Promotion of Least Cost Renewables in Indonesia (LCORE-Indo)

Final Report

Overview of Diesel Consumption for Captive Power in Indonesia

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List of Abbreviations

BPS	Central Statistics Agency
BOE	Barrel of Oil Equivalent
CO2e	Carbon Dioxide Equivalent
CPPs	Captive Power Plants
DGEEU	Directorate General of Electricity and Energy Utilization
FFB	Fresh Fruit Bunches
GDP	Gross Domestic Product
GDRP	Gross Domestic Regional Product
GHG	Greenhouse Gas
GOI	Government of Indonesia
HSD	High Speed Diesel Oil
IEA	International Energy Agency
ISIC	International Standard Industrial Classification
MBMS	Multi-Buyer Multi-Seller
MEMR	Ministry of Energy and Mineral Resources
NCV	Net Calorific Value
PLN	Indonesia's State-Owned Electricity Company
TWh	Terawatt Hours

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Chapter I

Introduction

1.1 Background

Indonesia's impressive economic performance over the past decade (2000 – 2010) which yielded an average real GDP growth at 5.2% has produced an expanding middle-class that has in turn stimulated a rapid surge in demand for electricity. This has not been matched by a similar increase in supply, and the state-utility PT. Perusahaan Listrik Negara (PLN) has been forced to implement frequent rolling blackouts in Java and Bali[1].

With the current electrification ratio stands at 71% in 2011 according to PLN, about one third of Indonesia's population still has no access to electricity which forces the Indonesian government to accelerate capacity expansion plans. The national electricity demand is expected to grow on average around 8.5% per year over the period from 2012 to 2021, indicating an electricity demand at around 358 TWh in 2019[2]. With no available electricity import possibilities, the domestic electricity generation in Indonesia must be increased to increase electrification ratio and meet growing demand.

As shown in Figure 1 below, Indonesia's generation run at full capacity[3] to cover demand, leaving a limited buffer to cover for demand hikes. Peak-demand therefore forces PLN to implement rolling blackouts in critical areas to avoid the risk of a full blackout of the entire system.

Figure 1: Shares of Total Installed on-grid Generation Capacity by Source in 2010

	Installed capacity		Production		Capacity factor
	GW	*Share*	*TWh*	*Share*	%
Coal	11.6	40%	75.6	44.9%	74%
Oil	8.4	29%	43.6	25.9%	59%
Gas	6.1	21%	40.4	24.0%	76%
Hydro	2.3	8%	8.8	5.2%	35%
Geothermal	0.6	2%			
Total	29	100%	168.4	100%	66%

Source: Indonesia Infrastructure Report 2010

[1] *The Archipelago Economy: Unleasing Indonesia's Potential*, McKinsey Global Institute, September 2012

[2] *Rencana Usaha Penyediaan Tenaga Listrik (RUPTL) 2012 - 2021*, PLN, 2012

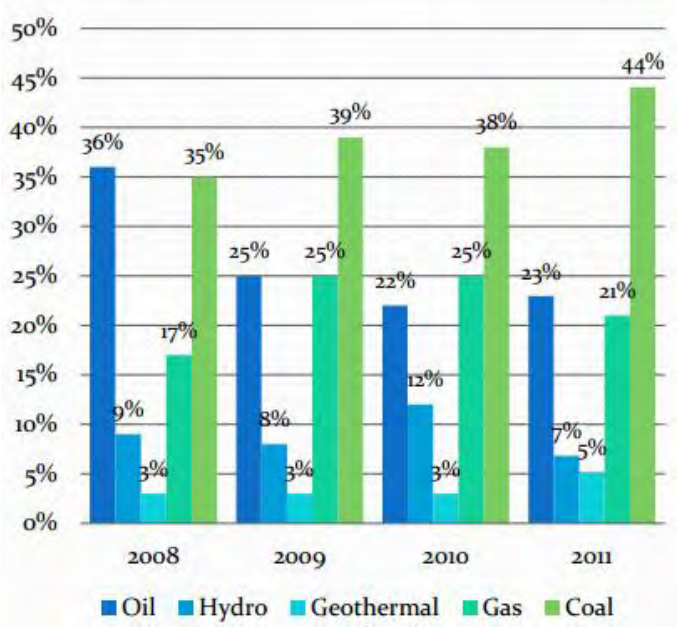
[3] *Capacity factor* is a measure of how often an electric generator runs for a specific period of time. It compares how much electricity a generator actually produces with the maximum it could produce at continuous full power operation during the same period.

The uncertainty associated with blackouts and the high costs of disrupted supply for the industrial sector in Indonesia are the primary reasons driving industry towards investing in captive generation facilities. Some of process industries like chemical, aluminum, cement etc. the need for uninterrupted quality power is a necessity rather than a requirement.

According to PLN Electricity Statistics 2012, the industrial sector is the second largest electricity buyer in Indonesia[4]. However according to the Ministry of Energy and Mineral Resources (MEMR) data, they are the largest energy consumer in Indonesia where it accounts for 43% of the total final energy consumption in 2011 or 316 million barrel of oil equivalent (BOE) [5]. This discrepancy indicates the widespread use of captive power generation in the industrial sector to make up PLN's inability to supply electricity.

The Government of Indonesia (GOI) has a target to reduce oil fuel consumption by replacing it with other form of energy (diversification) and improving efficiency (conservation) of energy utilization from upstream and downstream. Through Presidential Regulation 05/2006, GOI aims to reduce oil use by 20% and increase renewable energy utilization from the present 17% to 25% by 2025 while achieving its target of greenhouse gas (GHG) emissions reduction of 26% by 2020.

Figure 2: Energy Consumption Mix in Industry Sector by Sources



Source: MEMR, 2012

[4] See Appendix I for share of electricity sales by sector
[5] Commercial (tradable) energy which exclude biomass, see Appendix II for share of final energy consumption by sector (MEMR, 2012)

Figure 2 illustrates the energy consumption mix in the industrial sector. Though coal fuel consumption share is growing as indicated in the figure, the share of oil fuel in the energy mix is decreasing over the years which indicates a certain degree of success of the GOI's energy diversification[6] program.

1.2 Objective

The main objectives of the report are to:

a. Provide an overview of diesel consumption for captive power in Indonesia, particularly in the industrial sector; and
b. Identify specific industrial sectors and regions of potential replacement with renewable energy sources such as biomass, photovoltaic, or others.

1.3 Methodologies

Data used in this report is taken from online publications on the Indonesian energy and electricity market as well as online publications by relevant Indonesian government bodies, particularly the MEMR and PLN. In some cases, data is calculated from obtained PLN statistics.

The potential replacement of diesel fuel in the industrial sector is calculated from Central Body of Statistics (BPS) data. Diesel fuel consumption in the manufacturing industry is calculated from the BPS Industrial Survey, i.e. Annual Large and Medium Scale Industry Survey, 2006 – 2010; and diesel fuel consumption in the mining industry is calculated from the BPS Mining Survey. The two are separated because the mining sector produces raw materials only whereas the industrial sector takes raw material and process it into intermediate or final product.

The available data from the Mining Survey is only available as aggregated data on diesel consumption for electricity generation at the national level and is categorized into oil and gas and non oil and gas. Unlike the BPS Industrial Survey, the Mining Survey does not include data by province.

The BPS Manufacturing Industry Survey uses the International Standard Industrial Classification (ISIC) to classify the different industrial activities. ISIC numbers consist of 5 digits:

[6] Diversification according to GOI definition is a switch to any form of energy away from oil fuel

- First and second digit indicates division
- Third digit indicates group
- Fourth and fifth digit indicates class

The 2006 – 2009 survey uses the old 2005 ISIC and the 2010 survey uses the new 2009 ISIC. The old ISIC and the new ISIC have different codes and classifications. The old 2005 ISIC has 363 types of industry with 5 digits code from 15111 to 37200. The new 2009 ISIC has 365 types of industry with 5 digits code from 10110 to 33152. In this report, 3 digits ISIC is used for general discussion[7] and 5 digits is used to look into more details into specific industry such as crumb rubber or plywood industry.

[7] See Appendix III and IV for 3 digit industrial classification as listed in the 2005 ISIC and 2009 ISIC

Chapter II

Captive Power and Its Potential Replacement

Captive power is electricity generated independently by parties other than the electricity company for their own business, such as: industries, commercial building, offices, hospital, school, etc. There are some reasons to use captive power, such as: to secure electricity supply, to save electricity cost (using coal captive power), or it is the only available choice for electricity generation.

Captive power can be categorized into main power and reserve power. Captive power as main power is mostly used in areas with electricity shortage or no electricity service. It can also be used in areas with sufficient electricity supply in order to cover peak loads or to save electricity cost. Captive power as reserve power is a backup power that is used when there is electricity supply disruption from the grid.

2.1 Captive Power in Indonesia

Indonesia has substantial supply of captive power. Unfortunately, a consistent set of reliable data and information regarding the capacity of the captive power plants (CPPs) and their utilization do not exit, partly because more than 60% of the plants are small and scattered around the country in about 10,000 companies[8].

The Indonesian power system consists of eight domestic interconnected grids and 600 isolated grids, which are all operated by PLN as illustrated in Figure 3. The integrated grids includes Java-Bali-Madura or JAMALI and Sumatra grids. The Java-Bali system is the main high-voltage transmission grid and is used to serve the relatively high density of electricity demand in the two islands. It is however characterized by high transmission losses and electricity theft. In 2008, the technical transmission losses were close to 11%, a consequence of the five year-long period lacking necessary investments and maintenance[9]. Outside Java-Bali islands, the conditions are entirely different with scattered electricity demand that are mostly supplied by isolated system.

The above differing conditions produce different reasons to use captive power. In Java-Bali islands, captive power is used as reserve power in case the electricity supply from PLN is interrupted or to save the production costs for some large industries. Outside Java-Bali islands, captive power is mostly used as main power in the absence of

[8] *Indonesia – Averting an Infrastructure Crisis: A Framework for Policy and Action*. World Bank, June 2004
[9] *The Indonesian Electricity System – A Brief Overview*. Differ Group, February 2012

electricity supply from PLN or to make up for PLN's lack of electricity generating capacity. It can be said that, outside Java-Bali islands, PLN's capacity is to mainly serve the household sector whereas the industrial sector, especially large industries, rely on captive power to meet their energy needs.

Figure 3: Indonesia Electricity Infrastructure

Source: MEMR 2012

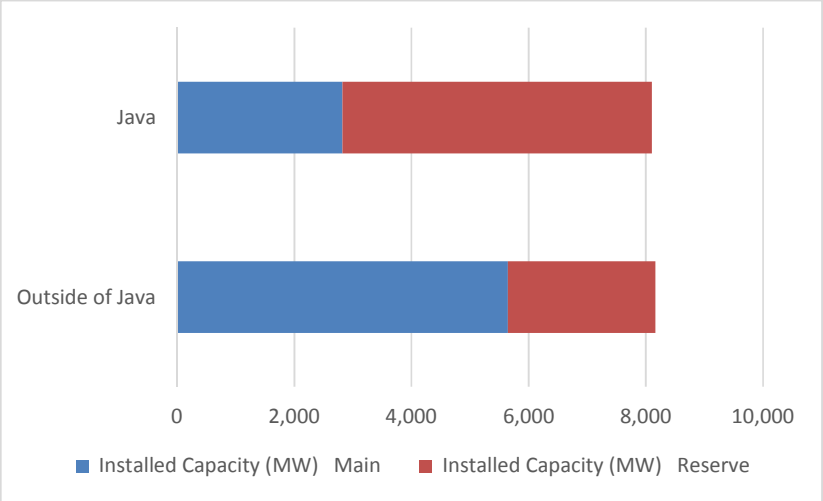
In light of the prevailing situation, CPPs are expected to play an important role in the future of electricity sector in Indonesia. Besides being used to meet industrial power needs and electrify geographical areas with no electricity grid, a World Bank report argues that a realistic future scenario will almost certainly present a restructured power sector, with open access to new entrants as well as regulations for wheeling charges to sell to a third party, and to trade electricity in a multi-buyer, multi-seller (MBMS) market. All these factor will give new momentum to the CPPs, which can then act as catalysts—opening the sector to more competition and accelerating the development of the MBMS market.

2.2 Installed Capacity

According to PLN data, the total installed capacity of captive power belonging to the private sector in Indonesia is 16.76 GW, where about half of it is in Java and the rest is outside Java[10]. In Java, a third of the total captive power capacity is used as main power whereas the figure increased to two thirds for outside Java as shown in Figure 4.

[10] See Appendix V for detailed breakdowns of installed captive power capacity by province

Figure 4: Installed Captive Power Capacity



Source: PLN Statistics 2009

As explained previously, the high proportion of CPPs outside Java reflects, to some extent, the less developed nature of PLN's systems in the other islands. The high proportion of reserve plants in Java reflects a greater degree of commercial and industrial development requiring a higher level of security of power supply.

With Indonesia's power generating capacity stands at 32.9 GW in 2012 according to PLN, the installed captive power capacity therefore accounts for more than 40% of total national power generating capacity and it simply reflects the prevailing poorly structured and insufficient electricity supply industry.

Steam and diesel power plants are the most common ones used to generate captive power in Indonesia. Steam power plant is selected by big industries due to cheap generating cost[11]. On the other hand, diesel power plant is selected due to its rapid customization to suit specific energy demand.

2.2 Diesel Captive Power in Indonesia

A huge proportion of the captive power capacity in Indonesia is comprised of diesel power generation systems. A 1998 study commissioned by the World Bank[12] which is the most comprehensive study ever undertaken on the Indonesian captive power

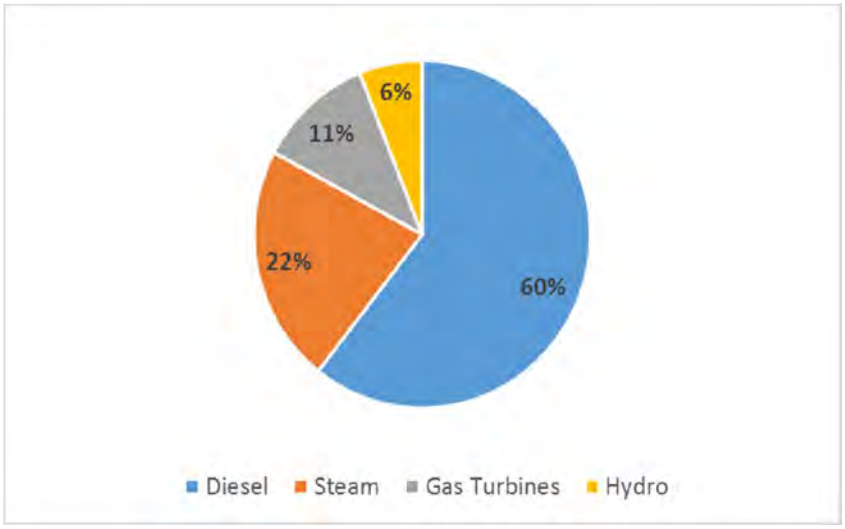
[11] In Indonesia, most steam power plants are coal-fired

[12] *"Captive Power Supply in Indonesia: Historical Development, Present Status and Future Role"* conducted by Heinz Pape in 1998

market to date, shows that HSD (High Speed Diesel Oil)-driven CPPs represent about 60% of installed capacity. Steam plants represent 25% followed by gas turbines at 11% and hydro plants at 6% as illustrated in Figure 5.

Another set of statistics published by the Directorate General of Electricity and Energy Utilization (DGEEU) in 2000 has only slightly different figures. The statistics indicate that the installed captive power capacity fueled by HSD amounted to 8,507 MW or 55.9% of total captive power capacity.

Figure 5: % Share of Captive Power Installed Capacity by Power Plant Type



Source: World Bank

The World Bank study also stated that co-generation plants represented about 25% of the CP installed capacity and about 35% of CPPs are connected to the PLN grid and 65% are not.

Since recent publications still refer to the 1998 World Bank study on captive power as a benchmark, this report assumes (for a baseline scenario) that 60% of captive power generation is fueled by HSD, the rest by natural gas, coal, fuel oil and hydro.

Using this estimate, this means that presently the diesel captive power generation in Indonesia have an installed capacity of approximately 10 GW (out of 16.76 GW installed captive power capacity). PLN itself according to their 2012 statistics has about 2.6 GW of installed capacity that is powered with diesel plants. Figure 6 illustrates the level of installed diesel captive and PLN power in relation to the overall installed capacity.

Figure 6: Installed (Diesel) Captive Power vs PLN (Diesel) Power

Source: PLN Statistics 2009 & 2012

The installed diesel power capacity of 2.6 GW above includes generators that are owned by PLN and those that are rented from the private sector[13]. The comparison in generating cost of the different power plants operated by PLN in Indonesia can be seen in Figure 7.

Figure 7: PLN Generating Cost in 2012

Source: PLN Statistics 2012

As illustrated in the figure above, diesel power plants have the highest generating cost per kWh compare to other type of power plants. Assuming that similar generating costs are borne by captive power users in the private sector, replacing diesel fuel with renewable sources therefore make a viable business case for both PLN and the private sector.

[13] See Appendix VI for installed capacity of diesel power plant by province in 2012

Chapter III

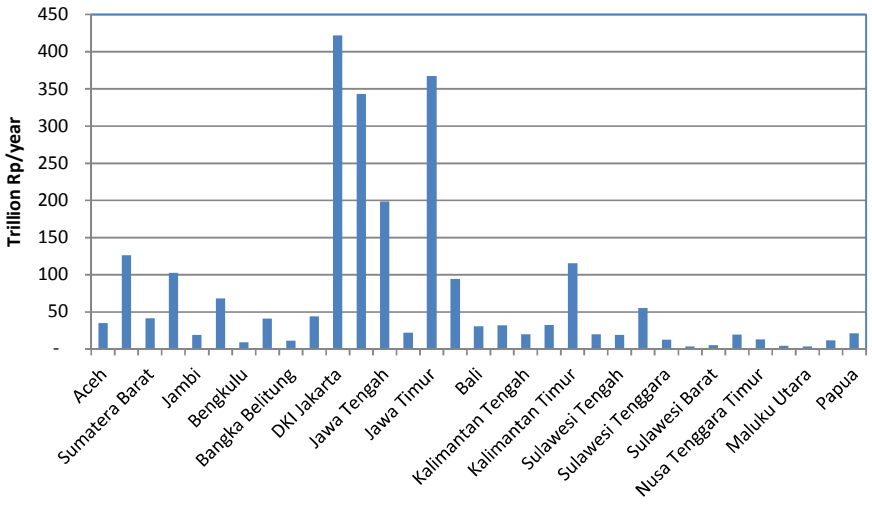
Diesel Fuel Substitution Potential

3.1 Industrial Activities in Indonesia

Indonesia is an archipelago country with 17,504 islands, of which Sumatra, Java, Kalimantan, Sulawesi and Papua are considered among the biggest ones. Although there are many islands, population and economic activities are not evenly distributed in each region. Java which only has about 7% of Indonesia's land area, is inhabited by 58% of the country's total population which makes it the most populous island in the world[14].

According to data from BPS, economic activities in Java accounts for about 61% of total economic activities of Indonesia. The top three provinces in Indonesia with the highest economic activities are located in the province of DKI Jakarta, East Java, and West Java provinces; all of them are in Java island. Outside Java, large economic activities can be found in North Sumatra, East Kalimantan, Riau, South Sumatra, and South Sulawesi province. The size of economic activity in a region or a province is represented by its Gross Domestic Regional Product (GDRP) which for Indonesia in the year 2011 is shown in Figure 8 below.

Figure 8: Gross Domestic Regional Product by Province 2011

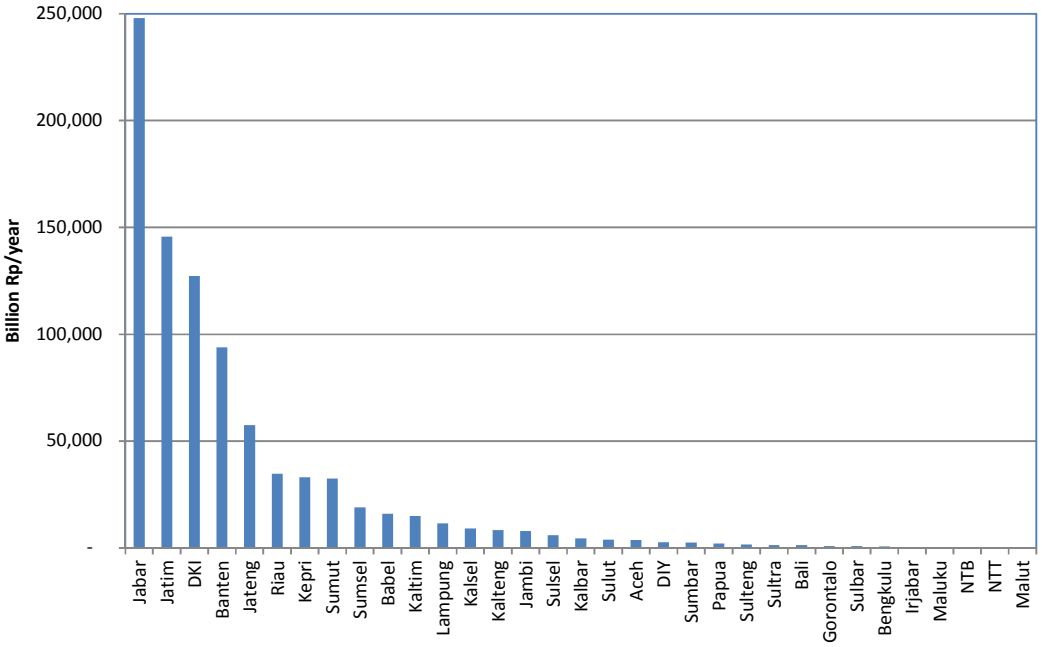


Source: Central Body of Statistics, 2012

[14] *Demographics of Indonesia* - www.wikipedia.org

Industry is one of the most important economic activities. The more developed a region the larger their industrial activities. The top five provinces that have the largest industrial contribution to the country's overall GDP (the so called value added of an industry) are in West Java, East Java, Jakarta, Banten, and Central Java provinces; all of them are in Java island. Outside Java island, provinces with the largest industry value added are Riau, Riau Island, North Sumatra, South Sumatra, Bangka Belitung, and East Kalimantan provinces as can be shown in Figure 9 below.

Figure 9: Value Added of Industry by Province in 2010



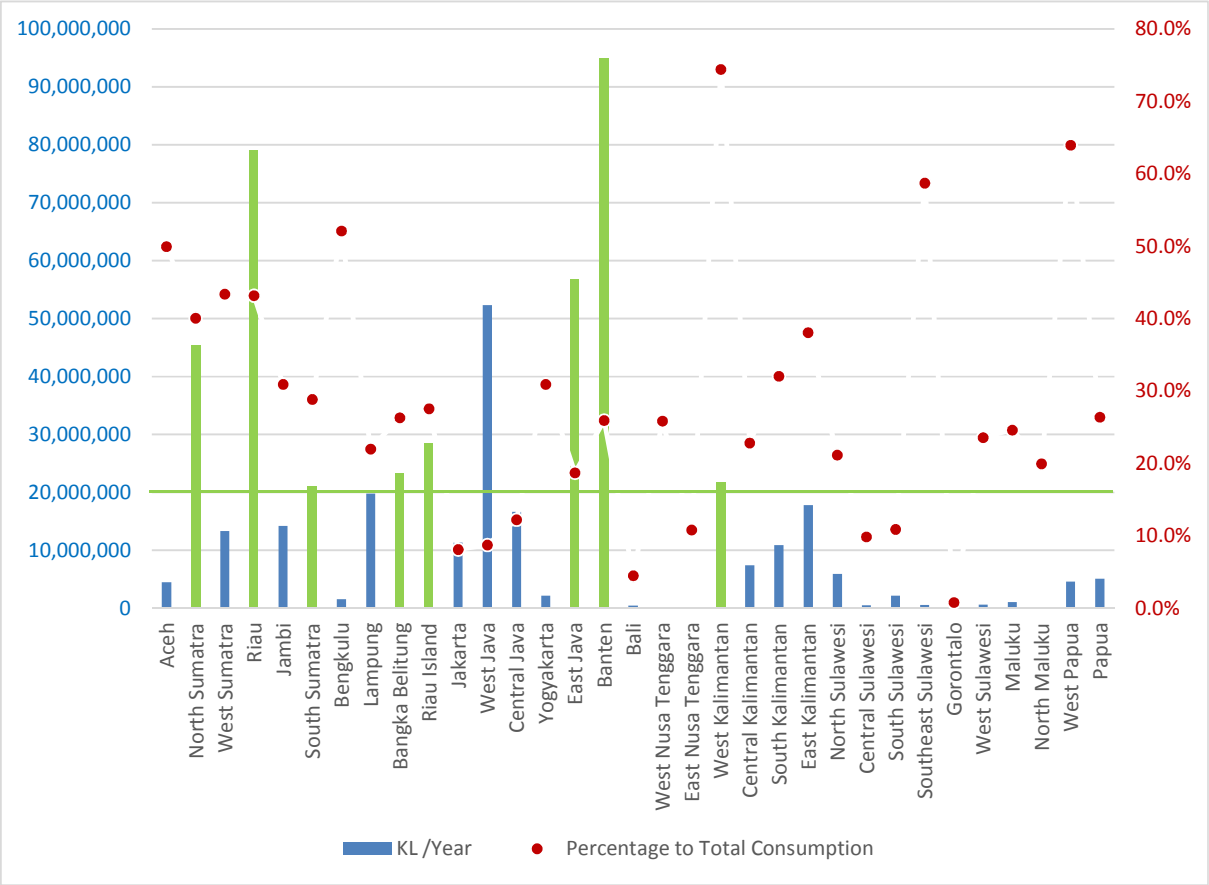
Source: Central Body of Statistics, 2012

3.2. Region and Industrial Sector for Potential Replacement

In the BPS Manufacturing Industry Survey, diesel fuel consumption is divided into two types of use, i.e. for process and for electricity generation[15]. The scope of this study only looks at diesel fuel used for electricity generation and does not consider diesel fuel used for process to be replaceable with renewable sources. Figure 10 shows the level of diesel fuel consumption for electricity generation in the manufacturing industry by province in 2010 (represented in blue bars). Included in the same graph are the red dots which indicate the percentage of diesel fuel consumption for electricity generation to the total diesel fuel consumption (includes diesel fuel used for process) in the province.

[15] See Appendix VII for Table on Diesel Fuel Consumption for Electricity Generation in Manufacturing Industry by Province in 2010

Figure 10: Diesel Fuel Consumption for Electricity Generation in Manufacturing Industry by Province in 2010



Source: Central Body of Statistics, 2012

From the above figure, it can be seen that there are big variations among the provinces. Some provinces have very high percentage of diesel fuel used for electricity generation but the actual level of diesel consumption is very low which make them unattractive for intervention as they indicate little industrial activities related to diesel fuel saving potential.

A balance of the two indicators therefore needs to be considered in order to identify provinces with sizeable potential for diesel fuel replacement. The following filter therefore is applied onto the graph as the minimum acceptable value of the two indicators:

1. 20,000 Kilo liter / year is set as the minimum level of diesel consumption in the province
2. 15% percentage is set for the minimum level of diesel fuel consumption for electricity generation to the total diesel fuel consumption in the industry by province

With the filter applied, the top provinces with the most potential for diesel fuel replacement (high use of diesel fuel consumption for electricity generation which accounts for a sizeable percentage of total diesel fuel consumption) are the following:

Figure 11: Provinces with High Potential for Diesel Fuel Replacement

No	Province	Diesel Fuel for Electricity Generation (KL/year)	Percentage to Total Consumption	Outisde Java - Bali Grid
1	Banten	94,976	26%	No
2	Riau	79,051	43%	Yes
3	East Java	56,773	19%	No
4	North Sumatra	45,368	40%	Yes
5	Riau Island	28,443	28%	Yes
6	Bangka Belitung	23,204	26%	Yes
7	West Kalimantan	21,646	74%	Yes
8	South Sumatra	21,062	29%	Yes

Source: Central Body of Statistics, 2012

As expected, the shortlisted provinces (represented in green bars in Figure 10) are dominated by those outside Java island where electricity infrastructure is poor. However some provinces identified (Banten and East Java) are located in Java island which is served by the JAMALI grid. While those industries have option to use electricity from PLN, the prevalence use of captive power by the sector indicates that their electricity supply must be met with captive power due to reasons stated previously.

Industries which generate its own electricity and produce excess power can however sell it to PLN without price negotiation and MEMR approval in order to strengthen the local electricity system. The mechanism is laid out in the Ministry of Energy and Mineral Resources (MEMR) Regulation 04/2012 which also set the excess power purchase tariff at Rp. 656/kWh x F[16].

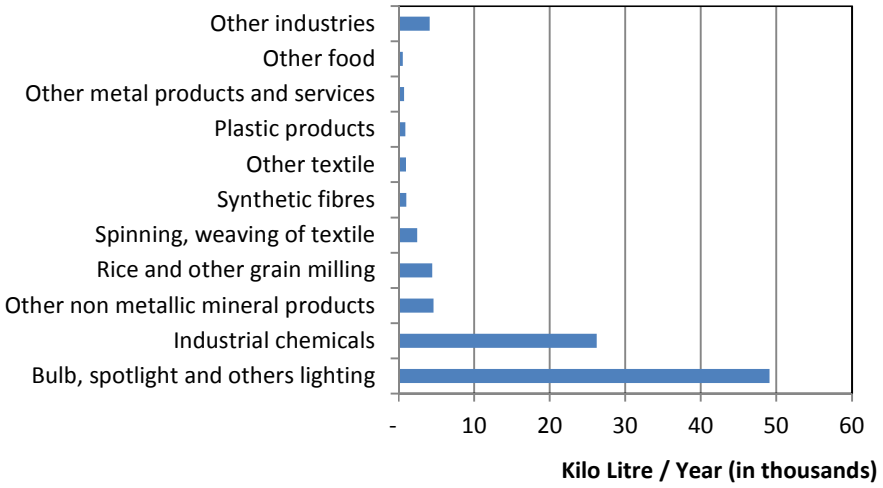
Now that the potential regions are identified, the report aims to identify potential industries in each respective province suitable for intervention. The following sub section gives an overview of diesel fuel consumption for electricity generation by industry type in the eight provinces identified for the year 2010.

[16] F is the incentive factor according to the location of the electricity purchase by PLN

3.2.1 Banten

The lighting and chemical industry account for almost 80% of the total diesel fuel consumption for electricity generation in Banten in 2010 as can be seen in Figure 12 (see Appendix VIII for detailed breakdowns by industry). Germany's OSRAM runs the largest lighting factory in the province although it is closing its plant in end of 2013[17]. Indonesia's biggest integrated petrochemical company PT. Chandra Asri Petrochemicals is also based in Banten.

Figure 12: Diesel Fuel Consumption for Electricity Generation in Banten Manufacturing Industry 2010



Source: Central Body of Statistics, 2012

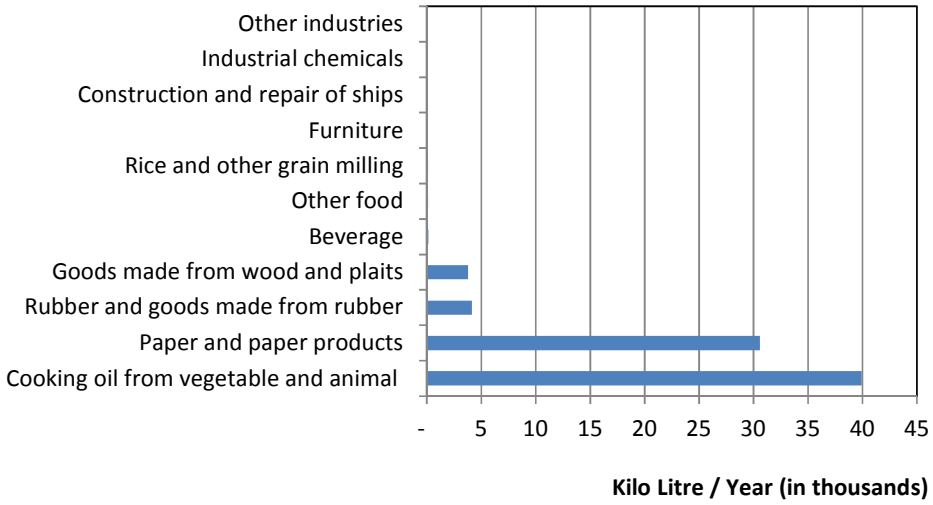
[17] http://www.euroinvestor.com/news/2013/05/08/osram-to-close-light-bulb-factory-in-indonesia/12326637

3.2.2 Riau

The largest diesel fuel substitution potential industries in Riau are the cooking oil industry (crude palm oil industry, cooking oil made from palm oil industry, vegetable and animal oil industry, and coconut oil industry) and the pulp industry in which the two industries account for close to 90% of diesel fuel consumption for electricity generation in Riau province in 2010. Riau is the biggest palm oil producer and plantation province and is also the site for the largest pulp industry in Indonesia.

Diesel fuel consumption for electricity in industry in Riau is shown in Figure 13 (see Appendix IX for detailed breakdowns by industry).

Figure 13: Diesel Fuel Consumption for Electricity Generation in Riau Manufacturing Industry 2010



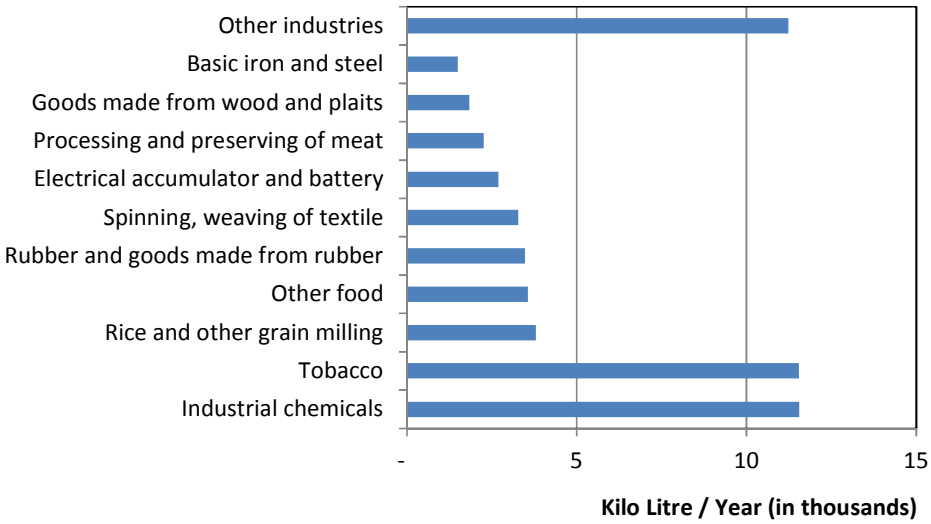
Source: Central Body of Statistics, 2012

3.2.3 East Java

There are two large industries in East Java, ie. chemical industry and tobacco industry, which account for 40% of diesel fuel consumption for electricity generation in the province at similar consumption level per. East Java is home to Kediri-based PT. Gudang Garam which is the largest cigarette manufacturer in Indonesia. By way of illustration, paint producers throughout Indonesia use intermediate materials manufactured at the Gresik plant of East Java chemical company, PT. Petro Widada.

Diesel fuel consumption for electricity in industry in East Java is shown in Figure 14 (see Appendix X for detailed breakdowns by industry).

Figure 14: Diesel Fuel Consumption for Electricity Generation in East Java Manufacturing Industry 2010



Source: Central Body of Statistics, 2012

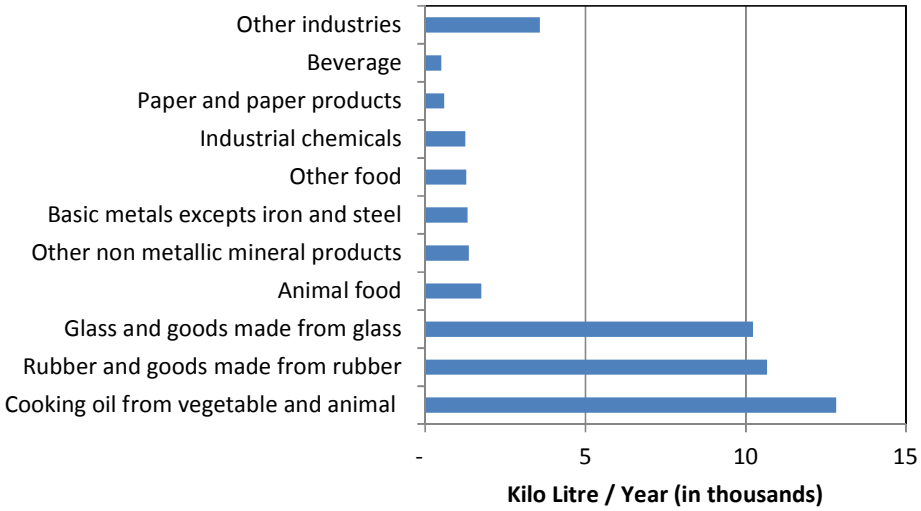
3.2.4 North Sumatra

There are three major industries in North Sumatra that consume large diesel fuel for electricity generation, the largest being the cooking oil from vegetable and animal industry (palm oil industry) followed closely by the rubber and glass industry. These three industries account for almost 75% of total diesel fuel consumption for electricity generation in North Sumatra 2010.

In recent years, the oil palm plantation and palm oil processing sectors have become a key part of Indonesia's economy. As of 2009, Indonesia was the largest producer of palm oil, surpassing Malaysia in 2006, producing more than 20.9 million tonnes[18]. About 75% of plantation estates and CPO production are located in Sumatra and Kalimantan, areas in Indonesia with a long history of oil palm cultivation, both in the form of large-scale estates as well as smallholder operations[19].

Diesel fuel consumption for electricity in industry in North Sumatra is shown in Figure 15 (see Appendix XI for detailed breakdowns by industry).

Figure 15: Diesel Fuel Consumption for Electricity Generation in North Sumatra Manufacturing Industry 2010



Source: Central Body of Statistics, 2012

[18] http://en.wikipedia.org/wiki/Palm_oil
[19] http://blog.cifor.org/17798/fact-file-indonesia-world-leader-in-palm-oil-production#.UldpI1BBNpk

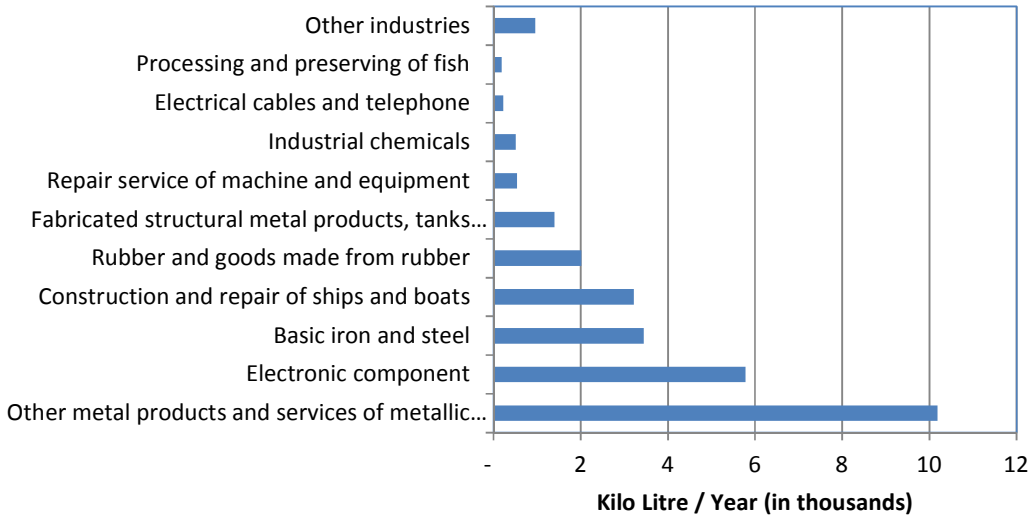
3.2.5 Riau Islands

The biggest diesel captive power user in Riau islands is the metallic products processing industry which includes machinery, metal coating, and metal products manufacturing. Other industries with sizable use of diesel fuel are the electronic components, iron and steel and the shipbuilding industry. Many of these industries are located in Batam, Bintan and Karimun which Under a framework signed in June 2006, the islands are a part of a Special Economic Zone with Singapore which eliminates tariffs and value-added taxes for goods shipped between these islands and Singapore.

The province's most developed island, Batam possesses numerous industrial parks dealing with electronics, biotech, semiconductors and other technology applications, oil services, shipbuilding and a wide range of other industrial and consumer products. It is home to prominent names such as McDermott, AT&T, PerkinElmer, Bechtel, Seagate Technology, Babcock & Wilcox, Honeywell, Matsushita, Kyocera, Hitachi, Sanyo, Nippon Steel, Hyundai, Sony and Philip.

Diesel fuel consumption for electricity in industry in Riau Islands is shown in Figure 16 (see Appendix XII for detailed breakdowns by industry).

Figure 16: Diesel Fuel Consumption for Electricity Generation in Riau Islands Manufacturing Industry 2010



Source: Central Body of Statistics, 2012

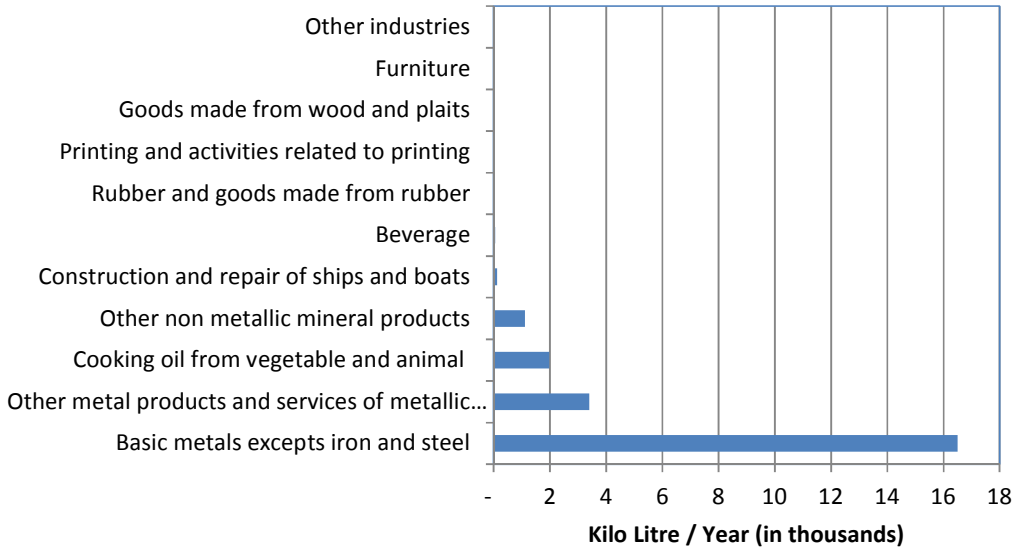
3.2.6 Bangka & Belitung

The basic metals industry (excepts iron and steel) is the biggest diesel fuel user in Bangka and Belitung and accounts for more than 70% of the total diesel fuel consumption in the islands. Specifically this industry is the tin mineral processing industry which processes tin ores into tin ingots which is then used to make solder and piping. Tin is an essential component in nearly all electronics and with the number of mobile devices in the world currently outnumbering people.

Bangka and Belitung is Indonesia's biggest supplier of tin. Bangka provides 90% of the nation's output and as such, is one of the world's principal tin-producing centers. It is home to the state-owned PT. Timah which is the world's second biggest tin miner.

Diesel fuel consumption for electricity in industry in Bangka & Belitung is shown in Figure 17 (see Appendix XIII for detailed breakdowns by industry).

Figure 17: Diesel Fuel Consumption for Electricity Generation in Bangka Belitung Manufacturing Industry 2010



Source: Central Body of Statistics, 2012

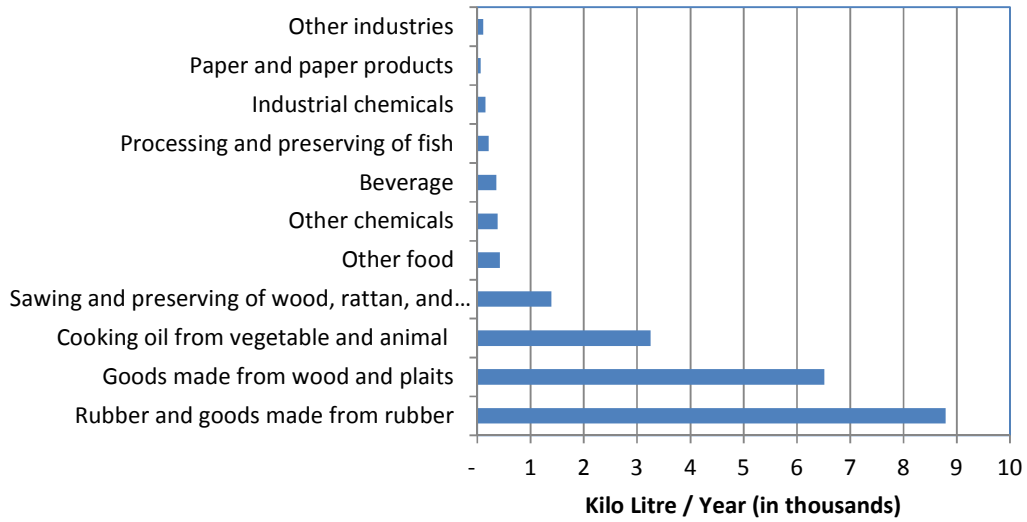
3.2.7 West Kalimantan

Rubber industry is the biggest diesel captive power user in West Kalimantan. According to data from the Food and Agriculture Organization (FAO) of the United Nations, Indonesia is the second-largest rubber producer after Thailand in 2011, and most of the country's rubber production - around 80 percent - is accounted for by smallholder farmers as in the case in West Kalimantan. Although the rubber industry consumes the most diesel fuel in the province, most rubber production stems from the provinces of Sumatra which is home to the largest rubber plantation companies in Indonesia.

The second biggest diesel fuel consumer is the plywood industry which draws all its raw material from natural forests, of which Kalimantan is famous for. According to data from APKINDO (Indonesian Wood Panel Producers Association), West Kalimantan has the second largest factories for plywood manufacturing in the country. Although Indonesia is one of the world's major supplier of plywood, the country's production of plywood has been on the decline in the past several years because of the scarcity of basic material supply.

Diesel fuel consumption for electricity in industry in West Kalimantan is shown in Figure 18 (see Appendix XIV for detailed breakdowns by industry).

Figure 18: Diesel Fuel Consumption for Electricity Generation in West Kalimantan Manufacturing Industry 2010



Source: Central Body of Statistics, 2012

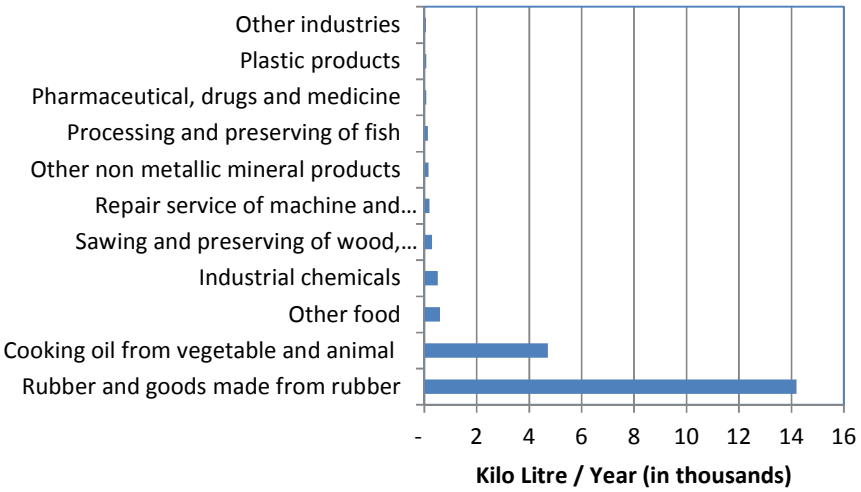
3.2.8 South Sumatra

The rubber industry in South Sumatra consumes the most diesel fuel by a wide margin compare to other industries in the island. As explained previously, Sumatra has the largest rubber plantations in Indonesia with 2.4 million hectares or 70% of the total area of rubber plantations in Indonesia. The province with the largest rubber plantation is South Sumatra which has 672,000 hectares in 2009[20] for production.

Apart from many small shareholder plantations, there are several large state-owned and private rubber plantation companies in the province. The state-owned PT. PTPN III owns the largest rubber plantation with 45,327 hectares in cultivation. Meanwhile, PT. Perusahaan Perkebunan London Sumatra Indonesia is the largest private rubber plantation company with 17,394 hectares in cultivation.

Diesel fuel consumption for electricity in industry in South Sumatra is shown in Figure 19 (see Appendix XV for detailed breakdowns by industry).

Figure 19: Diesel Fuel Consumption for Electricity Generation in South Sumatra Manufacturing Industry 2010



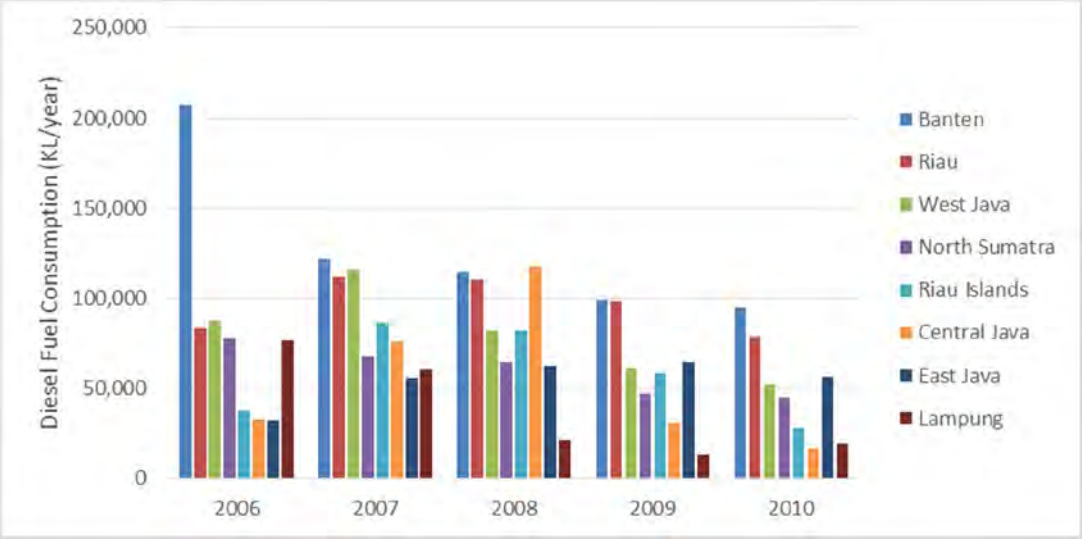
Source: Central Body of Statistics, 2012

[20] http://www.thefreelibrary.com/Profile+of+rubber+plantations+in+Indonesia.-a0234569991

3.3 Diesel Fuel Consumption in Manufacturing Industry 2006 – 2010

This section looks at time series data over five year period (2006-2010) to see whether a particular region occupy the same rank every year in terms of diesel fuel consumption in their manufacturing industry. The data is presented in Figure 20 below:

Figure 20: Top 5 Provinces with the Most Diesel Fuel Consumption in Manufacturing Industry 2006 - 2010



Source: Central Body of Statistics, 2006 - 2010

As shown in Figure 20, the same province has varying level of diesel fuel consumption by its manufacturing industry over the 5-year period[21]. One province might have the highest level of consumption in one year but may not be the case in the year after. As a result of this variation in consumption level, some provinces which appear in the Top 5 ranking of diesel fuel consumption during 2006 – 2010 period were not shortlisted in this report based on 2012 data (section 3.2) for provinces with the potential for diesel fuel replacement.

Establishing the mode[22] of the 5-year data, we get the Figure 21 which ranked provinces according to how often they appear in the Top 5 diesel fuel consumption during the 2006 - 2010 period.

[21] See Appendix XVI for detailed breakdown by province
[22] The value that appears most often in a set of data

Figure 21: Provinces with the Most Diesel Fuel Consumption in Manufacturing Industry 2006 - 2010[23]

Province	Mode Score 2006 - 2010
Banten	48
Riau	34
West Java	26
Central Java	14
East Java	12
Riau Island	10
North Sumatra	6

Rank	Score
1	10
2	8
3	6
4	4
5	2

As can be seen in Figure 21 above, five of the provinces ranked are included in the provinces selected in section 3.2 but that two others are not (e.g West Java and Central Java). Regardless of this historical trend, this report refers to the updated 2012 data on diesel fuel consumption and included provinces in its selection process, some whose manufacturing industry have been consistently ranked as the biggest diesel fuel consumer during the 2006 - 2010 period.

3.4 Diesel Fuel Substitution Potential in Mining Industry 2006 - 2010

According to data from BPS as illustrated in Figure 22, diesel fuel consumption for electricity generation in the mining industry has seen an increase during 2006 – 2009 in line with the world economic growth and mining production in Indonesia.

Figure 22: Diesel Fuel Consumption for Electricity Generation in Mining Industry 2006 - 2010

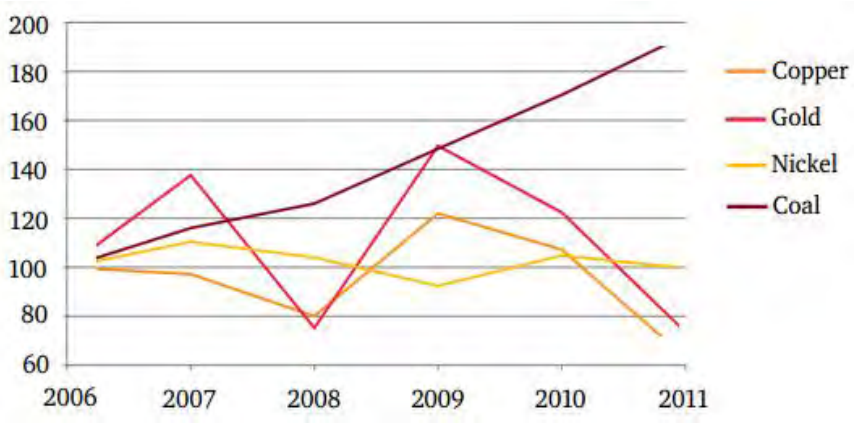
Mining Sector	Diesel Fuel Consumption (KL/year)				
	2006	2007	2008	2009	2010
Oil and Gas	134,783	130,136	120,578	162,787	131,352
Other Mining	332,589	355,711	575,550	810,195	451,997
Total	467,372	485,847	696,128	972,982	583,349

Source: Central Body of Statistics, 2008 - 2011

The continued growth in both mining production and diesel fuel consumption experienced a turnaround in 2009. All key minerals production output declined except coal which has seen ever increasing demand from China and India as illustrated in Figure 23.

[23] For the mode analysis, a province is assigned a score according to their diesel fuel consumption ranking in each respective year (right table). The score is then accumulated and the provinces are then ranked accordingly (left table).

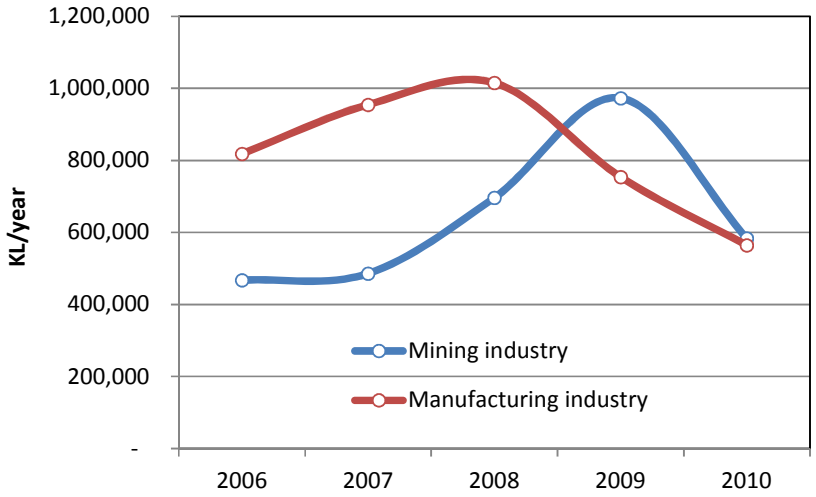
Figure 23: Indonesian Mining Output - % Change since 2006



Source: Mining in Indonesia: Investment and Taxation Guide 2012, PwC

The decline in diesel fuel consumption by the mining industry from the year 2009 brought it to a level similar to diesel fuel consumption for electricity generation by the manufacturing industry in 2010. This condition is illustrated in Figure 24 below.

Figure 24: Diesel Fuel for Electricity Generation in Mining Industry and Manufacturing Industry



Source: Central Body of Statistics, 2008 - 2011

Chapter IV

Case Study: Diesel Fuel Consumption in Palm Oil, Crumb Rubber, and Plywood Industry

The top 10 manufacturing industries in Indonesia with the highest diesel fuel consumption for electricity is shown in Figure 25 below. All these industries in the ranking can be found in the eight provinces which have been identified to have the highest potential for diesel fuel replacement (Chapter III).

This chapter takes a closer look at the diesel fuel consumption of three industries in the table ranking namely the palm oil (1st), rubber (2nd) and the plywood (6th) industry.

Figure 25: Top Ten of Diesel Fuel Consumption for Electricity In Manufacturing Industry 2010

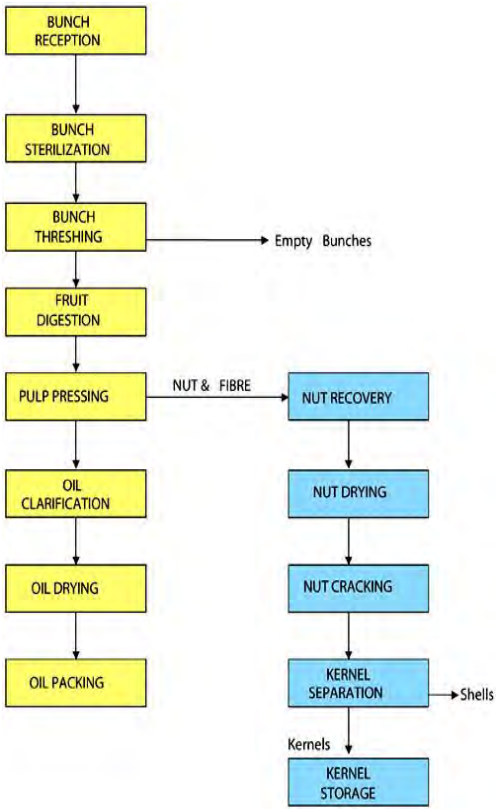
No	ISIC	Industry Type	Diesel Consumption (KL)
1	104	Cooking oil from vegetable and animal	96,086.8
2	221	Rubber and goods made from rubber	53,316.6
3	201	Industrial chemicals	52,679.5
4	274	Bulb, spotlight and others lighting	49,271.9
5	170	Paper and paper products	36,119.0
6	162	Goods made from wood and plaits	33,206.2
7	107	Other food	26,740.8
8	239	Other non metallic mineral products	23,957.2
9	242	Basic metals excepts iron and steel	22,154.1
10	259	Other metal products and services of metallic products	16,846.7
-	-	Other industries	153,912.0
Total			564,290.9

Source: Central Body of Statistics, 2012

4.1 Palm Oil Industry in Riau

4.1.1 Manufacturing Process

Figure 26: Palm Oil Manufacturing Process



The manufacturing process for producing palm oil consists normally of four stages: Sterilisation, stripping, digestion / pressing and oil extraction with clarification and purification. The Fresh Fruit Bunches (FFB) from the field are sterilised with steam in a steriliser to loosen the fruits from fruit bunches and also to dehydrate the FFB by about 10 %. In the stripping section, fruits and the palm leaves are separated from the bunch stalk by means of a mechanical bunch stripper. The fruits are then transferred to the digestion section where the oleosome membranes and cell walls are disrupted by the combined action of mechanical and thermal energy, thereby releasing the oil. A semi-solid mash constituting free oil, water, fibre, mucilage and the seeds embedded in it, enters the next step. The hot digested mash is subjected to pressure by a hydraulic press to expel the oil water mixture. The oil water stream from the press is clarified by decantation followed by purification in a high speed centrifuge.

This oil-water mixture then undergoes a separation process before the oil is purified and dried prior to storage. The water phase forms the bulk of the raw palm oil mill effluent, which is treated in the effluent treatment plant. Dry fibre and nuts after the press are separated in a winnowing system. The nuts are cracked to obtain the palm kernels while the fibre is used as fuel for the boiler. Two kinds of oil are obtained from the fruits, Crude Palm Oil (CPO) and Crude Palm Kernel Oil (CPKO).

4.1.2 Energy Consumption

Energy consumption in the palm oil manufacturing process is used for mechanical works, heating (thermal) and services (lighting and air conditioning). Heating is for purification, clarification, digesting, and pressing.

There are 86 palm oil companies[24] listed by BPS although it Industrial Survey listed energy consumption from 124 palm oil companies[25] in Riau. It can be seen that most of palm oil industry in Riau uses captive power generated from diesel fuel.

[24] See Appendix XVII for list of palm oil companies in Riau

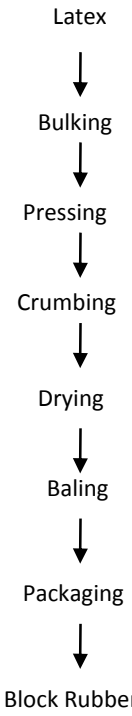
[25] See Appendix XVIII for data of energy consumption from palm oil companies in Riau

4.2 Crumb Rubber Industry in South Kalimantan

4.2.1 Manufacturing Process

Crumb rubber or block rubber is the basic material for producing rubber goods. Crumb rubber is processed from latex in middle to large-size factories. Small scale or household rubber industry only produce ribbed smoke sheet. Crumb rubber manufacturing process consists of bulking, pressing, crumbing, drying, baling and packaging. The plywood manufacturing process in pictures can be seen in Appendix XIX.

Figure 27: Crumb Rubber Manufacturing Process



In the initial step, latex is blended in a large bulking tank. Chemicals are then added to control viscosity and affect color. The latex containing the requisite chemicals is then coagulated by adding coagulants (formic acid) in a long coagulation trough.

Solid latex coagulum is then processed into crumb by either physical or chemical means. In the physical case, the coagulum is first fed though the rotating rolls of a creeping machine. The crepe is then mashed into small pieces through a hammer mill and finally converted into crumb by an extruder. Alternatively, incompatible oil is added to the

latex in the coagulation trough. The material is then fed though a creeper and transformed into crumb.

In both cases, the crumbs are then dried by hot air. Finally the crumb rubber is baled into certain size and packaged. Crumb rubber from Indonesia is standardized into SIR (Standar Indonesia Rubber) -5, SIR-10, and SIR-20.

4.2.3 Energy Consumption

Energy consumption in crumb rubber manufacturing process is used for mechanical works, heating (thermal) and services (lighting and air conditioning). Mechanical works and services use electricity whereas heating is used for drying.

Energy consumption of crumb rubber industry in South Sumatra is shown in Figure 28. The BPS industry survey data for plywood industry in East Kalimantan in 2010 only includes 14 companies[26]. As can be seen in the figure, most of the companies use electricity from PLN (state electricity company), some companies use diesel oil for captive power, and one company uses coal for captive power.

[26] See Appendix XX for list of crumb rubber companies in South Sumatra

Figure 28: Energy Consumption of Crumb Rubber Industry in South Sumatra 2010

No	Regency/City	Diesel (liter)		Coal (kg)		LPG (kg)	Electricity (kWh)		
		for process	for electricity	for process	for electricity		PLN	Non PLN	Captive Power
1	Ogan Komering Ulu	-	59,140	-	-	-	1,900,584	159,680	875
2	MuaraEnim	78,236	-	296,884	-	-	863,706	-	-
3	Musi Rawas	443,890	492,560	-	-	-	-	-	492,560
4	Musi Rawas	-	1,917,692	-	2,455,098	2,150	-	-	20,000,000
5	Musi Banyuasin	10,334,607	11,007,567	-	-	-	-	-	124,715,734
6	Banyuasin	3,092,241	702,909	-	-	-	3,274,614	2,064,463	7,963,959
7	Palembang	1,249,412	-	377,000	-	-	3,945,785	-	-
8	Palembang	323,253	-	571,770	-	-	3,387,134	-	-
9	Palembang	34,400	-	8,400	-	-	2,000,000	-	-
10	Palembang	1,155,171	-	-	-	-	3,849,422	-	-
11	Palembang	6,303	3,443	-	-	-	-	-	39,009
12	Palembang	617,112	-	-	-	-	7,302,995	-	-
13	Palembang	107,669	-	-	-	-	2,542,000	-	-
14	Palembang	1,592,169	-	-	-	-	4,206,106	-	-

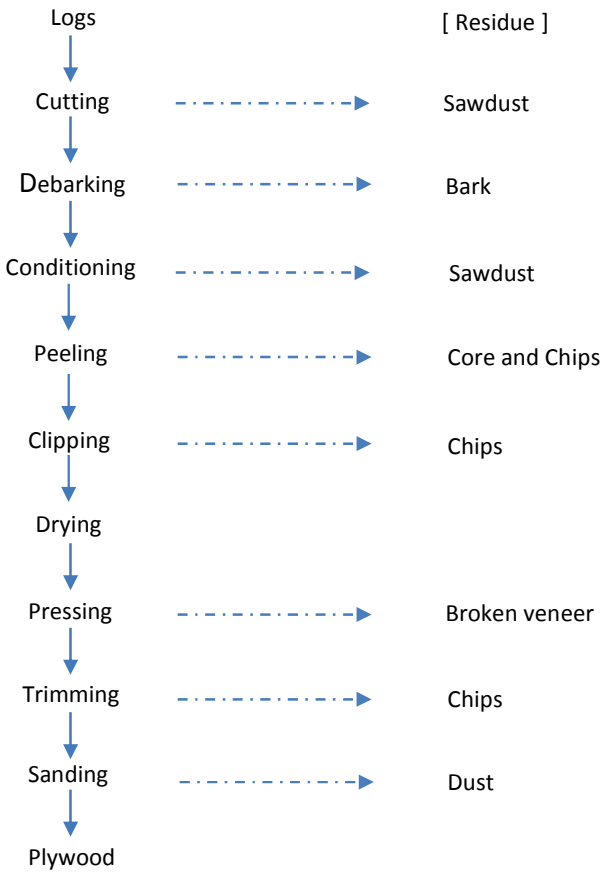
Source: BPS Industry Survey 2010

4.3 Plywood Industry in East Kalimantan

4.3.1 Manufacturing Process

Plywood is made from logs which are generally straighter and larger in diameter than one required for processing into dimensioned lumber by a sawmill. Typical process of plywood manufacturing consists of cutting, debarking, conditioning, peeling, clipping, drying, sorting, pressing, trimming, grading, and sanding as described in Figure 27 below. Waste from plywood manufacturing process includes sawdust, bark, core, chips, broken veneer, and dust. The plywood manufacturing process in pictures can be seen in Appendix XXI.

Figure 29: Plywood Manufacturing Process



4.3.2 Energy Consumption

Energy consumption in the plywood manufacturing process is for mechanical works, heating (thermal) and services (lighting and air conditioning), all of which requires electricity. Heating is used for log conditioning, glue preparation, veneer drying, and hot pressing.

Only 12 out of 24 companies[27] are included in the BPS industry survey data for plywood industry in East Kalimantan in 2010 and their energy consumption is shown in Figure 28 below. The numbers indicate that most plywood companies in East Kalimantan use captive power for their electricity generation.

Figure 30: Energy Consumption of Plywood Industry in East Kalimantan 2010

No	Company	Regency/City	Diesel (liter)		Electricity (kWh)	
			for Process	for Electricity	from PLN	Captive Power
1	Company 1	Kutai Kartanegara	-	-	795,332	-
2	Company 2	Penajam Paser Utara	2,331,651	896,104	-	10,152,858
3	Company 3	Penajam Paser Utara	2,456,607	1,445,654	-	16,379,260
4	Company 4	Samarinda	-	829,549	65,856	850,000
5	Company 5	Samarinda	1,024,746	3,410,218	-	38,637,770
6	Company 6	Samarinda	13,294	96,375	2,593,968	1,091,929
7	Company 7	Samarinda	-	1,267,796	-	6,338,980
8	Company 8	Samarinda	153,395	120,001	-	600,000
9	Company 9	Samarinda	20,000	20,000	-	200,000
10	Company 10	Tarakan	327,073	2,943,650	11,242,258	4,800,000
11	Company 11	Tarakan	116,940	91,655	-	1,038,451
12	Company 12	Tarakan	-	643,558	-	1,254,000

Source: BPS Industry Survey 2010

[27] See Appendix XXII for list of plywood companies in East Kalimantan

Chapter V

Evaluation of CO_2 Reduction Potentials

5.1. Background

As of the year 2011, Indonesia is ranked as the 11th largest CO_2 emitters by the German renewable energy institute IWR, emitting a total of 453 $mtCO_2e$, just behind Brazil and Mexico[28].

The prevalent use of diesel captive power in Indonesia contributes to part of the country's CO_2 emissions. Emissions from the consumption of liquid petroleum products historically have been the primary source of Indonesia's fossil-fuel CO_2 emissions. It noted that emissions from coal usage increased sharply in 2008 surpassing emissions from liquid fuels for the first time in many years[29].

The Indonesian government as set in the Presidential Regulation 05/2006, has a target to reduce its GHG emission by 26% in 2020. A parallel objective is to generate 25% of Indonesia's electricity from renewable sources by 2025 as a mean to reach its GHG emission reduction target.

As renewable electricity has become synonymous with CO_2 reduction, this chapter aims to look how much CO_2 emission can potentially be reduced by substituting the diesel fuel consumption with renewables in the selected provinces (Chapter III).

5.2 Methodology

As explained in the methodology section of this report in the previous chapter, the data on diesel fuel consumption in the manufacturing industry is calculated from the BPS Industrial Survey. Fuel density figure is obtained from the state-owned oil and gas company Pertamina as they are the main supplier of diesel fuel in Indonesia. The net calorific value (NCV) and CO_2 emission factor for diesel oil is based on the 2006 IPCCC guideline for GHG inventories as there is no specific country data.

[28] See Appendix XXIII for Global CO_2 emission in 2011
[29] http://cdiac.ornl.gov/trends/emis/tre_ido.html

5.3 CO2 Emission Reduction Potentials

Figure 33 shows the CO_2 emission reduction potentials by substituting diesel fuel consumption with renewable sources which arrives at a figure of 1,180,597 tCO_2 per year in total for the selected eight provinces. The assumption in place for the calculations is that all diesel captive power generation is 100% replaced with renewables.

Figure 31: CO2 Emission Reduction Potentials[30]

No	Province	Diesel Fuel for Electricity Consumption	Fuel Density*	Net Calorific Value**	CO2 Emission Factor for Diesel**	CO2 Emission Reduction Potential
		Kilo Litre / Year	Kg / Litre	TJ / t	tCO2 / TJ	tCO2 / year
		A	B	C	D	E= A*B*C*D
1	Banten	94,976	0.815	0.043	74.1	302,622
2	Riau	79,051				251,880
3	Jatim (East Java)	56,773				180,896
4	Sumut (North Sumatera)	45,368				144,556
5	Kepri (Riau Island)	28,443				90,628
6	Babel (Bangka Belitung)	23,204				73,935
7	Kalbar (West Kalimantan)	21,646				68,971
8	Sumsel (South Sumatera)	21,062				67,110
Total						***1,180,597***
** based on Pertamina Diesel Fuel 2007 MSDS*						
*** based on 2006 IPCC guideline for National Greenhouse Gas Inventories*						

[30] This particular calculation has been verified by official from the International Energy Agency (IEA)

Chapter VI

Conclusion and Recommendation

Captive power plays a tremendous role in fulfilling the supply of quality power in Indonesia as they account for more than 40% of the national installed power capacity of 32 GW. With about 60% of installed captive power capacity powered by diesel generators, there is a strong case to replace them with renewable sources, not just to lower the generating costs for both the private sector and PLN, but also to help Indonesia meets its CO_2 emission reduction target by 2020.

This study has identified regions (provinces) and industrial sectors in Indonesia where diesel fuel consumption by the manufacturing industry is at its highest in 2012 as summarized in Figure 34 below:

Figure 32: Diesel Fuel Consumption For Electricity Generation By Industry in 8 selected Provinces

No	ISIC	Industry Type	Banten	Riau	East Java	North Sumatra	Riau Islands	Bangka Belitung	West Kalimantan	South Sumatra
1	104	Cooking oil from vegetable and animal	98	**39,919**	38	**12,818**	115	1,980	3,251	4,715
2	221	Rubber and goods made from rubber	120	4,141	3,479	**10,663**	2,012	25	8,792	**14,183**
3	201	Industrial chemicals	**26,211**	59	**11,559**	1,249	507	-	151	520
4	274	Bulb, spotlight and others lighting	**49,116**	-	0	138	-	-	-	-
5	170	Paper and paper products	182	**30,595**	543	594	12	-	60	-
6	162	Goods made from wood and plaits	190	3,780	1,840	454	-	1	6,516	-
7	107	Other food	547	117	3,564	1,289	136	-	422	595
8	239	Other non metallic mineral products	4,620	1	535	1,359	135	1,111	-	161
9	242	Basic metals excepts iron and steel	351	-	8	1,322	157	**16,499**	-	-
10	259	Other metal products and services of metallic products processing	705	-	260	50	**10,189**	3,401	5	-
11	106	Rice and other grain milling	4,412	96	3,797	394	-	-	43	1
12	120	Tobacco	-	-	**11,547**	-	-	-	-	-
13	231	Glass and goods made from glass	3	-	217	10,230	-	-	-	-
14	131	Spinning, weaving and finishing of textile	2,449	-	3,283	-	-	-	-	-
15	141	Garment	220	-	38	8	11	-	-	-

Source: BPS Statistics 2012

If the biggest numbers (> 10,000 KL / year) are put to focus, the lighting industry in Banten comes out as the industry in Indonesia which consumes the most diesel fuel for electricity generation though its biggest player (Osram of Germany) is closing its factory at the end of December 2013. Riau province is home to two big industries that consume the second highest diesel fuel for electricity generation which are the palm oil and the pulp and paper industry. As mentioned in the report, Indonesia is one of the biggest producer countries in the world for the two commodities. The industrial chemicals

industry comes third and are located in Banten and East Java. Next is the tin mineral processing industry in Bangka which is mainly the state-owned PT. Timah Tbk followed by the rubber processing industry in Sumatra, the tobacco industry in East Java, and the metal processing industry in Riau islands.

A follow up to this study should focus on correlating the identified area and industry with the available local sources to be utilized for renewable energy utilization. Some industries may be located in areas with low solar irradiation, insufficient organic wastes or low wind that render efforts to replace diesel generators with renewable energy sources unfeasible. These factors need to be considered before deciding to intervene in a particular province and industry.

On a separate note, a separate study could look at provinces with low industrial presence but with known abundance of renewable sources such as high solar irradiation in eastern Indonesia. In these provinces, where diesel fuel cost tends to be higher due to long distance transport, there is a stronger business case to make for the industrial sector which should lessen resistance to the adoption of renewable energy solutions.

With an expected annual growth rate of 4% as estimated by the World Bank, CPPs will continue to play an important role in the future of electrification in Indonesia and any attempt to replace them with renewable energy sources will contribute to Indonesia's fight against climate change.

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APPENDICES

APPENDIX I: Share of Electrical Sales by Sector

Tahun	Rumah Tangga		Komersial		Industri		Penerangan		Sosial		Pemerintahan		TOTAL
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	
2004	38.588	39%	15.258	15%	40.324	40%	2.045	2%	2.238	2%	1.645	2%	100.097
2005	41.184	38%	17.023	16%	42.448	40%	2.221	2%	2.430	2%	1.726	2%	107.032
2006	43.753	39%	18.416	16%	43.615	39%	2.414	2%	2.604	2%	1.808	2%	112.610
2007	47.325	39%	20.608	17%	45.803	38%	2.586	2%	2.909	2%	2.016	2%	121.247
2008	50.184	39%	22.926	18%	47.969	37%	2.761	2%	3.082	2%	2.096	2%	129.019
2009	54.945	41%	24.825	18%	46.204	34%	2.888	2%	3.384	3%	2.335	2%	134.582
2010	59.825	41%	27.157	18%	50.985	35%	3.000	2%	3.700	3%	2.630	2%	147.297
2011	65.110	41%	28.309	18%	54.725	35%	3.064	2%	3.994	3%	2.790	2%	157.993
2012	72.133	41%	30.988	18%	60.176	35%	3.141	2%	4.496	3%	3.057	2%	173.990

Sumber : Statistik PLN, Statistik DJK dan Handbook of Energy and Economic Statistics of Indonesia, Pusdatin KESDM

Appendix II: Share of Final Energy Consumption by Sector

Year	Industry	Household	Commercial	Transportation	Other
2000	41.18	18.78	4.10	29.71	6.24
2001	40.63	18.36	4.13	30.58	6.31
2002	40.07	17.99	4.22	31.48	6.23
2003	43.34	17.07	4.04	30.08	5.48
2004	39.99	16.76	4.43	32.96	5.86
2005	40.50	16.49	4.59	33.03	5.39
2006	43.33	15.69	4.60	31.57	4.81
2007	44.83	15.21	4.59	31.06	4.32
2008	43.23	14.32	4.72	33.35	4.38
2009	41.09	13.14	4.79	36.56	4.42
2010	43.97	11.50	4.47	36.01	4.05
2011	42.91	11.60	4.44	37.68	3.37

Note: Commercial Energy (excluded biomass)

Appendix III: 2005 ISIC Industry Classification

Code	Type of Industry
151	Processing and preserving of meat, fish, fruits, vegetables, cooking oil and fat
152	Milk and food made from milk
153	Grain mill products, flour and animal feed
154	Other food
155	Beverages
160	Processed tobacco
171	Spinning, weaving and finishing of textile
172	Garments and carpets
173	Knitting
174	Kapok
181	Wearing apparels, except wearing apparels made of fur
182	Wearing apparels made of fur
191	Leather and goods made from leather
192	Footwear
201	Sawing and preserving of wood
202	Goods made from wood and plaits
210	Paper and paper products
221	Publishing
222	Printing and activities related to printing
223	Recording reproduction
231	Goods made from coal
232	Oil and gas refinery and goods made from oil
233	Nuclear fuel
241	Industrial chemicals
242	Other chemicals
243	Synthetic fibers
251	Rubber and goods made from rubber
252	Plastic products
261	Glass and goods made from glass
262	Goods made from porcelain
263	Clay products
264	Cements, lime plaster and gip
265	Goods made from stones
266	Goods made from asbestos
269	Other non metallic mineral products
271	Basic iron and steel
272	Basic metals excepts iron and steel
273	Metal smelting
281	Fabricated structural metal products, tanks and pressure vessels
289	Other metal products and services of metallic products processing

291	General purpose machineries
292	Special purpose machineries
293	Household appliances
300	Office accounting and data processing machineries and equipments
311	Electrical motor, generator and transformer
312	Electrical control and distribution equipments
313	Electrical cables and telephone
314	Electrical accumulator and battery
315	Bulb, spotlight and others lighting
319	Other electrical equipments
321	Electronic tube and value and other electronic components
322	Communication equipment
323	Radio, television, sound and picture recordings and other similar activities
331	Medical, measuring, testing, and other equipments except optical equipments
332	Optical and photographic equipments
333	Clocks, watches and other similar products
341	Motor vehicles
342	Motor vehicles bodies
343	Equipments and components of motor vehicles
351	Construction and repair of ships and boats
352	Train
353	Airplane
359	Other transport equipments
361	Furniture
369	Other processing
371	Recycling of metals
372	Recycling of goods other than metal

APPENDIX IV: 2009 ISIC Industry Classification

Code	Type of Industry
101	Processing and preserving of meat
102	Processing and preserving of fish
103	Processing and preserving of fruit and vegetable
104	Cooking oil from vegetable and animal
105	Milk and food made from milk
106	Rice and other grain milling
107	Other food
108	Animal food
110	Beverage
120	Tobacco
131	Spinning, weaving and finishing of textile
139	Other textile
141	Garment
142	Wearing apparels made of fur
143	Knitting
151	Leather and goods made from leather
152	Footwear
161	Sawing and preserving of wood, rattan, and bamboo
162	Goods made from wood and plaits
170	Paper and paper products
181	Printing and activities related to printing
182	Recording reproduction
191	Goods made from coal
192	Oil and gas refinery and goods made from oil
201	Industrial chemicals
202	Other chemicals
203	Synthetic fibers
210	Pharmaceutical, drugs and medicine
221	Rubber and goods made from rubber
222	Plastic products
231	Glass and goods made from glass
239	Other non metallic mineral products
241	Basic iron and steel
242	Basic metals excepts iron and steel
243	Metal smelting
251	Fabricated structural metal products, tanks and pressure vessels
252	Weapon and ammunition
259	Other metal products and services of metallic products processing
261	Electronic component
262	Computer
263	Communication equipment
264	Electronic audio and video equipment

265	Measurement, navigation and control equipment
266	Electro-medical and electrotherapy equipment
267	Optical and photographic equipments
268	Magnetic media and optical media
271	Electrical control and distribution equipments
272	Electrical accumulator and battery
273	Electrical cables and telephone
274	Bulb, spotlight and others lighting
275	Household appliances
279	Other electrical equipments
281	General purpose machineries
282	Special purpose machineries
291	Motor vehicles
292	Motor vehicles bodies
293	Equipments and components of motor vehicles
301	Construction and repair of ships and boats
302	Train
303	Airplane
304	War vehicle
309	Other transport equipments
310	Furniture
321	Adornment and precious goods
322	Music equipment
323	Sport equipment
324	Toys
325	Medical equipment
329	Recycling of metals
331	Repair service of machine and equipment
332	Installation service of machine and equipment

APPENDIX V: Captive Power Capacity

No	Province	Installed Capacity (kW)		
		Main	Reserve	Total
1	Aceh	542,191	54,718	596,909
2	North Sumatra	95,553	187,104	282,657
3	West Sumatra	60,284	149,256	209,540
4	Riau	832,828	144,296	977,124
5	Island of Riau	112,511	199,874	312,385
6	South Sumatra	368,541	89,514	458,055
7	Jambi	602,474	158,344	760,818
8	Bengkulu	315,519	91,317	406,836
9	Bangka Belitung	255,768	56,537	312,305
10	Lampung	118,219	47,106	165,325
11	West Kalimantan	143,577	64,253	207,830
12	South Kalimantan	158,810	168,824	327,634
13	Central Kalimantan	238,454	163,597	402,051
14	East Kalimantan	749,854	150,652	900,506
15	North Kalimantan	10,282	25,606	35,888
16	North Sulawesi	451,211	164,633	615,844
17	Gorontalo	18,250	14,875	33,125
18	Central Sulawesi	9,691	8,452	18,143
19	South and Central Sulawesi	23,940	62,211	86,151
20	South East Sulawesi	464,626	82,798	547,424
21	Maluku	101	13,296	13,397
22	North Maluku	2,047	4,696	6,743
23	Papua and West Papua	30,763	191,935	222,698
24	Bali	23,412	199,874	223,286
25	West Nusa Tenggara	11,257	15,038	26,296
26	East Nusa Tenggara	4,740	6,799	11,539
	Sub Total Outside of Java	5,644,902	2,515,604	8,160,507
27	East Java	514,024	493,499	1,007,523
28	Central Java	374,895	747,790	1,122,685
29	Yogyakarta	464,407	586,445	1,050,852
30	West Java	1,353,257	2,129,681	3,482,938
31	Banten	6,225	472,107	478,332
32	Jakarta	111,237	1,348,471	1,459,708
	Sub Total Java	2,824,045	5,274,614	8,602,038
	Total	8,468,948	7,790,218	16,762,544

Source: Calculated from PLN Statistics 2006 and 2009

APPENDIX VI: Installed Capacity and Electricity Production of Diesel Power Plant by Province 2012

No	Province	PLN Installed Capacity (MW)
1	Aceh	140.03
2	North Sumatra	12.64
3	West Sumatra	31.98
4	Riau	80.47
5	Riau Archipelago	82.84
6	South Sumatra	8.01
7	Jambi	10.22
8	Bengkulu	22.44
9	Bangka Belitung	89.42
10	Lampung	4.79
11	West Kalimantan	186.32
12	South Kalimantan	129.92
13	Central Kalimantan	79.01
14	East Kalimantan	211
15	North Sulawesi	103.59
16	Gorontalo	27.91
17	Central Sulawesi	125.13
18	South and West Sulawesi	81
19	Southeast Sulawesi	96.61
20	Maluku	134.94
21	North Maluku	43
22	Papua and West Papua	127.03
23	West Nusa Tenggara	145.23
24	East Nusa Tenggara	146.74
25	Bali	3.58
26	Java	99.63
27	PLN Batam	102.85
28	PLN Tarakan	19.22
29	Sumbagut	119.36
30	Sumbagsel	133.73
		2598.64

Source: PLN Statistics 2012

APPENDIX VII: Diesel Fuel Consumption For Electricity Generation in Manufacturing Industry 2010

No	Province	Diesel Fuel (KL/year)		% to Total Consumption
		Total	for Electricity	
1	Banten	365,843	94,976	26%
2	Riau	183,040	79,051	43%
3	Jatim (East Java)	302,724	56,773	19%
4	Jabar (West Java)	597,439	52,349	9%
5	Sumut (North Sumatra)	113,126	45,368	40%
6	Kepri (Riau Island)	103,159	28,443	28%
7	Babel (Bangka Belitung)	88,160	23,204	26%
8	Kalbar (West Kalimantan)	29,078	21,646	74%
9	Sumsel (South Sumatra)	72,965	21,062	29%
10	Lampung	89,761	19,763	22%
11	Kaltim (East Kalimantan)	46,798	17,819	38%
12	Jateng (Central Java)	135,912	16,666	12%
13	Jambi	45,987	14,239	31%
14	Sumbar (West Sumatra)	30,704	13,328	43%
15	DKI (Jakarta)	139,688	11,383	8%
16	Kalsel (South Kalimantan)	34,023	10,914	32%
17	Kalteng (Central Kalimantan)	32,607	7,454	23%
18	Sulut (North Sulawesi)	27,892	5,912	21%
19	Papua	19,293	5,097	26%
20	Irjabar (West Papua)	7,223	4,620	64%
21	Aceh	9,032	4,513	50%
22	Sulsel (South Sulawesi)	20,170	2,203	11%
23	DIY (Yogyakarta)	7,093	2,196	31%
24	Bengkulu	2,993	1,560	52%
25	Maluku	4,531	1,115	25%
26	Sulbar (West Sulawesi)	2,757	650	24%
27	Sultra (South East Sulawesi)	1,007	592	59%
28	Sulteng (Central Sulawesi)	5,446	539	10%
29	Bali	10,043	457	5%
30	NTB (West Nusa Tenggara)	677	175	26%
31	NTT (East Nusa Tenggara)	1,467	159	11%
32	Gorontalo	7,472	63	1%
33	Malut (North Sulawesi)	1	0.2	20%
	Total	2,538,107	564,291	22%

Source: Central Body of Statistics, 2012

APPENDIX VIII: Diesel Fuel Consumption for Electricity in Banten Manufacturing Industry 2010

No	ISIC	Industry Type	Diesel Consumption (KL)
1	274	Bulb, spotlight and others lighting	49,116
2	201	Industrial chemicals	26,211
3	239	Other non metallic mineral products	4,620
4	106	Rice and other grain milling	4,412
5	131	Spinning, weaving of textile	2,449
6	203	Synthetic fibers	994
7	139	Other textile	957
8	222	Plastic products	868
9	259	Other metal products and services	705
10	107	Other food	547
-	-	Other industries	4,097
Total			94,976

Source: Central Body of Statistics, 2012

APPENDIX IX: Diesel Fuel Consumption for Electricity in Riau Manufacturing Industry 2010

No	ISIC	Industry Type	Diesel Consumption (KL)
1	104	Cooking oil from vegetable and animal	39,919
2	170	Paper and paper products	30,595
3	221	Rubber and goods made from rubber	4,141
4	162	Goods made from wood and plaits	3,780
5	110	Beverage	129
6	107	Other food	117
7	106	Rice and other grain milling	96
8	310	Furniture	82
9	301	Construction and repair of ships	79
10	201	Industrial chemicals	59
-	-	Other industries	54
			79,051

Source: Central Body of Statistics, 2012

APPENDIX X: Diesel Fuel Consumption for Electricity in East Java Manufacturing Industry 2010

No	ISIC	Industry Type	Diesel Consumption (KL)
1	201	Industrial chemicals	11,559
2	120	Tobacco	11,547
3	106	Rice and other grain milling	3,797
4	107	Other food	3,564
5	221	Rubber and goods made from rubber	3,479
6	131	Spinning, weaving of textile	3,283
7	272	Electrical accumulator and battery	2,694
8	101	Processing and preserving of meat	2,267
9	162	Goods made from wood and plaits	1,840
10	241	Basic iron and steel	1,504
-	-	Other industries	11,240
Total			56,773

Source: Central Body of Statistics, 2012

APPENDIX XI: Diesel Fuel Consumption for Electricity in North Sumatra Manufacturing Industry 2010

No	ISIC	Industry Type	Diesel Consumption (KL)
1	104	Cooking oil from vegetable and animal	12,818
2	221	Rubber and goods made from rubber	10,663
3	231	Glass and goods made from glass	10,230
4	108	Animal food	1,756
5	239	Other non metallic mineral products	1,359
6	242	Basic metals excepts iron and steel	1,322
7	107	Other food	1,289
8	201	Industrial chemicals	1,249
9	170	Paper and paper products	594
10	110	Beverage	510
-	-	Other industries	3,578
Total			45,368

Source: Central Body of Statistics, 2012

APPENDIX XII: Diesel Fuel Consumption for Electricity in Riau Islands Manufacturing Industry 2010

No	ISIC	Industry Type	Diesel Consumption (KL)
1	259	Other metal products and services of metallic products processing	10,189
2	261	Electronic component	5,785
3	241	Basic iron and steel	3,442
4	301	Construction and repair of ships and boats	3,216
5	221	Rubber and goods made from rubber	2,012
6	251	Fabricated structural metal products, tanks and pressure vessels	1,401
7	331	Repair service of machine and equipment	534
8	201	Industrial chemicals	507
9	273	Electrical cables and telephone	215
10	102	Processing and preserving of fish	186
-	-	Other industries	955
Total			28,443

Source: Central Body of Statistics, 2012

APPENDIX XIII: Diesel Fuel Consumption for Electricity in Bangka Belitung Manufacturing Industry 2010

No	ISIC	Industry Type	Diesel Consumption (KL)
1	242	Basic metals excepts iron and steel	16,499
2	259	Other metal products and services of metallic products processing	3,401
3	104	Cooking oil from vegetable and animal	1,980
4	239	Other non metallic mineral products	1,111
5	301	Construction and repair of ships and boats	128
6	110	Beverage	52
7	221	Rubber and goods made from rubber	25
8	181	Printing and activities related to printing	4
9	162	Goods made from wood and plaits	1
10	310	Furniture	1
-	-	Other industries	1
Total			23,204

Source: Central Body of Statistics, 2012

APPENDIX XIV: Diesel Fuel Consumption for Electricity in West Kalimantan Manufacturing Industry 2010

No	ISIC	Industry Type	Diesel Consumption (KL)
1	221	Rubber and goods made from rubber	8,792
2	162	Goods made from wood and plaits	6,516
3	104	Cooking oil from vegetable and animal	3,251
4	161	Sawing and preserving of wood, rattan, and bamboo	1,386
5	107	Other food	422
6	202	Other chemicals	385
7	110	Beverage	354
8	102	Processing and preserving of fish	213
9	201	Industrial chemicals	151
10	170	Paper and paper products	60
-	-	Other industries	114
Total			21,646

Source: Central Body of Statistics, 2012

APPENDIX XV: Diesel Fuel Consumption for Electricity in South Sumatra Manufacturing Industry 2010

No	ISIC	Industry Type	Diesel Consumption (KL)
1	221	Rubber and goods made from rubber	14,183
2	104	Cooking oil from vegetable and animal	4,715
3	107	Other food	595
4	201	Industrial chemicals	520
5	161	Sawing and preserving of wood, rattan, and bamboo	307
6	331	Repair service of machine and equipment	198
7	239	Other non metallic mineral products	161
8	102	Processing and preserving of fish	138
9	210	Pharmaceutical, drugs and medicine	90
10	222	Plastic products	83
-	-	Other industries	73
Total			21,062

Source: Central Body of Statistics, 2012

APPENDIX XVI: Diesel Fuel Substitution Potential in Manufacturing Industry 2006 – 2010 by Province

Province	Diesel Fuel Consumption (KL/year)				
	2006	2007	2008	2009	2010
Aceh	3,299	6,481	22,207	23,758	4,513
Sumut	78,073	67,980	64,523	46,797	45,368
Sumbar	16,971	12,681	9,129	5,632	13,328
Riau	83,424	111,747	110,624	98,600	79,051
Jambi	7,089	25,009	21,038	8,479	14,239
Sumsel	16,754	21,829	57,241	32,266	21,062
Bengkulu	445	3,767	10,857	774	1,560
Lampung	76,960	60,352	21,547	13,717	19,763
Babel	21,074	5,102	30,621	26,770	23,204
Kepri	37,780	86,881	82,438	58,715	28,443
DKI	27,089	20,124	21,548	42,212	11,383
Jabar	87,488	116,099	81,903	61,502	52,349
Jateng	32,893	75,795	118,138	31,070	16,666
DIY	967	2,305	1,406	1,641	2,196
Jatim	32,127	56,022	62,545	64,823	56,773
Banten	207,165	121,796	114,284	99,017	94,976
Bali	626	849	496	303	457
NTB	108	55	102	97	175
NTT	437	1,570	43	94	159
Kalbar	18,579	41,792	33,639	16,594	21,646
Kalteng	6,726	37,222	53,648	52,698	7,454
Kalsel	11,887	12,321	25,375	18,553	10,914
Kaltim	19,308	28,330	27,190	18,115	17,819
Sulut	8,040	7,759	11,752	14,822	5,912
Sulteng	866	1,517	1,283	617	539
Sulsel	4,547	13,377	10,117	7,997	2,203
Sultra	996	3,792	9,686	801	592
Gorontalo	1,142	130	345	179	63
Sulbar	499	193	243	138	650
Maluku	1,788	2,747	4,023	2,387	1,115
Malut	7,306	262	6	1	0.2
Irjabar	3,066	5,504	1,341	1,169	4,620
Papua	2,616	3,129	5,581	3,402	5,097
Total	818,135	954,520	1,014,921	753,739	564,291

Source: Central Body of Statistics, 2008 - 2012

APPENDIX XVII: Palm Oil Companies in Riau

No	Regency/City	Subdistrict	Company	Labor (people)
1	Bengkalis	Pinggir	Adei Plantation And Industry, PT	116
2	Bengkalis	Mandau	Murini Samsam, PT	100
3	Dumai	Bukit Kapur	Taluk Kuantan Perkasa, PT	134
4	Dumai	Dumai Timur	Nagamas Palm Oil Lestari, PT	57
5	Dumai	Dumai Timur	Inti Benua Perkasatama, PT	399
6	Dumai	Sungai Sembilan	Sari Dumai Sejati, PT	89
7	Dumai	Medang Kampai	Bukit Kapur Reksa, PT	52
8	Dumai	Dumai Timur	Ivomas Tunggal, PT	41
9	Dumai	Dumai Timur	Bukit Kapur Reksa, PT	603
10	Indragiri Hilir	Keritang	Bhumireksa Nusasejati, PT	159
11	Indragiri Hilir	Reteh	Bumi Palma Lestari Persada, PT	1,023
12	Indragiri Hilir	Reteh	Hapenso Jaya, PT	24
13	Indragiri Hilir	Kateman	Pulau Sambu, PT (Cab.Sei Guntung)	2,591
14	Indragiri Hilir	Pelangiran	A.E Brothers Cab.Sei Guntung, Cv	50
15	Indragiri Hilir	Tanah Merah	A.E Brothers Company, Cv	198
16	Indragiri Hilir	Tanah Merah	Tunas Baru Lampung, PT	60
17	Indragiri Hilir	Tanah Merah	Pulau Sambu, PT (Cab.Kuala Enok)	1,645
18	Indragiri Hilir	Pulau Burung	Prima Sambu, PT	185
19	Indragiri Hilir	Tempuling	Inhil Sarimas Kelapa, PT	200
20	Indragiri Hilir	Pulau Burung	Riau Sakti United Plantation, PT	335
21	Indragiri Hulu	Batang Gansal	Kencana Amal Tani, PT	11,217
22	Indragiri Hulu	Lirik	Tunggal Perkasa Plantations, PT	1,689
23	Indragiri Hulu	Seberida	Inecda Plantation, PT	104
24	Indragiri Hulu	Peranap	Rigunas Agri Utama, PT	90
25	Indragiri Hulu	Peranap	Indri Plant, PT	126
26	Indragiri Hulu	Batang Gansal	Nirmala Abdi Damai, PT	128
27	Indragiri Hulu	Kelayang	Meganusa Inti Sawit, PT	307
28	Kampar	Siak Hulu	PT Perkebunan Nusantara V Sei Pagar	171
29	Kampar	Tapung	PT Perkebunan Nusantara V Pks Sei Garo	155
30	Kampar	Tapung	Tunggal Yunus Estate, PT	133
31	Kampar	Tapung	Ramajaya Pramukti, PT	193
32	Kampar	Bangkinang Barat	Ciliandra Perkasa, PT	157
33	Kampar	Tapung	Peputra Masterindo, PT	160
34	Kampar	Tapung Hulu	Riau Kampar Sahabat Sejati, PT	140
35	Kampar	Kampar	Johan Sentosa, PT	148
36	Kampar	Tapung Hulu	Arindo Tri Sejahtera, PT	155
37	Kampar	Tapung Hilir	Buana Wiralestari Mas , PT	647
38	Kampar	Tapung Hilir	Sekar Bumi Alam Lestari, PT	210

39	Kampar	Tambang	PT Perkebunan Nusantara Sei Galuh	179
40	Kampar	Koto Kampar	Padasa Enam Utama, PT	173
41	Kampar	Tapung Hulu	Sewangi Sejati Luhur, PT	156
42	Kampar	Tapung Hulu	PT Perkebunan Nusantara V Terantam	184
43	Kuantan Singingi	Benai	Duta Palma Nusantara, PT	9,741
44	Kuantan Singingi	Singingi Hilir	Mustika Agro Sari	126
45	Kuantan Singingi	Cerenti	Cerenti Subur, PT	6,655
46	Kuantan Singingi	Inuman	Wana Jingga Timur, PT	6,445
47	Kuantan Singingi	Kuantan Mudik	Tribakti Sari Mas, PT	156
48	Kuantan Singingi	Kuantan Tengah	Wana Sari Nusantara,PT	130
49	Kuantan Singingi	Kuantan Tengah	Citra Riau Sarana, PT	180
50	Singingi	Singingi Hilir	Kebun Pantai Raja, PT	150
51	Pelalawan	Ukui	Musim Mas, PT	512
52	Pelalawan	Ukui	Sari Lembah Subur, PT	915
53	Pelalawan	Bunut	Serikat Putra, PT	212
54	Pelalawan	Pelalawan	Inti Indo Sawit Subur-Buatan	257
55	Pelalawan	Pangkalan Kerinci	Sinar Siak Dian Permai, PT	80
56	Pelalawan	Ukui	Inti Indo Sawit Subur-Ukui	222
57	Pelalawan	Pangkalan Kerinci	Adei Plantation And Industry, PT	511
58	Pelalawan	Ukui	Gandaherah Hendana, PT	118
59	Pelalawan	Pangkalan Kerinci	Multi Palma Sejahtera, PT	121
60	Pelalawan	Pangkalan Kerinci	Jalur Pusaka Sakti Kumala, PT	28
61	Rokan Hilir	Bagan Sinembah	PT Perkebunan Nusantara V Tanjung Medan	166
62	Rokan Hilir	Bagan Sinembah	Lahan Tani Sakti, PT	1,245
63	Rokan Hilir	Bangko Pusako	Gunung Mas Raya, PT	161
64	Rokan Hilir	Pujut	Tunggal Mitra Plantations, PT	141
65	Rokan Hilir	Bagan Sinembah	Sawita Ledong Jaya	174
66	Rokan Hilir	Bagan Sinembah	Salim Ivomas Pratama,PT	460
67	Rokan Hilir	Bagan Sinembah	PT Perkebunan Nusantara V Tanah Putih	185
68	Rokan Hilir	Bagan Sinembah	Sinar Perdana Caraka, PT	200
69	Rokan Hilir	Bagan Sinembah	Darma Wungu Guna, PT	124
70	Rokan Hilir	Bagan Sinembah	Musim Mas, PT	196
71	Rokan Hulu	Kuntodarussalam	Eka Dura Indonesia, PT	1,020
72	Rokan Hulu	Kuntodarussalam	PT Perkebunan Nusantara V Sei Intan	174
73	Rokan Hulu	Kuntodarussalam	PT Perkebunan Nusantara V Sei Rokan	207

74	Rokan Hulu	Tandun	PT Perkebunan Nusantara V Sei Tapung	210
75	Rokan Hulu	Kepenuhan	Eluan Mahkota, PT	2,075
76	Rokan Hulu	Kepenuhan	Perdana Intisawit Perkasa, PT	194
77	Rokan Hulu	Tambusai Utara	Hutahaean, PT	176
78	Rokan Hulu	Tambusai Utara	Torganda, PT	190
79	Rokan Hulu	Kabun	Padasa Enam Utama, PT	115
80	Rokan Hulu	Kabun	Padasa Enam Utama, PT	197
81	Rokan Hulu	Tandun	PT Perkebunan Nusantara V Tandun	204
82	Siak	Tualang	Kimia Tirta Utama, PT	503
83	Siak	Tualang	Aneka Inti Persada, PT	135
84	Siak	Kandis	Ivomas Tunggal, PT	671
85	Siak	Lubuk Dalam	PT Perkebunan Nusantara V Lubuk Dalam	185
86	Siak	Dayun	PT Perkebunan Nusantara V Sei Buatan	190

APPENDIX XVIII: Energy Consumption of Palm Oil Companies in Riau in 2010

No	Company	Diesel (liter)		Electricity (kWh)		
		for Process	for Electricity	from PLN	from Non PLN	Captive Power
1	Company 1	214,026	214,026	-	-	40,000
2	Company 2	12,838,608	2,258,116	-	-	25,584,454
3	Company 3	138,496	27,669	-	-	1,550
4	Company 4	460,677	460,677	-	-	200
5	Company 5	1,488,811	1,308,349	-	-	14,823,594
6	Company 6	9,485,198	7,579	-	-	85,870
7	Company 7	159,097	159,097	-	-	345,275
8	Company 8	34,070	29,265	-	-	331,572
9	Company 9	418,674	58,544	-	-	112,522
10	Company 10	251,750	251,750	-	-	1,000,000
11	Company 11	296,085	84,027	-	-	952,026
12	Company 12	122,919	75,030	-	-	3,070
13	Company 13	134,786	130,946	-	-	380,420
14	Company 14	281,051	149,913	-	-	6,069
15	Company 15	431,509	431,509	-	-	6,094
16	Company 16	160,718	108,495	-	-	365,160
17	Company 17	545,375	247,674	-	-	2,806,146
18	Company 18	40,710	40,710	-	-	154,797
19	Company 19	9,600	-	-	-	-
20	Company 20	77,025	50,135	-	-	193,900
21	Company 21	133	53	-	-	600
22	Company 22	117,000	85,335	-	-	100
23	Company 23	1,501,722	1,457,663	-	-	14,179,647
24	Company 24	186,689	116,390	-	-	200
25	Company 25	265,234	223,200	-	-	682,177
26	Company 26	1,720,526	108,168	-	-	1,225,543
27	Company 27	1,322,273	155	-	-	1,756
28	Company 28	5,365,771	4,715,374	-	-	53,425,187
29	Company 29	-	-	-	-	-
30	Company 30	3,066,228	898,188	-	-	10,176,470
31	Company 31	-	-	-	-	-
32	Company 32	-	-	-	-	-
33	Company 33	210,290	210,290	-	-	10,839
34	Company 34	142,699	123,883	-	-	256,808
35	Company 35	257,509	117,067	-	-	200
36	Company 36	3,888	3,417	-	145,368	38,715
37	Company 37	247,384	152,179	-	-	1,724,188
38	Company 38	736,365	422,527	-	-	4,787,231
39	Company 39	150,767	-	-	-	-
40	Company 40	284,654	284,654	-	-	95,000
41	Company 41	86,433	13,044	-	-	147,789
42	Company 42	1,335,795	323,985	-	-	3,670,750
43	Company 43	117,349	117,349	-	-	249,678
44	Company 44	130,331	99,636	-	-	283,083
45	Company 45	134,183	120,270	-	-	293,860

46	Company 46	162,028	139,162	-	-	50,000
47	Company 47	531,760	471,218	-	-	50,000
48	Company 48	229,404	163,625	-	-	1,853,871
49	Company 49	97,905	74,681	-	-	2,984
50	Company 50	101,119	71,370	-	-	266,560
51	Company 51	386,010	179,127	457,398	84,372	2,110,634
52	Company 52	88,933	69,042	-	-	207,952
53	Company 53	150,600	-	-	-	-
54	Company 54	140,858	115,611	-	-	3,274
55	Company 55	128,294	-	-	-	-
56	Company 56	46,845	41,167	-	-	466,422
57	Company 57	150,600	150,600	-	-	115,000
58	Company 58	158,325	73,470	187,604	34,606	865,686
59	Company 59	10,125	8,898	-	815	100,814
60	Company 60	151,200	149,625	-	-	60,000
61	Company 61	74,150	28,770	-	-	40,897
62	Company 62	147,126	21,751	-	-	246,439
63	Company 63	66,736	4,685	-	-	53,081
64	Company 64	119,607	86,398	-	-	3,798
65	Company 65	282,000	235,593	-	-	100
66	Company 66	164,283	114,698	-	-	76,500
67	Company 67	64,308	48,038	21,032	-	283
68	Company 68	153,769	107,150	-	-	1,214,010
69	Company 69	251,565	174,880	-	-	50,000
70	Company 70	65,096	23,832	27,421	1,080	272,029
71	Company 71	360,002	-	-	-	-
72	Company 72	186,391	100,846	-	-	3,939
73	Company 73	62,915	46,577	-	-	527,717
74	Company 74	94,778	50,476	-	-	571,893
75	Company 75	181,260	124,700	-	-	8,084
76	Company 76	239,736	111,257	71,807	5,946	1,281,331
77	Company 77	2,081,229	89,138	-	-	1,009,934
78	Company 78	58,639	51,531	-	-	583,846
79	Company 79	537,482	-	-	-	-
80	Company 80	202,096	-	83,032	-	-
81	Company 81	200,000	-	-	-	-
82	Company 82	98,146	95,816	-	-	170,000
83	Company 83	159,929	107,318	-	-	200
84	Company 84	320,873	281,979	-	-	3,194,822
85	Company 85	58,822	38,383	-	-	434,879
86	Company 86	349,838	-	580,476	-	-
87	Company 87	85,658	30,110	-	-	341,146
88	Company 88	97,844	82,142	-	-	930,669
89	Company 89	197,516	193,448	-	-	16,000
90	Company 90	235,268	169,535	-	-	1,920,832
91	Company 91	537,590	483,513	-	-	160,000
92	Company 92	123,065	57,112	36,861	3,053	657,747
93	Company 93	727,202	337,481	217,813	18,036	3,886,709
94	Company 94	7,142,514	2,092,254	-	-	23,705,238
95	Company 95	63,134	55,482	-	-	629,671
96	Company 96	499,596	183,567	-	-	2,079,814
97	Company 97	237,822	-	-	-	-
98	Company 98	246,130	114,224	73,722	6,104	1,315,494

99	Company 99	94,189	83,721	-	-	948,559
100	Company 100	31,965	14,835	9,574	793	170,847
101	Company 101	315,108	220,575	-	-	171,560
102	Company 102	27,563	10,507	132,578	650	120,669
103	Company 103	57,648	17,602	-	-	58,510
104	Company 104	27,563	10,507	132,578	650	120,669
105	Company 105	45,832	12,200	-	-	38,699
106	Company 106	118,804	118,804	-	-	5,788
107	Company 107	71,749	18,800	-	-	51,480
108	Company 108	128,801	-	-	-	-
109	Company 109	374,934	374,100	-	-	1,200,000
110	Company 110	367,917	80,046	1,526,850	-	906,921
111	Company 111	14,330	11,194	-	-	126,828
112	Company 112	85,767	57,800	-	-	172,314
113	Company 113	101,090	98,690	-	-	170,000
114	Company 114	42,281	25,579	-	-	289,810
115	Company 115	141,000	56,620	-	-	380,000
116	Company 116	169,925	83,233	-	-	80,000
117	Company 117	229,299	165,366	-	-	850,000
118	Company 118	2,530,199	2,220,869	3,817,337	-	25,162,446
119	Company 119	410,073	-	2,049,167	-	-
120	Company 120	816,043	717,129	-	-	8,125,072
121	Company 121	8,770,736	8,669,514	4,170,031	-	30,497,354
122	Company 122	1,028,073	613,559	143,659	38,593	6,951,623
123	Company 123	673,379	636,138	-	-	7,207,444
124	Company 124	2,804,587	2,464,637	-	-	27,924,337

APPENDIX XIX: Crumb Rubber Manufacturing Process in Pictures

Bulking

Pressing

Crumbing

Drying

Baling

Packaging

APPENDIX XX: Crumb Rubber Companies in South Sumatra

No	Regency/City	Subdistrict	Company	Labor (people)
1	Ogan Komering Ulu	Lubuk Batang	Ptpn VII (Persero) U.U Kebun Baturaja	226
2	Muara Enim	Lawang Kidul	Lingga Djaja, PT	380
3	Musi Rawas	Nibung	Nibung Artha Mulia, PT	84
4	Musi Banyuasin	Lais	Ptpn VII (Persero) U.U Kebun Tebenan	735
5	Palembang	Kertapati	Prasidha Aneka Niaga, PT	193
6	Palembang	Gandus	GadjahRuku, PT	429
7	Palembang	Plaju	Hok Tong, PT	441
8	Palembang	Gandus	Panca Samudera Simpati, PT	316
9	Palembang	Kertapati	Remco, PT	297
10	Palembang	Gandus	Badja Baru Trading Company, PT	321
11	Palembang	Kertapati	Sunan Rubber, PT	417
12	Palembang	Sako	Cahaya Murni Sriwindo, PT	218
13	Palembang	Kalidoni	Muara Kelingi, PT	814
14	Palembang	Gandus	Aneka Bumi Pratama, PT	734

Source: BPS Directory of Industry

APPENDIX XXI: Plywood Manufacturing Process in Pictures

Debarking

Drying

Glue Mixer

Hot Press Machine

Cold Press Machine

Packaging

APPENDIX XXII: Plywood Companies in East Kalimantan

No	Regency/City	Subdistrict	Company	Labor (people)
1	Kutai Kartanegara	Loa Janan	Kayu Alam Perkasa Raya, PT	2978
2	Kutai Kartanegara	Sebulu	Sumalindo Lestari Jaya,PT	317
3	Kutai Kartanegara	Sebulu	NitiyasaMandiri	236
4	Penajam Paser Utara	Penajam	Inne Dongwha Development Ltd, PT	670
5	Penajam Paser Utara	Sepaku	International Timber Corp. Indonesia, PT	2308
6	Penajam Paser Utara	Penajam	Balikpapan Forest Industry, PT	1260
7	Balikpapan	Balikpapan Barat	Dwima Manunggal Raksa Wood Industry, PT	1090
8	Samarinda	Palaran	Daya Besar Agung Corporation, PT	1943
9	Samarinda	Palaran	Sumalindo Lestari Jaya Unit IIITbk, PT	451
10	Samarinda	Sungai Kunjang	Harimas Jaya Plywood, PT	1864
11	Samarinda	Samarinda Seberang	Meranti Sakti Indah Plywood, PT	654
12	Samarinda	Samarinda Seberang	Kayan River Indah Plywood, PT	842
13	Samarinda	Samarinda Seberang	Sumalindo Lestari Jaya, PT	2000
14	Samarinda	Palaran	Sangkulirang Bhakti, PT	928
15	Samarinda	Samarinda Seberang	Gani Mulia Sejahtera Industri, PT	1020
16	Samarinda	Palaran	Tirta Mahakam Plywood Industry, PT	1559
17	Samarinda	Sungai Kunjang	Melapi Timber, PT	2267
18	Samarinda	Sungai Kunjang	Wana Rimba Kencana, PT	677
19	Samarinda	Sungai Kunjang	Dharmawood Agung Industri, PT	222
20	Samarinda	Palaran	Segara Timber Co.Ltd., PT	1751
21	Samarinda	Sungai Kunjang	Kayu Lapis Asli Murni, PT	2079
22	Tarakan	TarakanTimur	Idec Abadi Wood Industries, PT	1300
23	Tarakan	Tarakan Utara	Intracawood Manufacturing, PT	3768
24	Tarakan	Tarakan Utara	ChipdecoIntiUtama	247

Source: BPS Directory of Industry

APPENDIX XXIII: Global CO_2 Emission Ranking 2011

Rank (prev yr)	Country	1990 mt CO2	2010 mt CO2	2011 mt CO2	% Change 1990-2011
	World	22,682	33,158	33,992	+50
1 (1)	China	2,452	8,333	8,876	+262
2 (2)	U.S.	5,461	6,145	6,027	+10
3 (3)	India	626	1,708	1,787	+185
4 (4)	Russia	2,369	1,700	1,674	-29
5 (5)	Japan	1,179	1,308	1,311	+11
6 (6)	Germany	1,029	828	804	-22
7 (7)	S. Korea	257	716	739	+187
8 (8)	Canada	485	605	628	+30
9 (9)	Saudi-Arabia	242	563	609	+152
10(10)	Iran	199	558	598	+201
11 (11)	Britain	625	548	513	-18
12 (12)	Brazil	246	464	488	+98
13 (13)	Mexico	283	447	464	+64
14 (16)	Indonesia	151	424	453	+200
15 (15)	S. Africa	329	437	452	+37
16 (14)	Italy	440	439	433	-2
17 (18)	Australia	279	367	391	+40
18 (17)	France	416	403	380	-9
19 (21)	Poland	382	325	347	-9
20 (19)	Spain	238	334	343	+44
21 (20)	Taiwan	136	331	329	+142
22 (23)	Turkey	142	307	323	+127
23 (24)	Ukraine	757	290	318	-58
24 (22)	Thailand	88	308	299	+239
25 (25)	Netherlands	219	276	267	+22
26 (27)	UAE	76	227	228	+200
27 (29)	Singapore	73	209	214	+193
28 (28)	Egypt	92	209	213	+132
29 (33)	Malaysia	67	167	203	+202
30 (31)	Venezuela	105	173	198	+88
31 (32)	Argentina	104	175	190	+83
32 (26)	Kazkahstan	250	235	169	-33
33 (34)	Pakistan	65	164	163	+150
34 (32)	Belgium Luxembourg	140	168	147	+5
35 (35)	Vietnam	36	122	128	+255
36 (36)	Uzebkistan	133	117	122	-8
37 (37)	Czech Rep	168	111	121	-28

38 (38)	Algeria	74	108	108	+46
39 (40)	Kuwait	26	85	94	+260
40 (41)	Hong Kong	41	83	93	+127
41 (39)	Greece	81	98	92	+13
42 (42)	Romania	169	80	85	-50
43 (45)	Chile	34	70	79	+133
44 (43)	Philippines	40	77	77	+91
45 (44)	Israel	36	76	76	+111
46 (48)	Qatar	17	66	75	+341
47 (47)	Colombia	52	68	72	+39
48 (46)	Austria	61	69	69	+12
49 (49)	Turkmenistan	36	65	68	+89
50 (51)	Belarus	111	62	67	-40
51 (52)	Bangladesh	17	59	61	+261
52 (50)	Portugal	46	63	57	+24
53 (54)	Sweden	61	56	56	-9
54 (53)	Finland	52	58	53	+2
55 (55)	Hungary	71	54	52	-26
56 (56)	Trinidad & Tobago	15	53	52	+244
57 (58)	Bulgaria	75	45	50	-33
58 (57)	Denmark	56	52	47	-16
59 (59)	Norway	35	43	46	+31
60 (62)	Peru	20	39	45	+126
61 (60)	Switzerland	45	42	41	-8
62 (63)	Slovakia	55	34	37	-32
63 (61)	Ireland	27	40	36	+34
64 (64)	New Zealand	29	34	35	+22
65 (65)	Ecuador	13	33	34	+161
-	Rest M. East	182	339	364	+100
-	Rest Africa	188	323	342	+82
-	Rest Eurasia	400	222	256	-36
-	Rest Lat Am	157	196	189	+20
-	Rest Asia Pac	176	128	139	-21

Sources: IWR Research, BP Statistical Review, German Economy Ministry