

GLOBAL WARMING PRIMER:

The Basic Science

INTRODUCTION: It is now beyond scientific dispute that our Earth's climate is heating up evermore quickly. 98% of climate experts agree with near-certainty that human activity is by far the major cause. This is mostly through burning of carbon-based fossil fuels—coal, oil and natural gas—but also through deforestation and certain farming practices. These activities release greenhouse gases—especially carbon dioxide (CO₂)—that trap heat in the atmosphere. No natural factor fits the patterns of the observed warming, melting ice and rising sea level.

It is the excessive buildup of greenhouse gases that poses a threat. Since we began burning fossil fuels 250 years ago, atmospheric CO₂ levels have increased from 280 to 392 parts per million (ppm)—about 40%. To keep a stable climate, CO₂ levels in the atmosphere must be reduced to 350 ppm, the estimated level that Earth's ecosystems can handle.

HISTORY OF GLOBAL WARMING SCIENCE: The foundations of greenhouse gas science have been understood for over 150 years. In the late 50's, Charles Keeling began measuring rising CO₂ levels in the atmosphere. In the 1970's, scientific concern grew. In 1988, James Hansen warned Congress of the dangers of global warming—which also first alerted the public.

EFFECTS ALREADY OBSERVED: Climate chaos is not a looming threat in the far-off future—it is already happening. The average global temperature has risen .9° Celsius (1.5° Fahrenheit). This seemingly small increase has an enormous effect. The last decade (2000 - 2009) was the hottest on record. 2010 tied with 2005 as the hottest year on record.

Storms, heat waves, droughts, fires, floods, and mudslides are increasing in severity and frequency. Since 1987, severe weather events have quadrupled. A warmer climate draws more moisture into the air and causes the system to speed up. Precipitation has increased nearly 20% overall globally, but the rain comes more in downpours. Polar ice and glaciers are melting, causing sea levels to rise. Rising sea levels are already measurable. The oceans are also warming up and are absorbing more CO₂, making the seawater 30% more acidic. Acidification dissolves calcium carbonate, an important building block for shelled creatures and corals. Plant and animal ranges have shifted poleward. Bark beetles—no longer held in check by cold winters—are destroying vast tracts of spruce and pine forests. The range of diseases caused by algae, mosquitoes and ticks has spread to new areas.

PREDICTED IMPACTS: Predictions for rising temperatures vary widely from a small but still potentially harmful rise of 1 - 2°F to a catastrophic rise of 6 - 10°F, within this century. This will have far-reaching impacts for humanity, such as crop failures, water scarcity, heat-related mortality, the spread of disease-carrying insects and the displacement of hundreds of millions of people. The extent of these impacts largely depends on whether we phase out fossil fuels as quickly as possible. The possibility of runaway climate warming lends tremendous urgency for quickly reducing CO₂ levels.

MAKING PREDICTIONS: Scientists predict future warming impacts by using computer simulations of the climate system called models. Many dynamic elements such as air movement, clouds, temperatures, ice cover and evaporation are included. Various possibilities are considered, and models are tested for accuracy. Scientists run them from some point in the past, to see how well they duplicate actual climate trends. They have successfully predicted the warming trend and show that rising greenhouse gas levels are the cause.

CAUSES OF CLIMATE CHANGE: Numerous natural processes can affect the Earth's temperature, such as solar activity, earth's orbit, shifting continents and volcanoes. Scientists have studied all these factors and have determined that human activity—causing rising greenhouse gas levels—is by far the major cause of the current warming. The burning of fossil fuels (coal, oil and natural gas) is the largest contributor. Deforestation, agricultural practices, landfills and livestock also play a role.

PAST CLIMATE CHANGE: Earth's climate has changed dramatically many times over billions of years. Causes include shifting greenhouse gas levels, solar activity, orbital cycles, shifting continents and volcanoes. Previous warming events show that our climate is very sensitive to changes in greenhouse gas levels. The few times in Earth's history with rapid CO₂ increases led to mass extinctions.

SCIENTIFIC CONSENSUS AND UNCERTAINTY: 98% of climate scientists have very high confidence that warming is the net effect of humanity's burning of fossil fuels. The world's leading scientific organizations—the national academies of science and professional scientific societies—have carefully examined and endorsed these conclusions. This is solid, settled science. A consensus of 98% for any line of scientific investigation is actually very high. The remaining true uncertainties include questions such as how high will temperatures rise, how quickly, or how high will sea levels rise.

HUMANITY'S RESPONSES: Humans are now in charge of the climate. We face a tremendous choice. We can take the path of reducing fossil fuel usage at a pace that stabilizes the climate, or we can continue business as usual, leading to uncontrollable climate chaos. Mitigation—preventing further climate damage by reducing greenhouse gases—must be our primary focus, and is essential for humanity's survival. Moreover, it is our least expensive response. We must also respond with adaptations—measures to reduce vulnerability to climate warming effects.

TO STABILIZE CLIMATE: Several broad measures must be enacted quickly, to prevent runaway climate destabilization. A carbon phase-out plan that limits warming to 2°C and is fair among nations is necessary. This means industrialized nations must phase out CO₂ by 2050, starting by 2014. The industrialized world must assist the developing nations with clean energy alternatives, so they can also phase out CO₂. Coal must be quickly phased out and tar sands must be left in the ground. In order to accomplish this, a steadily increasing price must be placed on carbon, with rebates to the public. This would allow clean energy and other low carbon technologies to become competitive.

CONCLUSION: The transition to clean energy makes a great deal of sense for many reasons. Immediately, clean energy means more jobs, more energy security, increased domestic manufacturing and improved health. While the costs of taking action are significant, the cost of inaction is far more unaffordable—in terms of storm damage, loss of crops, pollution damage, health care costs and many other hidden costs from burning fossil fuels. These costs grow larger and more unaffordable the longer we wait.

Scientific predictions about global warming—such as rising global temperatures, rising sea levels and melting ice—are coming true, even at the high end of forecasts. We cannot negotiate with the physics of the biosphere or ask the greenhouse warming to wait, while we begin to think about an adequate response. We act or we face complete cataclysm. The planet cannot carry but a small fraction of us if we allow climate chaos. To begin with, a rising fee on carbon is an initial effective response policy—and is even necessary to make this transformation happen. It is black or white; there are no shades of grey. We act, and act consequentially or we die.

ADDITIONAL RESOURCES:

Arnold, Jean. "Global Warming Primer: The Basic Science." (full report)

<http://www.saveourselvesnow.net/topics/view/71776/>

Cook, John. "Skeptical Science: Getting skeptical about global warming skepticism." *Skeptical Science*.

<http://www.skepticalscience.com/>

EPA: Climate Change Indicators in the United States

Slide show: http://www.epa.gov/climatechange/indicators/pdfs/climate_indicators_slideshow.pdf

Full Report: http://www.epa.gov/climatechange/indicators/pdfs/ClimateIndicators_full.pdf

NASA Earth Observatory: Global Warming: <http://earthobservatory.nasa.gov/Features/GlobalWarming/page1.php>

RealClimate: Climate science from climate scientists: <http://www.realclimate.org/index.php/archives/2007/05/start-here/>