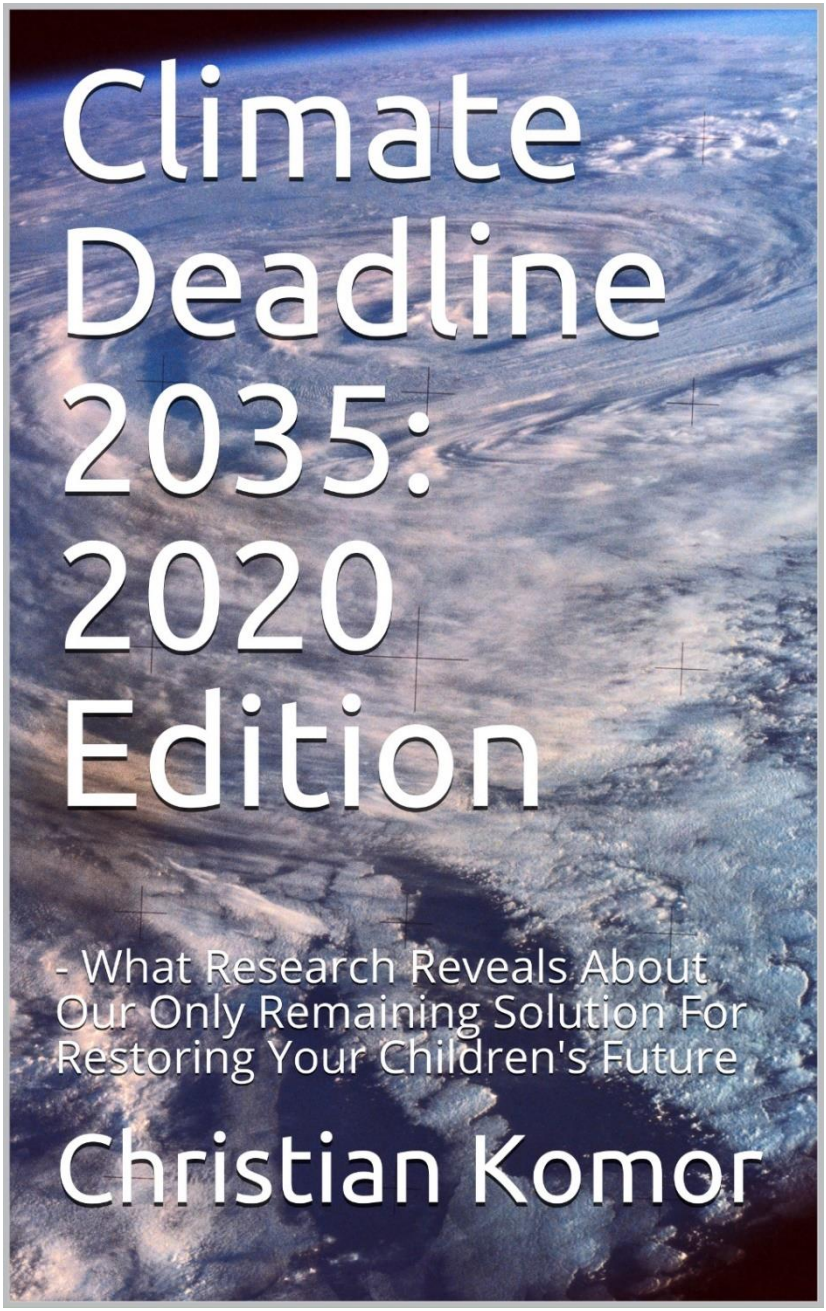
Climate Deadline 2035: 2020 Edition
- What Research Reveals About Our Only Remaining Solution For Restoring Your Children's Future
Christian Komor

CLIMATE DEADLINE 2035: 2020 EDITION

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CLIMATE DEADLINE 2035: 2020 EDITION

"By the time we saw that Climate Change is really, really bad our ability to fix it was extremely limited. That means that if you reduce emissions things are still going to get worse. If we don't remove carbon already in the atmosphere immediately, we will forfeit our children's future."

– Bill Gates, Founder Microsoft

"The choice is clear. Either we remove the overload of carbon already in our Earth's atmosphere, or we face removal of our species from this planet. I believe Dr. Komor's book Climate Deadline 2035 provides a reliable roadmap for escaping this terrible fate."

- Sir Patrick Stewart, Actor

The warnings about climate disruption have been extremely clear. We are facing a global climate crisis. We are running out of time, and we must have a planetary solution to a planetary crisis."

– **Al Gore, Former US Vice President**

"Very few people on earth ever get to say: "I am doing, right now, the most important thing I could possibly be doing." If you'll join this fight, that's what you'll get to say."

- Bill McKibben, Author 'The End of Nature'

"Tipping points are so dangerous because if you pass them, the climate is out of humanity's control: if an ice sheet disintegrates and starts to slide into the ocean in turn releasing huge stores of methane , there's nothing we can do about that. Several times in Earth's history, rapid global warming occurred, apparently spurred by these types of amplifying feedbacks. In each case, more than half of plant and animal species became extinct."

- James Hansen, Former Director NASA Goddard Institute

"Climate change is a clear and present danger"

- Secretary-General António Guterres

DEDICATION AND ACKNOWLEDGEMENTS

This book is dedicated to the children of our planet and especially my son Thomas. They are our hope for the future and our inspiration for working to restore that future! For their sake we will press forward through any and all challenges to achieve what must be achieved for so that our future generations have a home.

I one Climate Analyst and Advocate, a tiny ripple in the pool of scientists, environmentalists and even politicians working diligently on Climate Change today. In this work I have been especially inspired by: Vice President Al Gore, Bill McKibben, John Denver, Dave Randall, Thomas F. Crum, James Callner, Robert Fry, David W. Keith, James E. Hansen, Kevin Anderson, Henry Pollack, Peter Thorne, André Berger, John Tyndall, David Hone, Michael Mann, Paul Hawkin, Ken Caldeira, Rajendra Pachauri, Mike Hulme, Ban Ki-Moon, Felipe Calderón, Christiana Figueres, James Hansen, Naomi Klein, Pope Francis, Gina McCarthy, Christopher Monckton, Richard Tol, Bob Ward, Heidi Cullen, the courageous members of Extinction Rebellion, the men and women who serve with the United Nations Intergovernmental Panel on Climate Change (IPCC) and all those who will give their efforts large and small to see the dream of Emergency Climate Repair become a reality.

A major thank-you to my 2018 Gubernatorial campaign staff. Through your tireless work you allowed me to reach thousands of people with the essential message of our climate emergency and its solution. A very deep thank you to my partner, artist Li-Ling Hsiao who is showing me how to love others in a deeper way than I had known possible. Most importantly I want to thank my parents Carl & Sally who shown me how to love the natural world with a strength that has driven me to give up a portion of my life to her protection. And finally, thank you to you the reader who cares enough to explore this book. Hopefully, together, we will help to ensure that humanity is not just a footnote in the history of our planet.

All profits from this book will be reinvested in the Emergency Climate Repair effort.

Dr. Christian R. Komor

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DEFINITION OF TERMS

Albedo - Reflectance or brightness of a surface, such as the Earth's surface

BTU - British thermal units

Carbon Cycle - Process by which naturally occurring carbon interacts
with atmosphere (see next page)

CAT - Climate Action Tracker (from climateactiontracker.org, an independent scientific analysis produced by 3 research organizations tracking climate action since 2009)

Cap and Trade - A free market economic mechanism to incentivize carbon pollution reduction

CCD - Calcium compensation depth, depth at which all calcium carbonate is in solution

CCOS, **CCS** - Carbon capture and sequestration or carbon capture and
storage

CH_4 - Methane

CO_2 - Carbon dioxide

CRP - Climate Reality Project

CSE - Combined surface exchange

Delta T (or ΔT) - Difference in temperature

DMS - Dimethyl sulfide

DMSO - Dimethyl sulfoxide

EHUX - Emiliania huxleyi (or e. huxleyi), white algae [pronounced hux-lee-eye]

EAIS – East Antarctic Ice Sheet

GHG - Greenhouse gases

GW - Gigawatts

GtC/yr - Gigatonnes of carbon per year

GWP - Global warming pollution

H_2CO_3 - Carbonic acid

HaberBosch Process - Process used for creating nitrogen-based fertilizer from liquid nitrogen

HCO_3 - Bicarbonate ion ["baking soda"]

INDC - Individual nation-determined contribution (pledges)

IPCC - Intergovernmental Panel on Climate Change (part of the United Nations)

Lysocline - The depth in the ocean below which the rate of dissolution of calcite increases.

RPPM - Regional polar peroxide misting

TRAP - Tropospheric reduction of aerosol pollution

LEGACY EMISSIONS – Carbon and other greenhouse gas emissions already "stored" in Earth's atmospheric envelope.

LNG - Liquified natural gas

NATO - North Atlantic Treaty Organization

NH_4OH - Ammonium hydroxide [The nutrient is actually NH_4+]

NH_4NO_3 - Ammonium nitrate

NH_4Cl - Ammonium chloride

OACC&R – Ocean Assisted Carbon Capture & Reflection

O_2 - Oxygen gas

OH - Hydroxide is a diatomic anion with chemical formula OH^-. It consists of an oxygen and hydrogen atom held together by a covalent bond, and carries a negative electric charge

DARE – Direct Atmospheric Removal of Excess-Carbon

Oligotrophic - Term referring to the vast mid-latitude ocean existing from 40 degrees North to 40 degrees South latitude. Marine biologists have determined this area to be essentially devoid of sea life, owing to strong thermocline, which blocks nutrient upwelling from volcanic rifts in the deep ocean floor.

ppm - Parts per million

RPC - Representative concentration pathways [IPCC describes four of
these scenarios]

SCF-CO_2 - Supercritical fluid carbon dioxide [liquid CO_2]

SPAR platforms - Large floating platforms used mainly for oil drilling

UNFCCC - United Nations Framework Convention on Climate Change

WAIS - West Antarctic Ice Sheet

WTO - World Trade Organization

WMO - World Meteorological Organization

UNEP - United Nations Environment Program

PART I: THE CLIMATE EMERGENCY, OF FLOODS AND FIRE

"Climate change poses a very real extinction threat. Added to all the other stressors (overpopulation, mass migration, political instability), it really could be the proverbial straw that breaks the camel's back. There is still time to avoid the worst-case tipping point scenarios, but that window of opportunity will only be open for another few years, if we continue to change climate at the rate we have been."

- National Academy of Sciences

Liquid Houston 2017

CHAPTER ONE: WAKING UP FROM CLIMATE SHOCK

"We are a society that has inadvertently chosen the double-black diamond run without having learned to ski first. It will be a bumpy ride."

- NASA Climatologist Gavin Smith

Chapter Summary: Climate Change is not directly responsibly for claiming and estimated 300,000 lives per year with another 2,500,000 from atmospheric pollutions and millions more adversely affected by fires, floods displacement, illness, etc. (Source: Oxfam 2017). In fact, we have only until the mid-2030's before environmental feed-back loops embedded in climate disruption lock into a new environmental "normal" incompatible with human civilization altogether. Global Warming is not only an emergency it is ***The*** emergency and a *Clear and Present Danger* to the national security of each and every country!

Climate **C**hange due to global warming is in the news almost every day lately and it should be. The mainstream media has finally caught

on that this is "big news". For many of us, though, the situation seems murky, muddled and filled with more questions than answers. My job in *Climate Deadline 2035* is to brief you on where we are at with this global emergency – larger and more challenging than any World War – and then show you what we can and must all be doing to rescue the coming generations (our kids and grandkids) from a horribly painful and hopeless future.

YOU HAVE TO TRUST SOMEONE!

To do that successfully you first must be able to trust me. Unfortunately, we are living in an age where our trust has been breached on every level and paranoia is the law of the jungle – so I will need to digress into a little personal history. I was raised in one of those families that valued personal growth and altruism. My parents, both worked in special education and cheered the civil rights movement. It was no accident, then, that I trained as a doctor of psychology and have worked in that helping profession consistently since the early 1980's. A big part of my job for over 30 years has been assisting people in making sense of life and discovering their options – often ones they had never noticed or knew about – for making life better.

I was not originally trained as a climate scientist, biologist, meteorologist, or chemical engineer. I was just minding my own business, a regular guy who liked to do wilderness photography (you can find my photos on SmugMug). This love of nature, that I'm sure I share with many of you, led me to begin reading about global warming in the early 2000's. Using my natural pragmatism and academic training in reading and assimilating research, I had some on-the-job training with a group of hard-core climate scientists and Al Gore. I gradually became knowledgeable enough to write the first edition of this book in late 2017. Within a few months everyone was taking Climate Change seriously, but unfortunately not the 2035 deadline. Most folks are still under the impression we have plenty of time to let solar power and recycling work their magic and save us.

In 2018 I ran for Governor in Arizona talking about global warming as an emergency that needed to be handled before the mid-2030s. I got in a lot of interviews and pounded in a couple thousand yard signs. A few months later the UN Secretary General was calling Climate Change an "emergency" and "the fight for our lives". In the Spring of 2019 I was in US District Court as the chief litigant in a federal climate

lawsuit which has now become affiliated with the Children's Climate Lawsuit out of Portland, OR.

I recount these actions for several reasons: (1) Again, you need to trust the information in this book and rely on it as you move forward into climate activism; (2) You need to know that one regular person can get creative and take all kinds of action to help the climate situation. None of us are powerless.

I have been up, down, and around the problem of global warming and rubbed ideas from many of the big names in climatology. I have kept up with most of the research emerging since the mid-1970's when my first article on the environmental problems with cement (the third most troublesome greenhouse gas producer) was published. I have now spent hundreds of hours learning about climate disruption, how we can (and can't) fix the situation and how very little time we have remaining to do it. I have learned enough to know the odds of success, as General MacArthur once put it, are the width of an eyelash. But for years now I have been waking up each day and doing what I know how to do to respond to this global emergency – win or lose – as a "Climate Advocate".

In addition, and this is pretty unusual in the Climate Change field, for some reason I seem to have thus far been unerringly accurate in predicting the coming events in the global warming saga. I have been right every time about what is happening with our environment, how nature is going to respond to our human interventions, and what the next right step is to keep us from going off the climate cliff. I can't explain this phenomenon, but I'd be negligent not to take advantage of it - like a stock analyst, or a guy who knows his way around the horse track.

I think this phenomenon may, in part, have to do with my *not* being a climate scientist, politician, or on the payroll of Big Oil or Big Coal, or any of the large environmental organizations. I have no agenda for *getting the job of Climate Repair done* other than my affinity for nature and love for family and friends who I believe are in serious danger from climate disruption. I guess for this reason you could call me a "Climate Analyst" – hopefully one you will come to trust, because we have so much work to do and we can only do it together!

A FATE WORSE THAN DEATH

If you know much about Climate Change, you know this is a big subject – an overwhelming problem that brings up feelings of despair and hopelessness for many. You have said to yourself, "This is just too big, it's too much! We're too late!" I agree it often looks that way. Yet, history is filled with examples of those who were overmatched, outgunned, already injured and yet went on to victory.

One night recently I asked one of my longest-standing friends who spent a life in politics as a Senator what he thought of this fight to beat the Climate Deadline. Was it crazy and hopeless? His response, "Heck yes it's completely insane and unrealistic. The odds are so bad no one would even think about betting on winning. And you should definitely keep fighting!" He went on to explain, "We start where we are. We take the openings we see and give it our best shot and that's all we can do. And this is a desperate situation and we MUST do what we CAN do!"

There is a group of people who have been doing all they can do for some time now. Most people are aware that the leading organization collecting and disseminating research data on global warming is the *Intergovernmental Panel on Climate Change (IPCC).* The IPCC is made up of literally thousands of the world's top meteorologists, chemists, engineers, physicists, biologists, and other scientists (I suspect they have even recruited some UFO researchers). This group of dedicated folks is continually generating hundreds upon hundreds of research reports – alerting us to the global warming crisis as it evolves. The field is so new and changing so rapidly that most IPCC folks were recruited from whatever else they were doing to work on climate. Most of them (like me) are making far less money doing climate work but do it because they have children and grandchildren who they don't want to inherit the mess we are in now.

FOREGONE CONCLUSIONS

When I was giving professional lectures around the country for a living and I found the adage, "Tell them what you are going to tell them. Tell them. Tell them what you told them." to be remarkably helpful. With that in mind, I am going to give you the principles and conclusions presented in Climate Deadline right up front. Then, if you are one of the hundreds of thousands of people fleeing the hundreds of wildfires currently ravaging Australia or the deadly flooding which has submerged most of the capital of Indonesia you can skip the rest of the

book and get back to fighting to survive the effects of the Climate Emergency. If your one of us fortunate few still on dry and unscorched ground you read on at your leisure until these possibly unsettling conclusions make sense:

(1) That the Earth is unable to process the massive accumulation of legacy greenhouse gas (GHG) emissions already in the atmosphere using her own systems in a timeframe needed to avert a shift out of our current life-sustaining ecological balance. That these, as of yet uncontrolled, emissions are pushing our planetary ecology into a "new normal" inconsistent with the survival of most species of life currently on the planet.

(2) That Global Warming, caused by these GHG emissions and the resulting disruption of Earth's natural systems, is causing massive immediate and future suffering and death and is a *Clear and Present Danger* to most currently existing life on the planet. That the *Life and Liberty* of future generations have already been exterminated *unless restored* by emergency measures taken in the next few years making remainder of human endeavor and activity only palliative and mitigatory.

(3) That, because global warming is caused by anthropogenic changes humans have forcing in our environmental support system, those who cause and support such damage to our common life-support systems are a Clear and Present Danger to humanity.

(4) That, informed by this awareness of present and future suffering, we must find the strength and determination to shift from our current "business as usual" approach to human endeavors and adopt a "war footing". We must quickly build the *severe and unrelenting resolve* needed to act affirmatively to remediate Global Warming – whatever the costs or benefits.

(5) That this includes a refusal to engage in, or permit "war profiteering". While all people have a right to the median standard of planetary living, no one has a right to profit from a declared *Global Emergency.* This includes selfish attempts to patent or possess intellectual or real technology which would reasonably be expected to result in the resolution of this emergency until such time as that resolution (e.g. legacy carbon emissions returned to below 350 ppm) has been achieved.

(6) That accidental and deliberate delay in taking action has now left us with a very short timeline to manage this Global Emergency (450 ppm atmospheric carbon predicted on our current trajectory to arrive in the mid-2030's). That regardless of whether this timeline is realistic it is the *only possible timeline.* This timeline looks roughly like this: 2020-2022: United Nations systems, government and industry organized toward Climate Engineering. Selection of methodology and mobilizing of resources. • Years 2022-2025: Emergency Climate Engineering underway. • Years 2025-2030: Global temperatures returned to less than 350 ppm.

(7) That, because of the interconnectedness of our natural world, the changes affected by Global Warming are *not linear but rather exponentially expanding feedback loops*. While we do not fully understand these feedback loops, we know they are increasingly foreshortening the time available to resolve this Climate Emergency.

(8) That we must now support nature in recovering from the damages we have inflicted and use human-derived methodology to solve this human-caused problem in a one time effort.

(9) That to withhold or delay the use of Climate Engineering technology to assist and support our atmospheric and ecological systems in recovering to a level which will again sustain human, plant and animal life is the direct equivalent of the taking of human life.

(10) That methodology is currently available to resolve our Global Emergency in the form Climate Engineering – specifically Land-Based Carbon Removal, Ocean-Based Carbon Removal and Solar Radiation Management.

(11) That, while private funding is free to explore other avenues, due to the emergency nature of the current crisis we must now limit our efforts to refining and deploying the existing technology in these areas on a global scale.

(12) That the *United Nations* was established and is funded ultimately by The People through their various governments to manage global emergencies and should be *expected* to use these technologies to resolve Global Warming. To not do so would demonstrate genocidal negligence.

(13) That in order to accomplishing this work, elements of the United Nations should be modified until that the organization has the

necessary representation, administration, enforcement and regulatory capacity to complete this work.

(14) That once the Climate Emergency is resolved (e.g. legacy carbon emissions returned to below 350 ppm), we must then have the resolve to judiciously withhold additional use of this technology until, operating through the United Nations, a new ethic for working with our planet's systems (rather than abusing, degrading and damaging them), and for establishing carbon neutral and sustainable practices can be put in place. This will necessarily include adoption of alternative sources of energy, population and resource management. We will essentially need to learn to regulate ourselves within the ecological balance of our planet as well as we have learned to exercise our freedom, independence, covetousness and gluttony.

Looking back from some 50 years distance we will certainly find that there will have been some variation in these conclusions and recommended actions, but essentially this is the pathway we will necessarily have to take to find our way successfully through the Climate Emergency.

The flooded roadway into the Brooklyn Battery Tunnel in Manhattan after Hurricane Sandy.

THE TROUBLE WE ARE IN

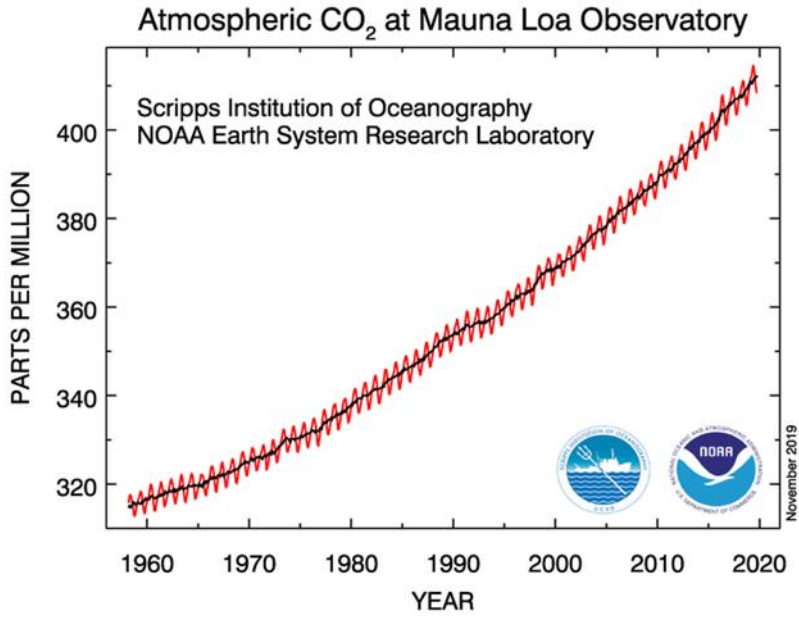
In November 2019 eleven thousand of scientists together published a statement declaring clearly, "Exactly 40 years ago, this same group from 50 nations met at the First World Climate Conference (Geneva 1979) and agreed that alarming trends for Climate Change made it

urgently necessary to act. Since then, similar alarms have been made through the 1992 Rio Summit, the 1997 Kyoto Protocol, and the 2015 Paris Agreement, as well as scores of other global assemblies and scientists' explicit warnings of insufficient progress (Ripple et al. 2017). *Yet greenhouse gas (GHG) emissions are still rapidly rising, with increasingly damaging effects on the Earth's climate. An immense increase of scale in endeavors to conserve our biosphere is needed to avoid untold suffering due to the climate crisis."*

There are now so many people from different fields and various countries working on climate issues that the media has started paying attention. Media mentions of "Climate Emergency" are up 10,000% just since I started my run for Governor in 2018. The Oxford English Dictionary named Climate Emergency the *Word of the Year* (well, phrase of the year anyway) in 2019. More than 1,250 governments, including the European Union, have now declared a Climate Emergency.

What they are saying is that this is not just *an* emergency. World wars were *an emergency*. Flu pandemics are *an emergency*. This is ***the*** emergency, the showstopper, the big one, the one nobody is going to walk away from - worse even in some ways than the specter of massive nuclear holocaust. The prospect we face, unless we make the right moves to change our current course, is an exponential (e.g. very rapid) increase in climate catastrophes until the ecosystem that supports us becomes so toxic our future generations will wish for the mercy of a quick nuclear death. And we are talking about this happening in *this century* not some far-off someday.

To add insult to injury, really hard solid research (it's hard to argue with *geologic records*) is telling us by the mid-2030's the situation will be so advanced that we will *no longer have the resources and technology to do anything about it*. Now to my way of thinking, no matter what else is happening with teacher salaries or the next dictator at home or abroad, if the Earth becomes unlivable for humans *nothing much else will matter*. Most of the scientists I know are freaking out with the rapidity of global warming and its effects of the planet. We have really stepped in it this time and our chances are as thin as a butterfly's wing.

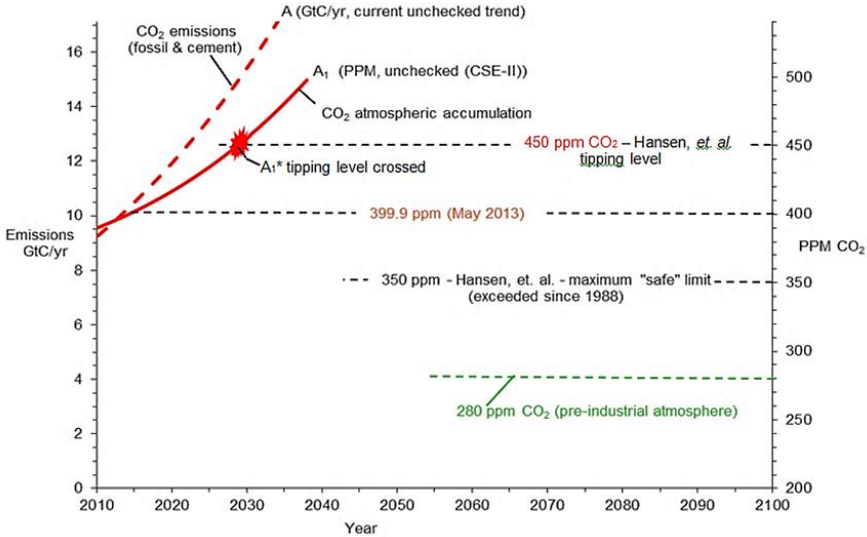


AN EXERCISE IN DOOM

Okay, it's time I hit you with what I like to refer to as "The Chart of Doom". I first ran into this chart when I was working with the Climate Reality Project in 2016. CRP has a vast network of very dedicated volunteers and a cadre of scientists, public servants and luminaries. One group of scientists led by chemical engineer Dr. Robert Fry had introduced CRP to the below chart based on research by Dr. James Hansen. Hansen, a former head of NASA's Goddard Institute for Space Studies, testifying at congressional hearings in 1988, was the first scientists to bring global warming to public attention.

The chart illustrates the current **- - -A** and Paris Accord modified **_____A_1** * trajectory of CO_2 emissions, and projects the approximate point in time where they will cross what is referred to as the "tipping level(s)". I refer to this as the Climate Deadline. After this point, geologic records indicate the feedback-loops set in motion will surpass humanities knowledge and resources to alter the effects of planetary warming. After this point the Earth will be too far into its transition to a "new normal" - one incompatible with the continuation of most of the forms of life existing today. (*There is currently no sign the Paris Accords are being adhered to as greenhouse gas emissions are for the most part continuing to rise.)

We will refer back to this essential chart later in the book. For now it is important to understand that: (1) Global warming is not a linear process. The complex systems that make up our planetary ecology interact with one another. As this interaction "heats up" the process will become exponential, racing out of our grasp. (2) There is already so much greenhouse gas (primarily carbon) in our atmosphere that even an immediate *full-stop* of emissions will still leave us on a warming trajectory (A_1) that passes the Climate Deadline in the mid-2030's if not before.



(A1 in 2029) 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 500 ppm (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).*

So, after gazing mournfully at the "Chart of Doom", allow me to be a psychologist for just a minute, ask you to take a little break, and do a small visualization exercise. Here we go: First, look around you wherever you happen to be - notice your immediate environment. There are probably people, places, animals, trees, birds – all the things that make up the web of life around you. Now visualize your community, that wider interwoven patchwork of people and organizations that surrounds you each and every day - maybe even extend that awareness out to your county, State or region. Now, I'd like you to add to this awareness of the web of life around you the information you've just learned (or been reminded of) – that, as of

now, unless you and I intervene, *all of this will be coming to an end in a matter of decades*. See if you can really feel this as an *iron-clad certainty* (it is). All of what you love, or hate, or don't even notice will be consumed by floods, fires, mega-storms, dust clouds, endless migrations, starvation, disease, killer heat-waves, and eventually war. (If you've seen the movie Interstellar or something similar you will have a good idea what this looks like.) Notice how you feel about saying goodbye to……all of this…….

I was recovering from triple-bypass heart surgery in a downtown Chicago hotel when I experienced what you just did. It was evening and the lights in the other tower of the hotel were turning on casting a warm glow against the weathered brick façade. I was deciding if I should go on with my clearly hopeless run for Arizona Governor - mainly an excuse to raise awareness about the urgency of climate disruption. As my eyes wandered, I thought about all the people in those rooms and their families and their families. I suddenly found myself in tears. The horror of what we *were all* facing (though most of those people in those warm windows I knew were blissfully and dangerously unaware) was too much. Like the first time as a Search & Rescue officer that I saw a body in pieces spread over a field. The mind rebels, it's just not supposed to be like that – the pieces are supposed to fit together in a meaningful way. The feeling of connection to the life around me that evening turned out to be enough to keep me going through the remainder of the campaign and on into the federal lawsuit that would follow.

Now that's me. I can tell you it took me months to wrap my head around the climate doomsday notion. It's too big – something I'm prepared to watch in a movie, but not in real life. It's surreal. I can tell you I really wish I didn't have to put this awareness of impending doom in your mind if it wasn't already there. But there it is and the only way to get to a cure is through a clear and accurate diagnosis. Right now, as things stand, our children have no future – it's a foregone conclusion. The only hope they have is us. If they're young, by the time they are old enough it will be too late to do anything about it. So……..it's up to you and me. Time for all hands on deck. If you had ever wished you had the chance to sign up to fight against tyranny – now is your chance. *This is The Big One.*

A DANGEROUS ILLUSION

Okay, deep breath. *Now there is good news* – and I'm going to give you that *now* to spare you those months of hopelessness I experienced

between when I found out we were doomed and when I found out we might possibly not be if we got it in gear. The good news is that, like Ebenezer Scrooge, we do have a chance to change the dark future that now awaits. But I have to warn you, it's *not* the future you're probably thinking of – the one with Al Gore triumphantly standing amid shining solar panels and huge wind turbines, soundless electric cars buzzing around. In that future things do look a little promising and everyone gets to feel good about themselves for making an effort – and then we are consumed by fires, floods and famine.

A happy ending for *that* future disappeared 40 years ago. That was the option we had back when the ozone hole was ripping open and OPEC did its first embargo, President Carter (bless his heart) was putting home-made solar panels on the White House roof and John Denver was singing "Rocky Mountain High" (if you are too young for all this look it up). Those were the days when, if we had listened to the Hippies, we could have put up wind and solar farms, kept making increasingly fuel-efficient cars, and maybe have skated right past all this gloom and doom.

But instead what happened is we were urged on by ever-fattening multinational corporations to buy something called SUVs. We built more buildings and roads, kept using more concrete, and burned more fossil fuel and….today *if we stopped all carbon emissions completely right now we would still stay on track to hit 450ppm in the mid-2030's.* Then Earth would still react as she has before to that level of carbon and trigger the cascade of feedback loops that will result in extinguishing most of the life forms currently occupying this planet.

Pursuing a renewable-sustainable agenda *will* be important, but *currently it's the biggest danger to our survival* – a distraction, a boondoggle. We need a different future – one that leads us eventually to that renewable-sustainable utopia, *but has an important mission to take care of first.*

Just what is that all-important mission? If all that renewable sustainable stuff won't save us what will? (And please don't throw those things away – we are going to need them later – if there *is* a later.) Well, our one, 11th hour, Hail Mary chance lies with something called *Emergency Climate Repair* (probably in the form of *Direct Atmospheric Removal of Excess-Carbon* (D.A.R.E.) and *Solar Radiation Management* (SRM)).

DARE involves scaling up a really, really big project for directly removing carbon from the atmosphere (and oceans). SRM involves using technology to block a percentage of solar radiation reaching our planet. There are several projects in each of these categories available right now – or possibly a combination. My favorite is called Ocean Assisted Carbon Capture & Reflection (OACC&R) because it simply increases a process already occurring in nature, has miniscule chance of doing damage in the process, combines carbon capture with radiation management, allows carbon emitting corporations and their political friends a way to cease emissions and re-tool while still operating, creates massive benefits for the world economy, and brings together nations in a positive collective effort. (More on OACC&R in Chapter Six.)

Can Climate Repair really be accomplished? That is the good news! *Yes*! We have the technology just on the cusp and - *if all of us push with all our might* to get DARE/SRM up and running in the next few years - we *can* just squeak out of this greenhouse-gas-death-trap we have created for ourselves.

A QUESTION OF TIME

So why can't emissions reductions and sustainability save us like so many people have been saying for so long. Well, although nature herself is pretty good at cleaning up atmospheric pollution, she does not work in our human time frame, in the time-scale we need and emissions reductions will not work fast enough (even if people were willing). As I mentioned, even if we stopped all greenhouse gas emissions now today it would take nature *thousands of years* on her own to get us back to the *safe zone* (below 350 ppm carbon). We have created an unnatural process and it will require an unnatural repair process to get us back on track – at least now. Forty years ago we could have shifted to renewable energy and begun rapid emissions reductions and squeaked by. But we have gone far, far beyond that point. Meanwhile, as I will discuss ad nauseum, climate scientists are clearly telling us we have only until the mid-2030's to fix this thing. Around that point (when the atmospheric saturation of carbon reaches around 450 ppm) those hard-as-heck-to-argue-with *geologic record*s are clear that Earth will shift her behavior to a "new normal" inconsistent with continued human survival. The interaction between altered functions in our ecological systems will accelerate exponentially, and our window for making change even using large-scale technology – will be closed. This, then, is our *Climate Deadline 2035*.

READ THE SCIENCE

Even were I capable of writing it, this book is not a scientific paper (although all of the science cited here is current and accurate as far as I know – no small task because climate science is moving at a breakneck pace). If you have any doubts about what you are reading here, I urge you to check the research (and I mean peer-reviewed, primary research journals like Climate Dynamics, Climate Research, Climatic Change, Earth Planet Science Letter, Ecological Applications, Ecological Model, Ecology, Energy Policy, Forest Ecology Management, Geology, Geophysical Research Letter, Global Change Biology, Global Planet Change, International Journal of Climatology, Journal of Climate, Journal of Geophysical Research-Atmospheric, Journal Hydrology, Oecologia, Papers of the National Academy of Sciences USA, Palaeogeographic Palaeoclimetology, Paleoceanography, Quarterly Sci Review, Science, etc. and NOT the popular press or internet) and see for yourself. In fact, I *implore* you to take the time to do so because it is essential that you are confident about the concepts put forward in this book. Imagine going off to battle in a war and not being certain about the cause you were fighting for. For most of us that would just not be acceptable.

When you are sure of the danger we are facing and the timeline we are working with – when that cold, hard reality sinks in if you have any heart, any conscience you will not in good conscience be able to go back to "business as usual". You won't *be able* put this book on a shelf, breath a heavy sigh and then take your kids to the next in a wave of movies about the apocalypse. (I wonder why all these doomsday movies are coming out now?) You will feel compelled to take action – to start donating your time and money to helping solve the Climate Emergency – and that is what we need to make this work. Much like in our world wars, we need everyone puling together on the same rope to heave ourselves over this hump in human civilization.

If you're really certain about the research, you won't be okay with being the guy or gal who ducked out of their public service when your friends were all signing up to go fight. Even if you are overwhelmed, even if you don't know what to do (and there are lots of suggestions in the back of this book for what needs doing) at first, even if you have a job and kids and parents getting older (like me) you will suck it up and *fight!* You will stop thinking about each day as just another day. You will start seeing each day is one of the *last remaining days* that your kids future can be saved. (One way to think about it is we currently

have eight periods of 6 months left – think how fast 6 months goes - we have only 8 six-month periods left until Mother Earth starts to clear the game board and gets out a new game.)

UNEXPECTED ACCELERATION

Planet Earth, which most of us inhabit, is approximately 4.5 billion years old. A geologic era is a subdivision of geologic time that divides an eon into smaller units of time. The Phanerozoic Eon is divided into three such time frames: the Paleozoic, Mesozoic, and Cenozoic (meaning "old life", "middle life" and "recent life") that represent the major stages in the macroscopic fossil record. The Hadean, Archean and Proterozoic eons were as a whole formerly called the Precambrian. This covered the four billion years of Earth history prior to the appearance of hard-shelled animals. More recently, however, the Archean and Proterozoic eons have been subdivided into eras of their own.

List Of Geological Eras In Earth's History ***Eon*** Era Time frame

--- *Anthropocene Boundary*: Catastrophic Extinction Boundary ---*
Phanerozoic Eon
Cenozoic Era 66 million years ago to present
----*K-Pg Boundary*: Catastrophic Extinction Boundary ---*
Mesozoic Era 251.902 to 66 million years ago
--- *P-T Boundary*: Catastrophic extinction boundary ----*
Paleozoic Era 541 to 251.902 million years ago
Proterozoic Eon
Neoproterozoic Era 1,000 to 541 million years ago
Mesoproterozoic Era 1,600 to 1,000 million years ago
Paleoproterozoic Era 2,500 to 1,600 million years ago

Archean **Eon**
Neoarchean Era 2,800 to 2,500 million years ago
Mesoarchean Era 3,200 to 2,800 million years ago
Paleoarchean Era 3,600 to 3,200 million years ago
Eoarchean Era 4,000 to 3,600 million years ago
Hadean **Eon** Formation of Earth to 4,000 million years ago

** There is evidence that catastrophic meteorite impacts and,or alterations in the Earth's orbit around the Sun, played a role in demarcating the differences between the eras.*

For decades, most scientists saw climate change as a distant prospect. We now know that thinking was wrong. As we now know, most of the predictions regarding the speed and magnitude of climate change were far too conservative and underestimated pretty much everything. This summer, for instance, a heat wave in Europe penetrated the Arctic, pushing temperatures into the 80s across much of the Far North and, melting some 40 billion tons of Greenland's ice sheet.

So far, the costs of underestimation have been enormous. New York City's subway system did not flood in its first 108 years, but Hurricane Sandy's 2012 storm surge caused nearly $5 billion in water damage, much of which is still not repaired. In 2017, Hurricane Harvey gave Houston and the surrounding region a $125 billion lesson about the costs of misjudging the potential for floods.

The climate change panel seems finally to have caught up with the gravity of the climate crisis. Last year, the organization detailed the extraordinary difficulty of limiting warming to 2.7 degrees Fahrenheit (1.5 degrees Celsius), over the next 80 years, and the grim consequences that will result even if that goal is met.

Scientists have long known that major volcanic eruptions or asteroid strikes could affect climate rapidly, but such occurrences were uncommon and unpredictable. Absent such rare events, changes in climate looked steady and smooth, a consequence of slow-moving geophysical factors like the earth's orbital cycle in combination with the tilt of the planet's axis or shifts in the continental plates.

In the 1960s, a few scientists began to focus on an unusual event that took place after the last ice age. Scattered evidence suggested that the post-ice age warming was interrupted by a sudden cooling that began around 12,000 years ago and ended abruptly 1,300 years later. The era was named the "Younger Dryas" for a plant that proliferated during that cold period.

In the early 1990s, scientists completed more precise studies of ice cores extracted from the Greenland ice sheet. Dust and oxygen isotopes encased in the cores provided a detailed climate record going back eons. It revealed that there had been 25 rapid climate change events like the Younger Dryas in the last glacial period.

The evidence in those ice cores would prove pivotal in turning the conventional wisdom. As the science historian Spencer Weart put it: "How abrupt was the discovery of abrupt climate change? Many

climate experts would put their finger on one moment: the day they read the 1993 report of the analysis of Greenland ice cores. Before that, almost nobody confidently believed that the climate could change massively within a decade or two; after the report, almost nobody felt sure that it could not."

In 2002, the National Academies acknowledged the reality of rapid climate change in a report, "Abrupt Climate Change: Inevitable Surprises," which described the new consensus as a "paradigm shift." This was a reversal of its 1975 report.

"Large, abrupt climate changes have affected hemispheric to global regions repeatedly, as shown by numerous paleoclimate records," the report said, and added that "changes of up to 16 degrees Celsius and a factor of 2 in precipitation have occurred in some places in periods as short as decades to years."

In the early 2000s, ice shelves began disintegrating in several parts of Antarctica, and scientists realized that process could greatly accelerate the demise of the vastly larger ice sheets themselves. And some major glaciers are dumping ice directly into the ocean.

By 2014, a number of scientists had concluded that an irreversible collapse of the West Antarctic ice sheet had already begun. Then this year, a review of 40 years of satellite images suggested that the East Antarctic ice sheet, which was thought to be relatively stable, may also be shedding vast amounts of ice.

As the seas rise, they are also warming at a pace unanticipated as *recently as five years ago*. This is very bad news. For one thing, a warmer ocean means more powerful storms, and die-offs of marine life, but it also suggests that the planet is more sensitive to increased carbon dioxide emissions than previously thought.

The melting of permafrost has also defied expectations. This is ground that has remained frozen for at least two consecutive years and covers around a quarter of the exposed land mass of the Northern Hemisphere. As recently as 1995, it was thought to be stable. But by 2005, the National Center for Atmospheric Research estimated that up to 90 percent of the Northern Hemisphere's topmost layer of permafrost could thaw by 2100, releasing vast amounts of carbon dioxide and methane into the atmosphere.

For all of the missed predictions, changes in the weather are confirming earlier expectations that a warming globe would be accompanied by an increase in the frequency and severity of extreme weather. And there are new findings unforeseen by early studies, such as the extremely rapid intensification of storms as when Hurricane Dorian's sustained winds intensified from 150 to 185 miles per hour in just nine hours, and last year when Hurricane Michael grew from tropical depression to major hurricane in just two days.

Scientists are warning that Climate Change will cause major food shortages due to desertification, flooding, and other disruptions in the ecosystem. Among this most serious is the heightened risk that more than one grain-producing region could be affected by adverse weather at the same time. Normally one crop region can compensate for crop failure in another, but more frequent extreme weather is making this backup system less dependable.

The 2019 Arctic Report Card, a major federal assessment of climate change trends and impacts throughout the region. The study paints an ominous picture of a region lurching to an entirely new and unfamiliar environment.

Especially noteworthy is the report's conclusion that the Arctic, *which is heating at twice the rate of the rest of the planet*, already may have become a net emitter of planet-warming carbon emissions due to thawing permafrost, which would only accelerate global warming. Permafrost is the carbon-rich frozen soil that covers 24 percent of the Northern Hemisphere's land mass, encompassing vast stretches of territory across Alaska, Canada, Siberia and Greenland.

There has been concern throughout the scientific community that the approximately 1,460 billion to 1,600 billion metric tons of organic carbon stored in frozen Arctic soils, almost twice the amount of greenhouse gases as what is contained in the atmosphere, could be released as the permafrost melts.

Warming temperatures allow microbes within the soil to convert permafrost carbon into the greenhouse gases — carbon dioxide and methane — which can be released into the air and accelerate warming. Ted Schuur, a researcher at Northern Arizona University and author of the permafrost chapter, said the report "takes on a new stand on the issue" based on other published work, including a study in Nature Climate Change in November.

Taking advantage of the new studies — one on regional carbon emissions from permafrost in Alaska during the warm season, and another on winter season emissions in the Arctic compared to how much carbon is absorbed by vegetation during the growing season — the report concludes permafrost ecosystems could be releasing as much as 1.1 billion to 2.2 billion tons of carbon dioxide per year. This is almost as much as the annual emissions of Japan and Russia in 2018, respectively.

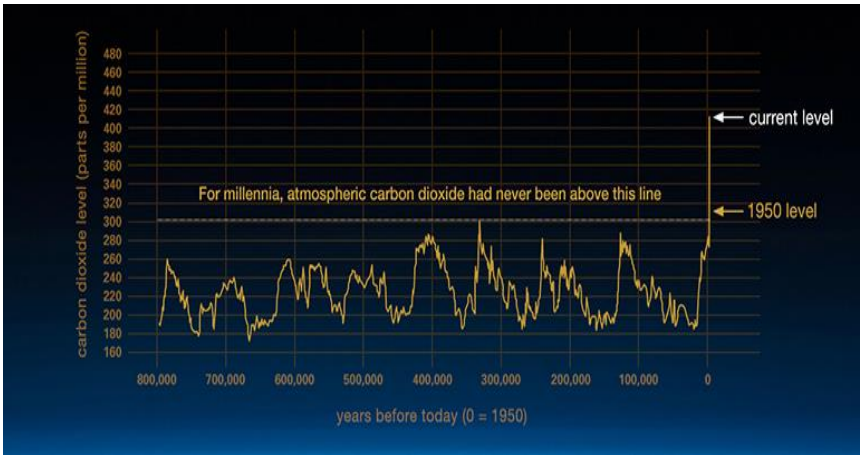
"These observations signify that the feedback to accelerating climate change may already be underway," the report concludes. For the purposes of this book we will refer to what we are trying to prevent by staying below 450 ppm atmospheric carbon, reaching net zero emissions (by 2050) and keeping the planetary temperature rise to no more than a 1.5C rise in temperature (by the year 2100) "the *Anthropocene Catastrophic Extinction Boundary*." If humans succeed in passing 450 ppm carbon, geologic research indicates we will push the Earth into a new set of characteristics unlike those of our current ecosystem. In other words, we ourselves (rather than a giant metior) will have triggered the planet to reset the very finely balanced conditions of life. Few, if any of the species living on the Earth today, will survive this change in our planetary habitat.

Even if scientists end up having lowballed their latest assessments of the consequences of the greenhouse gases we continue to emit into the atmosphere, their predictions are dire enough.

CAN WE AFFORD NOT TO D.A.R.E.?

At the rapid pace of human-induced Climate Change, we are facing a very real problem. We may spend the billions if not trillions of dollars needed to adapt to global warming – but adaptation does not equal evolution. Like the West African black rhinoceros, the Javan tiger, the Passenger pigeon, and countless other animal species, the human species is on track to become extinct.

Climate scientists have tried to envision ways that we could avoid destroying ourselves. It is more difficult to do now than it once would have been. Scientists and naturalists have been observing changes on Earth for more than 150 years. In the 1950s, 60s, and 70s, we became more confident in our judgments that we were playing the main role in temperature change on this planet. If we had changed our energy production system at that point, several decades ago, we would not be faced with today's dilemma.



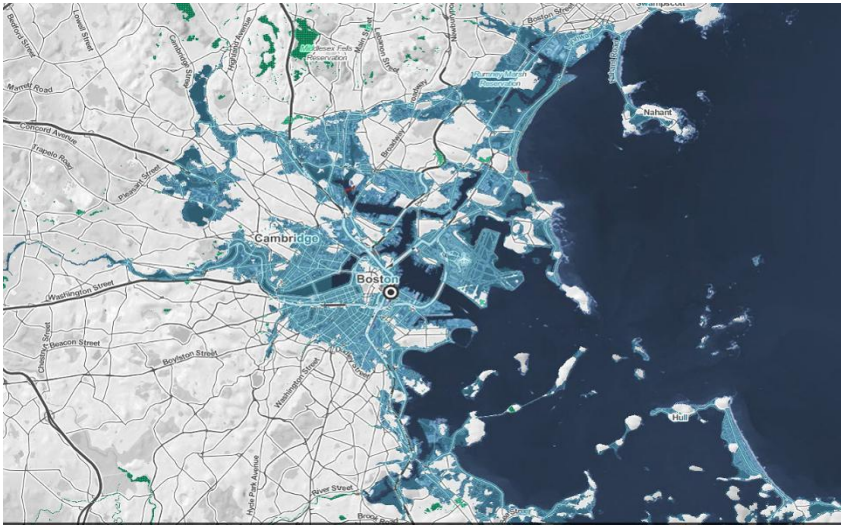
NASA Carbon Tracking Data

A RACE TO ASSIST MOTHER NATURE

The Earth, it seems, is an interconnected system. Unable to escape Earth's greenhouse-gas-saturated atmosphere, radiative heat warms our oceans triggering increasingly intense storms, floods and coastal flooding leading to the melting of precious polar ice - causing the release of massive stores of methane - leading to ocean current disruption and acidification - causing in turn altered weather patterns - leading to enduring drought triggering wildfires - leading to crop failures - contributing to the birth of novel carbon-releasing soil microbes – causing the release of massive carbon stores from soil - and famine leading to mass migrations - which in turn overwhelm the ability of governments to respond - causing social unrest and territorial wars and on and on….. All of this and more is already in our news every day.

Yet, life, for most of us, appears to go on day after day as it always has. We get the kids to school, we rush off to our jobs. Few of our conversations include the topic of Climate Change, which has been politicized in a way that can make us fear censure or reprisal at its very mention. Many of us pretend that nothing is changing. However, change *is happening,* and much faster than even the most unsparing and progressive minds in the scientific community could have expected. Humankind has changed life on Earth - geologists refer to this as the "Anthropocene Epoch" (or influenced by humans) in Earth's evolution. We have changed this planet so much that we are now faced with a planet-wide global warming crisis – a crisis that requires a massive response not seen since the mobilization to WWII.

The Red Cross is reporting that "since June 2019, torrential rainfalls and flash floods have hit 124 Local Government Areas within 36 states and Federal Capital Territory – Abuja (FCT) in Nigeria. This has affected a total number of 210,117 people with 171 casualties recorded in hospitals and 130,610 people reported to be displaced."

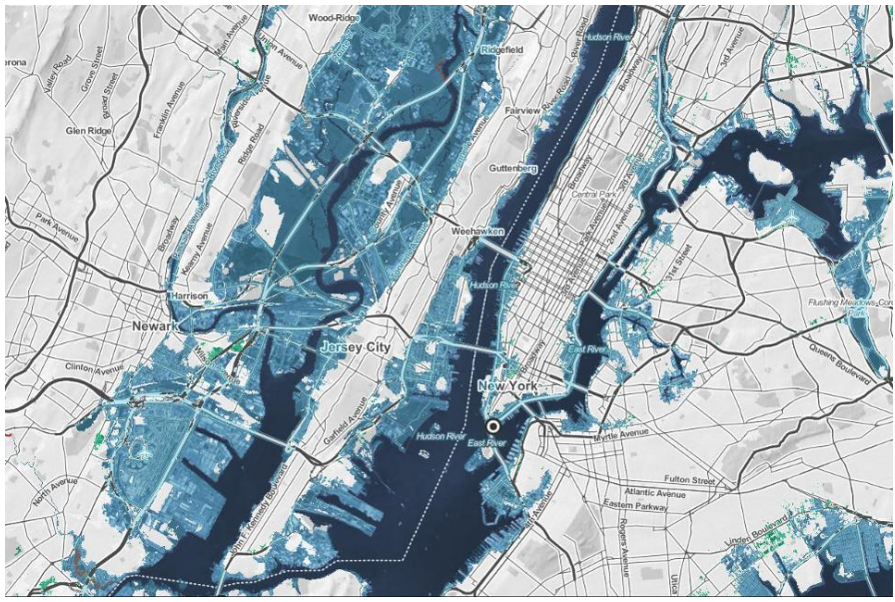


CoastalDEM Digital Elevation Model for Boston 2050

GLOOM AND DOOM

As I write the 2020 Edition of this book, unnaturally rising ocean temperatures and vastly increased amounts of water in the airstream overhead have helped to spawn hurricane Harvey. (Hurricanes now last over 60 percent longer and have peak winds 50 percent greater than a generation earlier.) The devastating super-storm has 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, tore through the Caribbean. In Florida a massively expensive evacuation was performed with over 5.6 million people ordered to evacuate. In its path across the Caribbean, Irma has 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*.



CoastalDEM Digital Elevation Model for New York 2050

Unless you're a hurricane watcher or live in Texas or Puerto Rico you probably don't even think much about Harvey or Irma – there have been so many climate-related events since then….. The Republic of the Marshall Islands, home to 750,000 souls and one of the lowest lying island nations in the world, has declared a *national emergency* over Climate Change. The country's president, Hilda Heine, tweeted the news Friday, blaming the international community for not acting quickly enough to mitigate global warming "of its own making." (If nothing else Climate Change is making it clear that, on most levels, it is ridiculous for countries to try to function as totally autonomous entities.)

At the same time, the Western United States are experiencing yet another "worst year ever" as 137 wildfires burn over 1,830,00 Acres in Western United States, including the largest fires in Los Angeles and Bay Area history, causing thousands to flee their homes. A year after the Camp Fire, California Power & Gas took the extraordinary fire-prevention step of shutting off power to millions of customers – and yet wildfires still raged. Indeed, the United Nations is currently reporting 65.9 million people forcibly displaced worldwide as a *direct* result of "climate-related disasters" not including those even now being forced to relocate as NOAA reports *this year's arctic ice "shows no sign of returning to a reliably frozen state"*.

In late 2019 Australia, suffering an intense three-year drought, is battling dozens of wildfires of "unprecedented" size with 1,500 firefighters putting their lives at risk in triple-digit temperatures and unusually high winds. In the process the iconic Koala Bear population has lost over 80% of its habitat. At this writing is nearly 2,500,000 acres have burned in New South Wales alone.

Likewise, in Deli, India all residents are being told to stay indoors indefinitely due to catastrophically bad air quality (a score of 439 on a scale of 0-50). The World Health Organization states living in Deli is equivalent to smoking 50-200 cigarettes daily.

Many found the agreement reached during the Paris Climate Accords reassuring. The agreement, reached after extensive deliberation and debate, officially targets a goal of 2 ºC (35.6 °F) global warming as the maximum temperature increase by 2100. Governments around the world have expressed a desire to achieve only a 1.5 ºC (34.7 °F) increase.

Unfortunately, not only has the United States, the number one contributor to atmospheric pollution, completely withdrawn from the agreement, but the Climate Action Tracker (CAT) (climateactiontracker.org), an independent scientific analysis produced by a consortium of three research organizations tracking climate action since 2009, forecasts *actual warming of 2.7 ºC (36.9 °F)*. Thus, we have three different numbers from Paris: $\Delta T = 2$ ºC is their official target, $\Delta T = 1.5$ ºC is their "wishful" target, and $\Delta T = 2.7$ ºC is the actual path that we are currently on.

And so. we find ourselves in a race to find a way to assist Mother Nature in removing massive amounts of carbon (the most prevalent and removable greenhouse gas) from our contaminated atmosphere…. and doing it on a very short timescale. Fortunately, there is now hope! Since the first Edition of Climate Deadline 2035 we have moved rapidly from denial, to acknowledging Climate Change is happening, to addressing it as an Emergency with a deadline somewhere near 2035. Now we are able to take the last crucial step – actually implementing a strategy called *Climate Repair* which will be discussed throughout this book. In university laboratories, think tanks and private corporations around the globe the race is on to create scalable, commercially and politically viable methods for actually removing carbon from our atmosphere. Therein lies our hope for avoiding Climate Deadline 2035 and each of us has a role to play.

One of the many reasons why *Climate Repair* is our best way out of the climate crisis is economics. In spite of the threat of extinction, even in the wealthier nations the price tag associated with limits of GHG emissions continues to discourage most governments from acting. (As I mentioned, I call this the Mistletoe Effect", where a less-evolved parasite continues to consume it's host even though it's unchecked greed eventually kills both the host and the Mistletoe.) Most approaches to Direct Atmospheric Removal of Excess-Carbon lead to a big payday for whomever shoulders the R&D and start-up costs. This is especially true of *Ocean Assisted Carbon Capture & Reflection* which is projected to bring trillions of dollars into the economy and meet the predicted 50 percent increase in energy needs in developing countries. So if we do it right, and we do it now, DARE technologies afford us the opportunity to not only win this war while making sure no one dies (who would not have anyway), draw disparate groups together in a common cause, *and* put jobs in the pockets and food on the table to hundreds of thousands of workers!

With all these benefits and an *auto-genocidal downside* if we do not take the D.A.R.E. why would we *not* at least try?

THE BIG PICTURE

As a Climate Analyst your author has been up, down, and around the problem of global warming for some time now – not as long as some, but long enough and deep enough that I'm pretty sure I have the big picture. I've also correctly predicted with outstanding accuracy each twist and turn and what our optimal response needed to be as the global warming bad dream has unfolded. In 50 years if our civilization is thriving, when we look back at the coming decades, I predict this is what you will see happened:

Notice that nowhere in this scenario is there time for rioting, overthrowing governments, or a total abandonment of geopolitical systems. Nor is there time for confusing agendas containing everything but the kitchen sink. Human rights are great, and right now we need to get this climate emergency handled or there won't be any humans around to have rights. Organizations like Extinction Rebellion are doing an amazing job of raising the alarm on our Climate Emergency, but their agendas are often bloated with (important) side-issues which need to wait or be handled by other organizations. We simply do not have time to do anything except stick to resolving global warming – and the only way to do that at this point is Emergency Climate Repair using Direct Atmospheric Removal of Excess-Carbon

and Solar Radiation Management. We need to be *laser-focused* on getting specific jobs done using the resources and national and international structures we have. We *can make the changes needed* to rescue ourselves in time within our current geopolitical framework and to do this we need a *concerted effort* between advocates, governments, and most importantly the United Nations – an organization built on the bloodshed and hard-won lessons of our Great World Wars for *exactly just such global emergencies as Climate Change*! (By the way, at the end of November 2019 the European parliament declared a Global Climate & Environmental Emergency.)

This would be an excellent time for some comments by Antonio Guterres, Secretary General of the United Nations

Dear friends of planet Earth,

Thank you for coming to the UN Headquarters today. I have asked you here to sound the alarm. Climate change is the defining issue of our time – and we are at a defining moment. Climate change is moving faster than we are – and its speed has provoked a sonic boom SOS across our world.

If we do not change course by 2020, we risk missing the point where we can avoid runaway Climate Change, with disastrous consequences for people and all the natural systems that sustain us.

Let there be no doubt about the urgency of the crisis. We are experiencing record-breaking temperatures around the world. According to the World Meteorological Organization, the past two decades included 18 of the warmest years since 1850, when records began. This year is shaping up to be the fourth hottest. Extreme heatwaves, wildfires, storms and floods are leaving a trail of death and devastation.

Last month the state of Kerala in India suffered its worst monsoon flooding in recent history, killing 400 people and driving 1 million more from their homes. We know that Hurricane Maria killed almost 3,000 people in Puerto Rico last year, making it one of the deadliest extreme weather disasters in U.S. history. Many of those people died in the months after the storm because they lacked access to electricity, clean water and proper healthcare due to the hurricane.

What makes all of this even more disturbing is that we were warned. Scientists have been telling us for decades. Over and over again. Far

too many leaders have refused to listen. Far too few have acted with the vision the science demands. We see the results.

In some situations, they are approaching scientists' worst-case scenarios. Arctic sea ice is disappearing faster than we imagined possible. This year, for the first time, thick permanent sea ice north of Greenland began to break up. This dramatic warming in the Arctic is affecting weather patterns across the northern hemisphere. Wildfires are lasting longer and spreading further. Some of these blazes are so big that they send soot and ash around the world, blackening glaciers and ice caps and making them melt even faster.

Oceans are becoming more acidic, threatening the foundation of the food chains that sustain life. Corals are dying in vast amounts, further depleting vital fisheries.

And, on land, the high level of carbon dioxide in the atmosphere is making rice crops less nutritious, threatening well-being and food security for billions of people. As Climate Change intensifies, we will find it harder to feed ourselves.

Extinction rates will spike as vital habitats decline. More and more people will be forced to migrate from their homes as the land they depend on becomes less able to support them. This is already leading to many local conflicts over dwindling resources.

This past May, the World Meteorological Organization reported that the planet marked another grim milestone: the highest monthly average for carbon dioxide levels ever recorded. Four hundred parts per million has long been seen as a critical threshold. But we have now surpassed 411 parts per millions and the concentrations continue to rise. This is the highest concentration in 3 million years.

Dear friends, We know what is happening to our planet. We know what we need to do. And we even know how to do it. But sadly, the ambition of our action is nowhere near where it needs to be.

I have heard the argument – usually from vested interests -- that tackling Climate Change is expensive and could harm economic growth. This is hogwash. In fact, the opposite is true. We are experiencing huge economic losses due to Climate Change. Over the past decade, extreme weather and the health impact of burning fossil fuels have cost the American economy at least 240 billion dollars a year. This cost will explode by 50 per cent in the coming decade alone.

By 2030, the loss of productivity caused by a hotter world could cost the global economy 2 trillion dollars.
More and more studies also show the enormous benefits of climate action. Last week I was at the launch of the New [Climate] Economy report from the Global Commission on the Economy and Climate Change. It shows that that climate action and socio-economic progress are mutually supportive, with gains of 26 trillion dollars predicted by 2030 compared with business as usual. If we pursue the right path. For example, for every dollar spent restoring degraded forests, as much as $30 dollars can be recouped in economic benefits and poverty reduction. Restoring degraded lands means better lives and income for farmers and pastoralists and less pressure to migrate to cities.

Now, there are still many who think that the challenge is too great. But I deeply disagree. Humankind has confronted and overcome immense challenges before; challenges that have required us to work together and to put aside division and difference to fight a common threat. That is how the United Nations came into existence. It is how we have helped to end wars, to stop diseases, to reduce global poverty ***and to heal the ozone hole.***

If we are to take the right path – the only sensible path -- we will have to muster the full force of human ingenuity. But that ingenuity exists and is already providing solutions. Another central message - technology is on our side in the battle to address Climate Change.

We stand at a truly "use it or lose it" moment…..a lack of decisive government action is causing uncertainty in the markets and concern about the future of the Paris Agreement. We can't let this happen.

Dear friends, There is no more time to waste. As the ferocity of this summer's wildfires and heatwaves shows, the world is changing before our eyes. We are careening towards the edge of the abyss. It is not too late to shift course, but every day that passes means the world heats up a little more and the cost of our inaction mounts. Every day we fail to act is a day that we step a little closer towards a fate that none of us wants -- a fate that will resonate through generations end in the damage done to humankind and life on earth.

Against the backdrop of persistent inequality, rising hatred, "a world at war and a warming planet"; with climate change as "a long-term problem" and "a clear and present danger"; Secretary-General

António Guterres said in his New Year's message that "we cannot afford to be the generation that fiddled while the planet burned".

But "there is also hope", he continued, paying tribute to the power of youth around the planet.

The United Nations stands with you, and belongs to you – UN Secretary-General

"From climate action to gender equality to social justice and human rights, your generation is on the frontlines and in the headlines", he said. "I am inspired by your passion and determination".

Noting that young people are "rightly demanding a role in shaping the future", he said: "I am with you".

"The United Nations stands with you – and belongs to you" spelled out the Secretary-General.

He pointed out that 2020 marks the 75th anniversary of the Organization and said that "we are launching a Decade of Action for the Sustainable Development Goals (SDGs), our blueprint for a fair globalization".

"This year, the world needs young people" to keep speaking out, thinking big, pushing boundaries and keeping up the pressure, concluded the Secretary-General wish wishes for "peace and happiness in 2020".
Our fate is in our hands. The world is counting on all of us to rise to the challenge before it's too late. I count on you all. Thank you.

- Antionio Guterres, Secretary General of the United Nations

CHAPTER TWO:
A BRIEF HISTORY OF OUR CARBON CONUNDRUM

"In fact, corporations are the infants of our society - they know very little except how to grow (though they're very good at that), and they howl when you set limits. Socializing them is the work of government. It's about time we took it up again."

– Bill McKibben, Author 'The End of Nature'

Chapter Summary: There is now ample evidence that Climate Change is not only happening, it is happening much, much faster than anticipated and with much more devastating outcomes both long and short term. It is vital we take note of the Ozone Hole success story from the 1980's. While much easier to tackle than our current difficulties with global warming, humanity did in that instance come together, devise a plan for fixing the problem, and succeed in implementing that plan. The equation for success seems to have been: Public Will + Available Technology + Win/Win Economics.

Forged in the heart of aging stars, carbon is the fourth most abundant element in the Universe. Most of Earth's carbon—about 65,500 billion metric tons—is stored in rocks. The rest is in the ocean, atmosphere, plants, soil, and fossil fuels. While there are a number of problematic greenhouse gasses contributing to global warming, carbon is by far the most prolific and the most malleable to removal by humans.

Carbon flows between ocean, atmosphere, plants, soils and fossil fuels in a (basically) closed-loop, exchange called the carbon cycle, which has slow and fast components. Any change in the cycle that shifts carbon out of one reservoir puts more carbon in the other reservoirs. Changes that put carbon gases into the atmosphere result in warmer temperatures on Earth.

Over the long term, the carbon cycle seems to maintain a balance that prevents all of Earth's carbon from entering the atmosphere (as is the case on Venus) or from being stored entirely in rocks. This balance helps keep Earth in a long-term stability - over a few hundred thousand years. This is called the *slow carbon cycle*. There is also a fast carbon cycle —tens to a hundred thousand years—where there is much greater variation in the Earth's temperature.

Parts of the carbon cycle may even amplify these short-term temperature changes. The uplift of the Himalayas, beginning 50 million years ago, reset Earth's thermostat by providing a large source of fresh rock to pull more carbon into the slow carbon cycle through chemical weathering. The resulting drop in temperatures and the formation of ice sheets changed the ratio between heavy and light oxygen in the deep ocean.

On very, very, very long time-scales (millions to tens of millions of years), the movement of tectonic plates and changes in the rate at which carbon seeps from the Earth's interior may change the temperature on the thermostat. Earth has undergone such a change over the last 50 million years, from the extremely warm climates of the Cretaceous (roughly 145 to 65 million years ago) to the glacial climates of the Pleistocene (roughly 1.8 million to 11,500 years ago).

Scientists have been observing temperature increases on Earth for over 150 years, and for more than a century, many scientists have suspected that increases in the amount of carbon in the atmosphere was related to increases in global temperature. Tens of thousands of hand calculations led Nobel Laureate Svante Arrhenius to the conclusion

that the Earth's temperature might increase by 5 to 6 degrees Celsius (41-42.8 °F) with a doubling of atmospheric CO_2. *A 1912 issue* of Popular Mechanics stated that, "A theory has been elaborated, primarily by the great Swedish scientist Arrhenius, that the Earth has had a warm climate when the carbon dioxide in the atmosphere was abundant, and a cold climate when it was scarce. It is believed that if the atmosphere contained two to three times its present amount, the climate would be considerably warmer."

LESSONS SUCKED FROM THE OZONE HOLE

In *May 1985*, scientists with the British Antarctic Survey shocked the world when they announced the discovery of a huge hole in the ozone layer over Antarctica! Technically a substantial thinning of the ozone layer, the ozone "hole", it turned out, had been opening every spring since the 1970s. Their data, collected at the Halley Research Station in Antarctica, suggested that CFCs were to blame. This disturbing discovery set the stage for an environmental triumph: the *Montreal Protocol of 1987*. This pact to phase out the use of CFCs and restore the ozone layer was eventually signed by every country in the United Nations—*the first UN treaty to achieve universal ratification*. The unparalleled cooperation has had a major impact. "If we had just kept letting CFCs increase at a pretty nominal rate characteristic of the 1970s, the decreased ozone levels of the hole would have eventually covered the entire planet," said atmospheric physicist Paul Newman of NASA's Goddard Space Flight Center. However, *now a complete rebound seems imminent*. Some scientists project that, by 2080, global ozone will have returned to 1950s levels.

In the 1980s, people were faced with the clear and present health dangers from ozone depletion, leading to widespread public support for CFC bans. "There was a scary side of the ozone hole, linked to skin cancers, cataracts and so on, which immediately engaged the public," the British Antarctic Survey's Shanklin said. Chemical manufacturers were also able to create substitutes for CFCs with little added costs, enabling governments to address the problem without great impacts on the economy or average lifestyle.

It is vital to take note of the Ozone Hole success story. While much easier to tackle than our current difficulties with global warming, humanity did in fact come together, devise a plan for fixing the problem, and succeed in implementing that plan. The equation for success seems to have been: *Public Will + Available Technology + Win/Win Economics.*

What did we learn from this very similar atmospheric adventure that we can apply to today's *Climate Emergency*?

(1) Most people are drawn toward what they desire and move away from what they fear. A threat must be real and tangible enough (cataracts and skin cancer in the case of the Ozone Hole) to get people to take action. [This is why it is *essential everyone who can joins a group fighting for Climate Repair* – groups like Sunrise Movement, Extinction Rebellion Citizens Climate Lobby, or Climate Strike. Being in such a group makes the problem real and tangible like the Ozone Hole was and has other benefits such as keeping us focused - when our culture is pushing us to have the attention span of a gnat with ADD.]

(2) People take action by pushing their representatives in government to formulate plans based on advice from the scientific community. This often leads to technological advances. [It is easier to push when you are part of a group like XR, Citizens Climate Lobby, or Climate Strike.]

(3) We needed the technology to manage the problem. [We have the technology to remove carbon from the atmosphere and block a portion of solar radiation.]

(4) The United Nations served as the hub to bring together governments, scientists and other stakeholders. The UN was designed to handle global-scale problems – we must rely on what we have built. [Fortunately, the UN is seeing the damage and loss of life from climate disruption and is highly motivated to see that Climate Change is addressed effectively. *We simply need to be empowering the UN* to coordinate measures to remove carbon from the atmosphere and increase solar reflectivity.]

(5) Business and government are influenced strongly by the economics of a situation. Politicians and businesspeople want to keep their jobs, money and power. This has always been so. In the 1980's companies broke even or made money finding alternatives the CFC's contributing to the Ozone Hole. There was no strong lobby against those changes and many politicians benefitted. The situation with Climate Change is far more complicated in that fossil fuels are so intertwined in our economy and politics. [Some of the technological fixes for Climate Change, like Regional Polar Peroxide Misting, are relatively inexpensive. Some of the strategies like Ocean Assisted Carbon

Capture & Reflection can actually create whole new job markets and significant economic benefits. Some can create breathing room so that the fossil majors will have time to transition to renewable energy and even make this profitable. It is crucial that this information becomes well understood by everyone, the public, politicians and corporations alike so that economics does not continue to appear to be an impediment to resolving Climate Change.]

Imagine if, instead of what actually happened, the citizenry of the 1980's had moved to overthrow their governments and set up whole new panels and citizen advisory committees in their place. Imagine if they had done nothing, taken no action and sat back waiting for someone else to do something. It's difficult to see a good ending down those roads. (Now, it would be different if the public will + technology + economics elements where *all there* and *everyone knew about them* and *still* the powers-that-be refused to take action. Then the people would have nothing to do but push for radical social reform.)

In today's situation with Climate Change we have the science and technology. We also have the economics down, though key players seem to be ignoring this good news for some reason. What we *decidedly do not* have, however, it the public will! Again, that is why it is so important you are reading this book. After doing so you will no longer, in good conscience, be able to go back to letting someone else handle the problem. So, the Ozone Hole Adventure has been very instructive. We know what needs to be changed to get Climate Change managed effectively- and mainly that is you and me! We must get active and outspoken and push for Emergency Climate Repair!

THE RISE OF CLIMATE CHANGE

In 1975, James Hansen, the former head of NASA's Goddard Institute for Space Studies, warned the U.S. Congress that the planet was warming dangerously—primarily because of unchecked fossil fuel combustion. In 1981, Hansen and his coauthors observed the following:

"It is shown that the anthropogenic carbon dioxide warming should emerge from the noise of natural climate variability by the end of the century.… Potential effects on climate in the 21st century include the creation of drought-prone regions in North America and central Asia as part of a shifting of climatic zones, erosion of the West Antarctic ice sheet with a consequent worldwide rise in sea level, and opening of the fabled Northwest Passage."

In 2008, Hansen et al. argued that, "If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing Climate Change suggest that CO_2 will need to be reduced from its current 385 ppm (now over 410 ppm to at most 350 ppm…. If the present overshoot of this target CO_2 is not brief, there is a possibility of seeing irreversible catastrophic effects." In 2016, Hansen and 18 other climate scientists warned that even stabilizing at a 2 °C warming could lead to devastating glacial melt, multi-meter sea level rise, and other catastrophic impacts: "We conclude that the message our climate science delivers to society, policymakers, and the public alike is this: we have a *global emergency*."

Had we listened to Hansen and his colleagues a few decades ago, and had more countries followed the leads of France and South Korea in the 1970s and 1980s by shifting to renewable energy sources, we would not be in the climate emergency we are in now.

Unfortunately, although some measures have been implemented, emissions of carbon and other greenhouse gasses have continued to rise. Particularly in the United States, conspicuous consumption is still the norm. Fossil fuels still account for the lion's share of energy production in most regions of our planet.

CLIMATE SHOCK

At this point in the unfolding of climate disruption most of us have progressed to what health care professionals are calling "climate shock." We feel increasingly anxious, worried, irritable, and stressed... without quite knowing why. We are kind of on-board now with recycling and sustainability, but in the background, there is a visceral sense that something big is coming and it's not good. Like animals sensing danger from a distant forest fire, our minds and bodies are telling us something is coming – something cataclysmic in nature. We see and feel the signs, but the enormity of the situation is too big to comprehend. Like the first seconds of a car crash, our brains are refusing to accept the reality of the threat. It seems just too overwhelming to acknowledge.

What we are sensing is the Earth preparing to respond to ever increasing levels of carbon and other GHG in the atmosphere. Yes, some of us are making some changes here on the ground – but the skies continue to function like our own personal open sewer. The evidence

is clear that at this late date even a total shift to sustainable energy sources will not stop global warming from reaching "tipping levels" in the mid-2030s... at which point an exponential acceleration in climate-change related disasters will surpass our ability to cope and survive as a species on this planet.

Ready or not, the effects of global warming are bearing down on us. We can try and deny it, but none of us can argue against the bare facts - time is luck, and luck runs out. We can no longer act as if we are still deciding to get into the boat – we are already in the *rapids* and there is a loud roaring sound coming closer!

Thus, the only valid question now is how to safely remove those global warming gases from the atmosphere without causing more damage and threat to our elegantly balanced ecosystem. *And* if we do not act quickly, we will run out of time to act. Our failure to decisively and aggressively act *now* will mean, in all probability, the actual extinction of most, if not all the species who currently call Earth home.

In 2018 the Director of the National Oceanic and Atmospheric Administration stated, "It's hard to respond when massive change (in our planetary ecosystem) is occurring *within a year* versus centuries".

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, mega droughts, mud slides triggered by "rain bombs," and crop failures. As a result, we will also face mass starvation and unsustainable mass migrations, such as we are currently seeing in the Mediterranean region and the resulting violence. Syria's civil war occurred after the 2006–2010 drought, which turned 60 percent 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 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. Mud slides have increased by 400percent since the 1950s. So-called "atmospheric rivers" have caused seven thousand-year-flood events in 7 years. Currently, *20,000,000 people* worldwide are nearing starvation.

"Everyone is looking at two degrees of warming, but to me it's a pipe dream," says Daniel Schrag, director of the Harvard University Center for the Environment, one of President Obama's top advisors on Climate Change. "I fear we'll be lucky to escape four, and I want to make sure nobody ever sees six."

The difference between two and four degrees is another quarter-billion people without reliable access to water, more than a hundred million more exposed to flooding, and massive declines in worldwide crop yields, according to a study by the Committee on Climate Change, a London-based scientific group established to advise the U.K. government.

The bill for releasing over 100 million tons of heat-trapping pollution (commonly called greenhouse gases) into the atmosphere *every day, 365 days a year*, has finally come due. Our atmosphere has been disrupted by anthropogenic (human-caused) global warming pollution. In scientific terms, this includes molecules with over two atoms that are radiatively active, such as carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons (CFCs - often used in refrigerants) and aerosol propellants. This release of poisonous gases into the atmosphere has and will cause ever more dire consequences for all life on this planet.

Without some kind of drastic action, Climate Change could be killing an estimated half-million people annually before the middle of this century. In an emergency of this proportion there is no time for finger-pointing (although both corporations and governments are now being dragged into various courts and held accountable). It is enough to say that the lack of strong regulation by world governments may have allowed the corporate sector, in its thirst for ever-increasing profits, to consume its own host like mistletoe consuming a tree until it is dead.

NO TIME FOR GRIEVING

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 it certainly is 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. Extinction does not have to be the end of our story.

YOU BREAK IT…… YOU BOUGHT IT

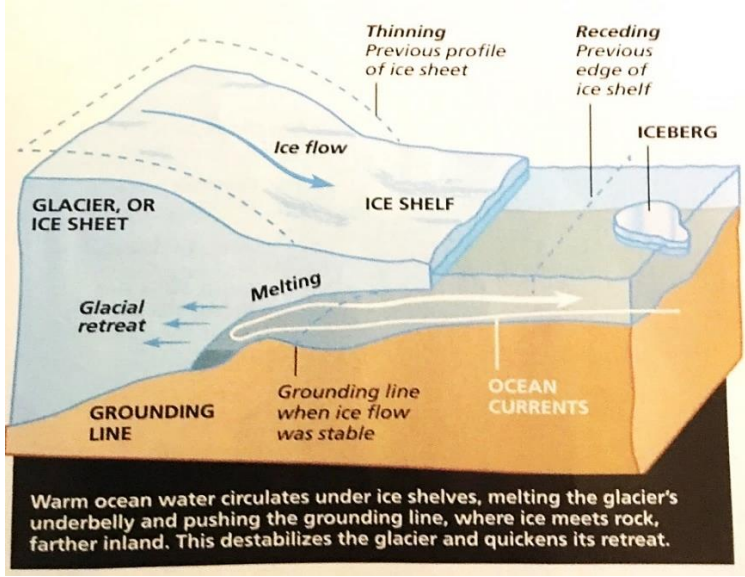
Inarguably, at this point, there is too much warming pollution in the atmosphere already. Unless we do something fast, the build-up of atmospheric pollution will continue, and the window for fixing the problem will close. The most prevalent and removable greenhouse gas is carbon – the fourth most prevalent element on Earth. There is about 65.500 billion metric tons of carbon on Earth – most of is stored in rocks, the ocean, atmosphere, soil, and of course, fossil fuels.

We need to develop and deploy a method of "carbon capture and sequestration" (geek-speak for storage), either isolating or neutralizing the carbon, so our planet can cool off again—*and we need to do it before 2035* when the situation will become *irreversible*. In this sense many of us have put the cart before the horse – all the solar and wind energy, electric cars and recycling will not save us unless we first remove excess carbon already in the atmosphere. (Yes, there are plenty of other nasty gasses up there, but carbon is the most prevalent, enduring, and we know how to remove it.) In short, we need to clean up the mess we have made before we can go and play with our new toys!

Even a 2 ºC increase in global temperatures will put us in the neighborhood of the geological "Eemian Period," which occurred 120,000 years ago when the Earth drifted slightly closer to the Sun. During this time the Earth warmed by 1.9 ºC (35.4 °F). (Notice that is almost identical to the Paris agreement's target of 2 ºC and the IPCC target of 1.8 ºC.) 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. *once again at risk*, 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 "tipping levels" being reached. A geologic cycle which occurs over hundreds of thousands of years has begun occurring in decades, and recently it seems, in *years*. Sadly, 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 2º 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 ºC 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 zombies). Even the most optimistic scenarios show that around 2035, Earth will reach "tipping levels" where atmospheric destabilization, caused largely through the melting of polar ice, will trigger 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.)

DANCES AND DODGES

How did all this get so far without us noticing and reacting? In his prophetic book "The Future" former US Vice President Al Gore gives a great description of the tobacco industry's very effective strategy to hide the information they possessed on the dangers of using their product – extending their profits at high levels for 40 years while millions of Americans died. Some of the same folks found new work in the fossil fuel industry as the discovery of the Ozone Hole in the 1960's threatened to draw attention to the other greenhouse gasses building up in the atmosphere.

The first approach to this marketing problem employed by the "fossil majors" was a type of "false flag" patriotism. A very successful campaign which made it virtually un-American to believe in "the global warming hoax" held over for decades. It was only recently when this quasi-patriotic smokescreen began to dissipate (there are now scores of lawsuits pecking at the profits of the global oil giants) that a subtle shift was made to the what I call the "moderation boondoggle".

The moderation boondoggle goes like this – "If only we can just cut back a little and throw in some renewables here and there, we can "mitigate" the damage and things probably won't get all that bad." It's brilliant because it contains enough truth to be plausible, plus the US government has been a big help on this strategy. In 2010, for example, the National Academy of Science published *Limiting the Future Magnitude of Climate Change*. Even popular climate heavyweights like Al Gore and James Hansen seemed to take the bait, arguing strongly for an immediate and profound shift to renewable energy, reforestation, recycling and the lot and poo-pooing any consideration of Emergency Climate Repair.

Unfortunately, what Gore, Hansen and other climate champions were missing (or had forgotten) is the reality of the interconnectedness of our planetary ecosystems, physical and chemical processes. Atmosphere, land, and seas interact and exchange water and gases. Like all interconnected systems (think of a power grid or the internet) if you destabilize one aspect of the system it's going to alter other interconnected aspects. If bees start moving to higher elevations (they are) the plants they pollinate will not be able to move that fast and if those plants die it will open the door for increased soil erosion, and if more soil is exposed more carbon can be released from that soil, and so on.

Another example, our water cycle on Earth has evolved to move heat, not water. When we heat up the atmosphere, we drive the hydrologic cycle harder, resulting in wetter climates, dryer deserts, more intense floods and droughts, and deserts moving poleward. These changes, in turn lead to crop failures and population destabilization which leads to mass migrations which leads to increased isolationism in political structures which makes it more difficult for countries to work together to solve the problem of atmospheric overheating. If you're not careful you will end up with an exponentially increasing cascade failure leading to the entire system "going down". This is the source of our anxiety and the danger we are facing in the mid-2030's.

Even with an increase in the deployment and use of sustainable energy technology in countries such as Sweden, Costa Rica, Scotland, Germany, Uruguay, and China, there's already too much CO_2 in the atmosphere. Unfortunately, carbon is extremely long lived.

APPROACHING THE CLIFF

Ninety percent of the radiated heat from the sun is absorbed by the oceans and redistributed around the globe. A re-analysis of data for ocean biosphere and solubility sinks (a carbon sink is anything that absorbs more carbon than it releases) gathered by scientists at the Carbon Dioxide Information Analysis Center at Oak Ridge National Laboratory indicate that, on average, combined natural ocean and land "sinks" exceeded land-use change emissions by a rapidly growing margin from 1959 to 2011. Anthropogenic, or human-caused, CO_2 emissions from fossil fuel consumption reached 9.9 gigatons of carbon per year in 2013 and are rising faster than the observed expansion in natural sinking capacity. The net impact is continued rising of atmospheric CO_2 accumulation at ~2 ppm/yr.

Hansen called for bringing atmospheric carbon dioxide levels down to levels not recorded since the 1980s. Hansen's solution, rapidly replacing coal with nuclear energy by 2030 while separately fostering 100 GtC worth of reforestation drawdown by 2080, is becoming increasingly impractical. His approach depended on initiating 1 percent annual emissions cuts starting in 2013, culminating in 90 percent cumulative cuts by 2050. Clearly, we are dramatically off this curve already.

In 2012, Hansen himself published a graph showing that delaying the start of 1 percent annual emissions cuts until 2020 would delay 350 ppm CO_2 restoration from 2100 all the way to 2300. Five years of Hansen's eight year "doomsday" delay has already elapsed with no appreciable progress in terms of atmospheric change. It is now 2019 and our vehicles continue to generate 5.6lbs of carbon per gallon, and we have nothing even approaching 1 percent annual emissions reduction.

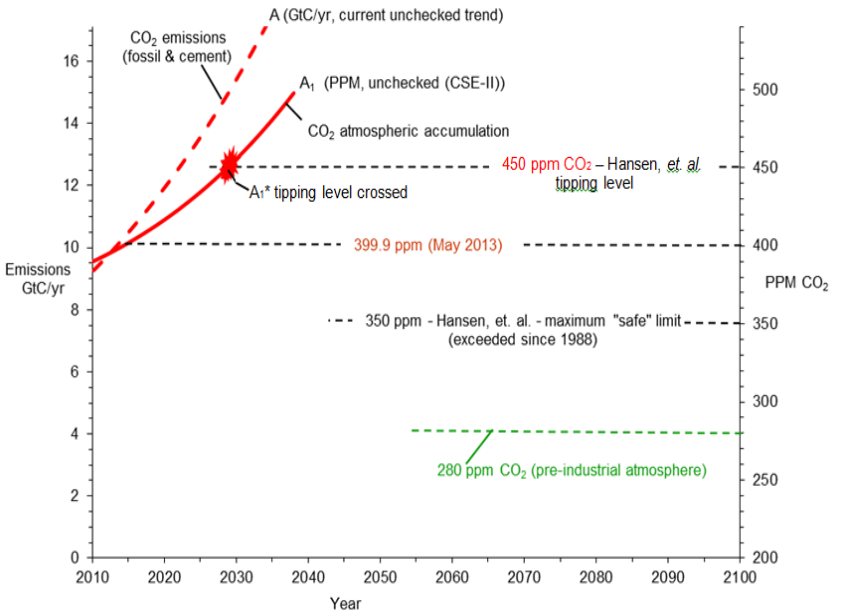
According to Hansen's theorizing, that means 5/8 of the dreaded doomsday delay has already occurred, and we are well on our way to ensuring that 350 ppm cannot and will not be achieved until 2300. That is clearly the limit of any approach to climate restoration based primarily on emissions control. It would have worked if it had begun decades ago, but now the time is passed, the window of opportunity closed, and a new approach is required.

As illustrated in chapter one, should humans continue warming the atmosphere at the current rate, the model forecasts that emissions will reach a disastrous 17 GtC/yr by 2034. Net atmospheric CO_2

accumulation will reach 450 ppm in 2029, in agreement with IPCC-AR5/RCP8.5 (Intergovernmental Panel on Climate Change–5th Assessment Report/ Representative Concentration Pathway 8.5) and 500 ppm by 2038.

These levels are not survivable for humans. This illustrates the need for immediate high-impact carbon removal intervention *in addition to* the shift to sustainable energy. Sustainable energy development and efficiency are indeed critical, but climate scientists are reaching consensus; if we do not take aggressive, proactive steps to "draw down" carbon from the atmosphere, life on Earth will change drastically. There could be little left of our civilization to "sustain."

On the following page you will encounter once more the "Chart of Doom" – the most important diagram in this book. This diagram shows a computer-generated plot of where carbon part per million in the atmosphere will take us over the "tipping level" - crossed in approx. 2030-2035. If anyone asks you why Emergency Climate Repair was optional 40 years ago, but now is essential this is the chart to show them. This is why we need to act now and act decisively!



(A1 in 2029) could lead to irreversible seeding of catastrophic climate impacts. Modeling studies by Cao and Caldeira (2008) imply that a marine die- Hansen et al. (2008, 2009) warn that crossing the 450 ppm tipping level would also accelerate when atmospheric CO_2 exceeds 450 ppm. Approaching*

500 ppm (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).

On the current trajectory, 50 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."

For instance, Climate Change affects the health of people and animals around the world through air pollution. Worldwide, air pollution kills 6.5 million people yearly. In some areas of China, life expectancy has 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.

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. Extreme heat events 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. By 2040, some allergens will have increased by 200percent, with grams of pollen increasing from 8,455 grains per cubic meter to 21,735 grains per cubic meter. In 2015, The Lancet Commission on Health and Climate Change stated, "Climate change is a medical emergency."

During the 21st century, we are projected to lose *over half of all land-based species*. Animals who can relocate to cooler temperatures are *already moving* an average of 15 feet per day toward the poles. Most critically by 2050, more than 90 percent of the Earth's ecologically essential coral, where many fish species are born and raised, will be

completely lifeless. Other life in the ocean will be increasingly threatened. As Captain Paul Watson of the Sea Shepherd Conservation Society said, "If we can't save the oceans, if the oceans die, we die."

And don't kid yourself that human beings are going to be in the minority of creatures that survive this anthropocene mass extinction. Scientists are clear about our chances and they are near zero. Humans with our big brains are clever, but not very adaptable. We are, in fact, predicted to be among the first species to go when things get really rough in the mid-2000's.

Numerous scientists, including Harvard biologist E.O. Wilson, have warned that we stand at the brink of the *sixth mass extinction.* MIT's Daniel Rothman puts a number to it - 310 GtC of excess dissolved CO_2 in the ocean as the threshold, reached in approximately 2100 via IPCC's most favorable scenario. The IPCC RCP2.6 scenario projects 420 ppm atmospheric CO_2 by 2100 (driving 300 GtC excess ocean-dissolved CO_2 by the same year). Other IPCC scenarios (collectively cited as being equally probable) run as high as 900 ppm (atmospheric CO_2) which would drive oceanic carbonation even higher yet.

By looking at what Earth's climate was like in previous eras of high CO_2 levels, scientists are getting a sobering picture of where we are headed. The last time the planet's air was so rich in CO_2 was millions of years ago, back before early predecessors to humans were likely wielding stone tools; the world was a few degrees hotter back then, and melted ice put sea levels tens of meters higher.

THE CARBON CURVE

"We're in a new era," says Ralph Keeling, director of the Scripps Institution of Oceanography's CO_2 Program in San Diego When scientists (specifically, Ralph Keeling's father) first started measuring atmospheric CO_2 consistently in 1958, at the pristine Mauna Loa mountaintop observatory in Hawaii, the CO_2 level stood at 316 parts per million (ppm), just a little higher than the pre-industrial level of 280 ppm. 400 was simply the next big, round number looming in our future.

The important fact to know is global temperatures have risen in parallel with CO_2, with each subsequent year generally standing as the hottest year since records started in 1880. At the current rate of growth in CO_2, levels will hit 500 ppm within 50 years, putting us on track to reach temperature boosts of perhaps more than 3 degrees C (5.4°F).

Unfortunately, long before that we will have passed the climate deadline.

Each landmark event has given scientists and environmentalists a reason to restate their worries about what humans are doing to the climate. “Reaching 400 ppm is a stark reminder that the world is still not on a track to limit CO_2 emissions and therefore climate impacts,” said Annmarie Eldering, deputy project scientist for NASA’s Orbiting Carbon Observatory-2 satellite mission at the Jet Propulsion Laboratory. “Passing this mark should motivate us to advocate for focused efforts to reduce emissions across the globe.

Back in the 1950s, scientist Charles David Keeling (Ralph Keeling’s father) chose the Mauna Loa volcano site to measure CO_2 because it is a good spot to see large atmospheric averages. Rising to 3,400 meters (11,155 feet) in the middle of the ocean, Mauna Loa samples an air mass that has already been well mixed from the inputs and outputs of CO_2 far below and far away. And the site, being a volcano, is surrounded by many miles of bare lava, helping to eliminate wobbles in the measurement from the “breathing” of nearby plants.

The start of Keeling’s effort was well timed: the 1950s was also when man-made emissions really began to take off, going from about 5 billion tons of CO_2 per year in 1950 to more than 35 billion tons per year today. Natural sources of CO_2, from forest fires to soil and plant respiration and decomposition, are much bigger than that — about 30 times larger than what mankind produces each year. But natural sinks, like plant growth and the oceans, tend to soak that up. The excess produced by mankind’s thirst for energy is what makes the CO_2 concentration in the air go up and up. Once in the air, that gas can stay there for millennia.
The “Keeling Curve” that plots this rise has an annual wiggle because the entire planet inhales and exhales like a giant living being. In the Northern Hemisphere (where the Mauna Loa Observatory is based, and also where most of the planet’s landmass and land-based plants sit), the air in spring is filled with the CO_2 released by soil microbes in the thawing snow, and by autumn the CO_2 has been vacuumed up by a burst of summer plant life; hence the annual high in May and low in September.

While Mauna Loa has become the global standard for CO_2 levels, measurements taken in other places have confirmed the Mauna Loa results. NOAA’s network of marine surface stations, and even a monitoring station in the remote, pristine Antarctic, all streaked past

the 400 ppm hurdle in 2016. NASA's Orbiting Carbon Observatory-2 shows the planet now hovering around 410 ppm, with variation from one place to another, due to atmospheric circulation patterns.

Some 500 million years ago, when the number of living things in the oceans exploded and creatures first stepped on land, the ancient atmosphere happened to be rich with about 7,000 ppm of carbon dioxide. Earth was very different back then: The Sun was cooler, our planet was in a different phase of its orbital cycles, and the continents were lumped together differently, changing ocean currents and the amount of ice on land. The planet was maybe as much as 10 degrees C (18°F) warmer than today, which might seem surprisingly cool for that level of greenhouse gas; with so many factors at play, the link between CO_2 and temperature isn't always easy to see. But researchers have confirmed that CO_2 was indeed a major driver of the planet's thermostat over the past 500 million years: large continental ice sheets formed, and sea levels dropped when the atmosphere was low in CO_2, for example.

Thanks to earth-shaking, slow-moving forces like plate tectonics, mountain building, and rock weathering — which absorb CO_2 — atmospheric concentration of CO_2 generally declined by about 13 ppm per million years, with a few major wobbles. As large plants evolved and became common about 350 million years ago, for example, their roots dug into the ground and sped up weathering processes that trap atmospheric carbon in rocks like limestone. This might have triggered a massive dip in CO_2 levels and a glaciation 300 million years ago. That was eventually followed by a period of massive volcanic activity as the supercontinent ripped apart, spewing out enough CO_2 to more than double its concentration in the air.

The last time the planet had a concentration of 300 to 400 ppm of CO_2 in the atmosphere was during the mid-Pliocene, 3 million years ago — recently enough for the planet to be not radically different than it is today. Back then, temperatures were 2 degrees C to 3 degrees C (3.6 to 5.4°F) above pre-industrial temperatures (though more than 10 degrees C hotter in the Arctic), and sea levels were at least 15-25 meters higher. Forest grew in the Canadian north and grasslands abounded worldwide; the Sahara was probably covered in vegetation. Homo habilis (aka "handy man"), the first species in the Homo line and probably the first stone-tool users, got a taste of this climate as they arrived on the scene 2.8 million years ago. (Homo sapiens didn't show up until 400,000 years ago at the earliest.)

To find a time when the planet's air was consistently above 400 ppm you have to look much farther back to the warm part of the Miocene, some 16 million years ago, or the Early Oligocene, about 25 million years ago, when Earth was a very different place and its climate totally dissimilar from what we might expect today.

Data for the last 800,000 years, when ice cores show that CO_2 concentrations stayed tight between 180 and 290 ppm, hovering at around 280 ppm for some 10,000 years before the industrial revolution hit. (There have been eight glacial cycles over these past 800,000 years, mostly driven by wobbles in the Earth's orbit that run on 41,000 and 100,000 year timescales). This is the benchmark against which scientists usually note the unprecedented modern rise of CO_2.

Frighteningly, this modern rise of CO_2 is also accelerating at an unusual rate. In the late 1950s, the annual rate of increase was about 0.7 ppm per year; from 2005-2014 it was about 2.1 ppm per year.

Paleo records hint that it usually takes much longer to shift CO_2 concentrations in the atmosphere; although researchers can't see what happened on time frames as short as decades in the distant past, the fastest blips they can see were an order of magnitude slower than what's happening today. These were typically associated with some major stress like a mass extinction, notes Dana Royer, a climatologist at Wesleyan University. During the end-Triassic extinction 200 million years ago, for example, CO_2 values jumped from about 1,300 ppm to 3,500 ppm thanks to massive volcanic eruptions in what is now the central Atlantic. That took somewhere between 1,000 to 20,000 years. Today we could conceivably change our atmosphere by thousands of parts per million in just a couple of hundred years. There's nothing anywhere near that in the ice core records, says Keeling.
"If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted… CO_2 will need to be reduced… to at most 350 ppm," Columbia University climate guru James Hansen has said. We sailed past that target in about 1990, and it will take a gargantuan effort to turn back the clock.

Let's not forget that the oceans absorb carbon also. Each day, millions of tons of CO_2 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. It is projected that excess CO_2 will reduce surface ocean pH by 0.3-0.5 units over the next century, which would be the largest change in pH to occur in the last 20-200 million years. The

subsequent rise in acidity will trigger massive extinction of marine life, leading to inland extinction. To date, the world's oceans have become 30 percent more acidic than before we first started burning fossil fuels.

The main cause of concern is that after 2035, we won't be able to stop this progression. We are already seeing massive climate disruption effects. Some researchers like Eric Rignot at NASA think it's already too late to stop the first 10 feet of sea rise from the collapse of the West Antarctic Ice Sheet (WAIS). We cannot wait until century's end, because the predicted tipping point of the "big splash," or the final collapse of these three polar ice sheets, will be in the 2030s. As the Secretary General of the United Nations recently stated in 2017 those of us working with Al Gore worried that people either weren't talking about Climate Change or were still debating if global warming was "a hoax".

The dangerous "tipping levels" approaching in the 2030s could irreversibly set catastrophic late-century climate impacts in motion. If this point arrives, according to James Hansen, "There is a possibility, a real danger, that we will hand young people and future generations a climate system that is for all practical purposes out of their control." These late century impacts would threaten the very survival of our species, either by the end of this century or early in the next. The window of opportunity for forestalling those impacts is likely closing in the 2030s. We must consider high-impact intervention on a massive scale.

One last very important point before we move on. There is a great deal of social energy surrounding the Climate Emergency right now and we need to get that energy pointed in the right direction. And at this late date there is only one correct direction – the one that leads to Direct Atmospheric Removal of Excess-Carbon. If you are doing nothing because you think there is no hope that's the same as opening the border and inviting the NAZIS to roll on it. If you are contributing to carbon reduction, recycling, and other sustainability measures – don't do it unless you can *first* afford to make a *larger* donation to atmospheric carbon removal. Without removing carbon first, everything else is just throwing energy and money down the drain,

LET'S NOT FORGET THOSE OTHER DELICIOUS GREENHOUSE GASSES

METHANE

A recent report in the New England Journal of Medicine indicates that inhaling human gaseous emissions (A-Huffing?) can have significant health benefits. I'm afraid this is as far as I was able to read without getting images I really don't want stuck in my head. If you're really interested, you will have to get the article yourself.

However, although it has a relatively short residence in the atmosphere (~10 years) and low concentration, methane is particularly dangerous as a greenhouse gas. It has much greater capacity to absorb and radiate long wave energy before oxidizing to CO_2.

Although produced by "natural" processes such as decay of organic material, most methane is released into the atmosphere as a result of human activity. This includes methane produced by the massive numbers of farmed animals (cattle, chickens, pigs, etc.), coal and other mining, oil refining and, most noticeably, as a feedback from anthropogenic global warming. The latter is responsible for thawing of permafrost and methane clathrates.

Permafrost, particularly on polar land, has resulted in organic material located on or beneath the surface being frozen. That stopped the decay process and associated release of methane. Global warming, particularly polar amplification, is causing permafrost to melt, initially at the surface then to an increasing depth.

This has two effects. First, buildings and other structures located on frozen land are subject to damage and destruction as permafrost thaws. Second, organic material also thaws and resumes decaying, releasing methane and other gases in the process. The quantum of this material and methane produced from thawing of land-based permafrost are not known but are thought to be significant. Emissions from this source are increasing, but do not pose as great a threat as thawing methane clathrate.

Methane continuously seeps from the earth's crust. When it comes into contact with very cold water it forms an ice-like substance known as clathrate. Normally this substance is stable at depths of 360 meters (m) in the Arctic, though studies in the Svalbard region of northern

Norway show that stability is now maintained at depths >400m, confirming the warming of Arctic Ocean waters.

When it melts, clathrate releases approximately 168 liters of methane for every liter of solid clathrate. It occurs beneath sediments offshore along the coastline of land bordering the Arctic Ocean and has also been found in the Antarctic. When clathrate melts at depths <400m, methane bubbles to the surface and enters the atmosphere where over a period of 10-12 years it oxidizes to CO_2. Clathrate melting at greater depths usually oxidizes to CO_2 before it reaches the surface, a process which creates hypoxic conditions, inimical to water breathing animals.

Shakhova (2010) reports that permafrost under the East Siberian Arctic Shelf, is, thawing and starting to leak large amounts of methane into the atmosphere and doing so at an accelerating rate. She estimates that 1.1 million tons of methane per annum now enters the atmosphere from this source, 3 times as much as is released from onshore marshlands in this area. By 2030, those emissions are expected to reach 1.5 gigatons/annum.

Consequently, atmospheric presence of methane in the Arctic has now reached the highest it has been for >400,000 years, 1.85 ppm compared to 0.7ppm normally found during warm periods. In parts of the East Siberian Arctic, methane in the atmosphere exceeds 2 ppm. This is partly responsible for temperatures in the Arctic rising 2-3 times faster than in the tropics – the so-called Arctic amplification, expected to continue and accelerate the release of methane and ice melt.

Methane oxidizes to CO_2 which has a residence in the atmosphere of ~100 years. In so doing it reduces the concentration of oxygen in the atmosphere and seawater. Amounts of CO_2 entering the atmosphere from this source will increase as the rate of methane emissions increases.

OZONE

Human release of chlorofluorocarbons (CFCs) prior to enforcement of the Montreal Protocol (1989) caused depletion of stratospheric ozone above the Antarctic and to a lesser extent the Arctic, causing increased exposure to health-damaging ultra-violet radiation. Ozone depletion also caused cooling of Antarctic surface temperature.

Over the last 20 years of curbing CFC emissions, damage to the ozone layer has been partly reversed and is expected to be fully recovered by

2050. Recovery will restore the radiative forcing of the ozone layer and have a warming effect globally and particularly over the Antarctic Region.

AEROSOLS

The radiative effects of aerosols are complex and short-lived but overall, they have a cooling effect. Increased industrial aerosol emissions 1940–1970 were probably responsible for much of the slight global cooling trend which occurred in that period. Since 1970, industrialized nations have significantly reduced aerosol emissions through legislation, regulation and, following collapse of the Soviet Union, by closure of old, high emitting factories.

More recently, industrial aerosol emissions have been reduced by India and China, where they continue to pose a health problem. As a result, the cooling influence of aerosols has diminished and will continue to do so.

RESTORING BALANCE

While all greenhouse gasses can be problematic most of the focus has been on carbon. Carbon is by far the most prevalent GHG and also the one which can be most "easily" modified by humans. It is essential to remember, however, that reducing carbon emissions will not be sufficient at this late date. We must actually remove carbon that is already in the atmosphere. This just makes sense really. It's sort of like contemplating new furniture for your living room without first addressing the huge piles of dirt under your carpet. We need to clean up our mess because no one else (not even Mother Nature) is going to do it for us.

Thankfully there is a great deal of social energy surrounding the Climate Emergency right now. It is essential that this energy is directed toward measures that can get us past the mid-2030's tipping point and only Direct Atmospheric Removal of Excess-Carbon and Solar Radiation Management fit that bill. If you are doing nothing because you think there is no hope that's the same as opening the border and inviting the NAZIS to roll on it. If you are contributing to carbon reduction, recycling, and other sustainability measures – don't do it unless you can first afford to make a *90% greater contribution to atmospheric carbon removal and, or solar reflection*. Without those more powerful measures everything else is just throwing energy and money down the drain.

PART II: NOT AN EXIT

The only thing that is going to save mankind is if enough people live their lives for something or someone other than themselves."

- Leon Uris

CHAPTER THREE: THIS IS NOT BUISNESS AS USUAL

"The only thing necessary for the triumph of evil is for good men to do nothing."

- Edmund Burke

Chapter Summary: There is already too much carbon (and other greenhouse gasses) in the Earth's atmosphere for emissions reductions to get us past the Climate Deadline. We like this idea because it allows us to do "Business As Usual". Like trying to appease the Nazis, it won't work. So, we must shift our priorities for a time. Ninety percent of our energies should be going toward implementing the climate-engineering solutions we have at our disposal and ten percent toward sustainability measures. This ratio can shift later once (if) we make it through the current climate bottleneck. We must also push our environmental organizations and political representatives to shift this focus immediately. This is our MOST IMPORTANT mission at the present time!

When we look up in the sky it appears to be an endless sea of blue….but our protective, live-giving envelope it is not endless. In fact, if you were to drive your car vertically upward at highway speed (please don't do this and say I told you to) in minutes you would be

outside the protection of Earth's life-giving atmospheric envelope. A good way to get a sense for this is to call up one of NASA's images of Earth's atmospheric envelope as seen from space. You will see we are living within a *very* thin band of breathable atmosphere around our planet. This thin layer around the Earth regulates the amount of heat and moisture in the atmosphere and protects the Earth from much of the Sun's damaging radiation.

It is into this thin layer of breathable atmosphere that we are currently dumping 31.7 gigatons of carbon (not to mention other greenhouse gasses) per year, or the *equivalent of 400,000 Hiroshima-sized atomic bombs each - 365 days per year*! We are basically using our life support system like an open sewer – and we have been doing so for over a hundred years. Until just a little over 200 years ago, humans released practically no carbon emissions, only the limited carbon released from heating and cooking fires. That changed radically with the Industrial Revolution and the widespread use of coal and other fossil fuels. Today we are releasing over 10 billion metric tons of carbon each year (not to mention other GHG) from such sources as coal mining, industrial processes, crop burning, fertilization, land transportation, landfills, construction, aging infrastructure, forest burning, oil and gas production, air transportation, coal plants, and thawing permafrost. It would not take 300,000 years for the Earth to process out all of this accumulated carbon.

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?

SUSTAINABILITY FIRST MUST HAVE SOMETHING TO SUSTAIN

The research is clear – as of right now we have no future, or at least our grandchildren don't. On our current trajectory we WILL trigger the "tipping points" waiting for us in the mid-2030's. After that we will be swept up in powerful self-amplifying environmental feedback-loops increasing exponentially until our money and technology can no longer mitigate the effect. Lost in famine, floods, fires and social disruption we will sink – taking most of Earth's other inhabitants including, apparently, those cute Koala Bears that recently lost a big chunk of their habitat with us.

What the Koala's understand, that we have yet to grasp, is that "sustainability" only works if you have something to sustain. It doesn't really have much relevance in our current struggle. It's wishful thinking – sort of like, "I'm sure the Nazis are just protecting the Jews from being persecuted during the war. I'm sure those camps are pretty plush like a vacation resort." Yes, it's great we are developing solar, wind and other energy sources. Yes, it's cool we are figuring out that plant-based diets are important. Taking steps to make it possible for developing nations to reduce their populations will be essential. So much good work is being done that we can be very proud of. It's just not going to fix the fact that we already have too much carbon (and other greenhouse gasses) in the atmosphere and if we don't remove manually what we put up there manually our goose is cooked.

Even the fast carbon cycle we discussed earlier takes hundreds and thousands of years to accomplish *what we now need accomplished in a decade or two.* In WWII, once the Germans were bombing Britain, the time for gentle diplomacy over tea was done. Planting more trees and recycling like crazy is not going to save us – not this close to the cliff.

So, we must shift our priorities for a time. Ninety percent of our energies need to be going toward implementing the climate-engineered solutions we have at our disposal and only ten percent toward sustainability measures. This ratio can shift later once (if) we make it through the current climate bottleneck. We must also push our environmental organizations and political representatives toward this realization. This is our MOST IMPORTANT mission at the present time!

TIME FOR ACTION – BUT LET'S BE CAREFUL IT'S THE RIGHT ACTION

When I first put it together that Climate Change was on a trajectory to end human civilization for me it was an immediate call to action. Since then I have wondered why more people aren't leaping into action. Why aren't churches exhorting their members to donate to climate research? Why weren't companies donating their material and talents to finding solutions? Most of all why weren't elected representatives acting like there was an Emergency and legislating the appropriate action?

I know a big part of the reason is our corporate dominated culture. The folks that had lied to the public about the dangers of smoking 40 years after they knew the truth are still out there. The guys and gals who assisted with millions of preventable deaths just to squeeze out the last profits of a dying (literally) industry are still hard at work. In fact, some of the actual individuals are those who have recently been caught hiding the data on Climate Change until it was (almost) too late. In addition, recent decades have seen the deliberate, or accidental training a public to be passive TV watchers and social media denizens rather than active wielders of their own civil rights. Corporations, after all, were designed to do only one thing – make profits – and whatever got in the way – be it Government regulation, medical reports, or public outcry – was to be "handled" and overcome. It is to their advantage to have us watching advertisements and consuming products.

So often, especially as I was running for Arizona Governor, I found that we Americans have been trained to passively watch TV and let the corporate powers-that-be lull us into trusting that everything is in good hands and there is no need to break with the daily routine. I thought about my relative's recollections of World War II – how "business as usual" was thrown out the window as whole industries retooled, neighborhoods collected raw materials, and young men and women crowded enlistment offices knowing there was a good chance they were signing up to give their lives to protect their families and communities. The future became more important than the present and ordinary citizens became willing to break with their routine and take risks. Extinction Rebellion (XR) members are awake to this reality and are out there breaking the rules (non-violently) and getting arrested for it! They know what is at stake – everything!

Frustrated with the whole capitalistic system that allowed things to get this bad, Extinction Rebellion and similar groups are ready to basically

blow up the whole system and install a "Citizens Assembly" (in each country?). This would pretty much look like an overthrow of all world governments – not really something we want to have happen when our boat is already on stormy seas and leaking like a sieve! On the other hand, XR is correct that donations to traditional environmental groups have been paying a lot of people big salaries (it might amaze you) and yet – well, look at where we are. So that's not the correct path either.

Some folks have been awakening from the consumer trance and taking action, but even then it is often to start a community garden, or (as I did once) coordinate a recycling program for their office building. Great things to be doing in your spare time *AFTER* fighting to make sure Climate Repair is put into action.

THREE CRITICAL LEAPS

So, we need to get focused! 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 Change.

HOW DO WE <u>KNOW</u> A CLIMATE DEADLINE IS APPROACHING?

As mentioned earlier, 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 ºC 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 ºC (35.4 °F). (Notice that is almost identical to the Paris agreement's target of 2 ºC and the Intergovernmental Panel on Climate Change, or IPCC, target of 1.8 ºC.) 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 2º 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 ºC 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.)

GOOD THINGS ARE STARTING TO HAPPEN, BUT WILL IT BE SOON ENOUGH?

Thanks to recently climate-engaged students and youth and the significant new Extinction Rebellion (XR) meta-group, September 2019 hosted the biggest environmental mobilization in history, with 7.6 million people in 185 countries marching and striking to call for a livable climate. Unfortunately, the same week the UN Climate Action Summit in New York saw 77 countries defer to an inadequate goal of "carbon zero by 2050" and shortly after the COP25 meeting in Madrid disbanded in squabbling, mostly over carbon credits. As a target 2050 is dramatically inconsistent with the Intergovernmental Panel on Climate Change's (very conservative) science. Not only do we need emissions reductions and carbon neutrality, we also need to remove the "legacy carbon" already existing in the Earth's atmosphere. The excess of greenhouse gasses contaminating our life-sustaining envelope did not get there naturally and they will not go away (in time) naturally either. That's too much to expect! World leaders must chart a course for sustainability and carbon removal (and possibly solar radiation management). With Arctic sea ice and permafrost now close to vanishing, financing of fossil fuels only increasing, and the broader ecological picture as grave as ever, it's becoming increasingly clear that we need to actively remove carbon from the atmosphere now before it's too late.

PHILANTHROPIC SUPPORT FOR CLIMATE-ENGINEERING RESEARCH – ANOTHER SIGN OF PROGRESS

Twenty-nine, mostly U.S.-based philanthropic institutions, including the John D. and Catherine T. MacArthur Foundation, the David and Lucile Packard Foundation and the William and Flora Hewlett Foundation plan to spend an unprecedented total of $4 billion USD over the next five years addressing Climate Change. Some of the foundations engaged in climate philanthropy spend significant sums on efforts to increase public awareness of the problem, sometimes through media coverage of global warming and helping develop better policies, such as the climate bill that cleared the House of Representatives – but not the Senate – during the Obama administration. There are foundations backing efforts to make the economy more equitable while it becomes less fossil-fueled as well.

And dozens of foundations have declared that they will no longer invest any money from their endowments in companies that extract or

produce oil, gas and coal. By refusing to own stocks and bonds in those industries, they are encouraging big corporations to reduce the greenhouse gas emissions that stoke global warming.

Microsoft co-founder Bill Gates, along with other billionaire philanthropists like Amazon founder Jeff Bezos, former New York City Mayor Michael Bloomberg and entrepreneur Richard Branson, created a $1 billion fund to back startups working on Climate Change solutions. Gates serves as the chairman of this private company.

Indeed, the costs of wind power and solar energy have fallen sharply over the past decade, making them far more competitive and sparking swift growth in the amount of power derived from renewable sources around the world and especially in China, according to the International Renewable Energy Agency, an intergovernmental organization that tracks this data.

And many donors support political candidates who pledge to take action on Climate Change – as the billionaire Tom Steyer and his wife Kathryn Taylor regularly do in addition to their climate-inspired giving.

How significant has climate giving become? While $4 billion may sound like a lot of money, it still represents a small fraction of 1 percent of the $410 billion U.S. individuals, estates, corporations and foundations gave in 2017 to nonprofits, faith-based organizations and other charities, according to the Giving USA 2018 report. More than half of this giving supports religious activities, education, social services, health care and medical research. Even though Climate Change by most accounts is the greatest threat to human health, philanthropy also still accounts for only a small percentage of all grants from the nation's foundations, which disbursed nearly $67 billion in 2017. Worldwide, spending on Climate Change, coincidentally, also amounts to about $410 billion a year, from governments, businesses and charities.

Philanthropy also contributes, though governments, even after the U.S. backed out of its commitments under the Paris climate deal, are by far the largest source. The European Union alone provided $23 billion to developing countries in 2016 to combat Climate Change, and it plans to spend at least a full 20 percent of its budget on Climate Change in the future, which comes to nearly $37 billion each year by 2020. (The problem is most of this money is for mitigation and disaster relief costs

which will continue to spiral upward, while doing nothing to repair the problem causing the need for relief.

Bloomberg Philanthropies, for instance, has announced Climate Change-related commitments or challenges totaling more than $200 million since 2015. The Ikea and MacArthur foundations have made commitments in the $40 million to $50 million range. And many private foundations announced large Climate Change commitments at the recent Global Climate Action Summit, the most notable of which was a $4 billion pledge over five years made by twenty-nine foundations from around the world.

READY TO MAKE HEADWAY

With citizenry on the alert, financial support ramping up and massive social demonstrations like those of Extinction Rebellion and Climate Strike we are finally ready to settle on and press forward with a safe and effective methodology for Direct Atmospheric Removal of Excess-Carbon / Solar Reflection Management and then scale those efforts up. In order to return the atmospheric CO_2 content to 350 ppm we would need atmospheric reductions of 50 ppm each year, and also to reduce current emissions by the equivalent of 2 ppm per year. Thus, even with effective technology, public will, and political/corporate cooperation we will still be pushing the limits of technology and time if we are to avoid the mid-2030's Climate Deadline.

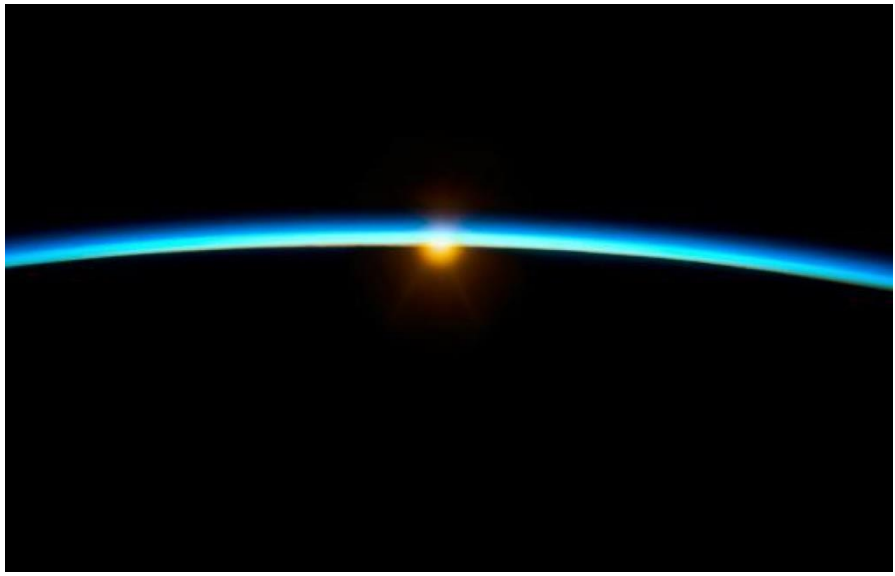
In the next Chapter we will look more specifically at what the options carbon removal and solar management are.

PART III: EXIT HERE IF YOU D.A.R.E.

World War II – Normandy Invasion

In the months leading up to World War II, there was a tendency among many Americans to talk absently about the trouble in Europe. Nothing that happened an ocean away seemed very threatening.

- Gene Tierney



CHAPTER FOUR: EMERGENCY CLIMATE REPAIR – GO BIG OR NO HOME

"The point in history at which we stand is full of promise and danger. The world will either move toward unity and widely shared prosperity – or it will move apart."

- Franklin D. Roosevelt

Chapter Summary: We are past discussion-time on the merits of manually repairing our leaking planetary lifeboat. It's not a question of *if* we use technology to remove carbon from the atmosphere (Direct Atmospheric Removal of Excess Carbon - DARE) and or reduce the amount of solar radiation reaching the planet (Solar Radiation management – SRM) it's only a question of how and when. Let's use what little time we have to choose wisely, keeping in mind that SRM without DARE would just be covering up the problem and DARE without Sustainability would be like cleaning up a child's mess without setting any rules so it would not happen again.

CO_2 concentrations in the atmosphere — the planetary thermostat — are now at 408.53 (November 5, 2019) parts per million (ppm) and rising by almost 3 ppm each year, reaching levels that have not been seen in 3 million years. Myles Allen of Oxford University's Environmental Change Institute says: "Every year we are not even trying to reduce emissions is another 40 billion tons of CO_2 dumped into the atmosphere that we are blithely committing future generations to scrub out again." With Oxfam reporting that one person is forced out of their home every two seconds as a result of climate change, even the conservative scientists are getting gloomy. Our plight seems dire & the time to turn things around is short – under 15 years before we reach 450 ppm, the Climate Deadline.

Way back in 1977, Austria-based International Institute for Applied Systems Analysis proposed ways of capturing all of Europe's CO2 emissions and injecting them into sinking Atlantic Ocean currents. In 1982, Soviet scientist Mikhail Budyko suggested filling the stratosphere with sulphate particles to reflect sunlight back into space. In 1997, Edward Teller, inventor of the hydrogen bomb, proposed putting giant mirrors into space. In 2006, Paul Crutzen, one of the world's leading climate scientists and winner of the Nobel Peace Prize for his work on atmospheric ozone depletion, published a paper called "Albedo Enhancement by Stratospheric Sulfur Injections: A Contribution to Resolve a Policy Dilemma?" In the paper, Crutzen acknowledged that the preferred way to address climate warming was to lower emissions of greenhouse gases, but he concluded that making *sufficient* cuts was only "a pious wish."

In the following years, climate-engineering gained more attention, including high-profile reviews by the U.K.'s Royal Society and the Washington-based Bipartisan Policy Center, both of which recommended further exploring Stratospheric Sulfur Injections. Now the IPCC itself suggests that while we must continue to implement solar and wind technology as quickly as possible, doing so won't avoid major climate catastrophes. CO_2 levels are already too high and scaling up renewable energy will just slow the rate of increase; it won't bring CO_2 levels down. For these reasons, the IPCC has finally begun to recommend some form of fiscally and ecologically sound Climate-Engineering; carbon capture, solar reflection, or both in combination with wind and solar power. "Time is no longer on our side," one Climate-Engineering advocate, former British government Chief Scientist David King, told a conference last fall. "What we do over the next 10 years will determine the future of humanity."

King helped secure the Paris Climate Agreement in 2015, but he no longer believes cutting planet-warming emissions is enough to stave off disaster. He is in the process of establishing a Center for Climate Repair at Cambridge University. It would be the world's first major research center dedicated to a task that, he says, "is going to be necessary." Technologies earmarked for the Cambridge center's attention include a range of efforts to restrict solar radiation from reaching the lower atmosphere, including spraying aerosols of sulphate particles into the stratosphere, and refreezing rapidly warming parts of the polar regions by deploying tall ships to pump salt particles from the ocean into polar clouds to make them brighter.

U.S. scientists are on the case, too. The National Academies last October launched a study into sunlight reflection technologies, including their feasibility, impacts and risks, and governance requirements. Marcia McNutt, president of the National Academy of Sciences, said: "We are running out of time to avoid catastrophic Climate Change. Some of these interventions … may need to be considered in future."

The study's prospective authors held their first meeting in Washington, D.C., at the end of April. Speakers included David Keith, a Harvard University physicist who has developed his own patented technology for using chemistry to remove CO_2 directly from the atmosphere (see Chapter Four), and Kelly Wanser of the Marine Cloud Brightening Project, which is studying the efficacy of seeding clouds with sea salt and other materials to reflect more sunlight back into space. The project is preparing for future field trials.

It is no longer a question of if we will engage in climate-engineering, it is a question of when – and if it will be soon enough.

FIRST DO NO HARM

Climate-Engineering is defined by the Oxford Climate-Engineering Program as "the deliberate large-scale intervention in the Earth's natural systems to counteract Climate Change." There are two main types. One is shading the earth from solar radiation, of which the shroud of sulphates in the stratosphere is emerging as the quickest, most effective, and least costly. This is referred to as Solar Radiaiton Management (SRM). The other is to remove CO_2 directly from the atmosphere (and oceans) – a group of strategies called Direct Atmospheric Removal of Excess-Carbon (DARE). The goal is usually a return (remember we are now over 400 ppm and rising) to 350 ppm

atmospheric carbon or sometimes even less. (Pre-industrial carbon levels were fairly stable, around 228 ppm, since the dawn of humanity.) Both must eventually be backed up with Sustainability.
Carbon dioxide removal would use various methods to reduce anthropogenic CO_2 levels in the air. Solar radiation management would send more sunlight back into space, reducing the input of what scientists call radiative forcing and what laypeople call heat. The former method works slowly, while the latter method can work within months. While SRM works faster than DARE the risks of collateral environmental damage are sometimes, but not always, higher. For example, some forms of SRM might change rainfall patterns and weather circulation as well as disrupting stratospheric chemistry and ice formation. It could also result in more ultraviolet light exposure, which would have a negative impact on human health.

The authors of a 2009 Royal Society report said that Climate-Engineering "is very likely to be technically feasible," although it is not a substitute for reducing emissions in the first place. But the lack of political will to reduce emissions, the increasing levels of greenhouse gases in the atmosphere, the present and future effects of Climate Change, and the need to act fast to counter these trends have led a number of scientists and policymakers to give Climate-Engineering serious consideration as a research endeavor and as a potential partial solution to near-term Climate Change.

"If mitigation efforts do not keep global mean temperature below 1.5C, solar radiation modification can potentially reduce the climate impacts of a temporary temperature overshoot, in particular extreme temperatures, rate of sea level rise and intensity of tropical cyclones, alongside intense mitigation and adaptation efforts," the report observes.

A search for engineered fixes will be necessary as the world is almost certain to miss the 1.5C goal. Current national pledges are forecast to lead to at least 3C of warming by the end of the century – and that is if governments keep their commitments.

IT'S TIME TO D.A.R.E.

Direct Atmospheric Removal of Excess-Carbon (DARE) actually fixes global warming, while SRM cools the planet, but does not remove greenhouse gasses. As a psychologist I liken this to someone taking medication for their anxiety or depression as opposed to resolving whatever problems are causing the unhappy symptoms.

Both might be needed – but eventually the underlying problem needs to be addressed.

There are several approaches to DARE including: Bioenergy with Carbon Capture and Storage, (2) Biochar/Hydrochar, (3) Ocean Fertilization, (4) Enhanced Weathering, and (5) Direct Air Capture and Storage. Although DARE sometimes builds off of methodology for removing CO_2 from the stack emissions of large fossil fuel point sources, such as power stations, it goes further to remove carbon dioxide from the atmosphere. In so doing DARE assists natural "carbon sinks" like forests and oceans to creates carbon net negative emissions that offset emissions from small and dispersed point sources such as automobiles and airplanes.

Carbon dioxide removal is different from reducing emissions, as the former produces an outlet of carbon dioxide from Earth's atmosphere, whereas the latter decreases the inlet of carbon dioxide to the atmosphere. Both have the same net effect, but for achieving carbon dioxide concentration levels below present levels, carbon dioxide removal is critical. Also, for meeting higher concentration levels, carbon dioxide removal is increasingly considered to be crucial as it provides the only possibility to fill the gap between needed reductions to meet mitigation targets and global emission trends.

POLITICAL HURDLES

In the United Nations IPCC Environmental Outlook to 2050 the authors commented on the need for negative emissions, stating "Achieving lower concentration targets (450 ppm) depends significantly on the use of Climate-Engineering".

Ethical and institutional questions also arise over who would oversee DARE / SRM operations and which areas would be affected. The report suggests a number of UN organizations as possible supervisory bodies. But authors also observe that there are scarcely any laws or regulations to stop any country that wants to push ahead by itself. The only guideline cited was the Convention on Biodiversity which states "no climate-related Climate-Engineering activity that affects biodiversity may take place."

There are doubts also over effectiveness. While the aerosols might constrain temperature rises, they would not stop the accumulation of carbon dioxide in the atmosphere and the acidification of the oceans. What happens when this "temporary measure" is halted is also an area

of concern, as the planetary system might suddenly be hit by a surge in temperature.

James Hansen said the tipping point in public opinion was more likely to come at a slightly higher temperature, but by then it may already be too late. “2C would force Climate-Engineering on today’s young people. Climate-Engineering, if global temperature passes 2C, would start, at the latest, once ice sheet collapse begins,” he told the Guardian. “Unfortunately, because of the inertia of the system, Climate-Engineering then would probably be too late to prevent locking in the eventual loss of coastal cities.”

Critics say that the technologies are unproven, will have unforeseen impacts and could distract from attempts to limit emissions of greenhouse gases. But advocates point to language in the summary for policymakers produced by the IPCC working group that assessed the scientific evidence for Climate Change as evidence that reducing emissions will not be enough.

At present, only small-scale, pilot Climate-Engineering projects are in operation, including reforestation efforts and capturing carbon from biofuel plants. This is due, in part, to what some scientists say is a baffling dearth of funding for researchers working in the area.

But that may change now that the IPCC is seeing Emergency Climate Repair as probably necessary due to the speed of advancing global warming. "To some extent, the treatment of Climate-Engineering in the IPCC reports is a reflection of growing governmental interest in these ideas," says Ken Caldeira, a climate researcher at the Carnegie Institution for Science, in Stanford, California. "It is hard to determine the extent to which possible increases in funding would be driven directly from this governmental interest and how much would be driven by the report itself."

Funding isn't the only concern. “There is serious work to be done relating to the technical feasibility, social acceptability, scalability and side effects relating to Climate-Engineering techniques. It seems perverse that policy-makers have thus far been content to leave such important questions unanswered,” says Tim Kruger, manager of the Climate-Engineering program at the University of Oxford, UK, and organizer of last week’s meeting in that city on technologies to remove CO_2 from the atmosphere.

The United States joined Saudi Arabia to derail a U.N. resolution that sought to improve the world's understanding of potential efforts to lace the sky with sunlight-reflecting aerosols or use carbon-catching fans. The two countries were joined by Brazil in blocking the resolution at the U.N. Environment Assembly conference in Nairobi, Kenya, earlier this week. The measure asked the world's decision-making body on the environment to commission a report outlining research and planning related to carbon dioxide removal and solar radiation management. Those controversial efforts are still in the planning stage and are not operational.

Switzerland and nine other nations originally asked the U.N. Environment Program for guidance on possible future governance options and analysis of the implications of Climate-Engineering, but they agreed to substantially reduce the scope of their resolution in hopes that the United States, Saudi Arabia and Brazil would allow it to move forward. The final version, which failed to gain consensus, would have asked UNEP only to provide a compilation by next year of current scientific research on Climate-Engineering and U.N. bodies that have adopted resolutions regarding it.

The United Nations Environment Assembly (UNEA) is the world's highest-level decision-making body on the environment. UNEA enjoys the universal membership of all 193 UN Member States and the full involvement of major groups and stakeholders. It gathers ministers of environment in Nairobi, Kenya every 2 years. Many scientists wish to see UNEA become the institutional home for Climate-Engineering within the U.N. structure. But the United States in particular insisted that questions about Climate-Engineering be left to the Intergovernmental Panel on Climate Change, a scientific body with a narrow focus on global warming. Climate-Engineering will be a key part of the IPCC's upcoming Sixth Assessment Report to be published in 2021 and 2022, and sources say the U.S. negotiators refused to agree to any other study or assessment that would be published before it.

The United States' focus on the IPCC raised eyebrows. Both the United States and Saudi Arabia angered parties at the U.N. climate talks in Katowice, Poland, in by questioning IPCC's work. The two countries joined Russia to block a popular proposal to "welcome" last year's landmark IPCC report that said the world must act aggressively to counteract Climate Change within 12 years. The special report said that failing to do so would result in catastrophic effects.

"There's definitely a lot of frustration on the part of those countries that have fought for the resolution in the last two weeks and have tried to improve it and find consensus," said Linda Schneider, a senior program officer with Heinrich-Böll-Stiftung.

Besides Switzerland, the motion was backed by Burkina Faso, Micronesia, Georgia, Liechtenstein, Mali, Mexico, Montenegro, New Zealand, Niger and Senegal. Other parties, including some European nations and Bolivia, argued for even stronger language for using caution in approaching Climate-Engineering. None of them opposed the final resolution.

The final version of the measure included a lengthy preamble that expressed concern about the "potential transboundary risks and adverse impacts of carbon dioxide removal and solar radiation management on the environment and sustainable development." It also emphasized the importance of "applying the precautionary principle" when fiddling with the world's thermostat.

Daniel Bodansky, a professor of law at Arizona State University and an expert on international climate agreements, criticized the resolution for painting direct air capture of carbon dioxide and solar radiation management with the same brush.

"I can understand fears about the latter," he said. "But I find it much more difficult to understand objections to the former. Lumping them together as 'Climate-Engineering' makes no sense to me, since they don't pose similar risks."

Some experts suggest that there could be unwanted side effects from infusing the atmosphere with aerosols, like more severe weather. While Bodansky said there are potential risks associated with solar radiation management, or SRM, he noted that the proposed resolution didn't balance those with the dangers of runaway Climate Change.

"It seems to me inconsistent to say, on the one hand, that global warming is the biggest problem that humanity faces, and then go on to say, on the other hand, but we shouldn't even do research on SRM because it may pose risks," he said. "Either Climate Change is the biggest problem we face or it's not. And if it is, then it's all hands on deck."

Bodansky also argued that the IPCC was the appropriate body to explore issues of Climate-Engineering. Last year's special report

found that there are no possible pathways to maintain the threshold of 1.5 degrees Celsius of warming that don't include large-scale carbon dioxide removal. The report also noted possible governance challenges.

The Swiss resolution's preamble recognizes the IPCC's work on the issue and the U.N. Framework Convention on Climate Change's authority over climate mitigation and adaptation. The Convention on Biological Diversity and the London Convention on the prevention of marine dumping have also weighed in on Climate-Engineering in the past.

The list of Switzerland's co-sponsors shows that climate-vulnerable countries want broader oversight of Climate-Engineering, too. Countries with small governments lack the personnel to sift through numerous reports, and they stand to suffer if the practices result in unintended consequences. Micronesia, late during last year's meeting of the Montreal Protocol, proposed language calling for an assessment of possible impacts on the stratospheric ozone layer from Climate-Engineering after an advisory panel warned that SRM could harm it. It wasn't adopted, but the country plans to offer a similar proposal at this year's conference.

Janos Pasztor, executive director of the Carnegie Climate Climate-Engineering Governance Initiative, said DARE and SRM would ultimately need to be treated separately when it came to global governance issues.

Mitigation means reducing emissions, and direct carbon removal will likely become a larger part of nations' goals under the Paris Agreement, he said. "When it comes to solar radiation management, that's where the challenge is. There's no home," said Pasztor, who is a former U.N. official.

Climate advocates and progressive countries also worry that the existence of tools to cool the atmosphere could blunt interest in climate mitigation and adaptation and lengthen global reliance on fossil fuels.

In any event, it is clear that citizens of the United States have a special role to play in our Climate Emergency. First, we allowed our politicians to permit our corporations into producing (historically) the highest levels of greenhouse gasses. Second, we are in the process of attempting to prevent the rest of the world from cleaning up the mess. I was shocked and disgusted as I researched background for the federal

lawsuit I filed in early 2019. In spite of knowing the harm being caused to its citizens the United States Government spent decades approving actions leading to massive greenhouse gas emissions. Even the Clinton and Obama Administrations fought hard against regulations on carbon emissions and opposed climate litigation with armies of attorneys. As with our treatment of the indigenous population in this country, our leaders carry a great shame for this betrayal of our Constitution which promises life, liberty and the pursuit of happiness. Climate disruption has made broken all of these promises. I should not have to be writing this book, filing lawsuits, or running for office to fight these betrayals of our Constitution – but there is nothing to do except fight, and we must do it together to have any hope of success!

CHAPTER FIVE:
DIRECT ATMOSPHERIC REMOVAL OF EXCESS-CARBON (DARE)

Doing all we can to combat Climate Change comes with numerous benefits, from reducing pollution and associated health care costs to strengthening and diversifying the economy by shifting to renewable energy, among other measures.

- David Suzuki

Chapter Summary: Solar Radiation Management (SRM) can, and probably will, be needed to bring rapid reduction in planetary temperatures. By itself, however, (with the exception of Ocean Assisted Carbon Capture & Reflection) this technology will not have a significant effect on greenhouse gas concentrations in the atmosphere. For that we need Direct Atmospheric Removal of Excess-Carbon (DARE). There are a number of DARE methods discussed in this chapter ready for final testing and implementation, the most promising of which are Ocean Assisted Carbon Capture & Reflection (OACC&R) and Direct Air Capture (DAC).

So, if we need to rapidly and safely remove excess carbon from our atmosphere, how do we do it. Notice that I said *rapidly* and *safely*. What exactly do those terms mean for us?

Rapidly: The latest (8/18) UN IPCC Report [1] requires removing 12 Gigatons (Gt) of atmospheric CO2 annually for several decades to avoid catastrophic Climate Change [2]. Each Carbon Repair (CE) [3] Direct Air Capture (DAC) commercial facility "DAC plant" [11] removes 1 Megaton of CO2 per year, thus requiring an array of 12,000 DAC plants to remove 12Gt annually.

Safely: With less than 2 decades left to make emergency repairs to our atmospheric system it is essential that we don't cause any more damage than has already been done. Some of the proposals made in all seriousness include such horrifying gems as installing massive tubes in the oceans to move cold water to the surface and warmer water deeper (disrupting ocean currents and potentially causing vast weather inversions destroying most land-based crops), separating CO_2 from other gasses in the air by freezing it into liquid form (drinking air might be fun?), or slowing the rotation of the Earth (do I even need to describe why this is a bad idea?). At the very least we must include in our DARE ethics, the principle of "first do no harm".

Note that, for accuracy, some of the descriptions in this section are taken directly from the descriptions provided by the labs/engineers themselves. Please also note that the descriptions of technology in the following chapters are designed only as an introduction. With today's internet access you will be able to research more complete details of the processes and procedures on your own.

BIO-ENERGY WITH CARBON CAPTURE & STORAGE

Bioenergy with Carbon Capture and Storage, or BECCS, uses biomass to extract carbon dioxide from the atmosphere, and carbon capture and storage technologies to concentrate and permanently store it in deep geological formations. BECCS is currently (as of October 2012) the only CDR technology deployed at full industrial scale, with 550 000 tons CO_2/year in total capacity operating, divided between three different facilities (as of January 2012).

The Imperial College London, the UK Met Office Hadley Centre for Climate Prediction and Research, the Tyndall Centre for Climate Change Research, the Walker Institute for Climate System Research, and the Grantham Institute for Climate Change issued a joint report on carbon dioxide removal technologies as part of the AVOID: Avoiding dangerous Climate Change research program, stating that "Overall, of the technologies studied in this report, BECCS has the greatest maturity and there are no major practical barriers to its introduction

into today's energy system. The presence of a primary product will support early deployment." According to the OECD, "Achieving lower concentration targets (450 ppm) depends significantly on the use of BECCS".

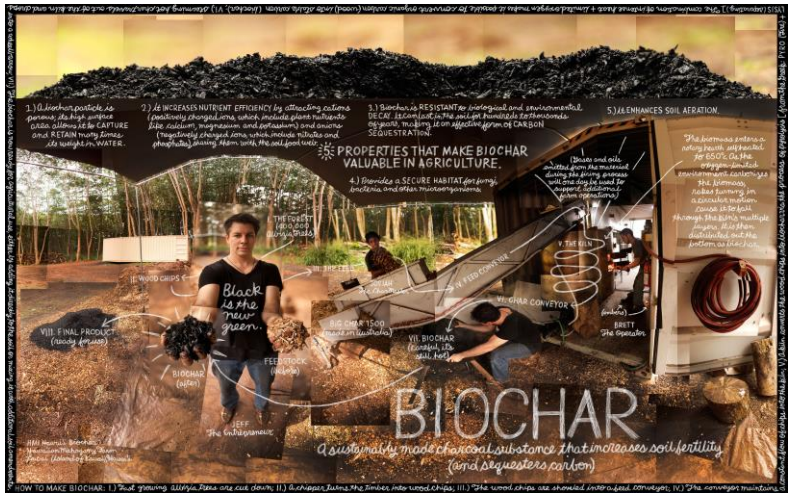
BECCS, however, is limited so far in the amount of atmospheric carbon it can remove. It may not be powerful enough on its own to help us avoid the mid-2030's climate deadline.

BIOCHAR

Biochar is created by the pyrolysis of biomass and is under investigation as a method of carbon sequestration. Biochar is a charcoal that is used for agricultural purposes which also aids in carbon sequestration, the capture or hold of carbon. It is created using a process called pyrolysis, which is basically the act of high temperature heating biomass in an environment with low oxygen levels. What remains is a material known as char, similar to charcoal but is made through a sustainable process, thus the use of biomass. Biomass is organic matter produced by living organisms or recently living organisms, most commonly plants or plant- based material.

The offset of greenhouse gas (GHG) emission, if biochar were to be implemented, would be a maximum of 12%. This equates to about 106 metric tons of CO_2 equivalents. On a medium conservative level, it would be 23% less than that, at 82 metric tons. A study done by the UK Biochar Research Center has stated that, on a conservative level, biochar can store 1 gigaton of carbon per year. With greater effort in marketing and acceptance of biochar, the benefit could be the storage of 5–9 gigatons per year of carbon in biochar soils.

One company now deploying this semi-DARE technology is Biochar Solutions Inc is developing a Network of distributed carbon sequestration and soil restoration capacity by designing, producing, and selling continuous process industrial equipment to convert forest residues (carbon liabilities) into biochar and bioenergy (carbon solutions). Together, their industry leading team built a suite of brands and companies including Soil Reef™ brand biochars and blends, Biochar Bob®, The Biochar Alliance, Biochar Solutions, Biochar Reclamation Labs and Hawaii Biochar Products. Based in Carbondale, CO.



ENHANCED WEATHERING (EW)

Enhanced weathering is a chemical approach to remove carbon dioxide involving land or ocean-based techniques. EW would speed up the chemical processes by which silicate rocks—the most abundant type on Earth—suck up CO_2 to create carbonate rocks like limestone. There are several versions of EW involving land and oceans. One example of a land-based enhanced weathering technique is in-situ carbonation of silicates. Ultramafic rock, for example, has the potential to store from hundreds to thousands of years' worth of CO_2 emissions, according to estimates. In another iteration scientists have also proposed heating limestone, sequestering its CO_2 underground, and taking the other byproduct to "lime the oceans." Liming the oceans would be another kind of fertilization, helping ocean life uptake more CO_2. Because lime is alkaline, adding it to the sea would also reduce ocean acidification.

Ocean-based Enhanced Weathering techniques involve alkalinity enhancement, such as grinding, dispersing, and dissolving olivine, limestone, silicates, or calcium hydroxide to address ocean acidification and CO_2 sequestration. Enhanced weathering is considered one of the least expensive Emergency Climate Repair options. One example of a research project on the feasibility of enhanced weathering is the CarbFix project in Iceland. The risk of unanticipated consequences should be low, since the processes are similar to those occurring naturally.

CO_2 SCRUBBING CHEMISTRY

Calcium oxide (quicklime) will absorb CO_2 from atmospheric air mixed with steam at 400 °C (forming calcium carbonate) and release it at 1,000 °C. This process, proposed by A. Steinfeld, can be performed using renewable energy from thermal concentrated solar power. Quicklime is made by heating limestone to release the CO_2 within it. Quicklime is mixed with sand for brick building as mortar, where it hardens by absorption of CO_2.

SODIUM HYDROXIDE AUGMENTATION

In another chemical-based approach Columbia University scientists Zeman and Lackner have outlined a specific method of air capture using sodium hydroxide. They point out that current Carbon Capture and Storage (CCS) technologies focus on large, stationary sources that produce approximately 50% of global CO_2 emissions. We propose an industrial technology that captures CO_2 directly from ambient air to target the remaining emissions. First, a wet scrubbing technique absorbs CO_2 into a sodium hydroxide solution.

The resultant carbonate is transferred from sodium ions to calcium ions via causticization. The captured CO_2 is released from the calcium carbonate through thermal calcination in a modified kiln. The energy consumption is calculated as 350 kJ/mol of CO_2 captured. It is dominated by the thermal energy demand of the kiln and the mechanical power required for air movement. The low concentration of CO_2 in air requires a throughput of 3 million cubic meters of air per ton of CO_2 removed, which could result in significant water losses. Electricity consumption in the process results in CO_2 emissions and the use of coal power would significantly reduce to net amount captured.

The thermodynamic efficiency of this process is low but comparable to other “end of pipe” capture technologies. As another carbon mitigation technology, air capture could allow for the continued use of liquid hydrocarbon fuels in the transportation sector.

Other companies such as Full Circle Biochar also hot on the trail of this technology. Full Circle offers proprietary biochar products that are scalable and profitable in major agricultural markets around the globe – notably its BioCore TM and BioCharge TM offerings which are standardized and stabilized biochar products.

ARTIC OCEAN TERRAFORMING (AOT): STABILIZATION OF THE SUB-SEA METHANE THROUGH A COOLING OF THE ARCTIC OCEAN

In AOT researchers propose minor adjustments to the terraform of the Arctic ocean, with a significant impact on atmospheric carbon. The Arctic has in geological time not always had the same form as today. Key changes could revert it back to what it was. As temperatures begin to rise the Greenland ice sheet will begin to melt. The Greenland ice sheet contains 2,850,000 cubic kms of ice. That will be a significant amount of cold water being dumped into the sea. It's enough cold water to raise the world's oceans 7m. However, it will not distribute evenly. Fresh water doesn't quickly mix with saltwater. The rest of the oceans are denser, and warmer. That denser water is not going to give way easily.

As a result, the melt will be blocked from going south. The cold water would flow towards the Arctic first. The immediate effect of that will be to cool it. 2.8 million cubic kms of cold water will flow into a place with shallow seabeds. The total volume of the Arctic ocean is 18,750,000 cubic kms. That is a replenishment of 15%. In a lake cold water goes to the bottom (called the hypolimnion). In terms of the methane deposits that is where it is needed most. The sea-beds are shallow and without an ice cover the water will begin to heat up. However, freshwater freezes at a higher temperature than does saltwater.

The ocean current called the Thermohaline Circulation (THC) brings warm water up from the tropics. It is the reason why England does not experience the temperatures of Siberia. Some of this dense warm water continues North into the Arctic ocean through the Fram Strait with dangerous consequences for the sub-sea methane deposits.

Scientists proposing this method of carbon reduction indicate two changes are required to promote negative feedbacks to Arctic warming. The warm water Atlantic flow into the Arctic can be throttled through the creation of an artificial reef in the Fram Strait. The Bering Strait would be blocked by a sea wall. That would stop the ice pack from exiting during winter and stop the warm Pacific Ocean from entering in summer. The changes required are in fact minor, but the feedbacks on Arctic warming would be significant.

The authors point out that once the Arctic ocean received enough fresh water Azolla could be used to sequester carbon on a significant scale.

A restoration of the polar vortex could have a variety of benefits including: Temperature differential increases via a decrease in the Arctic temperature the polar vortex would again contract to the North; The generation of significant quantities of clean hydroelectric energy from the Bering Strait sea wall; The generation of significant quantities of clean biogas energy from the harvesting of Azolla; A potential new food source for millions of people. Wildlife preservation through the establishment of a protected ocean area in an area away from Oxygen Minimum Zones; Economic benefits from an artificial reef; Economic benefits through trade between the US and Russia. A significant reduction of energy consumed in the bilateral trade.

MICROALGAE CARBON HYDROCHAR PROJECT

An international team named Aljadix whose members hail from Switzerland, the UK and Canada (www.aljadix.com), have designed, built and tested Aljadix's prototype microalgae cultivation platform?

The Hydrochar Project begins by consuming tons of carbon dioxide from the atmosphere. The gas is bubbled into an innovative fully sealed microalgae cultivation platform that floats on the sea surface. The microalgae inside the container use photosynthesis to consume carbon dioxide. Under the right conditions, microalgae grows fast and is harvested every three days. The harvest is fed as a liquid concentrate into a high-temperature, high-pressure vessel for ten minutes where it undergoes hydrothermal liquefaction (HTL). The products of HTL are biocrude (a liquid, like fossil crude, and suitable for upgrading to renewable diesel) and hydrochar (a solid, like charcoal, that contains chemically inert carbon that does not biodegrade or return to the atmosphere).

Together, the biocrude and hydrochar co-products make carbon negative biofuel. As you can see, the more biocrude that is consumed by industry to replace fossil crude, the more carbon is permanently removed from the atmosphere as inert carbon hydrochar. Brick by brick.

Of course, the carbon in the biocrude ultimately is burned and returned to the atmosphere as carbon dioxide (thus carbon neutral with respect to the atmosphere). But the carbon in the hydrochar remains permanently sequestered. This hydrochar can be used in materials, or simply buried, for example, in a retired open pit mine. And since the amount of carbon contained in the hydrochar exceeds the carbon cost of the energy required to drive the entire process (by full life cycle

analysis), the process is therefore carbon negative, with respect to the atmosphere, in an absolute sense.

The Aljadix process is also highly scalable. Existing biofuels are limited by lack of land and lack of freshwater. That is why existing biofuels (bioethanol and biodiesel) make up less than 3% of the worldwide liquid fuel supply. Aljadix overcomes these limitations with their innovative microalgae cultivation platform that floats on the sea-surface, using sea water-based growth medium inside the fully sealed platform. The Aljadix process will use no land and no freshwater. Aljadix will locate the platforms in sunny coastal regions of the world where the process is driven by freely available sunlight. Their extensively recycle nutrients from each stage of the process so that nothing is lost to the surrounding ocean. And of course, Their coastal locations are selected to be low-impact environmental zones which do not interfere with sensitive ecosystems, sea-life migration, commercial fisheries or tourism.

The Aljadix team states, “In our view, there are many industries which cannot eliminate their need for liquid hydrocarbon fuels by 2040, especially airlines, ocean tankers and chemicals/plastics. By converting these industries to carbon negative biofuel, we will transform them into a solution for Climate Change…and for our planet.”

While the Aljadix plan does not touch as many bases (completely sequestering all captured carbon and adding the capability for rapid cool down via increased ocean reflectivity) as Ocean Assisted Carbon Capture & Reflection (see below), Aljadix’s project is further advanced in it’s development. This is a significant advantage due to the race against the 2030’s Climate Deadline.

LAND-BASED DIRECT AIR CAPTURE

Land-Based Direct Air Capture approaches the excess atmospheric carbon problem by treating excess CO_2 similar to an "oil spill in the sky" to be vacuumed up by DAC. As a stand-alone approach to Direct Atmospheric Removal of Excess-Carbon (DARE) the proposal does not require or rely upon the success of any other CO_2 reduction plan. Carbon Capture such as pre-combustion and post-combustion CO_2 capture from large point sources can help slow the rate of increase of the atmospheric CO_2 concentration, but only the direct removal of CO_2 from the air, or direct air capture (DAC), can actually reduce the

global atmospheric CO2 concentration if combined with long-term storage of CO_2.

The Direct Air Capture approach is desirable in that it recommends a *single, relatively simple, and direct* method of CO_2 removal regardless of source or quantity, thereby providing countries the time to make the changes to renewable/sustainable technologies & meet the UN-IPCC goals without damaging economies or social systems. Very importantly, Direct Air Capture offers a *high degree of safety* in that it is minimally ecosystem invasive and can rapidly be discontinued if problems arise. DAC plants, distributed on a planetary scale will simply mimic a tree's CO2 removal ability.

Carbon Engineering's Direct Air Capture 1 Megaton/Year CO_2 removal commercial plant, air contactor component.
Source: Carbon Engineering

Carbon Repair, a Calgary, Alberta firm founded by Harvard professor Dr. David Keith and colleagues with backing from financial heavyweights like Bill Gates, has developed a pilot plant which will capture carbon dioxide using a solution of potassium hydroxide mixed with water. They hope to create and sell resulting synthetic fuels at a cost of $100 a ton. Carbon Repair has been working on the project since 2009. In the Carbon Repair vision, the process would begin at the UN level with recommending the plan to all countries as the right solution for meeting the UN Millennium Development Goals, particularly "Goal 7: Ensure Environmental Sustainability". Mass production of DAC plant components would be undertaken in each country using closed manufacturing facilities and giving hiring priorities to laid-off manufacturing workers. DAC plants would be distributed around the world *according to each country's historic global CO_2 contribution (*For example, in 2017, US 15%, China 28%, India 6%, Russia 5%, Japan 4%, remaining (~190) countries 42%.)

The Carbon Repair design DAC processor draws air through a highly efficient SOFC reactor, emits oxygen and hydroxyl radicals from the air feed-stock, and destroy all other greenhouse gases. The process uses NaOH (caustic soda) as an absorber. In this process, CO_2 from the air is chemically dissolved into NaOH(aq) solution as Na_2CO_3; the $Na2CO_3$ is then reacted with solid Ca(OH)2, which regenerates the solvent and produces CaCO3 crystals; lastly, heat is applied to the CaCO3 crystals to produce pure CO2 gas. Air is pumped through the CO_2 absorber as the first step of this process. CO2 absorber for DAC are designed either as a counter-current spray tower or as a counter-current thin-falling-film contractor to maximize the contact area between the air and the solvent and thus maximize the absorption driving force.

Carbon Engineering's carbon-dioxide-capturing plant in British Columbia. The company hopes to have first generation commercial plants running by 2021.

The solvent is regenerated in the causticization unit by reacting the Na2CO3 with Ca(OH)2, which also transfers the captured CO2 to the form of $CaCO_3$ solid crystals. A mechanical filter is then used to separate the $CaCO_3$ crystals from the water. Since the crystals come out wet from the filter, they are dried in a steam dryer. Then the dry crystals are heated in a furnace to produce CaO and pure CO_2 gas. The CaO is then hydrated to regenerate the Ca(OH)2 used for the causticization reaction. The pure CO2 stream is then compressed and ready to be transported for geologic sequestration, EOR, or other commercial applications. 1 M NaOH (aq) is a typical solvent concentration because this concentration is limited by the causticization reaction that regenerates the solvent and it is not too far

from the practical maximum of 2 M NaOH. The furnace/kiln can be powered renewably or by burning fuel on-site with pure oxygen produces in an on-site air separation unit. NaOH is economically competitive with other absorbents--e.g., amines--used for DAC processes.
A key issue is that atmosphere would still be clogged with 200 years' worth of human-produced carbon dioxide. "The question is, what do we do with all this excess CO2 in the atmosphere?" said Noah Deich, executive director and co-founder of the nonprofit Center for Carbon Removal.

A new application of old technology may be the answer. "Direct air capture" that removes the gas from ambient air has possible since the 1940s, but — at a cost estimated in 2011 to be as much as $1,000 per metric ton of CO2 — it has long been viewed as too expensive to be practical.

David Keith, the Gordon McKay Professor of Applied Physics at the Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS) and professor of public policy at the Harvard Kennedy School, thinks it can be done for a lot less. He and his colleagues estimate that their company, Carbon Engineering, could capture CO2 for between $94 and $232 per metric ton. In the journal Joule, the team outlined the material and engineering costs of their system — the first time the costs of a commercial direct-air-capture process have been published.

The paper could have major ramifications across the industry.

"Until now, basically no one in the industry has published an open-book number that will give credibility that direct air capture costs less than the $500 to $1,000 per metric ton that has been estimated," Deich said.

CO2 molecules make up only .04 percent of the air — that's one in 2,500 molecules. Nonetheless, "We need enormous volumes of CO2 removal and to achieve that, we need accurate economic analysis and hard engineering data," said Julio Friedmann, CEO of Carbon Wrangler LLC and senior advisor at The Global Carbon Capture and Storage Institute. "This paper provides that transparency."

Keith co-founded Carbon Engineering in 2009, when direct air capture was still on the fringes of industrial climate solutions. Carbon Engineering's goal is to use direct air capture to produce carbon-

neutral fuels and converting carbon-free energy into high-energy fuels for vehicles such as planes and barges, which are difficult to electrify.

The Carbon Engineering team's approach differs from their few competitors in the field. "We're not developing a fundamentally new product or unit operation," said Keith. "That's the design choice we made. We're making something that's never been done before — commercial large-scale air capture — but we're doing it on a basis of technology that already exists."

Another Direct Air Capture method has been developed by *COAWAY Company*. which uses a unique process for removing CO_2 from the air and utilizes existing power plant cooling towers that already move large quantities of air to create the necessary throughput for the carbon capture process. By surrounding the inlet of cooling towers with their CO_2 absorption apparatus, large amounts of air can be processed quickly, driving down costs. COAWAY captures the CO_2 in a chemical reaction with an aqueous solution. The resulting material is 'regenerated' in a thermal process that also releases the captured CO_2 as a concentrated stream ready for commercial use or sequestration.

Northern Lights – Part of The Full-Scale CCS Project in Norway
The Northern Lights project is part of the Norwegian full-scale CCS project. The full-scale project includes capture of CO2 from industrial capture sources in the Oslo-fjord region (cement and waste-to-energy) and shipping of liquid CO2 from these industrial capture sites to an onshore terminal on the Norwegian west coast. From there, the liquified CO2 will be transported by pipeline to an offshore storage location subsea in the North Sea, for permanent storage.

The full-scale project is a result of The *Norwegian government's* ambition to develop a full-scale CCS value chain in Norway by 2024. As part of this ambition the government issued feasibility studies on capture, transport and storage solutions in 2016. Combined, these studies showed the feasibility of realizing a full-scale CCS project. Based on this outcome the government decided to continue the development of the preferred concepts through a study agreement covering concept and FEED (front-end engineering and design) studies. Gassnova represents the Norwegian state and acts as the coordinating body. The studies cover: Capture of CO2 at the waste-to-energy plant Fortum Oslo Varme in Oslo. Capture of CO2 at the Norcem (Heidelberg Group) cement factory in Brevik. The combined transport and storage solution, governed by the collaboration

agreement between Equinor, Shell and Total in the Northern Lights Project.

CARBON CAPTURE UTILISATION (CCU)

Carbon Capture and Utilization (CCU) — is a scheme that effectively recycles the stored CO2. CCU involves building a plant that converts captured CO2 into products such as methanol, biofuel, and other forms of hydrocarbons to use as alternative and renewable sources of energy. (Technologically it may even be possible to expand the scope of greenhouse gas removal to include the other, even more damaging gasses contributing to the problem, particularly methane released by the melting of polar permafrost & potential ocean floor methane hydrate melt. This application of DAC would require use of an alternate means of filtering. Scientists at Lawrence Livermore University have already discovered & tested an effective methane-capturing porous adsorbent material called Zeolite SBN which might be an option.)

CO_2 AIR-CAPTURE BASED ON CYCLIC ADSORPTION-DESORPTION PROCESS

A Zurich, Switzerland company captures carbon dioxide from thin air and recycles it to use in greenhouses. The added CO2 allows the greenhouses to grow more food with less water and less fertilizer has developed and launched a commercial plant for carbon air-capture. Atmospheric CO2 is chemically bound to a sorbent. Once saturated the CO2 is reclaimed from the material by heating it to between 60-100°C, delivering high-purity (>99.3%, the rest being air) gaseous CO_2. Climeworks indicate that over 90% of the system's energy demand can be supplied by low-cost, low-grade heat. In addition to the long term potential of the system to enable the net removal of carbon from the atmosphere, Climeworks have identified a range of key near-term markets and application using capture CO_2 for the carbonation of soft drinks as well as for bottling sparkling wines and beers, packing of fresh meat and vegetables as it prevents growth of bacteria and oxidation. Dry ice is used for freezing or chilling food during production or transport.), greenhouse fertilization (Infinitree- LLC has Direct Air Capture technology using similar tech focused specifically just on greenhouse fertilization), and renewable fuel production.

Burning fuels creates mainly CO_2 and H2O. This reaction can be reversed with available industrial technology and synthetic fuels can be produced from CO_2, water and electricity as the only inputs. By

supplying Climeworks atmospheric CO_2 and renewable energies for fuel synthesis, the resulting fuel has the potential to be carbon-neutral, less intrusive to and impactful on biological systems.

Methane Gas Arrester Array

GREENHOUSE GAS OXIDATION AND DESTRUCTION USING METHANE ARRESTERS

All greenhouse gases need to be abated, but methane release is now a high-priority situation. As polar ice and permafrost melt vast quantities of methane are being released. This, in turn, will drive runaway warming in the very near future. The estimate for the methane release is 50 gigatons, which would triple the Carbon content of the atmosphere, but worse, contribute up to 10'C of global average warming to the climate.

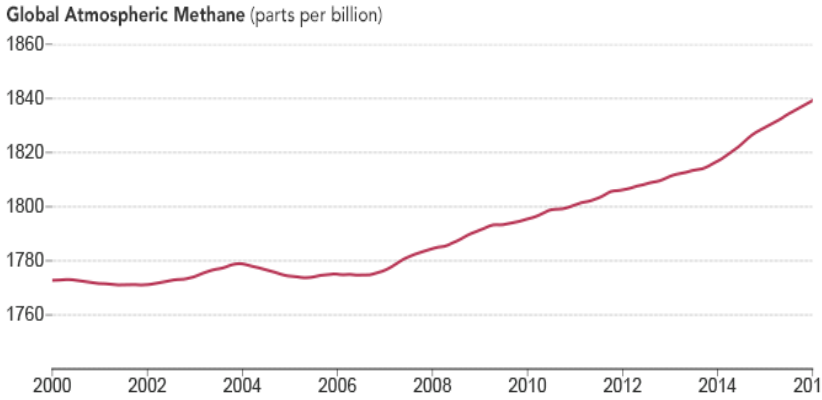
A team of scientists led by John Worden of NASA's Jet Propulsion Laboratory recently found that the concentration of methane in the atmosphere has risen sharply—by about 25 teragrams per year — since 2006. In recent years, different research teams have come up with viable but conflicting explanations for the increase. Some teams have published evidence showing that emissions from biogenic sources is driving the increase. Wetlands, ruminants, and rice paddies—all home to methane-producing microbes—are some of the major sources of biogenic methane.

Other teams have argued that a simultaneous increase in atmospheric ethane, a key component of natural gas, implies that fossil fuels are the culprit. Extracting and transporting fossil fuels add both ethane and

methane to the atmosphere via leaks in wells, pipes, and other infrastructures.

In the new study, Worden and colleagues make the case that both fossil fuels and biogenic sources (wetlands and agriculture) are responsible for the increase. Worden's team calculated that fossil fuels have contributed about 12 to 19 teragrams of methane to the atmosphere each year since 2006. They found biogenic sources contributed 12 to 16 teragrams per year. At the same time, emissions from biomass burning—wildfires and prescribed burning—decreased by 4 to 5 teragrams per year.

The weakness of methane gas is the hydroxyl radical, formed from oxygen radicals. It takes 10 years for the natural destruction of methane 9 much, much faster than carbon, but a Methane Arrester system can do it in months. Over a multi-year program, the technology can remove the dangerous methane, and reduce the dangerous and deadly impacts from the runaway methane warming.



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The proposal is to release one MT of oxygen radicals from the methane arresters every two years to the free troposphere, where they will reside as active radicals (O* or OH*) until they oxidize the gases. The arresters run on green electricity and are made of completely recyclable materials.

As methane builds up, and the natural hydroxyl radical methane removal system is overloaded, methane will remain in the atmosphere to worsen the warming forcing longer methane lifetimes in a feedback loop that will cause human extinction.

The time to act and apply Emergency methane arresters is now. Flood, fire and drought intensity is already close to 30% higher and is attributable to Climate Change caused by increasing greenhouse gases. Methane arresters remove all greenhouse gases from the air while they disperse concentrated hydroxyl radicals with no unwanted side reactions.

OCEAN FERTILIZATION

Ocean fertilization or ocean nourishment is a type of Emergency Climate Repair based on the purposeful introduction of nutrients to the upper ocean to increase marine food production and to remove carbon dioxide from the atmosphere. A number of techniques, including fertilization by iron, urea and phosphorus have been proposed. Adding iron or other nutrients to the ocean could promote algae blooms, which would capture carbon dioxide and store some of it deep in the ocean. It would directly address the root of Climate Change: carbon dioxide in the atmosphere.

At best, it could offset an eighth of the greenhouse-gas emissions attributed to humans, and it could harm ecosystems. Iron is a trace element necessary for photosynthesis in all plants. Iron fertilization is the intentional introduction of iron to the upper ocean to stimulate a phytoplankton bloom. This is under investigation in hopes of increasing carbon dioxide removal from the atmosphere. The safest and most controllable form of carbon “drawdown”. Could be massively effective if phytoplankton would cooperate. Unfortunately, iron-fertilization has failed due to various reasons limiting factors.

OCEAN BASED CARBON CAPTURE AND REFLECTION

While future generations may uncover even more elegant methods of removing atmospheric carbon, currently there is only one method for rapidly removing atmospheric carbon that will also not be resisted for decades by government and industry, or potentially cause drastic harm to the environment. Ocean Assisted Carbon Capture & Reflection (OACC&R) was painstakingly designed by a group of senior scientists in the United States who began their work shortly after Al Gore’s first

climate movie came out. (I am no longer affiliated with this group in order to keep my message conflict free.) OACC&R works with nature and the current energy infrastructure to remove carbon from the atmosphere. OACC&R uses byproducts from carbon capture filtration at energy and other major carbon-emitting plants to nurture short-cycle EHUX algae in non-life-bearing oceans. EHUX algae consume carbon from the air and water, then die and sink harmlessly to the ocean floor. (They created, for example, the White Cliffs of Dover.)

ENHANCED SOIL CARBON DRAWDOWN

Limited in its power, this dirt-based DARE solution would need to be used as an augmentation rather than a stand-alone fix. Of course, we are going to need to do it anyway at some point. "We have lost the biological function of soils. We have got to reverse that," said Barron J. Orr, lead scientist for the UN Convention to Combat Desertification. "If we do it, we are turning the land into the big part of the solution for Climate Change."

Rene Castro Salazar, an assistant director general at the UN Food and Agriculture Organization, said that of the 2 billion hectares (almost 5 billion acres) of land around the world that has been degraded by misuse, overgrazing, deforestation and other largely human factors, 900 million hectares could be restored.

Returning that land to pasture, food crops or trees would convert enough carbon into biomass to stabilize emissions of CO_2, the biggest greenhouse gas, for 15-20 years, giving the world time to adopt carbon-neutral technologies.

"With political will and investment of about $300 billion, it is doable," Castro Salazar said. We would be "using the least-cost options we have, while waiting for the technologies in energy and transportation to mature and be fully available in the market. It will stabilize the atmospheric changes, the fight against Climate Change, for 15-20 years. We very much need that."

CREATING "CARBON SINKS"

A carbon dioxide sink such as a concentrated group of plants or any other primary producer that binds carbon dioxide into biomass, such as within forests and kelp beds, is not carbon negative, as sinks are not permanent. A carbon dioxide sink of this type moves carbon, in the form of carbon dioxide, from the atmosphere or hydrosphere to the

biosphere. This process could be undone, for example by wildfires or logging.

Carbon dioxide sinks that store carbon dioxide in the Earth's crust by injecting it into the subsurface, or in the form of insoluble carbonate salts (mineral sequestration), are considered *carbon negative*. This is because they are removing carbon from the atmosphere and sequestering it for a considerable duration (thousands to millions of years).

Plants can also be modified to do more powerful carbon processing than they otherwise would be capable of. A new plant modification called "Kernza" has roots which extend over 3 metres beneath the soil, more than twice the depth of wheat, helping to stabilize soil, retain water and improve wildlife habitat – and, most importantly, storing carbon beneath the ground. Kernza is also good at trapping carbon in its roots. Fred Iutzi, president of the Land Institute, which developed the grain, describes it as being like a pump that takes carbon out of the atmosphere and stores it in the soil. It also traps nitrogen, preventing it from reaching streams and rivers.

Climate Change means we should be getting our staple foods from perennial plants like Kernza. Carla Vernón, Vice President of General Mills' Cascadian Farm brand, agrees. "We believe in the potential of this grain to make a positive ecological impact," she says.

While not capable on their own of getting us past the 2030's climate deadline, Regenerative Agriculture such as Kernza along with dynamic Forest Protection methods (especially applied to tropical forests) and Afforestation (especially applied to bamboo forests and peatlands) can make a significant dent in our atmospheric carbon surplus.

PHOTO-CARBONATION

Dimensional Energy's technology combines advanced optics for even light distribution with optimized photocatalysts in a high throughput reactor form that optimizes the interplay between feedstocks, catalyst, and light for maximum conversion. DE has adapted this platform to convert captured CO_2 to fuel. The Carbon XPRIZE installation at the test site in Wyoming will be DE's first pilot. While scaling the HI-Light platform, Dimensional Energy has developed a lab scale reactor product for photocatalysis research for university, national, and

industrial labs worldwide. Custom design photocatalytic testbeds and partnerships are available upon inquiry.

WHAT HAPPENS TO ALL THAT CARBON?

There are a variety of straightforward methods of storing or utilizing the carbon removed from the atmosphere through D.A.R.E. technology. Extracted CO_2 can be: Converted to fuel using CE's "Air-To-Fuels" (ATF) technology to make synthetic ultra-low carbon intensity transportation fuels including gasoline, diesel, or Jet-A compatible with today's infrastructure and engines which can significantly reduce emissions from transportation. CO_2 can also be utilized in materials production of to create steel, concrete, fillers, coatings, plastics, industrial chemicals, fertilizers, and carbonates".
Humankind will need to harness carbon capture and storage technologies to help keep global warming to 2 degrees C or less. New research shows that there's plenty of room to store captured CO2 — in offshore geologic rock formations.

Carbon capture and storage (CCS) will play a vital role in helping the world cut its carbon dioxide emissions, the Intergovernmental Panel on Climate Change (IPCC) says.

Yet less than two dozen CCS projects have been initiated globally, partly because of costs, but also because of uncertainty about the viability of the technology.

As policymakers wrap up their meetings in Madrid this week to discuss the next steps to curb global warming, a new study demonstrates that there's more than enough suitable storage for captured carbon dioxide on the world's continental shelves.

The study, published in Nature Scientific Reports, also shows that it's fully possible to develop enough CO2 injection wells over a relatively short period to meet the IPCC goals of using CCS to provide 13 per cent of worldwide emissions cuts by 2050.

"The great thing about this study is that we have inverted the decarbonization challenge by working out how many wells are needed to achieve emissions cuts under the 2-degree (Celsius) scenario," said lead author Philip Ringrose, an adjunct professor at the Norwegian University of Science and Technology and a geoscientist at the Equinor Research Centre in Trondheim.

"It turns out to be only a fraction of the historical petroleum industry ? or around 12,000 wells globally. Shared among 5-7 continental CCS hubs ? that is only about 2,000 wells per region. Very doable! But we need to get cracking as soon as possible."

Pressure, Not Volume, The Deciding Factor

Ringrose and his co-author, Tip Meckel from the University of Texas Bureau of Economic Geology, first looked at continental shelves worldwide to get a sense of how much capacity there would be to store carbon dioxide.

Previous studies of how much storage would be available offshore have mainly looked at estimated volumes in different rock formations on the continental shelf. The authors argue, however, that the ability of the rock formation to handle pressure is more important in figuring out where CO2 can be safely stored.

That's because injecting CO_2 into a rock formation will increase the pressure in the formation. If the pressures exceed what the formation can safely handle, it could develop cracks that would require early closure of projects.

A Classification System and History

Given that assumption, the researchers developed a way to classify different storage formations according to their ability to store CO2. Under this approach, Class A formations are those without significant pressure limits, and thus the easiest to use, while Class B formations are those where CO2 can be injected into the system up to a certain limit, and Class C formations are those where pressures will have to be actively managed to allow the CO2 to be injected.

"We argue that this transition from early use of CO2 injection into aquifers without significant pressure limits (Class A), through to CO2 storage in pressure-limited aquifers (Class B) and eventually to pressure management at the basin scale (Class C), represents a global technology development strategy for storage which is analogous to the historic oil and gas production strategy," the researchers wrote.

Essentially, the authors say, as experience with injecting CO2 into offshore formations grows, the ability to use the Class B and C areas will improve, much as geologists and petroleum engineers have gotten

better over the decades at extracting hydrocarbons from more and more challenging offshore formations.

Can We Drill Fast Enough?

It's one thing to have enough space to store CO2 — you also have to inject it into the storage formations fast enough to meet the IPCC estimates of 6 to 7 gigatons of carbon dioxide a year by 2050. By comparison, "Four existing large-scale projects inject 4 million tons CO2 per year. If all 19 large-scale CCS facilities in operation together with a further 4 under construction are considered, they will have an installed capture capacity of 36 million tons per year," the researchers wrote. This is clearly not enough, since a gigaton is 1,000 million tons.

Nevertheless, the history of the oil and gas industry suggests that ramping up the technology and infrastructure required to reach the IPCC target by 2050 is very doable, the researchers wrote. Assuming an average injection rate per well, they calculated that more than 10000 CO2 wells would need to be operating worldwide by 2050. While this may seem like an enormous number, it's equivalent to what has been developed in the Gulf of Mexico over the last 70 years, or five times what has been developed by Norwegians in the North Sea.

"Using this analysis, it is clear that the required well rate for realizing global CCS in the 2020–2050 timeframe is a manageable fraction of the historical well rate deployed from historic petroleum exploitation activities," the researchers wrote. "With this paper, we provide an actionable, detailed pathway for CCS to meet the goals," Ringrose's co-author Meckel said. "This is a really big hammer that we can deploy right now to put a dent in our emissions profile."

The study was funded by NTNU and the University of Texas Bureau of Economic Geology's Gulf Coast Carbon Center, with some support from Equinor.

Collected carbon can also be sequestered (meaning put somewhere where it will not be re-released or cause ecosystem damage) using gear like Norway's Statoilhydro-Sleipner natural gas offshore CO_2 sequestration platform. The Norwegian North Sea Sleipner West sea floor porous rock layer is estimated to potentially hold 600 Gigatons of CO_2.

Carbon can also be resold for industrial use in drink carbonation; fresh meat/veg packing anti-bacterial/oxidation agent; greenhouse

fertilization. Alternatively, CO_2 can be broken down chemically, using solar powered electrolysis/solar thermal/visible light, into O (for Oxygen tank) & CO (as main ingredient of green fuel Methanol).

Representatives of Reykjavik Energy and a team of scientists from a large number of universities, including the University of Southampton in the U.K. and the Lamont-Doherty Earth Observatory at Columbia University led by researcher Klaus Lackner, recently demonstrated a process for injecting carbon dioxide into basalt rock. The carbon dioxide is mineralized, or turned into rock, very rapidly. In two years, they report, over 95 percent of injected carbon dioxide had become mineral.

Carbon Upcycling Technologies (CUT) uses an IP-protected process to react waste CO_2 with solid feedstock (e.g. graphite, petcoke, fly ash) and create stable, solid nanoparticles. The resulting nanoparticles can then be added to a wide variety of materials in order to make the materials stronger or more efficient. To date, CUT has successfully completed over 12 different technical validations of its products' performance. The nanoparticles show beneficial functional performance in: concrete, plastics, ceramic & epoxy coatings, adhesives, 3D printing filaments, pharmaceutical drug delivery, lubrication, energy storage, and solar cell applications. Plus, the CO_2 captured in CUT's process is stable up to at least 180 degrees Celsius, almost two times the boiling point of water.

Carbon Upcycling Technologies converts waste CO_2 emissions from a liability to an asset. Since starting in 2014 as one of the 24 finalists out of 340 in the CCEMC Grand Challenge, CUT has scaled production of its nanoparticles from 0.5 grams per week to over 500 kg per week, and successfully begun generating commercial revenue with the sale of the AC-100 concrete coating in three US states. With the latest milestone, CUT became the youngest carbon utilization company to generate revenue, after only 2.5 years of operations, and the nanoparticles have an enormous potential to scale in applications spanning much wider than corrosion protection.

The Carbon Upcycling team brings together UCLA researchers and experienced industry professionals in the energy and environment sectors. Gaurav Sant leads the team's efforts towards the industrial realization of the CO_2NCRETE™ solution, a process for CO_2 utilization by manufacturing a low-carbon concrete-equivalent material. Ed Mueller, J.R. DeShazo, Jim McDermott, and Stephen Raab provide their expertise in commercialization, economic analysis,

strategy, and business development. Bu Wang, Gabriel Falzone, and Iman Mehdipour lead development of the CO_2NCRETE™ technology, including aspects of CO_2 processing and material/product performance.

UCLA's breakthrough technology enables the unprecedented, large-scale, beneficial use of CO_2 secured from flue-gas that is emitted by coal- and natural gas- power plants, and cement plants. This CO_2 is embedded in a building material, "CO_2NCRETE™." Lego®-like building components formed of CO_2NCRETE™ offer higher structural efficiency and flexibility in construction and accelerate onsite assembly; thereby lowering project periods and labor costs. CO_2NCRETE™ has a CO_2 footprint that is approximately 50% lower than that of traditional concrete; an industry responsible for nearly 9% of CO_2 emissions globally.

Carbon Upcycling's CO_2NCRETE™ manufacturing process captures flue gas-borne CO_2 and utilizes it to fabricate a low-CO_2 replacement for traditional cement concrete. The central technology involves a novel carbonation process (patent pending) that captures CO_2 from flue gas mixtures and embeds it via mineralization into limestone; a well-known natural cementation agent. The CO_2NCRETE™ solution may be used to manufacture a wide array of components that can be readily substituted into conventional construction practice. Simultaneously, the CO_2NCRETE™ production process provides a future-proof construction material solution, owing to its adaptability to user needs. The CO_2NCRETE™ solution is designed to be scalable and easily integrated into industrial cycles that provide a ready source of CO_2, e.g., natural gas or coal-fired power plants – without any pre-treatment, or post-treatment. CO_2NCRETE™'s production is environmentally friendly, as it produces no harmful byproducts, and minimizes waste production and water usage. With a sustainable, low CO_2 footprint process that enables unprecedented design flexibility and automation, Carbon Upcycling's CO_2NCRETE™ will transform construction, a traditionally low-tech sector, into an industry of the digital age – while providing a platform for global, gigaton-scale CO_2 utilization.

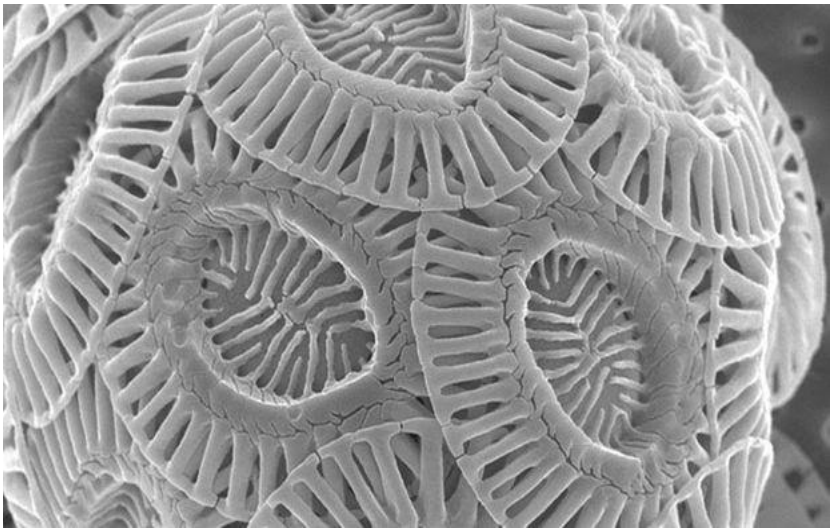
What if we could use the world's greenhouse gas as a resource to make sustainable materials? Founded in 2003, Newlight Technologies has developed a carbon capture technology that converts greenhouse gas into a bioplastic material called AirCarbon. AirCarbon is made by pulling carbon out of greenhouse gas and using that carbon to build sustainable materials that replace oil-based plastics. At Newlight, we

believe that the best way to reduce the amount of carbon in the air is to capture carbon and use that carbon as a resource to create high-value products. Newlight has also developed a system of carbon disposal that provides the electrocatalytic conversion of CO_2 into value added fuels and feedstocks using novel, high efficiency catalysts. Advances in catalyst design and performance have been achieved both for the anodic oxygen evolution reaction (OER) and the cathodic CO_2 reduction reaction (CO2RR) using nanostructured materials. A water splitting anode catalyst is made from cheap and common abundant earth metals in an easy scalable synthetic way. CO2 conversion catalyst is based on nanostructured metals synthesized using advanced materials processing techniques. Newlight brings this together in a compact and scalable system which utilizes flow cell technology modified from state-of-the-art fuel cells.

Carbon removal and disposal are now not only technologically possible, but in many cases ready to be scaled up as part of the DARE side of Emergency Climate Repair. What this technology needs most is people like you and me *talking about it and demanding its implementation NOW while we still have time to turn Climate Change around.*

CONCLUSION AND A TIMELY CAUTION

We are just starting to see strong interest in Climate Engineering, admittedly far to late in the Climate Emergency curve. All sorts of ideas and innovations are being generated, but the time for that was 20 years ago. We need to be scaling up and bringing systems online before 2025 – only a few years from this writing. *Direct Air Capture with Regional Polar Peroxide Misting* and *Ocean Assisted Carbon Capture & Reflection* are technologies that are powerful, safe, and for the most part ready for beta-testing and deployment. Given the major sociopolitical and organizational difficulties of affecting that deployment it is the recommendation of Climate Deadline that existing technologies be used and new research be relegated to university or philanthropic settings.



Emiliania huxleyi - single-celled marine phytoplankton that produce calcium carbonate scales (coccoliths). A scanning electron micrograph of a single coccolithophore cell. (Alison R. Taylor (Univ. of North Carolina Wilmington Microscopy Facility)

CHAPTER SIX: OCEAN ASSISTED CARBON CAPTURE & REFLECTION (ACC&R) - A D.A.R.E. THAT'S HARD TO RESIST

Climate change is real and it is happening right now. It is the most urgent threat facing our entire species, and we need to work together and stop procrastinating.

– Leonardo DiCaprio, 2016 Oscar Acceptance Speech

Chapter Summary: ACC&R may be the optimal choice for Emergency Climate Repair. The method has the potential to draw atmospheric CO_2 down at the rate of 10 GtC/yr and, at the same time, create enough solar reflectance to rapidly cool the planet. Also, unlike other DARE technologies, ACC&R simply augments a harmless natural process already occurring in our oceans. If begun soon, scientists estimate ACC&R could restore 350 ppm atmospheric carbon by 2050 and 280 ppm by 2075.

An ocean organism too small to be seen by the human eye could hold the key to fighting Climate Change, just by doing what it has always done. If you have ever had a biology class, you may have seen a picture in your textbook of Emiliania huxleyi, or EHUX for short - one of thousands of different species of phytoplankton. Phytoplankton are ubiquitous in all the world's oceans, and form the basis of virtually all marine food webs.

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! *The total phytoplankton biomass outweighs that of all marine animals put together*.

Massive Emiliania huxleyi blooms regularly turn ocean water in different parts of the world light blue, white. Their blooms are so bright and massive they can easily be seen from space. This is astounding when you realize that it was a mystery to us for some time, what exactly was happening when these enormous blooms turned sea water a light color. They were known as "white tides," but nobody knew that the "white" was coming from microscopic single-celled "plant-like" organisms, until the 19th century scientist Thomas Huxley noticed some pale round smudges in seafloor mud under a microscope. Like plants, they consume carbon dioxide. They produce a great deal of oxygen, about half the world's supply. They photosynthesize.

NASA photograph of an EHUX bloom In the Atlantic Ocean. OACC&R Farmed blooms will be located in lifeless ocean far from land.

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 coccolithophores, 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.*

The White Cliffs of Dover, England

EHUX is the centerpiece of the *Algae Assisted Carbon Capture* (AACC) repair plan which will hopefully soon be put into action. AACC is currently an "orphan technology" that was originally developed by Dr. Robert Fry a chemical engineer and colleagues. AACC depends on the natural function of algae doing what they already do now. Theoretically, project engineers can guide them very quickly through their natural cycle to produce trillions of coccoliths, then die (sorry SPCA) and sink to the deep ocean bottom (creating ocean sediment that will contain the carbon component of global warming pollution for centuries if not longer).

The ocean's functions are integral to the ecology of planet Earth and especially the movement of heat form 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. Ocean Assisted Carbon Capture takes advantage of this natural biological action.

WOcean fertilization has been the great hope of marine biologists for many years. There have been at least 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. If we can overcome them, we can use EHUX to achieve global atmospheric CO_2 drawdown on a scale large enough to restore pre-industrial temperatures and carbon levels.

The first limiting factor, ocean viral infections, either inhibit large algae blooms or prevent them from drawing down large amounts of CO_2. 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 CO_2. 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 CO_2, bacteria induce decomposition while the dead bloom floats. This causes most of the CO_2 to be released into the atmosphere again, before the dead algae become water-logged and can sink to export the captured CO_2 to the sea floor.

To overcome these limiting factors, the 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*.

EHUX algae will bloom on either phosphate nutrient or nitrogen-based nutrient. Phosphate should not be used because other slow sinking, semi-buoyant algae compete too well for phosphate. Since EHUX is the only algae that is heavier-than-water (post mortem), it's important to use purified EHUX starter seed and *ammonium nitrate nutrient*. Other algae could take weeks or months to sink after death, increasing its exposure to surface bacteria, which would cause decomposition and surface release most of the CO_2 captured during live blooming.

The nitrates will not be a pollution problem, because only metered doses of the nutrient, ammonium hydroxide (NH_4OH), 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."

Typical Deep-Water SPAR Platform

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 AACC process: (1) Liquid CO_2 -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 carbon per year (GtC/yr) of atmospheric CO_2 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 draw atmospheric CO_2 down to pre-industrial levels by 2100.

After the EHUX algae consume carbon from the atmosphere, they complete their life cycle and sink rapidly into the ocean depths. The carbon the EHUX capture will remain safely sequestered for thousands of years along with millennia of sand, silt and rock.

One of the most amazing parts of Ocean 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. Second, they will need to invest in *Carbon Capture technology*. This recently developed technology captures approximately 90 percent of CO_2 exhaust emissions while making electricity. The capture form is Super-critical Fluid CO_2 (SCF-CO_2) using a process similar to that developed by companies like Inventys, Inc. for capturing post-combustion CO_2 from industrial flue gas streams. *Instead of burying or otherwise dumping this CO_2, it will be shipped to be used as liquid CO_2 feedstock for the EHUX* in the sealed floating bioreactors. By the end of the AACC process the previously harmful fossil fuel products actually have a 1400 percent NEGATIVE carbon footprint. For That's a 14-fold capture amplification factor. For every 1 ton of CO_2 produced and captured at a CCS plant, there will be 14 more tons of atmospheric CO_2 captured at sea!

Next, methane (natural gas) will be used to spur very rapid algae 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 (N_2) to make anhydrous ammonia (NH_3). When anhydrous ammonia (NH_3) mixes with seawater (NH_3 + H_2O), it becomes ammonium hydroxide (NH_4OH). Fortunately, EHUX prefer a diet of ammonium nitrate (NH_4NO_3) with anhydrous ammonia, and NH_4OH (ammonium hydroxide), is *environmentally friendly*. The nutrient for the secondary open-ocean blooming will be a pH buffered mixture of 90 percent ammonium chloride (NH_4Cl) + 10 percent NH_4OH, *which exhibits ideal ocean pH 8.25*. Additionally, NH_4OH 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 CO_2 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.

CARBON CAPTURE AND SOLAR RADIATION MANAGEMENT IN ONE NATURE-APPROVED PACKAGE!

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 CO_2 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 depths 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 **Algae Assisted**

CARBON CAPTURE + REFLECTANCE = ACC&R

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.

Like any major new endeavor there will necessarily be cooperation between a variety of Repair 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 to 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.

AS ALWAYS THERE ARE CHALLENGES

The reflectance properties of DARE 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 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 DARE 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 DARE 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 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 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.

Also, the naked EHUX remain at the surface (post-shedding) because they're no longer heavier-than-water once they shed coccoliths. The naked EHUX contains about 50% of the captured carbon, but that half is organic carbon, which is subject to release (back to atmosphere - as CO_2) once surface bacterially induced decomposition sets in - which is inevitable, given the buoyancy which keeps the naked, dead EHUX floating at the surface for a long time. Also, 0.63 CO_2 are released for every coccolith CaCO3 produced in coastal waters. That's in addition to CO_2 released in decomposition after the coccoliths are shed and the now-naked (buoyant) EHUX die and their organic carbon decomposes (to CO_2). This means a large amount of organic carbon might be converted back to CO_2 and released back to atmosphere if surface decomposition is allowed to happen. So that would make a 50% capture-loss and it will therefore be necessary to engineer a way for the EHUX to sink rapidly with their coccolith shells intact. The situation is somewhat different in pelagic waters, such as the open seas. In that case, measurements have shown 0.37 CO_2 being released for each $CaCO_3$ formed. Once again, that release is in addition to large amounts of CO_2 released on surface decomposition of organic carbon from dead, naked, buoyant EHUX.

Challenges indeed, but likely surmountable by climate engineers.

Part of the nurturing of the EHUX will need to include saturation of the seawater with calcium ions to prevent coccolith dissolution high in the water column - long before reaching the seafloor. The seafloor carbonates found above hyoscine don't necessarily represent the fate that MOST coccoliths experience. Most shed coccoliths would begin sinking after they are shed, but they would tend to dissolve fairly high in pelagic water columns and never reach the seafloor (regardless of its depth).

Regardless of the challenges, with people already dying from climate disruption, species being extinguished and our entire civilization at risk, it is worth our effort to overcome the aforementioned difficulties if OACC&R is the correct choice for carbon removal. Certainly OACC&R is the most elegant and sophisticated DARE methodology.

If deployed correctly and soon OACC&R can: Impart Atmospheric CO_2-sinking ability to inland CCS fossil energy, draw down 750 GtC atmospheric CO_2 by 2100, restore 280 ppm CO_2 by the mid-2030's (and 280 ppm by 2075), return ocean pH to 8.2, restoring preindustrial temperature by 2030's, all while making a tidy profit – not to mention spinoff technologies.

When the United Nations Environmental Assembly meets in Nairobi in March 2020 let's hope OACC&R will be first on their list of discussions.

CHAPTER SEVEN: SOLAR RADIATION MANAGEMENT (SRM)

"You cannot escape the responsibility of tomorrow by evading it today." *– Abraham Lincoln*

Chapter Summary: Solar Radiation Management (SRM) can, and probably will, be needed to bring rapid reduction in planetary temperatures. By itself this technology will not have a significant effect on greenhouse gas concentrations in the atmosphere. This, like Prozac for the planet it will only mask the symptoms – not cure the problem. For that we need Direct Atmospheric Removal of Excess-Carbon as outlined in the previous chapter. However, SRM will have the most rapid effect on reducing global warming and will probably be necessary as an adjunct to DARE.

As mentioned in the previous two chapters, augmented planetary cooling and atmospheric carbon removal are our primary tools for Climate Repair to address global temperature rise. It may be that we need to first adopt an approach for planetary cooling via Solar

Radiation Management and then focus on carbon capture secondarily. Newer research is suggesting that *even a mid-2030's climate deadline may itself be too optimistic* and we may have less time than though as feedback loops accelerate. Solar Radiation Management (SRM) is the most expedient and best-known of the Climate-Engineering prospects.

Let's take a look at some of the existing options for planetary cooling. Just please keep in mind that SRM without DARE would just be covering up the problem and DARE without Sustainability would be like cleaning up a child's mess without setting any rules so it would not happen again.

Also, take note that the greatest caveat concerning any significant deployment of SRM is what researchers call the "*termination problem*." Simply put, once you stop SRM, the climate returns sharply to the temperature that the SRM has been hiding. Unmask the sun, and the world bakes. In a world where CO_2 has not been reduced, unmasking the sun will bring on an extremely rapid rise in heating. An SRM world with a lot more CO_2 is thus a very bad idea.

OCEAN ASSISTED CARBON CAPTURE & REFLECTION WITH, OR WITHOUT DIMETHYLSULFIDE CLOUD SEEDING

One of the helpful spinoffs of OACC&R as discussed in the last chapter would be *cloud seeding by dimethylsulfide*, or DMS. Dimethylsulfide is released naturally by EHUX blooms as they die and could be leveraged to increase the potency of Ocean Assisted Carbon Capture. The result would be additional reflection of solar radiation from extra ocean cloud cover that would be seeded. Luckily, by implementing OACC&R, we automatically receive the benefit of solar reflection, without incurring the risk involved in Emergency Climate Repair plans which propose injecting stratospheric sulfuric acid aerosols in our atmospheric envelope.

Remember the mysterious hole in the ozone layer that kept opening up during the summer? Opening in the summer, the O-Hole passes a lot of solar ultraviolet radiation to the troposphere below. That is where the DMS droplets will do their work. Since the droplets have sublimed to produce H_2O_2 gas, the misting process will end up irradiating the H_2O_2 gas with intense solar UV. This in turn will "photo-dissociate" the H_2O_2 molecule into a pair of electrically neutral OH radicals. Interestingly, these molecules are also the second most powerful

oxidant on known. The net effect will be to oxidize atmospheric methane (CH4) to carbon dioxide (CO_2). An excellent side-benefit!

STRATOSPHERIC SULFURIC ACID AEROSOL INJECTION (SSAAI)

Another form of atmospheric misting, SSAAI would utilize stratospheric sulfuric acid aerosol injection (or an alumina aerosol variation) to scatter more sunlight back into outer space. One of the best-known proposals is spearheaded by David Keith and his collaborator James Anderson, both of Harvard University. According to Keith's calculations, if operations were begun in 2020, it would take 25,000 metric tons of sulfuric acid to cut global warming in half after one year. Once underway, the injection of sulfuric acid would proceed continuously.

While this represents a relatively straight-forward and inexpensive atmospheric repair which could be very fast-acting, more research is needed to determine whether injecting sulfur into the stratosphere would have dangerous consequences. Some such consequences might include disrupting precipitation patterns or further eating away the ozone layer that protects us from damaging ultraviolet radiation. While sulfates would likely offset warming, it's not clear exactly how they would counteract some of the other effects of greenhouse gases, particularly changes in precipitation patterns. Finally, when sulfur injection ends, the underlying Climate Change it was masking would return – requiring ever increasing expense. Hopefully, however, by then the rate of change affecting ecosystems and humans would have been slowed and managed.

REGIONAL POLAR PEROXIDE MISTING (RPPM)

I used to live in Sedona, Arizona a town famous for crystal mysticism and UFO theorists. When you move there, you have to give yourself a "Sedona Name" like Dusty Moon-Twinkles. (No, I'm not tell my Sedona Name.) A favorite discussion around town was what the Government was putting in the contrails left by jet airplane engines. At last, if we end up giving Regional Polar Peroxide Misting a try, I can confirm that the Government is planning to put something in those contrails!

Regional deploying of aerosols was originally proposed by physicist Gregory Benford. This could restore summer sea ice, cooling the region and reflecting more sunlight. He and others say we need limited

trials to test particle size, verify the best altitude for dispersal, examine what happens when the particles reach the ground, and understand the effects on temperature at different locations. Benford calls the Arctic "our first focus" and says Climate-Engineering should "attack . . . incoming sunlight now, carbon dioxide later."

Regional Polar Peroxide Misting (RPPM), appears to be one of the most easily controlled strategy for achieving global cooling. In the plan, NASA engineers (not Aliens) will regionally crisscross the skies with "contrails" of hydrogen peroxide (H2O2 - tiny droplets of 60 percent hydrogen peroxide solution mist in the upper troposphere (but not in the stratosphere) - specifically over the ice sheets most heavily affected by Climate Change and which are at greatest risk of collapsing into the sea. The locations most likely for misting would be all of the Greenland Ice Sheet (GIS), the critical West Antarctic Ice Sheet (WAIS), and portions of the Eastern Antarctic Ice Sheet (EAIS). The hydrogen peroxide mist would be dispersed from aircraft only in the polar summer, so misting would be limited in both amount of time and location. Once in the atmosphere the H2O2 mists would flash-freeze, producing tiny ice crystals. The crystals would be small enough to hang in the air without descending appreciably, until the crystals dissipate, yielding water vapor and H2O2 gas, for several hours. The crystals would reflect a significant amount of light, reducing the light and the heat reaching the ice sheets below.

RPPM is extraordinarily safe. The H2O2 is guaranteed to remain airborne because the mist will contain very small droplets. It's guaranteed to freeze into tiny ice crystals at high altitude. The crystals are guaranteed to sublime, and there's no danger of harm from OH because it's already completely natural (we're just making a bit more of it, but it's guaranteed to react within less than one second, so there isn't time for it to descend to ground level (or even bird-flying level). It'll simply oxidize CH4 to CO_2.

So far there is no other proposal out there for trying to stop WAIS from sliding into the sea. It can't hurt anything, and it could possibly work. Given the disruption that a permanent 10-foot sea rise would cause - in addition to the initial splash-wave tsunami (Very possibly a wave more than 100-foot-high traveling from pole to pole.) We are certain that the resulting permanent sea rise would be about 10 feet, and that would put about 1/3 of Florida under water. Miami, West Palm Beach, Sarasota, Tampa, and Pensacola might be submerged permanently, depending on their altitude above sea level. This will probably ehappen sometime between 2040 to 2070.

As chemical engineer and primary creator of OACC&R Dr. Robert Fry describes it for those of you scientifically-inclined; "OH (Hydroxide) is a diatomic anion with chemical formula OH^-. It consists of an oxygen and hydrogen atom held together by a covalent bond and carries a negative electric charge. It rapidly, within less than one second, reacts with atmospheric methane resulting in a chain of chemical events where CH4 is oxidized to form CO_2. The important thing is that CO_2 is at least 24 times less potent (over 100 years) as a greenhouse gas than CH4. It is 84 times less potent if you consider the short term. This would reduce regional polar warming by about 9 percent just by misting H2O2 solution droplets. We could never afford RPPM globally, but we can likely afford it to do it regionally (just over specific glacial areas that are currently threatened - the West Antarctic Ice Sheet (WAIS), the East Antarctic Ice Sheet (EAIS), and parts of Greenland. The premise is that the RPPM supercooling effect ($\Delta T < 0^oC$), when combined with the OASR global cooling impact ($\Delta T = 0^oC$), would accelerate polar ice sheet stabilization and possibly prevent the most vulnerable sheets from mechanically collapsing into the sea."

Thus, while NASA scientists are tending to give up WAIS ice as a lost cause (leading to a certain 10-foot permanent sea rise during this century) if a combination of DARE and SRM are able to restore atmospheric temperatures as fast and as far the data shows (back to pre-industrial levels) it may yet be possible to rescue the WAIS ice sheets. We would need to first lower the global temperature with OACC&R by the 2030s and simultaneously add the impact of RPPM regionally over ice sheet targets during the polar summer only and do that all summer long and continue doing this every summer for 20 to 40 years. The summer warming damage may slow, and the ice would then begin to freeze more during winter - gradually freezing the separate moving segments back into a single solid mass, which would gradually come to a halt and stop sliding toward the sea.

STRATEGICALLY DELAYED TROPOSHERIC REDUCTION OF AEROSOL POLLUTION (SDTRAP)

We need coal power plant pollution! I know, I know but let me explain. Many researchers have called for the reduction of tropospheric aerosol pollution (referred to as TRAP). Ultimately this will be necessary as part of getting our sustainability act together, but in the near future, it could (and already is) getting us into a half-ton of trouble! With our atmosphere being as damaged as it is aerosol

pollution (like that from coal fired plants) actually scatters light and contributes to planetary cooling. If we close all the coal-powered plants now the aerosol pollution will dissipate rather quickly (unlike other greenhouse gasses) and we'd lose its cooling impact. The planet would heat up even more quickly than it already is! In a sense this type of pollution is acting like duct tape holding together our atmosphere until we can perform a permanent fix.

So, leave the coal plants alone for while! First, we must remove carbon pollution. Aerosol cooling is currently offsetting CO_2 warming by a considerable degree. We're currently cooler than we would otherwise be our current level of 405 ppm CO_2, because the sulfate aerosol pollution from coal burning is scattering a significant fraction of incident sunlight back into outer space. Contrary to claims from the natural gas industry, fuel switching would actually warm the planet for the first 25 years, despite coal CO_2 emissions being 50 percent greater than natural gas CO_2 emissions. Only when CO_2 is down to 350 ppm or below do we dare clear the air of sulfate aerosol.

Fortunately, we can extract the carbon emissions from those plants to use as feedstock for the hungry EHUX algae! So, push for carbon capture technology NOT coal plant closures! Once the excess CO_2 is gone, then we can start dialing back the sulfate aerosol pollution. This sounds counterintuitive, but it is in fact, true.

SPACE SHADES

One proposal involves trillions of disks launched into space to reflect incoming sunlight. Pros: Space-based systems don't pollute the atmosphere. Once in place, they would cool the earth quickly. Cons: The technology could take decades to develop, launching trillions of disks into space is fantastically expensive, the disks might cause unsurvivable damage to our planetary ecosystem, and be difficult to shut down if something went wrong.

LAGRANGE (L1) SPACE SHIELD

A large umbrella-like artificial shield to cast a shadow over the earth. The shield would be positioned to take advantage of a "Lagrange points" – a position in an orbital configuration of two large bodies where a small object affected only by gravity can maintain a stable position relative to the two large bodies.

CLOUD BRIGHTENING

In this iteration of Solar Radiation Management tiny droplets made by spraying an extremely fine mist of seawater into low-lying clouds could make them reflect more sunlight than ordinary clouds. Pros: Shading could be targeted—to stop the melting of Arctic Sea ice, for example. Cons: Scientists don't know how it would affect precipitation and temperatures over land, where it would matter most.

THE CHOICE IS NOW

Throughout Climate Deadline 2035 I have been attempting to convey a sense of urgency. The short timeline we are dealing with is hard for many people to grasp or accept. It has only been during the past few years that people have been waking up to the massive problem of Climate Change and (like a driver waking up in the middle of a car accident in progress) it is an additional shock to find we have not only grasp the enormity of the situation but also the advanced speed at which it is unfolding.

So, one thing this means is we do not have time to take a "wait and see" approach. We do not have time to wait for additional, perhaps more "elegant", strategies for carbon removal and planet cooling to emerge. We must choose from what is available now and bring the projects chosen out onto the world stage as rapidly as possible. The scale of whatever project(s) are chosen will be massive – larger even than the Allied mobilization to meet and defeat the Nazi threat in World War II. But, as with that endeavor, it is both necessary and ultimately in the best interest of everyone. Rewards such as greater citizen involvement, improved forms of democracy, met energy needs, reduced border conflicts, and whole new profit sectors may also come in time. At least, in this war, if we are successful no one dies!

CHAPTER EIGHT: RENEWABLES, MITIGATION AND SUSTAINABILITY –

"By 2030, demand for food may increase by 35%, for water by 40%, and for energy by 50%. Innovative solutions that meet this increased demand while conserving critical natural ecosystems are a necessity…"

- Achim Steiner, UN Development Program (UNDP)

Chapter Summary: While none of the activities leading to sustainability will get us past the mid-2030's crisis point, it is still important to begin shifting in the direction of renewable energy and sustainable lifeways. Currently, we need to put 10% of our money and time on Sustainability and 90% on DARE and SRM to get us "over the climate hump". Then, we can finish proving we know how to create a sustainable global society.

In early 2017 Sausalito businessman Paul Hawken edited a book called "Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming". Purporting to provide a recipe book of dozens of solutions to Climate Change Drawdown became a New York Times bestseller. One review said, "Reading it is an effective inoculation against the widespread perception of doom that humanity cannot and will not solve the climate crisis."

While virtually none of the strategies presented in Drawdown would actually "drawdown" carbon pollution or get us past the tipping levels in the mid-2030's the book is a useful compendium of Sustainability and Mitigation strategies. There is no reason to re-write what has already been written so this chapter will be brief.

A special report issued this in Fall 2019 by the Intergovernmental Panel on Climate Change (IPCC) considers the impacts of 1.5 °C global warming above preindustrial levels, in contrast to 2 °C, and how this lower warming target can be achieved. The report was written by hundreds of scientists hailing from 40 different countries and based on research from thousands of scientific studies.

Despite significant progress in recent years, the world is falling short of meeting the global energy targets set in the United Nations Sustainable Development Goals (SDG) for 2030. Ensuring affordable, reliable, sustainable and modern energy for all by 2030 remains possible but will require more sustained efforts, particularly to reach some of the world's poorest populations and to improve energy sustainability, according to a new report produced by the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the United Nations Statistics Division (UNSD), the World Bank and the World Health Organization (WHO).

Notable progress has been made on energy access in recent years, with the number of people living without electricity dropping to roughly 840 million from 1 billion in 2016 and 1.2 billion in 2010. India, Bangladesh, Kenya and Myanmar are among countries that made the most progress since 2010. However, without more sustained and stepped-up actions, 650 million people will still be left without access to electricity in 2030. Nine out of 10 of them will be living in sub-Saharan Africa.

We are making changes in our future. Every hour, the Earth receives enough solar energy to power the entire planet for one year. With new innovations in battery technology, solar energy will soon be catching up to wind. Since the year 2000, the United States has increased its solar capacity from 0 to 36,000 megawatts. New capacity in fossil fuel energy systems has decreased almost 25 percent since 2010, while renewable energy has increased by nearly 50 percent! Electric vehicles are just emerging into the marketplace and will make a substantial difference. More companies are purchasing their energy from renewable sources. Additionally, solutions to the climate crisis include changing our agricultural and land use practices and looking for more

sustainable ways of living. Efforts like reforestation and wetland restoration are a part of the solution. In addition, the poorest countries of the world need adequate healthcare and nutrition.

We *have* been making substantial progress on the sustainability side of the solution. Renewable energy accounted for around 90 percent of all new electricity generation in 2015. In 2016, $58.6 billion was invested in clean energy in the United States alone. In 2000, we projected worldwide wind energy capacity to reach 30 gigawatts (GW) by 2010. By 2016, that goal was exceeded by a factor of 16. The United States now has 75 GW of wind power installed, enough to power 20 million homes. Countries such as Scotland and Portugal have operated for days on end with renewable energy. Globally, wind could supply worldwide electricity consumption 40 times over. But all that is meant to power a future that will not arrive unless we remove carbon that is already in the atmosphere and do it by the mid-2030's.

Tracking SDG7: The Energy Progress Report also shows that great efforts have been made to deploy renewable energy technology for electricity generation and to improve energy efficiency across the world. Nonetheless, access to clean cooking solutions and the use of renewable energy in heat generation and transport are still lagging far behind the goals. Maintaining and extending the pace of progress in all regions and sectors will require stronger political commitment, long-term energy planning, increased private financing and adequate policy and fiscal incentives to spur faster deployment of new technologies.

The report tracks global, regional and country progress on the three targets of SDG7: access to energy and clean cooking, renewable energy and energy efficiency. It identifies priorities for action and best practices that have proven successful in helping policymakers and development partners understand what is needed to overcome challenges.

Here are the key highlights for each target. Findings are based on official national-level data and measure global progress through 2017.

Access to electricity: Following a decade of steady progress, the global electrification rate reached 89 percent and 153 million people gained access to electricity each year. However, the biggest challenge remains in the most remote areas globally and in sub-Saharan Africa where 573 million people still live in the dark. To connect the poorest and hardest to reach households, off-grid solutions, including solar lighting, solar home systems, and increasingly mini grids, will be crucial. Globally,

at least 34 million people in 2017 gained access to basic electricity services through off-grid technologies. The report also reinforces the importance of reliability and affordability for sustainable energy access.

Clean cooking: Almost three billion people remain without access to clean cooking in 2017, residing mainly in Asia and Sub-Saharan Africa. This lack of clean cooking access continues to pose serious health and socioeconomic concerns. Under current and planned policies, the number of people without access would be 2.2 billion in 2030, with significant impact on health, environment, and gender equality.

Renewables: Accounting for 17.5% of global total energy consumption in 2016 versus 16.6% in 2010, renewables have been increasing rapidly in electricity generation but have made less headway into energy consumption for heat and transport. A substantial further increase of renewable energy is needed for energy systems to become affordable, reliable and sustainable, focusing on modern uses. As renewables become mainstream, policies need to cover the integration of renewables into the broader energy system and take into account the socio-economic impacts affecting the sustainability and pace of the transition.

Energy efficiency improvements have been more sustained in recent years, thanks to concerted policy efforts in large economies. However, the global rate of primary energy intensity improvement still lags behind, and estimates suggest there has been a significant slowdown in 2017 and 2018.

Strengthening mandatory energy efficiency policies, providing targeted fiscal or financial incentives, leveraging market-based mechanisms, and providing high-quality information about energy efficiency will be central to meet world goals…...*IF* we can clear the 2030's Climate Deadline!

PART VI: STUCK IN THE DOORWAY AND THE HOUSE IS ON FIRE

"Climate change is not the concern of just one or two nations. It is an issue that affects the whole of humanity and every living being on this earth."

- The Dalai Lama

Beijing Elementary School Students taking a test in heavy atmospheric pollution

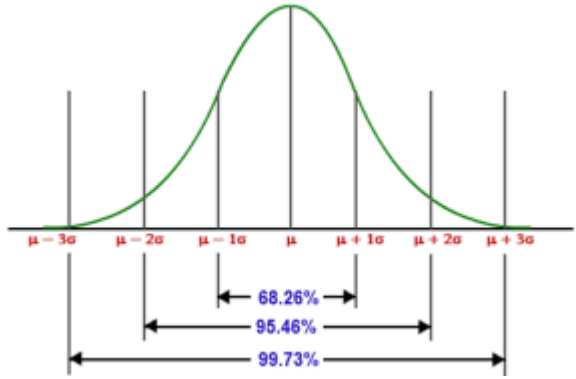
CHAPTER NINE: DOING THE RIGHT THING IS ELEMENTARY

"By 2030, demand for food may increase by 35%, for water by 40%, and for energy by 50%. Innovative solutions that meet this increased demand while conserving critical natural ecosystems are a necessity…" - Achim Steiner, UN Development Program (UNDP)

Chapter Summary: It would seem obvious that, as with our recent World Wars, almost everyone should see the Climate Change threat and take some sort of action. Not so, and we need to quickly figure out *why a critical mass of citizens are not taking action toward Climate Repair*. Major problems are likely: the threat is not focused; it has crept up on us (like frogs in hot water); our culture has been bred for passivity (so that watching it on video feels like we are doing something); we are trust-immune after being lied to often by leadership; it is difficult to focus when we are so stressed by a tightening economy and massive sales and social demands powered by electronic devices, and even if it weren't for all this there is no obvious action to take!! *Joining together in groups* is a powerful tool for helping us overcome these obstacles.

When my son was in elementary school the school Principal had a sign outside the main office which read simply: "Do the Right Thing Because It's the Right Thing to Do." The concept, stemming from a reliance on intrinsic universal values we all had in our DNA, was wonderful – build your own character and rely on it. Don't wait for rewards or other externalities.

The problem here is the Principal had forgotten his statistics – specifically that pesky bell-shaped curve we all loved so much in Research Methods 101.



True, a percentage of us are driven by internal values, but there is an *equal* segment of the population who feel it's only a sin if you get caught! *And* most everyone else is somewhere in the middle. People just don't self-motivate the way we wish they would all the time. Sometimes the bigger the issue (and especially if the situation is nebulous and indistinct) the less people will feel able to engage. Climate Change is HUGE. We have all seen enough dystopian, apocalypse movies to believe the whole concept is fictional. We forget that other civilizations on this very planet have disappeared and ours can too. Why not? Yet, unless you were in the New York subways, or Houston streets when they flooded, or California when it was burning, Climate Change can seem like a very far off, a hazy threat best left to someone else to worry about. After all, we all have plenty of more immediate problems to worry about. First things first!

What we don't think about unless we think it all the way through, is that *nothing* we are doing right now matters much more than polishing the silverware the evening before the Titanic sank did. The ultimate? If they will only be living out a nightmare of floods, famine, fires and other severe weather-related events is it selfish to have children now? Having read the research, I would say yes. My child is already in this

early twenties, so my only option is to work to restore his future. Many potential parents I know of childbearing age are opting not to have children right now until the future is more certain. It doesn't get much more serious than that.

You probably don't notice the subtle signs like less animals and birds, or the shifts in weather patterns as you go through the seasons. For this reason, climate scientists have talked for years about the need for a "Climate Pearl Harbor" to wake everyone up and get them moving. Unfortunately, as James Hansen mentioned in an earlier chapter, most agree by the time such a catastrophic event does unfold it will be too late to do anything but build lifeboats. The time for action is NOW.

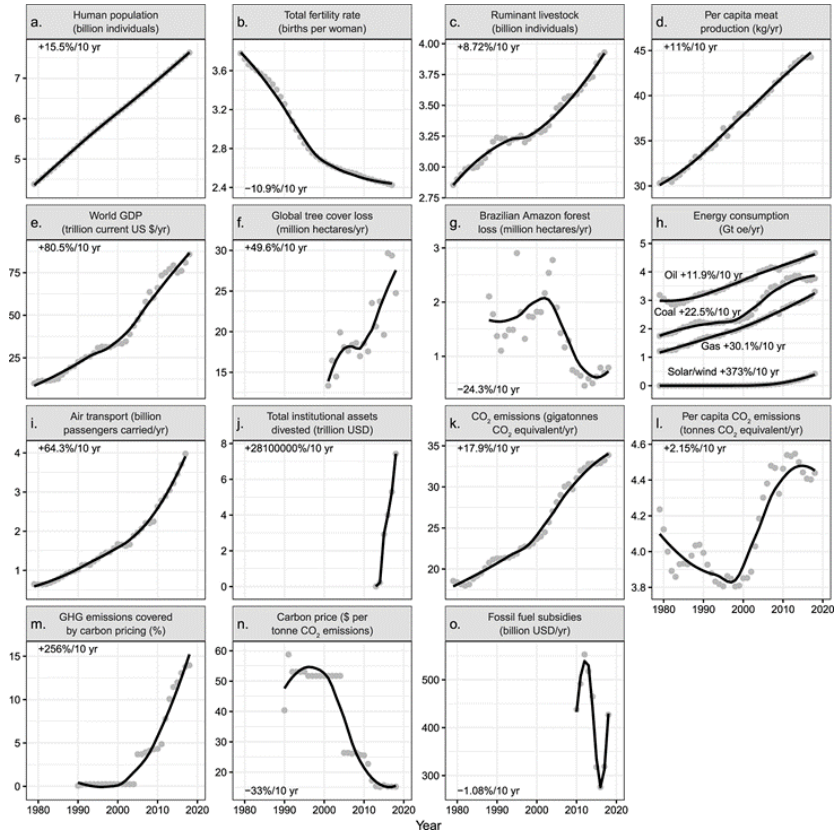
Politically, it seems we have two options; there is no longer any suitable centrist response to catastrophic climate change. On the far right is an emerging eco-fascism — a grim, selfish ideology that calls for hoarding resources, building walls to keep out refugees, and using brutal force to retain order as the world's multiplying problems are consigned away as someone else's responsibility. On the left, there is the possibility of what is optimistically described as eco-socialism — a drastic and immediate move toward a carbon-neutral society, with all of the redistribution of wealth and national priorities that entails.

JOIN UP AND SERVE

This is one reason why the emergence of groups like *Extinction Rebellion, Climate Strike, Climate Mobilization, the Sunrise Movement, Fridays for Future, Rebel Youth, and the Internationalist Solidarity Network (ISN)* (depending where you are in the world) are so important! Not all of them have the accurate big-picture that you are getting in Climate Deadline 2035, but they are making the noise! We must stretch our ability to see the probabilities for the future, place our bets now, and take action. Joining together in groups is essential at this point in the process. If you do nothing else after reading this book – find a climate rebellion group, join it, and push them toward the concepts in this book.

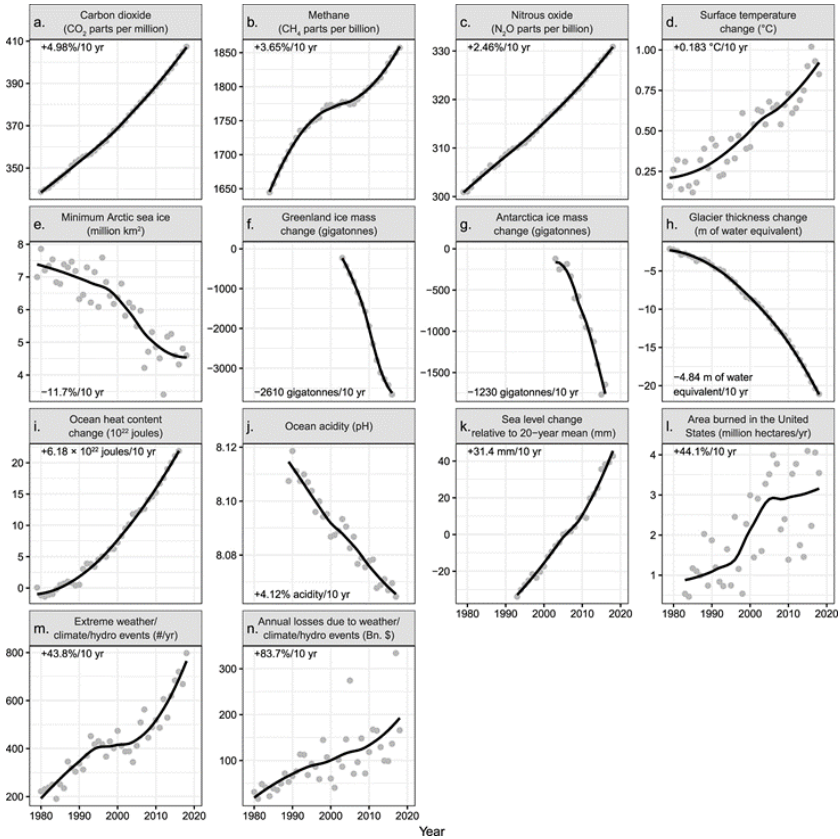
OUR VITAL SIGNS ARE FAILING

Below you will find *Climate Vital Signs* in chart form. These vital signs, collected by the United Nations, are designed to be useful to the public, policymakers, the business community, and those working to implement the Paris climate agreement, the UN Sustainable Development Goals, and the Aichi Biodiversity Targets.



Most of us realize the climate crisis is closely linked to excessive consumer consumption. The most affluent countries are mainly responsible for the historical GHG emissions and generally have the greatest per capita emissions. Profoundly troubling signs from human activities include sustained increases in both human and ruminant livestock populations, per capita meat production, world gross domestic product, global tree cover loss, fossil fuel consumption, the number of air passengers carried, carbon dioxide (CO_2) emissions, and per capita CO_2 emissions since 2000 (figure 1).

Encouraging signs include decreases in global fertility (birth) rates (figure 1b), decelerated forest loss in the Brazilian Amazon (figure 1g), increases in the consumption of solar and wind power (figure 1h), institutional fossil fuel divestment of more than US$7 trillion (figure 1j), and the proportion of GHG emissions covered by carbon pricing (figure 1m).



Change in global human activities from 1979 to the present. These indicators are linked at least in part to Climate Change. In panel (f), annual tree cover loss may be for any reason (e.g., wildfire, harvest within tree plantations, or conversion of forests to agricultural land). Forest gain is not involved in the calculation of tree cover loss. In panel (h), hydroelectricity and nuclear energy are shown in figure S2. The rates shown in panels are the percentage changes per decade across the entire range of the time series. The annual data are shown using gray points. The black lines are local regression smooth trend lines.

However, the decline in human fertility rates has substantially slowed during the last 20 years (figure 1b), and the pace of forest loss in Brazil's Amazon has now started to increase again (figure 1g). Consumption of solar and wind energy has increased 373% per decade, but in 2018, it was still 28 times smaller than fossil fuel consumption (combined gas, coal, oil; figure 1h). As of 2018, approximately 14.0% of global GHG emissions were covered by carbon pricing (figure 1m),

but the global emissions-weighted average price per ton of carbon dioxide was only around US$15.25 (figure 1n).

CLIMATE VITAL SIGNS

Change in global human activities from 1979 to the present. These indicators are linked at least in part to Climate Change. In panel (f), annual tree cover loss may be for any reason (e.g., wildfire, harvest within tree plantations, or conversion of forests to agricultural land). Forest gain is not involved in the calculation of tree cover loss. In panel (h), hydroelectricity and nuclear energy are shown. The rates shown in panels are the percentage changes per decade across the entire range of the time series. The annual data are shown using gray points. The black lines are local regression smooth trend lines.

Especially disturbing are concurrent trends in the vital signs of climatic impacts (figure 2, supplemental file S2). Three abundant atmospheric GHGs (CO_2, methane, and nitrous oxide) continue to increase (see figure S1 for ominous 2019 spike in CO_2), as does global surface temperature (figure 2a–2d). Globally, ice has been rapidly disappearing, evidenced by declining trends in minimum summer Arctic sea ice, Greenland and Antarctic ice sheets, and glacier thickness worldwide (figure 2e–2h). Ocean heat content, ocean acidity, sea level, area burned in the United States, and extreme weather and associated damage costs have all been trending upward (figure 2i–2n). Climate change is predicted to greatly affect marine, freshwater, and terrestrial life, from plankton and corals to fishes and forests (IPCC 2018, 2019). These issues highlight the urgent need for action.

Despite 40 years of global climate negotiations, with few exceptions, we have generally conducted business as usual and have largely failed to address this predicament (figure 1). The climate crisis has arrived and is accelerating faster than most scientists expected (figure 2, IPCC 2018). It is more severe than anticipated, threatening natural ecosystems and the fate of humanity (IPCC 2019). Especially worrisome are potential irreversible climate tipping points and nature's reinforcing feedbacks (atmospheric, marine, and terrestrial) that could lead to a catastrophic “hothouse Earth,” well beyond the control of humans (Steffen et al. 2018). These climate chain reactions could cause significant disruptions to ecosystems, society, and economies, potentially making large areas of Earth uninhabitable.

To secure a sustainable future, we must change how we live, in ways that improve the vital signs summarized by our graphs. Economic and population growth are among the most important drivers of increases

in CO2 emissions from fossil fuel combustion (Pachauri et al. 2014, Bongaarts and O'Neill 2018); therefore, we need bold and drastic transformations regarding economic and population policies. We suggest six critical and interrelated steps (in no particular order) that governments, businesses, and the rest of humanity can take to lessen the worst effects of Climate Change. These are important steps but are not the only actions needed or possible (Pachauri et al. 2014, IPCC 2018, 2019).

ENERGY

The world must quickly implement massive energy efficiency and conservation practices and must replace fossil fuels with low-carbon renewables (figure 1h) and other cleaner sources of energy if safe for people and the environment (figure S2). We should leave remaining stocks of fossil fuels in the ground (see the timelines in IPCC 2018) and should carefully pursue effective negative emissions using technology such as carbon extraction from the source and capture from the air and especially by enhancing natural systems (see "Nature" section). Wealthier countries need to support poorer nations in transitioning away from fossil fuels. We must swiftly eliminate subsidies for fossil fuels (figure 1o) and use effective and fair policies for steadily escalating carbon prices to restrain their use.

REDUCTION IN SHORT-LIVED POLLUTANTS

We need to promptly reduce the emissions of short-lived climate pollutants, including methane (figure 2b), black carbon (soot), and hydrofluorocarbons (HFCs). Doing this could slow climate feedback loops and potentially reduce the short-term warming trend by more than 50% over the next few decades while saving millions of lives and increasing crop yields due to reduced air pollution (Shindell et al. 2017). The 2016 Kigali amendment to phase down HFCs is welcomed.

NATURE

We must protect and restore Earth's ecosystems. Phytoplankton, coral reefs, forests, savannas, grasslands, wetlands, peatlands, soils, mangroves, and sea grasses contribute greatly to sequestration of atmospheric CO2. Marine and terrestrial plants, animals, and microorganisms play significant roles in carbon and nutrient cycling and storage. We need to quickly curtail habitat and biodiversity loss (figure 1f–1g), protecting the remaining primary and intact forests, especially those with high carbon stores and other forests with the

capacity to rapidly sequester carbon (reforestation), while increasing reforestation and afforestation where appropriate at enormous scales. Although available land may be limiting in places, up to a third of emissions reductions needed by 2030 for the Paris agreement (less than 2°C) could be obtained with these natural climate solutions (Griscom et al. 2017).

FOOD

Eating mostly plant-based foods while reducing the global consumption of animal products (figure 1c–d), especially ruminant livestock (Ripple et al. 2014), can improve human health and significantly lower GHG emissions (including methane in the "Short-lived pollutants" step). Moreover, this will free up croplands for growing much-needed human plant food instead of livestock feed, while releasing some grazing land to support natural climate solutions (see "Nature" section). Cropping practices such as minimum tillage that increase soil carbon are vitally important. We need to drastically reduce the enormous amount of food waste around the world.

ECONOMY

Excessive extraction of materials and overexploitation of ecosystems, driven by economic growth, must be quickly curtailed to maintain long-term sustainability of the biosphere. We need a carbon-free economy that explicitly addresses human dependence on the biosphere and policies that guide economic decisions accordingly. Our goals need to shift from GDP growth and the pursuit of affluence toward sustaining ecosystems and improving human well-being by prioritizing basic needs and reducing inequality.

POPULATION

Still increasing by roughly 80 million people per year, or more than 200,000 per day (figure 1a–b), the world population must be stabilized—and, ideally, gradually reduced—within a framework that ensures social integrity. There are proven and effective policies that strengthen human rights while lowering fertility rates and lessening the impacts of population growth on GHG emissions and biodiversity loss. These policies make family-planning services available to all people, remove barriers to their access and achieve full gender equity, including primary and secondary education as a global norm for all, especially girls and young women.

Human beings have always had challenges and life on Earth is imperfect at best. Now, however, we are seeing an escalation and accumulation of problems which threatens to become insurmountable in the very near future. Climate Deadline is your wake-up call to join in the fight while there is still time.

CHAPTER TEN: FOLLOWING THE MONEY

"Earth provides enough to satisfy every man's needs, but not every man's greed." *- Mahatma Gandhi*

Chapter Summary: We do not have time for a complete overhaul of world governance or economic systems. Climate disruption is a crisis that must be handled immediately. Therefore, solutions to Climate Change will need to be economically desirable to both government and corporations. Scientists must make certain their proposals for Climate-Engineering are economically viable and, if possible, disrupt the status-quo as little as possible. Profit-driven corporations and their lobbies aren't going to simply "do the right thing" as much as we wish they might. They need an economically feasible escape hatch, and a big push from governments.

Extreme weather, made worse by climate change, along with the health impacts of burning fossil fuels, has cost the U.S. economy alone at least $240 billion a year over the past ten years, a new coordinated, multi-university report has found. In 2017 three major hurricanes and 76 wildfires in nine Western states alone are topped $300 billion. Putting it in perspective, $300 billion is enough money to provide free

tuition for the 13.5 million U.S. students enrolled in public colleges and universities for four years.

In the coming decade, economic losses from extreme weather combined with the health costs of air pollution will spiral upward to at least $360 billion annually, potentially crippling U.S. economic growth (The Economic Case for Climate Action in the United States, published by the Universal Ecological Fund.)

“Burning fossil fuels comes at a giant price tag which the U.S. economy cannot afford and cannot sustain," said Sir Robert Watson, coauthor and director at the U.K's Tyndall Center for Climate Change Research. New research shows that if present trends continue, the total cost of global warming will be as high as 3.6 percent of gross domestic product (GDP). Four global warming impacts alone—hurricane damage, real estate losses, energy costs, and water costs—will come with a price tag of 1.8 percent of U.S. GDP, or almost $1.9 trillion annually (in today’s dollars) by 2100.

Munich Re, the world's largest reinsurance firm, blamed Climate Change for $24 billion of losses in the California wildfires. It warned that insurance firms will have to raise premiums to cover rising costs from extreme weather. That could make insurance too expensive for most people.

Scientists estimated that, if temperatures only rose 2 C, global gross domestic product would fall 15%. If temperatures rose to 3 C, global GDP would fall 25%. If nothing is done, temperatures will rise by 4 C by 2100. Global GDP would decline by more than 30% from 2010 levels. That's worse than the Great Depression, where global trade fell 25%. *The only difference is that it would be permanent.*

The World Employment and Social Outlook 2018 estimated that Climate Change threatens 1.2 billion jobs. The industries most at risk are agriculture, fisheries, and forestry. Maine is already seeing a decline in its lobster catches. Natural disasters have already cost 23 million working life years since 2000. On the other hand, efforts to stop Climate Change would create 24 million new jobs by 2030.

Climate change creates mass migration around the world. Immigrants are leaving flooded coastlines, drought-stricken farmlands, and areas of extreme natural disasters. Since 2008, extreme weather has displaced 22.5 million people according to the United Nations High Commissioner for Refugees. By 2050, Climate Change will force 700

million people to emigrate – an incredibly expensive process on all levels.

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On December 18, 2009 the UN Climate Summit produced the Copenhagen Accord. Countries pledged to limit global temperature increases to 2 C over the pre-industrial level. The developed countries agreed to pay $100 billion a year by 2020 to assist poor countries affected the most by Climate Change. That includes relocating communities hit by floods and droughts and protecting water supplies. The countries agree to provide $30 billion over the next three years.

Some countries refused to sign the agreement because the United States refused to cut more than 4% of its emissions by 2020. That foot-dragging signaled to many that Obama was not any more committed than the Bush administration.

Immigration at the U.S. border will only increase as Climate Change worsens conditions in Latin America. The World Bank estimates that *Climate Change could send 1.4 million people north by 2050*. Drought, shifting rain patterns, and extreme weather destroys crops and leads to food insecurity. The World Food Program found that almost half of Central American immigrants left because there wasn't enough food.

In 2017, the U.S. Department of Defense reported that Climate Change is a “direct threat” to U.S. national security. Climate change endangers 128 military bases and record numbers of soldiers are suffering heat-related injuries. A 2018 Pentagon survey revealed that U.S. Naval Academy in Annapolis, MD. has experienced storm surge flooding and hurricane damage. The Cape Lisburne Long Range Radar Station in Alaska has lost a seawall from extreme weather. In response, Congress asked DoD to identify the 10 most vulnerable sites and recommend solution strategies.

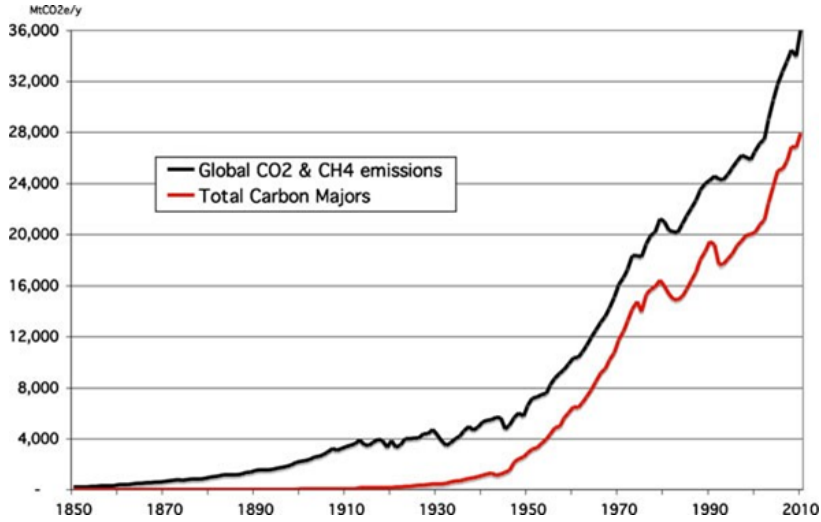
As America experiences more extremely hot days, food prices are rising. Corn and soybean yields in the United States plummet precipitously when temperatures rise above 84 degrees Fahrenheit. Those crops feed cattle and other meat sources, thus creating spikes in beef, milk, and poultry prices. During heart waves worker productivity

declines sharply, particularly for outdoor jobs. That further increases the cost of food.

A 2019 study found that a warming ocean has pushed global fish yields down 4% overall since 1920. That's 1.4 million metric tons. In the North Atlantic and Sea of Japan, that decline is 35%. That affects Atlantic cod, haddock, and herring. Many species are threatened with extinction. That affects the 3 billion people who rely on fish for their primary source of protein. It also affects the $100 billion fishing industry and the 56 million people employed. It especially affects the United States, which imports 90% of its seafood.

THE FOSSIL MAJORS

In a 2014 issue of Climatic Change, Dr. Richard Heede presented the first (several have followed) quantitative analysis of the historic fossil fuel and cement production records of the 50 leading investor-owned, 31 state-owned, and 9 nation-state producers of oil, natural gas, coal, and cement from as early as 1854 to 2010. This analysis traces emissions totaling 914 GtCO2e—63 % of cumulative worldwide emissions of industrial CO_2 and methane between 1751 and 2010—to the 90 "carbon major" entities based on the carbon content of marketed hydrocarbon fuels (subtracting for non-energy uses), process CO_2 from cement manufacture, CO_2 from flaring, venting, and own fuel use, and fugitive or vented methane. Cumulatively, emissions of 315 GtCO2e have been traced to investor-owned entities, 288 $GtCO_2e$ to state-owned enterprises, and 312 $GtCO_2e$ to nation-states. Of these emissions, half has been emitted since 1986.



The carbon major entities possess fossil fuel reserves that will, if produced and emitted, intensify anthropogenic climate change. The purpose of the analysis is to understand the historic emissions as a factual matter, and to invite consideration of their possible relevance to public policy.

A total of 914 billion tons of CO_2-equivalent ($GtCO_2e$) has been traced to 90 international entities based on analysis of historic production records dating from 1854 to 2010. These entities cumulatively produced 985 billion barrels (bbl) of crude oil and NGLs (79 billion bbl were used for non-energy products), 2,248 trillion cubic feet (Tcf), and 163 billion tons of various ranks of coal. The emissions traced to the carbon majors represent 63 % of global industrial CO_2 and methane from fossil fuel combustion, flaring, venting, fugitive or vented methane, own fuel use, and cement between 1751 and 2010. The top source is 366 $GtCO_2$ from the combustion of oil products from 55 entities representing 77.5 % of the global CDIAC estimate of oil emissions

Combustion	Entities #	emissions $GtCO_2e$	Percent of Carbon Majors
Oil & NGLs	55	365.73	40.00 %
Natural gas	56	120.11	13.14 %
Coal	36	329.60	36.05 %
Flaring	56	6.04	0.66 %
Own fuel use	56	7.12	0.78 %
Cement	7	13.21	1.45 %
Vented CO_2	54	4.83	0.53 %
Fugitive methane	83	67.62	7.40 %
Total	90	914.25	100.0 %
CDIAC global emissions 1751–2010		1,450.33	
Carbon Majors of global emissions		63.04 %	

Of total industrial CO_2 and CH4 emissions from 1751 to 2010, one-half has been emitted since 1984 (Marland et al. 2011). Of the emissions traced to carbon major fossil fuel and cement production, half has been emitted since 1986. Cumulatively, emissions of 315 $GtCO_2e$ have been traced to investor-owned entities, 288 $GtCO_2e$ to state-owned companies, and 312 $GtCO_2e$ to nation-states. The dip in relative production by nation-states in the late 1980s through early

2000s is due to the collapse of the Soviet Union and the creation of new state-owned oil and natural gas entities in Russia as well as the transformation of China's petroleum sector into state-owned entities.

The following chart traces actual cumulative emissions attributed to the twenty largest investor-owned and state-owned energy companies between 1854 and 2010 total 428 $GtCO_2e$, or 29.5 % of global industrial emissions from 1751 to 2010. The ten largest investor-owned companies alone contributed 230 $GtCO_2e$, or 15.8 % of global emissions through 2010. (Heede, 2014)

Entity	2010 emissions $MtCO_2e$	Cumulative 1854–2010 $MtCO_2e$	Percent of global 1751–2010
1. Chevron, USA	423	51,096	3.52 %
2. ExxonMobil, USA	655	46,672	3.22 %
3. Saudi Aramco, Saudi Arabia	1,550	46,033	3.17 %
4. BP, UK	554	35,837	2.47 %
5. Gazprom, Russian Federation	1,371	32,136	2.22 %
6. Royal Dutch/Shell, Netherlands	478	30,751	2.12 %
7. National Iranian Oil Company	867	29,084	2.01 %
8. Pemex, Mexico	602	20,025	1.38 %
9. ConocoPhillips, USA	359	16,866	1.16 %
10. Petroleos de Venezuela	485	16,157	1.11 %
11. Coal India	830	15,493	1.07 %
12. Peabody Energy, USA	519	12,432	0.86 %
13. Total, France	398	11,911	0.82 %
14. PetroChina, China	614	10,564	0.73 %
15. Kuwait Petroleum Corp.	323	10,503	0.73 %
16. Abu Dhabi NOC, UAE	387	9,672	0.67 %
17. Sonatrach, Algeria	386	9,263	0.64 %
18. Consol Energy, Inc., USA	160	9,096	0.63 %
19. BHP-Billiton, Australia	320	7,606	0.52 %
20. Anglo American, United Kingdom	242	7,242	0.50 %
Top 20 IOCs & SOEs	11,523	428,439	29.54 %
Top 40 IOCs & SOEs		546,767	37.70 %
All 81 IOCs & SOEs	18,524	602,491	41.54 %
Total 90 carbon majors	27,946	914,251	63.04 %
Total global emissions	36,026	1,450,332	100.00 %

Parties to the Framework Convention agreed in 1992 that Annex I nations would shoulder most of the burden of funding international negotiations, paying adaptation costs for the poorest nations, and taking the lead in combating climate change, on the basis of the argument that they had benefitted the most from being the largest historical emitters, and therefore had the greatest responsibility for addressing it. This regime has so far failed to reduce global GHG emissions

THE FINANCIAL SECTOR

But there's another bunch of people and businesses who should be firmly in our sights as we continue our struggle after the climate strikes – the finance industry. Author Bill McKibben published a new article in the New Yorker that lays out with devastating forensic detail how the finance industry is fueling the fire of global warming: our banks, asset-managers, and insurers, are all essential players in the modern expansion (yes it's 2019 and it's expanding) of fossil fuels.

But these financial players also have options and incentives to act swiftly and to accelerate the shift away from coal, oil, and gas. Plus institutions of the finance industry are everywhere – giving you a handy target wherever you live – to join in and pressure. You might want to join the campaign against JP Morgan Chase the world's biggest owner of fossil fuel interest? Or perhaps you're ready to take on one of the Japanese mega-banks? How about HSBC's loophole that lets it keep pushing coal in Bangladesh?

How about getting the world's biggest lender over the line on the strictest climate-safety policy in the world? That fight needs you right now as the decision might be made next month – get involved.

As more investors – both public and private institutions – demand fossil free indexes, the capital needed to fund these monstrous mega-projects will be impossible to raise. And that's not to even mention how hard it will get for the world's biggest polluters when no-one will insurer their mines, pipelines, and power-stations anymore.

When it comes to global warming, we know that the real problem is not just fossil fuels – it is the logic of endless growth that is built into our economic system. If we don't keep the global economy growing by at least 3% per year, it plunges into crisis. That means we have to double the size of the economy every 20 years, just to stay afloat. It

doesn't take much to realize that this imperative for exponential growth makes little sense given the limits of our finite planet.

Rapid Climate Change is the most obvious symptom of this contradiction, but we're also seeing it in the form of deforestation, desertification and mass extinction, with species dying at an alarming rate as our consumption of the natural world causes their habitats to collapse. It was unthinkable to say this even 10 years ago, but today, as we become increasingly aware of these crises, it seems all too clear: our economic system is incompatible with life on this planet.

The question is what to do about it. How can we redesign the global economy to bring it in line with the principles of ecology? The most obvious answer is to stop using GDP to measure economic progress and replace it with a more thoughtful measure – one that accounts for the ecological and social impact of economic activity. Prominent economists like Nobel Prize winner Joseph Stiglitz have been calling for such changes for years and it's time we listened.

But replacing GDP is only a first step. While it might help refocus economic policies on what really matters, it doesn't address the main driver of growth: debt. Debt is the reason the economy has to grow in the first place. Because debt always comes with interest, it grows exponentially – so if a person, a business, or a country wants to pay down debt over the long term, they have to grow enough to at least match the growth of their debt. Without growth, debt piles up and eventually triggers an economic crisis.

This might sound a bit odd, but it's quite simple. When you walk into a bank to take out a loan, you assume that the bank is lending you money it has in reserve – money that it stores somewhere in a vault, for example, collected from other people's deposits. But that's not how it works. Banks only hold reserves worth about 10% of the money they lend out. In other words, banks lend out 10 times more money than they actually have.

So, where does all that additional money come from? Banks create it out of thin air when they make loans – they loan it into existence. This accounts for about 90% of the money circulating in our economy right now. It's not created by the government, as most people assume: it is created by commercial banks in the form of loans. In other words, almost every dollar that passes through our hands represents somebody's debt. And every dollar of debt has to be paid back with interest. Because our money system is based on debt, it has a growth

imperative baked into it. In other words, our money system is heating up the planet.

Once we realize this, the solution comes into view: we need banks to keep a bigger fraction of reserves behind the loans they make. This would go a long way toward diminishing the amount of debt sloshing around in our economy, helping reduce the pressure for economic growth.

But there's an even more exciting solution we might consider. We could abolish debt-based currency altogether and invent a new money system completely free of intrinsic debt. Instead of letting commercial banks create money by lending it into existence, we could have the state create the money and then spend it into existence. New money would get pumped into the real economy instead of just going straight into financial speculation where that only benefit the mega-rich.

Abolishing debt-based currency may hold the secret to getting our system off its addiction to growth. The responsibility for money creation would be placed with an independent agency that – unlike our banks – would be democratic, accountable, and transparent, so money would become a truly public good. Commercial banks would still be able to lend money at interest, but they would have to back it dollar for dollar with their own reserves. In other words, there would be a 100% reserve requirement.

This is not a fringe proposal. It has been around since at least the 1930s, when a group of economists in Chicago proposed it as a way of curbing the reckless lending that led to the Great Depression. The Chicago Plan, as it was called, made headlines again in 2012 when progressive IMF economists put it forward as a strategy for preventing the global financial crisis from recurring. They pointed out that such a system would dramatically reduce both public and private debt and make the world economy more stable.

What they didn't notice is that abolishing debt-based currency also holds the secret to getting our system off its addiction to growth, and therefore to arresting Climate Change. As it turns out, reinventing our money system is crucial to our survival in the Anthropocene – at least as important as getting off fossil fuels. And this idea is already beginning to gain traction: in the UK, the campaigning group Positive Money has generated momentum around it, building on a series of excellent explanatory videos.

The idea has its enemies, of course. If we shift to a positive money system, big banks will no longer have the power to literally make money out of nothing and the rich will no longer reap millions from asset bubbles. Unsurprisingly, neither of these groups would be pleased by this prospect. But if we want to build a fairer, more ecologically sound economy, that's a battle that we can't be afraid to fight.

CHAPTER ELEVEN: CLIMATE POLITICS

…we shall fight on the beaches, we shall fight on the landing grounds, we shall fight in the fields and in the streets, we shall fight in the hills; we shall never surrender… *- Winston Churchill*

Chapter Summary: There are measures that can be taken to insulate politicians from controlling lobbies and financial interests, but we do not have time for such large-scale social changes. In order to push politicians into climate action under today's systems we must make repairing atmospheric damage viable politically. The solutions must allow these folks to keep their jobs, and please their constituents and lobbies.

In front of a gathering of arguably the most powerful leaders in the world, 16-year-old Greta Thunberg opened with a warning: "We'll be watching you." Thunberg made her speech to the United Nations Climate Summit in New York City on Monday, serving as an ostensible reminder to most nations of their Paris accord pledges to reduce carbon emissions.

The summit kicked off a day after the UN released a report outlining the current status of the Earth's carbon emissions and atmospheric tumult. Aside from the revelation that 2015 to 2019 appears to be the warmest five-year period in history, the report cited how far nations will need to go to waylay the worst outcomes of global warming. In order to limit warming to just 2 degrees Celsius, the effectiveness of global climate policies need to triple in scale, the report said.

That's especially true for the top-10 global emitters of carbon dioxide, as measured by the European Commission in 2017:

1. China: 10.8 million metric tons
2. United States: 5.1 million metric tons
3. European Union: 3.5 million metric tons
4. India: 2.5 million metric tons
5. Russia: 1.8 million metric tons
6. Japan: 1.3 million metric tons
7. South Korea: 0.67 metric tons
8. Iran: 0.67 million metric tons
9. Saudi Arabia: 0.64 million metric tons
10. Canada: 0.61 million metric tons.

Those 10 countries account for approximately 70 percent of the world's emissions, and all except one — India — are not on pace to meet the climate goals needed to prevent 2 degrees Celsius of warming. (Reminder: Two degrees of warming above pre-industrial levels would be catastrophic, but even 1.5 degrees could make Earth inhospitable to human life and the planet is already halfway there.)

"The developing world isn't really going to act seriously on reducing emissions until the developed world steps up and starts leading the way," said Noah Kaufman, a research scholar at Columbia University's Center on Global Energy Policy.

Each of the top-10 nations is falling behind with their climate mitigation. The Climate Action Tracker, an independent group of analysts that tracks government climate action and keeps tabs on the progress individual nations are making — or not making — toward their climate commitments. Launched in 2009, Climate Action Tracker calculates whether a country's actions are sufficient to prevent significant warming, based on a nation's "fair share" — the actions each nation must contribute to satisfy the goals outlined by the Paris accord. Fairness can feel like a subjective measure, so the team uses a

variety of criteria — such as past emissions, per capita pollution and economic capability — to determine the shares.

THE EUROPEAN UNION

European Union is still trailblazing but also learning from mistakes. Being a frontrunner requires bravery, but inherently that also means that mistakes will be made. The European Union adopted a two-degree-limit as a climate target 20 years before most of the world followed suit with the Paris accord in 2015. The European Union became an early serious adopter of renewable energy and energy efficient buildings — but had some miscues, too.

One example revolves around international carbon offsets. Often a component of cap-and-trade programs, international offsets call on developed nations to encourage carbon cuts in other countries, rather than executing them at home.

“In theory, the system says if we can encourage emissions reductions in the developing world for a cheaper price than we can do it here, that’s a win-win,” Kaufman said. But the early iterations of these programs were a disaster, he said, because European officials had a hard time verifying emissions reductions in the developing world due to a dearth of local oversight, corruption and fraud. The 2008 global financial crisis also threw off the ability to efficiently set carbon caps because of energy prices. Kaufman said the European Union has tightened these caps, leading to significant reductions in energy emissions over the last two years.

Room for improvement still exists for countries like Germany, which despite leading much of the charge on clean energy, could individually rank in the top-10 list of carbon emitters if not for its membership in the European Union. Germany remains Europe’s biggest consumer of coal, and energy transition to renewables has arguably stalled. Even though the country continues to roll out bids to have net-zero emissions by 2050 and new climate policies like carbon prices for economic sectors, transportation and buildings, Hohne said what Germany lacks is a long-term vision.

Both he and Kaufman contrast Germany with the U.K., which enlists a group of scientists to reassess if British climate targets are being met and, if not, update the country’s policy every five years. “The U.K. is a terrific example,” Kaufman said. “They’ve put in place a carbon price floor, support for renewable energy and coal phase outs. The

combination has basically gotten rid of coal in their power sector over the last five years, which is pretty remarkable."

The Climate Action Tracker argues that similar concrete targets need to be expanded across the 28 states in the European Union, which are as a group graded as insufficient.

CHINA

China is winning on energy efficiency, but losing on coal. "China is quite good in developing new renewable energy and supporting electric vehicles," said Niklas Hohne, a climatologist, founding partner of the NewClimate Institute and creator of the Climate Action Tracker. China has also made hefty investments in renewables and electric cars, significantly leveling off the growth rate of their carbon emissions. From 2001 to 2010, China's carbon dioxide emissions increased 137 percent. Since then they've grown 8 percent. Despite this progress, the Climate Action Tracker gives China a grade of "highly insufficient" because of their continued reliance on coal. The nation's renewables push also appears to be stalling.

"China is still unfortunately failing at stopping the building of new coal-fired power plants," Hohne said. "China is not doing that only at home, they are also financing coal fired power plants outside of the country, so increasing emissions elsewhere."

THE UNITED STATES

In the United States Republicans and Democrats are deeply divided on whether Climate Change should be a top priority. The partisan divide began in the late 1990s and has increased over time. In 1997, nearly equal numbers of Democrats and Republicans said that the effects of global warming have already begun. Ten years later, the gap was 34%: 76% of Democrats said the effects had already begun, and only 42% of Republicans agreed. Outside of a handful of cities and states — including but not limited to California, New York and Washington — the country is treading water because national progress on carbon is being counteracted by the Trump administration's industry deregulation and rollback of environmental policies. "The U.S., which probably more than any country in the world has a responsibility to reduce its emissions rapidly and lead on climate, is doing the opposite," Kaufman said. The United States receives a worse ranking than China — "critically insufficient" — from the Climate Action Tracker.

INDIA

India catches flack in the mainstream press because its emissions have increased 300 percent in 20 years, but the Climate Action Tracker lists it as the only G20 nation whose actions are compatible with keeping global warming under 2 degrees Celsius. (Only two countries in the world are currently compliant with the 1.5-degree-climate commitment: Morocco and The Gambia)

That's because, compared to nations like the U.S. and China, India's legacy of emissions is low. The nation's carbon pollution also remains limited relative to the size of its population, thanks to the Indian government's efforts to transition people away from large modes of transportation to small electric-powered scooters and three-wheelers.

India has also emerged as a leader in the energy transition, with solar and hydroelectric accounting for 34 percent of its power capacity. But the South Asian nation still relies on coal for more than half of its energy. At this week's U.N. climate summit, Indian Prime Minister Narendra Modi announced his intentions to expand renewable energy, but his plans would fall short of hitting a 1.5-degree-climate commitment. That's because it's unclear if India will significantly scale back on coal going forward.

JAPAN

Japan has traditionally excelled at energy efficiency in cars and its industries. But the Fukushima accident in 2011 was a fundamental shock to Japan, so much so that the nation shut down all of its nuclear plants and announced a complete review of its energy policy. Coal-fired power has risen in the absence of nuclear power, which cut into the country's progress on carbon reduction. Now, leaders are considering whether they should revamp these nuclear power plants, build more coal plants or switch investments to renewables, Hohne said. Japan's climate mitigation gets a middle-of-the-road grade of "insufficient" in the Climate Action Tracker.

SOUTH KOREA

South Korea, like Germany, has announced ambitious short-term plans for climate action, but its national policies don't back up those goals. For instance, South Korea, like China, has begun constructing coal plants outside of its borders. It received a "highly insufficient" rating from the Climate Action Tracker.

RUSSIA

Though Russia signed onto the Paris accord in 2016, it did not adopt the measure until far later (though the ratification came from the Prime Minister Dmitry Medvedev rather than the nation's parliament). Despite this move, Hohne said oil-dependent Russia has made little indication that it plans to decarbonize. "There are players in the country that want to do more. They talk about renewable energy for example, but so far I don't see any progress at all," Hohne said. Russia earns a "critically insufficient" grade in the Climate Action Tracker.

SAUDI ARABIA

Saudi Arabia carries the same rating, given it is considered a classic oil producer, Hohne said. The gulf state has proposed the adoption of renewable energy, launching the largest solar farm in the world last year that could cover Manhattan, parts of New Jersey and a chunk of Long Island with room to spare. But nearly nine out of $10 made by the Saudi Arabian government and nearly half the country's GDP are tied to petroleum, meaning a clean energy transition would basically require transforming the nation's whole economy, Hohne said.

IRAN

In Iran, sanctions have not only stopped trade, but also impaired the oil-laden country's ability to invest in renewable energy. Iran signed the Paris agreement, but its parliament hasn't ratified the measure. "The sanctions and the political situation make it very difficult to plan in any way forwards," Hohne said, and this lack of a climate mitigation policy explains why it has no grade in the Climate Action Tracker. "They need technology and knowledge from outside. If that's not happening, then emissions will continue to rise."

CANADA

Canada is pushing carbon prices but that may change. Kaufman cites Canada, like the U.K., as another example of a country with long-term visions toward serious reductions in emissions. Last year, Prime Minister Justin Trudeau's administration implemented the Greenhouse Gas Pollution Pricing Act, which called on its provinces to set their own carbon taxes — or be subject to a federal tax. "It's essentially a federal backstop program or a minimum requirement for either carbon prices or emissions caps," Kaufman said. "They're ratcheting up to an

economy-wide carbon price of about $50 a ton over the next few years, which is a really serious policy."

But Hohne said Canada continues to invest in unconventional fossil fuels — like tar sands and shale gas — "which are completely incompatible with the Paris Agreement,". Moreover, the opposition party has expressed its intention to reverse recent climate measures if elected into power this fall. All of which lands Canada in the "insufficient" category in the Climate Action Tracker.

Apologies to the many nations not included here due to space. Our overall point, however, is that no one is on track to cut emissions by anything close to the 45 percent we need.

WHO IS DRIVING THE BUS?

When we start to look at the issue of who will take the lead in Emergency Climate Repair there has been much unnecessary debate. Questions of ethics and emotion become questions of norms and governance, and these questions become boogiemen scaring the untrusting into gridlock. Who governs an endeavor that by its nature would cross national boundaries? A coalition of the willing? What treaties are needed? How to enforce them? Who compensates the "losers" in a geoengineered world? There is no existing transparent international framework for moving ahead even with small-scale experiments. That will have to change, and Oxford University's Steve Rayner reported that the House of Commons Science and Technology Committee recently endorsed regulating Climate-Engineering as a "public good," by keeping data open and transparent, assessing independently the impacts of Climate-Engineering research, developing "governance before deployment," and forbidding the militarization of the field.

Good grief! As we will discuss in the next chapter that wheel has already been invented. The United Nations was given a mandate – written in the blood of millions – to oversee and administrate global-level problems. Now we have the mother of all global level problems. The storm is rising, and the boat is taking on water. While it might be of some academic interest to ask if we should have gotten in this boat in the first place, it is *not* a good time to jump ship. Instead we need to be throwing *every resource we have* into making the boat we already chose as strong at is can possibly be to get us where we need to go! *If* we get through this crisis it will be the United Nations that leads. We don't have time to build another boat. In addition, the UN already has

the trust and resources of the best and the brightest from NASA to the IPCC. All that is needed is *our trust and support*!

THE POLITICS OF WAKING UP

For most of us, Climate Change can no longer to be considered simply a matter of opinion, conversation, or debate. It is a matter of fact agreed upon by the scientific community, the governments of 175 nations around the world, NASA, the Centers for Disease Control, Oak Ridge National Laboratories, the United States Military, the US Federal Emergency Management Agency, the Environmental Protection Agency (gag orders notwithstanding), the US Department of Energy, their counterparts around the world, and even many of the largest carbon polluters themselves.

Yet, in spite of the evidence at hand, Climate Change remains the toughest, most intractable political issue we, as a society, have ever faced. This is not to say that there hasn't been progress. In the United States, the amount of greenhouse gas emissions has held steady since 1990–even though our economy and our population has grown. But globally, greenhouse gases have increased since then, bringing humanity very close to the dangerous levels of global warming that were predicted.

As scientific evidence about the causes of Climate Change has mounted and as a consensus has evolved in the scientific community, the public has remained divided and large, important parts of the political class have been indifferent. For instance, although 2017 was a year of 16 different billion-dollar natural disasters, according to the National Oceanic and Atmospheric Administration, the percentage of voters who were "very concerned" about Climate Change stayed within the 40% range–where it has been rather stubbornly stuck – until only the past 12-18 months.

Given the severity of the climate crisis and the potential for massive and very real damage to the human race and planet why aren't our leaders taking sufficient action? *The explanations likely fall into at least four categories: complexity; jurisdiction and accountability; collective action and trust; and imagination.*

COMPLEXITY

Complexity is the death knell of many modern public policy problems and solutions. And complexity is inherent in Climate Change. The

causes of global warming are varied, including carbon dioxide, methane, and nitrous oxide. As the climate warms, it affects glaciers, sea levels, water supply, rainfall, evaporation, wind, and a host of other natural phenomenon that affect weather patterns. Unlike an earlier generation of environmental problems, it is hard to see the connections between coal plants in one part of the world and hurricanes in another. In contrast, when the water in your river smells and turns a disgusting color and dead fish float on top of it, no sophisticated scientific training is required to understand the link between what's happening in the river and the chemical plant dumping things into it. The first generation of the environmental movement had an easier time making the connection between cause and effect.

Evidence for this comes from approximately three decades of polling on the environment by Gallup. Note that, over time, the most worrisome environmental problems are visible pollution problems. Water, soil, and ocean and beach pollution are at the top. These are things average people can see and smell. Global warming or Climate Change is toward the bottom. These numbers change somewhat over time and understandably so, which is why data is included from 2019 where available. People are more worried about Climate Change than they used to be. Nonetheless, the complexity of the issue compared to the more straightforward cause-and-effect characteristics of other environmental issues is a major impediment to political action.

When former Vice President Al Gore was awarded the Nobel Peace Prize in 2007, along with the Intergovernmental Panel on Climate Change, the prize was for "their efforts to build up and disseminate greater knowledge about man-made Climate Change." Through his books, his famous slide show, and his 2006 movie, "An Inconvenient Truth," Gore made it his mission to explain the scientific processes that make global warming so dangerous. But the inherent complexity of cause and effect in Climate Change makes it a topic in need of continuous education.

JURISDICTION AND ACCOUNTABILITY

We currently attribute greenhouse gas emissions to individual countries under the United Nations Framework Convention on Climate Change, and we attribute greenhouse gases to their sources within the United States via the Environmental Protections Agency's Greenhouse Gas Reporting Program. But attribution without enforcement mechanisms is only half the battle–if that. Nationally and internationally there is no legal architecture that allows us to reward

and/or punish those who decrease or increase their greenhouse gas emissions. Even the Paris Agreement–which President Trump pulled the U.S. out of–is only a set of pledges from individual countries. Measurement is a first step toward accountability, and measurement needs constant improvement. But measurement in the absence of accountability is meaningless, especially in situations where many people are skeptical of cause and effect.

COLLECTIVE ACTION

The Toxic Release Inventory was established by Congress in 1982 as an amendment to the Superfund Bill. Over the years, the steady flow of information about the release of hazardous chemicals into the environment has had many positive effects on regulators, environmentalists, and industrialists. Studies have shown that "facilities reduce emissions by an additional 4.28% on average, and their use of source reduction increases by 3.07% on average when the relative assessed hazard level of a chemical increases compared to when it decreases."

But the Toxic Release Inventory has one advantage that the Greenhouse Gas Reporting Program does not. The effects of dangerous chemicals on a population are generally fairly clear and obvious: dirty water, dirty air, difficulty breathing, unusual rates of cancer, etc. The cause and effect are often undeniable as the many lawyers who have represented communities and won their cases against large polluters can attest. Greenhouse gas emissions affect people thousands of miles away from their source and make it easier to believe that it wasn't the fossil fuels at all, just the weather pattern or an act of God. Hence, the linkage between jurisdiction and accountability is weak.

Our increasingly hot summers drive the demand for air conditioning. However, air conditioning adds to the heat outside. Scientists estimate that under a realistic set of circumstances, "waste heat from air conditioners exacerbated the heat island effect, the phenomenon in which densely packed cities experience higher temperatures than similarly situated rural areas." Air conditioning could add as much as 1 degree Celsius (nearly 2 degrees Fahrenheit) to the heat of a city. Which one of us, however, would voluntarily turn off their air conditioning knowing full well that hundreds of thousands of other "free riders" would not?

This is just one simplified version of the collective action problem. People may understand that they should act in a certain way for the greater good, but as individuals, they are loathe to turn off their air conditioning or stop flying places for vacations—knowing that others will not be joining them. This is why government is the most frequent solution to collective action problems. Combating Climate Change requires collective action on many fronts, and it requires collective action both nationally and internationally. But this is extremely difficult in democracies like the U.S., which face strong individualist traditions in the culture along with a lack of trust in government.

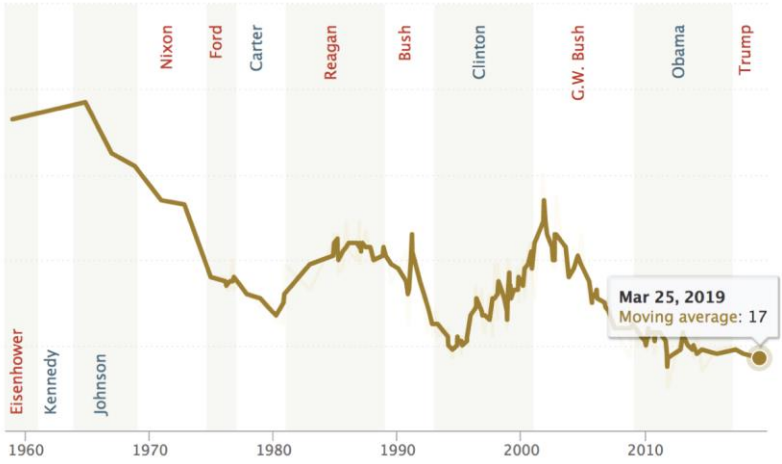
TRUST

It seems like the story of "The Boy Who Cried Wolf" was somehow skipped over in many Washington kindergartens. Since WWII "spinning" the truth seems to have become increasingly equated with *telling* the truth to the point where politicians themselves seem think being jaded is as necessary as wearing a tie. In fact, the lack of trust in government *by government itself* may be one of the foundational barriers to effective climate action. Writing in the journal Global Environmental Change, E. Keith Smith and Adam Mayer looked at 35 different countries. They found that a lack of trust in institutions blunts the public's risk perceptions and therefore their willingness to support behaviors or policies to address Climate Change.

A variety of individuals and institutions have for many years now been actively spreading disinformation to maintain the status quo on green house gas emissions. This has further muddied the waters and caused public confusion delaying action on climate disruption. For a look at who these entities are and how they operate go to:

https://www.desmogblog.com/global-warming-denier-database

Their findings make intuitive sense especially in the American context. Citizens want to trust their leaders, and there is a human tendency to rally behind. But, in many countries including the United States, there has been so many betrayals of public trust that it's hard to believe in anything or anyone. Below is a graph from the Pew Research Center showing the moving average over time of Americans who say they can trust the government in Washington to do what is right "just about always" or "most of the time." (Of course, you may not trust the Pew Research Center.)



Starting with Nixon our modern era has been one marked by increasing distrust. Imagine for a moment if F.D.R. went before Congress and gave a "Pearl Harbor" speech on Climate Change and the need for Emergency Climate Repair! (F.D.R. please wake up….. we need you!)

IMAGINING THE UNIMAGINABLE

The final piece to the puzzle of why the political salience of Climate Change seems so out of step with the physical proof and urgency of the issue may have to do with the realm of imagination. Climate Change is even more absent in the world of fiction than it is in nonfiction.

The absence of Climate Change from novels means that it is also absent from movies and television–the great powerful purveyors of stories in our time. One can't underestimate the power of fiction in shaping society's attitudes. Some older Americans can remember how the 1958 novel "Exodus," by Leon Uris, and the subsequent 1960 movie by the same name impacted a generation of non-Jewish Americans to be supportive of Israel. Or how the 2000 movie "Erin Brockovich," based on a true story of a young woman who takes on an energy corporation, helped popularize the environmental justice movement. While many mainstream films are now depicting global catastrophe, audiences may not make the leap to connect disaster with climate disruption.

We have trouble imagining the potential devastation of Climate Change. We have trouble trusting governments to lead us into much needed collective action. We have trouble defining the links between

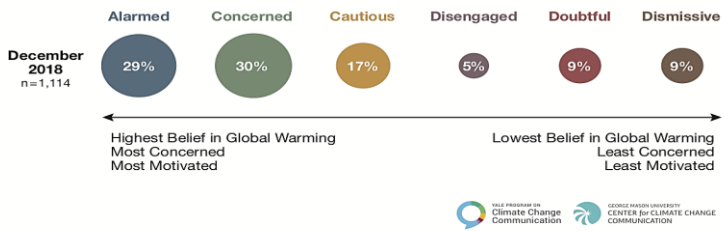
jurisdiction and accountability. And we have trouble understanding the causality in the first place.

How can we fix this? And can we fix this in time to avoid the severe consequences of Climate Change? Just as Al Gore won an Emmy for a movie on Climate Change, the creative elements in our society need to help explain what's at stake. They will find a receptive audience in the younger generation. As evidenced by their activism on this issue—this year, millions marched in countries around the world to protest inaction around Climate Change—young people are especially concerned with the environment. The millennial generation is a very large one, and they have so far shown themselves to be civic minded and environmentally engaged.

"Awareness without the ability to hold corporations, countries, and individuals accountable will not result in major action on environmental issues. But measurement and accountability without an understanding of the connections between a warmer planet and dangerous climate changes will not result in major action either."

SOME PROGRESS

A recent Yale University study found we are making some significant progress, especially the past 12-18 months. More citizens are concerned about Climate Change and are pushing the issue front and center for politicos.



In their recent article in Current Directions in Psychological Science, an interdisciplinary group of professors from the Netherlands, USA and Germany offer some innovative answers. They frame climate change as a social dilemma, a pervasive conflict between immediate self-interest and long-term collective interest. Lead author and Professor of Psychology at the VU Amsterdam, Paul van Lange, emphasizes that "For effectively reducing climate change, *it is essential to promote a longer-time perspective and a broadened*

intergroup perspective -- in addition to strengthening the belief that climate change is real."

But how can a longer-time perspective be promoted? One way is to emphasize that the young and vulnerable, especially one's own children, are the ones who need to deal with these futures. Manfred Milinski, Emeritus Professor of Evolutionary Biology at the Max Planck Institute at Plön, Germany, highlights the importance of kinship cues, and suggests that "The recommendation is to include children in public education campaigns for increasing awareness of what climate change means for the future. Children serve the cue of vulnerability and trigger the need of caring and protection."

This is not the only recommendation to promote an orientation to the future. Paul van Lange adds: " It is for some decisions wise to include relatively uninvolved people, expert-advisors, in discussions of climate change -- and especially in advice regarding urban planning and infrastructure. Involved people are likely to focus on the here and now of their houses, but research has shown that uninvolved experts are prone to look at longer-terms consequences of human decisions."

The final recommendation focuses on decisions that are made by representatives -- such as national leaders when they have to reach an agreement about the climate agreements. As we know, such agreements are often less than successful. Why might that be? According to Paul Van Lange and Manfred Milinski: "Our research has shown that leaders tend to have a distrustful and competitive mindset toward one another. And those who are competitive with other leaders are often well-supported by the constituency" One potential solution is therefore to use this competitive mindset by having leaders compete over global reputations. For example, installing a "sustainable city award" may help majors to develop local policy to reduce car use in their cities or promote public transportation.

CHAPTER TWELVE: THE UNITED NATIONS – THE KEY TO CLIMATE REPAIR IMPLEMENTATION

"It was close; but that's the way it is in war. You win or lose, live or die and the difference is just an eyelash"

- General Douglas MacArthur

Chapter Summary: Arising from the blood and ashes of WWII, our creation of the United Nations was one of the most bold and powerful steps forward in human civilization. The UN was chartered in order to, among other laudable goals, keep world peace and improve living conditions for people all over the world. Today the most significant threat to peace and stable living conditions is Climate Change which the UN itself has labeled an Emergency. To turn anywhere else but the United Nations to administer the task of Emergency Climate Repair would seem foolish.

The United Nations (the first global governance organization in the Universe – as far as we know ;-) was established on 24 October 1945 to promote international cooperation. It was founded to replace the League of Nations following World War II and to prevent another world conflict. To date it has succeeded! When it was founded, the UN had 51 Member States; there are now 193. Most nations are members of the UN and send diplomats to the headquarters to hold meetings and make decisions about global issues.

A LITTLE UNITED HISTORY

After World War I, the nations of the world formed the League of Nations. This organization was a place where nations could talk through their differences calmly. However, some countries like Germany, Italy and Japan ignored the League and tried to solve their problems through war. Members of the League of Nations did not want to go to war to protect other members and the League failed. A Second World War soon started. The earliest concrete plan for a new world organization to replace the ineffective League of Nations began under the aegis of the US State Department in 1939. The Allies of World War II often called themselves "the United Nations" (united against the Axis Powers).

On 12 June 1941, representatives of the United Kingdom, Canada, Australia, New Zealand, the Union of South Africa, and of the exiled governments of Belgium, Czechoslovakia, Greece, Luxembourg, Netherlands, Norway, Poland, and Yugoslavia, as well as General de Gaulle of France, met in London and signed the *Declaration of St. James's Palace*. This was the first of six conferences that led up to the founding of the United Nations and the *Charter of the United Nations.*

U.S. President Franklin Roosevelt first suggested using the name United Nations, to refer to the Allies of World War II, to British Prime Minister Winston Churchill during the latter's three-week visit to the White House in December 1941. Roosevelt suggested the name as an alternative to "Associated Powers", a term the U.S. used in the First World War (the U.S. was never formally a member of the Allies of World War I but entered the war in 1917 as a self-styled "Associated Power"). Churchill accepted the idea and cited Lord Byron's use of the phrase "United Nations" in the poem Childe Harold's Pilgrimage, which referred to the Allies at the Battle of Waterloo in 1815.

On 25th April 1945 in San Francisco, they decided on the name "'United Nations". In June they signed the United Nations Charter saying how the organization would work. The UN was created on 24 October 1945 and its first meeting was held in January 1946. Since, 1947 the 24th of October has been called “United Nations Day”.

All of the organs of the United Nations are based in New York City, USA, except the International Court of Justice which is located at The Hague in the Netherlands. UN also has important offices in Geneva (Switzerland), Nairobi (Kenya) and Vienna (Austria). The UN tries to be peaceful, but sometimes when talks do not work the UN, unlike the League of Nations, will fight too. In the 1950s the UN helped South Korea in a war against North Korea, and in the 1990s the UN helped to force Iraqi soldiers out of Kuwait. At other times, the UN has formed 'peacekeeping' forces. UN peacekeepers travel to troubled places in the world and try - sometimes successfully, sometimes not - to keep the peace.

THE UNITED NATIONS CHARTER

WE THE PEOPLES OF THE UNITED NATIONS DETERMINED
to save succeeding generations from the scourge of war, which twice in our lifetime has brought untold sorrow to mankind, and
to reaffirm faith in fundamental human rights, in the dignity and worth of the human person, in the equal rights of men and women and of nations large and small, and to establish conditions under which justice and respect for the obligations arising from treaties and other sources of international law can be maintained, and to promote social progress and better standards of life in larger freedom,
AND FOR THESE ENDS
to practice tolerance and live together in peace with one another as good neighbors, and to unite our strength to maintain international peace and security, and to ensure, by the acceptance of principles and the institution of methods, that armed force shall not be used, save in the common interest, and to employ international machinery for the promotion of the economic and social advancement of all peoples,
HAVE RESOLVED TO COMBINE OUR EFFORTS TO ACCOMPLISH THESE AIMS.
Accordingly, our respective Governments, through representatives assembled in the city of San Francisco, who have exhibited their full powers found to be in good and due form, have agreed to the present Charter of the United Nations and do hereby establish an international organization to be known as the United Nations.

THE SIX PRINCIPAL ORGANS OF THE UNITED NATIONS

1. UN Secretariat - Administrative organ of the U.N. Its chairman is the UN Secretary General
2. UN General Assembly - Deliberative assembly of all U.N. member states (each country has one vote)
3. U.N. Security Council - Responsible for the maintenance of international peace and security. The most powerful organ of the U.N., as it may adopt compulsory resolutions. UNSC has 15 members: five permanent members with veto power (China, Russia, France, the United Kingdom and the United States), and ten elected members
4. U.N. Environmental Assembly – Ministerial representatives from participating countries meeting every two years. Designed to be the "highest authority" on environmental matters.
5. The International Court of Justice - Universal court for international law (based in The Hague)
6. U.N. Economic and Social Council - For global economic and social affairs. Responsible for cooperation on economic and social fields (raising the general standard of living, solve economic, social and health problems, promotion of human rights, culture, education, and humanitarian aid). Has established numerous functional and regional commissions also coordinates the cooperation with the numerous specialized agencies of the United Nations. Has 54 members, who are elected by the U.N. General Assembly to serve staggered three-year mandates
7. Trusteeship Council (no longer meeting)

THE EIGHT SPECIAL AGENCIES (SOME OLDER THAN THE UNITED NATIONS ITSELF)

1. The United Nations Children's Fund (UNICEF)
2. The World Health Organization (WHO)
3. The Food and Agriculture Organization (FAO)
4. The United Nations Educational, Scientific and Cultural Organization (UNESCO)
5. The International Labor Organization (ILO)
6. The International Monetary Fund (IMF)
7. The United Nations Environment Program (UNEP)
8. The United Nations Development Program (UNDP)

The United Nations Headquarters in New York City – now threated by sea level rise due to global warming.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

Very importantly, the United Nations is home to the Intergovernmental Panel on Climate Change (IPCC) – an impressive coalition of thousands of scientists and researchers brought together at the request of member governments and dedicated to the task of providing the world with an objective, scientific view of Climate Change and its political and economic impacts. It was first established in 1988 by combining two existing UN organizations, the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP), and later endorsed by the United Nations General Assembly through Resolution 43/53. Membership of the IPCC is open to all members of the WMO and UNEP. The IPCC produces reports that support the United Nations Framework Convention on Climate Change (UNFCCC), which is the main international treaty on Climate Change. The ultimate objective of the UNFCCC is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic [i.e. human-induced] interference with the climate system."

CREDIT WHERE CREDIT IS DUE

The United Nations has been and is responsible for an amazing number of achievements around the globe such as: elections, reproductive health and population management, war crimes prosecution. Some examples:

The United Nations General Assembly

- The UN's World Food Program (WFP) provides food and assistance to some 91 million people in 83 countries. Additionally, WFP is planning for the future by developing programs to ensure a more stable food environment.
- The UN heads a campaign to end the use of leaded fuel (yes it's still around!) in over 100 nations
- Today, there are more than 68.5 million forcibly displaced people. The UN assists refugees fleeing war, persecution, famine and other global warming related suffering.
- The UN and its agencies supply vaccines to 58% of the world's children – saving 2.5 million lives each year. For example, the UN Children's Fund (UNICEF) and the World Health Organization (WHO) are core partners of the Global Polio Eradication Initiative, which has helped reduce polio cases by over 99% since 1988.
- The annual UN Peacekeeping budget is less than 0.5% of global military spending. The UN currently has more than 100,000 peacekeepers helping keep peace in 14 operations on 4 continents.
- The UN Advances democracy supports about 67 countries a year with their elections. The UN also uses diplomacy to prevent conflict.
- The UN Protects and promotes human rights through 80 treaties and declarations. The Universal Declaration of Human Rights is the first document to detail the fundamental human rights that must be protected. The declaration was proclaimed by the General Assembly in 1948. Security human rights is a key pillar of the UN's work.
- The UN fights poverty helping 370 million rural poor achieve better lives in the last 30 years.
- The UN mobilizes 12.4 billion USD in humanitarian aid to help people affected by emergencies.
- The UN promotes maternal health saving the lives of 30 million woman a year.
- The UN brought countries together in 2015 to launch a plan to end poverty, reduce inequalities, and protect the planet by 2030. The Sustainable Development Goals provide a common blueprint for countries to reach a world of dignity for all by 2030.

KEY CLIMATE AND ENVIRONMENTAL ORGANIZATIONS CONNECTED WITH THE UNITED NATIONS

There are now tens of thousands of professionals and para-professionals around the world participating in United Nations affiliated, or parallel meetings working on the issue of Global Warming. Compared to this number there is *only very small number working directly on the problem*. If this was WWII this would be akin to having 90% of our military working in office jobs studying and discussing the Nazi advance toward the United Kingdom. Global warming has overnight become a cottage industry with tens of thousands earning their living from the existence of this emergency.

These workers may feel they are doing something to solve the problem and many may be (although we yet do not have any positive results in terms of the one measure that is most important – reducing the amount of excess greenhouse gasses currently in the atmosphere). There is also a tendency to keep doing what one is doing. Lastly, politics loves complexity and we are living in an age that is increasingly risk-averse and inclusivity-oriented. One has the sense we could go on forever talking about change and how terrible it is rather than becoming focused and making change.

WHERE DO WE BEGIN

Okay so one of the things we need most right now is organization. Like I mentioned earlier, everyone can't put on a uniform of their own design, draw up their own battle plan, and run off toward the Nazi Blitzkrieg willy-nilly. Someone has to take point, pull things together and organize the effort to remove excess carbon emissions from the atmosphere. Give me a couple of billion dollars and a free hand with all UN programs and I will do it! I don't think that is likely to happen so here is a description of some of the organizations that could (with some modification and a bracing sense of urgency, adopt an approach in line with the ***Climate Deadline 2035 platform*** *being put forward in this book as follows*

The Intergovernmental Panel on Climate Change (IPCC)

Designed as a research-evaluative organization only, the IPCC was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) and was later endorsed by the United Nations General Assembly. Membership is open to all members of the WMO and UN. The IPCC

produces reports that contribute to the work of the United Nations Framework Convention on Climate Change (UNFCCC), the main international treaty on climate change. The objective of the UNFCCC is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system". The IPCC's Fifth Assessment Report was a critical scientific input into the UNFCCC's Paris Agreement in 2015.

IPCC reports cover the "scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation." The IPCC does not carry out original research, nor does it monitor climate or related phenomena itself. Rather, it assesses published literature, including peer-reviewed and non-peer-reviewed sources. However, the IPCC can be said to stimulate research in climate science. Chapters of IPCC reports often close with sections on limitations and knowledge or research gaps, and the announcement of an IPCC special report can catalyze research activity in that area.

Thousands of scientists and other experts contribute on a voluntary basis to writing and reviewing reports, which are then reviewed by governments. IPCC reports contain a "Summary for Policymakers", which is subject to line-by-line approval by delegates from all participating governments. Typically, this involves the governments of more than 120 countries.

United Nations General Assembly

Like much of the UN the GA was created during a different era entirely and has some major systemic flaws. Although public participation could now be easily be achieved technologically, only Member States and Permanent Observer Organizations may be on the floor for the debates. There is no mechanism for NGOs (Non-Governmental Organizations) to address or influence unless a Member State introduced an idea. The GA also has no ability to enforce any decision it makes – only persuade.

ECOSOC Science, Technology and Innovation Forum

Gives a "Chair's Summary of the Meeting" (does not include side events in the summary) - 2-day meeting of multi-strategic partnerships, again, side events are possible, costs money to reserve a room if your event is approved, always the chance in any -- repeat, ANY, no matter what the overarching conference is -- side event, if there are too many applicants, you will be asked to "share" the presentation with another group. You only have 75-90 minutes for any side event.

The UN High-Level Political Forum (replaced the former Commission on Sustainable Development)

High Level Political Forum - Event where Member States report on progress for SDGS and sometimes proposed modifications and additions. Three days of this two week event is set aside for the Environmental Ministers. Held in the first half of July every year - oversubscribed for side events. You will either share a presentation if you are approved (unlikely) for the side event or run the risk of having 10 persons come to your event, which could also be held across the street in the Church Center. Rental or rooms, of microphones, etc.

UN Framework Convention on Climate Change

The Paris Agreement on climate change was signed by the largest amount of countries ever in a single day. On Earth Day 2016, 174 world leaders signed the agreement at the UN headquarters in New York. The UN has clearly stated it’s commitment to fighting climate change, and the agreement builds on the UN Framework Convention on Climate Change. The 2019 United Nations Climate Change Conference, also known as COP25 The conference incorporates the 25th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), the 15th meeting of the

parties for the Kyoto Protocol (CMP15), and the second meeting of the parties for the Paris Agreement (CMA2).

Conference of the Parties (COP)

This is a conference between the parties to the current international agreements related to climate change. The most recent were the Paris Accords. The most recent conference was COP 26. An amazing 40,000 persons showed up in Madrid at the 2019 "event". A difficult deadline must be met to apply for accreditation to speak at the event itself. Side events can be proposed - luck of the draw for approval. COP 26 which will be chaired by the UK is scheduled to be held in Glasgow, Scotland in November of 2020. It is one of the more important COP meetings and many think the make or break meeting as to whether nations will step up their plans to meet the 1.5 or 2 degree C goal set in Paris. (Note: If you are planning a presentation keep in mind the UN is a union shop. You pay through the roof for simple support services that you are required to have.)

The UNFCCC Secretariat

Administrative organization for the United Nations Framework Convention on Climate Change (https://unfccc.int). The UNFCCC secretariat was established in 1992 when countries adopted the United Nations Framework Convention on Climate Change (UNFCCC). With the subsequent adoption of the Kyoto Protocol in 1997 and the Paris Agreement in 2015. Parties to these three agreements have progressively reaffirmed the secretariat's role as the United Nations entity tasked with supporting the global response to the threat of climate change.

UNFCC Secretariat

Responsible for organizing the COPs -- approves side events, etc., they do all the "heavy lifting" -- writing the outcomes, etc.

United Nations Environmental Assembly

The new UN Environmental Assembly is an intergovernmental forum created in 2012 to act as "the world's highest-level decision-making body on the environment". This is the meeting of all the Environmental Ministers from the nation states. In the U.S. that is the Secretary of State office. Consisting of 195 "Environment Ministers" from around the globe, the UNEA is designated as the highest-level environmental

decision-making body in the world. The UNEP is the working organization beneath this governing body, implementing the decisions of the Environmental Ministers. Ministers meet every 2 years in Nairobi. The Minister for the United States is normally and underling of the Secretary of State. Not all Ministers usually show up and the agenda is set ahead of time with side events usually in evidence. It takes a great deal of money and effort to get a side event approved. Very importantly, *a resolution on climate engineering is being considered at the 4th United Nations Environment Assembly (UNEA) in Nairobi, Kenya, in March 2019*. This is an important meeting to watch and will likely determine if this group has value for addressing the Climate Emergency.

United Nations Conferences

- Each year the United Nations hosts a number of regular U.N. conferences such as
- ECOSOC Science and Technology,
- High Level Political Forum, and
- Civil Society conferences such as the
- Global Communications program

ECOSOC Accredited Organizations

These organizations have the ability to request the Secretariat or a Member State to help hold a "consultation". (Might still cost money. Also, size of consultation, length, importance to you -- if you want to do something right hold it in the Dining Room since you cannot be bumped out of the space even if a Member State reserves the space. Dining Room, all day conference would run for 150 persons about $70,000.)

Non-Governmental Organizations

NGO's often coordinate with UN agencies and can also create their own events marketed to the 500 UNWTO affiliates or smaller events held at either the U.N. HQ in New York or the Geneva complex.

NGO Major Stakeholder Group

This represents the NGO "super groups" and includes the most NGO organizations and NGO leaders. (1 of the 9 major groups of Agenda 21.) This came out of the Earth Summit in 1992 and is the mechanism which allows Civil Society participation in most U.N. meetings.

(http://web.unep.org/environmentassembly/global-major-groups-and-stakeholders-forum)

EXAMPLE NGO: The Foundation for Climate Restoration (F4CR)

If public institutions like the United Nations and its affiliates fail us philanthropists must take center stage and pick up the ball!

F4CR is not actually part of the United Nations, but has been putting together forums for the UN focused on Climate Engineering. It's stated missions is to evaluate, develop and achieve global scale impact to restore the climate. The non-profit foundation began with a question: How might we reverse global warming and safely restore the climate and the Arctic ice by the year 2050? Today, we work with partners around the world - connecting the right people to the right ideas and resources - to launch financially viable Climate Restoration projects and, through the Climate Restoration Alliance, develop and deliver education, networking and advocacy programs.

"Solutions already exist to not just slow down climate change but to actually restore the Earth to the state it was in before the Industrial Revolution," said newly appointed Chief Executive Officer Rick Parnell. "These solutions are proven and effective. I am immensely proud to join an organization where I can encourage governments, NGOs, businesses and individuals around the world to join forces and get behind scalable, sustainable technologies that are our best hope for a healthy and habitable planet in the future."

The F4CR's goal is to return atmospheric CO_2 to historically safe levels of less than 300 parts per million by 2050. To reach that target, the Foundation is working with a cross-section of global partners around the world on a range of commercially viable projects.

"Our mission is to take specific solutions that have been in development for years," said physicist and F4CR Founder and Chairman Peter Fiekowsky, "and rapidly scale them up, by 2030, to the level required to effect real change. For example, Blue Planet Ltd.'s limestone aggregate solution can scale to remove a trillion tons – a trillion tons – of CO_2 from the atmosphere in 30 to 40 years."

"Under Rick's leadership," Fiekowsky continued, "and with our international experts, including the Foundation's Senior Policy Advisor Dr. Paul Zeitz in Washington D.C. and global leader and new

Board Member Melinda L. Kimble in Washington D.C., Ocean Expert Advisor Dr. Emma Roseline in Madagascar, and European Strategist Paul van Engen in Amsterdam, we know we will be able to fulfill our mission with strategic coordinated action on a global scale."

As the new CEO, Parnell is responsible for the direction and day-to-day operations of the F4CR and its sister organization, the Climate Restoration Alliance (formerly Healthy Climate Alliance). In his former position as Chief Operating Officer of the United Nations Foundation, Rick and the team helped mobilize $2.2 billion to support the UN agenda and build partnerships to solve global challenges.
Part of F4CR is the "Foundation for Global Climate Restoration" -- not a UN fund, that is a private Fund of undetermined size that deals with expenses relating to the climate restoration projects.
(https://foundationforclimaterestoration.org/climate-restoration-forum)

EXAMPLE NGO: The University of Cambridge Centre for Climate Repair

The University of Cambridge has recently established the *Centre for Climate Repair* to draw together research efforts on Climate Repair. Center founder Sir David King, an Emeritus Professor at Cambridge and former Chief Scientific Adviser to the UK government stated, "What we do over the next 10 years will determine the future of humanity for the next 10,000 years."

The University of Cambridge is launching a new research center to explore radical technological solutions including geoengineering to fix climate change. The Centre for Climate Repair will investigate radical approaches such as refreezing the planet's poles and recycling carbon dioxide (CO2) captured from the atmosphere. This first-of-its-kind research lab is being launched in response to the concerns of many climate scientists that reducing emissions might not be enough to stop or reverse climate change.

OH MY……

Okay so you're probably seeing the problem here. As usual, we humans have not yet learned to self-regulate. It's a wonder we even poop in toilets! Here we have layers and layers of organization (everyone getting paid and feeling good about themselves) and, as you read in Chapter Nine, on almost every measure of planetary health things are getting rapidly worse. Even the UN Secretary General

admits, "We are failing…" and especially *failing those most vulnerable* - future generations and plants and animals who cannot defend themselves against our onslaught of bad decisions.

In the space of only the last several years a vast number of organizations and initiatives have been started Again, using the Second World War as a comparison, it is as if dozens of armies all decided to fight back against the Nazi Blitzkrieg. A great thing, but will they just end up running into one another and tripping over each other – eventually becoming mired down in friendly fire incidents and bickering over strategy? Too many cooks do tend to spoil the broth.

Meshing nicely with these problems of *complexity, and inaccessibility*, Climate Change has also been cleverly *politicized*. This makes it difficult for educators to teach the science of global warming. Students are also not encouraged to become involved in the United Nations. UNESCO and UNICEF should develop and administer outreach and education programs for both developed and developing countries.

PUTTING THE PIECES TOGETHER IN THE RIGHT WAY

What are our take-aways from all this? Well, for one thing if you're feeling frustrated, disgusted and ready for your head to explode that would seem pretty normal. Basically the fate of our civilization is threatened (not to mention the Pandas in Australia), we've got tens of thousands of people from scientists to politicians to NGOs all getting paid to fix the problem, the UN charging $70,000 a day to rent out a dining room for a meeting and the boat is still sinking – *faster!*

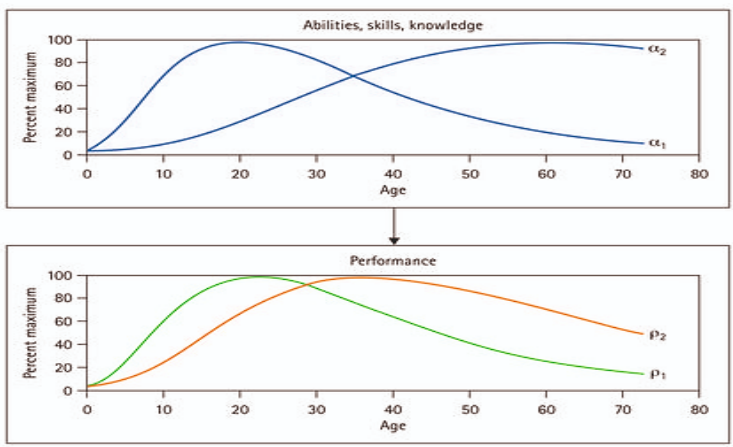
So, if your setting out to use the information in Climate Deadline to make change DO NOT buy it when someone tells you to get back in your place and let the "experts" handle things. There is only one measure here – success. It doesn't matter to our Grandkids (or the Pandas) if some "High Level Minister" feels badly about what's happen and scheduled another meeting. They (and we) *only had a good day dealing with our Climate Emergency if we moved the ball measurably closer to the goal of reducing atmospheric carbon*.

Now, the idea of "Climate Ministers" meeting every other year to make "decisions" about repairing our damaged atmosphere is kind of childish. We will need to reserve judgement and see how the March UN Environmental Assembly meeting plays out. If vigorous positive action does not appear it will be time to start finding ways to assist the UN in getting more serious. The more generalized focus of groups

such as Climate Strike, Sunrise Movement, and Extinction Rebellion should really be narrowed and directed toward the United Nations almost exclusively.

So, what should our demands be on the picket line? A measure that might be helpful (without threatening anyone's job security) is modifying the UNEA into a *United Nations Environmental Security Council* with the same operational guidelines as the Security Council with the exceptions of: (1) No veto, (2) A 55% supermajority vote, and (3) Open membership for all General Assembly member nations requesting to join prior to 2021. (After that the current membership would vote to add new members.) The decisions of the UNEC would be binding on all member nations and would be carried out by the already existing *UN Environment Program (UNEP).* Under UN75 this should be easier than usual. (The United Nations itself is currently, in a sense, up for review. The founders established a mechanism whereby after 75 years the United Nations could be modified if it was not functioning properly).

Who should these UNEC "Ministers" be? The segment of the world population most at risk from climate disruption are the young. They are also the most highly motivated for creative change. Studies at the Max Planck Institute found knowledge and decision-making performance normally optimize in the early 30s. Appointment of UNEC Representatives should focus on the 25-35 age group.



Pachur, T., Mata, R., & Schooler, L. J. (2009). Cognitive aging and the use of recognition in decision making. Psychology and Aging, 24, 901–915. Mata, R., Josef, A., Samanez-Larkin, G., & Hertwig, R. (2011). Age differences in risky choice: A meta-analysis. Annals of the New York Academy of Sciences, 1235, 18–29.

Another option to consider, the UN General Assembly (which does not have the ability to enforce its decisions) has the option – in extraordinary cases – to intervene if the Security Council (which does have the ability to enforce its decisions) cannot or will not do its job.

Also, members of the NGO Major Stakeholder Group can access and try to influence United Nations activities.

Finally, there is the option of making Climate Change a global security issue before the U.N. General Assembly. This is the mechanism the U.N. has when the U.N. Security Council is not able to do its job. It is a last resort option to mobilize global action. This is a strategy has only been used once in the history of the U.N. and that was back in 1956 during the Suez Canal Crisis. For this mechanism to be used, it would require Member States to do an enormous amount of work and would likely be nearly impossible. But with enough popular pressure who knows what might be accomplished.

MOSTLY GOOD NEWS

I hope you noticed that ultimately the news here is good. We not only have the technology and the public concern to resolve our Climate Emergency, but we also have organizational structures with the global reach required to coordinate Emergency Climate Repair. All we really need to do is get serious, put the pieces together in the right way and scale our interventions up to a global level.

Thousands of people are now earning their living both from causing and trying to remediate Global Warming. This creates a problematic dynamic. While scientists and staffers need to be compensated the decision makers should really be *volunteers* – those who are in the fight because it is the right thing to do not because they make a living from it. Often seen as lesser participants, volunteers are in reality a much higher order of worker. They work because they have a calling and the skills to do so – not because they followed a career ladder where they made the right maneuvers to "get where they are today" and are keeping one eye on their competition and protecting their turf.

Also, nearly all of the humanitarian resources of the United Nations and its surrounding organizations, governmental and NGOs is going to *mitigation* – fixing the damage from Climate Change and *almost none* to preventing / repairing the problem. While it is appropriate, kind and generous to want to assist those who are suffering, we first and foremost need to be directing resources, energy and time to the

massive mobilization needed to *repair the problem that is causing the suffering*. (To not do so is probably another symptom of the denial related to climate shock.)

With a Climate Deadline rushing up on us in as little as 15 years, we must move very rapidly to effect Emergency Climate Repair. We must coordinate nations and industries with the rapidity we did when facing the Second World War. Climate Change is no less real, no less urgent, much more all-encompassing….and final. (Not even armies mess with Mother Nature.) Only an adapted, somewhat-ruthlessly pragmatic and fully-supported United Nations can meet this threat with the speed and power necessary to restore our children's future that, as things stand, is already forfeit.

There are a variety of problems which may arise in focusing the resources of the United Nations on Climate Repair. One unique problem may be the very tendency for humanitarians to want to end suffering! Again, using WWII as an analogy – it was necessary at that time for the Allies to cause a great deal of suffering in order to repair what was broken. A high degree of ruthless pragmatism was necessary. Sometimes the doctor must ignore other problems to focus on the one that is life threatening to the patient (in this case the patient is planetary ecosystem we all depend on for life.) As noted earlier, we will simply run out of money and energy if we keep up with our reactive approach to Global Warming. As I write this Zimbabwe, once considered the breadbasket of Africa, is suffering what the World Food Program (WFP) is calling an "unprecedented climate disaster" after 5 years without a harvest. The WFP says an immediate $300 million dollars is needed to avert widespread starvation.

Recently I drove through the Las Vegas valley. On both ends were miles of solar panels working very hard at sustainability. Closer to town were huge cement factories (the third largest emitters of atmospheric carbon) working very hard at emitting carbon into the atmosphere. The city of Las Vegas itself could not be seen from 5 miles away - almost completely occluded with a thick haze of pollution. The solar panels were not keeping up with the cement factories even in fun city!

CHAPTER THIRTEEN: RESTORING YOUR CHILDREN'S FUTURE

"Never give in — never, never, never, never, in nothing great or small, large or petty, never give in except to convictions of honor and good sense. Never yield to force; never yield to the apparently overwhelming might of the enemy." *- Sir Winston Churchill*

Chapter Summary: This in not "Business as Usual". We all need to behave with the urgency that a 15-year Climate Deadline demands. It is recommended starting now, that every wage-earning adult living in a developed country contribute 5 hours a week and 5% of their family income toward seeing that *Direct Atmospheric Removal of Excess-Carbon and Solar Radiation Management* are put into action by 2025. If you set that as you goal, even if you fall down sometimes and even if we fail, you will be able to tell your grandkids you were there when the bell rang and you stood up and you did your best for them.

Right now, *today*, we have the technology and the resources to begin the Direct Atmospheric Removal of Excess Carbon using either *Land-Based Direct Air Capture* (a la Harvard's David Keith) and *Ocean Based Carbon Capture & Reflection.* We also have safe and viable techniques for rapid atmospheric cooling – and the capability to combine We even have an organization (the United Nations) ready,

willing and able to accomplish the work needed. Why isn't the problem getting fixed?

A ROADMAP FOR CLIMATE DEADLINE SUCCESS

Barring intervention from extraterrestrial neighbors, a rogue asteroid, or Heavenly Angels, the pathway which will need to be followed to resolve the immediate Climate Emergency is pretty clear. *(yes, you saw this platform of observations and recommendations in Chapter One also):*

(1) That the Earth is unable to continue to process the massive overwhelming accumulation of legacy greenhouse gas (GHG) emissions already in the atmosphere using Her own systems in a timeframe needed to avert a shift out of our current life-sustaining ecological balance

(2) That these, as-of-yet-uncontrolled-emissions are pushing our planetary ecology beyond the *Anthropocene Catastrophic Extinction Boundary* into a "new normal" inconsistent with the survival of most species of life currently on the planet. That, because of the interconnectedness of our natural world, the changes affected by Global Warming are not linear but rather exponentially expanding feedback loops. While we do not fully understand these feedback loops, we know they are increasingly foreshortening the time available to resolve this Climate Emergency. Unable to escape Earth's greenhouse-gas-saturated atmosphere, radiative heat is warming our oceans triggering increasingly intense storms, floods and coastal flooding ➡ leading to the melting of precious polar ice ➡ causing the release of massive stores of methane ➡ leading to ocean current disruption and acidification ➡ causing in turn altered weather patterns ➡ leading to enduring drought ➡ triggering wildfires (and flooding) ➡ leading to crop failures ➡ contributing to the birth of novel carbon ➡ releasing soil microbes ➡ causing the release of massive carbon stores from soil ➡ and famine ➡ leading to mass migrations ➡ which in turn overwhelm the ability of governments to respond ➡ causing social unrest and territorial wars and on and on. As is apparent, *linear projections of the progression of Climate Change are hopelessly inaccurate.* Nature cannot be viewed as isolated parts any more than countries can be viewed in a "flat Earth" fantasy of isolation from one another. Even the most optimistic scenarios show that around 2035, Earth will *lock into 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.) These "new normal" tipping level changes are already well underway including:
• Slowing and redirection of ocean currents which distribute heat around the planet.
• Melting of ice and permafrost at both poles.
• Release of vast stores of methane from beneath melting permafrost and ice.
• Altered insect borne disease vectors.
• Reduced or destroyed animal habitats and species.
• Emergence of new soil microbes which release carbon from the ground.
• A breech between plants and pollinators.
• Altered weather patterns leading to loss of life and costly infrastructure damage.

(3) That Global Warming, caused by GHG emissions and the resulting disruption of Earth's natural systems, is causing massive immediate and future suffering and death and is a *Clear and Present Danger* to most currently existing life on the planet. That the *Life and Liberty* of future generations have already been exterminated *unless restored* by emergency measures taken in the next few years making remainder of human endeavor and activity *only* palliative and mitigatory.

(4) That, because global warming is caused by anthropogenic changes humans have forcing in our environmental support system, those who cause and support such damage to our common life-support systems are a Clear and Present Danger to humanity.

(5) That, informed by this awareness of present and future suffering, we must find the strength and determination to shift from our current "business as usual" approach to human endeavors and adopt a "war footing". We must quickly build the *severe and unrelenting resolve* needed to act affirmatively to remediate Global Warming – whatever the costs or benefits.,

(6) That this includes a refusal to engage in, or permit "war profiteering". While all people have a right to the median standard of planetary living, no one has a right to profit from a declared *Global Emergency.* This includes selfish attempts to patent or possess intellectual or real technology which would reasonably be expected to

result in the resolution of this emergency until such time as that resolution has been achieved.

(7) That accidental and deliberate delay in taking action has now left us with a very short timeline to manage this Global Emergency (450 ppm atmospheric carbon predicted on our current trajectory to arrive in the mid-2030's). Geological records indicate that we have until perhaps the mid-2030's (or whenever we reach 450 ppm atmospheric carbon) before the above interactive feed-back loops in the environment shift to a "new normal" that is incompatible with continued human survival. That regardless of whether this timeline is realistic it is no longer dictated by us but by nature and so is *the only possible timeline*. This timeline looks roughly like this:
2020-2022: United Nations systems, government and industry organized toward Climate Engineering. Selection of methodology and mobilizing of resources. • Years 2022-2025: Emergency Climate Engineering underway. • Years 2025-2030: Global temperatures returned to less than 350 ppm.

(8) That the advance of Climate Disruption is continuing to accelerate. Right now, for example, the Arctic 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 2º 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 ºC of Eemian warming 120,000 years ago.

(9) That we must now support nature in recovering from the damages we have inflicted and use human-derived methodology to solve this human-caused problem in a one-time effort. While 40 years ago we could have and discontinued greenhouse gas emissions by shifting to alternative energy sources and waited for the Earth to clean up our mess for us, this line of thinking and action is now seriously distracting us from repairing our climate. There is already too much carbon in the atmosphere which will take up to thousands of years for the Earth to cycle out of the atmosphere on its own while human-caused GHG

emissions are continuing to increase despite stated international intentions otherwise. *Climate Engineering Now, Sustainability Later!*

(10) That to withhold or delay the use of Climate Engineering technology to assist and support our atmospheric and ecological systems in recovering to a level which will again sustain human, plant and animal life is the direct equivalent of the taking of human life.

(11) That methodology is *currently available to resolve our Global Emergency* in the form Climate Engineering – specifically Land-Based Carbon Removal, Ocean-Based Carbon Removal and Solar Radiation Management.

(12) That, while private funding is free to explore other avenues, due to the emergency nature of the current crisis we must now limit our efforts to refining and deploying the existing technology in these areas on a global scale.

(13) That the *United Nations* was established and is funded ultimately by The People through their various governments to manage global emergencies and should be *expected* to use these technologies to resolve Global Warming. To not do so would demonstrate genocidal negligence.

(14) That in order to accomplishing this work, elements of the United Nations should be modified until that the organization has the necessary representation, administration, enforcement and regulatory capacity to complete this work.

(15) That once the Climate Emergency is resolved (e.g. legacy carbon emissions returned to below 350 ppm), we must then have the resolve to judiciously withhold additional use of this technology until, operating through the United Nations, a new ethic for *working with* our planet's systems (rather than abusing, degrading and damaging them), and for establishing carbon neutral and sustainable practices can be put in place. This will necessarily include adoption of alternative sources of energy, population and resource management. We will essentially need to learn to *regulate ourselves within the ecological balance of our planet* as well as we have learned to exercise our freedom, independence, covetousness and gluttony.

WE MUST BEGIN NOW!

The time for doubting and distrusting is over. The time for research and discussion is over. Emergency Climate Repair will take time, coordination and resources to establish – a massive mobilization on a scale not seen since World War II. We must begin NOW! This will require (1) *A huge push* by the general public concerned about the future of their families and (2) *Pushing in the right place* – the only global organization designed and funded for handling international crises -*The United Nations*.

Public opinion polls show that many, or most Americans now believe climate change is a major problem that needs to be dealt with. Despite these beliefs, an effective, sustained grassroots movement to influence climate change policy has not developed in the United States. Stanford University Sociology Professor Doug McAdam (Annual Review of Political Science) identified several factors that help to account for the relative lack of action on climate:

(1) Social pressure from the relentless denial of the reality of climate change by anti-climate change forces creating fear and doubt.

(2) Increasing gridlock in Congress, making bipartisan action on any issue difficult.

(3) Lack of "ownership" of the issue by any significant segment of the American public, or any one country (in contrast to issues such as police violence against African Americans or sexual assaults against women, or the threat of deportation against Hispanics).

(4) Difficulty seeing the urgency of the situation. Mistaken extended "time horizon" associated with the issue, which reassures many that the impact of climate change is still off in the nebulous future.

(5) Our passive "observer-entertainment culture". We have been trained to default to this position which then allows those with vested financial interests to continue with business as usual.

(6) Desensitization to disasters.

(7) The mistaken idea that government or environmental organizations are taking care of things.

(8) There are too many other things to worry about (Russia, North Korea, healthcare, terrorism, border walls, impeachment hearings, etc).

(9) We have been told our government doesn't have enough money to do anything.

(10) The complexity of the situation.

(11) Lack of coordination among nations in dealing with this global problem.

There is a lot here to overcome and yet there is much more to lose! This was also true in World War II. Especially from the point of our neighbors across the pond in Great Britain things were touch and go, but and the forces of good prevailed. We have all we need to succeed again, but only if we want it bad enough.

WE CAN DO THIS, BUT ONLY IF WE DO IT!

As the UN Secretary General Antonio Guterres so clearly stated at the outset of Climate Deadline 2035, we must come together *now* over the realization that our children's future does not ultimately depend on any of the many things we are doing for them now. We can forget to change a diaper, or give them something less nutrition for dinner, or not save for their college, or skip their wedding and they will still survive and, hopefully, thrive. The *ONE THING* we cannot fail to do is stop atmospheric carbon levels from reaching 450 ppm and passing the Climate Deadline and initiating a shift in the components of our Holocene environmental leading to a planet uninhabitable by many of the species (including us) alive today.

It's very difficult to break ourselves out of the normal patterns of behavior. In world wars we had military's we could enlist in and support and governments behind those militaries. We are currently living in a fragmented society bred for passivity, consumption and entertainment.

And there lies the challenge before us – the reason for this book. The technology is there. The pieces haven't been put together before in exactly the same way, 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 overcome.

There is, however, the *human barrier* which must be surmounted! We must actively raise our awareness out of the day-to-day 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". We must first clean up our mess before we can go on to sustainability. As we have done several times throughout history, we must rise to the occasion and demonstrate that humanity is capable of cooperating for the greater good.

Take a moment to think about what you have learned in this book. Think over recent events, the suffering migrants who have lost their homes to drought, pictures of flooded cities, the wildfires raging through neighborhoods, the storms growing more powerful each year. You know in your gut and your brain where all this is headed. Now try to imagine that ending – the wealthiest 1 percent circling the wagons as far north as they can get, protected by private armies. Everyone else living through the chaos of some dystopian movie come to life. Is this the future you want for your children and grandchildren. Currently it is the only one available – unless WE create something different.

Now imagine the pride of standing next to those you are working with to make DARE and SRM a reality. Like soldiers on a winters night you are facing long odds, but your cause is the most just! And you are no longer alone in the disarray and division that had (by the design of those who stand to benefit) enveloped society.

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 (not in the 1%) is there really a choice?

Each and every one of us must find a way to move us forward toward *Emergency Climate Repair* a reality. Join an organization like those listed at the end of this chapter. If they aren't already working toward Emergency Climate Repair then push them to change. If they won't cooperate and you have tried long and hard, start your own organization – call it the Emergency Climate Repair Cooperative and get listed on Meetup.com, Linked-In and Facebook. Take your next vacation in New York and demand a meeting with the UN Secretary General's staff with a one-page information sheet distilled from this book or others like it. Write or call your representatives at all levels of government. Make a sign for your car or your yard. Start a group

at your church. Every effort counts and we really are running out of time!

In this effort we must be willing to "break some eggs" and even get egg on our faces. In World War II (again for example) – a horrible but far, far less serious conflict with much less at stake – in occupied countries people were willing to risk their very lives to achieve even small forward progress. They stood their ground "to the last man". We must daily remind ourselves that this conflict is even more needful of our risk and sacrifice. It is, in fact, bigger and more final than the hypothetical WWIII that has been the dread of the world since before I was born. *Unless you and I take action now* we *will* inexorably reach the 450 ppm tipping levels, and we *will* lose control of our oceans, polar ice, coastal cities, agriculture, and even the air we breathe. It is obviously imperative that we do not let this happen.

For all the corruption and greed and excess 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 long 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.

Is Climate Deadline 2035 naïve? How about that Declaration of Independence, signed by idealistic folks who had clear evidence their lives and liberties were being oppressed. They faced forces vast, interwoven and dead-set on their own agendas of profit and power. Have you ever read a more "naïve" document? Yet, every signer of the Declaration of Independence knew that, if they lost the effort, they were signing their own death warrant. They believed what they were doing was not naïve and did it anyway!

We are all going to die someday – no way around it. The only difference is if we go out on our knees or on our feet - standing up for something and leaving something of the best of ourselves behind.

Please, please stand up with me now. Like me you may be just a regular person – no big connections, no big resources. But if you look around you will eventually see a place to start – and start you will because now you *know* what is at stake and you *know* there is a way and *you can't unknow it!* The purpose of Climate Deadline 2035 have been to give you honest data on where we are now and a pathway

forward. It is up to you now to discern how you can be of service to your family, your country and the Earth.

Recent Dust Storm in Arizona

THE BOUNTIFUL ECONOMICS OF CLIMATE REPAIR

If we win our freedom there is a big upside! From a poverty perspective, Climate Change impacts are projected to slow down economic growth, make poverty reduction more difficult, further erode food security and prolong existing poverty traps and create new ones, the latter particularly in urban areas and emerging hotspots of hunger (medium confidence). Climate change impacts are expected to exacerbate poverty in most developing countries and create new poverty pockets in countries with increasing inequality, in both developed and developing countries.

One of the amazing paradoxes of war is that massive mobilizations also, historically, bring massive economic expansion in their wake. DARE/SRM will take a sustained major effort. There will be short-term investment required to build the technology to scale. However, successful implementation of DARE would forestall an estimated *$400 trillion* in damage – and that's just in the near term - including the permanent loss of hundreds of coastal cities around the world to a 30-foot sea rise.

Climate Change is a total loss, while investment in DARE/SRM would stimulate an even larger economic expansion, likely the largest in human history, likely exceeding even the period of growth after WWII.

Some forms of DARE would also help meet the doubled energy demand that is anticipated by mid-century.

DARE is estimated to enable a 60 percent rise in food production (as called for by the United Nations). Drought relief could be possible with this project. It is possible to target drought-parched areas for extra raincloud seeding from dimethyl sulfide (DMS) released by dying EHUX. With approval from conservationists and planners we could stimulate greening in strategic parts of South America, the American Southwest, East Africa, Mexico and, or India - radically boosting food production in those areas. The economic impact of creating tens of millions of new jobs, doubling energy revenues, and adding 60 percent more food production could be enormous.

There may be other less tangible, but even more important benefits of this process of coming to terms with Climate Disruption. Admittedly our world societies have become increasingly fragmented. (How many times have you heard someone say, "The only thing that will bring us all together is an attack on our whole planet by aliens from outer space." Well, climate disruption was not caused by aliens, but it is certainly an attack on our entire planet!) The more fragmented we become the less able we are to govern ourselves and the more power is assumed by those who seem to want everything for themselves. While those at the top get richer and consolidate their holdings, those at the bottom are kept distracted by crises (real or manufactured) or

encouraged to "blow off steam" with entertainment and ever-present media "outlets". (God forbid that steam be directed at that ever-widening gap between those at the top of the corporate empires and those kept busy struggling to make ends meet.)

And one of the benefits I like the best is if we DARE to take the right path now – no one dies!! (If we do not pretty much everyone does.) Will the mobilization to DARE be difficult and challenging? Definitely! But no solutions other than DARE appear capable of rescue our atmosphere – and thus our civilization!

Like the predictions given to Ebenezer Scrooge by the ghosts of Christmas, if our future remains unchanged, there is a high degree of probability it will be unpleasant for us, miserable for our children, downright nasty for our grandchildren, and just a cruel scramble for survival after that. This is one point all the experts agree on – unless we get Climate Change under control a quick death by nuclear bombardment is going to look pretty good by comparison.

Although the rise of sustainable practices and technology may soften the picture somewhat, our future without direct atmospheric carbon removal includes political instability, floods and mudslides, wildfires, droughts, storm damage, ocean acidification, infrastructure loss, climate refugees and mass migrations, melting glaciers, sea level rise, famine, water scarcity, ecosystem loss, infectious diseases, and mass species extinction, most likely including humans. Basically, your kids and their kids are in for a rough ride and beyond that……

Direct Atmospheric Removal of Excess-Carbon 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 the Climate Emergency. We must actively raise our awareness out of our day-to-day concerns and the political buffoons dancing to distract us and 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 2030's point of no return. Society is currently fragmented often and at-odds, but that has often been the case throughout history.

The timing is bad, but as we have done before 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 Climate Deadline 2035, you have entered the ranks of those who are aware of our climate situation, the emergent deadline we are under, and the solution of Direct Atmospheric Removal of Excess-Carbon. Once learning this you can't unlearn it! Your 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 after the mid-2030's it will be too late for them to repair the mess we are leaving). 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 restoration of our natural atmospheric balance a reality. Like soldiers on a winters night we are facing long odds together, 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 (again).

Suppose what you have read here about the extent and urgency of the Climate Emergency is exaggerated? What's the downside of pitching in to make things better? Nothing! On the other hand, what is 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***. Let's get busy and fix this shall we!

SPECIFIC THINGS YOU CAN DO TODAY:

I encourage you to think of *Climate Deadline 2035* the way you would a book on exercise and fitness. It's not going to do much good if you just read the book. The results come from putting what you have learned into action! If the ideas below aren't enough or you don't know where to start just get in touch and we will assist!

TELEPHONE: 1-800-844-0824
EMAIL: climaterepair@protonmail.com

1) Contact the State Department, your UN Environmental Minister, your state and national representatives, and anyone else you can think of and demand a committee to push for the United Nations Environmental Assembly to meet in March and fully support Climate Engineering solutions to Global Warming.

2) Decide to set aside 5 hours each week and 5 percent of each paycheck to promote UNEC/UNEP, Climate Repair and groups that are working toward this end.

3) Cut and paste the information here and share about Climate Repair and the UN Solution with all your social media networks. If you have an email list of friends and family send them the information. (So many people today are feeling hopeless and fearful regarding Climate

Change. You will be doing a great service letting those you care about know there is something they can do to solve the problem.)

4) Write an article, blog or letter to the editor for your workplace or social group or even your local newspaper.

5) Visit our sister site at www.theclimatelawsuit.com to get bumper stickers, baseball caps and other Climate Repair merchandise.

6) If your already involved with an environmental organizations let them know about what you have learned in Climate Deadline 2035. Many still mistakenly believe recycling programs and alternative energy will be enough to get us past the current emergency.

7) Extinction Rebellion (XR) has emerged recently as a particularly important Climate Change organization that needs to hear about and be encouraged to work with or demonstrate against the United Nations. Share what you have learned!

8) Younger people are waking up to the travesty Climate Change means for them. Give talks based on this book at schools, colleges, youth groups, a local YMCA.

9) If you have contact with a high-visibility individual (a movie or recording artist, or other well-known person) talk to them about what they can do to promote DARE and SRM and, or refer them to talk with our team.

10) The sky really is the limit – if you think about it you have nothing to lose and everything to gain. Write a book, run for governor, file a lawsuit in District Court :-)

11) Fossil fuel companies are crucial. If you can push one, push! They have the resources and the duty to implement Climate Repair. They know resources are running out and are the feeling pressure. Converting their use from the conventional "dirty" consumption to 90 percent efficient CCS consumption would benefit everyone. Currently Sunoco is the only oil company that has signed the CERES (Coalition for Environmentally Responsible Economies) principles, is a Global Sullivan Principles Signatory, and has a non-discrimination policy. Sunoco is also a BELC (Business Environmental Leadership Council) member, and they have officially stated that they acknowledge that Climate Change is affecting our planet adversely. By contrast, a Harvard University analysis of hundreds of ExxonMobil documents

found that the company deliberately tried to hide the truth about the direct connection between carbon emissions and global warming.

12) It's VERY important that you get involved in a group working on climate change! Everyone should be! Think of it this way - If everyone went off to fight WWII on their own willy-nilly without being part of a military organization the war would have been lost. As was true with that crisis we need to organizing groups to keep our focus on what needs to be done and stay in action. Also, most organizations are still stuck in the renewable-sustainable version of the future that is NOT going to work. Tell them what you have learned here about Climate-Engineering and convince them to start an exploratory committee or to immediately push for the establishment of a program for *Direct Atmospheric Removal of Excess-Carbon* and *Solar Radiation Management*. There is strength in numbers, and this is the only way this is going to get done! Here is the list

350.org
American Farmland Trust
American Forests
American Horticultural Society
American Oceans Campaign
American Rivers
African Wildlife Federation
Center for Marine Conservation
Chicago Wilderness
Citizens' Environmental Coalition
Climate Mobilization
Climate Strike
Defenders of Wildlife
Earthhope Action Network
EarthJustice
Extinction Rebellion
Environmental Defense
Environmental Working Group
Extinction Rebellion XR
Friends of the Earth
Greenpeace USA
International Wildlife Coalition
League of Conservation Voters
Museum of Science, Boston,
National Audubon Society
National Environmental Trust
National Geographic Society
National Parks Conservation Association
National Religious Partnership for the Environment
National Resources Defense Council
National Tribal Environmental Council
National Wildlife Federation
Nature and Environmental Writers
Nature Conservancy
New Mexico Environment Law Center
Orion Society
Physicians for Social Responsibility
Rainforest Action Network
Sierra Club
Student Environmental Action Coalition (SEAC)

Sunrise Movement	Wildlife Conservation Society
Trust for Public Land	World Resources Institute
Union of Concerned Scientists	World Watch Institute
Wilderness Society	World Wildlife Fund.

13) Don't underestimate the emotions and psychological challenges of coming to terms with our Climate Emergency. Try not to isolate – share your feelings with someone. There are also a great many opinions, approaches and beliefs out there – including about the role of our government and corporations in Climate Change. (A friend recently shared his belief that there are many businesses our there that welcome Climate Change because governments and individuals will be buying their products to cope and mitigate the problems!) We need to stay proactively focused on the first goal which is Solar Radiation Management and Direct Atmospheric Removal of Excess Carbon. This is a war and in war we need to not get pulled off course by emotions, other perfectly reasonable considerations, other people's agendas, etc. either we accomplish the goal, or we do not. We must stay below 450 ppm and then become sustainable. That's it.

The ability to process information and make decisions without being disabled by extreme emotional responses is threatened by climate change. Some emotional response is normal, and even negative emotions are a necessary part of a fulfilling life. In the extreme case, however, they can interfere with our ability to think rationally, plan our behavior, and consider alternative actions.

An extreme weather event can be a source of trauma, and the experience can cause disabling emotions. More subtle and indirect effects of climate change can add stress to people's lives in varying degrees. Whether experienced indirectly or directly, stressors to our climate translate into impaired mental health that can result in depression and anxiety (USGCRP, 2016). Although everyone is able to cope with a certain amount of stress, the accumulated effects of compound stress can tip a
person from mentally healthy to mentally ill. Even uncertainty can be a source of stress and a risk factor for psychological distress (Greco & Roger, 2003). People can be negatively affected by hearing about the negative experiences of others, and by fears—founded or unfounded—about their own potential vulnerability.

Following disasters, damage to social or community infrastructural components, such as food systems and medical services, results in many acute consequences for psychological well-being. In contrast,

gradual impacts of climate change, like changes in weather patterns and rising sea levels, will cause some of the most resounding chronic psychological consequences.

Acute and chronic mental health effects include the following:
• Trauma and shock
• Post-traumatic stress disorder
• Compounded stress
• Strains on social relationships
• Depression
• Anxiety
• Suicide
• Substance abuse
• Aggression and violence
• Loss of personally important places
• Loss of autonomy and control
• Loss of personal and occupational identity
• Feelings of helplessness, fear, fatalism, nostalgia, and eco-anxiety

In order to support individuals' success in becoming resilient, the following are tips to consider that address personal attributes and support social cohesion:

- Build belief in one's own resilience.
- Foster optimism.
- Cultivate active coping and self-regulation.
- Find a source of personal meaning.
- Boost personal preparedness.
- Support social networks.
- Encourage connection to parents, family, and other role models.
- Uphold connection to place.
- Maintain connections to one's culture

Climate solutions not only improve the quality of our air and food but also enhance our cognitive abilities and strengthen our mental health.

- Physical commuting, such as biking or walking, can reduce stress and other mental illnesses, as well as improve cognitive function and
- academic performance.
- Public transportation invigorates community mental health by

- creating opportunities and networks to increase community cohesion.
- Green spaces reduce people's stress levels and promote positive social interactions.
- Clean energy benefits lung function in children and can help prevent
- symptoms of anxiety and depression that are brought on by pollution.

14) We suggest you sit down with those close to you and brainstorm ways of assisting with Ocean Assisted Carbon Capture & Reflection. No contribution is too small or too large in this time of world crisis. If you need ideas contact us. **Send us your own ideas and we will add them to the next edition!**

Most Importantly – If you feel the information in the book is important pass it on to everyone you know including all your social networks. We don't have time for the regular routes of publication. This book is only found on Amazon. That means no one sees it unless they hear about it, or happen to run into it doing a search, OR YOUR TELL THEM. I believe we need this information to "go viral" and only you can make that happen!"

"The world will not be destroyed by those who do evil, but by those who watch them without doing anything."

- Albert Einstein

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