REACHING NET ZERO: 2021 YEAR END UPDATE

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Our outlook for future efforts to fight global warming is included as the last section of this report. This outlook is based upon our assessment of currently available information.

Executive summary

Our last report, "A Global Warming Update," was published July 19, 2021 and is available on our website, www.reachingnetzero.com. The following is a brief summary of important developments since our last report. Additional details are found following this summary.

- Greenhouse gas *emissions* are increasing after a temporary reduction due to the Covid-19 slowdown of the global economy. Greenhouse gas *concentrations* in the atmosphere are increasing along with the earth's average temperature.
- The Intergovernmental Panel on Climate Change (IPCC) issued a major report *Climate Change 2021: The Physical Science Basis.* This is the first major international assessment of climate-change research since AR5 in 2013.
- The Arctic is the canary in the coal mine concerning global warming. The Arctic is heating at two to three times the global average. Changes in the Arctic have a major effect on weather in the Northern Hemisphere.
- In the Antarctic, there is increasing concerns over the undersea melting of major ice shelves. If these shelves fail, it would accelerate the flow of land ice into the ocean and accelerate sea level rise.
- Because greenhouse gases already in the atmosphere will stay there for up to hundreds of years, we have to assume that the warming and resulting climate changes being experienced in the Arctic and Antarctic and other regions will last indefinitely and will get worse with additional emissions.
- The U.S. Biden administration rejoined the Paris Agreement and is passing major legislation, some of which addresses global warming. *HR 3684, The Infrastructure Investment and Jobs Act,* was signed into law November 15, 2021. A companion bill, HR 5376, *The Build Back Better Act,* has been approved by the House and is pending in the Senate.
- A major international conference of 197 countries met to address climate change. COP26 was held in Glasgow in November. Countries' pledges for greenhouse gas reductions are not sufficient to keep global warming under 2.0 degrees Centigrade (3.6 degrees Fahrenheit), the IPCC goal.
- There needs to be a smooth transition from the use of fossil fuels to renewables. We believe that current plans to shut down fossil fuel and nuclear power plants or reduce fossil fuel production are premature until there are reliable sources of energy from renewables to replace current sources. Critical infrastructure, such as regional and national transmission grids, are also needed and will take time to construct.
- "Green hydrogen" (hydrogen generated using renewable energy) is being promoted for use as a fuel, a feedstock to produce synthetic fuels, and as a means to store energy. Countries such as Japan, Germany, and South Korea are making major investments in a hydrogen economy. To be competitive, green hydrogen requires cheap electricity from renewables.

Global warming metrics

It will take some time before final estimates of total greenhouse gas emissions, the earth's temperature increase, and other data for year-end 2021 can be updated and published. Here's what we know so far:

Global CO_2 emissions, about 76 percent of total emissions, declined about 5.4 percent in 2020 due to the Covid-19 slowdown of the global economy, but recovered about 4.9 percent in 2021, approaching peak emissions recorded in 2019. Global emissions are on track to set a new record in 2022.

China and India both surpassed their 2019 emission peaks in 2021. Chinese emissions grew by 5.5% between 2019 and 2021, while Indian emissions grew by 4.4%. Both coal and gas emissions have already surpassed their pre-pandemic levels. Oil emissions remain around 6% below 2019 levels and this reduction is one of the main reasons 2021 *emissions* did not set a new record. However, at year-end 2021, CO_2 *concentration* in the atmosphere was 216 ppm, which was a new record and an increase of 3.1 ppm over 2020.

The 10 warmest years on record have all occurred since 2005. Averaged across land and ocean, the 2020 surface temperature was 1.2˚C (2.2˚F) warmer than the pre-industrial period (1880-1900). The rate of warming over the past 40 years has increased to 0.18° C (0.32° F) per decade since 1981. From 1900 to 1980 a new temperature record was set on average every 13.5 years; from 1981–2019, a new record was set every 3 years.

A recent report by the U.S. Oceanic and Atmospheric Administration confirms that the Arctic is heating two to three times faster than the global average. Sea ice, especially thick sea ice more than one year old, continues to decrease. For the first time, rain instead of snow was seen at the top of Greenland's ice cap. In northern Russia, summer temperatures reached a new record of 100.4 degrees Fahrenheit at Verkhoyansk. It should be noted that conditions in the Arctic have a strong effect on weather in the Northern Hemisphere.

In the Antarctic, further research and analysis is increasing concerns that a major ice shelf in the Antarctic could collapse. These ice shelves prevent or retard glaciers from flowing into the ocean. The Thwaites Glacier, approximately the size of Florida, is of most concern today. This glacier is anchored by an offshore underwater mountain. The glacier is being eroded underneath by warmer ocean water and could eventually fail or break loose. This would allow more land ice to flow into the ocean and accelerate sea level rise.

Irreversible changes

We can speed up but we can't slow down or stop the global warming that has already occurred. Greenhouse gases already in the atmosphere will stay there for up to hundreds of years until they are slowly dissipated by natural means. It is not possible to remove greenhouse gases from the atmosphere on a scale that would make a measurable difference. We have to assume that the warming and resulting climate changes experienced so far will last indefinitely and will get worse with additional emissions. It is also possible that due to latency the ongoing effects of emissions to date will lead to additional changes. Latency is the delayed reaction between cause and effect. The earth's climate reacts slowly to changes such as global warming.

Major conclusions of AR6

The Intergovernmental Panel on Climate Change (IPCC) issued a major report *Climate Change 2021: The Physical Science Basis*. This is the first major international assessment of climate-change research since AR5 in 2013. The following are the main conclusions of this report:

- It is indisputable that human activities are causing climate change.

- Rising greenhouse gas concentrations are driving profound changes to the earth's system.
- Climate change is already affecting every inhabited region across the globe with many changes in weather extremes.
- The scale of recent changes is unprecedented over many centuries to many thousands of years.
- Global warming of 1.5°C and 2°C *will be exceeded* during this century unless deep reductions in carbon dioxide and other greenhouse gas emissions occur in the coming decades.
- To stop global warming, it is necessary to achieve net zero, no net emissions of carbon dioxide and other greenhouse gases.
- Without aggressive actions, the earth's temperature could reach or exceed 3.0 °C by the end of this century and sea level could increase as much as one to three feet.
- Some changes, such as rising sea level, will persist for centuries.

U.S. President Biden's plans

During the presidential campaign, candidate Biden stated that he would spend $2.0 trillion during his first term to fight global warming. So far, he is not able to achieve this level of support as President.

HR 3684: The Infrastructure Investment and Jobs Act, public law No. 117-58, provides $1.2 trillion for a series of infrastructure improvements and some measures to address global warming. The official summary states that the bill addresses provisions related to federal aid to highway, transit, highway safety, motor carrier, research, hazardous materials, and rail programs of the Department of Transportation (DOT). Among other provisions, the bill:

- Extends FY2021 enacted levels through FY2022 for federal-aid highway, transit, and safety programs;
- Reauthorizes for FY2023-FY2026 several surface transportation programs, including the federal-aid highway program, transit programs, highway safety, motor carrier safety, and rail programs;
- Addresses climate change, including strategies to reduce climate change impacts on utilities, water systems, ports and harbors, and on surface transportation systems and prepare a vulnerability assessment to identify opportunities to enhance the resilience of the surface transportation system and ensure the efficient use of federal resources, and also to provide a nation-wide network of electric vehicle chargers;
- Revises Buy America procurement requirements for highways, mass transit, and rail;
- Establishes a rebuild rural bridges program to improve the safety and state of good repair of bridges in rural communities;
- Implements new safety requirements across all transportation modes; and
- Directs the Department of Transportation to establish a pilot program to demonstrate a national motor vehicle per-mile user fee to restore and maintain the long-term solvency of the Highway Trust Fund and achieve and maintain a state of good repair in the surface transportation system.

Our critique:

- Biden dropped the carbon fee measure, probably the single biggest incentive to reduce fossil fuel use.
- Some but not enough effort to develop the regional and national transmission system needed to get electricity from solar and wind farms where it is best produced to load centers where it is most needed.

- $7.5 billion to build charging stations *is not* needed. The government didn't need to build thousands of gas stations.
- The level of spending is much less than that emphasized during the presidential campaign.

The $1.75 trillion "Build Back Better" plan: what's currently in it?
The following items are currently in the scaled-down plan that was approved by the House on Friday, November 19 and sent to the Senate for approval:

- ***$550+ billion for clean energy and climate.*** The plan proposes cutting greenhouse gas pollution by over a gigaton by 2030, reducing consumer energy costs, helping to create more clean air and water, and creating hundreds of thousands of jobs. Home efficiency tax credits, electrification rebates, credit for U.S. made electric vehicles.
- **$400 billion for childcare and universal preschool.** The plan is designed to save most American families more than half of their spending on childcare by providing two years of free preschool for every 3- and 4-year-old in America and additional funding for childcare.
- **Family and medical leave.** Permanently authorizes the first-ever national paid family and medical leave guarantee for U.S. workers that provides up to four weeks of paid leave.
- **$200 billion for child tax Credit and earned Income credit.** The proposal extends the expanded Child Tax Credit for one year and provides additional funds to extend the expanded Earned Income Tax Credit.
- **$150 billion for home care.** This funding expands home care for older people and those with disabilities.
- **$150 billion for housing.** The plan invests in affordable housing, including construction and rehabilitation of homes, as well as investments in rental assistance and housing vouchers.
- **$40 billion higher ed and workforce development.** The legislation will increase Pell grants and provide post-high school education opportunities including apprenticeship programs for underserved communities.
- **$25 billion for the small business committee.** This provides for small business access to credit, investment, and markets.
- **$90 billion for equity and other investments.** Spending in this area will be designed to achieve equity through investments in maternal health, community violence interventions, and nutrition according to the White House.
- **$5 billion in supply chain investments.** These investments will be designed to safeguard our economy and support domestic job growth.
- **$10 billion to support child nutrition.** This investment will help expand eligibility and eliminate paperwork so more children can receive free school meals.
- **State and Local Tax (SALT) deduction relief.** Accomplished by increasing and applying the cap over the long-term, allowing states and counties to raise more revenue to deliver essential public services.
- **Agreement to lower prescription drugs costs.** The compromise plan would reduce the price of insulin and halt drug price hikes above inflation, which affects all Americans.
- **$130 billion in ACA credits.** This money will be used to expand affordable healthcare coverage, reduce premiums for more than 9 million Americans, and deliver healthcare to uninsured people in states that are not enrolled in expanded Medicaid coverage.

- **$35 billion Medicare hearing coverage.** While dental and vision coverage did not make the cut, Medicare recipients will have coverage for hearing aids and hearing tests. The funding will also cover nursing home transparency and staffing standards, and bolster funding for the Elder Justice Act program.
  Comment: could the $550 billion be listed first since it's all that really relates to global warming? Just a question. I deleted the yellow since it may not show up on a black and white print, underline and italics instead.
- **Corporate alternative minimum tax.** A 15% minimum tax on companies whose financial statements show at least $1 billion in profit—proposed by Senators Elizabeth Warren (D., Mass.), Angus King (I., Maine) and Ron Wyden (D., Ore.)—has been added to the current Build Back Better legislation to help fund it.
- **$100 billion for immigration.** This is part of the framework, but also separate since it requires a ruling by the Senate Parliamentarian. This would constitute an investment to reform the immigration system, reduce backlogs, expand legal representation, and make border processing more efficient and humane.

Our critique:

- A lot of money devoted to social goals that may be commendable but does nothing to reduce greenhouse gas emissions.
- U.S. greenhouse gas emissions peaked at 6 gigatons of CO_{2eq} in 2005 and 14 years later, by 2019, had only declined by about 0.5 gigatons. The "Build Back Better" plan, outlined above, states that by 2030 (9 years from now), greenhouse gas emissions will be reduced by 1 gigaton. That is about an 18% reduction, more than the current greenhouse gas emissions from the entire U.S. residential and commercial sector. To us, that seems improbable.
- At this date (December 2021), the Senate has not approved the bill. It is likely that many of the provisions for social programs will be deleted. The key measures we will be watching are those in the $550 billion provision for clean energy and climate.

The COP26, the Glasgow Conference

The U.N. Climate Change Conference that took place in Glasgow Scotland for 2 weeks beginning October 31, was promising in that we have a functioning international forum to deal with the global threat from global warming;196 nations are meeting annually. The bad news is that the most recent meeting was a huge disappointment, with little accomplished in terms of firm commitments to reduce global greenhouse gas emissions. Participating countries were asked to state their goal for greenhouse gas reductions—their "Intended Nationally Determined Contributions (INDC)." Regrettably, the sum of the INDCs from the participating countries is not yet sufficient to reach the IPCC warming goals of 2.0 °C and preferably 1.5 degrees °C by 2050.There were a few modest accomplishments:

- Countries will meet again next year to pledge further cuts to CO_2 emissions.
- Countries agreed to "phase down" coal use. (The language was changed from "phase out" to "phase down" at the insistence of China and India.)
- There was a pledge to increase money to help poor countries cope with climate change and switch to clean energy.
- World leaders pledged to phase out fossil fuel subsidies but no firm date was set.
- A side agreement was made between the U.S. and China to "cooperate more over the next decade."
- Leaders from 100 countries promised to stop deforestation by 2030.

- A scheme to cut methane emissions by 30% by 2030 was agreed to by more than 100 countries—except big emitters China, Russia and India haven't signed up.

The transition to renewables

To eliminate fossil fuels, the U.S. and other countries need to double or triple electricity generation and produce all this electricity using renewable sources. It is also important that the retail price of electricity does not increase significantly if businesses and individuals are expected to switch from fossil fuels to renewables.

There needs to be a smooth transition between fossil fuels to renewables. Fossil fuel and nuclear power plants can't be shut down until there are reliable sources of energy from renewables to replace them, to avoid brownouts and blackouts and sharp increases in energy prices. Otherwise, the transition will have an impact on the economy and compromise public support for reductions in fossil fuel use.

Energy from renewables is the cheapest form of energy in about 90 percent of locations, based upon the latest estimates, and is getting even less expensive due to improving technology and greater economies of scale. However, energy from renewables fluctuates with the weather and time of day. To be a reliable source of energy to replace fossil fuels, a massive amount of energy storage, short-term and longer-term, is required before renewables can be reliable enough to replace most or all fossil fuel and nuclear uses.

It is also important that essential infrastructure, mainly regional and national transmission grids, are available to transport electricity from renewables from where it is best produced to where it is needed. If this infrastructure is in place, private sector investors will provide most of the capital needed to build the renewable electricity production and storage facilities needed, since they will have access to the markets for this energy.

The cost and capacity of batteries for vehicles and for utility scale energy storage continues to improve. Hydrogen gas produced using electricity from renewables has the potential to store large quantities of energy in the form of a combustible gas. Hydrogen and hydrogen-based fuels such as ammonia can be used as gaseous or liquid fuels. Hydrogen can also be used to produce synthetic fuels such as jet fuel when combined with recycled CO_2, to produce steel without using coal or coke, or as a petrochemical and fertilizer feedstock. Several countries such as Japan, South Korea and Germany are making major investments to develop hydrogen economies.

The biggest challenge is to be able to produce hydrogen at an affordable cost using electricity from renewables. The declining cost of electricity from renewables is a positive trend. The literature also refers to "brown" hydrogen (made from coal) and "grey" hydrogen (made from natural gas). These forms of hydrogen are currently cheaper than "green" hydrogen (made from renewables) but result in significant greenhouse gas emissions.

Late news flashes:

1. On December 8, President Biden signed an executive order mandating that the U.S. government's operations reach net zero by 2050. This will apply to the government's 300,000 buildings, 600,000 vehicles and annual purchasing power of $650 billion in goods and services.
2. Some members of Congress are opposing a corporate and Income tax increase to help pay for Biden's "Build Back Better," infrastructure proposal. This has caused Senator Ron Wyden (Dem, OR), chairman of the Senate Finance Committee, to propose legislation that would put a price on carbon emissions, and using the revenues to help pay for the bill. This would be a big "about face" for Congress, but a huge step toward reducing emissions. Our advice: stay tuned, but don't hold your breath."

Our Outlook

So, what's likely to happen in the next few years? No one knows for sure. Based upon our research and present trends, we have our opinion of what's likely to happen. This is our outlook, not a forecast and will be updated as new information becomes available.

The first and most obvious question is how long can the world continue to discharge about 55 billion tons of greenhouse gases annually? Global greenhouse gas emissions are increasing again after a brief 2020 slowdown in the global economy due to the virus pandemic. Emissions are likely to set a new record in 2022. Can we continue to increase carbon dioxide concentrations in the atmosphere indefinitely? If not, when do we stop?

We are moving in the right direction, but not fast enough or on a big enough scale. There are encouraging positive developments, but we have to recognize that global warming may be too big or too complicated to address by a coordinated, well-thought-out global response. We may have to proceed in fits and starts with a number of setbacks before we succeed.

We will NOT reach NET ZERO in 2050. We don't see how enough can be done within the next 30 years to reach this goal. We believe it's way too late for the world to organize and take actions needed to limit global warming to 2.0°C, much less 1.5 °C. The earth's temperature increase will exceed 2.0 °C, probably in about 25 to 30 years or so.

Our fossil fuel supplies will taper off due to declining investment, shutdowns of power plants and pipelines, and for other reasons, before we install enough reliable renewable energy to replace it. This will lead to energy shortages from time to time and spikes in energy prices as we are seeing in Europe today.

The transition to electricity from renewables is likely to initially lead to higher, perhaps much higher, electricity prices. These problems will be discouraging for the average citizen who may come to doubt the wisdom of transitioning to renewables. Those who oppose efforts to stop global warming will point to these problems and claim that stopping global warming can't be done or isn't worth the effort.

Major and expensive efforts to adapt to higher temperatures and to mitigate the effects of climate change are unavoidable.

On the positive side, technology is moving forward and economies of scale are improving for renewable energy and energy storage. Renewables are becoming even less expensive and more reliable and will increasingly displace fossil fuels based upon their relative cost. Several large projects around the world are demonstrating that renewable energy is a practical alternative.

Over time, we could eventually reach net zero. When? It is not possible to make a prediction yet. Greenhouse gas emissions are still increasing. Failure is an option and we may never reach NET ZERO.

Let's hope we don't exceed any tipping points before we get there.

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