

# The Beginning of Solar Cells Applications in Khon Kaen University, Thailand

Chumnan Boonyaputthipong

Faculty of Architecture, Khon Kaen University, Khon Kaen, Thailand

Email: bchumn@kku.ac.th

Chainiyom Sintorn

Energy and Environmental Utility Management Division, Khon Kaen University, Khon Kaen, Thailand

Email: chainiyom@gmail.com

**Abstract**—Thailand ministry of energy has declared to increase the use of alternative energy 25% in 10 years, 2012-2021. Follow the government policy, Khon Kaen University, came up with the renewable energy plan as part of the main policy between 2012-2015. The beginning of solar cells projects in Khon kaen University are between the years 2012-2015 following the Thai government policy at that time. The public lighting and solar roof are the two main applications at this period. It can be concluded that during that period the university can produce 40,513.40 Kw-Hr/year or 164,231.10 bath/year. The projects draw attention of people within the campus and outside and made people concern of the renewable energy widely. Nowadays, as the solar cells technology has been changed, Khon Kaen University has to follow the new technology and plan for more solar cells application in the future.

**Index Terms**— Solar Cells, Renewable Energy, University

## I. INTRODUCTION

As energy consumption in building section increases, Thailand is partly depended on the import energy from other countries. As well as, the more concern of global warming makes the energy saving in building draw attention both for public and private sectors.

In 2012, Thai government launched the policy of saving energy 10% in the government and state enterprise buildings. Moreover, that year, the Thailand ministry of energy has declared to increase the use of Alternative energy 25% in 10 years, 2012-2021. Follow the government policy, Khon Kaen University, came up with the renewable energy plan as part of the main policy between 2012 and 2015. Part of the 2012-2015 policy focused on the beginning of healthy clean energy use. In detail, there were plans for using solar cell for street light, traffic light and buildings. The responsibility of these was under the infrastructures Development System Development Affairs.

This paper presents the officially first era of renewable energy applications in Khon Kaen University between 2012-2015, which, in Khon Kaen, Thailand, Solar cell is the most efficiency renewable energy.

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## II. SOLAR CELLS IN THAILAND

Photovoltaics (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. Photovoltaic power generation employs solar panels composed of a number of solar cells containing a photovoltaic material. Materials presently used for photovoltaics include monocrystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium gallium selenide/sulphide [1]. Nowadays, renewable energy is the energy source for solving the energy problem and PV is world's fastest growing power generation technology [2]. In Thailand, fossil fuel resources such as oil, gas, and coal are limited. In addition, the processes of energy producing and utilization as, among others, can increase environmental impacts. So, Promoting the Use of Renewable Energy, especially Solar energy in Thailand can be sustainable.

Solar Cells can be used for energy generating within university campus in different applications such as solar roof, street light, solar farm, etc. The beginning of solar cells project in Khon Kaen University is between the years 2012-2015 following the Thai government policy at that time. The public lighting and solar roof are the two main applications at this period.

## III. THE BEGINNING OF SOLAR CELLS APPLICATION PROJECTS IN KHON KAEN UNIVERSITY

The early stage of solar cells project for energy saving in Khon Kaen University can be divided to be 3 categories which are solar cells for public space lighting, solar cells for bus stop shelters and solar roof.

### A. The Solar Cells for Public Space Lighting

#### 1). The Sithan Park lighting

The Solar cells for Sithan Park lighting was the first solar cells project. There were 10 street lighting poles called E-KKU-1 version. (Fig.1) This version used a 4 inches round steel column to support the solar cells fame. The fame can adjust the angle as much as 40 degree vertically and 350 degree horizontally. The 100 W Mono

Crystalline solar cells were connected to the 42 W LED lighting bulb with 100 Ah battery and Solar Charger Controller. The project provides the lighting for part of Sithan Park, the main recreation area in Khon Kaen university. It can produce electricity of 1,814.4 Kw-Hr/year or 7,257.6 bath/year.



Figure 1. Sithan Park lighting

### 2). The president office's parking

The 5 street lighting poles, E-KKU-3 version, are designed for the parking area in front of the president office building, Sirikunakorn building. (Fig. 2) For this version, the square section steel column was used to support the LED light bulb. The design of the pole is different from the first version as 6 x 6 inches used for the bottom of the pole and 4 x 4 inches for the top portion of the pole. The 42 watt LED light bulb connects to the pole by 2 x 2 inches steel that can adjust 90 degree vertically. The 100 Ah 12 Volt battery is designed to located on the middle high of the pole. The project provides the lighting for parking area in front of the president office. It can produce electricity of 1,088.6 Kw-Hr/year or 4,354.6 bath/year.



Figure 2. The president office's parking lighting

### 3). The Rukhachat Park

The E-KKU-3 version applied for another university park, Rukhachat Park, located on the central of the KHon Kaen University campus. (Fig.3) The five sets of this version were installed mainly for the pathway of the park. The project provides the lighting for parking area in front of the president office. It can produce electricity of 1,080.0 Kw-Hr/year or 4,320.0 bath/year.



Figure 3. The Rukhachat Park lighting

### 4). The 22nd dormitory

The street light next to a student dormitory is the E-KKU-2 version. (Fig.4) This version used the 5 m. height steel column with 42 Watt LED light bulb, 120 watt solar cell panel and 100 Ah battery. The solar cells panel can adjust 38 degree vertically and 250 degree horizontally. The project provides the lighting for parking area in front of the president office. It can produce electricity of 544.3 Kw-Hr/year or 2,177.3 bath/year.



Figure 4. The 22nd dormitory lighting

## B. The Bus Stop PV Lighting

There were a number of bus stop pavilion renovation so the E-KKU-2 version PV light poles were used for 5 bus stop pavilions in different locations on Khon Kaen University campus. This version used the round steel column with adjustable panel to avoid building or tree shading. The five locations of the bus stop PV lighting included:

- 1). The Srithan bus stop can produce electricity of 103.68 Kw-Hr/year or 414.72 bath/year. (Fig. 5)
- 2). The Faculty of Agriculture bus stop can produce electricity of 103.68 Kw-Hr/year or 414.72 bath/year.
- 3). The student's union bus stop can produce electricity of 103.68 Kw-Hr/year or 414.72 bath/year.
- 4). The Complex, university's main cafeteria, bus stop can produce electricity of 103.68 Kw-Hr/year or 414.72 bath/year.
- 5). The main library bus stop can produce electricity of 103.68 Kw-Hr/year or 414.72 bath/year. (Fig.6)





Figure 5. The Srithan bus stop lighting



Figure 6. The main library bus stop lighting

### C. The Solar Roofs

#### 1). The university boards' parking

The project is the PV panels that attached on the roof of the university boards' parking. (Fig.7) The electricity from the PV cells separated to be three parts which are stored in the two 100 Ah battery, used in the adjacent building, the Energy Management and Innovation Office, and directly send the university grid.

This project can produce electricity of 13,068 Kw-Hr/year or 52,272 bath/year.



Figure 7. The university boards' parking

#### 2). The net zero energy building

This solar roof project was funded by Energy Policy and Planning Office, Ministry of Energy, Thailand. The office of Communication Affairs Division building, Khon Kaen University, was selected for the research and built. (Fig.8) Officially, it became the first Net Zero Energy Building in Thailand [3].

The 78 PV panels installed on the roof can produce electricity of 22,944 Kw-Hr/year or 91,776 bath/year.



Figure 8. The university boards' parking

### IV. RECENT SOLAR CELLS PROJECTS IN KHON KAEN UNIVERSITY

After the 2012-2015 periods, Khon Kaen university has one main solar cells projects, the smart solar farm. The Smart Solar Farm project is funded by the Energy Policy and Planning office (EPPO), Ministry of Energy, Thailand. (Fig.9) It is a 1 Mw solar farm that can save cost of electricity for the university about 500,000 bath per month. (Fig.10) The other projects are the university hospital solar roof, solar street lighting and other solar lighting in buildings and agriculture farm which are in the process of collecting data.



Figure 9. The Smart Solar Farm project  
Source: <http://www.pew.co.th/>

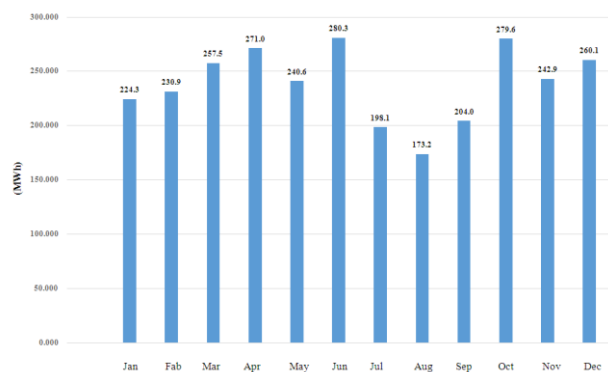


Figure 10. Electricity produced by the smart solar farm, 2019

## V. CONCLUSION AND SUGGESTION

During the year 2012-2015, it considers as the beginning of solar cells application projects in Khon Kaen University. It can be concluded that during that period the university can produce 40,513.40 Kw-Hr/year or 164, 231.10 bath/year. (Table I) It is a small number of renewable energy generated. However, the projects draw attention of people within the campus and outside. Especially, there were a number of the net zero energy building visitors. The public solar lights are located all over the campus. So, they made people concern of the renewable energy widely.

TABLE I. THE ELECTRICITY GENERATED BY SOLAR CELLS IN KHON KAEN UNIVERSITY DURING 2012-2015.

	Kw-Hr/year	bath/year
<b>3.1 The public space lighting</b>		
1). The Sithan Park lighting	1,814.40	7,257.6
2). The president office's parking	1,088.60	4,354.6
3). The Rukhachat Park	1,080.00	4,320.0
4). The 22 <sup>nd</sup> dormitory	544.30.	2,177.3
<b>3.2 The bus stop PV lighting</b>		
1). The Srithan bus stop	103.68	414.72
2). The Faculty of Agriculture bus stop	103.68	414.72
3). The student's union bus stop	103.68	414.72
4). The university's main cafeteria, bus stop	103.68	414.72
5). The main library bus stop	103.68	414.72
<b>3.3 The solar roofs</b>		
1). The university boards' parking	13,068.00	52,272
2). The net zero energy building	22,944.00	91,776
<b>Total</b>	<b>40,513.40</b>	<b>164,231.10</b>

After the first period of solar cells application in Khon Kaen University, the solar cells technology has been changed dramatically. The solar light became more compact and cheaper. So, the university has changed the solar panels attached to the street light to be an all in one solar lighting fixture. The solar roof panels still work very well but they need plan to replace by new and high technology solar cell in the near future. Moreover, there are a number of studies of solar cells application in the campus such as the net zero energy parking building [4], the net zero energy office building [5], the net zero art gallery, the solar roof for dormitory and classroom building, etc.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## AUTHOR CONTRIBUTIONS

Chumnan Boonyaputthipong conducted and approved the study. Chainiyom Sintorn worked on engineering analysis and construction process. Chumnan Boonyaputthipong wrote the paper; all authors had approved the final version.

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**Chumnan Boonyaputthipong** is an Assistant Professor of the Faculty of Architecture, Khon Kaen University. He received his B.Arch. from Khon Kaen University in 1993. He continued his Master Degree and Ph.D. study at Illinois Institute of Technology, USA, where he obtained his M.Arch. and Ph.D.(Architecture). Dr. Boonyaputthipong held the position of Vice President for Infrastructures Affairs, Khon Kaen University between 2011-2015. Recently, he is the Khon Kaen university's master plan committee. He currently interests involve in the research topic of sustainable and local green architecture.

**Chainiyom Sintorn** is a director of the Energy and Environmental Utility Management Division, Khon kaen University. He received his M.Eng. (Energy Engineering) from Khon Kaen University.