CHAPTER I

INTRODUCTION

General background

Cambodia, one of the Southeast Asian countries which has a total land area of 181,035 km^2, one capital city and 24 provinces with population of 14.8 million, does have plenty of renewable energy resources, such as hydro energy (micro/pico energy, which capacity is less than 15 MW), solar and biomass energy and efforts to utilize these resources on a large scale to provide cost-effective and quality energy solutions to the rural population is an on-going challenge for the government and the international community. Many developing countries in the world, providing energy to its people in an efficient and cost effective manner is strong highly challenging work. In spite of significant harnessing of the fossil fuel reserves and hydel power, the gap between supply side and demand side of energy is ever increasing by industrial revolution and population growth. One of the possible options to minimize this gap is extensive used solar energy, especially solar PV battery charging station. In the past decades, there have been several attempts to pilot different renewable energy technologies in the Kingdom of Cambodia, but the implementations are very slow and met many obstacles. Currently, there are a few policy incentives for promotion of renewable energy in the country in order to partly substitute the imported oil, because of the Kingdom of Cambodia is a country which imported oil 100% today and oil resources are today available only in certain areas of the world and oil demand has been increasing, the price of the oil also has rapidly increased from year to year, during the last 10 years, there are causing economic in both developing and developed countries. Due to her location near the equator, the Kingdom of Cambodia is very strong considered solar energy as one of the most promising renewable energy resources. As a result, solar radiation has temporal and spatial variations, it is very necessary to investigate the solar energy potentials for the entire country.

Most parts of the Kingdom of Cambodia's territories possess abundant solar radiation for most of the year. Solar energy arriving at the earth's surface is in a form of electromagnetic wave most of which is in the wavelengths between 0.3 to 3.0 μm. This radiation includes mainly visible light and infrared radiation. Geographical distribution of solar radiation over the region is normally different from other regions, due to position, the causing differences in solar energy potentials. The solar radiation in Cambodia is highest in March and April for most parts of the country. The yearly solar radiation map revealed that

the south-eastern part of the country received the highest solar radiation with yearly and daily average radiation in the range value between 5.00 to 5.20 kWh/m^2/day or equivalent of 1,860 kWh/m^2/year over the Kingdom of Cambodia [1]. In particular, the half of Kampot province's boundary received the highest solar radiation too. Thus far we sharply have concentrated on the need for low-energy design, and the means and the processes associated with its realization. The introduction of integrated renewable energy makes the holistic approach even more important. For pioneer of solar PV battery charging station, actually, is zero emission means that over the life of the battery, carbon dioxide produced by its installation and occupation is balanced by saving in carbon dioxide made possible by the supply of renewable energy sources.

Solar PV systems in the Kingdom of Cambodia

The annual report from the Ministry of Industry, Mines and Energy (MIME) on rural electrification by renewable energy in the year 2013 has shown the solar PV systems were classified into three main categories as below:

1. PV stand-alone system (SHS and PVBCS).
2. PV hybrid with diesel/biomass generation.
3. PV grid connected system (Mini-grid).

The PV stand-alone systems

In order to give the intermediate targets fixed by the Royal Government of Cambodia, all these stand-alone systems are modelled to be installed before the year 2020, and the investment amount over the coming 10 years is for from negligible for solar home systems (SHS), PV battery charging stations (PVBCS) and community PV. The solar PV communities have been predicting possibilities of this nature for some time but now they are also coming from the oil industry.

Therefore, the communities PV are separated as the following:

1. School and health center: 700 W_P.
2. Pagoda, temple and commune hall: 200 W_P.
3. Solar battery charging station: equivalent of 40-60 W_P/customer.
4. Solar home system: more than 100 W_P.
5. Telecommunication: telephone and GSM companies were used PV stand-alone system for daily operation [2].

The average payment for electricity in rural areas

Based on the average ability to pay for electricity of each household in rural areas in the Kingdom of Cambodia would be given as follows:

1. JICA Master Plan (2005): around 3 to 5 US$/month/household.
2. World Bank Rural Electrification Strategy (2010): 7.5 $/month/household.
3. Sustainable Rural Electrification Plan (SREP) survey in villages otentially eligible for hybrid PV/diesel systems (2011): 5.3 US$/month/household.
4. EAC's annual report for the year 2012: 9 US$/month/household.

Location and information of Kampot province

Kampot, one of the provinces in the Kingdom of Cambodia, is a biggest salt-farm and tourism province located in the southern part of the country where stayed along the coastal areas with fewer trees and high solar radiation to suitable for installing the PV battery charging stations, 150 km from Phnom Penh and it consists of 8 districts, 97 communes with a total of 477 villages, population around 620,217 (NIS, Ministry of Planning, 2012) and it has more potentials for the solar energy [1]. The solar energy potential of Kampot province can be determined from the geographical distribution of long-term average solar radiation which has been obtained from other works. In contrast, Kampot also has the lowest electrification rate in the country (nearly 55%, MIME, 2013), so the population of Kampot province also suffers from having very expensive electricity costs and energy costs based on primarily on expensive oil imported. The Figure 1 shows the map of the Kingdom of Cambodia and location of the Kampot province.

Figure 1 Map of the Kingdom of Cambodia

Source: Department of Energy Development of the Ministry of Industry, Mines and Energy (MIME), Kingdom of Cambodia

With a strong recent commitment taken in part of the Royal Government of Cambodia aims at reaching 15% of the overall energy supply to come from renewable energy sources by 2015 and all villages should have access to electricity from different sources of energy so much so that by the year 2020. Electrification is clearly defined here as a village where more than 50% of the households receiving some form of electricity supply. In addition, solar PV battery charging stations (PVBCS) could be very viable option to provide electricity in rural areas and where incomes are insufficient to pay for solutions like solar home systems (SHS). In general, solar PV battery charging stations operate reliably when good quality components are used. They are very known and reputed among the people who are living in rural areas in Cambodia for their high quality of charging, which allows battery utilization for about 7-10 days. Moreover, solar PV battery charging stations are very important for saving expenditures for people in rural communities which could help meet part of the political objective of the Royal Government of Cambodia soon, respectively [2].

So, this study will present the techno-economic analysis of PV battery charging station in Kampot, Cambodia by calculating, designing and evaluating some parameters of technical and economic assessment of solar PV battery charging station under Kampot climate in order to provide electricity to people in rural areas of the country to help improve living conditions. Moreover, participate to reduce greenhouse gas (GHG) emissions which are strong concerned and impacted on climate change today, hence protect the environment. This study could meet the political objective of the Royal Government of Cambodia reaching at 100% village electrification by the year 2020 by using different energy sources, including from batteries with access to a battery charging system. The main aim is to find the best technical and economic analysis that is very proper in the near future for rural communities in Cambodia.

Objective of the study

The purpose of this study is to identify and evaluate the solar PV battery charging station with high potentials for scaling up technology in Cambodia. The overall objective of this study is to analyse the potentials of solar PV battery charging station based on off-grid for rural electrification in the Kingdom of Cambodia. The specific objectives of this study are as the following:

1. To analyze the technical and economic factors of solar PV battery charging station in Kampot, Cambodia.

2. To propose the suitable techno-economic from this study to people who are living in rural areas of the Kingdom of Cambodia.

Scope of the study

In this study will be analysed the two main types of PV battery charging station such as technical and economic assessment as follows:

1. Selected location in Kampot province, Kingdom of Cambodia.

2. Calculate and design the PV battery charging system based on the energy needed of each household in Kampot, Kingdom of Cambodia.

3. Evaluate the economic assessment of solar PV battery charging station by using two types of PV module such as mono crystalline silicon and poly crystalline silicon (c-Si PV modules).

Benefit of the study

This study will reveal the technical and economic analysis of PV battery charging station as follows:

1. This study can identify alternative source of energy for the Cambodian rural communities as per need and location.

2. This study can be identified the types of PV battery charging station in the Kingdom of Cambodia.

3. With the results of this study, we can identify and determine locations most suitable for installing PV battery charging station.

4. This study will provide good technical and economic information of PV battery charging station to all stakeholders and other users.

5. This study can provide roadmap for future of PV battery charging system projects for the Ministry of Industry, Mines and Energy (MIME), Kingdom of Cambodia.

6. This study can be raising awareness to community people.

7. This study can be minimized the environmental impacts.

8. This study can provide more knowledge and understand the techno-economic assessment of PV battery charging station in Kampot of the Kingdom of Cambodia in near future.

Keywords

Techno-economic Analysis, PV battery charging, Solar cell, Kingdom of Cambodia.

Thesis structure

In this thesis is divided into 5 chapters, namely 1) Chapter I is an introduction and background of the Kingdom of Cambodia, 2) Chapter II is the basic facts of Kampot province, Cambodia and related literature review, 3) Chapter III is a methodology, research instruments, calculation and design PV system, 4) Chapter IV is mentioned about the results and discussions and 5) Chapter V is a conclusion and recommendation of the study.