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Fossil fuels, nuclear energy and renewable energy

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ABSTRACT
For the generation of energy sources, natural resources are used by man. The rapid growth of human populations, related to the phenomena of globalization and industrialization, has significantly increased the increase in the consumption of world energy sources. These energy sources can be renewable when the resources used are inexhaustible due to their constant renewal in the environment and non-renewable due to their slow process of formation in nature, thus becoming finite. Climate change is caused by increased emissions of greenhouse gases, mainly CO2, coming mainly from the burning of fossil fuels. However, new energy sources have been sought as a way not only to diversify the energy matrix of countries around the globe but also to develop alternatives that seek a reduction of impacts, especially of an environmental nature. While renewable energy sources such as solar, wind, and wave energy can provide eco-friendly alternatives to fossil fuels and nuclear power, the intermittent nature of these energy sources requires an energy storage medium that allows for a continuous supply of energy. The work developed emphasizes that regardless of the type of generating source, whether renewable or non-renewable, there is no zero impact on the generation of energy. Knowledge of the low energy efficiency of renewable sources, investments, and the intermittency of schemes that is a characteristic of many of them, has shown that renewable energy sources will almost always be complementary to non-renewable ones.

Keywords: Energy sources, renewable energy, sustainability, environment.

1 INTRODUCTION

The first sources of energy used by humanity to carry out work were energies generated through mechanical sources, such as muscular effort, hydraulic energy from the currents of rivers, and wind energy. Thus, as an understanding of energy sources, it can be perceived that they are linked to the ability to perform work and can be converted into other forms of energy to obtain the expected results.

Over the years, new forms of energy have emerged, making it possible for activities that previously could not be performed due to some limitations to be carried out. (SOUSA; FRANCO, 2018)

The rapid growth of human populations, related to the phenomena of globalization and industrialization, has significantly increased the increase in the consumption of world energy sources. (BURTON, 2021).

It is expected that between the years 2014 to 2035, the consumption of energy sources will go through an increase of about 35%, with fossil fuels still having as its largest representation of the total energy supply, approximately 80%.

The heavy reliance on fossil fuels has resulted in a string of environmental problems, such as global warming, air pollution, and acid rain. (WANG; YIN, 2018)

Non-renewable energy sources use limited natural reserves, with slow formation processes and short existence compared to rapid consumption by humans.

These sources use natural resources, which will be finite in a short period or even in the long term. In contrast, renewable energy sources are inexhaustible due to constant renewal when used within a significant time interval.

Also, they are considered clean for emitting fewer greenhouse gases – henceforth GHGs, when they are compared to fossil sources. (ALVES, 2019)

It is of global understanding that energy development has entailed an environmental cost that of small has nothing.

After centuries and centuries of emission of toxic gases into the atmosphere (mainly causing the greenhouse effect), degradation of large tracts of land, and pollution of important water sources, we see today a still timid movement of groups of individuals concerned with environmental issues.

Given that there is an intrinsic relationship with the very survival of mankind, as a consequence, the threat of depletion of important natural resources can put human life in question. (LAVEZZO, 2016)

Faced with this reality, new sources have been sought as a way not only to diversify the energy matrix of countries around the globe but also to develop alternatives that seek a reduction of impacts, mainly of an environmental nature, caused by the generation, distribution, and consumption of energy, whether on a large or small scale.

It is in this perspective that the discussion of the feasibility of implementing energies considered renewable arises, with emphasis on those that allow an increasingly minor disturbance to the environment and society as a whole (GOLDEMBER; LUCOM, 2007)

Based on energy issues, the present work presents fossil fuel sources, nuclear energy, and renewable energy, elucidating their obtainment, applicability, and main impacts on the environment.

2 FOSSIL FUELS

Due to the solar radiations that fell on the Earth hundreds of millions of years ago, they originated and developed from microorganisms, such as bacteria and microalgae, to giant trees and large animals, each with its life cycle ending in death and decomposition. (CARVALHO, 2008).

S Fossil fuels are considered the remains of plants and animals from the prehistoric era, which have now been reduced to simple chains of hydrocarbons, which are present in nature in the form of solids or liquids.

Fossil fuels have a very high combustion rate, so they release a lot of energy. Fossil fuels account for around 75% of the planet's energy and are used as an energy source for businesses, private homes, and vehicles. (RIBEIRO, 2014)

In the eighteenth century, the English forests were being devastated by the extraction of firewood, and coal was abundant and cheap, even reaching the surface of the land in certain regions. Before long, coal moved ahead of wood as an energy source and was driven by the Industrial Revolution.

Although coal is still one of the most consumed fuels, it was oil that consolidated the modern industrial model characterized by mass production, with the most dynamic sectors forcing the technological development of industries linked to their production lines. (OAK, 2008)

The history of world energy production shows that fossil energy has successively grown its share of the energy market.

Oil has taken the place of coal and will remain in the domain as long as there are productive reserves to be exploited. Natural gas has been increasing its market share, but there is the issue of natural gas being tightly controlled by the main producing countries of this energy. Russia and the Middle East are the countries that together hold about 68% of world production (PIVA, 2010).

2.1 COAL

It is a dark and rigid black sedimentary rock, similar to a stone. Composed of carbon, hydrogen, oxygen, nitrogen, and sulfur. Depending on the depth that is located, its extraction can be carried out through mining or open air (CARVALHO, 2008).

Coal has an important role to play in the search for a secure energy supply. It is abundant and the most economical of fossil fuels, as well as being present in almost every country in the world. Its price is historically lower and more stable than the price of oil (PIVA, 2010).

Coal production has grown by about 65 percent worldwide in the last 25 years. Being the most abundant fossil fuel is also at the same time the most polluting because it produces about 1.37 times more carbon dioxide than petroleum for the same energy content, also emitting significant amounts of

other air pollutants, especially nitrogen oxide, sulfur oxide, and ash. However, coal still supplies about 24% of the world's primary energy needs (CARVALHO, 2008).

2.2 PETROLEUM

It is a dark liquid formed by a mixture of hydrocarbons and other organic compounds of various molecular weights. It is impregnated in porous rocks, together with natural gas and water, these places being called oil deposits. Its geographical distribution is quite irregular and dispersed (CARVALHO, 2008).

Oil was the protagonist of the second industrial revolution. Used as a recurrent form by several peoples as a primary fuel, its trajectory is not linked to an exclusive product cycle since its chemical transformation, from the mid-nineteenth century, allowed the development of an immense range of by-products used in various media. It can be used as fuel for cars, planes, and ships in the heating of houses and buildings and is still raw material for plastics, chemicals, fertilizers, and fabrics (CARVALHO, 2008).

The world supply of oil depends on hundreds of variables: price, external relations, the accuracy of the information reported, measurability and data collection, technology, demand, etc.

There is so much uncertainty around these variables and many divergent opinions on how to interpret the information that everyone seems to be able to support a different estimate with a valid argument. Rising prices create a greater incentive to extract oil from more expensive sources.

Cheap and easily accessible oil reserves are running out, but technology and the world economy are preparing for this change (RIBEIRO, 2014).

2.3 NATURAL GAS

Natural gas usually occurs associated with petroleum, so it is formed under the same conditions and from similar components of petroleum, the main compound being methane. The gas may be dissolved in the oil when the reservoir is under high pressure. It is a highly flammable, odorless, colorless, and tasteless gas (CARVALHO, 2008).

Natural gas can be hard to come by since it's usually trapped in porous rocks deep underground. After extracting, the gas goes to a processing plant, where it is cleaned of impurities and separated into its various components (PIVA, 2010).

There is an advantage in the environmental impact of natural gas compared to other fossil fuels, as it emits fewer polluting gases that are blamed for the greenhouse effect.

The good news is that natural gas is the “friendliest” fossil fuel in the environment because, with its burning, less sulfur, carbon, and nitrogen are produced with the burning of other fossil fuels (PIVA, 2010).

3 NUCLEAR ENERGIES

Nuclear technology was first employed during World War II and, like other technologies used in the war, was given a use after its completion. Thus, it gave rise to the use of thermonuclear generation with the emergence of the first core-electric plants in the 1950s. (MARTIAL, 2006; HINRICHS et al., 2010)

As a definition, the electrical energy generated by thermonuclear plants originated through the application of the uranium atom (ANEEL, 2011).

As described by the National Electric Energy Agency – ANEEL (ANEEL, 2011), the nucleus of the atom goes through a process of division so that energy can be generated, thus generating heat by heating the water existing inside the reactors of thermonuclear plants produced steam that moves turbines generating electricity.

Thus, when in a pressurized water reactor system, a nuclear power plant has: the fuel element, control bars, pressure vessel, pressurizer, steam generator, electric generator, condenser, containment vessel, pumps, and the reactor building. (HINRICHS et al., 2010)

Thus, a nuclear reactor is equipment where a nuclear fission chain reaction is processed, while a nuclear power plant is an industrial facility employed to produce electricity from the energy generated by the reactor; a nuclear power plant can house one or more reactors. (HINRICHS et al., 2010; CALIJURI and CUNHA, 2013)

In the process of obtaining the fuel element, uranium goes through a complex processing process to reach the thermonuclear plant.

According to ANEEL, the process can be divided into three main stages: Mining and processing, with the extraction of the ore from nature and sending it to a processing unit to be purified and concentrated, giving rise to a species of salt of yellow color, known as yellow cake (U3O8).

The second conversion step is where the yellow cake is dissolved, purified, and converted to the gaseous state (UF6 gas). The third phase of enrichment is characterized by the increase in the concentration of uranium 235 atoms (in general, from 0.7% to approximately 4%).

3.1 ADVANTAGES OF NUCLEAR ENERGY

As a means of optimizing the nuclear power generating system, due to its high potential level and taking into account the different consumption at certain times (peak hours), the hypothesis of

integration between the nuclear power plant and possible thermal energy storage solutions is raised, in this way energy would be stored at times of low consumption and released at peak hours, maintaining uniformity in production. (EDWARDS et al., 2016)

However, even though its operation is equated as an electric term, the nuclear power plant practically does not release waste into the air, coming to be considered by some scholars a clean source of energy generation.

According to Atlas de Energia Elétrica do Brasil, in addition to releasing a low level of (CO_2) into the atmosphere, its growth is justified by the abundant reserves of uranium existing throughout the planet, ensuring its raw material for long years, the same occurring with the reserves in Brazil.

In addition, it would not be necessary to expropriate large areas for their installation or the devastation of fauna and flora, causing an imbalance in the biosystem, as happens with hydroelectric dams. (CARVALHO, 2012) estimates that 18000 km^2 will be flooded for the operation of the Amazon reservoirs.

The cost of production is minimal when compared to thermoelectric plants that require biomass or fossil fuels in their process. Nuclear power plant is a generator of toxic waste, but they are contained and controlled, being the only electric power generation industry to inventory its waste, thus obtaining a sustainability factor (MARCIAL, 2006).

3.2 SAFETY ON THE IMPLEMENTATION OF NUCLEAR ENERGY AND THE TAILINGS ARISING FROM ITS USE

According to ALIYU et al. (2015), in normal operating situations, the levels of pollutants generated during the operation of the plant must be below acceptable levels so as not to generate damage to health or degrade the environment.

For Wheatley et al. (2016), through a historical analysis of accidents, we can note that from 1952 there has been a considerable decrease in the rate of nuclear accidents with civilians and an apparent stability of 0.003 events per plant per year from 1970.

It is noteworthy that for an employee exposed to a high level of stress, it is necessary to support decision-making due to physical and emotional self-exhaustion, especially when this stress is caused by accident in a situation of total discomfort, starting from this, Saghafi and Ghofrani (2016) made a study that demonstrates the evolution of the accident management support tool (A.M.S.TS) that should be used together with the (SAMG), as support in decision making.

Demonstrating how you can learn from past mistakes in a way that keeps them from reproducing. One of the biggest problems of energy is the generation of toxic waste and how to dispose

of it, so among others, Atlas Electric Energy of Brazil (ANO) cites an unprecedented project of Eletronuclear, which would be storage in steel capsules that guarantees the safety of these wastes for about 500 years. That yielded the same environmental license to resume the work of Angra III.

One of the points that most hinder the use of nuclear energy is the waste generated by this energy matrix. These wastes are highly toxic, with a risk of developing cancer even in people exposed to low doses of radiation.

Technically, the waste is all material resulting from human activity that contains radioactive elements with risks to health and the environment and for which reuse is not recommended (HINRICHS, 2010).

Nuclear power plants, hospitals, and industries, among other institutions, give rise to these wastes. Radioactive waste is divided into three classes: the low level of radiation, of intermediate-level, and the high-level of radiation (HELENE, 1996).

The low-level waste has a short half-life and low radioactivity content; they have contaminated protective clothing and some equipment from hospitals, factories, universities, and nuclear power industries.

These are discarded in landfills, thrown into the sea, and inside steel drums (which is not allowed in some countries). The intermediate waste consists of solid material of greater volume, such as used equipment, transport bottles from power plants, fuel processing plants, and nuclear weapons manufacturing units. (HELENE, 1996)

The disposal method is to wrap it in concrete and/or steel and store it in special locations, usually in the mills. Researchers are looking for disposal methods in underground warehouses or in the deepest parts of the seas.

High-level waste includes solid and liquid fuels used in nuclear power plants. Liquid disposal methods involve stocking them in stainless steel tanks wrapped in concrete in an appropriate location, which can be solidified into a glass and stored in steel containers inside concrete buildings or underground warehouses.

Another option is to store them in the cooling pools of the very plants that produce them; this is what occurs in Brazil. (HELENE, 1996)

4 RENEWABLE ENERGY

Climate change is caused by increased emissions of greenhouse gases, especially CO_2, which is largely caused by the great proliferation of fossil fuel burning. (ANDRADE-CASTAÑEDA et al., 2017). While renewable energy sources such as solar, wind, and wave energy can provide eco-friendly

alternatives to fossil fuels, the intermittent nature of these energy sources requires an energy storage medium that allows for continuous supply. (BURTON, 2021).

Around this situation seen to the environment, the projections of improvement are far from being so encouraging. In the world view, the forecasts for 2030 bring a trend scenario in which oil will maintain a share of 35% of the world's energy supply, while coal will account for 22% and natural gas for 25%.

Other ways of obtaining energy, called renewable sources – hydraulic, biomass, solar, wind, and geothermal, currently account for 12.7% of the world's energy supply and may reach no more than 14% of the supply in 2030. (BERMANN, 2018).

In the Brazilian scenario, it is estimated that renewable energy sources will represent 84% of the Brazilian energy matrix by 2023.

The excellent levels of solar irradiation, added to the availability of wind in several regions and the capacity of biomass production, make Brazil a potential source of development of renewable energy matrix. These different sources are briefly commented on in the following subsections. (OLIVEIRA et al., 2018)

4.1 HYDROELECTRIC POWER

Water has an energy potential, and when dammed, it increases. In a hydroelectric power plant, there are turbines that, in the waterfall, run an electric generator, producing energy. (LAVEZZO, 2016).

Hydraulic energy comes from condensation, precipitation and evaporation of water, factors caused by solar irradiation and gravitational energy, which are responsible for the generation of hydraulic energy. Hydroelectric power plants can transform kinetic energy into electrical energy from the use of water movement. (QUEIROZ et al., 2016)

Although hydroelectric dams are considered a source of renewable and clean energy, it is known that, in addition to the impacts caused in the area bordering their formation, such as: the felling of vegetation, water cover-up of fertile areas for farming, displacement of entire communities and destruction of the local historical-cultural heritage, changes in the flow and bed of the river directly affect the ichthyofauna. (ALBUQUERQUE, 2022).

The structure of a hydroelectric plant works in an integrated and joint way, being formed mainly by the water collection and adduction system, the dam and the powerhouse and spillway.

The dam's function is to interrupt the normal course of the water, creating a reservoir where the water will be stored. In addition to storing water, this reservoir also allows the flow of rivers to be

adequate, both in rainy periods and drought, the capture of rain in adequate volume and a height difference necessary for the generation of hydraulic energy (QUEIROZ et al., 2016).

Hydroelectric plants that do not have a reservoir, or have a smaller size, are called "run-of-river hydroelectric plants"; that is, this type of hydroelectric plant uses the speed of river waters to be able to generate energy.

The absence of a reservoir means that in times of drought, the energy capacity produced by the hydroelectric plant is reduced, or in some cases, it is deactivated at certain times of the year. (QUEIROZ et al., 2016)

In Brazil, the main source of electricity is hydroelectric, with a 68.2% share in the country's electricity matrix.

The national hydroelectric system covers 98% of the demand for energy supplies, and most of the plants are concentrated in the southeast region, where the largest consumers and the highest population concentration are located. (BONDARIK, 2018)

4.2 PHOTOVOLTAIC AND HELIOTHERMIC ENERGY

The most important element for the generation of energy is its source, photovoltaic and heliothermic energy is dependent on the Sun, which is a star that is approximately 150 million kilometers from the planet Earth. It is projected that each square meter of the Earth receives a power of 1400 watts from the sun.

However, the sun's rays undergo some deviations before reaching the Earth's surface. Approximately 51% of the total value reaches the earth's surface by direct irradiation. Approximately 30% of the total value undergoes reflection, not reaching the earth's surface. Still, a value close to 19% reaches the Earth's surface by diffuse irradiation, quite present on cloudy days. (SOUSA; FRANCO, 2018)

Currently there are two ways to generate electricity from the sun's rays, known as photovoltaic and heliothermic.

Heliothermics use mirrors and lenses to concentrate the sun's rays at a specific point, heating a solution that will generate the steam and drive a turbine that is used to produce electricity. Photovoltaics, on the other hand, consist of the generation of electrical energy through semiconductor materials that have the photovoltaic effect.

This chemical/physical phenomenon can be defined as the formation of electrical voltage or current in a material that is exposed to light. (DANTAS; POMPERMAYER, 2018)

In the use of this type of energy, the photons transported with the light are absorbed by semiconductor materials, such as silicon, contained in photovoltaic plates. The energy from the

absorption causes the electrons to reach a higher energy state, generating a potential difference, which can be harnessed.

The composition of the semiconductor material is key to the proper functioning of photovoltaic plates. Because of this, it is usual to use boron-doped silicon and phosphorus-doped silicon in the layers that make up the plate. (OLIVEIRA et al., 2018)0

For a real evaluation of the attractiveness of photovoltaic energy, it is of fundamental importance to be able to know the cost of equipment, installation and maintenance. For this, it is necessary to previously analyze the desired load of the PV system, that is, how much energy will be produced by it.

Initially, the intention is to size PV systems to supply partially, totally and excessively the demand of average residential electricity.

In cases where production is greater than consumption, the difference is injected into the distribution network, characterizing a grid-tie installation.

This system model is connected directly to the power grid, requiring more complex equipment than off-grid systems, which use batteries to store spare energy. (DANTAS; POMPERMAYER, 2018)

4.3 WIND ENERGY

The energy of the winds or wind can have its elucidation, in physical terms, as that of kinetic origin formed in the masses of air in motion.

Its use is made by converting the kinetic energy of translation, in kinetic energy of rotation. For the production of wind energy, turbines are used, also known as wind turbines, and for the performance of mechanical work (such as pumping water or grinding wheat), pinwheels of various types. (BERMANN, 2018)

This type of energy has its value tied to the installation and the various components of a wind turbine: rotor, rotor blades, generator, tower, nacelle and transmission box.

The use of wind energy is the one that has been growing and being exploited the most, having its generation potential continuously high and receiving numerous investments.

Given the justification of the lower specific cost of wind energy concerning other renewable energies. (OLIVEIRA et al., 2018)

Wind energy is currently regarded as one of the most promising renewable energy sources, characterized by a mature technology based mainly in Europe and the United States of America.

Wind turbines, isolated or in small groups of four or five, and, increasingly, in wind farms with forty and fifty units, are already a common element of the landscape of many countries in Europe, such as: Germany, Denmark, the Netherlands and, more recently, the United Kingdom and Spain. In the

US, wind power developed mainly in California, with the massive installation of wind farms in the 80s. (CASTRO, 2009)

In Brazil, the first computerized anemographs and special sensors for measuring wind potential were installed in Ceará and Fernando de Noronha (PE) in the early 1990s. The areas with the highest electrical potentials are in the Northeast, South and Southeast regions.

Given that the performance of the turbine is directly linked to the presence, speed and direction of the wind. (BERMANN, 2018)

In recent years, wind power generation has been showing exponential growth in Brazil. It was predicted that by the year 2023, the Brazilian Ten-Year Energy Expansion Plan projected an installed wind capacity of 22.4GW, within which a 5.8% reduction in carbon dioxide emissions is expected in 2030 for the entire Brazilian energy matrix. (BONDARIK, 2018).

The main disadvantage of wind energy consists in the fact that, for its installation, specific places are needed, which meet optimal generation conditions and that compensate for the installation. There is also the inconvenience of the frequency, speed and incidence of winds, which present great variation. (OLIVEIRA et al., 2018)

4.4 MARITIME ENERGY

Faced with the search for alternative energies, one of the solutions may be related to obtaining energy through the oceans. At present, the use of sea energy is only experimental and rare. It may seem quite challenging how to obtain energy from the seas, so there are three ways to accomplish it: through waves, tides or displacement of the waters and the temperature differences of the oceans. (LAVEZZO, 2016)

4.5 GEOTHERMAL ENERGY

Geothermal energy originates from the heat coming from the Earth, more specifically from its interior.

Because of the search and the need to produce electricity more cleanly and in increasing quantities, a way to use this heat for the generation of electricity was developed.

In this scenario, the use of geothermal energy can occur in two different ways, directly and indirectly, and both have been widespread widely in various parts of the world since the 1980s, contributing to the decrease in the consumption of non-renewable sources such as fossil fuels.

Geothermal energy is stored as sensitive or latent heat, converted into mechanical energy and later into electrical energy, with a great diversity of applications. (CAMPOS et al., 2017)

5 FINAL CONSIDERATIONS

The work developed emphasizes that regardless of the type of generating source, whether renewable or non-renewable, there is no zero impact on the generation of energy.

Knowledge of the low energy efficiency of renewable sources, investments and the intermittency of schemes that is a characteristic of many of them, has shown that renewable energy sources will almost always be complementary to non-renewable ones.

Projections of future energy consumption depend critically on the vision and type of development and economic growth that nations on the planet will have.

For this reason, the various exercises that have been done both by world bodies, government, entities, NGOs, university groups among others, in search of reflections on different visions of the future, can thus bring new results.

The genuine interest in renewable energy sources, seek to meet some environmental commitments, signed with the main world economies.

It is important to highlight the 2030 agenda that brings with it the Sustainable Development Goals, which includes 17 determinants to be fulfilled, in search of a more sustainable and just planet.

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