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Analysis of Development Natural gas-based Petrochemical Industry in Teluk Bintuni Regency, West Papua Province using an Industrial Tree Model and Value Chain and Supply Chain Analysis

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ABSTRACT

The petrochemical industry, especially the petrochemical industry in Teluk Bintuni Regency, West Papua Province, is an industry engaged in natural gas processing by considering the needs of the Upstream Plastic Product Industry Market and its use in supporting human activities. It is hoped that the integration of the upstream-downstream industry can build a strong supply chain. This is in line with the application of industry 4.0 according to the roadmap of Making Indonesia 4.0, which aims to increase the competitiveness of the national industry in the global arena. Examples of upstream petrochemical industry products include methanol, ethylene, propylene, butadiene, benzene, toluene, xylene, coproduct fuels, petrol pyrolysis, fuel oil pyrolysis, raffinate, and C4 mixtures. The analysis developed is using an Industrial Tree Model and porter's value chain analysis and supply chain analysis. The results of this research are seven points.

KEYWORDS

Petrochemical
Industrial Tree Model
Value chain analysis
Supply chain analysis

INTRODUCTION

Teluk Bintuni Regency is rich in gas reserves, currently estimated at 17 T.C.F. and managed by a consortium led by British Petroleum. Currently, a robust train three is being developed with a production capacity of 1,200 MMSCFD, of which 90 MMSCFD will be allocated for the development of the petrochemical industry in Bintuni Bay in the first phase of 2021 and an additional 90 MMSCFD in the second phase in 2026.

In Government Regulation Number 14 of 2015 concerning the National Industrial Development Master Plan (RIPIN), it is stated that the Ministry of Industry has a plan to develop the methanol industry and its derivatives, as well as ammonia and its derivatives, as one of the petrochemical industries prioritized as a strategic industry.

To develop the industry, the Ministry of Industry has proposed the Development of Natural Gas-Based Petrochemical Industrial Estates in Teluk Bintuni Regency as a National

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Strategic Project on 6 December 2016. The letter received a positive response from the Committee for the Acceleration of Priority Infrastructure Development (KPPIP) with issuing a Regulation of the Minister of Finance. Number 58 of 2017 concerning National Priority Projects in which the Tangguh Train 3 Development Project impacts the planning of the Integrated Petrochemical Industrial Estate Development Project in Teluk Bituni Regency to become one of the National Strategic Projects.

The development of the Petrochemical Industrial Estate in Teluk Bituni Regency is expected to attract an investment of Rp 1.76 trillion and around USD 800 million for the construction of a methanol plant with a capacity of 800 Kilo Tons Per Anum (KTPA) for 20 years, which will utilize 50 Ha of land. In addition, there is a potential tenant from investors brought in by Genting Oil Kasuari, Pte. Ltd., who will utilize approximately 40 hectares of land, with a potential investment of USD 1.6 billion. The plant is expected to produce 1,600 KTPA of methanol over 20 years. The next potential tenant is the development of phase II of train 3 Tangguh, which delivers 90 MMSCFD of gas in 2026 for ammonia factories and their derivatives.

The availability of methanol can help meet the raw material needs of various chemical derivative products in the country, including raw materials for plastic ore, polyethylene, polypropylene, formaldehyde, dimethyl ether as a substitute for L.P.G., biodiesel blends, and others. With the availability of methanol as raw material for the domestic industry, it is hoped to reduce dependence on methanol imports and encourage downstream of the natural gas-based chemical industry.

LITERATURE REVIEW

In the last few years, the domestic gas market has experienced dynamic development characterized by a significant increase in the domestic supply allocation of total production share and a drop in the percentage of L.N.G. exports (Purwanto, 2016). On the international market, prices for petrochemical products tend to fall, thanks to falling raw material prices. According to World Bank data, the average oil price for 2019 weakened from USD 68.3 per barrel to USD 61.4 per barrel. Likewise, natural gas prices also declined. On the Henry Hub spot market in the United States, the price of natural gas fell 18.5%, from USD 3.2 per million British thermal units (MMBtu) to USD 2.6 per MMBtu (Pefindo, 2019).

With current low prices, the operation of new facilities is relatively unprofitable in the short term because it will lead to excess supply and a further drop in selling prices. Investment in the petrochemical sector is likely to proceed slowly in the next few years. Petrochemical projects are very capital intensive and require high economies of scale to achieve efficient production. Also, the construction of facilities can take quite a long time, at three to seven years.

Amidst the rise of electric vehicles, the oil and gas industry remains vital for Indonesia in the future. While fuel demand is predicted to decrease, the oil and gas industry will still be needed to develop Indonesia's petrochemical industry, and President Joko Widodo aims to stop the import of petrochemical products in 2024.

According to the data from The Indonesian Olefin, Aromatic, and Plastic Industry Association (Inaplas), Indonesia's volume of imports of petrochemical products is very high. For example, the national demand for polypropylene, polyvinyl chloride, polyethylene, and polystyrene is around six million tons per year. Unfortunately, the national petrochemical industry can only supply around 30 percent of domestic demand.

Petrochemicals are the chemical products obtained from petroleum by refining. The two most common petrochemical classes are olefins (ethylene and propylene) and aromatics (benzene, toluene, and xylene isomers). Oil refineries produce olefins and aromatics by fluid catalytic cracking of petroleum fractions. At the same time, chemical plants produce olefins by steam cracking of natural gas liquids like ethane and propane.

Olefins and aromatics are the raw materials for a wide range of materials. For example, ethylene produces paper, consumer electronics, detergents, footwear, and adhesives. Propylene is used to produce paints, furniture, textiles, pharmaceuticals, and food packaging.

The supply chain of the petroleum industry is highly complex compared to other industries. It is divided into two different, closely related, significant segments: upstream and downstream supply chains. The upstream supply chain involves the acquisition of crude oil, which is the specialty of the oil companies. The upstream process includes the exploration, forecasting, production, and logistics management of delivering crude oil from remotely located oil wells to refineries. The downstream supply chain starts at the refinery, where the crude oil is manufactured into the consumable products that are the specialty of refineries and petrochemical companies. The downstream supply chain involves the process of forecasting, production, and logistics management of delivering the crude oil derivatives to customers around the globe. Challenges and opportunities exist now in both the upstream and downstream supply chains (Al-Husain et al., 2006).

The structure of the petrochemical industry is exceptionally complex (Figure.1). It is severely cross-linked, with the products of one process being the feedstock of many others. For most chemicals, the production route from feedstocks to final products is not unique, and it includes many possible alternatives. As complicated as it may seem, this structure is, however, comprehensible (Toledo et al., 2010).

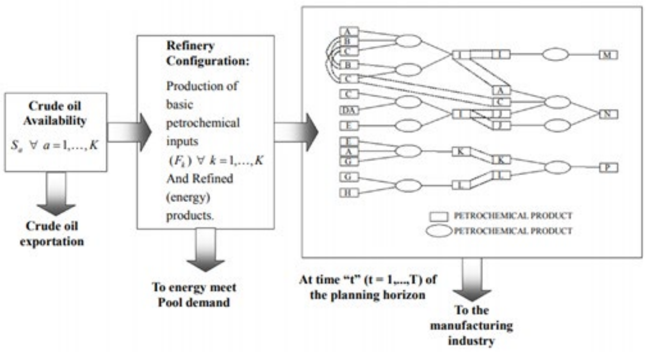

Figure 1 Intermediate and final petrochemical industry

The process technology of methanol synthesis is very mature and can be classified into high-pressure, low-pressure, and liquid-phase technology (Lee, 2015). It mainly uses the steam reforming of methane. A new development of methanol production technology is by direct hydrogenation of CO_2 using green hydrogen obtained from renewable energy (CRI, 2018; Joo et al., 1999) and has been demonstrated in a capacity of 1 ton/day (Aasberg-Petersen et al., 2011). The technology still needs to overcome the hurdles of the high cost of obtaining green hydrogen. Two fundamental types of methane reforming processes are steam reforming (S.R.) and auto thermal reforming (Lee, 2015). The reactions involved are:

$CH_4 + H_2O \leftrightarrow CO + 3H_2$ ΔH o 298K = 206 kJ/mol (steam reforming reaction)

$CH_4 + 1/2O_2 \leftrightarrow CO + 2H_2$ ΔH o 298K = −38 kJ/mol (partial oxidation reaction)

The utilization of CO_2 in natural gas reforming by the dry reforming reaction has been extensively studied.

$CH_4 + CO_2 \leftrightarrow 2CO + 2H_2$ ΔH o 298K = 247 kJ/mol (dry reforming)

However, the carbonaceous deactivation of the catalyst due to high CO_2 concentration is a critical problem (Ulber, 2015; Usman et al., 2015). The concept of combining steam reforming, dry reforming, and partial oxidation of methane, i.e., tri-reforming, was proposed for the production of syngas with desired H_2/CO ratios (Arora & Prasad, 2016). An optimization study for a maximum economic profit with the product H_2/CO ratio constraint (Arora & Prasad, 2016). The reactions involved in methanol synthesis are (Lee, 2015):

$CO + 2H_2 \leftrightarrow CH_3OH$ ΔH o 298K = −90.7 kJ/mol (4)

$CO_2 + 3H_2 \leftrightarrow CH_3OH + H_2O$ ΔH o 298K = −49.5 kJ/mol (5)

In industrial practice, the syngas feedstock for the methanol process is specified to have a CO_2/CO ratio of about 0.5 or lower and an M module value of 2.04–2.06 to limit H_2O formation and carbon deposition (König & Göhna, 1995). The M module is defined as $M = (H_2 - CO_2)/(C.O. + CO_2)$.

Once we know the material balance to determine the production capacity of the industry will eventually develop. The next step is to figure out the petrochemical industry's value chain and supply chain to be developed in the Teluk Bintuni Regency.

In Petrochemical Industries, the value chain is a full range of activities, including design, production, marketing, and distribution, that businesses go through to bring a product or service from conception to delivery. Michael Porter popularized the value chain analysis in 1985. A value chain is required to bring a product or service from concept through different stages of production, distribution, and to the final customer. Porter wrote, "Competitive advantage cannot be understood by looking at a firm as a whole; it stems from the many discrete activities a firm performs in designing, producing, marketing, delivering, and supporting its product. Each of these activities can contribute to a firm's relative cost position and create a basis for differentiation." (Michael Porter Competitive Advantage: Creating and Sustaining Superior Performance) Porter suggests that the activities within an organization add value to the services and products that a company produces.

Besides analysis value chain, to accomplish this research also conducting supply chain analysis. In modern markets, no company can compete successfully in isolation; instead, it must operate as part of supply chain networks. While firms are becoming increasingly interconnected, the very nature of such interdependencies has led to more complex and globalized supply chains. Such complexities are compounded by the need to improve internal efficiencies, grounded in philosophies such as lean manufacturing, just-in-time inventory, and supplier rationalization. The implementation of such philosophies, coupled with increasingly complex and global supply chain configurations, has led to firms becoming ever more susceptible to adverse conditions festering elsewhere in the value chain. As such, upstream supply disruptions often severely impact a firm's cost base, revenue, and shareholder value. Traditional risk management approaches, such as risk identification and quantification, seldom prove effective when a firm is confronted with an unexpected disruption (Chunshan & Wei, 2004).

In this research, the implementation of the economic feasibility study for petrochemical industrial development projects in Teluk Bintuni Regency is divided into main scopes (Kotzé et al., 2017): 1. Economic Feasibility Study 2. Petroleum industry 3. Risk and uncertainty analysis 4. Contract of oil and gas 7. The case study in this study only discussed economic feasibility studies and case studies on the downstream petrochemical product that came from the gas-based industry.

METHODOLOGY

In completing the work on the analysis of natural gas-based petrochemical development in Teluk Bintuni Regency, the author conducts detailed research to later be able to display an investment profile that matches the needs of investors and other stakeholders in terms of information that is analyzed and displayed later in the investment profile book. Schematically the flow of the framework from the preparation of the analysis of Natural Gas-Based Petrochemical development in the Teluk Bintuni Regency (figure.2) will be illustrated as follows:

Step 1:

A. Conduct a review of:
   1) Review of spatial and sectoral policies and legislation related to Bintuni Bay.
   2) We review policies and legislation on industrial management (upstream and downstream) in Bintuni Bay.
   3) Review of documents related to Bintuni Bay development planning, such as:
      - Master plan for the petrochemical industry in Bintuni Bay
      - Masterplan for the Tangguh SEZ in Bintuni Bay
      - Planning for the development needs of transportation infrastructure, logistics, energy, water, human resources, and technology
      - Preliminary feasibility study (outline business case) for the development of the Bintuni Bay industrial area
      - Feasibility study on the development of an integrated petrochemical industrial complex in West Papua

B. The central infrastructure and industrial support condition in the Bintuni Bay National Strategic Project (P.S.N.)

Step 2:

A. Develop a profile related to the general description of TelukBintuni Regency and regulations and policies that support the development of the natural gas-based petrochemical industry. At the same time, compile a profile of the existing areas and infrastructure in Bintuni Bay, especially if it is related to the central issue regarding the suitability and support of regulations and legislation for the development of the Teluk Bintuni National Strategic Project, as well as regulations on the management of the natural gas-based petrochemical industry in Teluk Bintuni from various related inter-ministerial regulatory sources.

B. Industrial Tree Analysis, the industrial tree analysis in question is related to what types of products and industry types will be developed in Bintuni Bay by prioritizing the natural gas-based petrochemical industry. So the hope is to prioritize the development of the natural gas-based petrochemical industry, which has the most significant added value.

Petrochemical Industry Product Lines, including:

- The Methanol Route
- Ammonia Route

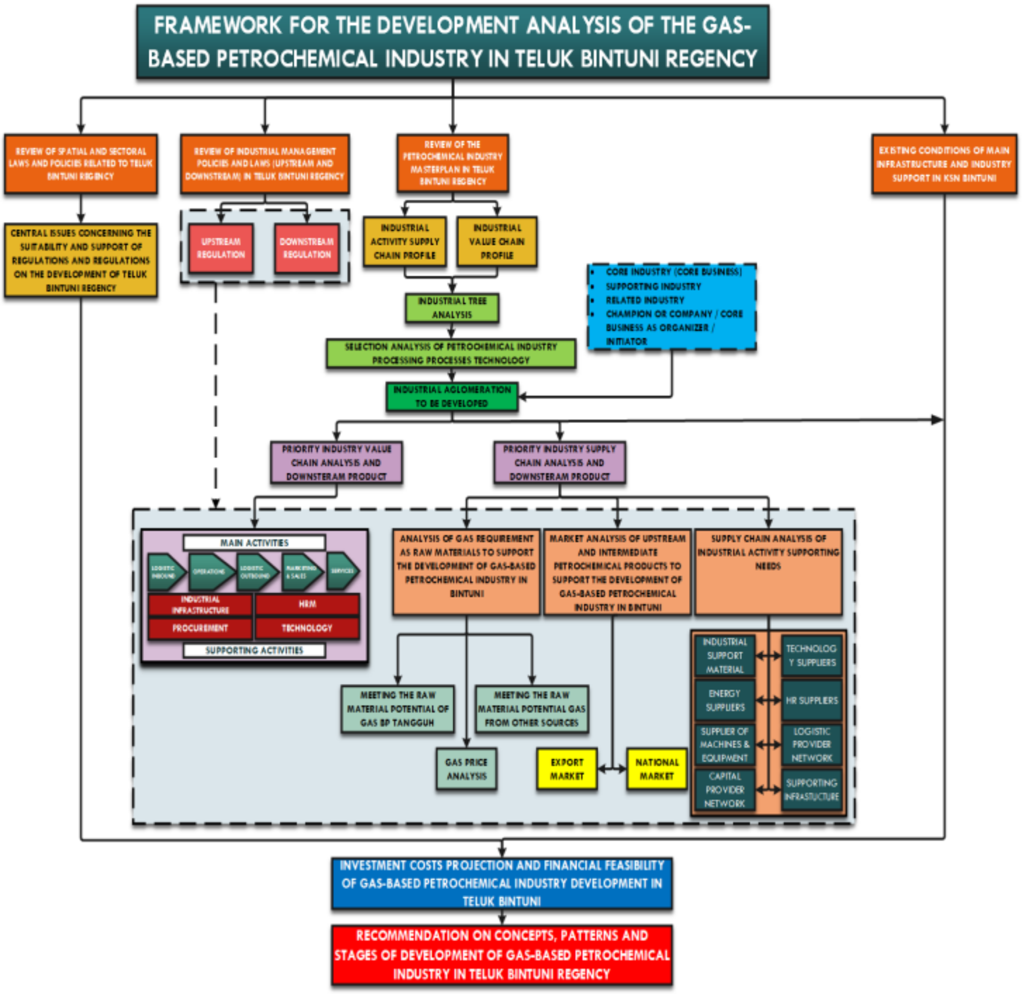

Figure 2. Methodology

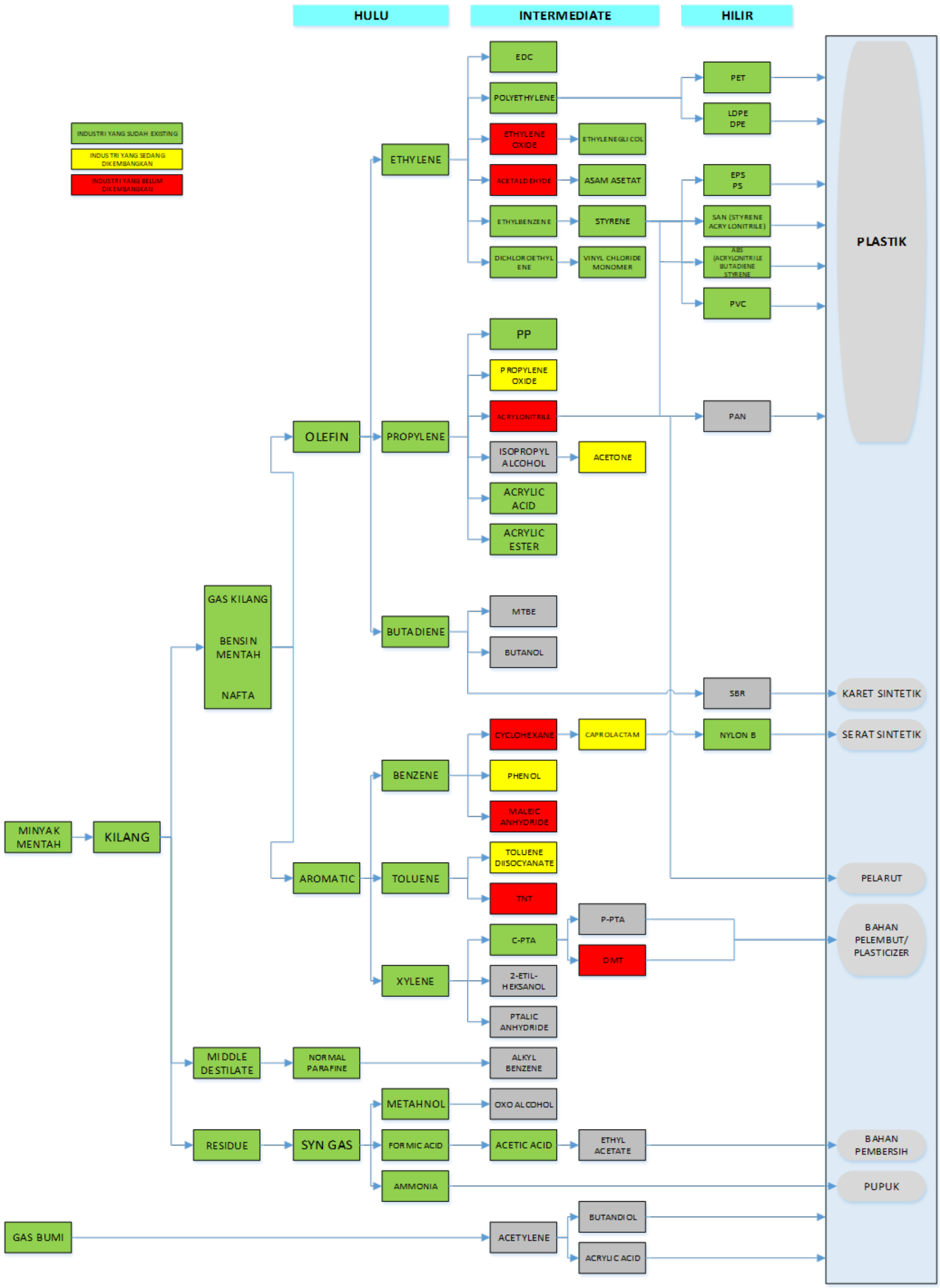

Figure 3. Petrochemical Industrial Tree

Step 3:

A. Conduct Value Chain and Supply Chain Analysis

1. Value Chain Analysis (Porter's Value Chain Model)

   Value chain analysis is the process by which a company identifies the main activities and their supporting activities that add value to the final product and then analyzes these activities to reduce costs or increase product differentiation. Value chains represent the internal activities carried out by the company when converting inputs into outputs.

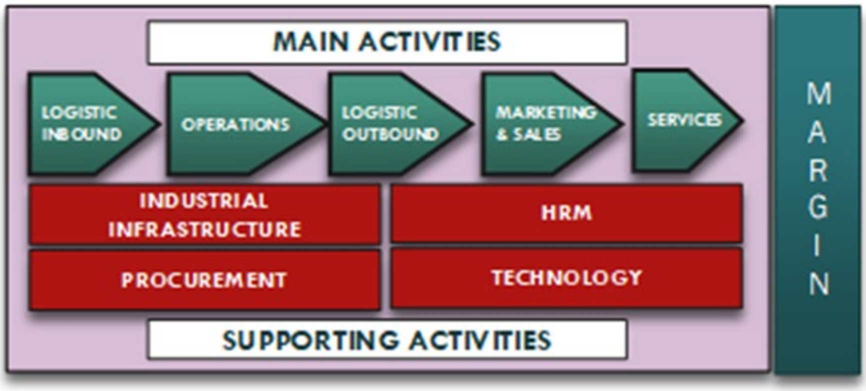

Figure 4. Value Chain Analysis Model According to Porter

   There are two different approaches to performing the analysis, depending on what kind of competitive advantage the company wants to create (cost advantage or differentiation).

2. Supply Chain Analysis
3. In the supply chain analysis in the study of the Natural Gas-Based Petrochemical Investment Profile in Bintuni Bay, it is divided into three groups, namely:
   a. Analysis of the fulfillment of natural gas raw materials to support the development of the natural gas-based petrochemical industry in Bintuni Bay, divided into three types of analysis: 1. Potential fulfillment of natural gas raw materials from BP Tangguh, 2. Potential fulfillment of natural gas raw materials from sources other (Genting Oil or other sources), 3. Analysis of gas prices that are still able to meet industry margins.
   b. Analysis of market fulfillment. Later, the analysis related to the demand side of the petrochemical industry will cover the national market as a form of market fulfillment in the form of import substitution or analysis related to the ASEAN regional market and the global market.
   c. Analysis of the supply chain needs to support industrial activities, which consists of the analysis of:
      - Industrial auxiliary materials
      - Energy suppliers
      - Machinery & equipment suppliers
      - Technology suppliers
      - H.R. suppliers

- Logistics provider network
- Capital provider network
- Regional supporting infrastructure

B. Investment Analysis and Financial Feasibility

This type of research is a descriptive study with a quantitative approach. The calculation of feasibility, both economically and financially, is done by calculating the Benefit-Cost Ratio (B.C.R.), Net Present Value (N.P.V.), and Internal Rate of Return (IRR). The implementation of descriptive research methods is not limited to collecting and compiling data but includes analysis and interpretation. The research procedure to estimate the financial feasibility is by estimating the development or investment costs of the natural gas-based petrochemical industry development in Bintuni Bay, then estimating operating costs based on standards, regulations, or regulations and previous studies. After that, an estimate of revenue from the existing infrastructure is also carried out. When these three estimation components are obtained, the cash flow will be calculated, and then the cash flow will be calculated by calculating the Benefit-Cost Ratio (B.C.R.), Net Present Value (N.P.V.), and Internal Rate of Return (IRR). The points to be discussed are as follows:

- Projected marketing value for natural gas-based petrochemical products in Teluk Bintuni Regency
- Projected investment costs for the development of a natural gas-based petrochemical industry in Teluk Bintuni Regency.
- Projected investment costs for infrastructure development to support the natural gas-based petrochemical industry in Teluk Bintuni Regency
- The sensitivity of changes in gas prices to components that make up production costs.
- The financial feasibility of investing in the development of a natural gas-based petrochemical industry in Teluk Bintuni Regency.
- Recommendations and phases for the development of the natural gas-based petrochemical industry in Bintuni Bay

In the final part of this report, what will be done is to prepare technical recommendations and the phasing in for the develop of the natural gas-based petrochemical industry in Bintuni Bay. The technical recommendations for the natural gas-based petrochemical industry will be presented, and financial recommendations for the natural gas-based petrochemical industry.

Then after recommendations are made, what will close this report is the phasing in the development of the natural gas-based petrochemical industry in Bintuni Bay, as follows:

Stages of development of the anchor industry and natural gas-based petrochemical derivative industry in Bintuni Bay

RESULTS

National Market Analysis for Petrochemical Products

Petrochemical products that have the potential to become the main industry in the Bintuni Bay Industrial Area include Methanol, PE & P.P., Ammonia, and Urea.

Methanol Route

During 2015 - 2020, methanol supply grew 20.30% per year. This growth is due to the increase in methanol consumption by the biodiesel industry starting in 2016. In 2015 the supply of methanol reached 365,200 tons, then in 2018, it increased to 1,062,090 tons, and in 2020 it is estimated to reach 1,106,678 tons. A detailed description is presented in table 1 below:

Table 1: Methanol Supply Demand in 2015 – 2020

Uraian	Unit	2015	2016	2017	2018	2019	2020	CAGR (%)
Kap Terpasang	Ton/Th	660.000	660.000	660.000	660.000	660.000	660.000	-
Produksi	Ton	568.670	617.271	691.939	670.000	650.062	600.000	0,90
Impor	Ton	219.414	436.988	557.362	699.456	772.196	822.268	24,63
	USD000	65.717	107.435	190.119	305.774	279.271	187.350	19,08
Ekspor	Ton	422.884	384.934	335.008	307.366	292.694	315.590	(4,76)
	USD000	75.434	51.728	66.239	90.190	63.398	46.571	(7,72)
Supply	Ton	365.200	669.325	914.293	1.062.090	1.129.564	1.106.678	20,30

source: Methanol Producers, B.P.S., and other sources, processed

The estimation results based on the semi-average projection method show in Tables 2 and 3 that in 2021 (even though the Covid-19 pandemic is still ongoing), Indonesia is expected to absorb 1,395,916 tons and will increase 1,544,152 tons in the following year and 2026. It is estimated to reach 2,137,095 tons.

Table 2: Methanol Supply Demand in 2015 – 2020

Uraian	Proyeksi Konsumsi Methanol (Ton)						Proyeksi (%)
	2021	2022	2023	2024	2025	2026	
Fame	1.051.694	1.161.739	1.271.784	1.381.829	1.491.874	1.601.919	7,27
Formaldehyde	327.107	364.669	402.231	439.793	447.355	514.917	7,86
Lainnya	17.115	17.744	18.372	19.001	19.630	20.259	2,85
Total	1.395.916	1.544.152	1.692.388	1.840.623	1.988.859	2.137.095	7,36

Source: Methanol Producers, B.P.S., and other sources, processed

Table 3. Indonesian Methanol Market Opportunities 2021 – 2026

Uraian	Lokasi	Proyeksi					
		2021	2022	2023	2024	2025	2026
Proyeksi permintaan Pasar, Ton		1.395.916	1.544.152	1.692.388	1.840.623	1.988.859	2.137.095
Proyeksi kapasitas terpasang, Ton/Th		660.000	660.000	660.000	660.000	660.000	660.000

Uraian	Lokasi	Proyeksi					
		2021	2022	2023	2024	2025	2026
Existing Comp (KMI)	Bontang	660.000	660.000	660.000	660.000	660.000	660.000
Proyek Baru		-	-	-	-	-	-
Bakrie-Ithaca-Air Product*	Kutai Timur	-	-	-	-	-	-
BA-Pertamina-Air Product*	Tj Enim	-	-	-	-	-	-
Peluang Pasar		735.916	884.152	1.032.388	1.180.623	1.328.859	1.477.095

Source: Methanol Producers, B.P.S., and other sources, processed

Polyethylene and Polypropylene. Industries are downstream industries from the methanol industry. Currently, two polyethylene (P.E.) producers operate in Indonesia with a total installed capacity of 1,186,000 tons per year. The largest polyethylene producer is PT Chandra Asri, which has completed its expansion project to 736,000 tonnes per year. Another producer, PT Lotte Chemical Titan Nusantara, located in Merak, Banten, has an installed capacity of 450,000 tons per year and has been operating since 1993.

Polyethylene is consumed as a raw material for the plastic industry, both for plastic products produced by molding and extrusion processes. In 2015, the total P.E. consumption was 1,081,669 tons, most of which amounted to 647,754 tons absorbed by the plastic film industry, the blow molding industry (plastic bottles, jerry cans) of 180,649 tons, the pipe industry 62,293 tons, the injection molding industry, 56,063 tons, the rest is absorbed by various other industries.

On the other hand, in Indonesia, polypropylene (P.P.) is produced by three companies with a total installed capacity of 825,000 tons per year. The largest factory owned by PT Chandra Asri Petrochemical Tbk (Tripolyta Indonesia), located in Anyer, Banten, has 480,000 tons per year. The second is owned by PT Polytama Propindo, located in Balangan, Indramayu, West Java, has an installed capacity of 300,000 tons per year, and has been operating commercially since 1995. Meanwhile, the smallest factory is owned by Pertamina, located in Plaju, South Sumatra, has an installed capacity of 45,000 tons. Furthermore, it has been operating since that.

Table 4. Projection of Polyethylene Market Demand and Opportunities, 2021-2026

Uraian	Unit	2021	2022	2023	2024	2025	2026
Proy Permintaan	**Ton**	**1.424.210.**	**1.474.677**	**1.525.145**	**1.575.612**	**1.626.079**	**1.676.547**
LLDPE		373.658	381.587	389.517	397.446	405.375	413.304
LDPE		251.768	261.694	271.620	281.545	291.471	301.396
HDPE		798.783	831.396	864.008	896.621	929.234	961.846
Proy Kap	**Ton/Tahun**	**1.186.000**	**1.186.000**	**1.186.000**	**1.186.000**	**1.186.000**	**1.186.000**
Existing		1.186.000	1.186.000	1.186.000	1.186.000	1.186.000	1.186.000
Proyek Baru		-	-	-	-	-	-
Peluang Pasar		**238.210**	**288.677**	**339.145**	**389.612**	**440.079**	**490.547**

Source: Inaplas, B.P.S., and other sources, processed

Table 5. Projection of Polypropylene Market Demand and Opportunities, 2021-2026

Uraian	Proyeksi Permintaan Polypropylene, (Ton)						Proy, (%)
	2021	2022	2023	2024	2025	2026	
Proyeksi Permintaan							
Homopolymer	1.295.343	1.325.450	1.355.556	1.385.663	1.415.770	1.445.877	1,85
Block Copolymer	256.411	260.053	263.695	267.337	270.979	274.621	1,15
Random Copolymer	255.940	261.356	266.772	272.188	277.604	283.020	1,69
TOTAL	1.807.693	1.846.859	1.886.024	1.925.189	1.964.354	2.003.519	1,73
Proy Kap Terpasang	825.000	825.000	825.000	825.000	825.000	1.225.000	6,81
Existing	825.000	825.000	825.000	825.000	825.000	825.00	-
Proy Baru (Lotte)	-	-	-	-	-	400.00	
Peluang Pasar	**982.693**	**1.021.859**	**1.061.024**	**1.100.189**	**1.139.354**	**778.519**	**(3,81)**

Source: Inaplas, B.P.S., and other sources, processed

Ammonia Route

Ammonia demand during 2015-2020 (table.6) averaged nearly 5 million tonnes per year, with a trend that tends to decline around -1.03% per year. In 2015, the demand for ammonia reached 4,985,124 tons. In the following year, it decreased to 4,707,089 tons, and in 2020, it is estimated to reach 5,110,964 tons. The details are presented in the table below.

Table 6. Analysis of Ammonia Supply in Indonesia, 2015-2020

URAIAN	UNIT	2015	2016	2017	2018	2019	2020	CAGR, (%)
Produksi	Ton	5.974.480	5.775.824	6.067.956	6.999.312	7.226.225	6.502.325	1,42
Impor	Ton	42.991	45.733	36.386	21.516	12.201	7.986	(24,46)
	US$ 000	21.630	15.454	11.165	7.192	4.043	2.206	(31,64)
Ekspor	Ton	1.032.347	1.114.468	1.055.327	1.395.556	1.792.830	1.399.347	5,20
	US$ 000	434.064	330.673	301.104	451.587	443.902	326.749	(4,62)
Penyediaan (Supply)	Ton	4.985.124	4.707.089	5.049.015	5.625.272	5.445.596	5.110.964	0,42

Source: Ammonia Producers, B.P.S., and other sources, processed

The prediction results show that until 2026 (table 7), the ammonia industry in Indonesia is still closed to new investment unless it is made for export market purposes.

Table 7. Projection of Ammonia Market Demand and Opportunities, 2021-2026

URAIAN	PROYEKSI					
	2021	2022	2023	2024	2025	2026
Proyeksi Permintaan Pasar, Ton	5.714.078	5.874.145	6.034.212	6.194.279	6.354.346	6.514.413
Proyeksi Kapasitas Terpasang, Ton/Th	7.746.000	7.746.000	7.746.000	7.746.000	7.746.000	7.746.000
Existing Capacity	7.746.000	7.746.000	7.746.000	7.746.000	7.746.000	7.746.000
Proyek Baru	-	-	-	-	-	-
Peluang Pasar	(2.031.922)	(1.871.855)	(1.711.788)	(1.551.721)	(1.391.654)	(1.231.587)

Source: Ammonia Producers, B.P.S., and other sources, processed

Products Provision of Raw Materials for Petrochemical Industry in Teluk Bintuni Regency

Potential Natural Gas resources in the Tangguh Block exploration area:

- Semai II = 17 TCF
- Semai III = 4.2 TCF
- Seedling V = 12.0 TCF
- Kasuri = 1.5 TCF
- West Papua I = 4.9 TCF
- West Papua II = 4.0 TCF

Note:

- The Manokwari, Timoforo, and Sareba blocks have no known natural gas potential
- Block Tangguh
- Proven Natural Gas reserves of 23.7 TCF
- Contracted natural gas reserves = 10.4 TCF

Remaining reserves that are not bound by contracts = 13.3 TCF

Gas Based Petrochemical Raw Material Feedstock Prices

On the international market, prices for petrochemical products tend to fall due to falling prices for raw materials. Based on World Bank data, the average oil price in 2019 weakened from USD 68.3 per barrel to USD 61.4 per barrel. Likewise, the price of natural gas has also decreased. In the Henry Hub spot market in the United States, natural gas prices fell 18.5%, from USD 3.2 per million metric British thermal units (MMBTU) to USD 2.6 per MMBTU

Process Technology of Methanol and Ammonia Production from Natural Gas

Process Technology of Methanol Production from Natural Gas

The following is a comparison of the methanol synthesis process from various licensors. The comparison of each of these processes can be seen in the table below:

Tabel 8. Comparison of Methanol Synthesis Process of Various Licensors

No	Specification	ICI	Lurgi	MGC	Kellog	Nissui Topsoe
1	Operation Conditions: • Pressure (Bar) Temperature (C)	50-100 220-280	40-100 220-260	50-150 200-280	100-150 200-280	100-200 200-310
2	Reactor: • Characteristics • Number of Reactors Cooling	*Quench* 1 *Cold quench*	*Shell & Tube* 1 Cooling Water (*on the shell*)	*Annular* 1 Cooling Water (*outer tube*)	Adiabatis (aksial) 3-4 *Intermediete coolers*	Adiabatis (radiall) 3-4 *Intermediete coolers*
3	Advantages	It has been proven and is the most widely used	High thermal efficiency and selectivity. Temperatur	Ideal temperature profile, little needed catalyst	High production speed and capacity	Kecepatan dan kapasitas produksi tinggi

			e is more stable			
4	Lack	Low thermal efficiency, catalyst breakdow n	The production capacity is not too big	Complicated , expensive reactor costs	Higher operating conditions reduce selectivity	Higher operating conditions reduce selectivity

Process Technology of Ammonia Production from Natural Gas

In the process of making ammonia from Natural Gas, several technologies that have been used in the industrial process are known as follows:

- The Haber-Bosch process
- Brown & Root Braun Process
- Haldor Topsoe A/S Process
- ICIAMV process
- The M.W. Kellogg
- Claude Process
- The Kellogg Advanced Ammonia Process (KAAP)

Tabel 9. Comparison of Methanol Synthesis Process of Various Licensors

LICENSOR	P (A.T.M.)	SUHU (^{O}.C.)	KATALIN	KONVERSI %	LOOP	ASAL H_2, N_2
Haber-Bosch	200	550	*Promoted iron*	8	Ya	*Water-gas*, gas proses
Modified Haber	250	550	*Doubly prom. Iron*	20	Ya	
Nitrogen Engineering Corp.	200-300	500	*Doubly prom. Iron*	20-22	Ya	*Gas Bumi, water gas*
Modifikasi NEC, Kellogg	300-350	500-525	*Doubly prom. Iron*	24-32	Ya	
Claude	900-1000	500	*Promoted iron*	40-85	tidak	*Pencairan coke-oven gas dan udara*
L'air Liquide	900-1000	500	*Promoted iron*		Ya	
Du Pont	1000	500	*Promoted iron*		Ya	*Gas Bumi*
Casale	600-610	500	*Promoted iron*	5680	Ya	*Bermacam-macam*
Fauser	200-240	500	*Promoted iron*	12-23	Ya	*Elektrolisis*

Analysis of Natural Gas-Based Petrochemical Industry Trees in Teluk Bintuni Regency

So far, natural gas has been used to fulfill export commitments, even though the potential for natural gas in West Papua can be used as raw material for the petrochemical industry based on ammonia and methanol.

Judging from the industrial structure (Figure.5), methanol and ammonia are building blocks for the petrochemical industry based on natural gas and syngas. Then the industry that produces formaldehyde, methyl methacrylate, acetic acid, and amine is an intermediate industry from the methanol route, while the industry that produces Urea, nitric acid, caprolactam, and acrylonitrile is an intermediate industry from the ammonia route. Polyethylene (P.E.), polypropylene (P.P.), dimethyl ether (D.M.E.), methionine, ammonium nitrate, and ammonium sulfate are downstream products, although seen from the industrial derivation, these products are at the initial stage of derivation. It is called downstream products because these products can be used directly by the end industry (end users) without experiencing chemical changes. Viewed from the market side, especially in the domestic market, the industry that produces these products is still considered prospective for the development.

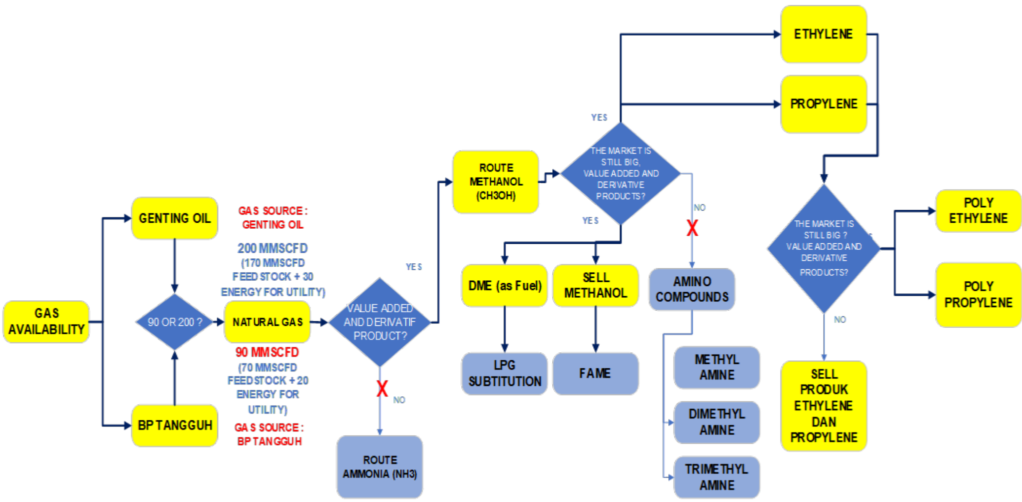

Figure 5. Natural Gas Based Petrochemical Industry Development Scenario in Teluk Bintuni Regency

The capacity planning for industries that will be developed in Bintuni Bay are:

1) Scenario 1: If the gas that can be prepared for the operation of the petrochemical industry is 221 MMSCFD
    - Gas sources are taken from the Genting Oil Gas field to produce ammonia to Urea with a gas allocation of 112 MMSCFD.
    - The ammonia industry, with an installed capacity of 825,000 TPA, and Urea, with an installed capacity of 1,115,000 TPA, consider the specifications for the gas content produced from the Genting Oil gas field.
2) Scenario 2: If the gas that can be prepared for the operation of the petrochemical industry is 221 MMSCFD
    - The gas source is taken from the Genting Oil gas field for methanol production with a gas allocation of 109 MMSCFD.

Methanol industry with an installed capacity of 990,000 TPA, considering the specifications of the gas content produced from the Genting Oil gas field.

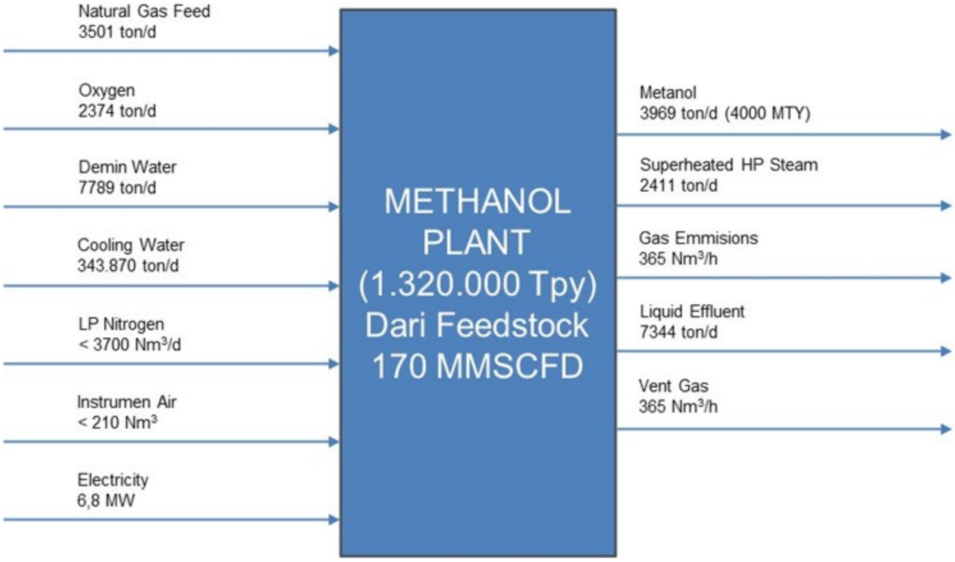

Figure 6. Mass Balance Methanol with Feedstock Specifications

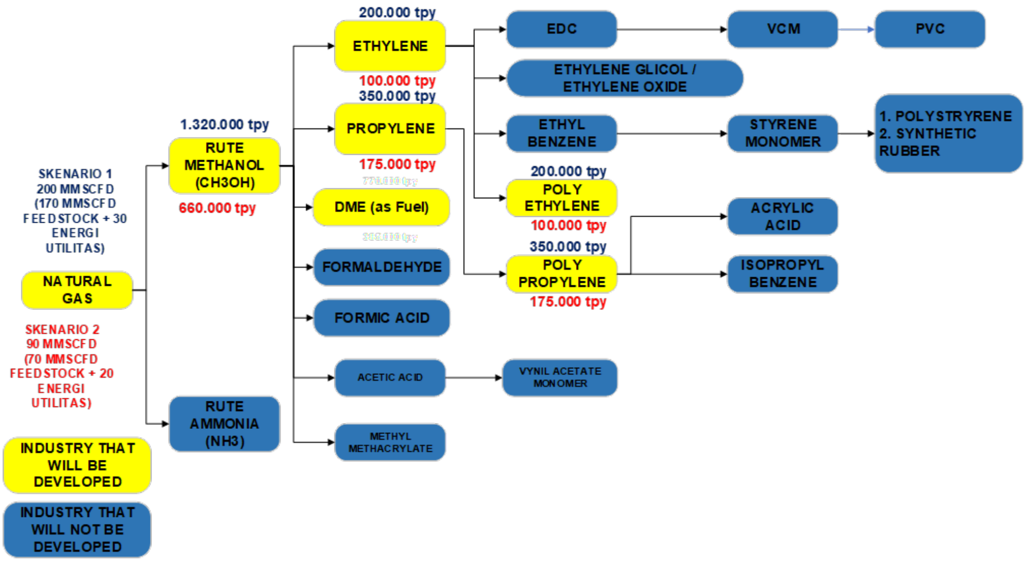

Figure 7. Scenarios for Gas-Based Petrochemical Industry Capacity Planning with the Methanol Route in Bintuni Bay

3) Scenario 3: If the gas that can be prepared for the operation of the petrochemical industry is 200 MMSCFD
   - Gas sources are taken from the Genting Oil gas field with a feedstock allocation of 170 MMSCFD and 30 MMSCFD energy for utilities.
   - Methanol industry with an installed capacity of 1,320,000 TPA and an actual optimum capacity of 1,428,000 considering the specification of the gas content produced from the Genting Oil gas field.

- Methanol to Polyolefin (MTP) Industry Installed a capacity of 550,000 TPA, which produces two types of polyethylene and polypropylene products
- Polypropylene (P.P.) The industry with a Production Capacity of 350,000 TPA and Polyethylene Industry with a Capacity of 200,000 TPA.

4) Scenario 4: If the gas that can be prepared for the operation of the petrochemical industry is 90 MMSCFD obtained from Tangguh L.N.G.:
    - Gas sources are taken from the Tangguh L.N.G. field with a feedstock allocation of 70 MMSCFD and energy for utilities of 20 MMSCFD.
    - Methanol industry with an installed capacity of 660,000 TPA and a real optimum capacity of 588,305 TPA considering the specification of the gas content produced from the Tangguh gas field.
    - Methanol to Polyolefin (MTP) Industry Installed with a capacity of 275,000 TPA, producing two types of Polyethylene and Polypropylene products with a proportion of 15% Ethylene and 27% Propylene, based on market availability and product prices for the two products.

Polypropylene (P.P.) The industry with a Production Capacity of 175,000 TPA and Polyethylene Industry with a Capacity of 100,000 TPA

Analysis of the Availability of Gas Raw Materials for Gas-Based Petrochemical Industry Raw Materials

Indonesia's natural gas reserves as of January 2017 reached 142.72 TSCF, of which 100.36 TSCF is proven reserves, and 42.36 TSCF is potential reserves. The largest reserves are in Region II at 74.83 TSFC, which includes East Natuna at 46 TSCF, then Region VI at 40.61 TSCF and Region V at 15.35 TSCF

The plan for natural gas to support the development of the petrochemical industry in Bintuni Bay is planned to come from Tangguh L.N.G. of 90 MMSCFD and Genting Oil of 200 MMSCFD.

The availability of natural gas that will be used for the petrochemical industry in Bintuni Bay with the first alternative is from Genting Oil of 200 MMSCFD which is expected to be realized in 2021 and the second alternative from Tangguh L.N.G. is 90 MMSCFD in 2026.

The choice of alternative one from Genting Oil is due to the fact that Genting Oil has explored from one well in 2013 and now has 14 wells, and it has been proven that the gas supply is 200 MMSCFD. On the other hand, Tangguh L.N.G. gas production for 2021 is no longer possible and will only be available again in 2026 at 90 MMSCFD, so an extension of the concession contract period is required to supply 20 years.

Genting Oil does not use an L.N.G. business scheme, unlike Tangguh L.N.G., which uses an L.N.G. business scheme. So that Genting Oil's commitment and readiness to supply gas is guaranteed.

The Genting Oil exploration process has been completed. It is just a matter of waiting for the exploitation process, this process does not take long, so it only needs piping from the gas source in Genting Oil to the petrochemical industry

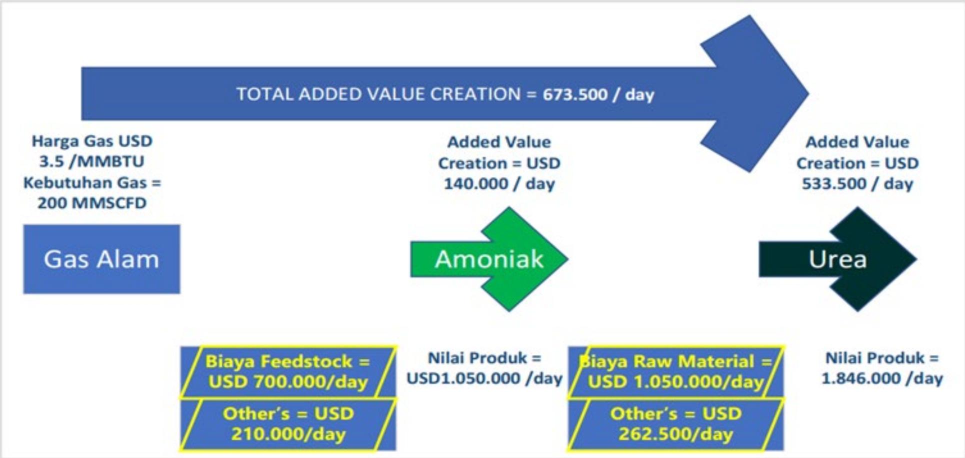

Figure 8. Ammonia Added Value Creation

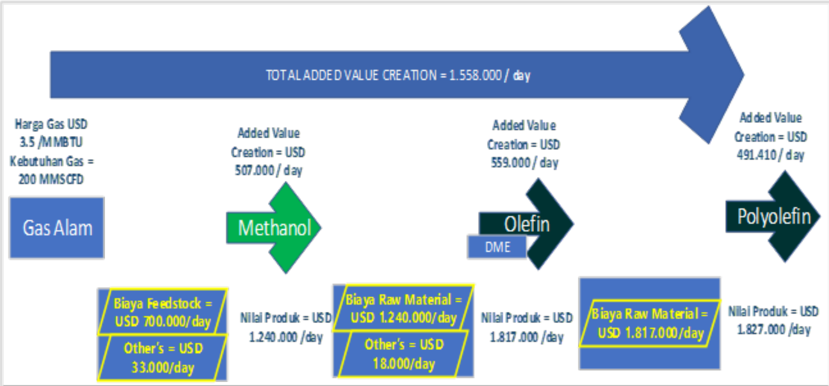

Figure 9. Methanol Added Value Creation

Supply Chain Analysis for Natural Gas-Based Petrochemical Industry Development in Teluk Bintuni Regency

1. Analysis of Natural Gas Raw Material Fulfillment to Support Gas-Based Petrochemical Industry Development in Teluk Bintuni Regency. The amount of raw material is mention in Table 10.

Tabel 10. Petrochemical Industry Raw Materials for Industrial Estates in Teluk Bintuni Regency

Stage	Flowrate	Source
Stage I	200	Genting Oil
Stage	90	LNG

2. Analysis of Market Fulfillment of Upstream and Intermediate Petrochemical Products to Support the Development of the Gas-Based Petrochemical Industry in Bintuni
Market Fulfillment of products produced by the industry to be built in the Bintuni Bay Petrochemical Industrial Zone are:
   a) Ammonia amounting to 825,000 TPA

b) Urea of 1,115,000 TPA
c) Methanol for 1,320,000 TPA
d) PE and P.P. amounting to 200,000 TPA and 350,000 TPA, respectively

From the calculation, the demand for methanol in the next five years is in the range of 1,200 to 1,700 KT if biodiesel (FAME) is maintained and developed. Subtracting the existing capacity (PT KMI), the market opportunity for methanol in the next five years is in the range of 600 KT to 1,200 KT

3. Technology Suppliers
   The companies holding the principal of Methanol, Ammonia, and Urea Processing Technology include:
   a. BASF Germany
   b. Kellogg's
   c. I.C.I.
   d. Lurgi
   e. M.G.C.
   f. Nissui Topsoe
   g. Uhde - thyssenkrupp Industrial Solutions
   h. Toyo Engineering Corporation
4. Energy Providers
   The total electricity demand is estimated at 20 M.W. for the methanol and polyolefin industry and 2 x 15 M.W. for the ammonia and urea industries so that each industry must cultivate it themselves or build a power plant whose results will be shared. The electricity distribution within the area uses an underground cable network starting from the power plant to each factory's electrical substation. For employee housing areas, electricity needs are usually supplied from a power plant
5. H.R. supplier
   Local workers can participate in the construction and factory construction stages. At the operational stage, it is expected that local workers will also participate, but it is necessary to increase the competence/capacity of human resources by providing training for local workers by experts.
6. Equipment and construction suppliers
   E.P.C. companies that usually build the Upstream and Intermediate Petrochemical industry in Indonesia, namely:
   1) Domestic: PT Rekayasa Industri, PT Inti Karya Persada Tehnik
   2) International: Samsung Engineering, Technip F.M.C., Petrofac, Técnicas Reunidas, SNC-leveling, SK Engineering & Construction Co, Saipem, Daewoo Engineering & Construction, Daelim Industrial Co, Maire Tecnimont, McDermott, Wood, Jacobs Engineering Group, WorleyParsons, K.B.R., Fluor Corporation, A.C.S. Group, Bechtel, L&T Hydrocarbon Engineering, Linde Engineering, Chiyoda, Hyundai Engineering & Construction, G.S. Engineering & Construction, Nuberg E.P.C., MMEC Mannesman, CTCI Corporation, Hyundai Engineering Co, National Petroleum Construction Company, J.G.C. Corporation, Mott MacDonald, Punj Lloyd, Rotary Engineering, CB&I,

7. Capital Provider Network
   Investment in Indonesia can be made in 2 (two) ways, namely Domestic Investment (PMDN) and Foreign Investment (P.M.A.). Based on Article 5 of Law 25/2007Indonesia's natural gas reserves as of January 2017 reached 142.72 TSCF, of which 100.36 TSCF

Industrial area supporting infrastructure

There are four components in the Bintuni Bay industrial area, namely:

1) Supporting components/infrastructure include:
   - Ports; Warehousing; Fire brigade; Office area; Service area; neighborhood environment; Public and social facilities.
2) Complementary components/infrastructure, which consists of:
   - Open space; Greenline; green area.
3) Facilities and infrastructure include:
   - Facilities of worship (mosques and churches); Shops and canteens; Multipurpose building; Facility Security (guard post); Health facilities (polyclinic); Road network; Clean water network and clean water treatment; Wastewater treatment network; WWTP; Drainage network; Energy and electricity networks; Telecommunication networks.

Techno-Economic Analysis of Petrochemical Industry Development Based On Natural Gas In Bintuni

The financial feasibility analysis for the development of the petrochemical industry in Bintuni Bay is based on four development scenarios, namely:

1) Ammonia Industry Development Scenario
   The first scenario, the industrial scenario that will be developed, is the ammonia industry with 2,500 Tpd. In this scenario, a 2 x 15 MW PLTG will be built, a desalination plant with a capacity of 1,500 Tph, electrical system facilities, gas piping from the Genting wellhead, and road infrastructure development facilities in the area.
   - **Total Investment Cost USD 1,155,317,044**
   - **Total Depreciation Cost USD 46,056,100**
   - **Pay Back Periode 5 years**
   - **Pay Out Time 9 years**
   - **IRR 13.27%**
   - **NPV USD 27,115,527**
2. Urea Industry Development Scenarios
   The second scenario, the ammonia route petrochemical industry development that will be developed, is integrating of the ammonia industry to its derivative industry, namely the urea industry. These investments include land acquisition investment, land maturation, investment in the construction of an ammonia factory with a capacity of 2,500 Tpd, a urea plant with a capacity of 3,500 Tpd, a 2 x 15 M.W. power plant, a desalination plant with a capacity of 1 x 2,000 Tph, construction of electrical system facilities, piping gas from wellhead Genting and road infrastructure development facilities in the area

- **Total Investment Cost USD 2,201,457,081**
- **Total Depreciation Cost USD 92,532,400**
- **Pay Back Periode 6 years**
- **Pay Out Time 10 years**
- **IRR 13.39%**
- **NPV USD 40,728,086**

3. Methanol Industry Development Scenarios of 4,000 tpd and 3,000 tpd
   This investment includes land acquisition investment, land preparation investment for the construction of a methanol plant with a capacity of 1,320,000 Tpy, a 1 x 10 M.W. power plant, a desalination plant with a capacity of 1 x 2,000 Tph, construction of electrical system facilities, gas piping from the Genting wellhead and infrastructure development facilities. road within the area
   - **Total Investment Cost USD 1,250,810,787**
   - **Total Depreciation Cost USD 50,166,800**
   - **Pay Back Periode 7 years**
   - **Pay Out Time 11 years**
   - **IRR 11.73%**
   - **NPV USD 75,491,151**

   In the third alternative, the investment developed is to build the petrochemical industry for the second scenario. This investment includes land acquisition investment, land preparation investment for the construction of a methanol plant with a capacity of 990,000 Tpy, a 1 x 10 M.W. power plant, a desalination plant with a capacity of 1 x 2,000 Tph
   - **Total Investment Cost USD 1,070,296,115**
   - **Total Depreciation Cost USD 42,916,800**
   - **Pay Back Periode 7 years**
   - **Pay Out Time 11 years**
   - **IRR 11.31%**
   - **NPV USD 35,003,324**
4. Development Scenarios for the Methanol Industry to the Polyolefin Industry (P.P. and P.E.)
   The fourth scenario, the investment scenario developed, is to build a petrochemical integration industry starting from the methanol industry, then ending with the development of the polyolefin industry. This investment includes land acquisition investment, land preparation investment for the construction of a methanol plant with a capacity of 1,320,000 Tpy, a polyolefin plant with a capacity of 550,000 Tpy, a 1 x 20 M.W. power plant, a desalination plant with a capacity of 1 x 2,000 Tph, construction of electrical system facilities, gas piping from Genting wellhead and road infrastructure development facilities in the area.

   - **Total Investment Cost USD 2,585,445,802**
   - **Total Depreciation Cost USD 106,431,500**
   - **Pay Back Periode 8 years**
   - **Pay Out Time 12 years**
   - **IRR 10.15%**
   - **NPV USD 25,090,527**

CONCLUSION

1) The need for natural gas raw materials for the petrochemical industry can be provided from the Tangguh gas field and from Genting Oil in an amount that reaches 200 MMBTU from Genting Oil and 90 MMBTU from the Tangguh gas exploration field (Table 10).
2) The added value created from developing the gas-based petrochemical industry for each route is as follows: a. For Ammonia Route is USD 673,000 per day, and b. The Methanol to Polyolefin route is USD 1.5 million per day. (Figure 8 and 9)
3) There are 2 (two) alternative locations for the development of the petrochemical industry, namely:
   a. Tangguh LNG concession area
   b. Industrial Estate in Kampung Onar
4) Types of industry developed in the Bintuni Bay industrial area are divided into 2 (two), namely:
   a. Methanol to Polyolefin route
   b. Ammonia route to Urea
5) The strategic plan for the development of the petrochemical industry in Bintuni Bay is recommended to follow: 1) the methanol route with a production capacity of 4,000 TPD, in the future, the industry can be developed to the polyolefin industry (MTP) with a production capacity of 1,600 TPD with Polyethylene and Polypropylene products or 2) Ammonia route with a production capacity of 2,500 tpd integrated with the urea industry with a production capacity of 3,500 TPD
6) The locations designated as alternative locations are the BP Tangguh concession location and the industrial area in Onar Village, where the core industry/champion will be in the BP Tangguh concession area.
7) There are 2 (two) alternative scenarios for the gas source that is used both as feedstock and as an energy source, namely: 1) The gas source from the Genting Oil exploration field is 200 MMSCFD which can be realized in 2025 and 2) The gas source from BP Tangguh is 90 MMSCFD which can be realized in 2026
8) A feasible gas price for the integrated industry from the Ammonia to Urea route, the integrated industry for the methanol to Polyolefin route, ranges from USD 3 / MMBTU - USD 3.5 / MMBTU
9) The current interest rate is 8% - 9%, so it is necessary to propose a reduction in interest rates of 5% - 6% in order to attract and not burden investors in returning investment loans and increasing
10) If the industrial development scenario in Bintuni Bay takes the ammonia route, then the production will reach Urea, where the investment value of the project reaches a cost of USD 2,201,457,081, then the NPV of the Project is USD 40,728.086, and the Return on Investment is 13.39%
11) However, if the methanol route is taken as an industrial development strategy, the production will reach Polyethylene and Polypropylene products, with an investment value of USD 2,585,445,802, then the NPV is USD 25,090,527, and the Return on Investment is 10.15%

12) The concept of industrial estate development management uses the Private Public Partnership concept, where the modalities for the industrial area Private Public Partnership project in Bintuni Bay are Design, Built, Maintenance and Transfer (DBMT). The management of the Petrochemical Industry in Bintuni Bay is recommended for Anchor Industry and other tenants to collaborate with the B.L.U. Industrial Estate through the K.S.O. or K.S.M. scheme

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