

# TECHNO-ECONOMIC VIABILITY OF BRIQUETTING MACHINE

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## Abstract

The establishments of Republic Act 9367 intended to shift the use of ordinary charcoal to “green” charcoal. The researchers of this study responded to this intension by providing charcoal of different shapes made of sawdust and paper waste. This research study was proposed to assess the demand of charcoal in industries within Laguna. Data acquired was coordinated with DTI Laguna. A briquetting machine to be used in the production of this briquette was also provided. Calculation of the number of units this machine can produce and how many units of briquette is needed to breakeven the cost of its operation.

With a total of 85 active industries all over Laguna is still using charcoal to market their goods. These industries are targeted to be the market of this green charcoal. Upon testing and computation, the machine can produce 435, 120 units per year and it is needed to produce 594,525 units to break even

**Keywords;** Briquette, Briquetting machine, Green charcoal, industry, economy

## I. INTRODUCTION

The current trends in technological process and innovation continue, demand for energy continues to increase due to population increase. Philippine

statistic Authority projected that the annual growth rate is 1.21 percent that is 142 million by 2045. <sup>2</sup>Table below shows the commercial and industrial users of wood fuels and biomass fuels in the Philippines aside from the household users.

Table 1. Commercial/Industrial Users of Wood fuels and Biomass Fuels in the Philippines

Industry	Description	Geographic Location	Wood fuel Use Patter
Bakeries	Use wood-fired “pogon” or brick oven	Nationwide, most rural bakeries apparently still use wood fuels, many urban bakeries have shifted to LPG	Mostly fuelwood, some charcoal
Restaurants/ Eateries	This category would include tens of thousands of “carrenderias” rarely listed as registered businesses	Nationwide, often located in urban areas near to schools, offices, hospitals, and factories. In rural areas these tend to be concentrated in	Extensive use of both fuelwood and charcoal. Fuelwood often used to cook large batches of food, charcoal to keep food warm for long

		market areas in the municipal center	periods
Barbecue/ Lechon Vendors	Range from sidewalk barbecue vendors to large-scale establishments	Nationwide, more concentrated in urban areas	Mainly charcoal, although some fuelwood might be used to prepare side dishes
Food Processing	Both large-scale and small-scale		

Source: Benseal and Remedio, 2003

This shows that there is a continuous demand in the wood and biomass fuels in Philippines. According to <sup>3</sup>*Fuelwood - Final consumption by Country, Energy Statistics Database | United Nations Statistics Division*, Philippines has 19540 thousand cubic meter consumption. To cope up with the needs, introduction of “green” charcoal or briquetting is a key factor. The briquetting process is the conversion of agricultural waste into uniformly shaped briquettes that are easy to use, transport, and store. The idea of briquetting is using materials that are unusable, due to a lack of density, and compressing them into a solid fuel of a convenient shape that can be burned like wood or charcoal. The briquettes have better physical and combustion characteristics than the initial waste. Briquettes will improve the combustion efficiency using the existing traditional furnaces, in addition to killing all insects and diseases as well as reducing the destructive fire risk in the countryside.

With the trend in fuel shift, this study will evaluate the techno-economic value of the Briquetting Machine developed by the Mechanical engineering students of Laguna State Polytechnic University. The machine has a 2 horsepower electric motor having a 1720 rpm that serves as the prime mover of the project. Composed of different mechanical parts like hydraulic pump, control valve, pressure gauge, v-belt and hydraulic cylinder. The machine contains a hopper with 3 different molding shapes (cylindrical, hexagonal, and cubical). It can

produce a maximum of 6 pieces of sawdust and paper briquette – 6 pieces per shape briquettes 2x2x1.5 inches average dimensions.

### Objectives

The main objective of the study is to determine the technical and financial viability of the Briquetting machine. Specifically, the researchers aim to achieve the following:

- a. Identify the demand of the briquettes in the province of Laguna
- b. Identify the number of units to be produced in able to overcome the expenses in utilization of the machine.

### Methodology

In this study, techno-economic analysis of the briquetting machine with 3 molding shapes using agricultural products as an input in was used. Comparison of the different shapes of briquette (cylindrical, hexagonal and cubical) in terms of combustion rate and flashpoint will be considered. Economic assessment of the product will be evaluated by identifying the demand and the economic quantity.

## Results and Discussion

**Table 2. Commercial/Industrial Users of Wood Fuels and Biomass Fuels in Laguna**

Industry	Description	No. of Establishment
Bakeries	Use wood-fired “pogon” or brick oven	0
Restaurants/ Eateries	This category would include tens of thousands of “carrenderias” rarely listed as registered businesses	60
Barbecue/ Lechon Vendors	Range from sidewalk barbecue vendors to large-scale establishments	21
Food Processing	Both large-scale and small-scale	4

Source: DTI Philippines

Table 2 shows the commercial users of charcoal/wood fuels in Laguna provided by the Department of Trade and Industry. Out of 85 registered establishment given by the DTI there are 60 registered restaurants, 21 barbeque/ lechon Vendors, 4 Food processing and no bakeries. According to Biofuel Act of 2006 (Republic Act No. 9367), the Act that impose the development and use of renewable energy reduce dependence on imported oil; reduce toxic emissions; and ensure the availability of alternative and renewable clean energy without causing any harm to the natural ecosystem, biodiversity and food reserves of the country. Given this Biofuel Act, the data given above are the target market for the briquettes in Laguna and according to <sup>5</sup>Department of Science and Technology (DOST) Forest Products Research and Development Institute (FPRDI), Los Banos, Laguna, that chicken roasting industry in the country would shift to “green” charcoal in cooking their

grilled products. In addition to this, according to the data of <sup>6</sup>PSA, fuelwood, charcoal and biomass residues were used for cooking and food preparation as reported by majority of the households using these types of fuel.

Ninety-nine percent of the 9.2 million households using fuelwood, 88.1 percent of the 5.7 million households using charcoal, and 86.0 percent of the 3.2 million households using biomass residues used them for cooking and food preparation.

About 10 percent of the households using fuelwood heated or boiled water for bathing. This use was also reported by 6.6 percent of the households using charcoal and 4.8 percent of those using biomass residues.

Both charcoal and biomass residues were utilized for ironing although the former (18.8%) was more widely used than the latter (2.8%).

Almost 14 percent used biomass residue for other uses such as space warming.

**Table 3. Calculated Average Values of Hexagonal, Cylindrical and Cubical briquettes.**

Shape	Ratio	Combustion Rate	Flashpoint
Hexagonal	20% sawdust, 80% paper	18 min. 8sec	53.50 secs
Cylindrical	20% sawdust, 80% paper	14 min. 27 secs	1 min. 5 secs.
Cubical	20% sawdust, 80% paper	10 min. 44 secs	1 min. 9 secs.

The briquettes were tested for its ignition time and combustion rate for several times and the values given on the table were recorded. Hexagonal briquettes had the average of 18mins and 8 secs combustion rate and 53.50 second ignition time, cylindrical briquette has 14 minutes and 27 seconds

combustion rate and 1 minute 5 seconds ignition time and cubical briquettes had 10 minutes and 44 seconds combustion rate and 1 minute and 9 second ignition rate.

**Table 4. Properties of Briquettes under Pressure of 50 kg/cm<sup>2</sup>**

Shape	Average Height ( inch )	Mass ( wet ) grams	Mass ( dry ) grams	Volume ( cu-in)
Hexagonal	2	79	40	7.74
Cylindrical	2	74	33	5.62
Cubical	2	63	34	5.82

The hexagonal, cylindrical and cubical briquettes undergoing the pressure of 50 kg/cm<sup>2</sup> had an average of 2 inches, volume of 7.74, 5.62 and 5.82 respectively and 79, 74 and 63 mass when the briquettes are wet and 40, 33, 34 when they are dry.

Table 5 shows the performance of the machine for 3 trials in an hour. For the first hour it has the capacity of 120 outputs, 90 outputs in the second trial and 144 pieces on the third trial. It has the average of 118 pieces in an hour of operation.

**Table 5. Production Rate of Briquetting Machine in one hour**

Trials	Output
1	120 pieces
2	90 pieces
3	144 pieces

**Break – Even Point for the Briquetting Machine**

With the formula of  $\text{Income} = \text{Expenses}$

Solving for the number of units to be produced to overcome the expenses of the machine

$\text{Income} = \text{Selling price per unit times Number of Units}$

$\text{Expenses} = \text{Material Cost per unit} + \text{Energy Cost} + \text{Operators Wage}$

Material Cost = Total Amount of Sawdust + Total Cost of Paper + Project Cost

Total Amount of Sawdust = 20 pesos/sacks  $\times$  10 sacks/day  $\times$  259 days/year = P51,800

Total Amount of Paper = 8 pesos/kg  $\times$  10kg/day  $\times$  259/year = P 20,720

Material Cost = 51,800 + 20, 720 + 66,840 = P 139,360

Energy Cost = No. of Operating hours  $\times$  Actual Operation Period  $\times$  Cost of Electricity per Kw-Hr  $\times$  Motor's Power Rating = 7 hours/day  $\times$  259 days/year  $\times$  10.5 pesos/1 kw-hr  $\times$  2 hp (.746kw)/1Hp = P28,402.458

Operator's Wage = 2 operators  $\times$  250 pesos/day  $\times$  259 days/year = P129,500

Expenses = P139,360+P28,402.458+P129,500 = P297,262.458

### To Break Even

Income = Expenses

Let x be the number of Units

$0.5x = 297,262.458$

$X = 594,524.916$  approximately 594,525 units

Annual Production = 1 hopper  $\times$  6 pieces/1.5min  $\times$  60mins/hour  $\times$  7hours/day  $\times$  259 days/ year = 435,120 pieces

The above calculation shows the estimated values of number of units to be produced in able to recover the expenses in development of the machine.

### Conclusion and Recommendation

In this study, economical evaluation of the different shapes of briquettes were evaluated. Given the demand of briquettes for over 85 Industry that uses charcoal all over Laguna. As a response to the Republic Act 9367, these establishments would shift from ordinary charcoal to "green" charcoal, with that the establishments identified by DTI were the

target market for these Briquette. Computing the number of units in order to break even, theoretically it is feasible for the briquette to make it to the market. With 594,525 units estimated units to break even and the machine can produce an average of 435,120 units per year.

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