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Thermal Energy and the Social and Environmental Impacts: Mitigation Alternatives in Thermoelectrics Plants Operation in Brazil

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ABSTRACT

The Thermoelectrics Plants are progressive development because of population growth and the consequent increase in demand for energy. However, even with all the benefits for the common good, it can become a major villain in the long term, this because of the generation of toxic waste in its maintenance and operation. In this context, it is of paramount importance to analyze and identify the main impacts of the operation of power plants. The present work had for finality conduct a comprehensive literature review in order to raise the main social and environmental impacts and possible ways to mitigate. It notes that the social and environmental impacts of these projects are immeasurable, being that, mostly, these impacts are unknown and interfere directly and/or indirectly in the local population, flora and fauna, without the necessary protective measures. That way, considered boastful concentration of efforts to develop innovative methods to generate electricity and create more favorable conditions to existing methods. Together, establish means low cost in operation and minimize the impacts resulting from these processes, whether social or environmental.

Keywords: poluição, termoelétrica, tecnologia.

INTRODUCTION

With population growth, particularly in large cities, it became necessary to increase the supply of electrical energy. The use of potential sources for their generation is being carried out in different forms, for example, adopting technological evolution and the environment for their generation (IZIDORO; FUNGARO, 2007). For the necessity are attended, the forms used today are hydroelectric, nucleares, wind energy, thermoelectric, in between

others (SALDANHA, 2005). The wind energy, solar e hydraulics was alternatives renewables energy generation (MENDES et al., 2013). The demand of energy resource also increases as a result of industrial growth, provided as major consumers of electricity.

Thus electricity became one of the key sectors within the energy matrix, which stands out not only as the wide consumption, but for convenience, accessibility, easy production and quality of raw materials available in nature (SOTOMONTE, 2009). Only, before all growth, either population or industrial, find the emergence of environmental problems, becoming crucial factor in human health in small and large scale and local biodiversity. In this case, it is considered to, currently, the world is facing serious environmental problems and, the energetic sector, it contributes as one of those responsible for statistical (MENDES et al., 2013).

Among the abovementioned forms of energy, stand out the energy from Thermal Power Plants that, according to the National Electric Energy Agency (ANEEL), it has the larger amount of operating enterprises, totalizing 2.885, followed by Central Hydropower Generation 555 e Small Hydropower Plants 457. Its installation depends on a number of variables including of economic order, when the facility transportation fuels and gas pipeline highways and environmental order mainly the location of areas of natural preservation, most often conflict with each other (ZAMBON et al., 2005).

Despite the diversity of power generation by thermoelectric means, more than 80% comes from the use of non-renewable resources, and 40% being generated from the burning of coal (SOTOMANTE, 2009). In this case, it considers that the participation of biomass sources in the energetic matrix should be increased, however, it appears necessary to replace fossil fuels in the process of thermoelectric, resulting in increased use of renewable energy sources (LIMA JÚNIOR et al., 2014).

In this context, it appears the need for a detailed study of the potential resources for power generation and its impact on the environment It shows the need for a detailed study of the potential resources for power generation and its impact on the environment, considering possible ways to combat the negative effects it generates, and its operation, the means of minimizing. The finality of this study was to analyze, in a wide literature review, the possible social and environmental impacts of the operations of thermoelectrics, as well as outline ways to mitigate them in the use of methods in the use of waste generated.

REVIEW

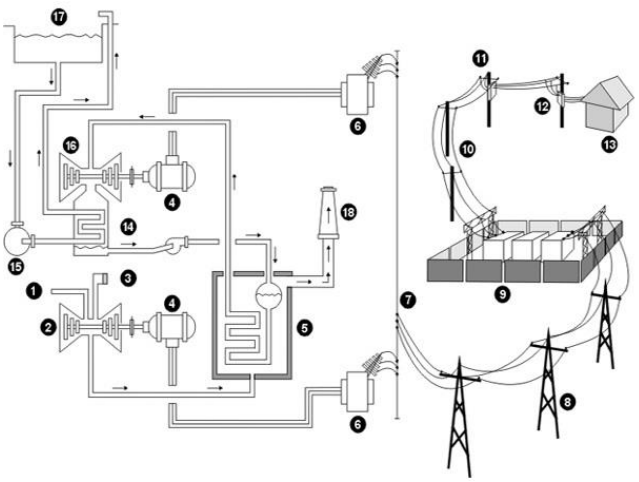
The electric energy is used in large proportions, either in domestic or industrial level. This demand follows, mostly, for utilization in situations where an energetic consumption is necessary, both for its versatility as the convenience (SOTOMONTE, 2009). According Reis & Santos (2015), even the electricity is a basic feature of citizenship, and necessary for the development of the individual, many still do not have access, making it difficult and distance of sustainability conditions.

Energy production in thermal power plants is due to the burning of coal, oil or natural gas. We can also say that nuclear power plants are thermoelectric, however, they use radioactive materials as a feeder source. One of thermoelectrics

features is the production of electricity from thermal energy by chemical or nuclear reactions, is the use of biomass (bagasse from sugar cane, firewood, rice husk, oleaginous, among others) and fossil fuels (mainly coal). In a simplified way, the Eletrobras Furnas defines as Thermoelectric Plant "*a set of buildings and equipment whose purpose is to generate electricity through a process of steps*" (Figure 1).

From start, it consists of burning fossil fuel (coal, oil, gas, etc.) to transform water into steam by the heat generated in the boiler. This vapor is utilized, high pressure, to move the turbine, which in turn, drives the electric generator. Then, the steam is condensed, which transfers the residue of its thermal energy to a cooling independent circuit, returning water to the boiler, completing the cycle (Eletrobras Furnas, 2011).

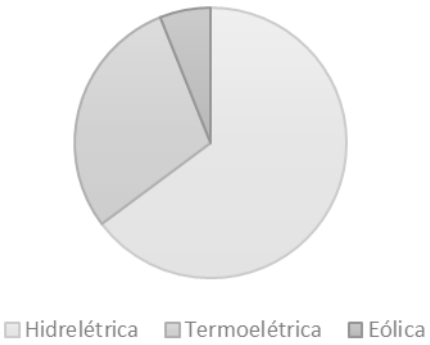
Figure 1: Operation of a thermoelectric power plant in combined cycle. Source: Eletrobras Furnas.



Subtitle		
1. Fuel input	7. Protection bus	13. Consumer
2. Gas turbine	8. Transmission Line	14. Condenser
3. Air input	9. Step-down substation	15. Cooling water pump
4. Generator	10. Distribution network	16. Steam turbine
5. Heat recovery boiler	11. Transformer	17. Cooling water supply
6. Elevator transformes	12. Measurer	

It is worth adding, according ANEEL (2016), currently in Brazil for investments in the use of these energy sources: wind energy, photovoltaic, hydroelectric, tidal and thermoelectric. Among they, the largest power generation is obtained by hydroelectrics adding 92.670.104 kW (65%), followed by thermoelectrics 41.627.849 kW (29%) and wind energy with 8.669.390 kW (6%) (Graphic 1).

Graphic 1 – Power associated with energy sources in operation. Source: ANEEL, 2016.



In this context, it has been raising the need for discussions on the impacts from the technological growth, mainly on the various problems arising from the degradation of natural resources with the issue of waste, which are dangerous to human health (WALTER et al., 2012). Paz et al. (2015) corroborate adding that it is necessary to analyze and understand the impacts associated with socio-economic activities and their implication in nature over time, regardless, understand the influence these have in production mode and environmental issues.

Waste of a thermoelectric are classified, according Zancheta et al. (2005), in gaseous, liquids and solids, the latter being the most presenting a potential pollutant, if it considered only atmospheric issues.

The effects generated by the growing demand for electric energy have been causing impacts, often irreversible. In featured on fossil fuels, as raw material to produce it as raw material to produce it, its burning has stimulated the increase in global temperature, focusing on the greenhouse effect and, consequently, causing natural disasters, in addition to providing high levels of toxicity (ALMEIDA, 2015).

It stands out among the main environmental problems in generating electric energy by plants thermoelectrics the large amount of coal ash (FUNGARO; SILVA, 2002). These wastes enable smaller elements, for leaching, contaminate underground sources with heavy metals and sulfate ions (FUNGARO; SILVA, 2002). According with Izidoro e Fungaro (2007), the brazilian coal becomes difficult to use because it contains high levels of ash and sulfur.

Table 1 – Main sourced from thermoelectrics pollutants. Source: FIOREZE; SANTOS, 2013.

Source	Main pollutants
Termoelectrics	SO^{-}_{4}, Si, Al, EC, Ca, S, Fe, P, K, Ti, NH^{-}_{4}, Sr, Zn, Pb, Cl, Se, Mn, Zr, Cu, Cr e Br.

The coal, utilized as raw material for energy generation, release large amount of ash, heavy and light (volant), the first being deposited at the bottom of the furnace and the second carried by wind and deposited on the soil next to the plant, contaminating (FLUES et al., 2008). The author highlights yet what, the example of the Czech Republic, where there are large areas of burning coal, It has a high sulfur content which may be linked directly to forest damage in that region.

The ashes directly affect animals that are associated with soil. The introduction of toxic substances, mainly the solubilization of heavy metals salts, can cause soil status changes resulting unfavorable effects on organisms that have a symbiotic relationship with its particles (MUSSAK, 2014). The author demonstrates in his work that soil contaminated with certain concentration levels for leakage to the control environment and, when not cause death, reduces the burden on individuals of the specie *Eisenia foetida* (worm - red - of - Califórnia), featuring a measurable chronic effect.

According with Cançado et al. (2006), the anthropogenic sources are the main causes of air pollution, which is derived from biomass, either in internal or external environment. The Ozone (O_3), Sulphur dioxide (SO_2) is the nitrogen oxides (NOx) they are gaseous materials and has toxic effect, fact related to be oxidizing agents, they are released by thermoelectric plants and reaches the airways, may cause inflammatory response in the neighboring population to the enterprise (CANÇADO et al., 2006). The National Electric Energy Agency (ANEEL) highlights what, in addition to the damage caused to human health, these gases are employees so that there is a reduction of rain pH making more acidic, which causes many negative impacts, from acidification of soil and water corrosion of metal structures.

Among the impacts to workers who work in plants, besides the local fauna and surrounding residents, stand out from the noise of the turbines and stationary engines what, on the other hand, cause gradual hearing loss (RIGOTTO, 2009). Add this a few consequences for the health and safety of workers as reported by Guida et al. (2013), with psychological distress narrations, emotional disturbances, musculoskeletal problems, gastrointestinal disorders, as well as cancer and

work accidents. In practice, Ferreira et al. (2010) in your search found irregularities in the workplace in mechanical maintenance shop of a power plant as excessive noise, deficient lighting, excessive heating and inadequate postures.

Concerning environmental impacts, deforestation is one of the important points to be discussed when it comes to environment. This problem develops by getting wood for burning. Through it follows several other factors that contribute to the ecological imbalance. The escape of animals by habitat loss, destruction of endemic vegetables and influence on the route of migratory birds.

Rigotto (2009) points out that, beyond of air pollution, the plants, in your operation, generating effluent in large scale and of difficult removal, compound of suspended solids, silica, hydroxides, between others. Points out that the sludge generated in treatment plants has strong potential polluter, since it has high concentrations of biomass and organic matter. Since then, It should be noted that the facilities of industries are at strategic points, should be close to watercourses for easy access to her appeal due to the cooling of the engines. That way, the contaminants are drawn by these bodies of water causing eutrophication and death of organisms.

Despite the difficulties encountered for handling and recovery of waste generated by thermoelectrics plants, the possibilities for these impacts are reduced. Sabedot et al. (2011), certifies that the fly ash, as well as heavy failing that, obtained by burning coal, they can be used as raw material for the cement industry, ceramic, filters, blocks and bricks, besides to its use in road paving. Another way of using ash, now from the burning of bagasse from sugarcane, it is in the production of pavers (concretes for paving), it is effective in partial replacement of fine aggregate, according the work of Martins e Altoé (2015). The compressive strength, absorption and abrasion of pavers proved satisfactory when added ashes. The above characteristics also become possible when using rice husk ash, from thermoelectric plants, in cement-based composites, considering viable and environmentally correct (TIBONI, 2007).

Fungaro e Silva (2002) they claim that the zeolite it can be produced by ash from coal after chemical treatment, this production is possible by the ash composition, which is basically composed of 50% silica (SiO_2) and 30 % of alumina (Al_2O_3). In this context, the zeolites are effective for the removal of metals and water effluents industrials, is an alternative low-cost absorber. According with Wasem et al. (2015), the synthesis of zeolites from coal bottom ash is a new technology that has been deployed by having potential for adsorption to reduce ammonia nitrogen industrial wastewater. The ashes, associated with clay, also showed favorable characteristics for mounting ceramic filters. According with Scheffer et al. (2015), as ash from a thermoelectric plant are effective in treating wastewater construction, with efficient processing for later reuse and disposal of water.

The implementation of thermoelectrics landfill becomes promising in biogas pipeline (methane gas), for the production of electric energy. The biogas from waste in landfills can reduce the use of fossil fuels, and contribute to environmentally sustainable solutions (ABREU et al., 2011). According Barbosa (2015), the management and proper waste management can present initiatives that ensure economic development and a positive

social and environmental return for the country. Abreu et al. (2009) highlights the potential of implementation in landfills, cites this fact contributed to the production of renewable energy and clean, as well as focus on the energetic matrix of renewable and clean countries, providing reducing global impacts from burning of urban solid wast: *"the proper management of waste and generating energy through waste biogas in landfills are environmentally sustainable solutions (generating clean and renewable electric energy). Besides that, the study of electric energy generation from biogas allows reducing leakage of greenhouse gases (GEE) and maximization of the methane conversion rate, accounted for in the calculation of carbon credits in the clean development mechanism".*

Galiza e Campos (2015) mention the use of urban solid waste to generate energy and highlights the importance of this process both in reducing waste in urban centers and to diversify the Brazilian energy matrix. Therefore, it provides several advantages to mitigate impacts on social and environmental. On the other hand, the use of biogas in rural networks through digesters provides higher voltage levels and financial gains for producers resulting from unused energy to spare (DALLEPIANE et al., 2015). The application of this method in rural areas prevents the emission of polluting gases in nature and, simultaneously, does not favor the greenhouse effect, and improvement the power supply in rural areas (DALLEPIANE et al., 2015).

From the standpoint of Walter et al. (2012), one of the ways to mitigate the impacts would be the use of renewable resources to replace fossil fuels. Consider that the use of rice as biomass contributes to the reduction of methane, furthermore it contributes by being a residue of the production process that would not be used for another function. On the other hand, the product will increase in price for food consumption result of increased demand for power generating process the product will increase in price for food consumption as a result of increased demand for power generating process. That way, Water et al. (2012) It proposes the use of rice husk in place of food as a source of energy what, in this case, ensure food security of the population and reduce emissions of greenhouse gases without compromising economic and social development.

The use of clean energy is also an alternative to minimize the impacts on the energetic sector. Carneiro e Cequeira (2016) highlights the expansion of wind energy and considered one of the most important energy sources. Also highlights the union of three factors that propel expansion in Brazil: good potential for wind (above all in the Northeast region), federal program and its energy auction participation.

Feitosa et al. (2014) they claim that the cost of energy for irrigation in modern agriculture is high, reached the level of 35% of total cost in irrigation, significant amount when compared to the profit of the producer. He concluded in his study that wind energy is a proposal, among the hydroelectric and thermoelectric, which has potential to reduce the costs of irrigation in rural production, presenting greater economic viability in the generation of electricity.

The health and safety of workers, monitoring noise is needed in interspersed periods, it suggests that the installed equipment is adapted to minimize the noise level or to use new technology for

machines with higher emission least noises, notwithstanding, the use of personal equipment (PPE) is essential. Workers should be informed as to the proper functioning of equipment, in addition to maintaining regularized maintenance. For Ferreira et al. (2010), the activities carried out in a power plant have risks inherent to the complexity of the process, that way, the electric sector is one the more features work accidents, showing the importance of seeking preventers measures to minimize the occurrence of these events.

Note that a range of issues related to the operation of power plants, which overcomes these problems the place where the industry is installed. Affecting everything from biodiversity to the health of workers and surrounding population, the problems are immeasurable. Direct surveys with the workers and the people involved become of paramount importance for the planning and implementation of health promotion and prevention.

For prevention, Technical studies should be performed to assess the air quality in the areas of activity of anthropogenic activities, taking into account the influence of power plants operation. The installation location of these industries should be studied in advance taking into account the proximity of urban areas and existing biodiversity, essential the Environmental Impact Study and the Environmental Impact Report (EIA – RIMA). In this context, plans for mounting thermoelectric plants cause many environmental and social impacts, may be irreversible in the future. Soon, it highlights the challenge to the environmental licensing system Country.

That way, the use of clean and renewable energy generated without aggression towards the environment and society is being encouraged and is a reality, but not accessible to all. Notwithstanding, is one of the ways to minimize the impacts of thermoelectric plants, hydroelectric and nuclear. The minigeneration of photovoltaics, with the sun, source of raw materials unlimited, is the more accessible in a matter of cost benefit for this function. Important to note that the impacts are minimal in the conversion process of the final product and its implementation is easy system.

It notes that electric energy is a commodity of essential consumption in life of society, techniques must be developed, enhanced and improved to finding ways of minor to the environment or, at least, create means to combat rampant pollution produced by power plants to generate electric energy and that considerably harm nature, especially on biodiversity.

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