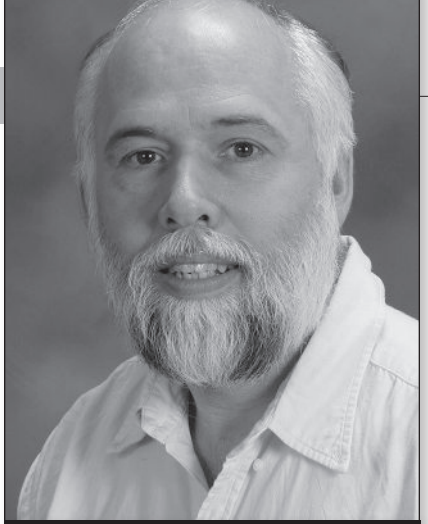
Geoengineering & Hubris: Altering Gargantuan Natural Flows of Energy



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I am a subversive environmental radical. I believe in the First Law of Thermodynamics, and for that matter, Quantum Mechanics. To relax in the evening, I sometimes enjoy a little nip of Physical Chemistry.

As carbon dioxide levels climb unabated, climate scientists and scientific organizations are increasingly researching, and sometimes even promoting geoengineering. Schemes proposed include reflecting incoming sunlight with small mirrors high in the atmosphere, building industrial facilities that capture carbon and sequester it deep underground, fertilizing the ocean and thereby sequestering energy in dead biomass at the bottom of the oceans, and seeding the atmosphere with sulfur aerosols or other particles to reflect incoming sunlight. Not so fast.

Geoengineering will entail creating new human institutions to control, divert, capture, and/or sequester absolutely immense amounts of energy. From the viewpoint of thermodynamics, all human societies and institutions — including the first complex society at Sumer, the U.S. government, a for-profit corporation like Monsanto, a local Congregational Church, and a family — are but machines that intake energy, use that energy to maintain the internal structure of the institution, and produce waste products and perhaps also useful output. Human institutions are like other things that intake and transform energy, for example automobiles, corn plants, and hurricanes.

In one year, the 7.5 billion humans on Earth use an almost inconceivable amount of energy: 600,000,000,000,000,000,000 joules. The vast majority of that comes from coal, oil, and natural gas, which when burned releases carbon dioxide.

Astonishingly, when we burn fossil fuels containing 1 joule, the Earth heats up by more than 10 joules. Those extra joules are the increased heat in Earth's atmosphere that arises because when we burn fossil fuels, we release carbon dioxide that absorbs thermal longwave radiation.

Sunlight hitting the Earth and its atmosphere contains energy. We know for absolute sure this incoming energy goes somewhere. Energy never disappears. The intransigent and totally uncompromising First Law of Thermodynamics demands conservation of energy.

In fact, the incoming sunlight gets transformed in the atmosphere, in the oceans, and on the surface of the Earth to other forms of energy, especially heat and thermal longwave radiation. When that thermal longwave radiation tries to escape the Earth, it is blocked by carbon dioxide, in ways quantum mechanics helps us understand. Specifically, carbon dioxide absorbs longwave radiation and then just reemits it as different longwave radiation. No big deal, except half of what is re-emitted is diverted from outer space, where it would do no harm, and is instead sent right back down to Earth's surface.

Why manipulate an unpredictable natural system rather than a predictable human one?

It gets worse. Human use of energy is minuscule in comparison to Earth's natural energy flows. As laid out by Ralph Cirerone in his 2000 paper in the *Proceedings of the National Academy of Sciences*, total natural energy flows in the Earth and its atmosphere that ultimately derive from incoming sunlight are more than 1,000 times greater than the energy flows that drive human civilization. For every 1 joule we capture and divert for human use from fossil fuels and other sources, we alter natural energy flows by the previously mentioned 10 joules, out of total natural energy flow of more than 1,000 joules. So geoengineering starts from way behind to begin with.

Remarkably, even that is not the end of the problems with geoengineering. Those coal-fired power plants, electric grids, internal combustion engines, and other devices of our fossil-fuel-based society are designed to be predictable, so you can control them. Engineers try to stay off the front page of the *New York Times*.

By contrast, weather and climate are inherently unpredictable (as the climate deniers repeatedly remind us). Indeed, Edward Lorenz's seminal 1963 paper on chaos sought to understand why weather (and by extension climate) is so unpredictable.

Why manipulate a natural system that is the quintessential example of unpredictability, when the alternative is to manipulate energy systems that humans have designed, built, and operate so as to be predictable?

In the *Collapse of Complex Societies,* Joseph Tainter shows how past civilizations have attempted to fix the problems of growth by becoming ever more complex, right up to when the society is so complex through its layers of interactions that it is vulnerable to collapse. Geoengineering could well be the ultimate stage in human complexity, the one that presages the beginning of the end of global society. And given the scale of what's required, it can't succeed anyway.