

Noam Chomsky & Robert Pollin: Humanity's Fate Isn't Sealed — If We Act Now



Noam Chomsky

We live in extraordinarily dangerous times. Climate breakdown is upon us, yet nation-states and their leaders continue to pursue policies based on “national security” and the pursuit of geopolitical objectives. The transition to a clean and sustainable global energy landscape is hampered both by powerful interests linked to the fossil fuel economy and lack of international cooperation. In fact, the war in Ukraine, which runs on fossil fuels, is not only delaying climate action but has increased reliance on the very energy sources that drive global warming and poison the planet. Indeed, the war has been a godsend to the fossil fuel industry. “Drill, baby, drill” is back with a vengeance, and oil and gas companies are reaping unprecedented profits as families everywhere are struggling with skyrocketing energy costs.

To be sure, “savage capitalism,” as Noam Chomsky powerfully remarks in this exclusive joint interview with economist Robert Pollin, is unleashed today even more destructively than it has in the past. Yet, as Pollin so astutely points out, there are ways to tame global warming and make a successful transition to a sustainable future based on clean energy systems (which do not include nuclear power plants or so-called negative emission technologies). In fact, Chomsky and Pollin agree that, in large part, it is political will that stands in the way of securing the future of humanity and the planet. As Chomsky notes, the task of political education in the age of global warming is analogous to the task of

philosophy as described by Ludwig Wittgenstein: “to show the fly the way out of the fly-bottle.”



Robert Pollin

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Robert Pollin is distinguished professor of economics and co-director of the Political Economy Research Institute (PERI) at the University of Massachusetts-Amherst. One of the world’s leading progressive economists, Pollin has published scores of books and academic articles on jobs and macroeconomics, labor markets, wages, and poverty, environmental and energy economics. He was selected by *Foreign Policy Magazine* as one of the “100 Leading Global Thinkers for 2013.” Chomsky and Pollin are co-authors of *Climate Crisis and the Global Green New Deal: The Political Economy of Saving the Planet* (2020).

C. J. Polychroniou: Noam, the systemic impacts of the war in Ukraine are enormous and they include economic shocks, food and energy security, geopolitical dimensions, and climate change. With regard to the latter, while it is difficult to make an accurate estimate of the climate impact of the war in Ukraine, it is crystal clear that it hinders current efforts to curb global warming and may even alter long-term strategy on climate action and action plan. How exactly are the war in Ukraine and the climate crisis connected, and why are governments

doubling down on coal, oil and gas instead of doubling down on the clean energy transition?

Noam Chomsky: An independent observer looking at the world today might well conclude that it is being run by the fossil fuel and military industries, or by lunatics. Or both.

The scientific literature is harrowing, regularly showing that earlier dire warnings were too conservative and that we are careening towards disaster at a frightening pace. Even without reading the literature, anyone with eyes open can see that nature is saying “enough”: extreme heat, huge floods, devastating drought and severe water crises, large regions of the earth approaching the point where they will soon be uninhabitable.

How are we reacting? The basic character is captured by a clip from the marvelous satirical journal *Onion* — except that it is perhaps even beyond their imagination. It is real. And reported, with disbelief, in the mainstream:

‘In a paradox worthy of Kafka, ConocoPhillips plans to install “chillers” into the permafrost — which is thawing fast because of climate change — to keep it solid enough to drill for oil, the burning of which will continue to worsen ice melt.’

In his bitter antiwar essays, Mark Twain wielded his formidable weapon of satire against the perpetrators. But when he reached the renowned General Funston, he threw up his hands in despair: “No satire of Funston could reach perfection,” Twain lamented, “because Funston occupies that summit himself.... [He is] satire incarnated.”

What is happening before our eyes is unleashed savage capitalism as satire incarnated. Even Twain would be silenced.

To see what is at stake, consider some basic facts. “[Arctic permafrost stores nearly 1,700 billion metric tons](#) of frozen and thawing carbon. Anthropogenic warming threatens to release an unknown quantity of this carbon to the atmosphere.... Carbon dioxide emissions are proportionally larger than other greenhouse gas emissions in the Arctic, but expansion of anoxic conditions within thawed permafrost and soils stands to increase the proportion of future methane emissions. Increasingly frequent wildfires in the Arctic will also lead to a notable but unpredictable carbon flux.”

The carbon flux may be unpredictable in detail, but the resulting devastation is all too predictable in its general outline. How then does unleashed savage capitalism respond? Simple. Let's employ our best brains to find ways to slow the melting down a little so that we can pour more poisons into the atmosphere for profit, and as a side effect, release those Arctic permafrost stores into the atmosphere more rapidly so as to make life unlivable.

Unfortunately, the observation generalizes. We find satire incarnate wherever we turn, even in marginal corners. Thus, one argument against solar energy is land use. A real problem, especially in the U.K., where golf courses take up over four times as much space as solar power, so we learn from political economist Adam Tooze's invaluable *Chartbook*.

Satire incarnate is just the cutting edge. It brings out dramatically the elements of dominant economic institutions that are lethal if unleashed. It would be hard to conjure up a more fitting epitaph for the species — or more accurately, for the institutions that have become dominant as what we call civilization marches forward.

The Ukraine war finds its natural place in this collective madness. One outcome of Putin's criminal aggression and the consequent sanctions regime is to restrict the fossil fuel flow from Russia on which Europe relies, particularly the German-based system that is its economic powerhouse. Economic consequences for Europe are severe, though not for the U.S., which is largely immune; or for that matter for Russia, which at least for now is profiting handsomely from rising oil prices and has [many eager customers outside of Europe](#).

Europe is seeking alternative sources of oil and gas, a bonanza for the U.S. fossil fuel industry, rewarded with new markets and expansive drilling opportunities to enable it to destroy life on Earth more effectively. And the military industry could hardly be more ecstatic as the killing and destruction mount.

People seem to have a different view. In Germany for example, where 77 percent of the population "[believe that the West should initiate negotiations](#) to end the Ukraine war."

One can think of other reasons to bring the horrors to a quick end, but the fate of organized human society is surely one. The Ukraine war has reversed the limited efforts to address the mounting crisis of environmental destruction. While it

should have accelerated efforts to move rapidly towards sustainable energy, that was not the path chosen by the political leadership. Rather, the choice has been to accelerate the race to the abyss.

What should be done at this critical moment is outlined perceptively by economist and political analyst Thomas Palley: “The European Union must build trade and commerce with Russia. That is an economic marriage made in heaven. Russia has resources and needs technology and capital goods. Europe has technology and capital goods and needs resources.”

And more generally, “[What should be done is a profound recalibration](#) that diminishes the influence of the US in Europe, strengthens the European Union, and aims for inclusion of Russia in the European family as envisaged by President Mikhail Gorbachev in 1990,” in his call for a “common European home” from Lisbon to Vladivostok with no military alliances, no victors or defeated, and a common effort to move towards a more just social democratic future — if not beyond.

“Getting there is beginning to look impossible,” Palley adds. But accommodation among the great powers must be achieved, and soon, if there is to be any hope for decent survival. The madness of devoting scarce resources to slaughter and destruction when cooperation to meet major crises is an absolute necessity simply cannot be tolerated.

Unleashed savage capitalism is a death sentence for the species. That has long been obvious, even before it reached the level of satire incarnated. The crucial word is “unleashed.” The leash should be, and can be, in the hands of those who have higher aims in life than enriching private power and enhancing the political forces that prefer global dominance to the Gorbachev vision.

We should not underestimate the barriers in economic and political realms, and also in the doctrinal systems that articulate and protect the structures of power. The matter is of particular importance in the U.S., for reasons too obvious to elaborate.

The barriers within the reigning doctrinal system are illustrated in a very revealing current essay in the major establishment journal. The authors are two well-informed foreign policy analysts at the more liberal end of received opinion, Fiona Hill and Angela Stent.

Their article illustrates graphically the extraordinary subordination to official doctrine that confines U.S. elites to an “alternative reality” that has little resemblance to the world. Confined within their self-reinforcing cocoon, they are simply incapable of comprehending the global reaction to their vocation of endless criminality.

Hill-Stent harshly condemn the Global South — most of the world — for its failure to join the U.S. in its profound distress “that Russia has violated the UN Charter and international law by unleashing an unprovoked [attack](#) on a neighbor’s territory.” The Global South even sinks so low as to “argue that what Russia is doing in Ukraine is no different from what the United States did in Iraq or Vietnam.”

Hill-Stent attribute this failure to rise to our level of nobility and understanding of global reality to Putin’s machinations. What else could account for such blindness?

Could there be a different reason, for example, the fact that outside the cocoon people actually look at the world and quickly discover that the U.S. is far and away the world leader in violating the charter and international law by unleashing unprovoked attacks — worldwide, even thousands of miles away? And could it be that they see that U.S. aggression in Iraq and Vietnam is an incomparably graver crime even than Putin’s aggression in Ukraine?

And as a minor footnote, perhaps these “backward” peoples are well aware that the Russian aggression, which they in fact harshly condemn, was in fact extensively provoked — as Western commentators tacitly acknowledge in their own curious way by conjuring up for this case alone the novel phrase “unprovoked attack,” which has become *de rigeur* in polite circles for the plainly provoked Russian aggression.

Given the climate of irrationality and subordination to doctrine that reigns in the U.S. it is necessary to reiterate, once again, that extensive provocation does not provide any justification for criminal aggression.

The Hill-Stent exercise in obfuscation is, regrettably, an instructive example of prevailing mentality among the more liberal sectors of doctrinal orthodoxy, amplified by conformist media and journals of opinion. These sectors of course play a prominent role in shaping the climate in which policy is designed and

implemented, a matter of overwhelming significance in the most powerful state in world history, with no close competitor.

The realities of the modern world impose unique responsibility on Americans. Ludwig Wittgenstein described the task of philosophy as “to show the fly the way out of the fly-bottle,” the flies being philosophers who buzz about in conventional confusions. Analogously, one task for those concerned about the future is to try to help educated elites find their way out of the doctrinal cocoon in which they have confined themselves, and to liberate the general public from the “alternative reality” that elite circles have constructed.

No small task, but an essential one.

Military operations produce enormous amounts of greenhouse gas emissions as capacity for and use of military force depend on energy that comes in the form of fossil fuels. In fact, the U.S. military emits more carbon into the atmosphere than some countries do and has a long history of fighting wars for oil. Is it realistic therefore to expect serious climate action on the part of the world's major powers if they continue to ignore how militarism fuels the climate crisis?

Chomsky: And, we may add, if they continue to ignore how the climate crisis fuels militarism. The climate crisis engenders conflicts. We've already witnessed that in Syria and Darfur, where migrations caused by unprecedented droughts provided a large part of the background for the horrors that ensued. There are looming crises that may put even these awful events in the shade.

India and Pakistan are at sword's point, engaged in constant armed confrontations. Both are suffering severely from global warming. One-third of Pakistan is under water, sometimes many feet deep, following an intense heatwave and a long monsoon that has dumped a record amount of rain. In neighboring India, poor peasants in mud huts are trying to survive drought and heat reaching 50 degrees Celsius (50°C), virtually unlivable, of course without air conditioning. Meanwhile the governing authorities race to produce more and better means of destruction. Another grim case of satire incarnates, perhaps. The sources of their water supplies are shared and diminishing. The rest can be left to the imagination.

What isn't left to the imagination is that both are armed to the teeth, including huge nuclear arsenals, an unsustainable arms race for much smaller Pakistan. For

both, it is an unconscionable waste of resources that are desperately needed to face their shared and devastating problems of global warming and other forms of destruction of the environment.

India-Pakistan is only one of many such examples of impending disaster. The U.S., though unusually privileged, is not immune, as we have seen in the past months.

As usual, the crises are not just human destruction of the environment. Scandals proliferate. The city that has been worst hit is Jackson, Mississippi, the state capital. The water system has been failing for years, and now its residents are literally without potable water — in a country with unparalleled wealth and natural advantages.

“Experts say this crisis was years in the making, a result of inadequate funding for essential infrastructure upgrades. For the past year, leaders of this majority-Black, Democrat-led city have pushed for additional funding from the White Republicans who run the state. [Little has come of those appeals.](#)”

Deeply rooted social pathologies make their own contributions to human misery, exacerbating those produced by destroying the environment and radical misuse of resources. The U.S. is, furthermore, far in the lead in accelerating the militarization of the world.

More tasks for Americans, and not them alone.

Bob, the world was falling short of meeting its climate goals even before the outbreak of the Ukraine war. Indeed, it's obvious by now that climate goals cannot be reached without fast and radical action. In that context, can you talk a bit about the role that carbon tax and cap-and-trade play as strategies for reducing carbon emissions?

Robert Pollin: Let's first be clear on what we mean by the world's "climate goals." The most basic goals were set out in 2018 by the Intergovernmental Panel on Climate Change (IPCC), the leading global organization that brings together and synthesizes climate change research. In its landmark 2018 special report "[Global Warming of 1.50C](#)," the IPCC established two primary goals: to reduce global carbon dioxide (CO₂) emissions by about 45 percent in 2030 relative to the 2010 level and to achieve net zero emissions by around 2050. The IPCC argued that these goals must be achieved to have a reasonable chance of limiting global

warming to 1.50C above pre-industrial levels. The IPCC had concluded that limiting global warming to 1.50C above pre-industrial levels is needed to dramatically lower the likely negative consequence of climate change.

Just since the IPCC's 2018 report came out, we have been seen much more severe impacts of climate change than what the IPCC had anticipated in terms of heat extremes, heavy rains and flooding, droughts, sea level rise and biodiversity losses. To take just one recent example, average daily temperatures were sustained at over 110°F during the heat wave in India this past May. The intensifying climate crisis is making such episodes increasingly frequent. As Noam discusses, the war in Ukraine is only worsening the situation. It is therefore fair to conclude that the IPCC's 2018 targets should be understood as what is minimally necessary to move onto a viable global climate stabilization path. This conclusion has been affirmed by the IPCC itself in its [even more extensive 2022 follow-up studies](#).

Where does the world stand today in terms of achieving the IPCC's emission reduction targets? As of the most recent data from the International Energy Agency (IEA) — the best-known and thoroughly mainstream organization that develops global energy models — global CO2 emissions were at around 36 billion tons in 2019. This represents a roughly 70 percent emissions increase since 1990 and a 14 percent increase just since 2010. More to the point, according to the IEA's projections for future emissions under alternative realistic scenarios, emissions will fall barely at all by 2030 and [will not come close to achieving the zero emissions target by 2050](#).

Specifically, in its 2021 "World Energy Outlook" report, the IEA developed two scenarios for future CO2 emissions levels based on what it considers to be realistic assessments of the current global policy environment. One is what the IEA terms a "Stated Policies Scenario." This scenario "explores where the energy system might go without additional policy implementation." It is based on taking "a granular, sector-by-sector look at existing policies and measures and those under development." In short, this scenario aims to project what CO2 emissions will be through 2050 if global policies remain basically fixed along their current trajectory. In this scenario, global CO2 emissions will not fall *at all* by 2030 and will decline by only 6 percent, to 33.9 billion tons, by 2050. In short, assuming we take climate science seriously, this is nothing less than a doomsday scenario.

Under a second “Announced Pledges Scenario,” the IEA “takes account of all of the climate commitments made by governments around the world, including Nationally Determined Contributions as well as longer term net zero targets, and assumes that they will be met in full and on time.” Under this more aggressive scenario, the IEA projects that emissions will still fall by only 7 percent as of 2030, and that by 2050, the emissions level will be at 20.7 billion tons — i.e. well less than halfway to achieving the zero emissions goal by 2050. In other words, even this more aggressive IEA scenario also is not too far from a doomsday scenario, assuming we take climate science seriously.

The IEA does also develop a scenario through which the world can reach zero emissions by 2050. The difference between the IEA’s stated policies and announced pledges scenarios relative to their net zero emissions by 2050 scenario is what the IEA terms an “ambition gap.” The question for getting to zero emissions is therefore to figure out how to close this “ambition gap,” i.e., how to avoid, somehow, a full-scale global climate catastrophe.

How much can carbon tax or carbon cap policies contribute here? Both of these measures aim to directly reduce the consumption of oil, coal and natural gas. This is critical since CO₂ emissions from burning coal, oil, and natural gas to produce energy is, by far, the largest source of overall CO₂ emissions, and thus, the major cause of climate change.

In principle at least, a carbon cap establishes a firm limit on the allowable level of emissions for major polluting entities, such as utilities. Such measures will also raise the prices of oil, coal and natural gas by limiting their supply. A carbon tax, on the other hand, will directly raise fossil fuel prices to consumers, and aim to reduce fossil fuel consumption through the high prices. Either approach can be effective as long as the cap is strict enough, or tax rate high enough, to significantly reduce fossil fuel consumption and as long exemptions are minimal to none. Raising the prices for fossil fuels will also create increased incentives for both energy efficiency and clean renewable investments, as well as a source of revenue to help finance these investments.

However, significant problems are also associated with both approaches. The first is their impact on the budgets of middle- and lower-income people. All else equal, increasing the price of fossil fuels would affect middle- and lower-income households more than affluent households, since gasoline, home-heating fuels and

electricity absorb a higher share of lower-income households' consumption. There is an effective solution here, developed initially by my PERI coworker Jim Boyce. That is to rebate to lower-income households a large share, if not most, of the revenues generated either by the cap or tax to offset the increased costs of fossil-fuel energy. Boyce [termed this](#) a "cap-and-dividend" program.

Another major problem with carbon caps is with enforcement. In particular, when these cap programs are combined with a carbon permit option — as in "cap-and-trade" policies — the enforcement of a hard cap becomes difficult to sustain or even monitor. So instead of measures that could be major contributors to fighting climate change, we end up with a mess of accounting tricks and exceptions. For the most part, [this has been the experience thus far](#) with cap-and-trade policies, both in the U.S. and Europe.

There are some easy fixes for this problem, as we have discussed in previous interviews. The most straightforward is to establish hard caps, such as utilities being required to reduce their fossil fuel consumption by, say, 5 percent per year, every year, with no exceptions and no cap-and-trade escape hatches. The CEOs of corporations who fail to hit these hard caps would face serious criminal liability.

Arguments in favor of the deployment of negative emission technologies, such as direct air capture and bioenergy with carbon capture and storage, are gaining ground these days in spite of their technological immaturity. Same goes for nuclear power plants and even geo-engineering in spite of the inherent risks that they entail. What role can such strategies play in the effort to make a complete break from reliance on fossil fuels?

Pollin: Neither negative emissions technologies nor nuclear power can likely contribute significantly to building an alternative global clean energy infrastructure. Indeed, it is more likely that they will create still more severe problems.

Let's start with nuclear. It does have the important benefit that it generates electricity without producing CO₂ emissions. But nuclear also creates major environmental and public safety concerns, which only intensified after the March 2011 meltdown at the Fukushima Daiichi power plant in Japan and still more, after Russia seized control of the Chernobyl and Zaporizhzhia nuclear power plants in the early stages of its invasion of Ukraine six months ago. Nuclear

disasters at both Chernobyl and Zaporizhzhia became active threats immediately. Just over the past month, the Zaporizhzhia plant has come under intense siege. Thus, as of August 3, the Director General of the International Atomic Energy Agency Rafael Grossi stated that conditions at Zaporizhzhia are “completely out of control” underlying “the very real risk of a nuclear disaster.” By mid-August, the *BBC* described “the growing concern over safety at the site...as both sides accuse each other of shelling the area.” The *BBC* article quotes U.N. Secretary General António Guterres’s [warning](#) that “any potential damage to Zaporizhzhia is suicide.”

Negative emissions technologies include a range of measures whose purpose is either to remove existing CO₂ or to inject cooling forces into the atmosphere to counteract the warming effects of CO₂ and other greenhouse gases. One category of removal technologies is carbon capture and sequestration. A category of cooling technologies is stratospheric aerosol injections.

Carbon capture technologies aim to remove emitted carbon from the atmosphere and transport it, usually through pipelines, to subsurface geological formations, where it would be stored permanently. The general class of carbon capture technologies have not been proven at a commercial scale, despite decades of efforts to accomplish this. After all, as we have discussed in previous interviews, carbon capture would be the savior for the oil, coal and natural gas industries if the technology could be made to work commercially at scale. However, even if carbon could be successfully captured at reasonable costs, the technology would still face the threat of carbon leakages that would result under flawed transportation and storage systems. These dangers will only increase to the extent that carbon capture becomes commercialized and operates under an incentive structure in which maintaining safety standards cuts into corporate profits.

The idea of stratospheric aerosol injections builds from the results that followed from the volcanic eruption of Mount Pinatubo in the Philippines in 1991. The eruption led to a massive injection of ash and gas, which produced sulfate particles, or aerosols, which then rose into the stratosphere. The impact was to cool the Earth’s average temperature [by about 0.60C for 15 months](#). The technologies being researched now aim to artificially replicate the impact of the Mount Pinatubo eruption through deliberately injecting sulfate particles into the stratosphere. Some researchers contend that doing so would be a cost-effective

method of counteracting the warming effects of CO₂ and other greenhouse gases.

However, the viability of stratospheric aerosol injections as a major climate solution has been refuted repeatedly by leading researchers in the field. For example, the Oxford University climate scientist Raymond Pierrehumbert, a major contributor to various IPCC studies, is emphatic in his 2019 paper, “There is No Plan B for Dealing with the Climate Crisis,” that this type of geo-engineering — what he refers to “albedo hacking” — does not offer a viable solution to the climate crisis. Pierrehumbert writes:

‘The excess carbon dioxide that human activities inject into the atmosphere has a warming effect that extends essentially forever, whereas the stratospheric aerosols meant to offset that warming fall out of the atmosphere in about a year. It’s just a matter of gravity –stuff denser than its surroundings falls — aided a bit by atmospheric circulations that enhance the removal. This is why the cooling effects of even a major volcanic eruption like Pinatubo dissipate after two years or so. Hence, whatever level of albedo hacking is needed to avoid a dangerous level of warming must be continued essentially forever.’

Pierrehumbert further [writes](#) that “We simply do not know the way the climate will respond to these novel forcings, or how our social and political systems will respond to these disruptive and possibly ungovernable technologies.”

Renewable energy critics argue that wind and solar are not reliable sources because of their variability. Others argue that wind farms encroach on pristine environment and destroy a country’s natural habitat, as is the case with the installation of thousands of wind turbines on scores of Greek islands in the Aegean Sea. How would you respond to such concerns, and are there ways around them?

Pollin: Three major sets of challenges arise in building a high-efficiency/renewable-energy dominant global energy infrastructure. They include the two you mentioned, i.e., 1) intermittency with solar and wind energy; and 2) the land use requirements for renewables, especially solar and wind. The third major challenge is the heavy mineral requirements as inputs for the clean energy infrastructure. In the interests of space, I will focus on just the first two.

Intermittency refers to the fact that the sun does not shine, and the wind does not blow, 24-hours a day. Moreover, on average, different geographical areas receive

significantly different levels of sunshine and wind. As such, the solar and wind power that are generated in the sunnier and windier areas of the globe will need to be stored and transmitted at reasonable costs to the less sunny and windy areas. In fact, these issues around transmission and storage of wind and solar power will not become pressing for many years into the clean energy transition, probably for at least a decade. This is because fossil fuels, along with nuclear energy will continue to provide a baseload of non-intermittent energy supply as these energy sectors proceed toward their phaseout while the clean energy industry rapidly expands. Fossil fuels and nuclear energy now provide roughly 85 percent of all global energy supplies. Even with a phase out to zero by 2050 trajectory, fossil fuels will continue to provide most of the overall energy demand through about 2035. Meanwhile, fully viable solutions to the technical challenges with transmission and storage of solar and wind power — including around affordability — should not be more than a decade away, certainly as long as the market for clean energy grows at the rapid rate that is necessary. For example, the International Renewable Energy Agency (IRENA) [estimates](#) that global battery storage capacity could expand between 17 — 38-fold as of 2030.

The issue of land use requirements is frequently cited to demonstrate that building a 100 percent renewable energy global economy is unrealistic. But these claims are not supported by evidence. Thus, the Harvard University physicist Mara Prentiss shows, in her 2015 book *Energy Revolution: The Physics and the Promise of Efficient Technology*, as well as in her more recent follow-up discussions, that well below 1 percent of the total U.S. land area would be needed through solar and wind power to [meet 100 percent of U.S. energy needs](#).

Most of this land use requirement could be met, for example, by placing solar panels on rooftops and parking lots, then operating wind turbines on about 7 percent of current agricultural land. Moreover, the wind turbines can be sited on existing operating farmland with only minor losses of agricultural productivity. Farmers should mostly welcome this dual use of their land, since it provides them with a major additional income source. At present, the U.S. states of Iowa, Kansas, Oklahoma and South Dakota all generate more than 30 percent of their electricity supply through wind turbines. The remaining supplemental energy needs could then be supplied by geothermal, hydro and low-emissions bioenergy, which are all non-intermittent renewable sources. This particular scenario includes no further contributions from solar farms in desert areas, solar panels

mounted on highways or offshore wind projects, among other supplemental renewable energy sources. However, if handled responsibly, all of these options are also viable possibilities.

It is true that conditions for renewable energy production in the United States are more favorable than those in some other countries. Germany and the U.K., for example, have population densities seven to eight times greater than the U.S. and also receive less sunlight over the course of a year. As such, these countries, operating at high efficiency levels, would need to use about 3 percent of their total land area to generate 100 percent of their energy demand through domestically produced solar energy. But using cost-effective storage and transmission technologies, the U.K. and Germany can also import energy generated by solar and wind power in other countries, just as, in the United States, wind power generated in Iowa could be transmitted to New York City. Any such import requirements are likely to be modest.

What about Greece? With co-authors, I am currently working on a study that considers the land use issues in Greece within the framework of achieving a zero-emissions economy there by 2050. I hope to be able to give more details on our results soon. For now, suffice it to say that there is no need for Greece to be installing wind farms on pristine sites. As with the U.S., there is more than sufficient land area in Greece to meet 100 percent of the country's energy demand through investments in high efficiency and building a renewable infrastructure situated on artificial surfaces like rooftops, parking lots, highways and commercial locations, as well as, to a relatively modest extent, agricultural lands.

Noam, we are the only species to evolve a higher intelligence, but we are not making the right decisions over climate and the environment. Is it because of politics and the way the world economy functions, or perhaps because of fears that the challenge of global warming is too overwhelming so we might as well go on with business as usual, make some alterations along the way and just hope for the best?

Chomsky: Evolution of higher intelligence is an intriguing scientific problem. It is even possible that we are the only species in the accessible universe to have evolved what we call higher intelligence, or at least to have sustained it without self-destruction. Yet.

As for why the existential crises that may soon end sustainable life on Earth receive far too little attention, one can think of many possible reasons. There is also a deeper question lingering in the not too remote background. The question burst into consciousness with dramatic intensity 77 years ago, on August 6, 1945. Or should have.

On that fateful day we learned that human intelligence had registered a grand achievement. It had devised the means to destroy everything. Not quite yet, in fact, though it was clear that further technological progress would soon reach that point. It did, in 1952, when the U.S. exploded the first thermonuclear weapon, and the Doomsday Clock advanced to two minutes to midnight. It did not become that close to terminal disaster again until Trump's term, then moving on to seconds as analysts abandoned minutes.

The question that arose with stark clarity 77 years ago was whether human moral intelligence could rise to the level where it could control the impulse to destruction. Can the gap be overcome? The record so far is not promising.

The game is not over unless we choose to end it. The choice is unavoidable. How humans will decide is by far the most important question that has arisen in the brief sojourn of humans on Earth. We will soon provide the answer.

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Political Economy of Saving the Planet (with Noam Chomsky and Robert Pollin as primary authors, 2020); *The Precipice: Neoliberalism, the Pandemic, and the Urgent Need for Radical Change* (an anthology of interviews with Noam Chomsky, 2021); and *Economics and the Left: Interviews with Progressive Economists* (2021).

Is Globalization Responsible For Climate Change? An Interview With Graciela Chichilnisky And Helena Norberg-Hodge



Helena Norberg-Hodge

What is the connection between economic globalization and climate change? Is globalization reversible? Can climate change be reversed? If so, how? In the interview that follows, two leading voices in the struggle for a safe planet and a sustainable future, *Graciela Chichilnisky* and *Helena Norberg-Hodge*, address these questions from their own unique perspectives and offer critical insights on how we can avert a climate change catastrophe.

A world renowned economist and mathematician, *Graciela Chichilnisky* is the architect of the Kyoto Protocol carbon market and cofounder and CEO of Global

Thermostat, a disruptive, carbon negative technology company based in the Silicon Valley that removes carbon dioxide from the air. She is Professor of Economics and of Statistics at Columbia University and Visiting Professor of Economics at Stanford University. *Helena Norberg-Hodge* is the founder and director of Local Futures, a pioneer of the “new economics” movement. She is the producer and co-director of the award winning documentary “The Economics of Happiness” and recipient of the Goi Peace Award.

J. Polychroniou and Marcus Rolle: Climate change is the most daunting problem facing humanity today, and globalization seems to be accelerating it. In fact, the effects of climate change are moving faster than predicted as free trade agreements are proliferating, multinational corporations move their operations to developing countries in order to avoid stricter environmental rules at the home country, and export-oriented industrial agriculture has replaced local farming. Do you agree with the view that economic globalization bears responsibility for climate change?

Helena Norberg-Hodge: Absolutely. Globalization – or the deregulation of global trade and finance – has direct consequences for the climate. It promotes unnecessary long-distance transportation of goods, rampant consumerism, biological monocultures, energy-intensive technology use, and mass urbanization – which leads to ever-increasing fossil fuel consumption. It is also worth noting that a 2013 study found that two-thirds of the fossil fuels that have been burned over the last 150 years were burned by just 90 corporate entities, including companies such as Texaco and ExxonMobil.

With the help of corporate-funded think-tanks, there is a commonly-held belief that individual citizens’ consumption patterns, rather than the systemic changes in production because of globalization are to blame for climate change. This is a very narrow framing of the climate crisis, but it’s one that has gained a lot of credence in the media due to the support of Al Gore and others. Meanwhile, it’s becoming increasingly clear every day that there are inherent and predictable connections between the deregulation of transnational corporations and the climate crisis. And people are beginning to notice those connections.

So reversing the trend towards further globalization needs to be central to the climate movement.



Graciela Chichilnisky

Graciela Chichilnisky: Yes: globalization was led by the Breton Woods institutions that were founded after WWII to encourage and enforce a pattern of international trade duplicating colonialism at a global scale: deep and extensive extraction of resources from developing nations that were exported at low prices for consumption in industrial nations. This pattern of international trade can be seen as a global tragedy of the commons, since developing nations lack property rights on extractive resources and their governments are dependent of international organizations and therefore “permeable” This term was introduced by Natasha Chichilnisky-Heal who documented the “permeability” of governments in developing nations that are rich in extractive resources in the cases of Mongolia and Zambia, with examples on the direct role of the World Bank in the case of Rio Tinto and Mongolia’s copper mines, the largest in the world.

J. Polychroniou and Marcus Rolle: What role do natural forces play in climate change?

Helena Norberg-Hodge: Looking back over millennia, we have to be extremely humble about our ability to grasp what has been going on. So it is possible that warming has happened because of ‘natural’ forces – ie without human intervention. However, in recent history there is no doubt that fossil-fuel based industrialization has had an enormous impact on ecosystems.

Graciela Chichilnisky: A key role: carbon dioxide acts as the butterfly in the butterfly effect within a complex earth climate system: very small variations in concentration of CO₂ in the atmosphere can alter atmospheric transparency and

create catastrophic effects such as global climate change.

J. Polychroniou and Marcus Rolle: What are some of the impacts that we can expect from climate change?

Helena Norberg-Hodge: Over the past decade, it has become clear that weather conditions are becoming ever more unstable and unpredictable. These are likely to become even more extreme and lead to more human suffering and mass migrations. Violent conflict over natural resources is likely to intensify, and new conflicts emerge in places that were once considered stable.

Graciela Chichilnisky: Right now the North and the South Poles are melting, obliterating species that live on ice sheets, such as polar bears and penguins. This raises the sea level globally, since melted ice occupies more space, and causes superstorms and tornadoes, flooding coastal areas, and forcing tens of millions of people to migrate with enormous humanitarian losses and untold political upheaval. As more CO₂ is absorbed by the oceans it acidifies it, obliterating calcium based species such as coral reefs and krill which has external calcium based skeletons, and is the foundation of much sea and land life. Floods superstorms hurricanes and tornadoes cause social disruption. An example is Superstorm Sandy and its effects on Manhattan, which left the city without water and electricity, closed schools and police stations and saw cars floating on the streets for weeks. Social disruption threatens institutions and becomes the first effects of climate change, perhaps the most immediate and dangerous.

J. Polychroniou and Marcus Rolle: Are there any benefits that can come from climate change?

Helena Norberg-Hodge: If anything positive comes out of the climate crisis, it will be the response to it. If it weren't for climate change, it would be possible to say 'Sure, the global economic system is failing, but wholesale reform is difficult, so let's leave it up to the next generation'. With climate change a real and present danger, that is no longer really possible. Climate change is drawing the 'demons' of the global economy out into the open, forcing us to confront them, and pushing us to consider systemic change sooner than we might have otherwise.

There is now compelling justification for switching to a less resource-intensive economic model as soon as possible. The more localized and resilient we can make the world's economies, and the less we depend on GDP growth (which

actually is making the majority poorer), the better-equipped we will all be to handle the social and ecological consequences of climate change.

Graciela Chichilnisky: Certain areas where ice sheets disappear become available for economic exploitation

J. Polychroniou and Marcus Rolle: Can changes in the production and use of energy impact on climate change, or is it already too late for such action?

Helena Norberg-Hodge: It is definitely not too late to take action. Fully modeling the complexities of the earth's regulatory systems is a fool's errand, and that means we cannot be certain of what the future will hold. There is a glimmer of hope that Gaia will have self-regulating tools up her sleeve, that our computer models could not anticipate. In any case -disregarding for a moment the need to address climate change- we have many other reasons to move away from our dependence on petroleum. Soaring cancer rates from pesticides, and endocrine disruption from plastics (as documented in the book [Our Stolen Future](#)), are two among a great many arguments for immediately moving away from this dependence.

Decentralized renewable energy systems can answer our needs without destroying social cohesion and ecological stability. Many communities are finding ways to integrate local-scale renewable energy into their lives, through initiatives such as the Low Carbon Hub in the UK and New Energy Economy in the US.

The key in navigating the transition to a post-carbon world is to embrace the transition to a new economy. Renewable energy that is produced and distributed by deregulated corporations cannot have a truly positive impact on the environment or society. We need to cease being merely passive consumers and engage as citizens in legal actions, letter-writing, seed-sharing, and other projects of resistance and renewal to change the status quo. Acting as isolated consumers and changing a lightbulb or using less hot water is not enough to make a dent in the climate crisis. We need 'big picture' thinking, and collective acting - changing the 'I' to a 'we'.

Graciela Chichilnisky: It is absolutely necessary to move away from burning fossil fuels into cleaner energy such as solar. This could take decades since the current power plant infrastructure is worth \$55 trillion according to the IEA and it is almost 90% fossil. This will take many decades to change; it cannot be changed to

renewable energy as soon as it is needed. However necessary is the change to renewable energy, it is not sufficient: the 2014 5th Assessment Report of the IPCC (page 101) which is the world's scientific authority, documents that much more is needed to avert catastrophic climate change. The IPCC documents that we now need to physically remove the CO₂ that is already in the atmosphere. The 2015 Paris Agreement, which is now ratified into international law, has four articles about the absolute need to remove the CO₂ that is already in the atmosphere, and do so in massive amounts.

J. Polychroniou and Marcus Rolle: Is globalization reversible? If not, how do we constrain some of its worse aspects?

Helena Norberg-Hodge: Globalization is without a doubt reversible – that's exactly what we mean when we talk about 'localization'. Globalization is heavily supported by governments through free-trade deals, subsidies, and regulations that discriminate against small- and medium-sized businesses. Current policies encourage businesses across the board to use more energy and technology, instead of employing people. Renewable energy technologies currently receive one-fifth as many subsidies as fossil fuels do.

These are political decisions which can be changed. If the artificial supports for globalization were removed, and taxes and subsidies were shifted to encourage real work by real people, globalization would cease to make economic sense and small-scale business would be the order of the day. Absurdities like redundant trade, whereby a country ships a commodity overseas and imports that same commodity right back, would become a thing of the past. Less packaging, processing, and transporting would mean a smaller carbon footprint. Localization would reduce the power of global corporations and banks, helping to reduce the pressure for economic growth that results in needless consumption. It would particularly help the Global South, by reversing the process of colonialism that to this day puts enormous pressure on people to emulate the consumer lifestyle of people in Europe and North America.

Graciela Chichilnisky: This wave of globalization has taken place since the 1945 creation of the Bretton Wood Institutions after WWII, and cannot be reversed quickly. It's effects are global and the time needed to address them is a main issue. Globalization had positive features but it led to a pattern of North – South Trade and of consumption of global extractible resources by the rich nations that

caused the environmental crisis of our times. This pattern cannot be reversed quickly but it must be reversed.

Global industrialization has caused a massive expansion of wealth inequalities globally (three times larger than before) and has magnified the global tragedy of the commons, leading to the climate change emergency that engulfs us all today. The only way to redress some of globalization's worst aspects is to agree on mandatory limits on the use of air water and biodiversity (food) nation by nation. It is possible and it must be done soon. The UN Kyoto Protocol did this for carbon emissions in 1997 and became international law in 2005, successfully reducing emissions of the Kyoto Nations by 30%. The Paris Agreement has no mandatory limits - indeed, it has no policy to implement its intended goals, none. Yet limits are key. From those mandatory limits can emerge global markets for water, carbon emissions, and biodiversity. Without limits they cannot. The carbon market I designed and wrote into the UN Kyoto Protocol, which was trading \$175 billion in 2012 is a successful example. But this market depends on mandatory emission limits that the US opposes as it is the largest emitter among industrial nations (and overall historically), and is the largest emitter today per capital. New global markets means new prices and new values for the main earth resources on which humans depend for survival: the atmosphere, the hydrosphere and the biosphere. The new economic values in turn alter fundamentally the notion of GDP and therefore of economic progress, aligning it with human survival as is now needed. All this must be put in place immediately as otherwise our economic incentives based on a dated notion of GDP can and probably will lead to the extinction of our species, for failure of meeting our basic needs.

J. Polychroniou and Marcus Rolle: What do you consider to be the most innovative solutions for ensuring that the Earth does not warm up to catastrophic levels?

Helena Norberg-Hodge: The localization initiatives that put food at the center. Localizing food economies is particularly important, both because food is a universal necessity, and because globalization is structurally linked to monoculture crops, which rely on agrochemicals, mechanized equipment, and growing practices that result in significant greenhouse gas emissions. Diversified, small farms are more productive, act as carbon sinks, use less energy in production and, linked to nearby markets use less processing and packaging.

We've highlighted a number of inspiring initiatives from around the world in our Planet Local web series, including, among many others, the [Mupo Foundation](#) in

South Africa's Vhembe district, which empowers the local Venda people to ensure food sovereignty and strengthen a local knowledge system which roots spirituality in ecology. We also showcase energy projects like the '[Our Hamburg, Our Grid](#)' project to create a local power utility in Hamburg, Germany, the [New Energy Economy](#) initiative in New Mexico, which campaigns against coal and nuclear power and installs community solar systems throughout the state. Initiatives like these are springing up practically everywhere you look.

Graciela Chichilnisky: It is now documented by the IPCC and stated in the Paris Agreement that we need to remove CO₂ in massive amounts from the atmosphere in order to prevent catastrophic climate change.

The most innovative solutions are new US technologies and business strategies that remove CO₂ directly from air and stabilize it on earth by selling it for the profitable production of building materials including plastics and carbon fibers, beverages, refrigerants like dry ice, water desalination, synthetic fuels, and many other rather valuable economic uses. One example is Global Thermostat — a new US company that has a carbon removal technology that captures CO₂ from air at low cost; the GT technology can transform a fossil fuel plant into a carbon remover and can transform a solar power plant into a massive CO₂ remover. This means that we can transform the \$55 Trillion global power plant infrastructure so that the more electricity we produce the more carbon we remove. The CO₂ is used to produce plastics, beverages, refrigerants like dry ice, greenhouses, desalinate water, produce synthetic fuels: there is an enormous global market for CO₂. It is extraordinary: it makes carbon emission limits feasible because removing carbon becomes a profitable activity that is consistent with economic progress, with additional jobs and exports. Therefore emission limits become acceptable within the constraints of the Byrd-Hagel Act of the US Congress, which need no longer veto agreements to reduce emissions as they can benefit rather than undermine the US economy. From such emission limits arises the UN Carbon market that was created in 1997 by this author and was already trading \$175 billion annually in 2012. Through the Clean Development Mechanism this money has provided and continued to provide important project finance (\$130Bn) for clean technology projects in developing nations. For example, the carbon market can fund the building of 40,000 carbon negative power plants that can remove 1million tons of CO₂ each per year, thus removing as much CO₂ as humans are currently emitting globally. This is the entire financial-technological solution to climate change, and it is the most innovative solution at

the same time. Observe that all this can be done profitably, since the costs of carbon removal are lower than the current market prices of CO₂. However to accelerate the process as needed to avert catastrophic climate change, one needs the carbon market and its Clean Development Mechanism in order to provide incentives to adopt the new technology and to make available the project finance needed to set up a \$200 billion/year Green Power Fund that will make all this possible in developing nations. This plan can combat poverty while cleaning the atmosphere as it can provide carbon negative power plants that produce power while removing carbon from the atmosphere. It must be done and soon.

Is Malfunctioning US Democracy Responsible For Climate Change? An Interview With Graciela Chichilnisky And Heikki Patomäki



Heikki Patomäki

As the climate change crisis continues unabated, it is becoming increasingly clear that the absence of global governance is a major factor in our failure to take necessary action for protecting the future of the planet. But an equally significant factor behind this failure is the dysfunctional state of the American political system as the global superpower's elected officials continue to deny the global

warming phenomenon and to insist on a business as usual approach vis a vis the environment in general and climate change in particular — in spite of the fact that the majority of the American people have a different view on the matter.

To what extent is the absence of global governance and the malfunctioning US democracy responsible for climate change? What will it take to turn things around and rescue humanity from an unmitigated disaster of its own making? Can technology provide a way out? These issues are debated below in a joined interview with two leading scholars: *Graciela Chichilnisky*, a world renowned economist and mathematician, Professor of Economics and of Statistics at Columbia University and Visiting Professor of Economics at Stanford University), and a leading force in the climate change battle (architect and author of the Kyoto Protocol Carbon Market, CEO and cofounder of Global Thermostat), and *Heikki Patomäki*, Professor of World Politics at the University of Helsinki, Finland, and a leading authority in the field of global governance.

J. Polychroniou and Marcus Rolle: Climate change has emerged in early 21st century as the most critical global problem, although there still continues to be plenty of denial and inexcusable political inertia across the globe. In this context, to what extent is the difficulty of addressing climate change a problem related to the absence of global governance?

Heikki Patomäki: Global governance in this field is not entirely absent, as witnessed by the Kyoto Protocol and Paris Agreement, but it is seriously lacking in many important ways. A key reason for why proper global governance – or government – is needed is that individual state-actions and world markets are often poor in preventing unnecessary, unneeded and unwanted worldwide developments from happening. World markets and separate states may generate economic crises and downturns or global warming or other unsustainable developments. Without legitimate and well-functioning common institutions it is also difficult to take action against underdevelopment, uneven industrialization or growth, or global accumulation of privileges and power – all of which may also be self-reinforcing processes in the absence of proper countervailing responses. Moreover, these processes can also trigger and strengthen conflicts among states, which may lead to securitization, even to arms-race and wars.

We can talk about reflexive self-regulation when knowledge about the way the social systems – including the world system as a whole – function is applied

recursively in interventions that aim at avoiding unwanted or achieving desired outcomes. But what is unwanted or desirable is always an ethico-political question. Not only are different anticipations about the possible and likely futures involved in the politics of climate change, but so are assumptions concerning justice or the extent to which either actual or administratively created simulated markets can regulate themselves.



Graciela Chichilnisky

Graciela Chichilnisky: Globalization emerged after World War II fostered by the Bretton Woods Institutions that were created in 1945: The World Bank, the IMF, the WTO. They provided governance of the world economy for the first time in history. The United Nations and its various organizations emerged in that same period, and offered diplomatic and political governance. But by their own design, the Bretton Woods institutions shaped *the world economy*, and, also by design, they were dominated by the United States, which emerged as the sole economic power after the destruction caused by WWII. It is not surprising, therefore, that the main obstacle for the global governance of climate change originates in the USA — in particular in the US Congress, which seems to be out of step with the American people. Economics, indeed industrialization as fostered by the Bretton Woods institutions and the USA as the chief supporter, is deeply anchored at the source of climate change. The Bretton Woods organizations enforced an economic model based on industrialization with deep and extensive overuse of natural resources of all types and particularly of fossil fuels as a source of energy. The world's resources were extracted by developing nations and exported at low

prices and overconsumed in the industrial nations. Climate change is a physical fact, but its origins are economic. There is nothing that can be done about climate unless we change our prevailing economic models and institutions including the overuse of global resources such as water, air, biodiversity, and fossil fuels. These are the economic factors at the source of the problem: the governance of the world economy we have is forcefully imposing a pattern of economic growth – and defining economic progress – in a way that may have been possible a hundred years ago but is no longer feasible now. Economic progress as defined by the Bretton Woods institutions will in all likelihood lead to catastrophic climate change and even to the extinction of the human species, destroying globally the sources of clean air, drinkable water, biodiversity, and a stable climate that are our basic needs for survival. We need to change the global governance of the world economy for our species to survive. The United Nations governance is anchored on the concept of nation states –it uses a “one nation one vote” principle, while the Bretton Woods institutions use “one dollar one vote”, governance is determined by the dollar amount that a nation controls. Nation states are a relatively new concept in human history, and there is nothing that a single nation can do by itself to avoid the worst outcomes of climate change which is a global phenomenon, since CO₂ concentration is the same everywhere in the planet, whether it is measured in New York, in Beijing, in Madrid or in Buenos Aires it is always the same. Each continent has enough fossil fuels to cause climate change by itself, affecting the entire world, Africa could cause trillions of dollars in losses to the USA, for example, just by burning its own coal. The issue is global and cannot be resolved by any single nation: it is truly a global issue and our global governing institutions are not appropriate for the challenge. Lord Nicholas Stern said that Climate Change is “the biggest externality in the history of humankind” and yet our economic governing institutions are based on markets for private goods that completely disregard externalities. We need new global governing institutions and a new economic discipline focused on internalizing externalities in order to face the climate challenge. This is the global carbon market I designed and wrote into the Kyoto Protocol achieves for the atmosphere. Traditional economics with private goods and private markets, with governing institutions based on nation states and private market values do not make the cut.

J. Polychroniou and Marcus Rolle: The political economy of climate change is a newly emerging field, yet it's epistemological foundations seem to rely heavily on traditional approaches to addressing social and economic problems, which

essentially means that it relies heavily on market-based solutions even when climate change represents the biggest market failure (as a negative externality) in the world. What's your view about market-based solutions to combatting climate change?

Heikki Patomäki: We live in a neoliberal era. Neoliberalism is a program of developing and resolving problems of human society by means of competitive markets. This ideology in turn is based on a discourse of modernity that presupposes atomist egocentrism, incapacity to understand wholes, abstract universality, lack of reflexivity and a number of other problematical assumptions. This worldview is more part of the problem than a solution to it.

The system of emissions trading means privatization of an aspect of the atmosphere. In economic theory, the idea of privatization as a solution to environmental problems is associated with the Ronald Coase and the Chicago School. The legal creation of property rights is supposed to enable efficient markets and contract mechanisms to function. Neoliberal thinkers believe that this should gradually solve the problem of climate change, although it may of course be admitted that past emissions may have delayed effects, or that for each state, there is a temptation to free-ride by allowing their firms off the hook, in order to make them more competitive.

In the cap-and-trade system some countries and firms can reap unearned profits by selling excess greenhouse gas allowances, depending on how those allowances are organized. Thus the cap-and-trade system creates a perverse incentive to be as polluting as possible during the initial assessment measurement, and a follow-on incentive to lobby for maximum numbers of permits by claiming for contingencies etc. This may co-explain the surplus of certificates and tendency for the prices of emission permits to decline.

The cap-and-trade system includes also trade with various financial derivatives of the certificates. Like speculative finance more generally, this encourages the search for quick profits and reinforces short-term temporal horizons. In the secondary markets of pollution permits, ecological sustainability appears as a secondary concern. What matters is money-making. Given this orientation, it is no wonder that the profit-oriented carbon trading has been liable to outright corruption. Apart from cases of fraud and bribery, abuses of power, and other conventional forms of corruption, as a UNDP report explains, "corruption in this

sector has also taken more original forms, such as the strategic exploitation of 'bad science' and scientific uncertainties for profit, the manipulation of GHG market prices, and anti-systemic speculation".

Graciela Chichilnisky: Capitalism is an ever changing force, whether it is viewed as a God or as a monster. It is always changing. Using its own internal engine of change, it is possible to evolve capitalism by creating global markets for the use of the global commons: for example, the atmosphere. This is the UN Carbon Market. Water markets and markets for biodiversity have the same objective and the same capabilities for water and biodiversity which are critically endangered global public goods on which our species depends for survival. These are new markets and will provide different market values for the global commons, for example giving enormous value to clean air, clean water and a thriving biodiversity. Therefore, once these new markets are created, optimizing GDP acquires a different value. GDP is the sum of the *market value* of all goods and services produced by the economy and acquires then a completely different definition, one where economic progress is consistent with human survival and the satisfaction of basic needs, a concept that I created in the mid-1970's in the Bariloche Model of Argentina. Basic Needs were voted and adopted by 150 nations at the 1992 Earth Summit of Rio de Janeiro as the cornerstone of Sustainable Development: satisfying the basic needs of the present without depriving the future from satisfying its basic needs. It is key to understand that markets for the global commons are first of all based on limiting the use of air, water and biodiversity globally, which is needed right now. Without mandatory limits, or property rights, markets do not work. Some people are against the carbon market for philosophical or ethical reasons, but this is a complete misunderstanding of what the carbon market means, what a market for water or biodiversity would mean. Markets cannot exist without mandatory limits on the use of air, of water and of biodiversity, nation by nation, and globally. Scientists agree that we need such limits. The critics of the carbon market do not argue with limiting the use of the atmosphere - which is needed before any market can operate. So what is the argument? The argument against the carbon market appears to be a misunderstanding. The argument is against the trading of rights to emit, which is the carbon market: but there is no argument from that side on the limits on emissions that are mandatory, nation by nation and global, and are sustained and implementing globally by the carbon market as is required by the scientists of the IPCC (UN Intergovernmental Panel on Climate Change, the global

scientific authority that was awarded the Nobel Peace Prize for its work on Climate Change). The more a nation goes above its limit, the more it has to pay per ton and in total for doing so, to the point that it cuts where it hurts: in the pocket or economics of the nation. This is not a simple economic transaction: it hurts to go above one's limit to the point that a nation could go bankrupt if it did. And it could lose its economic viability and therefore its political structure. In addition, the *carbon market is not a cap and trade system*. Yes: the carbon market is not the same as cap and trade. It is a market for user rights on a global public good – the planet's atmosphere – and therefore the initial distribution of endowments must favor lower income nations to reach an efficient market solution. This is new and different – certainly it is not even contemplated by “cap and trade” systems like the Chicago SO₂ market. In practice, within the Kyoto Protocol this became the “Clean Development Mechanism” that has transferred over \$120Bn to developing nations for clean technology projects since 2005, when the carbon market was ratified and became international law. So the creation of new markets for the global commons (for the atmosphere, the hydrosphere and the biosphere) embodies a profound economic change, a change in the way we relate to nature and in the value we give to humans and their survival. Is it possible that capitalism based on new property rights on the use of the global commons, as explained here, will change capitalism from within? Yes, this is possible. We already created the global carbon market and it is international law since 2005, the market I designed and wrote into the Kyoto Protocol, and this carbon market has been trading \$175Bn/year as of 2012. And it is based on carbon emission limits, nation by nation and globally. According to the World Bank, the carbon market nations have reduced since their emissions by about 30%, while the others increased their emissions since the carbon market became international law in 2005. We could do the same with water and biodiversity. Wait: I don't mean “we could,” I mean “we must”. If we don't value water, air and biodiversity, which are goods needed for our survival, our species will not survive.

J. Polychroniou and Marcus Rolle: The Kyoto Protocol was the first major effort on the part of the world community to tackle the problem of climate change. Does it remain a viable climate change policy for the 21st century?

Heikki Patomäki: The Kyoto Protocol is far from a satisfactory solution to the 21st century problems. The 1997 Kyoto Protocol sets carbon dioxide emission quotas for countries. Quotas and caps can be seen as fixed, as they often are, but the

Kyoto Protocol includes an emissions trading scheme that allows actors to trade their commitments. In other words, this system creates a market for carbon dioxide emissions, for a type of pollution. This has manifold moral and political implications. For instance, emission trading undermines the sense of shared sacrifice necessary to future global cooperation on the environment, while also encouraging an instrumental attitude towards nature.

The second Kyoto Protocol commitment period applies to emissions from 2013-2020. This system is far from being all-inclusive. The countries with binding targets in the second commitment period comprise only the members of the EU and a few other European states, such as Australia and Kazakhstan. Many of these countries are committed to reducing, by 2020, their emissions to 80% of their 1990 emissions. A problem of the second commitment period is that between 2005 and 2012, a number of countries saw their emissions cut by more than they had promised, so they now have a surplus of emissions permits. This was mostly because of the fall of industrial output due to the global recession of 2008-. If these emission permits were carried over into the second commitment period, it could render the whole exercise virtually pointless, as the extra permits would allow countries to continue emitting. Under the amendment "3.7ter", however, many of these permits will be cancelled by 2015. The second period can thus imply some new reductions in emissions, but encompasses only the EU and a few other countries.

By summer 2016, 66 states had accepted the Doha Amendment, while entry into force requires the acceptances of 144 states. Of the 37 countries with binding commitments, 7 have ratified.

Graciela Chichilnisky: Yes, it does. It's structure is working fine, but the limits on emissions that it harbors in its Appendix, nation by nation, must be extended to all nations and in time. Otherwise the carbon market cannot work. The carbon market trades rights to emits, and without limits there is nothing to trade. This is why the Paris Agreement has been called a "fraud" by James Hansen, the father of climate change science. The Paris Agreement has no mandatory limits. Can this be done? Can emission limits be successfully imposed? Definitely. Kyoto did it in 1997. As we saw October 14th 2016 at the UN climate meeting in Kigaly, Rwanda 170 nations are willing to cooperate and made HFC emission limits mandatory (they extended the Montreal Protocol to encompass HFCs, which did not require

US Congress approval) and HFCs are greenhouse gases. So the carbon market can thrive and produce the global change in values that is absolutely needed right now. The main and almost the single obstacle is the US Congress and this is explained above. However most Americans disagree with their Congress representatives on the issue, but polls show that fossil fuel lobbying shifts the US Congress' vote away from the American voter. The situation may change due to new technologies that are carbon negative and make carbon reduction possible while increasing profits and economic gains today. These could and eventually will turn US Congress around: the only question is how long this process will take. We are clearly running out of time with the North and the South Poles melting and the overwhelming damages caused by amplified draughts, floods and hurricanes caused by climate change, which lead to millions of people migrating and costs of hundreds of billions of dollars worldwide. It can be done: the question is when.

J. Polychroniou and Marcus Rolle: One of you (Heikki Patomäki) has been arguing in favor of a global Keynesian approach to climate change and the environment in general. What distinguishes the Keynesian approach to climate change and environment related problems from mainstream environmental economics?

Heikki Patomäki: Differences between tax and cap-and-trade systems concern distributional implications; simplicity and related administrative and transaction costs; effective scope; and dynamic effects. A tax can generate substantial public revenue that can be used for purposes of common good and global redistribution, as defined through a democratic process, also to compensate for the effects of global warming. A carbon tax is also relatively simple and can thus be easily specified in a fairly short legal text, whereas cap-and-trade proposals are much more complicated. Setting up caps and emission certificates and their trading system – an administratively created synthetic market – involves many intricate technical issues (e.g. the proposal needs to determine how allowances will be created and distributed), entailing high administrative costs. Moreover, a system of tradable permits entails also significant transaction costs to the actors themselves, because they have to search for traders, engage in negotiations, seek approval for deals and take insurance.

What is more, cap-and-trade systems can only be implemented among private firms or countries. In contrast, taxes have broader effects. For instance, a carbon tax extends to all carbon-based fuel consumption, including gasoline, home

heating oil and aviation fuels. The scope of greenhouse gas taxes is thus wider and covers comprehensively different sources of emissions. A further advantage of the tax is that it offers a permanent incentive to reduce emissions, whereas caps fix the preferred amount of decrease in emission, typically a result of compromise and lobbying.

At a deeper philosophical level, the idea of a global tax is part of a global-Keynesian approach that is more compatible with environmental concerns than conventional economics. According to the holistic perspective of Keynesian economic theory, economic developments, and especially the formation of effective aggregate demand, are seen from the standpoint of all actors and countries at once. The conditions in which actions are taken form a whole in which the various parts are dependent on each other. Thus understood, Keynesian theory is consistent with a cosmopolitan moral perspective, as morality in general requires sufficient universalizability across different contexts, concerns and interests. The aim of various versions of the universalization principle is to help in locating norms that can be accepted by different parties irrespective of race, gender, age, nationality, world-view, or even present conditions. Valid norms may, and sometimes also must, take into account future generations. When connections across temporal (and spatial) distance are robust and when the effects of activities on nature or society will be enduring, as in the case of global warming, the effects must be considered from an ethical point of view.

Graciela Chichilnisky: Generally speaking, the Keynesian approach views the aggregate demand of an economy as a public good, which makes it therefore part and parcel of economic policy. This is generally correct, although sloppy implementation can lead to very bad consequences. To be sure, Keynesianism's good will and positive hopes do not suffice. But think of it this way: a financial policy that offers high income individuals shares in new technology companies that deploy and scale up carbon negative technologies can reverse climate change and is both Keynesian and conservative at the same time. It can be done. The critical thing now, as stated in the 5th Assessment Report of the IPCC and the Paris Agreement, is to remove the excess carbon that is already in the atmosphere which will remain otherwise for hundreds of years and will inexorably lead to irreversible climate change disaster. And no, adopting clean energy and recycling positively and emphatically do not suffice — there is not enough time for that, nor for the great policy of planting more trees that is critical for biodiversity. These

policies are great, but, as demonstrated by UN studies, it will take decades and beyond this century to have an impact on climate change. Moreover, CO₂ already emitted stays in the atmosphere for hundreds of years and, if not removed right now, it will add up to additional layers of carbon dioxide which at this stage will overflow the glass. This means irreversible climate change. But carbon negative technologies that can clean the atmosphere today effectively and reverse climate change do exist, as reported by KPMG and Forbes Magazine in articles and videos two weeks ago, and they can use the carbon dioxide removed or “farmed” from the air to generate billions of dollars from the sale of CO₂ for the production of beverages, food, greenhouses, plastic and other building materials, carbon fibers that replace metals, synthetic gasoline, and water desalination. I am now reciting the business model of Global Thermostat www.globalthermostat.com whose proven technology is inexpensive and flexible, modular, and farms CO₂ directly from the atmosphere while transforming it into dollar bills from the sale of the materials and goods just described. Of course this can be done. We need 15-20 years at \$200Bn/year which the carbon market of the UN has already traded in 2012, in just one year. The process is low-cost and profitable, so the money is only project finance. We need, for example, to build 30,000 Global Thermostat plants removing 1MM tons of CO₂ per year each, which is about 150 per nation. That is all. And while Global Thermostat is a visionary leader, other technologies and firms will emerge to imitate its business model and the economy – and all of us – will be better off for that. Let’s do it.

J. Polychroniou and Marcus Rolle: The Industrial Revolution, which eventually gave rise to a global industrial civilization, was based on a fossil-fuel economy. However, the very source of energy that created a new dawn for human civilization is now responsible for the global warming phenomenon which, if it continues unabated, could begin very soon to have an immensely catastrophic impact on global industrial civilization itself by creating new sources of conflict and instability and even leading eventually to the destruction of civil society as we know it in the western world. Do you agree with this assessment and, if so, what do you consider to be the most practical and realistic clean energy systems that can be adopted in a world under complex interdependence?

Heikki Patomäki: I believe industrialization is a universal condition for humanity – it could have happened in China earlier, or it could have been postponed and happened somewhere else than Europe, but it was bound to happen at some point

somewhere. We can also talk about universal political economy stages can be defined in terms of the available forces of production and sources of energy. The development of humanity so far has proceeded through three different stages:

- (1) The stage of hunter-gatherers, who can handle fire and simple tools but have no other sources of energy than their own muscles and the heat of fire;
- (2) The stage of agricultural civilization, where the main source of energy is human and animal muscle, although increasingly also wind, water flows and chemical explosives are being exploited;
- (3) The stage of industrial civilization, based on the work of machines operated with external sources of energy, such as fossil fuels, wind or water flows which are transformed into electricity, and nuclear power. The problem with the stage (3) is precisely is that the use of fossil fuels or uranium is neither sustainable nor renewable.

Now we - the humanity - are facing an acute crisis and must move quickly to a new stage. The main source of all energy is the sun, although also Earth's internal heat can be a source of energy. The energy of the sun can be captured directly, but it also generates flows of air and water, which can be utilized too. In addition, hydrogen is a zero-emission fuel; and heat pumps can be used to save energy. And in principle we can also imitate the fusion processes of the sun on the Earth. These are all, at least in principle, either renewable energy sources or ways of saving energy, but no human system of harnessing or saving energy is ecologically, ethically or politically neutral.

Especially under the current politico-economic circumstances, I tend to favor decentralized solutions, such as household or factory based solar panels and heat pumps, although we need to invest in any possibilities that look at least potentially promising. Consider for instance using tidal energy for separating hydrogen from water. One of my favorite ideas is, however, really large-scale solar panels in space, the building of which might require also the use of a space elevator. A major problem with these kinds of solutions is, of course, that they could also be used as weapons. A global security community is a precondition for the feasibility of large-scale and centralized solutions - and even then it is not reasonable to put all one's eggs in one basket.

Graciela Chichilnisky: We need to build a large number of carbon negative power plants, which are already operating today: there is a Global Thermostat plant at SRI in Silicon Valley that is cleaning SRI's natural gas power plant — and with the

residual heat it cleans inexpensively the atmosphere from additional CO₂. This is possible, and the residual heat required can come from a solar plant, so GT can produce carbon negative power plants based on solar plants, thus accelerating the new and clean forms of energy. We need to build 30,000 such carbon negative plants, each producing electricity, while removing 1MM tons of CO₂ per year, which amounts to about 150 plants per nation. This is completely manageable and can be implemented in a few years, as described above, starting right now.

J. Polychroniou and Marcus Rolle: It is becoming increasingly obvious that the reduction of emissions is not enough to combat the climate change threat as there is too much carbon dioxide already accumulated in the atmosphere, thereby ensuring that temperatures will continue rising even with noticeable reduction in future emissions and other greenhouse gases. In your view, why is there little interest so far in using gigaton-scale carbon dioxide removal technologies?

Heikki Patomäki: Carbon dioxide removal is considered costly for public budgets when most parties seem keen in their attempts to cut down their public budgets. It can also be a relatively slow method, whereas the prevailing time horizon of profit maximizers and politicians tends to be very short.

The best method by far would be reforestation and the leaving of as much forest-space as possible to its natural stage (for example, the contemporary Finnish forests contain only a fraction of wood that the old forests did). But as you indicate in your question, there are also technological solutions that can and must be considered and used. The cleaning and stabilization of the planet Earth will be a costly long-term project. The good news is that from a global-Keynesian perspective, these kinds of investments can also stimulate the economy and reduce unemployment.

Graciela Chichilnisky: The reluctance is based on lack of information and the fear of large cost mammoth-like failed examples of plants that have done carbon capture and sequestration (CCS) until now. All failed. None produced CO₂ at a cost that could be sold for economic value. But Global Thermostat's new technology is completely different from our grandfather's CCS ("carbon capture and sequestration") which, as I mentioned, has failed and failed time and again, costing a lot of time and money loss in the process. How different? Global Thermostat's plants are small portable and modular, not huge mammoths. Each unit is about 12'x15'35' -that is all. To build a 1MM ton plant you put together

several units. And Global Thermostat ' CO2 removal cost is very low because the CO2 is farmed from air that is free and the energy used by GT is residual heat from industrial facilities that costs nothing. Free inputs and free energy explains why the price is so low. And let's not forget that CCS buries the CO2, which is what "sequestration" means, so it is all cost. Instead, Global Thermostat sells the CO2 it removes from the air to a large and hungry market mentioned above, making the whole thing a commercially viable proposition. And no additional emissions are created since no electricity is used. GT does not fall into the electrical cars trap, which use no gasoline but a lot of electricity, which is the worse emitter of CO2 in the world.

J. Polychroniou and Marcus Rolle: One final question. Why doesn't climate change trigger the moral judgment system as do some other social issues and problems?

Heikki Patomäki: Many scholars and movements are calling for new institutional responses to the risks and threats created by the processes of the originally European first modernization that has now become global. So it is not entirely true that climate change does not trigger the moral judgment system as do some other social issues and problems. Moreover, I would stress that there is something truly unique in this reflexive response to the problems we have ourselves created. For the first time in human history, we are systematically anticipating the next 50-200 years and trying to modify our practices and institutions accordingly. We are also increasingly aware of the politics of anticipation.

But there is a sense in which your question is well taken and right on the mark. It is of course difficult to orientate toward consequences that are hardly visible in one's everyday life. This practical difficulty of learning the lessons from what is happening can easily be combined with the prevailing mythology of liberal-capitalist market societies. A basic "mythologeme" of liberal-capitalist societies of the late-twentieth century and early-twenty-first century comprises of three temporal tiers:

- (i) the first tier is constituted by cosmic myths of desperation, involving the Copernican principle — "we don't occupy a privileged position in the universe" — and various narratives about how the story of humanity will inevitably end up in death, at some scale of time;
- (ii) sensibilities verging on cosmic desperation are then liable to fostering competitive ego- and ethnocentric short-termism, both compatible with Darwinist

ideologies; and

(iii) belief in technological progress and economic growth, providing sources of welfare and pleasure to the growing human population at least in the coming decades (i.e., at least as long as I, or we, can expect to live). All this amounts to saying nothing really matters; let's have fun here and now.

Against this worldview, I would like to propose an alternative, counter-hegemonic story. It is possible to outline an alternative story-line that revolves around life rather than death. Those real cosmic risks that are relevant in the human-historical scales of time — from decades up to tens of thousands of years — can best be addressed by means of future-oriented planetary co-operation. From a long-term perspective, it is critically important to recognize that our universe is not only physical. It is also biological and cultural, and constantly changing. The emergent layers of life and culture may gradually assume an increasingly important role in the further developments of the universe. Biological reality is multi-layered, hierarchically organized and involves interdependent functional synergies and higher-level controls, making purposive behavior possible. Complex systems of life have shaped the chemical composition and development of planet Earth for more than three billion years, setting it on a path of development systematically off its thermodynamic and chemical "equilibrium". The Earth is blue because it is teeming with life.

Since the industrial revolution, human culture has started to shape developments on a planetary scale. Thus we are talking about the Anthropocene. The impact may have been problematic so far, as shown by the mass extinction of species and anthropogenic global warming, but the role of humanity may turn out to be more life-promoting and ethical in the future. We humans are now deeply involved in the future developments of the planet. By cautiously generalizing from the experiences of the Earth, it is conceivable that, in the future, life and consciousness will play a co-formative role in our galaxy and possibly also in the universe as a whole.

Perhaps, as the well-known physicist Freeman Dyson has proposed, the gradual greening of the galaxy will become an irreversible process, in which we are playing a role. The expansion of life over the universe and its evolution qualitatively into new dimensions of mind and spirit would occur simultaneously. This scenario of the greening of the galaxy involves a future project for humanity; the expansion of life and culture into space may be one of the chief tasks awaiting

humankind. But first we must make life on this planet sustainable in the very long run. This is the only haven of life we know so far. No matter what will happen in the future, this will remain the home for the bulk of humanity for a very long time to come. There is no escape to the space.

Graciela Chichilnisky: What moral judgment system? This sounds like a good idea, to paraphrase Mahatma Gandhi when he was asked what he thought of Western Civilization.

There Is A Solution To Climate Change ~ And It Is Carbon Negative Technology



Climate change poses the greatest threat to human civilization as we know it. Yet, governments around the world are reluctant to take drastic action to avert a climate change catastrophe even though we have the means to do so, as I will point out in the latter part of this essay.

But let's take things from the start and look at the latest attempt of the part of the world's governments to redress the problem of climate change, i.e., the Paris Agreement of late 2015.

In contrast to the Kyoto Protocol, whose provisions run out in 2020, the Paris deal includes no legally binding carbon dioxide emissions limits. There are no mandatory emission limits and no mandatory payments to help poor nations develop clean energy technologies, nor to mitigate the damages caused by climate change on poor nations, when the damage was historically caused by the rich nations. Mandatory emissions limits are necessary for the carbon market to operate. What is traded in the carbon market is the right to exceed one's mandatory limits. With no mandatory limits, there can be no carbon market. The entire world is clamoring for a "price on carbon": this is the carbon market. The six largest oil and gas companies in the world publicly support a price on carbon (Including Shell, BP, Statoil, Total and Engie). Yet the Paris Agreement undermines the very foundation for a price on carbon by requiring no mandatory emission limits.

Why did the Paris climate change negotiations move away from mandatory targets on carbon emissions and adopted instead a voluntary approach to the climate change challenge? Because a legally binding treaty that needed ratification by governments back home would have reduced substantially the chances of reaching any kind of an agreement.

This is certainly the case for one of the world's biggest polluters, i.e., the United States. Any treaty on climate change that made its way to Capitol Hill would be shredded into pieces by the Republican-controlled Congress.

However, as time goes by, it is certain that more and more people will realize that the political compromise made in Paris over mandatory emissions comes at a great cost. Our ability to control rising temperatures caused by carbon dioxide accumulated in the air is greatly hindered since voluntary agreements guarantee failure.

But there is more. As the latest Intergovernmental Panel on Climate Change report points out, carbon emission cuts are not enough to slow down global warming. According to IPCC, we are headed with certainty towards an increase in temperatures by three degrees Celsius by 2100, although there are scientists who believe that two degrees of warming is "a recipe for disaster." It suffices to recall the superstorm Sandy that closed down New York City for weeks, with flooded subways, leaving entire neighbourhoods without electricity, no schools, no law enforcement, and automobiles floating in the streets of this proud city. Climate

change means an increase in the frequency and severity of such climate events. This means three or four Superstorm Sandies every year in New York, and the city cannot survive such climate change.

In addition to reducing drastically emissions through mandatory limits and adopting clean energy systems, it is now imperative that we utilize negative carbon technologies to remove existing carbon dioxide from the air. This was required by the IPCC, the scientific foundation of the climate negotiations, in its November 2014 5th Assessment Report. We procrastinated too much and now we have to massively reduce the CO₂ that is already in the atmosphere in addition to reducing emissions. There are carbon negative technologies in Silicon Valley, like those employed by Global Thermostat, that are operating at SRI in Menlo Park California, which can offer a solution to the greatest threat facing the future of human civilization as we know it. This requires that we accept mandatory emission limits and reactivate the carbon market that is based on mandatory emissions, and was trading \$175Bn/year by 2011.

The funding from the carbon market suffices to implement and scale up carbon removal around the world, as the IPCC requires, for example through carbon negative carbon plants that clean the atmosphere while they produce electricity- and do all of this in a low cost and profitable fashion. A proposal made by the author in Copenhagen COP15 was to use the Kyoto carbon market to offer finance to scale up globally such carbon negative carbon plants in poor nations, thus providing electricity that is needed by 1,3 Bn people around the world that currently have no access to electricity, all this while cleaning the planet's atmosphere. This was called the Green Power Fund and required \$200Bn/year for building carbon negative power plants; instead the Green Climate Fund was made into law, changing one word in its title and severing its connection from the source of funding, the carbon market of the Kyoto Protocol.

The reason the Climate Fund had its connection severed from its very source of funding, the carbon market of the Kyoto Protocol, was none other than the insistence of the US Congress – through its unanimously voted Byrd-Hagel Act — that there be no mandatory emissions limits.

But there is technology that can remove carbon from the atmosphere as required by IPCC. It is already operating in the Silicon Valley.

The carbon negative technologies in Silicon Valley, like those employed by Global Thermostat, which are fundamentally different from the now defunct carbon capturing and storing technologies, can offer a potential solution to the greatest threat facing the future of human civilization as we know it.

Such technologies, if employed on a global scale, can be used to clean the air from carbon dioxide, acting like trees do but much faster, as is needed now. Moreover, they are quite inexpensive and offer the potential of financial rewards, thus making them an attractive incentive to investors and entrepreneurs since, again, the logic of the global economy is not going to change overnight and we certainly cannot wait for the materialization of the “ideal society” for the planet and the future of human civilization to be saved.

At the same time, this is not to suggest that technology is magic. Technology does not exist in a vacuum nor can it be expected to be our robotic slave. We need to change today’s global financial institutions and the prevailing economic values as well. Economic values decide what is meant by economic progress. Today, economic values are based on short-sighted goals and on individualistic markets that defy logic, since they assign no value to clean air, to clean water or to biodiversity on which human survival depends. Assigning no value to the global commons—clean water, clean air, and biodiversity—leads to actions that threaten human survival. This has to change and can change. In the new Anthropocene era, humans are the most important geological force on the planet, and only with the right economic values can humankind survive.

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Climate Change: The Mother Of

All Geopolitical Challenges ~ Interview With Graciela Chichilnisky



In this interview, Graciela Chichilnisky, a world leading economist and one of the major climate change forces in our era, talks about the reality of climate change science, the reasons why some corporate interests continue to deny the facts about it, and explains why climate change may represent the greatest geopolitical challenge facing humanity.

Marcus Rolle: Despite the international scientific community's consensus on climate change, there are still people who deny that climate change exists or that it is caused by human activity. In fact, some of those naysayers have been funded by corporate interests such as ExxonMobil, as revealed by Exxon's former in-house climate change expert Lenny Bernstein. However, the evidence for global warming is overwhelming. Why, specifically, are some corporate interests bent on hiding the truth about climate change, and what's your opinion on the effects of global warming?

Graciela Chichilnisky: Some of the naysayers have been funded by corporate interests as was revealed by Lenny Bernstein, the in-house climate change expert of Exxon. Lenny fought me tooth and nail in Kyoto during December 1997, while I designed and then wrote the Carbon Market into the United Nations Kyoto Protocol. At the end the carbon market prevailed and is now international law, and ironically it is now advocated by six of the largest oil companies in the world and this includes ExxonMobil.

Corporate interests are far reaching and they can permeate the entire economy and the politics of a nation as a whole. In the case of fossil fuels the situation is

compounded by the central role played by energy in the economy. Fossil fuels are all about energy, and energy is the mother of all markets. Everything is made with energy, your home, your car, your food and the computer on which this article is written and read. For this reason the right to use fossil fuels is very basic and it is close to land's rights; as land's rights, the rights to fossil fuels can be the cause of wars. It is all about values. Some say that the right to fossil fuels is about the right to use the earth's resources, which were provided by God to humans, and they hold this as a human right whether or not burning fossil fuels can cause catastrophes and damage irrevocably the rest of the world.

Tackling climate change is like abolishing slavery. It is so deeply felt that it can cause wars. 150 years ago it was nearly obvious to everybody that slavery must disappear, because of basic human principles and of the most sophisticated arguments about freedom, civil rights and even economics. Yet 150 years ago the US fought a fratricide war that was the bloodiest in the nations' history, and tore the nation apart to defend the right to own slaves. The South lost, but it nevertheless attempted to resuscitate the war many times despite that.

US historians say that the economic value that is at stake from abolishing fossil fuels is about the same as the value that was involved in eliminating slavery in the US 150 years ago. The abolition of fossil fuels can destroy today the largest balance sheets in the planet: these are the balance sheets of the largest oil companies. It is not surprising that emotions and economic interests of that size run amok and cloud reason.

MR: You have said that climate change is the mother of all geopolitical challenges. Can you elaborate a bit on this?

GC: Climate change is all about the use of fossil fuels: over two thirds of the world's CO₂ emissions that cause climate change come from burning fossil fuels to produce energy. Fossil fuel energy is today the basis of industrialization, and its use since WWII is what is causing climate change. The period since WWII is when the world economy globalized, where the North and the South wealth gap increased deeply and became three times larger what it was before, when abject poverty led over 1.3 billion people to live below the level of satisfaction of basic needs, and on the brink of survival. The Bretton Woods institutions were created after WWII: the IMF, the World Bank, the WTO, and they were dominated by the US that become nearly 60% of the world economy after the destruction of

Germany and Japan. The Bretton Woods institutions used financial tools, denominated in US dollars, to encourage and coerce 80% of the planet's population in the developing nations to follow a resource intensive form of economic development, leading to the over-extraction and exports of their fossil fuel resources and other important natural resources at the lowest prices ever – except perhaps for the prices we face today – and their overuse in rich nations. Fossil fuels are intimately connected with globalization – indeed they are the basis of the current wave of globalization. Fossil fuels are the basis of industrialization and they are traded through international markets: the international markets are dominated by rich nations, and these markets grew three times faster than the world economy as a whole since WWII. In these markets, poor nations that house 80% of the world population over-extract the earth's resources within their territory for exports, and export them at prices that are lower than replacement costs, leading to sustained poverty, while rich nations who house 20% of the world's population overuse the world's resources and benefit from them at very low prices. This implacable process has led to a 3x increase in the world's wealth gap between the poor South and the rich North since WWII. The image is just 20% of the world's population siphoning and overusing the great majority of world's resources. But the process has reached its natural limits: the increasing inequality between rich and poor nations in the world economy and the corresponding overexploitation of resources is the cause of the global environmental crisis of our times. It is threatening every nation in the world. Global environmental risks are worst for the poor nations, but every nation is at risk from the massive overuse of resources our lopsided economies and international trade policies of the Bretton Woods institutions caused. Climate change means the rise of the seas which has the same level all over the world. While the poor will suffer more, rich nations will suffer \$trillions in economic losses, according to OECD reports in Paris, and will face massive immigration flows that will threaten their institutions, as the Pentagon anticipates.

The geopolitical risks of climate change are now becoming evident: they include massive migration caused by extreme climate conditions entailed in climate change. Record droughts and floods are the most immediate consequence of climate change. Not surprisingly, the current war in Syria started after four years of extreme droughts that left people without jobs, without food and without hope. The result is a massive exodus into Europe – just one million people last year, with several more millions expected this year and the next. This developments is highly

destabilizing. It leads to political fear and hate against the massive wave of immigrants. The fear of immigrants and refugees has become an everyday reality, with immigrants being demonized by the media and presidential candidates in Europe and the US alike. The fear is that immigrants will take away jobs, reshape the face of contemporary society, and be a source of violence and even terrorism. The fear of immigrants and refugees can cause nationalistic and even fascist tendencies, and provide the pretext for the emergence of authoritarian regimes in many advanced democratic nations in the world. In due time, such political scenarios can provide the source for the destruction of democratic institutions and the end of freedoms and liberties that took centuries to build and the excuse for the implementation of extreme political measures against minorities. In fact, they may lead to the reformulation of human civilized values as we know them. The ensuing political chaos can destroy civil societies even before the rising seas that are caused by the melting of the North and the South Poles swallow hundreds of millions of people and create global demographic chaos. This in a nutshell is why climate change is the mother of geopolitical changes today.

If this position seems extreme, consider that it is similar in many aspects to the position that the Pentagon itself has presented in official reports on the topic of climate change and national security risk during the last 8 years.

Why don't we hear more about this in today's political climate? Contemporary civil discourse avoids these issues because nobody seems to know what to do about it. It is a form of socio-psychological denial. Yet there are now technology solutions in the US that can resolve the problem and lead to a massive restructuring of our energy infrastructure. Such technologies and new infrastructure can also lead to economic boom. The main issue is redressing the economic and human value of a clean atmosphere, and of the survival of the human species. Despite the existence of solutions, enormous change in the foundations of energy use and even capitalism as we know it, are very difficult to accept. Short term interests are key factors that stand on the way to clear reason.

MR: The latest attempt on the part of the so-called international community to tackle the climate change challenge took place in Paris in November-December 2015. What's your assessment of the climate agreement at COP21?

GC: The Paris COP21 climate conference has produced an agreement that has been hailed by world leaders as a development signifying "a turning point for the

world,” the end of the fossil fuel era. The truth of the matter, however, is very different. The Paris COP21 climate agreement is simply empty of action, and can be called hot air. We are no closer to averting a catastrophic climate change scenario than we were before the start of the Paris talks. In fact, this could be the biggest failure of the global climate negotiations in their 21 years of existence. It’s an agreement that binds the signatories to nothing. My former colleague at Columbia University and from NASA, Professor James Hansen, a founding figure in identifying the risks of climate change, says the Paris agreement is “fraud.” We spent billions of dollars and weeks of talks in Paris with no action items to show for it. Climate change is a tough problem that cannot be resolved by wishful thinking. Voluntary solutions never worked. We have 18 years of experience to prove this fact.

The so-called Paris agreement also makes no commitment to funding. Yet, funds are needed to transform the \$55 trillion power plant infrastructure that emits 45% of the global emissions. There can be no solution to the climate change challenge without transforming the very infrastructure that is responsible for nearly half of the global emissions. The power plants upon which this infrastructure is based on operate through the use of fossil fuels and we need to move in the direction of clean power. This will also not happen through wishful thinking. Transforming the \$55 trillion power plant infrastructure requires solid financial targets and actions. It is an extremely difficult to do, but it can be done – indeed we now have the financial political and technological solution to resolve climate change – but it cannot happen merely by wishful thinking. Magical thinking will debilitate us and undermine our ability to succeed. And what is at stake here is nothing short of the survival of human civilization as we know it.

MR: Some developing nations are concerned about restrictions on greenhouse gas emissions as they feel that such measures will hinder their own economic development. In fact, they object to western moralizing about climate change since it has been the great western capitalist powers that have caused the problem of climate change. What will it take for developing nations to adopt clean energy power systems?

GC: It is possible with today’s proven technologies to capture of CO₂ directly from the atmosphere and at a very low cost – this is called direct air capture (DAC) technology. The CO₂ can be utilized in valuable products to reduce costs. With this carbon negative technology™ one can build “carbon negative power plants”™

that produce energy while they clean the planet's atmosphere. These power plants can produce CO₂ in a profitable manner, so the final product is more development with a cleaner atmosphere. In 2009 during COP15 in Copenhagen I created these technology concepts and the Green Power Fund a \$200Bn/year fund to build such carbon negative plants in developing nations, which would derive funds (\$200Bn/year) from the carbon market of the Kyoto Protocol (which was then trading over \$175Bn/year). These plants can provide clean power to poor nations and suffice to build enough carbon negative power plants to clean the world's atmosphere and to promote enormous and much needed economic development in Africa, Latin America and the Small Island States. These nations can grow and they can clean the planet's atmosphere at the same time.

In Copenhagen COP15 I presented my plan to the US delegation, and the US State Department announced two days later a version of it in Copenhagen. This version was called a Green Climate Fund (one word was changed) and is now international law. But as its name indicates, the changes built into the new version - the Green Climate Fund - destroyed the connection with power plants that are the source of the problem, and the possible solution, and the connection to the carbon market of the Kyoto Protocol (this was because the US has been against the Kyoto Protocol since Lenny Bernstein of Exxon and other lobbyist in the US had their way).

The Green Climate Fund is now international law but it is handicapped by having no source of reliable funding, while its mother the Green Power Fund that I created had the UN carbon market to fund it, and the carbon market had enough resources to pay for the Fund's \$200Bn/year. As a result of these disconnects, the new Green Climate Fund has never taken off. Despite good willing donations, it has no reliable source of funding and no clear objective beyond alleviating the worst outcomes of the climate change catastrophe.

We need to go back to the Green Power Fund because it can avert climate change altogether. On that financial basis we can now resolve climate change, using the new carbon negative technologies to build carbon negative power plants in the poor nations. It will take 15-20 years to overcome the worst part of the problem and it will cost US\$2-3trillion to build as many carbon negative power plants as needed, but every cent can be recovered since carbon negative power plants are commercially viable, namely they pay for themselves: they cost less to build than the revenue they produce from the sale of the CO₂.

This is a revolutionary transformation of the global political economy of the last two hundred years, including the dynamic that guides this century's globalization processes based on the extreme overexploitation of earth's resources - including the planet's atmosphere. But one must remember that that this plan needs new types of economic arrangements to succeed. It entails a transformation of capitalism.

Scientific computations show that all this can be self - financed: the CO₂ captured from the atmosphere can be sold for use in food and beverages, fertilizers, greenhouses, enhanced oil recovery where appropriate, for clean fuels, building materials, fertilizers, carbon fibers, and more - there is a \$1trillion market for CO₂ on earth, and these products can eventually utilize and remove enough CO₂ to eliminate the 38 gigatons of CO₂ that humans put up every year into the atmosphere.

It this plan seems extreme, consider that it is what the Intergovernmental Panel on Climate Change says is needed now in order to avert catastrophic climate change.

MR: Are thresholds on greenhouse gas emissions sufficient at this stage in the game to prevent a catastrophic climate change scenario?

GC: No, the Paris Agreement has no thresholds, none. It has been said to have "no teeth" for this reason. The Kyoto Protocol mandatory emissions/ limits are the only thresholds we have, that we ever had, and they expire in 2020. We need to renew and extend the Kyoto Protocol thresholds as a matter of urgency and implement the carbon negative technologies that the IPCC requires, which are available and even profitable for removing carbon from the atmosphere. We must extend the Green Climate Fund to become the Green Power Fund to help development in the poor nations, mainly China and India - and we must do this now. Time is of the essence.

MR: What type of strategies and tactics could activists and communities pursue to respond to the climate change challenge?

GC: This is a very important issue that requires immediate attention and political action. Once the solutions that are available become communicated and are well understood, the peoples of the world can help organize the actions needed through the UN COP meetings every year, and through communities, local and

national organisms that can implement them. Political action is required. This is what democracy is all about.

This will happen once the solutions are better known. They entail carbon negative technology that removes the existing carbon from the atmosphere – as explained above and as indicated in the 5th Assessment Report — in order to avert catastrophic climate change.

But technology isn't magic. It does not occur in a vacuum. It will develop within appropriate socio-economic structures, within appropriate political and institutional facilities. Here is a good practical example: After World War II, the leading economies created the Bretton Woods institutions to replace war by trade, so that the human species did not spend itself in increasingly savage and destructive world wars. The Bretton Woods institutions were deliberately created to implement change. They succeeded, but had unexpected consequences: they caused an enormous expansion of international trade and industrialization that created a lopsided world in which the rich nations that house only 20% of the human population consume most of the planet's resources and are now destroying the atmosphere, its bodies of water, and the complex web of species that constitutes life on earth.

The Bretton Woods institutions were the first global financial institutions created by humans, and they changed the world economy as they were meant to do. They were the brainchild of John Maynard Keynes but they were led by the USA, the largest economy in the world after WWII. The Bretton Woods institutions succeeded to such an extent that they led to the Anthropocene, a new geological period that overcame the Holocene, when humans are now the stronger geological force in the planet.

But we are now facing new, formidable challenges that carry far greater risks than the early postwar era. We need, therefore, to create new global institutions that provide a new view and radically new processes of economic progress, based on a harmonious relationship between humans and nature. The next transformation of the world economy requires new economic arrangements that re-value the earth's resources that we are destroying at an alarming and unprecedented rate. In addition to the global carbon market, that was created in 1997 and international law since 2005, we now need global limits in the use of water and biodiversity and economic arrangements that provide value for water and for biodiversity. Air,

water and food are three basic needs without which humans cannot survive. Yet today clean air, clean water and biodiversity have no economic value. The global markets I propose for carbon, water and biodiversity will make these the largest economic assets in the world, as they should be. It can be seen that these environmental assets are mostly in developing nations, which house the world's largest environmental riches. Because the atmosphere, the bodies of water and the world's biodiversity are global public goods, once we alter their use, the arrangements to use them will be completely different from the markets for private goods that we have today. For example, they would require more equity in order to achieve efficiency. These new global economic arrangements will transcend actually existing capitalism and will create a new economy in which the most important assets are the world's resources, equity is a foundational value, and equity as well as efficiency are closely linked, as they should.

Is this a dream or can this happen? If there is a future to human civilization it must happen, and it will happen. In a way it is already happening. The new generations know this and will rise to the occasion once we provide the awareness and the tools to build a new economic order that is actually attainable.

Welcome to the world of the future.

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*[Graciela Chichilnisky](#) has published scores of books, including *Saving Kyoto*, and some 350 scientific articles in the world's most prestigious economics and mathematics journals. The *Washington Post* calls her an "A-list star" and *Time Magazine* a "Hero of the environment". In addition, Chichilnisky has made revolutionary contributions to the world economy - like creating the concept of *Basic Needs* and the *UN Carbon Market*.*

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Climate Change And The Future Of The World: An Interview With Graciela Chichilnisky



In this highly insightful interview, climate change authority and leading economist Graciela Chichilnisky talks about the catastrophic threats that climate change pose to the future of the world if we fail to coordinate global actions aimed at the curbing of emissions and the removal of carbon dioxide from the air through the revolutionary technology available. Professor Chichilnisky also argues, however, that technology isn't magic, and that what is required for tackling global warming with carbon negative technologies are fundamental changes in the way the global economy and its institutions have functioned in the post-war era.

Marcus Rolle: You have been for many years one of the leading forces in climate-change efforts. How do we define climate change?

Graciela Chichilnisky: Climate change means a major shift in climate patterns, such as dramatic increase in the violence, frequency, length, and severity of climate events, including superstorms, tornadoes, typhoons, major floods, and long severe droughts, as well as other climate related environmental disasters. These events increase both in intensity and frequency as energy in the atmosphere increases, which occurs when the mean temperature increases. Climate change also means dramatic changes in long term climate patterns such as desertification, the alteration or the reversal of major ocean currents, changes in the sea level, melting of the planet's polar caps, and glacier periods.

MR: What evidence do you think supports the argument that climate change is taking place and that the global mean temperature is driven up by human

interference?

GC: The statistical evidence conforms to the definition just provided: the planet's polar caps are indeed melting, and the sea levels are indeed rising. This has been measured and is directly observed. We have increasingly violent, frequent, lengthy and severe climate events, major floods and unusual severe droughts that do not correspond statistically to standard deviations from the mean. Thousands of scientists from all over the world who report to the United Nations Intergovernmental Panel on Climate Change (IPCC) have come to the conclusion that changes in temperature are associated with changes in the concentration of greenhouse gases, of which the main one is CO₂, and that mean temperature is increasing due, for the most part, to the burning of fossil fuels – coal, natural gas and petroleum -- for economic purposes: industrialization.

MR: There is still resistance in various corporate and political quarters about the facts regarding climate change. Why is that?

GC: Above all, climate change means change. Big change. Enormous change. And there is always resistance to change. The image is a large ostrich sticking its head in the sand: denial of change. Climate change is particularly resisted or denied because it is directly connected to the use of energy, which measures economic growth today. The fear is that climate change will impair progress and economic growth by requiring we stop burning fossil fuels. Of course, economic growth may occur without burning fossil fuels, but in the last century and a half, economic growth meant burning fossil fuels (today, there is a tight statistical connection between the level of a nation's development and the amount of fossil fuels it burns). The same phenomenon happened in the US when slavery was abolished. The fear was that it would impair economic growth, since slaves represented energy and energy is the mother of all markets and the way we measure today economic growth. The connection is spurious. Equally, we can grow more and much better when we use solar energy – the sun after all is the source of all energy in the planet. In fact, fossil fuels are nothing else than solar energy canned in liquid form. But denial, and its cousin, lack of imagination, are powerful forces, they can cause wars and immense destruction. Humans are particularly prone at destruction that is unnecessary and occurs solely due to lack of imagination. The image is human life as a play written by an idiot full of sound and fury and signifying nothing. This is not an exact description of human life, of course – there are exceptions – but is not far off.

MR: It has been said that we must work towards keeping temperature from rising above 1.5C. Is this a safe operating space? And how can we be sure that temperature won't rise much higher than that?

GC: We definitely need to try to keep below a 1.5C increase in mean temperature. The changes we measure today have occurred as a result of just a 1C increase above the last century. According to the IPCC, an increase above 2C is catastrophic, meaning that the climate change disasters described above become frequent and the situation irreversible. Catastrophic changes will move the planet to another climate regime altogether – the point of no return. This happened in the planet Venus where the concentration of CO₂ in the atmosphere is huge, and now Venus cannot house life as we know it. However, staying within a 1.5C increase is very hard, because we emitted so much CO₂ and we have procrastinated so long in reducing fossil emissions. In fact, this is so hard that it is actually impossible (according to the UN IPCC, in most scenarios) unless we actually remove the CO₂ that is already in the atmosphere.

This is called carbon negative technology and it exists and can be utilized to effectively reverse the damage we have done. It would be a major global change, which can only be realized if we organize ourselves and the financial system to build carbon negative power plants to satisfy the desperate need for energy to fight poverty in nations, such as China and India. These are power plants that capture more CO₂ from air more than what they emit, about twice as much. These plants exist. They are possible. We need to build thousands of carbon negative power plants, mostly in poor nations that need them most. These will suffice to clean up all the CO₂ that humans are emitting every year into the atmosphere, which is about 38 gigatons of CO₂. It seems difficult to do but the economics are on our side. The capture of CO₂ from air is now economically feasible, it costs less than the price that markets pay for CO₂. Carbon negative power plants are an economic reality, they are commercially feasible. We just need project finance to get this done. Where will the project finance come from? The Green Power Fund (GPF) I proposed in Copenhagen in 2009, was partially adopted and became international law with the name, Climate Climate Fund (a one word change). The GPF derives its funding from the carbon market of the Kyoto Protocol which, by 2011 was trading about \$175 billion a year; enough to offer the project the finance needed to build the carbon negative power plants that will clean the planet's atmosphere. All that is required is to build a financial

institution – the Green Power Fund – that systematically offers debt finance for carbon negative power plants in developing nations, and circulates the revenues so they are used to build new such plants. This is certainly not beyond our financial abilities. In 15-20 years, climate change can be resolved at a total aggregate cost of \$2-3 trillion, which is less than 5% of the planet's GDP in a single year. Spread over 20 years, the financial burden of debt finance reduces to about 0.25% of GDP. But in reality, it is no burden since the carbon negative power plants are commercially viable and produce revenue. The initial money can be obtained from the carbon market of the Kyoto Protocol as well as its CDM.

It is true that, as the architect of the Kyoto Protocol Carbon market, I have an undeniable sympathy for the carbon market. But think of it this way. We all know we need to reduce emissions of CO₂, and simply by agreeing on mandatory limits, the carbon market can function – that is how it functions – and produces enough money to terminate the catastrophic threat of climate change. Also, to eliminate or alleviate poverty in the poorest nations of the world, who then become great consumers for the rich nations' exports. The circle closes. We just need to do it. There is nothing to lose and a lot to gain. And if we do not do it, we face catastrophe. It seems impossible to argue against it given the current technologies and what they have already demonstrated that they can do.

MR: According to the Paris COP21 agreement, no action will be taken until 2020, and even that is entirely voluntary. What do we do in the meantime, continue to release unlimited greenhouse gas emissions into air?

GC: In Marrakesh, where COP22 will take place, we need to create the Green Power Fund just described, as was proposed in detail in 2009, and to start building carbon negative power plants in the world's poorest nations. I also have a negotiating methodology in mind that works. We need universal agreement on carbon emission limits that extends the Kyoto Protocol emission limits, so the carbon market can function and provide the funding needed to clean the atmosphere. As everybody knows, this has proven impossible so far. But don't fret. We can start now with "conditional mandatory emission limits" that everybody can, and will, agree to. This is also possible due to carbon negative technology. The industrial nations can make their mandatory limits conditional on the use of technologies that increase economic growth (these are possible now as described above). Also, developing nations can make their mandatory emissions limits conditional on the funding for debt finance provided by the Green Power

Fund. These conditional mandatory limits are acceptable to every nation and do the job. On the basis of such mandatory emissions limits, the carbon market will function and will provide the funding needed to clean the planet's atmosphere. This is the value of global finance, and is an update of the Bretton Woods institutions that work for the 21st century.

MR: You have said that climate change is the mother of all geopolitical challenges. Given today's Europe massive refugee migration crisis, which is partly contributed to climate change, how much more severe could the migration problem become because of climate change?

GC: It is generally believed that this year and the next will see massive migration of tens of millions of people around the globe due to climate change. In their reports, the Pentagon views this situation as one of the major challenges of national security in the U.S. This is also the type of challenge that brings on the worst fears for voters, and causes xenophobic tendencies in a year of presidential elections. The concern expressed right now by the established leaders of the Republican Party is that democracy is at stake, and that fears of massive migration gets transformed into hate and anti-American expressions and policies against the migration of specific racial or ethnic groups, such as those of Muslim origin. Climate change may be the geopolitical factor at stake in the most disconcerting and feared presidential election phenomenon of this year, the successful stream of apparently irrepressible election victories by Donald Trump.

MR: Scientific reports have noted that we must go back to 15 million years to find carbon dioxide levels as high as they are today. You are advocating sucking CO₂ out of the atmosphere as part of the climate solution. How effective is today's state of carbon negative technology in cleaning up the air, and is there a market for it?

GC: Direct air capture or carbon negative technology – such as the version that is commercialized at present by Global Thermostat – is proven. It is operational in Silicon Valley at the famous technology campus SRI on Ravenswood Ave in Menlo Park, where the Internet first transactions were carried out, and it is ready to be deployed and scaled up globally. A good question is what to do with the CO₂ once it is captured. Is there a market for it? The answer is as good as the question: CO₂ is used to produce carbonated beverages such as Coca Cola and Pepsi, dry ice for McDonalds, it can be used to produce carbon fibers that replace metals in

most automobiles, is used to mix with hydrogen in order to produce economically clean synthetic fuels that are molecularly identical to gasoline but do not emit CO₂ in net terms, to desalinate water, to produce clean and safe fertilizers that do not poison the soil nor the water, and even to mix with cement to produce stronger and lighter building materials at lower costs. The use of CO₂ for building materials can sequester on earth enormous amounts of CO₂, soon enough to absorb all the CO₂ that humans emit into the atmosphere today, about 38 gigatons per year. We still need to reduce emissions of CO₂ to make all this possible, both reducing emissions and carbon removal is needed. But there is a solution today. We just need the organization and will to do it. It can be done. And we will all be better off, as the financial structure proposed here will help redress the enormous cruel and destructive inequality of wealth in the world economy, and the inhuman poverty levels that prevent the satisfaction of the most basic needs of over a billion people in the planet's population.

MR: Why do you think there is skepticism and resistance among certain environmental groups to a ""techno-fix"" of the climate change problem?

GC: It has been said that the radical left is against a technology solution to climate change. The term "techno fix" is a dead giveaway: the fear is the "moral hazard" created by an artificial solution that makes it possible to continue sinning namely continue overusing the earth's resources, such as fossil fuels, and in the process polluting the planet's atmosphere in an unsustainable and destructive way. Put this way, I tend to agree with the concern, even though I co-invented myself the most advanced carbon negative technology that exists today the Global Thermostat direct air capture technology - and even though I founded the firm to commercialize the technology as well.

We need change; we cannot just use technology to continue our destructive and unsustainable use of the world's resources. But there is a secret that I am pleased to share with the reader: technology does not exist in a vacuum nor can it be expected to be our robotic slave. Technology will change us, it will change everything. Moral hazard is a mythological construct. We cannot control technology but if it imitates nature, if it is harmonious with nature, if it is based on the most fundamental virtues of human societies, compassion hope and humility, it can become one with our harmonious development as an artificial organism that reinvents itself on planet earth. I cannot promise redemption but closing the carbon cycle, bringing down every molecule of CO₂ that we are

putting up simply reproduces the wisdom of nature: everything is a cycle. And alleviating abject inhuman poverty is a key to redemption if any exists. I say we do not have a lot of choices anyway: let's do it.

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