

Avoiding Extinction

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What Next?

For the first time ever, humans dominate planet Earth. We are changing the basic metabolism of the planet: the composition of gases in the atmosphere, its bodies of water, and the complex web of species that makes life on Earth. What comes next?

The changes we are precipitating in the atmosphere are fundamental and can lead to disruptions in climate and global warming. Signals abound: in the Southern hemisphere melting glaciers are observed and ice sheets are melting in Antarctica; in the Northern hemisphere Alaska's permafrost is melting, sinking entire towns whose inhabitants are being relocated at a cost of \$140,000 per person. Greenland's ice sheet is gone, creating hostile climate conditions for a number of species such as the polar bear that are now close to extinction. In Patagonia and the Alps we observe mountains without ice or glaciers, reducing the ability of these regions to store water needed for human consumption. In the Caribbean seas 50% of corals are already extinct. Desertification has overtaken 25% of China's land mass. Climate's instability has led to Australia's longest draught on record, followed by the worst floods in that continent's history. We observe disappearing summer ice in the Arctic Seas and soil erosion and storm surges in Alaska. Where is all this coming from? The rapid industrialization of wealthy nations during the last century is responsible for most of the changes and for the risks they entail. Historically OECD nations originated 70% and now still 60% of all global emissions of carbon, emissions that most scientists in the world, including those in the United Nations Intergovernmental Panel on Climate Change, believe to cause climate change. China's inexorable industrial growth of the last two decades is a sign of things to come: it accelerates the risk of climate change and underscores that in 20 or 30 years into the future most emissions could come from today's poor nations as they assume their turn to industrialize.

Water expands when it warms. Since the seas are warming they are rising all over the world. This irrevocable upward trend is well documented: slowly but surely the rising waters will sink the Maldives and most other island states – there are 43 island states in the United Nations representing about 23% of the global vote and most or all could disappear soon under the warming seas.

The current shift in climate patterns has led to habitat changes for many insect species and therefore vector illnesses, for example new outbreaks of malaria in Africa. 25 million people are reportedly migrating due to drought and other climate change conditions, and the numbers are increasing rapidly.

In the US the consequences are less extreme but they stack up: the mighty Colorado River is drying up, its basin under stress prompts orders to turn-off farm water. Lake Mead's waters in Nevada exhibit record lows threatening the main supply of water to Las Vegas, and arid areas spread quickly as Vegas new sites double water use. Wild fires from drought conditions multiply and spread rapidly around the region and in California since 2006.

The world is aware of the connection that scientists postulate between climate change and the use of fossil energy. The largest segment of carbon emissions, 45% of the global emissions of CO₂, originate in the world's power plant infrastructure 87% of which are fossil fuel plants that produce the overwhelming majority of the world's electricity. This power plant infrastructure represents \$55 trillion according to the International Energy Agency, about the size of the world's economic output. New forms of clean energy are emerging such as wind farms in Scotland and solar farms in Spain in an attempt to forestall carbon emissions. But the process is necessarily slow since the world's fossil power plant infrastructure is comparable to the world's entire GDP, and therefore changing this infrastructure can take decades. This timeframe - several decades - is too slow to avert potential catastrophes that are anticipated in the next 10 - 20 years. What is the solution?

Below we propose a realistic plan that involves market solutions in industrial and developing nations, simultaneously resolving the problems of economic development and climate change and the global climate negotiations. But the climate change issue is just one of several global environmental areas that are in crisis today. Biodiversity is another: industrialization and climate warming threaten ecosystems. Endangered species include sea-mammals, birds such as cockatoos, polar bears, and marine life such as coral, sawfish, whales, sharks, dogfish, sea-turtles, skates, grouper, seals, seals, rays, bass and even primates survival is at risk, our cousins in evolution. Scientists know that we are in the midst of the 6th largest extinction of biodiversity in the history of Planet Earth, and that the scope of extinction is so large that 75% of all known species are at risk today. The UN Millennium Report documents rates of extinction 1,000 higher than fossil records. The current 6th largest extinction event in planet Earth follows the dinosaurs' extinction that

took place 65 million years ago. But today's extinction event is unique in that it is caused, created, by human activity. And it puts our own species at risk. There is a warning signal worth bringing up: all major recorded planetary extinctions were related to changes in climate conditions. Through industrialization we have created environmental conditions that could risk our own species' survival.

99.9% of all species that ever existed are now extinct

Are we the next?

Will humans survive?

The issue now is how to avoid extinction.

Women and Survival

To avoid extinction we have to develop social survival skills. This seems reasonable and natural – yet the social skills that are needed are not here and are not obvious either. These skills could be quite different from what human societies' have achieved such as the individual survival skills that we are familiar with. A simple but somewhat unexpected experimental finding involves colonies of bacteria, which are one of the world's oldest living species. They have been around for billions of years and have shaped the planet's geology and atmosphere to suit their needs (Lynn Margulis). Bacteria are champions of survival. They seem to understand that they need appropriate survival skills, and have developed some unexpected skills based on 'altruism'. Yet since bacteria are some of the longest lived species in the planet, many times longer lived than relatively recent humanoids, we need to take their skills seriously as a model of survival. Bacterial colonies know how to avoid extinction. Here is new data: new findings indicate that *Escherichia Coli* ---- and indeed most known bacteria colonies -- when exposed to a pathogen or stressor such as antibiotics – not only evolve to develop resistance but the evolved members produce specific resistance tools that they do not need in order to share with the rest of the (non-evolved) members of the colony (cf. Hyun Youk & Alexander van Oudenaarden, Nature, 2010). In other words - when exposed to stress, mutant bacteria use some of their own energy - altruistically - to create a chemical called “*indole*” that protects non – mutants from the pathogen. This way the entire group survives. A way to summarize this finding is to say that *altruism* is an effective survival tool and bacteria -- those champions of survival – have developed and mastered altruism for this task.

This finding is quite different from what we believe to be effective survival skills in human colonies or societies. Until now human survival skills have focused on avoiding natural risks and confronting successfully the threats posed by other species that preyed on us, species that are dangerous to us. Altruism is often considered a weakness in human

societies; it is considered to be a desirable trait rather than a survival skill. Yet, it is a survival skill. Aggressive and individualistic behavior may have been a useful survival tool until now. The war society that humans have created has become an efficient killing machine. But when things change, as they are changing right now, then what used to be strength can become a weakness. And things have fundamentally changed and they continue to evolve quickly. Indeed physical strength and aggression matter much less today for human survival than intelligence. Some of the worst risks we face today are caused not by other species that prey on us, but by traits that evolved to succeed against our predators – for example extracting energy and burning fossil fuel to dominate nature and other species. In other words, we are now at risk due to the impact of human dominance on the planet. Our success as a species has become the source of our main social risks. Humans are causing some of the worst risks humans face. The situation is somewhat unusual and is new for our species, and it is also new for the planet itself. As the situation changes, the rules we used to follow for survival must change too.

Let's start from basic principles. Survival is about protecting life not just about inducing death. Life is difficult to define, but we all agree that it is a phenomenon characterized by reproduction. Only those systems that incorporate reproduction are said to be alive. Life forms are able to reproduce. To be alive means to be part of a time series of reproductive activities. Reproduction characterizes life. Destruction does not. Asteroids destroy very effectively, and so do volcanoes. But they are not alive, because they do not reproduce. We humans are alive because we do.

But reproduction requires fundamentally altruism rather than dominance and aggression. How so? This is simple. We must donate our energy and even our bodily resources and substance to be able to reproduce, sometimes at the cost of our own.

Yet in our male dominated society the essence of life is viewed differently. It is viewed as the ability to conquer, dominate and kill. Men think of life skills as those skills that allow them to win the battle for survival. War is an example. Ask any man what characterizes life. He will very likely say "the survival of the fittest" and "dog eats dog". This is a man's view of life. This may be because of the evolutionary role that males had originally in human's societies, a role that is somewhat outdated. The reality is that humans could not be live and indeed we could not be part of the chain of life, unless we reproduced. Women understand that reproduction means life, and requires altruism. Women donate their physical substance such as eggs, blood and milk – and they do so voluntarily – for the sake of reproduction. This is what reproduction is all about: voluntary donation of one's substance. All living beings - animals and plants - do the same. They donate their substance voluntarily to the next generation, sometimes at the cost of their own welfare and their own lives. Observe that donating voluntarily one's own substance, one's flesh and body fluids, is the very essence of altruism. And that this altruistic donation is the key to the survival of the species. The great British author and social commentator Jonathan Swift - once suggested, as a 'humble proposal' to the problem of poverty in Ireland, that humans should eat their own children (Swift, 1729). This is not as outlandish a proposal as it may sound at

first sight. It helps to illustrate the point I want to make clearly. If the essence of life was the survival of the fittest, then humans would eat their children who are totally powerless at birth –nothing is less fit than new born infants. Their bodies could certainly provide a lot of protein and nutrition to fit adults.

The question that we must answer is: why don't we follow Swift's humble proposal? Why not eat our own children?

Some societies may have done exactly that – and indeed child abuse, as we know, is a widespread problem in our society. But clearly those societies that systematically ate their children are not here to tell their tale, because if we ate our children, humans would not be around. Our species would not survive.

No species who ate its children would survive – it may not even get started as a species. Survival depends crucially on reproduction and this means protecting the weak – the weakest of all – the small children. This is quite different from the blanket policy of survival of the fittest, which re the adult members of the species. Indeed, I venture to say that survival is more than anything about altruism and cooperation, and about the protection of the weakest. It is not about 'dog eat dog' -- it is not about dominance and survival of the fittest. It is about the nurturing and protection of new generations; it is about voluntary donations, about protection and nurturing of the weakest, sometimes at the expense of our own survival. These are facts of life, facts that women understand well. We could say that men got it all wrong.

Women understand because their evolutionary role is to protect the weakest of all – namely the children at birth. Women are critical to human survival – they are the key to reproduction and they provide voluntarily their substance and energy to give birth and protect the weakest as needed for the survival of the human species. Men miss this important aspect of survival because of their evolutionary role appear to value physical strength more than anything else. This is a role that seems increasingly out of date.

It is fitting to raise the issue of 'avoiding extinction' in this lecture, during the month of March, Women History Month, when this lecture is delivered. Women History Month takes place in the midst of a male dominated world and a male dominated culture that is focused on violence, economic competition, and wars of choice. It is particularly fitting as to understand how, among the changes we need to avoid extinction, we need to assure a changing role for women so the entire ethos of destruction and dominance that permeates our male dominated society is balanced out by a modicum of altruism and the critical and necessary nurturing and protection of the weakest that is required to avoid extinction.

It is true that there have been changes in the role of women, most of all their rapid entrance in the market for labor in industrial societies. But this change has not been fast enough. Modern societies such as the US have enormous statistics of abuse of women at home and

elsewhere, both physical and economic abuse. For example the US has a 30% gender difference in salaries, which does not budge. These are the salaries that are paid to men and women even when comparing men and women with equal training, same age and experience, with everything other than gender being equal. The gender inequality is prevailing, persistent and systematic. In any given society, there is a deep connection statistically between the amount of housework a woman does at home and the difference between male and female salaries in the economy as a whole. These are two different statistics that are apparently unrelated -- two indices of abuse – but they are indeed related, because when women are overworked and underpaid at home this leads them to be overworked and underpaid in the marketplace (Chichilnisky: “The Gender Gap”) . Gender inequality in salaries is in reality legally sanctioned – for example the US still does not have an Equal Pay Act. Unequal pay is legal in the USA.

Why? Is there a reason to pay women less than men? If so, what is it?

The deepest suspicion created by sexism to explain the persistent unequal situation is based on a rationale of “genetic inferiority” of women. Even a former president of the oldest University in the US, Harvard University, Larry Summers, presented this suspicion in public as a plausible hypothesis to explain the 30% difference in salaries between women and men in our economy. Furthermore, when he was subsequently fired by the Harvard University faculty he served he went on to become an economic advisor of President Barack Obama. One wonders whether Mr. Summers would have been selected as an economic advisor of the President of the US – the first black US president - if he had presented in public his suspicions about the genetic inferiority of blacks, rather than the genetic inferiority of women. I venture to say he would not have been selected by President Barack Obama if he had said in public that blacks are genetically inferior. But saying this about women is acceptable, and went through and indeed was rewarded by President Obama with the economic advisory role. This was an amazing and very discouraging event for some of us, but not for the many US men who secretly or openly believe that women are indeed genetically inferior to men. One cannot but reflect the connection of the situation with the excuses that the Nazis presented to themselves to explain the most savage Holocaust in memory – namely, they explained Nazism as based on the genetic inferiority of the Jews. This is how serious is the issue of claiming genetic inferiority of some groups in our society.

Raising in public the hypothesis of genetic inferiority of women to explain their economic exploitation is not an innocent remark.

It is a way to justify a systematic way in which male dominated societies perpetrate economic and cultural abuse, violence and brutality against women, pornography, torture of women and rape that represent a form of social control and intimidation, and ultimately a deep social instinct against the altruism, protection of the weak and reproductive health that women bring to society and that is a necessary precondition for the survival of the human

species. Our society's manifested hate and violence against women is critically connected with the self-destructive aspects of our society – and the problem of avoiding extinction that we face now.

Until we change the current male dominated culture of abuse and its barbaric treatment of women – until we revolt against the seeming acceptance of electronic games that the US Supreme Court found acceptable for children in their recent 2011 decision, games involving the systematic torture and killing of women as entertainment, and until we develop altruism as an efficient survival skill, our society will not be well prepared to avoid extinction.

Avoiding Extinction: Summary of what is to come

The future of humankind may be played out in the rest of this 21st Century. Here is a summary of the situation and what to do about it – which I will develop further in the rest of this piece.

First let's take stock of the world today: in a nutshell we see energy limits confronting enormous future global needs for energy today and in the future. The problem of overuse of natural resources, more generally, continues to be a clash of civilizations: it is a North – South impasse in using the world's resources. The North are the rich nations that inhabit mostly the Northern hemisphere of planet Earth, the South the poor. The former have about 20% of the world population, and the latter, about 80%. We examine the market's role in getting us here and in finding a solution, and define three building blocks that are needed for any solution going forward. We discuss the next generation of green markets; how to bridge the global wealth gap and to transform capitalism as needed for this purpose – and whether is this possible? We examine the role of the United Nations Kyoto Protocol and its Carbon Market in this global transformation process – by itself and in conjunction with other global markets for environmental resources – for water and biodiversity – that are still to emerge. We examine the critical role of women, how the global financial crisis fits into all this, what is the light it throws onto our future, and the lessons we have learned.

Avoiding extinction is the ultimate goal of Sustainable Development.

Financial and Global Environmental Crisis

While we try to climb up from the depths of a global financial crisis that started its deadliest stages in 2008, the world knows that the game is not over yet. Judging by the threats from the Eurozone, it could all re-start next year. The recent downgrading of the US as a debtor nation – for the first time in history – and its financial markets shocks underscore these points. At the same time, within a larger historical context, the financial crisis takes a

second place. We have seen such crisis before. What we have never seen before is the global threat to human survival that is developing in front of our own startled eyes. We are in the midst of a global environmental crisis that started with the dawn of industrialization and exacerbated with globalization, ever since the Bretton Woods institutions were created after WWII to provide a financial infrastructure for international markets and for spreading the role of markets and industrialization across the world economy. In both cases, however financial mechanisms are at work, essentially financial markets are implicated in both situations. Both the financial crisis and the environmental crisis are essentially two aspects of the same problem.

How so?

We will explain how by using simple examples available through the media that is read by the average person in the street. The urgency of the situation has become clear. For example on Tuesday June 21 2011 The Times newspaper in London writes “Marine life is facing mass extinction” and it explains: “The effects of overfishing, pollution and climate change are far worse than we thought. The assessment of the International Program on the State of the Oceans (IPSO) suggests that a “deadly trio” of factors - climate change, pollution and overfishing – are acting together in ways that exacerbate individual impacts, and that “the health of the oceans is deteriorating far more rapidly than expected. Scientists predict that marine life could be on the brink of mass extinction.” Observe that *all the three causes* of extinction just mentioned – overfishing, pollution and climate change -- are attributable to the industrialized world who consumes the majority of the marine life used as sea food, and generates over 60% of the global emissions of carbon dioxide and uses 70% of the world’s energy, all this while housing only 20% of the world’s population. Industrialization is at work in the impending destruction and mass extinction in the earth’s seas, the origin of life as we know it.

The complexity of the problem is baffling scientists. Normally the Earth self-regulates, but now we are tying the Earth’s hands in self-regulating itself out of the problem industrialization has created. There is no quick fix. The standard way that the planet regulates carbon, for example sucks carbon from the atmosphere to maintain a balance, is by using its vegetation mass, which breathes CO₂ and emits oxygen. Animals – for example humans - do exactly the opposite. Animals breath oxygen and emit CO₂. In balance, the two sets of species – vegetation mass and animals - maintain a stable mix of CO₂ and oxygen, and therefore since CO₂ in the atmosphere regulates its temperature, a stable climate. But the enormous use of energy by industrial societies is tipping the scales, preventing the planet to readjust. On the same date, page 17 of The Times, writes: “Planting trees does little to reduce global warming” and explains how a recent Canadian report (The Times, 2011) has found that “even if we were to plant trees in all the planet’s arable land – an impossible scenario with the global population expected to rise to 9 billion this century – it would cancel out less than 10 percent of the warming predicted for this century from continuing to burn fossil fuels.” Observe that it is not the developing nations

with 80% of the world's population that are causing this problem. This is because over 70% of the energy used in the world today is used by 20% of the world population that lives in industrial nations, who emit 60% of the CO₂ therefore. These are the same industrial nations that created the Bretton Woods Institutions in 1945 and have consumed since then the overwhelming amount of all the Earth's resources (Chichilnisky 1995, 1998)

For these reasons I say that the financial crisis and the environmental crisis are two sides of the same coin. They are at the foundation of the current model of economic growth in industrial nations and of its voracious use of the Earth's resources. The world's financial crisis and the global environmental crisis – the two sides of the same coin - both require a new model of economic growth.

This opinion is not just mine. Indeed, the newly created international group G 20, the first world leading group of nations that includes developing countries, met in Pittsburgh, USA, on September 24 -- 25, 2009. Their Leader's Statement (G-20 Leader's Statement, September 2009) states: *"As we commit to implement a new, sustainable growth model, we should encourage work on measurement methods so as to better take into account the social and environmental dimensions of economic development."* *"Modernizing the international financial institutions and global development architecture is essential to our efforts to promote global financial stability, foster sustainable development, and lift the lives of the poorest."* *"Increasing clean and renewable energy supplies, improving energy efficiency, and promoting conservation are critical steps to protect our environment, promote sustainable growth and address the threat of climate change. Accelerated adoption of economically sound clean and renewable energy technology and energy efficiency measures diversifies our energy supplies and strengthens our energy security. We commit to: - Stimulate investment in clean energy, renewables, and energy efficiency and provide financial and technical support for such projects in developing countries.- Take steps to facilitate the diffusion or transfer of clean energy technology including by conducting joint research and building capacity. The reduction or elimination of barriers to trade and investment in this area are being discussed and should be pursued on a voluntary basis and in appropriate fora."* *"Each of our countries will need, through its own national policies, to strengthen the ability of our workers to adapt to changing market demands and to benefit from innovation and investments in new technologies, clean energy, environment, health, and infrastructure. It is no longer sufficient to train workers to meet their specific current needs; we should ensure access to training programs that support lifelong skills development and focus on future market needs. Developed countries should support developing countries to build and strengthen their capacities in this area. These steps will help to assure that the gains from new inventions and lifting existing*

impediments to growth are broadly shared." *"We share the overarching goal to promote a broader prosperity for our people through balanced growth within and across nations; through coherent economic, social, and environmental strategies; and through robust financial systems and effective international collaboration"*, and *"We have a responsibility to secure our future through sustainable consumption, production and use of resources that conserve our environment and address the challenge of climate change."* I could not have written this better myself. The G 20 knows the problems all right. What they don't know is the solutions. For this, read on.

Green Capitalism

The task in front of us is nothing less than building the human future. In the midst of the 6th largest extinction of planet earth, facing potentially catastrophic climate change and extinction of marine life in the world's seas - the Basis of Life on Earth – we can fairly say that this qualifies as a global emergency. And with the adult humans in charge we came so close to the brink that it would appear right now that only the young can help.

A green future is about sharing the wealth and saving the planet. Is this an impossible mandate? We need to stave off biodiversity extinction and reduce carbon emissions, while rebuilding the world economy and supporting the needs of developing nations. Is this possible?

It is, and to understand the solutions we need to look closer at the root of the problem so we can change it.

The World since WWII

Rapid expansion of international markets since WWII – which were led by the Bretton Woods institutions – led to enormous consumption of resources. Industrialization is resource intensive. It was fueled by cheap resources from developing nations – forests, minerals, biodiversity.

These resources were and continue to be exported at very low prices – and as a result poverty grew in resource exporting regions and provided 'competitive advantage' in the form of cheap labor and cheap resources that exacerbated and amplified resource overconsumption in the North. Resources were over-extracted in poor nations desperate for export revenues, and over consumed in industrial nations – thus leading to an ever expanding Global Wealth Divide. Globalization since WWII increased together with an

increasing Global Divide between the rich and the poor nations – the North and the South (Chichilnisky, 1994).

This is how the global financial system that was created by the Bretton Woods Institutions in 1945, which is tied up with the financial crisis of the day, is also tied up with the global environmental problems we face, and with the global divide between the North and the South (Chichilnisky, 1994).

Since energy use goes hand in hand with economic progress, and most of the energy used in the world today is fossil (87%), GDP growth is closely tied with carbon emissions today. Industrial nations consume about 70% of the world's energy, and the North - South divide is therefore inexorably connected to the carbon emissions that are destroying the stability of our global climate.

Of course the same North - South Divide is the stumbling block in the Climate Negotiation as it was clear in the last global United Nations negotiations on climate issues, in Copenhagen Denmark Convention of the Parties of the UNFCCC (COP) 15 and then Cancun Mexico COP 16. The problem is: Who should use the world resources? Or, otherwise put, who should abate carbon emissions? , Chichilnisky and Heal (1994).

It can be said that we are re-living last century's Cold War conflict, but this time it is a conflict between China and the USA (Chichilnisky, Time Magazine 2009). Each party could destroy the world as they are the largest emitters and can by themselves change the world's climate. Each wants the other to "disarm" – namely to reduce carbon emissions -- first. This time the conflict is between the rich nations represented by the USA and the poor nations represented by China. This time it has become clear that the solution requires that we overcome the North - South Divide, the use of the world's resources between the rich and the poor nations. Otherwise put, global justice and the environment are two sides of the same coin. Poverty is caused by cheap resources in a world where developing nations are the main seller of natural resources into the international market, resources which are consumed by the rich nations. This perverse economic dynamics is destroying the stability of the atmosphere of the planet, undermining climate patterns and causing the 6th largest extinction in the history of the planet.

Humans are part of the complex web of species that makes life on Earth. How long will it take until this situation reaches its logical limits and victimizes our own species?
How to avoid extinction?

The Gordian knot that we must sever is the link between *natural resources, fossil energy and economic progress*. Only clean energy can achieve this. But this requires changing a \$US55 trillion power plant infrastructure, the power plants that produce electrical power around the world (see *IEA*), because 87% of world's energy is driven by fossil fuels and

power plants produce 45% of the global carbon emissions.

In short - how to make a swift transition to renewable energy?

Who Needs a Carbon Market?

Energy is the mother of all markets. Everything is made with energy. Your food, your home and your car, the toothpaste and the roads you use, the clothes you wear, the heating of your office, your medicines: everything. Changing the cost of energy, making dirty energy more expensive and undesirable and clean energy more profitable and desirable – changes everything.

It makes the transition to clean energy possible. We have the technologies – we just have to get the prices right. Is it possible to thus change the price of energy?

Yes, it is. And it has been already done, although it requires more input at present to continue this process after 2012, as discussed below. This is what my life is all about now. This is what this presentation is all about.

Here is the background and a summary of the current situation. In 1997, the Carbon Market of the United Nations Kyoto Protocol was signed by 160 nations. In it, and after a long period of lobbying and designing the carbon market, I was able to write the structure of the carbon market (cf. Chichilnisky and Sheeran: [Saving Kyoto](#), 2009) The Kyoto Protocol became international law in 2005 when the protocol was ratified by nations representing 55% of the world's emissions - and the Kyoto Protocol and its carbon market have now been adopted as law by 195 nations. The US is excluded. In creating the carbon market I helped change the value of all goods and services in the world economy because the carbon market changes the cost of energy the world over: it makes clean energy more profitable and desirable and dirty energy unprofitable. This changes all the prices of products and services in the world – since everything is made with energy - and drives the economy to use cleaner rather than dirty energy sources. It is more profitable and less costly to use clean energy that reduces emissions of carbon now, this is precisely the role of the carbon market that I designed and I wrote into the United Nations Kyoto Protocol in Kyoto, December 1997.

The carbon market of the Kyoto Protocol is now trading carbon credits at the EU Emissions Trading System EU ETS, and as already stated, it is international law since 2005. The World Bank reports on its progress in its report “Status and Trends of the Carbon Market” which is published annually since the carbon market became international law in 2005. The report documents that by 2010 the EU ETS is trading \$200 Bn/year, and has decreased the equivalent of 20% of EU's emissions of carbon. Through the carbon market, those nations who over-emit compensate those who under emit – and throughout

the entire KP process the world emissions' remains always under a fixed emissions limit that are documented in Annex 1, nation by nation emissions limits for OECD nations. A 'carbon price' emerges from trading the 'carbon credits' or rights to emit, which represents the monetary value of the damage caused by each ton of CO₂. The carbon market therefore introduces a 'carbon price' that corrects what has been called the biggest externality in the history of humankind (cf. Stern, 2006)

The carbon market cuts the Gordian knot and makes change possible. It does so because it makes clean energy more profitable and dirty energy less profitable, and therefore encourages economic growth without environmental destruction: it fosters green development. The carbon market itself costs nothing to run, and requires no subsidies except for minimal logistics costs. In net terms the world economy is exactly in the same position before and after the carbon market – there are no additional costs from running the carbon market, nor from its extremely important global services. The over-emitter nations are worse off, since they have to pay. But every payment they make goes to an under-emitter, so some nations pay and some receive, but in net terms the world economy is exactly in the same position before and after the carbon market is introduced. There are no costs to the world economy from introducing a carbon market, nor from the limits on carbon emissions and environmental improvement that it produces. It is all gain.

What is the status of the carbon market today? As of 2010, it has been ratified in 195 nations, and this includes all the industrial nations except the US. It is international law since 2005. Its nation by nation carbon limits expire in 2012 but the Kyoto Protocol itself – its overall structure and the structure of the carbon market do not expire – they are and continue to be international law. All we have to do to keep the carbon market's benefits is to define new emissions limits nation by nation for the OECD nations – something that we should be doing in any case as they are the major emitters and without limiting their emissions there is no solution to the global climate issue.

What is the current status of the carbon market in the US, which is the single industrial nation that has not yet ratified the Kyoto Protocol? There are cross-currents in US, since it is a politically divided nation. But the US has already a carbon market for 10 North eastern US States, called RGGI, which is operating but timidly – the limits on emissions are small and so are the prices for carbon credits therefore. The economic incentives of Kyoto Protocol's carbon market are enormous. China, for example, created a reported 1 million new jobs and became the world's main exporter of clean tech equipment since 2005 after signing on and ratifying the Kyoto Protocol in 2005 and benefitting from US\$40 billion from its carbon market and Clean Development Mechanism. China is right now introducing its own carbon market. Many in the US want part of the carbon market advantages. President Obama said he wishes to ratify Kyoto the Protocol, and by now 22 States are planning to create a Carbon Market of their own including California. Hundreds of cities and towns support the carbon market in the US. In the Fall 2007 the US Supreme Court

agreed that Federal government and the EPA can enforce carbon emissions limits without requiring Congressional approval. Every effort to deem this regulation illegal by Republican representatives has failed so far. It is generally accepted that global businesses (for example the automobile industry) will benefit from KP's guidelines, and could suffer economic losses without the benefit of KP economic incentives at home. This is because the automobile industry is global, and cars that do not sell in other OECD nations create huge losses and lead to bankruptcies. Since all OECD nations are buying carbon efficient cars, because they ratified the KP, the US car industry is commercially isolated. For these reasons, in 2010 the EPA imposed automobile emission limits of 36.7 miles per gallon, an efficiency requirement that has been increased further by the Obama administration in 2011. The automobile industry voluntarily supported a rise to 54 MPH in 2011. Furthermore in December 2011 EPA announced that it would impose limits on stationary sources like power plants, which is the beginning of a US carbon market, but the issue is still hotly contested by the Republican Party which freezes decision making since we are close to another presidential election. Nevertheless a leading Republican candidate for president, Mitt Romney who was formerly a Governor of Massachusetts, endorses the creation a "cap and trade" system or a carbon market. A similar sequence of events took place when the SO₂ market was created at the Chicago Board of Trade 20 years ago – first it was quite controversial, but the SO₂ emission limits were eventually passed for US power plants and then traded in an SO₂ market at the CBOT, which is now widely considered to have been very successful in eradicating acid rain in USA.

Are the new EPA carbon limits the beginning of the US carbon market as were the SO₂ limits 20 years ago? History is being written right now.

Green Markets are the answer –they will transform Capitalism in the 21st century

What is a green market and why does it matter? A shining example of a green market is the Kyoto Protocol Carbon Market just discussed, which I introduced in 1997 and became international law in 2005. The EU ETS is trading \$200 billion annually today and has transferred already \$50 Bn to developing nations for clean technology private projects that promote sustainable development, and has decreased about 20% of the EU emissions since becoming law in 2005. Another successful example of a green market is the SO₂ Market in Chicago Board of Trade that was created about 20 years ago, which is quite different from the carbon market because SO₂ concentration is not a "global commons" since it varies city by city while CO₂ is the same uniformly all over the planet. There are more green markets in the works. Today the UN is exploring markets mechanisms for biodiversity and for watersheds. As in the case of the Kyoto Protocol carbon market, these are markets that would trade rights to use the global commons – the world's atmosphere, its bodies of water, its biodiversity – and therefore have a deep built-in link between efficiency and equity. In the carbon market of the Kyoto Protocol, by design, the poor nations are

preferentially treated, having in practical terms more access and more user rights to the global commons (in that case the planet's atmosphere). This is not the case with SO₂ which is a simple "cap and trade" approach as SO₂ is not a public good, as was discussed above.

Efficiency with equity is what it's all about. They are really two sides of the coin. One is equity and the other is efficiency. Both matter. The carbon market provides efficiency with equity. How? Through its Clean Development Mechanism the Kyoto Protocol provides a link between rich and poor nations – the only such link within the Kyoto Protocol -- since poor nations do not have emissions limits under the KP and therefore cannot trade in the carbon market. But developing nations still benefit from the CDM of the carbon market – how so?

Developing nations have benefitted from the KP. Since 2005, when it became international law, the KP carbon market funded US\$50 Bn in clean technology (CDM) projects in poor nations – see World Bank "Status and Trends of the Carbon Market" (2005-2010) – and the CDM projects have decreased so far the equivalent of 20% of EU emissions. The CDM works as follows. Private clean technology projects in the soil of a developing nation – China, Brazil, India - that are proven to decrease the emissions of carbon from this nation below its given 'UN agreed baseline' are awarded "carbon credits" for the amount of carbon that is reduced that are themselves tradable for cash in the carbon market – so as to recognize in monetary terms the amount of carbon avoided in those projects and fill the role of shifting prices in favor of clean technologies. These CDM carbon credits – by law – can be transformed in cash in the KP's carbon market. This is the role of the carbon market in the CDM, and this is how the KP has provided \$50 Bn in funding to developing nations since 2005 (The World Bank, "Status and Trends of the Carbon Market" 2005 – 2010)

The North-South conflict – namely, who should abate first - puts all this at risk. To move forward in the global negotiations we must overcome the China – US Impasse, which is in an intense form of the same conflict that prevails between rich nations and poor nations as a whole – the North and the South (see Chichilnisky, Time Magazine: Special Issue on Heroes of the Environment, last page, December 2009). But is it possible to overcome the North South divide? Yes, it is. But the interests of the industrial and developing nations are so opposed that once again, we need a two - sided coin. This is the same dual role that the carbon market played in the Kyoto 1997 global negotiations, where it provided market efficiency that the US and the OECD wanted, while limiting only OECD nations emissions which is what poor nations wanted. This is what I saw then, and how by introducing the carbon market into the wording of the KY I saved the negotiations and the Kyoto Protocol was voted by 160 nations. Equity and efficiency are the two sides of the coin. We need both.

Organizing Principles for Green Capitalism

At this point the reader may think that this is about doom and boom, but offers few details about how to fix the problem. Worry no more, that part is coming now.

I will show how Green Capitalism is the solution, and it remains to be explained how this works.

Green capitalism a way forward that is consistent with US technology and leadership, and with future emissions reductions by developing nations, China and India. The basis was explained in Time Magazine Chichilnisky 2009 (op.cit). The Kyoto Protocol CDM can play a critical role as a foundation of a major technology - driven financial investment that benefits from and propels the renovation of the Kyoto targets post 2012.

Here are three building blocks for the global UNFCCC negotiations:

(i) Efficient US Carbon Negative Technologies (ii) The Kyoto Protocol carbon market and its CDM, and (iii) Global Capital Markets

Carbon Negative Power Plants for developing nations (cf. Chichilnisky and Eisenberger, Cryogas International, 2011)

There are today cost efficient technologies that capture CO₂ from air (<http://www.globalthermostat.com>" [HYPERLINK "http://www.globalthermostat.com" www.globalthermostat.com](http://www.globalthermostat.com)). Global Thermostat LLC is an example. The firm is commercializing a technology that takes CO₂ out of air and uses low cost residual heat to drive the capture process, making the entire process of capturing CO₂ from the atmosphere very inexpensive. There is enough residual heat in a coal power plant that it can be used to capture twice as much CO₂ as the plant emits, thus transforming the power plant into a 'carbon sink'. For example, a coal plant that emits 1 million tons of CO₂ per year can become a sink absorbing a net amount of 1 million tons of CO₂ instead. Carbon capture from air can be done anywhere and at any time, and so inexpensively that the CO₂ can be sold for industrial uses or enhanced oil recovery, a very profitable opportunity. Any source of low (100 C) heat will do. In particular renewable (solar) technology can power the process of carbon capture. This can help advance solar technology and make it more cost efficient. This means more energy, more jobs, and it also means economic growth in developing nations, all with less CO₂ in the atmosphere.

(ii) The Kyoto Protocol carbon market.

The role of the Kyoto Protocol Carbon Market and its CDM is critical, as it can provide needed funding and financial incentives for investment to build carbon negative power plants that were described above in developing nations. The CDM can be used to provide "offsets", which are contracts that promise to buy the electricity that is provided by carbon negative power plants for a number of years and therefore unlock banking resources for the

investment.

The scheme covers fixed costs and greatly amplifies private profits

(iii) A US\$200 Bn a year Private/Public Fund – Green Power Fund - to build carbon negative power plants in developing nations, particularly in Latin America and Africa

This Green Power Fund was named and proposed by the author in writing to the US Department of State in Copenhagen COP 15 December 2009, and it was also published by the author in the *Financial Times* in 2009. It was accepted and two days later was publicly offered by US Secretary of State Hillary Clinton in the global negotiations COP 15 and subsequently in COP 16. It is making the rounds in the negotiations, where it has received substantial support although the entire scheme has not been incorporated, and its very positive connection with the Kyoto Protocol was not made explicit. The scheme proposed is a private – public Green Power Fund raised from global capital markets to invest in investment grade firms that build carbon negative power plants in developing nations, with CDM funding to provide off-takes to by the ensuing electricity, as mentioned above. The background and feasibility of the Green Power Fund are as follows.

As already mentioned, existing technologies (www.globalthermostat.com) can efficiently and profitably transform coal power plants and solar thermal sources of energy in a way that reduce atmospheric carbon concentration. Investment is needed to build carbon negative power plants in developing nations and elsewhere, to renovate the US\$55 trillion power plant industry infrastructure worldwide (IEA), which is 87% fossil today. What is required is about \$200 Bn/year for 15 years. This amount of money will go to investment-grade power plant builders (General Electric, SSE, Siemens, Linde, etc) to build carbon negative power plants in developing nations, which is exactly what the carbon market is trading today per year (US\$200 Bn, see World Bank’s “Status and Trends of the Carbon Market” 2010) and therefore the financial target proposed here is eminently achievable.

Blueprint for Sustainable Development

The premises for Sustainable Development are

1. Clean and Abundant Energy available worldwide
2. Sustainable growth in developing nations
3. Accelerating the transition to solar energy
4. Transforming fossil fuels into a clean alternative

Green Capitalism and Traffic lights for Human Survival

New types of markets are needed to transform capitalism by providing incentives that make green economic projects more profitable than their alternatives, fostering conservation of biodiversity, clean water, a safe atmosphere -- and some of them already exist and are described above. Green markets change GDP by valuing the Global Commons (the atmosphere, biodiversity, clean water) and they also link equity with efficiency

Examples of green markets are:

Carbon Market – international law since 2005

SO2 Market in US – trading at the CBOT since 1991

Markets for Biodiversity - to emerge, they are proposed by the author and under UN consideration

Markets for Water are in the same condition

These markets provide the missing signal of scarcity that is normally provided by market prices when a good or service becomes very scarce. Such signals are tantamount to Traffic Lights for Human Survival. Here are sign posts to implement the above strategies going forward. Within the UNFCCC Global Climate Negotiations, the annual COP meetings, the next of which is COP 17 in South Africa. In Copenhagen COP 15 December 2009 we were able to insert wording into the CDM allowing carbon negative technologies to be compensated as part of the CDM. Namely, that the CDM funds negative carbon technologies

Economic Incentives for the Short and the Long Run

There is a major difference between long run and short run strategies. And long run strategies do not work for the short run. We need economic incentives for the short and for the long run. They are different because in the short run we must actually reduce carbon in the atmosphere and do so fast – a carbon negative approach – and renewable energy as the long run solution. Renewable energy is too slow for the short run, since replacing a US\$55 trillion power plant infrastructure with renewable plants could take many decades. Action is needed sooner than that. For the short run we need carbon negative technologies that capture more carbon than what is emitted.

Trees do that – and they must be conserved to help preserve biodiversity. Biochar does that. But trees and other natural sinks are too slow for what we need today – see the beginning of this article.

Why Negative Carbon?

Negative Carbon is needed NOW as part of a blueprint for transformation, a blueprint for Sustainable Development:

While in the long run only renewable sources of energy will do, including Wind, Biofuels, Nuclear, Geothermal, and Hydroelectric energy – all of these are in limited supply cannot replace fossil fuels. Global energy today is divided as follows: 87% fossil, namely gas coal, oil; 10% is nuclear, geothermal and hydroelectric, and less than 1% solar power – photovoltaic and solar thermal. Nuclear fuel is very scarce and nuclear technology dangerous (Japan 2011) therefore it seems unrealistic to seek a solution in the nuclear direction. Only solar energy can: Less than 1% of the solar energy we receive can be transformed into 10 times the fossil fuel energy used in the world today

The short run is the next 10 years. There is no time in this period of time to transform the entire fossil infrastructure – it costs \$50 trillion (IEA) to replace. We need to directly reduce carbon in the atmosphere now. CCS works but does not suffice because it captures what power plants emit. Any level of emissions adds to the stable and high concentration we have today.

Yet we need short term strategy that accelerate long run renewable energy, or we will defeat long term goals

The solution? Combine air capture of CO₂ with storage into biochar, cement or other materials, and use it to produce renewable gasoline (gasoline produced from CO₂ separated from air and Hydrogen separated from water). Is this therefore too expensive? No – it is already feasible at commercial and competitive rates.

We can combine air capture with solar thermal electricity using the residual heat to drive the carbon capture process, making a solar plant more productive and efficient so it can out-compete coal as a source of energy.

In sum: the blueprint offered here is a private/public approach, based on industrial technology and financial markets' leadership, self-funded and using profitable derivative markets – carbon credits as the 'underlying,' based on the Kyoto Protocol CDM, as well as markets for biodiversity and water providing abundant clean energy to stave off impending and actual energy crisis in developing nations, fostering mutually beneficial cooperation for industrial and developing nations

The blueprint proposed provides the two sides of the coin, equity and efficiency, and it assigns a critical role for women as stewards for human survival and sustainable development.

ENERGY – Power Industry is Key

\$55 Trillion Infrastructure ---- 41% Global CO2 Emissions

Green Power Fund Proposed in Copenhagen Supported by Hillary Clinton who announced it	\$200 Bn/year for 15 years Needed to change power industry direction	Private Funding Government Support Investing only on triple A power plant firms	Building Negative Carbon Power Plants Based on PPAs and CPAs paid by KP CDM in Africa, LA & SIS
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Our Vision is a Carbon Negative Economy and Green Capitalism resolving the Global Climate Negotiations – the North South Divide. The more you produce and create jobs → The Cleaner the Atmosphere. Economic growth that is harmonious with the Earth resources

Summary: A Vision for Sustainable Development

Avoiding extinction is about the survival of the human species. Survival is not about violent competition & struggle. Survival is about life not death. Carbon Negative Solutions are the future of energy, and green markets lead the way to Green Capitalism, resolving the global climate negotiations and the Global Divide, providing clean energy and economic growth for the North and the South that is harmonious with the Earth's resources, and focused on creating and nurturing life. Building the future.

References

Hyun Youk & Alexander van Oudenaarden: “Microbiology: Altruistic Defense needed for Survival (*Nature* 2 September 2010)” p. 34 Vol. 467 Issue 7311.

Swift, Thomas: “A Modest Proposal for preventing the Children of Poor People in Ireland

from Being a Burden on their Parents or Country, and for Making them Beneficial to the Publick” Sarah Harding, London UK, 1729.

G-20 Leaders’ Statement from Meeting in Pittsburgh, USA, September 24-25 2009,
HYPERLINK "http://www.pittsburghsummit.gov/mediacenter/129639.htm" [http://
www.pittsburghsummit.gov/mediacenter/129639.htm](http://www.pittsburghsummit.gov/mediacenter/129639.htm)

G. Chichilnisky “North South Trade and the Global Environment” American Economic Review 1994.

Stern, N. The Economics of Climate Change, Oxford, 2006

Chichilnisky, G. “The Economic Value of the Earth Resources” in American Museum of Natural History: Scientists on Biodiversity (ed. Ellen Futter) New York, 1998.

Chichilnisky, G. “Biodiversity as Knowledge” Proceedings of the National Academy of Sciences, 1995.

Chichilnisky, G. “Forward Trading: a proposal to End the Stalemate between the US and China on Climate Change”, Time Magazine, Special Issue of Heroes of the Environment , last page, December 2009

The Times, page 15, Tuesday June 21 2011.

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