

IMPACT ANALYSIS OF  
**FOREIGN DIRECT INVESTMENT**  
IN INDONESIA'S ELECTRICITY AND AGROFORESTRY  
SUB-SECTORS ON THE REGIONAL ECONOMY,  
SOCIAL-ECONOMY, AND ENVIRONMENT

2022



TRACTION  
ENERGY ASIA

# TABLE OF CONTENTS

<b>LIST OF TABLES</b>	<b>5</b>
<b>LIST OF FIGURES</b>	<b>6</b>
<b>LIST ABBREVIATIONS, ACRONYMS, AND SYMBOLS</b>	<b>7</b>
<b>KEY FINDINGS</b>	<b>8</b>
Regional Economy	9
Social Economy	9
Social Conflict	9
Environmental Pollution	10
FDI Policy Strategy Recommendations	10
<b>CHAPTER I INTRODUCTION</b>	<b>13</b>
1.1 Background	13
1.2 Problem Formulation	14
1.3 Purpose	14
<b>CHAPTER II THEORETICAL REVIEW</b>	<b>15</b>
2.1 Coal-Fired Power Plants ( <i>Pembangkit Listrik Tenaga Uap/ PLTU</i> )	15
2.2 National Development Policy Strategy in the Electricity Sub-Sector in Harmony with the Concept of Sustainable Development	16
2.3 Correlation of FDI Projects in the Electricity Sub-Sector with the Regional Economy, Social-Economy, and the Environment	17
<b>CHAPTER III RESEARCH METHODS</b>	<b>18</b>
3.1 Research Approach	18
3.2 Research Locus	18
3.3 Types, Sources, and Collection Techniques of the Research Data	18
3.4 Data Analysis Technique	18
3.4.1 Data Processing and Analysis Techniques Used in the Impact Analysis of FDI in the Electricity Sub-Sector	18
3.4.2 Data Processing and Analysis Techniques Impact Analysis of FDI in the Agroforestry Sub-Sector	20
<b>CHAPTER IV GENERAL DESCRIPTION OF THE ANALYSIS OBJECTS</b>	<b>21</b>
4.1 PLTU Karangandri, Cilacap Regency, Central Java Province	21
4.2 PLTU Tanjung Jati B, Jepara Regency, Central Java Province	21
4.3 Palm Oil Plantation and Mill of PT Rezeki Kencana Kubu Raya Regency, West Kalimantan Province	22
4.4 Palm Oil Plantation and Mill of PT Agro Palindo Sakti, Sanggau Regency, West Kalimantan Province	22
4.5 Palm Oil Company (Industry) Policy on Economic, Educational, and Community Health Aspects of the Industry	22
<b>CHAPTER V IMPACT ANALYSIS OF FDI IN THE ELECTRICITY SUB-SECTOR ON THE REGIONAL ECONOMY, SOCIAL-ECONOMY, AND ENVIRONMENT</b>	<b>24</b>
5.1 Impact Analysis of FDI in the Electricity Sub-Sector on the Regional Economy	24
5.1.1 Impact of FDI in the Electricity Sub-Sector on Economic Growth	24
5.1.2 Impact of FDI in the Electricity Sub-Sector on Expenditure Distribution/ Income Inequality	24
5.1.3 Impact of FDI in the Electricity Sub-Sector on Poverty	25
5.1.4 Impact of FDI in the Electricity Sub-Sector on HDI Level	25
5.2 Impact Analysis of FDI in the Electricity Sub-Sector on Socio-Economy	25
5.2.1 Livelihood Impacts	25
5.2.1.1 Impact of PLTU Karangandri on Livelihoods in Karangandri Village and Slarang Village, Cilacap Regency	25

5.2.1.2	The impact of PLTU Tanjung Jati B on Karangkandri Village and Slarang Village, Cilacap Regency	26
5.2.2	The Impact on Socio-Economic Conditions	26
5.2.3	The Impact on Public Health	27
5.3	Impact Analysis of FDI in the Electricity Sub-Sector on Regional Infrastructure	28
5.4	Impact of FDI in the Electricity Sub-Sector on Human Resource Development	29
5.5	Impact of FDI in the Electricity Sub-Sector on the Environment	29
5.5.1	Pollution Level of PLTU Karangkandri	29
5.5.1.1	Impact of PLTU Karangkandri Cilacap on Air Quality	29
5.5.1.2	Greenhouse Gas (GHG) Emissions from the Operational Activities of PLTU Karangkandri Cilacap	33
5.5.2	Pollution Level of PLTU Tanjung Jati B Jepara	34
5.5.2.1	Impacts of PLTU Tanjung Jati B Jepara on Changes in Air Quality	34
5.5.2.2	Greenhouse Gas (GHG) Emissions from Tanjung Jati B PLTU Operations, Jepara	36
<b>CHAPTER VI</b>	<b>IMPACT ANALYSIS OF FDI IN THE AGROFORESTRY SUB-SECTOR ON THE REGIONAL ECONOMY, SOCIO-ECONOMY, AND ENVIRONMENT</b>	<b>38</b>
6.1	Impact Analysis of FDI in the Agroforestry Sub-Sector on the Regional Economy	38
6.1.1	The Impact of FDI in the Agroforestry Sub-Sector on the Economy	38
6.1.1.1	Result of Linkage Analysis Input-Output Analysis	38
6.1.1.2	Result of Multiplier Effect Analysis	38
6.1.2	The Impact of FDI in the Agroforestry Sub-Sector on the Distribution of Expenditure/Income Inequality	38
6.1.3	The Impact of FDI in the Agroforestry Sub-Sector on Poverty Levels	40
6.1.4	The Impact of FDI in the Agroforestry Sub-Sector on Human Development Index (HDI)	42
6.2	The Impact of FDI in the Agroforestry Sub-Sector on Social Economy	43
6.2.1	Health Impacts	45
6.2.2	Livelihood/Living Standard Impacts	45
6.2.3	Energy Accessibility Impacts	46
6.2.4	Social Conflict Impacts	46
6.3	Impact Analysis of FDI in the Agroforestry Sub-Sector on Greenhouse Gas Emissions and Environmental Changes	47
6.3.1	Greenhouse Gas Emissions	47
6.3.2	Changes in Environmental Quality	47
6.3.2.1	Water Quality	47
6.3.2.2	Forest Cover	48
6.3.3	Calculation of GHG Emissions Volume Impacts from FDI Project on Agroforestry Sub-Sector (Palm Oil)	50
6.3.3.1	GHG Emissions of Land Preparation (Clearing) for Palm Oil Plantations	50
6.3.3.2	GHG Emissions from Palm Oil Plantation Cultivation	50
6.3.3.3	GHG Emissions from Palm Oil Plantation CPO Production Activities	50
<b>CHAPTER VII</b>	<b>CONCLUSION</b>	<b>51</b>
7.1	FDI in Energy Sector, Electricity Sub-Sector	51
7.1.1	Regional Economy	51
7.1.2	Social Economic	51
7.1.3	Environmental Pollution	51
7.2	FDI in Energy Sector, Agroforestry Sub-Sector	52
7.2.1	Regional Economy	52
7.2.2	Social Economy	52

7.2.3 Social Conflict	52
7.2.4 Environmental Pollution	52
<b>CHAPTER VIII FDI POLICY STRATEGY RECOMMENDATION</b>	<b>54</b>
8.1 Low Carbon Development Concept	54
8.2 Challenges and Obstacles to Low Carbon Development	54
8.3 Low Carbon Development Policy Directions	54
8.4 FDI Policy Strategy for the Electricity Sub-Sector in Harmony with Low Carbon Development	55
8.5 FDI Policy Strategy for the Forestry Agriculture Sub-Sector in Harmony with Low Carbon Development	56
<b>REFERENCES</b>	<b>58</b>
Books, Journals, and Reports	58
Regulations	61
News Articles, Database, and Other References	61
<b>APPENDIX (RESEARCH METHODS)</b>	<b>64</b>
1. Data Processing and Data Analysis Technique in FDI Impacts on Electricity Sub-Sector	64
A. Error Correction Model	64
- Economic Growth	64
- Income Disparity	64
- Poverty Level	64
- Human Development Index (HDI)	64
B. Data Analysis Technique on Socio-Economic	65
C. Data Analysis Technique on Environmental Aspect	65
- Greenhouse Gas (GHG) Emissions	66
- Pollutant Emissions	66
2. Data Processing and Data Analysis Technique in Forestry-Agriculture Sub-Sector	68
A. Input-Output Analysis	68
- Direct Indirect Linkage Backward	68
a. Dispersion Coefficient	68
b. Sensitivity of Dispersion	69
- Multiplier Analysis	69
B. Disparity Analysis	70
C. Poverty Analysis	70
D. Data Analysis Technique on Environmental Impacts	71
- Greenhouse Gas (GHG) Emissions	71

# LIST OF TABLES

<b>Table 2.1</b>	Ministry of Energy and Mineral Resources Investment Target and Realization 2019 - 2024	16
<b>Table 3.1</b>	WHO Air Quality Guidelines	19
<b>Table 4.1</b>	Development Period of PLTU Karangkandri Cilacap	21
<b>Table 4.2</b>	Development Period of PLTU Tanjung Jati B Jepara	22
<b>Table 5.1</b>	List of PLTU Karangkandri CSR for Karangkandri Village and Slarang Village	26
<b>Table 5.2</b>	List of Tanjung Jati B PLTU CSR for Tubanan Village	27
<b>Table 5.3</b>	Availability and Quality of Basic Infrastructure in Affected Villages of PLTU Karangkandri and Tanjung Jati	28
<b>Table 5.4</b>	Percentage of High School/Equivalent and College Graduates in Affected Villages	29
<b>Table 5.5</b>	Calculation of the Amount of Pollutants from Coal Burning of PLTU Karangkandri Cilacap	31
<b>Table 5.6</b>	Calculation of the Quantity of CO <sub>2</sub> Emissions from PLTU Karangkandri Cilacap (2019 – 2021)	33
<b>Table 5.7</b>	Total Pollutant Emissions (SO <sub>2</sub> , CO <sub>2</sub> , and NO <sub>2</sub> ) of PLTU Tanjung Jati B Jepara	35
<b>Table 5.8</b>	Greenhouse Gas (CO <sub>2</sub> ) Emissions from PLTU Tanjung Jati B Jepara	37
<b>Table 6.1</b>	Direct Indirect Linkage Backward (DILB) and Direct Indirect Linkage Forward (DILF) of Palm Oil Commodities at the National Level	38
<b>Table 6.2</b>	Analysis of the Output Multiplier, Income Multiplier, and Labor Multiplier in the Palm Oil Commodity Sector in Indonesia	38
<b>Table 6.3</b>	Linear Regression Test Results of FDI, Domestic Investment (Penanaman Modal Dalam Negeri/PMDN), on Inequality and Poverty	39
<b>Table 6.4</b>	Development of the Human Development Index (IPM) for Kubu Raya Regency, Sanggau Regency, and West Kalimantan Province in 2010-2021	43
<b>Table 6.5</b>	The Development of Three Villages Affected by Palm Oil Plantation Company Activities Based on the Development Village Index (DVI) 2015-2022	43
<b>Table 6.6</b>	Levels of Household Income in Sei Deras Village, Telok Pakedai District, Kubu Raya Regency	44
<b>Table 6.7</b>	Percentage of Residents with Formal Education in the Villages of Jangkang One (Kubu Raya), Sungai Deras (Kubu Raya) and Mandong (Sanggau) in 2015 and 2020	44
<b>Table 6.8</b>	Matrix of Digital Literacy Level in the Community of Jangkang Satu Village (Kubu Raya), Sei Deras Village (Kubu Raya), and Mandong Village (Sanggau) Before and After Palm Oil Plantation Activities	44
<b>Table 6.9</b>	Living Standard Scores Based on 14 BPS Standard of Living Indicators by Village Affected Cases in Kubu Raya and Sanggau Regencies in 2005 and 2020	45
<b>Appendix Table 1</b>	WHO Air Quality Guidelines	67
<b>Appendix Table 2</b>	The Multiplier Formula for Output, Income, and Labor	69
<b>Appendix Table 3</b>	Greenhouse Gas Emission Factors by Forest Type in Kalimantan	72
<b>Appendix Table 4</b>	Publications on Greenhouse Gas Emissions in Oil Palm Plantation and Palm Oil Mills	73

# LIST OF FIGURES

<b>Figure 2.1</b>	Simple Schematic of PLTU Work System	15
<b>Figure 2.2</b>	Increasing the Efficiency of Coal Use at PLTU Cilacap	15
<b>Figure 5.1</b>	Number of Outpatient Disease Cases in Karangkandri Village and Slarang Village, Cilacap Regency in 2021	27
<b>Figure 5.2</b>	Number of Outpatient Disease Cases in Kembang District, Jepara Regency in 2021	28
<b>Figure 5.3</b>	Windrose Based on Cilacap Station for 30 Years	30
<b>Figure 5.4</b>	Windrose in Jepara Based on Semarang Station for 30 Years	30
<b>Figure 5.5</b>	NO <sub>2</sub> Dispersion in Ambient Air around PLTU Karangkandri Cilacap	32
<b>Figure 5.6</b>	CO <sub>2</sub> Dispersion in Ambient Air around PLTU Karangkandri Cilacap	32
<b>Figure 5.7</b>	SO <sub>2</sub> Dispersion in Ambient Air around PLTU Karangkandri Cilacap	33
<b>Figure 5.8</b>	Greenhouse Gas (GHG) Emissions from PLTU Karangkandri Cilacap (2019-2021)	34
<b>Figure 5.9</b>	Simulation of NO <sub>2</sub> Dispersion around PLTU Tanjung Jati B Jepara	35
<b>Figure 5.10</b>	Simulation of CO <sub>2</sub> Dispersion around PLTU Tanjung Jati B Jepara	36
<b>Figure 5.11</b>	Simulation of SO <sub>2</sub> Dispersion around PLTU Tanjung Jati B Jepara	36
<b>Figure 5.12</b>	GHG Emissions [g CO <sub>2</sub> e/kWh] per Unit of Generated Energy	37
<b>Figure 6.1</b>	Foreign Direct Investment (FDI), Domestic Investment (Penanaman Modal Dalam Negeri/PMDN), Gini Ratio, and Williamson Index of Kubu Raya District 2016-2020	39
<b>Figure 6.2</b>	Foreign Direct Investment (FDI) and Poverty in 10 Provinces with Highest Palm Oil Plantation Area in 2021	40
<b>Figure 6.3</b>	Foreign Direct Investment (FDI) and Poverty in West Kalimantan Province	41
<b>Figure 6.4</b>	Foreign Direct Investment (FDI), City and Regency Poverty in West Kalimantan Province in 2021	42
<b>Figure 6.5</b>	Sink Components from the GHG Cycle	47
<b>Figure 6.6</b>	Process of Decreasing Water Quality	48
<b>Figure 6.7</b>	Algae (a) and Secondary Canal (b) in Jangkang Satu Village	48
<b>Figure 6.8</b>	Two Components of the Most Important Sources of GHG Emissions: Land Clearing and Peat	49
<b>Figure 6.9</b>	Deforestation Tracks of PT Agro Palindo Sakti and PT Rezeki Kencana	49
<b>Figure 8.1</b>	Sustainable Development Scheme	56
<b>Figure 8.2</b>	Paradigm Shifts and Approaches to Sustainable Agroforestry Sub-Sector Implementation	57

# LIST OF ABBREVIATIONS, ACRONYMS AND SYMBOLS

<b>AFOLU</b>	Agriculture, Forestry and Other Land Use
<b>BPS</b>	<i>Badan Pusat Statistik</i> (Central Bureau of Statistics Indonesia)
<b>CKT</b>	Circuit (electrical)
<b>CO</b>	Carbon monoxide
<b>CO<sub>2</sub></b>	Carbon dioxide
<b>CO<sub>2</sub>e</b>	Carbon dioxide equivalent: the number of metric tons of CO <sub>2</sub> emissions with the same global warming potential as one metric ton of another greenhouse gas
<b>CPO</b>	Crude palm oil
<b>FDI</b>	Foreign Direct Investment
<b>FGD</b>	Flue Gas Desulfurization
<b>GHG</b>	Greenhouse Gas
<b>GRDP</b>	Gross regional domestic product
<b>GW</b>	Gigawatt
<b>HDI</b>	Human development index
<b>IDM</b>	Village development index
<b>IPP</b>	Independent power producer
<b>Kg</b>	Kilogram
<b>MW</b>	Megawatt
<b>MWh</b>	Megawatt hours: A megawatt hour (MWh) equals 1,000 kilowatts of electricity generated per hour and is used to measure electric output.
<b>MVA</b>	Megavolt amperes: a measure of active and reactive electrical power equal to one million volt-amperes.
<b>NDPE</b>	No deforestation, no peat, no exploitation
<b>NO<sub>2</sub></b>	Nitrogen dioxide
<b>NRE</b>	New and renewable energy
<b>PLTU</b>	<i>Pembangkit Listrik Tenaga Uap</i> : Coal-Fired/ Steam Power Plant, uses "hot steam" created by burning coal to evaporate water.
<b>POM</b>	Palm oil mill
<b>PPD</b>	Power plant developer
<b>SAIDI</b>	System Average Interruption Duration Index
<b>SO<sub>2</sub></b>	Sulphur dioxide
<b>WHO</b>	World Health Organization

# KEY FINDINGS

The aim of this research is to conduct a technocratic impact analysis to form the basis for compiling recommendations to improve the alignment of Indonesia's foreign direct investment (FDI) policy strategy in the energy sector with the energy transition scenario and Indonesia's low carbon development policy. The FDI sub-sectors referred to here are electricity and agroforestry, and our analysis assesses its impact on regional economies, social-economies, environmental quality, and greenhouse gas (GHG) emissions in Cilacap Regency and Jepara Regency in Central Java, and Sanggau Regency and Kubu Raya Regency in West Kalimantan.

There are several key findings:

- FDI from China and other countries in the electricity and agroforestry (agriculture, forest and land use - AFOLU) sub-sectors in general have positive impacts on the regional economy and social-economy through the provision of health and education facilities, infrastructure, infrastructure support, transportation, job creation and provision of entrepreneurial opportunities including encouraging the establishment of small independent plantations, as well as on digital literacy.
  - In the electricity sub-sector, FDI from China and other countries generally has positive impacts on regional economy and social economy through the provision of health education facilities and infrastructure, infrastructure support, transportation, job creation and entrepreneurial opportunities.
  - In the agroforestry sub-sector, FDI generally has positive impacts on the regional economy and social economy through job creation and entrepreneurial opportunities, including encouraging more small independent farmers to establish palm oil plantations, as well as on digital literacy.
- Quantitative and qualitative analysis shows that FDI in neither the electricity nor agroforestry sub-sectors contributes to reducing regional poverty. In addition, China's FDI generates about twice as many GHG emissions as FDI from other countries. Pollutants produced by FDI projects in these sectors often cause negative health, environmental and socio-economic impacts, such as upper respiratory tract infections, skin conditions, water air and soil pollution, hazardous waste, deforestation, reduced crop yields and fish catches etc. In addition to greenhouse gas emissions other negative impacts include social friction between residents and companies due to land disputes. The following are specific descriptions-of the negative impacts:
  - In 2021 the Chinese FDI coal plant project, PLTU Karangandri, produced 12,290,000 megawatt hours (MWh) of electricity per year, generating 13,729,943 tonnes of carbon dioxide equivalent emissions (CO<sub>2</sub>e) per year, or 0.94 tonnes of CO<sub>2</sub>e per MWh. This means that every dollar invested generated GHG emissions of 122.15 kg of CO<sub>2</sub>.
  - As a comparison, FDI from Japan for the PLTU Tanjung Jati B project has an average production of 17,600,000 MWh per year (twice that of PLTU Karangandri), with emissions of 16,550,622 tonnes of CO<sub>2</sub>e, or 0.94 tonnes of CO<sub>2</sub>e per MWh. It means that every dollar invested produces emissions of 119.17 kg of CO<sub>2</sub>.
  - Chinese FDI activities in the oil palm plantation sector have the potential to generate 3.06 million tonnes of CO<sub>2</sub>e from land preparation and 375,642.7 tonnes of CO<sub>2</sub>e, consisting of 224,269.9 tonnes CO<sub>2</sub>e from oil palm cultivation and 151,372.8 tonnes

CO<sub>2</sub>e from Crude Palm Oil (CPO) production activities of oil palm plantations.

- FDI from other countries in the same sector has the potential to produce 2,756.9 tonnes of CO<sub>2</sub>e from land preparation and annually generate 255,851 tonnes of CO<sub>2</sub>e emissions, consisting of 28,791.8 tonnes CO<sub>2</sub>e from oil palm cultivation and 227,059.2 tonnes CO<sub>2</sub>e from the process of producing palm oil.

In the electricity sub-sector, both coal plants produced harmful emissions such as carbon monoxide (CO), sulphur dioxide (SO<sub>2</sub>), nitrogen oxide (NO<sub>2</sub>) and fly ash, with NO<sub>2</sub> concentrations from both plants being above the WHO threshold. However, as both coal plants are fitted with flue gas desulfurization equipment (FGD) this reduced the concentrations of SO<sub>2</sub> considerably. The following are our key findings:

### **Regional Economy**

The two FDIs in the electricity sub-sector, PLTU Karangkandri (China) and PLTU Tanjung Jati B (Japan), contributed to a reduction in regional income inequality. Meanwhile, only PLTU Tanjung Jati B has contributed to economic growth in Jepara Regency. However, the two FDIs did not contribute to reducing regional poverty.

As for the agroforestry sub-sector, the palm oil commodity has a Direct and Indirect Linkage Forward (DILF) of 3.27 (see table 6.1), which means that increased demand will contribute to regional economic growth in terms of output, income and employment.

### **Social Economy**

Both electricity sub-sector FDIs have succeeded in providing social protection insurance assistance through CSR programs to increase income through job creation and entrepreneurial opportunities, as well as increasing the availability of infrastructure that supports community activities and mobility. However, these two FDIs also have negative health impacts on the local community. Pollutants such as SO<sub>2</sub>, NO<sub>2</sub>, CO, and fly ash generated by the two coal plants have triggered respiratory problems such as upper respiratory tract diseases, and skin irritation. PLTU Karangkandri in particular has polluted seawater around the coast, disrupting fishing activities and increasing the distance that the boats have to travel to find fish stock, which increases operational costs - fuel, labour, food.

Meanwhile, using the examples of FDIs in the agroforestry sub-sector, such as PT Rezeki Kencana Julong and PT Agro Palindo Sakti, both have succeeded in creating employment opportunities and entrepreneurial opportunities for nearby communities, thereby increasing household income and encouraging the development of small independent plantations managed individually. These two FDIs have also increased digital and information literacy in local communities.

### **Social Conflict**

In the agroforestry sub-sector, PT Rezeki Kencana Julong Group from China was involved in agrarian conflicts in Kubu Raya Regency, particularly in Sei Deras Village. The disputes arose due to different claims on land tenure between the company and the community. While the company holds a palm oil concession permit for the land, the people of Sei Deras Village assert that the land is their hereditary property. This conflict led to friction between residents and the company. However, uncertainty surrounding land claims was also caused by mishandling of the issue by the central government, as well as the actions of the

company in the field, and a lack of law enforcement by the government.

### Environmental Pollution

From the electricity sub-sector, both FDIs produce harmful emissions such as CO, CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>2</sub> and fly ash. For NO<sub>2</sub>, the concentration is above the WHO recommended threshold. although flue gas desulfurization equipment fitted to both studied coal plants have succeeded in reducing the concentration of SO<sub>2</sub> considerably. PLTU Karangandri has produced 12,500,000 MWh per year since 2021 with an emission to production ratio of 0.35 tonnes CO<sub>2</sub>e per 1 MWh, meaning that every dollar invested generates 40.27 kg CO<sub>2</sub>e emissions. Meanwhile, PLTU Tanjung Jati B has an average production of 23,000,000 MWh per year with an emission to production ratio of 0.36 tonnes CO<sub>2</sub>e per 1 MWh, meaning that every dollar invested has generated 60.27 kg CO<sub>2</sub> emissions.

In the agroforestry sub-sector, PT Rezeki Kencana Julong Group from China has had negative impacts on the surrounding environment. The waste generated by palm oil mill (POM) activities has polluted groundwater, reduced fish populations, and caused skin irritations when the water is used for daily needs. Potential GHG emissions from oil palm and POM plantation activities owned by PT Rezeki Kencana in Kubu Raya Regency reach 3.06 million tonnes of CO<sub>2</sub>e from land preparation, 224,269.9 tonnes of CO<sub>2</sub>e per year from oil palm cultivation, and 151,372.8 tonnes of CO<sub>2</sub>e per year from the palm oil production process.

Meanwhile, in Sanggau Regency, PT Agro Palindo Sakti from Singapore and the US have also had similar negative impacts on the surrounding environment. The pollution causes the growth of Hydrilla plants in the river used as a source of clean water and a main transportation route for the local community. Potential GHG emissions from PT Agro Palindo Sakti's oil palm plantation and POM activities reach 2,756.9 tonnes of CO<sub>2</sub>e from land preparation, 28,791.8 tonnes of CO<sub>2</sub>e per year from oil palm cultivation, and 227,059.2 tonnes of CO<sub>2</sub>e per year from coconut oil production.

### FDI Policy Strategy Recommendations

Considering the challenges and obstacles of implementing low carbon development in Indonesia's energy and agroforestry sectors, findings from Traction Energy Asia's other studies on the impacts of Indonesia's palm biodiesel program, and the findings of this impact analysis of FDIs in the electricity and plantation sub-sectors on the environment and GHG emissions intensity, **we formulated the following FDI policy strategy recommendations for the energy sector, with a focus on the electricity sub-sector (power generation):**

1. Ending investment offers for coal power plant development projects, and other destructive energy projects such as large hydroelectric infrastructure, and promoting investment opportunities for clean energy power plant development projects.
2. To implement the above recommendation the Indonesian government entities with mandates to manage Indonesia's inward investment - the Coordinating Ministry for Maritime Affairs and Investment, and the Investment Coordinating Board or *Badan Koordinasi Penanaman Modal* (BKPM), need to formulate an FDI policy strategy that strengthens governance systems and instruments for monitoring and evaluating inward investment in Indonesia's energy and agroforestry sectors to align with Indonesia's low carbon development ambitions and Paris Agreement emissions reduction commitments.
3. Indonesia has very high potential for solar, wind, geothermal and wave/tidal energy, as well

as abundant nature-based climate solutions, which can absorb and store carbon, such as intact natural forests, peatlands, mangroves and coral reefs. Indonesia's government needs to create the enabling conditions to encourage the development of a strong clean energy sector, including policy and regulatory support, financial and fiscal incentives/subsidies to attract FDI from countries with the experience and technological know-how to help Indonesia harness its abundant clean energy resources.

4. Indonesia's government must urgently revise the soon to be enacted RUU EBT (New and Renewable Energy Bill) to remove energy choices that are not aligned with the nation's low carbon development and Paris Agreement emissions reduction commitments. The current RUU EBT supports Indonesia's problematic energy transition and emissions reduction plans, which rely on palm-biodiesel, biomass and electric vehicles without the necessary environmental and social protection safeguards.
5. To boost Indonesia's transition to clean energy and low carbon development to support the nation's Paris Agreement emissions reduction commitments, and to encourage inward investment to develop a strong domestic clean energy sector, Indonesia's government needs to relax the local content requirement regulations to encourage foreign investment in the construction of large-scale solar power plants (SPP)/*pembangkit listrik tenaga surya* (PLTS), geothermal power plants, wind power plants (WPP)/*pembangkit listrik tenaga bayu* (PLTB), and exploration of Indonesia's wave/tidal power potential. In particular, incentives to encourage large-scale SPP/PLTS investment could help Indonesia achieve its SPP/PLTS development target of 4.68 gigawatts by 2030.
6. Indonesia's government must make it mandatory for all FDI projects in the power generation sub-sector to improve pollution control and install waste treatment systems that can recycle waste into input factors of production (circular economy) or convert them into renewable energy sources.
7. When Indonesia's delayed carbon tax is introduced in 2025 Indonesia's government must ensure that it also applies to foreign investment projects in the energy sector.

Based on our findings from the policy and trend analysis, in addition to findings from Traction Energy Asia's other studies on the impacts of Indonesia's palm biodiesel program, **we formulated the following FDI policy strategy recommendations for the agroforestry sector, with a focus on the oil palm plantation sub-sector, aligned with the energy transition scenario and low-carbon development:**

1. Ending foreign investment offers to open new land for oil palm plantations (no deforestation, no peat, no exploitation - NDPE).
2. Only providing investment offers/permits for plantation businesses that apply a sustainable plantation business pattern (intensification), are committed to no deforestation, no peat, no exploitation (NDPE), and apply the principles of good agricultural practices
3. Providing business investment offers for the oil palm plantation sub-sector to countries that have strong and real commitments to low carbon development and NDPE. Therefore, the Coordinating Ministry for Maritime Affairs and Investment, and the Investment Coordinating Board needs to strengthen its governance systems and instruments for monitoring and evaluating inward investment in Indonesia's agroforestry sector to align with Indonesia's low carbon development ambitions and Paris Agreement emissions reduction commitments.
4. Indonesia's government must promote alternative and sustainable feedstocks, such as used cooking oil and traceable supply from small independent farmers, as well as limiting the palm oil mix according to existing plantation capacity, for its ambitious biodiesel program to reduce the risk of palm oil expansion, deforestation and increasing emissions.

5. Investors must be able to generate economic value from forest utilization using a balance of conservation, protection and social functions. FDI projects in the oil palm plantation sub-sector must have a performance concept that provides leverage for regional economic development and brings benefits on the creation/absorption of green jobs and the growth of community resilience.
6. Indonesia's government must make it mandatory for all FDI projects in the agroforestry sector to improve pollution control and install waste treatment systems that can recycle waste into input factors of production (circular economy) or convert them into renewable energy sources, such as methane capture at palm oil mill effluent ponds.
7. When Indonesia's delayed carbon tax is introduced in 2025 Indonesia's government must ensure that it also applies to foreign investment projects in the agroforestry sector.

# CHAPTER I INTRODUCTION

## 1.1 Background

Investment is an important factor in economic growth, and increases in domestic and foreign investment are positively related to GDP. To achieve Indonesia's national economic growth target, the government determines investment needs of 6.6-7 percent and prioritizes the energy sector through the development of a palm-oil based biodiesel program and the 35,000 MW power plant energy program. National Electricity General Plan (Rencana Umum Ketenagalistrikan Nasional/RUKN) 2019-2038 projects that electricity demand will increase and the number of subscribers will increase in 2024 and 2030.

To meet the increasing demand for domestic electricity, the government is accelerating the development of the nation's electricity infrastructure, targeting additional capacity of 35,000 MW, with the majority supplied by coal-fired power plants (PLTU). Part of the ownership and construction of the power plant can be carried out in partnership with the Power Plant Developer (PPD), or Independent Power Producer (IPP). Apart from national efforts, IPP generator procurement projects were also opened to foreign direct investment (FDI).

In Central Java province, the realization of FDI in the electricity sub-sector under the IPP project scheme is being carried out through the construction of coal-fired power plants such as PLTU Cilacap, PLTU Tanjung Jati B Units 5 and 6, and PLTU Batang. The province of Central Java with a capacity of 7,971.65 MW in 2020, ranked 3rd after the provinces of East Java and West Java in providing electricity capacity (BPS, 2021).

In December 2020, 67 percent of electricity production in Indonesia still relied on coal energy. Based on the Electricity Supply Business Plan (*Rencana Usaha Penyediaan Tenaga Listrik/RUPTL*) of 2020-2030, the target for the use of renewable energy is 23 percent by 2025. With the still high level of dependence on fossil energy, the strategic and policy objectives of FDI in the energy sector are ideally directed at meeting the target of increasing Indonesia's renewable energy mix, while taking into account the impact on other aspects, such as the impact of social and environmental externalities. Investment is expected to have a positive externality impact.

Indonesia's Foreign investment strategy and policy formulation in the energy sector needs to be aligned with the national policy agenda for low-carbon development and to support Indonesia's Paris Agreement emissions reduction commitments. It is therefore important to analyse the impacts of FDI on the regional economy, social economy and the environment, including the generated GHG intensity in the energy and agroforestry sectors.

*Traction Energy Asia* conducted an impact analysis of FDI in the electricity sub-sector on the regional economy, socio-economy, and environment in Central Java Province, which generates the 3rd highest supply of electricity in Indonesia, largely from coal-fired power plants (PLTU). PLTU Karangandri in Cilacap Regency and, PLTU Tanjung Jati B in Jepara Regency, are two large-capacity PLTUs built and operated with foreign investment to supply electricity for the islands of Java, Madura, and Bali, and have been designated as national vital objects through a Decree of the Minister of Energy and Resources Mineral (ESDM) Number 159.K/ 90/ MEM/2020. The results of this study will provide the basis for technocratic arguments to formulate recommendations to improve alignment of Indonesia's foreign investment policy strategies in the energy sector with the nation's energy transition and low carbon development ambitions, as well as its ability to achieve its Paris Agreement commitments.

In addition, Indonesia's agricultural, forestry, and other land use (AFOLU), or agroforestry sector has historically accounted for the largest share of the nation's carbon emissions. The contribution of AFOLU to GHG emissions has not been well documented, even though this information is very important in many developing countries to bridge food security, climate resilience and mitigations, and development goals as a coherent package. Critical gaps in information, knowledge, and capacity building need to be addressed urgently.

Following Indonesia's ratification of the Paris Agreement, Indonesia is committed to reducing GHG emissions by 29 percent on its own, or by 41 percent with international assistance. From 2015-2021 palm oil plantations attracted most of the foreign investment in Indonesia's agroforestry sector. According to Indonesia's Central Statistics Agency (*Badan Pusat Statistik/BPS*) and the Ministry of Agriculture, between 2014-2018 the amount of land used for palm oil plantations increased by an average of 7.89 percent per year. This leads to the importance of conducting studies on the impact of foreign investment in the agroforestry sector on the regional economy, social economy, and the resulting GHG emissions. The results of the study are expected to become a guide in formulating FDI policy strategies in Indonesia.

## **1.2 Problem Formulation**

Based on the background, the formulation of the problem in this study is as follows:

1. What is the impact of FDI in the electricity sub-sector on the regional economy of Cilacap Regency and Jepara Regency, Central Java Province, and what is the impact of FDI on the agroforestry sub-sector on the regional economy of Sanggau Regency and Kubu Raya Regency, West Kalimantan Province?
2. What is the impact of FDI in the electricity sub-sector on the social economy of Cilacap Regency and Jepara Regency, Central Java Province and what is the impact of FDI on the agroforestry sub-sector on the social economy of the community?
3. What are the environmental impacts of FDI in the electricity sub-sector of coal-fired power plant projects in Cilacap Regency and Jepara Regency, Central Java Province, and what are the GHG emission impacts of FDI in the agroforestry sub-sector in Sanggau Regency and Kubu Raya Regency, West Kalimantan Province?

## **1.3. Purpose**

The aim of this research is to compile a technocratic impact analysis working paper as a basis for compiling recommendations for improving the foreign direct investment policy strategy for Indonesia's energy and agroforestry sectors to support Indonesia's transition to clean energy and low carbon development.

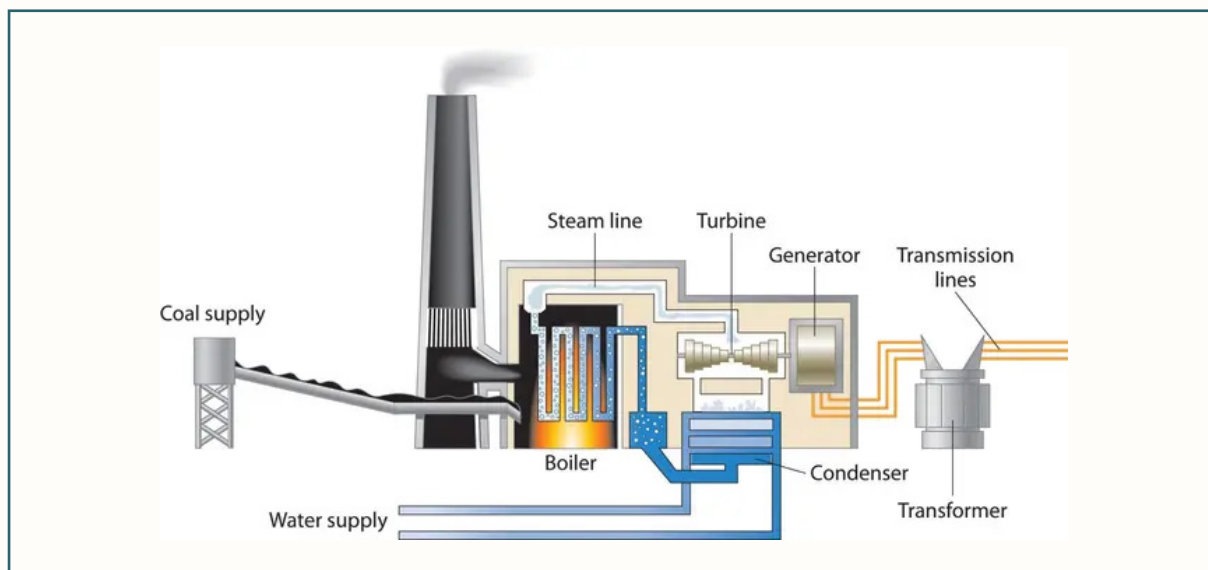
## CHAPTER II THEORETICAL REVIEW

### 2.1 Coal-fired Power Plant (Pembangkit Listrik Tenaga Uap/PLTU)

A Coal-fired power plant (*Pembangkit Listrik Tenaga Uap/PLTU*) is a power plant with coal as the energy source. Burning coal produces heat energy and is used to convert water into steam in the boiler. The hot steam then flows into the turbine to drive the turbine blades to generate electricity. The generated electricity is channeled to the user through the power grid (transmission line) (see **Figure 2.1**).

**Figure 2.1**

*Simple Schematic of PLTU Working System*

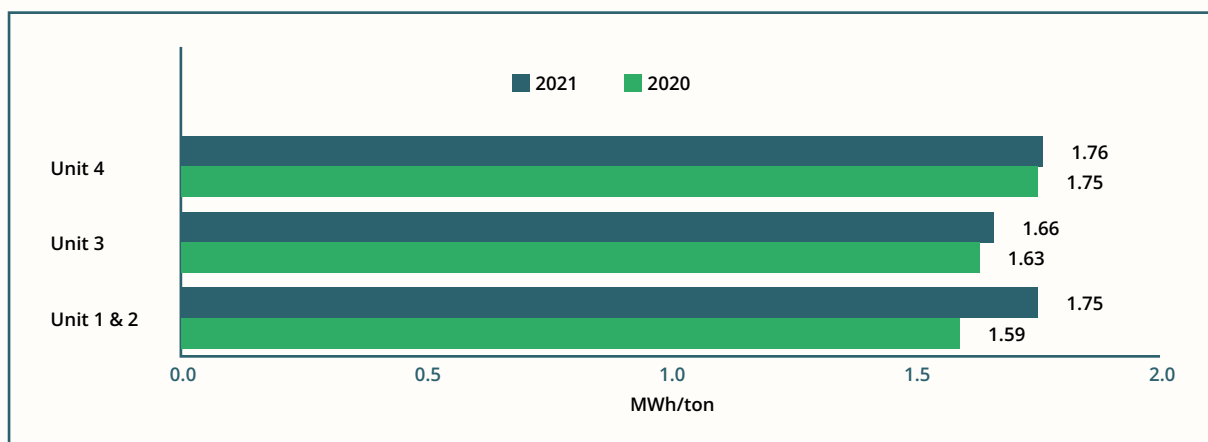


Source: <https://energycentral.com/c/ec/what-are-risks-related-coal-power-plant-investment>

The quality of the coal which is the energy source for the PLTU determines the amount of energy produced. One of the important parameters for coal and coal-fired power plants is energy efficiency (see **Figure 2.2**).

**Figure 2.2**

*Increasing the Efficiency of Coal Use at PLTU Cilacap*



Source: Processed, 2022

## 2.2 National Development Policy Strategy in the Electricity Sub-Sector in Harmony with the Concept of Sustainable Development

The construction of coal-fired power plants is a Strategic Project in the 2020-2024 National Medium-Term Development Plan (*Rencana Pembangunan Jangka Menengah/ RPJMN*), with 'Power Generation with a capacity of 27,000 MW, Transmission of 19,000 CKT, and Substations of 38,000 MVA' Major Project. The project funding is estimated at 1,121 trillion rupiahs coming from business entities. The project's target benefits include: (1) continued completion of the 35,000 MW program target; (2) supporting the new renewable energy (NRE) target in the primary energy mix by the end of 2024 of 19.5 percent; (3) availability of electricity supply for the target of electricity use of 1,400 kWh per capita in 2024; (4) reduction of CO<sub>2</sub> emissions from power plants by 3.5 million tonnes of CO<sub>2</sub> in 2024; (5) reducing the level of power outages or the System Average Interruption Duration Index (SAIDI) to 1 hour per customer in 2024; and (5) meeting the demand for electricity in national priority areas (RPJMN 2020 – 2024).

The national energy management policy strategy is also described in Appendix II of the National Energy General Plan (*Rencana Umum Energi Nasional/ RUEN*) Program Matrix. The electricity infrastructure development strategy in RUEN targets the development of electricity infrastructure to increase the installed capacity of power plants to 135.5 GW by 2025, comprising (90.4 GW fossil power plants, and New and Renewable Energy (NRE) power plants totalling 45.1 GW), and to 443.1 GW by 2050 (275.4 GW fossil power plants and 167.6 GW of NRE power plants.). The RUEN Program Matrix also includes a strategy to increase investment and develop energy sources abroad by BUMN. The person in charge is the Ministry of Energy and Mineral Resources with a policy instrument in the form of the Strategic Plan of the Ministry of Energy and Mineral Resources (Presidential Regulation or Perpres Number 22 of 2017).

In accordance with the National Medium-Term Development Plan of 2020-2024 in Strategic Priority Projects and the RUEN Program Matrix, the Ministry of Energy and Mineral Resources (*Energi dan Sumberdaya Mineral/ ESDM*) Strategic Plan also adjusts several target parameters in the electricity sector on the Energy Security Index. These include achieving an electrification ratio of up to 100 percent; increasing generation capacity from 69.70 to 96.85 GW, electricity consumption from 1,084 kWh per capita to 1,408 kWh per capita, and the System Average Interruption Duration Index (SAIDI), which continued to decrease from 17 hours per year to 1 hour per year. The Ministry of Energy and Mineral Resources is also targeting investment realization in various energy sub-sectors including the electricity sector, which in the 2019-2024 period are as follows:

**Table 2.1**

*Ministry of Energy and Mineral Resources Investment Target and Realization 2019-2024*

Electricity Sector Investment Target and Realization 2019 - 2024						
Parameters	2019	2020	2021	2022	2023	2024
Investment Target (USD Billion)	12.04	11.95	9.91	7.55	6.64	3.10
Investment Realization (USD Billion)	6.52	10.76	9.91	7.55	6.64	3.10

Source: Ministry of Energy and Mineral Resources Strategic Plan 2019-2024

To support sustainable development through energy transition scenarios, Indonesia has established a number of guidelines in the energy sector through the Indonesia Long-Term Strategy for Low Carbon and Climate Resilience 2050 (Indonesia LTS-LCCR 2050) containing the implementation of low-carbon and transition scenarios to increase energy efficiency to support development compared to the current policy scenario.

### **2.3 Correlation of FDI Projects in the Electricity Sub-Sector with the Regional Economy, Social Economy, and the Environment**

Investment in the energy sector in the electricity infrastructure sub-sector generally has a positive and significant impact on the regional economic growth rate. An increase in electricity distribution by 1 percent will increase economic growth by 0.219170 percent on the island of Java. Investment realization of 1 percent contributes to increasing the rate of economic growth by 0.032742 percent (Muflikhin, 2019).

The positive social impacts of the existence of coal investment projects are the creation of new jobs, increased employment, and increased community income (Siregar and Merinaldi, 2019; Lulu-fani and Setyadharma, 2020). However, coal-fired power plants have serious negative environmental, health and social impacts on the districts where they are based (Sasmita et al., 2021; Al Farizi et al., 2020).

## CHAPTER III

# RESEARCH METHODS

### 3.1 Research Approach

The research was conducted using both qualitative and quantitative approaches, with the following considerations:

1. A qualitative approach was taken to provide a descriptive picture of the causality relationship between parameters that are not measurable, or a description of certain conditions involving social and psychological aspects, community perceptions, and the like.
2. A quantitative approach was used to provide an overview of the condition of an aspect that was influenced by other aspects that were relatively easily measurable, such as the economic and environmental aspects analysed in this study.
3. A quantitative approach was also used for environmental aspects with measurable parameters such as the availability of environmental quality standards (e.g. for land, water, and air) as well as environmental quality-reducing agents in the form of environmental quality standards related to solids, liquids, gases, and environment (noise and smell).

### 3.2 Research Locus

The impact analysis of FDI in the electricity sub-sector was conducted in two regencies in Central Java Province, Cilacap Regency (PLTU Karangandri) and Jepara Regency (PLTU Tanjung Jati B). The analysis of the socio-economic and environmental impacts of each PLTU was carried out in two villages, namely in Karangandri Village and Slarang Village for the PLTU Karangandri, and in Tubanan Village and Dermolo Village for the PLTU Tanjung Jati B.

Meanwhile, the impact analysis of FDI in the agroforestry sub-sector was conducted on two companies in two regencies in West Kalimantan Province, the PT Rezeki Kencana palm oil plantation in Kab. Kubu Raya, which includes two villages (Sei Deras Village in Teluk Pakedai District and Jangkang Satu Village in Kubu District), and the PT Agro Palindo Sakti (APS) palm oil plantation in Sanggau District, Mandong Village, Tayan Hulu District.

### 3.3 Research Data Types, Sources, and Collection Techniques

The types of data in this study are primary data and secondary data. Primary data was obtained through observation, field observations, in-depth interviews, and conducting FGDs. Meanwhile, secondary data was obtained from research reports, publications by ministries, regional governments, village governments, health centers, the Central Statistics Agency (*Badan Pusat Statistik/BPS*), the Information and Geospatial Agency (*Badan Informasi Geospasial/BIG*), and the Meteorology, Climatology, and Geophysics Agency (*Badan Meteorologi, Klimatologi dan Geofisika/BMKG*).

### 3.4 Data Analysis Technique

#### 3.4.1 Data Processing and Analysis Techniques Used in the Impact Analysis of FDI in the Electricity Sub-Sector

##### *Error Correction Model*

The data analysis technique used in analyzing the impact of FDI in the electricity sub-sector on the regional economy was the Error Correction Model (ECM). Aspects

of analysis include (1) economic growth (Growth Domestic Product/GDP according to Business Field); (2) income disparity represented by the Expenditure Distribution; (3) poverty rate with indicators of the number of poor people; and (4) Human Development Index (HDI). Each aspect of the analysis has similarities in order to determine the impact of foreign investment in the electricity sub-sector on each aspect of the analysis. The dynamic regression equation for the ECM can be seen in the **Appendix**.

### *Socio-Economic Impact Data Analysis Techniques*

This qualitative analysis was carried out by comparing changes in socio-economic conditions in the period before the construction of the PLTU and the period after the PLTU began operating, including the social impacts after the expansion of the PLTU's capacity.

### *Environmental Impact Data Analysis Techniques*

The analysis of the environmental impact of the operation of the PLTU was viewed from two aspects, namely the impact of greenhouse gas emissions and the impact on environmental quality, especially air quality.

#### **1. Greenhouse Gas (GHG) Emissions**

The calculation of GHG emissions in the electricity sub-sector refers to the Intergovernmental Panel on Climate Change (IPCC) Guidelines 2006 method, where the total emissions were obtained from activity data for a certain time (amount of emission-producing inputs) multiplied by the emission factor.

#### **2. Pollutant Emissions**

Calculation of pollutant emissions in the form of gas concentrations in a place with x, y, and z coordinates ( $\text{g}/\text{m}^3$ ) with the midpoint of a coal power plant was carried out for three main pollutants, namely carbon monoxide (CO), sulfur dioxide ( $\text{SO}_2$ ), and nitrogen dioxide ( $\text{NO}_2$ ). Estimation was carried out using the Gaussian Dispersion Model method, which was obtained by multiplying the amount of coal burned for a certain time with the pollutant emission factor.

To calculate the gas concentration at a point around the PLTU, a gas dispersion calculation was performed by considering the chimney height and wind speed. The gas dispersion equation model was according to Gauss or called the Gaussian Dispersion Model (Peavy et al., 1985; de Nevers, 1995; Kiely, 1998; LaGrega et al., 2001). The results of calculating the concentrations of carbon monoxide (CO), sulfur dioxide ( $\text{SO}_2$ ), and nitrogen dioxide ( $\text{NO}_2$ ) emissions were then compared with the air quality recommendations for the three types of pollutants from the World Health Organization (WHO). An explanation of the air quality recommendations from WHO can be seen in the following table:

**Table 3.1**  
*WHO Air Quality Guidelines*

No	Pollutants	Value
1	$\text{NO}_2$	24-hour average is $25 \mu\text{g}/\text{m}^3$
2	$\text{SO}_2$	24-hour average is $40 \mu\text{g}/\text{m}^3$
3	CO	24-hour average is $4 \text{mg}/\text{m}^3$

Source: WHO (2021)

### **3.4.2 Data Processing and Analysis Techniques Impact Analysis of FDI in the Agroforestry Sub-Sector**

In analyzing the impact of foreign investment in the regional economy, macroeconomic indicators were used, which were based on GDP and GRDP data. To find out the contribution of foreign investment to the agroforestry sector, especially oil palm, Input-Output (I-O) Analysis of the Oil Palm Plantation Sector was used based on the 2016 National I-O including Linkage Analysis, Spread Coefficient & Spread Sensitivity Analysis, and Multiplier Effect Analysis. The description of the methodology can be found in the attachment.

## CHAPTER IV

# GENERAL DESCRIPTION OF THE ANALYSIS OBJECTS

### 4.1 PLTU Karangandri, Cilacap Regency, Central Java Province

The Karangandri Coal-fired Power Plant (PLTU Karangandri) is a coal-fired power plant located in Karangandri Village and Slarang Village, Kesugihan District, Cilacap Regency, Central Java Province. PLTU Karangandri is managed by PT Sumber Segara Primadaya S2P. The construction of the Karangandri PLTU was funded by Bank Rakyat Indonesia, the China Development Bank, and the Bank of China, the Ministry of Energy and Mineral Resources, 2016.

**Table 4.1**

*Development Period of PLTU Karangandri Cilacap*

Period	Investment Realization Development
1996	Planning for PLTU Karangandri development
1998	Monetary crisis 1998 and postponement of PLTU Karangandri construction
2003 - 2006	Construction of PLTU Karangandri Units 1 and 2 with 51% ownership of PT Sumber Segara Primadaya and 49% stake by PT Pembangkitan Jawa-Bali with funding from Bank of China of US\$ 408 million. Chengda Engineering Corporation from China is involved in the PLTU construction phase
2006	Inauguration of PLTU Karangandri Unit 1 and Unit 2
2016	Development of PLTU Karangandri Expansion 1 and Expansion 2 with funding from Bank Rakyat Indonesia, China Development Bank and Bank of China
2019	Inauguration of PLTU Karangandri Unit 3 (Expansion 1)

*Source:* Ministry of Energy and Mineral Resources, 2016; Central Java Provincial Government, 2016; detik.com, 2006; PT SSP, 2022; PT PJB, 2022; China Aid Data, 2022. Processed

Based on the history of development and operational data above, construction of PLTU Karangandri Unit 1 and Unit 2 began in 2003 and began operating in 2006. Then in 2016, the Unit 1 and Unit 2 expansion projects were carried out. In 2019, the Unit 1 expansion project was completed and carried out with the operation of PLTU Karangandri Unit 3. The object of impact analysis of PLTU Karangandri was carried out in the villages that became the locus of PLTU Karangandri, namely Karangandri Village and Slarang Village which are located in Kesugihan District, Cilacap Regency, Central Java Province.

### 4.2 PLTU Tanjung Jati B, Jepara Regency, Central Java Province

The Tanjung Jati B coal-fired power plant (PLTU Tanjung Jati B) is located in Tubanan Village, Kembang District, Jepara Regency, Central Java Province. PLTU Tanjung Jati B consists of four turbines, with two further turbines under construction. The capacities of each generating unit are as follows: 1) Units 1 to 4 have an installed capacity of 4 x 710 megawatts with a capacity of 4 x 660 megawatts for operational units. 2) Units 5 to 6 are under construction and are planned to have a capacity of 2 x 1000 megawatts. Units 1 to 4 are owned by Sumitomo Corporation through a subsidiary named PT Central Java Power. Unit 5 to Unit 6 are owned by a consortium of PT Bhumi Jati Power consisting of Sumitomo Corporation, Kansai Electric, and United Tractors PT Sumitomo Indonesia, 2017.

The stages of the development, operational, and unit expansion phases as well as the production capacity of PLTU Tanjung Jati B can be seen in **Table 4.2**.

**Table 4.2***Development Period of PLTU Tanjung Jati B Jepara*

Period	Investment Realization Development
1994	Signing of the Power Purchase Agreement (PPA) with PT HI Power Tubanan
1996 - 1998	Development of PLTU Tanjung Jati B
1998	Termination of construction of the Tanjung Jati B PLTU due to the monetary crisis
2002	Signing of the Financing Leasing Agreement between PLN and the Sumitomo Group
2002 - 2006	Construction of PLTU Tanjung Jati B Unit 1-2
2006	Inauguration of PLTU Tanjung Jati B
2009	Construction of PLTU Tanjung Jati B Unit 3-4
2012	Inauguration of PLTU Tanjung Jati B Unit 3-4
2019	Development of PLTU Tanjung Jati B Unit 5-6

Source: TJB Power Services, 2022; PT Sumitomo Indonesia, 2017; Ministry of Energy and Mineral Resources, 2012; PT PLN Persero, 2019; MedcoPower, 2019

The object of impact analysis of PLTU Tanjung Jati B is in Tubanan Village which is the locus of PLTU Tanjung Jati B and ring 2 village, namely Dermolo Village. The two villages are located in Kembang District, Jepara Regency, Central Java Province. Before the PLTU was built, Tubanan Village was an agrarian-maritime village producing rice and capture fisheries.

#### **4.3 Palm Oil Plantation and Mill of PT Rezeki Kencana Kubu Raya Regency, West Kalimantan Province**

PT Rezeki Kencana is an oil palm plantation company and also a Palm Oil Mill (POM) with the final product of crude palm oil (CPO). PT Rezeki Kencana is located in the Kubu Raya Regency, West Kalimantan Province. PT Rezeki Kencana is a subsidiary of China's Tianjin Julong Group. PT Rezeki Kencana began operating in 2002 at Desai Sei Deras based on the Location Permit document which was legalized through Decree of the Pontianak Regency Regent No. 40007-IL2002. The oil palm plantation land owned by PT Rezeki Kencana Julong Group is in two locations, namely in the Sungai Deras Village area, Teluk Pakedai District, Kubu Raya Regency, with a land area of 2.

#### **4.4 Palm Oil Plantation and Mill of PT Agro Palindo Sakti, Sanggau Regency, West Kalimantan Province**

PT Agro Palindo Sakti is an oil palm plantation company and POM. PT Agro Palindo Sakti is located in Sanggau Regency, West Kalimantan Province. PT Agro Palindo Sakti is a subsidiary of Wilmar International from Singapore and the United States. PT Agro Palindo Sakti began operating in 2005 with the issuance of Location Permit No. 400-17IL-41-20005. The location of the oil palm plantation area is in Mandong Village, Tayan Hulu District, Sanggau Regency, West Kalimantan Province, which consists of a nucleus plantation area of 1,331.62 hectares and a plasma plantation of 571.87 hectares.

#### **4.5 Palm Oil Company (Industry) Policy on Economic, Educational, and Community Health Aspects of the Industry**

The study was conducted on the two foreign investment oil palm plantation companies under review, namely Julong Group Indonesia, a company from a Chinese investor that owns PT Rezeki

Kencana in Arus Deras Village, Teluk Pakedai District, Kubu Raya Regency, West Kalimantan Province, and the Malaysian investor Wilmar Group Plantation that owns PT Agro Palindo Sakti APS in Tayan Hulu District, Sanggau Regency. The study includes the impact of the two companies' policies on the economic, educational, and public health aspects in the two villages reviewed, namely Jangkang Satu and Sungai Deras Villages in Kubu Raya, and Mandong Village in Tayan Hulu. Developments and social changes in the lives of the people of Jangkang Satu Village were influenced by the growth and development of PT Rezeki Kencana's oil palm plantations in the Kubu and Terentang areas. Even though the ownership of the oil palm plantation had changed, the figure of A Seng continued to play a role in creating interaction and communication between the plantation company and the residents of Jangkang Satu Village. In the 2012-2014 period, a POM was built in the Sei area and the expansion of oil palm plantations took place. In 2015, ownership of the plantation company moved to a Chinese company, Julong Group.

## **CHAPTER V**

# **IMPACT ANALYSIS OF FDI IN THE ELECTRICITY SUB-SECTOR ON THE REGIONAL ECONOMY, SOCIO-ECONOMY, AND ENVIRONMENT**

## **5.1 Impact Analysis of FDI in the Electricity Sub-Sector on the Regional Economy**

### **5.1.1 The Impact of FDI in the Electricity Sub-Sector on Economic Growth**

The PDRB dynamic regression equation model for Cilacap Regency shows that there is no long-term relationship between FDI in the electricity sub-sector and gross regional domestic product (GRDP). No cointegration was found between the independent variables and GRDP, including FDI in the electricity sub-sector. Previous studies have shown similar results and there is a negative relationship between foreign investment and long-term economic growth in Indonesia due to a lack of skilled labor. Meanwhile, in Jepara Regency, the GRDP model equation has cointegration at the level and the ECT probability value (-1) is significant. This means that there is a long-term and short-term relationship between FDI in the electricity sub-sector and GRDP in Jepara Regency.

In the long run, if there is an increase in foreign investment by 1 percent, it will increase the GRDP in Jepara Regency by 0.3 percent. Meanwhile, in the short term, if foreign investment increases by 1 percent, it also has the potential to increase the GRDP of the Jepara Regency by approximately 0.3 percent. These results confirm previous findings that stated that FDI has a significant influence on economic growth.

### **5.1.2 The Impact of FDI in the Electricity Sub-Sector on the Expenditure Distribution/Income Inequality**

The results of the dynamic regression equation for the Cilacap Regency and Jepara Regency expenditure distribution models show that there is a long-term and short-term relationship between FDI in the electricity sub-sector and expenditure distribution. Although not statistically significant, a 1 percent increase in FDI has the potential to increase the percentage of expenditure distribution by 0.1 percent where inequality becomes lower in the long run in Cilacap Regency.

Not much different from Cilacap Regency, an increase in foreign investment by 1 percent in Jepara Regency also has the potential to increase the percentage distribution of expenditure by 0.2 percent. The impact of foreign investment in reducing inequality in the Jepara District appears to be slightly larger than that in Cilacap District.

The existence of FDI is able to increase the percentage of expenditure distribution where inequality becomes lower in the long term. The estimation is consistent with a study conducted by Sari (2020) which shows that an increase in FDI can reduce income inequality in Java. This relationship is strengthened by the probability value of - error correction term (ECT-1), which is statistically significant and reflects short-term equilibrium. This means that there is an improvement in the short term if there is an imbalance between FDI in the electricity sub-sector and the distribution of expenditure within 1 year.

### 5.1.3 The Impact of FDI in the Electricity Sub-Sector on the Poverty Level

There is absolutely no long-term or short-term relationship between foreign investment in the employment sub-sector and the poverty rate in Cilacap and Jepara Regencies. It is known from the absence of cointegration and the probability value of ECT-1 which is not statistically significant. These results are consistent with previous research which showed that there was no significant effect between FDI and the poverty rate or the number of poor people in regencies/cities in Central Java Province (Mahendra, 2022). Similar findings are also shown by the results of the study by Sholikhati and Wardono (2020) where FDI has no significant effect on the poverty rate in Central Java.

### 5.1.4 Impact of FDI in the Electricity Sub-Sector on the HDI Level

Based on the estimation results, FDI in the electricity sub-sector has a different effect on the human development index (HDI) variable in Cilacap and Jepara Regencies. In Cilacap Regency, FDI in the electricity sub-sector has a long-term relationship with HDI, but no short-term relationship or equilibrium was found. Based on the results of long-term estimation, the effect between variables is not statistically significant, but both have a positive relationship. An increase in foreign investment of 1% has the potential to increase HDI by 0.1%.

Meanwhile, in Jepara Regency, foreign investment has a long-term or short-term relationship with HDI. Similar to Cilacap Regency, the relationship between variables is not statistically significant. Even so, there is a positive relationship in which an increase in foreign investment of 1% can increase HDI achievements by up to 0.1%.

In the short term, an increase in foreign investment actually tends to lower the HDI in Jepara Regency. An increase in foreign investment of 1 has the potential to reduce the HDI to 231. However, this can be resolved in the long run with a speed of improvement of 13.7 as shown by the statistically significant error correction term ECT coefficient. The existence of long-term and short-term relationships identified in this study indicates that there has been a transfer of technology and competency standards from incoming FDI in the electricity sub-sector so that it encourages the quality of HDI human development in the region.

## 5.2. Impact Analysis of FDI in the Electricity Sub-Sector on Socio-Economy

The analytical approach to determine the socio-economic impact of FDI in the electricity sub-sector is to compare the socio-economic conditions of the villagers before and after the PLTU was installed. The socio-economic indicators analysed include the people's livelihoods/income sources, the level of social welfare, and the population's access to basic infrastructure.

### 5.2.1 Livelihood Impacts

#### 5.2.1.1 The Impact of PLTU Karangandri on the Livelihoods of Karangandri Village and Slarang Village, Cilacap Regency

Before the PLTU Karangandri existed, the livelihoods of the residents of Karangandri Village and Slarang Village were rice food farmers, aquaculture fishermen, and

small businesses in the coastal tourism sector. With the existence of the PLTU since the construction phase, many residents switched jobs to become PLTU employees or self-employed as micro, small and medium enterprises (MSME) selling in locations around the PLTU project.

### 5.2.1.2 The impact of PLTU Tanjung Jati B on Karangkandri Village and Slarang Village, Cilacap Regency

As with Karangkandri and Slarang Villages, the existence of the PLTU Tanjung Jati B also has an impact on creating opportunities for people to work as workers in the PLTU project or do side business around the PLTU project site. Residents of Tubanan Village, Ring 1 Village, who work as workers in the PLTU project are more than the residents of Dermolo Village, Ring 2 Village. This happened because there was an agreement between the Tubanan Village government and the PLTU Tanjung Jati B project management that 60 percent of the PLTU's labor would be sourced from Tubanan Village.

## 5.2.2 The Impact on Socio-Economic Conditions

The infrastructure, facilities, and installation of the PLTU power plant is a very strategic vital object so its existence must be maintained and free from external interference during operation. Therefore, apart from the management, the protection also requires the participation and support of the community, especially residents around the PLTU project site. The community or residents around the location and their lifestyle habits are needed to be maintained and cared for as the PLTU's strategic environment.

**Table 5.1**

*List of PLTU Karangkandri CSR for Karangkandri Village and Slarang Village*

No	Program	Program Recipient Village
1	Waste Processing Training and Waste Bank Field Visits in Bantul, DI Yogyakarta, Karangkandri Village and Slarang Village	Karangkandri and Slarang
2	Iron Welding Training in Karangkandri Village and Slarang Village	Karangkandri and Slarang
3	COVID-19 vaccines in Karangkandri Village and Slarang Village	Karangkandri and Slarang
4	Outstanding Student Scholarships in Karangkandri Village and Slarang Village	Karangkandri and Slarang
5	Construction of the Karangkandri Village Multipurpose Building, Karangkandri Village	Karangkandri
6	Gifts for the Holidays of Karangkandri Village and Slarang Village	Karangkandri and Slarang

*Source: Primary data, processed*

It is likewise at PLTU Tanjung Jati B. Based on the results of observations and in-depth interviews, village officials stated that the CSR program of the PLTU Karang Jati B was carried out routinely. CSR program activities include assistance programs for village infrastructure development, courses and training, basic food package assistance, livestock business facility assistance, and in education.

**Table 5.2**

*List of PLTU Tanjung Jati B CSR for Tubanan Village*

No	Program	Program Recipient Village
1	Construction of the Tubanan Village Square, Tubanan Village	Tubanan
2	Construction of a Sport Field in Tubanan Village, Tubanan Village	Tubanan
3	Paving the Tubanan Village Road	Tubanan
4	Construction of the Tubanan Village Bridge	Tubanan
5	Skills Courses: Tailoring, Catering, HP Service, etc. Tubanan Village II	Tubanan
6	Nutritional food assistance: milk, fruit, vitamins and bread for school children in Tubanan Village	Tubanan
7	Packages of groceries in Tubanan Village and Dermolo Village	Tubanan and Dermolo
8	Distribution of Cattle per Family Head in Tubanan Village	Tubanan
9	Funding for Pursuing Packages B and C Programs in Tubanan Village	Tubanan

Source: Primary data, processed

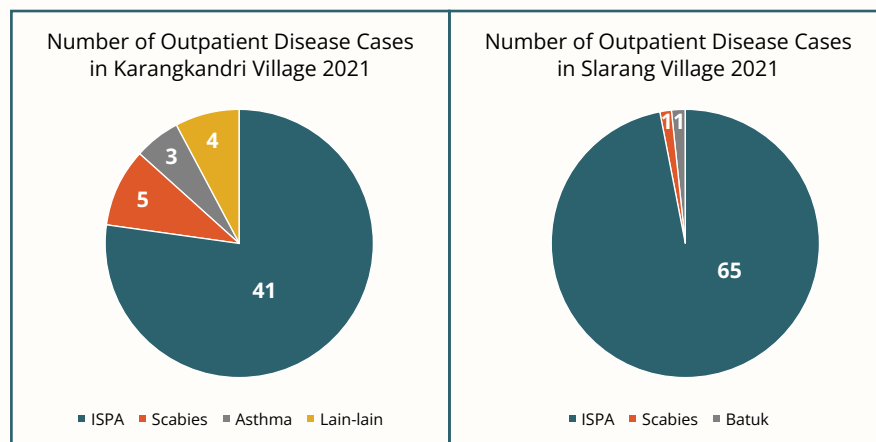
Based on the results of in-depth interviews with village officials and villagers, both the CSR programs from the PLTU Karangandri and from the PLTU Tanjung Jati B, according to the perceptions of village officials and villagers, have had a major impact on improving the socio-economic conditions of the community. The CSR program has an impact on increasing the income and welfare of the villagers.

### 5.2.3 The Impact on Public Health

The operational activities of PLTU, in this case, PLTU Karangandri Cilacap Regency and PLTU Tanjung Jati B Jepara Regency, both produce air pollution which includes chemical compounds such as sulphur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), carbon monoxide (CO), and fly ash. All these pollutants trigger the spread of respiratory diseases. From the results of in-depth interviews with residents of the affected villages, the most common ailments suffered by residents who live near the PLTU are respiratory ailments and itching.

**Figure 5.1**

*Number of Outpatient Disease Cases in Karangandri Village and Slarang Village, Cilacap Regency in 2021*

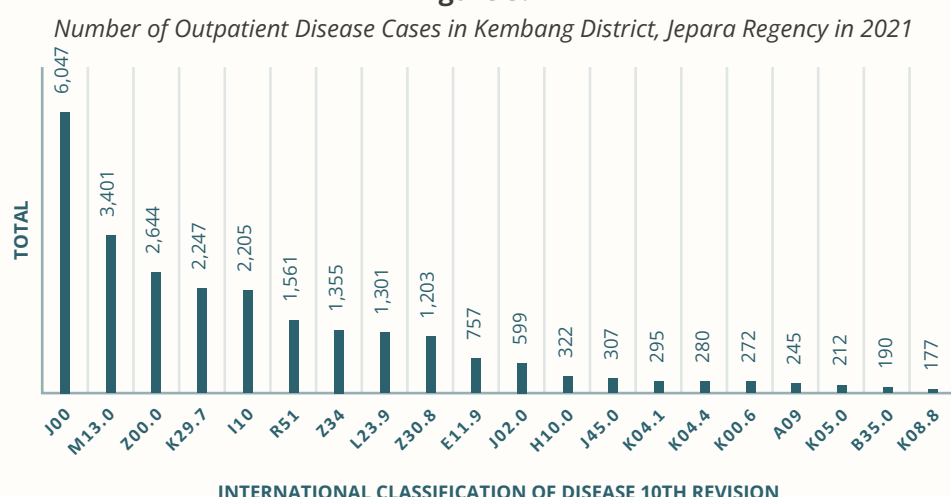


Source: Kesugihan Health Center (2022). Processed

From the data shown in **Figure 5.1**, it can be seen that the number of acute respiratory infection (ARI) cases in the 2021 period in Slarang Village is higher than in Karang-

kandri Village. This is due to the fact that Slarang Village is located near the waste disposal site of the Karangandri power plant, so the impact of the decrease in environmental quality is more intensive compared to Karangandri Village. The impact of the decrease in environmental quality is also in line with the higher number of ARI cases in Slarang Village compared to Karangandri Village. Meanwhile, in the observation areas of villages affected by the PLTU Tanjung Jati B, through in-depth interviews, the midwife in Tubanan Village reported that there have been no serious illnesses caused by the power plant's electricity production operations so far.

**Figure 5.2**



Source: Kembang Health Center (2022). Processed

### 5.3 Impact Analysis of FDI in the Electricity Sub-Sector on Regional Infrastructure

The presence of the Karangandri coal-fired power plant in Cilacap Regency and the PLTU Tanjung Jati B in Jepara Regency, from the construction phase to operational stage, creates positive externalities in the form of increasing demand for labor from the local population around the project site and demand for supplies of goods and services for the operational needs of the power plant project. This condition is attractive and draws potential economic resources from the hinterland towards the villages or districts where the PLTU Karangandri and PLTU Tanjung Jati B projects are located. Furthermore, in its development, the villages of Karangandri and Slarang in Cilacap Regency, as well as Tubanan and Dermolo villages in Jepara Regency, have grown and become the center of economic activity in the growth pole region.

**Table 5.3**

*Availability and Quality of Basic Infrastructure in Affected Villages of PLTU Karangandri and PLTU Tanjung Jati*

Basic Facilities	Villages			
	Karangandri	Slarang	Tubanan	Dermolo
Clean Water	Boreholes with pump/ PDAM	Boreholes with pump/ PDAM	Boreholes with pump/ PDAM	Boreholes with pump/ PDAM
Sanitation Type	Individual toilet	Individual toilet	Individual toilet	Individual toilet
Paving Type	Asphalt/ Concrete	Asphalt/ Concrete	Asphalt/ Concrete	Asphalt/ Concrete
Number of cellular tower	3 towers	1 towers	6 towers	3 towers
Cellular signal strength	4G/ LTE	4G/ LTE	4G/ LTE	4G/ LTE
Electrification ratio	100%	100%	100%	100%
Fuel access	Pertamina (gas station) and retail	Retail	Retail	Retail
Transportation mode	Land Transportation	Land Transportation	Land Transportation	Land Transportation

Source: Primary data were field observations and in-depth interviews in Karangandri and Slarang Villages, Cilacap Regency and Tubanan and Dermolo Villages, Jepara Regency, Processed

### 5.4 The Impact of FDI the Electricity Sub-Sector on Human Resource Development

Based on the field observation and in-depth interviews with several residents in four observation villages, it can be concluded that the existence of PLTU Karangkandri and PLTU Tanjung Jati B has an impact on the development of education sector.

**Table 5.4**  
*Percentage of High School/Equivalent and College Graduates in Affected Villages*

Villages	Level of education			
	Number of high school graduates	% of high school graduates in population	Number of higher education graduates	% of higher education in population
Karangkandri	1,640	20%	292	3%
Slarang	2,324	18%	491	4%
Tubanan	1,111	10%	210	2%
Dermolo	1,218	22%	232	4%

Source: BPS Cilacap (2022) and BPS Jepara (2022), Processed

The results of in-depth interviews with residents in the four observation villages indicate that after the operation of the PLTU Karangkandri and PLTU Tanjung Jati B, the number of high school and college graduates increased.

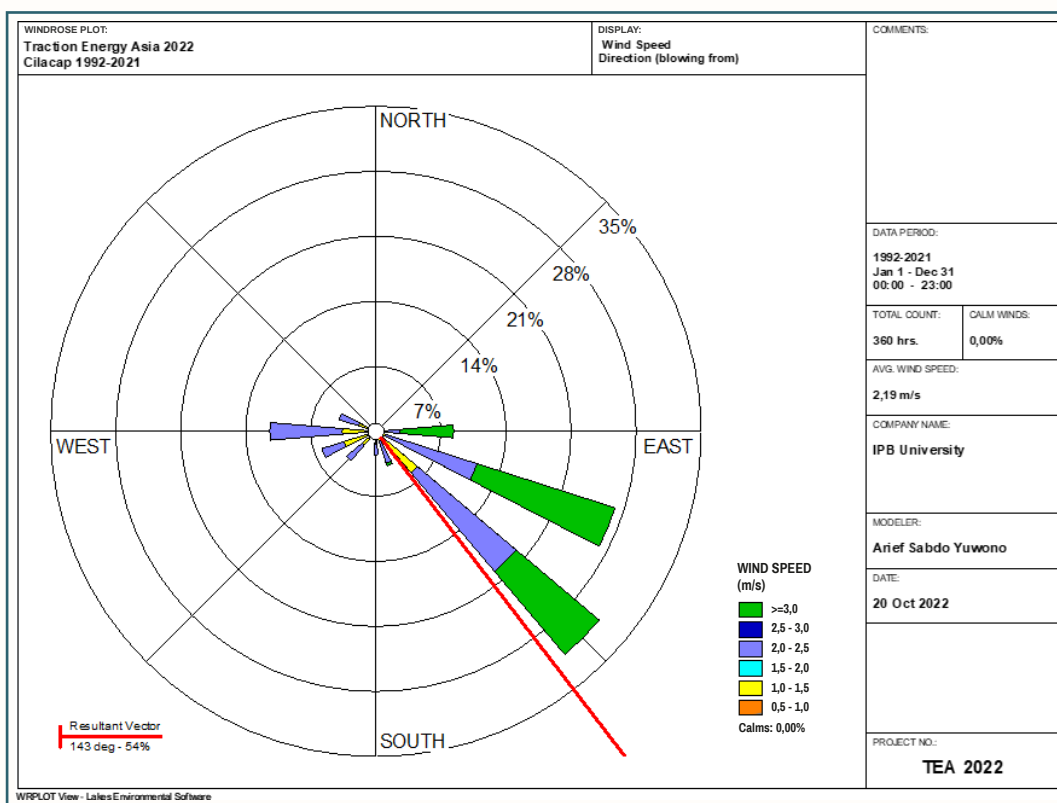
### 5.5 Impact Analysis of FDI in the Electricity Sub-Sector on the Environment

#### 5.5.1 Pollution Level of PLTU Karangkandri

##### 5.5.1.1 The Impact of PLTU Karangkandri Cilacap on Changes in Air Quality

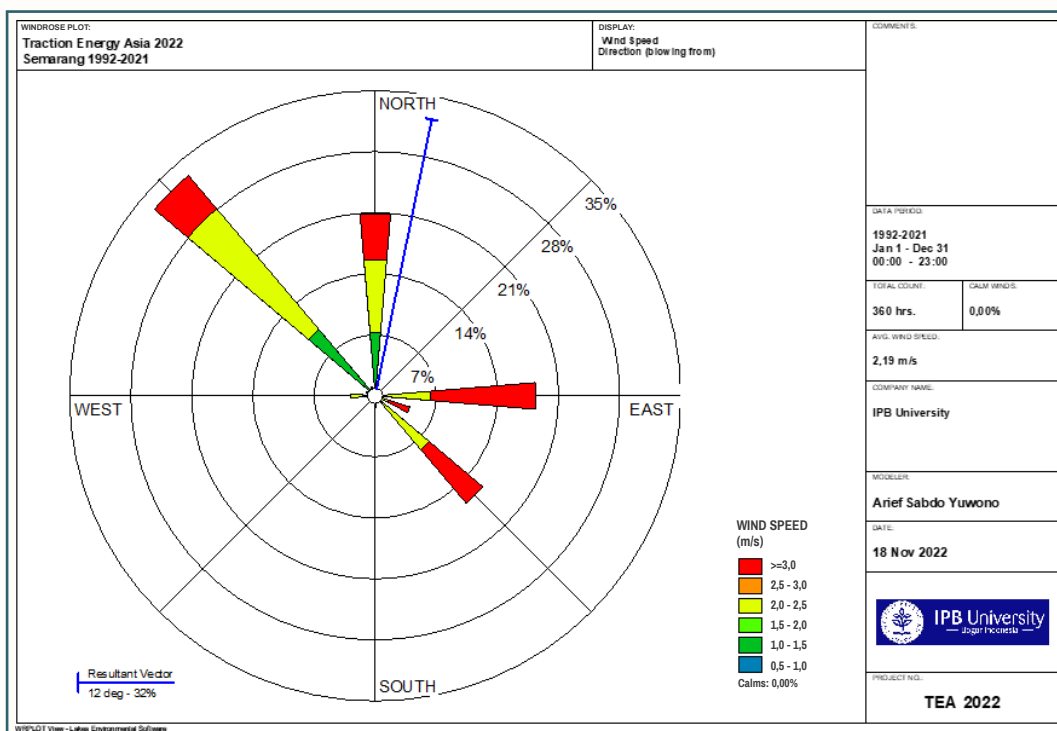
A definite consequence arising from coal-fired PLTU operations is air pollution. The level of intensity of pollution depends on the scale of PLTU production and the type or quality of coal used. Changes in air quality due to pollution from PLTU operational activities occur due to the release of gaseous pollutants from the coal-burning process into the ambient air.

**Figure 5.3**  
Windrose Based on Cilacap Station for 30 Years



Source: Processed, 2022

**Figure 5.4**  
Windrose in Jepara Based on Semarang Station for 30 Years



Source: Processed, 2022

**Table 5.5***Calculation of the Amount of Pollutants from Coal Burning of PLTU Karangandri Cilacap*

No	Items	Unit	Total	WHO Recommendation
1	Coal class: Medium calories (LHV)	kcal/kg	5,200	
2	PLTU Cilacap coal consumption (2021) <sup>a</sup>			
	Unit 1+2 [2*300 MW]	ton/year	1,959,505	
	Unit 3 [1*660 MW]	ton/year	2,255,409	
	Unit 4 [1*1000 MW]	ton/year	3,032,484	
3	Total coal consumption	ton/year	7,247,398	
		ton/day	19,856	
4	Average of fly ash content <sup>b</sup>	%	16.5	
5	Production of fly ash	ton/day	3,276	
Emission NO <sub>2</sub> , CO and SO <sub>2</sub>				
6	Emission factor NO <sub>2</sub> <sup>c</sup>	lb/ton	22	
	Total emission NO <sub>2</sub>	lb/day	436,832	
	Total emission NO <sub>2</sub>	kg/day	198,144	
	Emission rate NO <sub>2</sub>	µg/s	2,293,327,553	
	Highest NO <sub>2</sub> concentration	µg/m <sup>3</sup>	500	25
7	Emission factor CO	lb/ton	0.5	
	Total emission CO	lb/day	9,928	
	Total emission CO	kg/day	4,503	
	Emission rate CO	µg/s	52,121,081	
	Highest CO concentration	mg/m <sup>3</sup>	0.0026	4
8	Emission factor SO <sub>2</sub> (31S-38S); Avg. 34.5S [S=1.2%] <sup>c</sup>	lb/ton	0.414	
	Total emission SO <sub>2</sub> [gross]	lb/day	8,220	
	Total emission SO <sub>2</sub> [gross]	kg/day	3,729	
	Emission rate SO <sub>2</sub> [gross]	µg/s	43,156,255	
	Fuel Gas Desulphurization [removal efficiency] Unit 3	%	96	4
	Emission rate SO <sub>2</sub> [netto]	µg/s	30,263,205	
	Highest SO <sub>2</sub> concentration	µg/m <sup>3</sup>	11	40

Source: <sup>a</sup> Presentation materials PLTU Cilacap 27 July 2022

<sup>b</sup> Average from De Nevers (1995) 3.1-24.9% dan Berkowitz in Nukman (2006) 5-30%

<sup>c</sup> US EPA AP-42 1.1. Bituminous and Subbituminous Coal Combustion

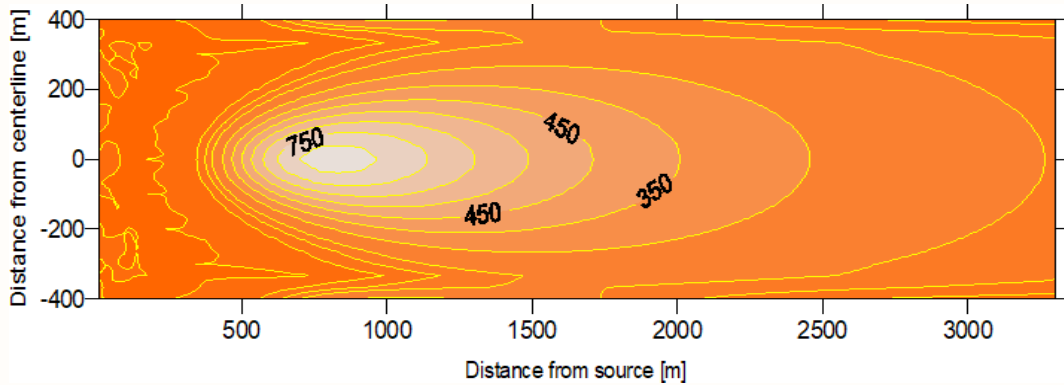
N.B. The above table uses the US imperial measurement system.

<sup>d</sup> Wiatros-Motyka (2019)

The results of the analysis of wind direction and speed form the basis for preparing forecasts for the dispersion of pollutant gases resulting from the coal combustion process. The simulation results of the dispersion of gaseous pollutants in the ambient air around the PLTU Karangandri Cilacap are presented in **Figure 5.3**, **Figure 5.4**, and **Figure 5.5**. These three images serve as material for consideration for justifying pollutant-exposed areas around the PLTU site. The results of this simulation are also used as material for consideration in examining the types of diseases suffered by residents around the PLTU and then looking for solutions to fix them systematically.

**Figure 5.5**

*NO<sub>2</sub> Dispersion in Ambient Air around PLTU Karangandri Cilacap*

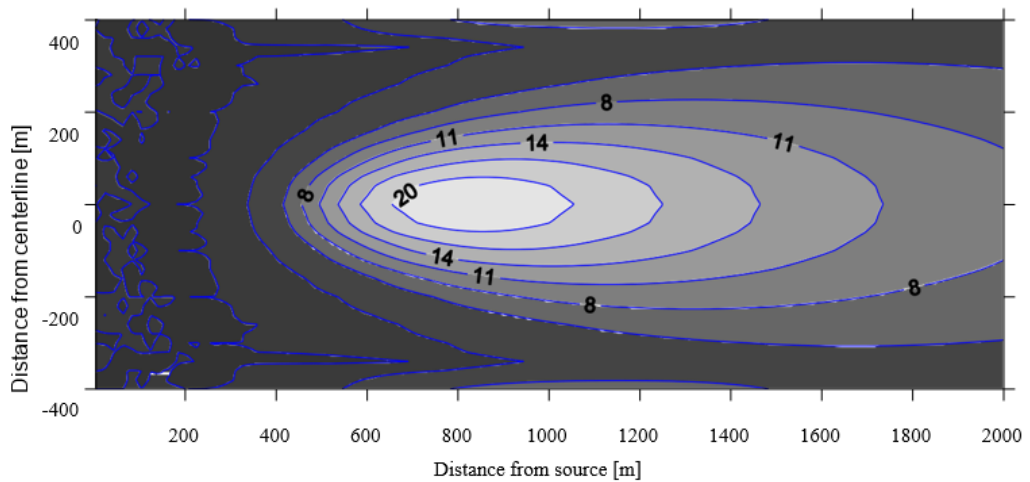


Source: Processed, 2022

The highest concentration of NO<sub>2</sub> gas produced by PLTU Karangandri Cilacap in 2021 in ambient air is 900 µg/m<sup>3</sup>, while the WHO recommendation is 25 µg/m<sup>3</sup>. The implication of this condition is poor environmental quality, in this case unhealthy ambient air quality around the PLTU Karangandri Cilacap due to high concentrations of NO<sub>2</sub>. High concentrations of NO<sub>2</sub> will have a significant public health impact.

**Figure 5.6**

*CO Dispersion in Ambient Air around PLTU Karangandri Cilacap*

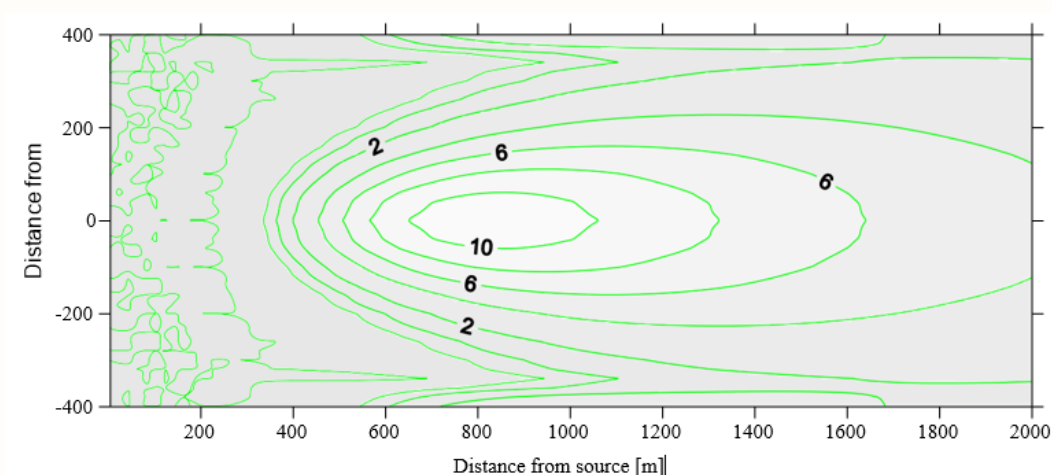


Source: Processed, 2022

The highest concentration of CO gas at PLTU Karangandri Cilacap in 2021 in ambient air is 0.0026 mg/m<sup>3</sup>, while the WHO recommendation is 4 mg/m<sup>3</sup>. The highest concentration of CO gas at the PLTU Karangandri Cilacap is still below the standard recommended by WHO. This means that the concentration of CO-type gas from the PLTU Karangandri Cilacap still meets the standards recommended by WHO. The highest concentration of SO<sub>2</sub> gas produced by PLTU Karangandri Cilacap in 2021 in ambient air is 11 µg/m<sup>3</sup>, while the standard recommended by WHO is 40 µg/m<sup>3</sup>. SO<sub>2</sub> gas concentration meets WHO standards. The low concentration of SO<sub>2</sub> gas from the Karangandri Cilacap PLTU is caused by the use of flue gas desulfurizer (FGD), which absorbs a lot of SO<sub>2</sub> before exiting the PLTU chimney. The use of FGD at PLTU Karangandri Cilacap reduces the concentration of SO<sub>2</sub> pollutants so that the concentration level is low.

**Figure 5.7**

*SO<sub>2</sub> Dispersion in Ambient Air around PLTU Karangandri Cilacap*



Source: Processed, 2022

### 5.5.1.2 Greenhouse Gas (GHG) Emissions from the Operational Activities of PLTU Karangandri Cilacap

Greenhouse gas (GHG) emissions (**Figure 5.8**) arising from PLTU operations are calculated directly based on the amount of energy produced by PLTU Unit 1 and Unit 2, Unit 3 and Unit 4. By using the appropriate emission factor, the amount of CO<sub>2</sub> emission produced is the product of the emission factor [tons CO<sub>2</sub>/TJ] and the amount of energy generated [TJ]. Total energy [TJ] is calculated based on the amount of coal consumed by the PLTU, as presented in **Table 5.6**. Calculations are limited to the operational time span of the PLTU for three years (2019-2021) or since 2019, according to the year PLTU Karangandri Cilacap Unit 4 started operating.

**Table 5.6**

*Calculation of the Quantity of CO<sub>2</sub> Emissions from PLTU Karangandri Cilacap (2019 – 2021)*

Unit	Coal (ton/year)			Electricity production (MWh)			Emission (ton/year)		
	2019	2020	2021	2019	2020	2021	2019	2020	2021
PLTU Unit 1&2	2,300,000	1,900,000	2,000,000	4,600,000	3,800,000	4,000,000	4,325,000.8	3,573,429.8	3,761,505
PLTU Unit 3	1,600,000	1,900,000	2,300,000	3,200,000	3,800,000	4,600,000	3,009,204	3,573,429.8	4,325,730.8
PLTU Unit 4	580,000	3,800,000	3,000,000	1,160,000	7,600,000	6,000,000	1,090,836.5	7,146,859.5	5,642,257.5
<b>Total</b>	<b>4,480,000</b>	<b>7,600,000</b>	<b>7,300,000</b>	<b>8,960,000</b>	<b>15,200,000</b>	<b>14,600,000</b>	<b>8,425,771.2</b>	<b>14,293,719.1</b>	<b>13,729,493.3</b>

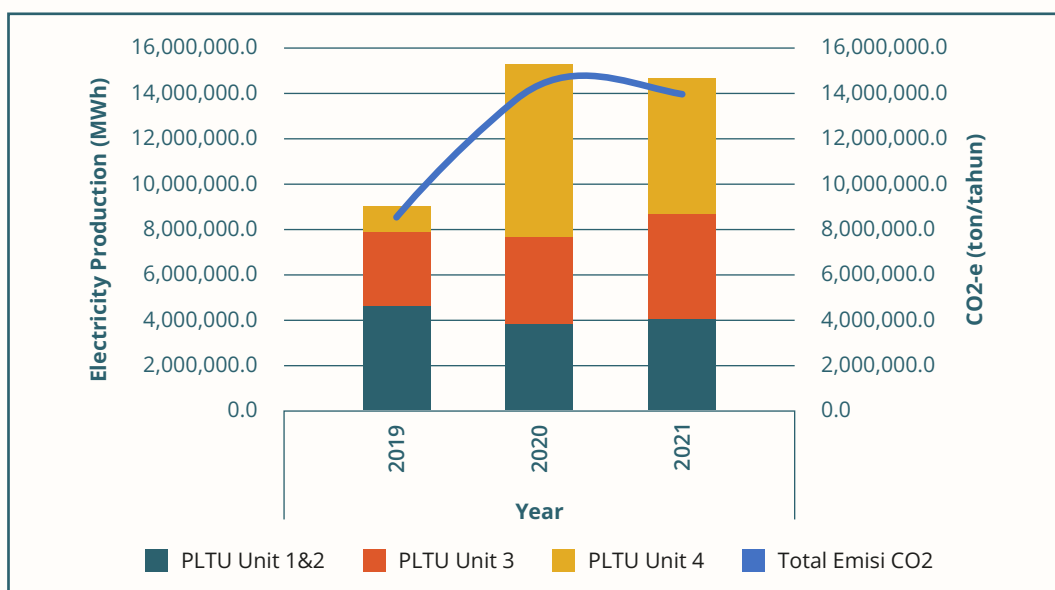
Source: Processed, 2022

N.B. The above table uses the US imperial measurement system.

In **Figure 5.6** it can be seen that CO<sub>2</sub>e emissions produced by PLTU Karangandri Cilacap from 2019-2021 have increased. This is due to the increased use of coal to increase electricity production capacity. The construction of Unit 4 which has a production capacity of 1,000 MW has a significant impact on increasing CO<sub>2</sub>e emissions produced by coal-burning activities.

**Figure 5.8**

*Greenhouse Gas (GHG) Emissions from PLTU Karangkandri Cilacap (2019-2021)*



Source: Processed, 2022

The investment value in the construction of PLTU Karangkandri Cilacap Units 1, 2, 3 and 4 is USD 2.81 billion. Assuming that after all units are operational in 2021, the PLTU Karangkandri Cilacap annually produces emissions of 13,729,493 tons of CO<sub>2</sub>/-year. If all units operate for a period of 25 years, this means that for every 1 (one) United States dollar invested in the coal-fired power plant project in Karangkandri, Cilacap Regency, it will produce emissions of 122.15 kg CO<sub>2</sub>e.

## 5.5.2 Pollution Level of PLTU Tanjung Jati B Jepara

### 5.5.2.1 Impacts of PLTU Tanjung Jati B Jepara on Changes in Air Quality

For PLTU Tanjung Jati B Jepara, the results of calculating the amount of pollutants obtained are presented in **Table 5.11**. In order to analyze the environmental impacts that occur as a result of PLTU operational activities, it is necessary to analyze wind data, namely aspects of wind speed and direction. Wind data around the PLTU location was obtained from the nearest climate station, namely the Ahmad Yani Climatology Station, Semarang. The results of this wind data analysis are then used to estimate pollutant concentrations around the PLTU location. Pollutant concentration forecasts are prepared by conducting dispersion simulations using the Gaussian Dispersion Model. Pollutant dispersion simulation results (NO<sub>2</sub>, CO, and SO<sub>2</sub>) are presented in Figures **5.7**, **5.8**, and **5.9**.

**Table 5.7***Total Pollutant Emissions (SO<sub>2</sub>, CO, and NO<sub>2</sub>) of PLTU Tanjung Jati B Jepara*

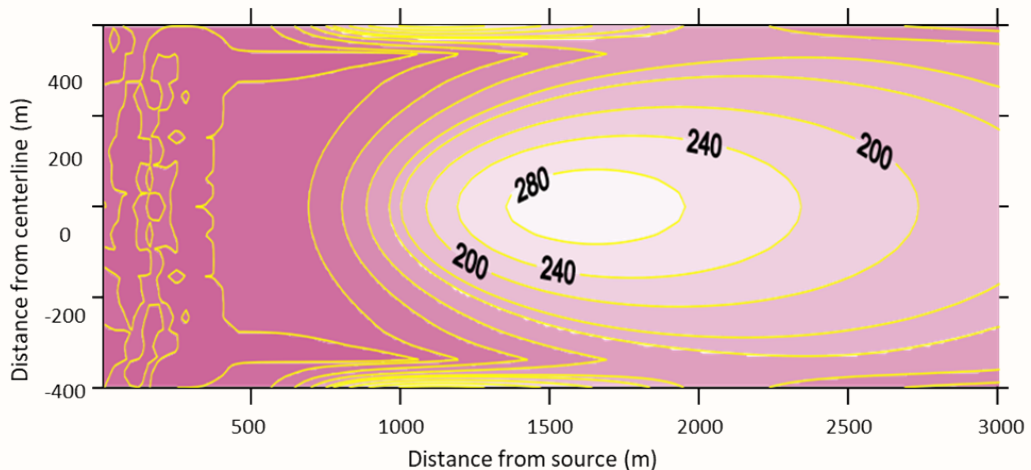
No	Items	Unit	Total	WHO Recommendation
1	Coal class: Medium calories (LHV)	kcal/kg	5,200	
2	PLTU Cilacap coal consumption (2021) <sup>a</sup>	ton/day	24,000	
4	Average of fly ash content <sup>b</sup>	%	16.5	
5	Production of fly ash	ton/day	3,276	
Emission NO <sub>2</sub> , CO and SO <sub>2</sub>				
6	Emission factor NO <sub>2</sub> <sup>c</sup>	lb/ton	22	
	Total emission NO <sub>2</sub>	lb/day	114,400	
	Total emission NO <sub>2</sub>	kg/day	51,891	
	Emission rate NO <sub>2</sub>	µg/s	600,589,407	
	Highest NO <sub>2</sub> concentration	µg/m <sup>3</sup>	280	25
7	Emission factor CO	lb/ton	0.5	
	Total emission CO	lb/day	2,600	
	Total emission CO	kg/day	1,179	
	Emission rate CO	µg/s	13,649,759	
	Highest CO concentration	mg/m <sup>3</sup>	0.0007	4
8	Emission factor SO <sub>2</sub> (31S-38S); Avg. 34.5S [S=1.2%] <sup>c</sup>	lb/ton	0.414	
	Total emission SO <sub>2</sub> [gross]	lb/day	2,513	
	Total emission SO <sub>2</sub> [gross]	kg/day	976	
	Emission rate SO <sub>2</sub> [gross]	µg/s	11,302,001	
	Fuel Gas Desulphurization [removal efficiency] Unit 3	%	96	4
	Emission rate SO <sub>2</sub> [netto]	µg/s	452,080	
	Highest SO <sub>2</sub> concentration	µg/m <sup>3</sup>	3.5	40

Source: <sup>a</sup> Average from De Nevers (1995) 3.1-24.9% dan Berkowitz in Nukman (2006) 5-30%

<sup>b</sup> US EPA AP-42 1.1. Bituminous and Subbituminous Coal Combustion

N.B. The above table uses the US imperial measurement system.

<sup>c</sup> Wiatros-Motyka (2019)

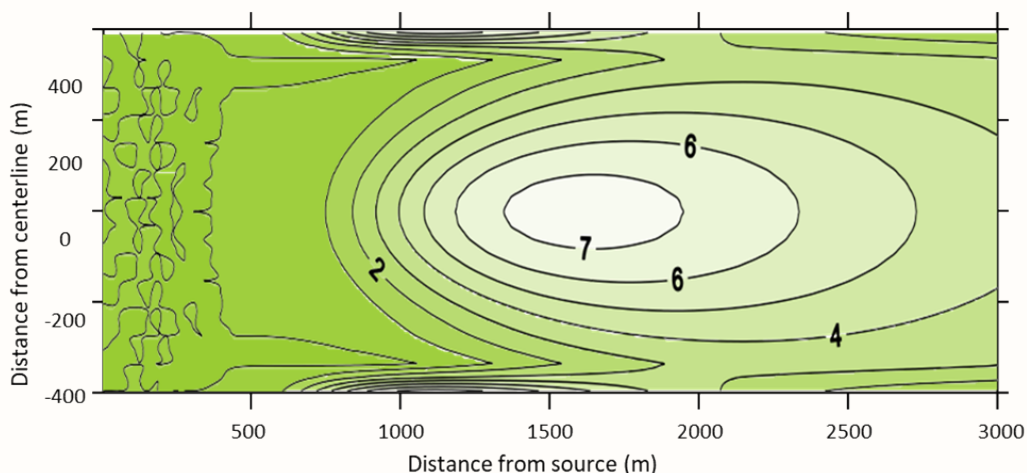
**Figure 5.9***Simulation of NO<sub>2</sub> Dispersion around PLTU Tanjung Jati B Jepara*

Source: Processed, 2022

The highest concentration of NO<sub>2</sub> gas from PLTU Tanjung Jati B Jepara in 2021 in ambient air is 280 µg/m<sup>3</sup>, while the value recommended by WHO is 25 µg/m<sup>3</sup>. High concentrations of NO<sub>2</sub> exceeding WHO recommendations in the air can have serious health impacts, especially on the respiratory system.

**Figure 5.10**

*Simulation of CO Dispersion around PLTU Tanjung Jati B Jepara*

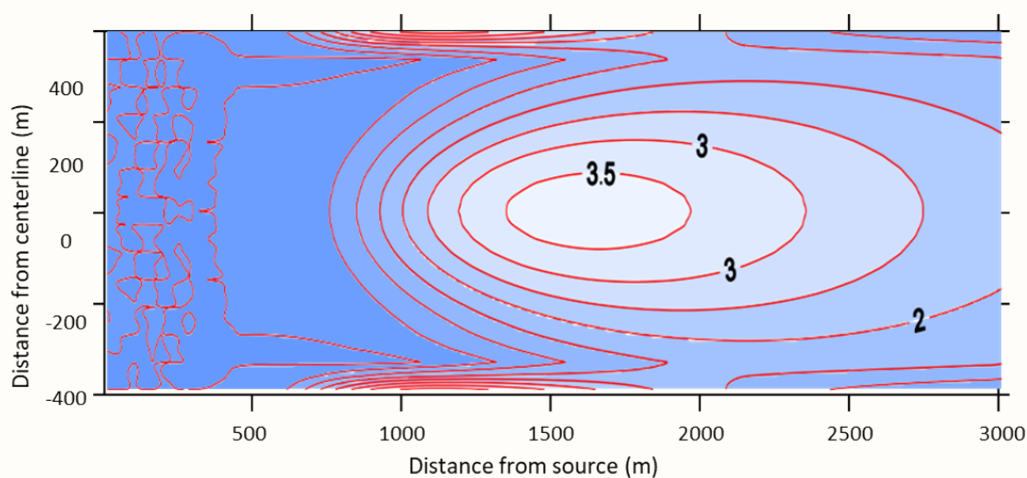


Source: Processed, 2022

The highest concentration of CO gas from PLTU Tanjung Jati B Jepara in 2021 in ambient air is 0.007 mg/m<sup>3</sup>, while the standard recommended by WHO is 4 mg/m<sup>3</sup>. The highest concentration of CO is still below or meets the value recommended by WHO.

**Figure 5.11**

*Simulation of SO<sub>2</sub> Dispersion around PLTU Tanjung Jati B Jepara*



Source: Processed, 2022

The highest concentration of SO<sub>2</sub> gas produced by PLTU Tanjung Jati B Jepara in 2021 in ambient air is 3.5 µg/m<sup>3</sup>. This value still meets the value recommended by WHO which is 40 µg/m<sup>3</sup>.

### 5.5.2.2 Greenhouse Gas (GHG) Emissions from Tanjung Jati B PLTU Operations, Jepara

PLTU Tanjung Jati B Jepara produces greenhouse gases of 8.37 million tons of CO<sub>2</sub> per year as a result of its operational activities. The amount of electricity generated is calculated based on the amount of coal consumed by the PLTU, which at the beginning of 2022 will produce electricity with a capacity of 4x710 MW Gross or 4x660 MW Nett, which is equivalent to a total power of 2640 MW. By operating for

365 days/year and 24 hours/day, the total energy produced is  $2.3 \times 10^7$  MWh, or equivalent to  $8 \times 10^4$  TJ/year. This amount of energy is used to calculate the resulting greenhouse gas emissions by multiplying them by the appropriate emission factor.

**Table 5.8**

*Greenhouse Gas (CO<sub>2</sub>) Emissions from PLTU Tanjung Jati B Jepara*

Parameter	Coal	Electricity Production		Emission Factor CO <sub>2</sub>	Emission CO <sub>2</sub>
Unit	[ton/year]	[MWh]	[TJ/year]	[ton/TJ]	[ton/year]
Quantity	8,800,000	17,600,000	164,560	100.58	16,550,622

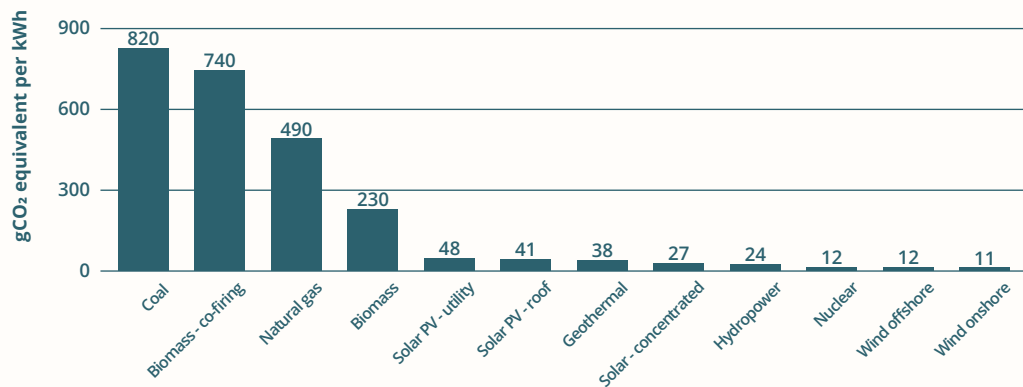
Source: Processed, 2022

The investment value in the construction of PLTU Tanjung Jati B Units 1, 2, 3 and 4 is USD 3.47 billion. Assuming that every year PLTU Tanjung Jati B produces emissions of 16,550,622 tons of CO<sub>2</sub>e/year, and all units will operate for 25 years, this means that every 1 (one) United States Dollar is invested in a coal-fired PLTU development project. Coal in Tanjung Jati B, Jepara Regency, produces emissions of 119.17 kg CO<sub>2</sub>e.

In the context of energy generation systems, the use of coal as fuel results in the highest GHG emissions among other energy sources, such as biomass, natural gas, solar, geothermal, water, nuclear, and wind. (Figure 5.12). This means that coal is the least environmentally friendly energy source because it contributes the most to increasing GHG emissions among these energy sources. Even when compared to solar energy (solar) GHG emissions from coal are equivalent to 20 times the emissions from solar power.

**Figure 5.12**

*GHG Emission [g CO<sub>2</sub>e/kWh] per Unit of Generated Energy*



Source: Schlömer et al., 2014

With the condition that Indonesia is in the tropics with the availability of solar energy throughout the year, efforts to use solar energy and other renewable energy sources need to be made a priority in providing energy sources for electricity generation in Indonesia. Currently (2022) the contribution of PLTU to the electricity generation system in Indonesia is still 50 percent of the total power of 74 GW of electricity generation in Indonesia or 37 GW. If the energy transition program goes well, in which the portion of new and renewable energy (EBT) is enlarged to become the majority, then the contribution of GHG emissions from energy generation will decrease because the emission factor of new and renewable energy sources is much smaller than that of coal.

## CHAPTER VI IMPACT ANALYSIS OF FDI IN THE AGROFORESTRY SUB-SECTOR ON THE REGIONAL ECONOMY, SOCIO-ECONOMY, AND ENVIRONMENT

### 6.1 Impact Analysis of FDI in the Agroforestry Sub-Sector on the Regional Economy

#### 6.1.1 The Impact of FDI in the Agroforestry Sub-Sector on the Economy

##### 6.1.1.1 Result of Linkage Analysis Input-Output Analysis

The results of Direct and Indirect Backward and Forward Linkages to the Back (KLTB) of oil palm plantations were 2.49 and Direct and Indirect Linkages to the Front (KLTD) were 3.27. This means that if there is an increase in final demand of IDR 1 million, the palm oil commodity sector will increase its input demand by IDR 2.49 million and its output by IDR 3.27 million for other sectors including the sector itself. The ability to drive a sector that utilizes output from the palm oil commodity sector is greater than driving inputs used by a sector of the economy, indicating that FDI in the agroforestry sub-sector has an impact on increasing economic output.

**Table 6.1**

*Direct Indirect Linkage Backward (DILB) and Direct Indirect Linkage Forward (DILF) of Palm Oil Commodities at National Level*

DILP	DILF
2.49	3.27

Source: Indonesia Input-Output Table on 185 product classifications in 2016 (processed)

##### 6.1.1.2 Result of Multiplier Effect Analysis

The results of the multiplier analysis are divided into three, namely the output multiplier (1.35), income (1.24), and labor (1.15). (Table 6.2) This means that an increase in household consumption working in the palm oil commodity sector of IDR 1 million due to an increase in final demand will increase output by 1.35 million, income by 1.24 million, and employment in the palm oil sector by 1,150,000 people in all sectors of the economy. It can be said that FDI allocated to the palm oil commodity will have an impact or a multiplier effect on the output produced, income, and employment.

**Table 6.2**

*Analysis of Output Multiplier, Income Multiplier, and Labor Multiplier in the Palm Oil Commodity Sector in Indonesia*

Type	Output Multiplier	Income Multiplier	Labor Multiplier
Multiplier Type I	1.35	1/24	1/15

Source: Indonesia Input-Output Table on 185 product classifications in 2016 (processed)

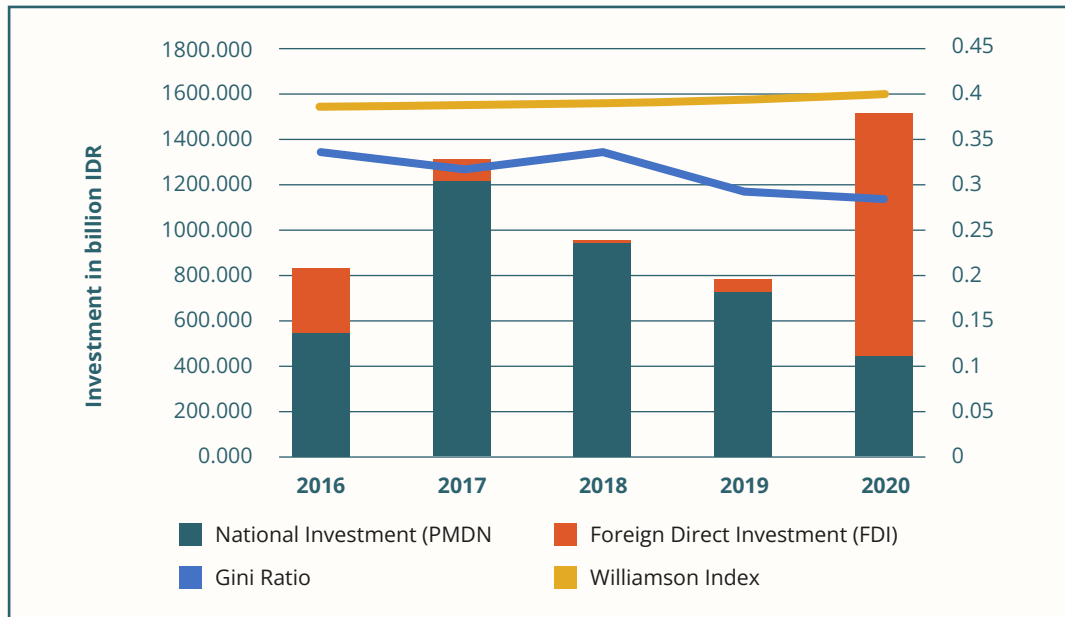
#### 6.1.2 The Impact of FDI in the Agroforestry Sub-Sector on the Distribution of Expenditure/Income Inequality

The nine sub-districts in Kubu Raya Regency have different characteristics of natural, social, and economic resources, which drive economic growth and the process of economic development in each region. Economic growth can have positive and negative impacts on economic equity. The focus of economic development should also be to eliminate and reduce poverty rates, income inequality, and unemployment rates (Todaro and Smith, 2006). During the 2016–2020 period, the average GDP per capita

inequality index number between sub-districts in Kubu Raya Regency was 0.4 (Figure 6.1).

**Figure 6.1**

*Foreign Direct Investment (FDI), Domestic Investment (Penanaman Modal Dalam Negeri/PMDN), Gini Ratio, and Williamson Index of Kubu Raya District 2016-2020*



Source: BPS 2022, BPS Kubu Raya 2022

The Williamson index is close to zero (0.4) indicating that economic equity in Kubu Raya Regency is still relatively even and economic inequality between sub-districts is relatively low. There are almost no significant fluctuations or developments, but its value has increased from year to year. Development progressed quickly but was still centered on certain sub-districts, such as Sungai Raya, Sungai Kakap, and Sungai Ambawang sub-districts. This has the potential for regional disparities. The Gini Ratio Index for Kubu Raya Regency fluctuates more than the Williamson index, but the trend is decreasing after increasing in 2018. The results of the Focus Group Discussion (FGD) in Kubu Raya found that there are no gaps or conflicts between workers and non-workers in oil palm companies (FDI) and between smallholders partners and independent smallholders. FDI inequality at the provincial level of West Kalimantan has no impact on income inequality

**Table 6.3**

*Linear Regression Test Result of FDI, Domestic Investment (Penanaman Modal Dalam Negeri/PMDN) on Inequality and Poverty*

Independent Variable	Dependent Variable	
	$\ln(Y1)_t$	$\ln(Y2)_t$
$\ln(FDI)_{t-1}$	<b>0.000</b> (0.008)	<b>0.003</b> (0.004)
$\ln(PMDN)_{t-1}$	<b>-0.005</b> (0.008)	<b>-0.010 **</b> (0.003)
Constanta	<b>-1.013 ***</b> (0.088)	<b>10.410 ***</b> (0.043)
Observations	10	10
R-Square	0.092	0.58

Note: Confidence level 99% (\*\*\*), 95% (\*\*), 90% (\*), value in the bracket is robust standard error

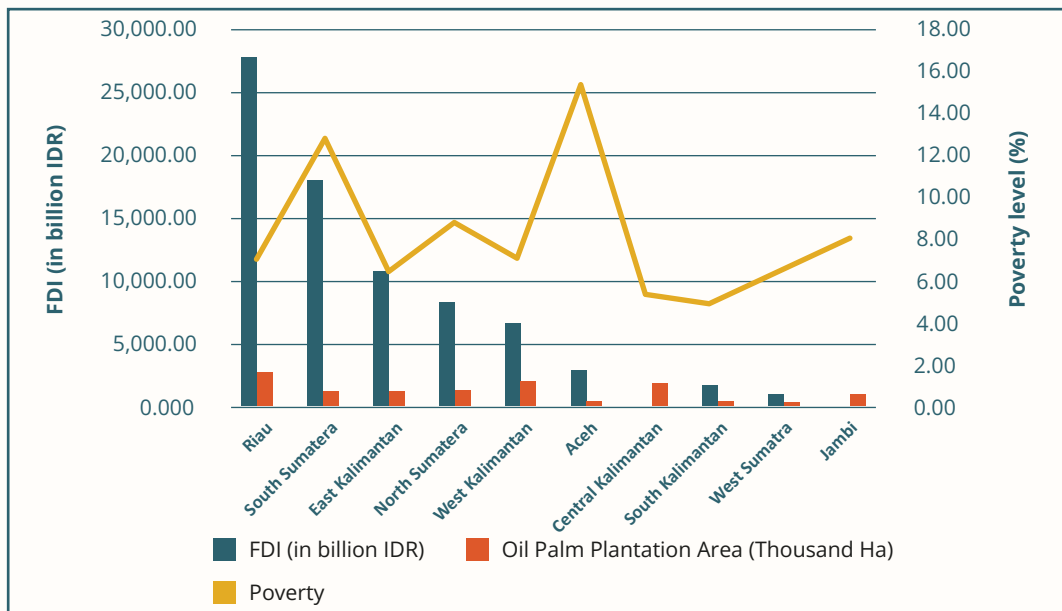
Source: Processed from Eviews 12

### 6.1.3 The Impact of FDI in the Agroforestry Sub-Sector on Poverty Levels

Not all areas with high FDI have low poverty rates. (Figure 6.2) West Kalimantan is the province with the second largest area of oil palm plantations after Riau and has the fifth largest FDI among the 10 provinces with the largest area of oil palm plantations. However, West Kalimantan has a fairly high poverty rate (7.00%). This pattern of non-directional relationships is found in several provinces (Figure 6.1) and in certain cities or districts (Figure 6.2) (Agustini and Erni, 2017) A relatively high number of poor people was found in the 10 provinces with the largest plantation area and with FDI. This means that FDI has not been able to fully help alleviate poverty and this is in line with the findings of Nizar et al. (2013).

**Figure 6.2**

*Foreign Direct Investment (FDI) and Poverty in 10 Provinces with Highest Palm Oil Plantation area in 2021*

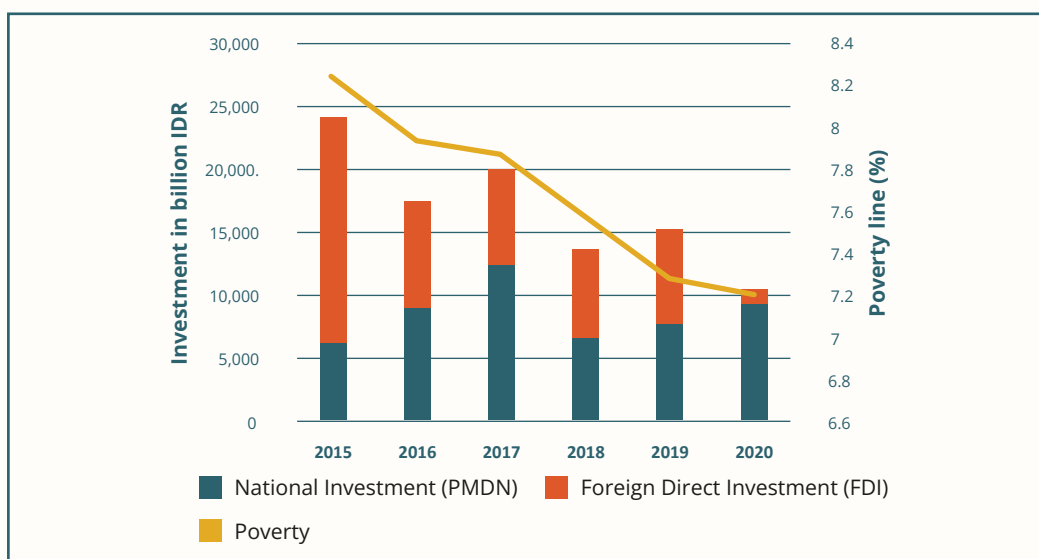


Provinces	FDI (billion IDR)	Palm oil plantation area (thousand Ha)	Poverty (%)
Riau	27,636.49	2,741.50	7.06
South Sumatera	18,118.92	1,191.40	12.82
East Kalimantan	10,718.60	1,254.20	6.41
North Sumatera	8,348.19	1,373.30	8.75
West Kalimantan	6,665.32	2,017.50	7.00
Aceh	2,924.17	487.50	15.43
Central Kalimantan	2,337.32	1,922.10	5.16
South Kalimantan	1,685.75	471.30	4.70
West Sumatera	963.70	379.70	6.34
Jambi	732.12	1,034.80	7.88

Source: BPS 2022, BKPM 2022 (processed)

**Figure 6.3**

*Foreign Direct Investment (FDI) and Poverty in West Kalimantan Province*



Source: BPS 2022, BKPM 2022

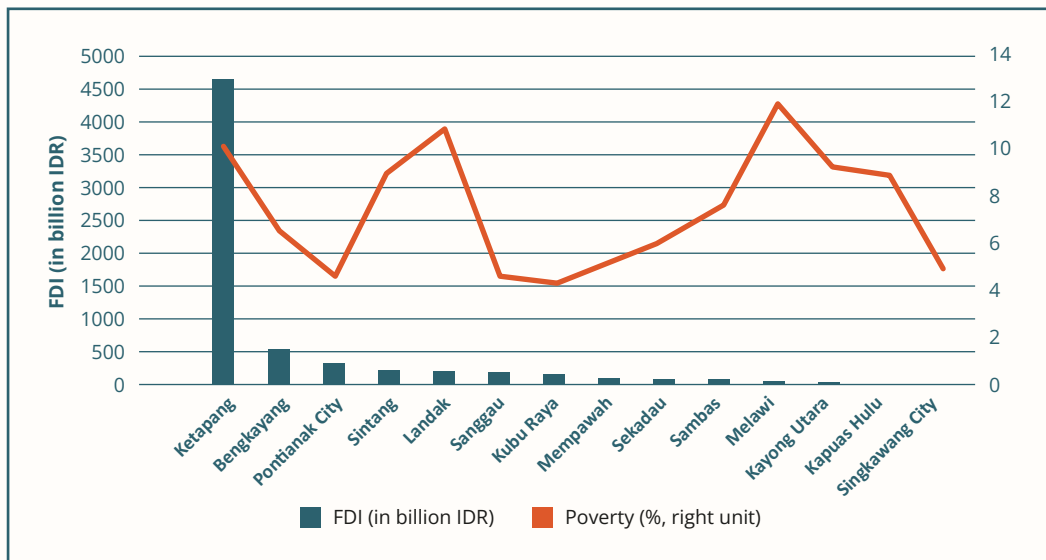
Poverty in West Kalimantan Province tends to decrease even though the amount of FDI decreases, especially in 2015 to 2016 (**Figure 6.2**). The Coordinating Ministry for Economic Affairs (2019) stated that although it excels in the area of oil palm plantations, West Kalimantan is a poor province according to BPS data. Oil palm plantations in West Kalimantan have not had a direct impact on people's welfare. The reasons are thought to be the small contribution of investment to poverty alleviation, including land conflicts with indigenous communities, changes in the lifestyle of communal indigenous peoples to individuals, loss of rights to manage customary forests, land legality, low productivity, conflicts between plasma smallholders and companies, the declining selling price of palm oil, to the difference in selling prices between independent smallholders and plasma.

It is ironic that Ketapang District, which has the largest FDI, actually has the third highest poverty rate (10.13%) after Melawi (12.01%) and Landak (10.99%). (Picture 6.4) Singkawang City with the smallest FDI actually has low poverty (4.83%). The lowest poverty rate of around 4 percent is in Pontianak City, Sanggau Regency, Kubu Raya Regency, and Singkawang City which have FDI values from 300 million to 5 billion rupiahs.

This confirms that FDI in the agroforestry sectors has not had an impact on poverty alleviation programs, especially in districts/cities in West Kalimantan Province. The World Development Report (2000) in Indonesia says that agriculture is the most common cause of poverty (Pradhan et al. 2000, Simatupang et al. 2004).

**Figure 6.4**

Foreign Direct Investment (FDI), City and Regency Poverty in West Kalimantan Province in 2021



Provinces	FDI (billion IDR)	Poverty (%)
Ketapang	4,619.32	10.13
Bengkayang	545.42	6.48
Pontianak City	320.13	4.58
Sintang	242.91	9.28
Landak	217.77	10.99
Sanggau	211.48	4.55
Kubu Raya	158.03	4.34
Mempawah	122.69	5.18
Sekadau	79.20	6.26
Sambas	70.35	7.66
Melawi	37.02	12.01
Kayong Utara	29.93	9.33
Kapuas Hulu	6.06	8.93
Singkawang City	5.24	4.83

Source: BPS 2021, BPS West Kalimantan 2021

Based on the 2022 FGD in Kubu Raya Regency and Sanggau Regency, the parties conveyed the need for CSR from oil palm companies to increase community capacity in plantations and agriculture, as well as increase accessibility to infrastructure, especially related to increasing garden and agricultural productivity as well as trade in business products.

#### 6.1.4 The Impact of FDI in the Agroforestry Sub-Sector on Human Development Index (HDI)

In 12 years (2010-2022), there has been an increase in HDI in Kubu Raya Regency (from 61.78 in 2010 to 68.16 in 2021), Sanggau Regency (from 60.57 to 66.20), and West Kalimantan Province (from 61.97 to 67.90). (Table 6.4) Using this data, if it is assumed that oil palm plantation companies have a share in the district HDI aspect, the share of FDI companies in Kubu Raya Regency (China) is relatively larger than those in Sanggau Regency (Malaysia).

**Table 6.4**

*Development of the Human Development Index (HDI) for Kubu Raya Regency, Sanggau Regency, and West Kalimantan Province in 2010-2021*

No	Regency / Province	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	Kubu Raya	61.87	62.56	63.42	63.94	64.52	65.02	65.54	66.31	67.23	67.76	67.95	68.16
2	Sanggau	60.57	60.96	61.39	61.72	62.06	63.05	63.90	64.61	65.15	65.67	65.77	66.20
3	West Kalimantan	61.97	62.35	63.41	64.30	64.89	65.59	65.88	66.26	66.98	67.65	67.66	67.90

The Village Development Index (Indeks Desa Membangun/IDM) describes the development of a village. IDM is an accumulation of the Economic Resilience Index, the Social Resilience Index, and the Environmental Resilience Index. IDM data for 2015-2022 regarding the extent to which the three village communities were affected by the activities of oil palm plantation companies can be seen in **Table 6.5**.

**Table 6.5**

*Development of Three Villages Affected by Palm Oil Plantation Company Activities Based on the Village Development Index (IDM) 2015-2022*

No	Village Name	IDM and Village Status				
		2015	2018	2019	2020	2021
1	Jangkang Satu (Kubu Raya)	0,4770 Extremely poor	0,6554 Developing	0,7994 Developed	0,8156 Developed	0,8416 Independent
2	Sungai Deras (Kubu Raya)	0,5394 Poor	0,6216 Developing			0,8283 Independent
3	Mandong (Sanggau)	0,4618 Extremely poor			0,5649 Poor	0,6690 Developing

The presence of oil palm plantation companies was followed by an increase in IDM in the three affected village communities, with the highest IDM in Jangkang Satu Village followed by Sei Deras Village and Mandong Village. The development of Jangkang Satu Village and Sei Deras Village is relatively the same, both have become Independent Villages. Meanwhile, the development of Mandong Village is relatively slow and will still have the status of a Developing Village in 2022. Based on the assumption that the activities of oil palm plantation companies have contributed to village development, it can be said that oil palm plantation companies investing in China are relatively better than investments from Malaysia. Regarding the tendency for a correlation between the development of district HDI and village development with IDM at the micro-local level, it can be said that the higher the HDI at the district level, the higher the development at the village community level.

## 6.2 The Impact of FDI in the Agroforestry Sub-Sector on Socio-Economy

PT Rezeki Kencana Julong Group's palm oil plantations and mills have had positive and negative impacts on the residents of Sei Deras Village, Kubu Raya District. The company's waste causes a disturbing odor and contaminates groundwater in RT 01 which causes cases of skin irritations and reduced fish populations. Floods occur because the waterways built for the tidal system are unable to hold the runoff when it rains. The pattern of relations between plasma farmers and companies tends to be unequal because the bargaining position of plasma farmers is weak towards the nucleus, and this is an economic institutional problem that needs to be addressed to improve the standard of living of plasma farmers in Mandong Village. The Impact on Community Income Levels.

**Table 6.6***Levels of Household Income in Sei Deras Village, Telok Pakedai District, Kubu Raya Regency*

No	Household case	Main income source	Additional income source	Average monthly income (IDR)
1	Household A	Farming	Farm labor	2,500,000
2	Household B	Fisheries	Farming	3,000,000
3	Household C	Trading	Farming	7,000,000
4	Household D	Public servant	Farming	8,000,000
5	Household E	Entrepreneur	Farming	5,000,000

*Source: Primary data (processed) 2022*

PT Agro Palindo Sakti provides work and business opportunities for villagers in Mandong, but there are still poor people due to the community's laziness and low work ethic. An analysis of the impact of oil palm plantation companies on education and digital literacy levels shows an increase in formal education in the three villages affected by the company, which correlates with an increase in household income. Compulsory education also played a role in reducing the percentage of the population who did not attend a school or primary school in the three villages.

**Table 6.7***Percentage of Residents with Formal Education in the Villages of Jangkang Satu (Kubu Raya), Sungai Deras (Kubu Raya) and Mandong (Sanggau) in 2015 and 2020*

No	Village Name	Uneducated		Elementary school		High school		Higher education	
		2005	2020	2005	2020	2005	2020	2005	2020
1	Desa Jangkang Satu (Kubu Raya)	9.5	7.2	48.2	22.8	32.5	50.3	9.8	19.9
2	Desa Sei Deras (Kubu Raya)	11.7	6.5	51.0	25.8	29.7	55.0	7.6	12.7
3	Desa Mandong (Sanggau)	16.4	12.9	70.8	39.4	11.6	40.0	1.2	7.7
4	Kabupaten Kubu Raya	11.3	8.0	49.1	30.7	31.8	48.7	7.8	12.6
5	Kabupaten Sanggau	17.2	13.3	69.0	53.7	11.5	28.9	2.3	4.1
6	Provinsi Kalimantan Barat	10.2	8.3	52.8	39.2	31.3	40.6	5.7	11.8

Regarding digital literacy, there have been changes in three village communities affected by the activities of oil palm plantation companies. This is indicated by an analysis based on indicators of digital device ownership, information literacy, computer literacy, media literacy, communication literacy, and technology literacy (**Table 6.8**) and the development of company activities with oil palm plantations and mills in the community. Some members of the affected village community are starting to have relatively new digital technology such as smartphones and laptops. The exchange of information is no longer dominated by face-to-face and consumptive information, but much has been done through the WhatsApp (WA) smartphone application and the information regarding productive aspects.

**Table 6.8***Matrix of Digital Literacy Level in the Community of Jangkang Satu Village (Kubu Raya), Sei Deras Village (Kubu Raya), and Mandong Village (Sanggau) Before and After Palm Oil Plantation Activities*

No	Level of Digital Literacy	Palm Oil Plantation Activity					
		Jangkang Satu		Sei Deras		Mandong	
		Before	After	Before	After	Before	After
1	Owner of digital gadgets	++	++++	++	++++	++	+++
2	Information Literacy	+	++	+	++	+	+
3	Computing Literacy	+	+++	+	++	+	+
4	Media Literacy	++	++++	++	+++	+	++
5	Communication Literacy	++	++++	++	+++	+	++
6	Technology Literacy	+	++	+	++	+	+

Note:

- Level = + . . . +++++

- Based on Observation and Interview

Communities in the three villages affected by the oil palm plantation company have experienced an increase in computer literacy and social media, especially in Jangkang Satu Village and Sei Deras Village. However, technological literacy is still limited to the use of a number of applications and there has been no use of drones at the village community level.

**6.2.1 Health Impacts**

There is no data explaining the difference in disease prevalence before and after oil palm plantation activities in the three affected villages. Poor water quality in the secondary canal in Jangkang Satu Village affects people's health, especially with the appearance of itching on the body. Palm oil processing factories produce waste that creates a very disturbing odor and degrades water quality in several water sources. The PT Agro Palindo Sakti palm oil mill produces waste that has been managed and controlled by the Sanggau Regency Environmental Service.

**6.2.2 Livelihood/ Living Standard Impacts**

Referring to data from the Central Statistics Agency (BPS) using Village Potential (Podes) data, the 2020 Population Census (SP) and the 2005 Inter-Census Population Survey (SUPAS), an analysis of the standard of living of a family or household includes 14 indicators of standard of living, namely : (1) Floor area of a residential building; (2) Type of floor of residence; (3) Type of residential walls; (4) defecation facilities; (5) Source of household lighting; (6) Source of drinking water; (7) Fuel for cooking; (8) Consumption of meat/milk/chicken; (9) Purchase of clothing (clothing); (10) Eat in a day; (11) Medical expenses if sick; (12) Source of income for the head of the household; (13) The highest education of the head of the household; and (14) Ownership of savings.

**Table 6.9**

*Living Standard Scores Based on 14 BPS Standards of Living Indicators by Village Affected Cases in Kubur Raya and Sanggau Regencies in 2005 and 2020*

No	Level of Digital Literacy	Living Standard Score		
		2005	2020	Margin (Δ)
1	Jangkang Satu (Kubu Raya)	87.65	123.73	36.08
2	Sei Deras (Kubu Raya)	85.47	121.41	35.94
3	Mandong (Sanggau)	69.74	98.05	28.31

Based on **Table 6.9**, the highest standard of living score in 2005 was in Jangkang Satu Village, Kubu Raya District, followed by Sei Deras Village and Mandong Village. The village of Jangkang Satu has the highest score after the oil palm plantation company operates, but the community's view of the standard of living of households in the village is different from the secondary data. Although the role of village workers in oil palm plantations has decreased, agriculture and other businesses have increased with the opening of road access. The existence of a company has a positive impact on the economy and people's lives, including job creation and trading activities. However, the decrease in the number of poor people was not significant. The same thing also happened in Sei Dera Village.

Mandong Village in Sanggau District feels the impact of APS in economic, social and environmental aspects. Positive impacts occur on the economic aspect by creating employment opportunities and business opportunities, while negative impacts occur

on social and environmental aspects. Becoming an independent smallholder in an oil palm plantation is more profitable than being a plasma farmer in Mandong Village. Foreign investment companies, Rezeki Kencana and Agro Palindo Sakti, have improved the living standards of the people in the three affected villages. Chinese investment companies have a bigger role in improving the standard of living of rural communities than Malaysian investment companies.

### 6.2.3 Energy Accessibility Impacts

Oil palm plantation companies bring about changes in the utilization of energy sources in the three affected villages, used for domestic needs and production. Previously, the community used wood and kerosene, but after the company entered, they switched to generators, the State Electricity Company (PLN) electricity, and cylinder gas. The energy needs in Jangkang Satu Village and Sei Deras Village are more easily met, and electricity from PLN creates a multiplier effect for productive economic businesses in the two villages.

### 6.2.4 Social Conflict Impacts

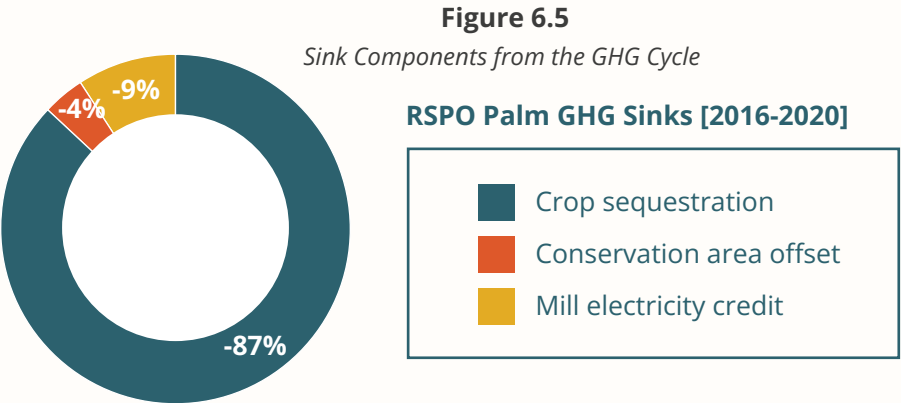
Oil palm plantation companies need land for production and this increases the demand for land resources in the vicinity. However, there are claims to land on the boundaries between villages that have the potential to cause conflicts between community members and institutions as vertical conflicts. In the village of Jangkang Satu, although there has not been a conflict between residents in terms of land tenure, there are land claims between villages, especially for the oil palm plantation partnership program. The historical factor of the change in the area of Jangkang Satu Village with the main village is the cause of this claim. On the other hand, PT Rezeki Kencana's palm oil plantation and processing factory activities have caused protests by residents against the company. The protests were never responded to by the company, and the community was relatively weak in this regard. They confronted the police and army who were seen as shields for the company and attempts to channel the problem to the authorities failed. This has created the potential for vertical conflict between the community and the company.

In the Sei Deras Village area, there are palm oil concession permits owned by PT Mitra Aneka Rezeki and PT Rezeki Kencana which cover the hamlets in the village. This causes friction between residents and these companies, as was the case in Gunung Ambawang Hamlet. Nonetheless, the APS oil palm plantation company operating in Mandong Village follows the customary law rules that apply in the community, and several conflict cases are resolved through the Mandoh customary law institution. Social solidarity in customary law institutions is maintained by the community with the Gawai event which is held every year at the Pedagi traditional house in Mandong Village. In this event, all members of the community in the customary law alliance are invited to explain the problems and rules that have been and will be applied in the customary law alliance. Gawai is an umbrella for the development of customary law institutions and the social capital of the community in Mandong Village as well as with residents outside the village who are still in one customary law alliance.

**6.3 Impact Analysis of FDI in the Agroforestry Sub-Sector on Greenhouse Gas Emissions and Environmental Changes**

**6.3.1 Greenhouse Gas Emissions**

The clearing of oil palm plantations from the original land (secondary forest) has implications in the form of changes in carbon stocks in the soil, due to the change in vegetation types from secondary forest to monoculture vegetation types dominated by oil palm. The quantity of changes in carbon emissions can be estimated based on emission factors, land area, and type of vegetation. Evidence that vegetation is the most important sink (carbon sink) is presented in **Figure 6.5**.



**6.3.2 Changes in Environmental Quality**

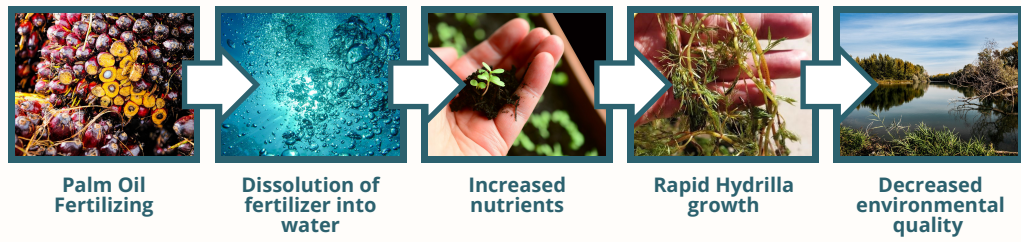
Environmental quality is calculated based on three environmental aspects, namely air quality, water quality, and land cover. Greenhouse gas (GHG) emissions are commonly included in the aspect of changes in air quality, although they are not fully appropriate.

**6.3.2.1 Water Quality**

A decrease in water quality or quality of the aquatic environment (**Figure 6.7**) was found in the secondary canals in Jangkang Satu Village, Kubu Raya Regency. The observed signs are the fertile growth of Hydrilla (*Hydrilla verticillata*) in water bodies. The extraordinarily fast growth can be caused by the abundance of nutrients in the water bodies which are thought to have originated from the dissolving of fertilizers in the oil palm lands. Because the oil palm cultivation land is in a flooded condition which is directly related to the tidal waters of the Kapuas River, this water-soluble fertilizer then flows into secondary channels and causes Hydrilla to obtain large amounts of nutrients so it grows at high speed. The next result is the siltation of the secondary canal so that the water flow rate drops significantly. Local residents are currently unable to use the secondary canal as a means of transportation as before.

**Figure 6.6**

*Process of Decreasing Water Quality*



**Figure 6.7**

*Algae (a) and Secondary Canal (b) di Jangkang Satu Village*



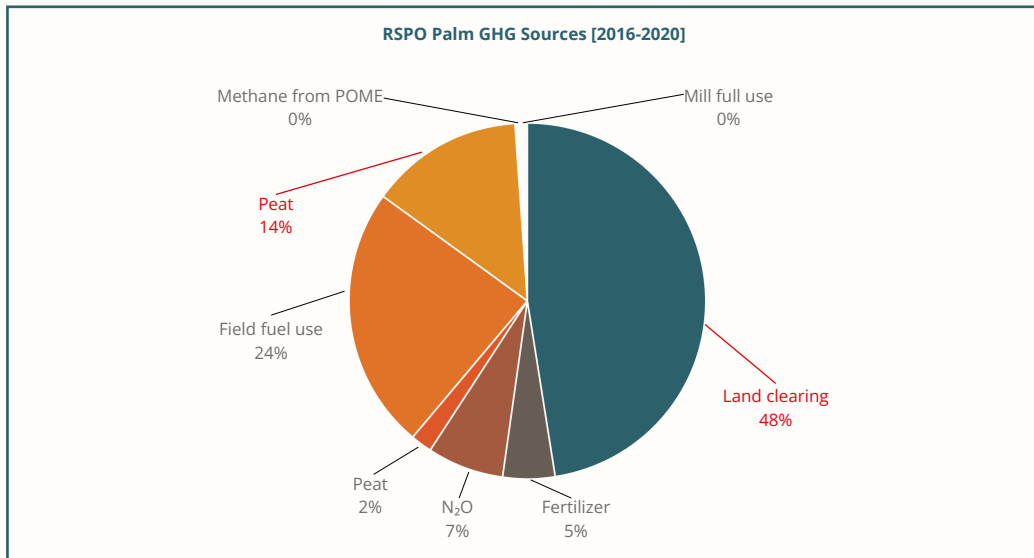
Hydrilla can thrive and spread quickly in freshwater waters. The presence of weeds in aquatic ecosystems can lead to vulnerability to ecosystem quality (Noviana, 2017).

### 6.3.2.2 Forest Cover

Forest cover is expressed in the form of Forest Cover Index (ITH) which is calculated based on the total area of primary forest (LHP) and secondary forest area (LHS) determined by the Minister of Forestry to the total area of the province (LWP). Primary forest area (LHP) plus secondary forest area (LHS) equals forest cover area (LTH). A primary forest is a forest that has remained relatively undisturbed by human activity. A secondary forest is a forest that grows through natural secondary succession on forest land that has experienced severe disturbance, such as ex-mining land, livestock, and sedentary agriculture. The opening of oil palm plantations has an impact in the form of changes in the value of the environmental quality index due to changes in the quality of surface water, changes in air quality, and changes in the area of forest cover. Changes in land cover, such as land clearing activities, are the largest source of GHG emissions (**Figure 6.8**).

**Figure 6.8**

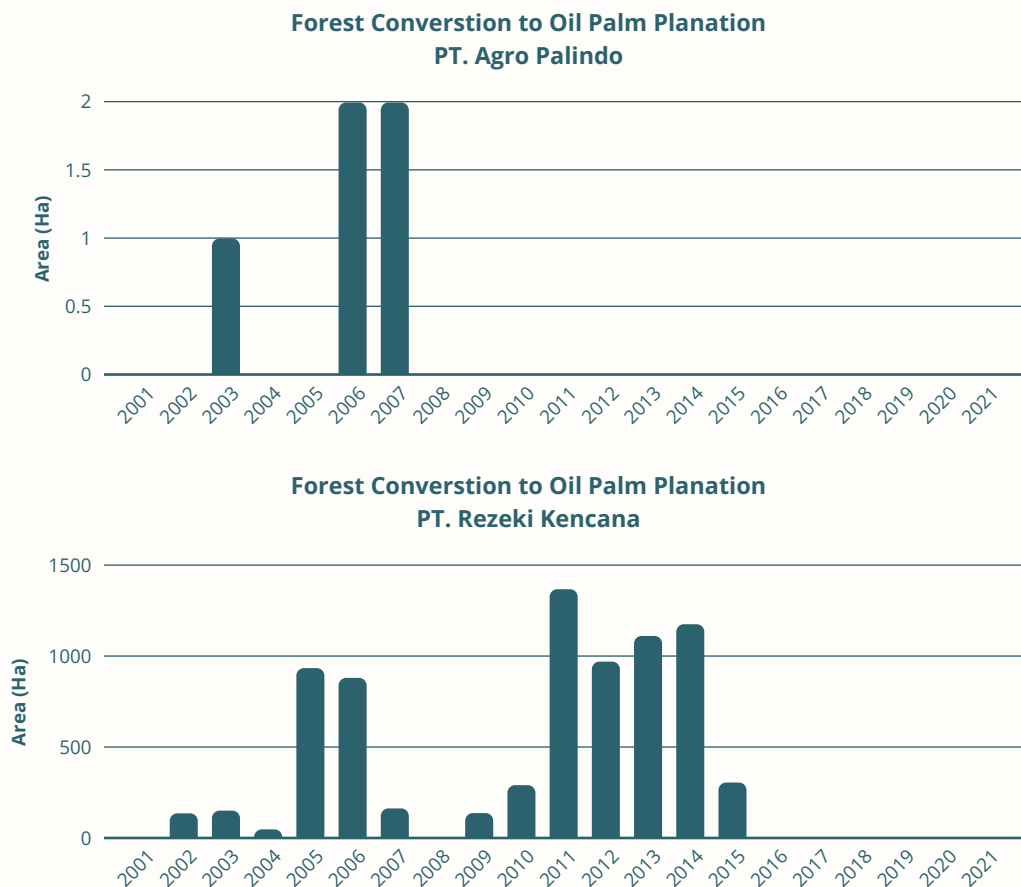
*Two Components of the Most Important Sources of GHG Emissions: Land Clearing and Peat*



PT Rezeki Kencana with a concession area of 21,345 hectares cleared forest areas in 2001-2020 covering an area of 7,689 hectares and PT Agro Palindo covering 5 hectares. This is due to differences in the initial vegetation cover conditions of each company prior to conversion to plantations (**Figure 6.9**).

**Figure 6.9**

*Deforestation Tracks of PT Agro Palindo Sakti and PT Rezeki Kencana*



Source: [map.nusantara-atlas.org](http://map.nusantara-atlas.org)

### **6.3.3 Calculation of GHG Emissions Volume Impacts from FDI Agroforestry projects (Palm Oil)**

The quantity of greenhouse gas (GHG) emissions arising from the operational activities of oil palm plantations and the palm oil processing industry into CPO can be estimated using a simple approach. Namely, GHG emissions from CPO production activities can be divided into three main parts, land preparation activities, oil palm cultivation, and oil palm FFB processing activities into CPO.

#### **6.3.3.1 GHG Emissions from Land Preparation (Clearing) from Palm Oil Plantation**

Land preparation for oil palm cultivation can generate emissions from deforestation activities. Based on [map.nusantara-atlas.org](http://map.nusantara-atlas.org) data, PT Rezeki Kencana has a deforestation footprint of 7,689 ha, 4 ha in dryland forest, 8 ha in a mangrove forest, and 7,677 ha in peatland forest. Meanwhile, PT Agro Palindo Sakti has a deforestation footprint of 5 ha in primary dryland forest. The deforestation activities of PT Rezeki Kencana and PT Agro Palindo Sakti have the potential to cause GHG emissions of 3.06 million tons of CO<sub>2</sub>e and 2,757 tons of CO<sub>2</sub>e, respectively. The total carbon stock in the PT Rezeki Kencana concession before deforestation occurred was 4.04 million tons of CO<sub>2</sub>e, while the carbon stock in the PT Agro Palindo Sakti concession before deforestation was 3,053 tons of CO<sub>2</sub>e.

#### **6.3.3.2 GHG Emissions from Palm Oil Plantation Cultivation**

The FFB harvest of oil palm is assumed to be 14 tons of FFB/year. With a planted area of 10,539 ha, PT Rezeki Kencana produces 147,546 tons of FFB a year. Meanwhile, PT Agro Palindo Sakti with a planted area of 1,353 ha produces 18,942 tons of FFB a year. The potential for GHG emissions from oil palm cultivation activities is 224,269.92 tons of CO<sub>2</sub>e/year for PT Rezeki Kencana and 28,791.84 tons of CO<sub>2</sub>e/year for PT Agro Palindo Sakti.

#### **6.3.3.3 GHG Emissions from Palm Oil Plantation CPO Production Activities**

Assuming that the factory works 24 hours for 365 days a year, PT Rezeki Kencana with a production capacity of 30 tons of FFB/hour produces 63,072 tons of CPO a year, and PT Agro Palindo Sakti with a production capacity of 45 tons of FFB/hour will produce 94,608 tons of CPO a year. Potential GHG emissions from palm oil mill activities are 151,372 CO<sub>2</sub>e/year for PT Rezeki Kencana's POM activities and 227,059 CO<sub>2</sub>e/year for PT Agro Palindo Sakti.

## CHAPTER VII

# CONCLUSION

### 7.1 FDI in the Energy Sector, Electricity Sub-Sector

#### 7.1.1 Regional Economy

PLTU Karangandri, with FDI from China, does not contribute to regional economic growth, while PLTU Tanjung Jati B with FDI from Japan makes a positive contribution both in the short and long term. Both contribute to reducing regional income inequality but do not contribute to reducing regional poverty. PLTU Karangandri contributes to the human development index in the long term, while PLTU Tanjung Jati B contributes to the human development index in the short and long term. The two PLTUs create centers of economic growth at the project site with complete regional infrastructure.

#### 7.1.2 Social Economy

The existence of the PLTU Karangandri in Cilacap Regency and the Tanjung Jati B PLTU in Jepara Regency have different impacts on the welfare of the surrounding community. The two projects succeeded in increasing income and providing social security assistance through CSR programs. However, the disposal of hot water waste from the PLTU Karangandri pollutes seawater around the coast, disrupting fishermen's activities and increasing their operational burden. Even so, the existence of the two PLTUs still has a positive impact on job creation and business opportunities. The operational activities of the two PLTUs also have an impact on the health of the local community. Pollutants such as SO<sub>2</sub>, NO, CO, and fly ash produced from the two PLTUs trigger respiratory diseases such as ARI and skin irritation itching. However, the existence of these two PLTUs has in fact triggered regional economic development and increased the availability of infrastructure that supports community activities and mobility.

#### 7.1.3 Environmental Pollution

The two PLTUs mentioned, namely PLTU Karangandri and PLTU Tanjung Jati B, both produce harmful emissions such as CO, SO<sub>2</sub>, NO<sub>2</sub>, and fly ash. However, for NO<sub>2</sub>, the concentration is above the WHO-recommended threshold. Flue Gas Desulfurization (FGD) succeeded in reducing the concentration of SO<sub>2</sub> pollutants in the two PLTUs. PLTU Karangandri has an average production of 12,920,000 MWh per year since 2021 with an emission-to-production ratio of 0.94 tonnes of CO<sub>2</sub>e per 1 MWh. The investment in the construction of the Karangandri PLTU is worth 2.81 billion USD and every dollar invested produces 122.15 kg of CO<sub>2</sub>e emissions. Meanwhile, PLTU Tanjung Jati B has an average production of 17,600,000 MWh per year with an emission-to-production ratio of 0.94 tonnes of CO<sub>2</sub>e per 1 MWh. Investment in the construction of PLTU Tanjung Jati B is worth 3.47 billion USD and every dollar invested produces 119.17 kg of CO<sub>2</sub>e emissions.

## 7.2 FDI in Energy Sector, Agroforestry Sub-Sector

### 7.2.1 Regional Economy

Analysis of the 2016 Input-Output Table shows that the palm oil commodity sector has a Direct and Indirect Linkage to the Future (KLTD) of 3.27, which means that increased demand will contribute to regional economic growth. In addition, the multiplier analysis shows that FDI allocated to the palm oil commodity will have an impact on output, income, and employment. However, the qualitative and quantitative analysis also shows that foreign investment in the plantation sub-sector does not contribute to regional income inequality and poverty levels.

### 7.2.2 Social Economy

Oil palm plantation companies such as PT Rezeki Kencana Julong Group and PT Agro Palindo Sakti in Indonesia have had a positive impact on the socio-economic life of the local community by creating employment and business opportunities for the affected villagers thereby increasing the community's income. In addition, the presence of oil palm plantation companies also had an impact on changes in digital and information literacy in village communities, with many villagers starting to use smartphones and laptops as well as the WhatsApp application to exchange information. Although it did not have an impact on the education and health sectors, the presence of oil palm plantation companies also had an impact on changing patterns of energy use in rural communities.

### 7.2.3 Social Conflict

PT Rezeki Kencana Julong Group from China caused agrarian conflicts in Kubu Raya District, especially in Sei Deras Village, due to different claims on land tenure between the company and the community. The company has a palm oil concession permit for the land, while the people of Sei Deras Village consider the land as their hereditary property. This conflict once caused friction between residents and the company.

### 7.2.4 Environmental Pollution

In Kubu Raya Regency, the presence of PT Rezeki Kencana Julong Group as an FDI company in the forestry agriculture sub-sector from China has had a negative impact on the surrounding environment. The waste generated by POM activities has polluted groundwater, reduced fish populations, and caused itchiness when the water is used for daily needs. Potential GHG emissions from oil palm and POM plantation activities owned by PT Rezeki Kencana in Kubu Raya Regency reach 3.06 million tonnes of CO<sub>2</sub>e from land preparation, 224,269.9 tonnes of CO<sub>2</sub>e per year from oil palm cultivation, and 151,372.8 tonnes CO<sub>2</sub>e per year from the palm oil production process.

In Sanggau Regency, the existence of PT Agro Palindo Sakti as an FDI company in the forestry agriculture sub-sector from Singapore and America has also experienced a similar impact on the surrounding environment. The pollution that occurs is the growth of Hydrilla plants in the river which is used as a source of clean water and a transportation route for the village community.

Potential GHG emissions from oil palm and POM plantation activities owned by PT Agro Palindo Sakti reach 2,756.9 tonnes of CO<sub>2</sub>e from land preparation, 28,791.8 tonnes of CO<sub>2</sub>e per year from oil palm cultivation, and 227,059.2 tonnes of CO<sub>2</sub>e per year. years from the palm oil production process.

## CHAPTER VIII

# FDI POLICY STRATEGY RECOMMENDATIONS

### 8.1 Low Carbon Development Concept

Low-Carbon Development (*Pembangunan Rendah Karbon/PRK*) aims to identify development policies that can maintain economic and social growth with low greenhouse gas (GHG) emission intensities and reduce the use of natural resources. Low-carbon development is a transitional strategy towards a green economy and sustainable development and is the backbone for Indonesia to achieve its 2060 net zero emissions target.

### 8.2 Challenges and Obstacles to Low-Carbon Development

Energy demand is expected to continue to increase threefold by 2060, so investment policies in the energy and agricultural sectors are needed that are in line with the concept of low-carbon development to reduce greenhouse gas emissions. As an illustration, based on data from the Ministry of Energy and Mineral Resources, in 2020 GHG emissions from Indonesia's energy sector totalled 587 m/tonnes CO<sub>2</sub>e, with coal plants accounting for 278 m/tonnes CO<sub>2</sub>e, transport 132.5 m/tonnes CO<sub>2</sub>e, and manufacturing 105.1 m/tonnes CO<sub>2</sub>e. (Danang Sugianto, 2021)

In comparison, by 2030 GHG emissions from the agroforestry sector are forecast to reach 478.5 m/tonnes CO<sub>2</sub>e.

### 8.3 Low Carbon Development Policy Directions

Indonesia has huge potential for renewable energy. According to Indonesia's Ministry of Energy and Mineral Resources (ESDM), in 2021 Indonesia's renewable energy potential totalled 417.8 GW, comprising 207.8 GW solar power, 75 GW hydropower, 60.6 GW wind power, 32.6 GW bioenergy, 23.9 GW geothermal energy, and 17.9 GW tidal/wave power.

Indonesia's government urgently needs to create the necessary policy conditions and incentives to harness its clean energy resources to drive the nation's low carbon development.

- Low carbon development must be incorporated across all development programs, at national, regional and sectoral levels.
- National development, regional development, sectoral development in the context of implementing low-carbon development must have a positive impact from an economic perspective, namely the availability of green jobs, green/sustainable investment, and low-carbon economic growth. From the social perspective, that is, it must be able to strengthen community resilience to pandemics, climate change, and environmental disasters. From the environmental perspective, it must have an impact on reducing GHG emissions, preserving biodiversity, and protecting forest/conservation areas, peatlands and mangrove.
- The Low Carbon Development Goals should focus on improving the process and quality of development planning towards a green economy in five areas: sustainable energy, sustainable land restoration, waste management, green industry development, and low carbon coastal and marine (blue carbon).

## 8.4 FDI Policy Strategy for the Electricity Sub-Sector in Harmony with Low-Carbon Development

The government has selected sectoral policies in the energy sector, especially the electricity sub-sector, to support low-carbon development, namely by encouraging the transition to renewable energy sources and reducing the use of coal by increasing the renewable energy mix from around 10 percent in 2018 to 23 percent in 2030 and then to 30 percent in 2045, and increase energy efficiency by 3.5 percent in 2030 and increase again to 4.5 percent in 2045. This is expected to reduce emission intensity (ratio of total GHG emissions to value-added GDP) by 30 percent in 2030 and 60 percent in 2045.

Meanwhile, in the agroforestry sector, especially the plantation sub-sector, the government implemented a policy to encourage an increase in agricultural land productivity by 4.4 percent per year, while simultaneously expanding the area of sustainable agricultural land to reach 45 percent of the total area of agricultural land.

Considering the challenges and obstacles of implementing low carbon development in Indonesia's energy and FOLU sectors, and findings from Traction Energy Asia's other studies on the impacts of Indonesia's palm biodiesel program, and the findings of this impact analysis of FDI in the electricity and plantation agroforestry sub-sectors on the environment and GHG emissions intensity, in which we found that coal plant and oil plantation projects with Chinese-FDI contribute relatively higher GHG emissions compared to other-FDI projects, **we formulated the following FDI policy strategy recommendations for the electricity sub-sector (power generation):**

1. Ending investment offers for coal power plant development projects, and other destructive energy projects such as large hydroelectric infrastructure, and promoting investment opportunities for clean renewable energy power plant development projects.
2. To implement the above recommendation the Indonesian government entities with mandates to manage Indonesia's inward investment - the Coordinating Ministry for Maritime Affairs and Investment, and the Investment Coordinating Board or *Badan Koordinasi Penanaman Modal* (BKPM), need to formulate an FDI policy strategy that strengthens governance systems and instruments for monitoring and evaluating inward investment in Indonesia's energy sector to align with Indonesia's low carbon development ambitions and Paris Agreement emissions reduction commitments.
3. Indonesia has very high potential for solar, wind, geothermal and wave/tidal energy, as well as abundant nature-based climate solutions, which can absorb and store carbon, such as intact natural forests, peatlands, mangroves and coral reefs. Indonesia's government needs to create the enabling conditions to encourage the development of a strong clean energy sector, including policy and regulatory support, financial and fiscal incentives/subsidies to attract FDI from countries with the experience and technological know-how to help Indonesia harness its abundant clean energy resources.
4. Indonesia's government must urgently revise the soon to be enacted RUU EBT (New and Renewable Energy Bill) to remove energy choices that are not aligned with the nation's low carbon development and Paris Agreement emissions reduction commitments. The current RUU EBT supports Indonesia's problematic energy transition and emissions reduction plans, which rely on palm-biodiesel, biomass and electric vehicles without the necessary environmental and social protection safeguards.
5. To boost Indonesia's transition to clean energy and low carbon development to support the nation's Paris Agreement emissions reduction commitments, and to encourage inward investment to develop a strong domestic clean energy sector, Indonesia's government

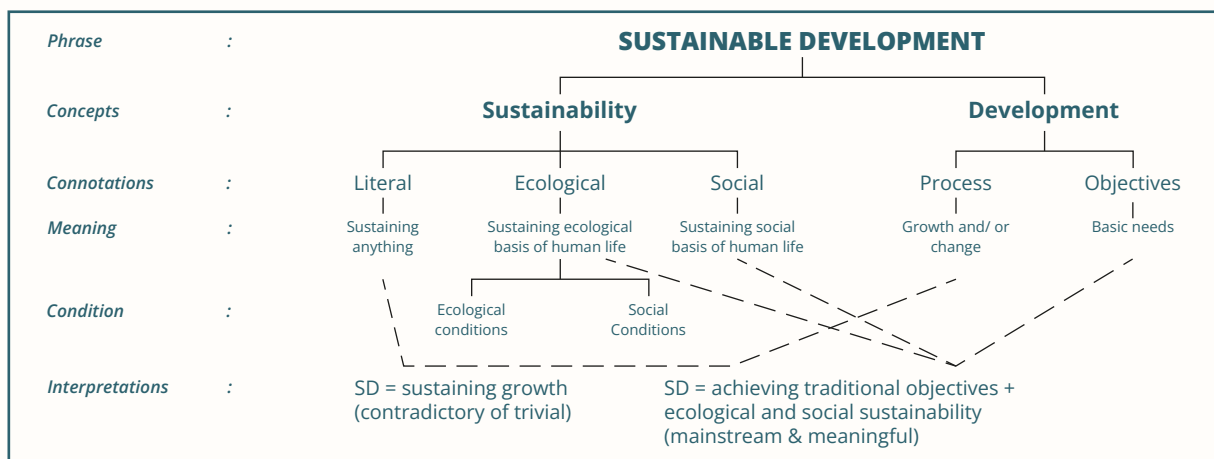
needs to relax the local content requirement regulations to encourage foreign investment in the construction of large-scale solar power plants (SPP)/*pembangkit listrik tenaga surya* (PLTS), geothermal power plants, wind power plants (WPP)/*pembangkit listrik tenaga bayu* (PLTB), and exploration of Indonesia’s wave/tidal power potential. In particular, incentives to encourage large-scale SPP/PLTS investment could help Indonesia achieve its SPP/PLTS development target of 4.68 gigawatts by 2030.

6. Indonesia’s government must make it mandatory for all FDI projects in the energy sector to improve pollution control and install waste treatment systems that can recycle waste into input factors of production (circular economy) or convert them into renewable energy sources.
7. When Indonesia’s delayed carbon tax is introduced in 2025 Indonesia’s government must ensure that it also applies to foreign investment projects in the energy sector.

### 8.5 FDI Policy Strategy for the Agroforestry Sub-Sector in Harmony with Low Carbon Development

The biggest contributors to Indonesia’s carbon emissions from 2010-2019 were the energy sector, the agroforestry sector, and peatland fires. The energy transition scenario and low-carbon development in the agroforestry sub-sector are oriented towards “sustainability”. Referring to this sustainability orientation, the agroforestry sector in the development process focuses on fulfilling basic human needs as a traditional objective and maintaining and enhancing the ecological basis of human life (ecosystem) and the socio-economics basis of human life (social system) (Figure 8.1). Recently, the development of the agroforestry sub-sector, historically the largest emitting sector, needs to implement a "transdisciplinary" approach, no longer using a multidisciplinary and interdisciplinary approach (Figure 8.2).

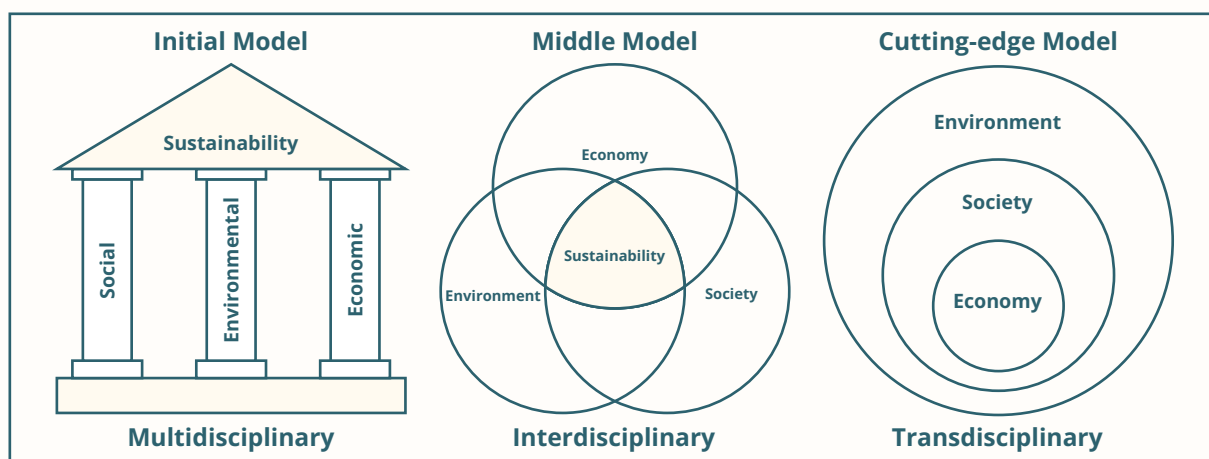
**Figure 8.1**  
*Sustainable Development Scheme*



Source: Lele, 1991

**Figure 8.2**

*Paradigm Shifts and Approaches to Sustainable Agroforestry Sub-Sector Implementation*



Based on our findings from the policy and trend analysis, in addition to findings from Traction Energy Asia's other studies on the impacts of Indonesia's palm biodiesel program, **we formulated the following FDI policy strategy recommendations for the agroforestry sector, with a focus on the oil palm plantation sub-sector, aligned with the energy transition scenario and low-carbon development:**

1. Ending foreign investment offers to open new land for oil palm plantations (no deforestation, no peat, no exploitation - NDPE).
2. Only providing investment offers/permits for plantation businesses that apply a sustainable plantation business pattern (intensification), are committed to no deforestation, no peat, no exploitation (NDPE), and apply the principles of good agricultural practices.
3. Providing business investment offers for the oil palm plantation sub-sector to countries that have strong and real commitments to low carbon (no deforestation) development and NDP policies. Therefore, the Coordinating Ministry for Maritime Affairs and Investment, and the Investment Coordinating Board needs to strengthen its governance systems and instruments for monitoring and evaluating inward investment in Indonesia's agroforestry sector to align with Indonesia's low carbon development ambitions and Paris Agreement emissions reduction commitments.
4. Indonesia's government must promote alternative and sustainable feedstocks, such as used cooking oil and traceable supply from small independent farmers, as well as limiting the palm oil mix according to existing plantation capacity, for its ambitious biodiesel program to reduce the risk of palm oil expansion, deforestation and increasing emissions.
5. Investors must be able to generate economic value from forest utilization using a balance of conservation, protection and social functions. FDI projects in the oil palm plantation sub-sector must have a performance concept that provides leverage for regional economic development and brings benefits on the creation/absorption of green jobs and the growth of community resilience.
6. Indonesia's government must make it mandatory for all FDI projects in the agroforestry sector to improve pollution control and install waste treatment systems that can recycle waste into input factors of production (circular economy) or convert them into renewable energy sources, such as methane capture at palm oil mill effluent ponds.
7. When Indonesia's delayed carbon tax is introduced in 2025 Indonesia's government must ensure that it also applies to foreign investment projects in the agroforestry sector.

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# APPENDIX (RESEARCH METHODS)

## 1. Data Processing and Data Analysis Technique in FDI Impacts on Electricity Sub-Sector

### A. Error Correction Model

#### Economic Growth

The dynamic regression equation used is as follow:

$$\ln(\text{GRDP})_{(t)} = \alpha + \beta_1 \ln(I)_{(t-1)} + \beta_2 \ln(\text{LB})_{(t)} + \beta_3 \ln(\text{HDI})_{(t)} + \varepsilon(t) \dots (1)$$

*Note:*

GRDP = GRDP by business sector

I = FDI on electricity sub-sector

LF = Population of the labor force 15 years and over

HDI = Human Development Index

#### Income Disparity

The dynamic regression equation used is as follow:

$$\ln(\text{DP})_{(t)} = \alpha + \beta_1 \ln(I)_{(t-1)} + \beta_3 \ln(\text{IPM})_{(t)} + \varepsilon(t) \dots (2)$$

*Note:*

DP = Distribution of expenses in the bottom 40%

I = FDI on electricity sub-sector

HDI = Human Development Index

#### Poverty Level

The dynamic regression equation used is as follow:

$$\ln(\text{POV})_{(t)} = \alpha + \beta_1 \ln(I)_{(t-1)} + \varepsilon(t) \dots (3)$$

*Note:*

POV = Poverty level

I = FDI on electricity sub-sector

#### Human Development Index (HDI)

The dynamic regression equation used is as follow:

$$\ln(\text{IPM})_{(t)} = \alpha + \beta_1 \ln(I)_{(t-1)} + \varepsilon(t) \dots (4)$$

*Note:*

HDI = Human Development Index

I = FDI on electricity sub-sector

The assumptions used in multiple linear regression analysis are:

1. Analysis using time series data for the period 2010 – 2020.
2. Regression analysis was carried out per district, meaning that the model analysis was carried out separately between Cilacap and Jepara districts.

Steps on ECM analysis are:

- **Stationarity Test**

Stationarity test is carried out on the variables to be tested. Time series data are often not stationary so they have the potential to produce spurious regression, which is a condition where the value of R<sup>2</sup> is very large, but the resulting regression results are actually incorrect or statistically biased. In addition to the data stationarity test, a model stationarity test was also carried out to see the long-term relationship between the dependent variable and the independent variable before the cointegration test was carried out.

- **Cointegration Test**

The cointegration test used in this study is the Engle-Granger approach, in which the cointegration between variables can be identified from the residual stationarity. If there is cointegration, then the analysis can be continued with ECM estimation.

- **ECM Estimation**

On ECM estimation, the equation used is as follows:

$$\Delta Y_t = a_0 + b_1 \Delta X_t - \pi u_{t-1} + e_t$$

The estimate provides an overview of the short-term relationship between the independent and dependent variables in the equation. In the equation, *b* gives the short-term impact of *X<sub>t</sub>* on *Y<sub>t</sub>* and *π* shows the adjustment effect which describes how much improvement is in the short-term if there is an imbalance in the long term.

## **B. Data Analysis Technique on Socio-Economic**

Socio-economic impact data analysis is a qualitative analysis by comparing changes in socio-economic conditions in the period before the construction of the PLTU and the period after the PLTU operates, including the social impacts after the expansion of the PLTU's capacity.

## **C. Data Analysis Technique on Environmental Aspect**

An analysis of the environmental impact of the operation of the PLTU is viewed from two aspects, namely the impact of greenhouse gas emissions and the impact on environmental quality, which consists of air quality.

## Greenhouse Gas (GHG) Emissions

Calculation of GHG emissions in the electricity sub-sector refers to the Intergovernmental Panel on Climate Change (IPCC) Guidelines 2006. This is in accordance with the Regulation of the Minister of Environment and Forestry Number P.73/MenLHK/Setjen/Kum.1/12/2017 concerning Guidelines for Implementation and Greenhouse Gas Inventory Reporting. Broadly speaking, the calculation of GHG emissions is obtained by multiplying activity data by emission factors, or by a simple equation as follows:

$$\Sigma \text{ Emission} = \text{DA} \times \text{EF}$$

**(Equation 1)**

*Note:*

$\Sigma$ Emission	= Total emission
DA	= Activity data for a certain time – number of inputs emission (generator)
EF	= Emission factor

Activity data is consumption data per type of fuel that has been converted to energy units. The formula for converting fuel consumption data from mass units (tons) to energy units (TJ) is as follows:

### Coal activity data

$$D_{ABB} = F_{BB} \times NCV \times 10^{-3}$$

*Note:*

DABB	= Coal activity data (TJ)
FBB	= Coal consumption per year (ton)
NCV	= Net Calorific Value (NCV) of coal

### Fuel activity data

$$D_{ABBM} = F_{BBM} \times \rho \times NCV \times 10^{-6}$$

*Note:*

DABBM	= Fuel activity data (TJ)
FBBM	= Fuel consumption per year (kilo liter)
NCV	= Net Calorific Value (NCV) of coal (TJ/GgBBM)
$\rho$	= Fuel density (kgBBM/m <sup>3</sup> )

## Pollutant Emission

Calculation of pollutant emissions in the form of gas concentrations in a place with x, y, and z coordinates (g/m<sup>3</sup>) with the midpoint of a coal power plant is carried out for three main pollutants, namely carbon monoxide (CO), sulfur dioxide (SO<sub>2</sub>), and nitrogen dioxide (NO<sub>2</sub>). Estimation was carried out using the Gaussian Dispersion Model method. The following are the steps in estimating the pollutant emissions:

$$\Sigma \text{ Emission}_i = \text{BB} \times \text{EF}_i$$

**(Equation 1)**

Note:

- $\Sigma$  Emission = Total pollutant emission i (CO, SO<sub>2</sub>, and NO<sub>2</sub>) per unit in a certain time (lb/day)
- BB = Amount of coal burned during a certain time (amount of emitting inputs) (ton/day)
- EF<sub>i</sub> = Pollutant emission factor i (CO, SO<sub>2</sub>, and NO<sub>2</sub>) (lb/ton)

Furthermore, the units of the amount of emissions in units of pounds per day (lb/day) are converted to units of micrograms per second (µg/s). The conversion is done with the following formula:

$$Emission\ rate = \frac{\Sigma\ Emission\ x\ K}{S}$$

**(Equation 2)**

Note:

- Emission rate = Total pollutant emission (CO, SO<sub>2</sub>, and NO<sub>2</sub>) in microgram per second (µg/s).
- K = Weight conversion factor from the pound (lb) to microgram (µg) is 0.453592E+09
- S = Time conversion factor from day to the second is 86,400

Furthermore, to calculate the gas concentration at a point around the PLTU, gas dispersion calculations are carried out by considering the chimney height and wind speed. The gas dispersion equation model according to Gauss or called the Gaussian Dispersion Model (Peavy et al., 1985; de Nevers, 1995; Kiely, 1998; LaGrega et al., 2001) used in this study is as follows:

$$C_{(x,y,z)} = \frac{Q}{\pi\sigma_y\sigma_zU} \exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right]$$

**(Equation 3)**

Note:

- C(x,y,z) = Concentration of gas at a coordinate place (x,y,z) [g/m<sup>3</sup>]
- Q = Stack emission rate [g/s]
- σ<sub>y</sub>; σ<sub>z</sub> = Dispersion coefficient corresponds to the Pasquill-Gifford curve [m]
- U = Wind speed [m/s]
- x = Horizontal distance in the x-axis direction from centerline [m]
- y = Horizontal distance in the y-axis direction from centerline [m]
- z = Vertical distance in the z-axis direction from centerline [m]
- H = Plume height from ground level [m]

The results of calculating the concentrations of carbon monoxide (CO), sulfur dioxide (SO<sub>2</sub>), and nitrogen dioxide (NO<sub>2</sub>) emissions were then compared with the air quality recommendations for the three types of pollutants from the World Health Organization (WHO). An explanation of the air quality recommendations from WHO can be seen in the following table:

**Appendix Table 1**  
WHO Air Quality Guidelines

No	Pollutants	Value
1	NO <sub>2</sub>	24-hour average is 25 µg/m <sup>3</sup>
2	SO <sub>2</sub>	24-hour average is 40 µg/m <sup>3</sup>
3	CO	24-hour average is 4 mg/m <sup>3</sup>

Source: WHO (2021)

## 2. Data Processing and Data Analysis Technique in Forestry-Agriculture Sub-Sector

### A. Input-Output Analysis

Table of Input-Output 2016 Domestic Transactions at Base Prices consisting of 185 products. The Input-Output Table for Domestic Transactions at Base Prices does not include transactions for imports of goods and services (Sahara 2017). The data was obtained from the Central Bureau of Statistics (BPS).

#### Direct and Indirect Backward

Direct and indirect backward linkages show the impact of a particular sector on sectors that provide intermediate inputs for that sector either directly or indirectly per unit increase in total demand. This type of relatedness is formulated as follows (Priyarsono et al. 2007):

$$KLTB_j = \sum_{i=1}^n \alpha_{ij}$$

Note:

$KLTB_j$  = Direct indirect linkage backward sector j

$\alpha_{ij}$  = elements of Leontief's inverse matrix of the open model

Direct and indirect forward linkages show the impact of a particular sector on sectors that use the output for that sector directly or indirectly per unit increase in total demand. This type of relationship is formulated as follows:

$$KLTD_i = \sum_{j=1}^n \alpha_{ij}$$

Note:

$KLTD_i$  = Direct indirect linkage forward i

$\alpha_{ij}$  = elements of Leontief's inverse matrix of the open model

#### a. Dispersion Coefficient

The dispersion coefficient is seen to determine how much the ability of a sector to attract increased production growth in other sectors that supply inputs for that sector. Sector j has a strong ability to attract upstream sector production growth if  $P_{dj} > 1$ , conversely, the agro-industrial sector is said to be weak in attracting its upstream industry if  $P_{dj} < 1$ . The formula for finding the dispersion coefficient value is:

$$P_{dj} = \frac{n \sum_{i=1}^n \alpha_{ij}}{\sum_{i=1}^n \sum_{j=1}^n \alpha_{ij}}$$

Note:

$P_{dj}$  = Dispersion coefficient j

$\alpha_{ij}$  = elements of Leontief's inverse matrix of the open model

n = the number of sectors

## b. Sensitivity of Dispersion

The sensitivity of dispersion or the power of dispersion in the future can provide information regarding the ability of a sector to boost productivity growth in its downstream sector, namely the sectors that use the output of that sector. Sector *i* is said to have a high dispersion sensitivity if the *S<sub>di</sub>* value is >1 and vice versa if the *S<sub>di</sub>* value is <1. The formula used to find the dispersion sensitivity value is:

$$Sd_i = \frac{n \sum_{j=1}^n \alpha_{ij}}{\sum_{i=1}^n \sum_{j=1}^n \alpha_{ij}}$$

Note:

*S<sub>di</sub>* = sensitivity of dispersion *i*

$\alpha_{ij}$  = elements of Leontief's inverse matrix of the open model

*n* = number of sector

## Multiplier Analysis

Multiplier analysis is carried out to determine the impact of certain endogenous variables if there is a change in exogenous variables such as final demand in the economy. Multiplier analysis includes production sector output, household income, and employment. Multiplier analysis with the Input-Output model using an open inverse Leontief matrix will produce an ordinary or simple multiplier number while a closed inverse Leontief matrix will produce a total multiplier number. The multiplier formula for output, income, and labor is presented in **Appendix Table 2**.

**Appendix Table 2**

*Output, Income, and Labor Multiplier Formulas*

Value	Multiplier		
	Output	Income	Labor
Initial effect	1	$H_j$	$e_j$
First round effect	$\alpha_{ij}$	$\alpha_{ij} h_i$	$\alpha_{ij} e_i$
Industry support effect	$\alpha_{ij} - 1 - \alpha_{ij}$	$\alpha_{ij} h_i - h_j - \alpha_{ij} h_i$	$\alpha_{ij} e_i - e_j - \alpha_{ij}$
Consumption induction effect	$\alpha^*_{ij} - \alpha_{ij}$	$\alpha^*_{ij} h_i - \alpha_{ij} h_i$	$\alpha^*_{ij} e_i - \alpha_{ij} e_i$
Total effect	$\alpha^*_{ij}$	$\alpha^*_{ij} h_i$	$\alpha^*_{ij} e_i$
Follow-up effect	$\alpha^*_{ij} - 1$	$\alpha^*_{ij} h_i - h_i$	$\alpha^*_{ij} e_i - e_i$

Source: Sahara (2017)

Note:

$\alpha_{ij}$  = Output coefficient

$h_i$  = Household income coefficient

$e_i$  = Labor coefficient

$\alpha_{ij}$  = elements of Leontief's inverse matrix of the open model

$\alpha^*_{ij}$  = elements of Leontief's inverse matrix of the closed-model

To see the direct and indirect impact per unit of measurement in terms of output, income, and labor, it is calculated using the type I multiplier formula, as follows:

$$\text{Type I} = \frac{\text{Efek Awal} + \text{Efek Putaran Pertama} + \text{Efek Dukungan Industri}}{\text{Efek Awal}}$$

## B. Disparity Analysis

Analysis of inequality or economic disparity is seen from inequality between communities and inequality between regions. Based on BPS, the Gini Ratio inequality index is used as an indicator of people's economic inequality. The Williamson inequality index is used to capture regional economic inequality. Analysis of household economic gaps was carried out by comparing the national, provincial, and district Gini ratios as sample study locations obtained from BPS.

Gini ratio index calculation formula:

$$GR = 1 - \sum_{i=0}^n f_{pi}x(Fc_i + Fc_{i-1})$$

Note:

GR = Gini Coefficient

F<sub>pi</sub> = Population frequency in the I-th expenditure class

F<sub>ci</sub> = cumulative frequency of total expenditure in class I expenditure

F<sub>ci-1</sub> = cumulative frequency of total expenditure in expenditure class to (i-1)

The Gini Ratio as a measure of income distribution between values 0 (zero) and 1 (one), with grouping into 3 (three) categories of levels of inequality as follows:

- Gini Ratio 0.50 – 0.70: high gap
- Gini Ratio 0.36 – 0.49: medium gap
- Gini Ratio 0.20 – 0.35: low gap

In order to find out the inequality of regional development between sub-districts that occurs in a district/city, it can be analyzed using a regional inequality index (regional inequality) called the Williamson inequality index (Sjafrizal, 2008). Sjafrizal further stated that the Williamson Index ranges from  $0 < IW < 1$ , where closer to zero means the area is more evenly distributed or equal, whereas if it is close to 1 then it is more unequal or unequal.

Williamson Index calculation formula:

$$IW = \sqrt{\frac{\sum (Y_i - Y)^2 f_i / n}{Y}}$$

Note:

IW = Williamson Index

Y<sub>i</sub> = GDRP per capita in District i

Y = GRDP per capita on average in West Kalimantan Province

f<sub>i</sub> = total population in District i

n = total population of West Kalimantan Province

## C. Poverty Analysis

BPS data is used to measuring poverty by comparing the national poverty rate with provinces in Kalimantan and districts as sample study locations. BPS uses the concept of the ability to meet basic needs (basic needs approach), in which the poor have an average expenditure per capita per month below the poverty line. The pover-

ty line measurement formula is:

$$GK = GKM + GKNM$$

Note:

GK = Poverty line

GKM = Food poverty line

GKNM = Non-food poverty line

The Food Poverty Line (GKM) is the expenditure value for minimum food needs which is equivalent to 2,100-kilo calories per capita per day, where basic food needs are represented by 52 types of commodities. The Non-Food Poverty Line (GKNM) is the minimum requirement for housing, clothing, education, and health, which is represented by 51 types of commodities in urban areas and 47 types of commodities in rural areas. BPS calculates the Percentage of the Poor Population using the Head Count Index (HCI-P0) concept, namely the percentage of the population below the Poverty Line using the following formula:

$$P_0 = \frac{1}{n} \sum_{i=1}^q \left[ \frac{z - y_i}{z} \right]^0$$

Note:

Po = percentage of the population living in poverty

Z = poverty line

yi = the average monthly per capita expenditure of the population is below the line poverty :  $y_i < z$

q = the number of people living below the poverty line

n = total population

#### D. Data Analysis Technique on Environmental Impacts

An analysis of the environmental impacts of the agriculture and forestry sector is viewed from two aspects, namely the impact of greenhouse gas emissions and the impact on environmental quality consisting of water quality and forest cover.

##### Greenhouse Gas (GHG) Emissions

The quantity of changes in carbon emissions can be estimated based on emission factors, land area, and type of vegetation. Emissions arising from oil palm plantations are divided based on activities, namely land preparation, cultivation, and palm oil production. The land preparation process is calculated based on the incident, meaning that it is not an activity that is carried out routinely every year, while the process of cultivating and producing palm oil is calculated annually.

Land preparation emission factors use guidelines issued by the Ministry of Environment and Forestry (2022) in the Kalimantan region with some vegetation, namely primary dryland forest, secondary dryland forest, primary swamp forest, secondary swamp forest, primary mangrove forest, and secondary mangrove forest. Furthermore, each type of primary and secondary forest is averaged to take a median value that represents the vegetation.

**Appendix Table 3**

*Greenhouse Gas Emission Factors by Forest Type in Kalimantan*

Forest Type	Above Ground Biomass		Below Ground Biomass		Total		Average
	Mean	SE	Mean	SE	Mean	SE	
Primary dryland forest	325.9	10.05	94.51	2.89	420	10	354
Secondary dryland forest	222.91	4.48	64.64	1.32	288	5	
Primary peat swamp forest	285.09	24.16	62.72	7.1	348	25	305.5
Secondary peat swamp forest	215.71	7.38	47.46	1.83	263	8	
Primary mangrove forest	247.98	14.39	77.12	4.43	325	15	249.5
Secondary mangrove forest	155.74	19.21	17.91	2.32	174	19	

Source: Rusolono, et al., 2022

Land preparation activities that cause deforestation result in the loss of biomass that has been accumulated over the years by natural forests. The biomass will dry up and cause emissions. The formula used to calculate the GHG emission generated from the land preparation activity in question is:

$$\sum \text{Emission}_{\text{land preparation}} = \sum (LV \times EF_{\text{forest}} \times CF \times K)$$

Note:

- Emission<sub>land preparation</sub> = Total emission during land preparation process (ton CO<sub>2</sub>e)
- LV = Area of each forest (ha)
- EF<sub>forest</sub> = Emission factor each forest (ton CO<sub>2</sub>e/ha)
- CF = Assumed biomass carbon fraction (dry weight) is 47% (1 tonne of biomass = 0.47 tonne C) following the IPCC Guidelines 2006.
- K = Conversion of carbon stock into carbon dioxide equivalent (CO<sub>2</sub>e) with a factor of 3.67 (44/12) (Paciornik and Rypdal, 2006).

Calculation of GHG emissions due to land preparation also takes into account the absorption of emissions by oil palm plantations after a natural forest is converted. One hectare of oil palm plantations can absorb 40.33 tons C/ha (Borbon et.al 2020). So that net emissions can be calculated by the emissions lost due to forest clearing minus the absorption of oil palm plantations. The formula used is:

$$\sum \text{Emission}_{\text{net}} = \sum (\text{Emission}_{\text{land preparation}} - (KD \times C \times K))$$

Note:

- Emission<sub>net</sub> = Total net emissions (ton CO<sub>2</sub>e)
- Emission<sub>land preparation</sub> = The amount of emissions resulting from the clearing of natural forest (ton CO<sub>2</sub>e)
- KD = Area of land planted with oil palm after deforestation (ha)
- C = Assumed oil palm plantation carbon value of 40.33 tons C/ha (Borbon et.al 2020)
- K = Conversion of carbon stocks to carbon dioxide equivalent (CO<sub>2</sub>e) with a factor of 3.67 (44/12) (Paciornik dan Rypdal, 2006).

A review of scientific publications from a number of studies that produce emission factors from palm oil production activities in selected plantations and palm oil processing mills into CPO is presented in **Appendix Table 4**.

**Appendix Table 4**

*Publication on Greenhouse Gas Emissions in Palm Oil Plantations and Palm Oil Mills*

No	Forest Type	Palm oil plantation emission factors [ton CO <sub>2</sub> e/ha.year]	Palm oil mill emission factors [ton CO <sub>2</sub> e/ton CPO]
1	Dewi <i>et al.</i> , 2009 (estate)	23.67	-
2	Dewi <i>et al.</i> , 2009 (plasma)	16.27	-
3	Anonim. 2022	-	5.00
4	Manning <i>et al.</i> , 2019 (Sabaju field)	27.98	-
5	Manning <i>et al.</i> , 2019 (Sebungan field)	16.17	-
6	Seng and Tamahrajah. 2021	-	2.85
7	Hoseini and Wahid. 2013	-	1.10
8	Sabiham 2019 (Gapki.id)	22.5	-
9	Andarani <i>et al.</i> , 2017	-	2,057
10	Frazão <i>et al.</i> , 2020	-	0.79
<b>Average</b>		<b>21.3</b>	<b>2.4</b>

Based on the understanding that emissions arising from CPO producing activities can be divided into two (2) stages, namely emissions from oil palm cultivation and emissions from palm oil mills, a simple mathematical equation that can represent this statement is:

$$\sum Emission_{plantation} = \sum (TBS \times FE)$$

*Note:*

$\sum Emission_{plantation}$  = The amount of emissions palm oil plantation process (ton CO<sub>2</sub>e/year)

TBS = Total production of Fresh Fruit Bunches (FFB) (tons/year) (According to Segara *et al.* (2019), 1 hectare of oil palm plantations produces 10-18 tons of FFB/year. By taking the average value, 1 hectare of oil palm plantations can produce 14 tons of FFB/year)

FE = The emission factor for oil palm plantations is assumed to be 1.52 tons CO<sub>2</sub>e/ton FFB (Based on the emission factors in Appendix Table 4, the average emission for oil palm plantations is 21.3 tons CO<sub>2</sub>e/ha/year. By dividing the emission factors oil palm and FFB/ha productivity, the emission factor per 1 ton of FFB will be obtained, which is 1.52 ton CO<sub>2</sub>e/ton FFB)

$$\sum Emission_{mill} = \sum (CPO \times FE)$$

*Note:*

$\sum Emission_{mill}$  = Total emissions from the palm oil production process (tonnes CO<sub>2</sub>e/year)

CPO = Total CPO production (tons/year) (calculated with the assumption that the yield of FFB into palm oil is 24%)

EF (Papilo et al. 2017; Leela and Nur, 2019), palm oil mills operate 24 hours for 365 days in 1 year)  
= The palm oil mill emission factor is assumed to be 2.4 (ton CO<sub>2</sub>e/ton CPO)



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