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RESEARCH & KNOWLEDGE

Research Article

Determining Eco Efficiency and Factor of Greenhouse Gas Reduction Project in Food Processing Industry; a Case Study of Ready to Eat Food Factory in Thailand

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Abstract: Greenhouse gas (GHG) reduction project is one of the key elements for industry to develop toward sustainability. This paper aims to determine eco efficiency of a greenhouse gas reduction project in food processing industry using a case study of a ready to eat food factory in Thailand. The study starts with an analysis of the Carbon Footprint for Organization (CFO) data of the factory in 2015 and 2016. A GHG reduction project is then formulated and implemented. The factory's CFO in 2017 is then calculate and eco efficiency of each year is then determined. From the study it is shown that eco efficiency of the factory in 2015, 2016, and 2017 is equal to 0.639, 0.575, and 0.693 unit/ton.co2e respectively. Finally, the factor of this study is calculated to be 1.085

Keywords: Eco efficiency, Factor, Carbon footprint for Organization, Food Processing Industry

1. Introduction

In 2013 Intergovernmental Panel on Climate Change, IPPC found that GHG from Industrial Sector is around 36.11 MtCO2e which mineral production is the main sector following by chemical production industry and metal production industry (IPPC, 2013). Beside these main sectors that mention early one of the industry that growth constantly related with number of world population is food industry. Ready to eat Food has played a major role in our daily life nowadays. Thus, it's not surprise that production volume of such a manufacturer has increased gradually. Greenhouse gas (GHG) reduction project is one of the key elements for industry to develop toward sustainability. This paper aims to determine eco efficiency of a greenhouse gas reduction project in food processing industry using a case study of a ready to eat food factory in Thailand which locate in Chachengsao province. This manufacturing system comprised of four main processes including preparing of raw material, cooking, packing, and warehousing. Thermal energy is used mainly in cooking and packing process. Main sources of energy are bunker-A oil used in boiler to generate stream.

2. Methodology

In this study, data collecting of Carbon Footprint for Organization (CFO) data using Thailand Greenhouse Gas Management Organization (TGO) standard (TGO, 2015) is done for the data of 2015 and 2016. Second, GHG reduction project is then formulated and implemented. Third, the factory CFO of 2017 is then calculated. Forth, Eco efficiency in the unit of unit/ton.CO2e is calculated for the data in 2015, 2016, and 2017. Finally factor of this study is then calculated

3. Data collection

3.1 CFO data of 2016 and 2017

Using Thailand Greenhouse Gas Management Organization (TGO) standard CFO of the case study in year 2016 and 2017 is shown in Table-1 Table-2 Fig-1 and Fig. 2 respectively.

Table-1 CFO of 2015 (Base Year)

CFO (2015)		Ton CO2e	Percentage	TonCO2e/Unit
SCOPE-1	LPG USAGE	19.77	0.33%	0.005
	BUNKER A USAGE	2,369.19	39.62%	0.621
	Mobile Combusion	15.94	0.27%	0.004
	Other Direct Emission	70.88	1.19%	0.019
SCOPE-2	Purchased Electricity	3,503.83	58.60%	0.918
Total		5,979.61	100.00%	1.566
Production Volume	3,818 Ton/year			

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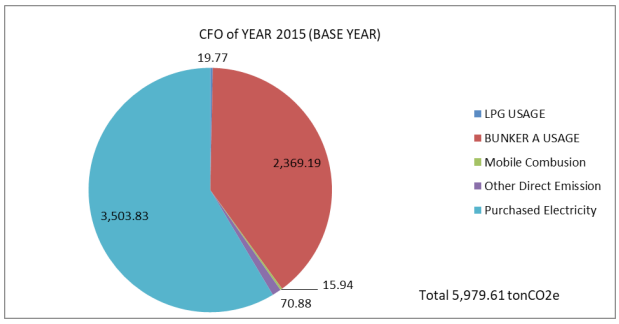

Fig-1 CFO of 2015 (Base Year)

Table-2 CFO of 2016

CFO (2016)		Ton CO2e	Percentage	TonCO2e/Unit
SCOPE-1	LPG USAGE	16.43	0.26%	0.004
	BUNKER A USAGE	2,829.95	44.47%	0.773
	Mobile Combusion	18.54	0.29%	0.005
	Other Direct Emission	86.85	1.36%	0.024
SCOPE-2	Purchased Electricity	3,412.08	53.62%	0.932
Total		6,363.85	100.00%	1.738
Production Volume	3,661 Ton/year			

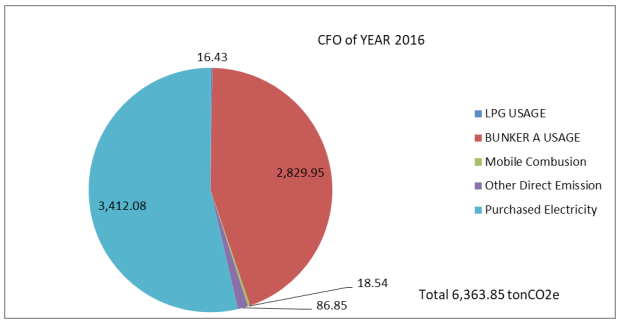

Fig-2 CFO of 2016

3.2 GHG Reduction plan and implementation

After CFO of year 2015 and 2016 has been determined, GHG reduction plan had also been issued regarding to significant of the GHG contribution of the CFO value. On both years depict that main contribution come from purchased electricity then bunker-A usage then will other direct emission. Therefore in this study a GHG reduction plan on reduction of bunker-A usage is has been established. Boiler pressure resetting has been conducted by reducing pressure setting of boiler-1 down from 7.0 bar to 6.0-7.0 bar and resetting boiler-2 down from 7.0 bar to 5.5-6.5 bar. This resetting cause reduction of bunker A usage 5,588 liter/year which lead to reduction of cost up to 59,233 baht/year and reduction of GHG 17.257 ton.CO_2e/year (Sangsai, 2018). This GHG reduction plan and implementation is shown in Fig-3 and Fig-4 below.

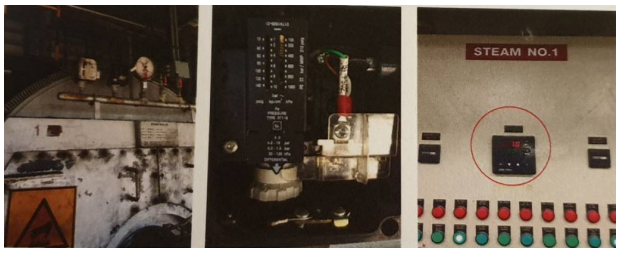

Fig-3 GHG reduction by resetting pressure of Boiler-1 (Sangsai, 2018)

Fig-4 GHG reduction by resetting pressure of Boiler-2 (Sangsai, 2018)

3.3 CFO of 2017

After GHG reduction plan has been implemented then in year 2017 using the same method as 2015 and 2016, CFO of case study factory has been calculated as shown in Table-3 and Fig-5

Table-3 CFO of 2017

CFO (2017)		Ton CO2e	Percentage	TonCO2e/Unit
SCOPE-1	LPG USAGE	24.60	0.34%	0.005
	BUNKER A USAGE	3,330.56	46.10%	0.665
	Mobile Combusion	20.15	0.28%	0.004
	Other Direct Emission	100.70	1.39%	0.020
SCOPE-2	Purchased Electricity	3,748.99	51.89%	0.749
Total		7,225.00	100.00%	1.443
Production Volume	5,007 Ton/year			

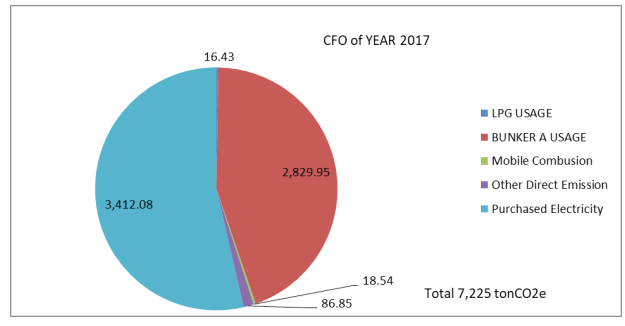

Fig-4 CFO of 2017

3.4 Eco Efficiency of 2015, 2016 and 2017

Using data from CFO of each year, eco efficiency of the case study factory can be determine using Eq (1) as follow

$$\text{Eco Efficiency} = \frac{\text{Product Volume/Year}}{\text{CFO}} \quad (1)$$

From Eq (1) Eco efficiency of the case study factory in year 2015 2016 and 2017 can be determined as shown in Eq (2) Eq (3) and Eq (4) respectively

$$\text{Eco Eff.}_{2015} = 3{,}818/5{,}979.61 = 0.639 \text{ unit/ton.}CO_2e \quad (2)$$

$$\text{Eco Eff.}_{2016} = 3{,}661/6{,}363.85.61 = 0.575 \text{ unit/ton.}CO_2e \quad (3)$$

$$\text{Eco Eff.}_{2017} = 5{,}007/7{,}225 = 0.693 \text{ unit/ton.}CO_2e \quad (4)$$

3.5 Calculating of Factor

Finally after eco efficiency have been determined then factor can be calculated compare to base year using Eq. (5)

$$\text{Factor} = \frac{\text{Eco Eff.}_{\text{Current Year}}}{\text{Eco Eff.}_{\text{Base Year}}} \quad (5)$$

Therefore in this study factor can be determined as

$$\text{Factor} = 0.693 / 0.639 \quad (6)$$
$$= 1.085$$

4. Results and Discussion

In this research we have found that CFO main contribute is from direct stationary combustion using Bunker-A heavy oil in the boiler and from electricity purchased from energy supplier. However for this study, GHG reduction plan has focus on resetting pressure of the boiler so that Bunker-A heavy oil will consume less therefore would lead to a reduction of CFO.

CFO or total GHG that emission from factory operation, by definition, both direct and indirect emission, is the total amount that harm this world and the environment however we can present this value in terms of intensity such as GHG per production volume or GHG per production value as shown in Fig-5

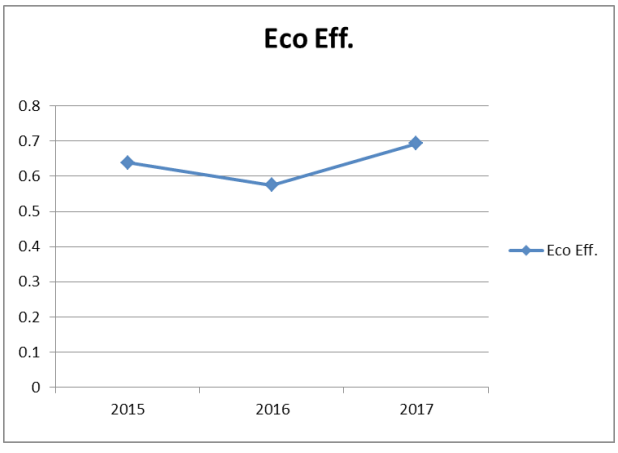

Fig-5 Graph represents Eco efficiency of the case study factory in 2015-2017

In Fig-5, it is shown that eco efficiency in 2016 is decrease from 2017 due to the effect of economic recession that affect the total production to decreases from 3,818 ton/yr in 2015 to 3,661 in 2016. While the production volume is alter but the main amount of energy to maintain the production to running still the same. Thus, its effect the eco efficiency in year 2016 to decreased. While in 2018, when economics situation is picking up, with production volume of 5,007 ton/yr, the eco efficiency is increased

5. Conclusion

From this study we can conclude that Eco efficiency in this case study factory is equal to 0.639 in year 2015, 0.575 for year 2016 and 0.693 for year 2017 The factor of the implementation in year 2017 compare to based year in 2015 is 1.085 which depict the improvement of 8.5%

6. Acknowledgement

This study would not have been possible without support from Case Study Company and also would definitely not success without the contribution of environmental manager for her support in data collection and advisor of the GHG reduction of energy conservation staff.

7. References

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