Public Policy Of Hydrocarbon Productivity Optimization For Oleo- And Petrochemical Industry: System Dynamics Approach (Case Study : Hydrocarbon Consumption In Riau Province, Indonesia)

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ABSTRACT

Nowadays, Riau Province located in Indonesia which is producing approximately fifty percent of Indonesia crude oil production and ten million metric tonnes (MT) of Crude Palm Oil (CPO) from two million hectares of palm oil plantation, has become a potential province to develop a centre of oleo- and petrochemical industry in Sumatra Island. Eventhough it is not a significant natural gas producer, the neighboring provinces such as Jambi and South Sumatra are supplying large amount of natural gas. It is such a challenging moment for Riau local government to have strategic policy of oil and natural gas productivity into petrochemical industry to manufacture its derivative products. It is also happening to CPO in oleochemical industry. If all of these hydrocarbons used as raw materials are high because of the expansion of oleo- and petrochemical industry, the usage of oil and natural gas, as the fossil energy should be substituted by renewable energy, such as wind, water, sunlight, geothermal power. Until now, government and private sectors seem less to care to optimize this productivity. System dynamics is used to simulate the behavior of this hydrocarbons consumption as the energy and product supply to the oleo- and petrochemical industries. Public policy as the intervention is introduced to become the feedback to the government and private sectors to take the growth of oleo- and petrochemical business.

Key Words: *Public Policy; System Dynamics; Oleochemical; Petrochemical; Renewable Energy*

1. INTRODUCTION

Riau Province located in Sumatra Island is a part of Republic of Indonesia. It consists of 12 cities and regencies which are Dumai City, Meranti Island Regency, Pelalawan Regency, Rokan Hilir Regency, Rokan Hulu Regency, Indragiri Hulu Regency, Indragiri Hilir Regency, Siak Regency, Pekanbaru City, Kuantan Sengingi Regency, Kampar Regency and Bengkalis Regency. The main industry are petroleum, natural gas, and palm oil. Riau province produces about 366,000 BOPD (Petromindo, 2013). Majority of it comes from Rokan Block operated by Chevron and CPP (Coastal Plain Pekanbaru) Block operated by PT. Bumi Siak Pusako – Pertamina Hulu. The natural gas production is not significant in this area. It is only about 100 MMSCFD which comes from Selat Panjang Block, but the recent status is not in production yet (Petromindo, 2013). At this moment, the supply of natural gas comes from neighboring province such as Jambi Merang JOB PSC via PGN, a national gas company which its pipeline has reach Riau Province.

Riau Province is the largest palm oil plantation in Indonesia. In 2010, it has about 2,100,000 hectares which is about 31% of Indonesia palm oil plantation (Rianto, 2010). Based on the data in the paper of Syahza (2013), it is estimated that the production is about 10 million MT of CPO per year in 2015. Most of the CPO products are delivered to overseas such as Korea, Japan and others. In Riau Province, it is very hard to find any industry which process CPO into its downstream products. The total area of palm oil plantation in Indonesia is about 3.9 million hectares in 1999, 7.3 million hectares in 2009, and 8.1 million hectares in 2013. (Rianto, 2010, Li, 2015).

The provincial population of Riau was 5,543,031 at the census 2010 which is conducted by BPS, central bureau of statistics (http://sp2010.bps.go.id/). The total population of Republic of Indonesia is about 237,560,000 at the same census 2010. It is predicted by worldbank (http://data.worldbank.org/country/Indonesia) that it becomes about 254,000,000 in 2015. The population growth is still increasing until this year, but the rate is decreasing. The increase of population is inline with the increase of the needs of products. A larger population impacts more energy consumption, especially for electricity, transportation and others.

Business atmosphere in Riau Province is very condusive. It keeps growing as the economic growth (6.78% in 2006). It is higher then the national economic growth (5.6% in 2006) (Pakis et al., 2013, Linuwih et al., 2010, Saw and Wong, 2009). This growth is inline with the growth of oil and gas, palm oil plantation business.

At this moment, Riau Province has three industrial area, which are Dumai industrial area, Tanjung Buton area and Tenayan area. Unfortunately, Dumai industrial area is the only area which is established with port and in full operation. It is about 80% of export from Riau transits through Dumai port (Fau et al., 2014). Local government has catagorized Tanjung Buton and Tenayan industrial area as strategic project (Fraco, 2010). Unfortunately, The other two areas are still in the development phase. The capacity of Dumai port has been saturated, the preparation and opening of other ports need to be expediated.

Riau Province also have two refineries in Dumai and Selat Pakning. The capacity of both refineries are about 170,000 BOPD (Hasan et al., 2012). Both refineries are feeded in by Sumatra Light Crude (SLC) which is produced mainly by Chevron and BOB PT. Bumi Siak Pusako – Pertamina Hulu. Government has identified the need to upgrade the capacity and technology of refineries as mention it in local newspaper (http://www.thejakartapost.com/ on 29/5/2015).

Riau Province needs more electricity power to support the growth of population and business. Based on the research conducted by ministry of energy (Priambodo et al., 2012) and collected data in 2014 from PLN Riau, electrification ratio is about 50% and lower than national electrification ratio 70% (Sakya, 2012, Watson et al., 2013). It means around an half of areas in Riau has not electrified yet. At this moment, government of Indonesia is still in bidding process to construct a new power plant in Riau and other places in Indonesia. The power capacity is about 234 MVA from power plant in Riau and the rest from PLN P3B Sumatra through 150KV interconnection electrical transmission network. Currently, most of the power plant in Riau is generated by diesel.

Based on the data from Pertamina, national energy company, it is about 50% of diesel consumption in Riau Province is used by PLN. Meanwhile, the rest is consumed by public transportation and also by private power plant. This private power plant is used by company or factory for their internal used.

The other power plants are generated by coal, gas and other non fossil energy. At this moment, the combination between coal and palm kernel oil is used in some power plants. Dual fuel, such as gas and diesel is applied in other power plants.

The negative side effects of burning hydrocarbons are discharged heat and CO_2 emission. Renewable energy is believed that can minimize those emissions. Not only to reduce the environmental issues, but also it can reduce energy fossil consumption. The government makes a target to achieve 25% in 2025 of renewable energy in total energy consumption (IBP, 2015, Sioshansi, 2013, Watson et al., 2013).

As we know, crude oil and natural gas are the main source of petrochemical industry, and CPO is the main source of oleochemical industry (Matar and Hatch, 2000). Both of them are able to contribute significantly to Indonesia's GDP. At this moment, Indonesia's GDP is about US$ 888.5 billion, but the contribution from petrochemical and oleochemical industry is still low. Manufacturing contributes about 24.3% to Indonesia GDP, mining contributes 11.95%, agriculture and food business contributes about 15% (PCC, 2012). If it is compared to world petrochemical business about US$ 559 billion and CAGR (Compound Annual Growth Rate) 6.8% (TM, 2015). For olechemical, the business is about US$ 29 billion and CAGR 6.4% (GVR, 2015). The availability of raw material and growth of market is the key for oleo- and petrochemical industry. Indonesia has those opportunities (Hasan et al., 2012,Rianto, 2010, Caroko, 2011).

The crude oil and natural gas and CPO production are excellent for development of oleo- and petrochemical industry in Riau Province. This will create economic multiplier effects to the local. In Java island, some petrochemical plants are able to produce ethylene, propylene for other industries. Meanwhile, other products such as mixed C_4 and pygas can be exported directly from the local port. Most of products, such as LLDPE and HDPE from polyethylene (PE) & polypropylene (PP) are still delivered from Java for consumption in Riau. For enhancement, the petrochemical industry can deliver styrene monomer which is the raw material for downstream industries manufacturing including polystyrene, expanded polystyrene (EPS), styrene butadiene rubber (SBR), styrene butadiene latex (SBL), styrene acrylonitrile (SAN), acrylonitrile butadiene styrene (ABS), and unsaturated polyester resin (http://www.chandra-asri.com/).

Riau Province has about two million hectares of palm oil plantation. It produces about 10 million MT of crude palm oil (CPO). It is a beneficial source for biofuel and many oleochemical products, such as fatty acids, fatty acid methyl esters (FAME), fatty alcohols, fatty amines and glycerols. Intermediate chemical substances produced from these basic oleochemical substances include alcohol ethoxylates, alcohol sulfates, alcohol ether sulfates, quaternary ammonium salts, monoacylglycerols (MAG), diacylglycerols (DAG),
structured triacylglycerols (TAG), sugar esters and other oleochemical products. Oleochemical products become a good alternatives when the crude oil price rise (https://en.wikipedia.org/wiki/Oleochemical).

Because of the potential opportunity of this oleo- and petrochemical business, it will be such a great moment if government is able to allocate the existing oil and natural gas quantity to this business and increase utilization of the renewable energy to overcome the shortage of fossil energy (Prayitno et al., 2010). The usage of refinery products for electricity and transportation can be reduced by this renewable energy. It can be biofuel, geothermal, biomass, wind, solar, nuclear, hydro, coal liquefaction (Aulia, 2010). In Riau Province, the most suitable renewable energy is biofuel, goethermal, wind, solar, and hydro. In 2006, Government of Indonesia publish a national energy policy (PR No. 5/2006) about the renewable energy percentage should achieve 17% in 2025. And in 2010, it revised to become 25%. The government also established a dedicated directorate general of new and renewable energy under ministery of energy (Watson, 2013). Unfortuntely, the support from government is not enough to increase the usage percentage of this renewable energy. Government, non government agency and public needs to work collaboratively. (Hasan et al., 2012).

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2. EXPERIMENT

A model is built to understand the behavior of the energy consumption, oleo- and petrochemical industry. On draft paper, the model is designed hierarchically and iteratively (Nasution, 2014) based on the system dynamics approach (Forrester, 1961, Sterman, 2000). The model consists of several subcomponent (see figure 1 and table 1.). A system dynamics software, vensim DSS v6.0a-1 is used in this experiment to simulate the interconnection between the subcomponents.

In this scenario, there are four subcomponents of industry, transporation and residential (Feng et al., 2012, Dyner et al., 1993). The four subcomponents of industry are agri, petrochemical, oleochemical and other industry. In our case, the agri business inclusive agriculture, livestock, forestry & fishery as well. The other industry is manufacturing, mining (exclusive oleo- and petrochemical) and quarrying. (Watson, 2013)

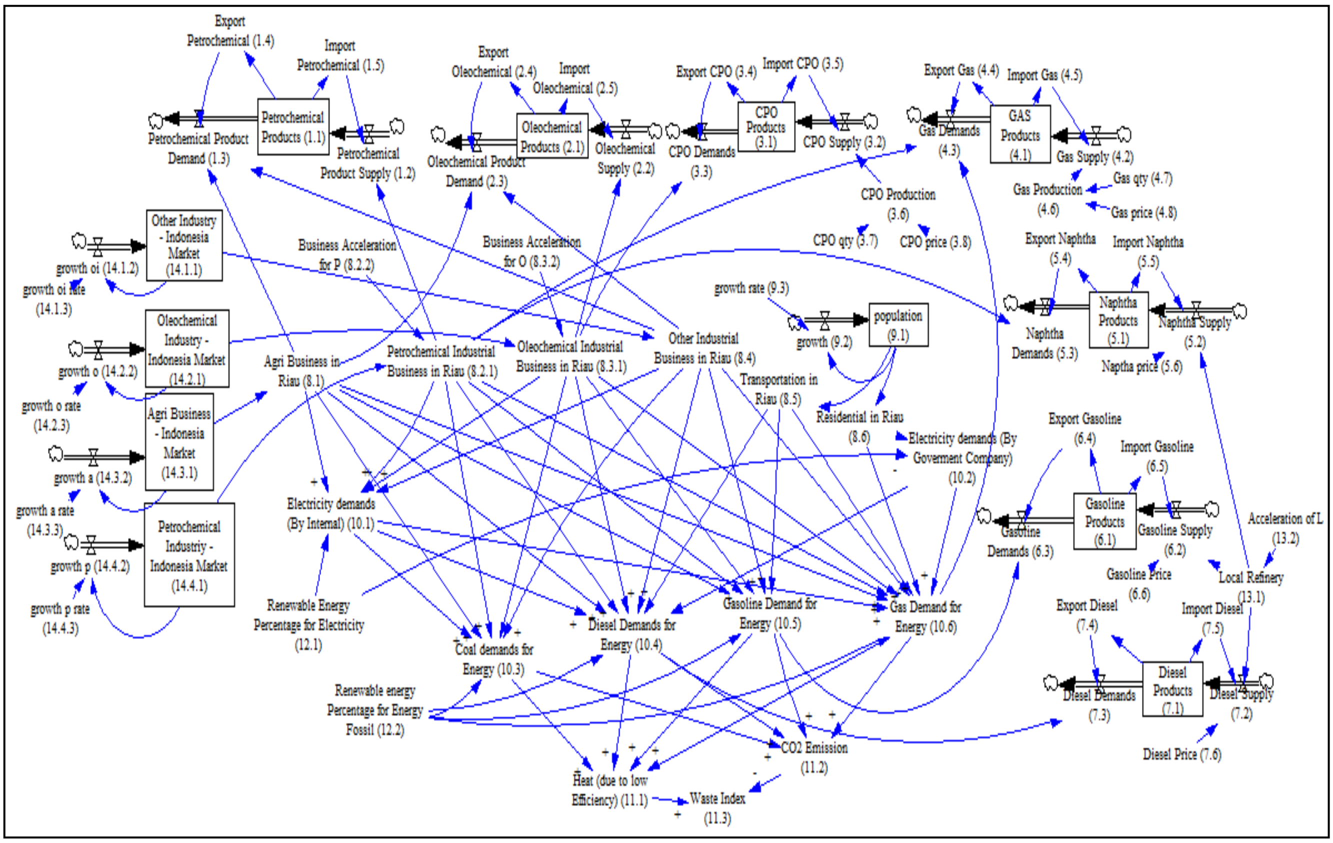

Figure 1. Model of System Dynamics

In our model, the interrelations between the components or subcomponents are not only input and output, but also cause and effect. The cause and effect interrelation is introduced due to the lack of input and output data. In our experiment, this cause and effect interrelations to predict the total consumption of the supply and demand in oleo- and petrochemical industry based on the spending in US$. Based on the best practice in the industry, it is predicted the amount of supply and demand for each industry.

These industrial subcomponents need energy for electricity and transportation. The electricity comes from renewable energy or fossil energy, such as diesel, gasoline, gas and coal. Unfortuntely, the renewable energy is not very popular at this moment. In this simulation, it assume that 20% of the electricity will use renewable energy in 3 years (see table 2). Government of Indonesia has planned to achieve 25% of energy consumption from renewable energy in year of 2025.

PLN, national electrical company provides the electrical service to residential and some of small scale factories. Most of larger scale factories are apparently able to provide their own electricity. It assumes that ten percent of the factories uses coal, fifty percent uses diesel and forty percent uses natural gas. Meanwhile, the gas comes from PGN (national gas company), Pertamina (national energy company) or gas producers, such as Petroselat, group of EMP (Energy Mega Persada) and others.

At this moment, PLN is planning to increase their capacity by introducing gas power plant. There is a delay in the implemention, but hopefully, the ratio of power plant will reach 50-50 for diesel and gas by the end of year 2015.

In transportation sector also consumes gas, diesel and gasoline. It assumes that ten percent uses gas, thirty percent uses diesel and sixty percent uses gasoline. The business in this transportation sector depends on the population. It assumes that thirty percent of the total people owned a vehicle and spend about US$ 50 per month for fuel. Residential uses electricity from PLN. If the income per capita is about US$ 1000, and eight percent of it is used to pay the electricity and two percent for gas, such as LPG.

Coal is supplied locally. Riau Province and neighboring provinces have a huge source of coal. Because of the decrease market and global environmental issue, export is not done well. Diesel, gasoline come from local refineries which produce 170,000 BOPD. (Hasan et al., 2012). Based on refinery documents (Enersos, 2012, ICCT, 2011), the estimated output of refineries are fifteen percent diesel, fifteen percent gasoline, fifteen percent naphtha, and fifty five percent residue. There are two ways to increase the output of these hydrocarbons from refineries which are increasing the supply of crude oil means increasing supply to local refineries or doing import from another oil producers. The gas supply is about 100 MMSCFD.

It is assumed that all prices are fixed. The price of naphtha is US$ 130 per barrel, gasoline is US$ 130 per barrel, diesel is US$ 120 per barrel and gas is US$ 2.5 per MMBTU.

In this simulation, it will be focused to oleo- and petrochemical product demands. Gas (inclusive metane and ethane), naphtha and CPO are inputs to the simulation. At this stage, other materials are not identified or ignored as the raw material. It is because thousands of material products are involved. It would be difficult to consider all products exist in the model. The simplicity of the model is used but not by ignoring the significancy of the result.

Indonesia's GDP is used as a benchmark to calculate the business market for agri business and other industry. Meanwhile,the global oleo- and petrochemical is used as a base to calculate the business market for oleo- and petrochemical industry.

The import and export of products are checked by monitoring the product capacity. If it is more than zero, the product will be exported 80%. If not, it is imported 120%. It is in order to maintain the stability of supply and demand of each product.

Side effects of the power generator or engine are discharged heat and CO_2 emission. Heat is calculated based on the efficiency of the power generator or engine. Most of the engine has efficiency about forty percent. CO_2 emission is calculated by the chemical reaction which is proportional to the total hydrocarbon being burned (Honorio et al., 2003). Waste index is combination of discharged heat and CO_2 emission. It becomes a good parameter index to see the status of environment and related to renewable energy percentage.

The final target in this model is to find how to decrease the import and increase the export of all products. There are few steps in this research. Case one, the baseline is created. Oleo- and petrochemical is not developed yet. Renewable Energy is almost zero percent.

Table 1. Parameters and Equations of Model (Case 1)

No	Components	Initial	Equation	Unit	Remarks
1.1	Petrochemical Product	P_P	P_S - P_D	US$	

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1.2	Petrochemical Suppy	P_S	P_B * 1 + P_I	US$	
1.3	Petrochemical Demand	P_D	A_B * 0.03 + OI_B * 0.01 + O_E	US$	
1.4	Export Petrochemical	P_E	If P_P > 0 then P_P * 0.8	US$	
1.5	Import Petrochemical	P_I	If P_P < 0 then P_P * -1.2	US$	
2.1	Oleochemcal Product	O_P	O_S - O_D	US$	
2.2	Oleochemical Suppy	O_S	O_B * 1 + O_I	US$	
2.3	Oleochemical Demand	O_D	A_B * 0.03 + OI_B * 0.01 + O_E	US$	
2.4	Export Oleochemical	O_E	If O_P > 0 then O_P * 0.8	US$	
2.5	Import Oleochemical	O_I	If O_P < 0 then O_P * -1.2	US$	
3.1	CPO Product	C_P	C_S - C_D	US$	
3.2	CPO Suppy	C_S	C_Po	US$	
3.3	CPO Demand	C_D	O_B * 0.3 + C_E	US$	30% for raw material
3.4	Export CPO	C_E	If O_P > 0 then O_P * 0.8	US$	
3.5	Import CPO	C_I	If O_P < 0 then O_P * -1.2	US$	
3.6	CPO Production	C_Po	C_Q * C_Pr	US$	
3.7	CPO quantity (qty)	C_Q	1 * EXP 7	MT	per year
3.8	CPO price	C_Pr	130	US$	
4.1	Gas Product	G_P	G_S - G_D	US$	

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4.2	Gas Suppy	G_S	G_Po	US$	
4.3	Gas Demand	G_D	P_B * 0.25 * 0.3 + G_Eg + G_E	US$	25% of 30%
4.4	Export Gas	G_E	If G_P > 0 then G_P * 0.8	US$	
4.5	Import Gas	G_I	If G_P < 0 then G_P * -1.2	US$	
4.6	Gas Production	G_Po	G_Q * G_Pr	US$	
4.7	Gas quantity (qty)	G_Q	100 * 365	MMSCF	Per year
4.8	Gas price	G_Pr	2.5 * EXP 3	US$	1MMSCF= 1000MMBTU
5.1	Naphtha Product	N_P	N_S - N_D	US$	
5.2	Naphtha Suppy	N_S	LR * 0.15 * N_Pr + N_I	US$	15% of crude
5.3	Naphtha Demand	N_D	P_B * 0.75 * 0.3 + N_E	US$	75% of 30%
5.4	Export Naphtha	N_E	If N_P > 0 then N_P * 0.8	US$	
5.5	Import Naphtha	N_I	If N_P < 0 then N_P * -1.2	US$	
5.6	Naphtha price	N_Pr	130	US$	
6.1	Gasoline Product	Go_P	Go_S - Go_D	US$	
6.2	Gasoline Suppy	Go_S	LR * 0.15 * Go_Pr + Go_I	US$	15% of crude
6.3	Gasoline Demand	Go_D	Go_Eg + Go_E	US$	
6.4	Export Gasoline	Go_E	If Go_P > 0 then Go_P * 0.8	US$	
6.5	Import Gasoline	Go_I	If Go_P < 0 then Go_P *-1.2	US$	

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6.6	Gasoline price	Go_Pr	130	US$	
7.1	Diesel Product	D_P	D_S - D_D	US$	
7.2	Diesel Suppy	D_S	LR * 0.15 * D_Pr + D_I	US$	15% of crude
7.3	Diesel Demand	D_D	D_Eg + D_E	US$	
7.4	Export Diesel	D_E	If N_P > 0 then N_P * 0.8	US$	
7.5	Import Diesel	D_I	If N_P < 0 then N_P * -1.2	US$	
7.6	Diesel price	D_Pr	120	US$	
8.1	Agri Business	A_B	A_M * 0.023	US$	23% ofMarket
8.2.1	Petrochemical Industrial Business	P_B	P_M * 0.023 * Ac_P	US$	23% ofMarket
8.2.2	Business Acceleration for Petrochemical (P)	Ac_P	Delay (0 times, in 3 years, init = 0)	US$	No P business
8.3.1	Oleochemical Industrial Business	O_B	O_M * 0.023 * Ac_O	US$	23% ofMarket
8.3.2	Business Acceleration for Oleochemical (O)	Ac_O	Delay (0 times, in 3 years, init = 0)	US$	No O business
8.4	Other Industrial Business	OI_B	OI_M * 0.023	US$	23% ofMarket
8.5	Transportation	T	P * 0.3 * 50 * 12	US$	30%, US$50, 12 month
8.6	Residential	R	P * 1000	US$	US$1000
9.1	Population	P	5.9 EXP 6	people	Riau in 2015
9.2	Growth	G	P * Gr	people	
9.3	Growth Rate	Gr	0.011		1.1%

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10.1	Electrical Demands (By Internal)	E_DI	(A_M + OI_B + P_B + O_B) * 0.07 * (1 – RE_E)	US$	8% for elec.
10.2	Electrical Demands (By Government Company)	E_DG	R * 0.10 * 0.80 * (1 – RE_E)	US$	R= 80 %
10.3	Coal Demands for Energy	C_Eg	(A_M + OI_B + P_B + O_B) * 0 * (1-RE_F) + E_DI * 0.10	US$	
10.4	Diesel Demands for Energy	D_Eg	(A_M + OI_B + P_B + O_B) * 0.01 * (1-RE_F) + E_DI * 0.50 + E_DG * 0.50 + T * 0.3	US$	1% for diesel
10.5	Gasoline Demands for Energy	Go_Eg	(A_M + OI_B + P_B + O_B) * 0.01 * (1-RE_F) + T * 0.6	US$	1% for Gasol.
10.6	Gas Demands for Energy	G_Eg	(A_M + OI_B + P_B + O_B) * 0.01 * (1-RE_F) + E_DI * 0.40 + E_DG * 0.5 + T * 0.1 + R * 0.10 * 0.20	US$	1% for Gas R= 20 %

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11.1	Heat (due to low Efficiency)	Heat	(Co_DE* 0.6 + D_DE * 0.6 + Go_DE * 0.6 + G_DE * 0.6) *0.000001		40%efficiency = 60% heat
11.2	CO2 Emission	CO	(Co_DE* 0.4 + D_DE * 0.4 + Go_DE * 0.4 + G_DE * 0.4) *0.000001		40%efficiency
11.3	Waste Index	WI	Heat + CO		
12.1	Renewable Energy Percentage for Electricity	RE_E	Delay (0.0.5, in 3 years, init = 0.05)	Percentage	5%
12.2	Renewable Energy Percentage for Energy Fossil	RE_F	Delay (0.0.5, in 3 years, init = 0.05)	Percentage	5%
13.1	Local Refinery	LR	170000	BOPD	
13.2	Acceleration of L	Ac_L	1		No acc.
14.1.1	Other Industry - Indonesia Market	OI_M	4.3 EXP 11	US$	
14.1.2	growth_oi	Gr_OI	OI_M * (1+ Gr_OI_R)	US$	
14.1.3	growth_oi_r	Gr_OI_R	0.04		
14.2.1	Oleochemical Industry - Indonesial Market	O_M	3.41 EXP 8	US$	
14.2.2	growth_o	Gr_O	O_M * (1+ Gr_O_R)	US$	
14.3.3	growth_o_r	Gr_O_R	0.064		

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14.3.1	Agri Business Indonesia Market	A_M	1.3 EXP 11	US$
14.3.2	growth_a	Gr_A	A_M * (1+ Gr_A_R)	US$
14.3.3	growth_a_r	Gr_A_R	0.08	
14.4.1	Petrochemical Industry - Indonesial Market	P_M	8.9 EXP 9	US$
14.4.2	growth_p	Gr_P	P_M * (1+ Gr_P_R)	US$
14.4.3	growth_p_r	Gr_P_R	0.068	

Case two, renewable energy is forced to twenty percent in 3 years. In this case, the supply and demand of energy are learned. How increasing of renewable energy percentage is able to save US$. How increasing capacity of local refineries can impact this supply and demand.

Table 2. Change on Parameters and Equations of Model (Case 2)

No	Components	Initial	Equation	Unit	Remarks
12.1	Renewable Energy Percentage for Electricity (12.1)	RE_E	Delay (0.2, in 3 years, init = 0.05)		Case 2a
12.2	Renewable energy Percentage for Energy Fossil (12.2)	RE_F	Delay (0.2, in 3 years, init = 0.05)		Case 2b
13.2	Acceleration of L	Ac_L	2		Case 2c
13.2	Acceleration of L	Ac_L	3		Case 2c-1

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Case three, the suitable market share are adjusted for oleo- and petrochemical industry for positive export. The crude oil, gas, palm oil supply are adjusted to find the positive export for hydrocarbon basic products as well.

Table 1. Change on Parameters and Equations of Model (Case 3)

No	Components	Initial	Equation	Unit	Remarks
8.3.2	Business Acceleration for Oleochemical (O)	Ac_O	Delay (1 times, in 3 years, init = 0)	US$	Case 3a
8.3.2	Business Acceleration for Oleochemical (O)	Ac_O	Delay (3 times, in 3 years, init = 0)	US$	Case 3a-1
8.2.2	Business Acceleration for Petrochemical (P)	Ac_P	Delay (1 times, in 3 years, init = 0)	US$	Case 3b
13.2	Acceleration of L	Ac_L	10		Case 3c-1

3. RESULTS AND DISCUSSION

Simulation Results

There are few simulations which have been done on each cases. The result is represented in graph. Each graph display is grouped into export or import of products, such as petrochemical, oleochemical, CPO, natural gas, naphtha, gasoline and diesel.

The legend of each graph are :

Case 1	:	1——1——1	Case 3a	:	6——6——6
Case 2a	:	2——2——2	Case 3a-1	:	7——7——7
Case 2b	:	3——3——3	Case 3b	:	8——8——8

Case 2c : 4 —— 4 —— 4 —— 9   Case 3c-1 : 9 —— 9

Case 2c-1 : 5 —— 5 —— 5

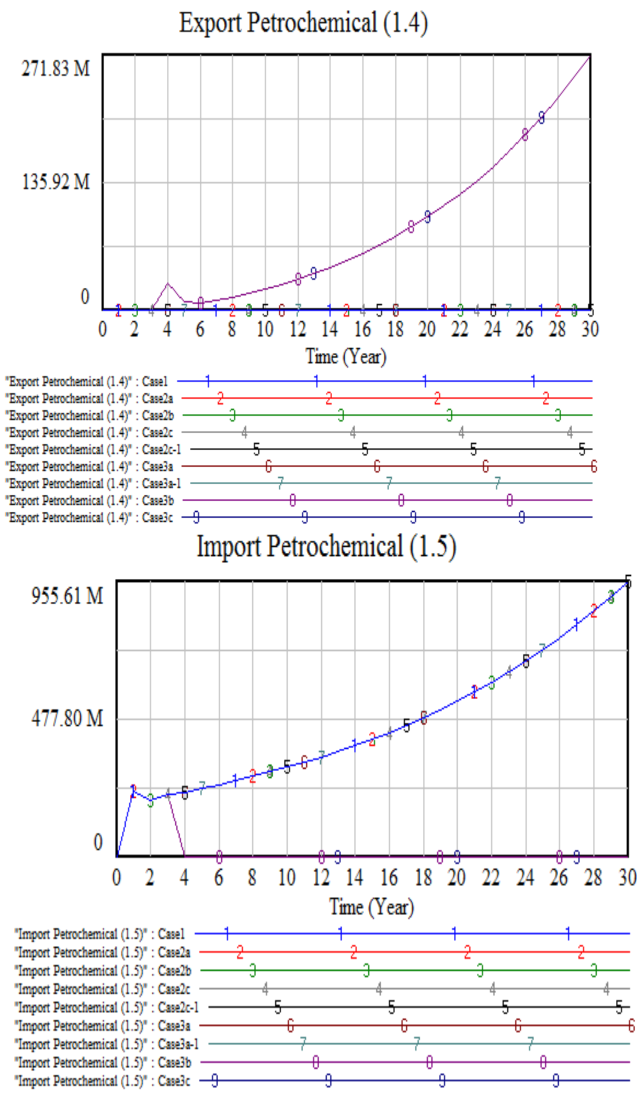

Figure 1. Petrochemical Export & Import (Time vs US$)

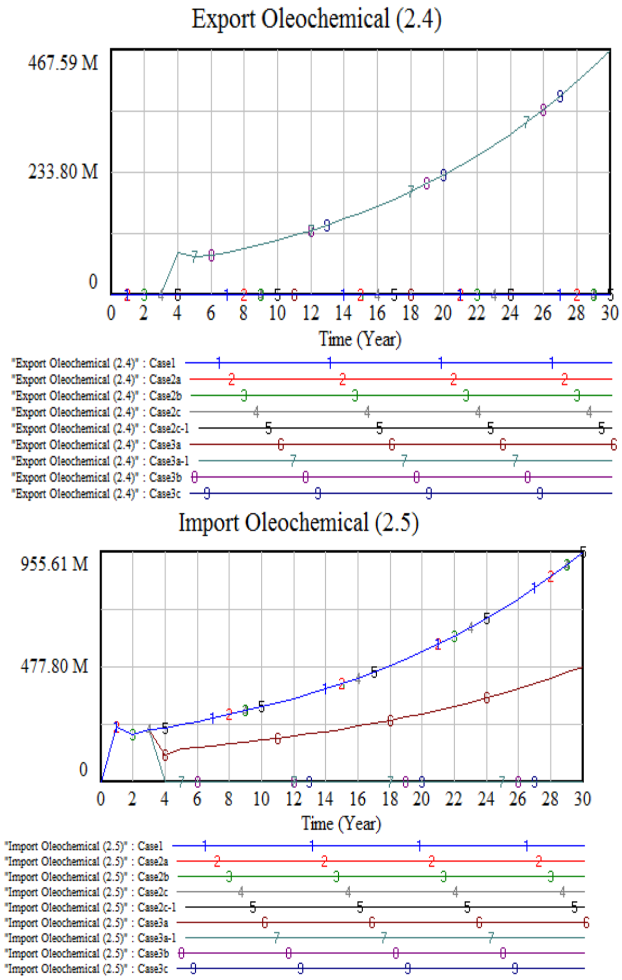

Figure 2. Oleochemical Export & Import (Time vs US$)

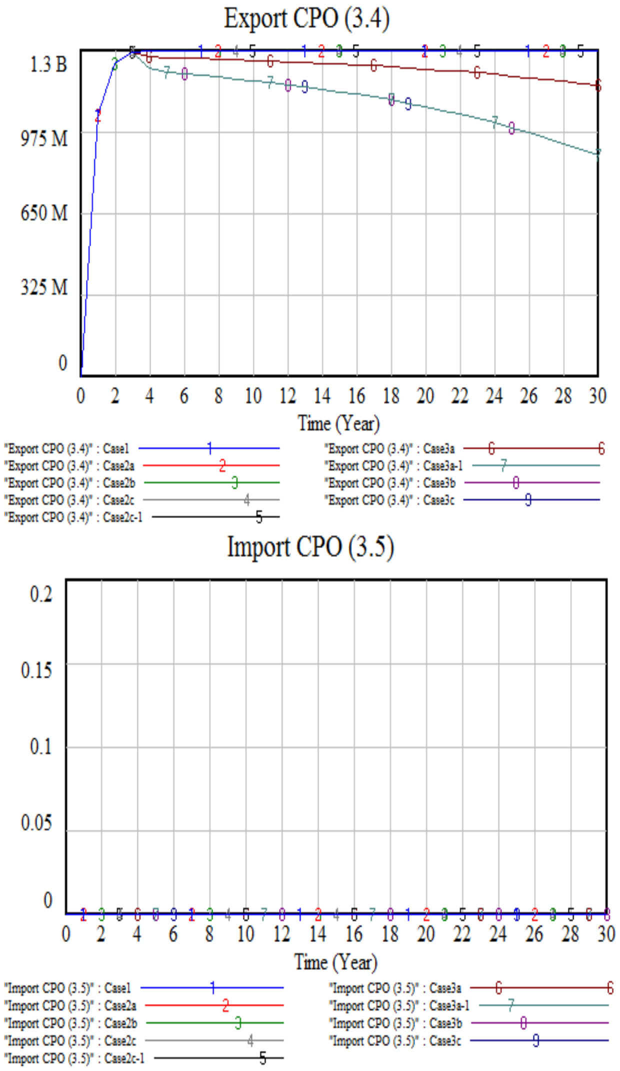

Figure 3. CPO Export & Import (Time vs US$)

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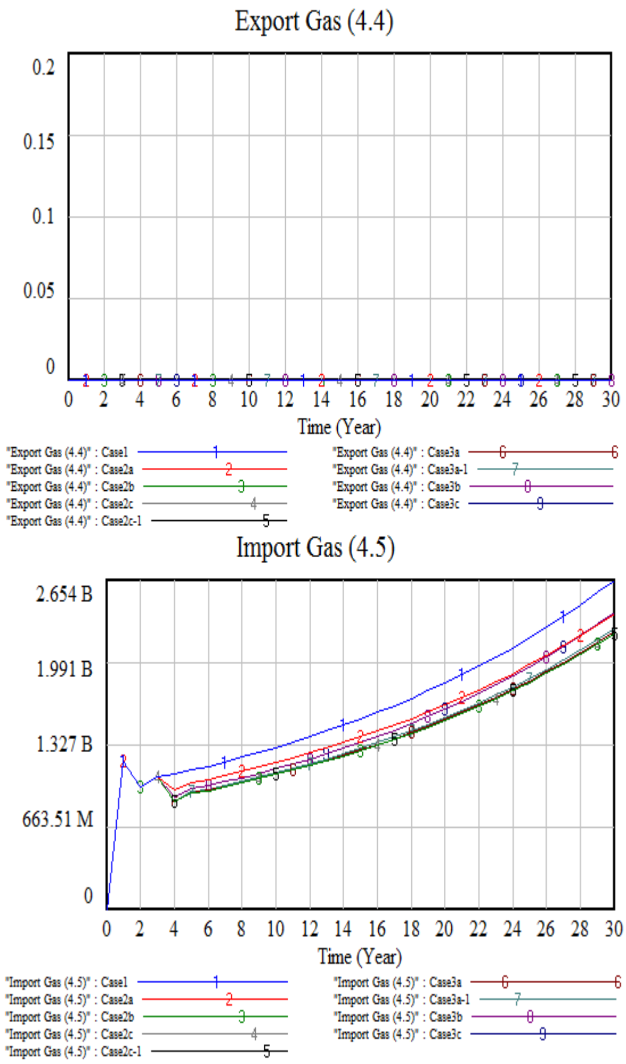

Figure 4. Gas Export & Import (Time vs US$)

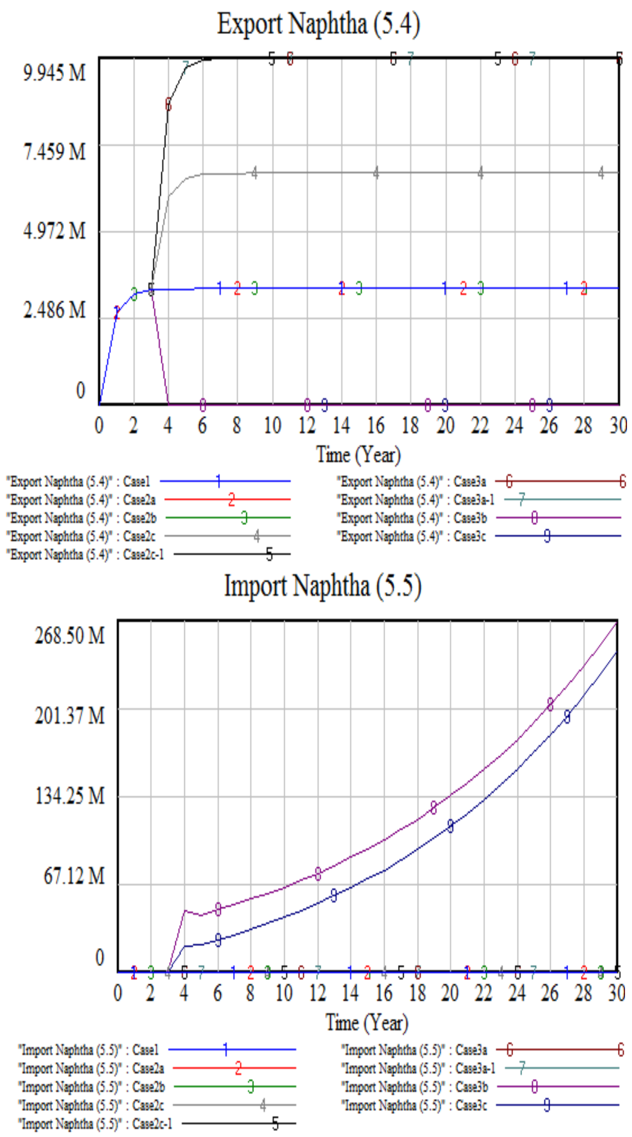

Figure 5. Naphtha Export & Import (Time vs US$)

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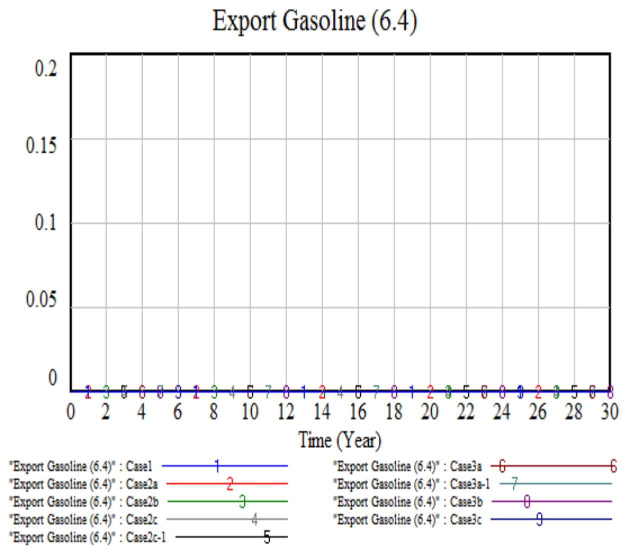

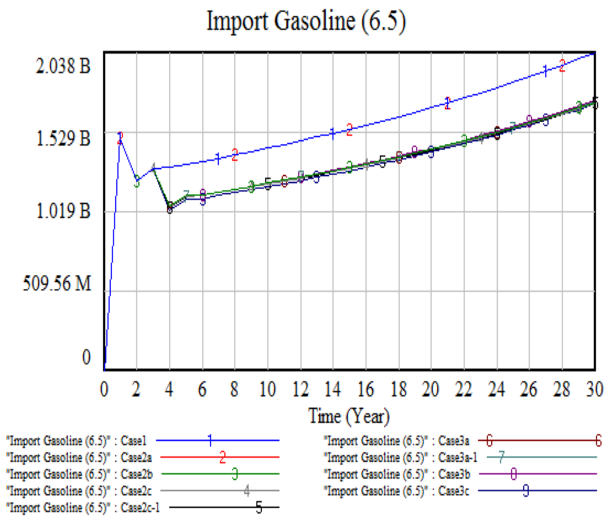

Figure 6. Gasoline Export & Import (Time vs US$)

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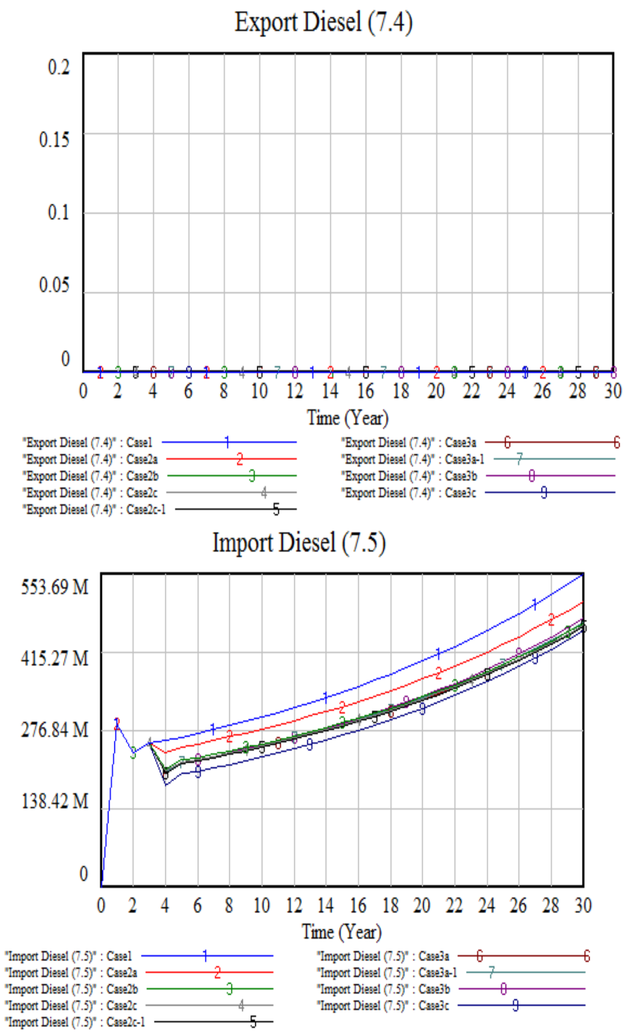

Figure 7. Diesel Export & Import (Time vs US$)

Analysis and Discussion

In case one, the market share of oleo- and petrochemical is simulated as zero. It means no manufacturing in Riau Province. In our simulation, the demand of oleo- and petrochemical products from agri business and other industry is not significant. It is only about three and one percent respectively. The import of oleo- and petrochemical is also not significant as it shows in figure 1 and 2.

The naphta and CPO import are zero. This is because no demand from oleo- and petrochemical industry. The gas, gasoline and diesel import is very high due to the electricity and transportation consumption.

The next cases which are case 2a and 2b, the renewable energy is able to achieve 20% in three years. Based on the figure 4, 6 and 7, the drop of import is higher on line 3 than line 2. It means the total consumption of energy fossil is higher on the non electricity usage such as for transportation and residential. Logically, it will improve significantly if the percentage of renewable energy increase higher. In case 2c, the capacity of local refineries increase in double. But, unfortunately there is no significant impact. If the capacity increase in triple, there is also no big impact. This because the usage of energy fossil is very high.

Cases 3a and 3a-1 are to simulate if there is a growth on the oleochemical industry. Case 3a is a baseline if the growth of oleochemical industry is as predicted in Riau Province market share (figure 2). Unfortunately, the import is still there. After increasing the market share three times in case 3a-1, it can be seen in figure 2 that the import is zero and the export is increasing.

The growth of oleochemical will impact to the export quantity of CPO in figure 3. The loss revenue from the dropping of CPO export and the gain revenue from increasing oleochemical export, it is very significant. It is about four times. It is understood that by selling value added product will contribute to increase national GDP.

Cases 3b is to simulate if the petrochemical industry growth is as predicted. In figure 1, the import is zero and export is increasing. The need of naptha is also increasing in figure 5. The local refineries which supply fifteen percent of his production as naphtha, not able to catch the growth. Unless the local refineries capacity is increasing. It is also happening to the gas. But, the gas productivity can be increased by being supplied from neighboring provinces.

It is also simulate if the capacity of refineries increase ten times in case 3c, but still no big impact on the supply. Unless there is a modification on the local refineries design to produce more products with the same input of crude.

Because of the market share of oleochemical is higher then petrochemical, the export of oleochemical products are higher than the petrochemical ones. The oleochemical is also supported by the huge of CPO resources so it makes no issues on the CPO import.

Of course, the growth of oleo- and petrochemical business will increase the energy demand. But, because the market share is not significant, the impact is not essential.

4. CONCLUSIONS

System dynamics can be used to simulate for certain scenarios to make better understanding for government in which area that they need to focus on. The cases have been done and it shows the behavior of renewable energy percentage, oleo- and petrochemical industry impact to export and import of products. Based on the experiment outcomes, it is recommend to the local government to act the necessary action by creating a public policy such as :

First, it is about the energy policy. Renewable energy is very crucial to minimize the import of diesel, gasoline, and naphtha (products of refineries). The renewable energy is of local refineries to produce more hydrocarbon products which are needed in the high-valued industry.

Second, oleo- and petrochemical industry can increase the Indonesia's GDP significantly. At this moment, many hydrocarbon products are exported as raw material. If there is an incentive policy to produce downstream products, it will multiply the increment revenue for Indonesia's GDP from Riau Province.

Third, government needs to help business to penetrate the market national and international. The bigger market share will create higher Indonesia's GDP. This will impact to other sectors as well.

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Dyner, I. et the must for Riau or Indonesia to handle the growth demand of energy to support their industries, transportation and residential usage. The total population of Indonesia is very significant to generate the energy demands. Eventhough, all capacity of local oil production which is fifty percent of Indonesia production is used to supply this market, it is still not enough. The government needs to increase their target of renewable energy percentage. At the same time, renew the technology al. (1993). System Dynamics Modelling for energy Efficiency Analysis.

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