WOOD FUEL AND ENERGY USE HYDRO TO IMPROVE EFFICIENCY
TEA PRODUCTION COSTS
(A Case Study of Tea Plantation Gods, PT. Chakra Desa Tenjolaya, Kecamatan Pasirjambu, Kabupaten Bandung, Jawa Barat)

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ABSTRACT

SUKIMAN. Influence of Wood Fuel and Energy Costs Against Hydro Energy Production and Quality of Green Tea.

Businesses survive the very tight competition caused by: (1) Removal of subsidies prices of fuel oil (BBM) which causes the cost of production of tea has increased significantly, (2) Establishments of a market segment that requires quality and safe products for consumption and environmentally friendly, (3) over supply condition is more common than the shortage of supply so that the price of the product tends to be low. To deal with and find solutions to these conditions conducted research in the tea plantations of the Gods, Bandung, West Java. The study was conducted in January to March 2006 This study uses a case study.

The purpose of this study is (1) To calculate the magnitude of the difference in cost of production of tea as well as the level of investment feasibility Minihydro Power and HE (heat exchanger) firewood, and (2) analyzes the impact of the use on firewood and hydro energy for the quality and safety of products.

On the basis of the results of research in the field of data analysis and the results it could be said that (1). Replacement of diesel engine fuel burner and heat exchanger by Minihydro firewood able to save energy cost of Rp. 2318.80 / Kg, (2) the replacement investment produces a net present value (NPV) is greater than zero, (3) Internal Rate of Return investment of 69.80%, (4) Net B / C ratio of 3.64, (5) project payback period of two years and one day, (6) Return on investment on energy cost savings of 26.38%, and (7) Based on the results of Mann - Whitney against tea products of the three months before and after the replacement of diesel and investment stove fuel by Minihydro and HE firewood moisture content of tea which significantly improved the water color and flavor while steeping water was not significantly different.
INTRODUCTION

1.1. Background

The agricultural sector has an important role in economic activities in Indonesia. Plantations as an important component in the effort Agribusiness (agriculture) has a significant role in the development of national agriculture. Tea plantation is one commodity that has an important role in the activities of the Indonesian economy. In the field of consumption, tea is the preferred beverage ingredient of most Indonesian people in addition to coffee and other beverages. National tea production of the period 2000-2004 has fluctuated from year after year, but tend to be stable. Indonesia is the fifth largest producer with 165 tons of production of China (835 tons), India (820 tons), Kenya (325 tonnes), Sri Lanka (308 tons) and nearly the same as the production of Turkey.

The development of Indonesian tea export volume of the period 2000-2004 also fluctuated from year after year, but tend to show a decline. Manufacturers of tea are required to produce a quality product and safe for consumption. To achieve these goals, the manufacturers are required to do the steps of production of tea are good and right through the implementation of Good Agriculture Practices (GAP), Good Manufacturing Practises (GMP) and the product can be traced back (Traceability) production process (Morrison, S. 2002).

The decline in tea export market shares and the low price of Indonesian tea is caused by the lack of competitiveness of Indonesian tea. Weak competitiveness of the tea products of the high cost of production. Factors which led to the increasing cost of production are the removal of a fuel subsidy by the government led to rising prices of fuel oil (BBM), LPG and rates.

One of the steps that can be taken to avoid losses and lid as well as efforts to improve the company's competitiveness is the tea industry by lowering the cost of production through the process of tea production cost efficiency. Cost reduction efforts can be done by replacing the input factors of production are very expensive with cheaper production inputs, production technology utilizing better and more efficient, improve to labor productivity through mechanization, konveyorisasi production process, transportation efficiency, and explore the potential production of superior clones with not reduce the level of quality and safety of products (Rosyadi, 2001). In line with the stages of the production process, efforts to improve the competitiveness of the commodity tea can be done in several ways (Nana et al., 1985; Rohayati et al., 1997), namely: 1). Improving the quality of tea products, 2). Produce tea products of market requirements, 3). Fixing marketing systems, 4). Streamlining the process of delivery, 5). Increasing new customer, and 6). Lowering the cost of production of cost efficiency.
Efforts made by PT. Chakra, the tea plantations of the Dewata to lower production costs is primarily done on the replacement of fuel oil (BBM) with wood fuel (BBK) and replacement of electrical energy from the generator / diesel fuel oil with renewable electricity replaced water power (Hydro Power). This effort is expected to meet one of the Tri Dharma Estates is environmental preservation. By incorporating environmental factors of the efficiency of production costs, expected production available resources can be used efficiently and sustainably (Sustainable).

Efforts to reduce production costs of efficiency cost of tea production can be done in various ways, one of the important activities are to improve the (improvement) processing technology. The processing of tea shoots require inpute form of fuel oil (BBM) in the forms into diesel fuel to a process of withering and drying.

Thermal energy source that can replace oil in tea processing firewood. Tea buyers from European countries and the USA currently has demanded the tea producers to implement sustainable tea agribusiness management (Sustainable Tea). Sustainable tea programs broadly aim to get three main objectives include, 1). Economically Feasible, 2). Environmentally Friendly, and 3). Socially Acceptable.

The use of wood fuel if not managed properly will increase the physical and biological sources of contamination that can degrade the quality of the product. Burning wood that leaves smoke, ash, and broken pieces of wood can be a source of contamination compared with fuel oil and LPG is relatively clean. The sources of contamination must be controlled so as not to because a decrease in quality and safety of finished tea products.

Certainty of supply of firewood from time to time needs to be prepared firewood by planting out the garden area. The provision of fuel wood plantations is done by converting some acreage lease rights (HGU). The amount and type of requirements acreage planted fuelwood largely determine the future supply of firewood.

On the basis of the above description, the issue will be examined in this study is an effort to improve the competitiveness of the tea plantation industry through the use of wood fuel and hydro power as an effort to increase the efficiency of production of tea.

1.2. Research Objectives

The purpose of this study is:

1. Calculate the magnitude of reduction in costs due to the use of fuel wood (BBK) and hydro energy (Hydro Power) and analyze the feasibility of investment in machinery wood-burning stoves and hydro energy (Hydro Power).

2. Analyze the impact of the use of fuel and hydro energy for the quality and safety of products.
II. LITERATURE REVIEW AND HYPOTHESES

2.1. Libraries Studies

Since the conduct of the Industrial Revolution, global environmental pollution which suffered a major impact on global climate change. The industrial revolution was built with energy derived from coal, petroleum, gas and dispose of waste greenhouse gases such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). The sun is shining on the Earth also generate to heat which is captured by the earth's atmosphere so that the air temperature comfortable for human life. Atmospheric greenhouse gases covered with the thermal radiation of the earth causes so that the temperature of the earth is reflected back up into heat (Murdiyarso, 2003).

Conferenceson Rio de Janeiro has alerted the country to secure the entire global environment. Almost all countries in the world form the institutions responsible for the preservation of nature and environment (Murdiarso, 2003).

Utilization of renewable energy is closely related to the conversion to environments, for example through the application of technology to the mini-hydro-electric power generation that does not emit CO2. Utilization of these technologies will not work if the forest buffer zone around the project is not properly maintained. Therefore, forest conservation programs to ensure the availability of water is good for the community and environment as well as to drive a mini-hydro turbine absolute implemented (YBUL, 2001).

Green tea processing stages include, (1). Withering, (2). Rolling, (3). Drying Phase I, (4). Drying stage II, (5). Sorting, (6). Packing, and (7) Storage (Suryatmo, 1998). Suryatmo, 1988 said that tea is a beverage that is a hygroscopic material (readily absorbs water). The addition of water to the tea may reduce the quality of the tea. Therefore, post-processing treatment should receive primary attention.

Sensory testing is a way of testing the properties of tea quality of using the sensitivity of human senses. Testing the senses also called subjective measurement because the measurement is based on the subjective response to humans as a measuring instrument (Soekarto, ST, 1990).

Technical eco-efficiency is an attempt to drink the average cost of production per unit of output while preserve natural resources and the environment. Technical eco-efficiency can be achieved if the following requirements are met: (1) input factors used in the production process does not impact on the quality of the environment, (2) More emphasis on the utilization of factors inputs that can be updated and being around the garden, (3) the new technology that is used to replace old technology must be environmentally friendly and less costly in terms of time dimension, and can increase the volume of production or maintain a minimum level of production has been achieved (Rosyadi, 2001).

Financial management is one area of science that consists of a concept or theory underlying the decision - financial decisions on an individual or company (Husnan, 1996).
Gittinger, J.P. (1986) defines that investment in agriculture is an activity that transform financial resources into capital goods that can generate profits or benefits after a few periods. Furthermore it is said that the investment is an activity that takes money (costs) with the hope of getting results and which logically is a container for carrying out the activities for planning, financing and implementation in a single unit.

Choliq, A. et al. (1996) explains that in order to find an overall size of a basis of acceptance / rejection or sequencing project has developed a variety of ways, called Investment Criteria (Investment Criteria). In other words, are a measure of investment criteria that determine whether a project is feasible or not feasible.

2.2. Hypothesis

1. The use of firewood and hydro energy will lead to a decrease in the cost of production of tea compared to the use of diesel fuel in the engine generator and burner (Burner). In terms of financial, utilization of alternative energy sources Minihydro and use of wood-burning stoves is feasible.

2. Use Minihydro Power and Fuel wood does not degrade the quality and safety of tea.

III. OBJECT AND METHODS

3.1. Object Research

This research was conducted at Tea Plantation Gods. This study will be conducted by monitoring all activity Dewata tea plantations since the activities in the field of production, processing, supply management activities firewood, hydro power management, labor administration activities and the use of material goods, as well as side activities income (revenue) company.

3.2. Research Methods

The research method used is the case study method. The results of case study research are dependent on the intended broad scope, can include entire life cycle of the unit under study may also include certain factors on the life cycle of the unit (Rusidi, 1985).

The data used in the analysis for solving the problem consists of primary data and secondary data to be converted in the form of quantitative data and qualitative data.

3.3. Sampling Techniques

This study will be conducted in the tea plantations of the Dewata which is the oldest estates in the PT group. KBP. Chakra. Plantation Dewata has hydro power plant with a capacity of 240 KWs. This hydro power plant constructed by utilizing Cikahuripan stream located in the forest area of the nature reserve of Mount Tilu. Dewata plantations have also to convert the use of fuel to the solid fuel Firewood (BBK).
3.4. Data Analysis

The data obtained was compiled and processed into an analysis. Observations wage data and material goods generators, Minihydro power, furnace and burner inserted into the parent table to be used as the material composing the cost of production reports, calculates the cost of the application of technology efficiency wood stoves and electric energy Minihydro power, prepare investment feasibility analysis, calculate material requirements fuel wood and timber plantation area.

3.5 Design Hypothesis Testing (1).
Testing the hypothesis (1) is done by comparing the cost savings of the two methods of energy use and wood-burning stoves Minihydro than gasoline.

3.6 Hypotheses about the feasibility of investing Minihydro and HE (Heat Exchanger) firewood.

In terms of financial, utilization of alternative energy sources Minihydro and use of wood-burning stoves is feasible. The data has been collected and analyzed further processed into a cost-benefit analysis. Cost-Benefit Analysis carried out by the investment criteria of the indicator Net present value (NPV), Internal Rate of Return (IRR), Net Benefit Cost Ratio (Net B / C), Profitability Ratio (PR), Payback Period, Average Annual Return on Investment method.

1.6. Research Schedule
When the study will be conducted for approximately 3 months. The experiment was conducted at the beginning of January 2006 until the end of March 2006.

IV. RESULTS AND DISCUSSION

4.1. Requirements and Testing Product Quality Tea

Dewata tea plantations since 2002 have implemented the HACCP management and has passed the test to get a certificate of HACCP (Hazard Analysis Critical Control Point). The use of firewood as the conversion to fuel oil (BBM) in its implementation must consider the requirements of HACCP.

Based on the analysis of the Dewata 1 grade tea is obtained by the average value of water content (before and after conversion) are 5.91% before conversion: after conversion of 5.7%, the color of water (liquor) 2.97: 2.90; and taste of water steeping 42.74: 42.66; while steeping water color residue equally get the value of c (being). While the Dewata grade 2 the average values obtained organoleptic test results as follows: 5.07% water content; 4.71%; water color 2.93: 2.94; flavored water steeping 42.05: 42.52 while steeping water color residues equally gets the value of c (being).

The water content of the Dewata grade is 5.91%: 5.7% (before and after conversion) after the calculation, calculate the probability (P count) of 0.0122.
Calculate the probability is less than $\alpha / 2$ is $0.05 / 2$: 0.025; Ho is rejected meaning that the percentage of water content was significantly different (significant). While in to grade 2 Water content of the Dewata is 5.07%: 4.71% (before and after conversion) obtained by calculating the probability (P count) of 0.00003. Calculate the probability is less than $\alpha / 2$ is $0.05 / 2$: 0.025. Ho kaedah decision is rejected it means the percentage of water content was significantly different (significant) between the water content before and after the replacement fuel stove with firewood furnace.

Based on the analysis of the data sample chop grade 1 and Dewata of the Dewata 2 post-conversion processing products actually have a color value of water (Liquor) higher. The average color of the water in the Dewata grade 1 is 2.97: 3.00 (water color before and after the conversion of fuel) while the grade of the Dewata 2 is 2.93: 2.94 (water color before and after conversion).

Dewata steeping water color grade 1 is 2.97: 3.00 (before and after conversion) obtained after calculation of z values: 2.93 and opportunities count (P count) of 0.0017. Calculate the probability is less than $\alpha / 2$, namely P (hit) $<\alpha / 2$ ($0.05 / 2$: 0.025). Ho refused kaedah decision is the color of water means significantly different (significant) between the product before and after replacement fuel stove with wood-burning stoves.

Based on the data analysis of the Dewata grade 1 chop samples processed products have a sense of the value of water (taste) 42.74: 42.66 (with fuel processing: BBK), while the grade of the Dewata 2 value sense steeping water is 42.05: 42.52 (with fuel processing: BBK).

Sense of steeping water Dewata grade 1 is 42.74: 42.66 (with fuel processing: BBK) obtained after calculation of z values: 1.04 and opportunities count (P count) of 0.1492. Calculate the probability is greater than $\alpha / 2$, namely P (hit)$> \alpha / 2$ ($0.05 / 2$: 0.025). Kaedah Ho acceptable means decision is not significantly different flavored water (not significant) between the product before and after replacement fuel stove with wood-burning stoves.

Analysis of the sense of the Dewata 2 grade steeping water is 42.05: 42.52 (with fuel processing: BBK) after the calculation, the value of z: 101.7 and opportunities count (P count) of 0.00003. Calculate the probabilities smaller than $\alpha / 2$, namely P (hit) $<\alpha / 2$ ($0.05 / 2$: 0.025). Ho kaedah decision is rejected it means steeping water taste significantly different (significant) between the product before and after replacement fuel stove with wood-burning stoves.

### 4.2. Comparison of Costs and Benefits Replacement Power Diesel Engine with Minihydro.

#### Net Present Value (NPV)

Based on the data source of costs, expenses, and earnings, the company can be presented calculation of Net Present Value (NPV) in combination *Minihydro* and stove fuel as shown in Table 12.
Table 1 Value NPV at *Minihydro* Power Plant (MHP).

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost of MHP</th>
<th>SAVING</th>
<th>PROFIT (LOSS)</th>
<th>DF (17%)</th>
<th>NPV 17%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4,365,331,350.00</td>
<td>1,027,013,750.00</td>
<td>(3,338,317,600.00)</td>
<td>0.85</td>
<td>(2,853,260,053.00)</td>
</tr>
<tr>
<td>2</td>
<td>408,763,215.00</td>
<td>1,077,465,125.00</td>
<td>668,701,910.00</td>
<td>0.73</td>
<td>488,486,745.00</td>
</tr>
<tr>
<td>3</td>
<td>363,345,080.00</td>
<td>1,130,349,138.00</td>
<td>767,004,058.00</td>
<td>0.62</td>
<td>478,917,334.00</td>
</tr>
<tr>
<td>4</td>
<td>317,926,945.00</td>
<td>1,185,778,426.00</td>
<td>867,851,481.00</td>
<td>0.53</td>
<td>463,172,336.00</td>
</tr>
<tr>
<td>5</td>
<td>272,508,810.00</td>
<td>1,243,870,363.00</td>
<td>971,361,553.00</td>
<td>0.46</td>
<td>443,038,004.00</td>
</tr>
<tr>
<td>6</td>
<td>227,090,675.00</td>
<td>1,272,992,097.00</td>
<td>1,045,901,422.00</td>
<td>0.39</td>
<td>407,692,374.00</td>
</tr>
<tr>
<td>7</td>
<td>181,672,540.00</td>
<td>1,302,644,371.00</td>
<td>1,120,971,831.00</td>
<td>0.33</td>
<td>373,507,814.00</td>
</tr>
<tr>
<td>8</td>
<td>136,254,405.00</td>
<td>1,332,820,700.00</td>
<td>1,196,566,295.00</td>
<td>0.28</td>
<td>340,782,081.00</td>
</tr>
<tr>
<td>9</td>
<td>90,836,270.00</td>
<td>1,363,512,459.00</td>
<td>1,272,676,189.00</td>
<td>0.24</td>
<td>309,769,384.00</td>
</tr>
<tr>
<td>10</td>
<td>45,418,135.00</td>
<td>1,394,708,636.00</td>
<td>1,349,290,501.00</td>
<td>0.21</td>
<td>280,652,424.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>6,409,147,425.00</td>
<td>12,331,155,065.00</td>
<td>5,922,007,640.00</td>
<td></td>
<td>732,758,444.00</td>
</tr>
</tbody>
</table>

*Minihydro* investment costs reached Rp. 3,911,150,000, this project has a positive NPV is 732 758 444. Investment *Minihydro* power generating net present value (NPV) positive and greater than 0 (zero) then the investment is viable or "GO".

**Internal Rate of Return (IRR) on investment *Minihydro* Power**

Internal rate of return (IRR) is the discount rate (the discount rate) that equates the PV of net cash flows to PV investment. Often interpreted as the IRR or internal rate of return sought by trial and error (interpolation). In other words, the IRR is the discount rate that makes the NPV equal to zero.

Based on the data during the project NPV is the year 2006 - 2015, the sum of the positive NPV sum amounted to 3,586,041,746 while a negative NPV at 2853262906 IRR sought by the method of interpolation as follows:

\[
3,586,041,746 = 23 \% + \frac{3,586,041,746 - 2,853,262,906}{23.55\% - 23.25\%}(23.55\% - 23.25\%)
\]

\[
3,586,041,746 - 2,853,262,906 = 24.3\% \times 1.3 = 24.3\%
\]

Investment *Minihydro* power generating Internal Rate of Return (IRR) of 24.3%. The magnitude of this project IRR exceeds the social interest rate that is 17% as well as the basis for calculating the feasibility of the project *Minihydro* power development project is feasible / passed "GO".
Profitability Ratio in the Investment Minihydro Power

Profitability Ratio is the ratio between the Present Value of Net Present Value of Benefite with investment. Investment decisions is if the value of Profitability Ratio (PR) is greater than 1 then the investment viable Minihydro / forwarded. Based on the data obtained, the value of PR is:

\[
PR = \frac{4.075.642.088}{3.324.863.248} = 1.22
\]

Profitability Ratio (PR) resulted in a number of PR value of 1:22 or more than one, then the combination of factory activity Minihydro feasible / forwarded or "GO"

Net Benefit Cost Ratio (Net B/C) pada Investasi Minihydro Power

Net Benefit Cost Ratio (Net B / C) is the ratio between the number of positive NPV is the number of negative NPV. Net B / C it shows the picture of how many times the benefits to be obtained from the cost incurred.

Investment decisions is if the value of Net B / C is greater than 1 then Minihydro viable investment. Positive NPV is the sum value of 3,755,004,447 while a negative NPV is the sum of 2,672,380,769, the value of net B / C is:

\[
Net B/C = \frac{3,586,041,746}{2,853,262,906} = 1.257
\]

Value Net B / C: 1,257 is more than 1, the conversion of diesel with Minihydro combination to generate electrical power for a decent run / forwarded or "GO".

Investment Payback Period on Mini Hydro Power

The length of time investment cost recovery is very important for the company. Rapid return on investment cost will encourage entrepreneurs to reinvest capital gained to other types of activities.

Based on data calculation capabilities of return on investment (payback period) in Table 1 above, with a total investment cost of Rp.3,911,150,000 Minihydro, - can be returned within 3.43 years. While age Minihydro economical engine power is estimated for 20 years.
4.3. Replacement Fuel Stove with Heat Exchanger (HE) Firewood

Heat Exchangers (HE) firewood is a machine that is used to replace the function of the fuel burner (Burner).

**Replacement Fuel Saving Stove with Fuel Wood Stoves**

Operational costs required for engine fuel stoves and wood-burning stoves are classified into direct costs and indirect costs. Calculations are based on the assumptions set forth in the calculation of costs and above the cost of production. The advantages derived from the use of stove fuel cost savings compared with the cost of the use of wood-burning stoves. Projected costs and benefits during the years 2006 to 2015 are presented in Table 2.

### Table 2 Comparison of Costs and Savings Use of Fuel Wood

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost of Energy (Rp/Kg)</th>
<th>Saving (Rp)</th>
<th>(Rp/Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stove Fuel</td>
<td>Fuel wood</td>
<td>Production</td>
</tr>
<tr>
<td>2006</td>
<td>3,283,773,000</td>
<td>1,431,411,000</td>
<td>1,852,362,000</td>
</tr>
<tr>
<td>2007</td>
<td>3,448,869,050</td>
<td>1,574,552,100</td>
<td>1,874,316,950</td>
</tr>
<tr>
<td>2008</td>
<td>3,622,310,643</td>
<td>1,734,351,060</td>
<td>1,887,959,583</td>
</tr>
<tr>
<td>2009</td>
<td>3,804,524,129</td>
<td>1,906,379,916</td>
<td>1,898,144,213</td>
</tr>
<tr>
<td>2010</td>
<td>3,995,958,084</td>
<td>2,095,611,658</td>
<td>1,900,346,427</td>
</tr>
<tr>
<td>2011</td>
<td>4,097,849,823</td>
<td>2,170,489,500</td>
<td>1,736.39</td>
</tr>
<tr>
<td>2012</td>
<td>4,202,488,134</td>
<td>2,697,391,778</td>
<td>2,157.91</td>
</tr>
<tr>
<td>2013</td>
<td>4,309,961,609</td>
<td>2,651,074,368</td>
<td>2,120.86</td>
</tr>
<tr>
<td>2014</td>
<td>4,420,363,048</td>
<td>2,593,712,083</td>
<td>2,074.97</td>
</tr>
<tr>
<td>2015</td>
<td>4,533,789,763</td>
<td>2,567,129,951</td>
<td>2,053.70</td>
</tr>
</tbody>
</table>

Based on the table above, the use of wood-burning stoves can save on production costs. The use of wood-burning stoves can save costs within 10 years of Rp. 22,092,926,851 or an average savings per year for Rp.2,209,292.685, -

**The calculation of the Underlying Investment Decision HE Wood (Fire Wood).**

**Net Present Value (NPV) Investment HE Firewood**

HE investment costs and wood-burning stoves and firewood planting as much as Rp. 2,059,256,555, - has a positive NPV is 7215209405. Investment wood-burning stoves produce a net present value (NPV) is positive and the magnitude is greater than zero then the investment is viable or "GO".

**Profitability Ratio on Fuel Wood Stoves Investment**

Profitability Ratio is the ratio between the Present Value of Net Present Value of Benefite with Investment. Calculation of Profitability Ratio (PR) is done
the same as the previous calculations and generate the PR value of 5,099. PR value is greater than one, then the replacement fuel stoves and wood stove with fuel HE deserves to be run / forwarded or "GO".

**Net Benefit Cost Ratio (Net B/C) on Minihydro Power Investment**

Net Benefit Cost Ratio (Net B / C) is the ratio between the number of positive NPV is the number of negative NPV. Net B / C it shows the picture of how many times the benefits to be obtained from the cost incurred. To determine the amount of Net Benefit Cost Ratio (Net B / C) on the replacement fuel stove with HE and wood-burning stoves is done as in the calculation of Net B / C before.

Value Net B / C: 19,679 is more than 1 then the replacement fuel stove with wood-burning stoves HE and feasible to run / forwarded or "GO"

**Pay Back Period of Investment HE Firewood**

Based on data calculation capabilities of return on investment (payback period) then the replacement investment by HE fuel stoves and wood-burning stoves with a total cost of Rp.2,059,256,555, - can be returned within 1.11 years or 1 year, 1 month and 10 days. Age economical machine is estimated for 5 years.

**Return On Investmen (ROI) Investment Stoves Firewood**

Investment feasibility replacement fuel stove with HE and wood-burning stoves also done by examining the rate of return based on the return on investment (ROI).

Average ROI throughout the life of the project are:

\[
\text{Average ROI} = \frac{974,516,916}{2,059,256,555} \times 100\% = 47.32\%
\]

The average value over the ROI with HE replacement fuel stoves and wood-burning stoves amounted to 47.32%. The ROI figure is much higher than bank deposit interest is only 12.5% so that the investment is financially feasible or "GO"

**4.4. Replacement Fuel Stove with Heat Exchanger (HE) Firewood and Replacement Power Diesel fuel with Minihydro**

To determine the ratio of the projected increase in the cost of processing and the cost of processing the combination of diesel and fuel stove with firewood HE Minihydro and more are presented in Table 3.
Table 3: Production Cost Comparison between Diesel fuel and stove combination BBM with Minihydro Power and Fuel Wood Stoves.

<table>
<thead>
<tr>
<th>Year</th>
<th>Diesel and Stove Fuel (Rp)</th>
<th>Minihydro and Fuel Wood (Rp)</th>
<th>Saving Cost (Rp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>4,592,576,000</td>
<td>1,694,072,750</td>
<td>2,898,503,250</td>
</tr>
<tr>
<td>2007</td>
<td>4,829,177,350</td>
<td>1,856,355,025</td>
<td>2,972,822,325</td>
</tr>
<tr>
<td>2009</td>
<td>5,340,658,109</td>
<td>2,231,276,768</td>
<td>3,109,381,341</td>
</tr>
<tr>
<td>2010</td>
<td>5,616,971,479</td>
<td>2,444,750,116</td>
<td>3,172,221,362</td>
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<td>2011</td>
<td>5,772,708,531</td>
<td>2,298,421,905</td>
<td>3,474,286,626</td>
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<td>2012</td>
<td>5,933,870,287</td>
<td>1,899,348,604</td>
<td>4,034,521,682</td>
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<td>2013</td>
<td>6,100,745,490</td>
<td>2,079,576,336</td>
<td>4,021,169,154</td>
</tr>
<tr>
<td>2014</td>
<td>6,273,645,419</td>
<td>2,275,419,382</td>
<td>3,998,226,037</td>
</tr>
<tr>
<td>2015</td>
<td>6,452,905,975</td>
<td>2,445,965,743</td>
<td>4,961,940,232</td>
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<tr>
<td></td>
<td>55,991,564,662</td>
<td>21,262,639,657</td>
<td>35,683,087,505</td>
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</tbody>
</table>


The calculation of the Underlying Investment Decisions Minihydro Power and Firewood furnace.

Investment assessment criteria furnace and heat exchanger (HE) is used as a measure of whether the investment is to be run, financially viable to continue. To determine the appropriateness of the investment are set out as follows:

The Net Present Value (NPV) and HE Minihydro Firewood

Net Present Value (NPV) of a project is the present value (present value) of the difference between Benefite (Benefit) with Cost (Cost) at a certain discount rate. Based on the data source of costs, expenses, and earnings, the company can be calculated Net Present Value (NPV) on investments and HE Power Minihydro firewood as in previous NPV calculation.

Wood-burning stoves investment costs and the amount of power Minihydro reached Rp. 5,875,906,555; This project has a positive NPV is 8,284,041,090. Investment wood-burning stoves and Minihydro power generating net present value (NPV) and positive value greater than 0 (zero) then the investment is viable or "GO".

Internal Rate of Return (IRR) and HE Minihydro Firewood

Internal rate of return (IRR) is the discount rate / discount rate that equates the PV of net cash flows to PV investment. Often interpreted as the IRR or internal rate of return sought by trial and error (interpolation). In other words, the IRR is the discount rate that makes the NPV equal to zero.

Based on the IRR calculation using the formula as in the previous calculation, the investment IRR Minihydro power and produce firewood HE Internal Rate of Return (IRR) of 69.8%. The magnitude of this project IRR exceeds the social interest rate that is 17% as well as the basis for calculating the
feasibility of the project, the project development Minihydro HE power and fuel wood in the tea plantations of the Dewata is feasible / passed "GO".

**Profitability Ratio Minihydro and Fuel Wood Stoves**

Profitability Ratio (PR) is the ratio between the Present Value of Net Present Value of Benefite with investment. Based on calculations using the value of PR PR formula as in the previous calculation, the investment Minihydro power and produces firewood HE Profitability Ratio (PR) of 2.65. Relative to the value of Profitability Ratio (PR) is 2.65, the value of PR more than one so that decisions and diesel replacement fuel stove with Minihydro power and HE as well as wood-burning stoves feasible to run / forwarded or "GO"

**Net BenefitCost Ratio (Net B / C) Minihydro and Stoves Firewood**

Net Benefit Cost Ratio (Net B / C) is the ratio between the number of positive NPV is the number of negative NPV. Net B / C it shows the picture of how many times the benefits to be obtained from the cost incurred.

Based on the calculation of Net B / C using the formula as in the calculation of Net B / C at the top of the investment Minihydro HE power and produces firewood Net B / C of 3.64. Value Net B / C: 3.64 is more than 1 then the decision and diesel replacement fuel stove with Minihydro power and HE as well as wood-burning stoves feasible to run / forwarded or "GO"

**Pay Back Period Minihydro and Fuel Wood Stoves**

Based on data calculation capabilities of return on investment (payback period) using the calculation formula as before, the payback period of investment Minihydro and wood-burning stoves with a total cost of Rp.5.875.906.555, - can be returned within a period of 2 years and a half days. Age economical HE machine and wood-burning stoves is estimated for 5 years, Minihydro power estimated 20 years, while the Eucalyptus plants can be harvested for 3 times (economic life of 18-21 years).

**Return on Investmen (ROI) Investment Minihydro and Stoves Firewood**

Minihydro investment feasibility and HE firewood also done by examining the rate of return based on the return on investmen (ROI). The average value throughout the life of the investment ROI -rata Minihydro with HE and wood-burning stoves is 26.38%. ROI figures are higher than bank interest deposits by 12.5%, the investment is financially feasible.
V. CONCLUSION

1. The use of firewood Minihydro power and is able to lower the energy costs of fuel oil (BBM) of Rp. 2,318.80 per kg of tea. Development Minihydro power and fuel wood which requires an investment of Rp. 5,875,906,555 have a Net Present Value (NPV) Rp. 8,284,041,090, Internal Rate of Return (IRR) of 69.80%, and Net B / C ratio of 3.64, then the project is feasible. Period of return on investment (payback period) Minihydro power projects with wood-burning stoves is 2 years and one day. Return on Investment (ROI) Minihydro project power and heat exchanger means firewood 26.38% energy cost savings due to the replacement investment is higher than deposit rates so that the project is feasible.

2. The use of firewood does not degrade the quality and safety of products. Mann - Whitney on water levels and water color grade steeping the Dewata and the Dewata 1 and 2 had significant improvement after using firewood in tea processing. The water content of tea that uses fuel wood decreased from 5.07% to 4.71% so that the tea shelf life will be longer. Steeping water color scale increased from 2.97 to 3.00. Overall quality of tea products, either using fuel processing and BBK meet quality requirements and product safety.

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