REACHING NET ZERO: 2021 MID-YEAR UPDATE

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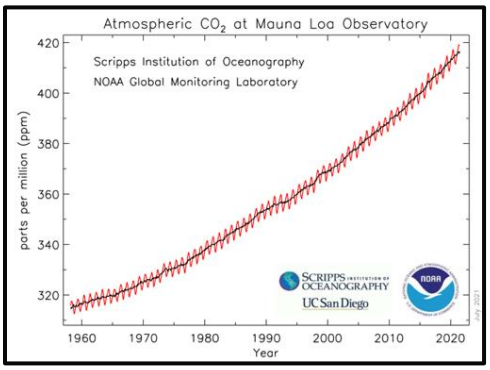
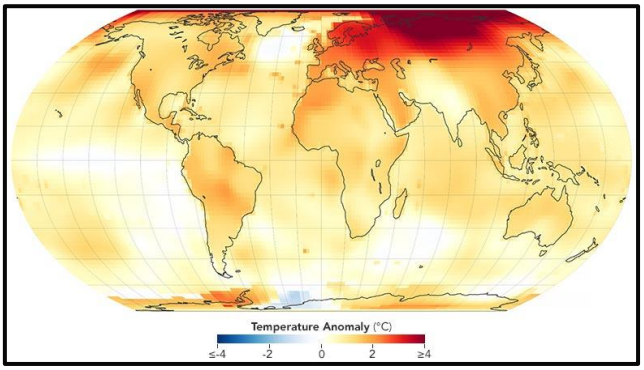
EXECUTIVE SUMMARY

- No permanent reduction in global greenhouse gas emissions so far, still about 55 gigatons/year and rising.
- Earth's carbon dioxide concentrations (219 ppm) and temperature anomaly (1.27°C) continue to increase.





- Recent National Oceanic and Atmospheric Administration (NOAA) analysis indicates that the amount of heat the earth traps has roughly doubled since 2005, contributing to more rapid global warming.
- The Arctic is heating more than twice as fast as the rest of the world and affecting weather in the northern hemisphere, such as drought and extreme heat events.
- The sea level and the temperature of the oceans continue to rise.
- It is unlikely that the world can reach net zero by 2050, the Intergovernmental Panel on Climate Change (IPCC) goal.
- It is unlikely that the earth's temperature increase can be limited to 1.5°C, or even 2.0°C, another IPCC goal.
- China is ahead of the U.S. and Europe in the manufacture and use of wind turbines, solar panels, batteries, electric vehicles and nuclear power plants, anticipating that these will be major new global growth industries.
- The Biden administration is reneging on a carbon fee, the single best way to reduce carbon emissions.
- The European Union is developing an aggressive plan to have a carbon free economy by 2050. This plan has to be approved by the member states.
- Dramatic improvements in the cost of renewable energy and batteries are continuing. Low-cost renewables will eventually displace fossil fuels.
- Low-cost electricity from renewables could make hydrogen a practical alternative to fossil fuels in some applications.
- The next major IPCC meeting on climate change, COP26, will be held in Scotland this fall. The main objective is to update countries' greenhouse gas emission targets.

The paragraphs that follow have additional information for those interested in the details.

₮ William Fletcher and Craig Smith are coauthors of *Reaching Net Zero: What It Takes To Solve The Global Climate Crisis,* Elsevier, July 2020. (https://reachingnetzero.com/book/)

DETAILS

WARNING SIGNS ARE INCREASING:

- **CO_2 continues its inexorable rise to all-time high levels.**
  In May, 2021, the weekly average CO_2 concentration in the atmosphere as measured at the Mauna Loa Observatory reached 419 parts per million (ppm), with some daily values of 420 ppm. In 2019 the peak concentration was 415 ppm. Since the Industrial Revolution, CO_2 concentration has steadily increased and is now 50% higher than the pre-Industrial Revolution (1880) maximum of 280 ppm.

  Total CO_2 emissions (primarily from transportation) dropped about 7 percent (2.5 Gmt) in mid-2020 due to the Covid-19 pandemic. This was a new record for a decline, greater than what occurred at the end of WW II or during the global financial crisis of 2009. This dramatic change shows what is possible if more efficient technologies replace fossil fuels. As the world relaxed coronavirus-induced lockdowns, CO_2 emissions surged back towards pre-pandemic levels.
- **Earth's temperature is rising.**
  The earth's average temperature anomaly (increase over the average temperature of pre-industrial times) was 1.27°C according to Berkeley Earth. 2020 was the second warmest year on record. The pandemic did not slow the earth's warming, which is driven by the huge load of greenhouse gasses in the atmosphere. The one-year decline in emissions did nothing to reduce this inventory.
- **The Arctic is warming more than twice as fast as the rest of the world.**
  In June, 2020, the temperature reached 38°C (100.4°F) in the Siberian town of Verkhoyansk, one of the coldest places on earth. Rising temperatures in the northern regions are changing weather in the northern hemisphere. There is evidence that this is affecting the Gulf Stream by weakening the Atlantic Meridional Overturning Circulation (AMOC) that drives it, resulting in colder and more extreme weather in Europe.

  Another of the consequences of warming is that permafrost is thawing. One immediate effect is the reduced bearing capacity of the frozen ground to support structures, causing building and roads to sink and sometimes collapse. Soil collapses have caused lakes to drain and shorelines to give way, forcing settlements to relocate inland. More insidious consequences are melting of ice, contributing to sea level rise, and the release of trapped methane, a potent greenhouse gas. Releases of methane in Siberia has created large holes in the permafrost that in some cases have ignited, causing fires. More than 60 percent of Russian territory is permafrost, yet the Russian government has announced plans for a mammoth expansion of oil prospecting and production in the Arctic. Russia is very dependent upon exports of oil and natural gas and is unlikely to reduce its fossil fuel production in spite of damage due to global warming. The Russian Minister of Natural Resources and Ecology, stated that thawing permafrost could cost the Russian economy $67 billion in infrastructure damage by 2050.
- **Ocean temperatures are rising.**
  Sea surface temperatures have been higher during the past three decades than at any other time since reliable measurements have been made. Recent data indicates that the global ocean temperature anomaly reached 0.8°C in 2020, while the Northern Hemisphere reached 1.0°C.
- **Greenland ice sheet melt is accelerating.**
  Greenland continues to lose ice through melting of glaciers, the calving of icebergs, and submarine melting. Since 1992, Greenland has lost 4 trillion metric tons of ice. In 2019 Greenland lost 532 billion tons of ice, exceeding previous records. This is enough ice to raise the sea level 1.5 millimeters.

- **Arctic and Antarctic Sea ice retreat**
  In 2020 the area of Arctic Sea ice neared a record low. Some scientists predict that it could be totally ice-free during the summer months by 2035. In the Weddell Sea in Antarctica, about 390,000 mi^2 of sea ice has disappeared in the last 5 years. In addition, the Antarctica ice cap has lost 2.7 trillion tons of ice in the last 5 years. The extent of other Antarctica sea ice appears to be stable for now.
- **Sea levels are rising**
  The rate of increase of sea level rise has more than doubled from 0.06 inches/yr (1.4 mm/yr) to 0.14 in /yr (3.6 mm/yr) between 2006 and 2015. The increase is due to a combination of thermal expansion, (as the oceans get warmer), and due to added melt water. By 2020, the sea level rise has been approximately 10 inches, of which 4 inches is due to thermal expansion and 6 inches due to melt water. We are beginning to see the effects of sea level rise on low-lying islands and coastal areas around the world. The evidence includes increased coastal flooding and salt water intrusion into ground water. As the sea rises, storms and high tides increase coastal flooding and erosion, ultimately destroying homes and crops in low lying areas.
- **Extreme weather events continue to increase**
  The intensity, frequency, and duration of North Atlantic hurricanes, as well as the frequency of the strongest hurricanes, have all increased since the early 1980s. Hurricane frequency, intensity, and rainfall are projected to increase as the earth and oceans continue to warm. The five-year period 2016-2020 saw 22 major North Atlantic hurricanes, resulting in 4,000 deaths and damage estimated at over $400 billion.

    In addition to storms, the world is experiencing heavier rainfall and flooding in some areas and drought in others, resulting in crop damage or loss, and more frequent and intense wildfires. Crop failures, droughts, and wildfires, have occurred in the past and are obviously not totally due to global warming which is believed to contribute to these problems. Wildfires in California burned 4.4 million acres in 2020. California was not alone, there were fires in all of the western US. In Australia, the 2019-20 fire season saw 46 million acres burn. Globally, there were major fires in Brazil, Indonesia and Siberia as well. Regarding wildfires in the western U.S., Daniel Swain a climate scientist at UCLA, stated that “climate change has driven more intense fires that become larger more quickly than they used to.”

FIRST MAJOR CONCLUSION: In the year since *Reaching Net Zero* was published, emissions continue to increase and there has been no diminution in the warning signs. Efforts to date have been inadequate and the risk of a global climate crisis has not decreased.

YET THERE ARE SOME POSITIVE TRENDS:

- **Increase in solar and wind generation.**
  In 2020 the world added 260 GW of solar and wind generating capacity, 50% more than 2019, bringing total solar/wind installed capacity to 1,446 GW, 20% of total global electricity generating capacity.
- **Improved batteries.**
  Utility scale storage battery costs have declined sharply since 2015, when the average cost was $2,152/kWh, to $618/kWh in 2018, and $137/kwh in 2020. This trend is continuing.
- **Increase in electric vehicles.**
  Globally, sales of electric vehicles were 2.1 million in 2019 increasing to 3.2 million in 2020. The global fleet of electric vehicles was about 8.5 million units in 2020.
- **Decline of coal.**
  Today coal is still the world’s main energy source for electricity generation and about 180 GW of new capacity is under construction. However, in the U.S. and Europe, coal is being phased out because it cannot compete with renewable energy and cleaner and cheaper natural gas in

the U.S. Most new construction is in China, India, and Japan. In India, some coal plants face the risk of becoming stranded assets because their generating cost is higher than that of new renewable energy plants.

- **European Union objectives.**
  The European Union is proposing ambitious legislation that would eliminate the sale of gas-powered cars by 2035, raise the cost of using fossil fuels, and impose a carbon fee on imports, a border adjustment tax, among other measures. This aggressive plan has to be approved by the 27 member counties.
- **Hydrogen developments.**
  Hydrogen as a fuel has been under consideration for a long time because it can be used in fuel cells to produce electricity and water (H_20) is the byproduct of burning hydrogen for power and heat. The biggest barrier has been its cost. If the cost of electricity from renewables is low enough, it would be possible to produce hydrogen by electrolysis at competitive prices. It could be used as way to store renewable energy, used as a fuel, or used as a substitute for fossil fuels in some industrial processes. The potential market for hydrogen is huge if hydrogen can be produced at competitive costs.

    Major programs are underway in Japan and Europe to use hydrogen as a fuel. There are several wind and solar projects in the US that will be using hydrogen to store energy to help match supply and demand for electricity production.

Continued progress in energy efficiency and conservation.
In 2019 and 2020 the improvement in energy efficiency was varied. In the U.S., Europe, Russia, India and Japan, efficiency savings increased compared to 2018, led by the U.S. with a 2.9 percent improvement. In some cases, adverse weather offset efficiency improvements, and in the case of China, growth in energy intensive industries (steel and cement) did likewise. However, overall, energy efficiency improvements avoided around 200 million tons of CO_2 emissions in 2020.

CAUSES FOR CONCERN:

- **Slow progress on implementing a price on carbon by major users.**
  Some progress is being made. China announced measures to launch a nationwide emissions-based trading system which will double the share of global carbon emissions being traded. The European Union announced its intention to apply a carbon tax on selected imports that are major sources of emissions. President Biden supported a carbon tax during his campaign but this proposal has been quietly dropped due to opposition to such a tax. So far, there has been no progress on implementing a uniform global carbon tax or fee.
- **Most countries are not meeting the goals of the Paris Agreement.**
  There is no enforcement mechanism and lack of a broad public mandate. These goals will be updated at the COP26 conference later this year. Will major sources of greenhouse gases such as the U.S. commit to meeting more aggressive emissions reductions?

Need to address agriculture.
Agriculture, forestry, and other land use changes (AFOLU), are responsible for about 25% of global greenhouse gas emissions. There are many things that could be done, such as implementing improved farming methods to reduce fertilizer use, reducing cattle ranching, stopping deforestation, planting trees, etc., but they are receiving inadequate attention. Developing countries such as Brazil and Indonesia don't have the financial incentives or the resources needed to reduce deforestation or to take other actions to reduce emissions from land use changes and agriculture.

- **Lack of broad public support.**
  Public concern about global warming is increasing. However, the public is not yet ready to support the investments and changes required to actually do something about global warming.

There is opposition to any increase in energy prices and opposition to transmission lines, wind turbines, and solar farms for example.

There are ongoing efforts to discredit efforts to stop global warming or to claim that it can't be done. The argument that we don't need to do anything about this problem is fading and it's generally recognized that this is a big problem. There are some claims that we should wait for next generation nuclear reactors or technology that will remove CO_2 from the atmosphere. In addition, the Coronavirus pandemic posed a very real, visible and immediate threat, distracting the public from most other concerns.

- **U.S. efforts.**
  The only efforts that count are those that actually reduce greenhouse gas emissions. The Biden administration plans to spend scarce resources on social programs that they link to global warming. These programs may be commendable but will not reduce emissions. We have already mentioned that a tax on greenhouse gas emissions has been quietly dropped. Any plan has to be approved by Congress where there will be opposition to some aspects of this effort.

  Distractions.
  We should not let ourselves be distracted or our efforts diverted by problems that can be solved or are insignificant compared to the 55 billion tons of greenhouse gases being discharged every year. A common complaint is the inaccuracy of climate models. We don't need a forecast to know we have a problem. The hard observations in this and other reports should be enough to tell us we have an immediate problem to deal with.

  The only way we can stop global warming is to stop using fossil fuels as soon as possible. To do this, we have to make an energy system based upon renewables work. Many important renewable energy projects are being implemented but we are not moving fast enough or on a large enough scale.

  We are also wasting efforts on projects that allegedly address climate change such as California's Bullet Train. Other programs such as ethanol production or using wood chips to fuel power plants have little benefit or are counterproductive.
- **Tipping points loom ever closer**.
  "Tipping points" are defined as the point where some event that has been slowly increasing reaches a condition where it accelerates, and there is an abrupt and irreversible change. The "straw that broke the camel's back" is a good analogy. There are a number of tipping points that should concern us such as a release of methane from melting permafrost, a slowdown of ocean currents, or the collapse of large ice sheets. Potential tipping points are impossible to forecast but are credible events that we have to be concerned about.

SECOND MAJOR CONCLUSION*:* We have not yet seen any real reduction in global greenhouse gas emissions. The only measure of success that matters is how many billion metric tons of carbon emissions can be eliminated. Just reducing carbon emissions is in itself a huge boon to the world's poor who will suffer the most from global warming. We've already missed any chance of getting to net zero by 2050. Global warming will exceed 2.0 degrees C. Not doing what needs to be done to stop global warming is a reckless disregard of the future.