

## Global Warming Twenty Years Later: Tipping Points Near

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**M**y presentation today is exactly 20 years after my 23 June 1988 testimony to Congress, which alerted the public that global warming was underway. There are striking similarities between then and now, but one big difference.

Again a wide gap has developed between what is understood about global warming by the relevant scientific community and what is known by policymakers and the public. Now, as then, frank assessment of scientific data yields conclusions that are shocking to the body politic. Now, as then, I can assert that these conclusions have a certainty exceeding 99 percent.

The difference is that now we have used up all slack in the schedule for actions needed to defuse the global warming time bomb. The next President and Congress must define a course next year in which the United States exerts leadership commensurate with our responsibility for the present dangerous situation.

Otherwise it will become impractical to constrain atmospheric carbon dioxide, the greenhouse gas produced in burning fossil fuels, to a level that prevents the climate system from passing tipping points that lead to disastrous climate changes that spiral dynamically out of humanity's control.

Changes needed to preserve creation, the planet on which civilization developed, are clear. But the changes have been blocked by special interests, focused on short-term profits, who hold sway in Washington and other capitals.

I argue that a path yielding energy independence and a healthier environment is, barely, still possible. It requires a transformative change of direction in Washington in the next year.

**O**n 23 June 1988 I testified to a hearing, chaired by Senator Tim Wirth of Colorado, that the Earth had entered a long-term warming trend and that human-made greenhouse gases almost surely were responsible. I noted that global warming enhanced both extremes of the water cycle, meaning stronger droughts and forest fires, on the one hand, but also heavier rains and floods.

My testimony two decades ago was greeted with skepticism. But while skepticism is the lifeblood of science, it can confuse the public. As scientists examine a topic from all perspectives, it may appear that nothing is known with confidence. But from such broad open-minded study of all data, valid conclusions can be drawn.

My conclusions in 1988 were built on a wide range of inputs from basic physics, planetary studies, observations of on-going changes, and climate models. The evidence was strong enough that I could say it was time to “stop waffling”. I was sure that time would bring the scientific community to a similar consensus, as it has.

While international recognition of global warming was swift, actions have faltered. The U.S. refused to place limits on its emissions, and developing countries such as China and India rapidly increased their emissions.

**W**hat is at stake? Warming so far, about two degrees Fahrenheit over land areas, seems almost innocuous, being less than day-to-day weather fluctuations. But more warming is already “in-the-pipeline”, delayed only by the great inertia of the world ocean. And climate is nearing dangerous tipping points. Elements of a “perfect storm”, a global cataclysm, are assembled.

Climate can reach points such that amplifying feedbacks spur large rapid changes. Arctic sea ice is a current example. Global warming initiated sea ice melt, exposing darker ocean that absorbs more sunlight, melting more ice. As a result, without any additional greenhouse gases, the Arctic soon will be ice-free in the summer.

More ominous tipping points loom. West Antarctic and Greenland ice sheets are vulnerable to even small additional warming. These two-mile-thick behemoths respond slowly at first, but if disintegration gets well underway it will become unstoppable. Debate among scientists is only about how much sea level would rise by a given date. In my opinion, if emissions follow a business-as-usual scenario, sea level rise of at least two meters is likely this century. Hundreds of millions of people would become refugees. No stable shoreline would be reestablished in any time frame that humanity can conceive.

Animal and plant species are already stressed by climate change. Polar and alpine species will be pushed off the planet, if warming continues. Other species attempt to migrate, but as some are extinguished their interdependencies can cause ecosystem collapse. Mass extinctions, of more than half the species on the planet, have occurred several times when the Earth warmed as much as expected if greenhouse gases continue to increase. Biodiversity recovered, but it required hundreds of thousands of years.

The disturbing conclusion, documented in a paper<sup>2</sup> I have written with several of the world's leading climate experts, is that the safe level of atmospheric carbon dioxide is no more than 350 ppm (parts per million) and it may be less. Carbon dioxide amount is already 385 ppm and rising about 2 ppm per year. Stunning corollary: the oft-stated goal to keep global warming less than two degrees Celsius (3.6 degrees Fahrenheit) is a recipe for global disaster, not salvation.

These conclusions are based on paleoclimate data showing how the Earth responded to past levels of greenhouse gases and on observations showing how the world is responding to today's carbon dioxide amount. The consequences of continued increase of greenhouse gases extend far beyond extermination of species and future sea level rise.

Arid subtropical climate zones are expanding poleward. Already an average expansion of about 250 miles has occurred, affecting the southern United States, the Mediterranean region, Australia and southern Africa. Forest fires and drying-up of lakes will increase further unless carbon dioxide growth is halted and reversed.

Mountain glaciers are the source of fresh water for hundreds of millions of people. These glaciers are receding world-wide, in the Himalayas, Andes and Rocky Mountains. They will disappear, leaving their rivers as trickles in late summer and fall, unless the growth of carbon dioxide is reversed.

Coral reefs, the rainforest of the ocean, are home for one-third of the species in the sea. Coral reefs are under stress for several reasons, including warming of the ocean, but especially because of ocean acidification, a direct effect of added carbon dioxide. Ocean life dependent on carbonate shells and skeletons is threatened by dissolution as the ocean becomes more acid.

Such phenomena, including the instability of Arctic sea ice and the great ice sheets at today's carbon dioxide amount, show that we have already gone too far. We must draw down atmospheric carbon dioxide to preserve the planet we know. A level of no more than 350 ppm is still feasible, with the help of reforestation and improved agricultural practices, but just barely – time is running out.

Requirements to halt carbon dioxide growth follow from the size of fossil carbon reservoirs. Coal towers over oil and gas. Phase out of coal use except where the carbon is captured and stored below ground is the primary requirement for solving global warming.

Oil is used in vehicles where it is impractical to capture the carbon. But oil is running out. To preserve our planet we must also ensure that the next mobile energy source is not obtained by squeezing oil from coal, tar shale or other fossil fuels.

Fossil fuel reservoirs are finite, which is the main reason that prices are rising. We must move beyond fossil fuels eventually. Solution of the climate problem requires that we move to carbon-free energy promptly.

Special interests have blocked transition to our renewable energy future. Instead of moving heavily into renewable energies, fossil companies choose to spread doubt about global warming, as tobacco companies discredited the smoking-cancer link. Methods are sophisticated, including funding to help shape school textbook discussions of global warming.

CEOs of fossil energy companies know what they are doing and are aware of long-term consequences of continued business as usual. In my opinion, these CEOs should be tried for high crimes against humanity and nature.

Conviction of ExxonMobil and Peabody Coal CEOs will be no consolation, if we pass on a runaway climate to our children. Humanity would be impoverished by ravages of continually shifting shorelines and intensification of regional climate extremes. Loss of countless species would leave a more desolate planet.

If politicians remain at loggerheads, citizens must lead. We must demand a moratorium on new coal-fired power plants. We must block fossil fuel interests who aim to squeeze every last drop of oil from public lands, off-shore, and wilderness areas. Those last drops are no solution. They yield continued exorbitant profits for a short-sighted self-serving industry, but no alleviation of our addiction or long-term energy source.

Moving from fossil fuels to clean energy is challenging, yet transformative in ways that will be welcomed. Cheap, subsidized fossil fuels engendered bad habits. We import food from halfway around the world, for example, even with healthier products available from nearby fields. Local produce would be competitive if not for fossil fuel subsidies and the fact that climate change damages and costs, due to fossil fuels, are also borne by the public.

A price on emissions that cause harm is essential. Yes, a carbon tax. Carbon tax with 100 percent dividend<sup>3</sup> is needed to wean us off fossil fuel addiction. Tax and dividend allows the marketplace, not politicians, to make investment decisions.

Carbon tax on coal, oil and gas is simple, applied at the first point of sale or port of entry. The entire tax must be returned to the public, an equal amount to each adult, a half-share for children. This dividend can be deposited monthly in an individual's bank account.

Carbon tax with 100 percent dividend is non-regressive. On the contrary, you can bet that low and middle income people will find ways to limit their carbon tax and come out ahead. Profligate energy users will have to pay for their excesses.

Demand for low-carbon high-efficiency products will spur innovation, making our products more competitive on international markets. Carbon emissions will plummet as energy efficiency and renewable energies grow rapidly. Black soot, mercury and other fossil fuel emissions will decline. A brighter, cleaner future, with energy independence, is possible.

Washington likes to spend our tax money line-by-line. Swarms of high-priced lobbyists in alligator shoes help Congress decide where to spend, and in turn the lobbyists' clients provide "campaign" money.

The public must send a message to Washington. Preserve our planet, creation, for our children and grandchildren, but do not use that as an excuse for more tax-and-spend. Let this be our motto: "One hundred percent dividend or fight!"

The next President must make a national low-loss electric grid an imperative. It will allow dispersed renewable energies to supplant fossil fuels for power generation. Technology exists for direct-current high-voltage buried transmission lines. Trunk lines can be completed in less than a decade and expanded analogous to interstate highways.

Government must also change utility regulations so that profits do not depend on selling ever more energy, but instead increase with efficiency. Building code and vehicle efficiency requirements must be improved and put on a path toward carbon neutrality.

The fossil-industry maintains its strangle-hold on Washington via demagoguery, using China and other developing nations as scapegoats to rationalize inaction. In fact, we produced most of the excess carbon in the air today, and it is to our advantage as a nation to move smartly in developing ways to reduce emissions. As with the ozone problem, developing countries can be allowed limited extra time to reduce emissions. They will cooperate: they have much to lose from climate change and much to gain from clean air and reduced dependence on fossil fuels.

We must establish fair agreements with other countries. However, our own tax and dividend should start immediately. We have much to gain from it as a nation, and other countries will copy our success. If necessary, import duties on products from uncooperative countries can level the playing field, with the import tax added to the dividend pool.

Democracy works, but sometimes churns slowly. Time is short. The 2008 election is critical for the planet. If Americans turn out to pasture the most brontosaurian congressmen, if Washington adapts to address climate change, our children and grandchildren can still hold great expectations.

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<sup>2</sup> Target atmospheric CO<sub>2</sub>: where should humanity aim? J. Hansen, M. Sato, P. Kharecha, D. Beerling, R. Berner, V. Masson-Delmotte, M. Raymo, D.L. Royer, J.C. Zachos, <http://arxiv.org/abs/0804.1126> and <http://arxiv.org/abs/0804.1135>

<sup>3</sup> The proposed "tax and 100% dividend" is based largely on the cap and dividend approach described by Peter Barnes in "Who Owns the Sky: Our Common Assets and the Future of Capitalism", Island Press, Washington, D.C., 2001 ([http://www.ppionline.org/ppi\\_ci.cfm?knlgAreaID=116&subsecID=149&contentID=3867](http://www.ppionline.org/ppi_ci.cfm?knlgAreaID=116&subsecID=149&contentID=3867)).