Cost and Environmental Impact Analysis of Waste Oil Utilization in Coal Mining Industry: A Case Study of PT Berau Coal

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ABSTRACT

PT Berau Coal, as a company engaged in the energy sector for coal commodities, contributes to global energy supply. One of the efforts of PT Berau Coal in maintaining environmental compliance is implementing the 3R waste oil utilization as a blending agent for blasting activities in the mining process. This improvement project provides multiple benefits to the company especially in terms of financial and environmental aspects. This research calculates the gap defined as the loss of opportunity that occurred in the 2015-2020 period and provides the optimization scenario for the utilization of waste oil in the 2021-2025 period to create the optimal impact on cost efficiency and environmental impact. The research scope and methodology are viewed from the financial aspect with the capital budgeting concept approach and environmental aspects through the Proper concept approach and carbon pricing to monetization of carbon emission reduction benefits. The results show that the optimum impact of optimization of waste oil on cost efficiency is IDR 38,049.63 Mio. The optimum contribution of reducing energy consumption intensity and GHG emission intensity increased by 0.62% and 0.04% from the achievement with exiting performance. In conclusion, waste oil utilization provides optimum multiple impact by 100% composition implementation.

Keywords: waste oil utilization, capital budgeting, energy and emission intensity, monetization of carbon emissions.

1. INTRODUCTION

1.1. Background

Coal plays an important role in meeting global energy needs and is crucial for infrastructure development – 38% of the world's electricity and 71% of the world's steel is produced using coal. Indonesia is one of the world's top coal exporters. The large quantity of Indonesia's coal exports is not proportional to the percentage of coal reserves owned by Indonesia to the percentage of world coal reserves. Of the total 891 billion tons of world coal reserves, Indonesia has around 30 billion tons of coal reserves, which is around 3.1% of world coal reserves (BP Statistical Review, 2016).

From an environmental perspective, Indonesia was the fourth largest emitter of greenhouse gases in the world in 2015. Indonesia's economy is the 16th largest in the world and the largest in Southeast Asia. The highest source of emissions comes from deforestation and peat forest fires, followed by emissions from burning fossil fuels for energy.

From the information above, it can be seen that the world coal trade continues to develop. Trade competition for coal commodities is very competitive, including Indonesia is involved in it. Accuracy in implementing the cost leadership strategy is one of the keys to strengthening the position and competitiveness in the market, one of the forms can be in the form of cost efficiency, branding commitment to compliance with environmental management and minimizing environmental pollution.

This increase in coal production demands the addition of mining operational equipment. In most coal mining industries, the mining method commonly used is the conventional method, one of which is characterized by the use of heavy equipment to dig, transport, and support various other mining activities. Most of the equipment used for its operation still relies on fuel oil and various types of oil and lubricants. According to Ruhe (1999) fuel used as a material for making ANFO can be mixed with used oil so that it can reduce the use of fuel. According to SNI Number 7642 (2010) a mixture of used oil with diesel can be done with a maximum ratio of 80%:20%.

Based on the Good Mining Practice concept there is an opportunity to reduce the environmental impact of mining business activities through the design and operation of processing plants that can reduce toxic waste, or to recycle or reuse waste through cleaner production initiatives and industrial ecological initiatives. Hazardous and Toxic waste utilization activities including the use of used oil as a substitute for diesel fuel in mixing explosives have benefits for the environment, economy, and social. This step is one of PT Berau Coal's efforts to get multiple benefits to reduce the impact on environmental pollution while increasing cost efficiency as a form of commitment to the implementation of Good Mining Practice principles.

In the coal mining industry, overburden stripping is the initial activity before coal getting. There are several ways to remove overburden, including digging, ripping, and blasting. At PT Berau Coal, the method used for overburden stripping is the blasting method. Blasting method was chosen because PT Berau Coal has relatively hard rock characteristics in overburden.

The large volume of OB material will be directly proportional to the amount of explosives used to disperse the OB material. Blasting activities at PT Berau Coal use 3 types of explosives, namely emulsion, ANFO and gel. ANFO itself stands for Ammonium Nitrate Fuel Oil with a mixture ratio of AN and FO of 94.3%:5.7%. This comparison can produce zero oxygen balance where the blasting product will not release poison / fumes because of the excess of one of the blasting materials.

Figure 1.1. Drilling and Blasting Activities at PT Berau Coal

Drilling and blasting activities at Figure 1.1, The five stages are:

- Preparation and hole marking, is the activity of preparing the drilling area for blasting and marking drill points in accordance with the blasting design.
- Drilling, is drilling activity for blasting in accordance with predetermined points.
- Hole sounding, is the activity of measuring the depth of the hole to calculate the need for explosives and stemming for each hole.
- Charging and stemming and tiep up, are a series of activities carried out after each sounding hole has been completed. Charging, is the activity of inserting explosives into the hole at a certain amount. As shown in Figure 1.1, one of the mixers of explosives is fuel oil. At PT Berau Coal, the role of fuel oil is partially / completely replaced by waste oil as one of the company's commitments in making efficient use of fuel oil. The efficient use of fuel oil contributes to the efficiency of operational costs and has a positive impact on the environment by reducing the intensity of energy consumption and emissions. Stemming, is an activity carried out after charging, namely closing the holes at a certain amount with aggregate / similar materials.
- Tie up, is the process of connecting inter connections between the blast holes so that they are centralized to a single initiator called a blasting machine.

An overview of the mixing process of ANFO and emulsion can be seen in Appendix 3.

1.2. Problem Statement

PT Berau Coal has obtained permits for the use of waste oil as a substitute for fuel oil as a mixing of explosives up to a composition at a composition of 50% in 2016, 50-100% in 2019, and the process of applying for a utilization permit up to a composition of 100% in all types of explosives used (there are at least 3 types of explosives so far used at PT

Berau Coal, ANFO type, type emulsions, and type of watergel with the portion of mixing of fuel oil will range from 1% - 6%). Until now in 2020, PT Berau Coal is only able to realize the use of waste oil as a maximum explosive mixing at a 50% portion only on the type of emulsion explosives with a level of consistency that is not optimal. In terms of business and ethics, PT Berau Coal has lost the opportunity of a gap between the existing waste oil utilization permit and the actual implementation. Various obstacles are faced, both technically, administratively, and managerially so that the continuous improvement in this project tends to be stagnant. Therefore, it is necessary to identify the impact on costs and the environment from the optimization scenario of the utilization of oil waste as a substitute for fuel oil as an explosive mixer up to a maximum of 100% according to the available permit space. The results of this study aim to encourage management to direct policies that are in line with the value of sustainable improvement in this case related to the utilization of oil waste as an explosive mixer so that it can provide an optimal impact both for PT Berau Coal and the environment. The most important thing is the commitment of PT Berau Coal in developing policies oriented to sustainable improvement that will provide a positive atmosphere in encouraging all lines to take part in giving the best for the company at various project scales.

1.3. Research Questions

The problem identification process of this research is approached by answering following questions:

1. Has the waste oil utilization as explosive mixing had the optimal impact on costs and the environment in 2015-2020?
2. What is the potential impact on costs and the environment if the waste oil utilization as the explosive mixer is optimized in 2021-2025?
3. What is the profile of the integration of the potential impact on cost and environment from the realization of proposed optimizing scenarios of waste oil utilization as the explosive mixing in 2021-2025?

1.4. Research Objectives

To Analyze the cost and environmental impact of the waste oil utilization scenario as a substitute for fuel oil in mixing explosives to generates the maximum benefit to PT Berau Coal.

1. Analyze the cost and environmental impact of the waste oil utilization as the explosive mixing in 2015-2020
2. Analyze the potential cost and environmental impact of the optimization scenarios of waste oil utilization as the explosive mixing in 2021-2025
3. Analyze and determine the integration of potential impact on cost and environmental from the realization of proposed optimizing scenarios of waste oil utilization as the explosive mixing in 2021-2025

1.5. Scope and Limitation

The limitations of this research are:

1. Cost impact analysis uses the concept of capital budgeting with a cost structure focused on financing in an effort to use waste oil as a substitute for fuel in explosive mixtures.
2. Environmental impact analysis refers to the Regulation of the Director General of Pollution and Environmental Damage Control NO.P.21 / PPKL / SET / KUM.I / 10/2018 about benchmarking the coal mining industry sector and monetization of emission reductions benefits.
3. The monetization concept is used to convert the carbon emission reduction benefit value into currency by referring to the carbon tax scheme.
4. Historical financial and environmental data used is all related data from 2015 – 2020 the beginning of this project was initiated, the projection period to be analyzed is from 2021 – 2025 refers to the limit of PT Berau Coal's PKP2B (Coal Mining Exploitation Work Agreement).
5. Capital expenditure information is based on actual data from PT Berau Coal.
6. Production plan data for 2021 - 2025 refers to PT Berau Coal planning data.

2. PREVIEW STUDY

2.1. Efficiency of Innovative activity

The article "Construction of Efficiency Indicators for Innovative Activity in Russia's Regions" (Rudskaia & Rodionov, 2017) is involved in various conditions of activities in various departments at PT Berau Coal so as to get a comprehensive and integrated picture of the impact-effort project. The article states that there is a time lag between innovation and the output of innovative activities which can be defined as, first, by the amount of investment, and second, by the technology life cycle prevailing in one place. The concept of efficiency is always based on the ratio of output to cost. A producer is efficient if it achieves maximum output with the available resource pool, or achieves the required output with the minimum resources involved (Greene, 1997). It should be noted that efficiency as understood in this way is only part of the understanding of the productivity of an economic system. In order to carry out a complex analysis, it is also necessary to select indicators for measuring efficiency and the extent to which the system is compatible with the selected development goals (outputs achieved, likelihood of achieving them, quality and acceptance as development goals) (Greene, 1997), as shown in Figure 2.1.

Two main types of efficiency are usually characterized in the literature - technical and allocative (price). Allocative efficiency (price) characterizes the efficiency level of the resource allocated to the price at which purchasing and distribution are managed.

Given the above considerations, we first look at the technical efficiency of innovative activities in an area. Technical efficiency is understood as the ability to produce outputs with certain resources. According to the initial definition formulated by T.C. Koopmans in 1951, "The producer is technically efficient if increasing output requires reducing at least one other output or increasing at least one input, and if reducing input requires increasing at least one other input or reducing at least one output. (Koopmans, 1951).

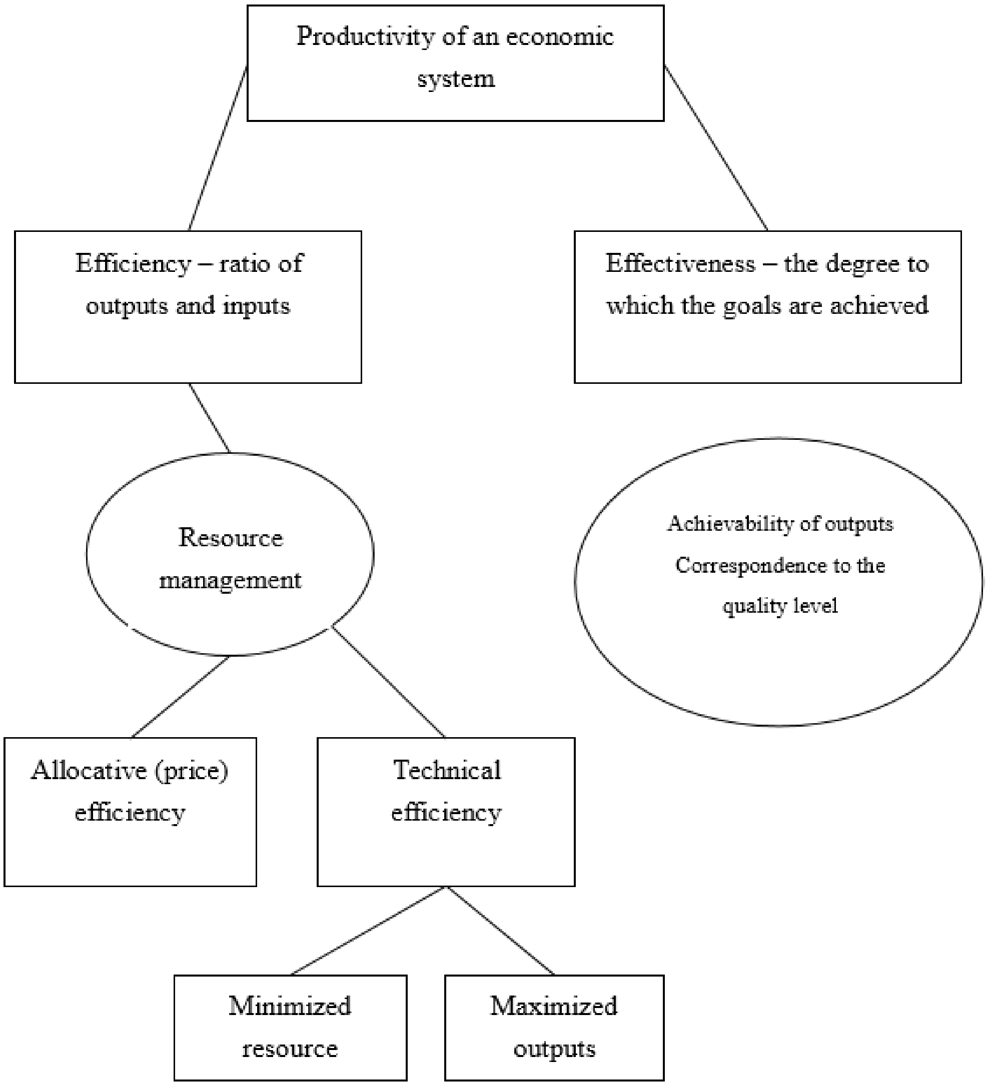


Figure 2.1. Contribution of efficiency and effectiveness in the productivity of an economic system

2.2. Economic Indicator and Investment Evaluation

- **Net Present Value (NPV)**

Definition:

According to Modigliani-Miller, Net Present Value (NPV) is defined as present value of all cash flow minus Initial Investment (Dr.Rodney Boehme: nd). The NPV method is important for the investors because it takes into account the time value of investor's money (Gitman, L.J., and Chad, I.Z., 2012). The NPV method is the investors expect a return on the money that they spent for the project. The rule is when the present value of the cash flow positive as well as negative in a project is greater than the cost of making the first place. As the result, the project will return success to meet investors's expectations and will increase the project value.

Function:

NPV is employed to conclude accept-reject decisions with criteria as follows:

- If the NPV is less than $0, reject the project
- If the NPV is greater than $0, accept the project (Gitman, 2009: 430)

Strengths:

- Cash flows assumed to be reinvested at the hurdle rate
- Account for time value of money - Considers all cash flows

Weaknesses:

- May not include managerial options embedded in the project

The formula:

NPV = Present value of cash inflows – Initial Investment (CFo)

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - CF_o$$

$$NPV = \sum_{t=1}^{n} (CF_t \ x \ PVIF_{r,t}) - CF_o$$

Equation 2.1. Net Present Value (NPV)

- **Internal Rate of Return (IRR)**

Definition:

Internal Rate of Return (IRR) is the discount rate that equates the NPV of an investment opportunity with $0; it is the rate of return that the firm will earn if it invests in the project and receives the given cash flows. (Gitman and Zutter, 2012).

Function:

To determine the compound annual rate of return that the firm will earn if they investing in projects and receives a given cash inflow.

Strengths:

- Account for time value of money - Considers all cash flows - Less subjectivity
- Weaknesses:
- Assumes all cash flows are reinvested at the Internal Rate of Return (IRR)
- Difficulties with project ranking and multiple IRRs

Formula:

$$\$0 = \sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} - CF_0$$

Equation 2.2. Internal Rate of Return (IRR)

- **Pay Back Period (PBP)**

Definition:

Payback period is the amount of time required for a firm to recover its initial investment in a project, as calculated from cash inflows (Gitman and Zutter, 2012: 393)

Function:

Payback period is factored in to make accept-reject decision based on the following criteria:

- If the PBP is shorter than the maximum acceptable payback period, accept the project
- If the PBP is longer than maximum acceptable payback period, decline the project (Gitman, 2009; 425)

Strengths:

- Easy to use and understand - Can be used as a measure of liquidity

Weaknesses:

- Does not account for time value of money - Does not consider cash flows beyond the payback period (PBP) - Cutoff period is subjective

Formula:

PBP = (Last year with a negative NCF) + (Absolute Value of NCF in the year/Total Cash Flow in the following year)

Equation 2.3. Pay Back Period (PBP)

- **Weighted Average Cost of Capital**

WACC according to Gitman and Zutter (2012: 368)

"…reflects the expected average future cost of capital over the long run; found by weighting the cost of each specific type of capital by its proportion in the firm's capital structure"

$$\text{WACC} = (w_i \, x \, r_i) + (w_p \, x \, r_p) + (w_s \, x \; r_{r\,or\,n})$$

Equation 2.4. Weighted Average Cost of Capital (WACC)

Where,

w_i = proportion of long-term debt in capital structure
w_p = proportion of preferred stock in capital structure
w_s = proportion of common stock equity in capital structure
$w_i + w_p + w_s = 1.0$

ri = after-tax cost of debt = rd x (1-T)
r_p = cost of preferred stock
$r_{r\,or\,n}$ = cost of common stock

- **Capital Asset Pricing Model (CAPM)**

Capital Asset Pricing Model is "the basic theory that links risk and return for all assets" (Gitman and Zutter, 2012:329)

Marking the birth of asset pricing theory, William Sharpe (1964) and John Lintner (1965) state the Capital Asset Pricing Model (CAPM) in the following equation: (Fama and French: 2004: 25-46)

(Sharpe-Lintner CAPM) $E(R_i) = R_f + [\, E(R_m) - R_f)] \, \beta_{im}, \quad i = 1,\ldots,N$

Equation 2.5. Capital Asset Pricing Model (CAPM)

Using the definition from Gitman and Zutter in "Principle of Managerial Finance" 13th edition, the components are as follows:

Where,

$E(R_i)$	:	The expected return on any asset
R_f	:	Risk-free interest rate
β_{im}	:	Asset's market beta
$E(R_m) - R_f$	:	The premium per unit of beta risk, which is market return minus risk-free interest rate

According to Sheridan, et all. (2011: 468), the advantages and disadvantages of CAPM are as follows:

R_f : *Risk-free interest rate is the required return on a risk-free asset*
β_{im} : *Asset's market beta or beta coefficient is a relative measure of nondiversifiable risk. An index of the degree of movement of an asset's return in response to a change in the market return*
R_m : *Market return; return on the market portfolio of assets*

The advantages of CAPM:

The model is simple and easy to understand and calculate since it is simply the sum of two components: the risk-free rate of interest and the firm's risk premium

Because the model does not rely on dividends or any assumption about the growth rate in dividends, it can be applied to companies that do not currently pay dividends or are not expected to experience a constant rate of growh in dividends

The disadvantages of CAPM:

- Specifying the risk-free rate
- Estimating beta
- Estimating the market's risk premium

- **Hurdle Rate**

Hurdle rates are, like value, inherently subjective and thus are based on estimates (Jr., et al., 2015). The model that is usually used in estimating the hurdle rate is the capital asset pricing model. The CAPM model is built on two core variables: a risk-free rate (nominal return on a security that has absolutely no possibility of default) and a risk premium (a function of the expected market return minus the risk-free rate and multiplier risk, which is based on the covariance of a firm's securities' prices to those of the broader capital market and is popularly known as beta). However, the use of this beta value creates a lot of controversy compared to other variables. Responding to this controversy, several companies used multi-factor models of arbitration pricing (APT; Ross, 1980). Whatever approach is chosen, at least a model is available to inform the hurdle rate estimate at the enterprise level in contrast to the situation that exists at the business unit level. there are also some companies that determine the hurdle rate at a certain level without being based on any model / analysis. Some companies determine the hurdle rate according to the expected value. This kind of determination has the potential to become a problem considering that determining the hurdle rate value is related to business risk.

2.3. Hazardous and Toxic Waste Regulation

Regulation of the Director General of Pollution and Environmental Damage Control NO.P.21 / PPKL / SET / KUM.I / 10/2018 about benchmarking of the coal mining industry sector regulates the benchmarking of green assessment of company performance ratings in environmental management of the coal mining industry sector. The purpose of this regulation is to provide a reference for Proper participants in the coal mining industry sector in carrying out benchmarking and provide a reference for Proper appraisers in evaluating performance beyond compliance.

Benchmarking regulated in this regulation consists of:

- Benchmarking of emission intensity (Figure 2.2);
- Benchmarking of energy intensity (Figure 2.2);
- Benchmarking of water intensity;
- Benchmarking of hazardous and toxic waste intensity; and
- Benchmarking of non-hazardous and toxic waste intensity.

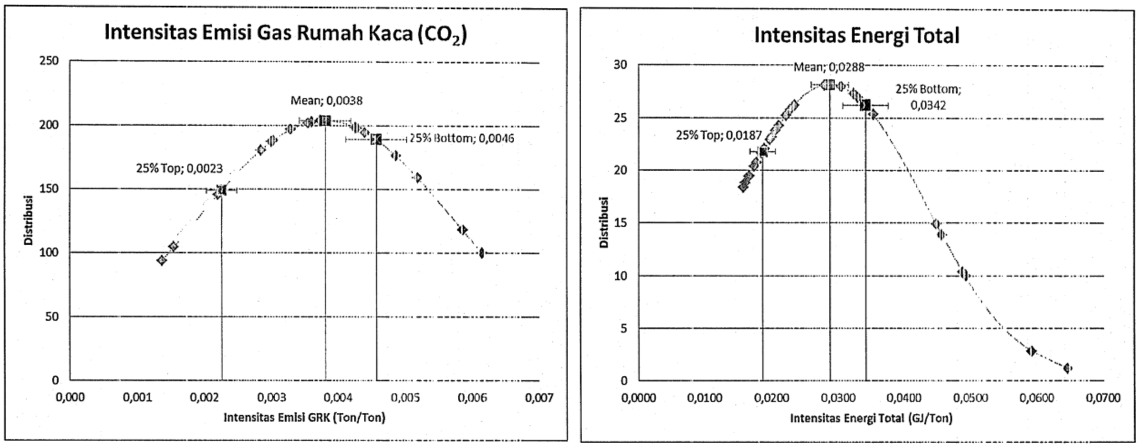


Figure 2.2. Benchmarking of Emission and energy Intensity

2.4. What is Carbon Pricing

Excerpted from www.worldbank.org/en/programs/pricing-carbon, there are several ways governments can price carbon, all of which lead to the same results. Carbon pricing helps transfer the burden of damage to those who are responsible and / or those who have the capacity to reduce it. Instead of dictating who should reduce emissions where and how, the carbon price signals the economy and polluters decide for themselves whether to stop their polluting activities, reduce emissions, or continue polluting and pay for it. In this way, the overall environmental goal is achieved in the most flexible and least costly way for society. Carbon Pricing also encourages clean technology and market innovation, driving new drivers of low-carbon economic growth. There are two main types of carbon pricing: emissions trading systems (ETS) and carbon taxes.

ETS - sometimes referred to as a cap-and-trade system - limits the total level of greenhouse gas emissions and allows low-emission industries to sell their extra benefits to larger emitters. By creating a supply and demand for emissions allowances, ETS sets a market price for greenhouse gas emissions. The cap helps ensure that the necessary emission reductions are made to keep issuers (in aggregate) within their previously allocated carbon budgets.

Carbon taxes directly set the price of carbon by setting tax rates for greenhouse gas emissions or - more generally - the carbon content of fossil fuels. This differs from ETS where the result of reducing emissions from the carbon tax is not predetermined but the carbon price is determined.

The choice of instrument will depend on national and economic circumstances. There are also more indirect ways to set a more accurate price for carbon, such as through fuel taxes, the elimination of fossil fuel subsidies, and regulations that may include a “social cost of carbon”. Greenhouse gas emissions can also be priced through payments for emission reductions. Private or regulatory entities can purchase emission reductions to compensate for their own emissions (called offsets) or to support mitigation activities through results-based financing.

3. METHOD, DATA, AND ANALYSIS

3.1. Conceptual Framework

The research analyzes the loss opportunity that occurs in this project and performs a projected opportunity that can be optimized in terms of environmental impact and cost efficiency. Business situation analysis is a combination of management expectations, literature review on the concept of environmental governance and specific cost efficiencies related to the use of hazardous waste cost efficiency, and external-internal analysis of the company using the TOWS matrix.

The research was divided into 3 scenarios, namely improvement waste oil utilization portion 100%, improvement waste oil utilization portion 50-100%, and improvement waste oil utilization with existing performance. The three project scenarios above were analyzed for impacts on cost efficiency and environmental impact. The results of the analysis are used as a basis for providing recommendations and implementation strategies for management to be able to optimize the use of waste oil as a mixing of explosives in mining activities so that the impact on environmental impacts and cost efficiency can be optimized. Overview of the framework conceptual flow as in Figure 3.1.

3.2.Research Design

The research design divides the research into 2 time frames, namely initial improvement (2015-2020) and improvement optimizing (2021-2025). In this research design section, the analysis used basically uses the same methods and approaches from both financial and environmental aspects. In the initial improvement, the impact obtained was calculated through the financial capital budgeting approach and decreased energy and emission consumption intensity. Likewise for improvement optimizing, what is different in this part of the analysis is that it is complemented by the conversion of carbon emission values into currency through the carbon pricing concept approach to provide a more familiar overview. Overview of the research design flow as in Figure 3.2.

3.3.Environmental Impact Projection

The research uses primary and secondary data. Primary data is acquired from PT Berau Coal combined with data obtained from observations during the project trial process. Secondary data was collected from books, journals, articles, and websites. Both primary and secondary data consist of quantitative and qualitative information. Primary and secondary data are used as the input of financial and environmental analysis to produce cost and environmental impact, and proposed optimum waste oil utilization scenario.

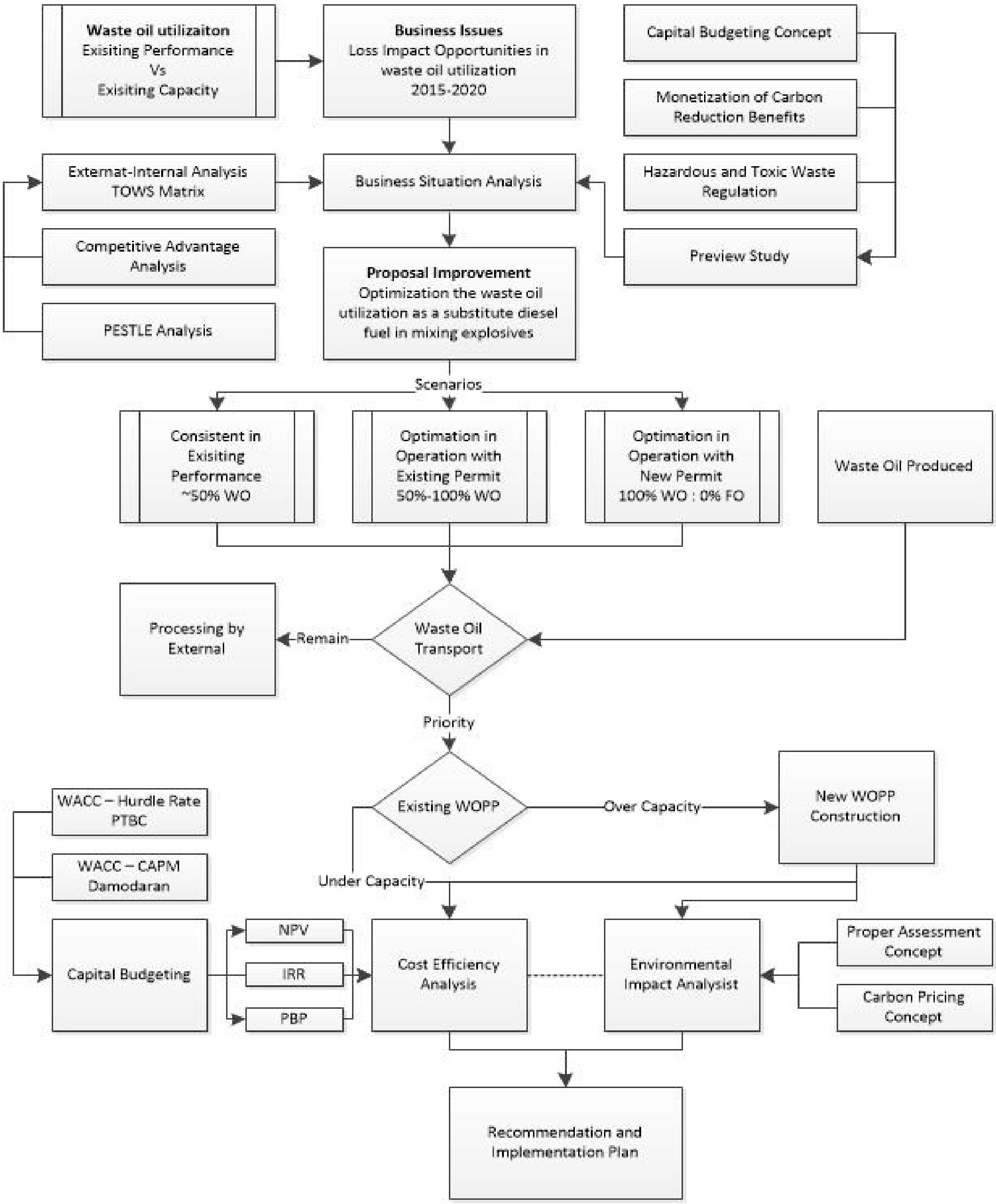


Figure 3.1. Conceptual Framework of Waste Oil Utilization

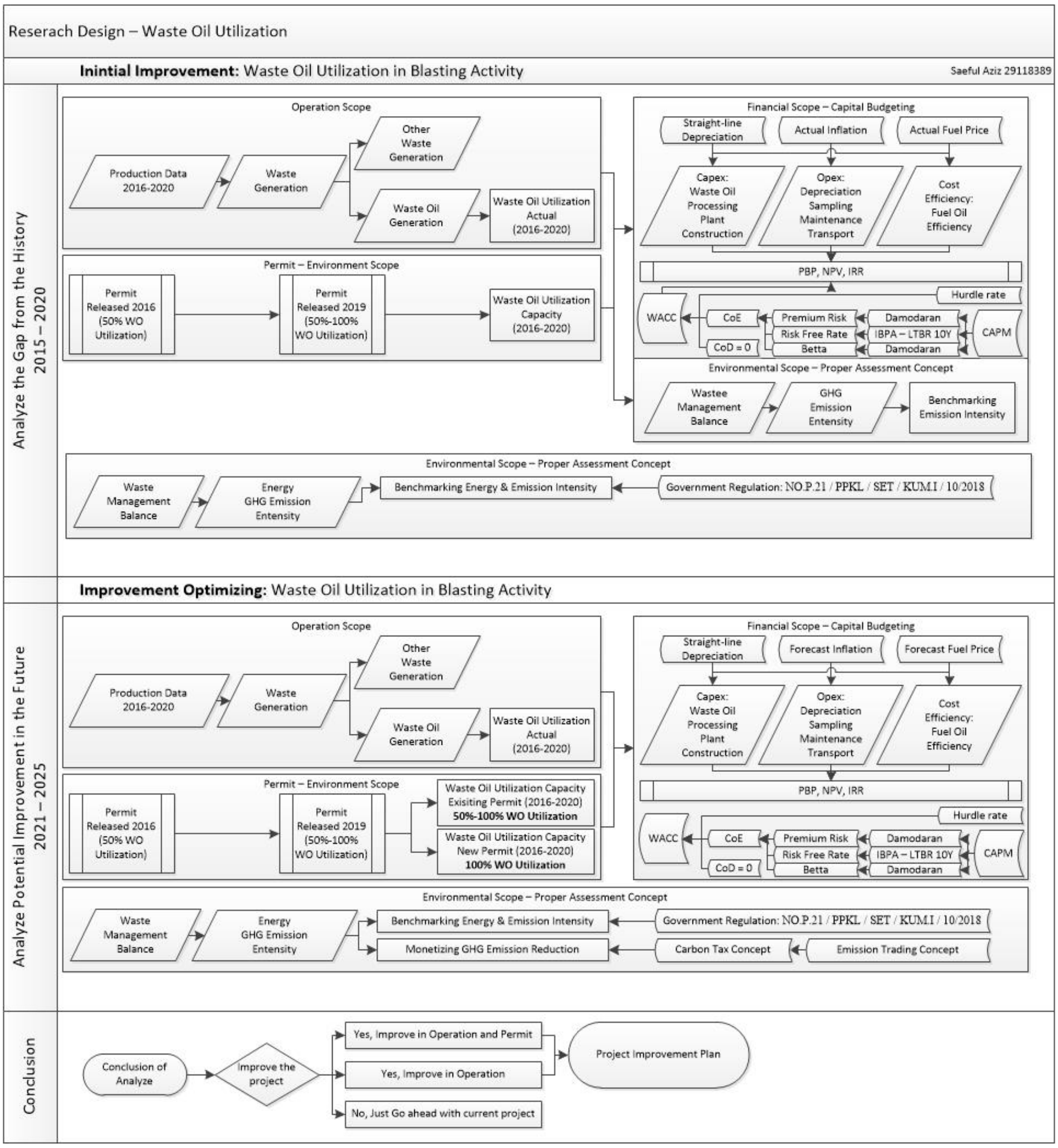


Figure 3.2. Research Design of Waste Oil Utilization

3.4.Loss Opportunity Cost and Environmental Impact in 2015 – 2020

As explained in subchapter 1.2. Problem Statement, related to the gap of the realization of the use of waste oil as a mixing of explosive fuel (fuel oil substitution) against permits that have been issued. This can be seen as missing an opportunity to have an optimal impact on the environment and cost efficiency.

In 2015, it was the investment period for the construction of a waste oil processing plant and its licensing. 2016 saw a period of trial and gradual implementation of waste oil utilization with a composition according to the permit. In Figure 3.3 It can be seen that there is still a gap between the implementation of waste oil utilization and capacity, in this case the permit and the capacity of the waste oil plant. Detail waste oil management balance pt berau coal (2016-2025) can be seen on Appendix 1.

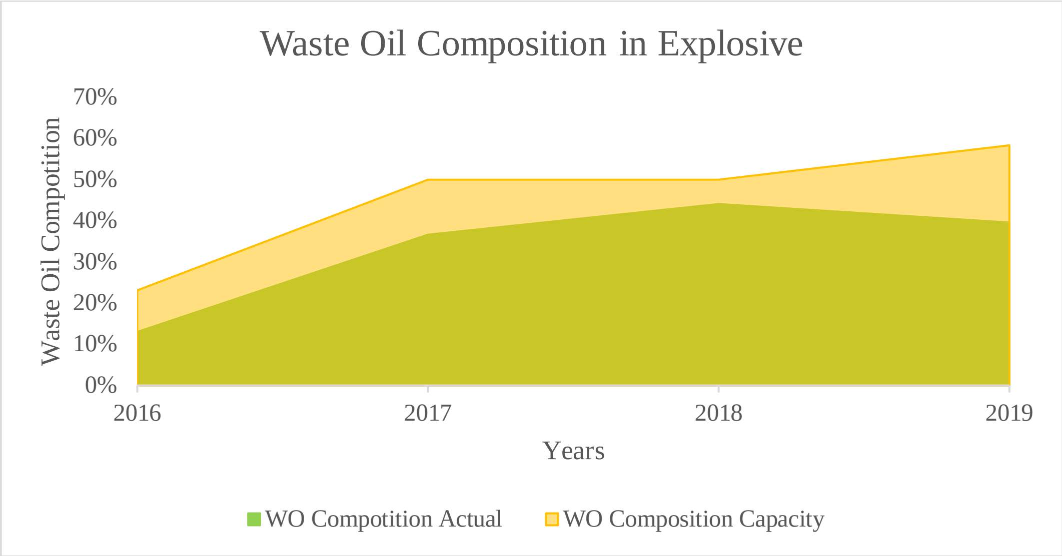


Figure 3.3. Gap Waste Oil Utilization in Explosive

The existing gap is further analyzed to the loss of opportunity cost efficiency from fuel savings and optimization of energy consumption reduction and emission reduction. In Figure 3.4, Seen from the financial aspect, PT Berau Coal has lost the opportunity cost efficiency of IDR 4,855.46 Mio (WACC-CAPM, 11.8%) or IDR 4,899.12 Mio (WACC – Hurdle rate, 11.5%) during the period 2015 - 2020 (based on actual income and expenditure data, except in 2020, an outlook is made of year-end achievements).

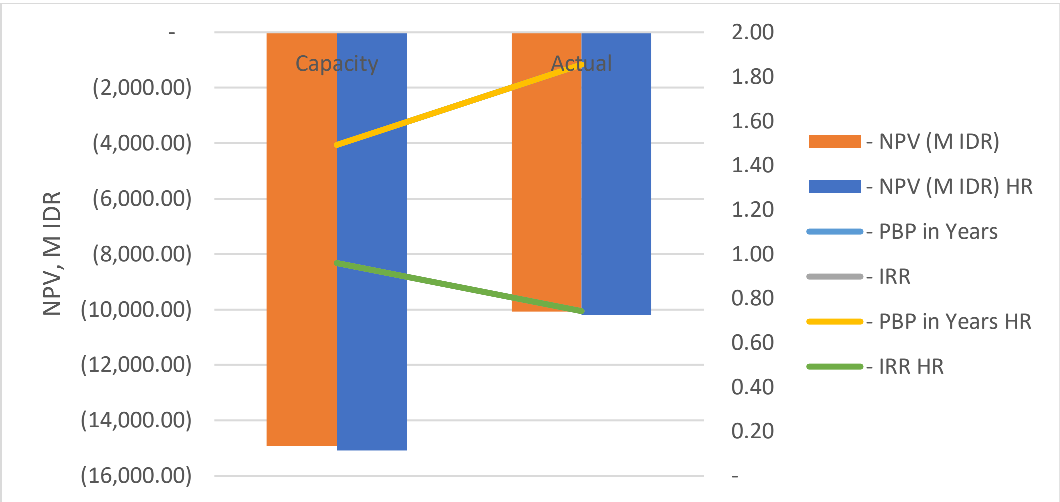


Figure 3.4. Capital Budget Comparison Waste Oil Utilization 2015-2020

Viewed from the environmental aspect with reference to Regulation of the Director General of Pollution and Environmental Damage Control NO.P.21 / PPKL / SET / KUM.I / 10/2018, lost opportunity for environmental impact can be seen in energy efficiency and reduced emissions. Figure 3.5 shows the total value of energy intensity. The actual waste oil utilization in the 2015-2020 period shows a total energy intensity of 0.02111941 GJ / Ton with a contribution to a decrease in energy consumption from the actual waste oil utilization of 199,986.16 GJ throughout the 2015-2020 period. Meanwhile, the capacity for waste oil utilization in accordance with the permit and capacity of the waste oil processing plant available in the same year period shows a lower total energy intensity value at 0.02110288 GJ / Ton with a greater contribution of decreasing energy consumption by 279,285.37 GJ. If the decrease in actual energy waste oil utilization is compared to the waste oil utilization capacity in accordance with the permit and the available waste oil processing plant capacity, there is still a gap of 79,299.21 GJ. This gap can be defined as the loss of opportunity for companies to reduce energy consumption. The same is the case with lost opportunities for a reduction in greenhouse gas emissions (in this study it is limited only to CO2 gas according to the reference regulation). The loss of this opportunity is 981.19 tons CO2eq.

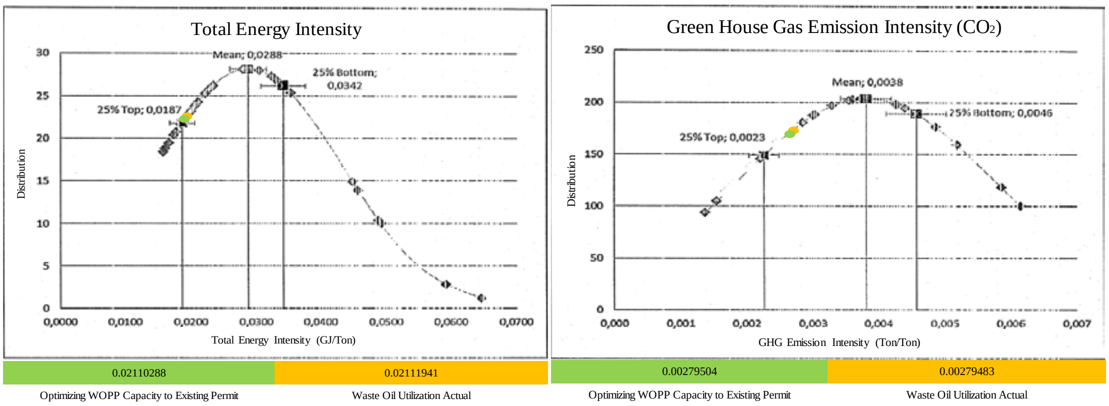


Figure 3.5. Total Energy and GHG Emission Intensity PT Berau Coal 2015-2020

Based on the overall discussion in chapter 2 related to exploration business issues, it provides an overview of the ways in which companies are dominated by aggregate forces and threats. Diversification is a strategy that companies should take in order to survive and continue to grow. The use of petroleum waste as the concept of blending explosives is in line with efforts to diversify the mining process sub-business which can contribute to increasing corporate value in terms of the environment and cost efficiency. This project can be seen more broadly as the company's effort and commitment to implement a cost leadership strategy with a focus on resource-based view which is expected to be an added value for the company in increasing its capacity to compete with competitors. Through this project improvement the company has a more optimal chance of impact where the magnitude is calculated in the next chapter.

4. RESULT AND DISCUSSION

4.1. Defining Assumptions

In accordance with the analysis in the previous chapter, it can be concluded that: Recommendation

These are the assumptions used in this Research (Figure 4.1). Initial Improvement impact analysis most of the data use actual data. Improvement Optimizing: Capital expenditures, improvement optimizing with existing permit use proforma data, in this scenario requires additional investment for Waste Oil Receiver Storage and Waste Oil Feeder Storage (increase capacity 200%). In improvement optimizing with new permit use proforma data, in this scenario requires additional investment for Waste Oil Receiver Storage (increase capacity 250%) and Waste Oil Feeder Storage (increase capacity 300%) and Waste Oil Procession Plant Opti-ten (increase capacity 125%). Operating Expenditures, in improvement optimizing consist of proforma data from history depend on production target. What is the difference? The addition of manpower related to Optimizing Effective Working Hour. Cost of Capital are doubled in each scenario based on the Weighted average cost of capital by Capital asset Pricing Model in 11.8 percent and the Weighted Average Cost of Capital by hurdle rate company in 11.5 percent. It was obtained from a reduction in the use of fuel oil with reference to the forecast fuel price from Mids Oil Platts of Singapore Price adjustment (detail in Appendix 2).

The assumptions used in measuring the environmental impact include improvement optimizing, Additional contribution of reducing the energy consumption intensity and GHG Emission Intensity from this project was calculated by study preview. Energy of Fuel Oil: 44.5 MJ / kg (mechanical, 2017) waste oil: 35.9 MJ / kg (mettek, 2015). In GHG Emission, Additional contribution from this project was calculated by study preview: CO2 Emission of Fuel Oil: 3.3 ton / ton, waste oil: 3.1 ton / ton (KLH, 2012).

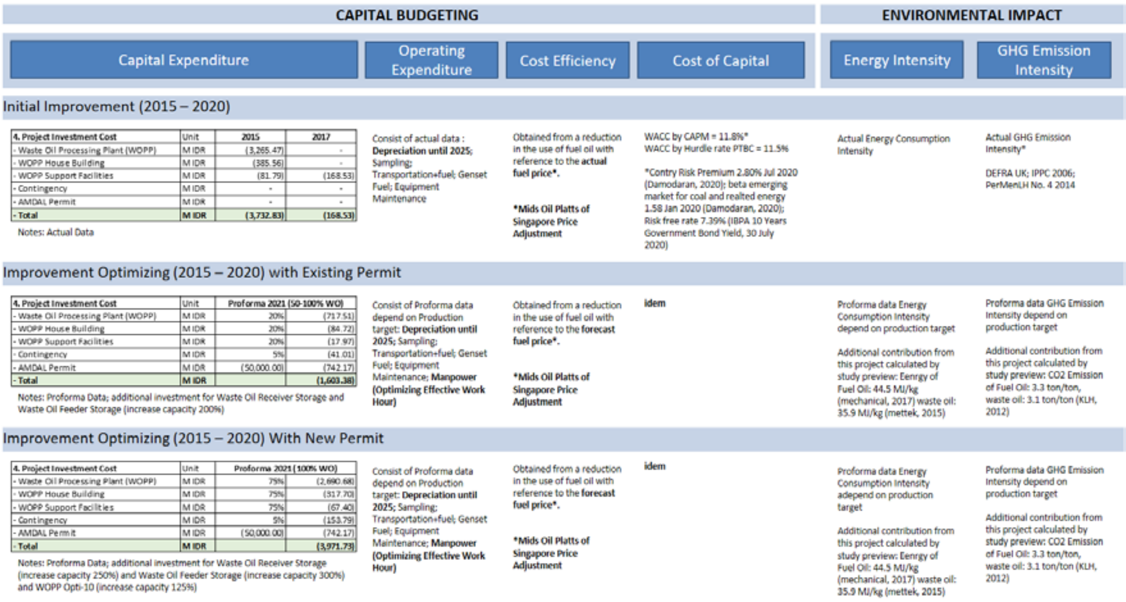


Figure 4.1. General Assumptions

4.2. Cost and Environmental Impact Projection

Optimizing the utilization of waste oil by increasing the capacity of the waste oil processing plant (WOPP) by 250% through the construction of several new WOPP parts, the effective utilization of WOPP working hours to 2 shifts, as well as proposals for permit to use waste oil with a maximum composition of up to 100%. As shown in Figure 4.2, optimization through the above methods will have an impact on cost efficiency which is equivalent to $ 1,188,403.28 (optimization NPV - existing NPV) during the period 2021-2025. The optimization NPV value is $ 2,086,995.64 with a payback period of less than 1 year.

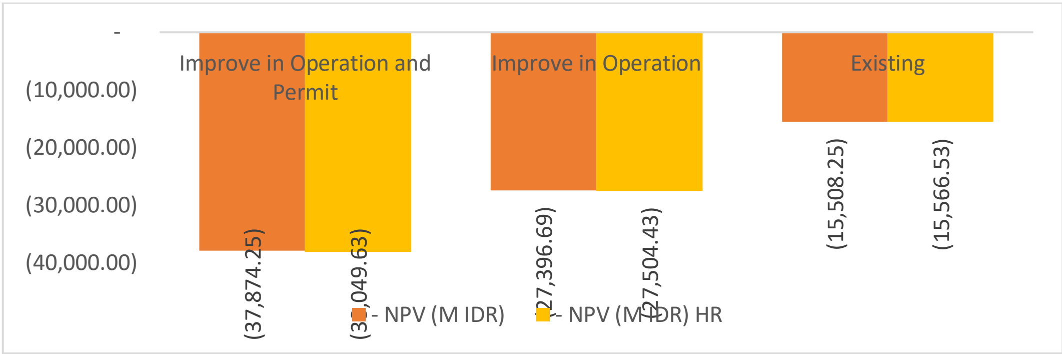


Figure 4.2. NPV Comparison of Waste Oil Utilization Scenarios 2021-2025

Figure 4.3 shown the impact on reducing energy consumption is 0.62% of the total energy intensity of PT Berau Coal during the period 2021-2025 or the equivalent of 365,280.77 GJ or equivalent to an increase in the contribution of reducing energy consumption by 200% compared to the utilization of existing waste oil. The impact on reducing greenhouse gas emissions is 0.04% of the total intensity of PT Berau Coal's greenhouse gas emissions during the 2021-2025 period or the equivalent of 4,519.69 tons of CO2eq or equivalent to an increase in the contribution of reducing greenhouse gas emissions by 266% compared to the utilization of existing waste oil. Through the carbon pricing approach (carbon tax), the emission reduction is equivalent to a NPV of $ 22,469.52.

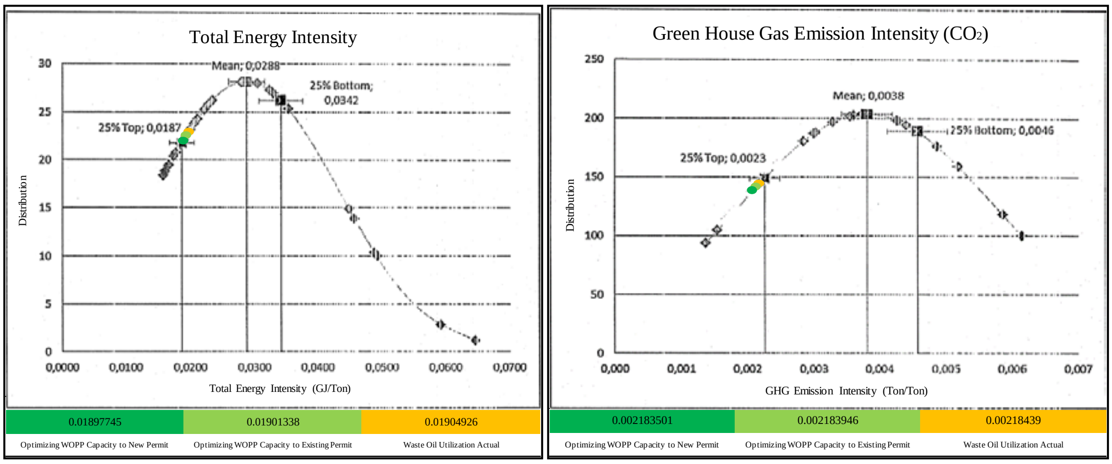


Figure 4.3. Total Energy and GHG Emission Intensity PT Berau Coal 2021-2025

From the graph, it can be seen that the gap between the scenarios is in accordance with the analysis in the previous sub-chapter that the more optimal the utilization of waste oil, the higher the financial and environmental impact. Improving the use of waste oil to 100% composition as a blending explosives provides benefits (can be in the form of a tax shield, tax reduction, or the like, according to the carbon tax system that will be implemented) of IDR 629.80 Mio in the total period 2021-2025 or provides benefits 267% for efforts to reduce carbon emissions compared to the existing scenario which was only able to provide benefits of IDR 234.91 Mio. Meanwhile, the improvement in the use of waste oil at a composition interval of 50-100% gives IDR 430.05 Mio in the same period or provides a benefit of 183% for reducing carbon emissions compared to the existing scenario (Figure 4.4).

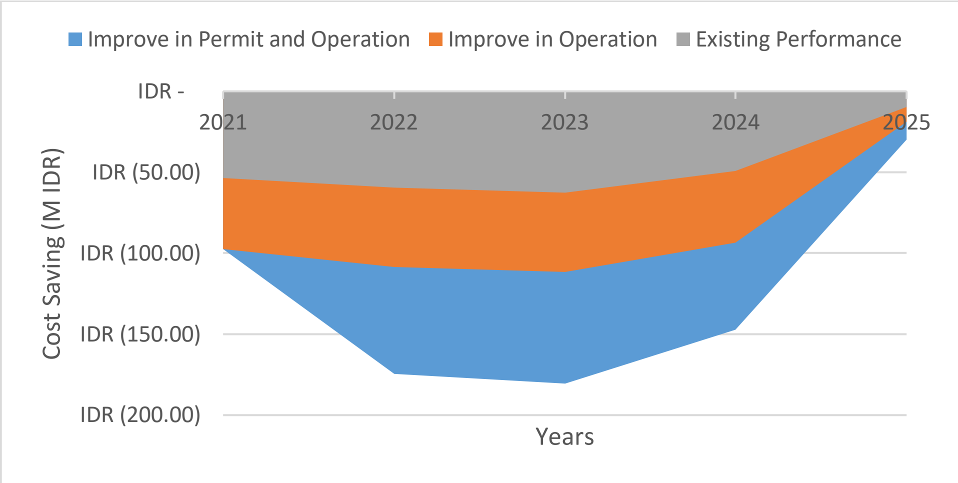


Figure 4.4. Monetization of Emission Reduction Benefits PT Berau Coal

Sensitivity analysis is carried out to determine the effect of changes in project parameters on system performance in the project in generating profits. In Figure 4.5 it can be seen that the composition of the use of waste oil as a substitute for fuel oil as a mixture of explosives in blasting activities as part of mining operations at PT Berau Coal has the highest sensitivity level to the NPV value. It can also be said that one of the effective efforts to maximize the benefits obtained financially is to maximize the composition of waste oil as an explosive mixer, because the higher the waste oil composition, the higher the cost efficiency obtained from fuel efficiency. Apart from the composition of waste oil, fuel price, blasting material portion, powder factor, production increase, and WACC also have high sensitivity, but as we know that fuel price and WACC values are very difficult to intervene directly.

In the spider type sensitivity analysis graph, the waste oil utilization composition factor in each explosive and the change in production capacity shows a non-linear graph because certain changes have implications for investment in changes in the capacity of the waste oil processing plant. Based on the level of dynamics of change and its impact on this project, fuel prices and changes in production are the most responsive factors, where changes in production are basically the impact of the dynamics of coal prices on the world market. Based on these two factors, scenario analysis is carried out at the fuel price value interval and the realization of certain production to see the impact on the net present value of this project. From the analysis, the value of fuel price and production realization when the NPV is 0 is obtained

- Improvement in operation with a new permit (± 100% waste oil composition): Actual production of 9% of the base scenario or fuel price of $ 0.08 / liter.

- Improvement in operation with an existing permit (± 50-100% waste oil composition): Actual production of 7% of the base scenario or fuel price of $ 0.07 / liter.

- Exisiting improvement (± 50% waste oil composition): Fuel price of $ 0.06 / liter.

Input Variable	Corresponding Input Value: Low Output	Base Case	High Output	NPV Output Value: Low	Base	High	Swing	Percent Swing^2
Waste Oil Utilization In Emulsion	100%	48%	0%	(19,373.14)	(18,703.89)	(3,463.11)	15,910.04	65.7%
Fuel Price	0.50	0.42	0.33	(23,094.33)	(18,703.89)	(14,313.45)	8,780.88	20.0%
Blasting Material Portion	99%	82%	66%	(18,596.84)	(18,703.89)	(15,016.61)	3,580.23	3.3%
Powder Factor	0.24	0.20	0.16	(18,596.84)	(18,703.89)	(15,016.61)	3,580.23	3.3%
Production Increase	145%	120%	96%	(18,614.45)	(18,703.89)	(15,047.08)	3,567.37	3.3%
WACC	6%	12%	18%	(20,219.39)	(18,703.89)	(17,434.51)	2,784.88	2.0%
Waste Oil Utilization in ANFO	100%	50%	0%	(18,463.96)	(18,703.89)	(15,951.12)	2,512.84	1.6%
Gradient Ex. Rate USD/IDR	27.44	22.87	18.29	(19,422.29)	(18,703.89)	(17,980.00)	1,442.29	0.5%
Waste Oil Utilization in Gel	100%	50%	0%	(19,034.63)	(18,703.89)	(18,261.02)	773.61	0.2%
Inflation Rate	2.60%	3.25%	3.90%	(18,778.33)	(18,703.89)	(18,627.80)	150.53	0.0%

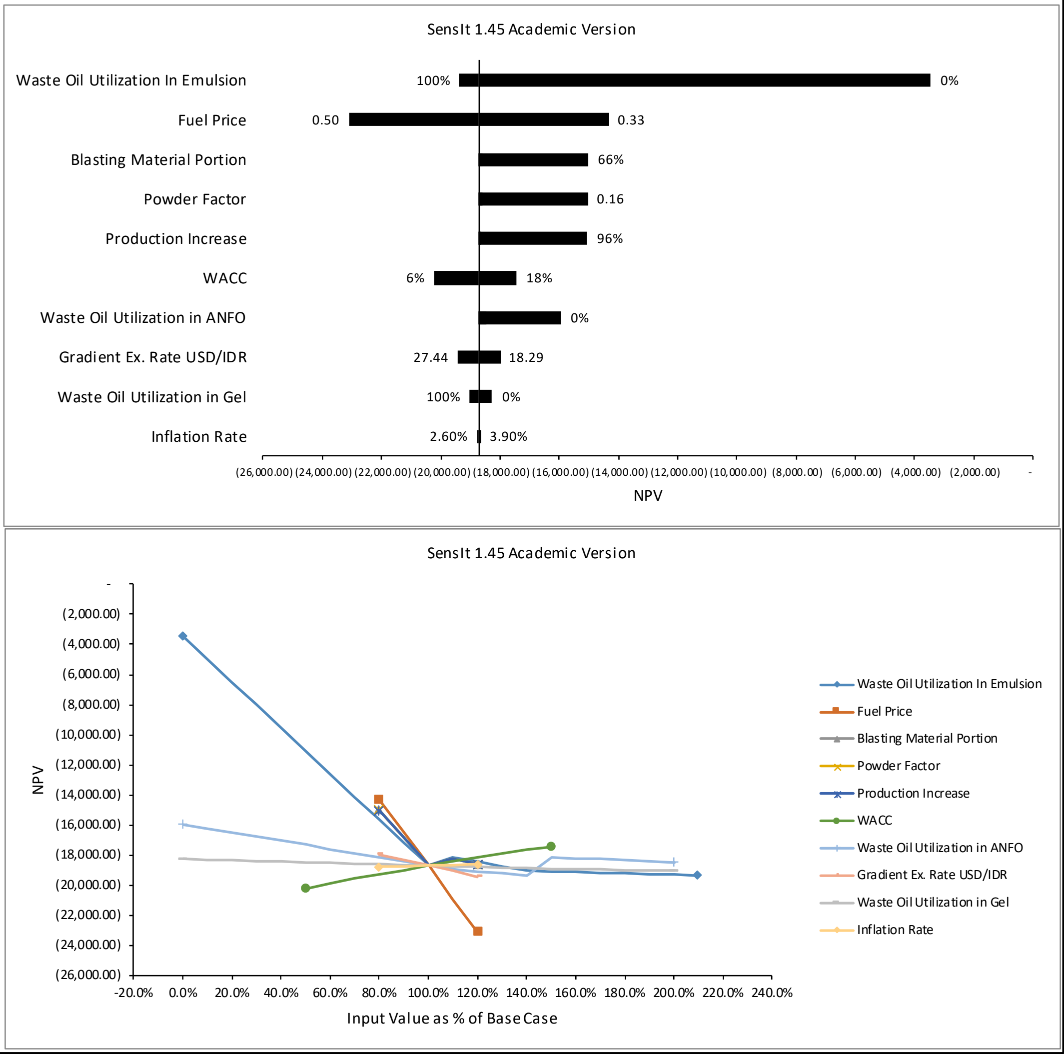


Figure 4.5. Sensitivity Analysis: Tornado and Spider Types

Furthermore, the cost and environmental impact of each improvement scenario is summarized into a filled radar graph to represent the impact of waste oil utilization as a whole in the context of cost efficiency and limited environmental impact on reducing energy consumption and reducing greenhouse gas emissions (can be seen in Figure 4.6).

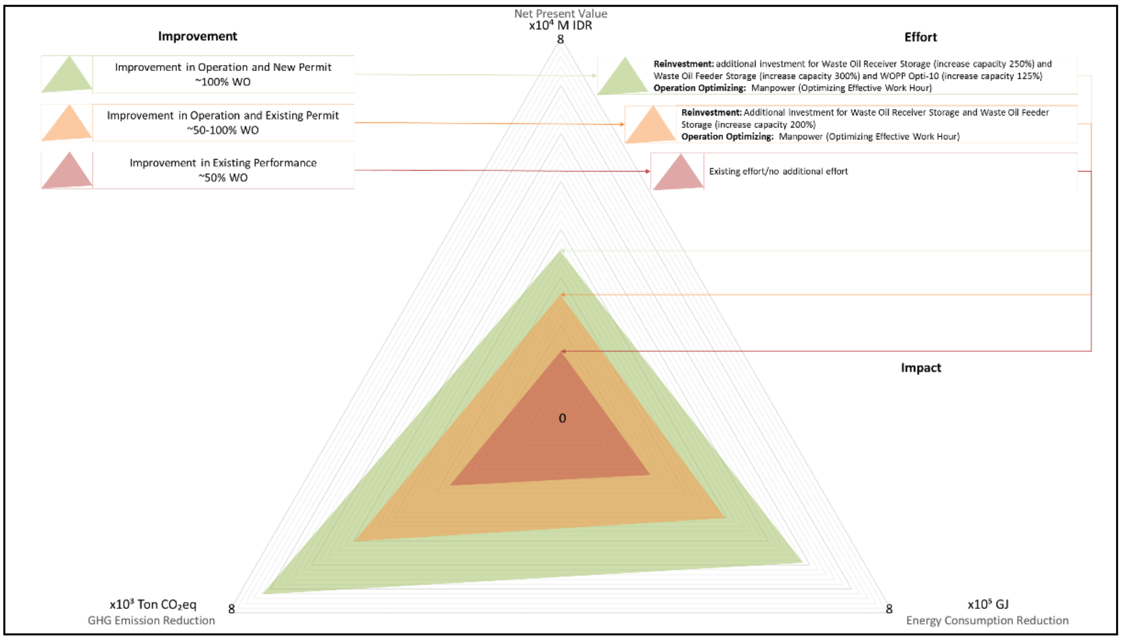


Figure 4.6. Cost and Environmental Impact Chart Filled Radar of Waste Oil Utilization Scenarios

The graph above shows the integration of the cost and environmental impact of waste oil utilization in each scenario. It is clear, that each improvement scenario has a positive contribution to cost efficiency, reducing energy consumption and reducing greenhouse gas emissions. However, improvement in operation with new permit ((± 100% waste oil composition) provides the highest multiple impact by reinvesting efforts for Waste Oil Receiver Storage (increase capacity 250%) and Waste Oil Feeder Storage (increase capacity 300%) and WOPP Opti-10 (125% increase in capacity). This scenario can be assessed as an improvement room owned by PT Berau Coal in optimizing waste oil utilization as a blending explosives.

5. CONCLUSION

The results of data processing, for the initial improvement at 2015-2020 PT Berau Coal has lost cost opportunity cost of IDR 4,855.46 Mio, has lost opportunity in reduce of total consumption energy and GHG Emission of 79,299.21 GJ and 981.19 tons CO2eq. Improvement Optimizing at 2021-2025 WO 50- 100% give impact: +176% NPV, reduce energy and emission intensity 0.19% and 0.02% or IDR 398.43 Mio. Improvement Optimizing at 2021-2025 WO 100% give impact: +244% NPV, reduce energy and emission intensity 0.41% and 0.04% or IDR 579.36 Mio.

Through the approach to the concept of capital budgeting, benchmarking energy intensity and emissions, and monetization of carbon values, the authors conclude that optimizing the use of waste oil with 100% composition as a substitute for fuel oil as a blending agent for blasting activities in the mining activities of PT Berau Coal has an optimal impact on cost efficiency and benefits to the environment in terms of energy efficiency and emission reduction.

6. IMPLICATION/LIMITATION AND SUGGESTIONS

In this research, the authors limit the research for case analysis at PT Berau Coal, due to the limited data available and the time available. This research is relatively sufficient to provide an overview regarding the feasibility study of the waste oil utilization as a substitute for fuel oil as a mixing agent for explosives in blasting activities in the mining process. For further research, the authors suggest that research can be carried out more broadly so that this project can be implemented in other mining companies. In addition, the concept of monetizing the value of carbon emissions in this research is still limited to the conversion of emission values into currency and has not become part of the integrated financial concept. For further research, the authors suggest that research can integrate the concept of monetization of the value of carbon emissions with the overall financial feasibility study, both through the Emission Trading System and Carbon Tax approaches.

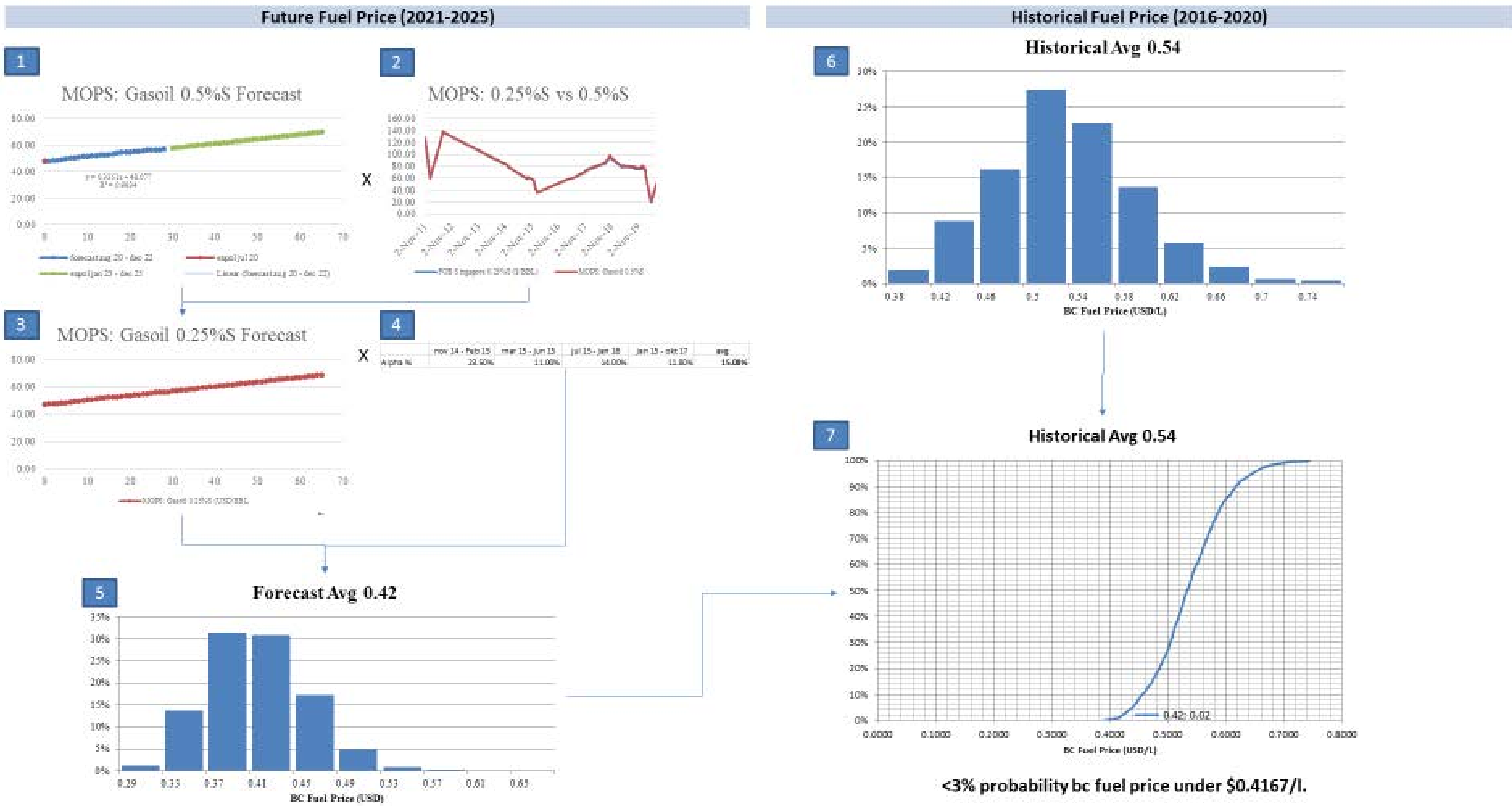
APPENDICES

Appendix 1. Waste Oil Management Balance PT Berau Coal (2016-2025)

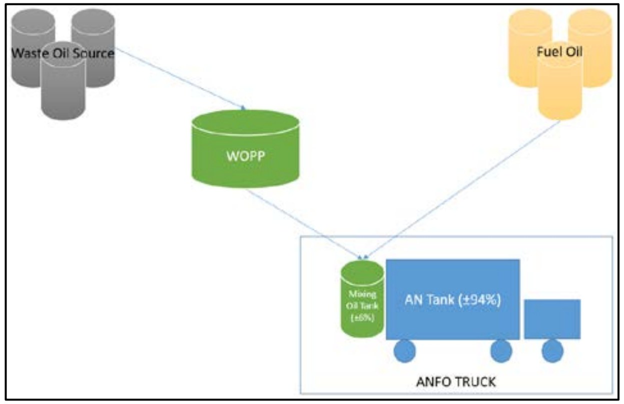
Type of Waste	Waste Code	SOURCE	UNIT	TREATMENT	Scenarios	Years										PRODUCED	WASTE MANAGED					NOT MANAGED
						2016	2017	2018	2019	2020	2021	2022	2023	2024	2025		STORED AT TPS	UTILIZED ITSELF	BEING OWN	LANDFILL ITSELF	SUBMITTED THIRD PARTY LICENSED	
Used Lubricant	B105d	ALL SITES FROM COMBINED ACTIVITIES	TON	PRODUCED		4,008.07	3,889.30	4,647.00	5,472.90	5,109.44	7,540.69	8,229.60	7,931.43	5,950.49	1,227.98	54,006.89						
				STORED AT TPS		61.27	50.00	134.90	62.30	78.11	115.28	125.81	121.25	90.97	18.77		858.66					
				UTILIZED ITSELF	Existing	282.97	940.44	1,357.27	1,036.52	938.04	1,231.14	1,305.52	1,306.63	981.95	186.22			9,566.71				
					Improve in Operation	503.37	1,285.52	1,541.09	1,528.44	1,503.09	2,244.90	2,378.27	2,328.69	1,858.42	357.96			15,529.74				
					Improve in Permit and Operation	503.37	1,285.52	1,541.09	1,528.44	1,503.09	2,244.90	3,825.99	3,767.70	2,930.53	562.62			19,693.25				
				BEING OWN		-	-	-	-	-	-	-	-	-	-				-			
				LANDFILL ITSELF		-	-	-	-	-	-	-	-	-	-					-		
				SUBMITTED THIRD PARTY LICENSED	Existing	3,663.83	2,898.86	3,154.83	4,374.08	4,093.30	6,194.26	6,798.26	6,503.55	4,877.57	1,022.99						43,581.53	
					Improve in Operation	3,443.43	2,553.78	2,971.01	3,882.16	3,528.24	5,180.50	5,725.52	5,481.48	4,001.10	851.25						37,618.49	
					Improve in Permit and Operation	3,443.43	2,553.78	2,971.01	3,882.16	3,528.24	5,180.50	4,277.79	4,042.48	2,928.99	646.59						33,454.99	
				NOT MANAGED		-	-	-	-	-	-	-	-	-	-							-

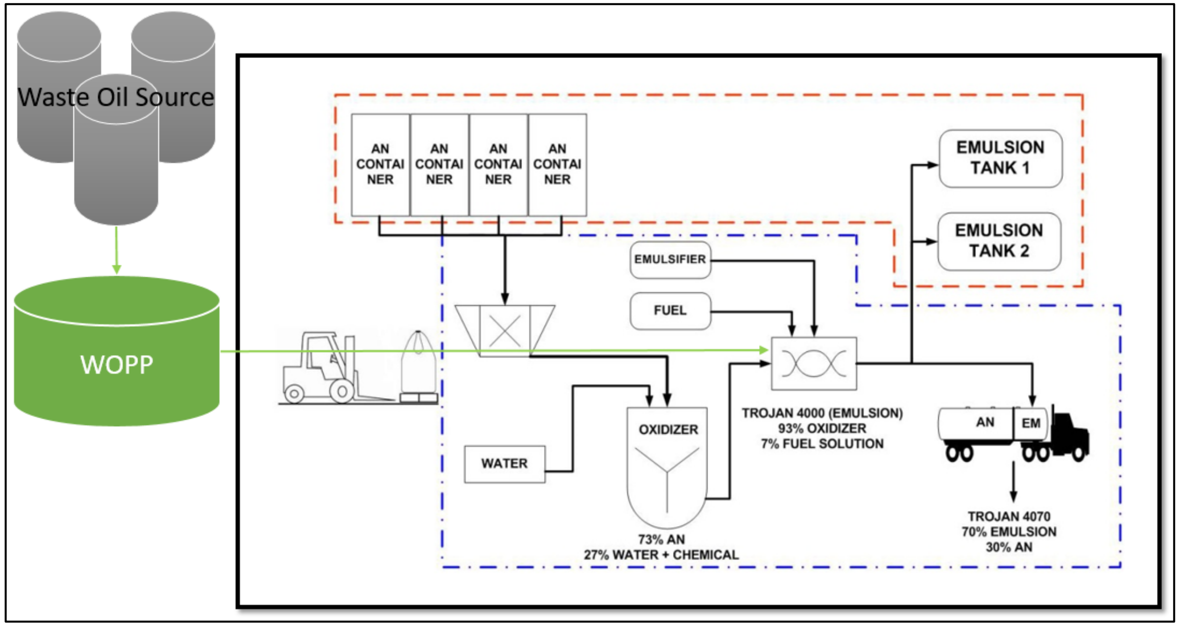
	PRODUCED	STORED AT TPS	UTILIZED ITSELF	BEING OWN	LANDFILL ITSELF	SUBMITTED THIRD PARTY LICENSED	NOT MANAGED
TOTAL WASTE OF HAZARDOUS AND TOXIC MATERIALS - SCENARIO EXISTING	54,006.89	858.66	9,566.71	-	-	43,581.53	-
		1.59%	17.71%	0.00%	0.00%	80.70%	0.00%
		100.00%					0.00%
TOTAL WASTE OF HAZARDOUS AND TOXIC MATERIALS - SCENARIO IMPROVE IN OPERATION	54,006.89	858.66	15,529.74	-	-	37,618.49	-
		1.59%	28.76%	0.00%	0.00%	69.65%	0.00%
		100.00%					0.00%
TOTAL WASTE OF HAZARDOUS AND TOXIC MATERIALS - SCENARIO IMPROVE IN PERMIT AND OPERATION	54,006.89	858.66	19,693.25	-	-	33,454.99	-
		1.59%	36.46%	0.00%	0.00%	61.95%	0.00%
		100.00%					0.00%

Appendix 2. Average Fuel Price Forecast



Appendix 3. ANFO and Emulsion Mixing Process





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