WilderShares, LLC

Q3 2020 Quarterly Report: WilderHill Clean Energy Index®, September 30, 2020

The Clean Energy Index® (ECO) began 3rd Quarter around 84, and ended around 125, up +50%. Rich in context, at first ECO rose sharply from 70 to over 90, then like much else in Q1 it crashed given Coronavirus going just under 50 – and recovered hard Q2. ECO bounded strongly up some +50% over Q3 and up +80% Year to Date (YTD). So even after a fall, this decarbonization theme roared back by over +100% from March. This November's election *may* possibly be bullish for clean energy this decade, *perhaps* contributing (or not) to momentum. Last 3¾ years, since start of 2017 when ECO Index® was 38, it is now up over +200%.

ECO passively captures a volatile theme so can & does at times surely 'drop like a rock' – seen in a plunge early 2020. Big gains can occur here, & bigger declines too. Plus we offer a mere observation: it's counter-intuitive perhaps yet ECO's theme rose sharply in Bush II & Trump Presidencies - though neither promoted green energy. There'd been drops under Obama – yet it was unique as China was gaining market share. Now, the 2020's *may* see new consolidation & perhaps ongoing growth within fast-maturing solar. *Perhaps* growth too in better batteries, wind power, electric vehicles, green hydrogen, and more – unlike anything seen before.

Past 5 years Benchmark ECO Index® live since 2004 and 1st for climate solutions, is now up more than +180%, over a time when *any* energy gains are arguably notable. For over these same 5 years, CO_2 laden dirty energy themes are far negative: coal, oil, natural gas are down -5% to -75%. Last 10 years, the fossil fuels are again far down; that's in stark contrast to green decarbonization stories that are positive with clearly the strongest returns in energy.

Worldwide clean energy seen in WilderHill® New Energy Global Index (NEX) is up 100% the last 5 years, also beating all fossil fuels. Both ECO & NEX outperform here too vs. a separate independent global clean energy Index most every sizable period, past 10 years, 12+ years, since inception etc: there's fewer components in that other Index maybe helping to explain the divergence. Meanwhile, Clean Ocean Index (OCEAN) for healthy seas & decarbonization is well up, too. The ESG thinking in ECO, NEX, OCEAN, well outperformed fossil fuels.

The Clean Energy Index® (ECO) live since 2004 has amply proven that coal, oil, & natural gas can no longer cover the broadening energy story. The Benchmark ECO Index® is no longer niche, and has far outperformed fossil fuels past 1, 5, 10 years & more. ECO, NEX, OCEAN capture new climate change solutions like solar, wind, batteries, electric vehicles, efficiency, hydrogen, & decarbonization. Each is 1st & best-known for these themes, with strong performances, and helpful non-correlation vs. fossil fuels. Plus they provide diversification, transparency and ESG thinking, helping diversify a model portfolio.

Source: NYSE.com

The Past Few Months under Covid-19 – and Next Few Months Ahead:
November *Potentially, might* be a Decade-long Inflection for Clean Energy

First in a binary matter, is the November 3rd election. Certifying results could take weeks, & the Administration may remain, in which case last 4 years may be what to expect on policy. Or a new President, whether Senate switches or not and far short of 60 seats – may be historic for clean energy policy this decade. Consider the future: young voters today demand a more sustainable, renewable, and zero-carbon future than what 'oldies' ever contemplated.

For a glimpse of what may be sought post-2020, should the challenger's party win, see a 500 page Select House Committee on the Climate Crisis Report compiled over Summer of 2020: https://climatecrisis.house.gov/sites/climatecrisis.house.gov/files/Climate%20Crisis%20Action%20Plan.pdf This is worth a look for voluminous changes contemplated. Not everything there will be accomplished - but real steps through 2020s to decarbonization would be a big change.

This Plan is no small beer. It's also grown far more ambitious & aggressive than contemplated only months ago. If there's a new White House (+ maybe Senate), the 2020s **may** be unlike anything before in clean energy. "Transformative" is a big word yet it could be, especially considering too ambitious Europe and now China. Still bear in mind when expectations get too ahead of reality – when there's unmoored *hype* like in past with both hydrogen (H_2) and fuel cells (rightly now called 'fool cells' by many) – then big drops grow yet more likely. This has been and it remains a volatile sector, that *can and does* at times drop like a rock!

Consider too how little's actually been done in U.S. for clean energy, so far, under Covid-19. Summer 2020 federal pandemic aid for fossil fuel-heavy sectors reached some $68 billion; yet much of that was to prop up airlines. By contrast $27 billion went to only slightly green-related areas here, mainly well of outside clean energy, like public transport grants.

More directly the fossil fuel companies themselves got $3 billion in forgivable loans for small businesses, to July. That contrasts with near zero support specifically for clean energy. Impossible to know if we're in calm before another Covid-19 wave, but Fall U.S. residential solar installations regained steam - especially vs. March nadir. For 2020 new residential installs may be up some >10% year over year. Costs have dropped 5%-8% this year, and about half big installers could re-reach pre-COVID expected levels, 2021 better. But for some small solar installers like for many other small businesses everywhere, it's tougher times.

Early months 2020, big offshore wind globally did especially well - despite Covid-19. In fact, first 6 months of this year were the best ever recorded for offshore wind! First half of 2020, more investments went into new offshore wind, $35 billion, than all 2019. This has tripled the world's figure first half of 2019. Major offshore wind array decisions in 1H 2020 included a coming 1.5 GW Vattenfall project off The Netherlands, largest to date at $3.9 billion; a 1.1 GW SSE Seagreen offshore farm in the U.K. for about $3.8 billion; a 600 MW Changfang Xidao project offshore Taiwan for $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 core driver is the huge decline in offshore wind costs. Since 2012, levelized offshore wind costs have dropped a startling 67%. Onshore, wind will always face tight land availability; the oceans instead are immense and windy spaces for massive turbines farther from view.

Another driver right now is that wind subsidies like China's, will expire end of 2021. Wind Farms can be a stable reliable return on capital. Renewables investments rose 1st half 2020 to $132 billion, vs first half 2019 at $125 billion, partly on offshore wind (and geothermal).

In a Covid-19 so far 3 nations have seen especially strong new renewables investments in part thanks to new offshore wind in first half 2020. China was up then more than +40% over 2019; France had tripled, and The Netherlands gained by 2.5 fold over 1H in the prior year.

Solar too is advancing. China confounded expectations for slowing solar manufacturing due to Covid first half 2020: instead, solar manufacturing there actually gained. First half of 2020, it produced 59 GW of solar panels, which was about 15% greater than 1H 2019.

Some European nations are pointing to gains ahead in decarbonizing. First half 2020 the E.U. made more power from renewables – than from fossil fuels. Notably nations there with more renewables, enjoy **cheaper** electricity prices – obliterating a 'higher costs' argument oft leveled. Despite oppositional dings that renewables 'suffer' (they do) from intermittency, there were no electricity supply interruptions in 1H in Europe – and none expected.

1st half 2020 among the 27 EU member states, wind, solar, hydro & bioenergy made 40% of electricity overall – fossil fuels made 34%. Latter part April to June, renewables made 44%; during this time Austria made 93% from renewables, Portugal 67%, and Germany 54%.

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

Wind & solar are growing from 13% of E.U.'s electricity in 2016, to 22% in first half 2020; yet there's a long, long way to go: it's failing badly if CO_2 is a concern. Greater flexibility, ability to export excess power, better transmission, better batteries are all needed! The U.S, has made even less progress. Renewables made only 18% of its electricity generation in 2019, fossil fuels 62%. Recall again how European nations with *more* renewables, oft have *lower* *Wholesale* electricity costs, rewarding greener areas where most is done. The E.U. chooses to add more Taxes, rendering Retail power costs higher – but that's a differing matter.

As seen in ECO/NEXOCEAN, consolidations continue and solar is fast maturing this decade. One large U.S. residential solar installer is buying another for hopeful economies. A China-based solar panel maker seeks dual equity listings on U.S. & China Exchanges, a second solar firm considering dual listings (maybe a 3rd too). Such may unlock lower-cost capital for faster growth. These are 'grown-ups' moves in solar – a long way since when only a few small solar listings were possible for ECO/NEX Indexes, we still well recall in 2005, even 2010.

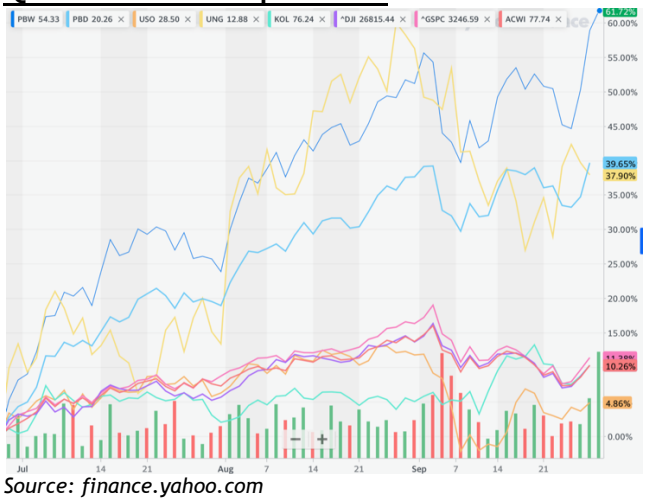
Data and the facts reveal an energy landscape fast challenging 'all we know about energy'. Clean energy, could well overtake fossil fuels, potentially this decade. Even more compelling, it now seems likely clean energy – *Without Any Subsidies* – will in a near future grow *more affordable - than dominant fossil fuels & nuclear*. That changes everything. Especially since fossil fuels & nuclear mainly will shrivel away without their own massive subsidies.

Let's turn to clean energy, to the stock markets, and so to benchmark ECO & NEX Indexes. First most recent and granular of all is this Q3 chart for last 3 months to late September: ECO/NEX trackers are most up, some +50% & +35%. ECO/NEX/OCEAN had strength early on: 1st month of Q3, ECO was up +20%; NEX was up +16%, OCEAN up +12%. Both 1st & 2nd months Q3, ECO was up +40%, NEX up +30%, OCEAN up +23%. (OCEAN isn't shown here simply as no tracker for it just yet). That's vs just some +7% for the S&P500, the Dow, and an all country world. Hence ECO & NEX trackers (OCEAN Index simply not shown as no tracker quite yet) – did much 'better' than once-dominant fossil fuels, oil & coal. (Natural gas here is briefly near NEX but only in closest view: gas is very far down as we zoom out over longer periods).

Problems discussed ahead confront all fossil fuels; they help explain why those lag so badly. As will be shown their problems are diverse & each one striking. Briefly, oil fell tremendously on its global demand collapse. The oil industry needs oil prices up over >$50, >$60. So, $40s/barrel punishes indebted shale producers. Oil under $50, foretells misery ahead for producers, even for countries relying on oil reserves. Equities are inherently forward-looking: hence oil's own vexing theme does not seem a very attractive destination for capital.

A key point to be repeated ahead is *clean energy's prices go very low at times, naturally*. This variability is a characteristic, a core trait of renewables. Oil producers, by contrast, face 'make or break' energy pricing floors beneath which their whole industries suffer. In past, recurring oil price busts brought near-term losses of drilling capacity - jobs were lost, non-producing wells shut in – invariably leading to price hikes later given demand. This time, oil doesn't enjoy a firm floor. Toughest to reach reserves may one day become stranded assets. **Demand destruction** is key; that along with new competition from renewables and maybe electric vehicles too in coming decades, all could impact the equity returns for oil. Here is how strongly, clean energy outperformed most all else at least Q3 to late September:

Q3 2020 to late-September:



Source: finance.yahoo.com

Coal lags too, so new coal-plants aren't built in the U.S. (but for gas hiccups meaning brief fuel switching). Within the U.S. coal is thus in decline. No matter which political party wins: basic economics & physics of coal overcome even strong political partisan will favoring it. Hence coal producers increasingly must look overseas, to export their product. That's not to say thermal coal isn't being burned massively worldwide. Asia has a strong appetite, so coal fired plants are built globally. But the fact coal once had in last century been the cheapest, very dirtiest, the most stable-cost source of power, is suddenly no longer in its favor.

As coal prices rose, renewables (and natural gas) grew relatively more affordable: thus did natural gas & clean energy become lowest-priced leaders. Especially on Covid demand loss: Utilities have turned to lowest-cost resources. This is often renewables, on 'free' sun & wind. Coal is left out in cold. Gas is still big; fracking brought price collapse though with spikes as (oil) wells get shut in, and that price collapse lingers. A relatively smallish 1H rise in oil, gas & coal prices off their own lows may be 'cute', but dirty fuels lack any very strong prospects for ongoing, sustainable gains ahead – especially versus clean/decarbonization today.

A few clean energy sub-themes even relatively flowered recent months. In some cases, like never before. Consider for instance, Electric Vehicles. Here, Carnot's Limit helps explain why electric vehicles are destined to outdo old-style 'gassers'. Note today's top 'gassers' are all inefficient and archaic even at their best. Their diesel or gasoline-powered heat engines only let them reach theoretical bests near say 40% efficiencies. More typically today's vehicle heat engines may be just a sad 20% efficient(!). Gigantic SUVs, so heavily anchored down, are relegated at times to a silly differentiation by e.g. their number of cupholders.

It's maybe not-surprising then, 2020 saw sudden outpouring of fresh electric vehicles globally. Because markets long under-appreciated what new lithium-ion batteries can do, once lashed to very-efficient (>90%) torquey AC motors, advancing swiftly now on better cheaper batteries over 20 years, there's volatile ongoing adjustment. One consequence had been outstanding non-correlation here as between some pure EVs stock pricing vs. much broader markets.

Or consider dottery thermal power plants today – again what Mr. Carnot observed early 1800s. Today's natural gas turbine steam plants reach efficiencies around 40%s. Cutting-edge best combined cycle power plants bump up against theoretical efficiencies only in 60%s. How silly, how ineffective, and what a plainly dottery way to make our needed electrical power.

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

And in work for which Mr. Einstein earned his Nobel Prize, we saw light acts as wave/particle in discrete quanta; photons can be harnessed by solar panels around now for 50+ years. Recently, benefitting from modern research simply on differing wavelengths, solar panels may yet enjoy maximum efficiency ceilings far higher than (silly) gas heat engines. And since fuel (sunlight) is free, it doesn't much matter! On time's arrow gifted by entropy, we've learned swiftly to harness Mr. Sun's free photon 'packets' at ever-lower costs per watt.

Step aside now from these academic musings; let's re-assess practically a stock chart 2 pages above. Winningly, decarbonizing stories ECO/NEX (and OCEAN) are at top. Much beneath their solar /wind /EVs/ hydrogen, so instead nearer dirty oil & coal are 3 key Benchmarks: the S&P500, Dow, & global all country world theme. The latter 3 are among best-known 'bogeys' in the world. While not direct comparisons to clean energy, they're widely used benchmarks for any performance comparison – and so shown here. We'll include these 3 in coming pages for past Quarter, Year to Date, and past 5 years. After that, we'll use in the lengthier past 10 and 12+ years comparisons an excellent narrow solar-only basket; also a separate (not ours) global clean energy basket, and an active managed alternative energy fund.

Next, 2020, Year to Date. This chart next page again shows clean energy most up by far, +80%. Even after falls Q1. Note too that a useful non-correlation ECO often displays vs dirty energy - is again vividly seen. What fine example of diversification among themes! While oil's much-followed story was in unprecedented historic free fall this year, instead we see clean energy's story and thus ECO Index® & NEX – marched in 2020 to a distinctly-different drummer.

Decarbonization/clean stories well outperformed dominant dirty themes YTD so far. Clean, also beat handily major Indexes YTD. 2020 began, rosily enough, in 1st month January with thematic clean thumping all. As captured by ECO, NEX, OCEAN, all 3 spiked upwards, more so than broad Indices. The COVID-related crash then hit all very hard mid-February, dropping markets 'round the world, along with clean ECO/NEX/OCEAN to a nadir late-March.

And yet. Past 9 months since, clean resumed upwards climbs to above start of 2020 – so exceptionally higher vs. dirty. Declines in clean were less enduring than fossil fuels, that are still down. Contrast that in a 2020 vantagepoint, with *dirty* energy, worst performing sector of the S&P 500 basket 4 of past 6 years. (In S&P500 'energy' still mainly is dirty fuels). Indeed a small slice of S&P 500 that's mainly fossil fuels, was off by -51% in Q1 2020, a period when overall S&P 500 was down 'only' -19%. Partly it's due to that Index's weighting methodology: just 1 big component in the S&P 500 basket based on market capitalization, might potentially have a heftier role than all its (dirty) energy components combined.

Latter 2020 (dirty) energy had fallen to be just 2.5% of the S&P500. By contrast it had been a bigger 7% in 2015, 11% in 2010, 16% in 2008, and in 1980 dirty energy was 7 of the top 10 in S&P500 by its market capitalization, over 25%! Conversely in 2010, technology stocks were 18% of that basket, growing to 28% by 2020. Technology rose – while green themes haven't been captured much, yet. (Tesla, a leader was anticipated by some for an addition in Q3; it could have been 1%+ of that Index, significant on ~$4 trillion trackers but was passed over). For further insight, let's consider the case there of an oil and gas behemoth, Exxon.

Latter 2020, importantly the Dow Jones Industrials Index announced it would drop Exxon from its leading 30-stock Dow basket. Why? Given Apple split 4-1, it meant the price-weighted Dow instead needed to find new component/s to add to help keep up with other baskets (Dow has significantly lagged in performance of late). New representation was chosen - but Not from anything in old-style dirty energy like oil – instead it was adding 3 technology-heavy names.

So the Dow deleted Exxon that had various incarnations been a component since 1928. Once longest-serving component of the Dow, no more. Only Chevron among oil, stayed. That's a reflection of both what happened last decade – traditional dirty energy fell fast – and also an indication maybe of what's perhaps ahead. Technology including clean, green new energy might possibly ascend robustly into Dow ahead, like into the S&P500 – just not quite yet.

Battles are going on here, quietly influencing hundreds of billions of dollars. In 2019/2020 the Administration's Department of Labor using ERISA law, wanted to know whether there are 'discernable trends' in how retirement funds are investing in energy (FAB 2018-1). There's been sizable outflows out of fossil fuels – and into sustainable energy themes. It's been reported the fossil-fuel industry & climate skeptics were an impetus here, trying to slow the inflows into ESG (Environmental, Social, Governance) investing. They'd hoped to see recent 'non-pecuniary' goals like climate get subverted; the election may have bearing here.

And yet, real-world returns for green energy have been hardly 'non-pecuniary': look at this YTD chart: the 2 very best performers are again ECO & NEX via independent trackers, well up YTD. ECO & NEX are well positive YTD some +80% & +50%, far better than old energy. (OCEAN up +22% has no tracker yet). Much better too than near-nil, S&P 500, Dow, and all country world theme – though latter 3 Indexes are major bogeys for comparisons. That contrasts too with once-dominant oil/coal/gas stories, trailing far behind; coal & natural gas are 'only' off roughly -20%, oil down -70%. So It's little surprise to see tens of $ billions flowing into ESG first months 2020, breaking a prior record for all 2019. ESG (per IB 2015-1) so outperformed, that climate concern even came under quiet attack by fossil fuels interests under ERISA.

Green energy did better too than most U.S. active Funds. So if proposed rules seek to prevent any look at climate change, for being 'non-pecuniary', that's curious given the facts:

2020 Year to Date to late-September:

Source: finance.yahoo.com

Yes, the 3 decarbonization stories ECO, NEX, OCEAN did fall big in Covid-19 February/March. Then they enjoyed a remarkable rebound across a pretty wide variety of market conditions. 2020 YTD here ECO/NEX/OCEAN are high-end of vertical barbell-shape returns. Hence at top, well up are clean green stories. Opposite end at far bottom – is old-style energy oil, gas, coal, clumping, negative with very large declines. In middle are 3 broad prevalent market 'bogeys' for comparisons: the S&P500, Dow, and an all country world theme basket. Latter 3 finish near nil or just up; close to so many active-managed funds year to date. Over a 2020 smitten by pandemic, on wildfires, temperature extremes, and storms, increasingly we see mounting evidence that the economy is a wholly-owned subsidiary of the environment.

In the 2020 YTD chart, above, one key theme – Oil - distorts all by falling -70%, *Downwards*. Oil futures fell tremendously, negative, rebounding back only somewhat. A few words about that unique oil index basket & tracker. Very unlike ECO/NEX/OCEAN, that other oil theme is instead based on a commodity - rather than equities. 'Worse' it was based on far front-end oil future contracts, pricing in turn influenced by tracker that can't take physical possession of oil. It's constrained by known rules & subject to pricing attack. When very nearest front-end month oil contracts 'broke' into contango in Spring, that oil index went extremely down. Most-near monthly pricing, moved quite unlike more stable futures pricing 12 months out that may better represent actual physical oil. We'll discuss oil much in pages farther ahead, but the point is oil over 2020 vastly fell. Clean, happily, was very different.

Clean energy saw consolidations due to growth in 2020. One leading U.S. solar panel maker sold its operations and management arm to another in O&M. A second dedicated solar name split in two. Once vertically-integrated it made solar panels – and installed/serviced them. Splitting in a spin allowed parent to re-focus downstream on residential & commercial solar in North America. It's a big market (with very thin margins) including solar & energy storage; with branding, distributed generation, and is fast getting bigger. It's also work that can't be outsourced, nor done overseas by cheaper, commoditized competitors elsewhere.

This event shines a light on very tight downstream solar margins – leading to consolidations. Post-spin, that parent may see better valuations in this hot space. U.S. solar installs are already rising fast: in fact a separate merger latter 2020 brings 2 leading U.S. solar installers together, as one behemoth. Post Q4 that installer might find a useful valuation comparable to the new solar downstream parent, as all are seeking low cost access to capital.

Meanwhile, upstream, the new spinoff is aiming to manufacture high-end panels affordably. But margin pressures are unrelenting here too. Some manufacturing is moving from China such as to Malaysia, Philippines, Mexico etc. There's huge commoditization in solar upstream ('just get us good panels, least cost per watt'); PV modules prices dropped 80% since 2012. Meanwhile, downstream, that parent entity may use panels from its spinoff, yet that panel brand leader spin now based in Singapore faces razor-tight margins supplying solar for commercial, residential around the globe. It will be interesting to see how coming stock performances unfold for both parent& spin. Once upon a time there were fat 30% margins here; now it's much slimmer with tough 10% margins in some power purchase agreements.

Thus does a roller-coaster 2020 already feel, in Fall, like it's an exhausting, thrilling year. The 2020 chart is remarkable: the world hasn't seen anything like it – and like this delta for clean vs dirty. With so much to unpack, there's unusually ~50 dense pages in the Report(!). Overshadowing all 2020, of course, is Covid-19 pandemic. Job losses skyrocketing on the Great Lockdown/s. Markets cratered in Q1 – and potentially may do so again ahead. Oil imploding to places not seen in 100 years. Rising attention seen in late 2019 for climate change and for clean energy solutions - overtaken by pandemic – perhaps yet again resurging.

Moving on, let's consider the longer Past 5 years period next. Dirty fossil fuels again stand out next page, again for declines. An interesting shift though is seen in this past 5 years chart. Until a few Quarters ago, last 5 years for ECO was generally down, for a long spell. Breaking that end of 2019, ECO left a long spell down past 5 years. Suddenly, sharply, clean energy had shifted past 5 years end of 2019 to up, positive, returning +50%. By end of 1st half 2020, the divide had grown starker. ECO was up by over +50% as dirty fell yet more. In Q3 so far at least, it's a striking divergence of +180% in clean energy themes - vs. the dirty themes.

Because 2016 had been a declining year in ECO/NEX – as 2021 scrolls ahead, past 5 year charts could by mathematical coincidence improve further – even if ECO/NEX are flat in 2021. Or, should ECO/NEX happen to even gain in 2021, then past 5 years chart could really rise. That is simply a mathematical fluke without much significance; so do be wary of it.

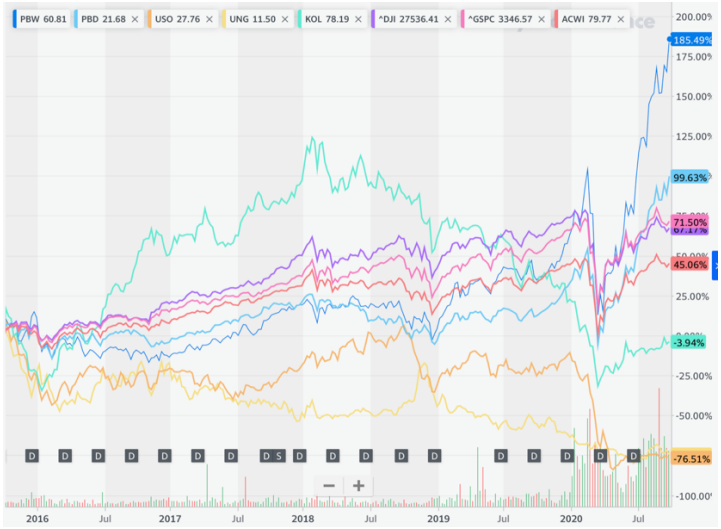
In sum 5 years capture but a sliver of time. Corrections happen, trees don't grow to sky. And temporal slices are just snapshots; e.g. at end 2019 the past 1-year ECO already was up sizably by +59% - so perhaps a big drop wasn't very 'surprising' early 2020. And clean energy's theme once long stick in past 5 years downturns in prior Quarterly Reports across 2010s, has shifted. That once-monolithic view linking ***all energy* down,** has lately been changing, a lot.

Now 3 striking factors in this 5-year Chart are: a) Clean energy's story so ECO/NEX is leaving 3 Down years, 2014-2016; b) this story increasingly captures 3 Up years 2017-2019 (maybe 2020 too?) with gains across ECO, NEX, OCEAN; and c) clean's up +180% has left dirty fuels 'in the dust', those *down* -5% to -70%. Clean is now beating too most major Indexes.

Past 5 years then an ECO tracker is strongest of all stories here, up about +180%; the global NEX is 2nd best, up +100%. A separate global clean energy Index (not ours and seen ahead) trails both; as noted that separate, good global clean energy Index underperformed vs ECO & NEX most every sizable period here: last 10 years, 12 years, & since inception. It, along with an excellent solar-only story, and active alternative energy fund, are seen in next charts for relevant stories past 10 years, 12+ years. Having too many lines clutters charts; these three will thus replace the Dow, S&P500, and All Country world theme for clarity within energy.

Big *drops* in clean energy *can and do happen*; ECO fell at times in 2020, more than key Indexes. On the other hand this past 5 year performance shows clean energy's *gains* can outpace the Dow, S&P500, and all country world, too. Consider that in August 2020 the Dow gained +7% in its 7th biggest monthly August gain since 1984; S&P500 rose +7%, in its 8th biggest August gain seen since 1986. That same month ECO Index was up in August by +20%, the NEX was up +15%, and OCEAN was up near +12% (for not their greatest single monthly gains).

ECO / NEX trackers vs. varied other clean & fossil fuels themes this Rolling 5 years: September 2015 to late August 2020. Once seen as 'tough times' for all energy, this increasingly is Differentiated - with Clean ECO/NEX at top greatly outpacing dirty:



Source: finance.yahoo.com

Next is a past 10 years chart, now modestly positive. Until recently, clean energy's story last decade was a relative 'dog'. Why, and what's changed so strongly? Mainly in a strictly charting sense it's due to leaving steep declines long ago in late 2000s and very start of 2010s.

2009, 2010, 2011, 2012 were final legs in a steep plunge then in renewables. So including all or most of those years, had bent performance down. Clean was relatively 'outperforming' dirty then at times. Yet clean too plunged hard. This warrants attention. Seen here next is a rolling chart for these past 10 years, from latter part of 2010 - to August 2020.

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10 years, NEX is up some +55%, and ECO up some +25%. This period is leaving behind a Great Recession that had thunderously first dropped all down 2009. That had put in bottoms among numerous *non-energy* stories, many moving up afterwards. But not so much within the energy stories which got hit harder and longer. As seen below, especially among dirty energy themes, much in energy went on falling afterwards, no immediate rebounding up.

Clean vs. dirty energy diverged since – lately by quite a lot, happily. Thus in apt 2020 words of the Wall Street Journal, in 'Green Energy is Finally Going Mainstream" (June 24, 2020), "After many false dawns, the sun is finally starting to shine on green-energy bets. …. The poor long-term track record of clean energy stock indexes and funds has much to do with the period roughly a decade ago when Chinese solar-panel manufacturers scaled up and drove down costs. That accelerated panel installations but crushed margins, leaving many much-hyped U.S. and European manufacturers, and their shareholders, in the red."

Solar upstream stabilized significantly, coping with commoditization's (thin) profit margins. The NEX for clean energy *Globally* is most positive here about +55%. Similarly, ECO is back positive about +25% for the 10 years to end of September. An independent, separate global clean energy Index (not ours) tells a differing, narrower story, it's negative here by -6%. An active alternative energy fund is down -22%. An excellent, narrow solar-only story is negative here about -40%. Meanwhile the fossil fuels plumb depths far down here -80% to -90%. It's a tale of declines outside of clean - dirty oft trailing by inarguably large amounts.

Natural Gas is the worst down some -92%. Next to it so deeply down is an Oil story: even with brief spikes, oil is down -90%. Coal is down roughly -80%. A passive Solar-only tracker as noted is down; yet this theme has done far 'better' more recent years – brought low if seen a past decade. The trailing active-managed fund shows again it's tough to beat passive Indexes.

So highest here is green encompassing global NEX, and ECO. They far outperform vs. all other energy themes here – yet far trail well behind the broad Indexes like say the S&P 500. On the other hand, clean ECO & NEX clearly did 'best' last 10 years – vs. other energy stories.

<u>Rolling Past 10 Years from September 2010 to August 2020:</u>

Source: yahoofinance.com

Before moving on to longer 12+ years period – an interesting development stands out. It's that **Global NEX** (in red, next page) & ECO both well outperformed an independent global clean energy index (next page) most every lengthy period here: the past 10 years, past 12+ years, since inception – increasingly so since start of their respective trackers. Why is that?

3 factors may help explain why that other global clean energy Index - has so trailed behind the global NEX clean energy Index; perhaps in part it's that the other (non-NEX) Index:

* Is far more concentrated with far fewer stocks and is heavily weighted in its top ten;
* The Represented countries and weightings outside top 2 there are often more limited;
* Diversity of clean stories captured is much narrower, given far fewer stocks in that basket.

Consider some differences of global NEX Index – vs. that **other global clean energy index**. Global NEX Index went live, first, just before that other Index, over 12+ years ago. Generally NEX has since had around ~90 (roughly 85 to 115) components in its years since. By contrast that other global clean energy Index has had some 30 components. Arguably, around just 30 might make it a bit more difficult to capture fast-growing global green energy stories.

Weightings concentration matters too; that other basket sorts by market capitalization. As a result, just its top 10 components alone in that other tracker may reach around half (or more) total Index weight. Clean energy's stories worldwide, are no doubt broader than 10 stocks – although this concentration can mean sharp upturns when its top 10 narrowly do well.

Instead, the NEX uses modified/straight equal weighting, given such a big diverse arena. This allows NEX/ and tracker to capture more stories, across diverse areas worldwide: solar, wind, electric vehicles, energy efficiency, geothermal, greener hydrogen, biofuels, etc, etc.

Neither version is 'right'. They simply provide differing measures for a story to be captured: in this case, clean new energy Worldwide across developed countries and exchanges.

Comparing their baskets, mid-2020, showed marked differences. There's about 3 times more components (some 90) in NEX tracker. Top 10 in the NEX tracker make up 17% of total weight, so allow many other stories (83%) to be captured in a basket overall. As important as top 10, is its Top 50% - and again NEX has far more components overall. This means more stories are allowed in global green energy, more countries, far greater diversity across this theme.

Now that the 2 Indexes have been calculating live 12+ years, we do see wide performance differences. It may be a bit interesting to understand, Why. Clearly a better performing NEX tracker (next page) does much better (-22%) than the other tracker well down some -65%. One difference may stem from variety / and number of representative countries in each Index. That other tracker in Summer 2020 had just 2 countries that made up some 50% of it: just the U.S. (38%) and China (12%) made up fully about half the countries by weight.

Four other countries helpfully, add roughly 7% each, Canada, New Zealand, Brazil, and Spain. Then there's seven more countries that generally make up the rest, under 5% each. So a big difference mid-2020, is that just two countries make up about half that other Index, with 11 more for its other half - albeit 1 or 2 companies from each of a few nations. Total there is some 30 components, as 13 represented countries for the other, global green energy theme. That to repeat is one fine approach to a basket; these are just differences of flavor.

NEX offers a much different construction. Seen in its tracker, top two countries are U.S. (25.37%) and China (9.46%) for about 35% - this also allows more components and more weights from other nations. Arguably useful given diversity of green energy. A case can be made that this may better reflect the global diversity of green new energy ideas, seen worldwide.

Nations in this much larger ~90 components NEX are U.S. (22 components), and China (with 8); there's also many components from Canada (7), Germany (5), Japan (5), Spain (5), Taiwan (4), New Zealand (4), S. Korea (3), Britain (3), Denmark (3), Norway (2), France (2), Sweden (2), Switzerland (2), Italy (2), and also Ireland, The Netherlands, and Finland (each 1).

Hence more weight for many nations. Relatively many components in NEX outside 2 weightiest nations U.S. and China. Had these two global green energy Indexes been simply always trading respective leadership, performances going back and forth, these differences might not have much mattered. But performances of the two Indexes has rather plainly favored one, with NEX tracker (red below) consistently ahead of other global green energy Index (blue). Hence these thoughts above about possible reasons for the past trends. This is seen now most every period in a lengthier past 5 years, 10 years, 12+ years, and since inception.

One metric they do differ on, is weighting – but that doesn't identifiably lean towards long-term performance one way or other. Yet it is a fundamental difference, so worth a moment's discussion. Whether equal weight (modified or straight) like in NEX – is 'better' than a market cap approach for green energy, cannot be said. Much ink has been spilled over this in major Indexes: probably it's most accurate to say there's periods equal-weight does 'better' – and periods market capitalization does 'better'. Neither can be predicted – each is identified in hindsight. For sure in leadership led by a few big momentum names, market cap may do better. Consider a market cap S&P 500 vs. equal weighted version. Since inception, the equal-weight wins. But it would be simple to pick periods market cap does better; there's no clear consistent winner here. At times one approach does better – other times, the other.

Here the global green energy theme captured by two Indexes live since trackers' inception 12+ years ago. It's interesting to see performance of each in these two trackers: in sum global **NEX** (**in red**) shows a 'better performance' in capturing clean energy worldwide:

Source: Google.com

One last point about charts, before moving on. A small problem with *rolling* Charts like past 1 year, 5 years, 10 years etc, is in a few years they *may* show very strong returns for ECO. Once charts leave a huge fall in ECO 2008-2012, and later tough times all energy 2014-2016, then relative drops removed, ECO *may* show even greater relative gains. For that reason, a view is needed with ECO's huge declines from 2009 preserved: hence this Chart below. From a fixed 2008, it looks onwards. Longer-running ECO + tracker could start in 2005, yet other trackers didn't all commence until later – so the earliest feasible start was mid-2008.

Over now 12+ years & growing, this *non-rolling* chart shows again a tale of pervasive energy declines. Unsurprisingly fossil fuels lag green by big amounts. But relative to rolling 10 years, above, a difference increasingly stands-out; the global crash 2009 so brightly highlighted, is strongly forever preserved. What energy might perhaps show ahead, will doubtless be of interest as 2020s scroll in ahead. Long-viewed as a tough time across all of energy – the coming last 12+ years *may instead* show as mainly tough for the fossil fuels, only. Or not!

This chart will go on emphasizing huge drops across energy, after steep run up mid-2000s. From about mid-2008, as many trackers are commencing near peaks, all would next plunge. That crisis and crash meant huge falls across countless themes, globally. A bog & deep mire since stretching across clean and dirty energy, is brightly preserved here 'in amber'.

Starting from bottom are fossil fuels, plus a solar theme; the 3 + 1 fell by near some -80%s to -90%s. Next 'up' is that independent other global clean energy Index off near -70%: that narrow theme fell very hard this period and with just 30 components differs vs. outperforming NEX with some ~90 or so components here. Roughly tied there to it is an active fund. 'Above' and down is ECO -50% though again far outperforming a separate global clean energy theme. Clearly 'highest' is global NEX, though underwater -31%. Again, broader major Indexes outside energy did *far, far* 'better', yet they do differ: energy is but a sliver there. Plus since 2017, clean energy has shown some up volatility too, which *may* yet change everything.

<u>Roughly Last 12 ½ Years starting from Fixed June 1, 2008, to August 2020:</u>

Source: yahoofinance.com

In a side note, clean energy's plummet February/March 2020 left only 1 ECO component positive at a so-far YTD bottom, March 18, 2020. That March 18th inflection was a bit memorable: ECO opened at 51.88, then fell to an intra-day low of 45.85 losing -12.57%; it would close at 47.37. So this basket here dropped over ½ early 2020, given its 93.65 high intraday on Feb. 20 close at 92.53. In just weeks, ECO plummeted over -50%, as world markets were crashing amidst fears of 2nd Depression like unemployment. And in September 2020 clean energy again dropped somewhat – although nothing (yet) like that seen 2009-2012.

Lest this Report over-emphasize negatives, e.g. spotlighting big declines long ago early last decade - there's also been sharp rises too like recent 2017 to 2019 (and maybe 2020). For example ECO components jumped over just a 3 days stint 2020 from March 24th, on a sharp +25% rebound. Volatility after those lows pushed ECO upwards some +15% in hours.

From closing under 50, March 23rd at 48.75 on fears of 25% unemployment & a Depression II, the Index reached 55.87 on March 24th, closing at 55.74 on hopes of $2 Trillion stimulus. Focused green support wasn't expected in a stimulus Phase 3: as expected such help didn't arrive since it was opposed politically. Yet clean energy as detailed ahead, is now fast-growing cost-competitive even *without* subsidies (unlike fossils/nuclear always needing support).

So gains *may* happen in clean energy. At times they may show up alongside broad markets, on perhaps more volatility. Consider say, April 6th to 10th: that 1 week the S&P500 & Dow rose some +12% in a biggest 1-week S&P gain since 1974, the 7th largest for Dow. Both ECO & the NEX – (latter NEX too) 'can drop like a rock' downwards to be sure; here they were just as, or more volatile: ECO rose by +19%; meanwhile a volatile NEX gained over +12%.

Looking at ECO/NEX first part 2020, some bunching is seen in best performers, these were in solar, energy efficiency infrastructure, electric vehicles, green hydrogen (H_2) & fuel cells.

Green hydrogen is a subsector differing from solar, wind, and electric vehicles. Making green H_2 would first require key breakthroughs in both production & in storage – meanwhile their companion fuel cells generating electricity from that green H_2 would require breakthroughs to be cost-competitive, and durable too. They're not even close to that today.

Solar, wind, EVs are instead reaching profitability, and can go unsubsidized, with far less uncertainty than H_2. That said, there's growing interest in H_2 like in Australia, perhaps on ammonia (simply H_2+nitrogen) as means to transport hydrogen like an energy currency.

For applications where super high furnace temperatures are needed like steel making, cement, aluminum etc, the clean electricity from solar and wind can't reach that. But adding an extra step, potentially could. With electrolysis from super-cheap clean power, green H_2 made from water (H_2O) – could in turn be combusted for super high temperatures.

Making sponge-iron for steel now produces 7% of carbon dioxide emissions globally; 10% of all the CO_2 emitted by Sweden. So note a test project there for green H_2 made by electrolysis: it aims to release only 25 kilograms of CO_2 per metric ton steel – versus 1.6 tons today.

ECO, NEX, OCEAN & an earlier pioneering H_2 Fuel Cell Index all have had exposure to hydrogen & fuel cell stories, since their earliest inception over 20 years ago in late 1999.

We avoid politics. So just side-note is sparse hope had existed mid-2020 for a stimulus squarely for green energy. 180 lawmakers did sign a June 15th Letter to the House Leadership calling for direct relief, given loss of 600,000 clean energy jobs since the pandemic. But the calculus for directed big green-only funding – let alone akin to a Green New Deal, like that vetted in the European Union – wasn't aligned Q2, or in Q3 2020. Senate Majority leadership squarely opposed it; and was also a non-starter in the White House. But much *may* change.

Musing over what conceivably may be, the November 2020 vote might soon go potentially any of many ways. The White House may change (although clean energy jumped last 3¾ years). In the Senate, 3 or 4 seats could change Majority Party: there's a modest possibility of a filibuster rules change to <60 seats. Post-2020 action might include Tax Credits renewed for the 30% Solar Investment Tax Credit, Production Tax Credit for Wind. Those credits otherwise are stepping down. But there's potential for far greater decadal U.S. policy change.

Policy action could go much deeper, should the challenger win the Presidency. At least $2 trillion+ *might* be spent over next few years. Utility solar jumping to 100 GW/year, battery storage shooting up to 40 GW – approaching ½ today's installed electric generating capacity. There may be flowering green growth. Cheaper batteries are a hardy perennial globally – lodestones to vastly improve intermittent renewables & EVs. They may go from under <300 Wh/kg to over >400 Wh/kg. Made in U.S. can = good jobs. Solar manufacturing capacity from 5 GW capacity, leaping >100 GW/yr. Or, if the incumbent instead wins, then decarbonization may be impossible by 2050. Scarier climate change CO_2 scenarios may yet arise.

So with change, there's precedent for green stimulus. A U.S. 2009 ARRA package boosted climate-friendly sectors on $90 billion of $800 billion. That tripled U.S. solar/wind installs, grew U.S. clean energy jobs from a few hundred thousand, to 3+ million. Today in Europe, a Green Deal and maybe carbon tax, are advancing. Although a 2020 U.S. CARES Act boosted jobs in carbon-heavy, older industries – a package 2021 could potentially be far greener. Cost reductions here are unlike in oil or coal. For once the renewables *achieve great cost declines, they hold onto & grow them farther still;* they are stickier, sustainable and welcome.

The pandemic ought not take our eyes off a 'climate solutions' prize. Juggernaut that was clean energy in Q4 2019, was throttled back Q1 2020 by economies prostate on their backs. A focus then on climate change & CO_2 was diverted, demand for clean energy lightened, solar & wind auctions waylaid, tax credits incentivizing solar/wind stepped-down; no one knows if/when global economies may regain prior confidence & growth. It's conceivable economies may yet crash again – and volatile ECO can drop like a rock! Yet, it's becoming known too that long term solar & wind can thrive without subsidies. Same can't be said of dirty energy requiring vexing fuels – nor of brittle supply chain choke points like a Straights of Hormuz. Nor of risky, costly nuclear power seen nowhere without its immense governmental support. CO_2, climate & costs are certainly now bedeviling all the fossil fuels, as never before.

A key turning point, at start of 2020s, is the renewables are often now increasingly *the most affordable* choice, worldwide. With that change, conversations can & should now shift. Fossil fuels are no longer cheapest choice. Climate change increasingly is accepted. This decade, U.S. energy *may* yet pivot towards a carbon free grid by 2035 saving money to boot. It's downright feasible! We'll look at this freshening possibility next. It *could* be a transformative decade for the U.S. & Europe – and Asia. Let's start with the U.S. and possibilities:

Assume for a moment the climate science is correct. If so, then we all must act faster – by cutting CO_2 emissions by ½ to 2030, then seeing 'only' 1.5 degrees C with some ravages of warming. Yet, we're nowhere close to 50% cuts. The trends today go weakly and languidly to 2050+ before seriously decarbonizing: that will be much, much too hot and too late.

Given science requires moves towards net-zero now, it's key that dramatically plunging solar, wind & energy storage costs have *immediately changed everything*. In the U.S., a power grid producing at least 90% less CO_2 is not only feasible, it now can be done in 15 years - with *cheaper* electricity. Past competing analyses had differed over last bits of 100% zero-carbon. But beyond 90%, is a smaller bit. Since analyses *agree* on first 90% or so – that it can be done in the U.S. (and elsewhere) more quickly than commonly understood with less cost – a major 2020 Report blueprinting how we can get there from U.C. Berkeley is very important.

It shows exactly how 90% carbon-free can now be achieved swiftly: within 15 years by 2035. With retail electricity costs consumers pay 2035, 10% less than today. So common assumptions got it badly wrong both on how long to 90% - (and perhaps 100% carbon-free power given even more recent advances in better cheaper batteries, just announced, sooner than thought), and on it being less costly for this new clean U.S. path (indeed, it actually saves money).

Remarkably this 90% less CO_2 is 'no-regrets'; sensible in its own right and better than status-quo No New Policy, by delivering cost savings. It's detailed in a "2035 Report: Plummeting Solar, Wind, and Battery Costs Can Accelerate Our Clean Electricity Future" (June 2020), https://www.2035report.com – and a companion Report, "Rewiring the U.S. for Economic Recovery" from Energy Innovation. Their conclusions differ sharply from the reports of only 8-10 years ago that once foresaw carbon-free electricity adding costs. Instead now:

> "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."

This study allows for use of all known 'zero-carbon' generation options. As expected a focus is on the cleanest: solar, wind, energy storage; yet baseload big hydro, geothermal, biomass, and nuclear are also permitted. (As in theory are fossil fuels on carbon capture/ sequestration – but least-cost models do not include new nuclear or sequestration). In contrast to this 90% No Carbon path, is a No New Policy of mere state & federal trends status-quo. That latter model reaches only 55% clean by 2035, falling way far short of what's required. Crucially this 90% Plan delivers reliable, firm power that's fully dispatchable, as needed. It will thus meet all demands, every hour of each day; there's no compromise on performance.

To reach a 90% zero-carbon target by 2035, annual U.S. deployment of U.S. solar & wind must notably double through 2020s, then triple its historical bests to 2030s. This rises up hard up from 15 GW of solar that was installed in 2016, and from 13 GW of wind installed in 2012.

Tremendous growth was seen before; natural gas plants grew by 65 GW in 2002. Now, what's needed, has changed: *energy storage* is 3rd leg of a crucial triad to solve the intermittency of renewables: energy storage deployment thus needs to grow by 25% per year. Starting from a mere 523 megawatts in 2019, it should grow to 20,000 megawatts storage in 2035!

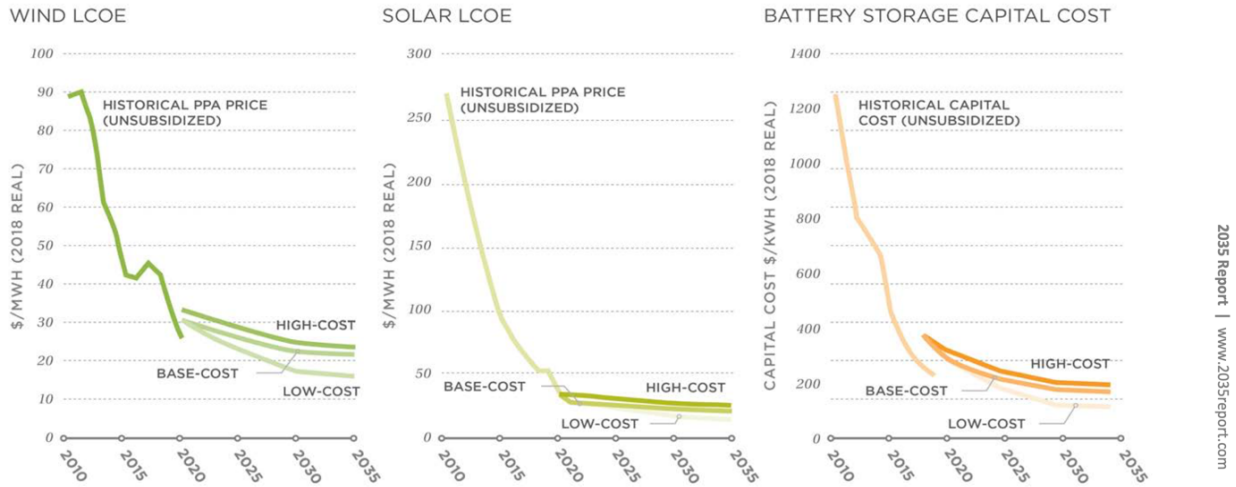
Only modest new transmission or spur lines will be needed to interconnect expanding clean power, so less pressing need for costly, long-to-build intergenerational lines. No imposing demand to overturn grid infrastructure, requiring long lead times. But, what does change, is the composition of both generation and storage over a fast-arriving 15 years.

First off, all U.S. coal plants need to be permanently shuttered by 2035 under this plan. In places like California that's already happened. Extant plants elsewhere, generally have been running for many years now, so 15 added years in this Plan leaves lead-time to recoup original capital investments. It's doubtful coal owners would want to burn very much longer, given costs and liabilities vs. clean power – but recouping costs is addressed in this Report.

Second, no *new* U.S. natural gas fired plants would be built. Existing gas plants and those going up now can remain; they'll play decreasing role in grid stability as new storage grows. Again, capital investments are recouped over this period – finally 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 to zero.

Since gas-plants pay for fuel, reducing their use helps achieve 2035 wholesale electricity costs *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 the past when the renewables were much more costly, than fossil fuels, such standard was not yet embraced.

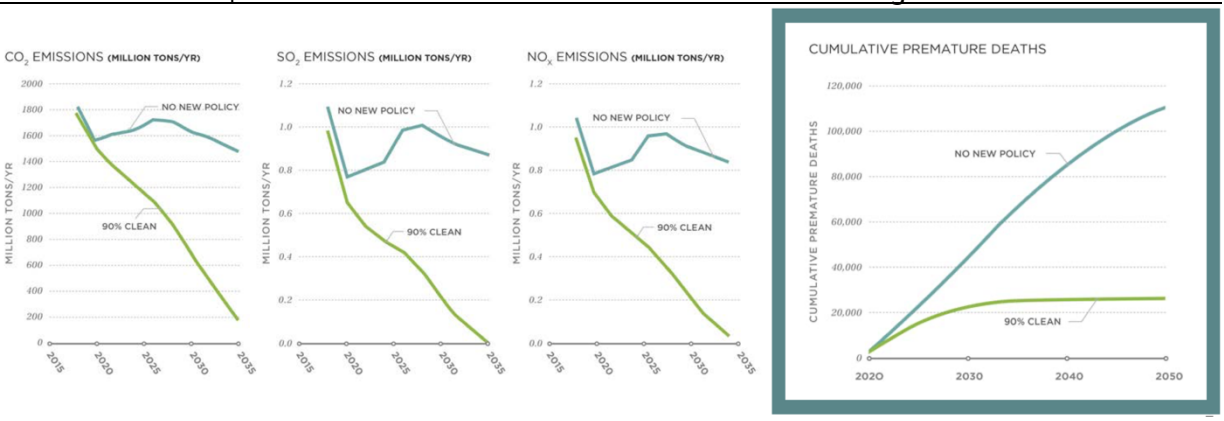
<u>Dramatic Declines in Costs Have Arrived 2020 Far Sooner than Expected:</u>



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

Relative to currently trending status-quo No New Policy, this 2035 Plan would instead reduce CO_2 emissions from energy generation by a whopping 88% by 2035. As a direct human health consideration, that reduces human exposure to polluting fine particulates (PM 2.5) and Nitrogen Oxides (NOX) and 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).

The 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 might assume solar for instance needs warmest climates, but in fact solar power does quite well in freezing settings - even say, at Poles and literally space.

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

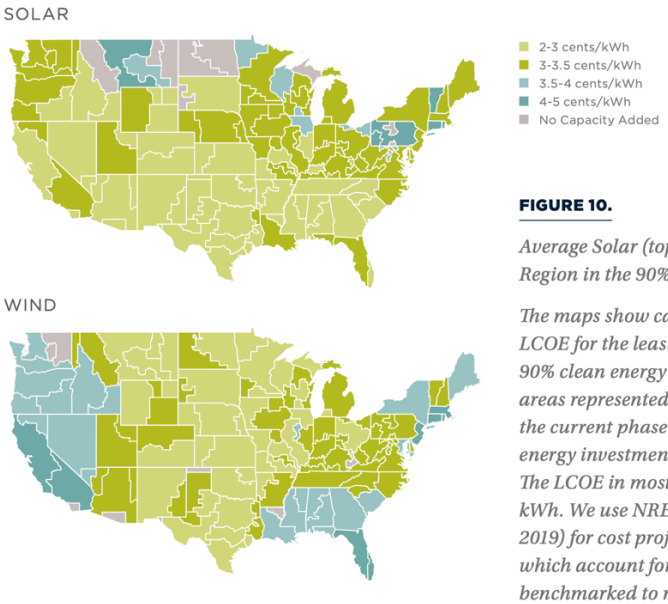


FIGURE 10.

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 the 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 and should be located near closing fossil fuel power plants; new jobs building solar, wind, storage going in where fossils are shuttering. Jobs will be front-loaded & prolific in construction - not so much in later operations, since neither fuel nor much maintenance is required. It will arguably also be very important to assist local communities that were once dependent on coal; shoring up their pensions, healthcare, jobs & training programs in a move to green energy.

If aiming for 'only' 1.5 degrees C warming as set out in the 2018 IPCC Report, global emissions would have to be halved by 2030. This green Plan isn't enough; it means a 27% reduction in CO_2 from U.S. electricity generation. That doesn't give the U.S. a 50% by 2030, nor globally, but there'll be (one hopes) big reductions too in industry, building, etc. And under this Plan's glidepath, finishing up with a fully 100% CO_2-free grid by 2035 too could be compelling.

Delivering *less-costly* power in 2035 that's also *cleaner* – wasn't regarded as feasible before - since 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 and necessary to replace (costly) unneeded fossils – in order for non-firm renewables to meet all our needs all of the time.

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

Renewables are oft criticized as faceplate capacity must be built several times what's needed - compared to firm, always-on power because of intermittency & variability. (Portrayed as a liability here, versus nuclear, coal, and natural gas). But it's just a characteristic.

Over 7 weather years modeled, in normal conditions, wind, solar, and 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, then existing natural gas plants, hydro, and nuclear together with batteries can in cost-effective fashion interim compensate for mismatch and they are able to meet needs. Natural gas-plants still will only contribute around 10% of annual electricity generation.

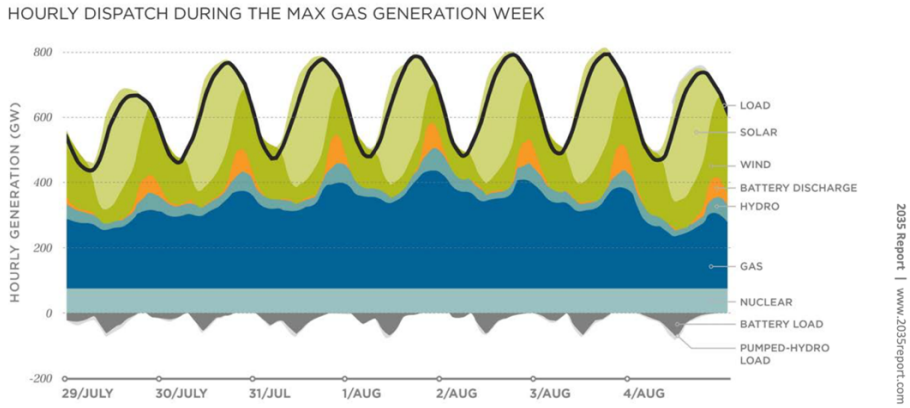
This Plan is so different from what's seen today, that one may naturally ask: How is this done? We know solar is sublimely binary: every day it makes zero power all night. So what happens when high demand evening hour – overlaps with little wind – drastically curtailing output?

Let's start then with a tough-case; A no-solar evening hour, little wind as well. Total solar & wind generation are then 94% below rated capacity, a mere puff of wind somewhere in grid - so 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.

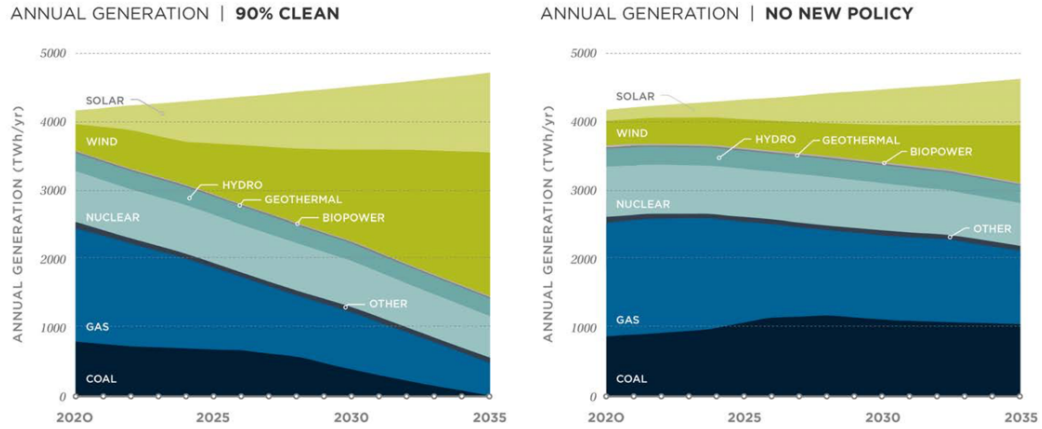
A Worst-Case Generation Period for Renewables: Still Moving Off of Fossil Fuels/Nuclear:



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 today is suddenly real.

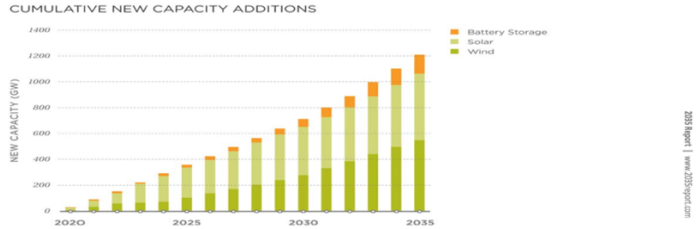
A 2035 Grid Mainly Solar/Wind/Storage, at Less Cost – than Coal/Gas/and Nuclear:



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, although less than one early COVID stimulus, and here with enormous positive benefits.

The No-Regrets path not only lowers consumer electricity costs, it improves human health and reduces damages - *without* considering climate change. Compared with business as usual, No New Policy, this 90% Plan saves money. Especially if one considers the impacts from say, sea-level rise over centuries, maybe millennia ahead – advantages can be compelling. (We'll briefly discuss ahead some potential impacts of e.g. possible sea level rise). Here's the Scaling Needed by 2035 Solar/Wind/Storage is Feasible – and Saves $$ Over Business As Usual:



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

Given renewables' intermittency and range of outputs, there's another side to this coin too: they do at times generate Far MORE power than immediately usable. At times electric power prices even 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 Spring 2020. Instead, it is here a *feature* of the clean renewables system – and one that really ought to be taken advantage of. Happily there's many ways to do so ahead. Batteries are most sensible & on track: maybe new single-crystal cathode, perhaps silicon nanowire anode, etc, etc.

This 2035 Plan has so much solar & wind built that 14% 'surplus' renewable power is curtailed/ shut at times. Consider then that it could also be stored in many new ways. Ponder hydrogen (H_2). It *still requires breakthroughs* to be cost-effective. Basic physics presupposes if one has made electricity to be used immediately, it makes little sense to lose efficiency by electrolysis in converting water to hydrogen for long-term storage. One incurs then further loses in again converting hydrogen back into electricity later, via fuel cells, or by combusting it.

But: if a unique situation presents itself of 'free' green electricity, that alters this equation. Sun shining & wind turbines spinning making too much power, that must be put to use or sadly curtailed as prices go negative - could in a case for green H_2 be made renewably, no CO_2. Clean zero-carbon renewable hydrogen, unlike steam reformed natural gas/CH_4 is today costly and impractical, yet mused about for decades. (For just an example of 20 years ago, see e.g. R. Wilder, 'We Need Clean Hydrogen Soon'. Engineering News Record. 244/59 (May 8, 2000); also, 'Develop Eco-Industrial Parks'. ENR (June 7, 1999)). In Europe more standard dirty 'grey' H_2 from gas now costs around $1.5/kilo, while far better clean and green H_2 might cost more than 4 times that. Plus, vast hype over hydrogen has spiked enormously of late.

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

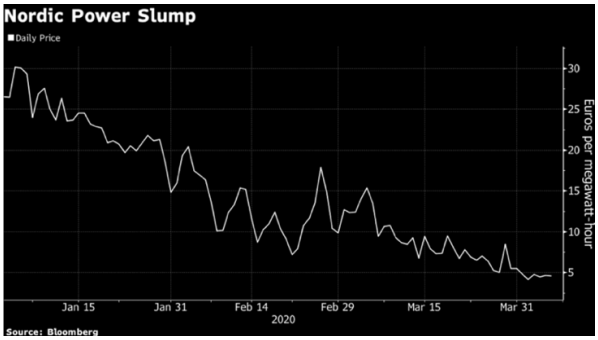
Moving on, let's peer into *applied* clean energy, today. At cases where renewables prices can and do drop swiftly – happening in good snowballing ways (unlike in oil). So note here 1st that Solar Power cost just hit a Record Low cost *of only 1.35 cents per kilowatt/hour* at a big 1.5 gigawatt solar farm going up in Abu Dhabi! True, it's in excellent solar circumstances, a desert for instance. But there are great deserts in the Western U.S. too, and 1.35 cents is cheaper than 'new' U.S. coal power, today, tomorrow, or in short ever. New solar power for about a penny is less pricey than new natural gas too. Frankly, no fossil fuel comes close.

As a practical matter consider 2 renewables together today at a world-leader, say, Sweden. There, clean energy can tell a bit of a startling story. Especially as more renewables get built like is happening, these present interesting twinned possibilities that may be repeated. So consider how in April 2020 as Sweden's then-largest onshore wind farm opened, right away it changed context for its nuclear plants – given how wind power (like renewable hydro, or solar) can in good circumstances, heartily underprice more costly, non-renewable yet firm, nuclear. That wind farm in Sweden is owned by a Dutch Pension Fund and consists of 80 large turbines each rated 3.6 MW, together near 300 MW of installed capacity expected to produce annually some 900 GWh. For more, https://www.vasavind.se/askalen-eng.aspx

Wind isn't the only big renewable operating there. Sweden already has big hydropower plants, so it's harnessing water in addition to wind. (Indeed most places on Earth could boast myriad untapped renewables even if now they're inexplicably ignored; blowing winds can be captured onshore/ offshore, there's often sun for solar power, geothermal potential, or maybe run of river for smaller hydro that's much better than limited big-hydro etc etc).

So Sweden already has its hydropower for significant power. And very rapidly, indeed just 1 day after this wind farm opened, with hydropower already making abundant cheap power, 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.

Now should there happen to be wind farms capitalizing on windy days – plus good hydropower conditions – they together make good use of all 'for free'. Such times certainly, increasingly crowd-out fossil fuels, & nuclear plants that must pay much for their fuel and operations. Risky nuclear moreover must pay to store its toxic wastes long after closed. An upshot was that electricity prices there start of April 2020 were hitting welcome new Lows. Were there say, a fleet of electric vehicles like is being required in California – only electric cars sold after 2015 – then in future those immense mobile batteries could store that cheap electricity to be released as needed into the grid, earning a nice sum for these many car owners:



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

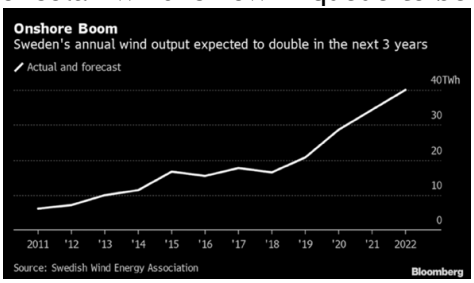
Yes, of course, renewables are intermittent. There's not always blowing wind, nor seasonal rains for hydro. Such times, other renewables may be tapped, in theory. For instance geothermal might possibly grow more common as firm power. Especially if oil rig counts drop on cheap crude, geothermal might become more attractive. Idled drill capability may perhaps be harnessed, helping accelerate geothermal baseload power. Capital is needed; geothermal may require deeper wells, wider bore holes, and is costlier upfront versus solar or wind.

Big Oil hasn't typically looked very much at big renewables projects like this. But if oil stays long near $40 barrel, renewable projects could rival $$ returns seen from a new oil field. Geothermal is costly now – maybe 3x or 4x more-than wind/solar. But geothermal is firm power, and build-out utilizes skills well-understood in oil/gas: how to drill holes deep into the ground. In time, geothermal too might grow more affordable. This is especially relevant say in California, where ~10% firm power supplied by 1 nuclear plant – is to be removed.

So the natural situation in Sweden is exacerbated in a good way, when windy days coincide with high-hydropower output. These charts from Bloomberg New Energy Finance (BNEF, prior longtime partner on global new energy innovation NEX Index) illustrates nicely how daily wholesale power costs in Sweden, were driven down "naturally" 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 needed 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 solar power too.

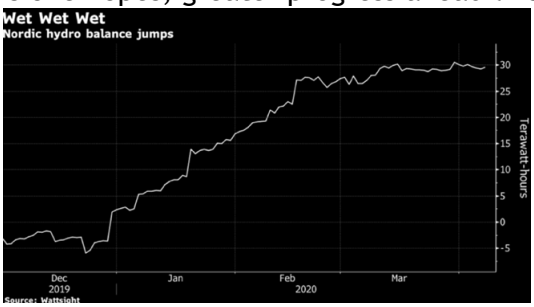
To local industries needing low-price power, big hydro is welcome. Sweden's mills, smelters, miners, aluminum manufacturers are energy-cost-sensitive. Yet big hydro is a static source; its potential capped, limited to big dam-able areas – with huge ecological burdens. So recently wind power entered in 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 a wind power boom. (Texas in 2020 may add near as much new wind nameplate capacity, as past 5 years combined: 31,000 MW; it may nearly triple solar capacity in 1 year to 6,000 MW. At Texas' ERCOT queue 2020 for the grid an astounding 77,000 MW is perhaps contemplated; that's 13,000 MW each of solar/wind is now in queue to be possibly built). Here's the booming Wind in Sweden:



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

Because wind, solar & hydro all 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 the benefits may snowball. Unlike pricey nuclear – and unlike natural gas-fired power - hence unlike electricity still made traditional dirty ways – renewable power potentially can get very inexpensive (below zero!). For this reason and fast-declining costs, it's credible that China reaches its own aims of peak CO_2 by 2030; maybe in 2025 or sooner. That's doable on its massive hydro & nuclear – and as its huge coal may soon be beaten by cheaper renewables + storage. Those became cheaper in last/and this decade, because of its lead there.

More dauting than Sweden, is China's new aim of "carbon neutrality" (not tough "climate neutrality") by 2060 as just announced. Europe is aiming to almost halve its own emissions in 4 decades; China would aim to go from its peak down to zero in 3-4 decades. Nuclear may have to ramp a lot (maybe too, also-not-desirable CCS) – and energy storage clearly needs to rocket up. Intermittency is an issue. Solar yields zero at night predictably; less forecastable is it drops hard on clouds. Wind is best windy days obviously. Hydropower too requires dimpled landscape and snow/rain; some seasons there's less precipitation (run of river micro-hydro ecologically far less burdensome than big hydro dams). Yet, we are in early innings, and there is one hopes, greater progress ahead like with the Nordic renewables in Sweden:



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

The U.S. is making some progress – thankfully moving beyond big hydro. A decade ago, the renewables made up just 10% of U.S. electric power in 2010 – much of that from big hydro despite vexing ecological impacts & limited room for growth. Somewhat noteworthy then, is U.S. renewables' slice grew to nearly 20% end of last decade - thanks mainly to rises in far more scalable clean wind & in clean solar which still have enormous room to grow.

End of last decade U.S. installed solar capacity rose to ~100 GW. (A gigawatt may be thought of as ~roughly one nuclear plant – yet intermittent, unlike nuclear, coal, natural gas). By 2020, solar & wind made nearly 10% of U.S. electric power. Hopeful – yet underwhelming. Note how that growth happened. Partly on China pushing down solar costs via cost-cutting, upheaval and consolidation. The world's biggest solar firm in 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, 1,000 people make 6,000 MW. Price per watt in solar manufacturing crashed -90% in that decade. And partly it has flowed too from a U.S. 2009 meltdown. American jobs were lost at rates of half a million per month; stocks and housing cratered. In response a massive $800 billion stimulus, American Recovery and Reinvestment Act (ARRA) gave a crucial $90 billion then for clean energy, electric vehicles, energy efficient infrastructure.

At the time in 2008, solar was making only 0.1 percent of America's electricity (!). Wind less than 1 percent. So they were vanishingly small in the U.S. energy mix. The ARRA sought to change all that while creating good new jobs and growth. It contained $25 billion for renewables, $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 at the time, so it became more liquid cash payouts. Developers were allowed as much as 30% of project costs, available instead of credits. In 2009 a stimulus really helped prime the pump for that decade of growth seen since. Also of help start of that decade was a U.S. SunShot Initiative, which reached its end decade goals early, and helped make solar much more competitive vs. dominant dirty energy. Consider that in the decade since the Recovery Act, U.S. solar power generation capacity has since grown by 48-fold, starting from a tiny base. Wind generation capacity has grown 4-fold plus.

Of key importance was China strongly entering solar and wind arenas. Seeking to gain market share in a big way, it pushed down pricing per kilowatt - dramatically. That put many established firms out of business in Japan, Germany, U.S. and elsewhere. Profit margins dried up, many couldn't keep up. Chinese firms enjoyed low costs of capital, cheaper labor, often free land, less environmental regulations, and local governments are glad to see big employment gains that these factories brought. Solar prices & margins plummeted.

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

Mid-decade, especially on wind, a marker was hit 2015 as more renewables were installed, 150 GW – than all fossil fuels plants added that year. Diverse kinds of renewable energy were growing common in Europe & the U.S. Various clean energy forms all put together good days, began to briefly even meet 100% of demand on occasion. Thus in 2016 all of 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. A first in its long industrial history, U.K. made more renewable power 2019 – than from fossil fuels combined. Not-sunny it 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, it was 10 times what it normally produces in a day there. What a change; in 2010 its dirty fossil fuels had met ¾ of demand, 10 times renewables. Renewables since jumped to 40% by 2020 and were gaining. Meanwhile, U.K. coal-fired power fell from 70% in 1990, to under 4%. In 2020 it seeks to end coal within 5 years. The E.U. aims for climate neutrality by 2050.

Global annual solar panel production has changed enormously from once-puny, 15 GW in 2010. Yet, as emphasized at ECO, NEX, OCEAN, a key issue is renewables (except geothermal and hydro) are intermittent. 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 the grid, maybe too rechargeable 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 clear years ago: it has paid off handsomely. Lately Europe is trying to catch up; it has identified batteries for new leadership in technology & manufacturing. Decarbonizing energy can move things forward there. Inexplicably, the U.S. has ceded ground early on here in energy storage and batteries, to China. 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. These essentially are a big battery surrounded by 4 wheels. Innovation in storage/batteries, it's clear, will be part & parcel of advancing intermittent renewables worldwide to replace fossil fuels.

Don't overlook practical issues. A Great Lockdown 2020 slashed jobs across U.S. clean energy - as in other industries and nations. March 2020, 100,000 new unemployment claims were filed in the U.S. 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 the grid, storage, and cleaner fuels. And it grew worse.

End of 1H there may have been 600,000 clean energy jobs lost in the U.S. Yet as will be discussed, far greater losses have been seen in coal, and oil. There things are far worse. Coal today employs a shadow of its former heft – though the mechanization there was brought in by that industry itself – and not by clean technologies. Here, in clean energy, there was initially waning consumer confidence in Q1 2020 meaning residential solar cancellations, caution at Utilities, auctions halted on fresh wind/solar projects. That said, Q3 was better - and far side after this pandemic – when/if reached, could possibly bring much activity.

Because costs of renewables are fast-dropping, naturally, and in a good way – unlike fossil fuels & nuclear – one useful change could be for Utility procurement processes ahead 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 well accepted many places – but not yet everywhere. When vertically-integrated Utilities tilt their procurement to fossil fuels, to status quo, and their own bottom-lines, that means excessive power generation – rather than cleaner competition, a clearer look at climate impacts, and truly lowest-cost power.

At places that decoupled Utility's revenues - from the amount of power produced – bottom lines may better advance efficiencies and lower system costs. 'Steel for fuel' swaps reward operational savings that come from new 'steel' (new wind & solar farms) - over uneconomic older fuel-intensive fossil fuel generation. Without such total re/views, an encumbrance of inertia and old-ways of thinking allows more-costly fossil fuels and CO_2 to unduly linger.

Change is now happening so fast, even young-ish decision-makers who 'knew' early 2000s that 'Renewables were the Most Costly' – are startled by the change. It's something of a wonder that in not even a decade, going from 2010 to 2018, Utility-scale solar power capacity grew amazingly 30x, a 30-fold scaling-up to swiftly reach over 60 GW. And it had recently looked to potentially double again in another 5 years (although perhaps not in a pandemic).

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

According to a useful November 2019 Lazard Report, in just a decade, wind energy costs have fallen some -70% on average. Solar photovoltaic costs have dropped more, near -90%. That's made clean renewables less than half the cost of nuclear power (with decades of costly toxic waste to dispose of). Thusly have renewables become often the best, lowest-cost path for Utility generation – preferable to even the once-dominant levelized cheapness of King coal. At times it's lower too than 'cheap' new natural gas. Issues are thus shifting to energy *storage* - to complete a firm power picture. See Lazard, Levelized Cost of Energy and Levelized Cost of Storage 2019. version 13.0. https://www.lazard.com/perspective/lcoe2019
Lazard's 2019 analysis was done just before a 2020 pandemic, but outcomes are clear. Solar & wind in good circumstances (strong sun, windy places) increasingly are least-cost.

What's key to consider here is the *levelized cost* 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 to use many wavelengths. On group III-V semiconducting materials, much more solar output can be captured - than cells today. Concentrate that sun further, using mirrors, and it may be possible ahead for these innovative solar cells to capture 400 times more solar power over an equivalent surface area.

Or consider Perovskites. These solar materials of 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 years ahead.

And yet. To dramatically cut CO_2 as the science shows is urgent *right now,* has not even seriously begun. CO_2 is today over 400 parts per million (ppm) and rising hard. That's after hundred/s of years accelerating greenhouse gas emissions. Yet more CO_2, accumulating over time too, could soon mean much. Consider Just potential (and likely) sea level rise soon.

Importantly a crucial fraction of the airborne carbon already emitted from the industrial revolution, plus in this century and next, can persist for tens of thousands of years. In short, the CO_2 from a window of just 150 years ago to a mere two centuries ahead may now be committing the world given great inertia, to impacts of rising seas lasting for millennia.

Notably the science indicates 50 ft, 100 ft or more of accelerating sea level rise may be locked-in by CO_2, perhaps going for many hundreds or even thousands of years.

This may happen, quickly. In a past meltwater pulse (from CO_2 although by natural causes, at rates less than now), the seas rose between 50 ft and 80 ft in just 400 to 500 years. That's to say, massive ice sheets that have retreated very swiftly before, could do so again.

Global reshaping is what we're talking about. So put aside a moment political debate about global warming. Ignore other aspects like maybe storms, disease, famine, drought, collapsing ecosystems. Set aside too follow-on consequences that might spread as ripples on a pond.

Instead look at just at one first domino to fall: on current CO_2 trends, warming for centuries, accelerating sea level could possibly go on millennia. This is said with unhappily a robust confidence. Scientists now assume total loss of say, Bangladesh, and Miami. As a real threat, one might reasonably assume it's long since been thwarted. After all the Paris Climate Agreement was the latest word here, and it was famously signed by almost every nation.

And yet. Reality is the Paris Accord's so-called targets are not close to being met; rising CO_2 hit new records in 2019. Peak CO_2 / greenhouse gases aren't expected a soon-foreseeable year. Not by 2025, nor by 2030 - despite flowery aspirational words to contrary aiming for 'just' 1.5 or even 2 degrees C of warming. Blowing past the hopes of Paris is a certainty.

1H 2020 did bring inspiring wins at margins. First half 2020 Ireland's slice of electricity made from wind surpassed all other sources, including natural gas. Wind turbines met 43% of Ireland's demand – vs. 41% met by natural gas. Spain, looking too to its natural blessings turned on Europe's largest solar farm, 500 megawatts (MW) of power for 250,000 people. In May, a bigger 690 megawatt U.S. solar farm was approved in Nevada to power as many people (as Americans consume more) – notably it includes 380 MW of battery storage.

Yet things are bleak on CO_2. Coal remains one of the worst carbon sources. And hundreds of new coal plants are being built, 2020, many across Asia. In China, coal is still a cheap and leading fuel given lax rules. So new coal plants there can be 30% less than renewable power. Solar & wind are growing cheaper in China, maybe beating coal by 2026 in its wealthy regions. That said, China remains 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% in 2018.

In 2019, coal capacity in China grew by a staggering 37 GW, more than in the whole world - because while coal is being shut down other places like in Europe, U.K., and the U.S. - enough permits have been granted in China to potentially expand its 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 of 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 2020: next 5 years it may build up to 22 new coal plants, at up to 17 locations. If all are built, they'll emit nearly roughly as much new CO_2, as all cars sold in the U.S., annually. Even Germany still has about 33% of its electricity from coal. While renewables are at least 40% there, it OK'd a (final) coal plant in June 2020. Many European plans to shut coal are being brought forward, shuttering sooner than now in pandemic – but that's not happening everywhere. It's all a tremendous current to swim against - if one aims not just to *slow rates of growth* of emissions – but absolutely to *Cut* the total CO_2 concentrations.

There's a Paris Agreement. Yet wealthy Japan set itself a low bar, aiming for just 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; by 2030 it expects coal to still be ¼. Renewables, 10% of its power in 2010, in 2018 made up only 17% (and much of that from big hydro). In sharp contrast, France expects to fully shut all coal plants by 2022. The U.K. to close all by 2025.

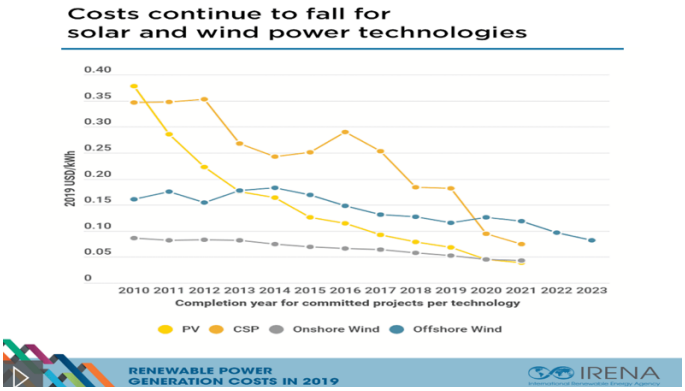
Japan's course is uninspiring. While clean renewables could become the cheapest power there by 2025, it's standing by coal. Unsurprisingly after a horrific nuclear accident, nuclear fell there from some 1/3rd of its power, to under 4%. Yet fossil fuels instead grew to 4/5ths today. And its renewables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

In the U.S., demand for thermal coal in power is dropping. 2019 it was 556 million tones, and 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 those 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 the world's demand/ consumption. India used 946 million tons thermal coal and is adding coal power plants. So while the U.S. and Europe are decreasing coal burning by closing 22 gigawatts of coal power – that's being swamped by the maybe 49 gigawatts of brand new coal plants across Asia-Pacific.

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

German Utilities today can *lose* money selling coal-fired electricity. Natural gas on the other hand, is relatively less filthy, needs fewer carbon credits, and more profitable there. So it's quite a mixed bag. And clearly good news, since 2010, is utility-scale solar PV costs dropped last decade a remarkable 82%. Onshore wind by some 39%, offshore wind by 29%. Global average solar PV power costs in 2019 were 6.8 cents per kWh; onshore wind just 5 cents per kWh. And average solar PV costs continue to fall; soon maybe just 3.9 cents in 2021.

So beyond China & India (more unburdened by rules, allowing for coal cheap), renewables are making great progress. (Ironically China's advances have made renewables far cheaper today – like a Petrostate, it may become an 'ElectroState'). This IRENA chart shows price declines,



Source: IRENA, Renewables Increasingly Beat Even Coal Competitors on Cost. 02 June 2020.

Yet hugely bad news is the Earth doesn't care about renewables' growth in wealthier nations. And we oughtn't pretend coal's impacts on us, are all that matters. As air-breathing mammals we tend to see only terrestrial impacts for we humans. That's a mistake. Earth's surface is mainly made of oceans, and they're declining fast. Skeptics who question if CO_2 is even linked to warming, have no ground here on which to stand. Oceans' uptake CO_2: undeniably so that rising CO_2 concentrations in air equate to acidifying seas. Surely, devastating harms ahead await reefs, kelp forests, fish populations, shellfish, marine mammals and more. Marine life, once weakened by acidification, stands lesser chance of surviving marine heat waves.

Ways shellfish for example calcify, growing shells from surrounding seawater are understood. Hence, it's perplexing to consider that we already know acidification lowers pH, doubtless enfeebling species essential to ecosystems, *and yet we care not a bit*. Shells getting too thin, accreting calcium from seawater too difficult – likely means a tipping catastrophic collapse. Places where more 'acidic' waters are naturally perturbated like nearby volcanic seeps, fish and habitats are now negatively impacted by CO_2 levels only a little above that today.

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

Nighttime temps rising faster than daytime highs, shall rob we humans of needed sleep. But for the rest of life, including in the seas & unable to resort to air conditioning, it's far worse. Potentially catastrophic ideas like geoengineering may do little for oceans - or far worse, allow their decimation as by lifting pollutants high into the air: that's no answer at all.

Nearer term, nickel, may replace vexing cobalt so making batteries greener. Batteries costing over $150 kWh can transition in short order to lithium iron phosphate under <$100 kWh. Novel green storage like 'million-mile batteries', flow battery electrolytes, nanostructures etc can and should change the world. Even green hydrogen after needed breakthroughs – maybe fuel cells too (unlike today's far more affordable solar, wind, batteries) – are conceivable.

With CO_2 rising 1 ppm/year the first Earth Day, more lately growing by a scary 2.5 ppm/year – it's manifest that rapid progress now, within this 2020 decade, is of first order.

Given how renewables uniquely thrive with declining prices – let's briefly look by contrast at **Oil** in a remarkable Spring of 2020. There, price dynamics for oil, a commodity, are *very different* from clean energy. Vivid moves in Oil are discussed next. With oil & coal both on their backs now, the cost declines painful – and unsustainable – they're so unlike renewables – where lower costs are a *great *feature** leading to further useful cost reductions.

Major Crash of Oil in Spring 2020

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

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

Normally on slightly slackening demand for some reason, supply could be slightly curtailed, excess stored and so 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.

In 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 that 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 $30 is a threat to America's oil industry, including the shale and conventional producers. From the huge to tiny, it's a diverse lot and all felt pain. Texas some has 174,000 wells with most every imaginable kind of rig – some are curious sites hard to believe.

So latter Q1 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 $30, a profitability floor for many. Particularly for the indebted shale producers. But oil then near $20 at that point was likely going lower due to demand destruction. It could go briefly below zero some places, or due to volatile futures contracts trading. Storage was filling, nearer tank tops, so fixes badly needed as a bridge until activity bounces back.

Now, May front-month WTI contracts would expire late-April. So on 25% less demand, if not met by great production cuts, fears were piling up of tank tops, like in Cushing, OK. May contracts would then need to be unwound fast by traders with neither desire, nor capacity to take crude delivery; it pushed front-end oil briefly under zero, to some -$37 by April 20th. That temporary artificial move that was a matter of finance wasn't really a great surprise at all! And not too much should be read into -$37 close. Contracts many months out were better, less distorted picture of physical crude, than May contract expiring as storage evaporated. But WTI oil near $20 still showed oil markets were still in distress. Even global benchmark and costlier North Sea Brent crude briefly dropped down to near $20 by late April.

Oil near $20 furthermore meant production would change worldwide. Perhaps 1 million oil patch jobs and 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 a pandemic's sudden demand destruction. That, with COVID, made disorderly consequences greater than maybe initially expected.

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

Here a playbook might have been a world awash in oil could allow lowest-cost conventional producers, to later raise prices, post shale bankruptcies. It's long been said the cure for cheap oil, is cheap oil – as seen again & again in this industry. Commanding market-share could then be re-captured by those able to lift oil from the ground most cheaply by conventional means. Once competing shale capacity was well-gutted, low-prices should disappear. Unlike then clean energy, where lower prices go lower, oil prices going back higher is what's sought.

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

Plus for nations it's important to realize crude's intrinsic vitality while richly valued. Vast underground reserves, if 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 an ascent of electric vehicles, or simply changed economics.

Globally then 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. April in Western Canada for instance, inland wells far from ports were lifting heavy crude that's difficult to move; suddenly, mounting product upended all, raising fears of runaway cratering. Vast demand destruction was being 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 was in Spring 2020.

So it was in April that OPEC+ with Russia agreed to a production cut of around 10 million barrels/day. With 25, even 30 million barrels of demand gone – those 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 U.S. 'organically' cutting – that is, producing less on low prices – rather than cutting capacity, was as different as width from length. Given that 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, called proration, it's not an option. So with a wink and a nod, Saudis & Russia agreed to a 10 million cut. And even that unprecedented big move, was just a (necessary) patch-up fix.

It made headlines. Concerns among technical oil-watchers were this cut was 2x or 3x smaller than it needed to be. Plus it didn't start until May, so it was pretty-much no surprise in April when in local cases lower-grade crude oil went cost-negative, less than zero. Even for more 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 about making it past the immediate crisis, re-starting oil demand. Crude might then rise organically. Free markets are how U.S. oil prices work, rather than fiat, and paths were envisioned to this stimulating rebounding. If say U.S. States begin re-opening, pandemic still-potent, lethal, yet is increasingly endemic more like a seasonal virus; if immunity gets conferred even if only for a season, if effective treatments arrive, or better yet a robust vaccine is developed, there were thus hopes for some return to demand normalcy.

A fascinating side effect of plunging oil was that coal – long the dirtiest/cheapest – while still the dirtiest – had just become most costly. Fracking long ago had pushed down natural gas prices wildly, as seen in charts above. Natural gas -90% cheaper became very attractive for making power (and unsurprisingly, another 15% of U.S. coal power plants had closed).

Thus when benchmark Brent crude fell in Q1 to around $26/barrel, with Australian coal sitting at $57 /metric ton, roughly equivalent by an analysis to $27 oil, broadly-speaking crude became cheaper than coal. True, coal vs. oil don't much directly compete. Thermal coal is burned in power plants – unlike say light sweet crude made into gasoline, or heavy sour into asphalt. But a thing is: coal became the most-dear. And tellingly it wasn't just natural gas taking market from Coal. As levelized Solar & Wind costs fell, they grew attractive. More polluting coal, in sum, was becoming both much less desirable, and relatively costly.

It's hard to fathom pathways to oil rebounding, other than economies revive, demand returns, plus production cuts so falling storage capacity wouldn't pinch. A worse oil collapse had been uncomfortably near, which may have upended more in the oil patch. A key hub, Cushing, OK has 4 huge tanks once nervously filling in April. Pipelines normally forward crude; had they slowed to be more like storage, it could have meant a kind of oil constipation backing-up to the producer. Or there's 5,500 miles of pipes sending refined product from Gulf Coast to Washington D.C. Those might stop accepting gasoline, without sure-contracted-buyers as the product off-takers. So a fascinating and scary April, yielded to a much different June.

As many hoped for, oil prices rebounded June, to $40.That was mainly on partially reviving economies, as well as production cuts by OPEC+ largely complied with (though Iran pumped rather freely). So a Q2 that began with oil crisis on everyone's lips, ended with oil largely unnoticed by Q3 – or at least – not a pressing concern as other matters came to fore.

Through it all, clean energy has been on a path perhaps the least impacted (in energy) by this Q2 oil demand crisis. Here, "storage" continues to be a key issue of a much different sort. It involves storing electricity – which could be done as simply as by pumped-hydro pushing water uphill to be released when power is needed, or by pushing air into caverns. Or by ever less-expensive, new 'million-mile' batteries. Storage needs to increase not just 150-fold, but maybe more 1,500 fold! We'll soon return, to clean energy here. But before doing that, moving on next, oil wasn't the only volatile story here in the larger energy complex.

Beyond a brief Q2 oil ride, there's been a larger trend standing out in an evolving energy landscape. In particular it needn't be guessed at. Nor pondered, as merely a possibility ahead, as it's well underway: *Coal has lost a huge slice of the U.S. energy pie the last 10 years.* As Yogi Berra said, "It's tough to make predictions, especially about the future" – so let's briefly ponder this seminal shift now happening, a movement from coal *already* started.

In 2005 little thought was given to the idea that U.S. coal could see dramatic losses. At that time 'King coal' made up some 50% of U.S. electric power generation. Minor early gains (small in absolute terms, big as percentages) were made in solar & wind – in natural gas more so – but those then hit coal only incrementally taking coal 'down' to some 45% by 2010.

Last 10 years though, U.S. coal dropped hard, from about ½ to <¼ of American power generation. Renewables now 20%+ and rising, natural gas is near 40%. Why is easy. Fracking's revolution pushed down natural gas costs tremendously. For a power plant with 30+ year-life, natural gas doesn't suffer opprobrium & pollution vexing coal. On ample domestic supply, it's embraced as safe & smart by power industry. Gas became the easy choice. Dispatchable firm power, less-dirty, with stable fuel-prices; it's widely popular and unquestioned.

What's perhaps more interesting now is another big change is only just beginning to unfold. It is that lately, clean renewables are now becoming this landscape's growing best bet. Now Energy Storage is becoming a fulcrum to really advance low-cost renewables. Especially as a pandemic shut-in people & shutters industry – lowest-fuel-cost (free) sun & wind makes the renewables best poised to gain market share – even in a tough market period. In fact it been rather **due to/ and because of** these current/tough conditions: when solar & wind are the cheapest fuels, that coal is jettisoned fast, and nuclear prospects dim considerably.

Hence fuel costs play a key role prioritizing power generation; we saw that when falling prices once grew prospects for natural gas-fired power plants. Recently, oil prices fell hard – yet it pays to be wary - this 'ain't the first rodeo' for cheap oil. Each time seems to only sow seeds of cyclical oil-rises later as wells are shut-in, production capacity falls. And everything possible is done to get oil prices back up – over $50, preferably for many oil producers over $70 and more. So it's unlike renewable energy, where low prices begat prices lower still.

For retail consumers of power, how electricity is delivered matters. Recall nimble Texas: some things there it does very well, as regulations are far lighter. There's more competition; 100% renewable power is available at just $10/month – plus *wholesale* costs of power. Wind power that's plentiful at night can cost under 9 cents/kWh. Texas residential power rates are some 37% less than in California, commercial & industrial rates about 50% less. Other things are not so good there; it still makes near 20% of its power by burning coal, around half from natural gas. Wind is growing, fast, but it is around that 20% figure, like coal.

By contrast California is far more regulated, its power much more costly. In San Diego power may cost base ~$16/month (not-wholesale) plus big added costs on time of use. Nighttime is great for electric car charging – and similar to Texas nearer 9 cents/kWh; but it fast jumps to 29 cents for much of the day – and leaps to 50 cents every late afternoon. So its costs may be 35 cents/kWh partly due to non-renewables, and little competition. And as California imports so much (CO_2-laden yet) needed power, in big heat waves roiling Western region and lacking enough energy storage, recently there's been rolling blackouts in this great State.

Consider CO_2: A Topic Gaining Importance

For ~20 years as the 1st & leading Clean Energy Index®, our emphasis has been on *Solutions*. Not CO_2, nor Climate Change *per se* – but helping bring forward solar, wind, electric cars etc as ecologically & economically better answers. Warming's threat was a driver - but CO_2 was hardly discussed by us. Lately, however, science is showing impacts are near very worst ends of what models expected. In short, CO_2 matters, so let's address that science briefly.

For an acute example of its role, a May 2020 piece in Proceedings of National Academy of Sciences warns that in a span of just "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." Thus on current trends of CO_2 and population, this narrow temperature niche our species has required, is projected to change more in just the next 50 years, than in the past six millennia. See Chi Xu, Timothy Kohler et al, *Future of the Human Climate Niche*. PNAS (4 May 2020). See, https://www.pnas.org/content/early/2020/04/28/1910114117

Hence this brief excursion into climate, as it's relevant to a wider clean energy story today. And consideration too of Environmental, Social & Governance / ESG factors (here the 'E'). First note CO_2 has been a hero to our species – in moderation. Earth without CO_2 could have had near a 0 degrees F frozen temperature at surface. Instead, warming thanks to lesser-CO_2 increases (then much under 400 ppm) naturally gifted us with surface temperatures near an ideal for us, 59 degrees F. We evolved well to that in hundreds of thousands+ of years.

In the late 1950s when regular CO_2 monitoring began, modern readings had already risen from what had long been high 200s PPM, to 315 PPM. By 1988, scientists became alarmed by the planetary warming due in part to increasing CO_2 that reached 350. A world conference held in that year called for reducing that high 350 figure, downwards -20% by 2005.

1992 a global compact was reached. Signed in Rio this U.N. Framework Convention on Climate Change lacked specific cuts. And looking back, that nebulous agreement to just try to act was a real failure – nowhere close to the task. CO_2 has 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 only grew and by +34% *higher by 2005*. (Looking back it would go on rising another +22% higher in 2017). So mere aspirational words, absent real acceptance and robust action like was seen with COVID-19 in 2020, has woefully not achieved what's needed on climate.

So more specific cuts were laid out 5 years later in a 1997 Kyoto Agreement on climate. Yet CO_2 again went on rising, even more sharply. It was a mockery of 'action' on CO_2. An 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 a uphill scary climb. Only 3 countries met an early target of the Paris terms: Marshall Islands, Suriname, & Norway, which made up only 0.1% of emissions globally. There's no cause today for optimism. A next gathering intended for Glasgow in 2020 was meant to take stock of progress (there's been none); it was postponed due to COVID-19.

In sum, commitment Isn't There. That's why it's crucial that 1) clean renewables are getting cost-competitive *unsubsidized* with fossil fuels; 2) there's growing public recognition of the Science, and 3) with COVID-19 we saw an historic oil crash making a decarbonizing shift from dirty fossils – to cleaner paths while creating jobs - more approachable worldwide.

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

The next 'lower' RCP 6.0 may be rather closer to where we're trending – on present 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, as they are now - but soon are regarded as a thing of the past under RCP 6.0. Electric car adoptions fast accelerate.

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

Next, better, and very ambitious is most hoped for RCP 4.5: emissions peak in about 20 years near 2040, then fall fast. Thus CO_2 levels not long ago stable <300, now past 400 & rising fast, in this scenario only go on rising to 'just' some 650. Strong decarbonization is assumed here to be undertaken, now, with CO_2 slowly dropping. That *might* be possible, although it's a huge stretch to be sure. And very unlikely. Especially since hundreds of new coal plants are *still being built, right now today* in 2020. Each may have working lives of 30 years or more, hence shall be operating in 2050 and after unless they are prematurely shuttered.

Since renewables make up only some 20% of electricity in many nations (although growing), coal 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 and say, sudden events, could hasten strong and real action on climate.

Climate models, inevitably, are now getting more complicated. Until recently they'd ignored ice sheet destabilization as warming seas melt glaciers from below. Yet if a new pulse of sea rise visibly gets underway undeniably, skeptics may melt away too. Especially as clean energy creating jobs is the *most economical choice*, unsubsidized and mated to storage.

Conclusion:

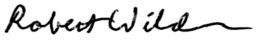
The Clean Energy Index® (ECO) began 3rd Quarter around 84, and ended around 125, up +50%. Rich in context, at first ECO rose sharply from 70 to over 90, then like much else in Q1 it crashed given Coronavirus going just under 50 – and recovered hard Q2. ECO bounded strongly up some +50% over Q3 and up +80% Year to Date (YTD). So even after a fall, this decarbonization theme roared back by over +100% from March. This November's election *may* possibly be bullish for clean energy this decade, *perhaps* contributing (or not) to momentum. Last 3¾ years, since start of 2017 when ECO Index® was 38, it is now up over +200%.

For past 5 years Benchmark ECO Index® live since 2004 and 1st for climate solutions is now up more than +180%, over a time when *any* energy gains are arguably notable. For over these same 5 years, CO_2 laden dominant dirty energy themes are far negative: oil, natural gas and coal are down -5% to -75%. Last 10 years, fossil fuels are again down farthest; in stark contrast to decarbonization stories that are positive and strongest relative returns in energy. Both ECO and NEX also outperform too versus a good but separate, global clean energy Index.

At clean energy ECO Index to start Q4, 1 Deletion was: Vivint – and 7 Additions were Azure, Blink, Arcimoto, Lithium Americas, Electrameccanica, Infrastructure & Energy Alternatives; and Maxeon (a spinoff Q3). At Global NEX for Q4 there were 12 Deletions: Atlantica, Audax, Canvest, Contact, Epistar, GCP Infra., Lextar, Meidensha, Northland, Ricardo, Tesla, Vivint - and 10 Additions: Azure (India; with U.S. listing), Ceres (U.K.), FuelCell (U.S.), ITM Power (U.K.), Lithium Americas (U.S.), Maxeon (U.S., a spinoff Q3), McPhy Energy (France), PNE AG (Germany), Prysmian SpA (Italy), and Xpeng (China; with U.S. listing).

As always, we welcome your thoughts and suggestions.

Sincerely,



Rob Wilder
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Appendix I:

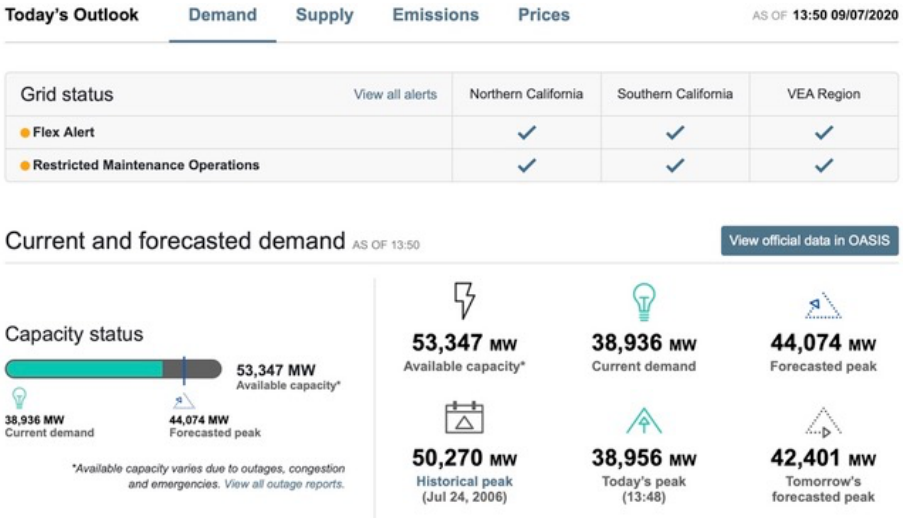
ECO Index (via independent tracker PBW) Descending Weights latter-Q3 on 9/15/2020, or about ~2 weeks before rebalance to start Q3 2020, 40 Stocks:

Name	Symbol	Weight %
Vivint Solar Inc	VSLR	5.5
Workhorse Group Inc	WKHS	5.3
Sunrun Inc	RUN	5.1
NIO Inc ADR	NIO	4.7
Tesla Inc	TSLA	3.8
SunPower Corp	SPWR	3.4
Renewable Energy Group Inc	REGI	3.2
Canadian Solar Inc	CSIQ	3.0
Daqo New Energy Corp ADR	DQ	3.0
Bloom Energy Corp	BE	2.9
Plug Power Inc	PLUG	2.9
First Solar Inc	FSLR	2.7
Enphase Energy Inc	ENPH	2.6
Livent Corp	LTHM	2.5
JinkoSolar Holding Co Ltd ADR	JKS	2.4
SolarEdge Technologies Inc	SEDG	2.4
TPI Composites Inc	TPIC	2.3
Quanta Services Inc	PWR	2.3
Albemarle Corp	ALB	2.3
Sociedad Quimica y Minera de Chile SA	SQM	2.3
Air Products and Chemicals Inc	APD	2.2
Sunnova Energy International Inc	NOVA	2.2
MYR Group Inc	MYRG	2.1
Gentherm Inc	THRM	2.1
Willdan Group Inc	WLDN	2.0
Woodward Inc	WWD	2.0
ESCO Technologies Inc	ESE	2.0
Cree Inc	CREE	1.9
Universal Display Corp	OLED	1.9
Ballard Power Systems Inc	BLDP	1.9
Ameresco Inc	AMRC	1.9
Hexcel Corp	HXL	1.8
FuelCell Energy Inc	FCEL	1.7
Ormat Technologies Inc	ORA	1.7
Advanced Energy Industries Inc	AEIS	1.7
Atlantica Sustainable Infrastructure PLC	AY	1.7

Itron Inc	ITRI	1.5
Veeco Instruments Inc	VECO	1.5
Kandi Technologies Group Inc	KNDI	0.7
American Superconductor Corp	AMSC	0.6

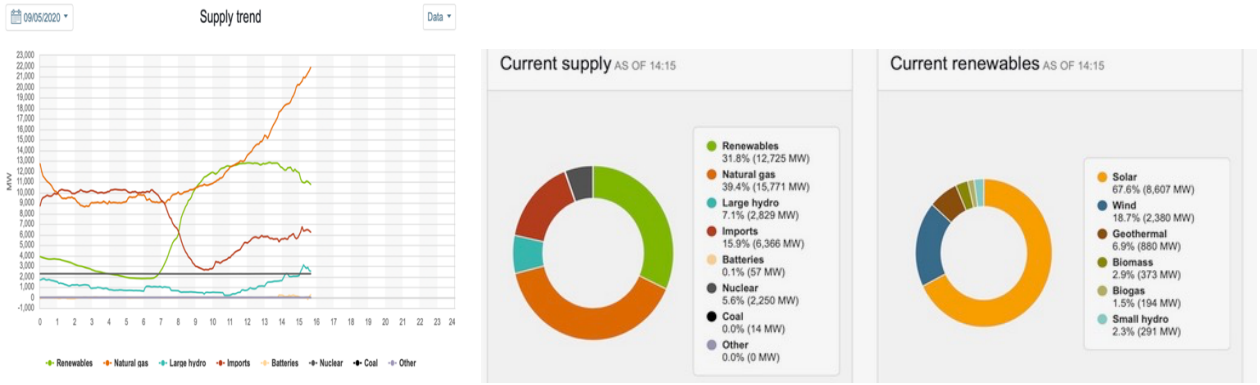
There's representation above at top, from *Solar; *Electric Vehicles; *Fuel Cells; *Biofuels.

Practical Renewables I: A recent Flex alert saw California's Energy *Cushion fall near-zero!* Demand in this Heat Wave Sept. 7, 2020 nearly Exceeded Available Capacity 53,347 MW - Forecast Afternoon Peak Demand hit 44,074 MW (had been 48,522 MW day before)! That left almost no cushion against Blackouts; yet such Demand is foreseeable. Emergency steps only got generation just over >50,000 MW. Far more Renewables + Energy Storage are needed, asap. Rather than adding more Natural Gas or Imports as those mean more CO2: climate demands that those/CO_2 go to zero. Too much (carbon-laden) power comes from neighboring States, who are likewise in dire straits during such big Western regional heat waves:



Source: CAISO.com - Sept 7, 2020 at 1:50 pm

In a Summer Heatwave, much natural gas was called upon as seen in this significant rise; steeply rising solar reduced large (carbon-laden) imports but just in daytime. Hence new Renewables, Batteries and Storage must play far greater roles ahead as baseload:



From: caiso.com/TodaysOutlook/Pages/supply.html - Sept 6 and 7, 2020.

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

INDEX (ECO) SECTOR & STOCK WEIGHTS FOR START OF Q4 2020. 46 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 - 23% weight (10 stocks @2.30% each)
Azure Power Global, AZRE. Solar, India; aims to be low-cost green energy.
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.
Hexcel, HXL. Light composites, in wind blades & spars, aerospace, vehicles.
JinkoSolar, JKS. Solar, wafers through solar modules, China-based OEM.
Maxeon, MAXN. Solar, PV panel maker after 2020 spinoff from Sunpower.
Ormat, ORA. Geothermal, also in areas of recovering heat energy.
Sunpower, SPWR. Solar, distributed sales and services; Maxeon panels.
TPI Composites, TPIC. Wind Blades; also light-weighting for transportation.

Energy Conversion - 23% sector weight (10 stocks @2.30% each)
Advanced Energy, AEIS. Power conditioning: inverters, thin film deposition.
Ballard Power, BLDP. Mid-size fuel cells; R&D, PEM FCs as in transportation.
Bloom Energy, BE. Stationary fuel cells, not-yet cleanest/renewable fuels.
Cree, CREE. Power electronics, moved into power devices including for EVs.
Enphase, ENPH. Microinverters, also energy storage systems and software.
ESCO Technologies, ESE. Power management, shielding, controls, testing.
FuelCell Energy, FCEL. Stationary fuel cells, for distributed power generation.
Gentherm, THRM. Thermoelectric, waste heat energy, battery management.
Plug Power, PLUG. Small fuel cells, for e.g. forklifts; drop in replacements.
SolarEdge Technologies, SEDG. Inverters, makes solar optimizers, inverters.

Power Delivery & Conservation - 22% sector (10 stocks @2.15 each +1 *banded)
Ameresco, AMRC. Energy saving efficiencies, net zero CO_2 decarbonization.
American Superconductor, AMSC. Wind, grid conditioning; superconductors.
Blink Charging, BLNK. EV Charging, among largest EV charge networks in U.S.
**Infrastructure and Energy*, IEA. Renewables, from power generation to delivery.
Itron, ITRI. Meters, utility energy monitoring, measurement & management.
MYR Group, MYRG. Transmission and Distribution, includes solar & wind farms.
Quanta Services, PWR. Infrastructure, modernizing grid & power transmission.
Universal Display, OLED. Organic light emitting diodes, efficient displays.
Veeco, VECO. Thin film equipment, for LEDs, energy efficient electronics.
Willdan, WLDN. Efficiency, in distributed energy, renewables, engineering.
Woodward, WWD. Converters, controls for wind power and energy storage.

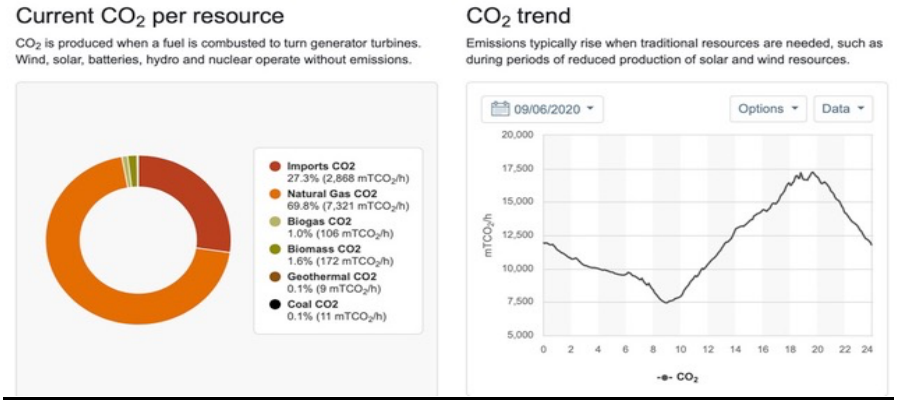
Greener Utilities – 7% sector weight (3 stocks @2.33% each)
Atlantica Yield, AY. Yieldco, Contracted renewables assets, also transmission.
Sunnova, NOVA. Solar provider, operating fleet for residential plus storage.
Sunrun, RUN. Residential solar systems, lease, PPA or purchase rooftop PV.

Energy Storage - 21% sector weight (8 stocks @2.50% each plus 2 *banded)
Albermarle, ALB. Lithium, specialty materials in batteries; for energy storage.

**Arcimoto*, FUV. EVs, smaller very low-cost 3 wheeled electric vehicles.
Chemical & Mining Co. of Chile, SQM. Lithium, energy storage, large producer.
**Electrameccanica Vehicles*, SOLO. EVs, 3 wheeled and custom electric vehicles.
Kandi, KNDI. Electric Vehicles, inexpensive small cars, early-stage, China-based.
Lithium Americas, LAC. Lithium, deposits in State of Nevada U.S., & Argentina.
Livent, LTHM. Lithium, and compounds for batteries in energy storage.
NIO Inc, NIO. Electric vehicles, China-based startup but loss-making so far.
Tesla, TSLA. Electric vehicles, solar; pure-play EVs & energy storage.
Workhorse, WKHS. Electric Vehicles, electric delivery trucks, early-stage.

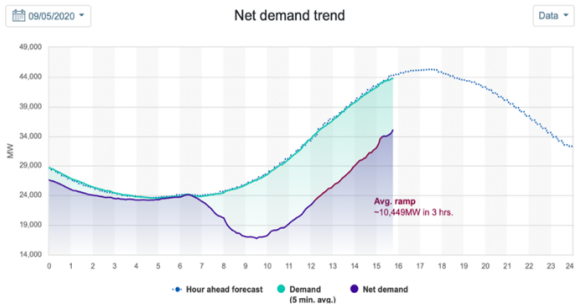
Cleaner Fuels – 4% sector weight (2 stocks @2.00% each)
Air Products & Chemicals, APD. Hydrogen, is a supplier of industrial gases.
Renewable Energy Group, REGI. Biodiesel, natural fats, oils, grease to biofuels.

Practical Issues in Renewables II: In this Flex Alert, CO_2 Emissions Were Allowed to Spike to get Supply High as Possible - up over 50,000 MW to Meet Peak Demand. That meant running natural gas and peaker plants full 100%, pausing maintenance, and more (dirty) imports from out of State. In Aug./Sept, on heat so bad and nearly zero wind:



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

Demand in California in a Heat Wave, Sept. 5, 2020 at 3:45 pm (left): Demand not yet peaking in mid-afternoon with wind nominal - solar is about to fall hard. On Right side: California Demand History shows Renewables/Batteries must grow very fast, since huge energy efficiency strides were already made - and California requires electric vehicles only after 2035 adding 25% more demand - yet peak Demand's now around 50,000 MW:



California ISO

California ISO Peak Load History 1998 through 2019

Year	Megawatts at Peak Load*	Date	Time
1998	44,659	August 12	14:30
1999	45,884	July 12	16:52
2000	43,784	August 16	15:17
2001	41,419	August 7	16:17
2002	42,441	July 10	15:01
2003	42,689	July 17	15:22
2004	45,597	September 8	16:00
2005	45,431	July 20	15:22
2006	50,270	July 24	14:44
2007	48,615	August 31	15:27
2008	46,897	June 20	16:21
2009	46,042	September 3	16:17
2010	47,350	August 25	16:20
2011	45,545	September 7	16:30
2012	46,846	August 13	15:53
2013	45,097	June 28	16:54
2014	45,089	September 15	16:53
2015	46,519	September 10	15:38
2016	46,232	July 27	16:51
2017	50,116	September 1	15:58
2018	46,427	July 25	17:33
2019	44,301	August 15	17:50

*This value is an instantaneous MW value at the time specified in the Time column

Source: CAISO.com

Appendix III: **WilderHill New Energy Global Innovation (NEX)** descending weights late-Q3 via independent tracker (PBD) on 9/15/20 or ~2 weeks before Rebalance for Q4 2020. 87 stocks:

Name	Symbol	Weight %
Vivint Solar Inc	VSLR	2.8
CS Wind Corp	112610 KS	2.8
Sunrun Inc	RUN	2.6
NIO Inc ADR	NIO	2.3
Plug Power Inc	PLUG	2.0
Tesla Inc	TSLA	1.8
Daqo New Energy Corp ADR	DQ	1.7
Ecopro Co Ltd	086520 KS	1.6
VERBIO Vereinigte BioEnergie AG	VBK	1.6
Canadian Solar Inc	CSIQ	1.4
CropEnergies AG	CE2	1.4
BYD Co Ltd	1211 HK	1.4
Bloom Energy Corp	BE	1.4
Solaria Energia y Medio Ambiente SA	SLR	1.4
West Holdings Corp	1407 JP	1.3
Siemens Gamesa Renewable Energy SA	SGRE	1.3
Renewable Energy Group Inc	REGI	1.3
Signify NV	LIGHT	1.3
Xinyi Solar Holdings Ltd	968 HK	1.3
SunPower Corp	SPWR	1.3
Vestas Wind Systems A/S	VWS DC	1.3
SMA Solar Technology AG	S92	1.2
First Solar Inc	FSLR	1.2
Kingspan Group PLC	KSP	1.2
Albioma SA	ABIO FP	1.2
JinkoSolar Holding Co Ltd ADR	JKS	1.2
Hannon Armstrong Sustainable	HASI	1.2
Gurit Holding AG	GUR SW	1.2
Ameresco Inc	AMRC	1.2
Enphase Energy Inc	ENPH	1.2
Sunnova Energy International Inc	NOVA	1.2
RENOVA Inc	9519 JP	1.2
Xinyi Energy Holdings Ltd	3868 HK	1.2
Neoen SA	NEOEN FP	1.1
SolarEdge Technologies Inc	SEDG	1.1
Eolus Vind AB	EOLUB SS	1.1
Sociedad Quimica y Minera	SQM	1.1

Encavis AG	CAP	1.1
Nordex SE	NDX1	1.1
EDP Renovaveis SA	EDPR	1.1
Samsung SDI Co Ltd	006400 KS	1.1
TPI Composites Inc	TPIC	1.1
Boralex Inc	BLX	1.0
Lextar Electronics Corp	3698 TT	1.0
Everlight Electronics Co Ltd	2393 TT	1.0
Verbund AG	VER AV	1.0
Nibe Industrier AB	NIBEB SS	1.0
Orsted A/S	ORSTED DC	1.0
Scatec Solar ASA	SSO	1.0
Willdan Group Inc	WLDN	1.0
Novozymes A/S	NZYMB DC	1.0
Acciona SA	ANA	1.0
Innergex Renewable Energy Inc	INE	1.0
Sino-American Silicon Products Inc	5483 TT	1.0
Epistar Corp	2448 TT	1.0
Northland Power Inc	NPI	1.0
Mercury NZ Ltd	MCY	1.0
Audax Renovables SA	ADX	0.9
TransAlta Renewables Inc	RNW	0.9
Caverion Oyj	CAV1V FH	0.9
Falck Renewables SpA	FKR	0.9
Renewables Infrastructure	TRIG LN	0.9
GS Yuasa Corp	6674 JP	0.9
Xebec Adsorption Inc	XBC	0.9
Universal Display Corp	OLED	0.9
Meridian Energy Ltd	MEL	0.9
GCP Infrastructure Investments Ltd	GCP LN	0.9
Arcosa Inc	ACA	0.9
Credit Suisse Real Estate Fund Green	GREEN SW	0.9
Meidensha Corp	6508 JP	0.9
Contact Energy Ltd	CEN	0.9
NEL ASA	NEL	0.9
Ballard Power Systems Inc	BLDP	0.9
Cree Inc	CREE	0.9
Terna Rete Elettrica Nazionale SpA	TRN	0.9
Atlantica Sustainable Infrastructure PLC	AY	0.9
Canvest Environmental Protection	1381 HK	0.9

Greencoat UK Wind PLC/Funds	UKW LN	0.8
Tilt Renewables Ltd	TLT	0.8
Xinjiang Goldwind Science & Tech	2208 HK	0.7
Landis+Gyr Group AG	LAND SW	0.7
Veeco Instruments Inc	VECO	0.7
Itron Inc	ITRI	0.7
Ormat Technologies Inc	ORA	0.7
Ricardo PLC	RCDO LN	0.7
PowerCell Sweden AB	PCELL SS	0.7
eRex Co Ltd	9517 JP	0.7
*Maxeon Solar Technologies Ltd	MAXN	0.3

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*Maxeon was a spinoff addition intra-Q3.
Among best performers seen this period above there's representation from *Electric Vehicles and *Energy Storage, *Solar Power, *Hydrogen, *Fuel Cells, and *Biofuels.

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*NEX Index Methodology: After a 2019 Market Consultation & Announcement the NEX components have gone from Large / or Small weightings - to a straight-equal-weightings starting with Q3 2019; also the NEX Sector Weights are assigned starting Q3 2019 according to the # of Constituents in each NEX Sector rather than by external Survey; these changes were effective Q3 2019.

** Effective 2019, WilderHill New Energy Global Innovation Index (NEX) calculated in $ U.S. Dollars. (Previously also calculated in theoretical way in Euros, Yen, GB Pounds; now only in $ USD).

Appendix IV:
WilderHill New Energy Global Innovation (NEX) - for start of Q4 2020. 85 Stocks.

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

Name	Description	Sector	Curr.	Activity
Acciona	Operates Wind, Solar/Thermal, Hydro, Biomass plants.	RWD	EUR	SPAIN
Albioma SA	Biomass, sugarcane, hybrid combustion, cogeneration.	RBB	EUR	FRANCE
Ameresco	Energy savings, performance contracts, in renewables.	EEF	USD	US
Arcosa	Wind Towers, structures for electricity transmission.	RWD	USD	US
Azure Power Global	Solar, India; aims to offer lowest-cost electricity.	RSR	USD	INDIA
Ballard Power Systems	Fuel cells; R&D, 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.	Batteries, potential use in EVs, rail, solar farms, more.	ENS	HKD	CHINA
Canadian Solar	Solar, vertically integrated solar manufacturer, China.	RSR	USD	CANADA
Caverion OYJ	Energy efficiency, buildings, infrastructure, Europe.	EEF	EUR	FINLAND

Ceres Power	Fuel cells, high temperature steel units.	ECV	GBP	BRITAIN
Cree Inc.	LED manufacturer power-saving, efficient lighting.	EEF	USD	US
CropEnergies AG	Bioethanol, from cereals and sugarbeet, Germany.	RBB	EUR	GERMANY
Credit Suisse Real E. Grn.	Sustainability in buildings, real estate.	EEF	CHF	SWITZER.
CS Wind	Wind power, both onshore, also offshore.	RWD	KRW	S. KOREA
Daqo New Energy	Solar, high-purity polysilicon for solar wafers, China.	RSR	USD	CHINA
EcoPro	Battery materials, Pollution Control catalysts, S. Korea.	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
Enphase	Inverters, micro-products for solar panels, storage.	RSR	USD	US
Eolus Vind	Wind power, also consulting services for wind.	RWD	SEK	SWEDEN
eRex Co. ltd.	Power generation, bus./ residential, biomass, Japan.	RBB	JPY	JAPAN
Everlight Electronics	LEDs, large manufacturer in optoelectronics, Taiwan.	EEF	TWD	TAIWAN
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
FuelCell Energy	Fuel cells, high temperature and hydrogen.	ECV	USD	US
Greencoat UK Wind plc	Infrastructure fund, invested in U.K. wind power assets.	RWD	GBP	BRITAIN
GS Yuasa	Battery technologies, also Lithium for EVs, Japan.	ENS	JPY	JAPAN
Gurit Holding AG	Composite Materials in wind, lightens cars, planes.	RWD	CHF	SWITZER.
Hannon Armstrong	Energy efficiency, capital & finance for infrastructure.	EEF	USD	US
Innergex Renewable	Renewable power, run-of-river hydro, wind, solar.	ROH	CAD	CANADA
ITM Power plc	Fuel cells, uses PEM technology; also hydrogen.	ECV	GBP	BRITAIN
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	SWITZER.
Lithium Americas	Lithium, projects in Nevada USA, and Argentina.	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 ZEAL.
Meridian Energy	Hydroelectric power stations, some wind, New Zealand.	ROH	NZD	NEW ZEAL.
Nel ASA	Hydrogen, fuel cell vehicles, renewably, Norway.	ECV	NOK	NORWAY
Neoen SA	Renewable energy mainly solar, some wind.	RSR	EUR	FRANCE
Nibe Industrier AB	Heating & cooling, sustainable technologies, Sweden.	EEF	SEK	SWEDEN
Nio	EVs, design, manufacture, and sale including SUVs	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
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
Prysmian SpA	Cables, renewable power transmission, global.	EEF	EUR	ITALY
Renewable Energy Group	Biodiesel, natural fats, oils, grease to biofuels.	RBB	USD	US
Renewables Infrastruc.	Wind Farm & Solar Park revenues assets, U.K.	RWD	GBP	BRITAIN
Renova	Wind, Solar, Biomass, power generation in Asia.	RWD	JPY	JAPAN
Samsung SDI	Batteries, innovative energy storage, EVs, South Korea.	ENS	KRW	S. KOREA
Scatec Solar ASA	Solar power parks worldwide.	RSR	NOK	NORWAY
Siemens Gamesa	Wind, onshore & offshore, turbines, gearboxes, Spain	RWD	EUR	SPAIN
Signify NV	Lighting, systems increasing efficiency, Netherlands.	EEF	EUR	NETHERL.
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	US
Solaria Energia	Solar, renewable power generation, Iberia.	RSR	EUR	SPAIN
SolarEdge	Inverters, panel-level solar optimizers, micro-inverters.	RSR	USD	US
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
Terna SpA	Transmission of electricity, increasingly is renewables.	EEF	EUR	ITALY
Tilt Renewables	Wind Farms, Australia and New Zealand, some solar.	RWD	NZD	NEW ZEAL.
TPI Composites	Wind Blades; also light-weighting for transportation.	RWD	USD	US
TransAlta Renewables	Renewables, operating wind power, some hydro.	RWD	CAD	CANADA
Universal Display	Organic light emitting diodes, efficient displays.	EEF	USD	US
Veeco instruments	Thin film equipment LEDs, energy efficient electronics.	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
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.	EEF	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	RSR	CHINA
Xinyi Solar Holdings	Solar, ultra-clear glass products, China.	RSR	HKD	CHINA
Xpeng Motors	Electric Vehicles, internet and autonomous features.	ENS	USD	CHINA

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12 NEX Deletions for the start of Q4 2020 were: Atlantica, Audax, Canvest, Contact, Epistar, GCP Infrastructure, Lextar, Meidensha, Northland, Ricardo, Tesla, Vivint.
10 NEX Additions for start of Q4 2020: Azure (India; has U.S. listing), Ceres (U.K.), FuelCell (U.S.), ITM Power (U.K.), Lithium Americas (U.S.), Maxeon (U.S., Q3 spinoff), McPhy Energy (France), PNE AG (Germany), Prysmian SpA (Italy), and Xpeng (China, has a U.S. listing).

NEX WEIGHT EACH COMPONENT

85 stocks/100 = Individual Weights for Q4 2020 1.17647059

1.176471

85 Stocks for Start of Q4 2020.

NEX SECTOR WEIGHTS for Q4 2020:	SECTOR	QUANTITY	% Approx. Weight
Energy Conversion	ECV	9	11%
Energy Efficiency	EEF	17	20%
Energy Storage	ENS	8	9%
Renewables - Biofuels & Biomass	RBB	6	7%
Renewables - Other	ROH	5	6%
Renewable - Solar	RSR	20	24%
Renewable - Wind	RWD	20	24%
		85	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 Start of Quarter*	**Energy Conversion**	**Energy Efficiency**	**Energy Storage**	**Renew. - Biofuels**	**Renewables - Other**	**Renewable - Solar**	**Renewable - Wind**
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%

*Prior to 2019, NEX components were divided into large or small, in survey of companies deemed active in new energy adjusting for factors including exposure to new energy and exchange restrictions. Subsequently after Q3 2019, NEX components are all equal weighted, and respective sector weights assigned according to number of components assigned to each NEX sector.

[1] PWS (Power Storage) name change to ENS (Energy Storage) at end of the 4th Quarter 2009.

[2] HFC (Hydrogen & Fuel Cells) name change to ECV (Energy Conversion) end of 4th Quarter 2008.

[3] HF (Hydrogen And Fuel Cells) became HFC (Hydrogen & Fuel Cells) after 2007 and then changed it's name to ECV (Energy Conversion) at the end of the 4th Quarter of 2008.

[4] DS (Demand Side Energy Savings) and GE (Generation Efficiency And Smart Distribution) were combined into EEF (Energy Efficiency) after 2007.

Appendix VII, Clean Ocean Index (OCEAN) Composition latter Q3 2020:
INDEX (OCEAN) SECTOR & STOCK WEIGHTS latter Q3 2020. 71 STOCKS.

Clean Ocean Index Components	Theme	Activity	Sector
Acciona SA	Water Treatment; Renewable Energy.	Spain	WT
Alfa Laval AB	Fluid Handling, controls, on vessels.	Sweden	WT
American States Water	Water and Wastewater Services.	USA	WT
American Water Works	Water and Wastewater Systems.	USA	WT
Aqua Am. (now Essential Utilities)	Water and Wastewater Services.	USA	WT
Austevoll Seafood ASA	Seafood in Norway; also pelagics Chile, Peru.	Norway	SF
Badger Meter	Water Metering.	USA	PP
Ballard Power	Fuel Cells, mid-sized PEM.	Canada	CE
Beyond Meat	Plant-based meats, less impactful proteins.	USA	PP
Bloom Energy	Work on new fuel cell powered Ships.	USA	GS
Bollore SA	Ports, Terminals, Logistics, Transportation.	France	GS
California Water Service	Water and Wastewater Utility Services.	USA	WT
Canadian Solar Inc	Solar, panel manufacturer.	Canada	CE
Cargotec OYJ	Ports & Terminals, attention to Sustainability.	Finland	GS
Cia Pesquera Camanchaca SA	Fishing, aquaculture, sustainability, Chile.	Chile	SF
CREE	LEDs Lighting.	USA	PP
CS Wind	Wind, towers.	S. Korea	CE
EDP Renovaveis SA	Renewables, across wind, hydro, solar.	Spain	CE
Encavis AG	Solar and Wind parks, Germany and Europe.	Germany	CE
Eolus Vind AB	Wind power projects in Sweden, US, Estonia.	Sweden	CE
Evoqua	Water, wastewater treatment.	USA	WT
First Solar	Solar, thin film panels.	USA	CE
FuelCell Energy	Fuel cells, hydrogen, decarbonization.	USA	PP
Grieg Seafood ASA	Seafood, aquaculture with high ESG scores.	Norway	SF
Intertek Group plc	Cargo and Trade services, quality assurance.	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
Landis & Gyr	Smart Metering, Better Grid	Switzerland	PP
Leroy Seafood Group	Seafood, with high FAIRR Report score.	Norway	SF
McPhy Energy SAS	Hydrogen, for decarbonization.	France	PP
Mercury NZ	100% Renewables, 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

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-sustain. seafood.	USA	SF
Norway Royal Salmon ASA	Fish farming, low carbon footprint vs. beef.	Norway	SF
Orsted A/S	Wind, Offshore; also inbioenergy and thermal.	Denmark	CE
P/F Bakkafrost	Seafood, with high FAIRR Report score.	Norway	SF
Pentair PLC	Water Efficiency and Treatment.	Britain	WT
Plug Power	Hydrogen, fuel cells, decarbonization.	USA	PP
PowerCell Sweden	Hydrogen, fuel cells, reformers, marine uses.	Sweden	CE
Pure Cycle	Water, supply and treatment.	USA	WT
SalMar ASA	Seafood, aquaculture with high ESG scores	Norway	SF
Samsung SDI	Li Ion Batteries.	S. Korea	CE
Signify NV	LEDs, was Philips Lighting.	Netherlands	PP
Sino-American Silicon Prod.	Solar feedstock, wafers.	Taiwan	CE
SolarEdge	Solar MicroInverters	USA	CE
Solaria Energia y Medio	Solar, Wind, power from renewables plants.	Spain	CE
Sunnova Energy	Residential Solar and Energy Storage.	USA	CE
SunPower Corp	Solar, efficient panels manufacturer.	USA	CE
Sunrun Inc	Solar, residential Installer.	USA	CE
Tassal	Seafood, aquaculture with high ESG scores.	Australia	SF
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	90% of power from Hydro, Austria.	Austria	CE
Vestas Wind Systems A/S	Wind power, in both products and services.	Denmark	CE
Wartsila OYJ	Ports, Terminals, energy with sustainability.	Finland	GS
Watts Water Technologies	Water quality, rainwater harvest, flow control.	USA	WT
Xebec Adsorption	Renewables gases, and hydrogen.	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
Xylem	Water Technologies.	USA	WT

Sectors in WilderHill Clean Ocean Index (OCEAN)

GREENER SHIPPING = GS

CLEAN ENERGY LOW CO_2 = CE

WATER TREATMENT = WT

SUSTAINABLE FISHERIES = SF

For Rebalance in Q3 2020 of OCEAN Index

2 Deletions: Koninklijke Bosk., Torm.

9 Additions: Bloom, Encavis, FuelCell, ITM, McPhy, Mercury NZ, Nio, Plug, Xebec.

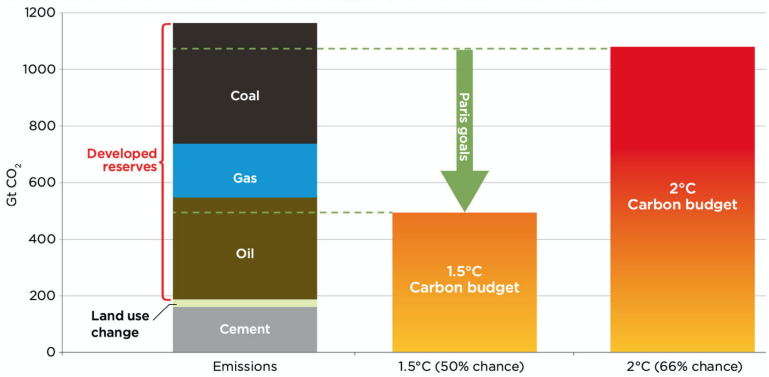
Equal Weight: 71 Components = 71/100 = 1.408450% each.

OCEAN SECTOR		**Approx %**
GREENER SHIPPING (GS) =	4	6%
CLEAN ENERGY (CE) =	24	34%
WATER TREATMENT (WT) =	14	20%
SUSTAINABLE FISHERIES (SF) =	10	14%
POLLUTION PREVENTION (PP) =	19	27%
Total CONSTITUENTS =	**71**	

For how Dire CO_2 trends may be: consider Oil Change Intl. (OCI) compared what will likely be burned of the fossil fuel reserves (coal, oil, natural gas) versus Earth's maximum carbon budget. These data indicate first off, for a 1.5 C warming goal to be realized – ALL the world's fossil fuels proved reserves not now producing, would have to abandoned – so no new mining or drilling! Of *developed* reserves, keeping to 1.5 C means all extant coal needs be abandoned this decade in a Thanos-like snap of the fingers – or we'll blow far past 1.5.

Only by a halt to all extant coal, most oil, and natural gas in the 2020s, could carbon budget keep to a 1.5 C rise. It's simple physics & chemistry. Whatever oil companies might desire, or coal, oil and gas-using nations may think, whatever they're prepared to give in a nod to demands, this budget, if it's accurate simply puts a ceiling on fossil fuel use, period. To state that our Planet/Oceans will likely realistically blow past that in 2020s, is acknowledging where things are now at start of the 2020s. Yet, they may look very different by 2030:

FIGURE 1: CO_2 EMISSIONS FROM DEVELOPED GLOBAL FOSSIL FUEL RESERVES, COMPARED TO CARBON BUDGETS WITHIN RANGE OF THE PARIS GOALS



Source: Oil Change International (OCI), 'Big Oil Reality Check: Assessing Oil and Gas Company Climate Plans.' Sept. 2020. See also, David Roberts, 'On Climate Change, Oil and Gas Companies Have a Long Way to Go.' Vox. September 25, 2020.
