



Government Climate and Energy Actions, Plans, and Policies Must Be Based on a Maximum Target of 350 ppm Atmospheric CO₂ and 1°C by 2100 to Protect Young People and Future Generations

INTRODUCTION

Human laws can adapt to nature's laws, but the laws of nature will not bend for human laws. Government climate and energy policies **must** be based on the best available climate science to protect our 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.

Because carbon dioxide (CO₂) is the primary driver of climate destabilization and ocean warming and acidification, all government policies regarding CO₂ pollution and CO₂ sequestration should be aimed at reducing global CO₂ concentrations **below 350 parts per million (ppm) by 2100**. Global atmospheric CO₂ levels, as of 2019, are approximately 407 ppm and rising.¹ An emission reductions and sequestration pathway back to 350 ppm could limit peak warming to approximately 1.3°C this century and stabilize long-term heating at 1°C above pre-industrial temperatures.

As explained in more detail below, there are numerous scientific bases and lines of evidence supporting setting 350 ppm and 1°C by 2100 as the uppermost safe limit for atmospheric CO₂ concentrations and global warming. Beyond 2100, atmospheric CO₂ may need to return to below 300 ppm to prevent the complete melting of Earth's ice sheets and protect coastal cities from sea level rise. Fortunately, it is still not only technically and economically feasible to return to those levels, but transitioning to renewable energy sources will provide significant economic and public health benefits and improve quality-of-life.

WHY 350 PPM AND 1°C LONG-TERM WARMING?

Three lines of robust and conclusive scientific evidence, based on the paleo-climate record and real-world observations show that above an atmospheric CO₂ concentration of 350 ppm there is: 1) significant global energy imbalance; 2) massive ice sheet destabilization and sea level rise; and 3) ocean warming and acidification resulting in the bleaching death of coral reefs and other marine life.

¹ Ed Dlugokencky & Pieter Tans, NOAA/ESRL, www.esrl.noaa.gov/gmd/ccgg/trends/.

1) Energy Balance

Earth's energy flow is out of balance. Because of a buildup of CO₂ in our atmosphere, due to human activities, primarily the burning of fossil fuels and deforestation,² more solar energy is retained in our atmosphere and less energy is released back into space.³ The energy imbalance of the Earth is roughly equivalent to 2500 Camp Creek⁴ fires **per day** burning around the world.⁵ Returning CO₂ concentrations to below 350 ppm would restore the energy balance of Earth by allowing as much heat to escape into space as Earth retains, an important historic balance that has kept our planet in the sweet spot for the past 10,000 years, supporting stable sea levels, enabling productive agriculture, and allowing humans and other species to thrive.⁶ The paleo-climate record shows that CO₂ levels, temperature, and sea level all move together (see Figure 1). Humans have caused CO₂ levels to shoot off the chart (circled in red), rising to levels unprecedented over the past 3 million years, and causing the energy imbalance.⁷

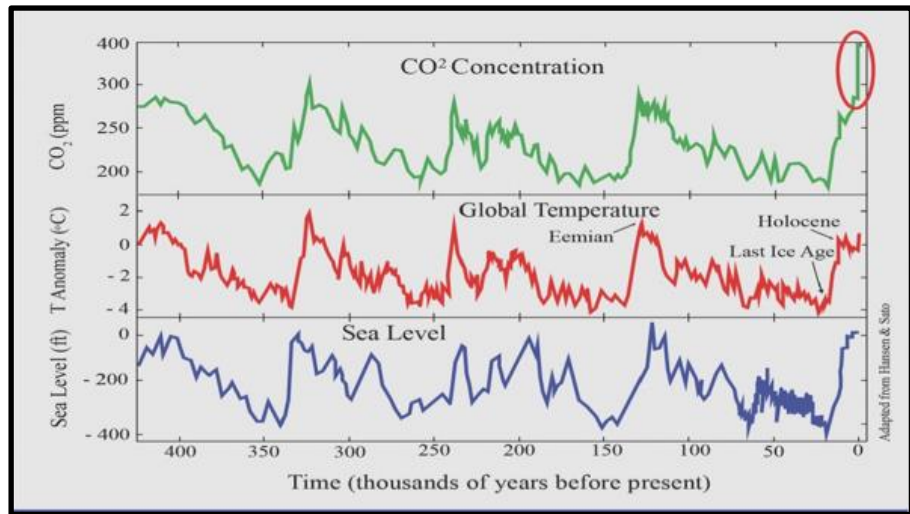


Figure 1: Evidence from the paleo-climate record showing the relationship between CO₂ concentration, global temperature, and sea level.

2) Ice Sheets and Sea Level Rise

The last time the ice sheets appeared stable in the modern era was in the 1980s when the atmospheric CO₂ concentration was below 350 ppm. The consequences of > 350 ppm and 1°C of warming are already visible, significant, and dangerous for humanity. With just 1°C of warming, glaciers in all regions of the world are shrinking, and the rate at which they are melting is accelerating.⁸ Large parts of the Greenland and Antarctic ice sheets, which required millennia to grow, are teetering on the edge

² Intergovernmental Panel on Climate Change, *Summary for Policymakers, Climate Change 2014: Impacts, Adaptation, and Vulnerability* 5 (2014).

³ 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”*].

⁴ The Camp Creek fire was the 2018 California fire, the deadliest and most destructive in the state’s history, that burned over 150,000 acres (almost 240 square miles).

⁵ Steven W. Running, *Declaration in Support of Plaintiffs, Juliana v. United States*, No. 18-36082, Doc. 21-12 (9th Cir. Feb. 7, 2019).

⁶ James Hansen, *Storms of My Grandchildren* 166 (2009).

⁷ Willeit et al., *Mid-Pleistocene transition in glacial cycles explained by declining CO₂ and regolith removal*. *Science Advances* (2019).

⁸ Zemp et al., *Global glacier mass changes and their contributions to sea-level rise from 1961-2016*. *Nature* (2019); B. Menounos, *Heterogeneous Changes in Western North American Glaciers Linked to Decadal Variability in Zonal Wind Strength*, *Geophysical Research Letters* (2018).

of irreversible disintegration, a point that if reached, would lock-in major ice sheet mass loss, sea level rise of many meters, and worldwide loss of coastal cities – a consequence that would be irreversible on any timescale relevant to humanity (see Figure 2).⁹ Greenland’s ice sheet melt is currently occurring faster than anytime during the last three and a half centuries, with a 33% increase alone since the 20th century.¹⁰ The paleo-climate record shows the last time atmospheric CO₂ levels were over 400 ppm, the seas were **70 feet higher** than they are today and that heating consistent with CO₂ concentrations as low as 450 ppm may have been enough to melt almost all of Antarctica.¹¹ While many experts are predicting multi-meter sea level rise this century, even NOAA’s modest estimate of 3-6 feet by 2100 would impact between 4 and 13 million Americans (see Figure 3).¹²



Figure 2: Antarctic melt water from the Nansen ice shelf.

Most climate models represent sea level rise as a gradual linear response to melting ice sheets, but the historic climate record shows something very different. In reality, seas do not rise slowly and predictably but rather in quick pulses as ice sheets destabilize.¹³ Scientists believe we have a chance to preserve the large ice sheets of Greenland and

Antarctica and most of our shorelines and ecosystems if we limit long-term warming by the end of the century to no more than 1°C above pre-industrial levels (short-term warming will inevitably exceed 1°C but must not exceed 1°C for more than a short amount of time).

⁹ Hansen, Assessing “Dangerous Climate Change,” 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*].

¹⁰ Trusel, L. D., et al., *Nonlinear rise in Greenland runoff in response to post-industrial Arctic warming*, *Nature* (2018).

¹¹ 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); Intergovernmental Panel on Climate Change: 2007 Working Group I: The Physical Science Basis, Chapter 6.3.2, What Does the Record of the Mid-Pliocene Show?; Dowsett & Cronin, *High eustatic sea level during the middle Pliocene: Evidence from the southeastern U.S. Atlantic Coastal Plain*, *Geology* (1990); Shackleton et al., *Pliocene stable isotope stratigraphy of ODP Site 846*, *Proceedings of the Ocean Drilling Program, Scientific Results* (1995).

¹² NOAA, Examining Sea Level Rise Exposure for Future Populations, <https://coast.noaa.gov/digitalcoast/stories/population-risk>.

¹³ Wanless, H.R., et al., *Dynamics and Historical Evolution of the Mangrove/Marsh Fringe Belt of Southwest Florida, in Response to Sea-level History, Biogenic Processes, Storm Influences and Climatic Fluctuations*. Semi-annual Research Report (June 1993 to February 1994); Hansen, *Ice Melt, Sea Level Rise and Superstorms*, at 3761; Hansen, *Assessing “Dangerous Climate Change,”* at 20.

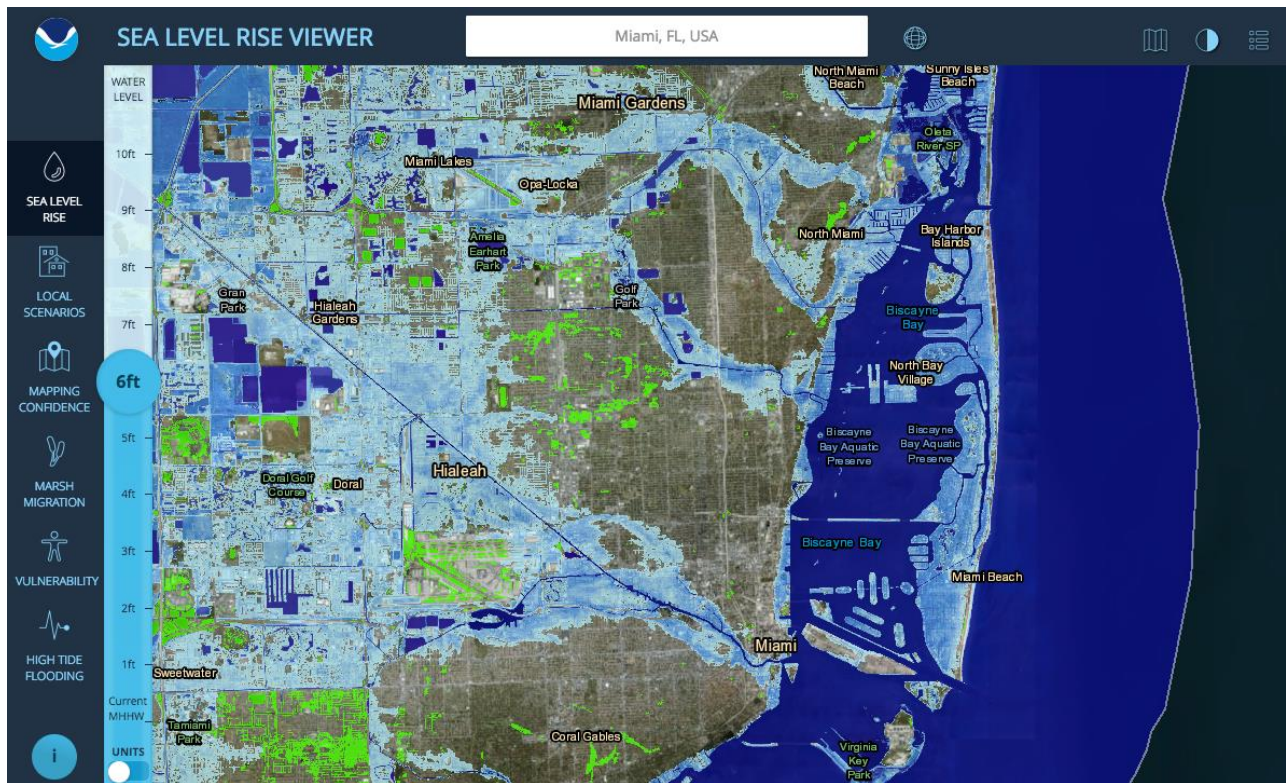


Figure 3: South Florida, including Miami, will face significant inundation with 6 feet of sea level rise.

3) Ocean Warming and Acidification

Our oceans have absorbed 93% of the excess heat in the atmosphere trapped by greenhouse gases (see Figure 4) as well as approximately 30% of CO₂ emitted into the atmosphere, causing ocean temperatures to surge and the ocean to become more acidic.¹⁴ Indeed, our oceans are warming much more rapidly than previously-thought.¹⁵ Many marine ecosystems, and particularly coral reef ecosystems, cannot tolerate the increased warming and acidity of ocean waters that result from increased CO₂ levels.¹⁶ At today's CO₂ concentration, around 407 ppm,¹⁷ critically important ocean ecosystems, such as coral reefs, are rapidly declining and will be irreversibly damaged from high ocean temperatures and repeated mass bleaching events if we do not quickly curtail emissions (see Figures 5 and 6).¹⁸ According to the Intergovernmental Panel on Climate Change, bleaching events are occurring more frequently than the IPCC previously projected and 70-90% of the world's coral

¹⁴ Hansen, *Assessing "Dangerous Climate Change,"* at 1; *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press, 2013); Cheng et al., *How fast are the oceans warming?* 363 *Science* 128 (2019); National Oceanic and Atmospheric Administration, *What is Ocean Acidification?*, <https://oceanservice.noaa.gov/facts/acidification.html>.

¹⁵ Cheng, L. et al., *How fast are the oceans warming?*, 363 *Science* 128 (2019).

¹⁶ Hughes et al., *Global warming impairs stock-recruitment dynamics of corals*, *Nature* (2019).

¹⁷ Ed Dlugokencky and Pieter Tans, NOAA/ESRL, www.esrl.noaa.gov/gmd/ccgg/trends/.

¹⁸ Frieler, K. et al., *Limiting global warming to 2 degrees C is unlikely to save most coral reefs*. *Nature Climate Change* 3:165-170. (2013); Veron, J., et al; *The coral reef crisis: The critical importance of < 350ppm CO2*. *Marine Pollution Bulletin* 58:1428-1436 (2009); Hughes, T. et al., *Spatial and temporal patterns of mass bleaching of corals in the Anthropocene*, *Science* 359: 80-83 (2018); Hughes, T. et al. *Global warming impairs stock-recruitment dynamics of corals*, *Nature* (2019).

reefs could disappear as soon as 2030 (the IPCC also predicts 99% of coral reefs will die with 2°C warming).¹⁹ Even the recent National Climate Assessment acknowledged that coral reefs in Florida, Hawaii, Puerto Rico, and the U.S. Virgin Islands have been harmed by mass bleaching and coral diseases and could disappear by mid-century as a result of warming waters.²⁰ Scientists believe we can protect marine life and prevent massive bleaching and die-off of coral reefs only by rapidly returning CO₂ levels to below 350 ppm.²¹

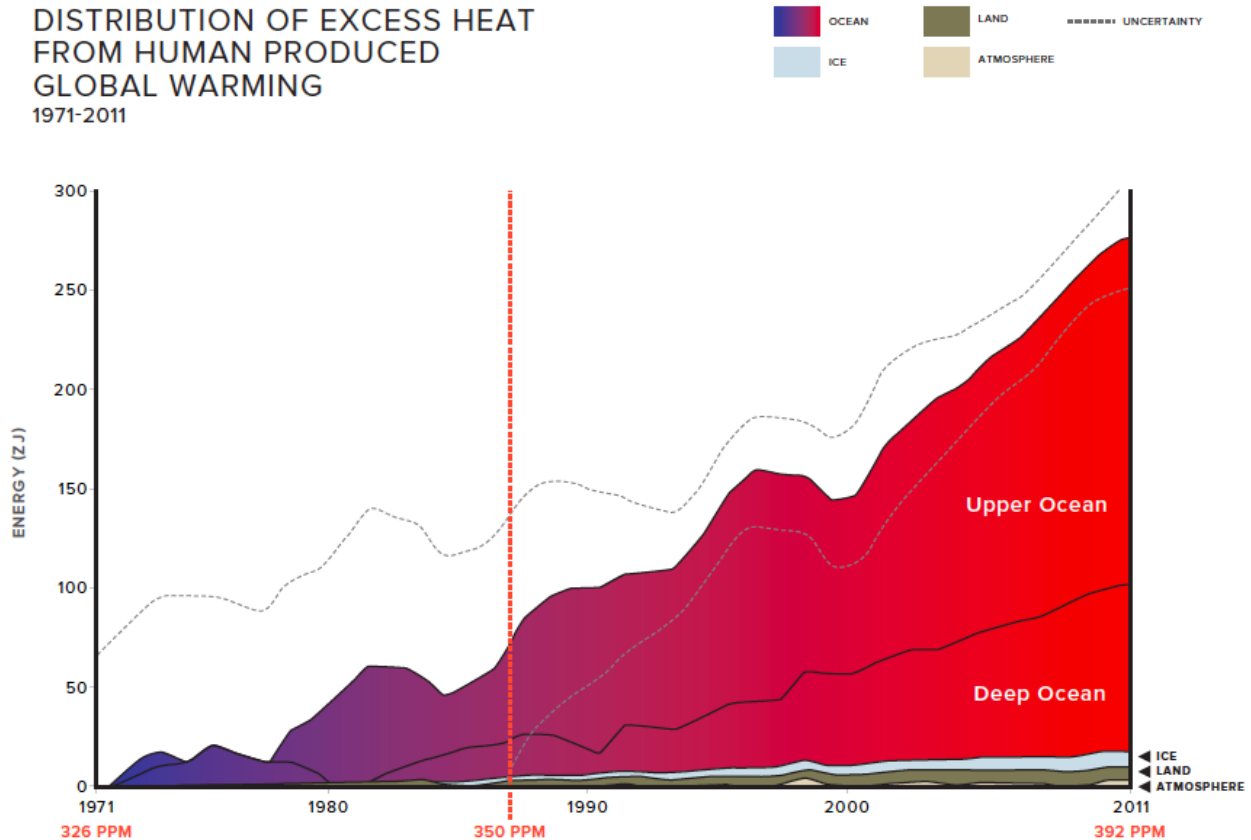


Figure 4: Over 90% of the excess energy from human caused climate change has been absorbed by the oceans, adding energy to storms and harming coral reefs around the globe.

No scientific institution, including the IPCC, has ever concluded that 2°C warming or 450 ppm would be safe for ocean life. According to Dr. Ove Hoegh-Guldberg, one of the world’s leading experts on ocean warming and acidification, and a Coordinating Lead Author on the “Oceans” chapter of the IPCC’s Fifth Assessment Report and on the “Impacts of 1.5°C global warming on natural and human systems” of the IPCC’s Special Report on 1.5°C:

¹⁹ Hoegh-Guldberg, Ove, et al., *Impacts of 1.5°C Global Warming on Natural and Human Systems*. In *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* at pp. 225-226 (2018); IPCC, [Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C Approved by Governments](#) (2018).

²⁰ Pershing, A. J., et al., *Oceans and Marine Resources*. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, USGCRP (2018);

²¹ Veron, J., et al., *The coral reef crisis: The critical importance of <350 ppm CO₂*, 58 *Marine Pollution Bulletin* 1428 (2009).

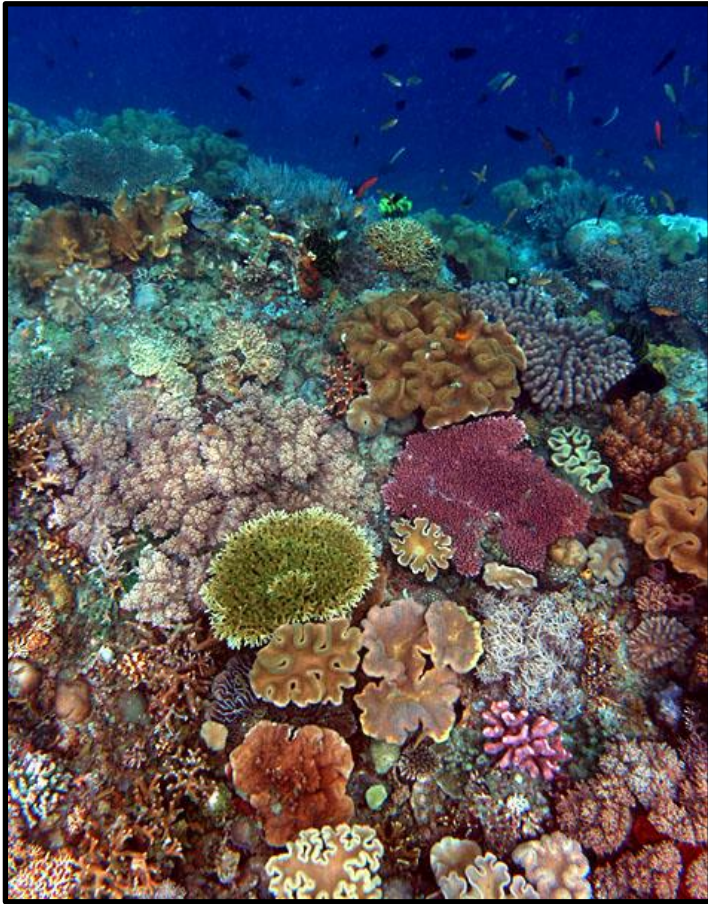


Figure 5: Healthy coral like this are already gravely threatened and will likely die with warming of 1.5°C.

“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.”²²



Figure 6: Bleached coral from warmer ocean temperatures.

ADDITIONAL OBSERVATIONS ILLUSTRATE THE DANGERS OF INCREASED WARMING

In addition to the evidence discussed above which illustrates the necessity of ensuring that the atmospheric CO₂ concentration returns to no more than 350 ppm, based on present day observations about climate impacts occurring **now**, it is clear that the present level of 1°C is already causing significant climate impacts and additional warming will exacerbate these already dangerous impacts. Climate impacts that are already being experienced today include:

- Declining snowpack and rising temperatures are increasing the length and severity of drought conditions, especially in the western United States and Southwest, causing problems for agriculture users, forcing some people to relocate, and leading to water restrictions.²³
- In the western United States, the wildfire season is now almost three months longer (87 days) than it was in the 1980s.²⁴

²² *Id.*

²³ Steven W. Running, [Declaration in Support of Plaintiffs, Juliana v. United States](#), No. 18-36082, Doc. 21-12 (9th Cir. Feb. 7, 2019).

²⁴ Steven W. Running, [Declaration in Support of Plaintiffs, Juliana v. United States](#), No. 18-36082, Doc. 21-12 (9th Cir.

- Extreme weather events, such as intense rainfall events that cause flooding, are increasing in frequency and severity because a warmer atmosphere holds more moisture.²⁵ What are supposedly 1-in-1000-year rainfall events are now occurring with alarming frequency – in 2018 there were at least five such events.²⁶
- Tropical storms and hurricanes are increasing in intensity, both in terms of rainfall and windspeed, as warmer oceans provide more energy for the storms (we saw this with Hurricanes Harvey, Irma, and Maria in 2017) (Figure 7).²⁷
- Terrestrial ecosystems are experiencing compositional and structural changes, with major adverse consequences for ecosystem services.²⁸
- Terrestrial, freshwater, and marine species are experiencing a significant decrease in population size and geographic range, with some going extinct and others are facing the very real prospect of extinction – the rapid rate of extinctions has been called the 6th mass extinction.²⁹
- Human health and well-being are already being affected by heat waves, floods, droughts, and extreme events; infectious diseases; quality of air, food, and water.³⁰ Doctors and leading medical institutions are calling climate change a “health emergency.”³¹ Children are being uniquely impacted by climate change.³²
- In addition to physical harm, climate change is causing mental health impacts, ranging from stress to suicide, due to exposure to climate impacts, displacement, loss of income, chronic stress, and other impacts of climate change.³³



Figure 7: Flooding in Port Arthur, Texas on August 13, 2018 after Hurricane Harvey.

Feb. 7, 2019).

²⁵ Kevin E. Trenberth, [Declaration in Support of Plaintiffs, Juliana v. United States](#), No. 18-36082, Doc. 21-3 (9th Cir. Feb. 7, 2019).

²⁶ Belles, F., *America’s ‘One-in-1,000-Year’ Rainfall Events in 2018*, The Weather Channel (Sept. 27, 2018).

²⁷ Kevin E. Trenberth, [Declaration in Support of Plaintiffs, Juliana v. United States](#), No. 18-36082, Doc. 21-3 (9th Cir. Feb. 7, 2019).

²⁸ Nolan et al., *Past and future global transformation of terrestrial ecosystems under climate change*, Science (2018).

²⁹ G. Ceballos, et al., *Accelerated modern human-induced species losses: Entering the sixth mass extinction*, Science Advances (2015); Steven W. Running, [Expert Report, Juliana v. United States](#), No. 6:15-cv-01517-TC, Doc. 264-1 (D. Or. June 28, 2018).

³⁰ Ebi, K. L., et al., *Human Health*. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, USGCRP (2018).

³¹ Solomon, C. G. & LaRocque R. C., *Climate Change – A Health Emergency*, N. Engl. J. Med. 380:3 (2019).

³² May, C., et al., *Northwest*. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, USGCRP (2018); Watts, N., et al., *The 2018 report of the Lancet Countdown on health and climate change: shaping the health of nations for centuries to come*, Lancet, Vol. 392 at 2482 (2018); [Brief of Amici Curiae Public Health Experts, Public Health Organizations, and Doctors in Support of Plaintiffs](#), No. 18-36082, Doc. 47 (9th Cir. Mar. 1, 2019).

³³ Lise Van Susteren, [Expert Report, Juliana v. United States](#), No. 6:15-cv-01517-TC, Doc. 271-1 (D. Or. June 28, 2018).



Figure 8: Offutt Air Force Base was impacted by flood waters during flooding in Nebraska during spring 2019.

• As Congress has recognized, “climate change is a direct threat to the national security of the United States and is impacting stability in areas of the world both where the United States Armed Forces are operating today, and where strategic implications for future conflict exist.”³⁴ Senior military leaders have called climate change “the most serious national security threat facing our Nation today,”³⁵ a conclusion similarly recognized by our Nation’s intelligence community.³⁶ Climate change is increasing

food and water shortages, pandemic disease, conflicts over refugees and resources, and destruction to homes, land, infrastructure, and military assets, directly threatening our military personnel and the “Department of Defense’s ability to defend the Nation” (see Figure 8).³⁷

- Climate change is already causing vast economic harm in the United States. Since 1980 the United States has experienced 246 climate and weather disasters that each caused damages in excess of \$1 billion, for a total cost of \$1.6 trillion.³⁸ In 2018 alone, Congress appropriated more than \$130 billion for weather and climate related disasters.³⁹

These already serious impacts will grow in severity and will impact increasingly large numbers of people and parts of the world if CO₂ concentrations continue to rise. If we want our children and grandchildren to have a safe planet to live on, full of health and biodiversity rather than chaos and conflict, we must follow the best scientific prescription to restore Earth’s energy balance and avoid the destruction of our planet’s atmosphere, climate, and oceans.

³⁴ National Defense Authorization Act for Fiscal Year 2018, Pub. L. No. 115-91, 131 Stat. 1358.

³⁵ Vice Admiral Lee Gunn, USN (Ret.), *Declaration in Support of Plaintiffs, Juliana v. United States*, No. 18-36082, Doc. 21-17 (9th Cir. Feb. 7, 2019) (emphasis in original); see also CNA Military Advisory Board, *National Security and the Accelerating Risks of Climate Change* (2014), https://www.cna.org/cna_files/pdf/MAB_5-8-14.pdf.

³⁶ National Intelligence Council, *Implications for US National Security of Anticipated Climate Change* (Sept. 2016), https://www.dni.gov/files/documents/Newsroom/Reports%20and%20Pubs/Implications_for_US_National_Security_of_Anticipated_Climate_Change.pdf.

³⁷ U.S. Dep’t of Defense, *2014 Climate Change Adaptation Roadmap* (2014), https://www.acq.osd.mil/eie/downloads/CCARprint_wForward_e.pdf.

³⁸ NOAA, *Billion Dollar U.S. Weather/Climate Disasters 1980-2019* (2019), <http://www.ncdc.noaa.gov/billions/events.pdf>.

³⁹ U.S. House of Representatives Committee on the Budget, *The Budgetary Impact of Climate Change 2* (Nov. 27, 2018).

INTERNATIONAL POLITICAL TARGETS OF 1.5°C OR 2°C ARE NOT SCIENCE-BASED AND ARE NOT SAFE

International, politically-recognized targets like 1.5°C or “well below” 2°C – which are commonly-associated with long-term atmospheric CO₂ concentrations of 425 and 450 ppm, respectively – have not been and are not presently considered safe or scientifically-sound targets for present or future generations.

Importantly, the Intergovernmental Panel on Climate Change (“IPCC”) has never established nor endorsed a target of 1.5°C or 2°C warming as a limit below which the climate system will be stable.⁴⁰ It is beyond the IPCC’s declared mandate to endorse a particular threshold of warming as “safe” or “dangerous.” 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.”⁴¹

Neither 1.5°C nor 2°C warming above pre-industrial levels has ever been considered “safe” from either a political or scientific point of view. The 2°C figure was originally adopted in the political arena “from a set of heuristics,” and it has retained predominantly political character ever since.⁴² It has recently been all-but-abandoned as a credible policy goal, in light of the findings in IPCC’s 1.5°C Special Report, and the mounting evidence leading up to its publication, that 2°C would be catastrophic relative to lower, still-achievable levels of warming.⁴³

On the other hand, the idea of a 1.5°C target was first raised by the Association of Small Island States (AOSIS) in the negotiations leading up to the ill-fated 2009 UNFCCC Conference of Parties in Copenhagen.⁴⁴ AOSIS, however, was explicitly advocating a *well below* 1.5°C and *well below* 1°C target, on the basis of the research of Dr. James Hansen and his colleagues.⁴⁵ Political compromise on this science-based target then led to the adoption of a goal of “pursuing efforts to limit the

⁴⁰ 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).

⁴¹ 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.

⁴² Randalls, S. *History of the 2°C Temperature Target*. 1. WIREs Climate Change 598, 603 (2010); Jaeger, C. and J. Jaeger, *Three views of two degrees*. 11(Suppl 1) Regional Environmental Change S15 (2011).

⁴³ 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; UNFCCC, *Report on the structured expert dialogue on the 2013–2015 review*, 18 (2015),

<http://unfccc.int/resource/docs/2015/sb/eng/inf01.pdf>; 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>; IPCC, *Global warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* (2018), <https://www.ipcc.ch/sr15/>.

⁴⁴ See Webster, R. *A brief history of the 1.5C target*. Climate Change News (December 10, 2015), <http://www.climatechangenews.com/2015/12/10/a-brief-history-of-the-1-5c-target/>; *Submission from Grenada on behalf of AOSIS to the Ad Hoc Working Group on Further Commitments for Annex I Parties Under the Kyoto Protocol*, U.N. Doc. FCCC/KP/AWG/2009/MISC.1/Add.1 (25 March 2009), <https://unfccc.int/sites/default/files/resource/docs/2009/awg7/eng/misc01a01.pdf>.

⁴⁵ *Submission from Grenada on behalf of AOSIS to the Ad Hoc Working Group on Further Commitments for Annex I Parties Under the Kyoto Protocol*, U.N. Doc. FCCC/KP/AWG/2009/MISC.1/Add.1 (25 March 2009), <https://unfccc.int/sites/default/files/resource/docs/2009/awg7/eng/misc01a01.pdf>, citing Hansen, J. et al. *Target Atmospheric CO₂: Where Should Humanity Aim?* 2 The Open Atmospheric Science Journal 217 (2008).

temperature increase to 1.5°C above pre-industrial levels” in Article 2 of the Paris Agreement. Yet the 2018 IPCC Special Report on 1.5°C has made clear that allowing a temperature rise of 1.5°C:

is **not considered ‘safe’** for most nations, communities, ecosystems, and sectors and poses significant risks to natural and human systems as compared to current warming of 1°C (*high confidence*)⁴⁶

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.”⁴⁷ 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.”⁴⁸

Tellingly, more than 45 eminent scientists from over 40 different institutions have published in peer-reviewed journals finding that the maximum level of atmospheric CO₂ consistent with protecting humanity and other species is 350 ppm, and no one, including the IPCC, has published any scientific evidence to counter that 350 is the maximum safe concentration of CO₂.⁴⁹

A 1.5° OR 2° C TARGET RISKS LOCKING-IN DANGEROUS FEEDBACKS

The longer the length of time atmospheric CO₂ concentrations remain at dangerous levels (i.e., above 350 ppm) and there is an energy imbalance in the atmosphere, the risk of triggering, and locking-in, dangerous warming-driven feedback loops increases. The 1.5°C or 2°C target reduces the likelihood that the biosphere will be able to sequester CO₂ due to carbon cycle feedbacks and shifting climate zones.⁵⁰ As temperatures warm, forests burn and soils warm, releasing their carbon. These natural carbon “sinks” become carbon “sources” and a portion of the natural carbon sequestration necessary to drawdown excess CO₂ simply disappear. Another dangerous feedback includes the release of methane, a potent greenhouse gas, as the global tundra thaws.⁵¹ These feedbacks might show little change in the short-term, but can hit a point of no return, even at a 1.5°C or 2°C temperature increase, which will trigger accelerated heating and sudden *and irreversible* catastrophic impacts. Moreover,

⁴⁶ Roy, J., et al., *Sustainable Development, Poverty Eradication and Reducing Inequalities*. In *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* at 447 (2018) (emphasis added).

⁴⁷ *Id.* at 15.

⁴⁸ 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.

⁴⁹ James Hansen, et al., *Target Atmospheric CO₂: Where Should Humanity Aim?* (2008); James Hansen, et al., *Assessing “Dangerous Climate Change”: Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature* (2013); 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* (2016); James Hansen, et al., *Young People’s Burden: Requirement of Negative CO₂ Emissions* (2017); Veron, J., et al., *The Coral Reef Crisis: The Critical Importance of <350 ppm CO₂* (2009); Frieler, K., et al., *Limiting global warming to 2 °C is unlikely to save most coral reefs* (2012).

⁵⁰ *Id.* at 15, 20.

⁵¹ *Id.*

an emission reduction target aimed at 2°C would “yield a larger eventual warming because of slow feedbacks, probably at least 3°C.”⁵² 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.”⁵³

IT IS TECHNOLOGICALLY AND ECONOMICALLY FEASIBLE TO REDUCE CO₂ LEVELS TO 350 PPM BY 2100

There are two steps to reducing CO₂ levels to 350 ppm by the end of the century: 1) reducing CO₂ emissions; and 2) sequestering excess CO₂ already in the atmosphere. Carbon dioxide emission reductions of approximately 80% by 2030 and close to 100% by 2050 (in addition to the requisite CO₂ sequestration) are necessary to keep long-term warming to 1°C and the atmospheric CO₂ concentration to 350 ppm. Emission reduction targets that seek to reduce CO₂ emissions by 80% by 2050 are consistent with long-term warming of 2°C and an atmospheric CO₂ concentration of 450 ppm, which, as described above, would result in catastrophic and irreversible impacts for the climate system and oceans. Importantly, it is economically and technologically feasible to transition the entire U.S. energy system to a zero-CO₂ energy system by 2050 and to drawdown the excess CO₂ in the atmosphere through reforestation and carbon sequestration in soils.⁵⁴

Deep Decarbonization Pathways Project and Evolved Energy Research recently completed research and very sophisticated modeling describing a nearly complete phase out of fossil fuels in the U.S. by 2050.⁵⁵ They describe six different technologically feasible pathways to drastically, and quickly, cut our reliance on fossil fuels and achieve the requisite level of emissions reductions in the U.S. while meeting our nation’s forecasted energy needs. All of the 350 ppm pathways rely on four pillars of action: a) investment in energy efficiency; b) electrification of everything that can be electrified; c) shifting to very low-carbon and primarily renewable electricity generation; and d) carbon dioxide capture as fossil fuels are phased out. The six scenarios are used to evaluate the ability to meet the targets even absent one key technology. For example, one scenario describes a route to 350 absent construction of new nuclear facilities; another illustrates getting to 350 with extremely limited biomass technology; still another describes a way to 350 without any carbon capture and storage. Even absent a key technology, each of these six routes are viable and cost effective.

The study also concludes that the cost of the energy system transition is affordable. The total cost of supplying and using energy in the U.S. in 2016 was about 5.6% of GDP (see Figure 9).⁵⁶ A transition from fossil fuels to low carbon energy sources is expected to increase those costs by no more than an additional two to three percent of GDP. Even with this small and temporary added expense, the cost would still be well below the 9.5% of GDP spent on the energy system in 2009 (not to mention well below the harm to the economy caused by climate change). Once the transition is complete, the cost

⁵² Hansen, Assessing “Dangerous Climate Change,” at 15.

⁵³ *Id.* at 19.

⁵⁴ 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 & Env’tl. 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); B. Haley et al., *350 ppm pathways for the United States* (2019).

⁵⁵ B. Haley et al., *350 ppm pathways for the United States* (2019).

⁵⁶ B. Haley et al., *350 ppm pathways for the United States* (2019).

of energy will remain low and stable because we will no longer be dependent on volatile global fossil fuel markets for our energy supplies. As Nobel Laureate Economist Dr. Joseph Stiglitz has stated: “[t]he benefits of making choices today that limit the economic costs of climate change far outweigh any economic costs associated with limiting our use of fossil fuels.”⁵⁷

Other experts have already prepared plans for all 50 U.S. states as well as for over 139 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 (with 80% reductions in fossil fuels by 2030).⁵⁸

Products already exist that enable new construction or retrofits that result in zero

greenhouse gas buildings. We have the technology to meet all electricity needs with zero-emission electric generation. We know how to achieve zero-emission transportation, including aviation. These actions result in other benefits, such as improved health, job creation, and savings on energy costs.

The amount of natural carbon sequestration required is also proven to be feasible. Researchers have evaluated the potential to drawdown excess carbon dioxide in the atmosphere by increasing the carbon stored in forests, soils, and wetlands, and have found significant potential for these natural systems to support a return to 350 ppm by the end of the century.⁵⁹ We know the agricultural, rangeland, wetland, and forest management practices that decrease greenhouse gas emissions and increase sequestration.

There is no scientific, technological, or economic reason to *not* adopt a 350 ppm and 1°C by 2100 target. There are abundant reasons for doing so, not the least of which is to do our best through human laws to respect the laws of nature and create a safe and healthy world for children and future generations who will walk this Earth.

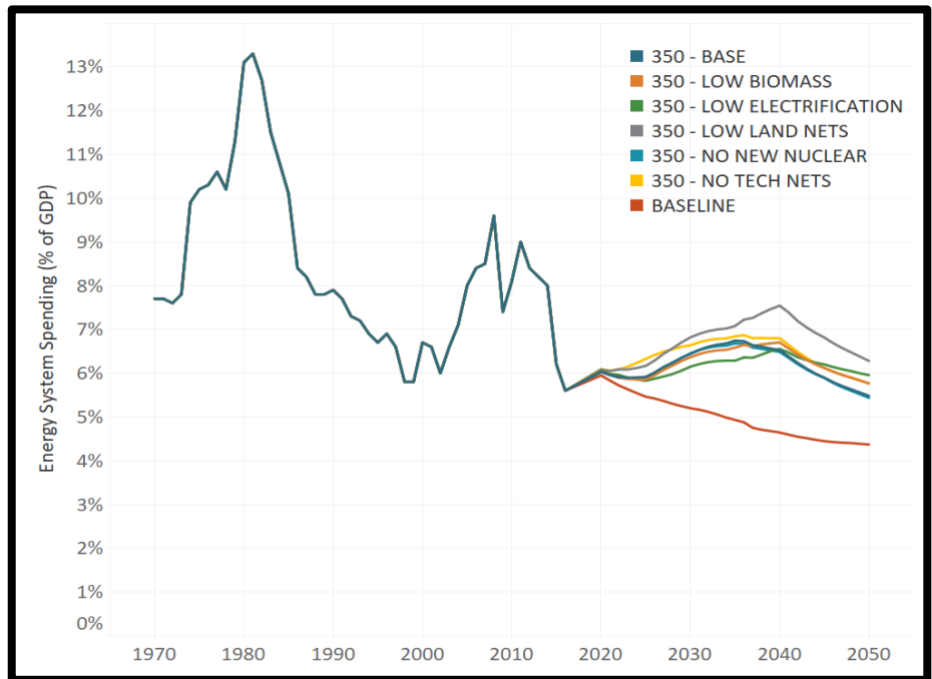


Figure 9: Historic and Projected Costs of Energy in the U.S.

⁵⁷ Joseph E. Stiglitz, Ph.D., *Declaration in Support of Plaintiffs, Juliana v. United States*, No. 18-36082, Doc. 21-14 (9th Cir. Feb. 7, 2019).

⁵⁸ 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 & Env'tl. Sci. 2093 (2015). For a graphic depicting the overview of the plan for the United States see: <https://thesolutionsproject.org/why-clean-energy/#/map/countries/location/USA>.

⁵⁹ Benson W. Griscom et al., *Natural Climate Solutions*, Proceedings of the National Academies of Sciences (2017); Joseph E. Fargione et al., *Natural Climate Solutions for the United States*, Science Advances (2018).