

## Commentary

### Global Climate Change and its Solutions

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#### Abstract

This article aims to present the solutions needed to avoid catastrophic climate change on planet Earth, which requires replacing the current energy model with another one based on renewable energy sources and replacing the current economic model with another one based on sustainable development model among other measures.

**Keywords:** Energy; Global warming; Renewable energy; Sustainable development

#### Introduction

Global warming is a climatic phenomenon to a large extent - an increase in the average temperature of the Earth's surface that has been going on for the past 150 years. The IPCC (Intergovernmental Panel on Climate Change), established by the UN (United Nations), says that much of the observed warming on the planet is due most probably to an increase in greenhouse and there is strong evidence that global warming is due to human activity. Many meteorologists and climatologists consider proven that human action is actually influencing the occurrence of the phenomenon.

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There is no doubt that human activity on Earth cause changes in the environment in which we live. Many of these environmental impacts are from the generation, handling and use of energy. The main reason for the existence of environmental impacts from the generation, handling and use of energy lies in the fact that the global consumption of primary energy from non-renewable sources (oil, coal, natural gas and nuclear) accounts for approximately 88% of total, leaving only 12% to renewable sources. As a result of the excessive use of fossil fuels, the carbon dioxide content in the atmosphere has been increasing steadily, leading many experts to believe that the increase in average temperature of the Earth's biosphere, which is being observed decades ago, is due to "Greenhouse Effect" caused by this increase of CO<sub>2</sub> and other gases in the atmosphere. This is why the current energy model must be replaced by renewable energy sources.

The unsustainability of the current model of society's development stems from the fact that it is responsible for the rapid rise in global temperatures, the exhaustion of the planet's natural resources and of rise of sea levels on a larger scale in the 21<sup>st</sup> century than in the 10 thousand years since the last ice age. The facts of life are increasingly showing the need for the paradigm that has guided the development of human society since the 1<sup>st</sup>. Industrial Revolution has to be profoundly modified. This is why the current economic model must be replaced by sustainable development model among other measures.

This study is of great importance because it deals with a subject of great interest for the future of humanity that is that of global climate change, besides proposing solutions that could eliminate its catastrophic economic and social effects. The methodology used consisted mainly of analyzing the existing literature about global climate change, world energy and sustainable development to characterize the causes, consequences and future evolution of global climate change, the world energy evolution and its environmental impacts and the sustainable development model to propose solutions to avoid global climate change.

This article is composed by the following parts:

- Global warming and consequential catastrophic climate change
- The global energy scenarios and greenhouse effect
- The third energy revolution needed to combat global warming
- The societal development model needed to prevent global catastrophic climate change in the 21<sup>st</sup> century
- The Paris Global Climate Agreement (COP 21) and its non-compliance
- Conclusion

#### Global Warming and Consequential Catastrophic Climate Change

Global warming, which was a matter of exclusive interest of the scientific community, assumes today a much broader dimension being a matter of concern by the world's people and governments around the world. The media has contributed enough to the issue of global

warming have become an issue of general interest publicizing the extreme climate change that has been recorded since the Industrial Revolution in England to this day in various parts of the world as well as the opinion of many scientists and institutions attesting to the severity of the problem.

Analysis of figure 1 reveals that Earth receives radiation emitted by Sun that is absorbed by the Earth's surface warming it. Much of this radiation is returned to the space and the other part is absorbed by the gas layer surrounding atmosphere causing the greenhouse effect.

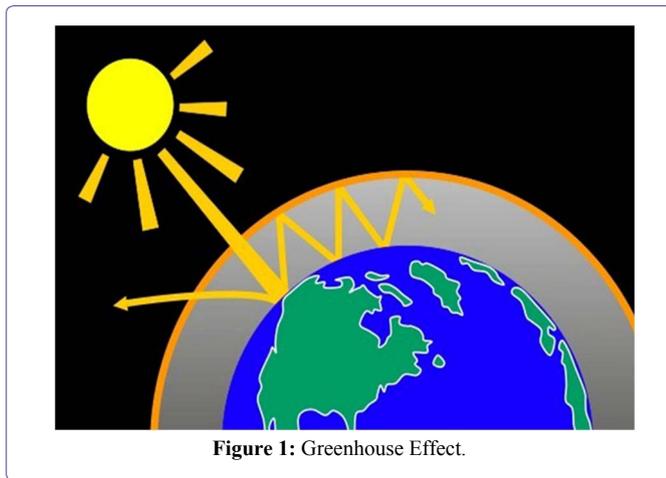


Figure 1: Greenhouse Effect.

Source: The Greenhouse Effect - www.ib.bioninja.com.au

Global warming results from the greenhouse effect caused by heat retention in Earth's low atmosphere caused by the concentration of gases of various kinds. Earth receives radiation emitted by Sun that is absorbed by the Earth's surface warming it. Much of this radiation is returned to the space and the other part is absorbed by the gas layer surrounding atmosphere causing the greenhouse effect. It is due to this natural phenomenon, the greenhouse effect; we have an average temperature of 15°C. Without this phenomenon, the average temperature of the planet would be -18°C.

To be climate balance, the Earth must receive the same amount of energy that sends back into space. If imbalance occurs for some reason, the globe warms or cools until the temperature reached again, the exact measure for correct heat exchange. The natural climatic balance was disrupted by the Industrial Revolution in England in 1786. Since the nineteenth century, carbon dioxide concentrations in the air increased by 30%, doubled the methane and nitrous oxide have risen 15%. Global warming is produced by human activity (anthropogenic) on the planet and also by natural processes such as decomposition of organic matter and volcanic eruptions, which produce ten times more gas than man. For ages, the natural processes alone ensured the maintenance of the greenhouse effect, without which life would not be possible on Earth. The gases responsible for the global warming derived from human activity are produced by fossil fuels used in cars, industries and power plants, for agricultural production and the burning in forests [1].

Figure 2 shows the main evidence for global warming comes from the temperature measurements in weather stations around the globe since 1890.

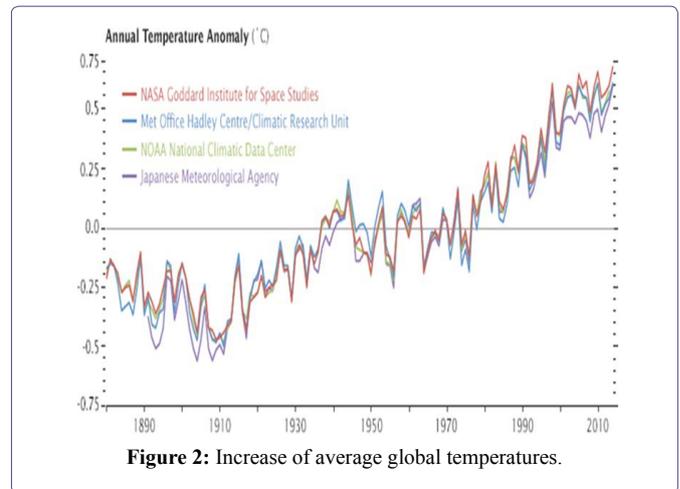


Figure 2: Increase of average global temperatures.

Source: <https://earthobservatory.nasa.gov/world-of-change/Decadal-Temp>

The largest increases in average global temperature were in two periods: 1910-1945 and 1970 - 2010. From 1940 - 1970, there was stabilization in the growth average global temperature. Figure 3 shows the temperature in the Earth's surface from 1880 - 2020 in Fahrenheit. The figures for the year 1000 - 1860 were estimated and the 1860 - 2000 were based on global observations by instruments.

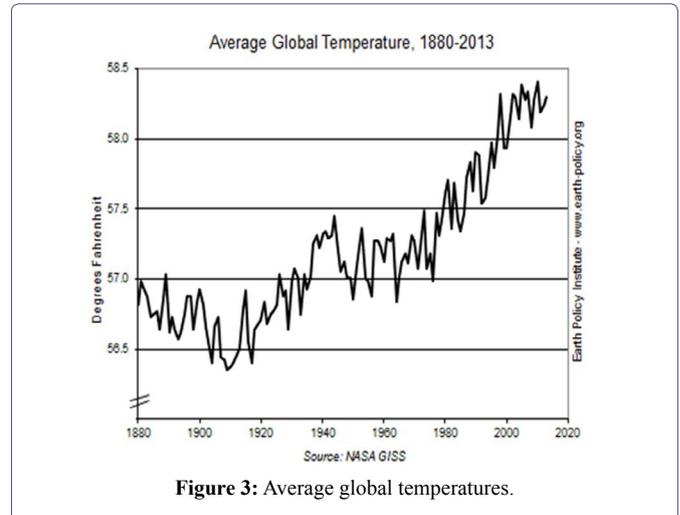
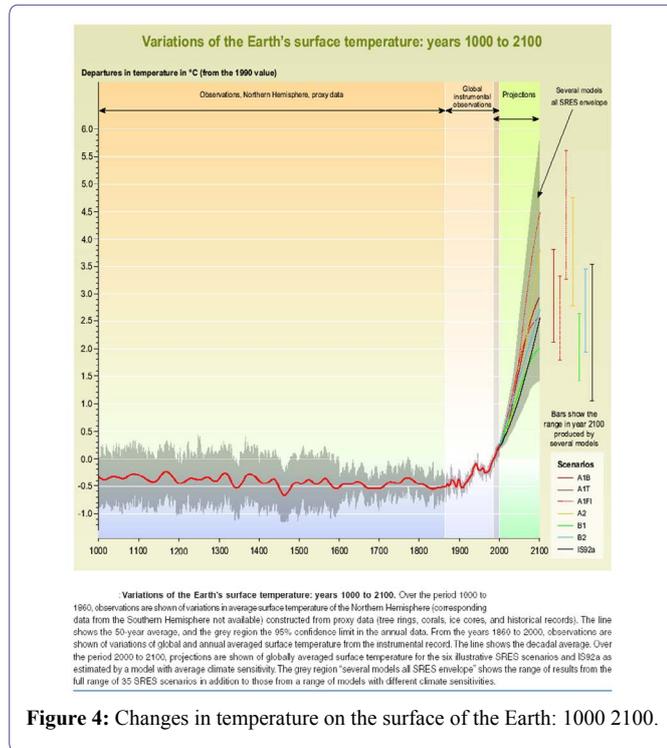


Figure 3: Average global temperatures.

Source: <http://www.earth-policy.org/indicators/C51>

Figure 4 shows the temperature variations in the Earth's surface from 1000 - 2000 and its projections up to 2100. The figures for the year 1000 - 1860 were estimated and the 1860 - 2000 were based on global observations by instruments. Due to global warming, it is likely that future climatic imbalances are abrupt and catastrophic. There will be a rapid and destructive increase in global temperatures unless carbon emissions are cut. If current trends continue, between 2020 and 2070, the concentration of greenhouse gases could double and the average surface temperature of the Earth could rise by about 4 - 5°C. It is estimated that kept the current rate of increase in emissions of greenhouse gases, the planet's average temperature should

raise from the current 15°C - 16.5°C at best, and 19.5°C in the worst assumptions in the year 2025. In the year 2100, the global average temperature will reach 18°C, at best and 29°C at worst. The most likely value for the average global temperature by the end of the 21<sup>st</sup> century would be 19°C [1].



Source: IPCC, Synthesis Report, figure SPM-10b

All indications are that sea levels may rise due to the increase in global temperature. There may be the melting of ice sheets deposited in the polar caps and the summits of the great mountain ranges. By 2050, sea levels may rise to 1.17 meters, in the year 2075 to 2.12 meters and in 2100 to 3.45 meters disappearing large tracts of coastal lands, islands and coastal cities. A greater number of hurricanes would occur with increasing of global temperature. Some scientists are concerned that in the future, the polar ice cap and glaciers melt significantly. If this happens, there may be an increase in sea levels in many meters. Galileo magazine, et al., published the text under the title Global warming and the economy in which informs that if the ice sheet of Antarctica disappear would be a catastrophe because the region has ice enough to get the level global seas rise by more than 65 meters [1,2].

In summary, global warming can cause structural and social transformations of the planet Earth caused by the increase in temperatures, whose consequences are as follows:

- Rising ocean temperatures and polar ice caps melting
- Possible flooding of coastal areas and coastal cities, as a result of rising sea levels
- Increased sunshine and solar radiation, due to the increase of the ozone layer hole
- Intensification of climatic catastrophes, such as hurricanes and

tornadoes, droughts, irregular rains, among other meteorological phenomena that are difficult to control and predict

- Extinction of species due to adverse environmental conditions for most of them

In recent times, there have been numerous attacks on the global warming thesis and its effects on the climate defended by the Inter-governmental Panel on Climate Change (IPCC) by questioning their reports produced with the participation of 2,500 scientists from 131 countries, bringing together observations, conclusions, forecasts and recommendations of several thousand climate scientists from around the world. What we are witnessing today is a real war of the media sectors and US government against the issue of catastrophic climate change and its relation to the predatory human activities such as the emission of greenhouse gases.

It should be noted that the controversy over climate change is established among scientists who support the theory that global warming results from natural causes and those who argue that it results from natural causes and human activity. This is a matter that is still under debate in the scientific community, although many meteorologists and climatologists recently stated publicly that they consider proven that human action has really influenced the evolution of this phenomenon. Most of the scientific community defends the thesis that global warming is man's responsibility. The paradigm of natural causes of climate change is being put into question by the new paradigm that assigns greater responsibility to the man.

Sabotage against science has become a routine component of the moment in which we live. Hire mercenaries of science is a practice of large corporations responsible for the use of fossil fuels to disqualify the evidence of global warming. The mission of skeptics and pseudo scientists artificially is inflate the uncertainties associated with scientific evidence, preventing or delaying so any measure to protect the environment of serious consequences for humanity. All sciences are vulnerable to this type of attack, since dealing with uncertainty is its intrinsic character. Any study is subject to criticism, legitimate or not. The strategy adopted to weaken even the most robust scientific conclusions is simple; just highlight selectively the uncertainties, by attacking the key studies one by one and, most importantly, systematically ignoring the weight of their evidence.

In contrast to the views of skeptics and pseudo scientists, more than 255 member's scientists of the US Academy of Sciences defended the theory of climate change in an article published on May 6, 2010, in the Science revue. In an article entitled The Climate Change and Science Integrity, 255 scientists claim that "there is consistent evidence that humans are changing the climate in a way that threatens our societies" [3].

The Science revue text also condemns the attacks by so-called "climate skeptics" in relation to the experts and institutions who warn both the existence, and for the possible effects of global warming. The researchers say that many of the attacks have been boosted by specific interests of large corporations or dogma, not by honest effort to provide an alternative theory. According to the article, the increase in temperature of the planet is due to the higher concentration of greenhouse gases in the atmosphere, which in turn are caused by human activity. At the conclusion of the article, the climatologists said humanity has two options: Omit the scientific data and rely on luck or act quickly to reduce the threat of climate change.

## The Global Energy Scenarios and Greenhouse Effect

Energy is an essential input for humans and for economic and social development. One can say that the most basic need of human beings is the search for energy to keep their bodies functioning. This aspect, the attendance of physiological need, predominated in human history until the discovery of human beings that could control energy forms which would be useful as the fire, which represented an important milestone for mankind to, with the use of thermal energy, be able to cook their food and heat. In the early days of human history, the domestication of animals provided the mechanical energy required for transportation, agriculture, etc., A few millennia, the hydraulic power of the rivers and the wind began to be used. However, only with the advent of the Industrial Revolution, about three centuries, it is that the use and production of energy have taken fundamental connotation in replacing humans and animals by machines [4].

Since the domain of fire 750,000 years ago until the advent of the Industrial Revolution there was no major evolution in human form using energy. But with the Industrial Revolution that took place in England in 1786 and the subsequent process of industrialization, the need for increased power and new primary sources with higher energy density, were introduced. The use of coal as an energy source marked the end of the era of renewable energy represented by the use of wood and the insufficient hydraulic and wind farms, to begin the non-renewable energy era, the era of fossil fuels.

The use of electricity and the invention of electrical machinery in the nineteenth century, along with the introduction of automotive vehicles, laid the foundation for the introduction of modern consumer society, characterized by energy intensity unprecedented in human history. With the advance of industrialization, it was necessary new fuels with most energy power, being oil the fuel that had these properties. It began thus a new phase of utilization of liquid fuels that endures to this day. More recently, after the Second World War, nuclear power seemed a promising alternative for the generation of electricity, but suffered a major setback due to the nuclear accident at Chernobyl in 1986 in Ukraine and Fukushima in Japan recently.

Many of these environmental impacts are from the generation, handling and use of energy. The main reason for the existence of environmental impacts from the generation, handling and use of energy lies in the fact that the global consumption of primary energy from non-renewable sources (oil, coal, natural gas and nuclear) accounts for approximately 88% of total. This huge dependence on non-renewable energy sources has led, in addition to ongoing concern about the possibility of depletion of these sources, the emission of large amounts of carbon dioxide (CO<sub>2</sub>) in the atmosphere, which in 2013 was of 36.3 billion tons, approximately 3.9 times the amount emitted in 1960 (9.3 billion tons).

Energy demand in the world will increase 35% in the period between 2010 and 2040. Increasing global energy demand will be driven by population growth that is expected to reach around 9 billion by 2040 (currently the world's population is 7 billion inhabitants) and the doubling of the global economy taking into account the annual growth rate of about 3% in much of the developing world [5]. Salowicz shows that natural gas will be the energy source that will grow more in the world. Global demand for natural gas is expected to increase about 65% between 2010 and 2040. According to projections, natural gas is expected to exceed, in 2025, coal as the second largest

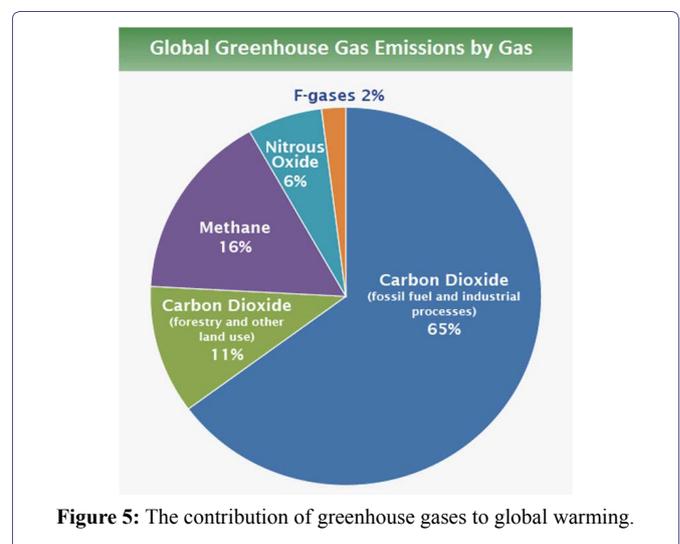
source of energy, surpassed only by oil. This article also shows that around 65% of the growth in the supply of gas will come from unconventional sources such as shale gas, which will account for a third of world production in 2040. The United States will lead the production of unconventional gas, accounting for more than half of the expansion between 2010 and 2040. According to the survey, demand for oil will grow about 25% in this period.

Liquid fuels such as gasoline, diesel and jet fuel remain as the main energy choice for the majority of transport by offering a unique combination of affordability, availability, portability and high energy density. Nuclear power may also have solid growth, led by Asia-Pacific region, where it is expected that production passes of 3% in 2010 to almost 9% in 2040. Renewable energy sources, including traditional as biomass, hydro and geothermal as well as wind, solar and biofuels will grow about 60%. Wind, solar and biofuels will probably compose about 4% of energy supply by 2040, surpassing the 1% recorded in 2010.

Energy sources used for electricity generation will continue to be the major components of global demand and is expected to grow by more than 50% by 2040. The increase reflects the expected increase of 90% in electricity use, led by developing countries where 1.3 billion people currently lack access to electricity. In the case of coal, the assessment is that demand will continue to grow until 2025, and then pass to fall. This will occur by the need to reduce greenhouse gas emissions by the countries of Organization for Economic Cooperation and Development (OECD), as well by China. Thus, it is estimated that the coal share in the energy matrix pass approximately 26% in 2010 to 22% in 2030.

Recent study by the International Atomic Energy Agency concluded that, by 2030, the world will be making use of 88.5% more energy compared to that recorded in 1990 and that most of it will be provided by coal, oil and for natural gas [6]. This is the energy scenario of reference for 2030 if the current world energy matrix is maintained. This is therefore the scenario that reveals for the planet's future if it remains on the current development model of society based on excessive consumption of fossil fuels.

The main greenhouse gases in the atmosphere are as follows:



Source: Global Greenhouse Gas Emissions Data. Available on <https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data>

Figure 5 leads to the conclusion that carbon dioxide (CO<sub>2</sub>) is responsible for 76% of global greenhouse gas emissions. According to the IEA (International Energy Agency), global emissions of carbon from burning fossil fuels, which in 1973 amounted to 16.2 billion tons a year of CO<sub>2</sub>, reached 22.7 billion tons per year in 1998. If the supply projections of the IEA energy are confirmed, the amount of carbon emissions is expected to increase reaching 32.8 tons of CO<sub>2</sub> in 2020.

Figure 6 shows the global emission of greenhouse gases by economic sector.

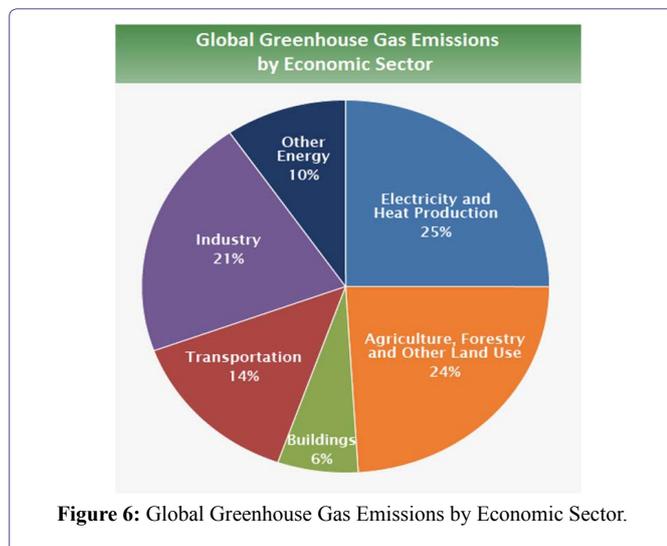


Figure 6: Global Greenhouse Gas Emissions by Economic Sector.

Source: Global Greenhouse Gas Emissions Data. Available on website <https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data>

The main factors contributing to the greenhouse effect in the atmosphere are shown in the table 1.

Causative factors of greenhouse effect	Contribution (%)
Energy use and production	57
CFC	17
Agricultural practices	14
Deforestation	9
Other industrial activities	3

Table 1: Main causes of the greenhouse effect.

Source: Lashof DA, Tirpak DA, n.2 [7].

Table 1 analysis reveals that the use and energy production are the most responsible for the greenhouse effect. This means that the strategy to reduce greenhouse gas emissions requires a significant reduction in consumption and energy production, especially those based on fossil fuels.

It is estimated that, in keeping with the current rate of increase in greenhouse gas emissions, the average temperature of the planet is

expected to rise from the current 15°C to 16.5°C at best and 19.5°C at the worst of the hypotheses in the year 2025. By the year 2100, the average global temperature will reach 18°C at best and 29°C at worst. The most likely value for the global mean temperature by the end of the twenty-first century would be 19°C. Figure 7 shows the record from 1900 onwards and projections of global mean temperature up to 2100.

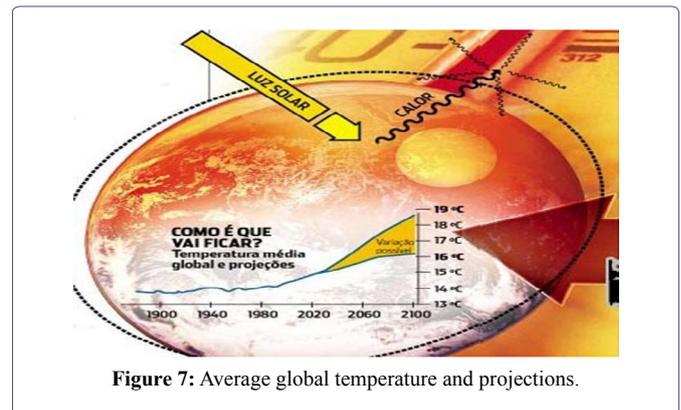


Figure 7: Average global temperature and projections.

Source: Alcoforado F, Aquecimento Global e Catástrofe Planetária. Curitiba: Editora CRV [6].

Due to global warming, it is likely that future climatic imbalances will be abrupt and catastrophic. There will be a rapid and destructive increase in global temperatures unless carbon emissions are cut. If current trends continue, between 2020 and 2070, the concentration of greenhouse gases could double and the average surface temperature of the Earth could rise by about 4°C.

### The Third Energy Revolution Needed to Combat Global Warming

In the second half of the eighteenth century, the first energy revolution in the world took place in England with the use of coal in substitution of wood that had been widely used as an energy source. The first energy revolution occurred simultaneously with the advent of the 1st Industrial Revolution. Equipped with a calorific power far superior to the fuels used until then, the coal provided much higher energy for the same volume, besides being easier and cheaper to transport it. The development of coal mines and the invention of the steam engine contributed to the birth of a new economy in Europe and the West.

The steam engine drives the machines in the factories, the locomotives in the first railroads, and the ships that replace the sailboats. People, commodities, capital, and ideas begin to circulate at a hitherto unknown speed. Soon a new environment is revealed with the emergence of the first metropolises and changes in social organization. The first energy revolution was confined to Europe, initially in Britain and then in Western Europe, then in the United States at the beginning of the twentieth century.

The second energy revolution, which coincided with the 2<sup>nd</sup> Industrial Revolution, occurred with the advent of oil and electricity. The use of oil as an energy source in the world began in the United States with the exploration of the first well in 1901 in Texas. Just as the steam engine became widely used with the advent of coal as an energy source, the internal combustion engine became widely used with

the advent of petroleum. The discovery of an energetic vector such as electricity and the invention of electric machines in the nineteenth century together with the introduction of automotive vehicles paved the way for the introduction of the modern consumer society, characterized by an energy intensity never seen in the history of mankind.

In one way or another, all human activities on Earth have caused changes in the environment in which we live. Many of these environmental impacts are derived from the generation, handling and use of energy which is responsible for 57% of the emission of greenhouse gases in the atmosphere resulting from human activities. The main reason for this significant participation of energy processes can be observed in the fact that, in 2011, the world consumption of primary energy from non-renewable sources (oil, coal, natural gas and nuclear) accounted for approximately 88% of the total, with only 12% renewable.

This enormous dependence on non-renewable sources of energy has led to the emission of large quantities of carbon dioxide (CO<sub>2</sub>) into the atmosphere by coal, oil and natural gas-based fossil fuels, which in 1973 was 16.2 billion tons per year in 1998 of 23 billion tons and in 2013 was about 36.3 billion tons, approximately 3.9 times the quantity emitted in 1960 (9.3 billion tons). As a consequence of the reliance on non-renewable sources of energy, the carbon dioxide content in the atmosphere has increased progressively, leading many experts to believe that the increase in the average temperature of the terrestrial biosphere that has been observed for some decades is due to "Greenhouse effect" caused.

If there is no immediate reduction in the emission of greenhouse gases, the means used to mitigate them will not suffice and life on the planet will be threatened. Global warming resulting from the emission of greenhouse gases will trigger climate change that will leave no part of the globe intact. If there is no reduction of greenhouse gases, scientists predict severe and irreversible impacts on mankind and ecosystems as a consequence of catastrophic climate change. Storms with unusual frequency, floods due to sea level rise that can submerge many islands and coastal cities, prolonged periods of drought and extreme heat all over the world should occur. Extreme weather events can lead to the breakdown of energy infrastructure networks, transport, communications and services. There is a risk of food insecurity, lack of water, loss of agricultural production and income, particularly among the poorest populations.

The world is facing a challenge that is to not allow the global average temperature grow in the 21st century above two degrees centigrade. In order to avoid such average global temperature increase above 2°C, carbon dioxide (and equivalent) concentrations would have to be stabilized at 450 ppm (parts per million) without which the world would face the end of the 21<sup>st</sup> century with a catastrophic climate change that can threaten the survival of mankind. To do so, global emissions will have to be reduced below their 1990 levels. Reducing emissions from 1990 levels is a gigantic challenge. It is important to consider that the International Energy Agency (IEA), in designing recent trends, forecasts a 50% increase in energy demand by 2030, with continued dependence on fossil fuels.

The International Energy Agency (IEA) has warned that "The world will be headed for an unsustainable energy future" if governments do not take "urgent measures" to optimize available resources [8]. To optimize the energy resources available on the planet, we must

start the third energy revolution that must translate into the implementation of a sustainable energy system on a planetary scale. In a sustainable energy system, world oil production should be halved and coal reduced 90%, while renewable energy sources (solar, wind, biomass, tidal, geothermal, hydrogen, etc.) should grow almost 4 times by 2030. By the year 2030, renewable energy should be on the order of 70% of the total energy production of the planet.

With the sustainable energy system, it is quite possible that natural gas will become, among fossil fuels, the predominant energy resource in the future because it is the least polluting of fossil fuels. Nuclear energy would not be an important source of energy in a truly sustainable energy system. This is largely due to the accidents at Three Mile Island in the United States, Chernobyl in the former Soviet Union and Fukushima in Japan. A sustainable energy system will only be possible if energy efficiency is greatly improved, that is, if it is maximized the relation between the amount of energy used in an activity (useful energy) and that made available for its realization (total energy). These are the requirements of a sustainable energy system throughout the world.

The first step in deploying a sustainable energy system around the world is to redirect a large number of government policies to meet the central objectives of reducing fossil fuel use and increase energy efficiency. For example, rewarding the manufacture of efficient motor vehicles and electric cars, encouraging high-capacity mass transport alternatives to replace cars, restructuring energy industries and raising taxes on fossil fuels, among other measures.

The use of renewable energy sources would bring about major changes across the globe, including the creation of entirely new industries, the development of new transport systems and the modification of agriculture and cities. The major challenge nowadays is to continue developing new technologies that use energy efficiently and economically use renewable resources. This is the alternative energy scenario that could avoid compromising the global environment. This means that profound changes in global energy policy must be put into practice to make the third energy revolution possible in the world.

## The Societal Development Model Needed to Prevent Global Catastrophic Climate Change in the 21<sup>st</sup> Century

The risk that global warming contributes to the occurrence of catastrophic climate change requires that all mankind adopt the precautionary principle that has its application based on two assumptions: 1) The possibility that human conducts cause collective damages linked to catastrophic situations that can affect all living things; and, 2) Uncertainty about the existence of the dreaded damage. The fact that possible catastrophic events resulting from global warming did not have measurable risk would require the adoption of precautionary measures to prevent their occurrence. It should be noted that we are dealing with a non-measurable, potential, non-assessable risk.

The adoption of precautionary measures reinforces the duty of prudence. Prevention is better than cure. The precautionary principle goes further than the idea of preventing certain risk, since it seeks to preserve the environment considering an uncertain risk. Caution is taken when the risk is high - so high that full scientific certainty should not be required before corrective action is taken and should be

applied in cases where any activity could result in lasting or irreversible damage to the environment. The precautionary principle differs from the principle of prevention that is directly related to a certain risk known to science. The precautionary principle is that it should preside over decisions related to addressing catastrophic climate change.

Once the world is facing a challenge not to allow average global temperature to be 2°C higher in the 21<sup>st</sup> Century, it is imperative that carbon dioxide (and equivalent) concentrations are stabilized at 450 ppm (parts per million). Without such attitude, the world will face catastrophic climate change at the end of this century, which can threaten the survival of mankind. To do so, global emissions will have to be reduced below their 1990 levels. Reducing emissions from 1990 levels is a gigantic challenge.

This is why it is imperative to implement the “sustainable development” model based on forms and processes that, when used, do not affect the integrity of the environment on which they depend. The new society to be built in the world would have to be sustainable from the economic, social and environmental point of view. The concept of sustainability has become a key element in finding viable solutions to solve the world’s greatest problems, relying on the thesis that a sustainable society is one that meets the needs of the present generation without diminishing the possibilities of future generations to meet their needs. How to build a sustainable society? This is a task aimed at achieving the sustainable development objectives described below:

- Reduce global carbon emissions by promoting changes in the global energy matrix based on fossil fuels (coal and oil), on the other, based on renewable energy resources, hydroelectricity, biomass and solar and wind energy to prevent or minimize global warming and, consequently, the occurrence of catastrophic changes in the Earth’s climate
- Improve energy efficiency by developing actions to achieve energy savings in the city and in the countryside, in buildings, in agriculture, in industries and in transport in general, thus contributing to the reduction of global carbon emissions and consequently, the greenhouse effect
- Make motor vehicles and equipment for domestic, agricultural and industrial uses more efficient, buildings designed for maximum lighting, cooling, and heating economy, agriculture and industry are modeled to require the least energy resources and raw materials, also contemplating the self-production of energy with the use of waste from its production processes based on reverse logistics and, finally, the use of new transport alternatives from the bicycle to those of high capacity based on railways, among other initiatives
- Combat pollution from land, air and water, reducing waste by recycling the currently used and discarded materials. In this perspective, essential materials should only be used in production processes and in other applications only in the last case. When used in the various applications, they must first be reused many times; second, they must be recycled to form a new product; thirdly, they must be burned in order to extract all the energy they contain and, ultimately, they must be removed to a landfill
- Adjust population growth to the resources available on the planet, reducing their birth rates, especially in countries and regions with high rates of population growth

- Reduce social inequalities, including the adoption of measures that contribute to meeting the basic needs of the world’s population, such as food, clothing, housing, health services, employment and a better quality of life. For sustainable development, therefore, all human beings must meet their basic needs and be given opportunities to realize their aspirations for a better life
- Ensure that the economic growth and wealth that results from it are shared by everybody, education services enable the population to increase the qualification levels for work and culture, health services are effective in combating child mortality and contribute to the increase in the life expectancy of the population, all men and women have decent housing, and there are public and private investments at the necessary level that contribute to the reduction of mass unemployment as a result of the general crisis of the world capitalist system which tends to worsen in the future
- In order to avoid catastrophic climate change, it is therefore necessary to establish a society based on the model of sustainable development on a world scale that satisfies the needs of the present generation without diminishing the possibilities of future generations to meet their needs and, in this way, contribute to avoid the exhaustion of the Earth’s natural resources and to prevent catastrophic climate change on a global scale

### The Paris Global Climate Agreement (COP 21) and its Non-Compliance

After several years of negotiations, impasses, timid advances and failures, 195 countries and the European Union produced at COP 21 in Paris a global agreement that defines how humanity will fight global warming in the coming decades. For the first time, every country in the world commits itself to reducing greenhouse gas emissions, strengthening resilience (ability to return to its natural state, especially after a critical and unusual situation) and to unite in a common cause to climate change. The agreement has no legal character for all goals, as the majority wanted.

The COP 21 agreement consists of a 31 page document. It contains a 12 page text, the Paris Accord, and a decision detailing how the agreement will be implemented. Together, the two documents form a sort of manual of reorientation of the world economy. They signal, albeit in a very preliminary way, that the bundle of emissions of greenhouse gases must come to an end sometime in the 21<sup>st</sup> century. To the optimists, the deal represents the end of the era of fossil fuels.

The stated aim of the Paris Agreement is to contain the global average temperature rise by well below 2°C above pre-industrial levels and to make efforts to limit the temperature rise to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change. The reference to the target of 1.5°C came about thanks to the joint action of the island countries, which will be condemned to extinction in the long term by the rise in sea level resulting from a warming of 2°C.

As the greenhouse gas emission reduction targets presented are unable to hold the temperature to the required level, it has been decided that adjustments will need to be made every five years, starting in 2023. These adjustments would need to be considered in the text of the Paris Agreement. The Paris Accord also envisages that rich countries commit to disbursing at least US\$ 100 billion a year from 2020 for emission reduction projects in emerging countries and confirms that

developing countries can expand the donor base in the future, even if on a voluntary basis.

Two key aspects were not considered in the Paris Agreement: 1) The long-term goal of decarbonizing the economy by 2050 or cutting at least 70% of global greenhouse gas emissions by the mid 21<sup>st</sup> century; and 2) The temperature target is not accompanied by a road map telling how the world intends to reach less than 2°C or 1.5°C, which weakens the pursuit of that target. In other words, COP 21 has produced an agreement that is, in practice, a mere letter of intent.

It is therefore perceived that the Paris Agreement does not solve the fundamental issues, and the voluntary targets indicated by each of the nations are not enough to ensure that global warming is well below 2°C towards 1, 5°C by the year 2100. Moreover, the document is silent in not presenting proposals that contribute to the construction of a model of sustainable development on our planet in place of the unsustainable current model of existing capitalist development.

To change this situation and put an end to the constant climate change that threatens to destroy our planet and humanity, it is necessary to promote a deep transformation of the current society. The unsustainability of the current model of capitalist development is evident, since it has been extremely destructive of living conditions on the planet. Faced with this, it is imperative to replace the current dominant economic model throughout the world with another that takes into account man integrated with the environment, with nature, that is, the model of sustainable development. This was not considered at COP 21.

Another issue not addressed at COP 21 concerns wars, which is also largely responsible for the planet's environmental aggravation, which is proliferating throughout the world. Among the countless dire consequences of wars are the devastating effects on the environment. The bombing of military targets and civilian populations, the intense movement of military vehicles and troops, the great concentration of combat flights, the missiles thrown over cities and the destruction of military and industrial structures during all these conflicts also provoke the emission of metals and other substances that contaminate soil, water and air. In addition to environmental contamination, it is also necessary to consider the modification of natural landscapes and the loss of biodiversity in the long term, either by the presence of landmines or chemical agents dispersed in the environment. This was also not considered at COP 21.

Finally, it is important to emphasize that the Paris Agreement is also silent on the construction of a system of governance on the planet that is capable of ensuring the reorganization of the world economy that is leading the world to depression, of the planet's environment threatened by catastrophic climate change and of international relations that worsen every day fueling the proliferation of wars. Faced with these serious omissions of COP 21, it can be said that we will hardly succeed in trying to avoid catastrophic changes in the climate of planet Earth in the 21<sup>st</sup> century.

Katie Reilly, et al. reports that IPCC of United Nations warned that sufficiently limiting man-made global warming will "require rapid, far reaching and unprecedented changes in all aspects of society" in order to avoid dramatic global consequences, including rising sea levels, dying coral reefs and human casualties due to extreme heat [9]. Reilly states that the special report - published by the United

Nations' Intergovernmental Panel on Climate Change - assessed what it will take to limit global temperature increase to no more than 2.7°F (1.5°C) above preindustrial levels, in accordance with the 2015 Paris Agreement. Scientists consider that temperature to be a tipping point at which many severe effects of global warming will be realized.

The special IPCC UN report shows that "examples of actions include shifting to low or zero emission power generation, such as renewable; changing food systems, such as dietary changes away from land intensive animal products; electrifying transport and developing 'green infrastructure', such as building green roofs, or improving energy efficiency by smart urban planning, which will change the layout of many cities. The report called climate change "An urgent and potentially irreversible threat to human societies and the planet," and warned that delayed action would make it impossible to limit warming to 2.7°F (1.5°C). "While the pace of change that would be required to limit warming to [2.7°F] can be found in the past, there is no historical precedent for the scale of the necessary transitions, particularly in a socially and economically sustainable way" the report stated. "Resolving such speed and scale issues would require people's support, public-sector interventions and private-sector cooperation".

Reilly K, et al. reports what the UN report presents as some changes that will need to be made in order to stop the current pace of global warming [9]:

- Reduce carbon emissions by 45%

By 2030, global carbon dioxide emissions should be 45% less than they were in 2010, the report found. And carbon dioxide emissions must reach net zero around 2075 meaning the amount of carbon dioxide entering the atmosphere equals the amount being removed. By 2050, emissions from other heat-trapping greenhouse gasses, including methane and carbon black, should be reduced by 35%, relative to the 2010 rate. Emissions would need to decline rapidly across all of society's main sectors, including buildings, industry, transport, energy, and agriculture, forestry and other land use.

- Remove carbon dioxide from the air

In addition to reducing carbon dioxide emissions, the reported carbon dioxide removal measures including planting new trees and carbon capture and storage, the process by which carbon dioxide is trapped and prevented from entering the atmosphere. Most current and potential [carbon dioxide removal] measures could have significant impacts on land, energy, water, or nutrients if deployed at large scale.

- Use 85% renewable energy and stop using coal entirely

The report recommended far-reaching changes to land use, urban planning, infrastructure systems and energy use - changes that will be "unprecedented in terms of scale". Climate scientists said renewable energy sources will have to account for 70% to 85% of electricity production by 2050. The use of coal should decrease steeply and should account for close to 0% of global electricity, and gas just 8%. While acknowledging the challenges, and differences between the options and national circumstances, political, economic, social and technical feasibility of solar energy, wind energy and electricity storage technologies have substantially improved over the past few years, the report stated. These improvements signal a potential system transition in electricity generation.

- Plant new forests equal to the size of Canada

Scientists recommend that up to about 3 million square miles of pasture and up to 1.9 million square miles of non-pasture agricultural land are converted into up to 2.7 million square miles for energy crops, which can be used to make biofuels. That would amount to land a little less than the size of Australia. The report also recommends adding 3.9 million square miles of forests by 2050, relative to 2010 - which is roughly the size of Canada.

“Such large transitions pose profound challenges for sustainable management of the various demands on land for human settlements, food, livestock feed, fibre, bioenergy, carbon storage, biodiversity and other ecosystem services”, the report stated. Mitigation options limiting the demand for land include sustainable intensification of land use practices, ecosystem restoration and changes towards less resource-intensive diets.

Jonathan Watts, et al. reports that “The world’s leading climate scientists have been warned there is only two years of global warming to be kept to a maximum of 1.5°C, beyond which even half a degree will significantly worsen the risks of drought, floods, extreme heat and poverty for hundreds of millions of people [10]. “ Watts claims that the authors of the landmark report by the UN Intergovernmental Panel on Climate Change (IPCC) say urgent and unprecedented changes are needed to reach the target, which they say is affordable and feasible although it lays at the most ambitious end of the Paris Agreement pledge to keep temperatures between 1.5°C and 2°C. The half-degree difference could also prevent corals from being completely eradicated and ease pressure on the Arctic, according to the 1.5°C study, which was launched after approval at the final plenary of all 195 countries in Incheon in South Korea that saw delegates hugging one another, with some in tears.

Jonathan Watts, et al. states that policy makers commissioned the report at the Paris climate talks in 2016, but since then the gap between science and politics has widened [10]. Donald Trump has promised to withdraw the US - the world’s largest source of historical emissions - from the Paris Agreement. The Brazil’s presidential election put Jair Bolsonaro in a strong position to carry out his threat to withdraw Brazil from the Paris Agreement and also open the Amazon rainforest to agribusiness.

The IPCC UN report shows that the world is currently 1°C warmer than preindustrial levels. Following devastating hurricanes in the US, record droughts in Cape Town and forest fires in the Arctic, the IPCC makes clear that climate change is already happening, upgraded its risk warning from previous reports, and warned that every fraction of warming would worsen the impact. The report was presented to governments at the UN climate conference in Poland. At the current level of commitments, the world is on course for a disastrous 3°C of warming.

The UN report authors are refusing to accept defeat, believing the visible damage caused by climate change will shift their way. Climate change is occurring earlier and more rapidly than expected. This report is really important. It has a scientific robustness that shows 1.5°C is not just a political concession. There is a growing recognition that 2°C is dangerous.

## Conclusion

Global climate change tends to produce a real crisis of humanity that makes it imperative to build a new society that acts in an interdependent and rational way with common objectives in each country and on a planetary scale without which it can be placed in check the survival of humans and life on planet Earth. The lack of convergence among countries around the world in tackling climate change is reflected in some countries’ failure to meet the targets set out in the Paris Agreement at COP 21.

It has been proven that, in order to avoid climate change, it is not enough to meet goals such as those established at COP 21. It is also necessary to build a new sustainable society from an economic, social and environmental point of view. The new sustainable society could be based on the vision of Capra et Lenore and Ernest Callenbach et al. [11,12]. In their works, Capra Lenore and Callenbach argue that the concept of sustainability has become a key element in the global movement, crucial to finding viable solutions to solve the world’s greatest problems. Both rely on the definition of Lester Brown, founder of the Worldwatch Institute: A sustainable society is one that meets their needs without diminishing the chances of future generations to meet their needs.

Capra, Lenore and Callenbach also point out that global sustainability requires that the world’s population stabilize to a maximum of eight billion people, that sustainable economies are not driven by fossil fuels, but by solar energy and its many direct and indirect forms (heating and photovoltaic electricity, wind energy, hydric and so on), nuclear power is no longer used due to its long list of economic, social and environmental disadvantages and risks, energy production is more decentralized and, therefore, less vulnerable to cuts or blackouts and a much more efficient sustainable energy system to be used.

The authors mentioned above argue that transport in a sustainable society will be much less wasteful and polluting than today, people will live much closer to their workplaces and will move around in the vicinity by highly developed bus and rail transport systems, fewer cars and bicycles which will be an important vehicle in the sustainable transport system, recycling will be the main source of raw materials in sustainable industries, and product design will focus on durability and repeated use rather than the short and disposable life of products. They add that the desirable will be a mindset based on recycling ethics. Recycling companies will take the place of current urban cleaning and disposal companies, reducing the amount of waste by at least two-thirds.

The above authors defend the thesis that in a sustainable society there will be a need for a restored and stabilized biological base, land use will follow the basic principles of biological stability (nutrient retention, carbon balance, soil protection, conservation of water and preservation of species diversity), rural areas will have greater diversity than currently with balanced land management, where there will be crop rotation and species cultivation, there will be no wasted crops, tropical forests will be conserved, there will be no deforestation to obtain wood and other products, millions of hectares of new trees will be planted, efforts to halt desertification will transform degraded areas into productive land, the exhaustive use of pasture will be eliminated, as will food chain of affluent societies, to include less meat and more grains and vegetables.

Finally, Capra, Lenore and Callenbach consider that value systems that emphasize quantity, expansion, competition and domination will give rise to quality, conservation, cooperation and solidarity among human beings, the decisive characteristic of a sustainable economy will be the rejection of the blind quest for growth, gross domestic product will be recognized as a failed indicator, economic and social as well as technological changes will be measured by their contribution to sustainability, military budgets will be a small fraction of what they are today, governments will invest in a strengthened United Nations peacekeeping organization instead of keeping expensive and polluting defense institutions, nations will decentralize power and decision making within their own borders and at the same time will establish a degree unprecedented level of cooperation and coordination at the international global problems.

It can be argued that the introduction of the concept of sustainable development will entail profound changes in the way society develops, so that economic growth is less intensive in the consumption of raw materials and energy and more equitable in the distribution of its results to the population. Above all, a real political and cultural revolution must be carried out all over the world, so that the paradigm of current development is replaced by the paradigm of sustainable development.

We are, for the foregoing, facing a critical moment in the history of Earth and humanity, at a time when it must choose the course to be given to its future. As the world becomes increasingly interdependent and fragile, mankind faces at the same time great dangers and great promises in regard to its future. We must recognize that in the midst of a magnificent diversity of cultures and ways of life, we are a human family and a terrestrial community with a common destiny. We must join forces to create a sustainable global society based on respect for nature, universal human rights, economic justice and a culture of peace. To arrive at this purpose, it is imperative that all of us, the peoples of the Earth, declare our responsibility to one another, to the continuity of life on the planet and to future generations.

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