Our Children's Trust

Policies Must Be Based on 350 ppm and 1 Degree Celsius to Protect Young People and Future Generations

The Best Climate Science Provides a Prescription for Restoring the Atmosphere, Stabilizing the Climate System, and Protecting the Oceans from Acidification and Warming. It Requires Us to Return Atmospheric CO_2 Levels to Below 350 ppm by 2100.

In order to protect our planet's climate system and vital natural resources on which human survival and welfare depend, and to ensure that young people's and future generations' fundamental and inalienable human rights are protected, government climate pollution policies *must* be based on the best available climate science. There are numerous scientific bases for setting 350 parts per million (ppm) as the uppermost safe limit for atmospheric carbon dioxide (CO_2) concentrations.

First, returning CO_2 concentrations to below 350 ppm would restore the energy balance of Earth and allow as much heat to escape into space as Earth retains, which has kept our planet in the sweet spot for humans and other species to thrive.

Second, CO_2 levels exceeding 350 ppm are creating a planet warmer than humans have ever lived in and are disrupting the physical and biological systems in which human civilization has developed. The consequences of even 1 degree Celsius of warming will be significant for humanity, but scientists believe we can preserve our ice sheets and most of our shorelines and ecosystems if we limit *long-term* warming to no more than 1 degree Celsius (short-term warming will inevitably exceed 1 degree Celsius but must exceed 1 degree Celsius for only a minimal amount of time). If we allow sustained global average temperature increases of more than 1 degree Celsius, we will suffer irreversible climate destabilization and a planet largely inhospitable to human civilization.

Third, marine animals, including coral reefs, cannot tolerate the acidifying and warming of our ocean waters that results from increased CO_2 levels, 30% of which is absorbed by the oceans. At 400 ppm CO_2, coral reefs and shellfish are rapidly declining and will be irreversibly compromised if we do not quickly reverse course.

All government policies regarding greenhouse gas/CO_2 pollution and de/reforestation worldwide should be aimed at 350 ppm by 2100. Fortunately, it is still not only technically and economically feasible to get there, but transitioning to renewable energy sources will provide significant economic and public health benefits and improve the quality of lives. But time is running out. We cannot continue to base life and death policies on politics rather than science. Read more below for details and references to the science that should govern policies that protect, rather than condemn, the future of humanity and other species on the planet. If we want our children and grandchildren to have a safe planet to live on, full of biodiversity and not chaos and conflict, we will heed the best scientific prescription for how to stop the destruction of our only planet's atmosphere, climate, and oceans.

Restore the Energy Balance of Earth

To protect Earth's climate for present and future generations, we must restore Earth's energy balance. By burning fossil fuels and deforesting the planet,[1] which results in an increase in greenhouse gases in the atmosphere, especially CO_2, humans have altered Earth's energy balance.[2] The best climate science shows that if the planet once again sends as much energy into space as it absorbs from the sun, this will restore the planet's climate equilibrium.[3] Scientists have accurately calculated how Earth's energy balance will change if we reduce long-lived greenhouse gases such as CO_2.[4] We would need to reduce atmospheric CO_2 concentrations by at least 50 ppm, from their 2015 level of 400 ppm in order to increase Earth's heat radiation to space, if other long-lived gases do not continue to increase.[5]

Stop Global Surface Warming that Will Disrupt the Physical and Biological Systems on Which Humans Depend

In order to protect the physical and biological systems on which humans rely for their basic needs and the stability of their communities, we must reduce atmospheric CO_2 concentration to no more than 350 ppm and stabilize GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.[6]

Current science shows that while global surface heating may rise as much as 1.5 °C above pre-industrial temperatures because of warming already locked into the pipeline from existing CO_2 pollution, to protect Earth's natural systems, long-term average global surface heating should not exceed 1°C this century. In other words, even 1.5 °C of heating is unsafe, and we must stabilize at no more than 1°C of heating over pre-industrial temperatures. According to current climate science, to prevent global heating greater than 1°C, concentrations of atmospheric CO_2 must decline to 350 ppm or less by the end of this century.[7] However, today's atmospheric CO_2 levels are over 400 ppm and rising.[8]

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[1] Intergovernmental Panel on Climate Change, *Summary for Policymakers, Climate Change 2014: Impacts, Adaptation, and Vulnerability* 5 (2014).

[2] James Hansen et al., *Assessing "Dangerous Climate Change": Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature*, PLOS ONE 8:12 (2013) [hereinafter Assessing "*Dangerous Climate Change*"].

[3] John Abatzoglou et al., *A Primer on Global Climate Change and Its Likely Impacts, in Climate Change: What It Means for Us, Our Children, and Our Grandchildren* 11, 15-22 (Joseph F. C. DiMento & Pamela Doughman eds., 2007).

[4] James Hansen, Storms of My Grandchildren 166 (2009) ("Also our best current estimate for the planet's mean energy imbalance over the past decade, thus averaged over the solar cycle, is about +0.5 watt per square meter. Reducing carbon dioxide to 350 ppm would increase emission to space 0.5 watt per square meter, restoring the planet's energy balance, to first approximation.").

[5] James Hansen, Storms of My Grandchildren 166 (2009); *see also* James E. Hansen et al., *Target Atmospheric CO_2: Where Should Humanity Aim?* 2 The Open Atmospheric Science Journal 217, 217-31 (2008), http://www.columbia.edu/~jeh1/2008/TargetCO2_20080407.pdf [hereinafter *Where Should Humanity Aim?*].

[6] *See* Hansen, *Where Should Humanity Aim?*, 217 (2008) ("If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, Paleoclimate evidence and ongoing climate change suggest that CO_2 will need to be reduced from its current 385 ppm to at most 350 ppm.").

[7] *See id.*; James Hansen, Storms of My Grandchildren (2009).

[8] NASA, Facts, Carbon Dioxide, http://climate.nasa.gov/vital-signs/carbon-dioxide/ (last visited May 2, 2016).

A target of keeping global surface heating to 2°C above pre-industrial temperatures, which approximately equates to an atmospheric CO_2 concentration of 450 ppm, cannot be considered a safe target for present or future generations, and is not supported by current science of climate stabilization or ocean protection. Earth's paleoclimate history demonstrates that climate impacts accompanying global warming of 2°C or more would be irreversible and catastrophic for humanity. For example, the paleoclimate record shows that warming consistent with CO_2 concentrations as low as 450 ppm may have been enough to melt almost all of Antarctica.[9] The warming of the past few decades has brought global temperature close to (if not slightly above) the prior maximum of the Holocene epoch. Human society must keep global temperature at a level within or close to the Holocene range to prevent dangerous climate change. Global warming of 2°C would be well above Holocene levels and far into the dangerous range and has been described as "an unacceptably high risk of global catastrophe."[10]

The widely used models that allow for 2°C temperature increase, and therefore advocate for a global CO_2 emission reduction target aimed at a 450 ppm CO_2 standard, do not take into account significant factors that will compound climate impacts. Most importantly, they do not include the slow feedbacks that will be triggered by a temperature increase of 2°C.[11] Slow feedbacks include the melting of ice sheets and the release of potent greenhouse gases, particularly methane, from the thawing of the tundra.[12] These feedbacks might show little change in the short-term, but can hit a point of no return, even at a 2°C temperature increase, that will trigger further warming and sudden catastrophic impacts. For example, the Greenland and Antarctic ice sheets "required millennia to grow to their present sizes. If ice sheet disintegration reaches a point such that the dynamics and momentum of the process take over, reducing greenhouse gases may be futile to prevent major ice sheet mass loss, sea level rise of many meters, and worldwide loss of coastal cities—a consequence that is irreversible for practical purposes."[13]

These slow feedbacks are part of the inertia of the climate system, where "[t]he inertia causes climate to appear to respond slowly to this human-made forcing, but further long-lasting responses can be locked in."[14] Thermal inertia is primarily a result of the global ocean, which stores 90% of the energy surplus, and therefore perpetuates increased global temperature even after climate forcings, or emissions, have declined.[15] Thus, the longer we wait to reduce global CO_2 concentrations, the more thermal inertia will already be in play and climate impacts will continue to escalate.

Furthermore, 2°C targets would lead to an increase in the use of fossil fuels that are more difficult to extract, and thus are compounded with the expenditure of greenhouse gases due to the transport and intensive mining process resulting in "more CO_2 [emissions] per unit useable

[9] Dec. of Dr. James E. Hansen, *Juliana et al., v. United States et al*., No. 6:15-cv-01517-TC, 14 (D. Or. Aug. 12, 2015).
[10] *Id*. at 17.
[11] Hansen, *Assessing "Dangerous Climate Change*," at 15.
[12] *Id*.
[13] *Id*. at 13; *see also* James Hansen et al., *Ice Melt, Sea Level Rise and Superstorms; Evidence from Paleoclimate Data, Climate Modeling, and Modern Observations that 2 °C Global Warming Could be Dangerous*, Atmos. Chem. & Phys. 16, 3761 (2016) [hereinafter *Ice Melt, Sea Level Rise and Superstorms*].
[14] Hansen, *Assessing "Dangerous Climate Change*," at 1.
[15] *Id*. at 4-5, 13.

energy."[16] The 2°C target also reduces the likelihood that the biosphere will be able to sequester CO_2 due to carbon cycle feedbacks and shifting climate zones.[17] Under the allowable emissions with this target, other greenhouse gases, such as methane and nitrous oxide would continue to increase, further exacerbating climate change impacts.[18] These factors are missing from the 2°C scenarios, which have been widely accepted and used in the creation of climate policies and plans.

A temperature rise of 2°C will not only lock in a further temperature increase due to thermal inertia, but it will also trigger irreversible impacts, including rapid, nonlinear sea level rise and species loss described above.[19] Most models look at sea level rise as a gradual linear response to melting ice sheets. However, "it has been argued that continued business-as-usual CO_2 emissions are likely to spur a nonlinear response with multi-meter sea level rise this century."[20] This sea level rise would occur at a pace that would not allow human communities or ecosystems to respond.

An emission reduction target aimed at 2°C would "yield a larger eventual warming because of slow feedbacks, probably at least 3°C."[21] Once a temperature increase of 2°C is reached, there will already be "additional climate change "in the pipeline" even without further change of atmospheric composition."[22] Dr. James Hansen warns that "distinctions between pathways aimed at 1°C and 2°C warming are much greater and more fundamental than the numbers 1°C and 2°C themselves might suggest. These fundamental distinctions make scenarios with 2°C or more global warming far more dangerous; so dangerous, we [James Hansen et al.] suggest, that aiming for the 2°C pathway would be foolhardy."[23] This target is at best the equivalent of "flip[ping] a coin in the hopes that future generations are not left with few choices beyond mere survival. This is not risk management, it is recklessness and we must do better."[24] Thus, a global average atmospheric concentration of CO_2 of 450 ppm, or a concentration of CO_2e between 450 and 550 ppm, would result in dangerous anthropogenic interference with the climate system and would threaten all public natural resources around the world and the health and well-being of all Earth's inhabitants.

Importantly, the Intergovernmental Panel on Climate Change ("IPCC") has not established nor endorsed a target of 2°C warming above the preindustrial period as a limit below which the climate system will be stable.[25] The 2°C figure was reached as *a compromise* between the emission reduction scenarios and associated risks summarized by Working Group I of the 2007 IPCC Fourth Assessment Report,[26] and because policy makers felt that it was

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[16] *Id*. at 15.
[17] *Id*. at 15, 20.
[18] *Id*. at 20.
[19] *Id*. at 6; Hansen, *Ice Melt, Sea Level Rise and Superstorms*, at 3761.
[20] Hansen, *Assessing "Dangerous Climate Change,"* at 20.
[21] *Id*. at 15.
[22] *Id*. at 19.
[23] *Id*. at 15.
[24] Matt Vespa, *Why 350? Climate Policy Must Aim to Stabilize Greenhouse Gases at the Level Necessary to Minimize the Risk of Catastrophic Outcomes*, 36 Ecology Law Currents 185, 186 (2009), http://www.biologicaldiversity.org/publications/papers/Why_350.pdf.
[25] See Dec. of Dr. James E. Hansen, *Juliana et al., v. United States et al*., No. 6:15-cv-01517-TC, 5 (D. Or. Aug. 12, 2015).
[26] *See* IPCC, *Summary for Policymakers*, Climate Change 2007: The Physical Science Basis (Solomon, et al. eds.)

politically achievable.[27] As the IPCC makes clear, "each major IPCC assessment has examined the impacts of [a] multiplicity of temperature changes but has left [it to the] political processes to make decisions on which thresholds may be appropriate."[28] *Two degrees Celsius warming above pre-industrial levels has never been universally considered "safe" from either a political or scientific point of view*. As the United Nations Framework Convention on Climate Change ("UNFCCC") stated: "The 'guardrail' concept, in which up to 2°C of warming is considered safe, is inadequate and would therefore be better seen as an upper limit, a defense line that needs to be stringently defended, while less warming would be preferable."[29] And according to a Coordinating Lead Author of the IPCC's 5th Assessment Report, the 2°C "danger level" seemed:

> utterly inadequate given the already observed impacts on ecosystems, food, livelihoods, and sustainable development, and the progressively higher risks and lower adaptation potential with rising temperatures, combined with disproportionate vulnerability.[30]

The most recent IPCC synthesis of climate science confirms that additional warming of 1°C (we already have 0.9°C warming above the preindustrial average) jeopardizes unique and threatened systems, including ecosystems and cultures.[31] The IPCC also warns of risks of extreme events, such as heat waves, extreme precipitation, and coastal flooding, and "irreversible regime shifts" with additional warming.[32]

Protect Ocean Life From Deadly Acidification and Warming of Ocean Waters

Conveniently, oceans have the same scientific standard of protection as the atmosphere and climate system. Marine organisms and ecosystems are already harmed and will increasingly continue to be harmed by the effects of ocean acidification. Critically important ocean ecosystems, such as coral reefs, are severely threatened by present day CO_2 concentrations of approximately 400 ppm and it is vitally important that atmospheric CO_2 levels are reduced to below 350 ppm in order to protect ocean ecosystems.[33] The IPCC never concluded that 2°C warming or 450 ppm would be safe for ocean life.[34] According to Dr. Ove Hoegh-Guldberg, one of the world's leading experts on ocean acidification and the Coordinating Lead Author of the oceans chapter of the 5th Assessment Report of the IPCC:

(2007) (Table SPM.3).

[27] *See* Dec. of Dr. Richard H. Gammon, *Foster v. Wash. Dep't of Ecology*, No. 14-2-25295-1 SEA 1 (Wash. Super. Ct. Aug. 24, 2015).

[28] IPCC, *Climate Change 2014: Mitigation of Climate Change, Contribution of Working Group III to the Fifth Assessment Report*, 125 (2014), http://report.mitigation2014.org/report/ipcc_wg3_ar5_chapter1.pdf.

[29] UNFCCC, *Report on the structured expert dialogue on the 2013–2015 review*, 18 (2015), http://unfccc.int/resource/docs/2015/sb/eng/inf01.pdf.

[30] Petra Tschakert, *1.5 °C or 2 °C: a conduit's view from the science-policy interface at COP20 in Lima, Peru*, Climate Change Responses 8 (2015), http://www.climatechangeresponses.com/content/2/1/3.

[31] IPCC, Summary for policymakers at 13-14, Climate Change 2014: Impacts, Adaptation, and Vulnerability (2014), http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/ar5_wgII_spm_en.pdf.

[32] *Id*.

[33] *See* Dec. of Dr. Ove Hoegh-Guldberg, *Foster v. Wash. Dep't of Ecology*, No. 14-2-25295-1 SEA, 1 (Wash. Super. Ct. Aug. 24, 2015).

[34] *Id*. at 2.

> Allowing a temperature rise of up to 2°C would seriously jeopardize ocean life, and the income and livelihoods of those who depend on healthy marine ecosystems. Indeed, the best science available suggests that coral dominated reefs will completely disappear if carbon dioxide concentrations exceed much more than today's concentrations. Failing to restrict further increases in atmospheric carbon dioxide will eliminate coral reefs as we know them and will deny future generations of children from enjoying these wonderful ecosystems.[35]

Even the 2015 Paris Agreement backed off of making any assumptions that 2°C is a safe level of warming (though it did not state a maximum safe level of long-term warming).[36] To prevent further degradation or the eventual depletion of the oceanic resources, it is imperative that atmospheric CO_2 concentrations be returned to below 350 ppm by the end of this century.

<u>Policies for Emission Reductions and Reforestation Must Be Aimed at 350 ppm and It Is Both Technologically and Economically Feasible to Do So</u>

It is imperative that all states and governments around the world set GHG emission limits targeted at limiting the long-term global temperature increase to no more than 1°C, or a maximum of 350 ppm in global CO_2 levels, in order to avoid the cascading, irreversible impacts that will occur with a 2°C or 450 ppm default policy based on political feasibility rather than scientific necessity. To reduce global atmospheric CO_2 to below 350 ppm by the end of this century, assuming global CO_2 emissions peaked in 2012 (they did not), would have required 6% CO_2 emission reductions per year beginning in 2013, alongside 100 GtC of global reforestation throughout the century. If emissions had peaked and reductions had began in 2005, only a 3.5% per year reduction would have been necessary to reach 350 ppm by 2100. If global CO_2 emissions peak and reductions begin in 2017, the annual rate of reduction will be 8% per year. However, if emission reductions do not begin until 2020, a 15% per year reduction rate will be required to reach 350 ppm by 2100. If reductions are delayed beyond 2020, it might not be possible to return to 350 ppm until well after 2500.[37]

Continued delay makes it harder and harder for youth and future generations to protect a livable world. It is imperative to establish emission limits that put states and sovereigns around the world on a trajectory aimed at returning atmospheric CO_2 to below 350 ppm.

Atmospheric CO_2 levels are currently on a path to reach a climatic tipping point.[38] Absent immediate action to reduce CO_2 emissions, atmospheric CO_2 may reach levels so high that life on Earth as we know it is unsustainable at these levels. Governments have the present ability to curtail the environmental harms detailed above. Atmospheric CO_2 concentrations will decrease if states stop (or greatly reduce) their burning of fossil fuels.[39] The environmental harms and threat to human health and safety as described above can only be avoided if atmospheric CO_2 concentrations are immediately reduced. Any more delay risks irreversible and catastrophic consequences for youth and future generations.

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[35] *Id*.
[36] Paris Agreement, Article 2, Section 1(a).
[37] Hansen, *Assessing "Dangerous Climate Change."*
[38] James Hansen, Storms of My Grandchildren 224-30, 260 (2009).
[39] Harvey Blatt, America's Environmental Report Card xiii (2005) ("How can we stop this change in our climate? The answer is clear. Stop burning coal and oil, the sources of nearly all the carbon dioxide increase.").

Fossil fuel emissions must decrease rapidly if atmospheric CO_2 is to be returned to a safe level in this century.[40] Improved forestry and agricultural practices can provide a net drawdown of atmospheric CO_2, primarily via reforestation of degraded lands that are of little or no value for agricultural purposes, returning us to 350 ppm somewhat sooner.[41] However, the potential of these measures is limited. Immediate and substantial reductions in CO_2 emissions are required in order to ensure that the youth and future generations inherit a planet that is inhabitable.

A zero-CO_2 U.S. energy system can be achieved within the next thirty to fifty years without acquiring carbon credits from other countries. In other words, actual physical emissions of CO_2 from fossil fuels can be eliminated with technologies that are now available or reasonably foreseeable. This can be done at reasonable cost by eliminating fossil fuel subsidies and creating annual and long-term CO_2 reduction targets. Net U.S. oil imports can be eliminated in about 25 years, possibly less. The result will also include large ancillary health benefits from the significant reduction of most regional and local air pollution, such as high ozone and particulate levels in cities, which is mainly due to fossil fuel combustion.[42]

Experts state that approaches to transition to a renewable energy system and to phase out fossil fuels by about 2050 include: A cap on fossil fuel use that declines to zero by 2050 or a gradually rising carbon tax with revenues used to promote a zero-CO_2 emissions energy system and to mitigate adverse income-distribution effects; increasingly stringent efficiency standards; elimination of direct and indirect subsidies and other incentives for fossil fuel extraction, transportation, and combustion; investment in a vigorous and diverse research, development and demonstration program; banning new coal-fired power plants and phasing out existing coal-fired power plants; adoption of a policy that would aim to have essentially carbon-free state and local governments, including almost all of their buildings and vehicles by 2030; and adoption of a gradually increasing renewable portfolio standard for electricity until it reaches 100% by about 2050.[43] Products and services already exist for building or remodeling buildings to have zero GHG emissions; for generating sufficient electricity with zero carbon dioxide emissions; for zero-emission transportation and industrial processes; and agricultural and forest processes that can also decrease GHG emissions and increase CO_2 sequestration. Governments around the world should fully consider these measures in achieving its own annual emissions reduction measures to transition off of fossil fuels.

Furthermore, experts have already prepared plans for U.S. states as well as for over 100 countries that demonstrate the technological and economic feasibility of transitioning off of fossil fuels toward 100% of energy, for all energy sectors, from clean and renewable energy sources: wind, water, and sunlight by 2050. [44]

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[40] Hansen, *Where Should Humanity Aim?*, 217 (discussing the need to reduce the atmospheric CO_2 concentration to 350 ppm).
[41] *Id*. at 227.
[42] *See* Mark Z. Jacobson et al., *100% Clean and Renewable Wind, Water, and Sunlight (WWS) All-Sector Energy Roadmaps for the 50 United States,* 8 Energy & Envtl. Sci. 2093 (2015) (for plans on how the United States and over 100 other countries can transition to a 100% renewable energy economy see www.thesolutionsproject.org); *see also* Arjun Makhijani, Carbon-Free, Nuclear-Free: A Roadmap for U.S. Energy Policy (2007).
[43] *Id*.
[44] *Id.*