Comprehensive Evaluation on the Increase of Cocodiesel Blend Usage in Lucena City, Philippines

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Abstract

Philippines is one of the countries in Asia that is dependent on imports for its energy consumption. However, due to the continuous increase on price of fossil fuels in the recent years, the possible exhaustion of its available reserves due to large-scale usage, and its harmful by-products, it triggered the country to search for cleaner, cheaper and more sustainable alternatives. Since the signing of the Republic Act No. 9367 (RA 9367) last January 12, 2007, which is known as the "Biofuels Act of 2006" that aims to reduce dependence on imported fuel, efforts have been made all throughout the Philippines as an act of support. One of which is the project of Lucena City that aims to make the city as the "Biofuels City" of the country by increasing the biofuels blends from 1% to 100% purity. In this study, the effect of increasing the cocodiesel blend to the environment, economics, and society was evaluated. The location and calculation of distances between farms, oil mills and biodiesel production plant was done using Geographical Information System (GIS). The result in the life cycle analysis (LCA) using Sustainable Process Index (SPI) shows that cocodiesel production and usage has an average overall footprint ranging from 16.98 – 18.98 at 1% - 30% percent blend that is lower than the petroleum diesel which has 26.1 m^2.a/MJ. However, the increase in % blend has a minimal effect due to the increase in transportation distance as % blend increases since the number of sources for coconut oil to supply the demand increases as well. In the GAMS simulation, the most suitable farms or oil mills to supply the coconut oil to biodiesel plant were selected depending on the capacity of the farms and oils mills and the demand created from the increase in % blend. Also, it was found out that even if the CO_2 emission from transportation increases as % blend increases, the amount of CO_2 emission reduced from the use of higher blend is still higher than the transportation emission. Lastly, survey shows that majority of the respondents from Lucena City support the project but only willing to pay up to US $ 0.02 per liter for usage and up to US $ 0.04 for production, which is equivalent to 18.2 – 33.3% and 36.4 – 66.7% cocodiesel blend, respectively.

I. INTRODUCTION

Lucena City is the capital of Quezon Province which is known in the Philippines for coconut plantations. It is one of the major producers of coconut oil that is primarily being exported, and this can be attributed to its location, which is basically suitable for growing coconuts. According to Lucena City government, in 2006, about 77% of the its land area was utilized for agricultural purposes, and about 47% of it was for coconut farming while about 38% was for the rice fields, and the remaining areas were for fishponds, mangroves, shorelines, and for growing other crops. On the other hand, the other 33% of Lucena's land area was mostly used as residential area while others for infrastructures, industry and commercial purposes.

At present, the local government of Lucena City had volunteered to be a laboratory for the testing of biofuels at higher blends, from 20% - 100%, primarily cocodiesel, since its resource is widely available in the area. This is in line with Republic Act 9367 (RA 9367) or the "Biofuels Bill" which supported the mandate for the use of 1-2 % blend of biodiesel and 1-5% of bioethanol nationwide. In this regard, the study for the sustainability of increasing the cocodiesel blend as well as its effect economically, environmentally and socially is needed.

II. OBJECTIVES

This study aims to comprehensively evaluate the effect of increasing the cocodiesel blend in Lucena City in terms environmental, economic and social aspect by using various tools for analysis such as Life Cycle Analysis (LCA), Contigent Valuation Method Also, it aims to come-up with alternative solution/s to secure the sustainability of coconut-oil-based industries (COBI) including cocodiesel by using simulation. The data being considered are; supply and demand, number of companies and its capacity, price, blends: 1% – 100%, and GHG emissions such as; CO_2 and SO_x.

III. METHODOLOGY

The study will be conducted in four major steps which are as follows:

1. Data gathering – gathering information from statistics, review of related literature, conducting interview and surveys.
2. LCA of Cocodiesel Industry – the LCA will be conducted using LCA software such as Eco-it and Eco-edit Ecodesign tools, SimaPro 7.1, and Sustainable Process Index (SPI). The LCA of cocodiesel production process will start from coconut farming up to cocodiesel production at different blends. The analysis will be divided into four phases (see Fig. 01).
3. Based on the LCA results, further analysis of the scenarios that are found to be environment-friendly, economically advantageous and socially acceptable, will be conducted by simulation using General Algebraic Modeling System (GAMS) and Geographic Information System (GIS).
4. Then, based on the results of the analyses, decision-making models will be made and will be presented to the local government of Lucena City to provide options that will aid them on making the policy for the use of biofuels within their vicinity.

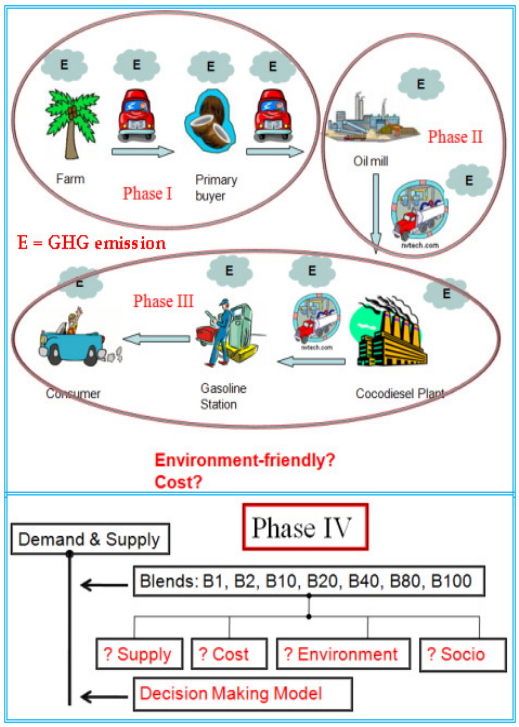
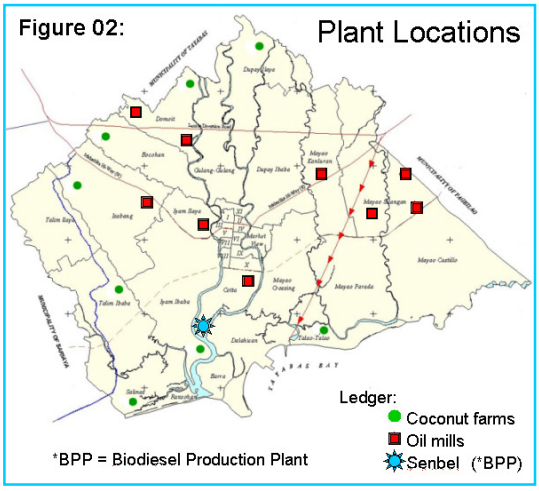


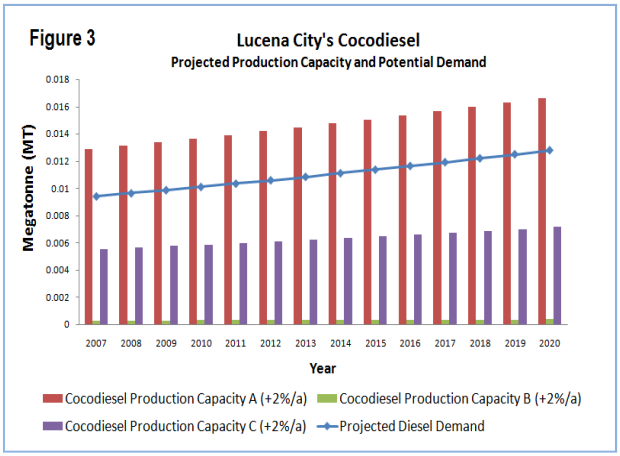
Figure 01: LCA Phases (Cocodiesel Production Process)

IV. RESULTS AND ANALYSIS

Based on the data gathered, it was found out that 9 out of 19 coconut oil mills within Quezon Province, which include 2 of its largest, are located at Lucena City. It has a total milling capacity of 384, 000 metric tonnes (T) or 0.3 Megatonne (MT). In addition, Senbel Fine Chemicals Company, Inc. has its biodiesel production plant (BPP) at Lucena City as well, which has a processing capacity of 61 MT of cocodiesel. According to the Annual Report of Lucena City last 2006, about 29.9 km^2 of its total land area was devoted for coconut farming, which could produce about 0.01318 MT cocodiesel as calculated. However, upon visiting the location, it was learned that only 6.32 km^2 are actively engaged in coconut farming and being nurtured by about a hundred farmers, and none of which supply copra or coconut oil to any of the oil mills within or outside the city due to small quantity of production. In the interview conducted with the coconut farmers, it was found out that at present, they are struggling with the market of their products, thus, they are putting their hopes to the city's project regarding the increase on cocodiesel blend that would create a higher demand for coconut oil. The active farms are located within 8 barangays and have a cocodiesel production capacity of 271.5 T per year. The mapping of coconut farms (CF), oil mills (OM) and biodiesel production plant (BDP)' location and the calculation for distance between CF and OM to BDP were done using GIS. Please see Fig. 02 for the location of the said farms/plants. Since there is no data



available for the diesel demand for Lucena City, it was calculated using the data from Calabarzon (Region where Quezon Province is) based on the average diesel demand/person. Comparing the cocodiesel production capacity and the calculated diesel demand for Lucena City, only about 2-3% of the projected cocodiesel demand can be provided by the local farms (see Fig. 03). Thus, 4% from the allotted amount for coconut oil export from each oil mills were taken as part of the supply. This includes oil mills from other municipalities that are near to Lucena City (see Figure 4). The diesel demand was projected based on a 2.2% population growth rate per year and the cocodiesel production capacity at 2% increase in coconut harvest and coconut oil production annually.



Cocodiesel Production Capacity A(CPB-A) = 2006 Lucena City Report, CPB-B = Lucena City Agriculturist's Office, CPB-C = CPB B + 4% of the allotted portion for export from each

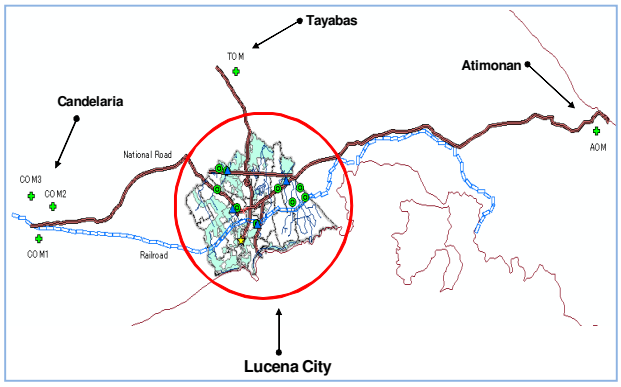


Figure 4: Location of oil mills outside Lucena City

Result from the SPI analysis shows that the production and use of cocodiesel is more environment friendly than petroleum diesel. In the analysis, the overall footprint of cocodiesel at different scenarios ranges from 16.98 - 18.5 m^2.a/MJ compared to petroleum diesel that has 26.1 m^2.a/MJ. In this part of the study, the effect of different transportation distance and mode of transportation were the ones evaluated with the consideration on the combustion emission due to the increase of cocodiesel blend since the process chemicals and process energy for the production of a kg of cocodiesel, regardless of where it is being processed, is assumed to be identical. (see Table 1 for the conditions on each scenario and the results of the analysis). Based on the result, the effect of increasing the cocodiesel blend is minimal. Even though there was an increase in SPI footprint as the transportation distance increases with % in blend, the reduction from the combustion emission compensate with it. The combustion emission includes CO_2 and sulfur.

Table 1: Conditions and Results of the SPI analysis on different scenarios

Scenario	Blend	Transportation (16T= 16ton truck, 28T= 28ton truck, 40T= 40ton truck, RW= Railway)	Combustion emission (% share on SPI Footprint)	Transportation (% share on SPI Footprint)	SPI Footprint (m^2.a/MJ)
SC1*	1%	40T	54.61%	0.61%	17.36
SC2*	1%	40T, RW	54.73%	0.42%	17.32
SC3**	1%	40T, RW	54.08%	1.61%	17.53
SC4*	10%	16T, 28T, 40T, RW	49.62%	4.71%	17.01
SC5*	10%	40T, RR	49.71%	4.58%	16.98
SC6***	20%	16T, 28T, 40T, RW	41.85%	13.57%	17.42
SC7***	20%	40T, RW	42.24%	12.78%	17.26
SC8***	30%	16T, 28T, 40T, RW	33.66%	23.79%	18.25
SC9***	30%	40T, RW	34.17%	22.62%	17.98

Using GAMS simulation, the most suitable farms or oil mills to supply the coconut oil to biodiesel plant were selected depending on its capacity and the demand created from the increase in % blend. See Table 2 for the summary. Also, it it was found out that even if the CO_2 emission from transportation increases as % blend increases, the amount of CO_2 emission reduced from the use of higher blends is still higher than the transportation emission. Thus, it is more environment friendly if we use higher blends. See Table 3.

Lastly, on the survey, out of the 120 targeted respondents, 89.17 % complied with the survey. The survey

Oil Mill/Farm to BDP	Monthly Supply Allocation (T) per % blend						
	1%	10%	20%	30%	40%	50%	60%
fcluster1 a.BDP1			8.47	8.47	8.47	8.47	8.47
fcluster2a.BDP1			2.15	2.15	2.15	2.15	2.15
fcluster3a.BDP1					9.15	9.15	9.15
fcluster4a.BDP1					5.37	5.37	5.37
LOM1 .BDP1					23.38	23.38	23.38
LOM2 .BDP1						35.07	35.07
LOM3 .BDP1			11.69	11.69	11.69	11.69	11.69
LOM4 .BDP1		56.39	73.06	73.06	73.06	73.06	73.06
LOM5 .BDP1	9.36	35.07	35.07	35.07	35.07	35.07	35.07
LOM6 .BDP1						43.84	43.84
LOM7 .BDP1			32.91	87.68	87.68	87.68	87.68
LOM8 .BDP1						6.01	35.07
LOM9 .BDP1					23.38	23.38	23.38
COM1 .BDP1			23.88	23.88	43.84	43.84	43.84
COM2 .BDP1				38.84	36.53	36.53	36.53
COM3 .BDP1					14.68	23.38	23.38
TOM .BDP1							23.38
AOM .BDP1							20.46
TOTAL Monthly Demand	9.36	93.6	187.23	280.84	374.45	468.07	540.97

Table 2: Supply allocation from different farms and oil mills, fcluster = farm cluster, LOM = oil mills from Lucena City, COM = oil mills from Candelaria, TOM =oil mill from Tayabas and AOM = oil mill fromAtimonan

Amount of CO_2 per month	Cocodiesel blend					
	1%	2%	3%	4%	5%	6%
CO_2 emission in kg (Transportation)	6.83	55.03	142.73	258.71	371.82	525.63
CO_2 emission in kg (Reduced)	3116.88	31172.13	62347.59	93519.72	124691.85	155867.31

Table 3: CO_2 emission from the transportation for cocodiesel production and reduction from the usage depending on % blend

forms were written in English and Filipino and were distributed depending on the respondents' preference in order to make sure that every individual had a clear understanding of the questions. handed and collected personally at a random order. Among 89.17% respondents, 32% are students, 28% are government employees, 14% are farmers, while the remaining 26% includes plain housewives, electricians, former overseas contract workers among others Results show that majority of the respondents from Lucena City support the project but only willing to pay up to US $ 0.02 per liter for usage and up to US $ 0.04 for production, which is equivalent to 18.2 – 33.3% and 36.4 – 66.7% cocodiesel blend, respectively. See Figure 5.

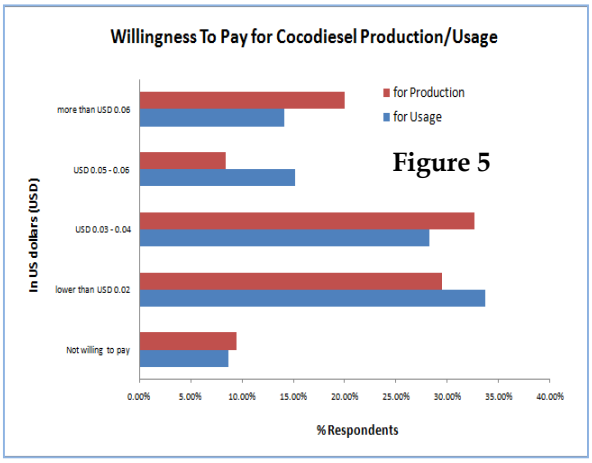


Figure 5

V. CONCLUSION and FUTURE PLANS

Results show that there is a minimal effect of increasing the blend on cocodiesel if the transportation of raw materials increases due to the shortage of supply. In the GAMS simulation, it was observed that misjudgment on the supplier may account up to 7000g of CO_2 emission per tonne delivered, thus, it is important to consider the location and capacity of each farm or oil mill for the supply allocation. In addition, the use of higher blends may reduce CO_2 emission largely compared to the CO_2 emitted from the transportation on its production. However, due to the higher price of cocodiesel compared to the conventional diesel, only up to 30% blend is recommended for Lucena City based on the survey results. For future plans, further studies should be considered on how to minimize the cost of cocodiesel in order to make it more competitive.

VI. REFERENCES and ACKNOWLEDGMENT

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