

Sustainable Parameters in Introducing Renewable Energy Technology

Kamaruddin Abdullah

Laboratory of Solar Energy Conversion
Technology

Darma Persada University,

Member of PII, Member of IRES

Jl. Radin Inten 2, Pondok Kelapa, East Jakarta,

Phone:+62-21-8649060/Fax:+62-21-8649052

Email:rektor@webmail.unsada.ac.id

Abstract

Since several years ago the author had proposed a concept of the E³ⁱ village, in which locally available renewable energy sources can be transformed to supply the mechanical, thermal, and electrical energy for the house hold, SMEs and cooperative as well for the transportation sector in the rural areas. Such an idea could be immediately implemented knowing the fact that many research results achieved by various research institutions including the universities are beginning to show their results for industrial applications. It needs an integrated approach and holistic energy planning, however, in order to make

the introduced technology pay and effective to induce sustainable development, particularly in the rural areas. As the first step toward the realization of the E³ⁱ village concept, renewable energy technology is applied to provide the required thermal and mechanical energy for value added activities in Small Processing Unit. This paper is proposing a methodology to measure the effectiveness and sustainability

of the introduced renewable energy technologies for Small Processing Unit, taking an example of solar drying applications.

Keywords: solar drying, rural development, Small Processing Unit, sustainability parameters.

1. Introduction

Many of the introduced renewable energy technology in this country have ceased to operate to several reasons. One is that the project is only financially supported for a very short period of time, without monitoring and evaluation as well as proper supervision programs leaving no working capital and after sales services to ensure the sustainability of the project. Another problem is the availability of full time managers and their supporting staff to take care of the provided facilities who possess adequate managerial skills and motivation to seek for necessary support from different sources particularly from local authorities including the private sectors. The manager should actively conduct market survey of their products or extend the existing production lines for more value added activities to increase the benefit of the technology.

Experiences have shown that on paper the facilities provided should bring benefit to the beneficiaries provided that they could be provided with multi years funding support, say 5 to 10 years in addition to proving proper supervision and guidance until the system can reach a level of self propelling growth. Recently the government under the coordination of Coordinating Minister of Economics and Industry had launched

a national wide Energy Self Sufficient Villages, which aims to create the spirit of self help of the villagers in providing their energy needs from locally available renewable energy sources [1]. The project which was started in 2007 is being supported by several Ministries, each implementing renewable energy technology programs under their own management. Some take care of solar PV, some promoting bio-fuels, mini/micro-hydro, biogas etc. This program seems to have all necessary supporting components to resolve past failures in introducing renewable energy technologies in Indonesia. In addition it complies with and supportive to the author's concept of E³ⁱ villages (Empowerment of autonomous village in Renewable Energy, Economics and Environment) proposed some years ago. [2]

This paper is proposing a novel method in introducing renewable energy technologies for rural development by measuring sustainability parameters comprising, cash flow analysis of the business unit, such as the proposes Small Processing Unit (SPU) employing renewable energy technologies, managerial characteristics, and regional impact of the introduced technologies [2][3]. The latter approach needs more time to apply awaiting for some years to accumulate adequate data after the introduction of the technology.

2. Strategy in making SPU operation sustainable

Modified tunnel dryer and greenhouse type ICDC (Integrated Collector and Drying Chamber) solar dryer were installed in respective three sample villages, namely in Ped, in Bali, Daleman in Klaten and Mulyo Haji villages in Lampung. The following analysis was based on data taken from these three villages. Some of data had been extended after taking into consideration the potential capacity of the products to be process and market access.

2.1 The economic benefit of solar drying system

The following data was collected from Mulyo Haji village. The dryer was used to process cassava wastes.

- 1) Initial capital (land, building and dryer): Rp 65,000,000.
- 2) Operational Costs per day: Rp 310,000.
- 3) Benefit per month (with 10% tax reduction): Rp. 5,175,000.
- 4) Pay back: 1,05 years

2.2 The production function [4]

Assume that a renewable energy technology has been installed in a rural cooperative or in village community in the form of stand alone or as SPU and to be managed by an entrepreneur. Let the production function of the cooperative using the dryer can be represented by

$$dC / dt - a_1 C = f(t) \tag{1}$$

with IC; at t=0, C=0

Here C is the number of sales or production per month, Rp/month (kg/month), a_1 is a coefficient depending on the attribute of management of the dryer (1/month), b is a coefficient related to the increment trend of dried product measured in terms of their selling price (1/month), and t is the duration of data collection (month).

The solution of eq.(1), for $f(t) = e^{bt}$ is, assuming that both a_1 and b are constant

$$C(t) = \frac{1}{(a_1 - b)} \exp(a_1 t) - \left[\frac{\exp(bt)}{(a_1 - b)} \right] \tag{2}$$

The value of a_1 and b then can be determined after solving eq.(2) using more than two data simultaneously by using the least square methods.

Now let $f(t)=b$, then the solution of eq.(1) becomes, after applying the initial condition,

$$C(t) = \frac{b}{a_1} \{ \exp(a_1 t) - 1 \} \tag{3}$$

Field data were collected from the three sample villages in Mulyo Haji village, Central Lampung where batch type

solar dryer was intalled, in Daleman village, Klaten, Central Java and in Ped village, Nusa Penida island, Bali, provided each with modified tunnel dryers. Solar dryer in Lampung was used to dry processed cassava wastes, while in Klaten and Bali, was for sea weeds. And *soun* (chinese noodles) drying, respectively. These products have their respective captive market and, therefore, the facilities provided can help the beneficiaries to generate increasae their income.

From field survey the estimated production trend of the three sample village is given in **Table 1** below. From these data the respective value of the production coefficient a_1 and b as described in eq.(1), were respectively, $a_1 = 0.0043$, and $b=3040$ for Lampung, $a_1= 0.0112$ and $b=1129$, for Klaten and for Bali, $a_1= 0.0210$ and $b=17660$.

TABLE 1. Estimation of production of ICDC solar dryer installed in three sample villages

Time (week)	Production estimate		
	Lampung (kg)	Klaten (kg)	N.Penida (kg)
0	0	0	0
1	2500	1020	10000
2	5500	2160	35000
3	9000	3330	65000
4	12500	4530	73000
5	15500	5790	85000
6	18500	7080	115000
7	22000	8370	140000
8	25000	9630	150000
9	27500	10650	170000
10	31000	11790	200000

Figure 2 shows the comparison between data and estimation using eq. (3), which indicates that the model is in good agreement of the data collected for the three sample villages.

The respective parameter a_1 and b can be plotted for each villages indicating the level of entrepreneurship of the SPU managers and the impact of the introduced technologies. As shown in **Figures 1** and **2**, it indicated that the managerial skill and impact of introduced solar drying technology of SPU at Ped village in Bali was the biggest among the three selected sample villages for the study. However, in the near future, more data should be collected from these three villages including training and supervision in order to have a more convincing conclusions of this study. It is envisaged that it may take at least 5 years should be needed to provided supervision and assistance in order to make the selected business ventures to become really sustainable.

One immediate action and strategy to disseminate the utilization of the currently installed prototype solar dryer (*Figure 4*) in a small tanneries in Garut is by using a leasing method. The small holders may bring along their respective raw materials, processed into wet blues available within the tanneries complex and use the dryer under a leasing system. Currently, small holders in the neighbourhood of the tanneries may bring along their respective raw materials, processed into wet blues available within the tanneries complex and use the dryer under a leasing system. Currently, the small holders are using the dryer by bringing along their respective fuel wood to generate steam as a back up heating system. Each small holders is charged with certain amount to dry wet blues from sheep or goat and different charge for wet blues of cattle. The data collected indicated that the daily amount of wet blues dried was on the average of 304 pieces/day with the revenue varies from Rp. 240,000 to Rp 496,000 per day or an average of Rp 368,000/day (US\$ 49,8/day). The total revenue for the month of April was Rp. 1,720,500 (US\$ 172) for only 11 days of operation. The revenue is expected to become more than double of the current value if the whole month could be used effectively. In *Figure 5*, a comparison between data and the production function has been made accomodating the sustainability parameter a_1 , the managerial coefficient and b , the technology intervention coefficient. These parameters can be used to compare the performance of traditional system with the same drying capacity or to evaluate the effectiveness of any renewable energy intervention program. (Darma Persada University, 2009).

Assuming that drying operation can be conducted all year round, except around one month free during the fasting month of Ramadhan, the expected annual revenue will be Rp. 113,344,000 (US\$11,334) for 11 month.

As the price of the dryer is Rp 120 million, for a taylor made dryer, the investment can be recovered within less than 2 years. It would be much faster if the dryer can be mass produced where the fabrication cost could be reduced significantly.

3. The diffusivity of coefficient and the regional impact of technology intervention

In addition to what described above, two more important parameters should be included once the installed facilities had been operated for sometimes. The first is the diffusivity coefficient which describes how far the applied technology have been known to the future users, either within the physical or administrative boundaries of the project sites. The diffusivity coefficient is analogous to transport phenomena in physical process such as in the transfer of mass, momentum and energy.

The second parameter will the change in economic structure of the region or village where the renewable energy technology was applied in industries. The introduction of value added technology should result in many positive impacts on other economic sectors, such as described in the wellknown Leontieff's I/O Table. It may have positive impact on the creation related industries or business ventures which will open new labor market, increase in local content, additional regional income in terms of tax, etc., and consequently gross regional income.

Conclusion

- 1) Implementation of the E³ⁱ village concept can be initiated by starting to provide the village with value added facilities in the form of SPU supported renewable energy technology such as solar drying technology.
- 2) Based on the available data, a preliminary attempt to measure the sustainability parameters of SPU installed in the respective three villages under study had been determined. However, it needs more years for accumulated data before we can draw a solid conclusions. In addition, there are several parameters still remain to be included in the future to ensure sustainability of the technology intervention.
- 3) The E³ⁱ village concept is complimentary to the now on going ESSV program of the Indonesian government.

Acknowledgement:

This study is part of the work conducted under insentive program research grant from the Minsitry of Reserach and Technology of Indonesia, contract No.:97M/Kp/XI/2007.

The author wishes to thank all research team members from the three collaborating institutions, namely, UNSADA, METI and IPB for their valuable contributions.

References

- [1] Directorate General of Electricity and Energy Utilization, Development of DME (In Indonesian). Bulletin Energi Hijau (The Green Energy Bulletine), No. XV, March. 2007.Ministry of Mines and Energy Resources.
- [2] Kamaruddin Abdullah, (2007). (Ed.). Teknologi Berbasis Sumber Energi Terbarukan Untuk Pertanian (in Indonesian), CREATA-LPPM, IPB, Bogor,
- [3] Kamaruddin Abdullah,2007. Energi terbarukan untuk mendukung pembangunan pertanian dan perdesaan, IPB Press, ISBN, 978-979-493150-9, 2007.
- [4] Darma Persada University. Pengembangan Unit Pengolahan Skala Kecil (UPSK) dengan Memanfaatkan Sumber Energi Terbarukan (SET) Setempat dalam Rangka Mewujudkan Desa Mandiri E3i.(in Indonesian) Insentive Program Research Grant, Ministry of Research and Technology, final Report, 2008.
- [5] Kamaruddin A., 2009. Hybrid GHE solar dryer for leather and textile products, draft, final report to SENADA Project, USAID by Darma Persada University.