The heat is on

Scientific understanding of the causes and risks of climate change is clearer than ever, but is it enough to change the public's behavior?

As they recognize 50 years of atmospheric carbon dioxide records, experts say potential solutions are within reach

This illustration shows a comparison between the 2005 and 2007 minimum sea ice extent. The state of California, shown in outline form, is compared to the area of melted region. The 2007 Arctic summer sea ice has reached the lowest extent of perennial ice cover on record, about 23 less than the previous low set in 2005. Additionally, the 2007 minimum, reached on Sept. 14, is about 38 percent lower than the climatological average. Such a dramatic loss has implications for ecology, climate and industry.

Courtesy NASA

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By Clint Talbott
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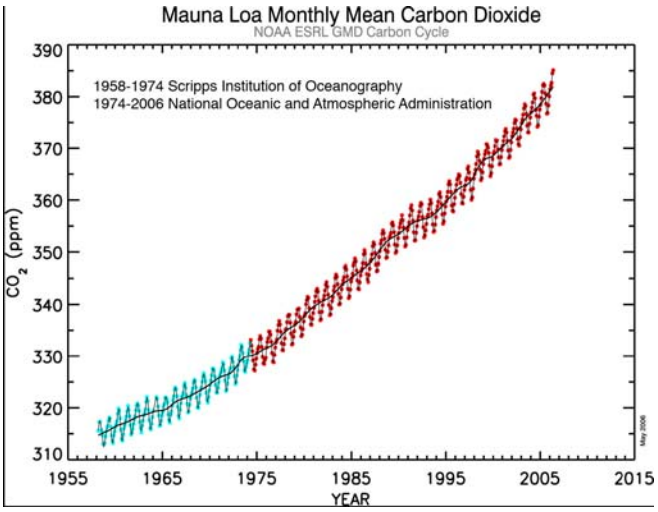
When humanity attacks a global environmental problem, it can succeed. The record shows this. Exhibit A is the Montreal Protocol, an international pact that required sharp restrictions on chemicals that deplete stratospheric ozone, which intercepts dangerous ultraviolet radiation.

The Montreal Protocol is often cited as a beacon of hope in the context of human-caused climate change. The world surmounted that environmental crisis, so surely it can do so again. So say the optimists.

But there are key differences between human-induced ozone depletion and climate change. One is that confronting climate change is significantly more complex.



And while the stakes are higher than ever, there is no concomitant unanimity about the urgent need to act.

That incongruity stems from public confusion about the extent of the climate crisis and, perhaps, a sense of helplessness about the prospects for changing course.

The gulf between public and expert scientific understanding of climate change was evident at a recent symposium marking the 50th anniversary of the global carbon dioxide record. At the symposium, held near the Mauna Loa Observatory in Hawaii (which has carefully tracked atmospheric CO2 for five decades), leaders in science, business and politics discussed a wide array of attainable strategies to cut greenhouse-gas emissions.

But citizens (and their elected representatives) are unlikely to act quickly and decisively until most of them see climate change for what it is: dangerous and accelerating. In the United States, many simply do not grasp this.

In a recent survey, 68 percent of Americans said they supported a strong, international treaty to replace the Kyoto Protocol, which expires in 2012. While that's encouraging, only about half of U.S. respondents said they were personally concerned about climate change.

The survey, which was conducted by Yale University, Gallup and the ClearVision Institute, indicates growing concern about climate change. But it also reveals the depth of public confusion about the best, peer-reviewed climate research. Only 48 percent of Americans believe there is scientific consensus about the causes of climate change. Only 40 percent believe there is scientific consensus that warming is, in fact, occurring.

As the Intergovernmental Panel on Climate Change stated this year, warming is "unequivocal." And, the IPCC concluded, most of the observed increases in globally averaged temperatures in recent decades is "very likely due to the observed increase in anthropogenic greenhouse-gas concentrations." (See http://www.ipcc.ch/).

In this context, "very likely" is calibrated language, and it means the likelihood that humans are driving much of the observed changes in climate is at least 90 percent.

What is known

The best available science tells us much more about the state of the planet.

Atmospheric concentration of carbon dioxide is now 383 parts per million. Before the industrial revolution, it was about 280 ppm. Analysis of ice cores indicates that today's CO2 concentration is significantly higher than at any point in the last 650,000 years.

The atmospheric concentration of CO2 has increased because humans have emitted about 770 billion tons of carbon dioxide - by burning fossil fuels that had been underground.

As atmospheric CO2 has risen, global land and sea temperatures have risen correspondingly. Global average temperatures are 0.76 degrees Celsius warmer than in the latter half of the 19th century. Eleven of the last 12 years have been in the dozen warmest since 1850.

(Yet somehow, 40 percent of Americans believe there is "a lot of disagreement" about the very existence of global warming, an empirical fact.)

Arctic temperatures have risen twice as fast as the global rate. Average annual Arctic sea ice (on which polar bears depend) has shrunk by 2.7 percent per decade. Summertime sea ice has decreased 7.4 percent per decade. This year's value of Arctic summertime sea ice minimum, which occurs in September, shattered the previous record for the month, set in 2005, by 23 percent. Additionally, it was far lower than any climate model predicted.

Ocean levels are rising; the total 20th-century rise was 0.17 meters. And oceans are becoming more acidic.

The climate forecast calls for more of the same. Sea level is expected to rise 0.2 to 0.6 meters by the end of the century. That amount of increase could be conservative, however, as the dynamics of ice sheets (like that of Greenland, whose ice-melt this year was 10-percent greater than any other on record) are not fully understood. (See nsidc.org and cires.colorado.edu).

By the end of the century, the oceans are expected to become even more acidic - a trend that has grave implications for the food chain. On land, there will probably be more heat waves and extreme storms. Hurricanes and cyclones are expected to gain more intensity. Land at mid-latitudes is expected to get drier (causing new struggles for food and water).

Managing risk

For those and other reasons, human-caused climate change is rightly viewed by the U.S. military as an issue of national security. Paul G. Gaffney II, a retired naval vice admiral, was on a military advisory board for a recent report called "National Security and the Threat of Climate Change." The report was produced by the CNA Corporation for use by policy-makers. (See securityandclimate.cna.org/report).

Gaffney addressed last month's symposium, which was organized by the National Oceanic and Atmospheric Administration in Boulder.

Gaffney noted that some threats posed by rapid climate change may be uncertain, but the potential impact is high. Gaffney quoted a fellow member of the military advisory board, Army Gen. Gordon R. Sullivan, who said: "You never have 100-percent certainty. If you wait until you have 100-percent certainty, something bad is going to happen on the battlefield. That's something we know."

The battlefield lesson applies to climate change, Gaffney said. In Africa, Asia, the Mideast and the Americas, climate change could precipitate food and water shortages, coastal flooding, the spread of infectious disease and even armed conflict.

The U.S. military, he noted, needs to plan accordingly.

What is 'safe'?

Richard C.J. Somerville, a coordinating lead author for the IPCC and distinguished professor emeritus at the Scripps Institution of Oceanography, noted that IPCC is policy-neutral, but that individual scientist-contributors are free to espouse policy.

Somerville, an expert in computer simulations of the atmosphere, cited the unexpectedly rapid decrease of Arctic sea ice and other observations. Previous climate projections cited by the IPCC have not, he said, exaggerated the coming changes and may have under-estimated them, "in particular for sea level."

For those and other reasons, Somerville advocated a global treaty that aims to limit global warming to 2 degrees Celsius above pre-industrial averages. That goal, which has already been adopted by the European Union, would require cutting global greenhouse-gas emissions by at least 50 percent below 1990 levels by the year 2050.

To reach that goal – and keep CO2 concentrations below 450 ppm – global GHG emissions must peak and decline within the next 15 years. Thus, Somerville noted, "this is urgent."

Somerville and more than 200 of the world's leading climate scientists signed the "2007 Bali Declaration," which espoused the same goals. That declaration was released during this month's U.N. Climate Change Conference in Bali. (See http://www.climate.unsw.edu.au/bali).

A key point in the Bali negotiations is how to determine (and who determines) when human-caused climate change becomes "dangerous." Ralph Cicerone, president of the National Academy of Sciences, made this point during the Hawaii symposium.

The U.N. Framework Convention on Climate Change, forged in 1992, aims to stabilize atmospheric greenhouse gases at a level that would "prevent dangerous anthropogenic interference with the climate system."

Cicerone noted the difficulty of defining "dangerous," particularly given the uncertainty about the magnitude of future climate change. One possibility is to link "danger" with irreversible change, such as the loss of biodiversity, he said.

Worldwide energy use - tied to economic development and population growth - is projected to increase sharply in the coming decades. It therefore makes sense to maximize energy efficiency and minimize energy use, and to develop new sources of clean energy, Cicerone said.

Progress can be made even without a global treaty or federal intervention, Cicerone suggested. Per-capita electricity usage in California has remained roughly constant since the mid-70s - about 7,000 kilowatt-hours. Meanwhile, the U.S. per-capita average has climbed to about 12,000 kWh.

'Wedge' solutions

Climate change need not be seen as insurmountable. Right now -today -humans have the tools to reduce drastically their greenhouse-gas emissions. We only need the commitment to deploy these tools.

That is one message of Robert Socolow, a professor of mechanical and aerospace engineering at Princeton University, who addressed the CO2 symposium last month. Socolow and his colleague Stephen Pacala published a landmark paper in Science in 2004 outlining how to solve the climate problem using existing technologies.

Socolow divides CO2-reduction strategies into discrete "wedges," each of which would reduce CO2 emissions by 100 gigatons over 50 years. By the end of five decades, each "wedge" would be cutting four gigatons of CO2 annually.

Socolow argues that CO2 emissions could be stabilized over five decades with eight wedges in six broad categories, including energy efficiency, decarbonized electricity (e.g., wind or nuclear power), decarbonized fuels (e.g., capture and sequestration of carbon from coal-fired power plants.

By 2055, one wedge could be accomplished by replacing 2 billion cars getting 60 mpg instead of 30 mpg, assuming 10,000 miles driven per year. Another wedge from efficiency could stem from a 25-percent reduction in commercial and residential electricity use, which could be attained via efficient motors, light bulbs and cogeneration units.

Some American political leaders suggest that the United States should not be expected to cut its emissions while other countries' emissions are sharply increasing. The implication is that Americans deserve to emit a disproportionate share of pollution because, well, we're already doing it.

Socolow suggests a more equitable strategy, arguing that developed countries like the United States, whose per-capita CO2 emissions are five times the global average, should accept sharp reductions in carbon emissions and to let developing nations grow economically (and to moderately increase their CO2 emissions), thereby giving the world's poorest people some relief.

New nukes

Such a strategy might prompt the United States to pursue a nuclear-power "wedge." As Socolow points out, achieving one wedge of carbon savings via the nuclear option would mean having 700 gigawatts of nuclear-generated power by 2055. That's twice the current capacity of U.S. nuclear facilities.

Such a task is not impossible. But it would require a significant U.S. commitment. That's one point made by Helen Howes, a vice president of Exelon Corporation, the nation's largest supplier of nuclear power.

Exelon, which is also the fourth-largest U.S. power company, generates 91 percent of its energy via nuclear plants. Exelon believes new nuclear plants are necessary in a low-carbon energy future, Howes said.

Though nuclear plants are expensive, the capital cost per kilowatt-hour is about the same for that of another controversial technology, coal-fired Integrated Gasification Combined Cycle plants with Carbon Capture and Sequestration.

Today, 21 new nuclear plants have been proposed in the United States. If all were approved, they would add 39 gigawatts of low-carbon energy to the grid. That's less than 6 percent of the 700 gigawatts needed for one nuclear "wedge."

And, as Howes noted, the time required to get government approval and build a nuclear plant can be well more than a decade. Nuclear power might well be a necessary strategy for reducing carbon emissions. But it is no panacea.

Burying carbon

Other wedge strategies will have to be employed. Fred Palmer, senior vice president for government relations at Peabody Energy, the world's largest private coal

provider, recently returned from China, which he describes as leading the "second industrial revolution."

Like the United States, China has abundant stores of coal, which it fully intends to burn, Palmer said. He argued that coal is critical to American energy security, and he argued for the rapid pursuit of coal-fired IGCC plants with Carbon Capture and Sequestration.

Such facilities, which could produce 90-percent less CO2 than traditional coal plants, do not yet operate on a commercial scale. But Palmer believes they will be viable soon, and he argues that the United States has ample room to safely store captured carbon deep underground.

That view has the expert endorsement of Julio Friedmann, carbon management program leader for Lawrence Livermore Laboratory. Friedmann noted that smaller-scale facilities in Norway and Algeria have been capturing and sequestering carbon for years. The current knowledge, he said, suggests that CCS is competitive and "actionable." He said CCS could allow CO2 reductions of 15 percent to 50 percent worldwide. (See eed.llnl.gov/co2/1.php)

Regardless of what happens with nuclear power and carbon sequestration, however, carbon emissions are likely to become more tightly regulated. Several bills in Congress testify to this fact.

Bruce Braine, vice president of strategic policy and analysis for American Electric Power, the nation's largest electric company, understands this and favors national or global rather than statewide restrictions. AEP has announced plans to add carbon-capture technology to two of its plants.

Braine contends that the nation could make sharp reductions in carbon emissions through "aggressive" pursuit of energy efficiency, renewable energy, nuclear power, coal capture and sequestration and plug-in hybrid-electric cars.

Renewables and efficiency

Utility executives Braine and Howes both emphasized the necessity to conserve energy, a strategy that is elegant, effective and economical. Howes noted that Exelon has cut its company headquarters' internal energy usage by 50 percent via simple initiatives such as turning off office lights when not in use.

Encouraging people to save energy can be as simple as posting an office's monthly energy use in a central place, she said. People who aware of their energy consumption are more likely to conserve. (This effect is familiar to anyone who's driven a hybrid car.)

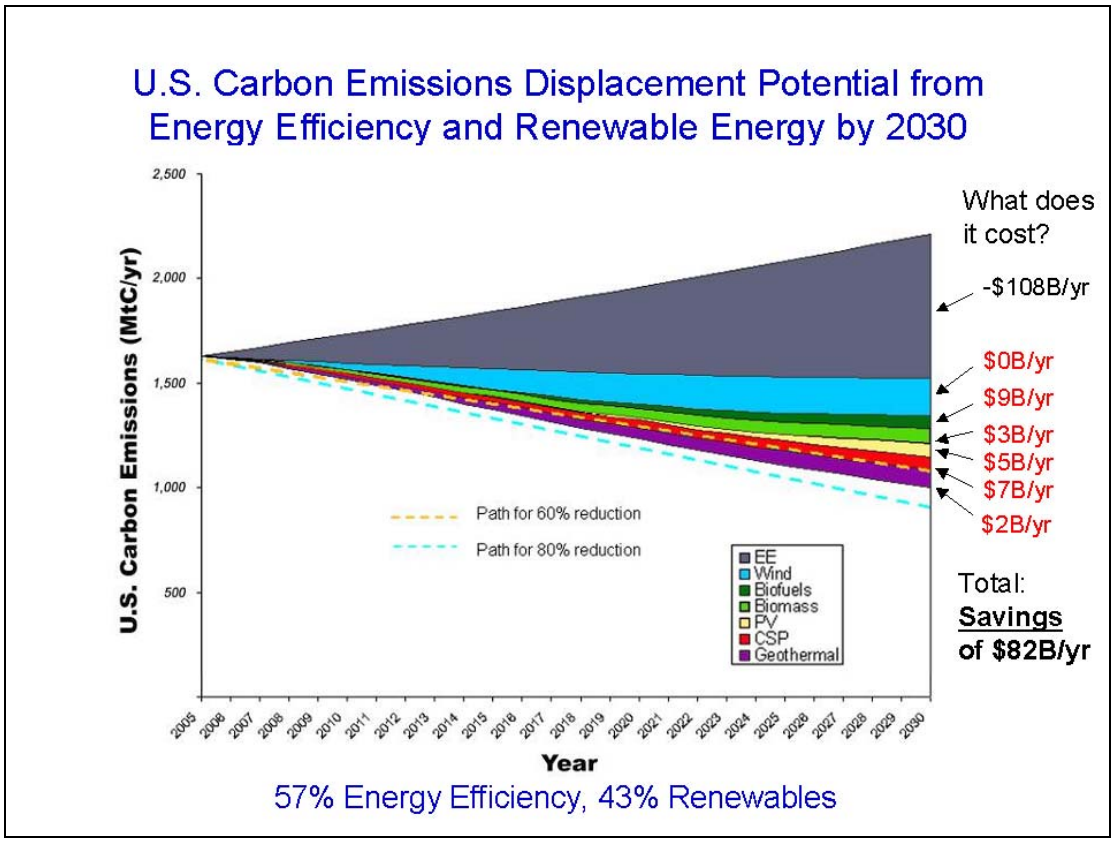
But the first step is awareness, Howes said, adding that most people could not answer this basic question: How many kilowatt hours does your house use each year?

Efficiency and renewables are championed by Chuck Kutscher, an engineer with the National Renewable Energy Laboratory in Golden, who provided convincing evidence that the United States could cut its emissions by 60 percent to 80 percent by 2030 with energy conservation and renewable sources of energy.

Energy efficiency alone could prevent 688 megatons of carbon emissions annually, Kutscher said. His analysis concludes that another 523 megatons of carbon emissions could be cut via wind, photovoltaic, concentrating solar, biomass, biofuels and geothermal power.

What's more, Kutscher argues, this strategy could pay for itself. The renewable-energy initiatives could cost about $26 billion annually. But energy-efficiency could save about $110 billion a year, yielding a savings of about $82 billion annually.

Kutscher's findings are distilled in a report published in January by the American Solar Energy Society. (See http://www.ases.org/climatechange).



Chuck Kutscher, an engineer at the National Renewable Energy Laboratory in Golden, coordinated an analysis that determined that energy efficiency alone could prevent 688 megatons of carbon emissions annually. He concludes that another 523 megatons of carbon emissions could be cut via wind, photovoltaic, concentrating solar, biomass, biofuels and geothermal power. Such a strategic plan is one way to implement greenhouse-gas cutting "wedges," such as those championed by Robert Socolow, professor of mechanical and aerospace engineering at Princeton University, who has published well-known papers in Scientific American on wedges.

Courtesy of the American Solar Energy Society and Chuck Kutscher

Will we act?

Though they have varied expertise in science, business and policy, all of these experts concur on some common points: Human activity is propelling much of the observed changes in climate. Though it's not known how great some impacts will be, or how quickly they will come, the changing climate poses uncertain and potentially significant danger. The world's response must be quick and aggressive.

As leading experts testify, this challenge can be met. This battle can be won. But America must lead.

It has failed - and is failing - to lead, much less negotiate. In Bali last week, the U.S. government refused to accept any hard, numerical caps on CO2 emissions. By taking that stand, the United States of America defied most of the world. It also flouted the clear will of the American people, 69 percent of whom favor a strong climate-change treaty.

By acknowledging a problem but refusing to act accordingly, the U.S. government exploits the public's confusion, which is evidenced by the 40 percent who believe there's a scientific dispute about the irrefutable fact of global warming.

Our government's stand is no surprise. As a just-released congressional investigation confirms, the Bush administration's attempts to muzzle government scientists and exaggerate the uncertainties of climate science were more widespread than previously reported. (See oversight.house.gov.)

Neither citizens nor their Congress is likely to demand an appropriate climate-change response until people understand the depth and breadth of the crisis. Instead of emphasizing the scientific understanding of climate, however, our government has practiced distortion. Citizens deserve something better. The unvarnished truth.

As he recognized the Mauna Loa Observatory's precise, 50-year CO2 record, an integral part of climate science, Socolow emphasized the urgent need to communicate climate science with the public. "The warnings about global climate change from the climate scientists have launched a deep reexamination of the energy system and other resource-intensive aspects of ordinary living," Socolow said.

"It is crucial that these scientists convey, as carefully as possible, what they know and how well or poorly they know it. You have been doing this very well. Now, the stakes are rising."

Our government must accept — and spread — the word.

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