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Economics of Palm Oil Empty Fruit Bunches Bio Briquettes in Indonesia

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ABSTRACT

This study provides background data and justification for the development of bio briquettes from palm oil empty fruit bunches (EFB) and evaluates a pilot project utilizing this palm oil industry waste by-product in Indonesia. This activity is also important from the environmental standpoint since it helps in achievement of sustainable environment in Indonesia. This is due to the fact that EFB that is left to decay and is not processed is a significant source of pollution (Chiew and Shimada, 2013). Indonesia has become the world's biggest palm oil producer with more than 20 million tons crude palm oil (CPO). Annual growth rate is about of 10%. This helped to Indonesian economic growth and poverty alleviation, provided benefits for big companies and thousands of smallholders. But this led also to deforestation and reduction of biodiversity. The Indonesian palm oil industry now still did not recover from palm oil prices drop down and use of palm oil by products should be on the focus also to support this Indonesian main business. Palm oil is facing criticism for using food crop as fuels, but EFB is absolutely non-food palm oil production by product. This by-product is underestimated in economic way and relatively huge amount is not used in Indonesia and could potentially contribute to sustainable green energy production especially for power generation needs in Indonesia (Mohammed et al., 2012).

Keywords: Sustainable Development, Crude Palm Oil, Briquettes, Renewable Energy, Profitability
JEL Classifications: Q2, Q4, Q5

1. INDONESIAN PALM OIL PRODUCTION

Oil palm tree (*Elaeis guineensis*) is a tropical species that produces crude palm oil (CPO). This tree originates in West Africa, but nowadays grows in many parts of the world, including Indonesia. CPO became internationally traded commodity. Malaysia and Indonesia covers more than 90% of CPO global production. Indonesia is number one producer and production is estimated to exceed 20 million metric tons with almost 10 million hectares planted. CPO is used especially for production of cooking oil and related products and for biodiesel production and as a biofuel (McClanahan, 2013). CPO as any other commodity is also very important in sense of sustainable trade development (Svatos et al. 2013, Sulaiman and Abdullah, 2011).

For example, Indonesian state power company PT PLN has started to operate a 10 megawatts power plant fired by CPO in Dumai, Riau Province. The power plant was initially fuelled with diesel but was later converted to a CPO-fuelled power plant by installing converter equipment at the plant (Alfian, 2008).

Sumatra is the leading CPO production center in Indonesia. Oil palm tree has made huge contributions to poverty alleviation in Indonesia, helping to millions of smallholders (McClanahan, 2013).

Oil palm tree is also produces big amount of biomass. 1 kg of CPO is accompanied approximately by 4 kg of dry biomass which is produced. One third of this biomass are oil palm empty fruit bunches (EFB) and the rest are fronds and oil palm trunks. Besides CPO production, there is interest to create source of renewable energy by using oil palm biomass. EFB is obviously used for composting and mulching on plantations. This article is focused on EFB bio briquettes production. Advantages of using bio briquettes are also clear from Table 1 where key characteristics for briquettes are analyzed (Chiew and Shimada, 2013).

BRIQUETTES FROM PALM EFB

Shredded fibers of EFB were collected at palm oil mill which belongs to state owned Indonesian oil palm plantation company PT. Perkebunan Nusantara Indonesia in village Dolok Sinumbah on North Sumatra. Shredded fibers of EFB were delivered to leading Czech Republic bio briquette machine producer and the material was tested for bio briquettes production. Final briquette's density was from 0.83 kg/dm^3 to 0.92 kg/dm^3. Moisture of raw material was 14.6%. The briquettes have following properties that are summarized in Table 2.

2.1. Economy of Small Scale Briquetting EFB Project in Indonesia

Below, economy of 100 kg/h briquetting line (small scale project) is evaluated. These calculations are based on assumption that the material is dried. In other case, it would be needed to increase line capacity and invest into a drier with a boiler. It is also assumed that already shredded EFB are used. For example, the palm oil mill in Indonesia has an EFB shredder already in place since EFB compost is already produced there. Nevertheless, half of EFB is unused. Therefore, there is a potential to use this for briquetting. Below, two scenarios are analyzed. Firstly, a scenario with natural drying in the sun is considered. This is definitely a less expensive option with lower initial capital requirement but it also may lead to uncertain level of moisture in the input material. Secondly, a scenario with a dryer machine is introduced (Nieves et al., 2011). This is a costly option but it gives a certainty of desired level of humidity in the input material. In order to evaluate economy of this project, it is necessary to determine key dynamic profitability indicators. Net present value, payback period as well as turn even point are evaluated through cost determination and output price evaluation (Gunstone, 2008).

2.2. Briquetting without a Dryer

Major economic variables are described in the Table 3 for the case without a dryer.

This leads to calculation of variable and fixed costs, total revenue and profit that are presented in Table 4 of this paper.

After determining cost, revenue and profit, it is possible to calculate some of the profitability indicators (return on investment [ROI], payback period).

ROI is the benefit to the investor that results from an investment into some resource. A high ROI means the investment gains can be favorably compared to the investment cost. As a performance measure, this indicator is used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments. In purely economic terms, it is one way of considering profits in relation to capital invested (Farris et al., 2010).

$$\text{Return on investment} = \frac{(\text{gain from investment-cost of investment})}{\text{cost of investment}}$$

Payback period in capital budgeting refers to the period of time required to recoup the funds that are spent in an investment, or to reach the break-even point (BEP) (Farris et al., 2010).

$$Payback\ period = \frac{(p - n)}{p} + n_y = 1 + n_y - \frac{n}{p} (unit : years)$$

where n_y is the number of years after the initial investment at which the last negative value of cumulative cash flow occurs, n is the value of cumulative cash flow at which the last negative value of cumulative cash flow occurs and p is the value of cash flow at which the first positive value of cumulative cash flow occurs (Farris et al., 2010).

Payback period and ROI are summarized in Table 5.

Finally, using the data, BEP is graphically represented in Figure 1. The BEP in economics, business, and specifically

Table 1: Characteristics for briquettes

Fuel type	Parameters calorific value (MJ/kg)	Ash content (%)	Other factors
Briquette	17.58-20.10	0.5-8	No sulphur and smoke
Coal	15.07-18.84	30-50	Aromatic contents and sulphur
Fire wood	9.21-12.98	20-25	High smoke

Source: Chiew and Shimada, 2013

Table 2: Laboratory tested properties of briquettes

Parameter	Value
Dry mass (% mass)	93.70
Net calorific value (MJ/kg)	17.61
Ash (% mass)	5.9
Nitrogen (%mass)	1.7
Carbon (% mass)	47.10
Sulphur (% mass)	<0.10
Hydrogen (% mass)	6.20
Oxygen (% mass)	40.54
2 ross calorific value (MJ/kg)	18.96

Source: Own research

Table 3: Briquetting without a dryer

Costs	Price
Electricity (USD/year)	4,130
Labour (USD/year)	4,082
Input material (USD/tonne)	10
Sales price of final briquettes (USD Ex work)	56
Briquetting machine (EUR)	24,446
Land	0

Source: Own compilation

Table 4: Cost, revenue and profit calculations

Costs	Price
Costs of materials (USD/year)	5,760
Total costs (USD/year)	13,927
Total sales (USD/year)	32,256
Expected profit (USD/year/EURO)	18,329/13,295

Source: Own compilation

Table 5: Summary of economic results

Payback period (years)	1.33
Expected ROI (%)	75

Source: Own compilation. ROI: Return on investment

Table 6: Dryer and briquetting machine

Costs	Price
Electricity (USD/year)	102,150
Labour (USD/year)	12,246
Costs of material (USD/year)	57,600
Total cost (USD/year)	171,996
Total sales (USD)	322,560
Expected profit (USD/year/EURO)	150,564/113,556
Price for briquetting dryer including transportation (EURO)	422,500

Source: Own computation

Table 7: Payback period, ROI

Payback period (years)	3.72
Expected ROI (%)	26.87

Source: Own computation. ROI: Return on investment

cost accounting, is the point at which total cost and total revenue are equal: There is no net loss or gain, and one has "broken even." A profit or a loss has not been made, although opportunity costs have been "paid," and capital has received the risk-adjusted, expected return. In short, all costs that needs to be paid are paid by the firm but the profit is equal to 0 (Farris et al., 2010).

Some of the drawbacks of these calculations are that investment into a shredder is not calculated. Also, assumption is made that drying is done in the sun rather than by a dryer. Therefore, since also a raining season must be taken into consideration, the second scenario deals with a case when a dryer is purchased (Own compilation).

2.3. Briquetting with a Dryer

Economic calculations while a dryer is utilized.

For this scenario machinery that does both drying and briquetting is purchased with a production capacity of 1 ton/h. In Table 6, key economic variables are introduced for the calculations.

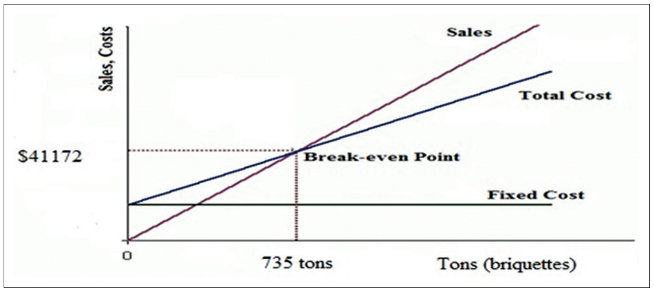
These data are further analyzed using indicators of ROI and payback period which are presented in the Table 7.

Finally, similarly to no dryer option, also for the dryer scenario, BEP is calculated and graphically represented in the Figure 2.

2.4. Analysis of Output Prices

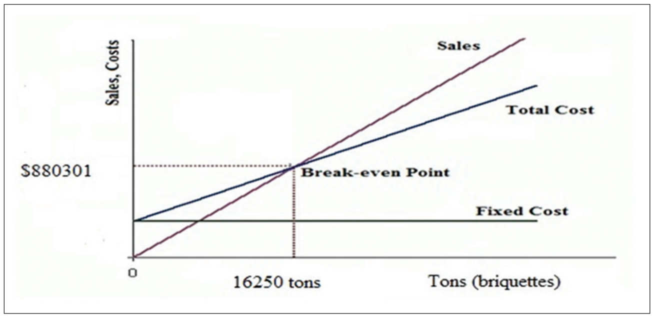
For the analyzed project, one of the most important variables is the potential development of the output price. As there are no data on price of briquettes made from palm trees, authors of this article found data on producer price index of pellets, briquettes, logs or similar forms made of wood shavings and other sawing by-products (Biomass Briquette Systems). This producer price index is graphically demonstrated in Figure 3.

Figure 1: Break-even point no dryer



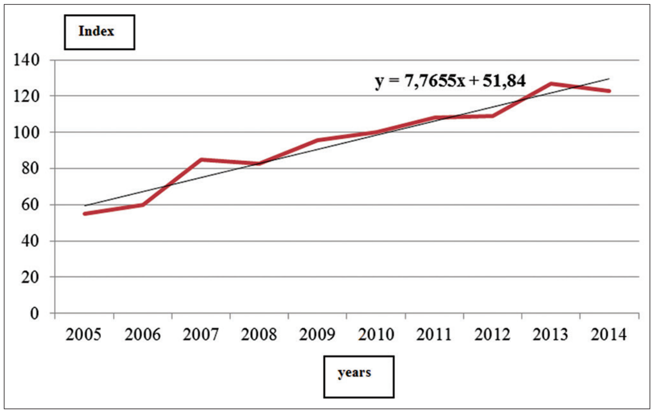
Source: Own compilation

Figure 2: Break-even point dryer



Source: Own compilation

Figure 3: Producer price index for pellets, briquettes, logs or similar forms made of wood shavings and other sawing by-products



Source of data: Biomass briquette systems, own compilation

Trend analysis in Figure 3 shows a positive result with an increasing trend that may further enhance profitability of the analyzed project. Finally, it is important to mention also the risk of this project. Investment risk can be defined as the probability or likelihood of occurrence of losses relative to the expected return on any particular investment (McNeil et al., 2005). Authors of this research consider one of the highest risk to ensure sufficient supply of residues to the briquetting machine.

3. CONCLUSION

Evaluation of briquetting is positive in both cases – w/o and with a dryer with fast payback period. In our opinion drying on concrete of shredded EFB on the sun would be possible and therefore first option seems to be more feasible. For example, coffee producers have long term experience with drying material on the sun in Indonesia. Also, analysis of output price shows increasing trend which is positive for the investment. Authors consider this project very interesting of such a project could be done on North Sumatra where so many palm plantations are located and power plants which use biomass and coal difficult to obtain for a good price (not many mining sites in that location) (Nasution et al., 2014). In addition, this topic is related to the issue of the construction of biomass power plants in Indonesia generally (Nasution et al., 2014). This is dependent largely upon support of government. The government can also intervene in the pricing of different types of biomass feedstocks so that a regular supply of raw materials for biomass-based power plants is assured. If investors have the assurance of regular and equitable supply of raw material prices, the financial risk will go down drastically and will invest more in the creation of new biomass plants.

The Ministry of Energy should also be involved in setting the rules governing market and the old power plant on the oil/coal power plant to convert biomass. The introduction of specific incentives for the combined combustion of coal based power plants to biomass as a co-fuels will create interest. When using a fuel mixture of 95% carbon and 5% biomass, other infrastructure investments are required, and these projects should be strongly encouraged by the government. The Indonesian government could also consider providing tax benefits and subsidies and low interest rate financing for biomass power. All these regulations and incentives are very important for biomass energy, to realize their hidden potential (Thacker, 2013).

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