Analysis of the energy and environmental situation and the use of biofuels worldwide

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Summary

The manuscript examines the historical interaction between economic and energy development, highlighting its impact on the environment. The importance of energy efficiency and the good use of natural resources are emphasized as solutions to reduce the demand for energy worldwide and the emissions of polluting agents into the atmosphere. An analysis is made and the decrease in fossil fuel reserves and the increase in the generation of renewable energy, especially biofuels, are reflected. The cases of Cuba, China, Japan, Mexico, Russia and Zambia are analyzed in terms of energy matrices, dependence on fossil fuels and advances in renewable sources, stressing the use of biofuels. The role of biofuels in the energy transition is highlighted and the question is raised about their feasibility to face current challenges.

Keywords: biofuels, energy efficiency, renewable energy, climate change.

Introduction

Throughout history, the main economic developments of humanity have been linked to significant energy developments, such as the discovery of fire, bringing with it protection and better nutrition; the great Industrial Revolution; and today, all the existing developments in the energy field. But all this brought about a significant deterioration of the environment, causing a climate change that seems unstoppable. (Carrera et al., 2021). Climate change is one of the biggest challenges worldwide, mainly due to the consequences it entails, from meteorological changes to natural disasters.

No increase in energy production is required to achieve greater productivity from current energy consumption. Therefore, efficiency costs less and is easier to achieve than any other means of production. Efficiency is also the cleanest energy source since it does not increase emissions. Globally, the expected growth in energy demand is on an unsustainable trajectory, and energy efficiency and conservation will play a key role in slowing that growth. Electricity generation through renewable sources is an effective alternative to mitigate climate change since its environmental impact is lower than that of fossil fuels. (Lalith & Kirubakaran, 2021; Pérez et al., 2021).

Biofuels represent a potential renewable energy source that could generate new and large markets for agricultural producers. However, only some of the current biofuel programs are viable, and most carry high social and, ironically, environmental costs. Fuel's economic, ecological, and social effects must be widely debated and carefully assessed before extending public sector support for large-scale biofuel programs. Country biofuel strategies should be based on carefully evaluating these opportunities and costs in the medium and long term. One of the factors to take into account is that oil reserves will run out, according to experts, in fifty years (Iturralde et al., 2021; Serna et al., 2011).

This leads us to the thesis of implementing adequate energy management based on renewable energies, mainly biofuels worldwide, to achieve greater energy efficiency in all areas and greater business competitiveness and environmental protection. Atmosphere.

Development

The permanent industrial development, the practically unstoppable growing demand by the population for the use of new technologies to access other services and amenities, and a worrying culture of wasting electricity bring, as a consequence, a considerable increase in the consumption of said energy, which led to the fact that there are not a few countries that are currently at the limit of their generation capacity, or that they have simply already exceeded it. On the planet, GHG emissions continue to increase slowly, and emissions due to energy (fossil fuels) and industrial processes (Figure 1) remained stable from 2014 to 2016, representing approximately 70% of total global emissions of GHG (Celis, 2020).

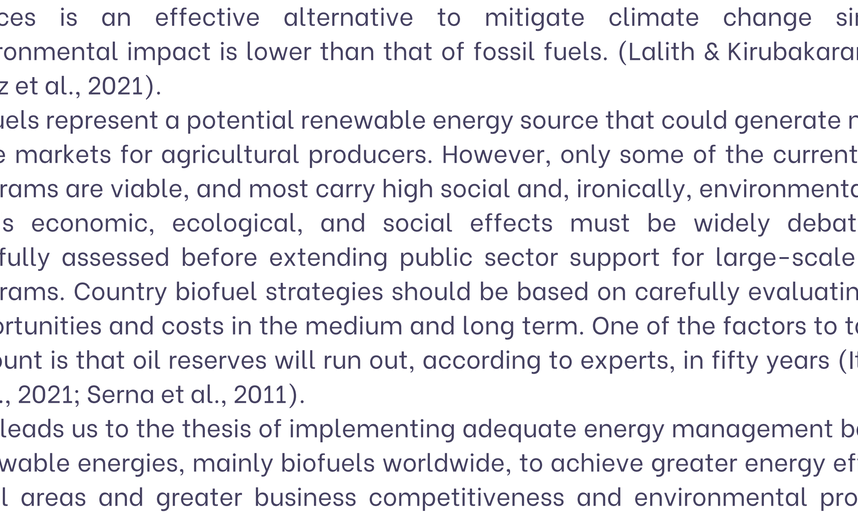

Figure 1. CO2 emissions from fuel combustion. Source: Own production, 2022. Data taken from (Carrera et al., 2021).

As a summary of the current state of energy worldwide, you can see the serious situation in the world with respect to environmental pollution, mainly due to the burning of fossil fuels and the incorrect use of energy management, mainly in underdeveloped countries. You can see the decline in fossil fuel reserves. It can also be observed in figure 2 the growth of energy demand worldwide.

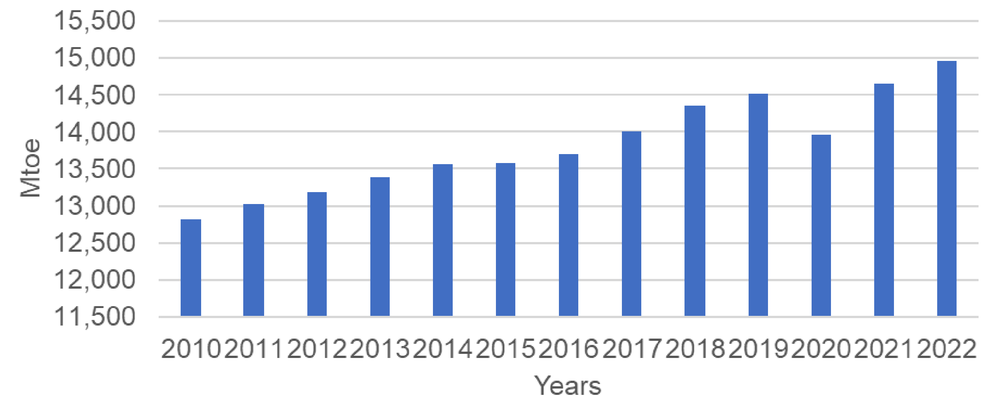

Figure 2. Annual growth of primary energy demand 2010-2022. Source: Own production, 2022. Data taken from (Carrera et al., 2021; Enerdata, 2023).

Solar power generation grew 23% last year, and wind power 14%. Combined, they account for more than 10% of global electricity generation. All clean electricity sources generated 38% of global electricity in 2021, more than coal (36%). Regarding biofuels, in 2021 they represented more than 7% in the world energy matrix, according to figure 3, they continue to grow worldwide.

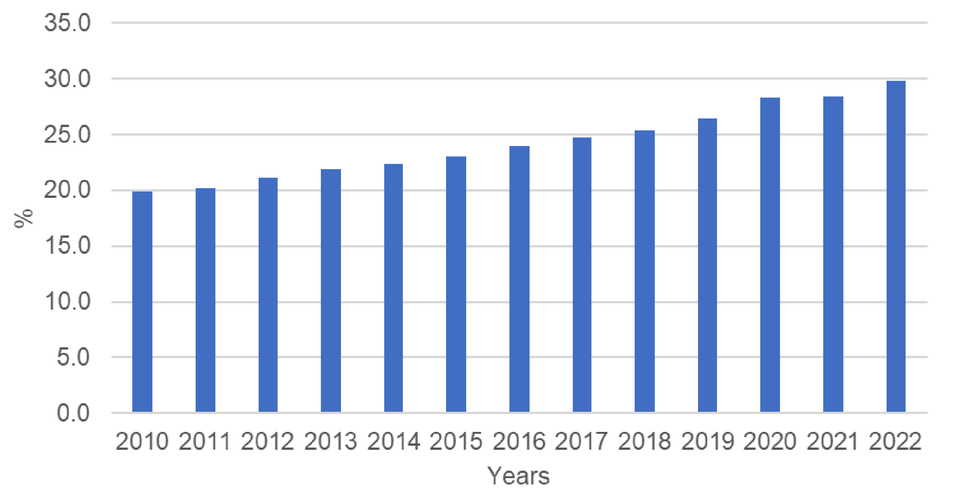

Figure 3. Percentage representation of renewable energies with respect to the global energy matrix. Taken from: (Carrera et al., 2021; Enerdata, 2023).

The world is facing a huge global campaign, the objective of which is to incorporate, as quickly as possible, different raw materials such as: sugar cane, soybeans, corn, rapeseed, beets, etc., into the production of biofuels as perfect substitutes. of petroleum derivatives. The main justifications found for this phenomenon are based on global warming and environmental pollution. 1st generation biofuels use specific crops as raw materials; the most widely used are biodiesel and bioethanol. The latter represents more than 90% of the total biofuels currently used in the world. (Serna et al., 2011).

The distribution matrix of biofuel production worldwide is shown below (Figure 4):

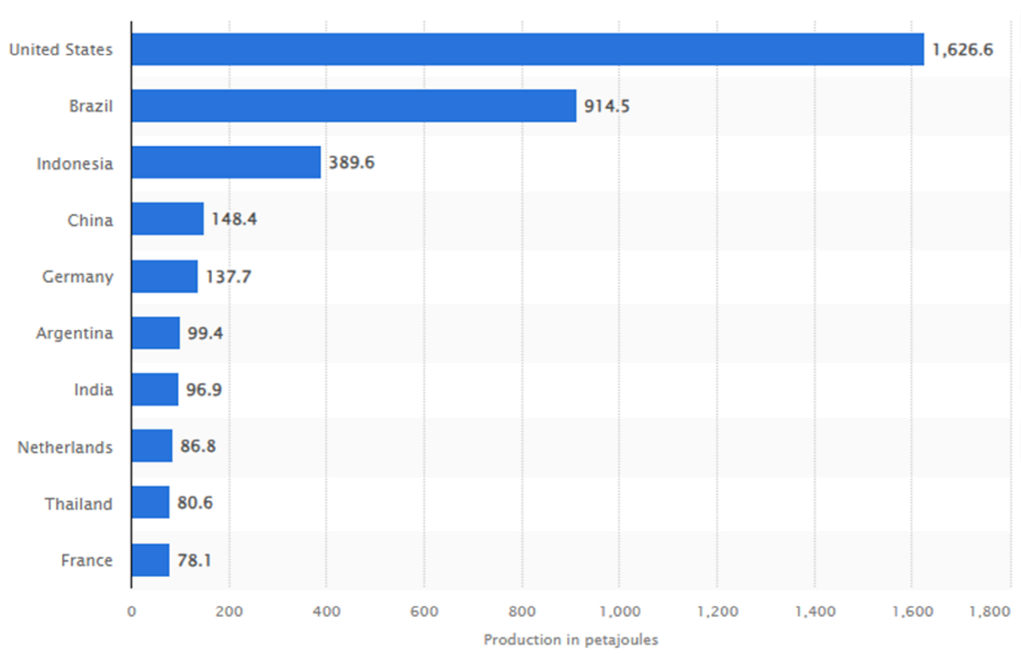

Figure 4. Distribution of world biofuel production in 2023. Source: Taken from (Statista, 2023).

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Analysis of the energy matrix and the use of biofuels in China, Japan, Cuba, Mexico, Russia and Zambia.

Cuba:

Nearly 96% of the country's electrical energy is produced from fossil fuels, "with a high dependence on imports, high generation costs and a technological infrastructure with high greenhouse gas emissions" (GHG), points out the Third National Communication to the United Nations Framework Convention on Climate Change (UNFCCC). This places it in a position of high vulnerability to unplanned interruptions in supply. (Alvarez, 2021).

In its Nationally Determined Contribution of 2020 (commitment to reduce GHG emissions made by each country), the Cuban government declared as one of its objectives the increase in electricity generation by 24% from renewable sources, specifically, a 14 % from sugarcane biomass and the other 10% from solar, wind and hydroelectric energy. The Cuban energy matrix shows a marked dependence on fossil fuels for power generation. From 2006 to 2019, these represented 69.9% of the primary energy production on the Island, with 52.3% crude oil and 17.6% gas. The remaining 30.1% came from cane products (27.1%), firewood (2.7%), and hydropower (0.2%), according to Cuba Energía. In turn, in 2019 biomass represented 97.6% of the energy from renewable sources. The remaining 2.4 % biogas represented 7.9% (Álvarez, 2021; Alvarez et al., 2021; Borges et al., 2017; Iturralde et al., 2021).

China

China transits its energy matrix in electricity generation through so-called clean energy, such as: solar, wind, hydroelectric, cellulose and even nuclear. The energy transition is a process of structural change of energy sources. Electricity generation in the Asian country is still given mainly by coal. The important thing is found in the growth rates of use of sources for electricity generation. Coal use grew at 9% from 1995 to 2004, then came a change in regulation to generate less power from coal, and growth slowed between 2006 and 2013 to 6%. As of 2014, the average growth is 0. Nuclear energy has an average growth trend of 15% since 1995 in a relatively constant manner. Solar energy presents average rates of 42% per year from 1995 to 2004, and from 2006 onwards to an average of 55%. Hydropower presents rates of 8% between 1995 and 2004, and 11% between 2006 and 2016.(Lewkowicz, 1618615160; OBELA, 2019).

China has been encouraging the production of biofuels such as ethanol and methane from renewable resources to reduce the country's growing reliance on imported oil. Once an exporter, China now imports at least 43%t of its oil supply. Chinese economic planners have made the development of green energy such as ethanol and biodiesel a key priority in the country's five-year economic plan. By 2020, they want green energy to account for 15% of all transportation fuels in the country. China is the fourth largest producer of liquid biofuel and the third largest producer of bioethanol in the world.

Japan:

After the Fukushima disaster, the government ordered a cold shutdown of all the country's nuclear reactors, which dealt a severe blow to the energy policy of Japan, which was the third largest producer of electricity from nuclear energy, and to the that nuclear was the closest thing to an autochthonous energy source, given the scarcity of their own energy resources. According to data from the Japanese Ministry of Economy, Trade, Industry (METI), in 2017, the country's energy self-sufficiency ratio was only 9.6%. (Redacción, 2021). The V Strategic Energy Plan, which sets the basic orientation of Japan's energy policy, has been approved by the Council of Ministers on July 3. The Government of Japan is required by the Basic Law of Energy Policy to develop strategic plans, the first of which came in 2003. Since then, the plan has been revised every three to four years. This plan, which comes four years after the previous one, shows the problem of energy choice by adopting a more long-term perspective, since in addition to the target year of 2030, which is the one that had been handled up to now, it adds a new horizon, that of 2050 (Figure 6).

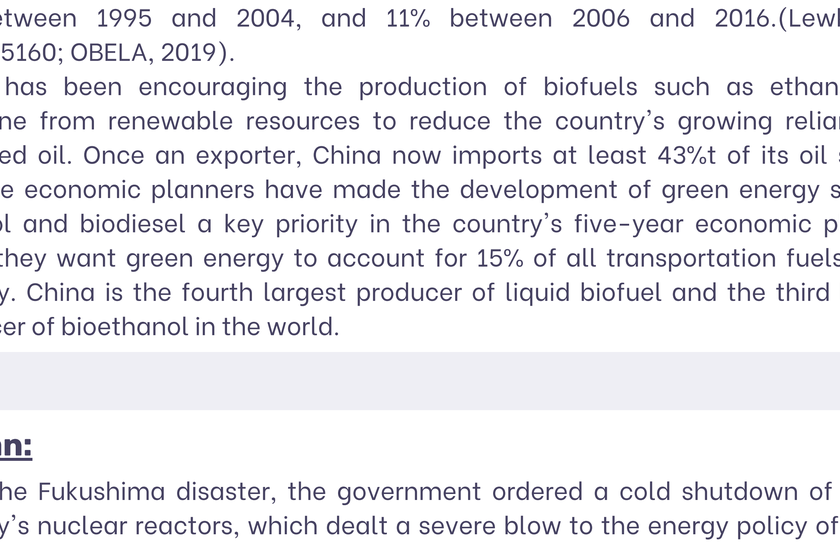

Figure 5. Japan's electrical power sources.

Biofuels represent 38% of Japan's renewable energy matrix, which in turn represents 6% of the energy matrix of all types of energy. They develop projects in the area of biodigesters and biofuels. The Japanese electricity company eRex will build the second largest biomass electricity production plant in the world with a capacity of 300 megawatts (MW) in Japan. The Tokyo-based power company is immersed in the process of selecting the location of the facilities, whose operations would begin in 2024 or 2025 after carrying out a feasibility study, and its construction will cost about 90,000 million yen (810 million dollars). (BioEconomy, 2018).

Mexico:

In 2020, fossil fuels represented 64.50% of Mexico's installed capacity and 72.15% of electricity generation. Additional electricity was generated from hydroelectric (8.59%), wind (6.31%), solar (4.33%), biomass (3.49%), nuclear (3.48%), and geothermal (1.46%).

Between 2018 and 2021, Mexico increased its participation of renewable energies in the energy matrix, from 21% to 27.5%. This increase, however, is insufficient for the country to meet its energy transition commitments. Biofuels represent 51% of the renewable energy matrix in Mexico. Derived from international commitments in relation to climate change and the reduction of GHG emissions, on December 24, 2015, it was established that SENER will set as a goal a minimum participation of clean energies in the generation of electrical energy of 25% for 2018, 30% for 2021 and 35% for 2024.(SENER, 2019).

Considering biofuels as a sustainable development opportunity, the Mexican Government has focused mainly on the production of liquid biofuels such as ethanol and biodiesel. Ethanol is produced from the sugars and starches found in vegetables, such as sugar cane and corn, among others. For its part, biodiesel is obtained from animal or vegetable fats found in sunflowers and soybeans, among others. In this regard, the Secretariat of Energy of Mexico (SENER), sponsored by the Inter-American Development Bank (IDB) and the GTZ (German Technical Cooperation), carried out a study entitled "Potentials and Feasibility of the Use of Bioethanol and Biodiesel for the Transportation in Mexico", which presents a diagnosis of the possibilities of bioethanol and biodiesel as fuels for transportation in Mexico. (García et al., 2018).

Russia

Russia's energy policy is spelled out in an "Energy Strategy" document, which establishes the nation's policy until the year 2020. In 2000, the Russian government approved the basic provisions of said strategy, which it confirmed in 2003. The The document outlines several priorities: increasing energy efficiency, reducing the impact on the environment, sustainable development, energy and technological development, and improvements in the efficiency and competitiveness of the sector.

Russia, one of the world's great energy powers, is rich in natural energy resources. It has the largest known natural gas reserves, at the same time that it is the second nation in coal reserves, and the eighth in oil reserves. It is the fourth world producer of electricity after the United States, China and Japan. It exports 70% of the oil produced, making it the world's leading exporter of net energy, as well as the largest supplier to the European Union.

The Russian energy matrix is led by gas which represents 43%, this is followed by oil with 35% and coal with 16% and to close renewable energies and electricity which add up to 6%. Biomass represents less than 1% of it. (Enerdata, 2023).

Russia can increase the share of renewables in its energy mix from around 3% today to more than 11% by 2030, according to new results from the International Renewable Energy Agency (IRENA). The growth in the use of renewable energy would represent a nearly four-fold increase in the share of renewable energy between 2014 and 2030. The document on which these claims are based, Renewable Energy Prospects for the Russian Federation, was presented to stakeholders from high level at a meeting in Moscow between the Ministry of Energy of the Russian Federation and IRENA. Russia has significant potential from all renewable energy sources, with hydropower and bioenergy being the main sources of renewable energy in the country's energy system. By the end of 2015, the total installed capacity of renewable energy generation reached 53.5 GW, which represents around 20% of the country's total capacity, most of which is in large hydroelectric plants. (FuturEnergy, 2017).

Zambia

Zambia could be completely self-sufficient with self-produced energy. The total production of all electrical energy production facilities is 12 MM kWh. This represents 105% of the countries' own use. Despite this, Zambia trades energy with foreign countries. Other energy sources such as natural gas or crude oil are also used. Today renewable energy in Zambia represents more than 80% of its energy matrix.

The need to provide safe, clean, affordable and renewable energy is of great importance throughout the world. The same is true for poor households in Zambia, where around 80% of its population depends on wood fuel in the form of firewood and charcoal for cooking, while burning candles and kerosene. Woodfuel is associated with the use of inefficient stoves that increase poverty, health, and environmental impacts. With the availability of abundant biomass and about 250 hours of sunshine per month with a potential energy output of 5.5 kWh/m 2 /day in Zambia, micro-hybrid biomass solar PV plants are considered to be the energy solution for Zambia. This solution will not only be an important part of kitchen and home lighting, but also an important aspect of rural renewable energy development and sustainable development in Zambia.

Conclusions

- With respect to climate change, planet Earth is at a critical moment, due to the lack of initiative of the main world powers, the economic crises that do not allow underdeveloped countries stable growth.
- As a positive aspect at the global level, the decrease in energy intensity and the growth in the use of renewable energy sources stand out, but the demand for energy worldwide increases for years.
- It was possible to appreciate that biofuels have taken a fundamental role worldwide. The countries analyzed present a development of renewable energies, mainly biofuels, despite their deference to their economic development.

Will renewable energies, mainly biofuels, be the most viable solution to solve the energy and environmental situation that the planet presents today?

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