEIGHTS for Q2 2021:	SECTOR	Quant. #	% Approx. Weight
Energy Conversion	ECV	20	16%
Energy Efficiency	EEF	16	13%
Energy Storage	ENS	20	16%
Renewables - Biofuels & Biomass	RBB	11	9%
Renewables - Other	ROH	5	4%
Renewable - Solar	RSR	30	24%
Renewable - Wind	RWD	23	18%
		125	100%

Appendix VI:

Historical Weightings: WilderHill New Energy Global Innovation Index (NEX).

NEX Historical Sector Weight Information

	ECV	EEF	ENS	RBB	ROH	RSR	RWD
Sector Weights	Energy Conversion	Energy Efficiency	Energy Storage	Renewables - Biofuels	Renewables - Other	Renewable - Solar	Renewable - Wind
Q4 2020	11.00%	20.00%	9.00%	7.00%	6.00%	24.00%	24.00%
Q3 2020	5.70%	24.10%	6.90%	8.00%	6.90%	24.10%	24.10%
Q2 2020	5.70%	23.00%	6.90%	8.00%	6.90%	26.40%	23.00%
Q1 2020	5.50%	23.10%	6.60%	8.80%	6.60%	27.50%	22.00%
Q4 2019	4.00%	23.00%	8.00%	10.00%	6.00%	26.00%	23.00%
Q3 2019	3.77%	22.64%	9.43%	9.43%	5.66%	26.41%	22.64%
Q2 2019	1.40%	29.72%	9.11%	6.13%	4.41%	21.75%	27.49%
Q1 2019	1.42%	30.07%	9.36%	8.48%	4.49%	20.72%	25.46%
Q4 2018	1.05%	30.25%	9.00%	7.94%	3.63%	21.78%	26.34%
Q3 2018	0.79%	29.62%	8.48%	6.60%	3.71%	23.67%	27.12%
Q2 2018	0.80%	30.50%	8.80%	7.90%	3.90%	22.50%	25.50%
Q1 2018	1.00%	30.67%	7.64%	7.74%	3.92%	23.37%	25.66%
Q4 2017	1.14%	29.36%	6.75%	8.21%	4.68%	20.58%	29.28%
Q3 2017	0.76%	30.88%	5.91%	9.11%	4.55%	18.80%	29.98%
Q2 2017	0.67%	33.68%	6.50%	8.75%	4.92%	18.73%	26.75%
Q1 2017	1.00%	31.83%	5.64%	9.03%	5.43%	17.92%	29.14%
Q4 2016	0.71%	32.00%	3.58%	8.48%	5.20%	18.84%	31.19%
Q3 2016	1.12%	31.00%	4.54%	7.76%	5.87%	21.09%	28.61%
Q2 2016	1.02%	32.18%	3.69%	7.15%	5.18%	21.60%	29.18%

Q1 2016	1.01%	34.83%	3.61%	9.38%	4.26%	20.14%	26.77%
Q4 2015	0.95%	33.54%	3.09%	9.19%	5.19%	20.40%	27.65%
Q3 2015	0.95%	32.97%	3.18%	8.05%	4.52%	24.65%	25.67%
Q2 2015	1.22%	33.68%	2.26%	9.55%	6.90%	24.88%	21.50%
Q1 2015	1.68%	33.88%	2.14%	11.54%	6.84%	24.86%	19.06%
Q4 2014	1.42%	33.67%	2.26%	12.31%	8.45%	24.67%	17.22%
Q3 2014	1.42%	33.42%	2.30%	12.44%	9.09%	23.78%	17.56%
Q2 2014	1.11%	34.20%	2.00%	12.16%	9.86%	23.16%	17.52%
Q1 2014	1.17%	33.13%	2.34%	12.17%	10.33%	23.95%	16.91%
Q4 2013	1.28%	35.26%	2.28%	14.02%	12.47%	19.58%	15.10%
Q3 2013	1.25%	35.04%	2.35%	14.61%	13.06%	19.10%	14.58%
Q2 2013	1.31%	33.43%	2.63%	15.42%	14.05%	17.54%	15.62%
Q1 2013	1.31%	33.43%	2.63%	15.42%	14.05%	15.90%	14.14%
Q4 2012	1.50%	33.93%	2.97%	14.50%	14.50%	19.59%	13.04%
Q3 2012	2.32%	28.30%	6.70%	14.22%	8.35%	21.17%	19.00%
Q2 2012	1.34%	28.14%	4.16%	14.61%	13.98%	22.00%	15.96%
Q1 2012	1.60%	28.01%	4.01%	13.85%	14.70%	20.83%	17.00%
Q4 2011	1.14%	25.06%	4.12%	12.13%	11.63%	26.48%	19.45%
Q3 2011	1.28%	22.72%	6.24%	10.17%	10.49%	24.60%	24.32%
Q2 2011	1.50%	23.34%	8.06%	10.69%	9.53%	25.76%	21.04%
Q1 2011	1.50%	26.95%	6.99%	10.50%	9.46%	24.59%	20.00%
Q4 2010	1.79%	24.32%	8.80%	11.21%	6.02%	24.16%	23.71%
Q3 2010	1.97%	20.31%	8.86%	11.70%	6.59%	24.42%	26.16%
Q2 2010	1.90%	17.29%	8.53%	12.36%	6.58%	24.29%	29.05%
Q1 2010	2.04%	16.93%	8.65%	12.25%	6.73%	25.03%	28.36%
Q4 2009	2.25%	15.20%	7.10%[1]	11.26%	7.10%	27.51%	29.58%
Q3 2009	2.59%	13.77%	5.38%	10.76%	6.81%	29.24%	31.45%
Q2 2009	2.42%	12.89%	4.79%	12.21%	6.49%	30.57%	30.63%
Q1 2009	2.77%	15.14%	5.29%	14.19%	8.25%	25.70%	28.68%
Q4 2008	2.25% [2]	23.93%	3.57%	12.09%	6.48%	26.63%	25.05%
Q3 2008	3.31%	20.03%	3.33%	13.14%	6.54%	27.27%	26.39%
Q2 2008	3.81%	17.85%	2.81%	14.32%	6.47%	27.03%	27.71%
Q1 2008	3.93%	13.56%	2.94%	14.26%	6.99%	30.00%	28.34%

*To Q2 2019, NEX components were divided into large or small in a survey of companies deemed active in new energy, adjusting for factors including exposure to new energy and exchange restrictions. From Q3 2019, NEX components all equal weighted, sector weights accord to number in each sector.

Appendix VII, Clean Sustainable Ocean Index (OCEAN) for latter Q1 2021, 101 components:

WilderHill OCEAN constituents	Theme	Activity	Sector
Acciona SA	Water Treatment; Renewable Energy.	Spain	WT
Advanced Drainage	Water management, drainage products.	USA	WT
Aker Offshore Wind	Offshore wind, deep water floating, Norway.	Norway	CE
Alfa Laval AB	Fluid Handling, controls, on vessels.	Sweden	WT
Alfen NV	Smart power grids, energy storage.	Netherlands	PP
American States Water	Water and Wastewater Services.	USA	WT
American Superconductor	Wind power, better power grid.	USA	PP
American Water Works	Water and Wastewater Systems.	USA	WT
Austevoll Seafood ASA	Seafood, aquaculture with high ESG scores.	Norway	SF
Azure Power	Solar power, India focus.	India	CE
Badger Meter	Water Metering.	USA	PP
Ballard Power	Fuel cells, future power in Ports and Shipping.	Canada	GS
Beyond Meat	Plant-based meats, less impactful proteins.	USA	PP
Bloom Energy	H2 fuel cells, power ahead ports, shipping.	USA	GS
Bollore SA	Better Sustainability in Ports & Terminals.	France	GS
BYD	Batteries, zero emission vehicles.	China	PP
California Water Service	Water and Wastewater Utility Services.	USA	WT
Canadian Solar Inc	Solar, panel manufacturer.	Canada	CE
Canoo	Electric vehicles, multi-purpose.	USA	PP
Cargotec OYJ	Better Sustainability in Ports & Terminals.	Finland	GS
Ceres Power	H2 fuel cells, power ahead ports, shipping.	Britain	GS
Corbion NV	Algae, sustainable alternative in aquaculture.	Netherlands	PP
CREE	Power electronics in EVs, Si-C.	USA	PP
CS Wind	Wind, tower structures.	S. Korea	CE
Danimer Scientific	Bioplastics, biodegradable materials.	USA	PP
Doosan Fuel Cells	Fuel cells, future power in Ports and Shipping.	S. Korea	GS
EDP Renovaveis SA	Renewables, among world's largest in wind.	Spain	CE
Else Nutrition	Plant-based food and baby formula products.	Canada	PP
Encavis AG	Renewable Energy, solar & wind in Europe.	Germany	CE
Enlight Renewable	Solar, construction and operations, also wind.	Israel	CE
Eolus Vind AB	Wind power projects in Sweden, US, Estonia.	Sweden	CE
Eos Energy	Zinc battery chemistry, alternative to Li-ion.	USA	PP
Essential Utilities (was Aqua)	Water and Wastewater Services.	USA	WT
Evoqua	Water, wastewater treatment.	USA	WT
First Solar	Solar, thin film panels.	USA	CE
Flat Glass Group	Glass, specialized solar panels.	China	CE
FuelCell Energy	H2 fuel cells, power ahead ports, shipping.	USA	GS

Geberit AG	Waste treatment, supply, piping.	Switzerland	WT
GreenPower Motor	Electric Buses and large transit vehicles.	Canada	PP
Grenergy Renovables SA	Solar power parks, wind power.	Spain	CE
Grieg Seafood ASA	Seafood, aquaculture with high ESG scores.	Norway	SF
Gurit Holding AG	Wind, composites, also in transportation.	Switzerland	CE
Halma plc	Water analysis, monitoring, treatment.	Britain	WT
HydrogenPro AS	Hydrogen electrolyzers, from solar or wind.	Norway	GS
Idex	Water, pumps, flow meters, fluid systems.	USA	WT
Innergex Renewable	Run-of-river Hydro power, Wind, Solar.	Canada	CE
Intertek Group plc	Cargo and Trade services, quality assurance.	Britain	PP
Invinity Energy	Flow batteries, grid, non-degrading vs. li-ion.	Britain	PP
ITM Power PLC	Electrolysis for green hydrogen, zero CO2.	Britain	PP
Itron	Smart Grid Power and Water Management.	USA	PP
Kingspan Group PLC	Building Insulation.	Ireland	PP
Kuehne und Nagel	Shipping Logistics, clean cargo group.	Switzerland	PP
Kurita Water	Water Treatment, wastewater systems.	Japan	WT
Leroy Seafood Group	Seafood, with high FAIRR Report score.	Norway	SF
Maxeon Solar	Solar, higher-efficiency premium PV panels.	USA	CE
McPhy Energy SAS	Hydrogen, for decarbonization.	France	PP
Mercury NZ	100% Renewables by hydro, geothermal, wind.	New Zealand	CE
Meridian Energy	Power generation 100% from renewables.	New Zealand	CE
Metawater	Water purification, sewage treatment plants.	Japan	WT
Mowi ASA	Seafood, with high FAIRR Report score.	Norway	SF
MP Materials	Rare Earths, used in EVs, wind turbines etc.	USA	PP
Nel ASA	Hydrogen, made from renewable resources.	Norway	PP
Neoen S.A.	Renewables, using wind, solar, biomass.	France	CE
Nibe Industrier AB	HVAC, other areas in sustainability.	Sweden	PP
Nio	Battery electric vehicles, China based.	China	PP
Nomad Foods	Moving to 100% Certified-sustainable seafood.	USA	SF
Norway Royal Salmon ASA	Seafood, aquaculture with high ESG scores.	Norway	SF
Orsted A/S	Wind, offshore and onshore; also solar power.	Denmark	CE
P/F Bakkafrost	Seafood, with high FAIRR Report score.	Norway	SF
Pentair PLC	Water Efficiency and Treatment.	Britain	WT
Plug Power	H2 fuel cells, power ahead ports, shipping.	USA	GS
PNE AG	Wind, offshore and onshore, also hydrogen.	Germany	CE
PowerCell Sweden	H2 fuel cells, power ahead ports, shipping.	Sweden	GS
Primo Water	Water, less waste large refillable exchanges.	Canada	WT
Quantumscape	Solid state lithium-metal batteries.	USA	PP
Royal DSM Konink.	Algal omega-3 salmon aquaculture feedstock.	Netherlands	SF
SalMar ASA	Seafood, aquaculture with high ESG scores	Norway	SF

Samsung SDI	Li Ion Batteries.	S. Korea	CE
Scatec Solar ASA	Solar, developer across emerging nations.	Norway	CE
Signify NV	LEDs, was Philips Lighting.	Netherlands	PP
Sino-American Silicon Products	Solar feedstock, wafers.	Taiwan	CE
SolarEdge	Solar MicroInverters	USA	CE
Solaria Energia y Medio	Solar, Wind, power from renewables plants.	Spain	CE
Solarpack Tecnologica SA	Solar, utility-scale EPC and development.	Spain	CE
Sunnova Energy	Residential Solar and Energy Storage.	USA	CE
SunPower Corp	Solar, services plus storage.	USA	CE
Sunrun Inc	Solar, residential Installer.	USA	CE
Terna SpA	Grid Efficiency for more Renewables.	Italy	CE
Tilt Renewables	Wind Farms, Australia & New Zealand, solar.	New Zealand	CE
Tomra Systems ASA	Recycling wastes, materials recovery.	Norway	PP
Veolia Environnement	Water and Wastewater Treatment.	France	WT
Verbund AG	Renewable Energy, hydropower.	Austria	CE
Vestas Wind Systems A/S	Wind power, in both products and services.	Denmark	CE
Vow ASA	Wastewater treatment, in Aquaculture.	Norway	WT
Wartsila OYJ	Ports, Terminals, energy with sustainability.	Finland	GS
Watts Water Technologies	Water quality, rainwater harvests, flow control.	USA	WT
Xebec Adsorption	Hydrogen, generation and purification.	Canada	PP
Xinjiang Goldwind Science	Wind, turbine manufacturer, also in services.	China	CE
Xinyi Solar Holdings Ltd	Solar glass, has spun off solar farms.	China	PP
Xpeng	Electric vehicles, connectivity.	China	PP
Xylem	Water Technologies.	USA	WT

OCEAN Rebalance for latter Q1 2021

Deletes: Cia Pesquera, Ecopro, Tassal.
Additions: Advanced Drainage, Aker Offshore Wind, Canoo, Danimer, Doosan Fuel Cell, Else Nutrition, Enlight, Eos, GreenPower, Hydrogenpro, Invinity, Maxeon, MP Materials, Primo, Quantumscape, Vow.

OCEAN Equal Weight for latter Q1 2021 = 101/100 = 0.9900990% each.

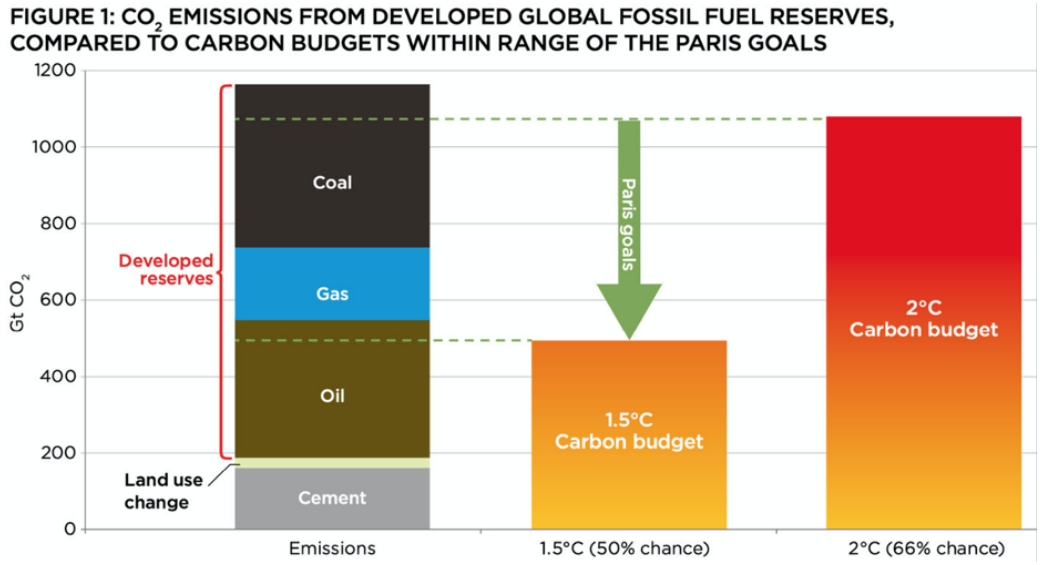
OCEAN Index SECTOR

GREENER SHIPPING (GS) =	11
CLEAN ENERGY LOW CO2 (CE) =	33
WATER TREATMENT (WT) =	19
SUSTAINABLE FISHERIES (SF) =	10
POLLUTION PREVENTION (PP) =	28
TOTAL CONSTITUENTS =	**101**

For how Dire CO_2 Facts & Trends may already be in 2021: consider this Carbon Budget Chart next by Oil Change International (OCI) comparing what's likely to be burned of fossil fuel reserves coal, oil, and natural gas - vs Earth's possible carbon budget. These data imply, first, that for Paris' goals of just 1.5 C warming to be achieved – ALL world fossil fuels proven reserves not now producing, would have to abandoned! No New mining or drilling there!

That seems almost 100% certain NOT to Happen. While some European oil firms for instance are thinking seriously of becoming more 'energy companies' than in fossil fuels, majors in the US and elsewhere seem more intent on marketing & promoting carbon capture, so relying on fossils. As for *developed* reserves, keeping to 1.5 C means all extant coal must be abandoned this decade in a Thanos-like snap of fingers – or we'll blow past 1.5 C. Only by halting all extant coal, plus most oil & natural gas in 2020s, may a carbon budget keep to 'just' 1.5 C rise. It's simple physics & chemistry. Whatever oil companies might desire, nations may think, whatever leaders are prepared to 'promise' about a distant 2050 in a vague nod to demands, this budget if it's accurate puts a hard ceiling on fossil fuels right now, period.

To state our Planet & Oceans will likely realistically blow past it this decade of the 2020s is a hard truth. It scarily acknowledges where things are at start of the vital 2020s. And yet, much might just possibly look very different in 10 years' time at end of seminal 2020s:



Source: Oil Change International (OCI), 'Big Oil Reality Check: Assessing Oil & Gas Company Climate Plans.' 2020.

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

For more on the three WilderHill Indexes, see:
https://wildershares.com
For the 1990s, antecedent WilderHill Hydrogen Fuel Cell Index, see, http://h2fuelcells.org

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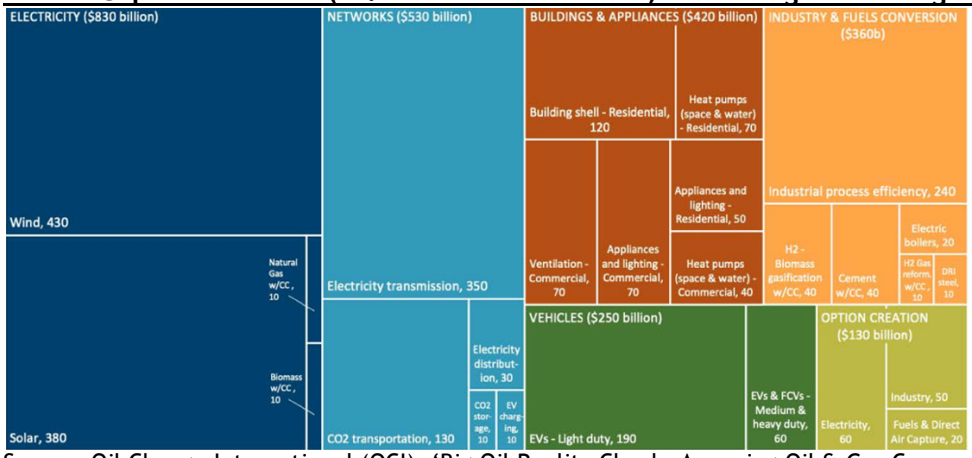
A Look at some important divergent Possibilities Over 2020s Decade:

From: Interim Report. Net-Zero America: Potential Pathways, Infrastructure, and Impacts. By E. Larson, C. Greig, J. Jenkins, E. Mayfield, A. Pascale, C. Zhang, J. Drossman, R. Williams, S. Pacala, R. Socolow, EJ Baik, R. Birdsey, R. Duke, R. Jones, B. Haley, E. Leslie, K. Paustian, and E. Swan. Princeton University, Princeton, NJ. December 15, 2020.

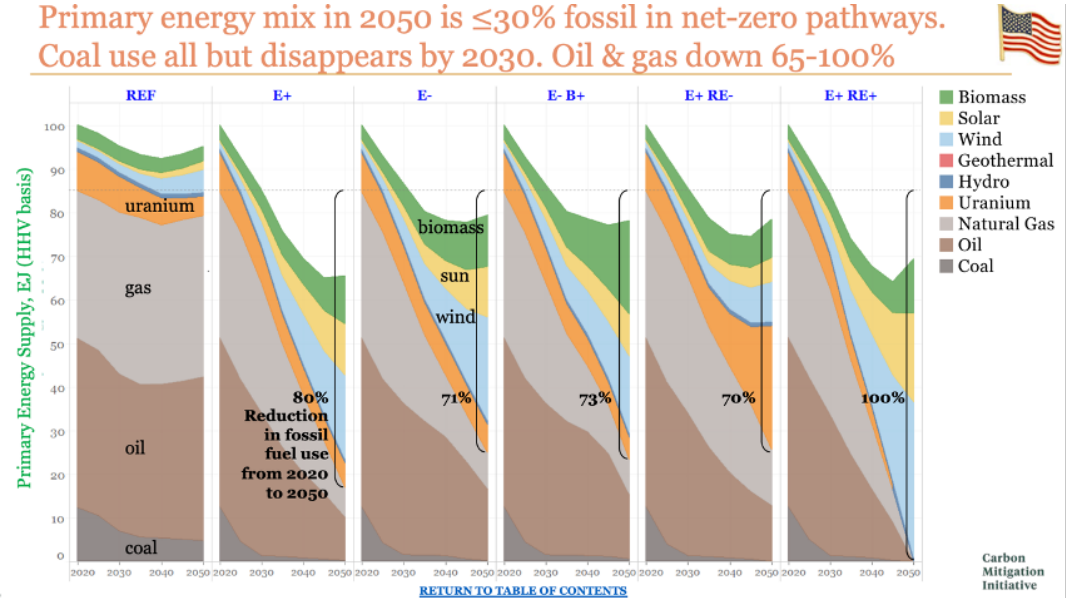
Added Capital Invested (vs. reference scenario) in coming 2020s might be >$2.5 Trillion:



Source: Oil Change International (OCI), 'Big Oil Reality Check: Assessing Oil & Gas Company Climate Plans.' 2020.

Total additional capital invested 2021-2030, by sector and subsector for a net-zero pathway vs. business as usual (billions 2018 $)

Source: Net-Zero America. High Meadows Environmental Inst., Carbon Mitigation In. Princeton Univ., Dec 2020.



Source: Net-Zero America. High Meadows Environmental Inst., Carbon Mitigation In. Princeton Univ., Dec 2020.
