Copenhagen Consensus: The four best ways to fight global warming.

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Can You Really Make Clouds Whiter and More Reflective?

Scientists are getting there, and it might be the one of the best ways to fight climate change.

Would a carbon tax actually reduce emissions enough to fight climate change?

Robert Nickelsberg/Getty Images.

In this series, Bjorn Lomborg explores the smartest investments to respond to global challenges—and readers get to have their say. See the earlier articles here. And read Bjorn's responses to readers and find out which investments are currently at the top of Slate readers' priority list. Be sure to vote in the poll at the bottom of each article.

Of all of the issues in the Copenhagen Consensus 2012 project, climate change is perhaps the most talked-about and charged. Although efforts to strike an international climate deal have come to naught, more newspaper space and celebrity attention has been devoted to this issue in the past decade than any other.

Copenhagen Consensus 2012 devotes four research papers to this topic. The climate change research is released today. These papers build on a 2009 Copenhagen Consensus project that focused solely on this topic. (You can read all of the project's research in this Cambridge University Press book, Smart Solutions to Climate Change.)This lets us look at very different ways to deal with this global challenge.

Let's look first at the path that policymakers have chosen so far. Richard Tol makes the case that there is wide agreement in the economic literature that reducing greenhouse gas emissions is best done through a carbon tax. Climate policy, he notes, is not about spending money. It is about raising money (and, of course, about finding the best way to spend the revenues raised through a carbon tax).

Tol argues that the costs of deep emission cuts are relatively small if the following conditions are met: Emission reduction targets are lenient at first but accelerate over time; every part of the economy emitting carbon is regulated; all gases are regulated and at the same price; all countries reduce emissions; and climate policy is coordinated with other policies. If these rules are violated, then the costs of reducing harmful emissions rapidly escalate.

Unfortunately, policymakers violate these rules a lot in the real world. It is increasingly clear that governments have great difficulty in delivering the cheapest possible emission-reduction programs. (See Tol's earlier paper looking at the very large price tag of European Union climate change policies.)

Very stringent emission-reduction targets such as the long-term goals of the European Union simply do not pass the benefit-cost test: They actually cause more damage than they prevent. However, very modest reductions in carbon

emissions appear to be justifiable with any number of assumptions, while more stringent emission reduction needs more favorable assumptions.

Tol finds that a low tax of about $1.80 on each ton of carbon would generate benefits (of avoided climate damage) worth between $1.50 and $9. However, a high tax set at $250 would cost much more than it would gain, with benefits of just two cents to 12 cents, putting it in the category of ”does more damage than it prevents.”

Isabel Galiana and Christopher Green propose a technology-led climate policy. This means dramatically increased research and development, testing and demonstration of scalable, reliable, and cost-effective low carbon emitting energy technologies. This will be funded by a low but gradually rising carbon tax, but unlike Tol’s proposal the main focus is on innovating cheap, green energy sources.

They argue that the size of the energy technology challenge is huge, and there is a current lack of technological readiness and scalability in low-carbon energy sources. They show that adopting a “brute force” approach to reducing emissions with a carbon tax before green technology is actually ready to take over from fossil fuels could generate economic costs 10 times or more than widely published estimates of CO2 mitigation cost estimates.

The authors argue that while the importance of new technologies to slowing and eventually reducing global emissions is more widely accepted than it once was, there have been no fundamental developments on the low-carbon energy front in recent years. Moreover, funding has gone mainly to subsidizing manufacture and deployment rather than to research. With continued increases in carbon emissions despite an enduring global economic crisis, the case for a technology-led climate policy is stronger than ever.

Galiana and Green conclude that increased funding for low-carbon research and development would have benefits ranging from threeto 11 times higher than the cost, depending on the rate of success and time horizon.

But what can we achieve by preparing ourselves for climate damage? Carlo Carraro, Francesco Bosello, and Enrica De Cian look at what can be achieved with adaptation policies.

They find that the most important impacts of global warming will be on agriculture and tourism, where nations will lose, on average, about one-half of 1 percent of GDP from each by midcentury. However, they point out that much of this damage will actually be avoided by people choosing for themselves to adapt to the change in their environment. Farmers will choose plants that thrive in the heat. New houses will be designed to deal with warmer temperatures.

Taking this into account, rich countries will adapt to the negative impacts of global warming and exploit the positive changes, actually creating a total positive effect of global warming worth about one-half a percentage point of GDP.

However, poor countries will be hit harder. Adaptation will reduce the climate-change-related losses from 5 percent of GDP to slightly less than 3 percent, but this is still a significant negative impact. The real challenge of global warming, therefore, lies in tackling its impact on developing nations. Here, more needs to be done, above and beyond the adaptation that will happen naturally.

Adaptation may serve multiple purposes, including helping developing countries to boost education, health, and economic development.

The researchers find that, broadly, every dollar spent on adaptation would achieve at least about $1.65 worth of positive changes for the planet.

The final paper, by J. Eric Bickel and Lee Lane, looks at geo engineering This essentially means cooling the planet by reflecting more of the sun’s rays back to space. There are a few different ways to achieving this. One promising approach is stratospheric aerosol injection—where a precursor of sulfur dioxide would be continuously injected into the stratosphere, forming a thin layer of aerosols to reflect sunlight. The amount of sulfur required to offset global warming is on the order of 2 percent of the sulfur that humans already inject into the atmosphere, largely through burning fossil fuels. Another suggested approach is marine cloud whitening, where seawater would be mixed into the atmosphere at sea to make the clouds slightly whiter and more reflective.

Bickel and Lane do not suggest actually implementing such programs at this point, but they look at the costs and benefits of preparing the knowledge of how they might be deployed in the future. They estimate that the cost of a climate-engineering research and development program is on the order of $1 billion: a small fraction of what the United States alone is spending on climate-change research each year. They estimate that each dollar spent could create roughly $1,000 of benefits in economic terms.

Such high benefits reflect the fact that solar radiation management holds the potential of reducing the economic damages caused by both warming and costly CO2 reduction measures (such as carbon taxes). These early-reduction costs tend to be higher than those of climate change; so by lessening the stringency of controls, climate-engineering may also provide near-term benefits—compared to strategies relying solely on emissions reductions.

Moreover, if climate change should suddenly get much worse (reaching the so-called ”tipping points”), geoengineering appears to be the only technology that could quickly cool the Earth. This feature would allow it to act as an insurance against extreme and highly uncertain climate outcomes.

The four papers reveal four different paths to resolving the challenge of climate change. Do you think one or more of these should be given a high priority by policymakers? Have your say in our daily poll:

Remember: In each of the stories published to date, there’s a poll, and you can still go back and vote in all of the polls today. Each day, as well as publishing a new topic of research, I respond to your comments and update you on how readers are prioritizing pieces so far. See which priorities are currently the favorites of Slate readers.

Tomorrow, we turn to the challenge of armed conflict, looking at the hidden costs of war and how we can try to reduce its carnage.

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