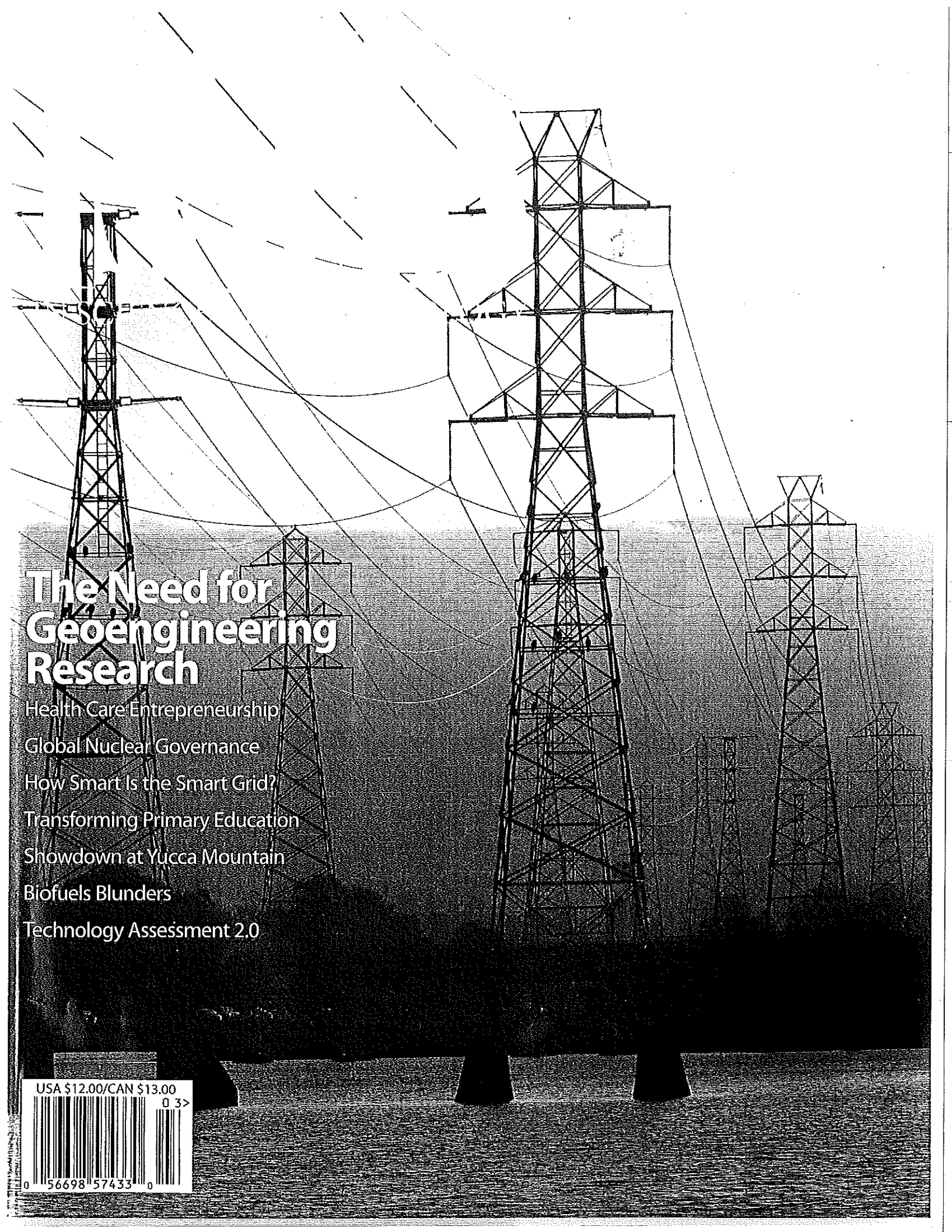


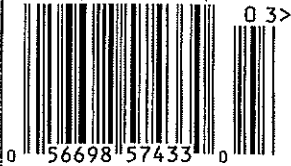


The Need for Geoengineering Research

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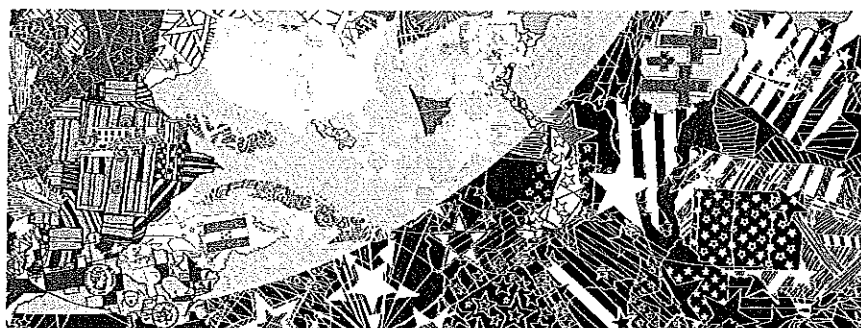
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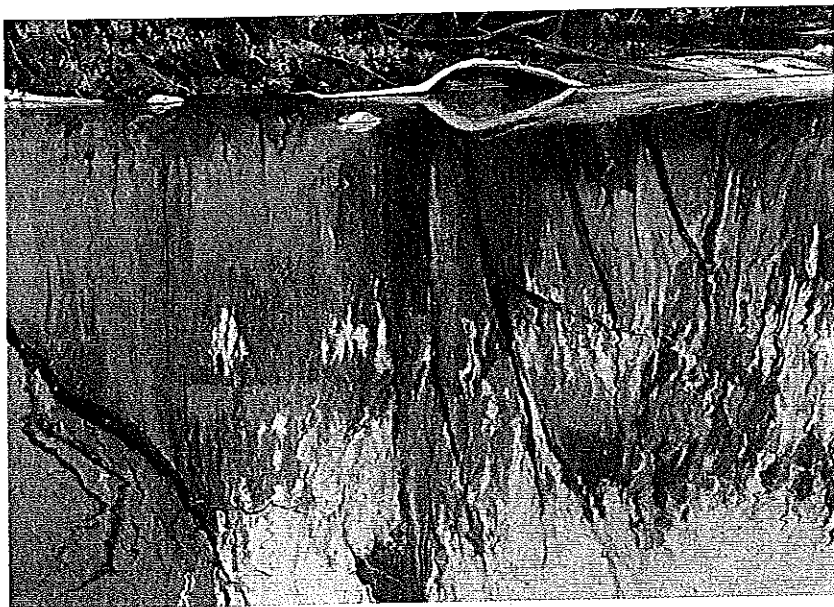
Perspective

ART



Above: Benjamin Volta, Tectonic Quilt (detail).

Cover: Brian Wallace, High Tension Sunset (detail), from the Tracing Lines Project



DIANE BURKO, *Wissahickon Reflections: East Frieze, #1*, Oil on canvas, 65 x 92 inches, 1997.

two-week workshops in DC each summer that give young scientists and engineers a first look at the complexities of political decisionmaking.

Through my experience with these programs, I agree with Marburger that perhaps the most important lesson scientists can learn about policymaking is that the scientific method is not the only way to arrive at a decision. The scientific method is an incredibly valuable tool, but in many policy decisions it can only assist; it cannot determine. This understanding is especially important because scientists who disregard it can undermine the "charisma" that Marburger deems so important for the authority of scientists.

In addition to the good track record that Marburger credits, social scientists argue that a key source of the charisma of scientists is that they are often seen as free from the "contamination" of politics. Sociologist Thomas Merton argued that one of the main reasons why science is a unique form of knowledge is that its practitioners adhere to the norm of disinterestedness. This idea resonates with the public.

Unlike politicians, scientists aren't supposed to have an agenda and therefore can be trusted. Scientists simply want to better understand the world and refuse to let prejudice or personal gain distract from that goal. Political scientist Yaron Ezrahi has written extensively about how useful it can be for politicians to cite the objectivity of science to justify a policy choice, rather than arguing one subjective value over another.

There are times, however, when citizens do not see scientists as objective. When scientific consensus does not support a potential policy, those promoting the policy sometimes question the disinterestedness of scientists. But the perception of bias can also occur when scientists make arguments that extend beyond scientific knowledge. The scientific method cannot be used to determine what types of stem cell research are ethical or how international climate change agreements should be organized. Scientists as citizens certainly should have a say in such matters, but when the public sees scientists as an interest group, the

charisma that stems from the ideals of disinterestedness is reduced. Scientists who understand the nuances of the policy process develop ways of balancing these roles. They can speak to what science knows and to what they think is best for the country without conflating the two.

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Can geoengineering be green?

In their provocative article, "Pursuing Geoengineering for Atmospheric Restoration," Robert B. Jackson and James Salzman put forth a new objective for the management of Earth. Atmospheric restoration would return the atmosphere "ultimately to its preindustrial condition." The authors are

persuaded that the only responses to climate change are compensation and restoration, and they deeply dislike compensating for a changed atmosphere with other forms of planetary manipulation, notably injecting aerosols into the upper atmosphere.

For the foreseeable future, however, the active pursuit of atmospheric restoration would be a misallocation of resources. It is inappropriate to undertake removal of carbon dioxide (CO₂) from the atmosphere with chemicals at the same time as the world's power plants are pouring CO₂ into the atmosphere through their smokestacks—in the case of coal plants, at a 300 times greater concentration. First things first. Priority must be given to capture of CO₂ emissions at all fossil fuel power plants that the world is not prepared to shut down. As for biological strategies for CO₂ removal from the atmosphere, early deployment is appropriate in limited instances, especially where forests can be restored and land and soil reclaimed. But biological strategies quickly confront land constraints.

CO₂ capture from the atmosphere with chemicals may become a significant activity several decades from now. The cost of CO₂ capture from the atmosphere is highly likely to be lower at that time than it is are today. This will be a side benefit of R&D that is urgently needed now to lower the costs of capture from power plants.

Even at some future time when CO₂ capture from the atmosphere with chemicals becomes feasible, restoration of the atmosphere is a flawed objective. Imagine success. For every carbon atom extracted as coal, oil, or gas during the fossil fuel era, an extra carbon atom would be found either in the planet's biomass, in inorganic form on land or in the ocean, or tucked back into the earth deep below ground via

geological sequestration. But unless all the carbon atoms were in underground formations, the world's lands and oceans would differ from their preindustrial predecessors. Why not restore the lands and oceans as well? Why privilege the atmosphere?

Robert Solow, in a famous talk in 1991 at Woods Hole Oceanographic Institute, provided a vocabulary for dealing with such objectives, invoking strong and weak sustainability. Strong sustainability demands that nothing change. Weak sustainability allows only change that is accompanied by new knowledge that enables our species to function as well in a changed world as in the world before the changes.

Strong sustainability everywhere is impossible. Strong sustainability in selective areas of life while other areas are allowed to change fundamentally is myopic and self-defeating. But the embrace of weak sustainability has its own perils: It readily leads to complacency and self-indulgence. We should not even aspire to atmospheric restoration. This single task could well commandeer all our creativity and all our wealth. A much more diverse response to the threat of climate change is required. It would be more productive for us to acknowledge that we cannot leave this small planet unchanged, but also that we are obligated to invent the policies, technologies, behaviors, and values that will enable our successors to prosper.

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Since the word "geoengineering" was first introduced by Cesar Marchetti in 1973, the technologies embraced under this heading have attracted both

apprehension and curiosity: apprehension about tinkering with Earth's climate system on a grand scale and curiosity about whether there might indeed be a technical fix for the human addiction to fossil fuels. Robert B. Jackson and James Salzman suggest that we can distinguish between good geoengineering and bad geoengineering. They write of the "promise and peril of geoengineering" and of the "risks and uncertainties." They then suggest that there are three types of geoengineering that potentially offer "the greatest climate benefits with the smallest chance of unintentional harm."

Jackson and Salzman thus convey some level of acceptance of geoengineering, and yet they pick delicately from the menu of geoengineering options. Their selections (combined with reducing emissions) focus on "atmospheric restoration" with technologies that meet the criteria of treating the causes of climate change rather than the symptoms, minimizing the chance of harm, and having what they believe to be the highest probability of public acceptance. Previous analysts have looked for technologies that could be implemented incrementally and could be halted promptly if the results were unacceptable.

The first choice of Jackson and Salzman is forest protection and restoration. This seems to me to be a no-brainer, with multiple benefits; but it really hardly qualifies as geoengineering, and it does not fully confront the problem of burgeoning greenhouse gas emissions from fossil fuel combustion. It is nonetheless widely agreed that we should be pursuing this goal for many reasons.

Jackson and Salzman then give limited endorsement to research on the industrial removal of CO₂ from the atmosphere and the development of bioenergy, combined with carbon cap-