The Climate Crisis and a Renewable Energy and Materials Economy (REME): A Global Green New Deal (GGND) that Includes Arctic Sea-Ice *Triage* and Carbon Cycle *Restoration*

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Abstract: A Global Green New Deal (GGND) that Includes Arctic Sea-Ice Climate Triage and Carbon Cycle Climate Restoration, and that, following (Eisenberger, 2020), would move us toward a Renewable Energy and Materials Economy (REME), is necessary to turn our current civilization and species threatening climate crises into an opportunity to stabilize our planet's climate and advance to a new more equitable and prosperous stage of human development. Immediate, potentially catastrophic, global climate impacts of imminent Arctic Sea-Ice loss, the first global climate "tipping point", are reviewed, and practical and efficient potential climate triage methods for avoiding this are summarized. Longer-term Direct Carbon Removal (CDR) and Carbon Storage, Sequestration, and Use (CCSU) methods that would move us toward long-term carbon cycle climate *restoration* are presented. A general reframing of climate policy, and specific GGND policy proposals that include Arctic Sea-Ice climate *triage* and carbon cycle climate *restoration,* that would rapidly move us toward a REME and avoid increasingly catastrophic climate impacts are proposed.

I. Introduction

A Global Green New Deal (GGND) is a critical transformative goal that needs to include practical climate triage and restoration in addition to mitigation and adaptation. This is because climate change is fundamentally a "closing the carbon cycle" reuse problem, and as it is impossible to reuse as much carbon as we need to sequester in the coming decades, also a carbon sequestering waste management problem (Eisenberger 2020) (Lackner et al 2012). In the short run the climate can and must, due to the time urgency, be addressed within *existing* capitalist social and economic systems and with *current* and evolving infrastructure and technologies including emergency climate *triage*. However, in the long run the climate crisis is an opportunity to transform the forces *and* relations of production in ways that restore a stable climate and reduce or eliminate energy and materials scarcity allowing for the possibility of a more prosperous and just economy.

Figure 1 below suggests that *mitigation* (or Green House Gas (GHG) emissions reduction) and *adaptation* (to increased global warming) alone will be inadequate to prevent ever greater climate catastrophe. Urgent climate *triage* (to slow or prevent the Arctic sea ice from melting) and *restoration* (Carbon Direct Removal (CDR) and Carbon Capture, Sequestration, and Use (CCSU)) must be implemented as well.[1] The need for climate restoration, or negative emissions, has now been officially acknowledged as necessary to stay "well below" 2.0 degrees Celsius global warming as stipulated in the Paris Accord (IPCC 2019; National Academy of Sciences 2019; UNCC 2021). This welcome acknowledgment highlights the fact that GHG

[1] In 2014, 76 percent of GHG emissions were carbon dioxide, 16 percent methane, 6 percent nitrous oxide, and 2 percent F-gases. About 50 percent of carbon released into the atmosphere will be removed within 30 years, a further 30 percent within a few centuries, but the remaining 20 percent may remain for many thousands of years (IPCC 2007). As methane and nitrous oxide are less abundant and removed more quickly (average lifetime 8.4 and 120 years, respectively, the focus of GHG climate change analysis in this paper is on carbon dioxide, though Methane, for example, is a much more potent GHG in the short run than carbon dioxide (IPCC 2018: Table 4.1(a)).

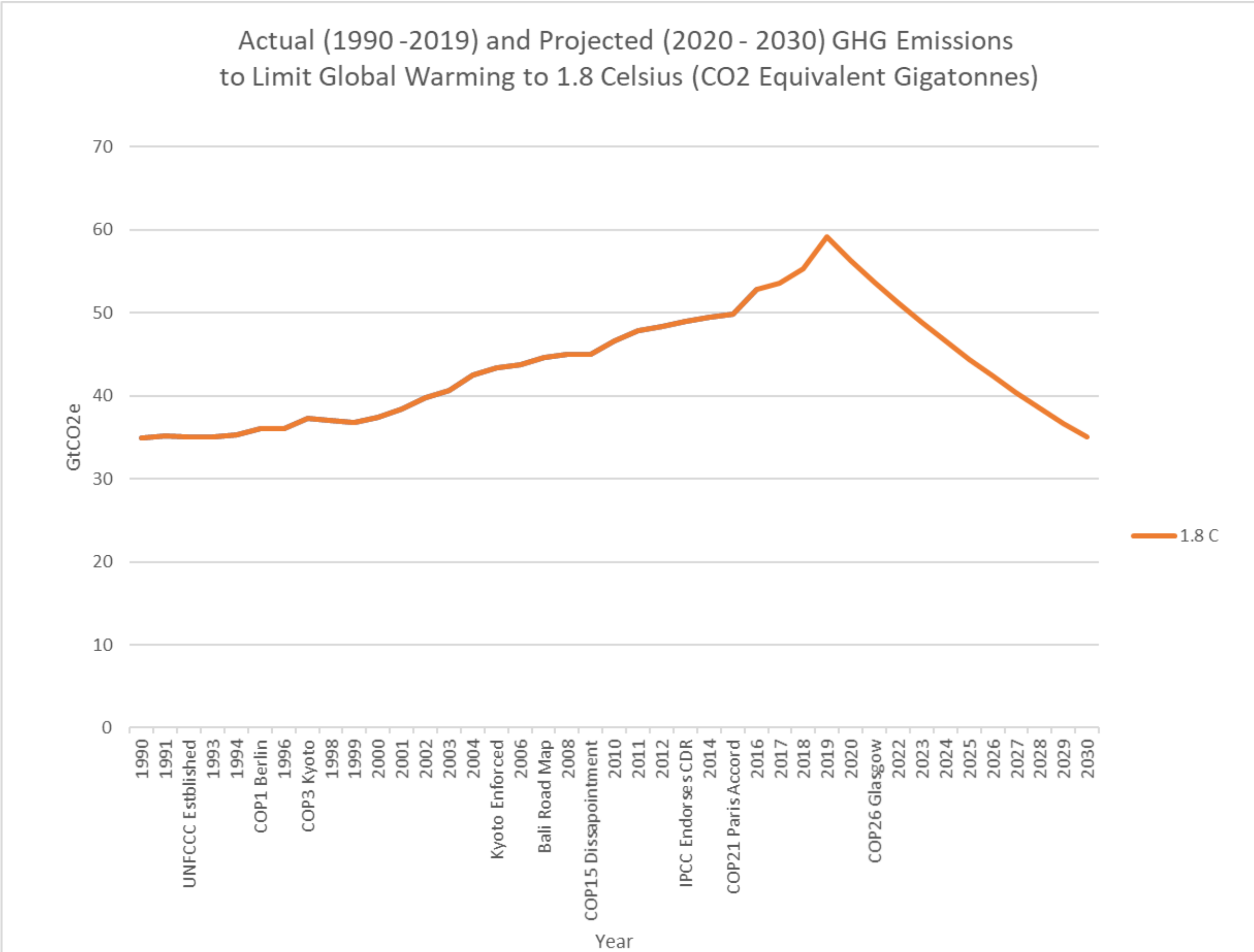
accumulation is a *stock* problem that should be framed in carbon use and waste management carbon cycle closure terms, rather than simply a *flow* reduction problem (section III). Unfortunately, there has not yet been any official acknowledgement that the well below 2.0 degree Celsius guardrail is too high given the melting Arctic summer sea ice (see figure 2). Climate triage is now also urgently necessary to prevent an acceleration of calamitous climate change (section II).

Figure 1 shows that since 1990 GHG emissions (and thus global warming) have continued to trend upward despite numerous international GHG mitigation agreements and commitments. The 1.8 Celsius projected trend line in the figure is based on the UNEP (2020: IX) estimate that global emissions in 2030 must have a global warming impact that is less than that of 35 billion metric tons of carbon dioxide, or 35 Gigaton Carbon Dioxide Equivalent (GtCO2e), to have a 66 percent chance of keeping global warming below 1.8 degrees Celsius (UNCC 2021). However, as of the end of 2020, updated and more "ambitious" Nationally Determined Contributions for 75, or almost 40 percent of the 197 countries that signed the Paris Agreement, representing 30 percent of global GHG emissions, would reduce global GHGs in 2030 to only 46.1 GtCO2e (UNCC 2021).[2] It therefore appears highly unlikely that global warming from GHG accumulation will be kept well below 2.0 degrees Celsius unless Paris Accord voluntary Nationally Determined Contributions are dramatically increased, or a more stringent *mandatory* commitment regime, like the now lapsed global Kyoto cap and trade system, that includes support for a rapid scale up of negative emissions technologies, is implemented at the Glasgow COP26 (section IV).[3]

[2] 46.1 GtCO2e is 1 percent less than the 2010 46.6 GtCO2e estimate displayed in figure 1.

[3] Achieving 35 GtCO2e emissions levels by 2030 would require average annual reductions of 4.65 percent a year for 11 years from 2019 estimated emissions of 59.1 GtCO2e as displayed in figure 1.

Figure 1: The Failure of Global Climate Mitigation and Adaptation Policy



Sources: Author's calculations from (Ritchie and Roser 2020) data for 1990–2015, (UNEP 2018; UNEP 2019; UNEP 2020) data for 2016–2019 and 2030 1.8 degrees Celsius estimate, and y axis timeline from (Chichilnisky and Bal 2019: 132–3).

The climate crisis will also not wait for fundamental social transformation. There is no question that over the long term we must work to address our existing unconscionable environmental justice issues including efforts to: a) stop despoiling and destroying vulnerable human and natural habitats, b) work on medium term soil and water cycle climate regeneration (Baiman 2020), and c) reduce human population encroachment into hitherto distant viral and bacterial pools that increases the incidence of global pandemics. However, the long- and medium-term social transformations that we on the left envision as a solution to the climate crisis require a fundamental reorientation of our political economy, including both forces (technologies) and relations (social organization) of production, that will likely take decades if not centuries to accomplish on a global scale. This should not be viewed as a political or moral failure of our species. Fossil fuels account for 84 percent of the world's energy and a large share of raw material inputs for much of modern industrial civilization (BP 2020: 4). This is slowly changing. Solar is catching up and, in many cases, is less expensive than fossil fuel in terms of unit energy cost (even without accounting for the externality costs of carbon dumping that most fossil fuel producers do not currently bear), but not in terms of dispatchability and portability. Carbon-negative cement and concrete, and substitutes for steel, aluminum, fuel, fertilizer, and many other materials using carbon from the air, currently exist or are being developed. However, especially for developing countries, and particularly those who are dependent on fossil fuel or natural resource exports, often produced by public companies, there may be no other viable options.[4] A REME will develop these alternatives, but not overnight (section III).

In fact, the pervasive "carbon-free," as opposed to a "net carbon-free" or "carbon cycle closing," economic framing may have become an obstacle to practical progress in addressing climate change and making it an opportunity instead of a problem (Zachs 2019). The goal after all is not an economy free of carbon, or "carbon purity," but rather to reduce and drawdown "fugitive carbon" from the atmosphere and ocean, as carbon is not a pollutant but a primary molecule of life (McDonough 2016). There is no question that the world economy needs to achieve *net* "deep decarbonization" in the long run, but in the short run rapidly reducing atmospheric carbon *and* equitably raising global living standards will require continued innovative use of fossil fuels, for example adding negative emissions technology to existing natural gas fired electric power plants (section III).[5]

Similarly, "Moral hazard" arguments against climate triage are not convincing given the historic dependence of our current industrial "hunter gatherer" civilization on fossil fuels and the infrastructural inertia caused by this. If, as it appears, we may be able to temporarily slow or reverse Arctic sea ice melt and climate change more generally with climate triage, there is no valid reason for not pursuing this. Not to do so could result in additional unnecessary, possibly cataclysmic, suffering for human and other life on our planet, and economic costs that would far outweigh the relatively modest costs of investigating and piloting these efforts.

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[4] This was driven home to me by two incidents: a) the President of Ecuador offering to not exploit newly discovered oil reserves in the Amazon rain forests if the international community would reimburse Ecuador for forgone oil earnings, and after getting no response, moving ahead with oil extraction (Goldman 2017), b) Norway (one of the most social democratic, environmentally responsible, and wealthiest (per capita) countries in the world) going ahead with exploitation of newly discovered north sea oil reserves using "green" technologies (Kottasovana 2020). If Norway cannot resist cannot fossil fuel exploitation, I doubt that any other major country in the world will be able to.

[5] Estimates suggest that atmospheric warming, from the elimination of fossil fuel SO2 aerosol cooling, could in the short term offset much of the initial cooling impact of net decarbonization (Samset et al 2018). If this is the case, though there is no question that a full transition to renewable energy is necessary in the long run, it may be wise to couple this with substitute tropospheric cooling aerosol methods such as marine cloud brightening and iron salt aerosol and continued *net* carbon-negative fossil fuel use (such as Global thermostat's (GT) Direct Air Capture (DAC) from natural gas power generation technology) in the transition period (sections III and IV).

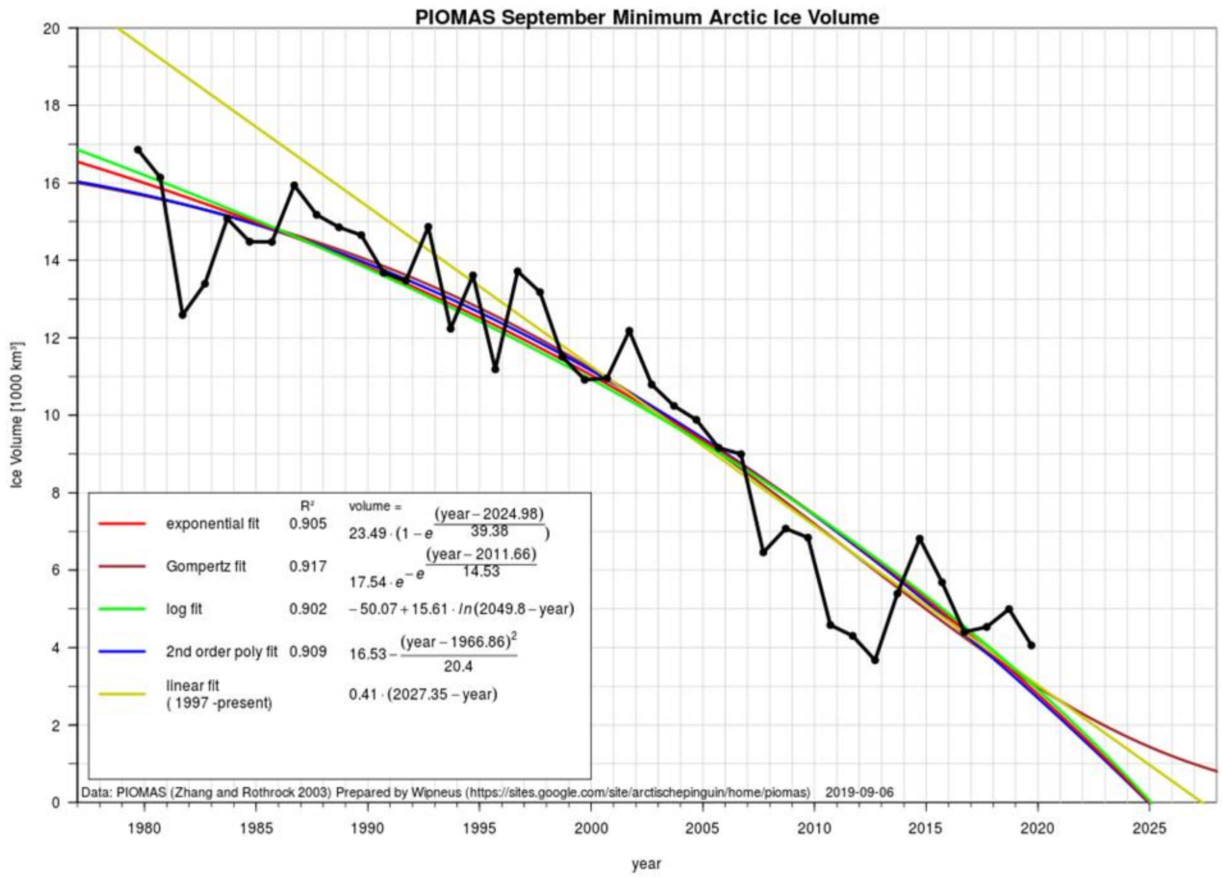
II. Saving Arctic Sea Ice Climate Triage

Arctic sea ice melting is the first major climate tipping point (Lenton et al. 2020). Melting Arctic ice, unlike the Greenland and Antarctic ice sheets, is not voluminous enough to cause massive sea level rise, so this is not the major effect that makes this a climate tipping point. Rather, due to the important role of Arctic sea ice in the global climate system, an ice-free summer Arctic will abruptly accelerate the frequency of catastrophic climate events around the world and the risk of crossing other climate tipping points (Lenton et al. 2020). Estimates suggest that complete Arctic summer sea ice melting would have a global warming impact equal to that of 17.3 years of current (2019) global emissions of 40 GT, or billions of metric tons, of CO2 per year (relative to a 2016 base) that would cause global warming to blow through the 2.0 degrees Celsius Paris Accord guard rail (Pistone, Kristina, Ian Eisenman, and Veerabhadran Ramanathan 2019).[6]

As can be seen in figure 2 below, the exponential, log, and 2nd order polynomial, fits for September Arctic sea ice go to zero in 2025, the linear fit in 2027, and the Gompertz fit (with the highest displayed R2) appears to asymptote with the horizontal axis outside of the plot sometime between 2030 and 2040. In other words, climate data is telling us that if current trends continue there will be a zero "blue ocean" September Arctic sea ice event by 2025–2040. Similar trends for other months suggest that complete Arctic sea ice melt will occur in following years.

[6] The authors use the approximate formula f = (5.35 W/m^2) ln(x/R) where f is radiative forcing relative to R, and x atmospheric concentration (Pistone et al 2019: 7479). For a given R and f this implies that: $x = Re^{(\frac{f}{5.35})}$. The authors used f=0.71 W/m^2, which they estimate is increased radiative forcing from 1979 to an ice-free Arctic, but used 2016 400 CO2 ppm for R, to get 456.8 CO2 ppm, or an increase of 56.8 CO2 ppm, from Arctic sea ice melting. They then multiply this by 7.77 and divide by 0.44 to get 1002.5 GT increased CO2 in the atmosphere. By dividing this by average 2019 emissions of 40 GT CO2 they derive an estimate of 25 years of CO2 emissions at current levels. However, they estimate 0.5 W/m^2 not 0.71 W/m^2 as radiative forcing from 2016 (Pistone et al 2019: 7476). Correctly starting with f = 0.5 W/m^2 and using the same procedure as above produces an estimate of 17.3 years of 40 GT CO2 emissions from 2016.

Figure 2: September Minimum Arctic Sea Ice Volume 1979–2020



Sources: Graph prepared by Wpneus, based (Zhang and Rothrock 2003) using US Dept. of Energy Climate Model Intercomparison Project (CMIP) data. Accessed at: https://sites.google.com/site/arctischepinguin/home/piomas

Proposed triage methods for saving the Arctic sea ice include the following, see Table 1 below.

Table 1: Methods for Saving Arctic Sea Ice with Cost Estimates

	Cost per Year ($ billions)	Start Up Funding ($ billions)	Persistence of Start Up Funding (Yrs)	Current Scope
Stratospheric Aerosol Injection (SAI)	2.25	3.6	7	Global. May be able to temporarily slow and restore Arctic sea ice loss and temporarily reverse many of the most harmful climate change effects.
Marine Cloud Brightening (MCB)	0.1	0.01	0.1	Local. May be able to temporarily slow and restore Arctic sea ice loss, and slow or temporarily reverse harmful climate change effects. Currently being piloted to save coral reefs.
Tropospheric Iron Salt Aerosol Injection (ISA)	0.05	0.002	0.1	Local. May be able to temporarily slow or restore Arctic sea ice loss, draw down methane and carbon, fertilize the ocean, reduce ocean acidification, and slow or temporarily reverse harmful climate change effects
Floating Sand	5	0.002	0.5	Local. May be able to temporarily slow or restore Arctic sea ice, and other ice loss.

Sources: (Fiekowsky, Peter, Carole Douglis, and Susan Lee 2019: 25) (Smith and Wagner 2018) (Latham et al. 2012) (Readfearn 2020) (Oeste et al. 2017) (Field et al. 2018)

Stratospheric Aerosol Injection (SAI) mimics the planetary cooling impact of large-scale volcanic eruptions by dispersing sulfate aerosols that reflect sunlight into the stratosphere. Mount Pinatubo, for example was estimated to have released about 15 million tons of sulfur into the stratosphere and cooled the planet by about 0.6 degrees Celsius for 15 months (NASA 2011). Among climate triage methods SAI has relatively well studied. A leading current SAI injection proposal is estimated to have a capital cost of $3.6 billion over 7 years and operational cost of $2.25 billion a year over 15 years to develop and deploy a fleet of 14 customized aircraft that, starting in 2025, would slowly ramp up sulfur dioxide SAI to a level sufficient at its 2100 peak to, with mitigation, reduce average global temperature by about one degree Celsius and restore global mean precipitation closer to its preindustrial levels (MacMartin, Douglas G., Katharine L. Ricke and David W. Keith 2017: Figure 3(a)).

Marine cloud brightening is another relatively well studied climate triage method. Marine cloud brightening proposes to increase the reflectivity of low-lying marine stratocumulus clouds by spraying them with aerosol produced from sea water, possibly using a fleet of remotely controlled wind driven spray vessels (Latham et al. 2012). Marine cloud brightening is currently being piloted as part of an effort to save the coral of the Great Barrier Reef (Readfearn 2020).

SAI and Marine cloud brightening are highlighted as examples of methods that would be included in a comprehensive federal solar radiation management research program proposed in a recent National Academy of Science report (National Academy of Sciences 2021).[7] These methods have also attracted significant federal and private nonprofit funding (Flavelle 2020).

Tropospheric iron salt aerosol injection is a less studied solar radiation management and GHG mitigation method that mimics the role that natural iron dust storms, and anthropogenic coal fired power plant and industrial iron emissions have played in fertilizing the oceans and cooling the planet. According to one estimate, adding iron salt aerosol precursor aerosol to the emissions of 100 large coal burning power stations would have an aggregate global cooling effect equivalent to eliminating current global CO2 emissions of approximately 40 GT, or 40 billion metric tons, per year. The iron salt aerosol would be elevated to heights of 1000 meters above ground and would stay in the troposphere for only weeks. The iron aerosol would also reduce methane and harmful ozone in the troposphere and stimulate ocean fertilization and carbon sequestration when it falls into the ocean (Oeste et al. 2017: 33).

III. Carbon Cycle Climate Restoration through Carbon Direct Removal and Carbon Capture Sequestration and Use

CDR projects utilize chemistry or biology to remove carbon, directly from point source or ambient atmospheric sources, or indirectly from the atmosphere, by interacting with the ocean or land, and sometimes also produce economically useful outputs. The objective of CDR is to capture carbon from the atmosphere, and the objective of CCSU is to sequester this carbon over the long term (more than 100 years) in the land or deep ocean, or to use it to produce synthetic materials like: fuel, cement, concrete, steel, aluminum, rugs, fertilizer, feed, and food (Wilox, Jennifer, Ben Kolosz and Jeremy Freeman 2021; Eisenberger 2020). Below are short descriptions of three existing methods for doing this.

Numerous companies like Blue Planet and CarbonCure are currently producing carbon negative, or reduced carbon, cement, aggregate, and other building materials. Carbon negative concrete has been used in construction for the San Francisco airport. Estimated costs of synthetic stone at $50/ton at capacity are competitive with quarried stone at $30–$200 a ton (Fiekowsky 2020: 20). Concrete is the most widely used building material in the world, as twice as much concrete

[7] A third solar radiation management example discussed in the National Academy of Sciences report, Cirrus Cloud Thinning (CCT), is less studied and more uncertain.

is used as any other building material (Gagg 2014), and construction materials (roughly 35 GT in 2009) make up over a third of all materials used globally by humans (Eisenberger 2020: 21). Other major categories of materials are biomass, fossil energy, and ores and industrial materials.

Multiple point source, or point source related, carbon capturing plants are currently operational and capturing carbon at scales of thousands of tons a year. Global Thermostat, a company founded and run by two academics, Graciela Chichilinsky and Peter Eisenberger, is operating two plants that capture 3– 4 thousand tons of CO2 a year and is currently collaborating with Exxon Mobil to build a scaled up 50-thousand-ton CO2 a year plant (Soltoff 2019; Chichilinsky and Bal 2019). The plants are designed to be added to existing and new natural gas fired electric power generators to draw down carbon from the air when the gas plant is operating, using excess heat generated by the power plants, and from the air using concentrated solar energy when the gas plant is not operating—in both cases with a net carbon negative outcome. These carbon negative plants would facilitate continued use of existing fossil fuel infrastructure for Direct Air Capture DAC of carbon and CCSU to advance toward a REME (Eisenberger 2020).

Klaus Lackner, reportedly the first person to prove that DAC is feasible (Lackner 2012), and his team, have developed "mechanical trees" that reportedly can remove carbon from the ambient air much faster than ordinary land or sea-based organisms. Lackner's mechanical trees rely on energy from sorbent moisture swings in dry air to capture CO2, and just like real trees, capture carbon from the air passively by letting the wind blow through them. This reduces estimated energy costs per ton of carbon capture to below $100 per ton. The mechanical trees are also not limited by access to, or proximity to, a point source carbon emitter. A cluster of 1,200 mechanical trees, like the one that Silicon Kingdom Holdings is planning to build in California, are estimated to draw down about 36,500 metric tons, or 67,057 pounds, of CO2 a year. In comparison, a normal tree removes about 48 pounds of CO2 a year, a rate that is 1,397 times slower per "tree" (tenmilliontrees, 2021). It is estimated that large scale "farms" of 120,000 mechanical trees would draw down roughly 4 million tons of CO2 annually and occupy a land area of about one square mile, so that 250 of these farms could remove about a gigaton of CO2 (ASUNow 2019). Forests of trees, bamboo, and Buffalo Grass can also potentially draw down large amounts of carbon but over much larger areas and longer time periods.[8]

IV. Climate Policy for a Renewable Energy and Materials Economy

The climate crisis can be considered a climate opportunity for a fundamental transformation of the forces of production from being based on the work of "hunter gatherers" of carbon-based fossil fuel energy and materials and one-way utilizers of the oxidization part of the carbon cycle,

[8] Nature based CCSU in the ocean, for example from macroalgae like kelp, is limited less by space than by essential mineral nutrients.

to “cultivators” of a “Human Designed Carbon Cycle Run by Renewable Energy” (Eisenberger 2020). Until now humans have relied on nature to close the carbon cycle for reuse through photosynthesis, and sequestration through weathering mineralization and ocean sinks, but we have reached the limits of our hunter gatherer unidirectional utilization of carbon-based energies and materials found in the ground, as our planet’s atmosphere and oceans can no longer absorb the excess carbon imbalance that we have created.

As we are unlikely to be able to *use* enough of the stock of accumulated carbon that we need to remove from the atmosphere and ocean at a rapid enough pace to stabilize planetary climate, we are also going to have to assist nature in sequestering it for long periods of time. Carbon sequestration methods include mineralization, geological sequestration in basalt rock formations, and sequestration in saline aquifers or in enhanced oil recovery wells. It has been estimated for example, that about 72 percent of CO2 captured by CarbFix, and injected into Basalt rock formations, mineralized within about 2 years (Pogge von Standmann et al. 2019). As basalt rock, saline aquifers, and oil wells are widely available, there appears to be no near-term problem with sequestration options at levels necessary to restore a stable climate.[9]

Policies necessary to practically address the climate crisis within a climate dictated timeframe include the following:

a) A global mandatory net carbon “dumping fee” or “cap and trade” market for GHGs with a cap that very rapidly goes to zero, based on responsibility and capacity, and enforced by national governments should be established.[10] A revived global Emissions Trading System would increase the efficiency and scope of drawing down GHGs and lead to a large transfer of funding and investment to developing countries, as occurred under the Clean Development Mechanism (CDM) of the Kyoto Protocol, and would address the regulation and governance issues raised by critics (Chichilnisky and Bal 2019; Hahnel 2012). Hahnel points out that as national GHG emissions can be more accurately estimated than those of many specific transactions, individual countries can be held responsible for their emissions regardless of whether traded GHG offsets are real or not – an issue that is less likely to be a problem for carbon capture than for, especially natural, GHG mitigation.[11] An additional, or alternative, global cap and trade market for produced CO2 extracted from the atmosphere or ocean, and a “Clean Investment Mechanism” to support investment in this “Negative Emissions Technology” in developing countries, analogous to the Kyoto CDM, has recently been suggested (Chichilnisky 2021 p. 24–5). A Clean Investment Mechanism would foster profitable investment in Negative Emissions Technology in developing and developed countries to achieve carbon capture goals and comply

[9] My calculations from data in Schuckmann et al (2020) suggests that about 1,710 Gigatons of CO2 would need to be removed from the atmosphere to get back to the 1989 level of 353 ppm CO2 in the atmosphere.
[10] As proposed for example by the Greenhouse Development Rights Framework (Greenhouse Development Rights 2021).
[11] For example, California’s cap and trade law carbon dioxide compliance offset protocols (Urban forest, and US forest) apply exclusively to natural mitigation (California Air Resources Board 2021).

with the1997 Byrd Hagel law stipulating that any US climate response grow the economy. If the Clean Investment Mechanism included social floor regulations, such as wages, working conditions, and corporate income taxes, it could serve to leverage capitalist incentives to rapidly scale up production of CDR, a public good, and raise living standards in developing countries (Baiman 2017: 135–63).

b) Public and private compliance markets for carbon negative products, and for carbon and carbon-based materials should be created by passing laws and regulations mandating the use of carbon neutral or negative construction materials, fuel, plastics, fertilizers, and other goods and services. The minimum price for ambient (atmospheric or oceanic) carbon drawdown would become the effective carbon tax in a publicly enforced “no carbon dumping” compliance regime, and the public subsidy price for large scale additional carbon drawdown and climate restoration. Thus, the more efficient DAC and other forms of CDR become, the more pressure there will be on point source emitters like fossil fuel based electric power generators and industrial plants to rapidly develop less costly (than DAC) carbon-zero or carbon-negative facilities, like the Global Thermostat DAC from natural gas power plant technology discussed above.

c) Large scale carbon markets should also be directly subsidized and supported by using public policy to directly fund CCSU to address global economic equity and real, rather than rentier, production of goods and services (Baiman 2020). Sources of funding for this could be the unique power of the US federal government to directly pay for global GHG drawdown by issuing and lending dollars (as in the Marshall Plan), and additional carbon, high income, and wealth taxes (Baiman 2020). [12] These funds could be used to stimulate GGND targeted climate justice economic development by supporting CDR and CCSU projects (Baiman 2020) and creating carefully monitored public or private carbon offset certificates and sequestering facilities that would prioritize underdeveloped and climate crisis affected locations.

In summary, Arctic sea ice-saving climate triage must be immediately researched, piloted, and deployed to avoid crossing the first global climate tipping point. Mandatory global GHG emissions and carbon negative investment trading systems must be created or recreated. For-profit markets embedded in government compliance regulations and tax and subsidy regimes to incentivize the development of renewable energy use and CCSU must be developed. Direct public investment in renewable and *net-carbon-negative* energy and material production that

[12] Dollars created by the US Federal Reserve for the 2008–2011 bail-out of global finance would have paid for almost 30 years of GGND climate triage, regeneration and mitigation, and a case could be made that as the current custodian of the world’s global fiat currency, the US government has a responsibility to employ its unique monetary power to help all of humanity by issuing dollars to restore a stable global climate (Baiman 2020). Similarly, money creation to fight Covid-19 has been much larger, and would be sufficient to address global climate change, certainly Arctic Sea ice climate triage. Over ten years from June 2009 to June 2019 the Fed stock of T-Bills increased by $1.7 trillion (Baiman 2020). Over eight months from February 12, 2020 to October 28, 2020 the Fed stock of T-Bills increased by $2.1 trillion (FRED 2020). As the Fed is legally required to turn its profit (minus negligible operations costs) to the Treasury, this represents money created by the Fed for public spending.

will increase environmental sustainability and equitable economic development must be provided. All are necessary to support a very rapid transition from a REME one-way carbon combustion and materials industrial “hunter gatherer” to a Human Designed Carbon Cycle Run by Renewable Energy industrial “cultivator” human civilization of the future (Eisenberger 2020). This is the moral imperative, challenge, and opportunity, of our epoch that we must immediately and urgently take on. We humans have never faced anything as important for ourselves and our fellow living species on this planet.

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