New UN report: Limiting global warming to 1.5 degrees Celsius requires deep decarbonization across all sectors

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Scientists from Berkeley Lab contributed to landmark climate change reports published between 2018 and 2022. Their work laid the foundation for a new Intergovernmental Panel on Climate Change report urging nations to cut greenhouse gas emissions in half by 2030. Top row, left to right: Bill Collins, Stephane de la Rue du Can, Nina Khanna. Bottom row, left to right: Charles Koven, Chaincy Kuo, Michael Wehner, Nan Zhou. Credit: Jenny Nuss/Berkeley Lab

Limiting global warming to 1.5 degrees Celsius above pre-industrial levels will require severely cutting greenhouse gas emissions in half by 2030. Doing so calls for the immediate, large-scale adoption of renewable energy like solar and wind, electrified transportation, energy-efficient systems, alternative fuels, and carbon capture and storage technologies across all sectors globally.

This is one of the key messages in the "Synthesis Report of the Sixth Assessment Report" released this week by the United Nations' Intergovernmental Panel on Climate Change (IPCC).

The synthesis report provides policymakers with the most up-to-date knowledge on climate change, including impacts and future risks along with strategies to mitigate those risks. It is based on the content of the Sixth Assessment Report, which includes three working group assessment reports and three special reports published between 2018 and 2022, with most of the work completed during the height of the pandemic.

Seven Lawrence Berkeley National Laboratory (Berkeley Lab) scientists contributed significantly to the Sixth Assessment Report's "Working Group 1—Physical Science Basis," "Working Group 3—Mitigation of Climate Change," and the special report "Global Warming of 1.5°C." They were among hundreds of researchers from 65 countries who together assessed tens of thousands of scientific publications and reviewed comments while writing the reports.

"We found that globally, greenhouse gas emissions are still on the rise. In order to reach a temperature target of 1.5 degrees Celsius, emissions need to peak before 2025 and be reduced by around 43% by 2030," said Nan Zhou, a senior staff scientist in Berkeley Lab's Energy Technologies Area.

Zhou is a lead author of the "Mitigation and Development Pathways in the Near- to Mid-Term" chapter of the Sixth Assessment Report. It shows how taking action now can slow down global warming and move societies toward a more equitable, livable world. "But it will be challenging to limit global warming to 1.5 degrees Celsius without drastically changing how we consume energy across all sectors and switching to renewable or cleaner low-carbon technologies soon," Zhou said.

Decarbonizing industry

Under the 2015 Paris climate agreement, nearly every nation agreed to hold global warming to 1.5 degrees Celsius. The world is already 1.1 degrees Celsius above pre-industrial levels as a consequence of "more than a century of burning fossil fuels," resulting in "more frequent and more intense extreme weather events," the IPCC said in a recent news release.

One major solution to prevent further warming involves decarbonization strategies for industry.

"We know that close to 50% of greenhouse gas emissions come from the production of chemicals, iron and steel, and cement," said Stephane de la Rue du Can, a lead author of the Sixth Assessment Report's industry chapter.

"To reduce greenhouse gas emissions from these sectors, we will need to completely change the way we produce materials and consume goods by using less cement and steel, developing different compositions of low-emissions cement, and enabling a circular economy by recycling more steel and developing recyclable plastics."

Decarbonizing the industrial sector will also necessitate incentives on top

of mitigation measures. "Benefits and opportunities will need to be transparent for workers who will be affected by the transition to a renewable industry, and decision makers will need to implement new policy regulations that would allow consumers to buy green steel or green concrete, and help us choose the lower carbon products," added de la Rue du Can.

The Sixth Assessment Report also describes how our societies' other sectors—including energy, transportation, urban planning, buildings, and land use—can cut their emissions in half by 2030.

For example, electric vehicles offer the greatest potential to globally reduce greenhouse gas emissions, as long as they are combined with low- or zero-carbon electricity sources, the Sixth Assessment says. Advances in battery technologies could assist in the electrification of trucks and enhance electric rail systems. Alternative fuels such as low-emission hydrogen and biofuels could also help to decarbonize the aviation and shipping industries.

Another Berkeley Lab researcher who contributed to the Sixth Assessment report is Nina Khanna, a principal scientific engineering associate in the Energy Technologies Area. Contributions by Zhou, de la Rue du Can, and Khanna are part of the "Working Group 3—Mitigation of Climate Change" report for the Sixth Assessment released in 2022.

Last year, Zhou became the technical program manager and de la Rue du Can became the South Africa coordinator for the U.S. Department of Energy's Net Zero World Action Center, which provides strategies to accelerate global energy decarbonization in support of the Net Zero World Initiative (NZWI). The center brings together 10 DOE national laboratories, nine U.S. government agencies, and a myriad of philanthropic organizations to promote net zero-emission energy systems around the world that are inclusive, equitable, and resilient.

Major advances provide the clearest picture yet of climate change

The Sixth Assessment Report also measures how the climate is changing by looking at the average temperature of the Earth's surface, and the levels of gases that trap heat in our atmosphere. These findings were released in 2021, in the "Working Group 1—Physical Science Basis" report.

"Our findings uphold the idea that the total warming from around 1850 until now is proportional to cumulative carbon dioxide emissions. That means that the faster we emit, the faster it's going to warm. And the more we emit, the more it's going to warm. And it doesn't matter where or when those emissions occur," because it still results in more warming, said Charles Koven, a staff scientist in Berkeley Lab's Earth and Environmental Sciences Area (EESA) and a lead author of the chapter on the carbon cycle.

Koven added, "But if we're able to reduce our emissions very rapidly, then the warming will also slow down. And if we're able to get to net zero emissions, then we expect any further warming to stop and stabilize almost immediately. "

In writing the chapter, Koven relied on global climate models to explore the dynamics between greenhouse gas emissions released by fossil fuels, the rise in global warming, and ecosystem disturbances like wildfires or melting permafrost that release carbon into the atmosphere and thus feed into climate change.

The Sixth Assessment Report is also the first time that short-lived climate forcers—which include substances such as aerosols, methane, black carbon, ozone, carbon monoxide, and hydrofluorocarbons (or

HFCs)—have had their own chapter in an IPCC report. Bill Collins, associate laboratory director of Berkeley Lab's Earth & Environmental Sciences Area, is a lead author on the chapter, and Berkeley Lab affiliate Chaincy Kuo is a contributing author and chapter scientist.

That chapter found that almost 40% of the warming caused by residential and commercial emissions are from HFCs, which are commonly used as refrigerants, such as in air-conditioning. "They have a very high global-warming potential," Kuo said in a news release from 2021. "That's a concern with global warming, with more people buying air conditioners in regions where they typically weren't needed, such as the Pacific Northwest in the United States."

Another Sixth Assessment chapter on extreme weather took advantage of sophisticated high-resolution models, a first in the history of IPCC reporting made possible by recent advances in computer modeling. (Some of the hurricane simulations for the report were performed at Berkeley Lab's National Energy Research Scientific Computing Center.)

These supercomputer-driven models show how extreme weather changes with climate change at regional levels all over the world, a new level of detail that will help regional planners develop climate adaptation policies in various sectors.

"Our results show that as global warming levels increase in various scenarios, from 1.5 degrees Celsius or 2 degrees Celsius or more, heat waves will be much worse, we will experience more frequent droughts, and precipitation events will be heavier in big storms.

The strongest storms like hurricanes and tropical cyclones will be stronger in terms of wind, storm surge, and associated damages in the relatively near future, depending on warming levels," said Michael Wehner, a senior scientist in Berkeley Lab's Applied Mathematics and

Computational Research Division and a lead author on the extreme weather chapter.

Wehner added, "We don't have to have a 2 degrees Celsius or 3 degrees Celsius warmer world if we act now to mitigate emissions. We need to recognize that dangerous climate change is already here. Our choice is how much dangerous we will allow it to become."

"All global pathways that limit warming to 1.5 degrees Celsius involve rapid and deep, and in most cases, immediate greenhouse gas emission reductions in all sectors. We can still pull this off, but we have to slam on every conceivable brake we can think of," said Collins. "There is no more delay built into the system. This has to happen right now."

More information: Synthesis report: www.ipcc.ch/ar6-syr/

Provided by Lawrence Berkeley National Laboratory

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