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Analysis of the Carbon Emissions (Co2) Reduction in Waste Power Plants using Life Cycle Analysis

Khalifa Manshour Khalifa[1], Muhamad Haddin[2], Arief Marwanto[3]
Department of Electrical Engineering, Universitas Islam Sultan Agung, Semarang, Indonesia
e-mail: khalleefahmansour@gmail.com

Abstract

A Growth in energy demand Electricity in a city will show significant economic growth. Likewise, in the Libyan city of Sirte, economic growth per year is around 6% and with a population growth rate of around 2% per year, the city is struggling to get ahead. Thus, waste generated due to economic activities of the population also increased. While all the garbage is thrown away and not utilized. Separation of types of waste contributes to the economic potential for local governments to manage organized waste. In general, 37% of waste is disposed of in landfills, 8% of which are disposed of in organic form and put into sanitary machines that produce gas. While disposal to open areas around the world includes about 31% of waste with 19% recycled through composting and 11% burned at final disposal. The last recycled process, potentially has increased of CO emission in wasted power plant. To mitigate these situations, depth analysis of the procedure collection of the wasted power plant materials is proposed. In order to reduce carbon pollutant, life cycle analysis has been usage to measure the potential reduction of CO emission in Sirte City of Libya. The performance resuls shows that by using separation materials and life cycle analysis deployment has given significant contributions that able reducing CO emission of has reduced CO Emission. By supply of 1400 tons per day, it can be seen that the electricity production generated is 3.64 MJ which is 2.6% of the production generated from the total waste burned. With the resulting heat of 9.19 MJ, it is a total heat production of 3.7%. Of the emissions produced by the material, PVC contributed the largest contribution to pollution released from the incinerator by 57.7% compared to corrugated box / board which was only 15.2% and / or injection molding by 15.2%. By amounts of 1400 tons wasted assumption, the CO2 that can be generate based on LCA analysis is 2076.87 Kg, moreover, climate change index is equivalent to 3817.58 of CO2 (Kg). Ozon depletion has shown very wonderful grade as show -164.84, meaning that the release of CFCs into the air is significantly reduced. Low carbon index has been shown based on this results, LCA could perform best good treatment for wasted classification arranged with the LCA stage.

Keywords: *Carbon Emission, Waste Power Plants*

1. Introduction

Sirte is a city in Libya. This city is located in the north. Precisely in the District of Sirte. In 2010, the city had a population of 75,358. The city empties into the Gulf of Sidra and has a height of 28 m. Growth in energy demand Electricity in a city will show significant economic growth. Likewise in the Libyan city of Sirte, economic growth per year is around 6% and with a population growth rate of around 2% per year, the city is struggling to get ahead. Thus, waste generated due to economic activities of the population also increased. While all the garbage is thrown away and not utilized.

Waste management that has not been properly organized, has made environmental sanitation around the garbage very poor. Communal health is a major issue in regional governments and in developing countries. This is a development priority that emphasizes a sustainable global environment. Data from the World Bank states that in the Middle East and North Africa (including Libya) waste production in 2016 is 129 million tons predicted in 2030 to 177 million tons and in 2050 to 255 million tons [1].

While the projected largest pile of garbage in 2050 is estimated to be produced by East Asian countries, including China and India, which have the largest population in the world.

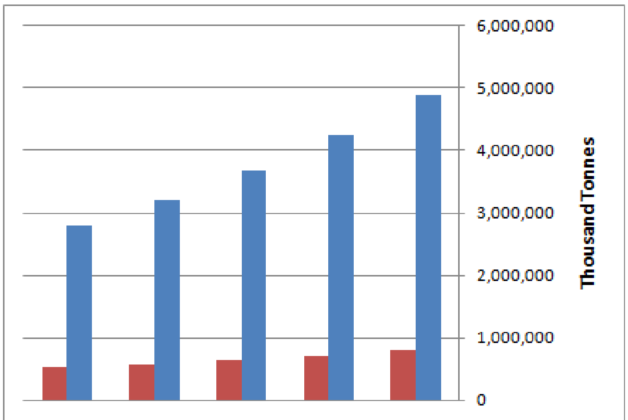
If the projected pile of garbage is not managed properly, it will have an impact on global warming and the health of the world's population. According to the World Bank, this garbage heap is the impact of rising levels of income and the welfare of people around the world. As noted in Figure 2, the World Bank states that an increase in revenue contributes to the world's garbage production which accounts for 96% [2]. Often there is a misunderstanding that states that technology is an effective solution to overcome unmanaged waste. As evidence, developed countries manage their waste and waste well so that it can minimize the impact of using waste management technology. They do not openly dispose of waste but rather manage it perfectly in some form of processed waste. Separation of types of waste contributes to the economic potential for local governments to manage organized waste. In general, 37% of waste is disposed of in landfills, 8% of which are disposed of in organic form and put into sanitary machines that produce gas. While disposal to open areas around the world includes about 31% of waste with 19% recycled through composting and 11% burned at final disposal [2].

On the other hand, the increased use of energy and the process of building energy plants also creates its own problems. Some of the problems faced are the release of greenhouse gas (GHG) emissions. Landfill gas is generated continuously by microbial action on biodegradable waste under anaerobic conditions. Methane and carbon dioxide are the main constituents of landfill gas and contribute to the greenhouse effect. This is in the spotlight because the current conditions experienced by the earth are currently at an alarming stage where mainstream energy resources are decreasing and the level of global warming effects is increasingly real [3].

Based on the studies above, to reduce CO gas emissions in wasted power plants, the Life Cycle Assessment (LCA) method is proposed for the category of environmental standard calculations. It’s aimed to calculate the potential for reducing residual CO gas emissions based on incinerator materials which refers to LCA process. The study includes estimating the potential for methane gas production with SimaPro 9.10 software and the potential for electricity production from waste in the Sirte City landfill site in Libya.

Research Backgrounds

In Libya, the amount of waste that is produced annually is 3-4 million tons. Number of wasted production in Libya 2012 - 2030 [4] and the energy converted into electricity in the Figure 1.



yaer	2012	2015	2020	2025	2030
total waste	2,789,158	3,207,532	3,688,662	4,241,961	4,878,255
Tripoli	525,746	580,949	641,949	712,563	790,945

Figure 1 The amount of Libyan waste production and the potential for Electric Energy Conversion until 2030 [4]

According to [5] Urban waste treatment technology can be categorized as follows:

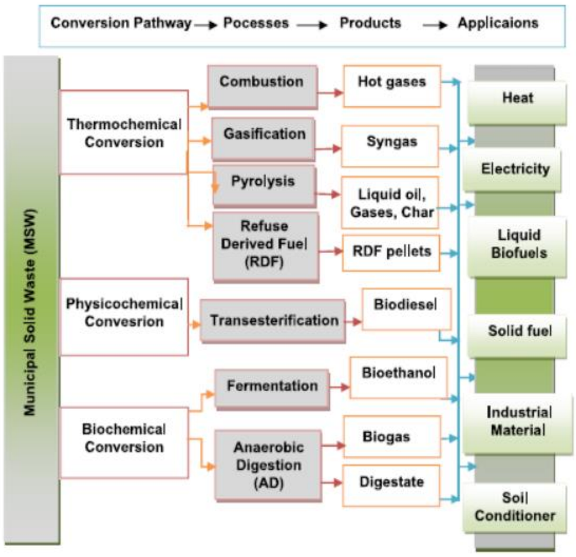


Figure 2. Waste-to-Energy Conversion Process [5]

Then according to [5] power generation potential (MW) and Net generation potential (MW) is given with the following equation:

$$Energy\ Recovery\ Potential\ \left[GW\frac{hr}{day}\right] = \left(\frac{dry\ waste\left(\frac{tones}{day}\right)*LHV\ of\ waste\left(\frac{kwhr}{kg}\right)}{1000}\right) \quad (2.1)$$

$$Power\ Generation\ Potential\ (MW) = \left(\frac{dry\ waste\left(\frac{kg}{s}\right)*LHV\ of\ waste\left(\frac{kw}{kg}\right)}{1000}\right) \quad (2.2)$$

$$Net\ Power\ Generation\ Potential\ [MW] = \eta * Power\ Generation\ Potential \quad (2.3)$$

In view of the potential waste produced by the Libyan community, the opportunity for energy conversion can be obtained from the composite of waste material showed in table 1[6]:

Table 1. Composite energy produced by waste in Libya [6]

Material	Waste composition %	Energy content (Btu/Ib)	KW h/Kg Material	KW h/Kg in Waste HHV
Paper	13.5	6800	4.39	0.58
Plastic	10	14000	9.05	0,905
Glass	2.6	0	0	0
Wood	2.8	7300	4.73	0.132
Textiles	10.8	8100	5.20	0.561
Organic	56.3	2400	1.55	0.872
Others	5.7	5200	3.36	0.191
Total energy for mass Burn with recycling scenario (KW h/kg)				1.443

The impact of global waste production has resulted in an increase in CO2 gas production in 2016 of 1.6 billion tons of glass gas emissions or 5% of total global emissions. These emissions are generated from waste disposal in open landfills and landfills without collection of landfill gas. 50%

consists of food waste and it is estimated that in 2050 glass gas emissions will be 2.39 billion CO2 equivalent if no improvements are made in the management of this waste [2].

As an illustration, the waste management process that occurs in the City of Sirte is carried out by analyzing the benefits to its residents by making the City of Bandung a reference model for waste management as done by [7]and the city of Yogyakarta [8] which analyzes the social cost of the existence of PLTSa. While the feasibility study of PLTSa has been carried out by [9] with conducting two methods about the potential that exists in the waste contained in Padang City's Cold Water Landfill. The first method is calculating a rough estimate of bio gas production, potential methane gas emissions and the potential estimation of electricity generated from potential waste in the Padang Air Cool Landfill. While the second method is project investment appraisal for the establishment of PLTSa from the results of the potential waste in the Padang Air Cold Landfill.
The potential 9 MW of electricity production from PLTSa is estimated to be produced by PLTSa from an analysis conducted by [10] using landfill technology at Muara Fajar TPA Pekanbaru. While [11] has conducted an analytical study to find out the Landfill gas production produced by the Banjarmasin Basirih Landfill to produce electricity and find out the investment needed to build a PLTSa. Likewise conducted by [12]–[16] who conducted an analysis of the potential LFG on the landfill for PLTSa generation.

Optimization Point
The fact shows that the potential use of municipal solid waste for power generation is huge, either by the Thermal method or the Landfill method [4], [6]. By identifying and measuring the potential of waste that can be used as fuel for power generation, either with landfill gas technology (LFG) or with thermal technology as an alternative source of renewable energy electricity can be done in the City of Sirte, Libya. World Bank data shows that technology management can optimize the potential energy generated by waste. Pyrolysis is another method besides LFG and Thermal, waste management will also contribute to the optimization of waste energy.

To that end, management of waste management from production to landfill must be carried out for the analysis of the potential of electric energy generated by waste. There are no researchers who make research objects about the evaluation of energy production. And the analysis of reducing CO2 carbon production in PLTSa has not received the attention of researchers, especially in Indonesia.

There are several evaluation models that can be done, one of which is the life cycle assessment (LCA) which can be applied to the LFG and Thermal models. We can analyze the potential energy loss for optimizing PLTSa. As conducted by [17] who conducted a life cycle assessment (LCA) of the process of hoarding, burning, recycling, digestion and composting in PLTSa. Policy decision making as well as strategic decisions in the waste management system are the main results of this research. Another impact is that the process can reduce the greenhouse effect. In this study, LCA is used to test the waste hierarchy and identify conditions of invalidation of the hierarchy. The results of this study indicate that the combination of plastic and paper waste can be used as PLTSa fuel while reducing the greenhouse effect. Another study was shown by [18] who conducted a life cycle cost analysis of steam turbines. With the LA-LCAA method an in-process efficiency was found in the turbine process cost of 9% on fuel costs and hidden emissions of around 12%. LCA is also used to reduce carbon emissions (CO2) to the environment as shown by [19]. Life Cycle Energy Analysis (LCEA), applied to two tourism accommodation facilities in Poole, Dorset (UK) to measure their CO2 emissions. The impact of current energy use practices in hotels is analyzed to further improve energy performance and reduce carbon emissions. LCA is also used as a model of reducing energy consumption in building facilities and buildings. By combining the analytical hierarchy process (AHP) and LCA methods, [20] has carried out energy conservation in buildings and can be used as a field assessment for energy conservation in buildings.

Thus, an evaluation of the PLTSa process can be done to find out the hidden processes in the PLTSa by [21] using the LCA method is very necessary. Furthermore, carbon emissions can be calculated to determine the potential contribution of greenhouse pollution from PLTSa to global warming.

Feasibility studies of waste into electrical energy have been carried out throughout the world, as compares in Indonesia, these research has been conducted by several students to analyze the potential and feasibility of PLTSa such as [7]–[13], [22] [14]–[16], [23]–[27]

Supriyadik [12] states that the total volume of waste piled up at the Putri Cempo TPA is around 1,014,486 tons in 2038. Assuming the annual increase in waste is 2.81%, then the assumption of the volume of waste in 2038 is around 3,069,903 tons of waste. While the PLTSa incinerator will consume 450 tons / day, then in a year the total demand is 160,200 tons. The total amount of garbage piled up in the period 2007 to 2017 was 1,014,486 tons of waste. So that with consumption of 450 tons of waste per day, the amount of waste will be exhausted within a period of 19 years. It takes 24 years to 2038 to spend the current volume of waste. Prediction results of the calculation of Electricity energy produced by PLTSa by burning rubbish at 160,200 tons / day is 8.57 MW per day, and in one year produces the potential electric power of 30,843.04 MWh. While [11] conducted an analysis of the Cost Ratio (BCR) and Internal Return Rate (IRR) on the potential PLTSa in the city of Banjarmasin, Indonesia.

The results showed the Basirih landfill has the potential for waste production from Landfill Gas (LFG) of 8,176,975 m3 per year. Electricity is sold to PT PLN (Persero) in the amount of 11,956,766 kWh. Based on the calculation, the investment cost needed to realize the waste power plant in the Basirih Landfill is Rp. 36,049,645,664. Net Present Value (NPV) = Rp. 11,852,966,356, - Pay Back Period (PBP) = 3.4 years, Break Event Point (BEP) = 9.72 years, Benefit Cost Ratio (BCR) of 1.11, and Internal Return Rate (IRR)) = 8.47%. This means that waste electricity generation is feasible to be realized. The results of the feasibility study have also been reported by [9] which shows that the investment appraisal study of the PLTSa project in Padang Air Cool Landfill. The results of calculations show the potential for LFG production of 10,405.76 tons / year, the electric power that can be generated is 3,215.67 kW and the electrical energy that can be generated is 28,169,259.47 kWh. The least cost method is used to calculate the Net Present Value of Rp. 62,709,495,336, -, the value of the Internal Rate of return is 22.22% and the value of the Benefit Cost ratio is 12.33 and the Payback Period is 1.13 years.

Potential methane gas for PLTSa was reported by [15] where until 2019 the Tangerang Rawa Kucing TPA produces an average of 194,143 tons of organic waste and has an average methane gas production of 63,999,439 m3 and is predicted to produce 34 MW of electrical energy by 2028. This calculation includes a Net Present Value (NPV) prediction parameter of Rp. 82,272,163,083 (NPV> 0), Internal Return Rate (IRR) 13.455% (IRR> 0), and a Payback Period of 8.67 Years (PP <Age economy).

Potential energy Electricity in eastern Indonesia has also been reported as a feasibility study as reported by [16] to reduce green house gas emissions (GHGs), so PLTSa is needed to reduce CO2 carbon emissions by calculating the amount of LFG from landfill. Thus the amount of LFG produced by Makbon City TPA in Sorong can be known and the potential of PLTSa Electricity production based on methane gas content is also known. The parameters that determine Electricity production are the number of tons of waste that enter the landfill each year, the size of the landfill, and the total population. The LandGEM-v302 software downloaded from the US Environmental Protection Agency (EPA) is used for LFG estimation. With the sanitary landfill model in the city of Sorong, the maximum emissions of methane gas is 7,321 x 105 m3 in 2035 if it is assumed that 2020 has started to receive waste. And the maximum potential electrical energy generated is 1,685 x 106 kWh.

While in West Java the potential for waste energy is reported by [24], [26], [28]–[31] [32]–[34] which is scattered in several places, including Bandung, Bekasi, Bogor , Banten and Sukabumi. From some of the projections submitted, the total potential for waste in West Java generates more than 1000 MWh of electricity. This can be an alternative for the development of new renewable energy potential that can support the availability of electricity in Java while reducing CO2 carbon emissions.

The life cycle analysis (LCA) model has been widely used in industry and energy audits, one of the LCA models applied to ocean wave based energy conversion [30], [31] which uses analysis of the use of LCA and CO2 emissions associated with the first generation of Pelamis converters. The results showed that at 293 kJ / kWh and 22.8 gCO2 / kWh the energy and carbon intensity were each comparable to large wind turbines and relatively very low compared to fossil fuel generation. The energy payback period is around 20 months and the CO2 return is around 13 months. The LCA analysis shows that the results of the analysis of material use were identified as the main contributors to energy and carbon which were realized by delivery (including maintenance) by contributing 42%. Optimization of performance in the Pelamis environment can be achieved by increasing structural efficiency, replacing some steel structures with alternative materials, especially concrete, and using fuel-efficient shipping.

The LCA model [35] applied to the PLTSa analysis consists of 4 frameworks namely (1) scope and objectives (2) Inventory analysis (3) Impact of the assessment and (4) interpretation. In line with [36] who conducted an LCA analysis on biofuels energy, this application is to find a sustainable renewable energy source that includes 3 elements, namely (1) economy, (2) environment and (3) social.

Air pollution is caused by the influence of pollutants into the air such as SO2, CO, hydrocarbon (HC), NO2, photochemical oxidants. Pb, Ozone and volatile organic compounds (VoC). Apart from air pollution, greenhouse gases also play a role in the absorption of infrared radiation which determines the temperature of the atmosphere. These greenhouse gases are caused by human activities and natural activities that occur on the earth's surface by absorbing and re-emitting infrared radiation into the atmosphere. Some parts of the sun's radiation in the form of short waves are received at the earth's surface and re-emitted in the form of long waves into the atmosphere, so that the suspended radiation will cause the greenhouse effect [36]–[39].

Greenhouse gases can be calculated from biological waste processing by referring to the following equation [40]:

$$\mathrm{CH_4\ Emission} = \sum(((Mi\ x\ EF) * 10^{-3}) - R\ x\ GWP) \quad (2.4)$$

$$CO_2\ \mathrm{Emission} = \sum(((Mi\ x\ EF) * 10^{-3}) - R\ x\ GWP) \quad (2.5)$$

Where:

Mi = Gas Mass (Gg/year)
EF = emission gas Factor (g); EF CH4 = 4 g CH4/kg; EF CO2 = 0,90 g CO2/kg.
R = Number of gas that can be recovered
GWP = Global Warming Potential

Life Cycle Assessment LCA

Life Cycle Assessment (LCA) is a technique used to assess the environmental impact associated with a product. The first stage in LCA is compiling and inventorying the inputs and outputs related to the product to be produced [41]. LCA is a "cradle-to grave" approach to assessing industrial systems. "Cradle-to-grave" begins with the collection of raw materials from the earth to create a product and ends at the point when all the materials are returned to the earth. LCA allows estimation of the cumulative environmental impact resulting from all stages in the product life cycle, so it will be known which part has the greatest impact on the environment [42].

After knowing the critical impact of all activities on the environment, several alternative improvements will be obtained for each activity in the supply chain. The improvement alternatives proposed for each chain can be used as a basis for making alternatives to the existing life cycle so that a supply chain is obtained that is in accordance with the green supply chain management concept [43].

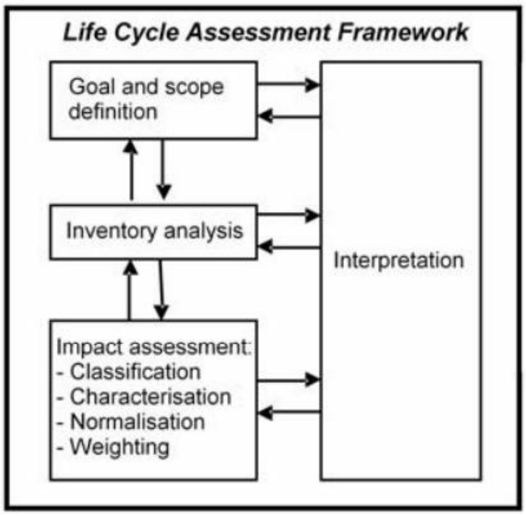


Figure 3. Life cycle assessment framework [36]

Figure 3 show the life cycle assessment framework. High and temporal variation of data on the characteristics of the data collected in this Biofuels study. The sustainability of renewable energy sources depends on these 3 pillars, the existing constraints on the socio-economic side, and the environment will reduce the potential of the energy produced. Thus LCA can be used effectively to assess the sustainability of renewable energy sources [35], [44]. The focus of research on bio-energy received serious attention by [44] with the adoption of LCAs involving agricultural chains. Issues of direct or indirect land use change. Furthermore, the implication of applying the assessment is that the biomass feedstock is produced through an agricultural system which is the case for LCA. Agricultural land use has been indicated as a major contributor to GHG emissions in the bioenergy life cycle chain.

2. Method

In this section, it is explained the results of research and at the same time is given the comprehensive discussion. Results can be presented in figures, graphs, tables and others that make the reader understand easily [2], [5]. This methodology has been shown on figure 4.

The incineration process from waste to electricity is based on a process consisting of [45] describes as follows:

1. Garbage is transported from the Waste Disposal Site (TPS) by garbage truck to wasted plant.
2. Waste separation is carried out to obtain good heat (thermal) as boiler fuel, so that optimization of the generator can be carried out. At this stage, the plastic, paper and metal waste are separated according to the procedure in the LCA
3. Garbage, which is ready to be burned, will be transported to the incinerator. Garbage from these trucks will be put into the incinerator bit by bit, incinerating waste at high temperatures, namely (850ºC - 950 ºC)[45]. In order to get perfect combustion, it is necessary to add fuel in the initial combustion to trigger combustion so that the combustion temperature is reached.
4. The hot gas produced from burning waste will be used to heat water in boiler pipes.
5. High temperature and high pressure steam from the boiler is fed to the turbine, steam flows from the nozzle through the blade so that the turbine rotates and is connected to the electric generator.
6. After the heat has been used to generate gas vapor, the combustion products will be streamed to the exhaust gas processor so that acid gases such as HCl, Nox, Sox, dioxins, and heavy metals are lost.

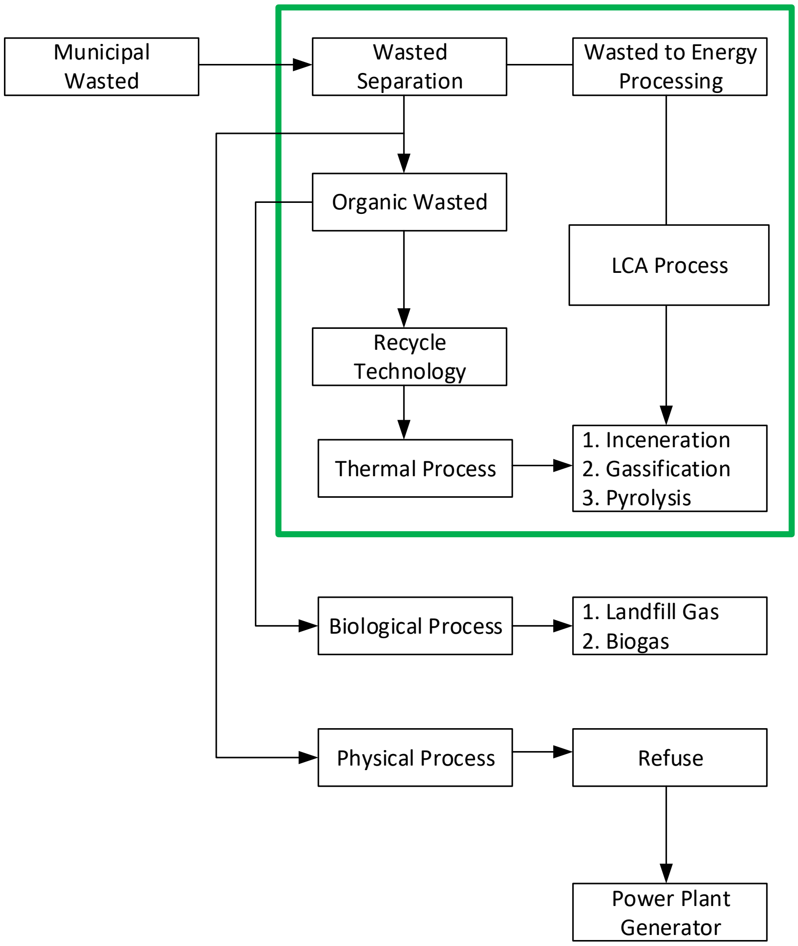


Figure 4. Method

The data obtained from the volume of waste transported by the Sirte City Garbage an average of 1756 ton/day. After knowing the volume of waste, the assumption of calorie value is determined Libya waste of 1000-2000 kcal [6]. With these Calorie Value, then taken the mean calorific value of 1500 kcal. Moreover, looking for the number energy per day is the product of the number of calories times the average number of calories which is equal to 0.00116 kWh / kcal [17]. In the process of calculating this research apply the formula as described in equations (3.1) to (3.3)

To find the number of calories that supplies the boiler, equation (3.1) is used

$$k\text{Calori} \; / \; \textbf{day = Wasted Volume × value of wasted calories} \qquad (1)$$

After getting the calorie results, then the amount of energy (kWh/day) is calculated, which is which multiplied by the caloric value that has been determined, by equation (2)

$$Per \; \textbf{day = Number of Calories} \; (kkal \; / \; \textbf{day}) \times \textbf{0.00116} \; (kwh \; / \; kkal) \quad (2)$$

Calculating the amount of thermal waste entering the boiler, so that WPP operates continuously continuous 24 hours shown in equation (3.3)

$$\textbf{Number of } Thermal = \textbf{Number of } Energy \; (kwh \; / \; \textbf{day}) \; \textbf{Number of Hours / Day} \quad (3)$$

The power generated by WPP is highly dependent on the amount of waste volume, the amount of waste generated in the city of Sirte, the energy supply tha inside the boiler, and the efficiency of the tool system at WPP, so to determine the capacity of WPP, it is necessary to calculate the total volume of wasted, measurements the energy inside the boiler. In general, the power generated WPP fulfills the equation in (3.4)

$$P = W \times \eta_{boiler} \times \eta_{turbine} \times \eta_{generator} \quad \textbf{(4)}$$

After getting the amount of thermal waste that inside the boiler. The output power in the boiler with the assumed boiler efficiency and apply the formula described in equation (5)

$$Pb = W \times \eta_{boiler} \quad \textbf{(5)}$$

After getting the output power on the boiler. The output power in the turbine with the assumed turbine efficiency. This process applies the formula described in equation (6)

$$P_{turbine} = P_{boiler} \times \eta_{turbine} \quad \textbf{(6)}$$

Moreover, the output power in the turbine has been provide. The output power of the generator with the assumed generator efficiency will reach it. This process implements formula described in equation (3.7)

$$P_{generator} = P_{turbine} \times \eta_{generator} \quad \textbf{(7)}$$

with:

W : Electrical Energy (J)
η_{boiler} : Boiler Efficiency
$P_{generator}$: Generator Output Power (W)
$\eta_{turbine}$: Turbine Efficiency
P_{boiler} : Boiler Output Power (kW)
$\eta_{generator}$: Generator Efficiency
$P_{turbine}$: Turbine Output Power (kW)

The calculation of the generator output power (kW), the electrical energy can be generated by applying equation (8)

$$W = P\ x\ t \quad \textbf{(8)}$$

by:

W: electrical energy (kWh)
P: output power in generator (kW)
Q: 24 hours

The capacity of inceneration has led to the potential to fuel WPP. It is requires an hourly incinerator capacity. In order to continue operating of the incenerator, the feed will be calculated on average the volume of waste per year [19]. Calculating the incinerator capacity by using equation:

$$Q = VT \quad \textbf{(9)}$$

where:

Q = Capacity (ton / hour)
V = Waste Volume
t = Time (hour / minute / second)

In the LCA model, waste sorting becomes a model that is proposed so that the incinerator combustion process produces perfect heat such as corrugated, PVC plastic and metal materials.

In order for the caloric value to be stable, it requires a minimum volume of waste per day of around 1400 tons totally per day or more than 6500000 tons per year [12].

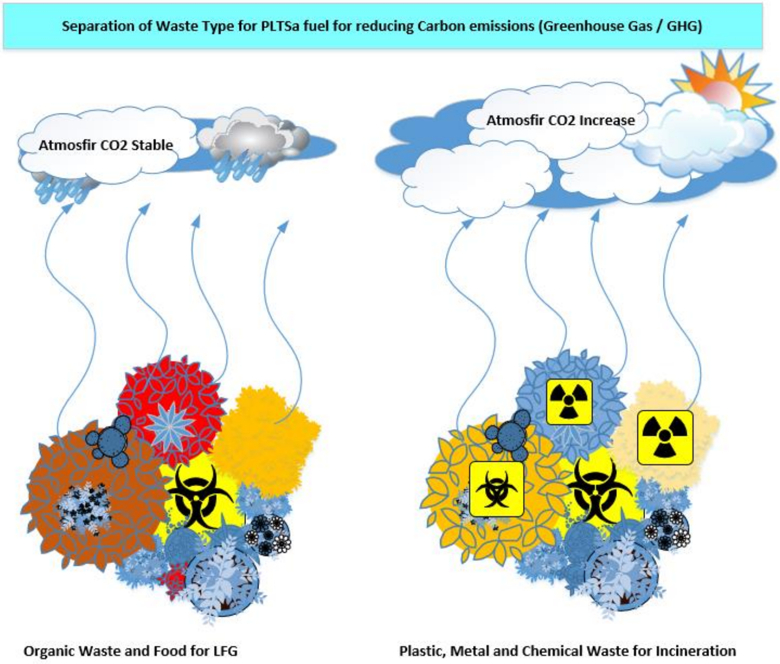


Figure 5. Waste Separation Model for PLTSa

In this study only waste in the form of corrugated, PVC and aluminum are proposed for use in the incinerator that be shown in figure 5. The impact of selecting this material will be examined on the environment as well as CO emissions and the power generated by the WPP.

Research Model Systems

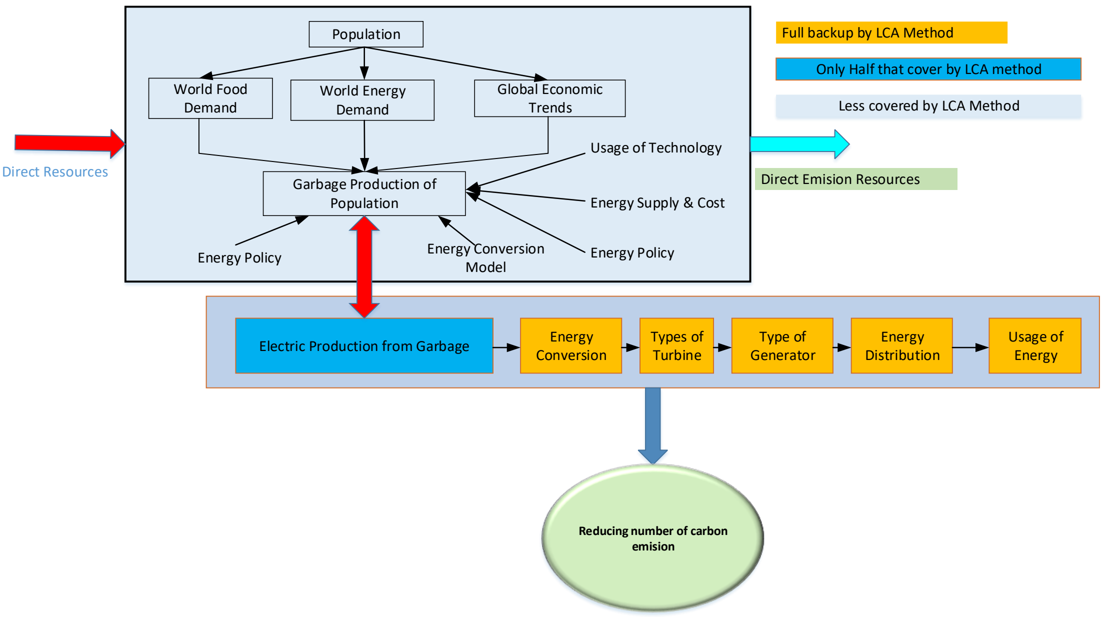


Figure 6. Direct and indirect effects of the PLTSa Carbon Audit system (modification of [32]).

This study will refer to a model approach in figure 6 to the impact of environmental impacts due to pollutant emissions and resource consumption on the system that works on the WPP. Ecological Scarcity Model - 2013 will be used in this study using SIMAPRO 8.3 software.

The first stage is to carry out an inventory that includes data collection, calculation of input and output to the environment from the system being evaluated. This stage takes an inventory of resource use, energy use and release to the environment associated with the system being evaluated.

The next stage is a life cycle impact assessment, which deals with the impact on the environment, all impacts of resource use and resulting carbon emissions will be grouped and quantized in a certain amount. After that it is given weight according to the level of importance. At this stage, characterization, normalization, weight and single score will be carried out.

At the characterization stage all inputs and outputs will be contributed according to the impact determined in the previous stage. Whereas the normalization stage is the impact stage which has been assessed to be compared and simplified on the basis of the same measure. The aim is to get the same comparison for each impact category so as to facilitate further interpretation. In the next stage, all impacts that occur will be weighted and accumulated as a total score. Meanwhile, the last stage is a single score which shows each production process that has an impact on the environment around the WPP

3. Results and Analysis

In this chapter, an analysis of the results is discussed. According to the Europe Emission standard, some parameters are applied in this measurement. In wasted-power plants, materials that impacted to the performance incinerator gas turbine has been experiences, such as CO2, CH4, N2O, NH3, SO4, PO2, etc. Table 4.1 has shown the performance of impact vector of materials that are composing of wasted-power plant in Sirte-City of Libya
LCA Process for CO emission reduction in wasted power plants in Sirte City of Libya

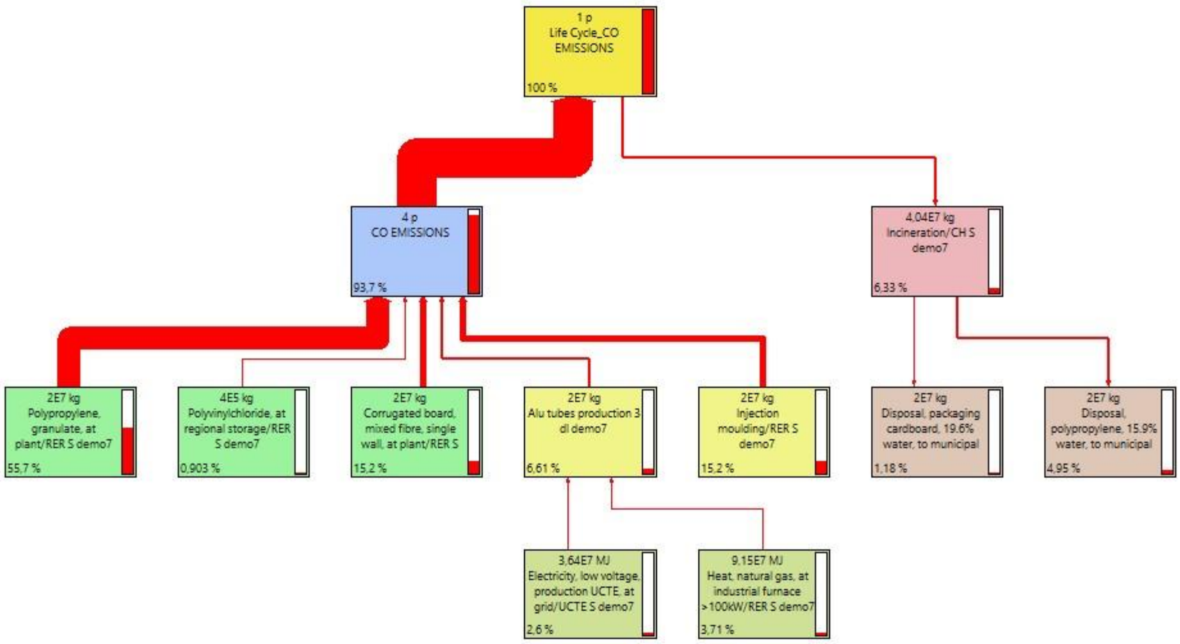


Figure 7 Waste power plant of Sirte City Libya model using LCA systems

Table 2 Inventory Emission Analysis and Impact Vector of the Materials of Wasted-Power Plants in Libya with amounts of 1400 tons wasted

	Inventory of emissions (g)		Impact vector (h)

Fossil energy (GJ)	-1.59	climate change (kg CO2 eq)	**3817.58**
CO2 kg	2076.87	ozone depletion (kg CFC-11 eq)	**-164.84**
Ammonium, ion, water (kg)	0.00	agricultural land occupation (m2a)	451128.72
PM2.5 (kg)	0.00	fossil depletion (kg oil eq)	-37.74

Refre to table 2, by amounts of 1400 tons wasted assumption, the CO_2 that can be generate based on LCA analysis is 2076.87 Kg, moreover, climate change index is equivalent to 3817.58 of CO2 (Kg). Ozon depletion has shown very wonderful grade as show -164.84, meaning that the release of CFCs into the air is significantly reduced. Low carbon index has been shown based on this results, LCA could perform best good treatment for wasted classification arranged with the LCA stage. With a total land area of 45 hectares are needed, energy generated by waste can be optimized.

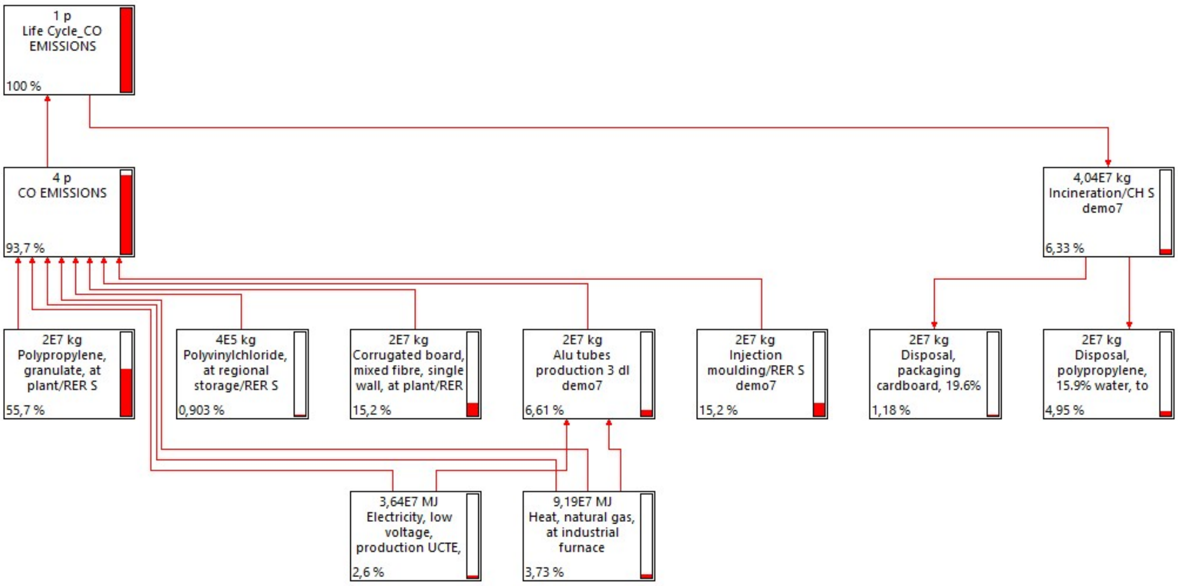


Figure 8. Sorting process of wasted materials of optimalization electricity production to reduce CO emissions

Figure 8 shows the CO emission life cycle of the fuel used in the incinerator, with a supply of 1400 tons per day. It can be seen that the electricity production generated is 3.64 MJ which is 2.6% of the production generated from the total waste burned. With the resulting heat of 9.19 MJ, it is a total heat production of 3.7%. Of the emissions produced by the material, PVC contributed the largest contribution to pollution released from the incinerator by 57.7% compared to corrugated box / board which was only 15.2% and / or injection molding by 15.2%.

There're some elements of wasted materials that can be used such as plactics, PVC, corrugated board and some of chemical materials and aluminium thins materials. The material is proposed to perform some scenarios, the first scenario only used poly PVC materials, the second scenario is corrugated board materials and third scenario using injection moulding dan alumunium tubes and fourth scenario is disposal packaging and polipropylene. Figure 4.6 has shown the scenario results. The 2nd scenario dan 4th scenario has show significant reduced of carbon emission standard.

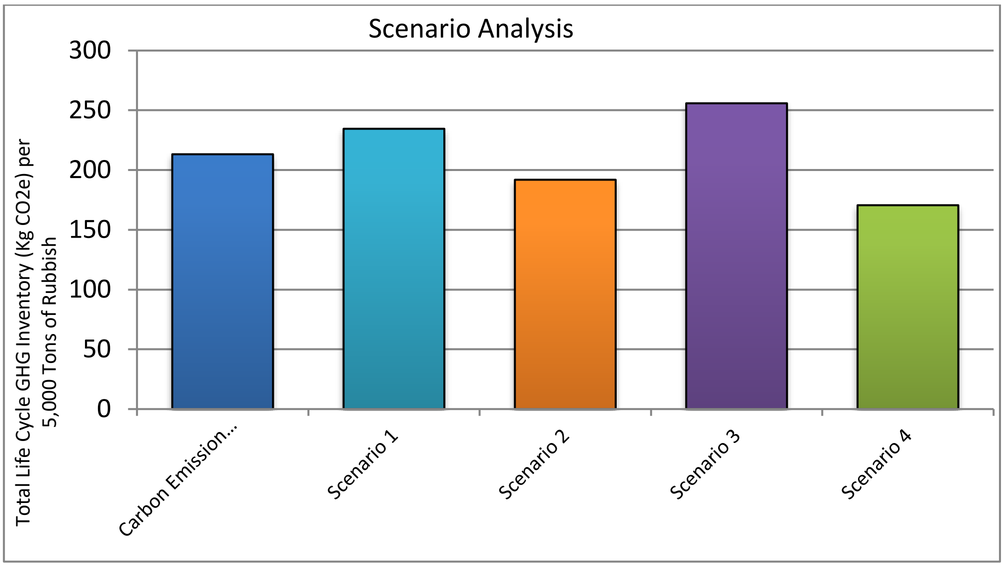


Figure 9. Scenario impact of carbon emission of 5000 tons of rubbish using LCA.

1. CHARACTERIZATION

A. CO EMISSIONS IMPACT:

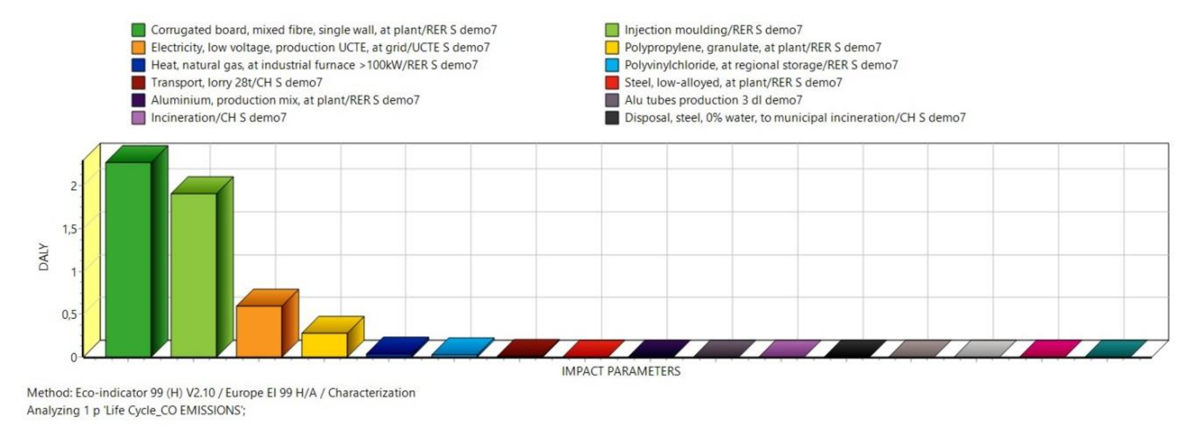


Figure 10. Daily CO emission impact of the whole materials of the rubbish

Figure 9,10 and 11 show that corrugated and injection moulding has play important role of CO emission. While other materials do not contribute significantly to co emission.

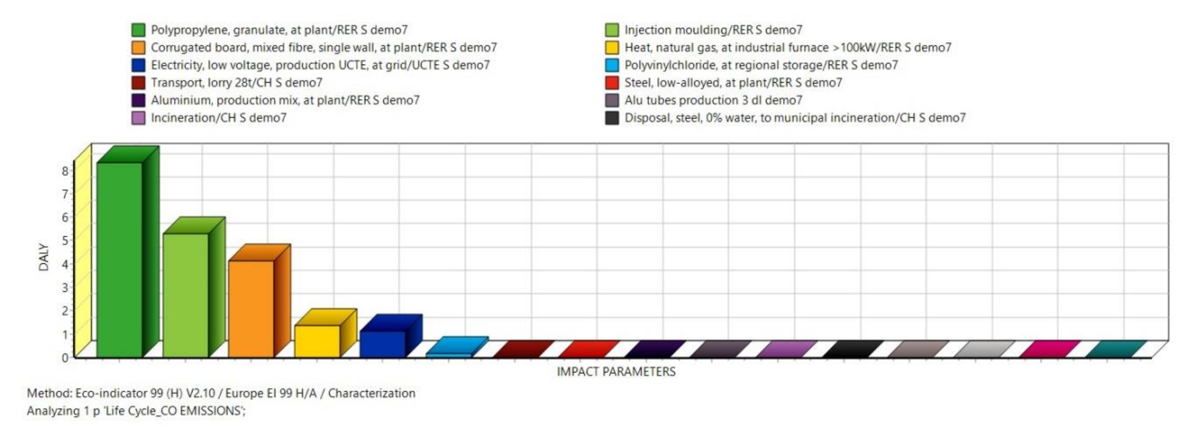


Figure 11. Impact of the carsinogen to the environment

Polypropylene and corrugated materials has contribute to the carsinogen part to the environment, but less than the use of waste materials as a whole. Significant reducing carsinogen has shows by deploying of LCA systems in the WPP.

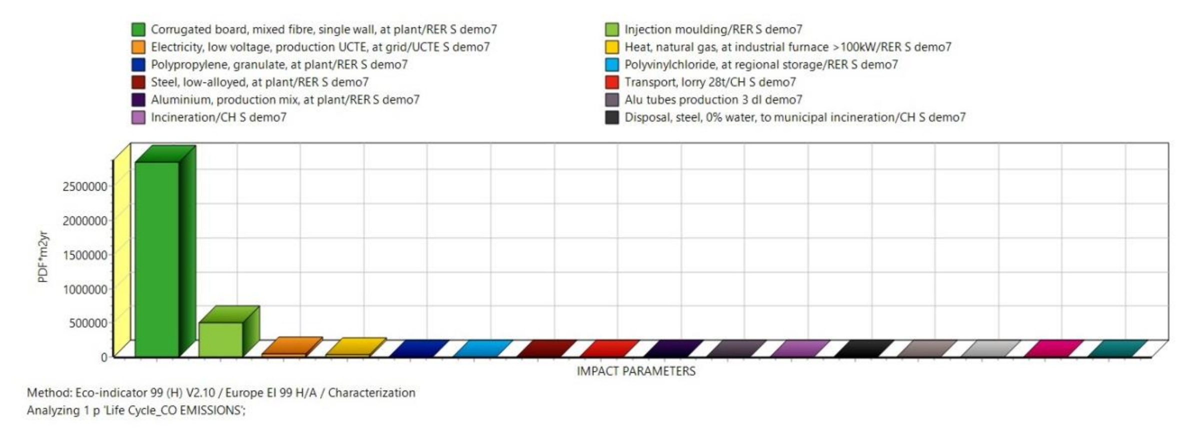


Figure 12. Characterization of Fossil fuel impact of the WPP using LCA Analysis

Figure 4.10 shows that corrugated board and injection moulding has contribute large impact of fossil pollution. However, less than the standard if using the whole waste materials.

INCENERATOR IMPACT:

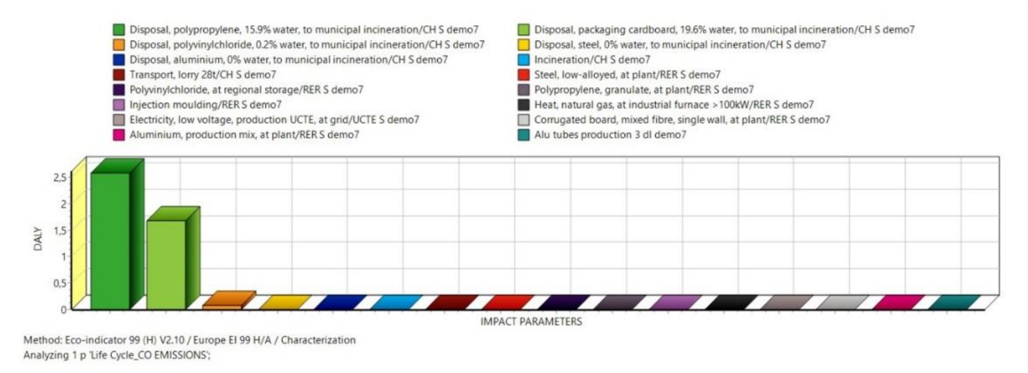


Figure 13. incenerator impact of waste materials in LCA environment

Figure 13 shows that packaging and PVC has given significant contribution to the incenerator performance. These material contribute high level degree of heating transfer to the bolier which able to conduct generator. Thus, the optimization of electricity production can be achieved by implementing an LCA environment.

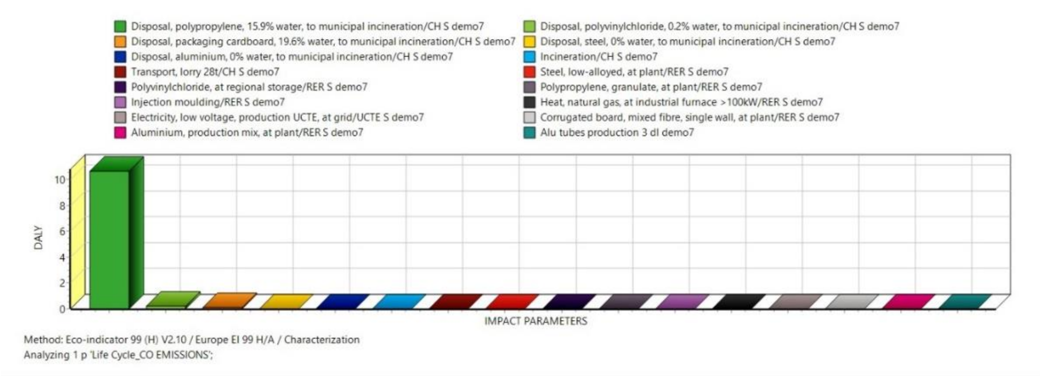


Figure 14. Carsinogen impact of waste materials in LCA environment

Disposal PVC has shown the big impact of carsinogen when WPP used this materials as shown in Figure 14. can be seen that incenerator reactor could produce harmful pollutan whenever PVC is used. Therefore, avoiding this material contribute less impact to the environment.

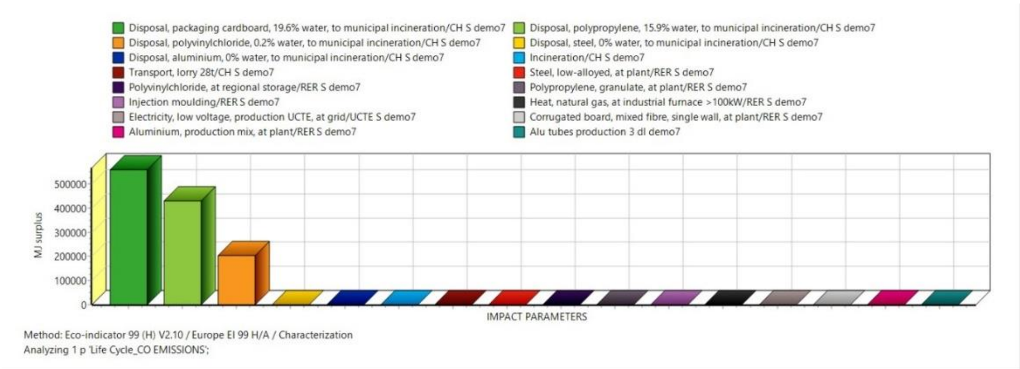


Figure 15. Climate change impact of waste materials in LCA environment

Municipal disposal of incenerator also given high impact to climate change, 19,6 % has contribute to the pollutant impact while PVC has contribute 15,9%. It is indicates that sorting and selection of materials able to conduct impact of the incenerator production and less climate change.

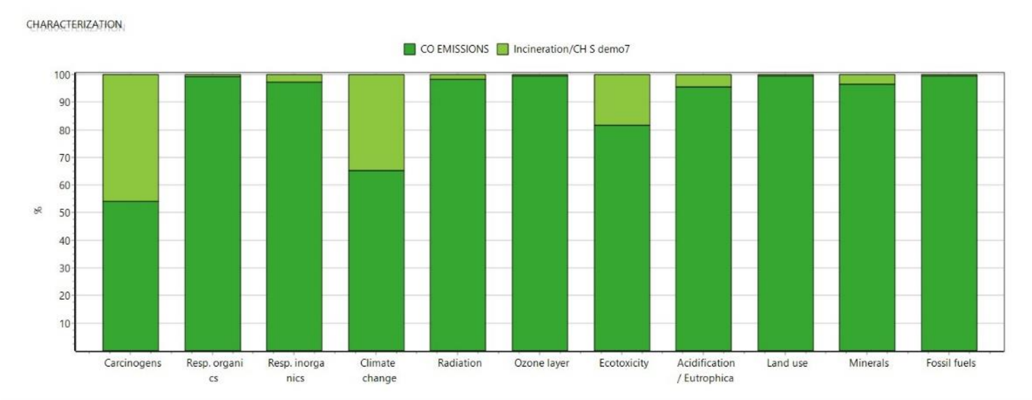


Figure 16 Impact Assessment of the WPP using LCA Systems

All performance can be summarized in Figure 4.15. starting from carsinogen has reduce to 50%, climate change also reduce to 60%, ozone depletion reach of 98% and fossil fuels impact to 100%.

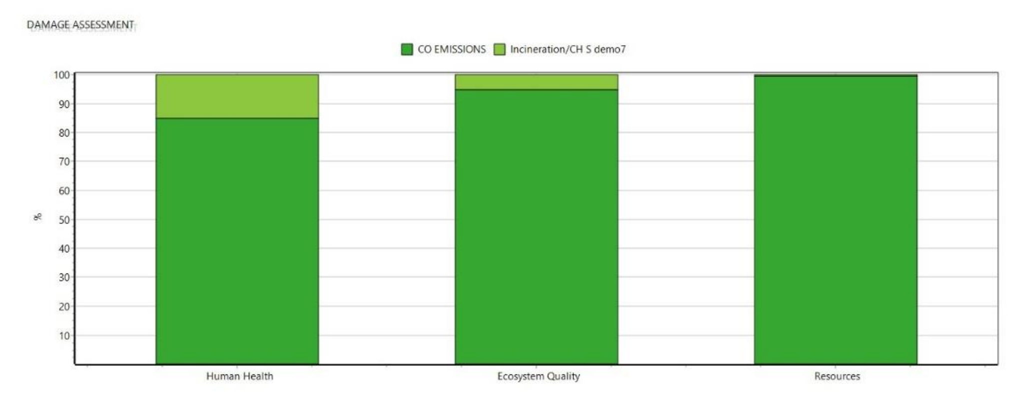


Figure 17. Damage Asessment of CO emission of WPP using LCA system models

Figure 4.16 show the damage assessment impact to the human health of the proposed model using LCA systems. In human health impact, CO emission has reduce to 80% and incenerator impact reduce to 20%. This result shows that the potential use of the LCA system in WPP can reduce health hazards to humans in addition to optimizing the production of electrical energy.

4. Conclusion

An analysis of the separately of wasted material by following LCA procedure has reduced CO Emission. By supply of 1400 tons per day, it can be seen that the electricity production generated is 3.64 MJ which is 2.6% of the production generated from the total waste burned. With the resulting heat of 9.19 MJ, it is a total heat production of 3.7%. Of the emissions produced by the material, PVC contributed the largest contribution to pollution released from the incinerator by 57.7% compared to corrugated box / board which was only 15.2% and / or injection molding by 15.2%. By amounts of 1400 tons wasted assumption, the CO_2 that can be generate based on LCA analysis is 2076.87 Kg, moreover, climate change index is equivalent to 3817.58 of CO2 (Kg). Ozon depletion has shown very wonderful grade as show -164.84, meaning that the release of CFCs into the air is significantly reduced. Low carbon index has been shown based on this results, LCA could perform best good treatment for wasted classification arranged with the LCA stage.

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