1.5 Degrees in the Rear View Mirror

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1. Introduction

World economies have long had a goal of limiting global warming due to climate change to 1.5°C. In case you haven't heard, we will exceed this goal this year.

The battle to keep global warming within 1.5 degrees Celsius has been a rallying cry for climate action for nearly a decade. Now, with the planet almost certain to blow past the target, diplomats and campaigners at the COP29 summit have found themselves awkwardly clinging to a goal that no longer makes sense.[1]

The evidence has become harder and harder to ignore. This year will once again be the hottest on record as greenhouse gas emissions continue to soar and Earth will likely register an average reading of 1.5C above pre-industrial levels for the first time. A study released this month using a new technique for measuring the rise in temperatures suggests the world was already 1.49C hotter at the end of 2023.

"1.5C has been deader than a doornail" for a while now, said Zeke Hausfather, a climate scientist at Berkeley Earth. Many of his peers agree. The United Nations has concluded that the world is on track to warm roughly 3.1°C before the end of the century if nothing changes. That report was released just before representatives from nearly 200 countries gathered in Baku, Azerbaijan for the UN's annual global climate conference, where they have been mired in bitter negotiations over how to raise money to help developing nations combat global warming.

Author's comment: Note the text: "*3.1°C before the end of the century if nothing changes…*" Not that I'm a blooming optimist, but things have begun changing: more renewables are being deployed to offset power generation via fossil-fuels, more electric vehicles (EVs) on the road not burning fossil-fuel nor pumping greenhouse gases (GHG) into the atmosphere, and movement towards more along this line in the future. In 2025 Mr. Trump will fix that: more drilling more GHG and everyone having a good gas guzzling time. By the way, my local utility, *Pacific Gas and Electric Company (PG&E) retail customers received 100% greenhouse gas-free electricity in 2023, making the company's portfolio of electricity sources one of the world's cleanest.*[2]

Even the environmentally-conscious billionaires are pessimistic regarding the 1.5-degree goal:

At COP28 last year, Bill Gates said realistically even 2°C isn't that likely anymore, and the world should just be sure to stay below 3°C.

Speaking of Mr. Gates, I recently read a book he wrote on potential solutions to climate change, and promptly wrote a brief post on this – summarized and linked below.

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[1] Zahra Hirji and John Ainger, Bloomberg via MSN, "The 1.5C Climate Goal Is Dead. Why Is COP29 Still Talking About It?" Nov 18, 2024, https://www.msn.com/en-us/money/other/the-1-5c-climate-goal-is-dead-why-is-cop29-still-talking-about-it/ar-AA1ug3tU

[2] https://investor.pgecorp.com/news-events/press-releases/press-release-details/2024/PGE-Customers-Electricity-100-Greenhouse-Gas-Free-in-2023/default.aspx

The Final Steps – The Complete Solution: *This is the fifth and final paper in a five-paper series on Climate Change. Each of the former parts to this series are from the same book, and were about solutions that can mitigate climate change. This final part is about the whole process, and is from a different book by a different author, albeit one that you may have heard of.*

https://energycentral.com/c/ec/final-steps-%E2%80%93-complete-solution

And the earlier parts in the "…Steps…" series, in reverse chronological order are:

The Second Steps - The Climate Capitalists

https://energycentral.com/c/ec/second-steps-climate-capitalists

The Second Steps -- Big Oil's Transition

https://energycentral.com/c/og/second-steps-big-oil%E2%80%99s-transition

The Second Steps: Carbon Capture & Sequestration

https://energycentral.com/c/ec/second-steps-carbon-capture-sequestration

The First Steps: Low-Carbon Cement

https://energycentral.com/c/ec/first-steps-low-carbon-cement

Back to Reference 1.

2. How Much Pain

It's a common refrain and testament to how effective 1.5°C has been as a tool for conveying the dangers of climate change. After countries agreed in the Paris Agreement to try and limit global warming to well below 2°C, and ideally 1.5°C, the UN asked the world's top scientists to investigate the impacts of breaching both thresholds. The resulting special report, published in 2018, detailed how big a difference that half degree would make. A 1.5°C world would see far lower sea level rise, fewer intense heat waves and other disasters than a 2°C one.

Author's comment: The above mentioned "special report" was considered for insertion, but it was just too voluminous and convoluted. I expect that most documents from the IPCC suffer from these flaws, at least that has been my experience in the past. However, for readers that wish to suffer through this, go through the link below.

https://www.ipcc.ch/sr15/

I will continue with Reference 1.

This had a decidedly positive impact on climate action: Countries and companies increasingly put forward more aggressive climate targets, and started pouring money into renewables and green technologies. "It wasn't that long ago that we were on a 3C, 4C degree sort of trajectory," said Samantha Gross, energy security and climate initiative director at the Brookings Institution, "and now we're not."

For the world's most at-risk nations, abandoning the 1.5C goal is not an option. The annual COP meetings are their only opportunity to hold rich nations to account for the decades of pollution responsible for more extreme weather that now threatens their very existence. Including the 1.5C goal in the Paris Agreement was a major win for poor, climate-vulnerable countries and it remains a crucial instrument for them to press their case for more financial aid and urge large economies to take more aggressive steps to cut emissions.

Cedric Schuster, the Samoan minister who chairs the Alliance of Small Island States (AOSIS), is quick to point out that the world still hasn't technically breached the Paris Agreement's 1.5C target, which is based on the 20- to 30-year average of human-induced global warming.

"AOSIS finds it necessary to disabuse critics of this notion that 1.5C is dead," he said in a press briefing in Baku. "With appropriate measures, 1.5C is still achievable. In this regard we must see countries rise to the occasion with new, highly ambitious" targets, he said.

Until a better totem emerges, the climate community seems determined to stick to the 1.5C talking point. It's important to reckon with the usefulness of the goal, says Gross from the Brookings Institution. But she worries about the optics of doing it right now, when Trump's re-election has already cast a shadow on prospects for progress.

"You don't want it to look like Trump killed it," she says. "Because he actually didn't. It was already dead."

Back to the title of this section (extended): **How Much Pain** is the World Willing to Suffer Before Acting? Of course, the answer is different depending on each person's perspective.

For your author, this is clearly not my fight, other than through my writings. I take care of my health, and if I'm really lucky, I might still be around (and hopefully still writing) a decade or two in the future. Given the probable sources of pain from climate change in that time, I'm pretty well positioned to avoid most of it.

For a young person that lives on one of the Alliance of Small Island States (highlighted above), they should be fighting as hard as they can, as soon as they can. Ditto anyone that:

- Lives in a coastal area that is close to sea-level
- Lives in an area that is susceptible to hurricanes
- Lives and/or works outdoors in an area that is already life-threateningly hot part of each year
- Lives close to a river that is already prone to flooding
- Is a farmer or works in agriculture
- Already suffers from food insecurity.

3. Steps to Reduce Global Warming

At the end of Section 2, I listed vulnerable groups that suffer most as the effects of climate change worsen. As I've started to write this section, I've collected what appear to be several really good sources with ideas about the steps to reduce these effects, but I'm not sure how this information will be categorized, so here we go.

3.1. The US Fifth National Climate Assessment

The subsection title assessment is referenced below.[3]

[3] Allison R. Crimmins (Lead Author), US Global Change Research Program (for a full list of authors and contributors, see the Overview of this report), "The US Fifth National Climate Assessment," 2023, https://nca2023.globalchange.gov/

The US GHG emissions have decreased, while the economy and population have grown.

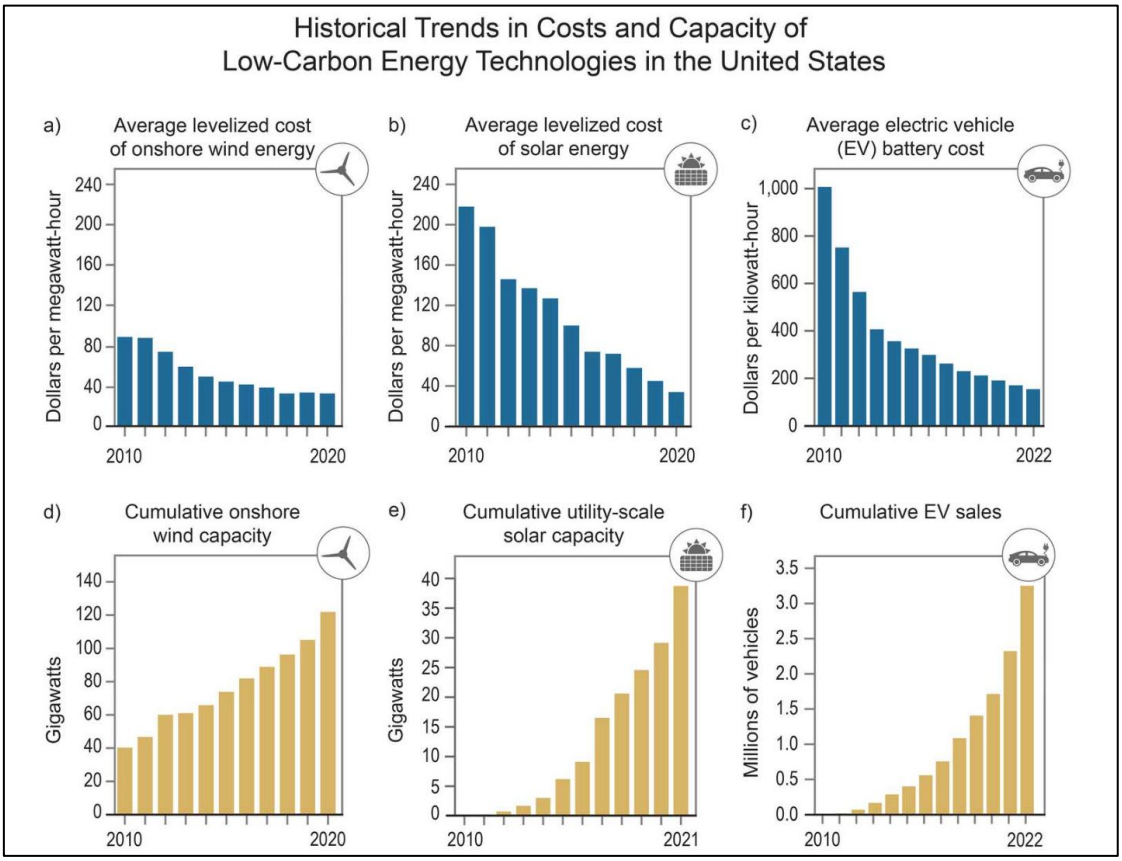
Annual US greenhouse gas emissions fell 12% between 2005 and 2019. This trend was largely driven by changes in electricity generation: coal use has declined, while the use of natural gas and renewable technologies has increased, leading to a 40% drop in emissions from the electricity sector. Since 2017, the transportation sector has overtaken electricity generation as the largest emitter.

As US emissions have declined from their peak in 2007, the country has also seen sustained reductions in the amount of energy required for a given quantity of economic activity and the emissions produced per unit of energy consumed. Meanwhile, both population and per capita gross domestic product (GDP) have continued to grow.

Recent growth in the capacities of wind, solar, and battery storage technologies is supported by rapidly falling costs of zero- and low-carbon energy technologies, which can support even deeper emissions reductions. For example, wind and solar energy costs dropped 70% and 90%, respectively, over the last decade, while 80% of new generation capacity in 2020 came from renewable sources.

Across all sectors, innovation is expanding options for reducing energy demand and increasing energy efficiency, moving to zero- and low-carbon electricity and fuels, electrifying energy use in buildings and transportation, and adopting practices that protect and improve natural carbon sinks that remove and store CO_2 from the atmosphere, such as sustainable agricultural and land-management practices.

See the figures below.



Regarding the chart in the upper left, EV batteries and Battery Energy Storage Systems' batteries now use the same technology, and thus cost curves should be about the same.

As more people face more severe climate impacts, individuals, organizations, companies, communities, and governments are taking advantage of adaptation opportunities that reduce risks. State climate assessments and online climate services portals are providing communities with location- and sector-specific information on climate hazards to support adaptation planning and implementation across the country. New tools, more data, advancements in social and behavioral sciences, and better consideration of practical experiences are facilitating a range of actions.

3.2. What is Climate Change Mitigation?

Climate change mitigation refers to any action taken by governments, businesses or people to reduce or prevent greenhouse gases, or to enhance carbon sinks that remove them from the atmosphere...[4]

Since the industrial era began, human activities have led to the release of dangerous levels of greenhouse gases, causing global warming and climate change. However, despite unequivocal research about the impact of our activities on the planet's climate and growing awareness of the severe danger climate change poses to our societies, greenhouse gas emissions keep rising. If we can slow down the rise in greenhouse gases, we can slow down the pace of climate change and avoid its worst consequences.

Reducing greenhouse gases can be achieved by:

Shifting away from fossil fuels: *Fossil fuels are the biggest source of greenhouse gases, so transitioning to modern renewable energy sources like solar, wind and geothermal power, and advancing sustainable modes of transportation, is crucial.*

Improving energy efficiency: *Using less energy overall – in buildings, industries, public and private spaces, energy generation and transmission, and transportation – helps reduce emissions. This can be achieved by using thermal comfort standards, better insulation and energy efficient appliances, and by improving building design, energy transmission systems and vehicles.*

Changing agricultural practices: *Certain farming methods release high amounts of methane and nitrous oxide, which are potent greenhouse gases. Regenerative agricultural practices – including enhancing soil health, reducing livestock-related emissions, direct seeding techniques and using cover crops – support mitigation, improve resilience and decrease the cost burden on farmers.*

The sustainable management and conservation of forests: *Forests act as carbon sinks, absorbing carbon dioxide and reducing the overall concentration of greenhouse gases in the atmosphere. Measures to reduce deforestation and forest degradation are key for climate mitigation and generate multiple additional benefits such as biodiversity conservation and improved water cycles.*

Restoring and conserving critical ecosystems: *In addition to forests, ecosystems such as wetlands, peatlands, and grasslands, as well as coastal biomes such as mangrove forests, also contribute significantly to carbon sequestration, while supporting biodiversity and enhancing climate resilience.*

[4] United Nations Development Program, "What is climate change mitigation and why is it urgent?" February 29, 2024, https://climatepromise.undp.org/news-and-stories/what-climate-change-mitigation-and-why-it-urgent

Creating a supportive environment: *Investments, policies and regulations that encourage emission reductions, such as incentives, carbon pricing and limits on emissions from key sectors are crucial to driving climate change mitigation.*

Enhancing sinks: *Other forms of mitigation, like growing new forests and designing and building "direct air capture" systems, work by taking greenhouse gases out of the atmosphere—sometimes called "carbon removal." These approaches are challenging to do at a very large scale, and they do not eliminate the need to drastically lower our emissions. Still, authorities like the IPCC agree that some carbon removal will be needed to head off the worst climate change scenarios.*

Author's comment: Building enough direct air capture to make a dent in the carbon dioxide and other greenhouse gases (GHG) in our atmosphere is probably not practical. This would involve creating a new huge industry to build complex chemical processing equipment, in quantities ranging from tens of thousands to millions, and then also using wells (mostly depleted oil wells) and pumps to geologically sequester the GHG in deep, stable formations. Also, these processes would require major new energy sources (which should be zero-GHG), and there would be costs to build and operate these.

A more practical approach to carbon capture that would use a boost from Mother Nature will be to use existing and new forests that would (1) capture the carbon in trees, (2) build long-lived structures from lumber milled from those trees, (3) bury residual wood waste from (2) as described in the post below and (4) ditto for the debris from demolishing the structures that have reached the end of their lives. Expanding forests would immediately begin sequestering CO_2. There would be only minimal be costs to monitor and safeguard the forests, offset by many side-benefits offered by these. Also (2) above would have no additional costs vs. today. The additional cost for (3) and (4) would be minimal (read the post linked below).

Long-Term Sequestration of Woody Biomass: *A recent discovery may give us a short-cut to isolate biomass from the biosphere for a very long time without extensive processing.*

Limiting climate change requires achieving net-zero carbon dioxide emissions. Although substantial reduction in fossil fuel emissions is essential, it is insufficient for achieving the international goal of restricting global warming to 1.5° or 2°C above preindustrial levels. Achieving net-zero necessitates approaches that remove carbon dioxide from the atmosphere, known as carbon dioxide removal (CDR).

Engineering CDR methods, such as direct air capture, are expensive and energy-intensive. Nature-based CDR, such as reforestation and afforestation, are cheaper but face land-use competition, scalability, and carbon leakage risks.

Forests are central to climate change discussions because of their critical role as a dominant land carbon sink in natural carbon cycles. They sequester carbon from the atmosphere through photosynthesis. This carbon is stored in wood with ~50% carbon content that varies by species. The carbon is released back to the atmosphere through burning (forest fires or prescribed burning for fire risk management) or decomposition of woody biomass.

This paper describes a pathway to making deadwood carbon storage a reality. The authors present a CDR approach involving the burial of sustainably sourced wood in an underground engineered structure called a "wood vault" to prevent wood decomposition.

https://energycentral.com/c/ec/long-term-sequestration-woody-biomass

What are some of the challenges to implementing the above actions:

- *The global economy's deep-rooted dependency on fossil fuels*
- *Expansion of renewable energy and energy storage is driving increased demand for critical minerals such as copper, lithium, nickel, cobalt, and rare earth metals.*
- *Agriculture is currently the largest driver of deforestation worldwide. A transformation in our food systems to reverse the impact that agriculture has on forests and biodiversity is undoubtedly a complex challenge.*

The goal of mitigation is to avoid significant human interference with Earth's climate, "stabilize greenhouse gas levels in a timeframe sufficient to allow ecosystems to adapt naturally to climate change, ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner" (from the 2014 report on Mitigation of Climate Change from the United Nations Intergovernmental Panel on Climate Change, page 4).

Final author's comment: I recently read an excellent book on forests and trees. The following edited-quote and excerpt is from that book, which is referenced below.

Per the UN Food and Agricultural Organization's (FAO's) 2020 Global Forest Resource Assessment: …*forests covered 4.06 billion hectors (6.56 billion acres) … that estimate is close to the one first reported in 1948.* Thus, this report estimates that there has been no net loss (or gain) of forest acreage during this period. Note that this estimate is based on UN Member Nations self-reporting their forest resources.[5]

3.3. What is Climate Change Adaptation

Adapting to life in a changing climate – involves adjusting to actual or expected future climate. The goal is to reduce our risks from the harmful effects of climate change (like sea-level rise, more intense extreme weather events, or food insecurity). It also includes making the most of any potential beneficial opportunities associated with climate change (for example, longer growing seasons or increased yields in some regions).

Throughout history, people and societies have adjusted to and coped with changes in climate and extremes with varying degrees of success. Climate change (drought in particular) has been at least partly responsible for the fall of civilizations.

Earth's climate has been relatively stable for the past 10,000 years, and this stability has allowed for the development of our modern civilization and agriculture. Our modern life is tailored to that stable climate and not the much warmer climate of the next hundreds to thousands of years. As our climate changes, we will need to adapt. The faster the climate changes, the more difficult it will be.

[5] Lauren E. Oakes, "The Treekeepers," Nov, 2024, Basic Books, pages 26 & 27, Amazon site for this book: https://www.amazon.com/Treekeepers-Forested-Future-Lauren-Oakes/dp/1541603346