

---

**JOURNAL OF THE ASIA RESEARCH CENTRE**

**YANGON UNIVERSITY**

**Vol.6, No.1 & 2**

---

---

**Published by**

**The Asia Research Centre, Yangon University**

**Yangon, MYANMAR**

---

---

**JOURNAL OF THE ASIA RESEARCH CENTRE**

**YANGON UNIVERSITY**

**Vol.6, No.1& 2**

---

---

**Published by**

**The Asia Research Centre, Yangon University**

**Yangon, MYANMAR**

---

**First Edition: January 2017**

**200 copies**

**The publication of this journal was funded by the Asia Research Centre,  
Yangon University**

**Published by  
The Asia Research Centre, Yangon University  
MYANMAR**

**Tel: 095-1-536503, Fax: 95-1-527067**

**Email: [contact@uy.edu.mm](mailto:contact@uy.edu.mm)**

# Foreword

University of Yangon ( UY ) makes an all-out effort to be a leading higher educational institution in Myanmar as a Flagship university on par with regional counterparts and in line with international trends. UY therefore expands the frontiers of knowledge by developing research culture.

UY created a research-teaching nexus namely Universities' Research Centre (URC-UY) where research informs and enhances teaching agenda. University education is fundamentally about how to solve problems based on data and/or logical thought. Those involved in research are better at imparting these skills to students with inquiring minds. The Korea Foundation for Advanced Studies (KFAS) has been supporting research activities in UY through the Asia Research Centre (ARC-UY). To a researcher in UY, ARC-UY and URC-UY should be seen as two sides of the same coin in much the same way as financial support and research activity should be regarded.

Research is only meaningful if it is communicated, so the research outcomes must be published and contribute to the body of knowledge; even better if research outcomes can be impactful through commercialization or implementation. This journal proudly presents 15 research papers resulted from the outstanding research projects carried out by the academic departments of UY.

I would like to express my appreciation and congratulations on the concerted effort of the researchers who have made a great deal of excellent contribution to this issue. I also would like to to express my heartfelt thanks to Mr. Park In-Kook, President of the KFAS for his continued support to the ARC-UY.

Prof. Dr Pho Kaung  
Rector, University of Yangon

## Development of Optimized PV-Backup System in University of Yangon

May Thet Mon<sup>2</sup>, Aye Aye Thant<sup>1</sup> and Khin Khin Win<sup>2</sup> and Pho Kaung<sup>\*</sup>

<sup>1</sup>Universities' Research Centre, University of Yangon

<sup>2</sup>Department of Physics, University of Yangon

### Abstract

Interest in PV systems is increasing and the installation of PV systems that are interactive with the utility grid is accelerating. Advanced PV system technologies include inverters, controllers, related balance of system, and energy management hardware. In this research, the Solar Energy Grid Integration System SEGIS architecture has been developed. The incorporated features such as voltage regulation, backup power and frequency regulation have been studied. PV system has been modified in coupling with generator backup system as well as energy storage unit in this SEGIS design.

**Keywords:** energy storage; grid Inteiration; PV system; SEGIS design; solar energy

### I. Introduction

This study is being conducted with the aim of developing a standard procedure for the design of large-scale institutional grid-connected solar PV (Photovoltaic) systems using the roof of building. The standard procedure developed will be validated in the design of a 16.5 kW grid-connected solar PV system for six-story research building of University of Yangon (UY). The study is necessary because most of the country have experienced a number of power crises over the last two decades, mainly due to the heavy reliance on hydroelectric power which is more often than not dependent on the rain fall pattern of the country. It has been estimated that grid electricity would grow for the country's electricity generation from renewable energy and this will come mainly from solar, small and medium sized hydro, wind, biomass and municipal solid wastes.

Grid-connected solar photovoltaic (PV) systems employ the direct conversion of sunlight into electricity which is fed directly into the electricity grid without storage in batteries. This will be a very good way to boost the existing electricity production capacity in the country, which is mainly from hydro and thermal sources. This will contribute positively to the worsening energy situation in the country. Solar energy, being a renewable source, will also provide energy without pollutants and greenhouse gas emissions. This can go a long way to help mitigate the adverse effect of global warming as well as contribute to sustainable energy development. The main objective of the project is to design approximately a 16.5 kW grid-connected solar photovoltaic system for six-story research building of UY using the roof of the building.

### II. A Grid-Connected Photovoltaic Power System

A grid-connected photovoltaic power system or grid-connected PV power system is an electric generating solar PV power system that is connected to the utility grid (the public electricity grid). This energy may be shared by a residential or commercial building before or after the revenue measurement point. A grid-connected PV system consists of solar panels, one or several inverters, a power conditioning unit and grid

---

<sup>\*</sup> Pho Kaung, Universities' Research Centre, University of Yangon



connection equipment. They range from small residential and commercial rooftop systems to large utility-scale solar power stations. When conditions are right, the grid-connected PV system supplies the excess power, beyond consumption by the connected load, to the utility grid. When determining a renewable energy system, there are two main types of grid-tie Systems to consider: basic grid-tie system and grid-tie with battery back-up system.

### **Solar inverter for grid-tie PV system**

A solar inverter or PV inverter converts the variable direct current (DC) output of a photovoltaic (PV) solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network. It is a critical balance of system (BOS)–component in a photovoltaic system, allowing the use of ordinary AC-powered equipment. Solar power inverters have special functions adapted for use with photovoltaic arrays, including maximum power point tracking and anti-islanding protection.

### **Automatic transfer switch (ATS)**

As well as transferring the load to the backup generator, an ATS may also command the backup generator to start, based on the voltage monitored on the primary supply. The transfer switch isolates the backup generator from the electric utility when the generator is on and providing temporary power. The control capability of a transfer switch may be manual only, or a combination of automatic and manual. The switch transition mode of a transfer switch may be Open Transition (OT) (the usual type), or Closed Transition (CT).

An open transition transfer switch is also called a break-before-make transfer switch. A break-before-make transfer switch breaks contact with one source of power before it makes contact with another. It prevents back feeding from an emergency generator back into the utility line. During the split second of the power transfer the flow of electricity is interrupted. A closed transition transfer switch (CTTS) is also called a make-before-break transfer switch.

### **Incoming AC distribution box**

A distribution board (also known as panel-board, breaker panel, or electric panel) is a component of an electricity supply system that divides an electrical power feed into subsidiary circuits, while providing a protective fuse or circuit breaker for each circuit in a common enclosure. Normally, a main switch, and in recent boards, one or more residual-current devices (RCD) or residual current breakers with overcurrent protection (RCBO), are also incorporated.

## **III. Designing a Grid-Connected PV System in UY**

A grid-connected solar PV system to generate electricity of 16.5 kW has been designed and installed on the roof of six-story research building of UY. This system includes solar PV modules, inverters, utility grid, and power conditioning equipment, safety equipment, meters and instrumentation.

## **Configuration of grid-tied PV/Solar system**

The grid-tied PV system in UY is installed on frames which are mounted on the roof of the building. The PV arrays are located on the roof that are facing south at an angle of 35°. The inverters, automatic transfer switch, AC distribution board are placed inside the building and connected to the main electrical supply. A meter is included in the system to measure the kWh generated. If the PV electricity production exceeds power than building demand then the excess can be exported to the grid, and vice versa. This system can be used as a standard AC supply in the event of a power cut, to allow essential loads to keep working. Besides, a battery with the inverter is also placed for storage.

In this design, solar energy gathered by photovoltaic solar panels, which is intended for delivery to a power grid must be conditioned, or processed for use, by a grid-connected inverter. Fundamentally, an inverter changes the DC input voltage from the PV to AC voltage for the grid. This inverter sits between the solar array and the grid. The inverter must monitor grid voltage, waveform, and frequency. One reason for monitoring is if the grid is dead or strays, the inverter must not pass along any solar energy. An inverter connected to a malfunctioning power line will automatically disconnect in accordance with safety rules. Besides, the inverter must synchronize with the grid waveform, and produce a voltage slightly higher than the grid itself, in order for energy to smoothly flow outward from the solar array. The configuration of the grid-tied PV/solar system is shown in Figure 1.

## **Operation mode of grid-tied PV/Solar system in the sunny day time**

The operation mode of grid-tied PV/Solar system in the sunny daytime is presented in Figure 2. The arrows describe the operation steps. In this grid-tied PV/solar system, PV output is supplied to emergency load and surplus PV power is supplied to general load. Battery is charged by PV output. Grid-tie system with battery back-up generates power when the sun shines and the grid is operational. It also provides power to essential backed-up loads during a power outage.

## **Operation mode of grid-tied PV/Solar system at night time**

Figure 3 shows the operation mode of grid-tied PV/solar system at night time. In this grid-tied PV/solar system at night time, PV output is not supplied to emergency load and general load. Battery is not charged by PV output. Grid-tie system with battery back-up does not generate power when the sun does not shine however the grid is operational and output power is delivered to emergency load and general load.

## **Operation mode of grid-tied PV/Solar system during blackout**

In the grid-tied PV/solar system during blackout, PV and battery supply to the emergency load and the general load. Grid-tied system with battery back-up generates power but the grid is not operational. The operation mode of grid-tied PV/solar system during blackout is configured in Figure 4.



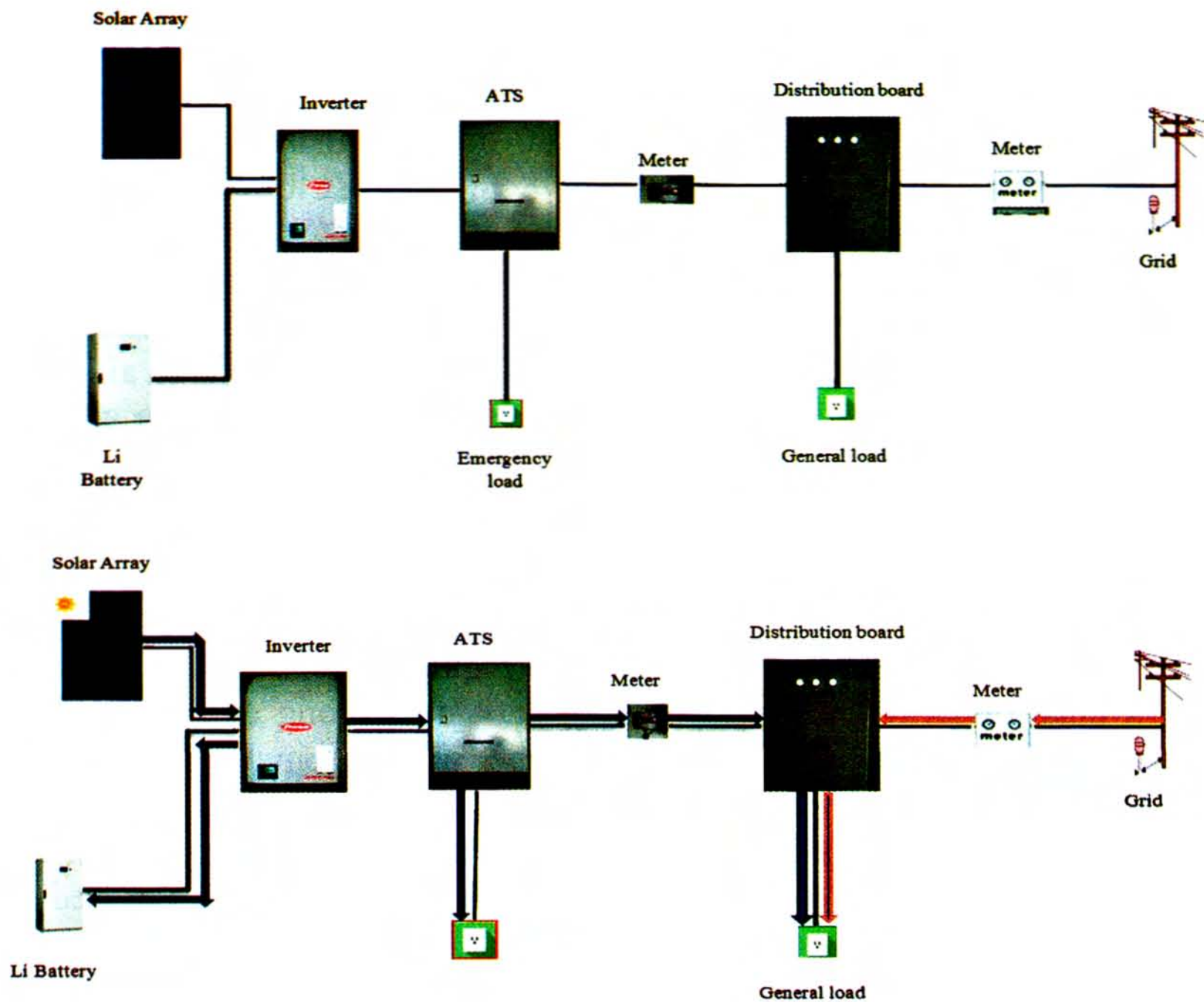


Figure 2. The grid-tied PV/Solar system operation mode (sunny daytime)

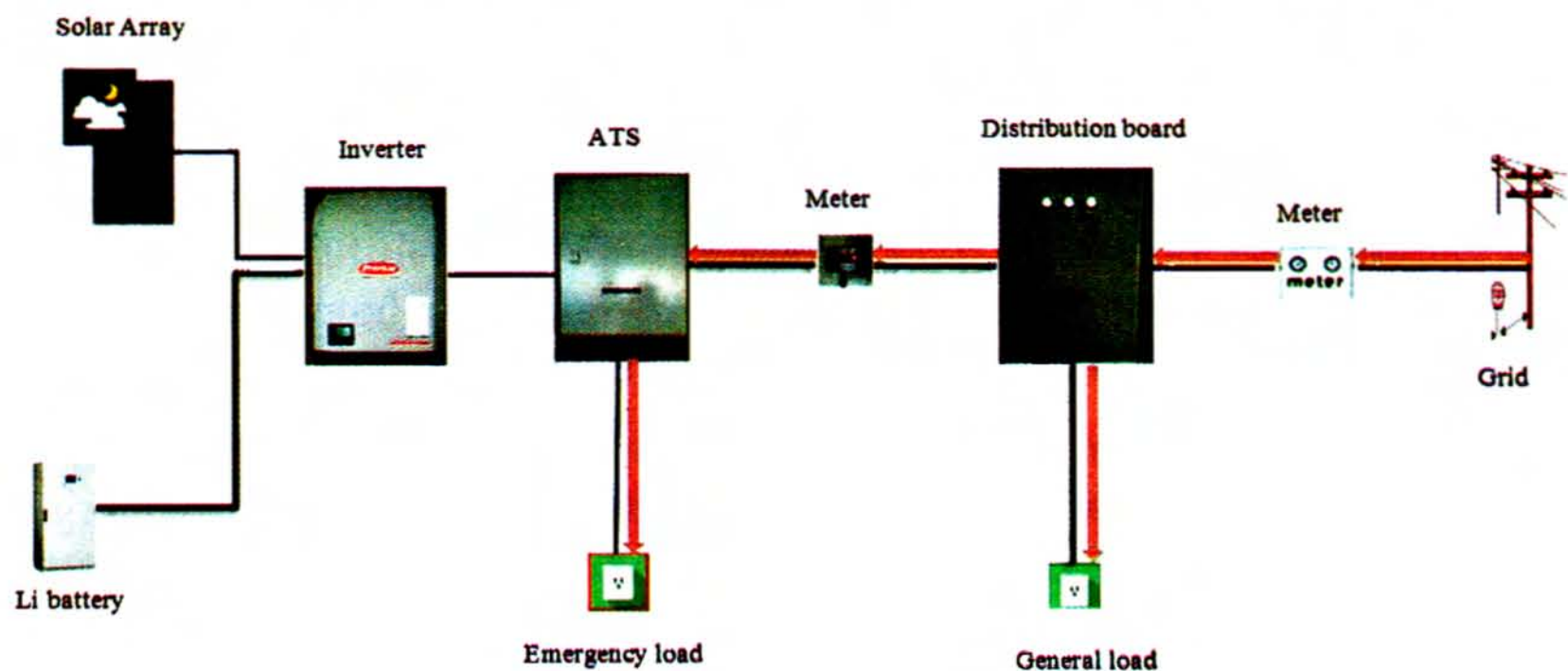
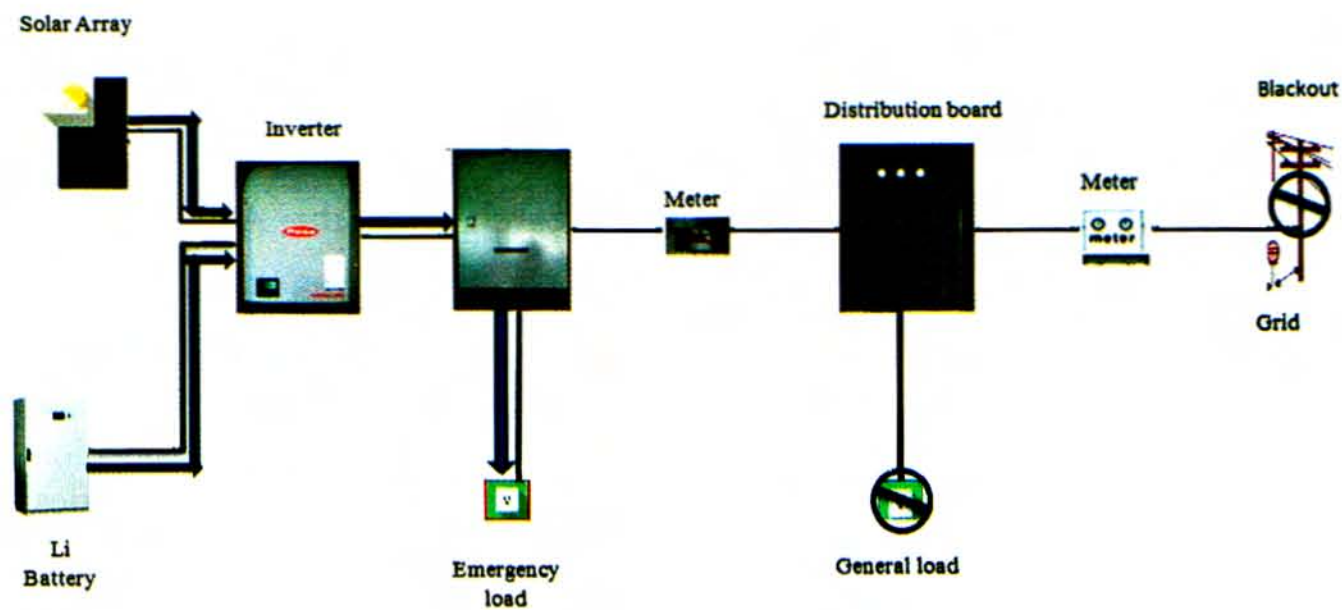
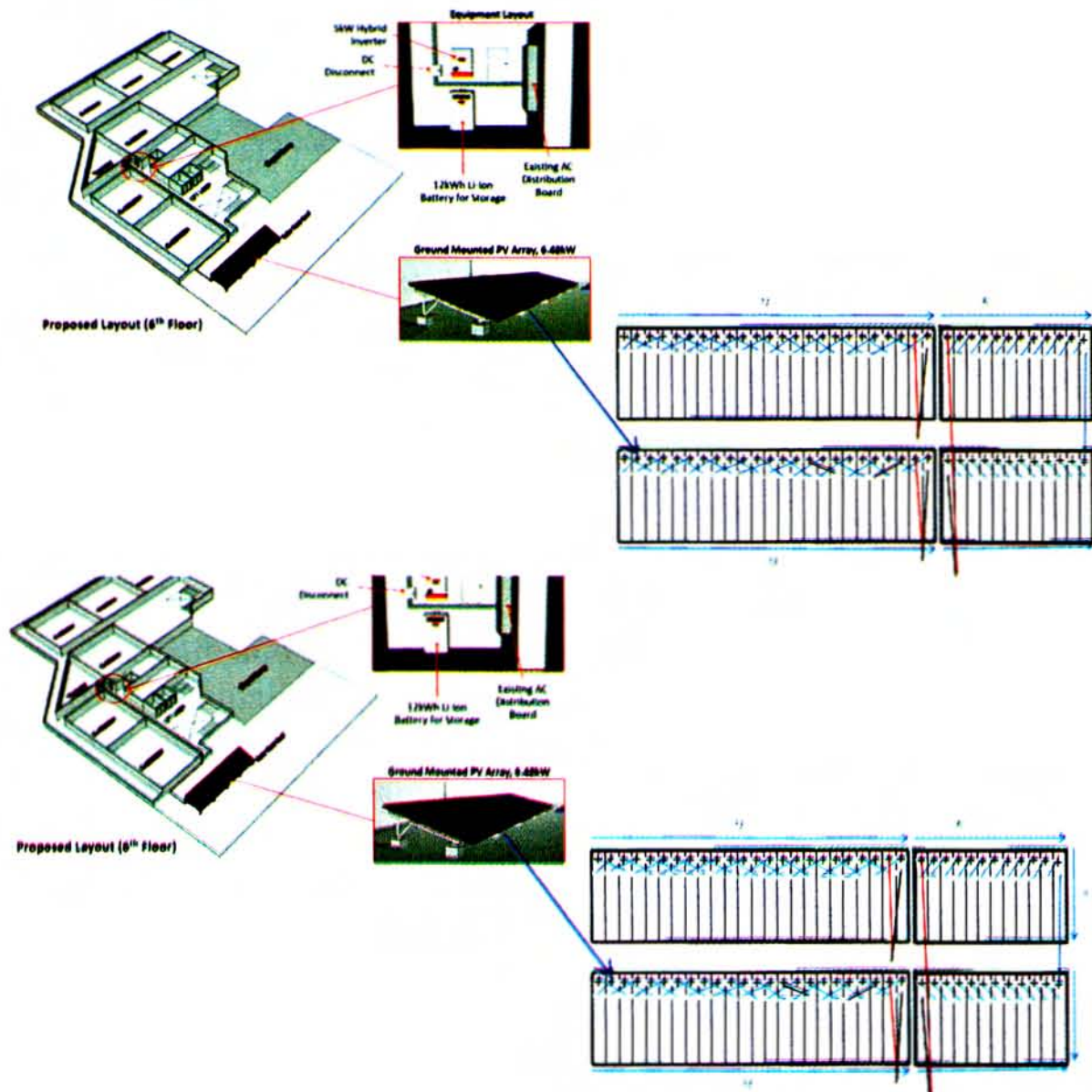


Figure 3. The grid-tied PV/Solar system operation mode (night time)





**Figure 4.** The grid-tied PV/Solar system operation mode (blackout)



**Figure 5.** The layout of the installation of the grid-connected PV system

#### IV. Conclusion

In this research, the Solar Energy Grid Integration System (SEGIS) architecture has been developed and installed on the roof of the six-story building and the incorporated features such as voltage regulation, backup power and frequency regulation

have been studied in this SEGIS design. Based on the data obtained in real operation, SEGIS will be modified to achieve better efficiency with lower cost in the future.

### **Acknowledgement**

The receipt of research funding for this research from the Asia Research Centre, University of Yangon is gratefully acknowledged.

### **References**

- Azoumah, Y., Yamegueu, D. and Py, X., 2012.** Sustainable Electricity Generation by Solar PV/Diesel Hybrid System without Storage for Off Grids Areas. IOP Conf. Series: Materials Science and Engineering, 29, 012012.
- Liping. G., 2013.** Design and Simulation of a Sun Tracking Solar Power System. Northern Illinois University.
- Nayar, C. V., 1995.** Recent Developments in Decentralized Mini-Grid Diesel Power Systems. Australia Applied Energy, 52, 229- 42.
- Ashari, M. and Nayar, C. V., 1999.** An Optimum Dispatch Strategy Using Set Points for a Photovoltaic PV–Diesel–Battery Hybrid Power System, Solar Energy, 66(1), 1-9.
- Yamegueu, D., Azoumah, Y., Py, X. and Zongo, N., 2011.** Experimental Study of Electricity Generation by Solar PV/Diesel Hybrid Systems without Battery Storage for Off-grid Areas. Renewable Energy, 36, 1780-87.