A Practical Methodology for Photovoltaic Development at a Thai Educational University

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ABSTRACT

This paper presents the methodology of the development for photovoltaic (PV) systems, all of them are stand alone types that have been installed in Rajamangala University of Technology Thanyaburi (RMUTT) which is located at Klong 6, Thanyaburi district of Pathumthani province in Thailand. The main objective for installation these energy systems is to promote some solar energy projects in terms of PV systems based on the university's energy policy. The PV projects were partially supported by the government's budget, for example the pumping system, street lighting, solar home system, board of the Faculty map and so on. The systems have providing an installed of capacity around 2,170 W_P The resultant information will include the system performance over a two year monitoring period and together with some operational experiences in terms of reliability and maintenance, acceptability and user satisfaction. However, the life cycle cost of each system is comparable and the key issues discussed in the paper are the problems encountered under installation.

Key words: PV stand alone, life cycle cost, reliability

1. INTRODUCTION

Rajamangala University of Technology Thanyaburi, Pathumthani province of Thailand, has had the policy for many renewable energy projects. PV stand alone system is one of these projects and has been promising research work of the university. There are 6 PV system projects that have been installed within the area of the university since 2003. These PV application systems have installed capacity about 2,170 W_P can be broadly addressed as follows:

(1) a pumping system	520 W_p
(2) three street lighting systems	450 W_p
(3) two tracking systems	450 W_p
(4) a solar home system	300 W_p
(5) a vaccine refrigerator	300 W_p
(6) a board of the faculty map	150 W_p

At present, these PV systems have been working and some system performances have also been measured. The design of control circuits were experimentally done in these works. Protection of the battery from damage of deep discharging and overcharging by controllers were also considered. The results of operational experience are able to provide useful information for

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rural electrification planners to install in a particularly rural area such as rural school/university or rural village in Thailand. They should be applicable in other countries that are situated the same latitude angle with a similar climate.

2. SYSTEM COMPONENTS

Most of system components for PV projects that to be installed at the university are generally consist of as follows:

2.1 Photovoltaic Module

one example of a PV module has some details in terms of the characteristics as follows: [1]

Rated power	75 watts@ 25^{0}C
Voltage @ max. power	17.0 volts
Current @ max. power	4.45 amps
Short circuit current	4.75 amps
Open circuit voltage	24.1 volts
Warranted minimum	65 watts
Maximum system voltage	600 volts
Temperature coefficient of I_{sc}	(0.065±0.015) % / ^{0}C
Temperature coefficient of V_{oc}	-(80±10) mV/^{0}C
Temperature coefficient of power	-(0.5±0.05) % / ^{0}C
NOCT	47±2^{0}C
Dimension	53.7 cm×120.9 cm×5 cm
Weight	7.7 Kg

2.2 Controller

A few of these projects, the regulator from BP solar # GCR 2000 has been mounted to control the state of charge and discharge of the battery. Maximum rated current for this type is about 20 A. This charge control is specifically developed for charging battery powered by photovoltaic modules. It includes an LCD display that provides continuous battery storage and battery bank conditioning data. In addition, the controller is the heart of the energy management of PV power system. This is because it controls the energy of the battery and the way it is spent on the different parts of the system. Accordingly, the design of an additional control circuit was experimental done in this work. Normally, the operating voltage of this system is about 12 volts. A solar charging controller with 20 A rated from BP solar company has been used in one of the PV systems. Its internal circuit can be shown in Fig 8.

2.3 Microcontroller

In the PV system for a board of the faculty map, basic data for design the program on microcontroller are as follows: [2]

a) there are 16 switches (16 points of destination) to push for selecting location where user wants to go.

b) use LED to show the way from starting place to another department or another building that someone who wants to go within the Faculty of Engineering on a board of the faculty map. Users are able to know the amount of space in meters between the starting place and destination from reading on display segment.

c) there is a display segment

d) control the period of time for an operating of a fluorescent lamp.

2.4 Inverter

A few of these projects, the inverter of model # G-12-150 has been mounted for transforming the voltage level from DC to AC. The inverter of model # G-12-150 has been mounted for the photovoltaic water pumping system. The ac output voltage and frequency vary continuously as a function of the irradiation that can be seen from the Fig. 12. Its characteristics are as follows:

Output power 25 min	1500 watts
Output power 10 min	1700 watts
Output power continuous	1200 watts
AC output	220 volts
Regulation	±5%
Output waveform	modified waveform
Phase	single phase
DC input voltage	10-15 volts
Low battery alarm	10.7 volts
Low battery shut down	10 volts
Frequency	50 Hz
Efficiency	85-90%

2.5 Battery

Most of PV projects, the battery with maintenance free type #DJM12120 has been mounted. The rated voltage and ampere-hour are 12 volts and 120 ampere-hour respectively.

3. LIFE CYCLE COST ANALYSIS

ALCC analysis is based on the key assumptions (year 2003). The costs of installation and operation and maintenance are estimated by multiplying the capital cost of PV arrays with 0.2 (20%) and 0.02 (2%) respectively. This is based on 25 years of the period of life time for analysis and the value of the inflation rate is 5%.

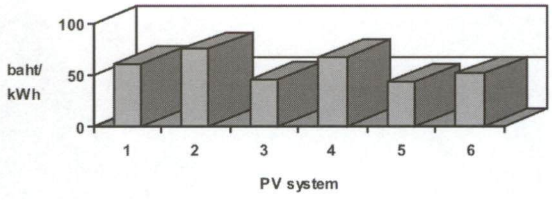

Figure 1: comparison of LCCA of each PV system

the figures in the Fig. 1 are meaning as follows:

1. pumping system
2. tracking system
3. solar home system
4. street lighting system
5. vaccine refrigerator system
6. board of the faculty map

4. SURVEY AND ANALYSIS OF RESULTS

The survey was based on 2 main activities:

- survey of existing PV projects that have aimed to promote and implement in social university.
- Survey of policies and strategies of university

The objective of the survey was to know how to develop and how opinion of people who are users PV systems.

Summary of results:

Lessons learnt from users who have already used the PV systems

- Guidelines for maintenance of system are required and should be made available in an easy to understanding way to attract social university.
- It is very important to involve the people as early as possible and to give them the opportunity to develop their own ideas.
- Typical design requirements for PV systems should be reported or be summarized and presented on the internet.
- In general, there are no serious problems have been reported.

Lessons learnt from people who have not yet already used the PV systems

- the advantages from installation of PV systems have been asked

- the economic factor of PV systems was found to be a critical factor that has to be addressed in order to attract these people for interesting PV systems.
- Most of them have information in their own house.

Lessons learnt from financing for installation the PV systems

- the cost of PV systems has been mentioned as a major drawback for the adoption of PV in social university premises.
- The funding mechanisms available to social university are a key factor for the effective implementation of PV in the sector.
- Development of a financial model should be done

5. EXAMPLE OF THE STAND-ALONE PV SYSTEMS INSTALLED AT RMUTT

There are some PV systems which to be installed at the RMUTT can be shown from the following figures

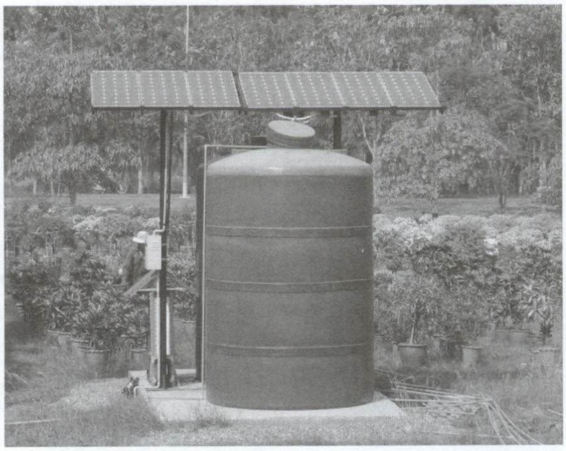

Figure 2: The PV water pumping system that seen from the south of the design location

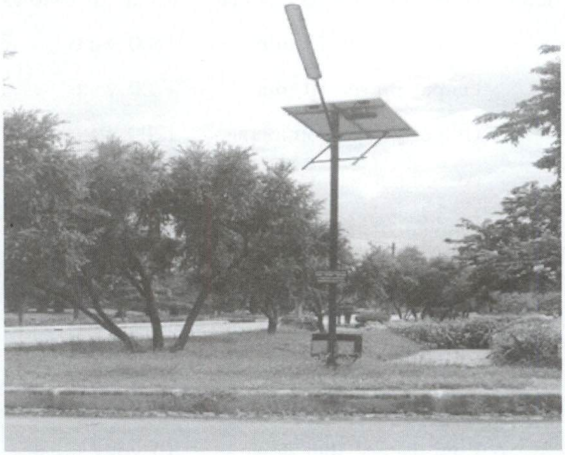

Figure 3: The PV street lighting

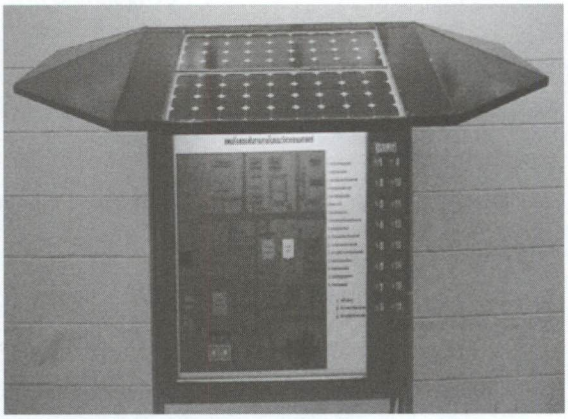

Figure 4: PV system for a board of the faculty map

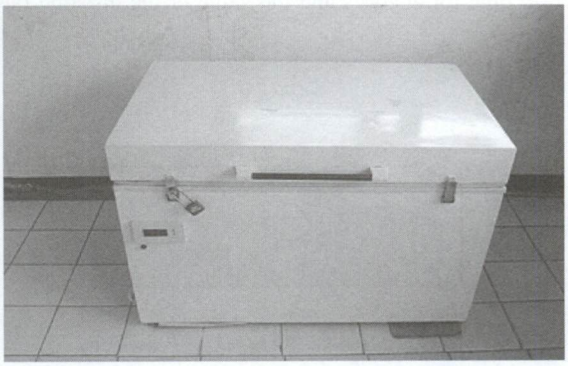

Figure 5: PV vaccine refrigerator

Figure 6: solar home system

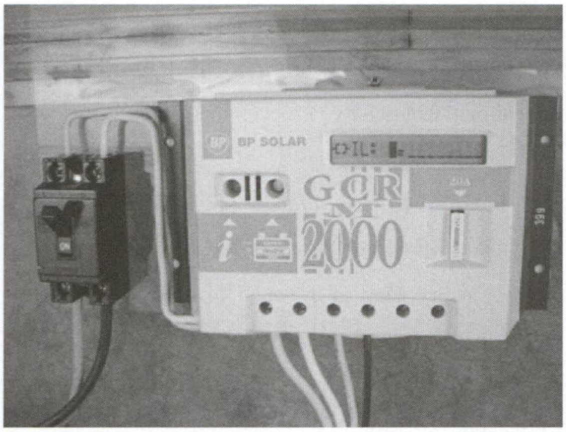

Figure 7: Typical regulator to be used in PV project

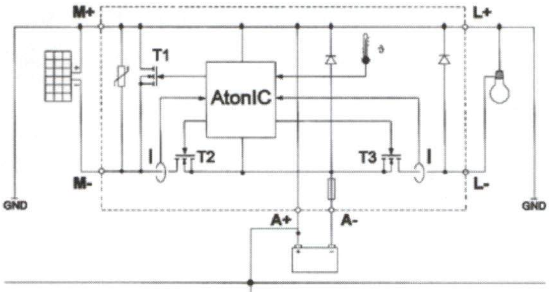

Figure 8: an internal circuit of solar charging controller

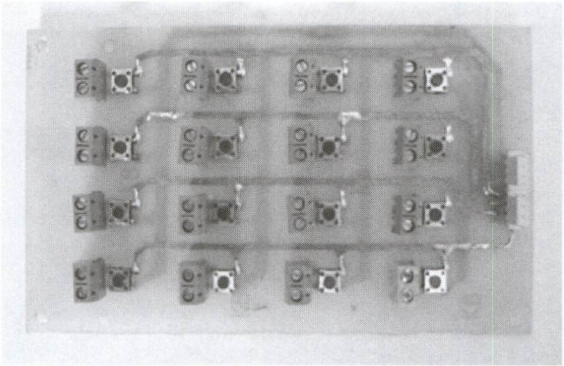

Figure 9: set of matrix switches for controlling push button on a board.

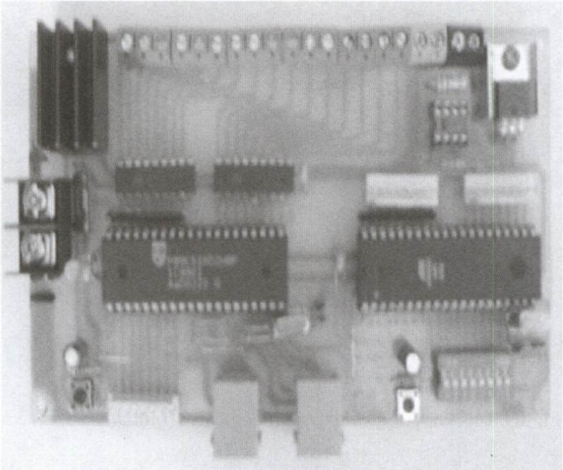

Figure 10: the microcontroller set.

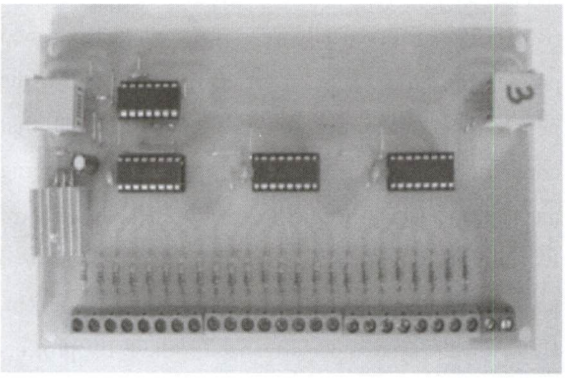

Figure 11: circuit for driving the LED

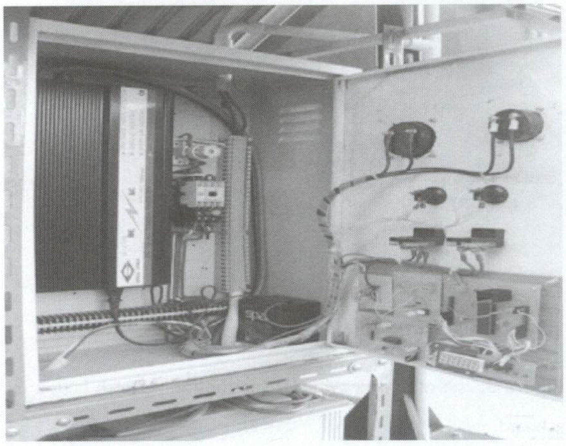

Figure 12: An inverter to convert DC-AC with controlling circuit

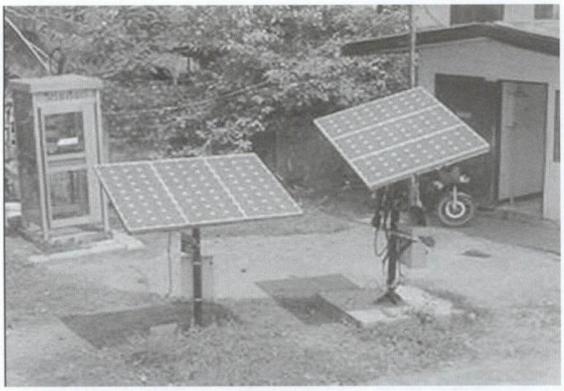

Figure 13: A PV tracking system compared with a fixed system

6. CONCLUSIONS

Most PV projects, which are installed in Rajamangala University of Technology Thanyaburi (RMUTT), are practically promising works and good progress in terms of an operational experience for the people who are users to know more details that concerned with renewable energy. The financing mechanisms and strategic model for development of PV projects should be more encouraged compared to partially regular budget from the central government. However, the system performance of these PV projects should be more monitored. There are normally no problems with the design and installation process and the visual appearance could often be improved. The results of the survey showed that in most cases the social university are already convinced of the value of PV project.

7. ACKNOWLEDMENTS

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8. REFERENCES

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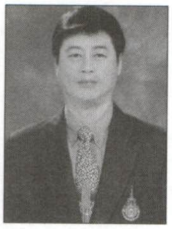

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