Impact of Fuel Oil Power Plant Diversification to Operational Effectiveness: Case Study in A Mining Company

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Abstract

This research paper has the main objective to study in Smelter Mining in Indonesia. Energy contributed more than 30 Percent of total cash cost production Smelter. Due to This Condition, Smelter Plant must be controlling budget power plant to reduce cash cost production of plant. Existing Power Plant PT Antam, Tbk consumed Fuel Oil as fuel to produce Electricity. In order to get efficiency and then excellence Operation must be analysis the other option for fuel to produce electricity. Case Study research is conducted by reviewing secondary data from PT Antam, Tbk. This case to implementing diversification strategies. The Expectation gives positive Impacts on the financial and operation to the PT Antam,Tbk.

Keywords
Smelter, Power Plant, Operational Effectiveness, Diversification, Green House

1. Introduction
In the globalization era, competition pace among the industry has been becoming faster. This leads in changes on business process of many companies, including companies in Indonesia. Implementing international standards for management system becomes a critical step and decision for the companies in order to survive in the competition. (Nurcahyo and Alfredo 2018). Brent Crude oil is a major benchmark price for purchases of oil worldwide. While Brent Crude oil is sourced from the North Sea the oil production coming from Europe, Africa and the Middle East flowing West tends to be priced relative to this oil. Brent is the leading global price benchmark for Atlantic basin crude oils. It is used to set the price of two-thirds of the world's internationally traded crude oil supplies. It is one of the two main benchmark prices for purchases of oil worldwide, the other being West Texas Intermediate (WTI). Indonesia have a Standardization of fuel oil Price called Indonesia Crude Price (ICP). If looked Figures 2 and 3, ICP and Brent Crude Oil have same fluctuation. And the Figure 4, the comparison of fuel oil and gas price showed any gap that can be opportunity PT Antam, Tbk to get Operational Effectiveness.

The authors focus on Brent e of Crude oil majority increased. This situation is important to PT Antam Tbk, related to the fuel oil Price that consumed to produce electricity. If the ICP or Brent Crude Oil increase, impact the cash cost production of the smelter will be increased). Main purpose of optimization in industry is to increase efficiency in production (Nurcahyo, et al. 2016).

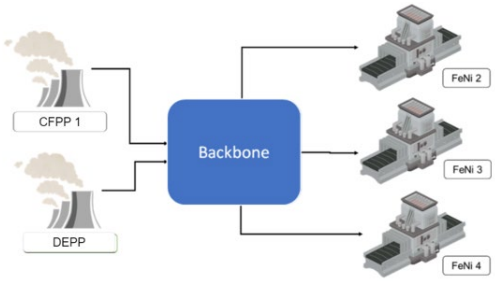


Figure 1. Power Plant Scheme PT Antam, Tbk
(Source: Report Retrofit ANTAM 2020)

If compare to other option fuel. there is one option to change to gas. There are some advantages if PT Antam Tbk will have a plan to diversification fuel oil from fossil oil to gas. Companies operating in this industrial sector must be able to implement strategies that can result in better performance growth in facing the challenges above. To supply electricity smelter, PT Antam, Tbk operate Power Plant are 8 x 17 MW Diesel Engine Power Plant and 2 x 30 Coal Fired Power Plant (Figure 1)

Figure 2. History Brent Crude Price 2019 – 2022
(source: https://tradingeconomics.com/commodity/brent-crude-oil, 2022)

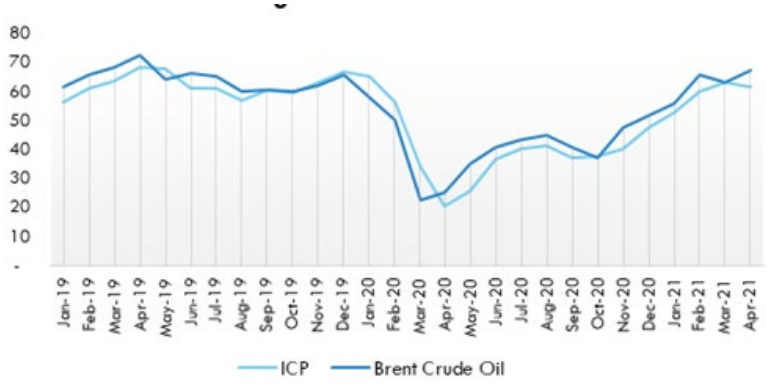
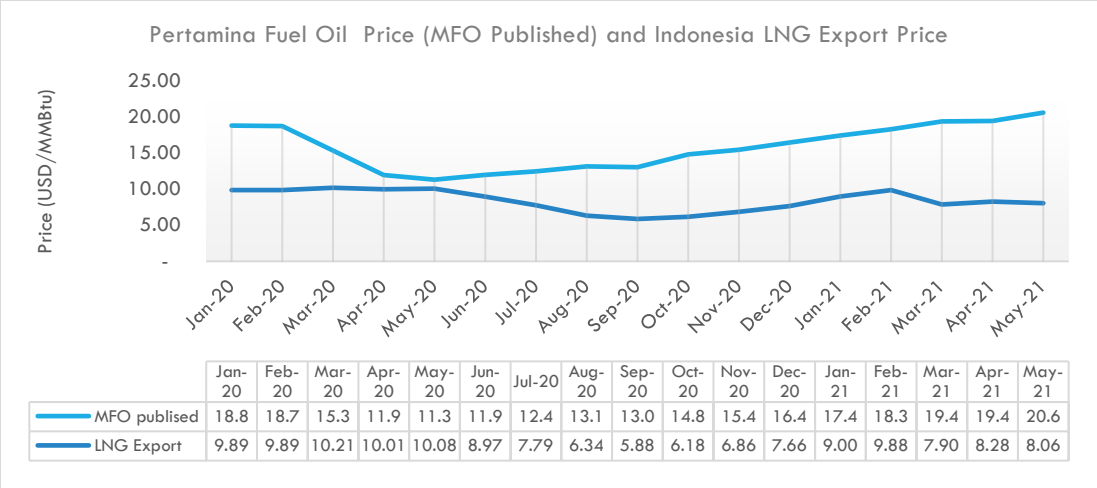


Figure 3. History Brent Crude Price 2019 – 2022
(Source: ICP Price 2019 - 2021)



	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21
MFO publised	18.8	18.7	15.3	11.9	11.3	11.9	12.4	13.1	13.0	14.8	15.4	16.4	17.4	18.3	19.4	19.4	20.6
LNG Export	9.89	9.89	10.21	10.01	10.08	8.97	7.79	6.34	5.88	6.18	6.86	7.66	9.00	9.88	7.90	8.28	8.06

Figure 4. Comparison Fuel Oil & Gas Price
(Source: Report Retrofit ANTAM, 2020)

The Other concern if PT Antam, Tbk still using fuel oil are The Emissions. Green House Gas (GHG) emissions have a negative effect on the environment because they can cause global warming and climate change. Therefore, efforts to reduce GHG emissions, both nationally and globally, continue. Based on the Paris Agreement in 2015, countries around the world are committed to preventing climate change and reducing GHGs. GHG emission reductions must be carried out immediately to achieve a net-zero value in the second half of the 21st century. Each country must determine, plan, and periodically report its contribution to GHG reduction. Although there is no specific target given for each country, the GHG reduction target in one period must be better than the previous period. In contrast to the Kyoto Protocol, based on the Paris Agreement, all countries (both developed and developing countries) are required to make GHG emission reduction plans. At the 15th Conference of The Parties in Copenhagen, Denmark in 2009, President of Indonesia stated that Indonesia could reduce GHG emissions by 26% by 2020. President of Indonesia also stated that GHG emissions could be reduced by 41% if Indonesia receive international assistance.

At the 21st Conference of The Parties in Paris, France in 2015, President stated that Indonesia was able to reduce GHG emissions by 29% by 2030. Nationally, the emission reduction target in 2030 based on the Nationally Determined Contribution (NDC) is 834 – 1.081 million tons of CO2-e. In order to provide information on the achievement of the targets of the NDC commitments, as well as control over the progress of NDC achievements, as well as the implementation of Presidential Regulation No. 71 of 2011 concerning the Implementation of the National Greenhouse Gas Inventory, the Government of Indonesia has organized a National GHG Inventory, as well as Monitoring, Reporting, Verification (MPV), with reference to the Intergovernmental Panel on Climate Change (IPCC) Guidelines 2006 .

Emissions are calculated for 4 (four) categories of emission sources or sectors, namely energy, industrial processes and product use, agriculture and forestry and other land use changes, and waste management. PT Antam Tbk can contribute to efforts to reduce national and global GHG emissions by reducing the amount of GHG emitted by diversification Fuel Oil to Gas in Power Plant. The global leading nickel producer association, the Nickel Institute, stated that the production of 1 kg of nickel metal produces 13 kg of carbon dioxide emissions, with direct emissions of 60% of total carbon dioxide emissions and indirect emissions related to electricity consumption of 15% of total carbon emissions. dioxide. GHG emissions of 13 kg CO2/kg nickel equals 13 tons CO2/ton nickel. Another study on the calculation of GHG emissions of various Nickel industries showed **Figure 4**. To enhance competitiveness, it is important for companies to foster a sense of innovation, and to focus on the quality of the products or services provided (Nurcahyo and Habiburrahman 2021).

Table 1. Comparison Emission Smelter
(Source: Report Retrofit ANTAM, 2020)

Location	Ore		Product		Emission (ton $CO_{2\text{-}eq}$/ton unit)
	Ore	%Nickel	Metal	%Nickel	
Australia	Laterit	1.3	FeNi	30	13.9
China	Laterit	1.05	FeNi	16	12.2
Yunani	Laterit	1.1	FeNi	20	12.6

1.1. Objectives

The objective of this research is to understand strategic initiatives conducted by a company that operates in Nickel Smelter in Mining sector to achieve better performance growth by facing the increase of fuel oil price. This research selected one of leader companies in Indonesia that operates in Nickel mining: PT Antam Tbk.

2. Literature Review

2.1. Operational Effectiveness

Organizations need to pay attention to their operational effectiveness in their attempt to meet these objectives so as to remain competitive, as this is a primary driver of business performance (Ben et al., 2008; Slack, Chambers, & Johnston, 2009; Wheelwright and Bowen 1996). Operational effectiveness refers to the ability to establish processes based on core capabilities within the organizations that encourage them to exceed customer's expectations (Evans & Lindsay,\ 2011; Porter 1996). Furthermore, in the search for effectiveness, organizations need to deliver value-adding products or services of exceptional quality, on time, and at a competitive price. Operational effectiveness involves improving and measuring process performance by leading and controlling the operations within the firm. A better use of resources through these core processes enables the organization to eliminate waste and reduce costs, adapt more appropriate technological innovations, and therefore perform better than competitors (Porter, 1996). Competitiveness is one of the organization goal. In this era, such a goal can be achieved by entering the customer image and keeping its loyalty. In order to do this, companies need to maintain their product quality, as well as their safety and environmental-based production process. Certifications are made for these criteria as soon as it is available, such as quality management systems, environmental management systems, and occupational health and safety management systems (Nurcahyo and Elfianus 2018).

The five performance dimensions or objectives an organization seeks to fulfill to attain operational effectiveness include cost, quality, reliability, flexibility, and speed (Hill 2005). Improving cost performance means that organizations need to identify the inefficiencies and waste in processes such as procurement, product, or service design, and the performance of staff (Russell and Taylor 2008). Cost efficiency refers also to productivity relative to the cost being effective without wasting time or effort or expense, and relative balance of effectively meeting reach and frequency goals at the lowest price (Bisbe and Otley 2004). The measurement of costs allows quality-related activities to be expressed in the language of management (Hazlettaet al. 2013).

Manufacturing performance is integral to the success of companies where superior performance leads to an increase in competitiveness (Amrina and Yusof 2011). In the manufacturing sector, it is important for companies to identify and evaluate the parameters that improve their performance, especially those related to operational performance (Tan and Wong 2015). The main objective of a manufacturing organization should be to improve its operational performance (Ali et al. 2020). The most commonly used measurements of operational performance are quality, time and delivery, cost, flexibility, customer satisfaction (El Mola and Parsaei 2010), and productivity (Feng et al. 2007). Global competition encourages manufacturing industries to enhance their competitiveness on a multidimensional scale (Desai and Prajapati 2017). Additionally, the operational performance has a significant positive impact on the business performance. This study also reveals the major obstacles in the effective implementation of ISO 9001 in the manufacturing industry, which include a lack of qualified personnel, inadequate training, employee resistance, and lack of commitment among top-level management executives (Nurcahyo and Habiburrahman 2021)

Quality is viewed as a consistent provision of products and services that satisfy customers, rather than only minimizing defects and conforming to specifications without any clear market-oriented continuous improvement (Russell and Taylor 2008). Yang (2011) pointed out that in terms of service quality, the service and public-oriented firms have

different operational features but can still have common characteristics (e.g., time, communication, personnel, convenience, safety, etc.). Reliability suggests that an organization's processes consistently perform as expected over time. That is, customers are satisfied by organizations that provide services that do not fail over a period of time or with services that are delivered as agreed (Corbett 1992; Porter 1996). When customers are evaluating the characteristics of a product, they may find that it performs differently from its intended purpose or malfunctions after a period of time (Wild 2000). Thus, reliability is essential in the effectiveness of operations and is closely related to the satisfaction of customers with the use of services or products. For systems, reliability can best be described as the likelihood that a system will not fail to perform its function as designed within a given time horizon and environmental conditions (Kuo and Zuo 2003). Main purpose of optimization in industry is to increase efficiency in production. A mathematical model of the preventive maintenance and production scheduling is developed (Nurcahyo et al. 2016).

Operational flexibility is a vital managerial tool to both manufacturing and service industries especially in the present highly competitive business and market environment (Slack et al. 2006). Operational flexibility simply refers to the managerial capabilities that can be set up quickly in order to provide a rapid response to environmental changes that are familiar or routine in an organization (Verdu-Jover et al. 2004). Furthermore, flexibility includes the capacity to produce a wider range of services and products, respond to any seasonal demand factors, meet shorter lead times, and cope with customers' specification changes during the process (Hill 2005). The present technological age and changing environment make flexibility one of the most competitive priorities that most service firms have to deal with in their operations. Flexibility in operations generally gives organizations more options to diversify their products and services, allowing them to handle a greater variety of market needs and customers. However, the flexibility concept of service process also suffers from the same confusion that overwhelmed the manufacturing process for years (Chanopas et al. 2006). In essence, flexibility involves the quick introduction of newly designed services into the service delivery system, handling changes in the service mix and variations in customer delivery schedules, rapid adjustment of capacity, and customizing services (Aranda 2003).

Competitiveness is one of an organization goal. In this era, such goal can be achieved by entering the customer image and keeping its loyalty. In order to do this, companies need to maintain their product quality, as well as their safety and environmental-based production process. Integrated management system defined in this research consists of quality management, environmental management, and occupational health and safety. Total quality is an effective system that integrates all efforts to define, design, fabricate, and install a product or service costing the cheapest possible while providing total customer satisfaction (Noori and Radford 1995). This quality management indicates that the purpose of quality standards is to demonstrate to customers, the supplier chain and endusers that the product or service concerned is subject to rigorous systematic evaluation and continuous improvement (Walker 2000). Environmental management (EM) in industrial process is a particularly important issue.

It has two general objectives: prevention of incidents or accidents that might result from abnormal operating conditions, and reduction of adverse effects that result from normal operating conditions (Sanz-Calcedo et al. 2015). Many industries have invested interest in protecting the environment because attractive and safe surroundings are part of its core product (Chan & Hsu 2016). This way of thinking concludes that environmental management is not just about being environmentally friendly, rather, it is about good business sense and higher profits (Prajogo et al. 2014). Health and safety management is one of the total quality management aspects that would imply a goal of an injury free and healthy working environment. Vasie (1998) has stated that organizations adopting this approach, therefore, need to recognize that proactive risk control, through an assured health and safety management system, is more effective than reacting to accidents and ill-health once they have occurred. Firm's operational performance are indicators of effectiveness, efficiency, and environmental responsibility such as, cycle time, productivity, waste reduction, and regulatory compliance (Business Dictionary 2017). Also, it is stated that operational performance is usually measured as a composite of several performance dimensions and reflects the performance of the internal operation of a company in terms of product/process quality and inventory performance (Martin 2016).

Finally, the speed with which an organization can provide new products or service development is an important capability because the environment is constantly changing (Tidd and Bessant 2009). Manufacturers are discovering the advantages of time-based competition (Russell and Taylor 2008). Competing on speed, however, requires an organization characterized by fast moves, fast adaptation, and tight linkages (Russell and Taylor 2008). At the same instance, the speed with which an organization can provide new products or service development is an important capability because the environment is constantly changing (Tidd and Bessant 2009).

2.2. Strategy Formulation

The strategic management process consists of three stages: strategy formulation, strategy implementation, and strategy evaluation. Strategy formulation includes developing a vision and mission, identifying an organization's external opportunities and threats, determining internal strengths and weaknesses, establishing long term objectives, generating alternative strategies, and choosing particular strategies to pursue (David 2007). Vision and mission is an important part of strategic management, vision is generally seen as a picture of excellence, something that the person, team or organization wants to create in its best possible future. The mission should be defined before we develop the strategy and the space in which we create a strategy. The strategy, defined based on the SWOT matrix, determines how to get closer to the goal (David and David 2017).

Albert Humphrey of the Stanford Research Institute developed the SWOT analysis technique in the 1960s as a strategic planning tool. The SWOT acronym is formed by combining the initial letters of the four terms Strengths, Weaknesses, Opportunities, and Threats. Strategic planning and environmental analysis tool, this qualitative strategic technique is used to identify the key internal (strengths and weaknesses) and external (opportunities and threats) strategic factors that an organization (group, person, etc.) faces and affect its objectives (Amirshenava et al. 2022).

Based on this technique's results, appropriate strategies can be developed to maximize strengths, eliminate weaknesses, exploit opportunities, and counter threats. However, despite all the mentioned advantages, SWOT analysis's subjective and linguistic nature is considered the main weakness of this method, making it challenging to examine the strategic factors and compare the selected strategies (Hill and Westbrook 1997; David and David 2017). The process of defining strategies or directions to achieve a goal and deciding how to apply these strategies is known as strategic planning. In a systematic strategic planning process, by creating knowledge of the internal and external environment, the project manager can benefit from appropriate strategies to reduce vulnerabilities and ensure the project's success. The strategy, defined based on the SWOT matrix, determines how to get closer to the goal (David and David 2017).

3. Data Collection

3.1. Company's Report

PT Antam, Tbk have big resources in mineral reserves, the biggest reserve is from nickel, 375,52 Million WMT (Sustainability Report Antam 2020). PT Antam, Tbk was established on July 5, 1968 based on Government Regulation (PP) No. 22 of 1968 under the name "Perusahaan Negara (PN) Aneka Tambang" and announced in an additional No. 36, BNRI No. 56. The establishment was carried out through the merger of several state-owned mining companies that produce various mineral and coal commodities. PT Antam, Tbk is engaged in managing mining and mineral processing operations throughout Indonesia. In 2017, PT Antam, Tbk became part of PT Indonesia Asahan Aluminum (Persero) or MIND ID (Mining Industry Indonesia), which served as Mining Industry Holding under PP No. 47 of 2017 concerning the Addition of Republic Indonesia's Equity Participation. PT Antam Tbk, PT Bukit Asam Tbk, PT Freeport Indonesia, and PT TIMAH Tbk officially joined the SOE holding company in the mining industry sector under the supervision of PT Indonesia Asahan Aluminum (Persero) (INALUM) or MIND ID.

Table 2. Result Customer Satisfaction Index
(Source: Sustainability Report PT Antam, Tbk, 2020)

Produk | Product	CSI	Status Peringkat | Rate
Feronikel | Ferronickel	88,76	Sangat Baik | Very Good
Bauksit | Bauxite	80,31	Baik | Good
Logam Mulia | Precious Metal	83,04	Tinggi | High

Together carries out the main task of managing strategic mineral reserves and resources to create civilization and Indonesian society's welfare. Antam have vision to become a leading global corporation through diversification and integrated natural-resources based business. The result of Our Customer Satisfaction CSI survey showed Table 2 for

Ferronickel and Bauxite was carried out by internal team, meanwhile CSI for Precious Metals products was carried out by external party.

Table 3. Total Energy Consumption ANTAM
(Source" Sustainability Report PT Antam, Tbk 2020)

Unit Bisnis Business Unit	Sumber Energi Energy Source	Satuan Unit	Periode | Period					
			2018		2019		2020	
			Volume	GJ	Volume	GJ	Volume	GJ
UBP Nikel Sulawesi Tenggara Southeast Sulawesi Nickel Mining Business Unit	*Marine Fuel Oil* (MFO)	Liter	136.777.617	5.249.525	149.872.395	5.752.103	131.303.059	5.039.411
	Industrial Diesel Oil (IDO)	Liter	5.941.778	222.282	5.163.754	193.176	5.369.023	200.855
	Batu Bara | Coal	Kg	272.317.085	5.146.806	221.880.000	4.193.550	328.457.939	6.207.855
	Solar | Diesel		554.874	20.758	612.105	22.899	473.516	17.714
	Bensin | Fuel	Liter	280.450	9.415	302.520	10.156	220.854	7.414

In the Table 3. ANTAM still using fuel Oil (Marine Fuel Oil) to produce electricity for Smelter Nickel Plant. If benchmarked to other Power Plant that have been converted from fuel oil to gas, using of gas fuel is able to provide savings on the basic production costs (BPP) of electricity. For example, the use of biodiesel fuel (B20/B30) at the Sorong PLTMG Table 4 initially produced an electricity BPP of Rp 1847/kWh, while the conversion of fuel to gas could reduce the electricity BPP to Rp 1368/kWh. The result of the other Power Plant are good news to PT Antam, Tbk for saving cash cost production. If the Electricity Price decrease, it could be impact to lower cash cost production. To Implemented diversification fuel oil to gas must have best planning. First of all, the activity to make sure the price of gas compare to Fuel Oil is lower than it. Based on data, Indonesia Government have regulatory for gas price fixed in several sector and the one sector is Power Plant (PP No 8/2020). The second concern is projection of Price between Fuel Oil and Gas in 30 years later. some formula for gas are 11.5% x ICP+ 4.67 + 0.0958 x ICP x 11.5%.

Table 4. Comparison Power Plant
(Source, Report Retrofit Antam 2020)

Aspect	PLTDG Pesanggaran	PLTMG II Arun	PLTMG Sorong	PLTMG Nias	PLTMG Balai Pungut	PLTG Amurang
Fuel	LNG, HSD	LNG	LNG, B30	LNG	LNG, HSD	LNG, HSD
Capacity Power Plant	182.4 MW	250 MW	50 MW	25 MW	110 MW	105.5 MW
Total Engine	12 unit	13 unit	5 unit	5 unit	7 unit	6 unit
System Gas	FSRU+FRU	LNG	LNG	LNG	Gas Piping	FSRU

3.2. Progress of Company's Diversification Strategies

To obtain valid data regarding the performance of Diesel Engine Power Plant with other fuel combinations, there are 3 methods:

a) Experimenting/commissioning with each fuel combination.
b) Using the results of experiments/research using each fuel combination in other motors of the same type (benchmarking).
c) Performing a combustion engine simulation with combustion engine modeling software, such as AVL BOOST, as well as combustion engine modeling software used by the engine maker, Wärtsilä.

ANTAM has been Commissioning Engine Diesel Power Plant from Fuel Oil and Gas. The efficiency of engine is 43.52%, 43.48%, and 43.60%. The commissioning has been held in 2 hours using CNG. The result is significant based on heat rate engine and fuel consumption.

In the environment aspect there is analysis of greenhouse gas (GHG) emissions to determine more environmentally friendly fuels. GHG emission analysis is carried out based on the Intergovernmental Panel on Climate Change

Guidelines for National Greenhouse Gas Inventories (IPCC2006) with a Tier-1 approach, which has been widely used by various institutions in the world. GHG emissions due to fuel combustion include carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O).

Based On Data Commissioning, Antam has good result diversification from fuel oil gas. The results of the GHG emission calculation show that the replacement of fuel oil to gas can reduce GHG emissions by 25% showed table 5, from the original 390 thousand tons CO2-eq/year to 292 thousand tons CO2-eq/year, or from the original 15.04 tons CO2-eq. /ton nickel in ferronickel to 11.25 tons CO2-eq/ton nickel in ferronickel. Reducing GHG emissions can provide benefits for PT Antam Tbk, because it can reduce carbon tax. The Nickel Institute states that in nickel batteries, the nickel content in the battery is considered a significant contributor to the carbon footprint of the battery. In NMC batteries (nickel, manganese, cobalt), nickel at the cathode of the battery accounts for 7% of the total carbon footprint of the battery. The nickel industry has reduced GHG emissions by 9% from 2007 to 2017. Efforts to reduce emissions are still ongoing and are expected to reduce nickel's contribution to the battery's carbon footprint.

Table 5. Comparison GHG Emission
(Source, Report Retrofit Antam, 2020)

GHG emission	Fuel Oil	Gas
Year (Million-ton $CO_{2\text{-eq}}$/year)	390.54	292.11
Per ton nikel (ton $CO_{2\text{-eq}}$/TNi)	15.04	11.25

3.3. Evaluation of Company's Strategies

The first strategy that has been implemented in ANTAM is diversification as one of David's alternatives strategies. By implementing diversification. Switching from fuel oil and gas can be choosen ANTAM depend on price. Right now, if Antam using gas to fuel of Power Plant, it can reduce 40 percent of total cost Power Plant. This strategy will be advantages in cash cost Nickel Smelter Plant Antam. Total cost of Smelter Plant is very important to get sustain and compete to other competitor.

The Second Are Strategy Formulation, to analyze the strategic situation so that all internal and external factors of the company can be mapped properly. One of the tools commonly used in situation analysis is the SWOT analysis. The author describes the internal and external factors Table 6 and 7 that compose the SWOT analysis at PT Antam Tbk as well as the decrease in the TOWS analysis.

This analysis combines the factors that exist in the SWOT analysis to produce a TOWS matrix containing the combined strategies. The types of strategies that can emerge from the TOWS analysis are as follows:

- ST strategy (combination of Strength and Threat) or diversification strategy; which means taking advantage of a certain strength to deal with a threat
- SO strategy (combination of Strength and Opportunity) or offensive strategy; which means taking advantage of certain strengths to reach opportunities
- WT strategy (combination of Weakness and Threat) or defensive strategy; which means minimizing or eliminating certain weaknesses to deal with threats
- WO strategy (combination of Weakness and Opportunity) or rationalization strategy; which means minimizing or eliminating certain weaknesses by taking advantage of certain opportunities

Table 6. Internal Analysis (Strength and Weakness)

No.	*Strength*	No.	*Weakness*
1	*Commissioning* retrofit have good impact to know readiness conversion fuel oil to gas,	1	PT Antam Tbk doesn't have any experience using Gas Fuel.
2	The Power analysis get no trouble conversion ue oil to gas.	2	PT Antam, Tbk doen't have any experience in procurement of gas
3	Stability and financial PT Antam is very good.	3	Existing Energy Portion are 30 Percent
4	Nickle Product have main target in export sector.	4	Emission from fuel oil higher than gas and past limitation.
5	PT Antam, Tbk have equipment convert fuel oil to gas	5	Low Capacity in the gas demand. Impact the price can be higher

Table 7. External Analysis (Opportunity and Threat)

No.	*Opportunity*	No.	*Threat*
1	Gas Supply Domestic is oversupply	1	Pertamina can give discount of fuel oil
2	Emission Carbon of Gas lower than fuel Oil	2	Some Seller of gas doesn't have equipment fulfil in PT Antam, Tbk requirement
3	International Market have big concern in emission of Product	3	Fluctuation of fuel oil price have a big uncertainty
4	Price of gas lower than fuel oil	4	Process LNG can be increase of gas price
5	There some distributor of gas have good experience		

4. Results and Discussion

If we can see table 8, the result from the fuel cost can be decrease around 40% from fuel oil to gas showed Table 8. The other impact in the operation of power plant, it can be reduced maintenance cost 25%.

Table 8. Cost Fuel Oil and Gas

Component	Fuel Cost (USD)	Maintenance
Fuel oil	90,040,764.35	1,250,000.00
Gas	55,637,388.10	1,000,000.00

In the Table 9, if we can see the breakdown unit gas price, the total cost of electricity around 911 Rupiah/kWh, this is the big impact result because the existing price of electricity around 1500 – 1800 Rupiah/kWh.

Table 9. Breakdown Unit Gas Price

Cost component	Unit	Gas Price
Gas unit price	USD/MMBtu	6.15
Fuel cost	IDR	435,752,778,040.84
Other fuel cost	IDR	289,637,342.37
Labour cost	IDR	18,480,957,192.17
Service cost	IDR	45,109,599,051.78
Other cost	IDR	298,858,089.00
Depreciation	IDR	64,873,246,018.80
Amortization	IDR	(1,004,525,162.00)
Total	**IDR**	**563,800,550,572.97**
Fuel cost/electricity produced	USD/MWh	50.93

Unit cost of electricity	Rp/MWh	911,834.92
Unit cost of electricity	**Rp/kWh**	**911.83**
Unit cost of electricity	**USD/MWh**	**65.89**

carbon tax showed Table 10 that the replacement of fuel from Fuel Oil to gas can reduce carbon tax by 25%, from the original 1.95 million USD/year to 1.46 million USD/year, or from the original 75.2 USD/ton nickel in ferronickel to 56.3 USD/ton nickel in ferronickel.

Table 10 Carbon Tax Fuel Oil and Gas

Carbon Tax	***Fuel Oil***	**Gas**
Year (Million USD/Year)	1.95	1.46
Ton Ni (USD/TNi)	75.2	56.3

5. Conclusion

The Strategy of PT Antam Tbk to diversification Fuel oil to gas got big impact in the Operation of Smelter and environment. The Concern to achieve this strategy is obtaining competitive gas prices at plant gates with guaranteed supply from sustainable gas providers, so that savings is obtained when compared to the use of fuel oil. Changing in fuel to gas do not affect the performance of the electrical system, both in terms of capability and generator performance at Diesel Engine Power Plant (DEPP), so Diesel Engine Power Plan can still operate properly. Substitution of fuel from Fuel Oil to gas can reduce the company's annual GHG emissions and carbon tax by 25%. GHG emissions from the original 390 thousand tons CO2-eq decreased to 292 thousand tons CO2-eq with a decrease in GHG emissions per tons' nickel in ferronickel by 3.79 CO2-eq (from 15.04 tons CO2-eq to 11.25 tons CO2-eq). Carbon tax from the original 1.95 million USD decreased to 1.46 million USD. The reduction in carbon tax per tons of nickel in ferronickel is 19 USD (from 75.2 USD to 56.2 USD).

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