Modelling for Business

OPTIMIZING AND FORECASTING THE AMOUNT OF BIODIESEL STOCK DISTRIBUTION AVAILABILITY IN INDONESIA (FOR PERIOD 2023-2035): A DYNAMIC SYSTEMS APPROACH

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01

BACKGROUND, DEFINE THE PROBLEM, AND DATA INPUT

Background

- In Indonesia, biodiesel is predominantly derived from palm oil, a crucial agricultural product in the nation.
- The Indonesian government actively promotes biodiesel as part of its efforts to advance clean energy, strengthen energy security, and boost rural economic growth.
- The main objective is to decrease reliance on fossil fuels and reduce environmental pollution by adopting more sustainable energy sources.

The Problem

The availability of biodiesel stock in Indonesia faces several problems, especially with increasing demand both domestically and for global export. Here are some examples of problems that may arise such as the following:

- **Limited Production:** Although Indonesia is one of the main producers of biodiesel, production capacity is often not enough to meet increasing demand. Factors such as bad weather, pest attacks, or problems in the raw material supply chain can disrupt production.
- **Distribution Infrastructure:** Rising demand requires adequate distribution infrastructure to deliver biodiesel products to consumers, both domestically and internationally. Infrastructure limitations can hinder supply efficiency.
- **Regulation and Policy:** Changing government policies on biodiesel, including export subsidies and tariffs, can create uncertainty in the market, affecting investment and production planning.

Addressing these issues requires collaboration between government, industry, and other stakeholders to ensure a sustainable supply of biodiesel amidst rising demand.

Data Input

BIODIESEL CONSUMPTION SECTORS IN INDONESIA PERIOD (PERIOD 2015 - 2025)

Sector	April 2015	January 2016	January 2020	January 2025
Micro business, fishery, transportation and PSO	15%	20%	30%	30%
Non-PSO transportation	15%	20%	30%	30%
Power plants	25%	30%	30%	30%
Industrial and commercial	15%	20%	30%	30%

Source:

https://www.indonesiapalmoilfacts.com/prospects-for-indonesian-biodiesel-in-2024-and-beyond/
https://www.sciencedirect.com/science/article/pii/S1364032123007694

Data Input

Biodiesel Supply and Demand in Indonesia (Period 2008 - 2017)

Tabel 1. Permintaan Dan Penawaran Biodiesel Indonesia

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Beginning Stocks	18	15	81	38	40	55	7	57	34	34
Production	630	330	740	1800	2200	2800	3000	1180	2450	2600
Import	0	0	0	0	0	0	0	0	0	0
Exports	610	204	563	1440	1515	1800	1350	343	200	100
Consumption	23	60	220	358	670	1048	1600	860	2250	2400
Ending Stocks	15	81	38	40	55	7	57	34	34	134

Biodiesel Production Capacity in Indonesia (Period 2008 - 2017)

Tabel 2. Kapasitas Produksi Biodiesel Indonesia

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Number of Biorefineries	14	20	22	22	26	26	26	27	28	29
Nameplate Capacity	3138	3528	3936	4281	4881	5670	5670	6750	7286	7628
Capacity Use (%)	20%	9%	19%	42%	45%	49%	53%	17%	34%	34%

Source:

https://gapki.id/news/2017/09/13/perkembangan-biodiesel-di-indonesia-dan-terbesar-di-asia/

BIODIESEL DOMESTIC DEMAND, PRODUCTION, AND DISTRIBUTION STOCK AVAILABILITY IN INDONESIA (PERIOD 2009 - 2023)

Source:

www.Palmoilmagazine.com
https://gapki.id
https://www.statista.com

Data Input

	Year	Domestic Biodiesel Demand (Kilo Litre)	Domestic Biodiesel Production (Kilo Litre)	Biodiesel Export to Global (Kilo Litre)	Stock Distribution Availability (Kilo Litre)
1	2009	119000	190000	70000	1000
2	2010	167400	271250	94091	1580
3	2011	241240	369219	114823	2915
4	2012	346536	503926	172634	5622
5	2013	465150	689148	201016	10705
6	2014	660010	943828	310128	19744
7	2015	904014	1384014	391652	35168
8	2016	1464420	1855519	527628	60621
9	2017	1876188	2567589	674289	101419
10	2018	2568664	3447935	936239	165090
11	2019	3572130	4609661	1246721	261875
12	2020	5008982	6450783	1742397	404965
13	2021	6916575	8707327	2254902	609905
14	2022	9605205	12331325	2940025	892020
15	2023	14103288	17605572	3814941	1259621
Total		**48018802**	**61927096**	**15491486**	**3832249**

02

DECLARE THE RESEARCH QUESTION

Research Question Regarding Domestic Biodiesel Demand, Domestic Biodiesel Production, and Stock Distribution Availability

- What are the primary variables to drive biodiesel stock distribution availability in Indonesia?
- How does Indonesia manage biodiesel stock distribution availability levels to make sure that supply stability to meet the demand?
- How could increase biodiesel production with new policy and technology ?
- How does Indonesia balance biodiesel production for domestic use versus export global markets?
- What policies could support better alignment between biodiesel production and demand, ensuring market stability?

03

DEFINE THE PURPOSE OF THE MODEL

Purpose of The Model

- The main purpose of the model is to find out whether the stock distribution availability in Indonesia will be able to meet the needs of both domestic and global export markets.
- To identify the growth in demand for biodiesel exports to the global market as an influencing factor in the stock distribution availability in Indonesia.
- To analyse the product quality, and affordable price average rate for both industrial and retail as an important variable in increasing increasing domestic demand in Indonesia.
- To analyse the influence of the use of the latest technology average rate as an important variable in increasing domestic biodiesel production in Indonesia.
- To analyse the availability of facilities, and infrastructure development average rate as an important variable in increasing biodiesel distribution to stock in Indonesia.

04

DEFINE THE MODEL BOUNDARY AND IDENTIFY KEY VARIABLES

The Model Boundary

Data:

- Industrial Product Quality Average Rate
- Affordable Industrial Price Average Rate
- Retail Product Quality Average Rate
- Affordable Retail Price Average Rate
- Lower Energy Efficiency Average Rate
- Engine Performance and Compatibility Issues Average Rate
- Economic Downturns Average Rate
- Lack of Supporting Infrastructure Average Rate
- Growth of Electric Vehicles Average Rate
- Inconsistent Government Policies Average Rate
- Fluctuating Crude Oil Prices Average Rate
- Domestic Biodiesel Demand

Data:

- The Influence of The Use of The Latest Technology Average Rate
- Domestic Biodiesel Production Average Rate
- Caused by Force Majors Average Rate
- By System Error Average Rate
- By Human Error Average Rate
- Domestic Biodiesel Production

Data:

- Infrastructure Development Average Rate
- Availability of Facilities Average Rate
- Low Product Quality Average Rate
- Economic Crises Average Rate
- Unattainable Prices for Customers Average Rate
- Low Resource Availability Average Rate
- Domestic Biodiesel Production to Stock Average Rate
- Domestic Biodiesel Demand for Customers Average Rate
- Biodiesel Export to Global Average Rate
- Biodiesel Export to Global
- Stock Distribution Availability

The Key Variables

Model: Domestic Biodiesel Demand

No	Variable Names
1	Industrial Product Quality Average Rate
2	Affordable Industrial Price Average Rate
3	Industrial Demand Average Rate
4	Retail Product Quality Average Rate
5	Affordable Retail Price Average Rate
6	Retail Demand Average Rate
7	Increasing Domestic Demand
8	Domestic Biodiesel Demand

No	Variable Names
9	Lower Energy Efficiency Average Rate
10	Engine Performance and Compatibility Issues Average Rate
11	Economic Downturns Average Rate
12	Lack of Supporting Infrastructure Average Rate
13	Growth of Electric Vehicles Average Rate
14	Inconsistent Government Policies Average Rate
15	Fluctuating Crude Oil Prices Average Rate
16	Declining Domestic Demand

The Key Variables

Model: Domestic Biodiesel Production

No	Variable Names
1	The Influence of The Use of The Latest Technology Average Rate
2	Domestic Biodiesel Production Average Rate
3	Increasing Domestic Biodiesel Production
4	Domestic Biodiesel Production
5	Caused by Force Majors Average Rate

No	Variable Names
6	By System Error Average Rate
7	By Human Error Average Rate
8	Caused by Error Average Rate
9	Declining Domestic Biodiesel Production

The Key Variables

Model: Stock Distribution Availability

No	Variable Names
1	Infrastructure Development Average Rate
2	Availability of Facilities Average Rate
3	Biodiesel Distribution to Stock
4	Domestic Biodiesel Production to Stock Average Rate
5	Domestic Biodiesel Production to Stock
6	Domestic Biodiesel Demand for Customers Average Rate
7	Domestic Biodiesel Demand for Customers

No	Variable Names
8	Low Product Quality Average Rate
9	Economic Crises Average Rate
10	Unattainable Prices for Customers Average Rate
11	Low Resource Availability Average Rate
12	Biodiesel Distribution to Customers
13	Stock Distribution Availability

The Key Variables

Model: Stock Distribution Availability

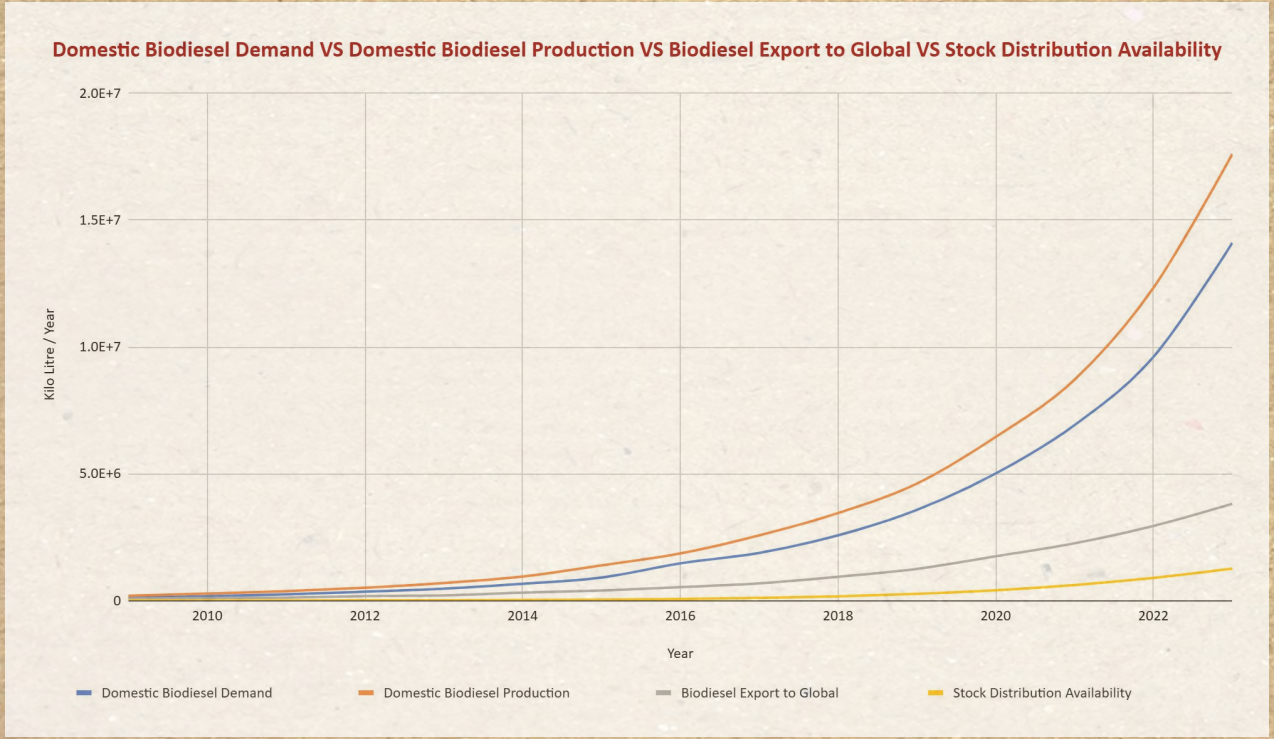
Submodel: Biodiesel Export to Global

No	Variable Names
1	Biodiesel Export to Global Average Rate
2	Biodiesel Export to Global

05

DESCRIBE THE BEHAVIOR OR DRAW THE REFERENCE MODES OF THE KEY VARIABLES

Draw The Reference Modes of The Key Variables



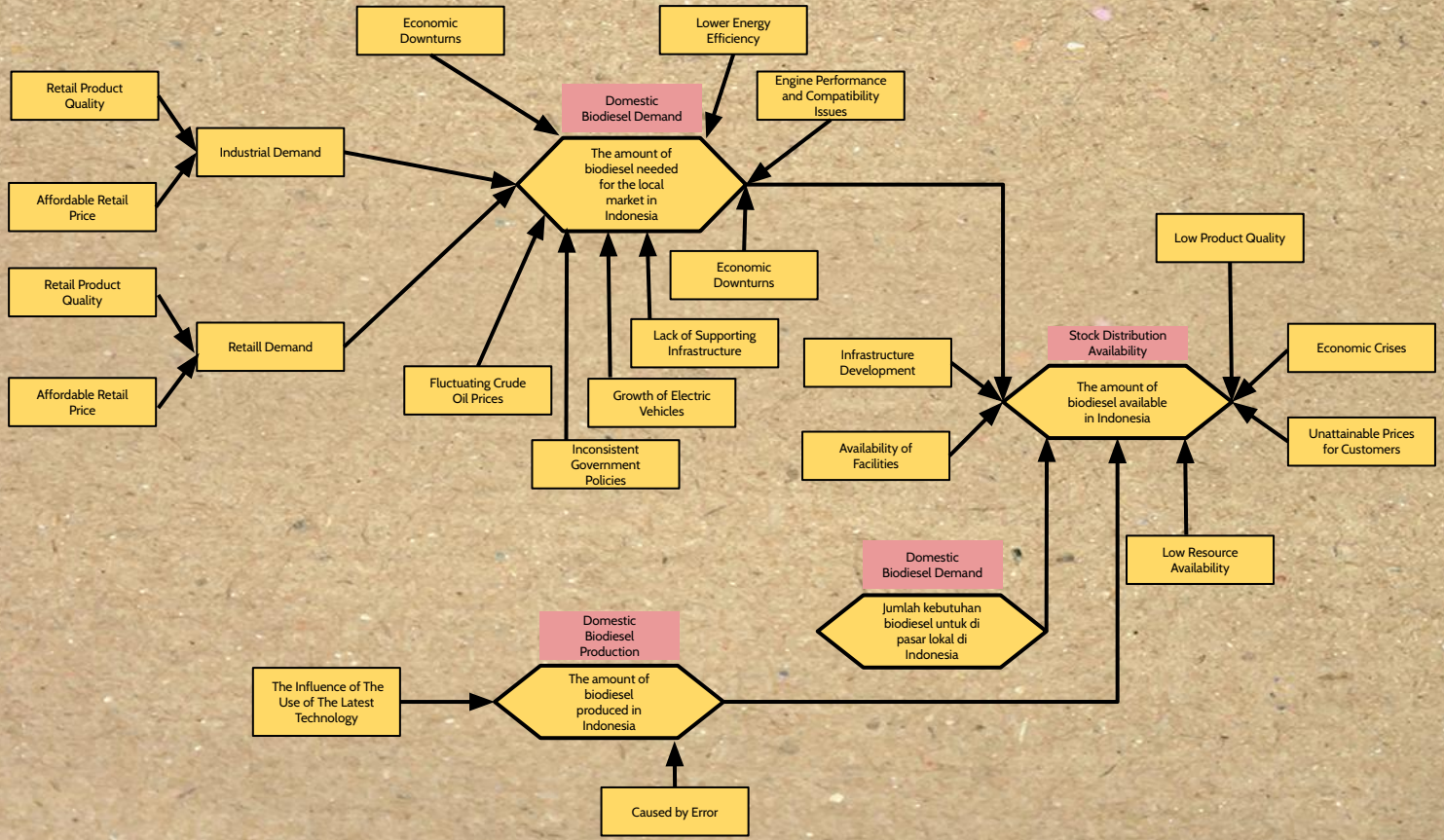
From this graph, we could see that the domestic biodiesel demand variable is increasing significantly, but domestic production variable is growing faster, allowing exports to the global market variable to increase. However, the growth of stock availability for distribution variable seems to be lagging, which could be a problem point for further development of the scale of biodiesel distribution in the future.

Source: Data Processed in 2024

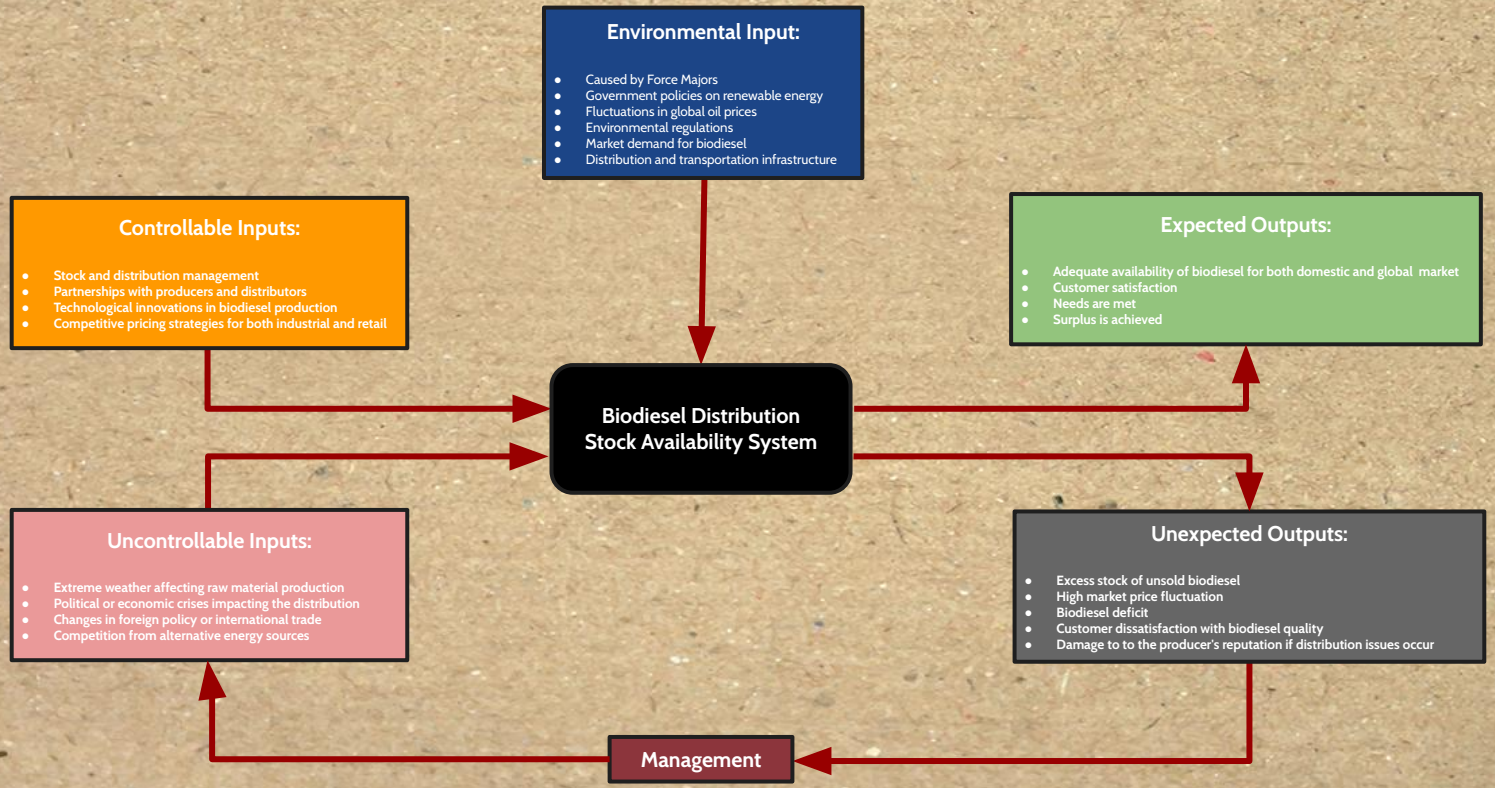
06

DIAGRAM THE BASIC MECHANISMS, THE CAUSAL LOOP DIAGRAM, OF THE SYSTEM

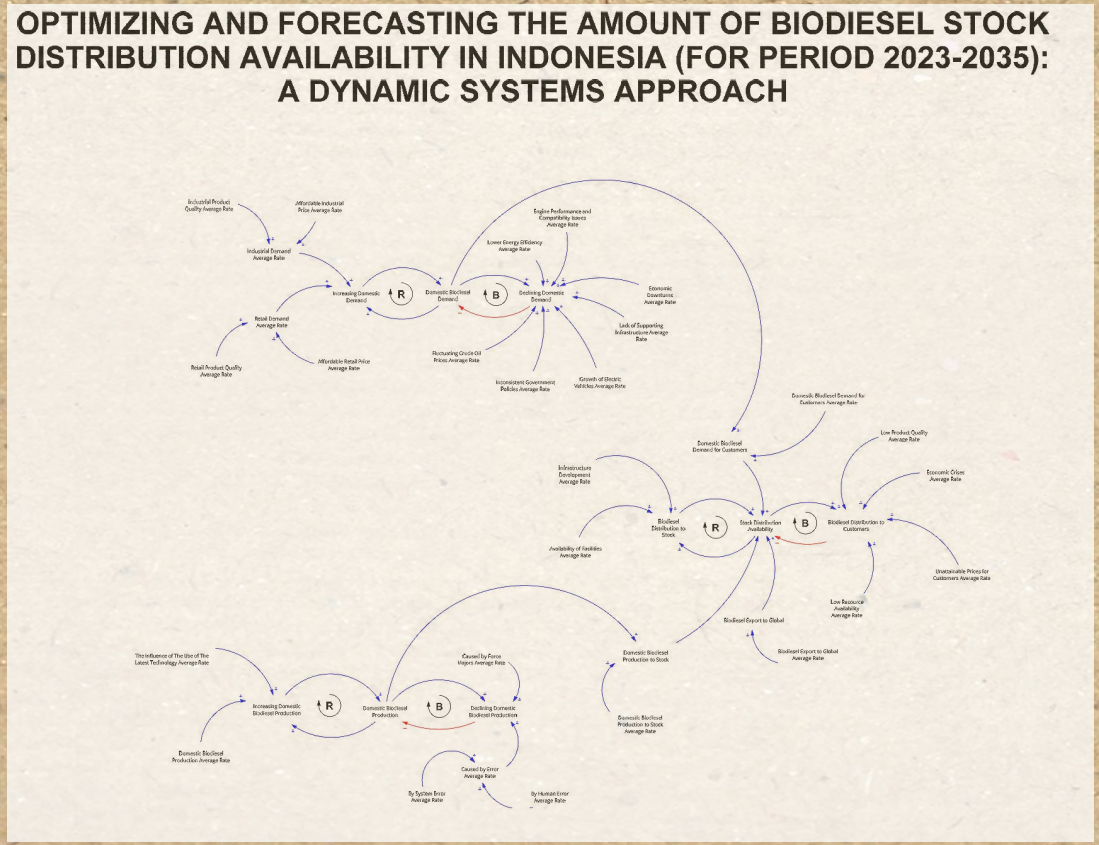
The Influence Diagram



Input-Output Biodiesel Distribution Stock Availability System Diagram



Causal Loop Diagram (CLD)

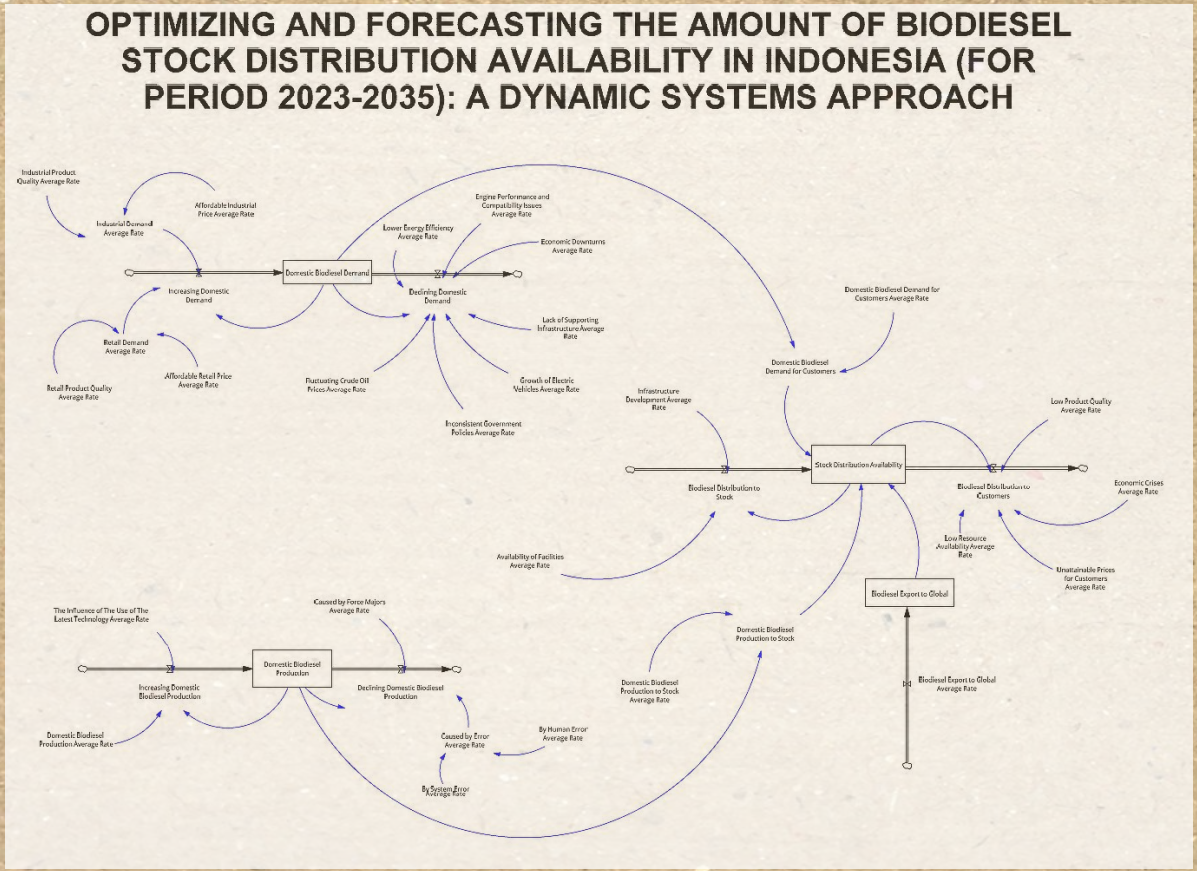


Source: Vensim Software PLE Version 10.2.1

07

CONVERT CAUSAL LOOP DIAGRAM (CLD) TO STOCK AND FLOW (SFD)

Stock and Flow Diagram (SFD)



Source: Vensim Software PLE Version 10.2.1

08

DEFINE EQUATIONS FOR EACH VARIABLE

EQUATIONS FOR EACH VARIABLE

No	Variable	Mathematical Equations	Unit
1	Industrial Product Quality Average Rate	0.15	Dmnl
2	Affordable Industrial Price Average Rate	0.05	Dmnl
3	Industrial Demand Average Rate	Affordable Industrial Price Average Rate+Industrial Product Quality Average Rate	Dmnl
4	Retail Product Quality Average Rate	0.05	Dmnl
5	Affordable Retail Price Average Rate	0.15	Dmnl
6	Retail Demand Average Rate	Affordable Retail Price Average Rate+Retail Product Quality Average Rate	Dmnl
7	Increasing Domestic Demand	(Industrial Demand Average Rate+Retail Demand Average Rate)*Domestic Biodiesel Demand	Kilo Litre/Year
8	Domestic Biodiesel Demand	INTEG(Increasing Domestic Demand-Declining Domestic Demand, 14103288	Kilo Litre/Year
9	Lower Energy Efficiency Average Rate	0	Dmnl

EQUATIONS FOR EACH VARIABLE

No	Variable	Mathematical Equations	Unit
10	Engine Performance and Compatibility Issues Average Rate	0	Dmnl
11	Economic Downturns Average Rate	0	Dmnl
12	Lack of Supporting Infrastructure Average Rate	0	Dmnl
13	Growth of Electric Vehicles Average Rate	0	Dmnl
14	Inconsistent Government Policies Average Rate	0	Dmnl
15	Fluctuating Crude Oil Prices Average Rate	0	Dmnl
16	Declining Domestic Demand	(Economic Downturns Average Rate+Engine Performance and Compatibility Issues Average Rate+Fluctuating Crude Oil Prices Average Rate+Growth of Electric Vehicles Average Rate+Inconsistent Government Policies Average Rate+Lack of Supporting Infrastructure Average Rate+Lower Energy Efficiency Average Rate)*Domestic Biodiesel Demand	Kilo Litre/Year
17	The Influence of The Use of The Latest Technology Average Rate	0.13125	Dmnl
18	Domestic Biodiesel Production Average Rate	0.2438	Dmnl

EQUATIONS FOR EACH VARIABLE

No	Variable	Mathematical Equations	Unit
19	Increasing Domestic Biodiesel Production	(Domestic Biodiesel Production Average Rate+The Influence of The Use of The Latest Technology Average Rate)*Domestic Biodiesel Production	Kilo Litre/Year
20	Caused by Force Majors Average Rate	0	Dmnl
21	By Human Error Average Rate	0	Dmnl
22	By System Error Average Rate	0	Dmnl
23	Caused by Error Average Rate	0	Dmnl
24	Declining Domestic Biodiesel Production	(Caused by Error Average Rate+Caused by Force Majors Average Rate)*Domestic Biodiesel Production	Kilo Litre/Year
25	Domestic Biodiesel Production	INTEG(Increasing Domestic Biodiesel Production-Declining Domestic Biodiesel Production, 17605572	Kilo Litre/Year
26	Infrastructure Development Average Rate	0.30	Dmnl
27	Availability of Facilities Average Rate	0.45	Dmnl

EQUATIONS FOR EACH VARIABLE

No	Variable	Mathematical Equations	Unit
28	Biodiesel Distribution to Stock	Stock Distribution Availability*(Availability of Facilities Average Rate+Infrastructure Development Average Rate)	Kilo Litre/Year
29	Domestic Biodiesel Production to Stock Average Rate	0.95	Dmnl
30	Domestic Biodiesel Production to Stock	Domestic Biodiesel Production*Domestic Biodiesel Production to Stock Average Rate	Kilo Litre/Year
31	Domestic Biodiesel Demand for Customers Average Rate	0.93	Dmnl
32	Domestic Biodiesel Demand for Customers	Domestic Biodiesel Demand*Domestic Biodiesel Demand for Customers Average Rate	Kilo Litre/Year
33	Low Product Quality Average Rate	0	Dmnl
34	Economic Crises Average Rate	0	Dmnl
35	Unattainable Prices for Customers Average Rate	0	Dmnl

EQUATIONS FOR EACH VARIABLE

No	Variable	Mathematical Equations	Unit
36	Low Resource Availability Average Rate	0	Dmnl
37	Biodiesel Distribution to Customers	Stock Distribution Availability*(Economic Crises Average Rate+Low Product Quality Average Rate+Low Resource Availability Average Rate+Unattainable Prices for Customers Average Rate)	Kilo Litre/Year
38	Biodiesel Export to Global	INTEG(Biodiesel Export to Global*Biodiesel Export to Global Average Rate, 3814941	Kilo Litre/Year
39	Biodiesel Export to Global Average Rate	0.33	Dmnl
40	Stock Distribution Availability	INTEG(Biodiesel Distribution to Stock-Biodiesel Distribution to Customers+Domestic Biodiesel Production to Stock-Domestic Biodiesel Demand for Customers-Biodiesel Export to Global, 1259621	Kilo Litre/Year

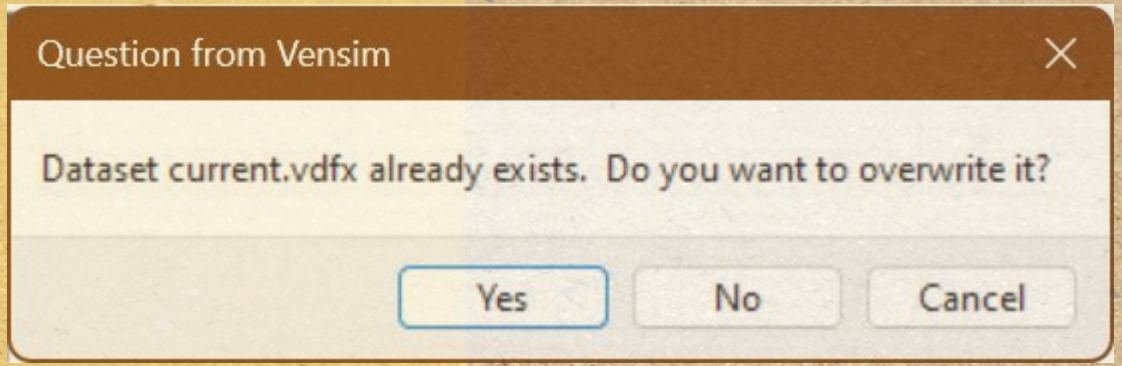
09

VERIFYING, VALIDATING, FORECASTING PROJECTION, AND OPTIMIZING THE SIMULATION MODEL (INCLUDING INTERPRETING THE RESULT)

Vensim PLE Version 10.2.1

Verifying: The Simulation Model

The model that has been created is then verified to see whether an error occurs or not. If an error occurs in the existing model, then the logic of the simulation created is not completely correct. Models that experience errors must repeat the creation of the initial simulation model. The results of running the model created in 3 model areas and 1 submodel are shown in the image below and it can be seen that the model is free from error. So the model has fulfilled the following verification stages:



Source: Verification of Vensim Model

Validation: Real Data VS Simulation Data

The validity of the simulation is identified by the Root Mean Square Percentage Error (RMSPE), which compares actual historical data and simulation results which are getting smaller RMSPE number, the higher the validity of the simulation data.

$$RMSPE = \sqrt{\sum_{i=0}^{n} \frac{(\frac{x_s - x_e}{x_e})^2}{n}} \times 100\%$$

Where:

Xs = Simulation Data
Xe = Existing (Real) Data
n = Period / Amount of Data

Interpretation of RMSEP values:

- **Error < 5% =** Very valid in describing existing (real) conditions
- **5% < Error < 10% =** Valid in describing existing (real) conditions
- **Error > 10% =** Invalid in describing existing (real) conditions

Validation: Real Data VS Simulation Data

Output Data and Domestic Biodiesel Demand Validation

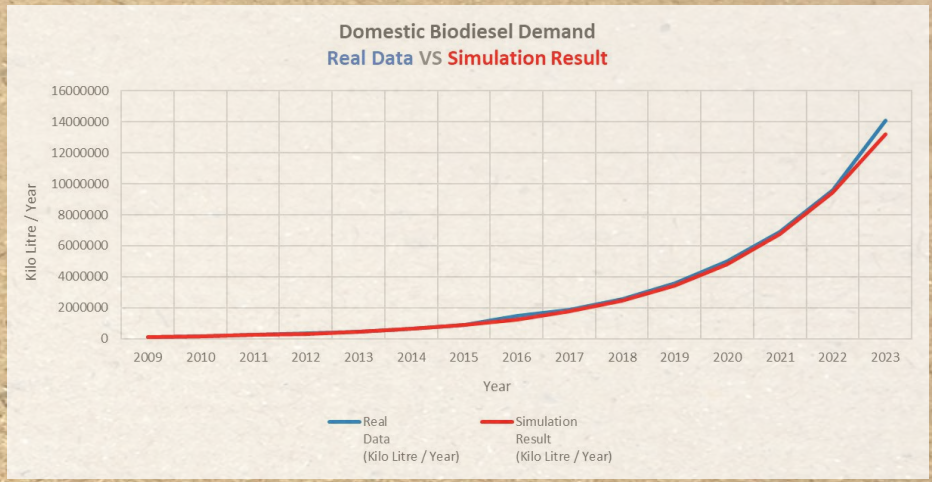
Simulation Result on Vensim Software:

Table | Domestic Biodiesel Demand

File View Window

Time (Year)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Domestic Biodiesel Demand : current	119000	166600	233240	326536	457150	640011	896015	1.25442e+06	1.75619e+06	2.45866e+06	3.44213e+06	4.81898e+06	6.74658e+06	9.44521e+06	1.32233e+07

Variable	Year	Real Data (Kilo Litre / Year)	Simulation Result (Kilo Litre / Year)	Absolute Difference (Kilo Litre / Year)	Absolut Persentase Error (APE) (%)	Squared APE (%)	RMSPE (%)
Domestic Biodiesel Demand	2009	119000	119000	0	0.00%	0.00%	
	2010	167400	166600	800	0.48%	0.00%	
	2011	241240	233240	8000	3.32%	0.11%	
	2012	346536	326536	20000	5.77%	0.33%	
	2013	465150	457150	8000	1.72%	0.03%	
	2014	660010	640011	19999	3.03%	0.09%	
	2015	904014	896015	7999	0.88%	0.01%	
	2016	1464420	1254420	210000	14.34%	2.06%	
	2017	1876188	1756190	119998	6.40%	0.41%	
	2018	2568664	2458660	110004	4.28%	0.18%	
	2019	3572130	3442130	130000	3.64%	0.13%	
	2020	5008982	4818980	190002	3.79%	0.14%	
	2021	6916575	6746580	169995	2.46%	0.06%	
	2022	9605205	9445210	159995	1.67%	0.03%	
	2023	14103288	13223300	879988	6.24%	0.39%	
							5.15%



Due to The RMSPE = 5%<**5.15%**<10%, Thus, the Domestic Biodiesel Demand Simulation Results is **valid** in describing existing (real) conditions

Source: Data Processed in 2024

Validation: Real Data VS Simulation Data

Output Data and Domestic Biodiesel Production Validation

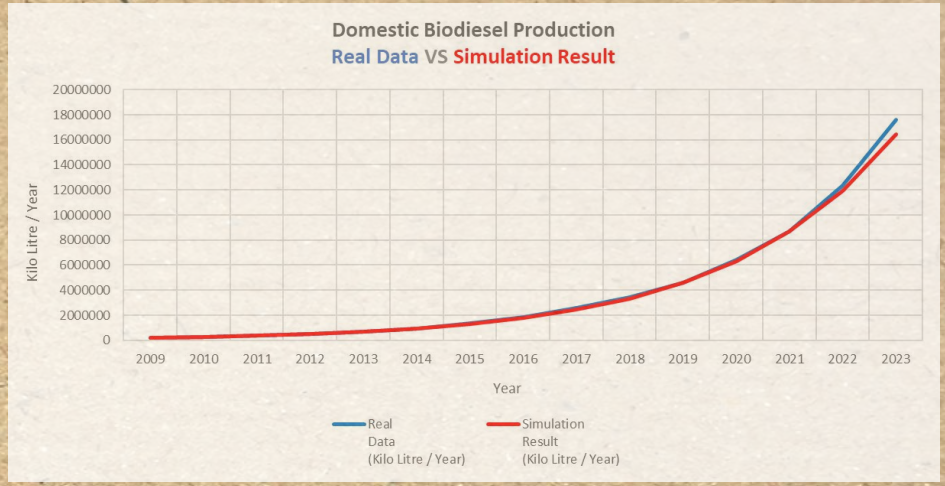
Simulation Result on Vensim Software:

Table | Domestic Biodiesel Production

File View Window

Time (Year)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Domestic Biodiesel Production : curren	190000	261260	359245	493980	679247	933998	1.28429e+06	1.76597e+06	2.4283e+06	3.33903e+06	4.59133e+06	6.31331e+06	8.68111e+06	1.1937e+07	1.64139e+07

Variable	Year	Real Data (Kilo Litre / Year)	Simulation Result (Kilo Litre / Year)	Absolute Difference (Kilo Litre / Year)	Absolut Persentase Error (APE) (%)	Squared APE (%)	RMSPE (%)
Domestic Biodiesel Production	2009	190000	190000	0	0.00%	0.00%	
	2010	271250	261260	9990	3.68%	0.14%	
	2011	369219	359245	9974	2.70%	0.07%	
	2012	503926	493980	9946	1.97%	0.04%	
	2013	689148	679247	9901	1.44%	0.02%	
	2014	943828	933998	9830	1.04%	0.01%	
	2015	1384014	1284290	99724	7.21%	0.52%	
	2016	1855519	1765970	89549	4.83%	0.23%	
	2017	2567589	2428300	139289	5.42%	0.29%	
	2018	3447935	3339030	108905	3.16%	0.10%	
	2019	4609661	4591330	18331	0.40%	0.00%	
	2020	6450783	6313310	137473	2.13%	0.05%	
	2021	8707327	8681110	26217	0.30%	0.00%	
	2022	12331325	11937000	394325	3.20%	0.10%	
	2023	17605572	16413900	1191672	6.77%	0.46%	
							3.68%



Due to The RMSPE = **3.68%**<5%, Thus, the Domestic Biodiesel Production Simulation Results is **very valid** in describing existing (real) conditions.

Source: Data Processed in 2024

Validation: Real Data VS Simulation Data

Output Data and Biodiesel Export to Global Validation

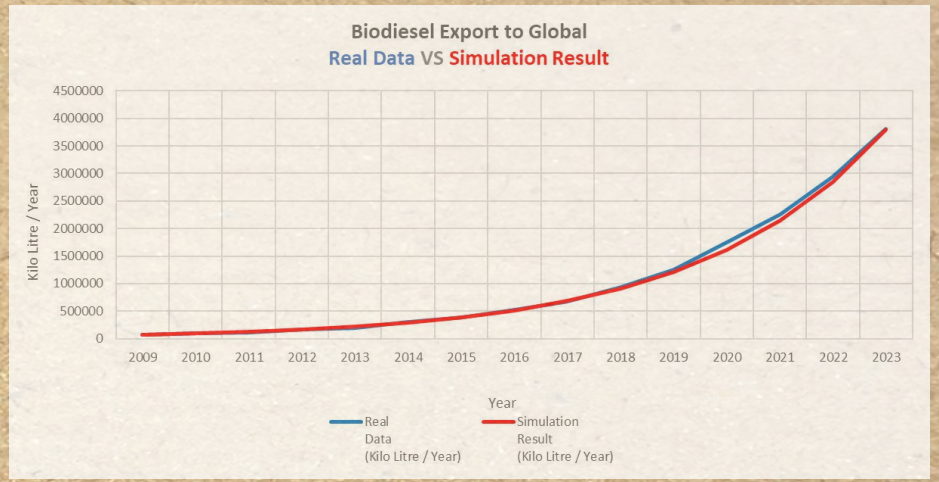
Simulation Result on Vensim Software:

Table | Biodiesel Export to Global

File View Window

Time (Year)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Biodiesel Export to Global : current	70000	93100	123823	164685	219031	291311	387443	515299	685348	911513	1.21231e+06	1.61238e+06	2.14446e+06	2.85213e+06	3.79333e+06

Variable	Year	Real Data (Kilo Litre / Year)	Simulation Result (Kilo Litre / Year)	Absolute Difference (Kilo Litre / Year)	Absolut Persentase Error (APE) (%)	Squared APE (%)	RMSPE (%)
Biodiesel Export to Global	2009	70000	70000	0	0.00%	0.00%	
	2010	94091	93100	991	1.05%	0.01%	
	2011	114823	123823	-9000	-7.84%	0.61%	
	2012	172634	164685	7949	4.60%	0.21%	
	2013	201016	219031	-18015	-8.96%	0.80%	
	2014	310128	291311	18817	6.07%	0.37%	
	2015	391652	387443	4209	1.07%	0.01%	
	2016	527628	515299	12329	2.34%	0.05%	
	2017	674289	685348	-11059	-1.64%	0.03%	
	2018	936239	911513	24726	2.64%	0.07%	
	2019	1246721	1212310	34411	2.76%	0.08%	
	2020	1742397	1612380	130017	7.46%	0.56%	
	2021	2254902	2144460	110442	4.90%	0.24%	
	2022	2940025	2852130	87895	2.99%	0.09%	
	2023	3814941	3793330	21611	0.57%	0.00%	
							4.57%



Due to The RMSPE = **4.57%**<5%, Thus, the Domestic Biodiesel Production Simulation Results is **very valid** in describing existing (real) conditions.

Source: Data Processed in 2024

Validation: Real Data VS Simulation Data

Output Data and Stock Distribution Availability Validation

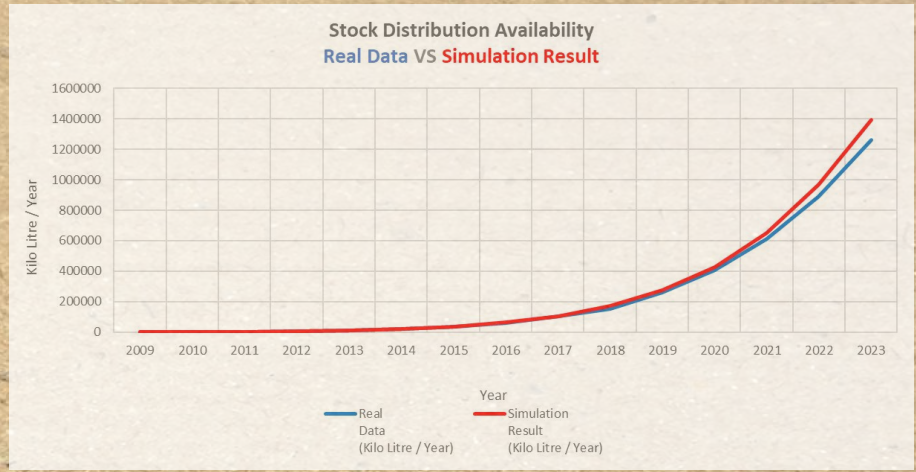
Simulation Result on Vensim Software:

Table | Stock Distribution Availability

File View Window

Time (Year)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Stock Distribution Availability : current	1000	1580	2923.51	5662.56	10827.1	20051.3	35867.7	62111.1	104454	171071	273379	426683	650309	966324	1.39501e+06

Variable	Year	Real Data (Kilo Litre / Year)	Simulation Result (Kilo Litre / Year)	Absolute Difference (Kilo Litre / Year)	Absolut Persentase Error (APE) (%)	Squared APE (%)	RMSPE (%)
Stock Distribution Availability	2009	1000	1000	0	0.00%	0.00%	
	2010	1593	1580	13	0.82%	0.01%	
	2011	3015	2923.51	91.49	3.03%	0.09%	
	2012	5622	5663	-41	-0.73%	0.01%	
	2013	10705	10827	-122	-1.14%	0.01%	
	2014	19744	20051	-307	-1.55%	0.02%	
	2015	35168	35867	-699	-1.99%	0.04%	
	2016	59621	62111	-2490	-4.18%	0.17%	
	2017	101419	104454	-3035	-2.99%	0.09%	
	2018	154090	171071	-16981	-11.02%	1.21%	
	2019	261875	273379	-11504	-4.39%	0.19%	
	2020	404965	426683	-21718	-5.36%	0.29%	
	2021	609905	650309	-40404	-6.62%	0.44%	
	2022	892020	966324	-74304	-8.33%	0.69%	
	2023	1259621	1395010	-135389	-10.75%	1.16%	
							5.43%



Due to The RMSPE = 5%<**5.43%**<10%, Thus, the Domestic Biodiesel Demand Simulation Results is **valid** in describing existing (real) conditions

Source: Data Processed in 2024

Forecasting Projection: Without Policy Strategy Intervention For Period 2023-2035

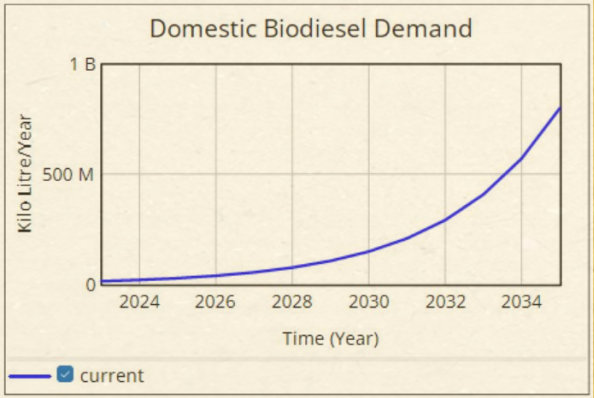
Output Data of Domestic Biodiesel Demand, Domestic Biodiesel Production, Biodiesel Export to Global, and Stock Distribution Availability

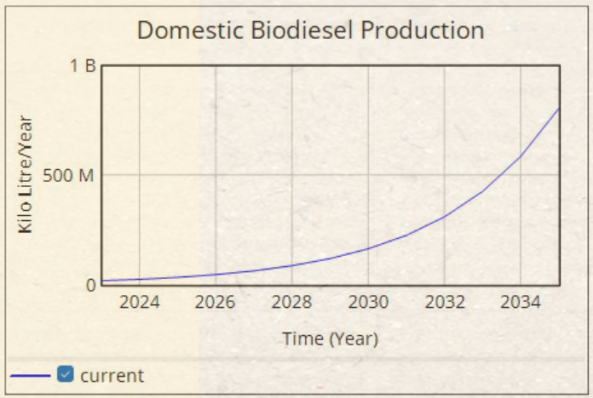
Simulation Result on Vensim Software:

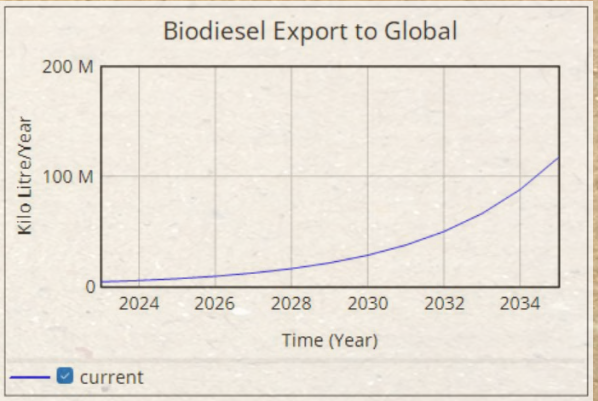
Table | Selected Variables

File View Window

Time (Year)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Biodiesel Export to Global : current	3.81494e+06	5.07387e+06	6.74825e+06	8.97517e+06	1.1937e+07	1.58762e+07	2.11153e+07	2.80834e+07	3.73509e+07	4.96767e+07	6.607e+07	8.78731e+07	1.16871e+08
Domestic Biodiesel Demand : current	1.41033e+07	1.97446e+07	2.76424e+07	3.86994e+07	5.41792e+07	7.58509e+07	1.06191e+08	1.48668e+08	2.08135e+08	2.91389e+08	4.07944e+08	5.71122e+08	7.99571e+08
Domestic Biodiesel Production : curren	1.76056e+07	2.42085e+07	3.3288e+07	4.57726e+07	6.29396e+07	8.65451e+07	1.19004e+08	1.63636e+08	2.25008e+08	3.09397e+08	4.25437e+08	5.84997e+08	8.044e+08
Stock Distribution Availability : current	1.25962e+06	1.99863e+06	3.05937e+06	4.52172e+06	6.43135e+06	8.72387e+06	1.10671e+07	1.2548e+07	1.10691e+07	2.21238e+06	-2.28691e+07	-8.13141e+07	-2.05569e+08





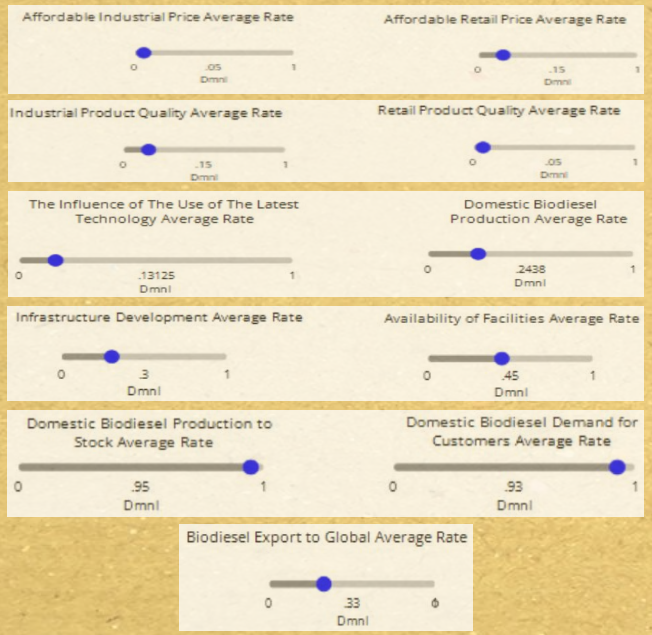


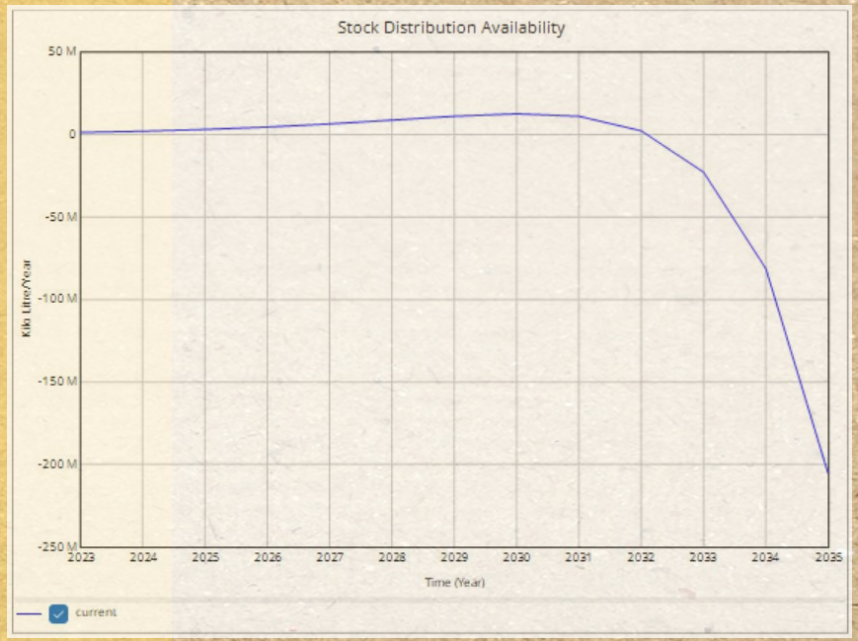
Source: Data Processed in 2024

Forecasting Projection: Without Policy Strategy Intervention For Period 2023-2035

Output Data of Domestic Biodiesel Demand, Domestic Biodiesel Production, Biodiesel Export to Global, and Stock Distribution Availability

Simulation Result on Vensim Software:





The simulation results for the "Stock Distribution Availability" has shown that although initially there was an increase from 2023 to 2032, yet there was a sharp decline from 2033 to 2035 due to the increase in biodiesel domestic & export to global demand far exceeding existing the biodiesel production.

Source: Data Processed in 2024

Our Group's Policy Strategies

Therefore, to continue meeting the needs for "Stock Distribution Availability" of biodiesel in Indonesia in the coming years, we have determined the following 3 policy strategy options:

#1. Increasing The Biodiesel Production Average Rate Policy Strategy

#2. By Declining The Export to Global Average Rate (in Order to Fulfil The Availability in Domestic Needs First)

#3. Combining The #2 & #3 Strategy Policy

Optimizing The Model (With Policy Strategy Intervention For Period 2023-2035)

#1 Scenario: By Increasing The Domestic Biodiesel Production Average Rate

Before

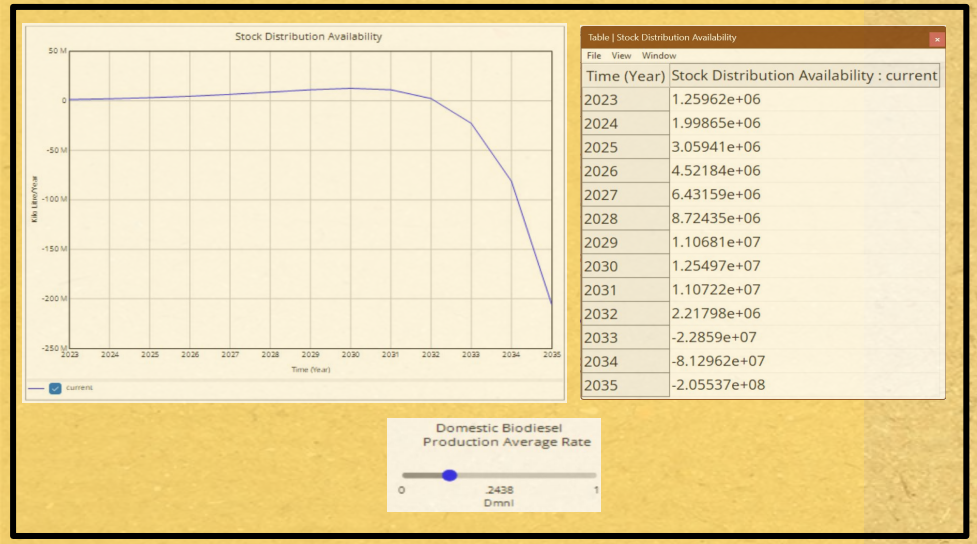


Table | Stock Distribution Availability

File View Window

Time (Year)	Stock Distribution Availability : current
2023	1.25962e+06
2024	1.99865e+06
2025	3.05941e+06
2026	4.52184e+06
2027	6.43159e+06
2028	8.72435e+06
2029	1.10681e+07
2030	1.25497e+07
2031	1.10722e+07
2032	2.21798e+06
2033	-2.2859e+07
2034	-8.12962e+07
2035	-2.05537e+08

After

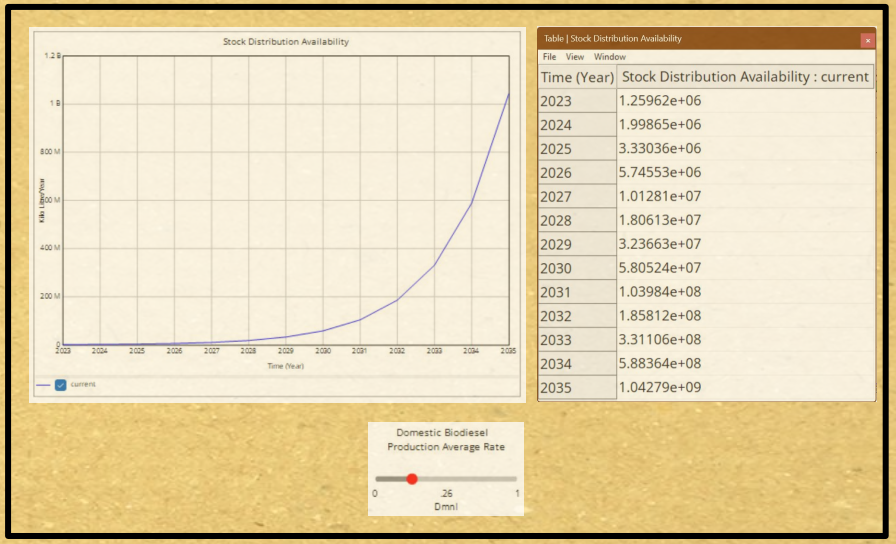


Table | Stock Distribution Availability

File View Window

Time (Year)	Stock Distribution Availability : current
2023	1.25962e+06
2024	1.99865e+06
2025	3.33036e+06
2026	5.74553e+06
2027	1.01281e+07
2028	1.80613e+07
2029	3.23663e+07
2030	5.80524e+07
2031	1.03984e+08
2032	1.85812e+08
2033	3.31106e+08
2034	5.88364e+08
2035	1.04279e+09

By increasing the "Average Rate of Domestic Biodiesel Production" at minimum 0.012 (1.2%) from 0.248 to 0.26, the results show that the "Availability of Stock Distribution" value increased sharply, especially in 2033 to 2035, different from the previous situation.

Optimizing The Model (With Policy Strategy Intervention For Period 2023-2035)

#2 Scenario: By Declining The Export to Global Average Rate (in Order to Fulfil The Availability in Domestic Needs First)

Before

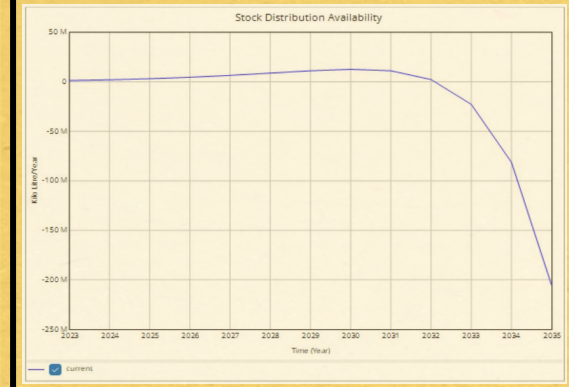
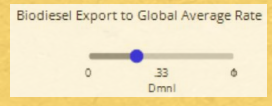


Table | Stock Distribution Availability

File View Window

Time (Year)	Stock Distribution Availability : current
2023	1.25962e+06
2024	1.99865e+06
2025	3.05941e+06
2026	4.52184e+06
2027	6.43159e+06
2028	8.72435e+06
2029	1.10681e+07
2030	1.25497e+07
2031	1.10722e+07
2032	2.21798e+06
2033	-2.2859e+07
2034	-8.12962e+07
2035	-2.05537e+08



After

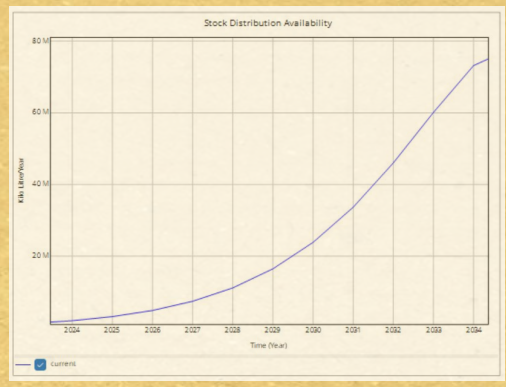


Table | Stock Distribution Availability

File View Window

Time (Year)	Stock Distribution Availability : current
2023	1.25962e+06
2024	1.99865e+06
2025	3.13571e+06
2026	4.85679e+06
2027	7.4166e+06
2028	1.11501e+07
2029	1.64714e+07
2030	2.38406e+07
2031	3.36573e+07
2032	4.60056e+07
2033	6.0102e+07
2034	7.31749e+07
2035	7.82775e+07

By declining the "Export to Global Average Rate" at minimum 0.02 (2%) from 0.33 to 0.31, the results show that the "Availability of Stock Distribution" value increased sharply, especially in 2033 to 2035, different from the previous situation.

Optimizing The Model (With Policy Strategy Intervention For Period 2023-2035)

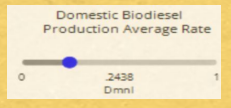
#3 Scenario: By Combining The #2 & #3 Strategy Policy

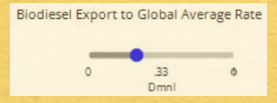
Before

Table | Stock Distribution Availability

File View Window

Time (Year)	Stock Distribution Availability : current
2023	1.25962e+06
2024	1.99865e+06
2025	3.05941e+06
2026	4.52184e+06
2027	6.43159e+06
2028	8.72435e+06
2029	1.10681e+07
2030	1.25497e+07
2031	1.10722e+07
2032	2.21798e+06
2033	-2.2859e+07
2034	-8.12962e+07
2035	-2.05537e+08



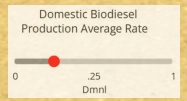


After

Table | Stock Distribution Availability

File View Window

Time (Year)	Stock Distribution Availability : current
2023	1.25962e+06
2024	1.99865e+06
2025	3.20126e+06
2026	5.15698e+06
2027	8.33489e+06
2028	1.34958e+07
2029	2.18764e+07
2030	3.54924e+07
2031	5.76405e+07
2032	9.37342e+07
2033	1.52702e+08
2034	2.49336e+08
2035	4.08263e+08



By increasing the "Average Rate of Domestic Biodiesel Production" at minimum 0.002 (0.2%) from 0.248 to 0.25 and declining the "Export to Global Average Rate" at minimum 0.01 (1%) from 0.33 to 0.32, the results show that the "Availability of Stock Distribution" value also increased sharply, especially in 2033 to 2035, different from the previous situation.

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CONCLUSION AND SUGGESTION

Conclusion

- From the results of simulations carried out without any policy strategy intervention, the variables that influence of "Availability of Stock Distribution" are "Domestic Biodiesel Demand", "Domestic Biodiesel Production", and "Biodiesel Export to Global", where the amount of "Stock Distribution Availability" from 2023-2035 decreases significantly with the average rate 44.68%.

- Based on scenario #1, the policy strategy intervention carried out by increasing the minimum "Domestic Biodiesel Production Average Rate" by only 1.2% (for example, the 2023-2035 period) could increase the "Stock Distribution Availability" which was previously minus from -22859000 KL/Year (2033) , -81296200 KL/Year (2034), and -205537000 KL/Year (2035), to become 331106000 KL/Year (2033), 5.88E+08 KL/Year (2034), and 1042790000 KL/Year (2035). This increase has had a very significant influence on the existing forecast for increasing the "Stock Distribution Availability" of Biodiesel.

- Based on scenario #2, the policy strategy intervention carried out by declining the "Export to Global Average Rate" (in order to fulfil the availability in domestic needs first) by only minimum 2% (for example, the 2023-2035 period) could increase the "Stock Distribution Availability" which was previously minus from -22859000 KL/Year (2033) , -81296200 KL/Year (2034), and -205537000 KL/Year (2035), to become 60102000 KL/Year (2033), 73174900 KL/Year (2034), and 78277500 KL/Year (2035). This increase has had a very significant influence on the existing forecast for increasing the "Stock Distribution Availability" of biodiesel.

- Based on scenario #3, the policy strategy intervention carried out by Combining The #2 & #3 Strategy Policy by increasing the minimum "Domestic Biodiesel Production Average Rate" by only 0.2% and also declining the "Export to Global Average Rate" (in order to fulfil the availability in domestic needs first) by only minimum 1% (for example, the 2023-2035 period) could also increase the "Stock Distribution Availability" which was previously minus from -22859000 KL/Year (2033) , -81296200 KL/Year (2034), and -205537000 KL/Year (2035), to become 152702000 KL/Year (2033), 249336000 KL/Year (2034), and 408263000 KL/Year (2035). This increase has had a very significant influence on the existing forecast for increasing the "Stock Distribution Availability" of biodiesel.

- After running all of the three scenarios above, it could be concluded that the most optimal and efficient scenario for increasing the "Stock Distribution Availability" of biodiesel is scenario #1 without declining our quantity of "biodiesel export to global market".

Suggestion

- Based on simulations that have been carried out for the 2023-2035 period, the Indonesian government must be responsive in handling the level of biodiesel demand which increases every year in Indonesia, both in terms of domestic demand and the need for export to the global market.
- By increasing the Domestic Biodiesel Production Average Rate, the Availability of Stock Distribution of Biodiesel can be fulfilled to meet the needs of both domestic and global markets.
- The government needs to issue policies to increase the ratio of Domestic Biodiesel Production Average Rate such as the following:
  - **Boost Innovation and Technology**: Focus on developing advanced and more efficient technologies for biodiesel production and application.
  - **Enhance Investment**: Encourage greater financial backing from both public and private sectors to support the growth of the biodiesel industry.
  - **Increase Public Awareness**: Promote education and awareness among the public and industries about the crucial role of biodiesel in ensuring a sustainable energy future.
  - **Strengthen Policy Framework**: Implement clear and consistent policies that will promote and support the biodiesel sector's development.

THANKS

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2024