THE GLOBAL CLIMATE CRISIS
April 24, 2022

Global warming

In 2019, total greenhouse gas emissions were 57 billion metric tons/year. Emissions are on track to set a new record in 2022 following a temporary decline due to the virus pandemic. This includes CO_2 emissions of about 43 billion metric tons/year.

Due to the greenhouse effect, the earth's average temperature has increased about 1.2°C (2.2°F) since the start of the industrial revolution in the U.S., about 1860. The rate of warming has increased to 0.18°C (0.32°F) per decade since 1981. A new temperature record is being set about every 3 years.

In 2021, the CO_2 concentration in the atmosphere set a new record, reaching 416 parts per million (ppm), an increase of 2.8 ppm over 2020. CO_2 accounts for about 75 percent of total greenhouse gas emissions. About 50 percent of greenhouse gases in the atmosphere were put there in only the last 30 years.

Global warming can only get worse. Most greenhouse gases already in the atmosphere will stay there indefinitely and are only removed by slow natural processes. Stopping emissions will stabilize but not decrease the earth's temperature.

Those who claim that we don't have to give up fossil fuels make the implicit assumption that we can discharge massive amounts of greenhouse gases into the atmosphere indefinitely.

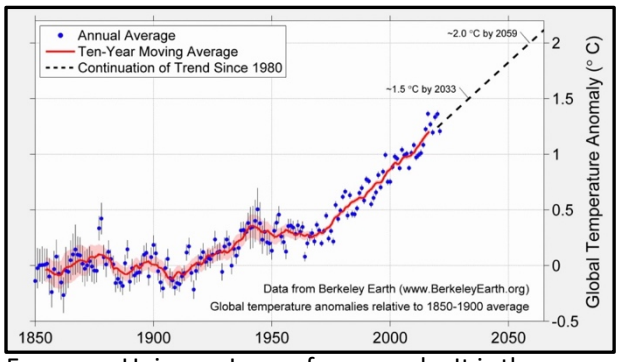
The ocean temperature is also increasing, but more slowly, about 0.8°C (1.4°F). The ocean is a huge heat sink and absorbs over 90 percent of the heat produced by global warming.

The sea level has risen an average of about 10 inches due to melting ice and thermal expansion of water in the warming ocean. The rate is about 1.5 inches every 10 years and accelerating.

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.

Fossil fuel use is responsible for about 75 percent of greenhouse gas emissions. Fossil fuels (coal, oil, and natural gas) account for most CO_2 emissions and a large share of methane and nitrous oxide emissions. Agriculture, mainly cattle raising, land use changes such as deforestation and some industrial processes account for most of the remainder.

China is the largest single source of greenhouse gas emissions, about 30 percent. The U.S. is the second largest at 15 percent. The U.S. was the largest for a very long time until surpassed by China in 2005. On a per capita basis, the U.S. is the largest emitter at 18 tons/person. This is over twice the per capita emissions of China, the



European Union or Japan, for example. It is three times the world average and ten times the per capita emissions of India.

Where are we headed?

The present forecast by the International Panel on Climate Change (IPCC) is for the earth's temperature increase to be from 2.2 to 3.5 °C (4.0 to 6.0 °F) by the end of this century based upon present trends. This is less than 80 years from now.

Sea level could to rise from between 1.0 to 3.0 feet by the end of this century.

Climate change

Increases in the atmosphere and ocean temperatures change the earth's climate.

Climate change is longer-term changes in the earth's weather such as over 30 years or more. It's difficult to differentiate between climate changes such as a severe storm or drought and normal weather changes. Was this drought due to climate change, or a 100-year event that has been recorded before, or some combination of both?

Even if emissions stop today, climate change will persist until the concentration of greenhouse gases in the atmosphere is slowly reduced by natural processes.

Global warming is directly responsible for rising temperatures, melting glaciers, heat waves and sea level rise. Climate change is responsible for droughts, more severe storms, and other weather effects.

The consequences of both global warming and climate change include infrastructure damage, water scarcity, floods, health problems, crop failures, migrations, and the collapse of ecosystems among other effects.

To stop global warming

The world must reach NET ZERO to stop global warming. NET ZERO is when there are no net emissions of carbon dioxide and other greenhouse gases, except those that are offset by artificial or natural means such as planting billions of trees. At present there are no artificial means to remove CO_2 or other greenhouse gases from the atmosphere.

The international goal is to reach NET ZERO by 2050 to limit global warming to 2.0 °C and preferably to 1.5 °C (3.6 to 2.2°F) (This objective was agreed to in the Paris Agreement signed by 195 countries in 2015. This goal is to keep the effects of global warming within tolerable limits.

It is very unlikely that NET ZERO can be achieved by 2050. The earth's temperature is likely to exceed 1.5 °C or even 2.0 °C.

Action plan

To stop global warming, the world needs to eliminate the use of fossil fuels and make significant changes in agriculture and deforestation and some industrial processes. There will be some need for liquid and gaseous fuels made from recycled CO_2 such as for aircraft and ocean shipping.

Renewable energy, mainly electricity from solar and wind farms, can supply all the energy the world needs without producing greenhouse gases. Renewables are already the cheapest source of energy in most locations. The cost of renewable energy continues to decline due to improving technology and economies of scale.

Major trends are in the right direction but not moving fast enough, such as the construction of many large solar and wind farms and aggressive efforts by all major automobile manufactures phase out gasoline and diesel-powered vehicles.

A global response by governments, industry and individuals is required. But, if we don't do the big things smaller actions won't make a significant difference. The following is required:

- Improve energy conservation and efficiency.
- Use electricity for power and heat wherever possible.
- Generate all electricity using renewable sources, mainly solar and wind.
- Expand transmission and distribution systems to get renewable energy from where it is best produced to where it is consumed.
- Use synthetic fuels and possibly hydrogen where necessary.
- Implement new agriculture techniques to reduce emissions such as from fertilizer use and cattle raising.
- Stop deforestation and plant billions of trees.
- Plan a smooth transition from fossil fuels to renewables to avoid price spikes and energy shortages.

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Solve the Global Climate Crisis, Elsevier, Oxford UK, 2020.