CHARPTER I

INTRODUCTION

Rationale for the Study and Statement of the Problem

In the recent decades two major crises have been emerged in connection with the human development around the globe. They are termed as "Shortage of energy" and "environmental pollution" [1]. In the mid of 19th century nuclear energy development attracted the World but soon lost its glamour due to environmental and other hazards involved. The turning point in the development of renewable energy technologies was the world awareness about the environmental pollution and its implications rather than the energy shortage.

It is a well-known fact that world energy demand is growing rapidly with the increase in population and changing lifestyles. A statistical review done by BP in 2012 shows global energy consumption growth rate as 1.6% per annum for the period from 210-2030 [2].

The future socio-economic development is linked with the adequate supply of clean energy. During the past two decades climate changes around the globe has been felt severely, and scientist believe that if the pattern continues, life on our planet will be under serious threat of demolition. The major reason for these abnormal changes in climatic conditions is Global warming, caused due to the emission of Greenhouse gases, which is a mandatory result of fossil fuel utilization for energy production. The researchers around the globe are working on the Renewable Energy Technologies to cope with this challenge. At present not only the developed countries but developing countries too are actively involved in the development and adaptation of RE technologies.

The clean alternatives to the depleting fossil fuels are the Renewable Energy resources like Solar, wind, Tidal, wave, Biofuels, Geothermal, Hydro(small scale), fuel cells etc. The sun is the basic source for most of the above mentioned energy resources. The sun energy can be used either direct or indirect to meet the future energy requirements of the world. Solar energy can be used for heating & cooling purposes and for electricity generation as well.

Electricity generation through the use of Solar cells (photovoltaic) is an important dynamics of solar energy. Different types of semiconductor Photovoltaic Modules are in use for converting the solar energy directly into the electrical energy. This technology has far reaching effects on the future development. There are many advantages which this technology offer as compared to other RE technologies like easy to use, long life, no moving parts, almost zero maintenance, zero Carbon dioxide emission during the operation.

At present Crystalline Silicon modules are holding an over whelming share of PV market in comparison to Thin Film Modules. Crystalline Silicon PV modules have relatively high conversion efficiency (15% - 18%) as compared to other types [3]. As the RE means are going to replace the conventional energy sources gradually, the reliability of RE technology is becoming an important subject in this scenario. All the future power planning and economic evaluations depend upon the consistency in performance of RE Technology over the extended periods of time. The investors and users are reluctant to proceed because of the uncertainty about the real performance of RE components when they will be exposed to the operating conditions for long time.

In the case of PV modules though the performance guarantees provided by the manufacturers are very encouraging, but needs to be authenticated under the operational conditions in the different climatic conditions in various parts of the world, as it is a proven fact that PV modules Performance graph is not linear when operating environment goes under change [4, 5]. At present the average life of PV module is being guaranteed up to 25 years, whereas a few years ago its range was between 15 to 20 years. Taking into consideration the output power degradation, manufacturers are generally providing guarantees in the following fashion. A 10% decrease in the guaranteed power after 10-12 years of use and a 20 % decrease after 25 years of operation in the field [6].

The verification work is drawing attention of researchers from all over the world. Although studies have been conducted in some areas of the world and results generally conforms to the guarantees provided by the manufacturers, but there are still a large number of climatic zones with diverse conditions in which this work needs to be done [6]. Another important aspect of this research is that there are continuous technological developments/improvements in the PV modules manufacturing, so the

results of previous studies soon become obsolete [4]. The performance guarantees mainly represented by output power needs to be authenticated after long term field operations to ensure their reliability and performance guarantees. The need for this research becomes more significant when it connects with the prevailing & prospect trends of PV Grid connected large scale Power Plants. It is very important to ensure the performance related parameters such as output power warranties. The bases for economic evaluations of PV projects must be doubt free to encourage the investment in the new emerging clean energy sector.

Objectives of the study

1. To measure the output power of long term used PV modules and to compare it with nameplate data for calculation of output Power degradation.

2. To calculate the yearly degradation rate and its comparison with other similar studies.

Scope of the study

1. Following lots of Silicon PV modules are under study, which were under continuous operation at SERT Energy Park, Naresuan University, Phitsanulok, Thailand.

Table 1 Details of PV modules under study

Type	Year of manufacturing	Years under operation	Total no. of modules	*Samples selected	Power peak(W_p)
Mono Crystalline	2003	10	26	3	75
Poly Crystalline	2005	9	45	5	80
Amorphous Silicon	2005	9	68	7	54
Mono Crystalline	2000	13	96	10	75

*Details regarding sampling have been given in Chapter 3.

2. Modules were exposed to weather conditions of Phitsanulok, Thailand having coordinates 16.8158° N, 100.2636° E.

3. The selected modules are to be tested under field conditions for I-V curve parameters (short circuit Current I_{sc}, open circuit Voltage V_{oc}, maximum Current I_{mpp}, maximum Voltage V_{mpp} & output Power P_{max}) measurement and hence calculation of Efficiency (η) & Fill Factor (FF).

Keywords or Definition Term

PV Module, Power output, Degradation.

Benefits of the study

The benefits associated with this study are:

1. Enhancement in investor and end user trust by analyzing the guarantee parameters in real time after long term operation.

2. Assurance of reliability for PV technology.

3. Authentication of PV modules performance after long term field operations under diverse climatic conditions.

4. Provision of scientifically tested base for economic evaluations.

5. Feedback for the manufacturing facilities.