



Climate Deadline 2035

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WHY ONLY DIRECT ATMOSPHERIC CARBON REMOVAL CAN STOP GLOBAL WARMING BEFORE THE 2035 “TIPPING LEVEL” DEADLINE

*“The definition of a pessimist is someone who sees difficulty in every opportunity.
Optimists see opportunity in every difficulty.”
- Sir. Winston Churchill*

*“The only thing necessary for the triumph of evil
is for good men to do nothing.”
- Edmund Burke*

Note: All of the information in this article and the following Climate Deadline Quiz is based on observational, or controlled research published in peer-reviewed journals by universities and organizations including the National Aeronautics and Space Administration, the Intergovernmental Panel on Climate Change, Oak Ridge National Laboratories, the National Science Foundation, the Council on Environmental Quality, the US Department of Agriculture, the US Central Intelligence Agency, the US Department of Defense, the US Department of Energy, the US Department of the Interior, the Bureau of Land Management, the US Fish and Wildlife Service, the National Park Service, the US Geological Survey, the National Oceanic and Atmospheric Administration, the Woods Hole Oceanographic Institute, the US Environmental Protection Agency, The Lancet Commission on Health and Climate Change, the United Nations Environment Program and others.)

A CRUCIAL TURNING POINT

It is early 2019 and there are still a few yard signs to be seen from my campaign last year for Governor of Arizona in hopes of impacting climate change. As the election wrapped up, once again major fires were threatening the nearby state of California. So far, the death toll as a result of a single fire in Northern California, the Camp Fire, now stands at 88, most of the victims burned alive – burned alive. According to the Butte County Sheriff's Department, 563 people remain unaccounted for. The Camp Fire has burned more than 153,000 acres and has destroyed more than 13,000 residences, as well as 514 commercial structures and more than 4,000 other buildings. Asking for help fire officials are stressing the connection between Climate Change and increasingly deadly and extensive fires. *(Over 137 deadly wildfires burned more than 1,830,00 acres in the Western United States during the 2017 fire season alone.)*



Meanwhile, flooding along the Missouri river triggered preparations to shut down power plants, including the Cooper Nuclear Plant, forcing 1,200 people to evacuate. Elsewhere a 30-knot windstorm, probably the first in Nepalese history, hit Bara and Parsa districts killing 28 and injuring over 500 people. Mozambique, Malawi, Madagascar, Zimbabwe, South Africa Tropical Cyclone Idai left entire cities demolished, close to 1,000 dead and more on the way from disease and starvation.



Farther north in neighboring Canada, as I write this the bodies of Valérie Théorêt and her 10-month-old daughter, Adele Roesholt, were found by her husband. They had been mauled to death by a grizzly bear – their bodies ripped apart. Wildlife experts report that bears are staying out longer than usual because of warmer conditions. Erratic climate is driving older bears to attack humans out of desperation due to hunger.



In spite of my years of experience on Search & Rescue teams, it remains difficult for me to imagine the horror of being burned alive, the helplessness of being at the mercy of a massive windstorm, or the terror and pain of being ripped apart by the teeth and claws of a large animal.

In 2017, unnaturally rising ocean temperatures and vastly increased amounts of water in the airstream overhead helped to spawn hurricane Harvey. (Hurricanes now last over 60 percent longer and have peak winds 50 percent greater than only a generation earlier.) The devastating super-storm left Houston and 50 counties around it submerged and battered. More than 30,000 people fled to shelters, 21.5 percent of oil production and 23.2 percent of natural gas production has shut down, and there remains estimated \$180 billion dollars in damage.



Meanwhile, Hurricane Irma, the most powerful Atlantic Ocean hurricane ever recorded, with wind speeds over 185 miles per hour evacuated 5.6 million people from Florida and left millions without power, and thousands of homes destroyed. In the United States, all of the Virgin Islands and Puerto Rico remained without power for months, and, in many areas, without drinking water... including *all of the hospitals on Puerto Rico.*

World-wide the United Nations is currently reporting that 65.9 million people are forcibly displaced a result of “climate-related disasters” - not including those even now being forced to relocate in high latitudes as NOAA reports this year’s arctic ice “shows no sign of returning to a reliably frozen state”. The fire season of the American West is already 150 days longer than it was 50 years ago. Heat waves are 150 times more frequent than in pre-industrial times, and often reach levels over 120 degrees Fahrenheit. Extreme heat events now cause more deaths annually in the United States than all other extreme weather events combined. Most at risk are the elderly and disabled, as well as infants and children. Mud slides have increased by 400percent since the 1950s. “Atmospheric rivers” have caused seven thousand-year flood events in seven years. Currently, 20,000,000 people worldwide are nearing starvation.

Fifty percent of the world’s population in coastal areas are expected to experience major flooding by the year 2070. In addition to the lives lost, the economic impact would be devastating. For example, New York City, with real estate valued at \$120 billion, currently lies in the flood zone. In 2012, Hurricane Sandy caused *billions* of dollars in damage, including flooding the 9/11 Memorial with seven feet of water. Tomas Regalado, mayor of the City of Miami, stated in 2016, “Anyone who thinks that the topic of climate change is a partisan issue is not focused on the reality which we as public officials and citizens are dealing with. This is a crisis that grows day by day.”

Air pollution now kills 6.5 million people yearly and, in some areas, life expectancy has already been reduced more than five years due to heat stress, infectious disease, and waterborne diseases such as cholera, dysentery, hepatitis-A, typhoid fever, e. coli, campylobacter, and cryptosporidium.

In 2015, The Lancet Commission on Health and Climate Change stated, “Climate change is a medical emergency.” Natural ecosystems are being disrupted in ways that make it easier for infectious disease to develop and spread. Even slight increases in temperature can lead to dramatic increases in microbes. Increasing temperatures and precipitation factors enable disease carrying insects such as mosquitoes to expand their range, reproduce more often, and increase their metabolism so they feed more frequently.

By 2040, many allergens will have increased by 200%, with grams of pollen increasing from 8,455 grains per cubic meter to 21,735 grains per cubic meter.

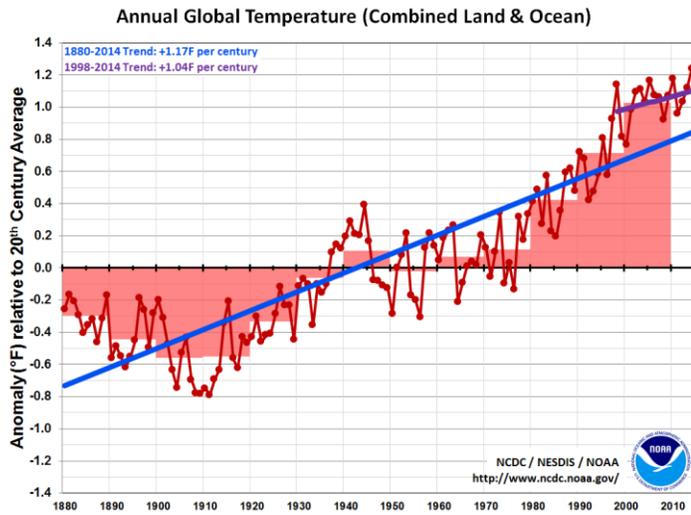
During the 21st century, we are projected to lose *half of all land-based species*. Animals who can relocate to cooler temperatures are moving an average of 15 feet per day toward the poles.

Each day, millions of tons of CO₂ are dissolved in seawater, reacting to form carbonic acid (H₂CO₃). This reaction lowers the pH of the ocean, which is indicative of its rising acidity. By 2050, more than 90 percent of the Earth’s ecologically critical coral, where many fish species are born and raised, will be completely lifeless.

Of course, none of these tragedies large or small are evidence of climate change. For that we need to look to scientific data collected over long periods of time (see NOAA chart below). What I am sharing with you now is the human face of climate change. The very real pain which will soon begin to increase exponentially if we do not intervene. Indeed, most of us have already been affected in some way by this immense process of atmospheric disruption even if it is only increased exposure to allergens, air pollution, contaminated water, or unpleasant temperatures.

On our present trajectory, our grandchildren *will* face a future of freakish superstorms, increasingly deadly and prevalent parasites and illnesses, vastly increased wildfires, catastrophic sea rise, flooding of coastal areas where 90 percent of the world’s population is clustered, collapsing economies, relentless heat waves, megadroughts, mud slides triggered by “rain bombs,” and crop failures. As a result, our grandchildren will also face starvation and unsustainable mass migrations, such as we are currently seeing in the Mediterranean region and the resulting

violence. We are already seeing this happening. Syria’s civil war occurred after the 2006–2010 drought, which turned 60percent of Syria’s fertile land into desert, prompting the Syrian Minister of Agriculture to announce the situation was “beyond our capacity as a country to deal with.” The window for fixing the problem is closing.



Whether measured in massive disasters costing taxpayers hundreds of billions of dollars or in a single human life, humanity is now engaged in the most deadly, far-reaching conflict it has ever faced. Humankind has changed life on Earth - geologists refer to this as the “Anthropocene Epoch” in Earth’s evolution. We have “assumed dominion over the Earth”....and promptly broken it. We have changed this planet so much that we are now faced with a planet-wide global warming crisis – a crisis that requires not the far-off wishing of “sustainability”, but *a massive response not seen since the mobilization to the Second World War.*

LET’S TRY NOT TO GO OUT WITH A WHIMPER

As a juried nature photographer, I initially became alarmed by the condition of our ecosystem a number of years ago while photographing fracking sites immediately adjacent to the headwaters of the Colorado River - from which many of you are drinking water right now today. Hydraulic Fracturing for fossil fuel resources involves the use of highly toxic chemicals which often leak or spill during the process and then are usually stored in concrete tanks under the ground near aquifers. Fortunately, concrete never cracks (especially when exposed to varying geologic pressures) right? Right?



After this experience I began training with Al Gores “Climate Reality” team which then led me to work with and a specialized group of senior scientists and engineers working for the past dozen years on Ocean Assisted Carbon Capture & Reflection (more on OCC&R later). In January 2018 I began my campaign for Arizona Governor in order to gain public awareness for OACC&R which has the potential to restore our atmosphere to its pre-industrial condition.

I picked a good year to run. *The year 2018 will mark the point when Americans transitioned from climate denial to climate change acceptance.* If you are like most of us conscious human beings you know the score, you feel it in your bones and your jangled nerves. Something is terribly, terribly wrong. It’s not the passing political landscape – it’s bigger and more primal....and it’s getting worse not better. Eleven months later at the end of the campaign season we have collectively made a rapid move to a clear awareness that there is a global threat to our atmosphere. (An awareness fossil-fuel companies have been fighting to keep below our consciousness for decades.)

From where we are now in our “climate awakening” we need to make *3 more critical leaps in our understanding.* *First,* we need to grasp the immediacy of the threat. We have only until the mid-2030’s to reign in global warming or we will trigger an exponentially-synergistic cascade into probable near-extinction. I refer to this as our “Climate Deadline”. *Secondly,* we need to accept the reality that carbon already in our atmosphere is not going

anywhere no matter how fast we put the brakes on further carbon emissions. Even if we stopped ALL carbon emissions right now today, what is already “up there” is enough to drag us into a death-spiral ending, most probably, in a long-slow-painful-extinction. *Thirdly*, we need to get into gear and start removing those gigatons of carbon already in the atmosphere.

Now, here is the good news – *we know how to do this!* It will be a large and expensive endeavor (think about the mobilization to World War II and you will be in the ballpark), but we have the technology and nature itself has a blueprint. We CAN fix Climate Disruption. I lost my bid to get the ball rolling leveraging state government, but I am now on to filing a Federal Climate Lawsuit – and you are welcome to join me.

We collectively came out of climate denial in 2018 and now are in some sort of weird shock – but don’t confuse this with the stages of grieving. Grief is NOT an appropriate response to global warming (though possibly to specific losses we experience due to climate change). Why? Well, at the end of the traditional stages of grieving is *acceptance*. Do you really want to be in a process that eventually leads to *acceptance of the end of our civilization*? What if during World War II we looked over at Europe and said, “How sad. Let’s all have a group cry.” Not really what was needed. The appropriate response was to fight HARD against something that was wrong and work to correct it.

I have authored 24 books including one on the topic at hand (“Climate Deadline 2035”) and never plagiarized in all those years. Never occurred to me. Yet I am happy to say I shamelessly pirated some of the background in Juliana V. United States. Why now? Most people would cite the fact that I am losing, not making, money on this effort. The main reason, however, is - as I hope I conveyed - that we are in an emergency comparable to the days just prior to World War II. The Greatest Generation were not squeamish when Ford, GM and other manufacturers copying designs in the service of creating the best possible tools to fight the War. It was an emergency, and everyone understood that. To even suggest plagiarism in the service to resolving a world crisis would have been seen as shameful at the time. We are in a much worse emergency now and part of what is making the emergency worse is that people are not yet getting that it IS an emergency (in the same way they were not listening to those of us saying climate disruption was a real issue 5 years ago). With 15 years give or take a couple to mount a massive carbon removal effort (even reducing emissions to zero TODAY would not change the fact that we already have far too much carbon (et al) in the atmosphere to have a hope of missing the “tipping levels” coming up around 450ppm. To quibble about who owns what idea under these circumstances only provides more proof that matters cannot be left in their hands. They can't grasp the urgency of the situation AND be concerned about niceties like whose idea was this or that. As I said, this is a time for “All hands-on deck” and people need to start to get that NOW.

The primary architect of Ocean Assisted Carbon Capture 7 Reflection is Robert Fry. Bob is one of those very, very rare and amazing geniuses. I left Bob Fry's think tank because he had fallen in with a group of corporate types that were actually thinking of profiting from OACC&R - keeping it essentially “under wraps” until Exxon Mobile or some other carbon major got nervous enough to seek out a solution to their global warming fiasco. I regard this as “war profiteering” so I left the group after 2 years and have no qualms about telling everyone possible about OACC&R. The horror of the future that our future generations are facing as things stand now outweighs most other considerations. This is the reality of climate change ethics in my view.

WE ARE NOT THE FIRST CIVILIZATION TO FACE EXTINCTION

Now before you get too upset, we are *not* talking about the End of the World – *only the end of one of the civilizations that have flourished on Planet Earth*. There have been other civilizations on our planet that lasted thousands of years and then – due to climate change, or some other intervening force – faded out of the picture. The Indus Valley Civilization in what is now Pakistan, the Khmer Empire in Cambodia, the Anasazi in what is

now New Mexico, the Olmec Civilization in Mexico, the Mycenaean Civilization in Greece, the Moche Civilization in Peru, the Clovis Culture right here in Arizona where I am writing this. Civilizations do end, usually leaving a few stragglers to suffer through until the planet becomes more hospitable again. “Extinction” is not only possible; it has happened many times on this planet. Civilizations do flourish and then come to an end. They have throughout history. Ours can too. *The only question is do we want to fight to keep that from happening?*

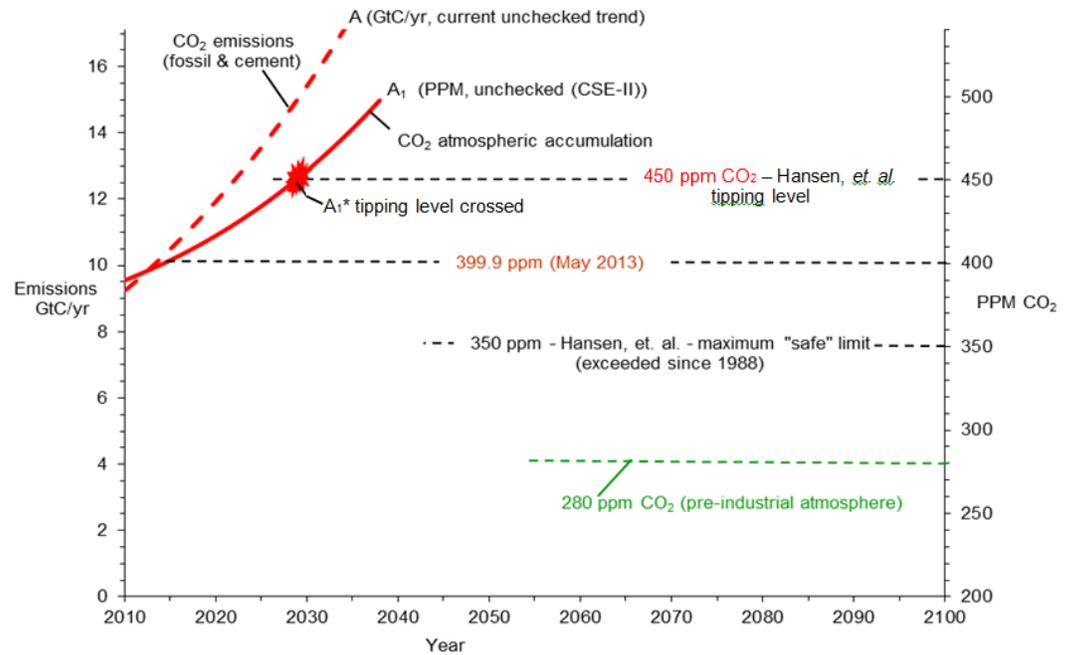
SO HOW DO WE KNOW A CLIMATE DEADLINE IS APPROACHING?

In 2017 more than 16,000 scientists from 184 countries published a second “Warning to Humanity.” The letter essentially says that if there is not a groundswell of public pressure to change human behavior, the planet will soon sustain “substantial and irreversible” harm. We know from geologic records that a 2 °C increase in global temperatures will trigger irreversible feedback loops (called “tipping levels”). For example, 120,000 years ago the Earth drifted slightly closer to the Sun and put us in the geological “Eemian Period”. During this time the Earth warmed by 1.9 °C (35.4 °F). (Notice that is almost identical to the Paris agreement’s target of 2 °C and the Intergovernmental Panel on Climate Change, or IPCC, target of 1.8 °C.) According to world-renowned paleoclimatic research teams, during the Eemian Period the polar ice caps *at first* underwent “linear” gradual melting, which produced a gradual sea rise, *but then* suddenly several major discontinuities arose that no longer followed linear gradual melting behavior. Instead, three major ice sheets in Western Antarctica, minor sections of East Antarctica, and Greenland *abruptly and spectacularly collapsed* in several stages, causing very rapid sea level rises ranging from 16 to 30 feet. The resulting high seas *lasted for more than 1,000 years*, ending only with the appearance of the next ice age.

Now here’s the thing – *right now* those same three ice sheets are *behaving the same way* they did during the Eemian Period – this time thanks to greenhouse gas (GHG) global warming. Not only is our current rate of ice melt historically unheard of, but we are starting to see multiple patterns beginning which are similar to those detected in geologic records. A geologic cycle which occurs over hundreds of thousands of years has begun occurring in decades, and recently it seems, in *years*. Already in May 2014, NASA presented “observational evidence that the West Antarctic ice sheet has gone into irreversible retreat,” and Greenland is losing *a cubic meter of ice every day*. If we let global average temperatures rise 2° C, models predict we will have the same melting and the same eventual spectacular ice collapses with the resulting abrupt 16 to 30-foot permanent sea rise that happened with 1.9 °C of Eemian warming 120,000 years ago.

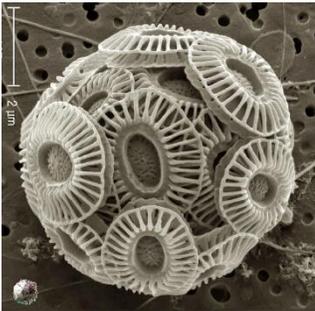
This should be terrifying to all of us (except, of course, those who have been looking forward to the Biblical Apocalypse and the rising of the dead – personally I am not a big fan of Zombies). Even the most optimistic scenarios show that around 2035, Earth will begin establishing “new normals” - a cascade reaction of geometrically escalating climate-related events. Already melting ice is releasing vast stored methane deposits, shorter winters are increasing microbial activity in the soil in turn releasing escalating amounts of carbon, melting ice is beginning to disrupt ocean currents vital for distributing heat around the Earth. (Go ahead and check the science on this until you too are convinced.)

Referencing the chart right, Hansen et al. (2008, 2009) warn that crossing the 450-ppm tipping level (A1) could lead to irreversible seeding of catastrophic climate impacts. Modeling studies by Cao and Caldeira (2008) imply that a marine die-off would also accelerate when atmospheric CO₂ exceeds 450 ppm. Approaching 500ppm (2038–2042) would further magnify and accelerate catastrophic climate and ocean impacts (Cao and Caldeira 2008; Fry et al. 2016; Hansen et al. 2008; Hansen 2009; and Lovelock 2006). Note: Tipping level crossed in approx. 2030-2035.



TO FIX THIS WE NEED TO DO A LITTLE FARMING

As mentioned earlier, by far the safest and most effective method of climate repair involves what is referred to as Ocean Assisted Carbon Capture & Reflection (OACC+R). Simply put, by retrofitting carbon-emitting plants with available “Carbon Capture” technology, carbon pollution can be converted into the by-products needed to grow *Emiliana Huxley*, or EHUX, algae in deep oligotrophic (non-life sustaining) waters in Earth’s equatorial regions. EHUX algae are nature’s own carbon scrubbing system and, if properly encouraged with byproducts from Carbon Capture, can both remove carbon from the atmosphere in the massive levels needed and create increased solar reflectance.



The ocean’s functions are integral to the ecology of planet Earth and especially the movement of heat from the Equator to the Poles.

Since we first started warming the atmosphere, much of the warming has been mitigated by the world’s oceans. That’s one reason why the ocean can be a powerful player in reversing this problem. Its temperature and chemistry are closely integrated with those of the atmosphere. Massive *Emiliana huxleyi* blooms regularly turn ocean water in different parts of the world light blue, white. *Emiliana huxleyi* are the most abundant species of all coccolithophores. When exposed to carbon they do something amazing (not discovered until scanning electron microscopy was invented in the early 1950s) they create an elegant kind of “armor,” called *coccoliths*.....**from calcium carbonate**. Yup, that’s right, the same stuff we need to remove from the atmosphere! Like plants, they consume carbon dioxide. They produce a great deal of oxygen, about half the world’s supply. They photosynthesize.



EHUX coccoliths are extremely tiny; only three one-thousandths of a millimeter in diameter. They are made from one-part calcium, one-part carbon, and three-parts oxygen (CaCO_3) - essentially limestone! Very small little fellows, but also (much like another species I can think of) powerful when they come together for a common purpose! If you have ever seen the White Cliffs of Dover—they are built of coccolithophores!

EHUX clad in coccoliths, are heavier than water. It is the only algae for which this is true. After creating all of these coccoliths, these organisms die and sink to the bottom of the ocean – fast enough that the sequestered carbon doesn't have a chance to release into the warmer ocean above the thermocline. Once the EHUX sinks below the thermocline to the deep ocean floor the carbon it brings with it will remain harmlessly at the bottom of the ocean forming sediment. *Three hundred and twenty pounds of carbon go into every ton of coccoliths produced.*



Utilizing nature's scale and humanity's need for energy we will nurture accelerated, short-cycle blooming of tiny white algae called EHUX which, repetitively bloomed en masse across vast mid-latitude open-oceans, can cumulatively capture and sink 500 billion metric tons carbon (500 GtC) of atmospheric CO_2 by 2100. White EHUX blooms also cool the planet by reflecting a fraction of incident sunlight back into outer space. Restoring preindustrial temperature by 2030's and reducing atmospheric CO_2 to 280 ppm by 2075 will restore climate and preserve coastlines while meeting rising energy demand and stimulating economies.

EHUX biochemistry is the strategic key. EHUX seed algae will be grown at sea in sealed bioreactors floating in mid-latitude open oceans—far from polar seas and all coastal waters. Concentrated liquid CO_2 from inland CCS fossil-fueled power plants will be shipped to bioreactors clustered around deep-water SPAR platforms that extract natural gas from beneath the deep-sea floor. A fraction of the gas will be converted to NH_4^+ (ammonium ion solution) and used as nutrient for bioreactor EHUX. A starter EHUX culture, NH_4^+ , liquid CO_2 , and sunlight are the main ingredients for blooming large amounts of EHUX seed. NH_4^+ and liquid CO_2 both come from fossil fuels, which is why EARTH2075 is a fossil-fueled climate restoration. (Perhaps it's fitting that the main source of excess CO_2 becomes a crucial part of the solution restoring a healthy climate centuries earlier than emissions cuts alone.)

The EHUX “farming” will probably need to be done on Single Point Anchor Reservoir (SPAR) platforms. SPAR platforms are floating oil platforms typically used in very deep water. Because the Algae Climate Repair project will be so large in scale, it will require about ten times the current world production of ammonium nitrate! It may not be desirable to ship enough liquefied natural gas (LNG) or fertilizer from seaports to the SPAR platforms. Too large a quantity may be needed. Fortunately, NH_4OH (ammonium nitrate) could be made right at the SPAR platform from natural gas harvested from beneath the sea. If needed it could be made right at sea in Haber plants onboard the SPAR platforms.



From the SPAR bioreactors, seed boats will repeatedly fan out to disperse bioreactor seed (with NH_4^+ nutrient) across the mid-latitude oceans. High seed levels will overwhelm viral and zooplankton limits. Fast-sinking will avoid bacterial decomposition re-releasing photosynthetically captured CO_2 . High seed levels will stimulate massive secondary open ocean EHUX blooming, drawing down atmospheric CO_2 at 14X the rate of original liquid CO_2 capture by inland CCS power plants. For each ton of CO_2 captured from an inland CCS power plant, OACC will capture 14 more tons at sea. EHUX will consume

carbon from the atmosphere while also reflecting sunlight back into space! OACC will impart a 1400% negative carbon footprint to CCS fossil energy—reducing CO₂ to 280 ppm by 2075 and also restoring preindustrial temperature ($\Delta T = 0^\circ\text{C}$) by the 2030's.

The challenges in “farming” EHUX on the scale we’re talking about have been steadily solved through 15 major attempts since the 1990s. The three most serious *limiting factors are ocean viruses, zooplankton, and ocean bacteria*. These are the limiting factors which have inhibited Ocean Iron Fertilization attempts to date. OACC&R has solved them all making us finally ready to move to Beta testing on a larger scale.

SCIENCE STUFF (You can skip this section and still “get it”)

One of the most important leaps forward has been the solution of what are known as “limiting factors”. The first of these are ocean viral infections which either inhibit large algae blooms or prevent them from drawing down large amounts of CO₂. The second limiting factor is voracious zooplankton that feed on the starter blooms, often devouring them before the bloom matures and captures a full quota of CO₂. The third and final limiting factor has been ocean bacteria that decompose dead floating algae at sea—so even if a large bloom develops and captures a large amount of CO₂, bacteria induce decomposition while the dead bloom floats. This causes most of the CO₂ to be released into the atmosphere again, before the dead algae become water-logged and can sink to export the captured CO₂ to the sea floor.

To overcome these limiting factors, the OACC&R plan is to start cultivating algae seed in sterile, sealed bioreactors to be placed at sea, so that the algae can be quite advanced in their growth when they are released into the open ocean - and therefore ready to bloom almost at once. From the large amounts of bioreactor seed produced, the secondary ocean blooms will start much higher than normal on their nonlinear (upward bending) growth curves, so *the secondary ocean blooms will occur so rapidly that they overwhelm ocean viruses and zooplankton grazing*. When released into the ocean for their secondary bloom, the algae will receive a *special nutrient mix designed to encourage their growth but not support the growth of other algae*: a cocktail of ammonium nitrate (fertilizer) nutrient, with trace thiamine (small amounts only). This regimen will support EHUX algae to *bloom almost exclusively*.

Next, methane (natural gas) will be used to spur very rapid algal growth by producing feedstock for the secondary EHUX bloom in the open ocean. It will achieve this via an industrial technique called the Haber process, which has been used to make anhydrous ammonia fertilizer from methane since the 1940s. The Haber process combines 3 of the 4 hydrogen atoms from methane (liquefied natural gas) with 2 atoms of atmospheric nitrogen (N₂) to make anhydrous ammonia (NH₃). When anhydrous ammonia (NH₃) mixes with seawater (NH₃ + H₂O), it becomes ammonium hydroxide (NH₄OH). Fortunately, EHUX prefer a diet of ammonium nitrate (NH₄NO₃) with anhydrous ammonia, and NH₄OH (ammonium hydroxide), is environmentally friendly.

The nutrient for the secondary open-ocean blooming will be a pH buffered mixture of 90 percent ammonium chloride (NH₄Cl) + 10 percent NH₄OH, *which exhibits ideal ocean pH 8.25*. Additionally, NH₄OH has another important benefit. When the algae digest the nutrient, one OH⁻ is left, which *neutralizes ocean acidity*. The OH⁻ reacts with carbonic acid (H₂CO₃) in ocean waters, added by 150 years of excess atmospheric CO₂ dissolving in the ocean, to create HCO₃⁻. Thus, this process can make a significant contribution to reversing the current ocean acidification which is today such a large part of the global warming problem.

The nitrates will not be a pollution problem, because only metered doses of the nutrient, ammonium hydroxide (NH₄OH), will be used—smaller doses than what the EHUX algae will consume. There *shouldn't be any residual nitrate left after the 8th day of blooming*. Ammonia will also not be a problem as algae *only forms ammonia in*

shallow waters, not the type of deep-water conditions in which the EHUX will be born and raised. EHUX blooming will occur in mid-ocean, from 40°N latitude to 40°S latitude, far removed from polar oceans and coastal waters. The bioreactors will need to be placed far out in the vast ocean desert, where the water is nutrient poor *keeping away zooplankton*. EHUX typically does well in these nutrient-poor parts of the ocean. These regions are also depleted of phosphates, which would be an advantage. Although the dead EHUX will sink to significant ocean depths, the live blooming will occur within the top 100 meters or so of the ocean. They are exclusively "surface blooms."

Spurred by anhydrous ammonia fertilizer, the massive secondary EHUX "fields" will bloom in the open ocean, *turning the waters a bright white color*. This will have a powerful secondary benefit - reflecting light and heat back into space! In so doing the EHUX will naturally perform the same function that as injecting aerosol into the stratosphere – reflection of solar radiation away from the Earth. Very importantly we will be able to control the amount of reflectance by varying the depth of the EHUX blooms. Scientists are carefully monitoring an array of Earth's vital signs and will be able to detect problems as they emerge and direct needed alterations in the EHUX bloom intensity. Bloom depth should be relatively easy to control. For bright surface blooms (60 percent reflectance) seed and nutrients would be released only at the surface. For dim blue blooms (down to 5 percent reflectance) seed and nutrients can be released from long, weighted hoses trolled deeply behind seed boats. The seed and nutrient amounts will be similar, just released at greater depth to diminish the albedo. As long as this still occurs within the photic zone, there should still be appreciable CO₂ capture, but not much in the way of albedo cooling.

After eight days, the EHUX will reach the end of its life cycle sinking harmlessly into a depth of the ocean. This will effectively "sequester" the captured carbon. Thus, when we add the element of the EHUX natural reflectance we have a process most accurately referred to as **Ocean Assisted Carbon Capture + Reflectance**. It is also critical to select places in the deep ocean where the floor is no deeper than about 4500 meters (around 15,000 feet), or the level of the calcium compensation depth (CCD) or lysocline. The lysocline is the ocean depth at which the rate of dissolution of calcite (calcium carbonate) increases dramatically. Carbon could not be sequestered below the lysocline, because the water chemistry at those depths tends to re-dissolve the calcite. Therefore, coccoliths would not accumulate there. Above the lysocline, the calcium carbonate won't re-dissolve, even after millions of years! It's ultimately the safest possible storage, with no holes that fill up, and no chance of being suddenly reintroduced to the atmosphere by seismic disruption.



And so we have our two OACC process: (1) Liquid CO₂ -driven bioreactors producing massive primary blooms of purified EHUX algae starter seed, sufficient to overwhelm viruses and predators, and (2) Amplified secondary open-ocean EHUX blooms, supplied with anhydrous ammonia fertilizer, which have the potential to capture 10 gigatons of carbon per year (GtC/yr) of atmospheric CO₂ at sea.

If widely and regularly dispersed with optimal nutrient over 50 percent of the ocean between 40 deg. south and 40 deg. north latitude, high-density bioreactor algae could rapidly and selectively seed massive secondary mid-ocean EHUX algae blooming. In this region of the ocean, termed oligotrophic because scientists have found very little life or activity, the EHUX will be able to bloom without competition. These natural obstacles overcome, accelerated phytoplankton blooming would offer the greatest, *and safest*, potential to rapidly draw atmospheric CO₂ down to pre-industrial levels.

OACC&R PLANNING HAS BEEN CAUTIOUS AND COMPREHENSIVE

The reflectance properties of OACC+R will necessarily occur in specific areas of the ocean, and the resulting cool-down will be rather localized. It will occur specifically where the white EHUX blooms occur. In one sense, that's good because there wouldn't be any atmospheric pollution. However, in another sense, having the cooling more highly localized could be problematic. Specific locations will need to be carefully selected in order to avoid disrupting certain key ocean currents that impact climate.

The Gulf Stream is, of course, part of a larger “ocean conveyer belt”, which – if interfered with can create significant climate swings – like for instance an “ice age.” Care must be taken so that OACC+R does not inadvertently disrupt the Gulf Stream, which carries salt northward and heat to Europe. The most critical regions in this regard are likely be near Panama and north from there – along the U.S. and Canadian eastern seaboard and up to Iceland. Algae Climate Repair may possibly want to avoid that region, and perhaps concentrate OACC+R further east in the Atlantic.

If the western Mid-Atlantic is cooled too rapidly, then the Gulf Stream might not be saline enough when it gets to Iceland. This might cause it to fail to sink to the deep-sea floor in that location – which is a primary driving force for the ocean conveyer belt. If the ocean conveyer slows down, then the Gulf stream will no longer warm Europe. They could experience a mini-ice age that plays havoc with their agriculture.

Another reason for caution regarding disruption of ocean currents are the mid-latitude ocean thermoclines which could potentially restart nutrient upwelling in the targeted OACC&R bloom zones. Nutrient upwelling would favor blooming of slow sinking algae, and that would in turn bring larger ocean viruses, zooplankton, and bacterial populations which could regain numerical advantage devouring the defenseless EHUX before they can do their work.



Given the current level of expertise, scientists working with OACC&R will be able to identify areas where cooling the ocean water would NOT be advisable, and OACC+R teams can simply remove them from the targeted seeding zones. Alternatively, it might be advantageous to seed in these areas anyway, only deeper within the photic zone. The photic zone extends to about 100 meters in depth. As OACC&R fine tunings for aspects such as these will need to be made. “Concept proofs” will determine whether widespread surface blooming with bright white EHUX affects thermocline or not. Very importantly, we will be working with the Earth rather than against it as we use her natural processes to correct temperature.

It is important to keep in mind that in order to put OACC&R into place in time (even starting relatively soon) we will have to work expeditiously. This is a gigantic undertaking! In the words of researcher Dr. Robert Fry, one of the chief architects of the idea of algae-based climate repair, “Pilot systems will have to be constructed before concept proofs are completed. Alpha system scale-up will have to commence before pilot system testing is complete. Beta system scale-up will have to start before alpha system testing is complete.” Caution is prudent, but scientists sometimes suffer from an overabundance of caution. Often their worst fear is being “wrong”, so they check, triple-check and then suggests more studies to check the triple checks. Fools rush in, but when there are 10-15 years remaining to install thousands of SPAR platforms, master fledgling carbon capture technologies, and bring a massive system online the larger danger is not getting started.

AN OPPORTUNITY FOR THE FOSSIL MAJORS

One of the most amazing parts of Algae Assisted Carbon Capture is that its *deployment can profitably be financed by oil, gas and coal industries*. For some time, these mega-corporations have been aware that they are running out of time to use their assets. They are under fire from conservationist groups, and alternative sources of energy are sweeping powerfully into the marketplace – their growth vastly eclipsing fossil fuels. Recently developed research technologies have been employed to trace almost down to the gigaton where the carbon polluting our atmosphere came from, and to put a *price tag* on the dumping of that pollution. Just as the garage that changes your car’s oil must pay to dispose of that oil, fossil fuel corporations could soon be pressured to foot the bill for their share of the carbon in our atmosphere. As you can imagine, those bills would be astronomical. However, if the carbon is no longer in the atmosphere..... well, it doesn’t take a climate scientist to see the advantage. Companies like Exxon/Mobile, British Petroleum and Shell may soon be clamoring to be part of the EHUX project. Not only can they escape heavy fines and obtain a new lease on life, but also gain access to a *huge new market* (feeding the EHUX) and walk away with a brand-new public image as major contributors to the resolution of global warming!

This will require the traditional energy companies to do two major things. First, they will need to foot the bill for deployment of a fleet of SPAR platforms around the meridian of the Earth from which to raise the EHUX. This seems only fair given the profits made from generations of free atmospheric dumping rights. Besides this they will get to keep some of the equipment after OACC&R winds down. Second, they will need to invest in *Carbon Capture technology*. This recently developed technology captures approximately 90 percent of CO₂ exhaust emissions while making electricity. The capture form is Super-critical Fluid CO₂ (SCF-CO₂) using a process similar to that developed by companies like Inventys, Inc. for capturing post-combustion CO₂ from industrial flue gas streams. *Instead of burying or otherwise dumping this CO₂, it will be shipped to be used as liquid CO₂ feedstock for the EHUX* in the sealed floating bioreactors. By the end of the OACC&R process the previously harmful fossil fuel products actually have a 1400 percent NEGATIVE carbon footprint. That’s a 14-fold capture amplification factor. For every 1 ton of CO₂ produced and captured at a CCS plant, there will be 14 more tons of atmospheric CO₂ captured at sea!

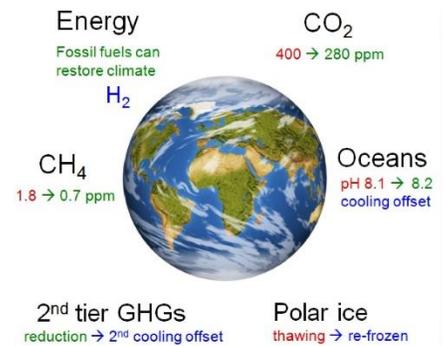
THE UP-SIDE FOR EVERYONE

Like any major new endeavor there will necessarily be cooperation between a variety of engineering and scientific disciplines. Testing of the CCS natural gas power plants, or molten carbonate fuel, managing the LNG tanker ships and feeding schedules for the EHUX. New SPAR platforms will need to be designed and built accommodate crews and processes. Thousands of new jobs will be created in the process and employment for the coal and gas industries (whose futures are limited by the rise of sustainable energy technologies) would be ensured for decades. Other companies involved in creating biofuels from algae can design the submersible bioreactors to be able to withstand ocean storms.

OACC&R has the potential to draw atmospheric CO₂ down at the rate of 10 GtC/yr starting in 2025. It will still be important to move forward with essential cuts in emissions - 50 percent by 2050, and 90 percent by 2078. The combination of emissions cuts, sustainable energy technology, population control, and 10 GtC/yr of OACC+R drawdown from 2025 to 2070 would restore 350 ppm by 2050 and 280 ppm by 2075—centuries earlier than IPCC or Paris Agreement emissions cuts alone, or any other carbon sequestration program. Warming would be eliminated ($\Delta T = 0^{\circ}\text{C}$), rather than increase to 2 °C, or most likely greater.”

OACC&R is the only strategy developed to date (and we are out of time for more theorizing) that is powerful enough - a relatively small amount of nutrient from CO₂ (0.7 GtC of liquid CO₂ from CCS power plants) essentially drives 10 GtC/yr of atmospheric capture - to remove a sufficient amount of carbon fast enough from the atmosphere to avert the impending “tipping levels” – *and do it safely!*

We all stand to benefit from OACC&R. “Dirty” energy industries, facing extinction in the face of newer, sustainable energy industries, will have a new lease on life, and new support from the government and the public. Environmental groups will finally have a path toward achieving a sustainable civilization. Governments will have a solution to many overwhelming problems currently draining their resources. OACC&R is the ultimate win-win solution.



OACC&R can meet the predicted 50% increase in world energy demand while enabling CCS fossil energy (liquid CO₂ utilization, CCS fossil hydrogen (transportation), doubling fossil energy revenues, making CCS fossil energy *1400% carbon negative*, creating a fleet of deep-water SPAR platforms which can be dual-purposed for liquid natural gas production. Additionally, revenue will be generated by the sale of downstream OACC&R related products including energy, agriculture and jobs will also factor significantly. We anticipate a massive net gain from OACC&R on many levels (jobs, tourism, investment, reduced energy costs, etc.).

A CLIMATE OF HOPE

“I think it is fair to say that during World War II there was a high sense of purpose. The country had a very clear vision of its own standing, of its own morality. It was not an ambiguous time. Today, we live in a world that is highly ambiguous, very fractured, with many of the historical, traditional values in a state of collapse, really.”

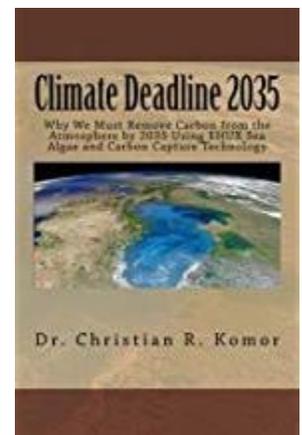
—Friedrich St. Florian, Architect of the World War II Memorial

“[A] house divided against itself cannot long endure.”

- Abraham Lincoln

Ocean Assisted Carbon Capture & Reflection can repair our atmosphere and resolve our Climate Disruption Crisis. The pieces haven’t been put together before in exactly this way before, but the pieces already exist, and they work. They just need to be assembled in a different way. Scientifically and technically, there appear to be no barriers that can’t be surmounted.

There is just one problem.....*human barrier!* We are WAY behind the curve in coping with Climate Disruption. We must actively raise our awareness out of our day-to-day concerns to see the bigger picture. We must stretch our awareness to see that climate change is a *necessary* battle, that climate-engineering is the *only* way to avoid the fast-approaching “point of no return,” and that Algae Climate Repair is the *safest and most effective* climate-engineering solution currently under discussion. Society is currently fragmented often and at-odds but has been the case sometimes throughout history. The timing is bad, but as we have done several times during our human journey, we must rise to the occasion and demonstrate that humanity is capable of cooperating for the greater good. We need to ask why there are so many “end of the world” and “superhero” movies. It is our collective conscious emerging to tell us there is something seriously wrong and we need some big time “heroes” to solve it.



I must congratulate you, by the way. Ready or not, through reading this article, you have entered the ranks of those who are aware of our climate situation, the emergent deadline we are under, and Ocean Assisted Carbon Capture as a solution. *Once learning this you can't unlearn.* You one of us now and there are two paths to follow from here. First, you can find a way to hide or rationalize non-action and abandoning our grandchildren to a horrible fate (remember it will be too late for them to repair the mess we are leaving after the mid-2030's). Second, you can stand with those of us who are fighting to see direct atmospheric carbon removal become a reality in the next 15 years. With all my heart I hope you will take the higher road. Personally, I could not live with myself to choose anything else. And imagine the pride of standing next to those you are working with to make Ocean Assisted Carbon Capture a reality. Like soldiers on a winters night we are facing long odds, but our cause *is the most important in the history of human civilization!* We are working to rescue the families of the future who (having past the 2030's deadline) would not have the chance to change their fate.

So which path, which future do you choose? Now is the time to make a choice and to not make a choice is to make a choice for dystopia and despair. For any sane person is there really a choice?

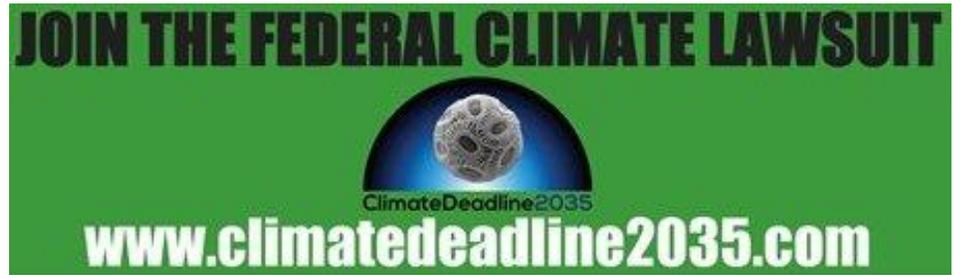
I wasn't there, but I am guessing that our "Greatest Generation" felt much the same on hearing the news of Pearl Harbor. They had just survived the Great Depression and now the Nazis are rampaging through Europe and the Japanese attacking Hawaii! "What next" they must have sighed! *But* they summoned their collective courage, gathered their collective strength, and (with the guidance of an astute government) marched off to war. (Of course, they had not yet been specifically and carefully groomed to be good, passive consumers. Somewhere along the way we transitioned from an information culture to an entertainment culture. Our world comes to us through screens of various shapes and sizes that amuse us. Even NPR is now describing their news broadcasts as "shows". We watch the news of a war, or famine in some distant place and then move on to the commercial. If we continue to deal with Climate Change the same way it will deal with us – and we won't like it.)

Mid-way through this year's campaign I was in a hotel room in Chicago recovering from triple bypass surgery (2 arteries 90% blocked and the other 100%). As night fell, I could see lights come on in a hundred other widows outside mine. What I was doing to help our odds of surviving climate disruption had brought me close to the end of my own life, but somehow it seemed worth it. I felt this connection in the warmth of all those other lights – a connection bigger than all of us together. Perhaps global warming will be what brings us all together in a quest for common survival. Perhaps my Bible-following friends were right – the human propensity for greed had finally brought us to Armageddon and I was Don Quixote tilting at windmills.

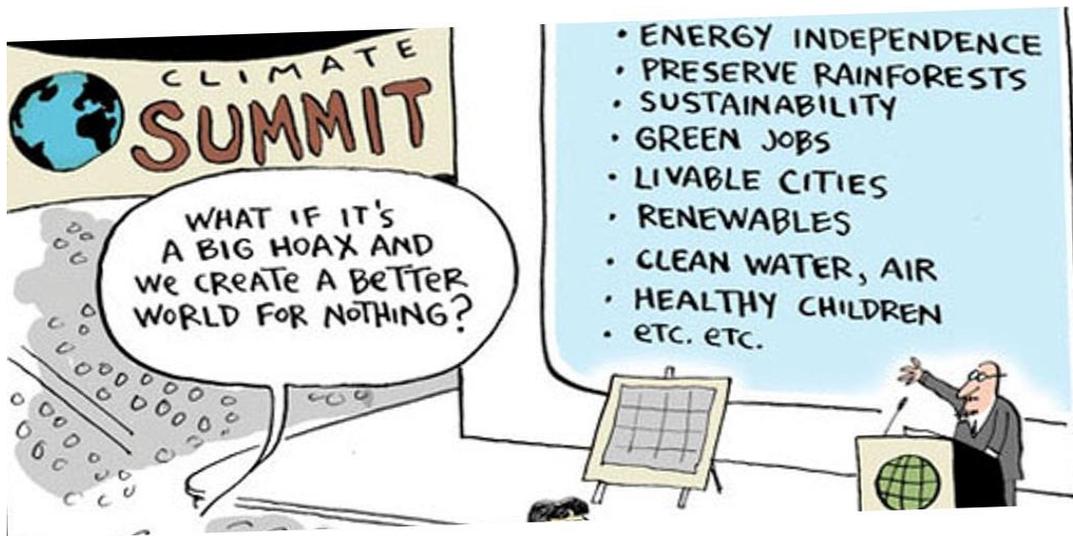
For all the corruption, greed, inequity and headline horrors you and I know there is good in most of us. Most of us would come to the aid not just of a friend, but of someone we don't even know. Most of us feel deep love in our hearts as we watch our children sleeping. Most of us hunger for the arms of another – because we are human and capable of love! And that love makes us willing to sacrifice, to stand up with courage for what we feel is right.

I think sometimes about the signers of the Declaration of Independence - folks who had clear evidence their lives and liberties were being oppressed by forces too vast, interwoven and dead-set on their own agendas of profit and power to see reason. Every signer of the Declaration of Independence knew if they lost the war, they were signing their own death warrant (and not by lethal injection either). They did it anyway! Suppose what you have read here about the extent and urgency of climate disruption is exaggerated? What's the downside of beta-testing OACC&R? Nothing! On the other hand, what's the downside if most of what you have read here is basically correct and WE DON'T DO ANYTHING? Right, the end of civilization as we know it. *So, let's get busy and fix this!*

Ocean Assisted Carbon Capture & Reflection must happen and we must begin soon to talk about the real solution to climate disruption. My team has launched *The Climate Lawsuit* in Federal Court. We are suing the United States government to reinstate policies and regulations



which reduce carbon pollution and, far more importantly, establish Ocean Assisted Carbon Capture & Reflection as developed by Dr. Robert Fry and colleagues (or another reasonable alternative) for active carbon removal. We need your assistance to *forwarding this article or reference it in all your social networks* and donating and signing up at www.theclimatelawsuit.com. Remember, supporting OACC&R is primary. Investments in alternative energy and other sustainability projects will not have value unless we first remove carbon directly from the atmosphere. We need to create a groundswell of discussion and public awareness. If you are saving for your child's college tuition or looking forward to their marriage realize that mobilizing a program for direct atmospheric carbon removal is the only way to ensure those future events become reality!



You won't want to miss the [Climate Deadline Quiz](#) below. Some of the information in the Quiz is contained above and some is new. Good luck and you can find the answers at the end of the Quiz.)

The Climate Deadline Quiz

- (1) If we had made a full transition to “sustainable” practices (solar, wind, recycling, etc.) 40 years ago it would have been enough to avert the current Climate Change crisis. Currently the only method of doing so is by actively removing carbon from the atmosphere. **YES NO**
- (2) Approximately 60% of carbon emissions (most from fossil-fuel burning and cement production) remain in Earth’s atmospheric envelope thousands of years. **YES NO**
- (3) During previous ice ages, CO₂ levels were around 200ppm (parts per million). During interglacial periods they normally hovered at 280ppm. Since society became industrialized CO₂ levels have steadily and rapidly increased and are now near 410 ppm which corresponds to approximately 3200 gigatons of CO₂, containing approximately 870 gigatons of carbon. **YES NO**
- (4) Computer and human modeling has, with a high degree of certainty, determined that if carbon in the atmosphere reaches the 450ppm (which it will in the mid-2030’s) the Earth will cross a threshold or climate deadline (“tipping levels”), beyond which:
 - (4a) Global warming changes will become “locked in” and unstoppable **YES NO**
 - (4b) Global warming will adopt a new exponentially escalating trajectory making life on Earth a torment for our children and grandchildren. **YES NO**
 - (4c) Climate Change will shift to a “new normal” incompatible with human survival **YES NO**
- (5) These “new normal” tipping level changes are already well underway including:
 - (5a) Slowing and redirection of ocean currents which distribute heat around the planet **YES NO**
 - (5b) Melting of ice and permafrost at both poles **YES NO**
 - (5c) Release of vast stores of methane from beneath melting permafrost and ice **YES NO**
 - (5d) Altered insect borne disease patterns **YES NO**
 - (5e) Reduced or destroyed animal habitats and species **YES NO**
 - (5f) Emergence of new soil microbes which release carbon from the ground **YES NO**
 - (5g) A breach between plants and pollinators. **YES NO**
 - (5h) Altered weather patterns leading to loss of life and costly infrastructure damage. **YES NO**
- (6) Climate Change cost U.S. taxpayers 350 billion dollars in 2017 alone and will eventually outstrip our ability to pay for the mitigation costs **YES NO**
- (7) Between 2030 and 2050, climate change is expected to cause approximately 250,000 *deaths per year*, from causes such as malnutrition, malaria, diarrhea and heat stress. **YES NO**
- (8) *There is currently no safe and effective atmospheric carbon removal program underway or even in the planning stages anywhere in the world.* **YES NO**
- (9) Although many individuals’, organizations and governments have taken steps to reduce carbon omissions, the *amount* of carbon being added to the atmosphere has *continued to increase each year*. **YES NO**
- (10) Once the 2035 climate deadline (or “tipping level”) has been crossed human beings will probably have less than a century before experiencing an extinction event. **YES NO**
- (11) While essential in the future, “sustainability” practices such as recycling, shifting to solar or wind power, or driving hybrid vehicles *even if adopted by 100% of the world’s population immediately* would not alter the “tipping levels” in the 2030’s by even one year. These efforts may, in fact, be distracting from the larger and more immediate work of atmospheric carbon removal. **YES NO**

- (12) How are you dealing mentally and emotionally with the knowledge that the human race will most likely not survive the current century unless we are able to alter the course of climate change in the next 15 years? _____.
- (13) There is a safe and effective procedure for directly removing carbon from the atmosphere using EHUX sea algae fed initially on boil-off from carbon capture retrofitting carbon-emitting power plants. **YES NO**
- (14) EHUX algae (which formed the White Cliffs of Dover) was designed by nature to remove carbon and can naturally achieve 350ppm, or even a pre-industrial climate if properly cultivated using boil-off from carbon-capture at fossil fuel burning plants. **YES NO**
- (15) In order to survive as a species Climate Change is demanding that we come together and work cooperatively. We know how to remove carbon from the atmosphere, but the effort must be coordinated. Some might view this as a test of our maturity and worthiness as a species. **YES NO**

*** All Climate Deadline Quiz answers are YES**