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Determination Specific Emission Factor From Industrial Sector For Estimating Carbon Footprint And Mapping In Sumenep District-East Java

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***Abstract*—The value of carbon footprint of industrial sector is 1692,60 ton CO_2/year. The SEF of industrial sector are 0,229 ton CO_2/year.ton production for food industry, 0,039 ton CO_2/year.unit for metal industry (keris) and 0,00258 ton CO_2/year.unit for mineral products non metal industry (roof-tile). In environmental aspect, the best scenario for industrial sector is scenario 1 because it can decrease karbon emission 47,7% than existent CO_2 emission. In legal aspect, the government of Sumenep district should has regulation about using LPG (Liquid Petroleum Gas) for industrial sector which refers to "President Regulation of the Republic of Indonesia No. 104 Year 2007" about on provision, distribution and pricing of *Liquefied Petroleum Gas* 3 kg"**

***KeyWords*---Industry, Carbon Footprint, CO_2 emission, Specific Emission Factor, Sumenep District**

I. Introduction

One of sources of air pollution from industrial sector is production process emission (from used fuel). Carbon emission is the biggest contributor of Greenhouse Gases. Even today estimated CO2 concentration in atmosphere is the most dominant of all greenhouse gases [1]. In line with that, produced CO_2 emission from activity of fossil fuel combustion is quite high, ranging from 10-12% [2]. Based on the problems, Indonesian goverment issued a regulation in "President Regulation No. 71/2011 about implementation of the National Greenhouse Gas Inventory". It require that each provincial and district government to do inventory of greenhouse gas which one of them is CO_2 emission. The result of inventory should be reported every year by district government to provincial government, provincial government to national governement and national government to the secretariat of the UNFCCC (United Nations Framework Convention on Climate Change). Therefore, this study will be carried out calculation to estimate the carbon footprint from industrial sector in Sumenep District. Based on spatial plans map of East Java, Sumenep District is area with the function of regional development of agriculture/horticulture. The parameter in this study is CO_2 emission and the calculated CO_2 emission is primary emission.

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II. Method

A. *Data Collection*

- Number of fuel consumption and production capacity in the industrial sector.
- Number of industry for each type of industry
- Government regulation

B. *Aspect of Study*

- Technical Aspect

  This aspect explains about calculation from the obtained data. It begins from calculating the carbon footprint (CO_2 emission) using IPCC guidlines Tier 2. Then calculating specific emission factor and mapping the estimated carbon footprint (CO_2 emission). The purpose of calculating SEF is helping other regions with the function of regional development of agriculture/horticulture (the same spatial plans) that do not have complete data for doing inventory of greenhaouse gases. Mapping the carbon footprint can be use to arrange strategic measure to decrease CO_2 emission that has spread. The used formula to estimate carbon footprint is

  $$\text{Emisi } CO_2 = \sum FC \times CEF \times NCV \quad (1)$$

  $\sum FC$ = Total Consumption Fuel (Gg)
  CEF = Carbon Emission Factor of CO_2 Emission (Based on the type of fuel) (Kg/TJ)
  NCV = Net Calorific Volume (Based on the type of fuel) (TJ/Gg)

- Aspek Lingkungan
  This aspect consists of some scenarios. The purpose of determination of scenarios is as attempt or alternative measures to reduce CO_2 emission in Sumenep District based on existing CO_2 emission. After calculating every scenario, persentage of CO_2 emission reduction will be known. Persentage of

CO_2 emission reduction can be as consideration for alternative election which can be applied in Sumenep District. There are 2 scenarios in environmental aspect, they are:

Scenario 1 : How much CO_2 emission if the entire of food industries that use firewood as fuel of the production process is changed using LPG
Scenario 2 : How much CO_2 emission if half of food industries that use firewood as fuel of the production process is changed using LPG

- Legal Aspect
  Legal aspect explains about legal/regulation in Sumenep District which regulating industrial sector. This study gives the better regulatory recommendations related to generated CO_2 emission from industrial sector.

III. Result

After doing survey, there are 3 types of industry that produce the primary emission in Sumenep District. They are food industry, metal industry (keris) and mineral products non metal (roof tile). Some types of industry use electricity for production process (producing secondary emission). Used fuel in production process for food industry in the manufacture of coconut oil and palm sugar is firewood while others use LPG. Used fuel for mineral product non metal industry for the manufacture of roof tile using straw, coconut fiber, husk and coconut leaves.

1. Technical Aspect

- Carbon Footprint Calculation

  Carbon footprint is calculated based on fuel consumption for production process in industrial sector. It is calculated using (1). The emission factor for CO_2 and NCV each type of fuel can be seen in Table 1

TABLE I. EMISSION FACTOR CO_2 AND NCV OF FUEL

Type of Fuel	CEF (Kg/TJ)	NCV (TJ/Gg)
LPG	63100[3]	47.4[4]
Kayu Bakar	112000[3]	15[4]
Arang	112000[3]	30[4]
Serabut Kelapa	100000[3]	9.8[4]
Jerami	100000[3]	15.2[4]
Sekam	100000[3]	14.4[4]
Biomassa Lain (coconut leaf)	100000[3]	11[4]

Source: [3] IPCC, 2006
[4] IPCC, 1996

After calculating the carbon footprint using [1] then value of CO_2 emission from sector industry in Sumenep District is obtained.

TABLE II. CARBON FOOTPRINT OF INDUSTRIAL SECTOR

Carbon Footprint (Ton CO_2/year)	Industrial Type		
	Food	*Base Metal (Keris)*	*Mineral Products non Metal (Roof Tile)*
CO_2 emission	1107.05	115.25	470.3

The higest value of CO_2 emission is food industry because the amount of food industry is the higest than other industries, moreover mostly using forewoof

- Specific Emission Factor calculation

  SFE calculations is obtained after calculating the carbon footprint. The carbon footprint is devided by activity data. The used activity data is production capacity.

TABLE III. SPECIFIC EMISSION FACTOR OF INDUSTRIAL SECTOR

	Industrial Type		
	Food	*Basic Metal (Keris)*	*Non-Metal Mineral Products (Roof Tile)*
Specific Emission Factor	0.229 (ton CO_2/year.ton of production)	0.039 (ton CO_2/year.unit)	0.00258 (ton CO_2/year.unit)

As the production capacity for food industry is 4825.33 ton/year while for basic metal industry (keris) and non-metal mineral product (roof tile) are 1440 unit/tahun dan 182.500 unit/year.

- Mapping

  Mapping is drawn for every subdistrict in Sumenep district based on industrial deployment.

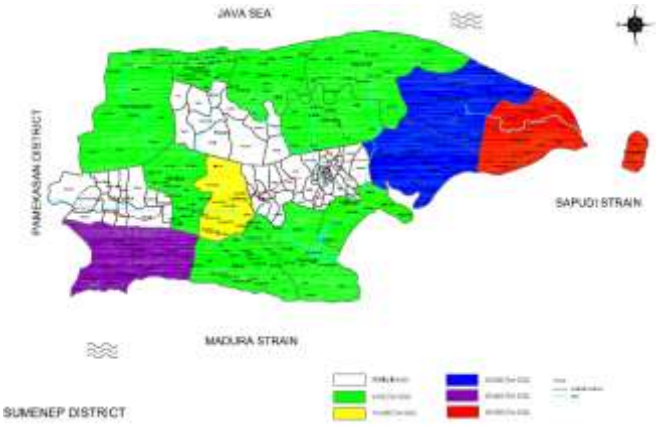

Figure 1. Mapping of CO_2 Emission Every Subdistrict

TABLE IV CARBON FOOTPRINT MAPPING OF INDUSTRIAL SECTOR

Name of Subdistrict	Color	CO_2 Emission (ton CO_2/year)
Dungkek	Red	401-500
Batang-batang	Blue	201-300
Gapura	Blue	201-300
Lenteng	Yellow	101-200
Bluto	Green	0-100
Pragaan	Gray	0-100
Batuan	Green	0-100
Batu Putih	Green	0-100
Manding	Green	0-100
Dasuk	Green	0-100
Kalianget	Green	0-100
Ambunten	Green	0-100
Pasongsongan	Green	0-100
Saronggi	Green	0-100

Mapping results indicate that the subdistrict having the highest CO_2 emission is Dungkek. It is because there are many food industries using firewood as fuel of production process and the non metal mineral products (roof tile) industries use some biomassa fuel such us palm leaves, coconut fiber, straw and husk.

2. Aspek Lingkungan

The calculation result of several determinated scenarios can be seen in Table V

TABLE V. PRESENTAGE OF REDUCTION

	Scenarios	
	I	***II***
Presentage of reduction (%)	47.4	24.7

The higest reduction persentage of CO_2 emission is skenario 1 (47%). For further it can be alternative measure to decrease CO_2 emission in Sumenep District for indutrial sector.

3. Legal Aspect

The function of legal aspect is supporting the implementation of selected scenario. at this time there is no regulation in Sumenep District regarding the obigation to use LPG for fuel of small industry and prohibiting to use of biomass fuel. Sumenep Government is expected having regulation by reffering to "President Regulation of the Republic of Indonesia No. 104 Year 2007" about on provision, distribution and pricing of *Liquefied Petroleum Gas* 3 kg" as reference material. Then arrange the socialization about the regulation to Sumenep people in order they can understand and obey it.

IV. Conclusion

Based on this study, it can be conclude that usage of biomass fuels such as firewood, rice husk, straw and others can produce high CO_2 emission compared to the usage of LPG fuel . That is because the emission factor of biomass fuels is high and the net calorific volume is small, inversely proportional to LPG which has the small emission factor and high net calorific volume value.

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