

Crisis management: Seven ways to engineer climate

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Credit: public domain

Dismissed a decade ago as far-fetched and dangerous, schemes to tame global warming by engineering the climate have migrated from the margins of policy debates towards centre stage.

"Plan A" remains tackling the problem at its source. But a major UN climate science report released in South Korea on Monday makes it clear that slashing carbon pollution—even drastically—won't be enough to keep Earth from seriously overheating.

Here, then, is a menu of "Plan B" geo-engineering solutions:

Direct CO₂ capture

Experiments have shown it is possible to suck carbon dioxide directly from the air, converting it into fuel pellets or storing it underground.

A Canadian company backed by Microsoft co-founder Bill Gates launched a pilot facility in Canada in 2015, and another company unveiled one in Iceland earlier this year.

DRAWBACK: As of now, the technology is prohibitively expensive and cannot operate at scale.

Massive afforestation

Extensive planting of trees could significantly slow the concentration of CO₂ in the atmosphere, which currently stands at more than 400 parts per million.

DRAWBACK: Even if deforestation could be reversed—millions of hectares of tropical forests still disappear each year—the number of trees needed to put a dent in CO₂ emissions would clash with food and [biofuel crops](#).

BECCS

Bioenergy with carbon capture and storage (BECCS) marries a natural process with a high-tech one.

Step 1: Plant rapeseed, sugarcane, corn or "second-generation" biofuel crops such as switchgrass, which pull CO₂ from the air while growing.

Step 2: While burning the harvested plants for energy, sequester the CO₂ produced.

The result is "negative emissions", with less CO₂ in the atmosphere than when the process started.

Virtually all climate change models projecting a future consistent with the Paris Agreement's target of capping [global warming](#) at "well below" two degrees Celsius (3.6 degrees Fahrenheit), or 1.5C if possible, assume a key role for BECCS.

DRAWBACK: Studies calculate that upward of 40 percent of arable land—twice the area of India—would need to be given over to biofuel crops, putting the scheme in conflict with food crops.

Ocean fertilisation

Microscopic ocean plants called phytoplankton gobble up CO₂ and drag it to the bottom of the ocean when they die.

Their colony size is limited by a lack of natural iron, but experiments have shown that sowing the ocean with iron sulphate powder creates large blooms.

DRAWBACKS: Scientists worry about unintended impacts. Die-offs of plankton, for example, use up oxygen, which could create massive "dead zones" in the oceans, something already on the rise.

Enhanced weathering

Natural weathering of rocks—a chemical process—removes about one billion tonnes of CO₂ from the atmosphere every year, about two percent of total man-made CO₂ emissions. What if technology could accelerate that process?

Spreading a powdered form of a greenish iron silicate called olivine across certain landscapes—especially over the oceans and in the tropics—does just that, experiments have shown.

DRAWBACKS: Enhanced weathering could probably be rapidly scaled up, but it would be expensive to mine and mill enough olivine to make a difference.

Biochar

Biochar is charcoal made by heating plant waste—rice straw, peanut shells, wood scraps—over long periods in low-oxygen conditions, for example buried in the ground. It can store CO₂ for long periods, and also enriches soil.

DRAWBACK: The scientific jury is still out on how quickly this method could be scaled up, and on the stability of biochar used as a fertiliser.

Solar radiation management

Unlike other strategies, solar radiation management does not target CO₂. The goal is simple: prevent some of the sun's rays from hitting the planet's surface, forcing them back up into space.

One idea is to inject or spray tiny reflective particles into the stratosphere—possible with balloons, aircraft or through giant tubes.

Nature sometimes does the same: Debris from the 1991 eruption of Mount Pinatubo in the Philippines lowered the planet's average surface temperature for a year or two afterwards.

Scientists have also calculated ways to alter clouds that could help beat the heat. One is to brighten the white, billowy ocean clouds that reflect sunlight. Another would thin cirrus clouds, which unlike other types absorb more heat than they reflect.

DRAWBACKS: Even if it works as intended, solar radiation management would do nothing to reduce atmospheric CO₂, which is making oceans too acidic. There is also the danger of knock-on consequences, including changes in rainfall patterns, and what scientists call "termination shock"—a sudden warming if the system were to fail.

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