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Renewable Energy Resources for Small Scale Agro-Processing Unit at Tourism Area: Case Study at Telaga Warna

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PREFACE

Pusat Penelitian Lingkungan *Hidup* - *Institut* Pertanian *Bogor* (PPLH-IPB) [Center for Environmental Research - Institut Pertanian Bogor (CER-IPB)]was established in 1976. One of the Center's goal is to develop policies and concepts for natural resources and environmental management based on ecosystem characteristics, community participation, local community tradition, economic justice, and global environmental change.

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We are pleased to publish Dr. Y. Aris Purwanto's paper **Renewable Energy Resources for Small Scale Agro-Processing Unit at Tourism Area: Case Study at Telaga Warna. We** also express our gratitude and appreciation to Mr. Hendi Satrio Aji, Dr. Lilik Budi Prasetyo, and Ellyn K. Damayanti, Ph.D.Agr. for their cooperation in proof-reading and lay-outing the manuscript.

Finally, we hope this publication will be valuable and beneficial for those who have interest in Indonesia's natural resource and environmental management.

September 2009,

Kukuh Murtilaksono
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ABSTRACT

In the future, Indonesia's energy consumption is expected to increase along with economic growth. To anticipate this energy problem, the Indonesian government plans to increase the number of energy-self-sufficient village. An energy-self-suffiient village is a village capable of meeting its own energy needs and in the process creating job opportunities, reducing poverty and inducing productive activities. Renewable energy, such as solar, wind, micro-hydro and biomass, is usually available in the rural area and hence, by transforming and converting these sources of energy to power various processing machines, added value of agricultural can be made.

Utilization of combined solar, wind and biomass for a small scale agro-processing unit at rural area, which uses solar, wind, and biomass as a power source to operate a small agro-processing unit, is one of method to develop rural area. The objective of this study was to explore the potency and the possibility of the use of renewable energy from solar, biomass and wind energy resources for small processing unit at Telaga Warna area, one of the tourism areas located at Bogor, West Java.

The results showed that the potency of renewable energy sources at Telaga Warna area was mostly from solar energy and biomass. Potency of renewable energy from solar was 538.6 kWh/m^2. Potency of biomass energy from paddy field was 140.17 ton/year and from other area was 2045 m^3. The average of wind velocity at Telaga Warna area was 1m/s or less than 75 W/m^2. The utilization of renewable energy sources at Telaga Warna area was demonstrated for mushroom cracker drying using GHE solar dryer. It was found that for one unit of GHE solar dryer (30 kg of sample) required energy of 25.1 kW. This amound of energy was supplied by solar energy of 4.62kW and the rest was added by biomass energy.

Keywords: Utilization of renewable energy, solar energy, biomass energy, GHE solar dryer

1. INTRODUCTION

1.1. Background

The rapid depletion of oil reserve has forced Indonesia to find alternative energy supply to sustain economic development (Dasuki, 2000). Renewable energy resources are the energy from biomass, geothermal, wind energy, solar energy, micro hydro etc. The potency of renewable energy in Indonesia is shown in Table 1.

Table 1: Renewable Energy Potential and installed capacity in Indonesia

RE Source	Installed Capacity*) MWe	Potential (MWe)	% Utilization
Geothermal	589	19650	3.00
Micro-hydro	21	458.75	4.58
Solar/PV	5	156487	3.20E-03
Wind	0.5	9286	5.38E-03
Biomass	178	49807	0.36
Biogas	10	684.83	1.46
Total	**803.5**	**236373.58**	**0.34**

Source: RIPEBAT, 1997.

In the future Indonesia's energy consumption is expected to increase along with economic growth. To solve the energy problems, the Indonesian government plans to increase the number of energy-self-sufficient villages from 140 now to 2,000 by the end of the 2009 (Antara News 15 February 2007). An energy-self-suffisient village is a village capable of meeting its own energy needs and in the process creating job opportunities, reducing poverty and inducing productive activities. The promotion of renewable energy utilization can trigger rural industrialization in the form of Small Medium Enterprises and cooperatives to help in increasing added value of natural resources in various regions of the country, create more employment opportunity, and ultimately improve the overall quality of life of the people living in the rural areas.

1.2. Objectives of the Research

This study explored the potency and the possibility of the use of renewable energy from solar, biomass and wind energy resources for small processing unit at the area where the economic growing rapidly. The location of this study was the area of Telaga Warna, one of the tourism area located at Bogor, West Java.

2. METHODOLOGY

2.1. Solar Energy

Solar irradiation was measured by pyranometer type MS-401 which has sensitivity of 7 mV/kW/m^2 (Fig.1). The measurement was carried out daily from 08:00 - 15:00. The value of solar irradiation was calculated by using equation 1.

$$I = \frac{1000}{7} I_p \qquad (1)$$

Where:

I = solar irradiation (W/m^2)
Ip = solar irradiation measured by pyranometer (mV)

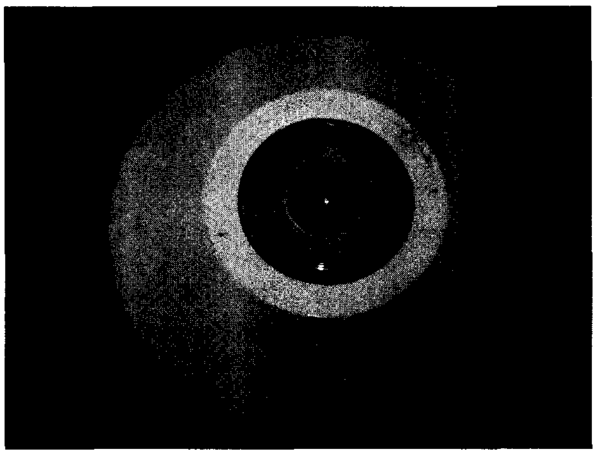

Fig.1. Pyranometer type MS-401

2.2. Biomass energy

Biomass is a rather simple term for all organic material that stems from plants (including algae), trees, and crops. Potency of biomass depends on the productivity (land utilization, plant, cultivation etc.), total area and biomass utilization.

2.3. Wind Energy

Winds develop when solar radiation reaches the earth's highly varied surface unevenly, creating temperature, density, and pressure differences. Wind energy is the kinetic energy from air with mass (m) and velocity (v).

$$E \quad - \frac{1}{2} \text{ x m x} \qquad (2)$$

When the air with total area A m^2 move with velocity of v m/s resulted the mass:

$$m = A.v.\rho (kg/s) \qquad (3)$$

2.4. Utilization of renewable energy for Small Scale Agro Processing Facilitity

Abdullah (1999) initiated to use renewable energy for energy sources for small scale agro processing facilities (drying process). The renewable energy technology provided to support the processing unit comprised of a Green House Effect (GHE)Solar Dryer (Fig.2).


a. Cabinet type


b. Tunnel model

Fig. 2. GHE Solar Dryer

Utilization of renewable energy for small scale agro processing facility was calculated from the need of energy for drying unit as shown below:

1. Energy for drying:

$$Q = \frac{m_p C_p (T_p - T_a)}{t} + H_{fg} \times m \quad \text{.................................} \quad (4)$$

2. Air velocity for drying process

$$Debit_{,,} = \frac{aiwelocity\ (kg/s)}{air\ density\ (kg/m^3)} \quad \text{...} \quad (5)$$

3. Heat load inside dryer

$$Q = A \times U \times \Delta t \quad \text{..} \quad (6)$$

4. Heat flow inside dryer

$$Q = \frac{Q}{Cp_{air} \times \Delta t} \quad \text{..} \quad (7)$$

5. Biomass requirement

Total biomass was calculated from the total energy for drying process3.

3. RESULTS AND DISCUSSION

3.1. General Information of Telaga Warna

Telaga Warna is located at Tugu Utara Village, Cisarua, Bogor district, West Java. (Fig.3). Total area of Tugu Utara village is shown at Table 2. Potency of renewable energy sources at Tugu Utara village mainly is biomass. This biomass mostly come from agriculture area, plantation and wet land.

Table 2. Area and land use at Tugu Utara village

Land use	Area (hectare)
▪ Total area	1703
▪ Protected forest area	363.25
▪ Telaga Warna Park area	5
Wet land	5
▪ Park	5
▪ Plantation	630
Dry land	170
▪ Pond	1
▪ Other	524.75

Source : Kecamatan Cisarua office (2007)

Telaga Warna area

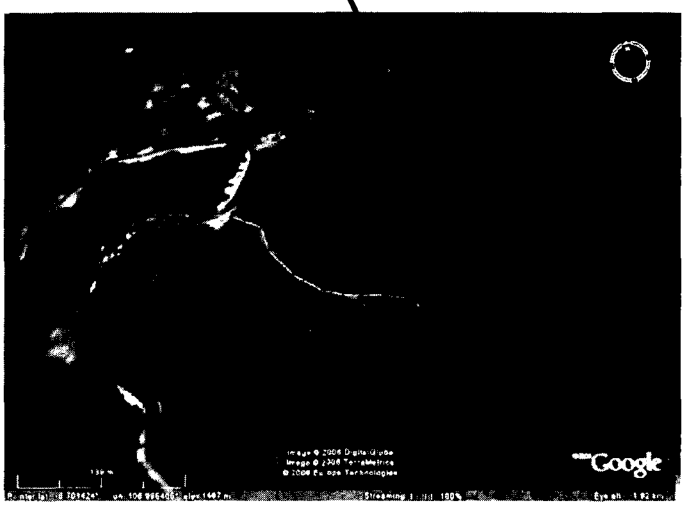

Fig.3. Telaga Warna Area

3.2. Analysis of Potency of Renewable Energy at Telaga Warna Area

Solar iradiation at Telaga Warna area measured during April - July are shown at Fig 4. The average of solar irradiation measured during 7 days at April, may, June and July were 411.66, 434.20, 494.01 and 506.75 W/m^2. Data from Meteorology station at Citeko (near Telaga Warna area) showed that the length of solar irradiation daily was 40% or equivalent with 3.2 hours. So, the potency of solar energy at Telaga Warna area was equivalent with 1.5 kWh/day or 538.6 kWh/m^2/year. Data from Ministry of Energy and Mineral Resources showed that the average of solar irraditon in Indonesia was 4.8 kWh/m^2/day.

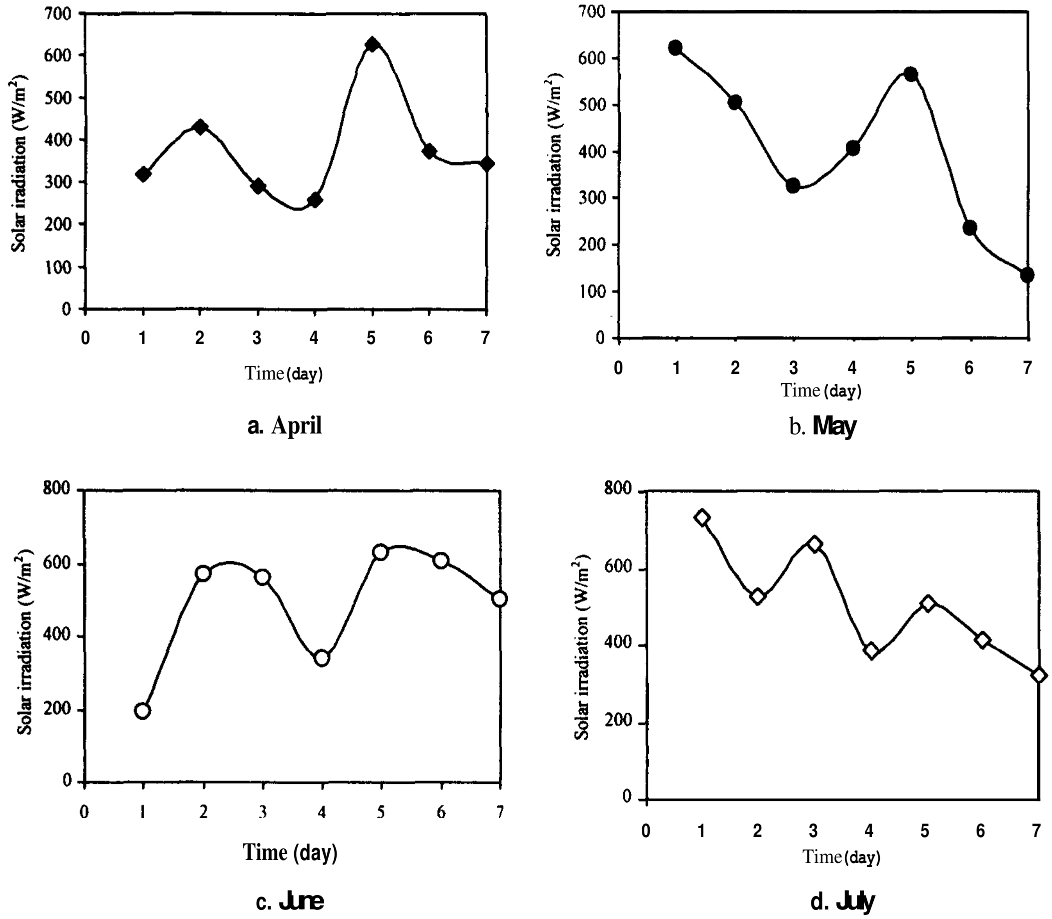

Fig. 4. Solar irradiation during 7 days in April-July

3.3. Biomass Energy

Biomass from agricultural waste mostly was obtained from paddy field. With the total area 5 hectare and productivity per hectare was 5.35 ton, the total production was 26.75 ton. Agustina (1990) reported that the waste conversion from paddy to paddy straw was 500% and from paddy to husk was 24%. The total biomass from paddy was 140.17 ton per year. Biomass from tea plantation was obtained from the replanting activity. Replanting of tea plantation around Telaga Warna was carried out per 15 hectare every 5 year. Agustina (1990) explained that from 1 hectare of tea plantation resulted biomass of 1 m^3. Potency of biomass from tea plantation was calculated as 15m^3 of wood equivalent (Fig. 5). Potency biomass from dry land at Tugu Utara village was 18m3/hectare/year (Agustina, 1990). With total area of dry land of 5 hectare, the potency of biomass from dry land was 90m^3/year.

Fig. 5. Biomass from replanting of tea plantation

3.4. Potency of Wind Energy

The potency of wind energy at Telaga Warna area is depended on the wind velocity at this area. Wind velocity is depended on the pressure gradient, location and altitude. Data of wind velocity obtained from the Meteorology Station near Talaga Warna showed that the average of wind velocity was 1m/s. This value is less than 75 W/m^2 which recommended as a minimum value can be utilized as an energy resource. Fig. 6 shows the wind velocity monthly during 6 years at telaga Warna area.

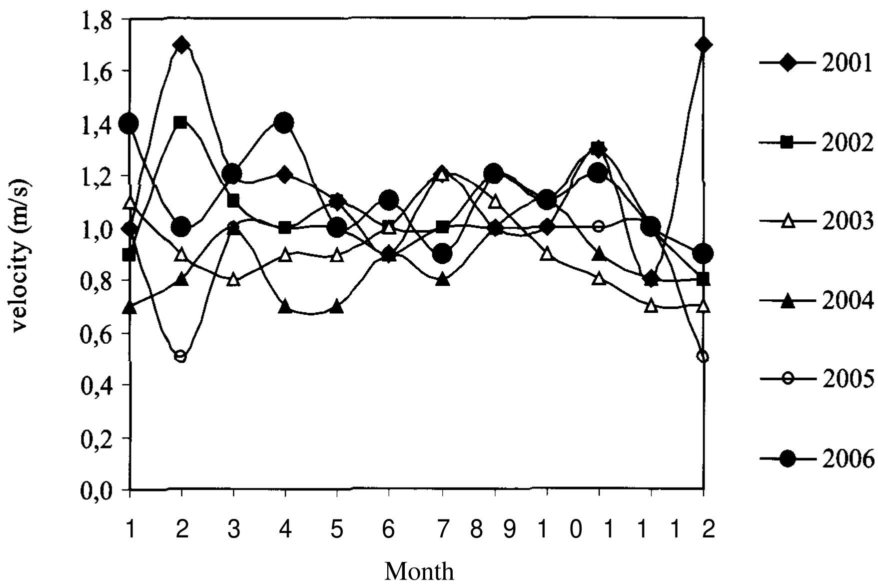

Fig. 6. Wind velocity at telaga Warna area during 2001-2006

Table 3 shows the summary of potency of renewable energy at Telaga Warna area. The potency of renewable energy sources was mostly from solar energy and biomass.

Table 3. Potency of renewable energy at Telaga Warna area

Souces	Unit per year	Potency
• Solar radiation	kWh/m²	538.60
• Biomass		
Paddy straw	ton	133.75
Husk	ton	6.42
Waste of tea plantation	m³	15
Waste from Park area	m³	90
Waste from Dry land	m3	2040

3.5. Analysis of Utilization of Renewable Energy for Drying Facility

The existing agro processing observed at around Telaga Warna is mushroom cracker processing. This small scale industry was managed by the local people around Telaga Warna area. The process included the drying process to produce the dried cracker. This process was carried out tradionally by puting the wet product on the floor, so the process was depended on the daily weather.

Utilization of renewable energy (bimass and solar energy) at Telaga Warna area for small agro processing unit was demonstrated using GHE solar dryer designed by Abdullah (1999). Weight of wet cracker to be dried was 30 kg, initial water content was 68% wet basis, final water content was 5% wet basis and drying period was 3.2 h. Period of drying process for cracker with drying temperature of 70°C was 3.2h. It was found that total heat load for drying process of cracker was 25.1 kW. Total solar irradiation measured at Telaga Warna area was recorded as 461.6 W/m2, this amount of solar irradiation was not enough for drying process of cracker, so the auxiliary heat must be added as amount of 20.48 kW. This energy was supplied from the biomass energy.

4. CONCLUSION

1. The potency of renewable energy sources at Telaga Warna area was mostly from solar energy and biomass. Potency of renewable energy from solar was 538.6 kWh/ m2. Potency of biomass energy from paddy field was 140.17 ton/year and from other area was 2045 m3.

2. The average of wind velocity at Telaga Warna area was 1 m/s or less than 75 W/m2.

3. The utilization of renewable energy sources at Telaga Warna area was demonstrated for mushroom cracker drying using GHE solar dryer. It was found that for one unit of GHE solar dryer (30 kg of sample) required energy of 25.1 kW. This amound of energy was supplied by solar energy of 4.62kW and the rest was added by biomass energy.

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