A Climate Repair Manual

Global warming is a reality. Innovation in energy technology and policy are sorely needed if we are to cope BY GARY STIX

OVERVIEW

- New reports pile up each month about the perils of climate change, including threats to marine life, increases in wildfires, even more virulent poison ivy.
- Implementing initiatives to stem global warming will prove more of a challenge than the Manhattan Project.
- Leading thinkers detail their ideas in the articles that follow for deploying energy technologies to decarbonize the planet.

Explorers attempted and mostly failed over the centuries to establish a pathway from the Atlantic to the Pacific through the icebound North, a quest often punctuated by starvation and scurvy. Yet within just 40 years, and maybe many fewer, an ascending thermometer will likely mean that the maritime dream of Sir Francis Drake and Captain James Cook will turn into an actual route of commerce that competes with the Panama Canal.

The term "glacial change" has taken on a meaning opposite to its common usage. Yet in reality, Arctic shipping lanes would count as one of the more benign effects of accelerated climate change. The repercussions of melting glaciers, disruptions in the Gulf Stream and record heat waves edge toward the apocalyptic: floods, pestilence, hurricanes, droughts—even itchier cases of poison ivy. Month after month, reports mount of the deleterious effects of rising carbon levels. One recent study chronicled threats to coral and other marine organisms, another a big upswing in major wildfires in the western U.S. that have resulted because of warming.

The debate on global warming is over. Present levels of carbon dioxide—nearing 400 parts per million (ppm) in the earth's atmosphere—are higher than they have been at any time in the past 650,000 years and could easily surpass 500 ppm by the year 2050 without radical intervention.

The earth requires greenhouse gases, including water vapor, carbon dioxide and methane, to prevent some of the heat from the received solar radiation from escaping back into space, thus keeping the planet hospitable for protozoa, Shetland ponies and Lindsay Lohan. But too much of a good thing—in particular, carbon dioxide from SUVs and local coal-fired utilities—is causing a steady uptick in the thermometer. Almost all of the 20 hottest years on record have occurred since the 1980s.

No one knows exactly what will happen if things are left unchecked—the exact date when a polar ice sheet will complete a phase change from solid to liquid cannot be foreseen with precision, which is why the Bush ad-

Carbon emissions are heating the earth.

CARY WOLINSKY (*photograph*); JEN CHRISTIANSEN (*photo/illustration*)

ministration and warming-skeptical public-interest groups still carry on about the uncertainties of climate change. But no climatologist wants to test what will arise if carbon dioxide levels drift much higher than 500 ppm.

A League of Rations

PREVENTING the transformation of the earth's atmosphere from greenhouse to unconstrained hothouse represents arguably the most imposing scientific and technical challenge that humanity has ever faced. Sustained marshaling of cross-border engineering and political resources over the course of a century or more to check the rise of carbon emissions makes a moon mission or a Manhattan Project appear comparatively straightforward.

Climate change compels a massive restructuring of the world's energy economy. Worries over fossil-fuel supplies reach crisis proportions only when safeguarding the climate is taken into account. Even if oil production peaks soon—a debatable contention given Canada's oil sands, Venezuela's heavy oil and other reserves—coal and its derivatives could tide the earth over for more than a century. But fossil fuels, which account for 80 percent of the world's energy usage, become a liability if a global carbon budget has to be set.

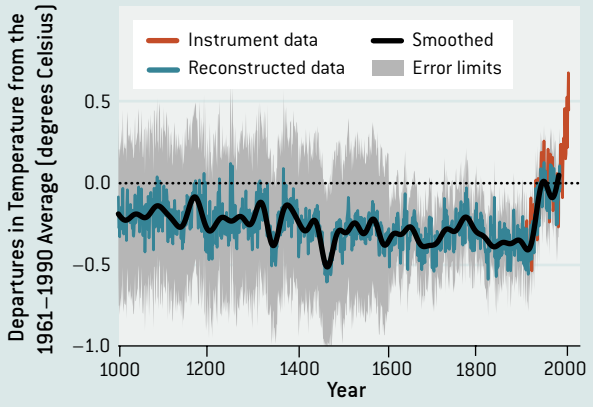
Translation of scientific consensus on climate change into a consensus on what should be done about it carries the debate into the type of political minefield that has often undercut attempts at international governance since the League of Nations. The U.S. holds less than 5 percent of the world's population but produces nearly 25 percent of carbon emissions and has played the role of saboteur by failing to ratify the Kyoto Protocol and commit to reducing greenhouse gas emissions to 7 percent below 1990 levels.

Yet one of the main sticking points for the U.S.—the absence from that accord of a requirement that developing countries agree to firm emission limits—looms as even more of an obstacle as a successor agreement is contemplated to take effect when Kyoto expires in 2012. The torrid economic growth of China and India will elicit calls from industrial nations for restraints on emissions, which will again be met by even more adamant retorts that citizens of Shenzhen and Hyderabad should have the same opportunities to build their economies that those of Detroit and Frankfurt once did.

Kyoto may have been a necessary first step, if only because it lit up the pitted road that lies ahead. But stabilization of carbon emissions will require a more

THE HEAT IS ON

A U.S. senator has called global warming the "greatest hoax" ever foisted on the American people. But despite persistently strident rhetoric, skeptics are having an ever harder time making their arguments: scientific support for warming continues to grow.

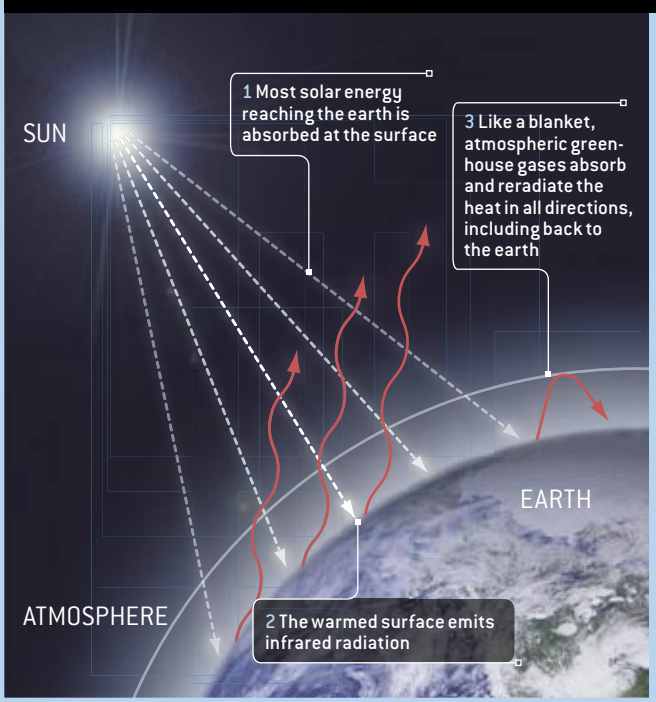


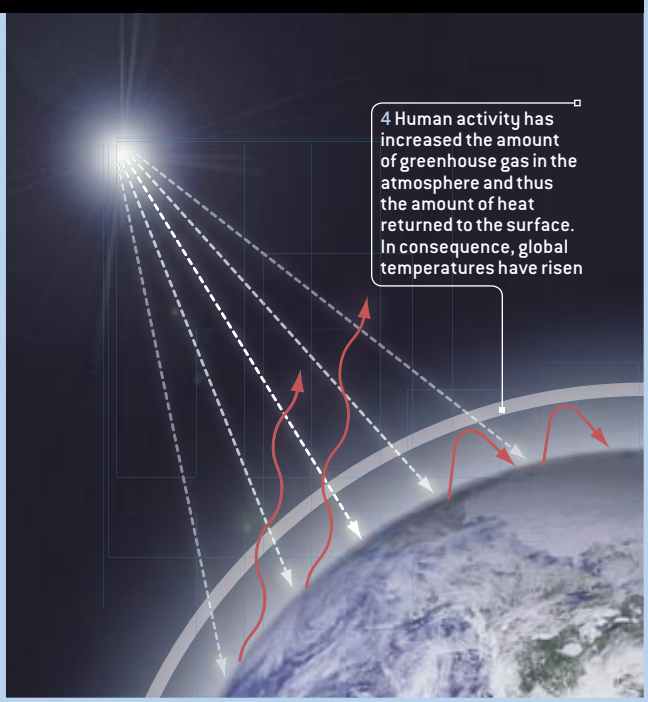
This "hockey stick graph," from one of many studies showing a recent sharp increase in average temperatures, received criticism from warming skeptics, who questioned the underlying data. A report released in June by the National Research Council lends new credence to the sticklike trend line that traces an upward path of temperatures during the 20th century.

A line of SUVs symbolizes high per-capita U.S. energy consumption. But rising expectations pervade the developing world. Many Chinese dream of trading a bicycle for a car.

GREENHOUSE EFFECT

A prerequisite for life on earth, the greenhouse effect occurs when infrared radiation (heat) is retained within the atmosphere.





JEN CHRISTIANSEN, SOURCE: *IPCC THIRD ASSESSMENT REPORT* (*graph*); RICHARD MICHAEL PRUITT *Dallas Morning News/Corbis* (*SUVs*); FREDERIC J. BROWN *AFP/Getty Images* (*China*); LUCY READING-IKKANDA (*illustrations*)

tangible blueprint for nurturing further economic growth while building a decarbonized energy infrastructure. An oil company's "Beyond Petroleum" slogans will not suffice.

Industry groups advocating nuclear power and clean coal have stepped forward to offer single-solution visions of clean energy. But too much devoted too early to any one technology could yield the wrong fix and derail momentum toward a sustainable agenda for decarbonization. Portfolio diversification underlies a plan laid out by Robert H. Socolow and Stephen W. Pacala in this single-topic edition of *Scientific American*. The two Princeton University professors describe how deployment of a basket of technologies and strategies can stabilize carbon emissions by midcentury.

Perhaps a solar cell breakthrough will usher in the photovoltaic age, allowing both a steel plant and a cell phone user to derive all needed watts from a single source. But if that does not happen—and it probably won't—many technologies (biofuels, solar, hydrogen and nuclear) will be required to achieve a low-carbon energy supply. All these approaches are profiled by leading experts in this special issue, as are more radical ideas, such as solar power plants in outer space and fusion generators, which may come into play should today's seers prove myopic 50 years hence.

▲ Then and now: Sunset Glacier in Alaska's Denali National Park, shown covering a mountainside in August 1939, had all but vanished 65 years later when photographed during the same month.

No More Business as Usual

PLANNING in 50- or 100-year increments is perhaps an impossible dream. The slim hope for keeping atmospheric carbon below 500 ppm hinges on aggressive programs of energy efficiency instituted by national governments. To go beyond what climate specialists call the "business as usual" scenario, the U.S. must follow Europe and even some of its own state governments in instituting new policies that affix a price on carbon—whether in the form of a tax on emissions or in a cap-and-trade system (emission allowances that are capped in aggregate at a certain level and then traded in open markets). These steps can furnish the breathing space to establish the defense-scale research programs needed to cultivate fossil fuel alternatives. The current federal policy vacuum has prompted a group of eastern states to develop their own cap-and-trade program under the banner of the Regional Greenhouse Gas Initiative.

Fifty-year time frames are planning horizons for futurists, not pragmatic policymakers. Maybe a miraculous new energy technology will simultaneously solve our energy and climate problems during that time, but another scenario is at least as likely: a perceived failure of Kyoto or international bickering over climate questions could foster the burning of abundant coal for electricity and synthetic fuels for transportation, both without meaningful checks on carbon emissions.

A steady chorus of skeptics continues to cast doubt on the massive peer-reviewed scientific literature that forms the cornerstone for a consensus on global warming. "They call it pollution; we call it life," intones a Competitive Enterprise Institute advertisement on the merits of carbon dioxide. Uncertainties about the extent and pace of warming will undoubtedly persist. But the consequences of inaction could be worse than the feared economic damage that has bred overcaution. If we wait for an ice cap to vanish, it will simply be too late. SA

MORE TO EXPLORE

The End of Oil: On the Edge of a Perilous New World. Paul Roberts. Houghton Mifflin, 2004.

Kicking the Carbon Habit. William Sweet. Columbia University Press, 2006.

An Inconvenient Truth. Al Gore. Rodale, 2006.

McINTYRE *AP Photo/National Park Service (top)*; R. D. KARPILO *AP Photo/National Park Service (bottom)*