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ENVIRONMENTAL LOADS ASSOCIATED WITH A POLYGENERATION SUPERSTRUCTURE FOR A TERTIARY SECTOR BUILDING

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Abstract. *The environmental impacts associated with an energy supply system are evaluated here through the Life Cycle Analysis (LCA) methodology. A superstructure is proposed to meet the energy demands (electricity, hot water, steam and cooling) of the Lauro Wanderley University Hospital, located in João Pessoa - PB. The introduction of LCA nowadays has allowed for the planning of the system that produces a service or product, and is capable of identifying opportunities to reduce environmental loads, both in the use of resources and waste scenario considered. The SimaPro® software was utilized, considering the availability of renewable energy sources (solar photovoltaic, biomass). The material composition of the equipment was considered, as well as lubricating oils and other composts used during operation, and final waste scenario (recycling, reuse or landfill). It was observed that the most polluting equipment was the diesel generator, which presented the highest CO_2 emissions. Other equipment, such as the mechanical chiller, heat exchangers and photovoltaic system, provided fewer emissions. Regarding the fuel options, electricity generated the highest emissions, while biomass promoted better results.*

Keywords: *Life Cycle Analysis, Polygeneration, Superstructure*

1. INTRODUCTION

The Lauro Wanderley University Hospital (HU) is located on campus I of the Federal University of Paraíba, in João Pessoa, and has an approximate architectural set in 44.000m² area, of which about 9,000m² are under construction (HU; EBSERH, 2013).

According to Brazilian Company of Hospital Services (EBSERH, 2013), the HU is the most important health center in the Atlantic Forest, which covers 14 cities of Paraíba, and currently has 238 beds in Unified Health System (SUS), distributed in various therapeutic wards, such as the clinical and surgical wards (CNES, 2014); Also note that only the city of João Pessoa, represents 61.24% of the population served by the first health region (EBSERH, 2013).

If we consider the latest census conducted by the Brazilian Institute of Geography and Statistics (IBGE, 2010), the population of the city of Joao Pessoa represented 723,515 inhabitants, as the census has conducted every 10 years and is making use of estimates, the population estimated for the year 2014 was 780,738 inhabitants, which represents an increase of approximately 7.91%. Parallel to population growth has also increased demand for care. In 2012, for example, the number of monthly medical visits was 9,178 and the annual reached 110,130; comparing the prediction made in 2014, the number of monthly visits rose to 21,053 and the annual reached 252,636, which means an increase of almost 130% in the number of calls in a just two years' time (EBSERH, 2013). The total percentage of consultations increased far beyond population growth, which also represents a significant increase in hospital energy consumption, and consequently in its operating expenses, which caters exclusively to the SUS.

The current Brazilian energy crisis could, eventually, compromises the care of some health care services, especially hospitals even though 46% of the country's energy matrix is generated from renewable sources (hydroelectric) this feature today inspires the attention and efforts of various governments so as not to extinguish (BEN, 2014). There is also the environmental issue directly related to the energy crisis, as energy inefficiency and waste are entirely related to the operation of the hospital, demanding power backup systems available at any time, especially in places where it processes the hospital medical-assistance.

Taking into account the abundance of sunlight in Brazil, solar energy emerges as sustainable option among the renewable energy sources availables, for application in heating water and hospital environments as well as in own generation lighting (BITENCOURT, 2006). The panels or photovoltaic modules are produced from photosensitive semiconductor devices, which capture sunlight and convert radiation into electrical energy. Although not all have access to this kind of technology, because of the cost of installation, some experimental programs conducted by CESP have enabled this integration in the public health care system, such as the adoption of photovoltaic panels held in 10 health centers located in the Valley region of the Ribeira. Thus, it was possible to perform cooling of vaccines and serum, lighting, as well as the supply of the load required for the operation of the VHF radio; as a result, it was noticed that the panels have proved very efficient in power generation (as in minimum maintenance expenses), which could facilitate its adoption in other public health facilities (FERREIRA, 1993).

According to ABNT (2015), the ISO 14040, which addresses environmental management, Life Cycle Analysis (LCA) studies the environmental aspects and potential impacts throughout a product's life (from "cradle to grave "), from acquisition of raw materials, through production, use and disposal (either disposal or recycling). Hinz et al. (2006) measures the LCA as a simple methodology that will facilitate the analysis of the environmental impacts generated by the activities of a company. With the creation of this methodology, you can check not only the prevention of pollution itself, but a reliable scheme that can help in the decision making process in order to generate the least possible environmental impact, and even compare other methods in the same analysis (HINZ *et al.*, 2006).

A good example of its application would be the adoption of life cycle analysis in buildings. LCA is an effective management tool, being able to detect the impacts to the environment at every stage of its life (from extraction of raw materials and transportation, energy consumption required to manufacture the produced materials and waste, earthmovings, water consumption and energy needed for construction and use of the building, demolition and maintenance) in order to evaluate and propose alternatives that minimize environmental burdens potentially produced. (ENERBUILCA PROJECT, 2012).

That is, the life cycle analysis can be seen from project design to delivery and even after maintenance delivery of construction. The Verdegreen Hotel, located in João Pessoa – PB, opened in December 2008 and its environmental management system (EMS) was planned in 2009 and installed in 2010; when it started to adopt environmental policy together with the life cycle of materials, which included aspects of sustainability from the building systems employees as well as the development of environmental awareness among staff and even guests, which allowed this short period of operating results fairly satisfactory, ranging from the reduction of environmental impacts and costs in own building maintenance (RAMOS, 2013).

In 2012 it was adapted to ISO 14001 and was elected by the "Brazil Guide Prize" as sustainable hotel of the year, offering inclusive the green leaf seal (which is conferred only sustainable hotels) and TripAdvisor's excellence certification making it a sustainable venture respected not only in Brazil but in the world. Among the environmental strategies adopted, it has: natural lighting throughout the social area; use only reforestation wood in construction; rainwater reuse, of sinks and showers to supply the gardens, orchards and even toilets; smart elevators; organic garden, for purposes of consumption and environmental education, as the host itself can help in the management of the garden; low consumption LED lighting; water heating by solar energy; Most vendors found less than 100 km; dual drive discharges; use of recycled and certified paper; garbage selective collect; conservation and maintenance of public garden; among others (SALGADO *et al.*, 2014)

This study will quantify the environmental impacts associated with the components of the supply of energy superstructure of a hospital. Energy resources and equipment will be assessed through technical life cycle analysis, which is the basis of the study that the future will serve as a technical reference in decision making photovoltaic deployment in Lauro Wanderley University Hospital, located in João Pessoa-PB.

2. MATERIALS AND METHODS

According to the Society of Environmental Toxicology and Chemistry, *apud* Fullana & Puig (1997), one can define the Life Cycle Analysis as a process capable of evaluating environmental burdens associated with a product, process or activity in order to identify and quantify all materials and energy necessary for it to be produced. LCA also allows find out what the possible impacts to the environment, providing an overview of the entire chain (starting from the extraction of raw materials and ends at the final disposal of waste). This analysis will be critical in the decision making process, as well as creating measures to minimize the impacts may also influence the final cost of the product, process or activity.

Starting from that point as a reference, it is clear that LCA is an important mechanism to be used in decision-making because it allows to evaluate from environmental issues (such as the polluting gases allocated to production or transportation of a product, the degrading effects that the installation of a specific activity may generate a location) to the viability of the cost. In other words, it is a very complex report that allows the evaluation of several decision parameters, which mostly include the environment, to optimize processes and materials for minimal waste possible, and therefore, the minimum possible impact.

In the face of this, the present study made use of LCA as technical and environmental assessment process to measure the environmental impact associated with the constituent elements of an energy superstructure proposal for the Lauro Wanderley University Hospital, located in João Pessoa (Paraíba).

As it is an assistance unit, where continuity and reliability of energy supply are extremely important requirements, the study proposes a superstructure (Figure 1) equipment to meet the energy demands of electricity, hot water, steam and cooling. All hardware which make the superstructure are commercially available technologies as well as energy resources necessary for their supply. In this context, it is thought the ability to improve energy generation from the hospital, with the use of conventional non-renewable sources, solar panels were inserted to generate electricity and biomass to produce heat.

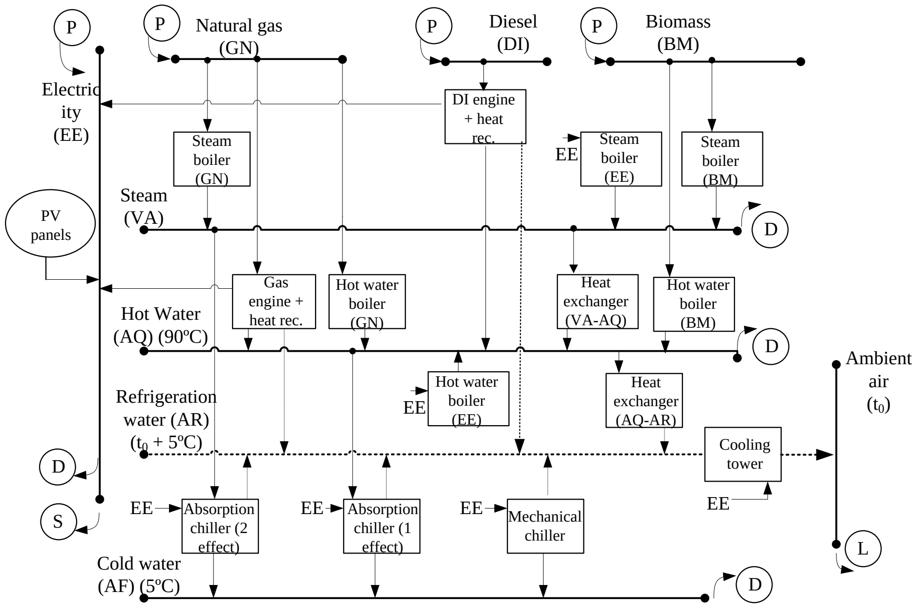

Figure 1 - Polygeneration superstructure for the hospital.

The use of biomass has grown considerably in Brazil, particularly biomass waste, waste from crops such as sugarcane, mandioca, soy, sorghum, corn and eucalyptus. The most widespread is still derived from sugarcane, largely encouraged by the government with the creation of the Incentive Program for Alternative Sources of Electric Energy (PROINFA) in 2002, from the necessity to contain the energy crises in country, stemmed from a lack of oil, coal and water (BRAZIL, 2002).

From then on, this energy resource already represents 7.6% of electricity generation in the country, second only to natural gas (11.3%) and water resources, representing 70.6% of electricity generation (EPE , 2014).

According to the IEA (2012), solar energy along with geothermal and wind power represent 0.4% of primary energy in Brazil. Although it seems little, compared to other energy sources, if we take into account the existing availability in the country, about 2,200 hours of sunshine (national average per year), representing a potential equivalent to 15 trillion MWh, which corresponds to about 50,000 times the Brazilian energy consumption (RODRIGUES, MATAJS, 2004).

Photovoltaic solar energy is characterized by the production of electric current through direct capture sunlight. This current is collected and processed by device drivers and converters which can be stored in batteries or used directly in systems connected to the grid (VILLALVA and GAZOLI, 2013). The insertion of this type in the superstructure system is mainly motivated by the use of the sun as an energy resource, to strengthen the conventional supply being suggested here the interconnected system, since, in the case of a hospital and continuity of supply must be maintained.

The Life Cycle Analysis was performed using the software SimaPro (Pré Consultants, 2015) which is a world leading program in LCA segment keeping in view its wide range of existing databases and their compliance with the recommendations of the ISO 14040 standards and 14044, dealing with the adoption of LCA in the environmental impact assessment (ABNT, 2015). In SimaPro you can analyze all processes and input and output streams on the form of inventory, engaged in any activity (COSTA, 2012).

Among the various databases available in version 8.0.3 of the Simapro the Ecoinvent (Version 3) (Ecoinvent, 2013) was chosen, bearing in order to have photovoltaic solar panels, one of the objects of analysis in this study. The Ecoinvent is considered today as the leading global provider of life cycle inventory, and this is due to the quality of the data it obtained (from studies based on industrial science) capable of generating broad and rigorous evaluations, with life cycle indicators of the materials (Ecoinvent, 2013).

The method IPCC, 2013 version, for environmental impact assessment was adopted the which express environmental impacts in kg CO_2 eq, then air emissions are quantified and multiplied by a conversion factor (IPCC, 2014). Developed by the Intergovernmental Panel on Climate Change, which lists possible climate change factors between periods of 20, 100 and 500 years, the method has a targeted approach to the problem (midpoint). With the chosen database (Ecoinvent 3), the program allows confront the characterization factors of an activity or product (in this study, the implementation of photovoltaic cells) to generated emissions.

In this context it was held the LCA of energy superstructure to the Lauro Wanderley Hospital, considering all their necessary equipment and energy resources.

To do the analysis was necessary to insert all the data relating to equipment (such as material composition and consumption), in Simapro, which caused inventories processes, as well as the very assembly of equipment and disposal (which culminated in detailing all emissions from assembly through to recycling or disposal of materials).

From there, a flowchart representing each stage of LCA from manufacturing to re-use was prepared analyze which of the equipment would be more effective among the above.

2.1. Scope of Analysis

Armed with all the necessary information about the equipment, it began compiling the inventory (key piece in LCA). Through data collection (raw material, energy, manufacturing and transportation), it became clear all inputs and outputs of resources in order to assist in the comparison process between the proposed equipment and resources.

More broadly, it can be said that the Simapro allows you to draw a schematic map of each component. This is due to the inclusion of all data concerning each (specifying materials), as well as in measuring the information required for its use (water, fuel and transportation when necessary), maintenance and final disposal.

It was felt that in some equipments for wastewater and the oil used were treated and reused and when this was not possible, they were discarded. Each equipment of the superstructure was detailed with the specification and chemical composition informed by the manufacturers. Table 1 following the considerations of the main materials of each equipment that makes up the superstructure considering a useful life of 15 years. Then, Table 2 shows the characteristics of energy sources used in the energy supply of the system.

Table 1 - Main components of the superstructure equipment

Item	Equipment	Function in superestructure	Weight (kg)	Material Composition (kg)
01	Gas Engine	Power generation, hot water and chilled water.	1,620	Low Alloy Steel = 225, cast iron = 1,300, decarbonized water user = 660, lubricating oil = 540, chrome steel plate = 75, polyvinyl chloride (PVC) = 5 (wiring)
02	Diesel Generator	Power generation and hot water, chilled water	5,118	Plate chrome steel = 375, cast iron =3,500, lubricating oil = 1,292, low alloy steel = 300, Synthetic rubber = 50, decarbonized water user = 870, polyvinyl chloride (PVC) = 20, Battery = 240, copper = 105 (for wiring). Obs.:Battery composed of: sulfuric acid = 0.250, Lead = 0.250, = 0.500 Polypropylene
03	Biomass boiler	Hot water and steam production	2,000	Chromed steel tube = 200, chrome steel = 1,780, chromed steel plate = 37.50, Copper =50, Polyvinyl chloride = 10 (for wiring).
04	Boiler electricity and natural gas	Hot water and steam production	1,630	Rock wool = 115, aluminum anodized sheet = 77.328, low alloy = 490 steel, chrome steel = 980, chrome steel plate = 37.50, Copper = 50, Polyvinyl chloride (PVC) = 10 (for electrical installation).
05	Photovoltaic System	Electricity production	4,000	Photovoltaic panel = 1,200, inverter 500 kW = 2,445, chrome steel plate = 37.50, Copper = 300, Polyvinyl chloride (PVC) = 25 (for wiring).
06	Chiller mechanical	Mechanical cold production (refrigeration)	2,536	Scroll compressors type = 120, decarbonized water by User = 4.92, rigid polyurethane foam = 30, anodized aluminum sheet = 106.43, chrome steel = 2000 Copper = 30, Polyvinyl chloride (PVC) = 10, Chapa chrome steel = 37.50 (for wiring).
07	Heat exchanger - (Steam-Water Hot)	Steam conversion in hot water	96.90	Titanium dioxide = 2, iron alloy chrome = 93.35, Epoxy Resin = 0.5
08	Heat exchanger -	Hot Conversion cooling water	78.70	Titanium dioxide = 3, iron alloy chrome = 75, Epoxy Resin = 0.5.
09	Cooling Tower	Evacuated heat not usable for the environment	3,000	Fiberglass = 2,622, cast iron= 200, copper = 10, chrome steel plate = 37.50, povinila chloride (PVC) = 10 (for wiring).
10	Cooling machine for Simple Absorption Effect	Cold water production (cooling)	9,500	Lithium bromide = 2,200 chrome steel= 7,418, chrome steel plate = 37.50, Copper = 30, Polyvinyl chloride (PVC) = 10 (for wiring).
11	Cooling machine for Double Effect Absorption	Cold water production	8,800	Lithium bromide = 1.600, chrome steel = 7,338, chrome steel plate = 37.50, Copper = 30, Polyvinyl chloride (PVC) = 10 (for wiring).

Table 2 - Energy Resources considered in the superstructure

Item	Resource	Considerations for 1 kWh
01	Natural Gas	Formed mainly by methane, ethane, propane and butane.
02	Diesel Oil	Formed mainly of carbon, hydrogen and low concentrations of sulfur, nitrogen and oxygen.
03	Biomass	Processing of sugarcane bagasse combustion to produce heat and electricity.
04	Conventional Electricity	Electricity produced by high voltage power plant: 0.4804 kWh Electricity produced by high voltage power plant: 0.4458 kWh Electricity produced by high-voltage wind farm: 0.0738 kWh Broadcast networks: 700 km Distribution Networks: 20 km

2.1.1. Gas Engine

For the gas engine was considered the remanufacturing by the manufacturer, since it provides the possibility. To make this possible, it was stipulated in the calculations of LCA shipping to import, given that the location of the manufacturer is in another country (USA), estimated distance in 8,400 km; and, over the useful life of the equipment (15 years), it was considered that the equipment would be sent back to the manufacturer for remanufactured, and the other directed to the municipal waste landfill Joao Pessoa (distance of approximately 21.4 kilometers from hospital). In this case, they considered the terrestrial transport and by ship for delivery, useful afterlife, back to the manufacturer.

2.1.2. Diesel Generator

In the case of diesel generator, it was estimated that it would be recycled by a company specializing in recycling industrial equipment located 2,700 km hospital, then, truck transportation to send to the company was considered in the analysis. As to the treatment given in addition to the waste water and oil, it was considered that the treatment also extend to waste rubber, PVC and scrap copper used in the conductors for wiring the same, as well as lead scrap batteries collected for local appropriate for your collection and disposal. And the remnant waste directed to the municipal landfill in João Pessoa, with approximate distance of 21.4 km.

2.1.3. Boilers for producing hot water and steam

In the superstructure, there are six boilers to produce steam and hot water, two biomass, two natural gas and two electricity. Material composition of equipment is almost the same and the significant change in the analysis is through fuel used in each of which will be analyzed in a future work optimization.

For boilers, it was considered recycling (PVC, copper, steel and aluminum) by a company specializing in industrial equipment, located 2,700 km in hospital. For disposal, it was considered that the waste would be directed to the municipal landfill João Pessoa, at a distance of 21.4 kilometers.

2.1.4. Photovoltaic system for the production of Electric Power

For the PV plant, it was estimated the availability of 200 photovoltaic solar panels, which occupied the corresponding area is 328m² and 100 inverters of 500kW. As the proposed system is interconnected to the electric grid, were not provided batteries for energy storage purposes.

It was considered transport both for the supply of components and for recycling (PVC waste, glass and copper and aluminum scrap), carried out by a specialized company, apart from Joao Pessoa about 2,700 km. As for the other waste that can not be reused, predicted up its focus on municipal landfill at a distance of 21.4 km.

2.1.5. Mechanical Chiller

Recycling was estimated for polyurethane waste, aluminum and PVC, as well as copper scrap, with the company responsible for transporting these materials to own recycling company (distance estimated at 2,700 kilometers); as the other waste, it was considered that would be assigned to the municipal landfill (distance 21.4 km).

2.1.6. Heat Exchangers

It was set recycling of PVC waste and scrap iron, steel and copper by a company specializing in the business (estimated distance of 2,700 km); and other waste disposed to the municipal landfill (distance 21.4 km).

2.1.7. Cooling Tower

It was considered recycling by a specialized company (distance estimated at 2,700 kilometers) for glass fiber waste and scrap steel, iron and copper; as the other waste, it stipulated that would be directed to the municipal landfill (distance 21.4 km).

2.1.8. Refrigeration machines by absorption

It was estimated the recycling by a specialized company, approximate distance in 2,700 km to PVC waste, glass and copper scrap and aluminum; other solid waste disposed in municipal landfills (approximate distance 21.4 km).

2.1.9. Energy Resources

For natural gas and diesel oil were used processes in the software database Simapro. The composition was considered in the calculation for generating 1kWh energy of each fuel.

In the case of biomass, it was used as a source the sugarcane bagasse resulting from sugar manufacturing process alcohol, ease of supply, since in the state of Paraiba are cane sugar plants.

For conventional electricity were considered every step of the Electric Power System (EPS), and Generation, Transmission and Distribution to the delivery point of the hospital. The energy matrix used was based on information obtained in Information Preliminary Operating Daily issued by the National Electric System Operator (ONS, 2014), the load and power supply in northeastern Brazil by the National Interconnected System (SIN), with reference the average percentage seen in a day of the months of January, April, July and October. In this composition were considered 48.04% of the energy produced from hydroelectric, thermoelectric 44.58% and 7.38% wind (ONS, 2014).

3. ANALYSIS OF ENVIRONMENTAL IMPACT

Table 3 shows the CO_2 equivalent emission data in kg for equipment used in the superstructure.

Table 3 – CO_2 emissions for the superstructure equipment

Equipment	kg CO_2-eq
Gas Engine	353
Diesel Generator	$6{,}98\ 10^6$
Steam boiler for the production of Biomass	$2{,}73\ 10^6$
Biomass boiler for hot water production	$2{,}73\ 10^6$
Boiler electricity for steam production	$2{,}23\ 10^6$
Boiler electricity for steam production	$2{,}23\ 10^6$
Natural gas boiler for steam production	$2{,}23\ 10^6$
Natural gas boiler for steam production	$2{,}23\ 10^6$
Heat exchanger - (Hot Water Vapor)	$1{,}50\ 10^3$
Heat exchanger - (Cooling Hot Water Water)	$1{,}47\ 10^3$
Cooling tower	$9{,}71\ 10^3$
Cooling machine by absorbing Single Acting	$3{,}25\ 10^5$
Cooling machine for Double Effect Absorption	$2{,}47\ 10^5$
Photovoltaic system	$1{,}56\ 10^6$
chiller Mechanical	$1{,}39\ 10^4$

Table 4 – CO_2 emissions for 1 kWh of energy resource consumption.

Energy Resource	kg CO_2-eq/kWh
Natural Gas	0.256
Diesel Oil	0.319
Biomass	0.147
Electricity	0.580

Among the equipment that make up the superstructure, it is observed that the diesel generator is what contributes most negatively with the emission of CO_2 into the atmosphere during its lifetime, followed by boilers used to produce steam and water hot. The fact that it was considered in the process, sending the equipment, ground transportation, and after the end of that life, for a company specializing in disposal and remanufactured industrial equipment, 2,700 km from the hospital, strongly contributed to this amount of CO_2 emissions. The photovoltaic system (Figure 1) also stands in CO_2 emissions due to its import and the use of frequency inverters. As planned disposal also by independent experts, ground transportation to disposal site is an important process in the contribution of CO_2 emissions by the system.

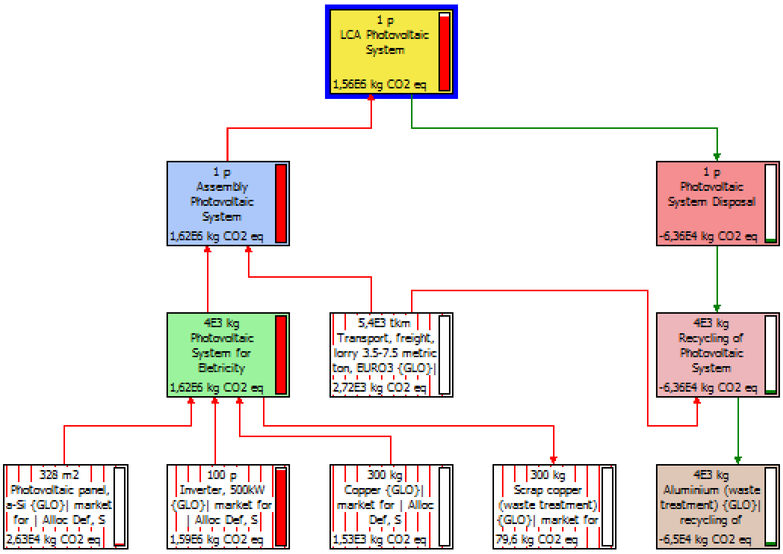

Figure 1 - Environmental Load Network of Photovoltaic System

The equipment that was positively highlights in this superstructure, according to the data reported in Table 4 is the gas engine, since the manufacturer receives the equipment back after the useful life of reuse of the same.

In the case of energy resources, the greatest amount of CO_2 emitted was the production of 1 kWh of conventional electricity as they have been considered in the process, all stages, from generation to point of consumption for the production of electricity.

Another factor analyzed on these features was the proximity of the University Hospital with Biomass plants, since the state of Paraíba has eight plants installed. By Table 4 it is clear that biomass bagasse from sugar cane was the feature that generated the least impact in terms of CO_2 emissions (0.147 kg CO_2) for each kWh, compared to other commonly used fuels such as diesel, which showed 0.319 (kg CO_2), and the very conventional electricity, which emits 0.580 kg CO_2 per kWh generated.

Also, in terms of price, biomass has more attractive price relative to other fuels, making it a great option to be subject including, enlarged, energy use of the enterprise.

When it comes to decision-making, one should not take into account only the cost of equipment or your lifetime, this is only the economic aspect, but all the benefits that will be produced during this time; this is where comes the concern for environmental issues and the resources employed in them.

The LCA proposed here aims to subsidize, through the equivalent CO_2 emissions information, the construction of an optimization design of the studied superstructure, seeking the setting equipment to have less environmental impact. In this context, it is necessary to conduct further analysis of the indicators available, since, as it is a hospital, you may want to include health indicators in the study.

4. CONCLUSIONS

Adopting more efficient, economical equipment, and generate less emissions to the environment, it should be analyzed carefully by enterprises, especially by public sectors, as reflected directly on the image that your target audience will make of the brand; besides adding value to be adopted resources.

It is clear that a device that requires more energy resources, especially a fuel with a higher consumption compared to other, more negative will be the impact on the environment. Furthermore have higher maintenance requirements, and that is designed for a certain period of use, will not always (bearing in mind that the higher the usage, the greater the wear and damage of its physical components). This is where the life-cycle approach comes as through an analysis of the various equipment possibilities (and energy resources to be adopted), are taken into account numerous factors, particularly environmental, which over the cycle life of materials will determine what equipment will be most suitable for the project.

It is a thorough and qualitative study, which, though still little spread in Brazil, is an important environmental management tool because it is able to set goals (whether for equipment, for a sector or for a whole project), which will be seen previously, and managed throughout the period determined by the company.

The measurements provided here and will be studied in detail the decision criteria inserted in an energy supply optimization model to a hospital. To achieve reduction of environmental impacts goals, first must be quantified and then make disclosure.

5. REFERENCES

ART, PSI, EPFL, ETH, EMPA. "The Ecoinvent database". 29 Nov 2014. < http://www.Ecoinvent.org/database/>.

BITENCOURT, Fábio. “Sustainable Hospitals: A utopia component or survival?”. 09 Nov 2014 < <http://sei.ipog.edu.br:8090/upload/arquivo/1460/SUSTENTABILIDADELIVROUFBA180506.pdf>.(IN PORTUGUESE)

BRASIL. Decret N°. 76593 of 14 November 1975. "Establishing the National Program of Alcohol and other measures". 05 Dec 2014 < http://www2.camara.leg.br/legin/fed/decret/1970-1979/decreto-76593-14-novembro-1975-425253-norma-pe.html> (IN PORTUGUESE)

COSTA, K. A. *The use of life cycle assessment in the decision-making process on sustainability in the construction industry in building sub-sector*. Thesis (Doctorate). Federal Fluminense University, 2012. (IN PORTUGUESE)

Brazilian Company of Hospital Services, EBSERH. “Lauro Wanderley University Hospital / UFPB: Scaling care services and educational and research management”. 08 Nov. 2014 < http://www.ebserh.mec.gov.br/images/pdf/contratos_adesao_huf/ufpb/dimensionamento_de_servicos_hulw_ufpb.pdf>. (IN PORTUGUESE)

Brazilian Company of Hospital Services, EBSERH. “Restructuring plan of the University Hospital Lauro Wanderley: Federal University of Paraíba”. 08 Nov. 2014: < http://ebserh.mec.gov.br/images/pdf/contratos_adesao_huf/ufpb/plano_de_reestruturacao_hulw_ufpb.pdf>. (IN PORTUGUESE)

Brazilian Institute of Geography and Statistics, IBGE. “Statistical profile of the city of João Pessoa-PB”. 08 Nov < http://cidades.ibge.gov.br/xtras/perfil.php?codmun=250750>.(IN PORTUGUESE)

Company Research and Energy, EPE. “National Energy Balance 2014”. 23 Nov. 2014 <https://ben.epe.gov.br/BENRelatorioSintese2014.aspx>.(IN PORTUGUESE)

FERREIRA, Maria Juliana Guerra. *Integration of photovoltaic solar energy in Brazil.* Dissertation (Master). Universidade de São Paulo, 1993. (IN PORTUGUESE)

FULANA, Pere; PUIG, Rita. Notebooks Environment: Life Cycle Analysis. *Rubes Editorial*. Barcelona, 1997.

GOEDKOOP, M.; OELE, M.; Schryver, A.; VIEIRA, M. “Pré Consultants. Simapro Database Manual”. 29 Nov 2014 < http://www.pre-sustainability.com/download/manuals/DatabaseManualMethods.pdf>.

HINZ, Roberta Tomasi Pires; VALENTINA Luiz V. Dalla; FRANCO, Ana Claudia. “Environmental sustainability of organizations through cleaner production or the Life Cycle Assessment”. 09 Nov 2014 < http://revistas.unisinos.br/index.php/estudos_tecnologicos/article/view/6078>.(IN PORTUGUESE)

Ministry of Mines and Energy, MME. "Publications and Indicators. National Energy Balance, the base year 2013”. Brasília – DF, 2014” .09 Nov 2014 https://ben.epe.gov.br/downloads/S%C3%ADntese%20do%20Relat%C3%B3rio%20Final_2014_Web.pdf>. (IN PORTUGUESE)

NBR ISO 14.040. “Environmental management - Life cycle assessment - Principles and framework”. 09 Nov 2014 < http://www.abntcatalogo.com.br/norma.aspx?ID=40200>. (IN PORTUGUESE)

ONS - National System Operator. 2014. "Daily operation Bulletin". 27 Mar 2014 Disponível em: <http://www.ons.org.br/resultados_operacao/ipdo_new.aspx>. Acesso em 27 mar 2015. (IN PORTUGUESE)

PréConsultants. 2015. SimaPro software. 13 Apr 2015 Disponível em: <www.simapro.nl>.

Projeto EnerBuiLCA. 2012. “Explanatory Life Cycle Assessment applied to the construction sector”. 13 Apr 2015 <http://www.interreg-sudoe.eu/contenido-dinamico/libreria-ficheros/EFDEB073-3C69-3AC9-41D4-0603A70E0709.pdf>

RAMOS, M. R. “Environmental management and competitive advantage: a case study in the Hotel Verdegreen”. Monograph (Graduate). State University of Paraíba, 2013. (IN PORTUGUESE)

RODRIGUES, D., MATAJS, R. 2004. “Sunbathing to Brazil. Sao Lourenco da Serra: Vitae Civilis” 13 Apr 2015 <http://www.ufsj.edu.br/portal-repositorio/File/mestradoenergia/UmBanhoDeSol.pdf>. (IN PORTUGUESE)

SALGADO, C. C. R.; COLOMBO, C. R.; AIRES, R. F. F. “Environmental management system in Verdegreen Hotel - João Pessoa / PB: A case study from the perspective of resource-based view”. 21 de Nov. 2014 <http://semead6.tempsite.ws/17semead/resultado/trabalhosPDF/879.pdf.>. (IN PORTUGUESE)

6. RESPONSIBILITY NOTICE

The authors Danielle Delgado, Cíntia Medeiros and Monica Carvalho are the only responsible for the printed material included in this paper.