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The Economics of 350: The Benefits and Costs of Climate Stabilization¹

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- Recent scientific evidence recommends lowering the target atmospheric concentration of carbon dioxide (CO₂) from 450 parts per million (ppm) to 350 ppm to avoid the most dangerous risks of climate change.
- To reach 350 ppm will require wholesale conversion of the world's energy system to low-carbon or carbon free sources by the end of the century, and near-zero annual carbon emissions by mid-century. The ability to remove carbon emissions from the atmosphere through land use change and other technologies will largely determine whether we reach 350 ppm by 2100 or later.
- A review of the research on the costs of achieving a 350 ppm target finds that estimates range from 1%-3% of global gross domestic product (GDP).

A New Target: 350 ppm CO₂

Although international awareness and response to climate change has never been better, it is still not enough. Several countries have set moderate to ambitious climate change goals. More are in the process of making commitments; even the United States is finally proposing more serious initiatives. While this is important progress, it is 'progress-inadequate' because we are dealing with a moving target². The former 'safe' level of 450 ppm CO₂ atmospheric concentration, to which most goals are set, is proving insufficient to achieve climate stabilization. Policy will have to catch-up.

Recent empirical evidence supported by paleoclimatic research on earlier climate change episodes indicates that climate change is taking place considerably faster than previously thought. In response, a new target of 350 ppm CO₂ has been endorsed by many policy makers and scientists including Rajendra Pachauri, head of the Intergovernmental Panel on Climate Change (IPCC), Nicholas Stern of *The Stern Review* (2006), and James Hansen, the chief climate scientist at NASA. Should we exceed this level, it is highly likely that we will reach climatic 'tipping points' such as the melting of ice sheets, increases in sea-levels, sharp declines in

¹ Full report available online at: http://www.e3network.org/papers/Economics_of_350.pdf

² *The Economics of 350*, Grist, Oct. 6th, 2009, <http://www.grist.org/article/the-economics-of-350/>



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agricultural output, irreversible species extinction and other effects that may create vicious warming cycles only deepening the consequences.

The target level of CO₂ is dependent on climate sensitivity, the global average temperature increase from a doubling of atmospheric CO₂. Climate sensitivity is, however, inherently uncertain³. Scientific literature as of 2006 implies that the most likely estimate of climate sensitivity is 3°C. On the other hand, paleoclimatic records support an estimate of 6°C, as supported by Hansen. Upon testing a range of possible values, it is found that earlier stronger response is the best choice outcome regardless of the climate sensitivity value. Two approaches to achieving 350 ppm CO₂ are identified and explored, proving such a target feasible.

Possible Pathways

NASA's James Hansen and co-authors detailed how we can reach 350ppm CO₂ by 2100. Their scenario assumes oil and natural gas use decreasing over time with rising prices, conversion to renewable energy sources, and either phasing out coal burning or achieving 100% carbon capture and storage by 2030. Zero land emissions are achieved by 2015 and turn significantly negative after 2030 due to large-scale initiatives for reforestation and biochar, carbon sequestration by burying charcoal made from plant material.

E3 network economists ran an alternative scenario for achieving 350 ppm by 2200 that does not rely on negative emissions. This scenario requires that emissions are reduced by 97% of 1990 levels by 2050.

Both Hansen's and E3's scenarios require that the world energy system be carbon free or low carbon by successful implementation of renewable energy schemes by mid century. This is arguably a more ambitious goal than any current policy proposal on the table.

We Can Afford 350ppm

Peer reviewed studies are generally considered the 'gold-standard' in academic research. A review of the peer-reviewed research in economics generally finds support for aggressive and immediate actions to reduce emissions and mitigate the worst risks of climate change. This is often in stark contrast to most industry-sponsored research that predicts economic ruin from even very modest efforts to curb emissions and improve energy efficiency. The peer-reviewed literature lags behind the recommendations of climate science; the majority of academic studies have focused on target concentrations of 450 ppm or more. Yet recent studies from research groups directly addressing the 350 ppm target conclude that the costs range between 1-3% of global GDP.

³ Roe, G. H. and M. B. Baker (2007). "Why is Climate Sensitivity So Unpredictable?" Science 318: 629-632.



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To put these estimates in perspective, imagine spending the equivalent of 2.5% of GDP, roughly the rate at which developed countries' economies grow each year, on climate protection. That would be equivalent to skipping one year's growth, and then resuming. Average incomes in the U.S. would take 29 years to double from today's level, compared to 28 years in the absence of climate protection costs. In an economy experiencing 10-percent annual growth, as China has in many recent years, imposing a cost of 2.5 percent per year is equivalent to skipping 3 months of growth; if 10-percent growth is sustained, average incomes would reach double the current level in 86 months, compared to 83 months in the absence of climate protection costs.

Or consider this: In 68 countries, military spending is greater than 2.5 percent of GDP. In both the United States and China, military expenditures exceed 4 percent of GDP. Military spending in France and India, among others, is at or above 2.5 percent of GDP. Around the world, people willingly spend very large sums to protect themselves against perceived threats to their way of life. Catastrophic climate change is just such a threat.

We Must Afford 350ppm

Climate protection is insurance for the planet. The reason people buy, for example, fire insurance is not because they are certain that their house will burn down; rather, it is because they cannot be sufficiently certain that it will not burn down. Likewise, the projections of dangerous climate risk if the world exceeds 350 ppm CO₂ in the long run are not certainties; they are, on the contrary, necessarily uncertain. Insurance never passes a simple cost-benefit test; the expected value of payments to policyholders must be less than the value of their premiums, in order for insurance companies to remain solvent. Consumers nonetheless buy insurance because they are risk-averse when facing the large losses associated with house fires, premature deaths of young parents, and other personal catastrophes. If the worst happens, our grandchildren will inherit a degraded Earth that will not support anything like the life that we have enjoyed. On the other hand, if we prepare for the worst but it does not happen, we will have invested more than, in perfect hindsight, was necessary in clean energy, conservation, and carbon-free technologies. How would we feel about discovering we had done too much about climate change, compared to discovering we had done too little?

The most important conclusion from our study involves what we did not find:

- No reasonable studies targeting 350 ppm CO₂ predict economic ruin
- No studies advocate waiting before taking action on climate protection
- Rather there is strong widespread endorsement of policies to promote energy conservation, energy-efficiency, the development of new energy technologies, and price incentives and other economic measures to redirect the world economy to a low-carbon path to sustainability.



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What we cannot afford is too little climate policy, too late.