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Energy indices suggest that global temperatures could be kept below 2°C, consistent with the Paris Accord. However, without accelerated deployment of technologies for capturing atmospheric carbon and storing it underground and sustained growth in renewables such as wind and solar, the world will miss the 2°C target and the long-term goal of net-zero climate pollution.

The finding, published in the January 30 issue of the journal *Nature Climate Change*, is part of a new study that aims to track the progress and compare emission pledges of more than 150 nations that signed the Paris Agreement, a 2015 United Nations convention that aims to keep global warming below 2°C of pre-industrial levels.

“The good news is that fossil fuel emissions have been flat for three years in a row,” said Robert Jackson, chair of Stanford’s Department of Earth System Science. “Now we need actual reductions in global emissions and careful tracking of emission pledges and country level statistics.”

In the new study, Jackson and his colleagues developed a nested family of metrics that can be used to track different national emissions pledges and thus global progress toward reaching the objectives of the Paris Agreement.

When the researchers applied their method to the recent past, it revealed that global carbon dioxide emissions remained steady at around 36 gigatons of carbon dioxide for the third year in a row in 2016. While part of that slowdown can be attributed to the rapid deployment of wind and solar, most of it is due to economic factors and reduced coal use, mostly in China but also the United States.

In China, the coal reduction was driven by reduced output of cement, steel, and other energy-intensive products, and also a dire need to alleviate outdoor air pollution, which is responsible for more than 1 million premature deaths annually.

The reasons for the decline in the U.S. were more complex, driven not only by a decline in coal use, but also gains in energy efficiency in the industrial sector and the rapid rise of natural gas and wind and solar power. “2016 was the first year that natural gas surpassed coal for electricity generation,” said Jackson, who is also chair of the Global Carbon Project (globalcarbonproject.org), which tracks the amount of carbon dioxide emitted by humans each year.

Looking to the future, the researchers predict that the greatest challenge to meeting the goals of the Paris Agreement is the slower-than-expected rollout of carbon capture and storage technologies.

“Most scenarios suggest the need for thousands of facilities with Carbon Capture and Storage by 2030, and this compares with the tens currently proposed”, said Glen Peters, Senior Researcher at the Center for International Climate and Environmental Research – Oslo (CICERO) and lead author for the study.

Jackson notes that carbon capture and storage technology will be even more crucial if newly elected U.S. President Donald Trump sticks to his campaign pledge of resuscitating the nation’s struggling coal industry.

“There’s no way to reduce the carbon emissions associated with coal without carbon capture and storage,” Jackson said.

Jackson is also a senior fellow at the Stanford Woods Institute for the Environment and the Precourt Institute for Energy (jacksonlab.stanford.edu).

Other authors on the study, entitled “Key indicators to track current progress and future ambition of the Paris Agreement,” include Robbie Andrews and Jan Ivar Korsbakken of CICERO; Josep Canadell of the Global Carbon Project; Sabine Fuss of the Mercator Research Institute on Global Commons and Climate Change; Corinne Le Quéré of the University of East Anglia; and Nebojsa Nakicenovic of IIASA.

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