# Drastically Altered Energy Use Is Needed To Stabilize Future Climate

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Approximately 80 percent of the rise in carbon dioxide from its preindustrial level to its current level is due to the worldwide burning of fossil fuels (coal, oil and natural gas). The remaining 20 percent is due to deforestation and other land use practices. All studies of future global warming, including the Fourth Assessment Report by the Intergovernmental Panel on Climate Change in 2007, project that carbon dioxide emissions from fossil fuels will remain the dominant cause of the problem. Constraints on conventional oil, natural gas and coal supplies will play an important role in determining the magnitude of future climate change. But we cannot simply take the unacceptable risk that such constraints will solve the climate problem by themselves. We can and must change the way we obtain energy in order to prevent disastrous climate change.

Before the Industrial Revolution, the global atmospheric carbon dioxide level was around 280 parts per million (ppm). Today, it is closer to about 385 ppm. The UN Framework Convention on Climate Change, which went into force for virtually the entire world in 1994, aims to stabilize "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." Although there is overwhelming consensus among climatologists regarding human-induced climate change, we have not yet reached consensus about precisely what levels of greenhouse gases would constitute "dangerous anthropogenic interference."

Many scientific studies imply that we can stabilize carbon dioxide levels at 450 ppm, or even higher, without significant consequences, such as the polar ice sheets melting, sea levels rising significantly and countless species going extinct. But my colleagues and I argue that 450 ppm is an unacceptably high target and will likely lead to disastrous consequences. Instead, a much more appropriate initial target carbon dioxide level for this century is 350 ppm. This conclusion stems from detailed analysis of atmospheric carbon dioxide concentrations throughout the past 65 million years, taken together with numerous lines of empirical evidence of substantial recent and ongoing climate impacts. This target is about 35 ppm lower than the present level, yet it is still achievable.

Reducing the current level of carbon dioxide within this century will clearly require massive worldwide efforts. The most fundamental requirement is a phase-out of emissions from coal burning, in particular, within the next two to three decades at most. This focus on coal is needed for several reasons: It is the most abundant of the conventional fossil fuels (more than oil and gas combined); it has the highest life-cycle greenhouse gas emissions; and it is likely the most amenable to mitigation, given that there are viable, commercial-scale electricity substitutes available now, such as renewable sources, supplemented by nuclear power as needed. Phasing out coal emissions will likely mean greatly curtailing coal usage in the near term, since large-scale deployment of truly "clean" coal plants with near-zero emissions is still decades away. This near-term phase-out of coal emissions/usage is crucial even if coal supplies are much scarcer than widely assumed.

Conventional oil and natural gas are not as big of a concern as coal, because even assuming we have substantial supplies of these fuels left, their use alone is not sufficient to take carbon dioxide levels above 400 to 420 ppm this century. Moreover, there is less that can be done to eliminate their emissions anytime soon, given the current lack of large-scale/low-carbon substitutes for liquid fuels in particular.

Nonetheless, to achieve our 350 ppm goal, it is vital to use oil and natural gas as conservatively and efficiently as possible. This will buy time to develop substitute fuels — such as next-generation biofuels that are truly carbon-neutral/negative — or electric vehicles that rely on carbon-free electricity. It could also help minimize the socioeconomic impacts of peak oil, as well as the temptation to extract fuels from pristine areas such as the Amazon and the Alaskan wilderness. Lastly, it would also reduce the need to use coal-to-liquids or the putatively vast unconventional fuels like tar sands or oil shale as substitutes.

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Ultimately, the peaking of global oil/natural gas/coal production could have a major effect on future carbon dioxide levels and therefore global climate, depending entirely on choices made for substitute energy sources. We suggest that a fair, effective and increasing tax on carbon emissions is crucial for guiding energy choices and policies in a climatically sound direction.

In the next decade or so, the greatest potential for reducing fossil-fuel carbon dioxide emissions lies in energy efficiency and conservation measures. In the mid to long term, further reductions can be achieved via large-scale deployment of renewable (and possibly nuclear) electricity sources. In addition to fossil fuel-related mitigation, attainment of the 350 ppm target will require major improvements in land use, notably large-scale reforestation, halting deforestation and soil carbon conservation. There is still enough time to achieve these measures — what is missing largely seems to be the will, not the way.

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**http://pubs.giss.nasa.gov/abstracts/2008/Kharecha_Hansen.html**
**and**
**http://pubs.giss.nasa.gov/abstracts/2008/Hansen_etal.html**
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