

Reaching negative CO₂ emissions

David Kramer's article "Negative carbon dioxide emissions" (PHYSICS TODAY, January 2020, page 44) provides an excellent overview of the pros and cons of several climate-ameliorating interventions in the global carbon cycle. But it overlooks what ought to be at the top of our list: protection of natural carbon sinks.

Over the past decade, natural sinks have removed from the atmosphere about 5 gigatons of carbon per year, with approximately three-fifths going to the oceans and the rest to terrestrial ecosystems. That removal rate is about one-half of annual anthropogenic emissions worldwide. And nature does it for free!

That natural sink strength is far greater and far cheaper than any engineered scheme can promise to deliver over the coming two or three decades. If the strength is maintained, a 50% reduction in today's emissions would stabilize atmospheric carbon dioxide; with a fur-

ther reduction in emissions, atmospheric levels would decline over time, albeit at an ever-decreasing rate.

Unfortunately, natural sinks are threatened today by a combination of deforestation, soil erosion, ocean acidification, agricultural malpractices on prime land, increasing exploitation of poorer quality lands for food production, and climate change itself. Yet on farmland, protection and augmentation of natural sinks can even increase crop yields.

The most important thing we can do to sequester carbon is to prevent the degradation of existing, priceless, and cost-free natural sinks. Combined with rapid deployment of renewable energy, they might give us a chance to prevent climate catastrophe.

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I appreciate David Kramer's informative article "Negative carbon dioxide emissions" (PHYSICS TODAY, January 2020, page 44). It appears that negative emission technology (NET) will be needed. However, I am puzzled by one phrase—"achieving Paris goals without retarding economic growth." Isn't it obvious that perpetual economic growth in our finite terrarium/aquarium is not possible? Long-time PHYSICS TODAY readers will remember several items by Albert Bartlett about exponential growth (see, for example, PHYSICS TODAY, July 2004, page 53, and March 1994, page 92). Such growth—economic and other—is a primary driver of increasing carbon dioxide emissions and thus of climate change.

Kramer quotes Julio Friedmann: "We have to create an industry the size of the oil and gas industry that runs in reverse." The oil and gas industry generates its output to make a profit. The "reverse output" of the NET industry—tens of gigatons of CO₂ sequestered annually—is not a marketable product to be sold for up to \$100 per ton. A carbon fee may be needed to fund NET.

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