

**T.C.
ISTANBUL GEDİK UNIVERSITY
INSTITUTE OF GRADUATE STUDIES**



ENERGY MANAGEMENT OF DC POWERED HOME SYSTEMS IN IRAQ

MASTER'S THESIS

Mohammed Rashad DAHAM

Engineering Management Department

Engineering Management Master in English Program

AUGUST 2022

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DECLARATION

I, Mohamad Rashad DAHAM, hereby certify that this thesis entitled "Energy Management of DC -Powered Home Systems in Iraq" is my original thesis for the award of Master's Degree in Engineering Management at the Faculty of Engineering Management. I further certify that this thesis or any part thereof has not been submitted and presented for any other degree or research thesis at any other university or institution.

Mohammed Rashad DAHAM



DEDICATION

I'd want to dedicate my modest efforts to completing this work to my family, coworkers, and all of my friends for their unwavering support and encouragement throughout my academic, research, and life journeys. A particular thank you to Prof. Dr. Gözde ULUTAGAY, my father, mother, and family for their support and prayers throughout my research, as well as to my university, "Istanbul Gedik University".



PREFACE

I would like to thank everyone who has supported me during what is normally a very long journey. I would like to thank my supervisor, Prof. Dr. GÖZDE ULUTAGAY, for being my compass even when I felt lost and for being an extraordinary part of the culmination of this effort. I would also like to thank my supervisor for his encouraging comments that greatly improved the quality of this project. I believe that this institution, where I have been a guest all these years, has earned its place as my home. My gratitude goes to my parents, whose ideals and upbringing encourage me to continue, to my brothers and relatives for their endless affection, and to my nation, which remains resilient and must rise despite its suffering.

August 2022

Mohammed Rashad DAHAM

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ABBREVIATIONS

UNDP	: United Nations Development Program
IEA	: International Energy Agency
UN	: United Nations
NZEB	: Net-Zero Energy Buildings
AC	: Alternative Current
DC	: Direct Current
PV	: Photovoltaic
GCPV	: Grid Connected Pv Systems
HVDC	: High Voltage Direct Current
LED	: Light Emitting Diode
MTOE	: Million Tons Of Oil Equivalent
LCOE	: Levelized Cost Of Electricity
RES	: Renewable Energy System
NPV	: Net Present Value
MW	: Mega Watt
US	: United States
GHG	: Green House Gas
NASA	: National Aeronautics And Space Administration
NPC	: Net Present Cost
COE	: Cost Of Energy
O&M	: Operation And Maintenance
SEDA	: Sustainable Energy Development Authority
CBA	: Cost Benefit Analysis
IOT	: Internet Of Things
DSM	: Demand Side Management
EMS	: Energy Management System

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ENERGY MANAGEMENT OF DC POWERED HOME SYSTEMS IN IRAQ

ABSTRACT

Solar energy is mostly important forms of renewable energy, although equipment for exploiting this energy is still very expensive. One of the most important challenges facing solar energy systems is the ignorance of societies about the culture of renewable energy and the ways to benefit from it. The large number of energy conversion processes from one form to another is considered one of the most important causes of energy loss due to the low efficiency of the conversion circuits and the losses that caused by the conversion processes because of the switching operations and thermal loss of the switches. An electrical energy management system has been proposed for a house that is fed by a solar cell array independently of the grid, this house was fed with direct current in order to reduce energy conversion losses. The proposed house suits the climate of Iraq, which is often hot and dusty in many cases. The presence of alternating current loads was taken into consideration, so a high efficiency voltage source converter was added to supply these loads. The results of the system simulation, which was conducted using the MATLAB/SIMULINK program, showed a good performance and high efficiency in the process of exploiting solar energy.

Keywords: *Solar energy, Efficiency, Power conversion, Switching losses*

IRAK'TA DC POWERED EV SİSTEMLERİNİN ENERJİ YÖNETİMİ

ÖZET

Güneş enerjisi, yenilenebilir enerjinin en önemli kaynaklarından biridir, ancak bu enerjiyi kullanmak için gerekli ekipman hala çok pahalıdır. Güneş enerjisi sistemlerinin karşılaştığı en önemli zorluklardan biri, toplumların yenilenebilir enerji kültürü ve bundan yararlanma yolları hakkında bilgi sahibi olmamasıdır. Bir formdan diğerine çok sayıda enerji dönüşüm süreci, çevrim devrelerinin veriminin düşük olması nedeniyle enerji kaybının en önemli nedenlerinden biri olarak kabul edilir ve çevrim işlemlerinden kaynaklanan anahtarlama işlemleri ve termal kayıplar nedeniyle dönüşüm süreçlerinden kaynaklanan kayıplar. anahtarlar. Şebekeden bağımsız olarak güneş pili dizisi ile beslenen bir ev için elektrik enerjisi yönetim sistemi önerilmiştir, bu ev enerji dönüşüm kayıplarını azaltmak için doğru akımla beslenmiştir. Önerilen ev, çoğu durumda genellikle sıcak ve tozlu olan Irak iklimine uygundur. Alternatif akım yüklerinin varlığı dikkate alınmış, bu yükleri beslemek için yüksek verimli bir voltaj kaynağı dönüştürücü eklenmiştir. MATLAB/SIMULINK programı kullanılarak gerçekleştirilen sistem simülasyonunun sonuçları, güneş enerjisinden yararlanma sürecinde iyi bir performans ve yüksek verim göstermiştir.

Anahtar Kelimeler: *Güneş enerjisi, Verim, Güç dönüşümü, Anahtarlama kayıpları.*

1. INTRODUCTION

Approaching energy (thermally and electrically) is essential for providing fundamental human necessities such as clean water, sanitation, a functioning health care system (International Energy Agency, 2011). The United Nations Development Program (UNDP) has drawn public attention to this issue. A graph showing the relationship between a country's energy consumption and its human development indicates that the higher the index, the more energy a country consumes per capita (UNDP, 2012). Despite this, 1.20 billion people haven't the opportunity enjoying electricity, and more than 2.70 billion do not, most of whom do not have access to clean cooking facilities. Depending on statistics of the International Energy Agency (IEA), the majority of people in developing countries settle in rustic areas. The International Energy Agency (IEA) (2016d) has therefore made the employing of renewable energy is considering as one of the most important axes for the transition to a sustainable energy system. Attention in power generation from renewable energy sources has raised over all the world. This widespread adoption of renewable energy applications has led to a noticeable reduction in the cost of electrical energy generated, and this rate is expected to continue to increase. Electricity generation from renewable sources by about a third year by 2022, as fossil energy sources have become doubtful of their ability to continue to provide electrical energy security globally and locally, in light of the successive economic and population growth, as they are depleted sources, which calls for diversifying the sources of electric power generation in Iraq. It is highly dependent on fossil energy sources to generate electricity. The increasing consumption of energy, makes the main target of energy shortage solutions, in addition, energy is the most important driver of climate change, it is responsible for more than 60% of the total greenhouse gas emissions in the world. Therefore, it is necessary to focus on accessing clean energy through the expanded use of renewable energy, which is gaining very great importance. Creating and sustaining sustainable societies, as well as creating the ability to the impacts of climate variations, climate change is an example of an environmental issue (UN website, 2019). Concept of net-zero energy buildings (NZEB). At the local and

global levels, great attention has been paid to energy issues from all countries, especially developed countries. In recent years it states that a certain amount of electricity provided by utilities comes from renewable sources. These renewable energy sources were created to increase energy resources availability and encourage the renewable energy sources development. To improve economic development, domestic energy production should be increased. Therefore, the solar photovoltaic(PV) technology has now become commercially acceptable and requires minimum work force attention and nominal maintenance costs are incurred. Photovoltaic farms are simple to build and take only a few days to complete. A proper and accurate evaluation of solar resources is the only necessity for PV farm construction by either doing meteorological measurements or utilizing data from existing historic meteorology stations (Numbi and Malinga, 2017).

1.1 Purpose of the Study

The world's largest source of greenhouse gases is energy production and consumption (Greenhouse gases). As a result, the energy sector is critical to countries around the world's efforts to develop and implement long-term climate strategies. Policies promoting energy efficiency, such as the regulation of energy consumption laws in buildings and standards for the manufacture of devices and equipment while harmonizing with renewable energy sources, have resulted a raising in the utilizing of direct current (DC) power for specific purposes. Several factors influence building applications.

- DC distribution maximizes the use of electricity generated by the on-site PV system it eliminates many temporary power conversions from DC to AC.
- In buildings with connected storage batteries, energy savings can be even higher since, the batteries act as a load and a source of DC current.
- The number of internally powered DC devices is increasing with more diffusion of solid lighting and consumer electronics.
- Rapid growth and declining prices of solar PV systems and installation

In addition to the growing demand for battery storage systems and the growing market and interest in electric vehicles, start and enhance the need for construction site equipment that stores produce and consume continuous electricity in DC(Pantano, May-Ostendorp and Dayem, 2016).

1.2 Research Aims

Through previous research, it is possible to use DC directly from the source of DC, which is renewable energy, and we take the solar energy model, As a result, the goal of the research is to investigate the viability of using DC systems in Iraqi homes.

1.3 Idea Project

The major idea of this research is to determine whether DC electricity has the ability to be used as a basic residential power distribution system. The current study is centered on residential dwellings in Iraq. The scope of the assessment also takes into account the presence of PV system with energy storage on location. In addition, the study looks into the possible energy savings for new construction buildings aiming for NZE designation.

1.4 Historical View

In shaping the future of power distribution, the 1880s were a pivotal moment in world history. It was also known as the War of Currents during the time. The proponents of this conflict recognized that whoever won would have a say in how power is distributed in the future in the United States and, who knows, the entire world. An electric current that flows in a single direction all of the time -Edison invented direct current (DC), also known as alternating current (AC). During the early years of the internet's existence, in the United States, DC remained the standard. There were, however, some difficulties with DC being the principal electrical power source the biggest issue was the difficulty of transforming it. Higher or lower voltages can be achieved by converting DC to higher or lower voltages. Nikola Tesla, a Serbian-American inventor in the nineteenth century, was the exception. In the 19th century, alternating current (AC) was thought to provide a solution to this difficulty. A transformer can quickly convert alternating current to different voltages since it switches direction numerous times each second. Westinghouse's design of a low-cost AC transformer allowed electrical power to be transferred at high voltage and then converted to low voltage for later use. However, there was no alternate method for using DC electricity in the 19th century(Kellow, 2008).

1.6 Grid Connected PV Systems

Nacer et al. performed a feasibility assessment of GCPVS for small farms with 10 to 30 milk yield in Algeria, taking technically, economical, and regional legal considerations into account (Nacer et al., 2016). The investigation observed that the mean energy demand per cow per year was among 330 and 560 kWh. For the planned PV systems of different sizes in Algeria, power costs ranged between €0.008 and \$0.033 per kWh. Bey et al. (Bey et al., 2016) investigated the efficacy of a dairy farm's GCPVS energy supply, reporting a 67% reduction in grid energy use, an 8% increase in milk output, and a 68% reduction in CO₂ emissions.

Obi and Bass (2016) reviewed current trends and developments in GCPVS. According to them, significant penetration of distributed generating causes an unanticipated load on power grid. Lau et al. (Lau et al., 2016) investigated an influence of feed-in tariffs and carbon taxes upon on the grid-connected PV systems in the residential field of Malaysian and demonstrated that the adoption of grid-connected PV systems is quite possible at PV system costs of \$1120/kW or less. Using life cycle analysis, Hou et al. (Hou et al., 2016) studied the environmental effects of GCPVS power generation from crystalline silicon solar modules in China. According to their findings, the energy payback period of GCPVS with crystalline is relatively short.

According to Pillai et al. (Pillai et al., 2014), the shortage of understanding of the desired economic profits of GCPVS is the greatest issue to their proliferation. The authors devised a prosumer-friendly unit cost of electricity metric for evaluating the short-term economic benefits of PV systems. The results indicate that PV systems give homes in India with short-term economic benefits, whereas cost reductions are required in the United Kingdom. To prevent islanding, Silvestre et al. (Silvestre et al., 2015) examined the identification of transitory flaws induced by partial shade of the PV system or inverter shutdown when the grid voltage or frequency changes. Monitoring the evolution of these indicators and the performance losses induced by these effects was effective for recognizing these scenarios, according to the study. Khalid et al. (Khalid et al., 2016) emphasized the significance of the performance ratio as a key performance indicator by citing relevant studies and working advancements. The goal of this review was to analyze and examine certain generally

accepted PV observation criteria, suitable guidelines, significant proficient papers, and business approaches for estimating the PV system's power rating (PR).

1.7 DC Powered Homes

DC power is frequently regarded as a progressive alternative to traditional power delivery. Throughout the years, DC power systems have been widely used in a variety of vehicles and boats. In addition, traditional telephone service has been powered by DC, as have modern USB and Power over Ethernet (PoE) technologies in buildings. New methods to convert the direct current to greater with less voltages were developed and made available. Because of the stability of direct current (DC), researchers are looking at methods for using the high-voltage direct current (HVDC) for transporting the electricity through long remoteness under lower energy loss. In addition, HVDC lines have been successfully installed all over the world.

Because of their ability for decreasing the energy conversion losses, upgrade the power, raise the reliability of the system, reduce system total cost, and support the transport to inveterately more effective DC-based equipment in constructions, DC distribution networks and micro - grids are becoming the subject of much research. DC Distribution systems have lately been implemented in a variety of applications, including data centers and commercial lighting systems. As these systems have established themselves in specific applications, the question of whether more constructions must be connected with near DC circuits as well as instead of AC circuits has been debated. Approximately half of the energy consumed in buildings today is absorbed as direct current (DC) in electrical passes or loads through a transition state DC as a motor control method, producing in undesired great losses at time in which a grid-distributed alternating current (AC) is rectified with inefficient distributed power sources. (Magdefrau et al., 2016).

As technology giants like Siemens (HV Direct Current Transmission System) and ABB pursue efficient energy solutions, a substantial amount of research has recently been performed in the efficiency of HVDC. The potential benefits of direct current networks over alternating current (AC) networks explain the growing interest in them. Microgrids and DC electricity distribution systems have the potential to improve overall power quality and reduce power losses due to conversion, as well as increase system dependability, lower system costs, and encourage the move to more

efficient DC-powered equipment in buildings, (Wickramasinghe *et al.*, 2017). Alternating current is still the primary source of electricity today. LEDs, solar systems, computers, and electric cars, on the other hand, all need DC electricity. The fear of irreversible climate change raises global environmental consciousness, encouraging people to pay attention and employ more efficient power systems to cut back on greenhouse gas emissions. As a result of the anthropogenic challenges, energy behemoths have stepped up their efforts to make sustainability a top priority.

While trying to give a humble 100W power to a DC fueled home in a relentless way, some academic works have managed the plan and execution of a sun-oriented PV based home with continuous power supply. The power grid and battery provide backup power. To maintain a constant yield voltage, the sunlight-based PV system is fed by a step-down converter with PWM modulator circuit. A Proportional regulator changes the Kp esteem which keeps up with the result voltage at a steady level. The experimental outcomes show that the proposed plan displays an astounding presentation (Jain *et al.*, 2016).

Low component costs, national photovoltaic property tax credit, Infrastructure pure energy meter reading schemes, and a growing renewable portfolio have all contributed to the unabated rise of residential PV installations, which is not anticipated to slow down in the near future. Numerous components of DC residential micro grids have been the subject of intense research due to the aforementioned causes (Feldman *et al.*, 2014).

1.8 Background

Iraq's energy profile is still locked in patterns common to the pre-2003 period. Other than hydropower, the contribution of renewable energy is insignificant, with no clear steps to tap its renewable resources foreseen. Because it is located in the global sun belt, Iraq has plentiful potential of solar energy with high year-round solar radiation (Figure 1). Using PV panels, each 100 km² of unused land in the western and southern deserts (al-badiya al-shimaliya wal al-janoubiya) has the potential to generate 30 million tons of oil equivalent (MTOE) of energy per year. As a result, Iraq is an ideal location for solar energy investment, and it has the potential and provide a long-term solution to electricity shortages. The solar energy potential is estimated at about 3.4 billion kWh per year, representing a total capacity of 5.9 GW.

This is equivalent to about 10 square kilometers of solar panels at 16 percent efficiency. Solar energy can be used extensively in two-thirds of Iraq. In the western and southern regions, solar radiation duration is between 2,800 and 3,000 hours per year with over 6.5 - 7 kWh/m² of horizontal radiation per day. This makes the two regions extremely favorable for investment in the construction of solar power plants (Istepanian, 2018).

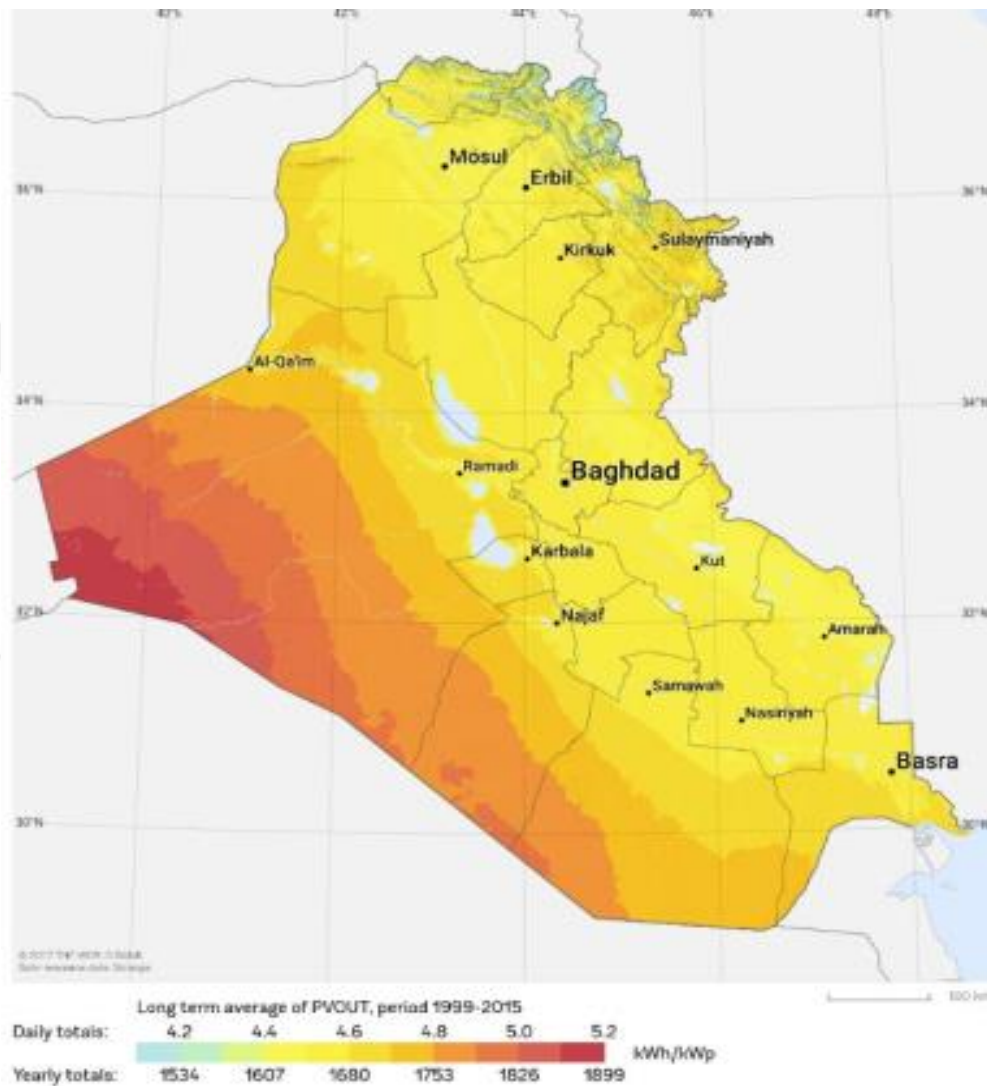


Figure 1.1: Solar Irradiance Level distribution in Iraq

1.9 Thesis Outlines

This thesis is divided into five major sections, excluding the introduction chapter. An overview of the thesis' structure and organization is provided in Figure 1.2.

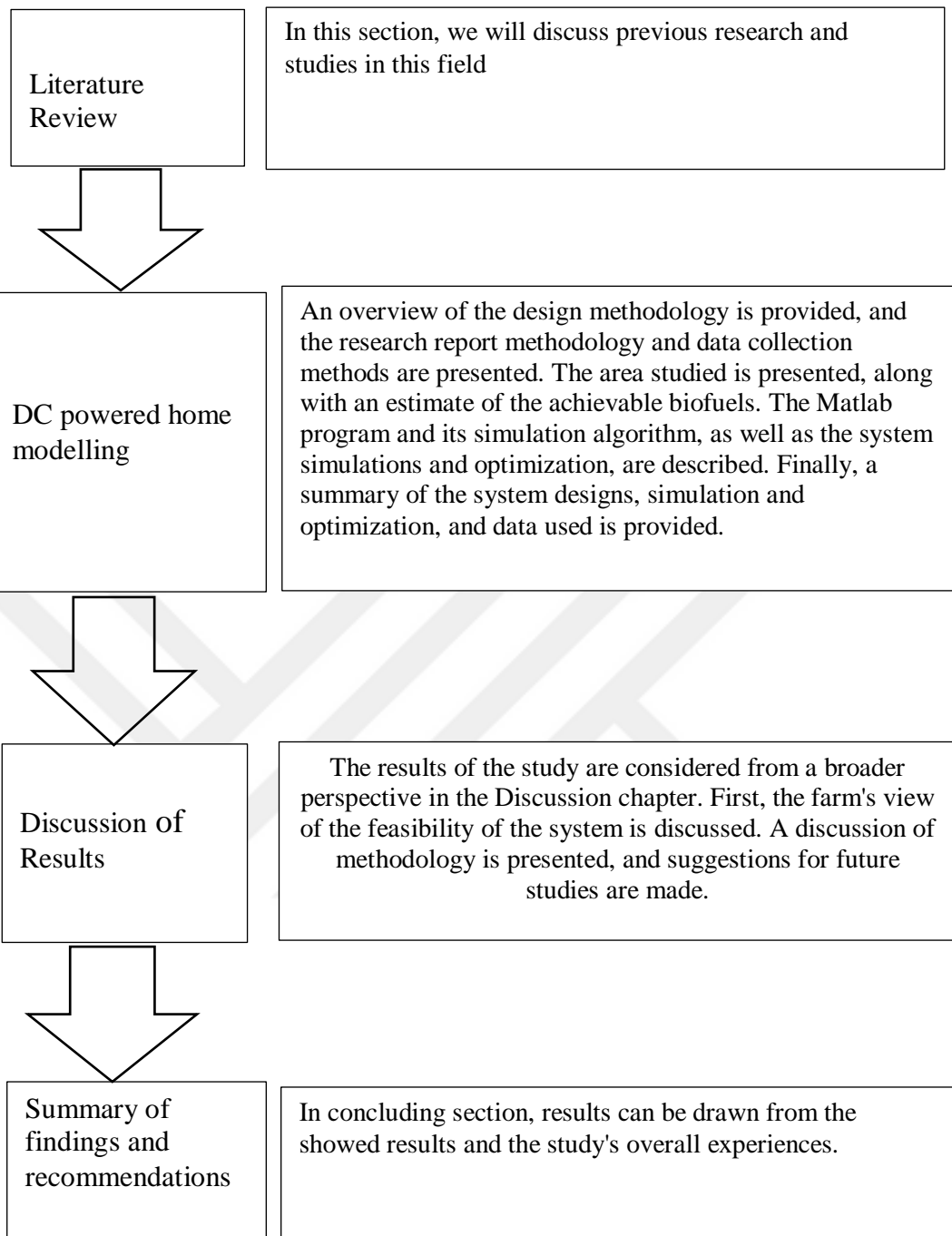


Figure 1.2: Thesis structure

2. LITERATURE REVIEW

2.1 General Background

There are many studies and research related to renewable energy and the feasibility and benefits of using it, so we will investigate some of these researches and the results that researchers have drawn from them that can help us in this research.

The researcher Remember Same by studying renewable energy, wind energy and solar energy and the feasibility of using them in Zimbabwe and concluded the following results. Few searches have been conducted in the subject of hybrid renewable energy. These academic works had various objectives, but none of them evaluated externalities such as the annual cost of carbon avoided. In addition, they did not establish a specific aim to be attained, such as predicting energy need, nor did they advise policymakers for working towards 100 percent connectivity by factoring expected electricity need. Zimbabwe's economy is in shambles and it faces numerous obstacles, with electricity being one of the greatest. As a result, primary goal of studying us to maximize renewable power system fraction. Where Zimbabwe has experienced electrical power deficiencies bringing about electrical energy imports ascending to somewhere in the range of 40% and half of absolute energy needs (Mbohwa and Fukuda, 2003).

For the viability of these systems, numerous technological, economical, financial, and environment criteria were taken into account. One recently adopted parameter is the Loss of Power Supply Probability (LSPS), which enables an economical setup by preventing blind capital expenditures based on the cost and dependability of the system. The feasibility of the system was further determined by setting the Levelized Cost of Electricity to \$0.20 per kilowatt-hour; any system design with an LCOE more significant than this figure was deemed not practical.

Depending on that the study was conducted over phases, the bellow are the findings:

- i. The entire nation of Zimbabwe has sufficient sun resources to generate power using photovoltaic technology. The locations were chosen for the analysis

depended on the available dataset on the Meteonorm program, the availability of area for building the desired plants, connection them to the grid, as well as the available wind and solar resources.

- ii. Therefore, for windy analysis alone, a wind turbine with a low cut-in speed is required because Zimbabwe does not have an abundance of wind resources. In mountainous places, such as Mutare, the highest wind speeds are reported. At the tested sites, the range of gross power generation in megawatt-hours (MWh) was 4,488 to 6,658; Bulawayo had the lowest and Mutare the highest. Additionally, between 7,500 and 11,200 MWh of power can be exordium to the grid. The model of the wind turbine was chosen due to its low cut-in speed of 1.5 m/s, high cut-out speed of 27 m/s, and rated power of 5,000 kW at a hub height of 95 m. The suggested 10 MW wind farm investment will require 242,811 m²/MW of land.
- iii. According to energy forecast studies, primary energy consumption will rise from 0.17 quadrillion Btu in 2015 to 0.183 quadrillion Btu in 2030. In 2015, electricity contributed for 761 ktoe of the aggregated consuming of the primary energy, or 17.75 percent of the total primary energy consumption. With the assuming that the similar percentage of power would be consumed in 2030, the estimated electricity consumption in 2030 is 819.18 ktoe. Using an easy percentage and assumption that all other parameters remain constant, the Zimbabwe peak need is projected to increase from 2200MW to 2368.19MW by 2030 using a simple proportion. With an average daily energy generation of 1300MW (Wickramasinghe et al., 2017), Zimbabwe's present electricity mix must be augmented by more than 1000MW. As a result, the entire electrical demand considered in this analysis has been multiplied by 7.65 percent, as this is the anticipated need growth.
- iv. Integration of ESSs into a photovoltaic /Wind system raises the system's capital expenditures without significantly boosting the RES percentage. Integrating Zinc Bromine and Lithium-ion batteries was only tested for the G-wanda area, and this system only had a RES percentage of 60.5%, NPV of \$39,130, and a capacity factor of 30.82. This system was comprised of 157 kWh of Zinc Bromine batteries, 2 MW of wind capacity, and 503 kW of PV capacity. In building the model employed for configuring the grid-connected

hybrid PV and wind systems in this work, certain assumptions have been made, from which the following findings might be taken.

- v. A grid-connected hybrid system with 4 MW wind capacity and 1328.76 kW PV capacity has the highest RES percentage of 74.03 percent, the maximum throughput factor of 30.84 percent, the highest NPV of \$9.41 million, and the largest annual avoided carbon dioxide emissions of 19042.64 tons, resulting in an annual avoided cost of \$760,000. During the building of such a system, however, a round number will be utilized for the PV capacity; for instance, in the case of 1328.76 kW, 1400- or 1500-kW capacity will be built. Practically, this system was situated at Victoria Falls, and its SPBP was 5.58 years. With a rating of 0.41, this site has the lowest LSPS value, which is used to measure the feasibility of a system by considering power reliability and cost. Thus, photovoltaic/Wind investments, actually, are more advantageous near Victoria Falls than anywhere else in Zimbabwe.
- vi. Zimbabwe is the minimum desirable area for the installation of a Photovoltaic /Wind hybrid system. Possible infrastructure at this site comprises 967.66 kW PV and 4 MW wind. This system does have the smallest throughput factor of 28.26%, minimum NPV of US\$ 6.62 million and the smallest yearly prevented carbon dioxide emissions of 16257.15 tons which chose to give aggregate yearly averted the ren of US\$ 650000. At this site, the highest LSPS of 0.484 is seen, along with the highest SPBP of 6.29 years. Reducing the PV capacity of the system configuration has a significant effect on these outcomes. Although, the system is stay viable because it has a positive Net present value and the SPBP is only 6.29 years, that is significantly less than the system's 20-year lifespan.
- vii. Generally, the hybrid system increased the proportion of renewable energy sources, the capacity factor, and the yearly power generation comparing with the Photovoltaic only and wind-only systems. The issue of intermittent nature can also be solved by merging wind and PV, thereby boosting the proportion of renewable energy sources and the hybrid system's reliability. In conclusion, hybrid systems reduce the disparity between electricity energy demands.

- viii. This study proposes adding an additional 81.58 MW of renewable energy capacity to the Zimbabwean electricity framework. This is over 10 percent of the anticipated increase. In light of this, Zimbabwe seems to be a low-income nation where there is a need to find a significant correlation without drastically raising prices.
- ix. The results of the study could then be used to advise energy policymakers that they integrate the use of mixed RES with what the legislation suggests in order to boost Zimbabwe's electrified rate (Samu, 2019).

2.2 Survey of Previous Studies

Researchers Mehdi J., Ahmad H., Akbar A.Sh., Ali M., and Luis M. P. drew the following results after examining the viability of using grid-connected renewable energy facilities to provide power electrical and hydrogen gas for residential purposes in the southeast of Iran. Utilizing a national grid to produce electricity and hydrogen at prices of \$3.036 and \$0.496 per kWh of electricity and per kilogram of hydrogen production, including both, is the most economically optimum method of electricity and hydrogen production.

- In power network cell concept, solar cells provide 35% of the energy and the national grid generates the other 65%.
- Economically, the Spiral turbine with a net current cost of \$86394 is advised in power network turbine model.
- EOLO and Spiral turbines are most cost-effective source of generating electricity and hydrogen in the power network turbine/solar cell combination, with costs of \$1.55/kWh and \$0.547/kg, respectively.
- EOLO wind turbine is suggested when the investigated system is to be utilized in distant places without access to the power network (Jahangiri et al., 2019).

Rehmana et al. discussed the feasibility of grid connected photovoltaic electric stations with an installed capacity of 10 MW in Saudi Arabia. They simulated a solar cell system using the RET Screen application and analyzed the elements (annual energy yield estimation, investment statements, GHG emission reduction analysis)

and the extent of their impact on geographic distance for 44 sites in the Kingdom of Saudi Arabia (Rehman et al., 2017).

Yousef Kassem et al. did a study on Northern Cyprus solar energy technology. Observation, statistics, and feasibility analysis comprised the project's three primary axes. On the basis of current global sun radiation statistics obtained by the Meteorological Department, the researchers experience and increases the potential for solar energy in five areas in Northern Cyprus. With a amount of 160.78 kWh/m², Lefko sa has the highest worldwide solar radiation, following by YeniBo gazici with a rate of 160.33 kWh/m². In furthermore, the monthly average values of solar radiation were compared to the databases of the PVGIS CMSAF and NASA to verify the goodness of the remotely sensed dataest. According to the produced values, the two databases produce accurate estimations, as indicated by the high R² amount. Moreover, it is discovered that the actual value and predicted values for the Lefko sa zone are nearly same. Due to the highest levels of solar output and sunlight length, Lefkosa is the best place for future PV system installation. This study investigates the economics of solar energy use in Northern Cyprus, a precondition for any PV installation. In addition, Lefkosa's meteorological parameters (total solar energy, around air temperature, duration of the sunshine, in addition to the factor which always be want to be low which is relative humidity) were investigated. In addition, statistical characteristics such as kurtosis and skewness of the periodic meteorological parameters were utilized to identify the distribution type. According to the data, the most prevalent distribution type in Lefko sa is the III kind, which is distinguished by a modest peak with a good conclusion for GSR, and the VI type, which is likely multifactorial and symmetric and has an apartment-shaped peak for T, SS, and RH. In addition, the effect of meteorological conditions on GSR was investigated, and a give valid was presented to match the curves that fluctuate as a result of T, SS, and RH. This work closes with a thorough and completed analysis of feasibility for 100 MW grid-connected wind plantation or photovoltaic Solar plans, two of the significant cost-effective projects/plans for reducing power demand and greenhouse gas emissions in the selected region. Results indicate that the cost of power generation in the specified location is \$0.0933 per kwh of electricity and that more than 290,691,717 tons of CO₂ emissions can be avoided yearly (Kassem, mur and Alhuoti, 2020).

In (Moury and Ahshan, 2009), researchers Sanjida Moury and R. Ahshan of the Faculty of Engineering and Applied Sciences at Memorial College in Newfoundland studied the viability of using renewable energy and chose to use solar panels for a residential building in the capital city of Dhaka. They used a Home Pro simulation to replicate the extracted household consumption figures for a single home, and then extrapolated them to Bangladesh as a whole. However, there are arguments in favor of such an endeavor. The renewable energy system involves a significant initial investment. The project has a twenty-year lifespan. Selling electricity to the grid can recoup some of the initial investment costs. PV power can meet 68 percent of load demand, leaving the grid to meet only 32 percent of load demand. Solar systems have other limitations besides their high initial cost. PV systems initially generate electricity irregularly because they operate only when the sun shines. For PV systems that are connected to the grid, this is not a problem because the utility company immediately supplies the user with the additional electricity needed. For PV systems that operate off-grid or autonomously, cells can be bought to store energy amount of energy use. PV electricity is typically more costly than utility-supplied electricity. If a consumer resides near an existent electric grid, a solar assistance program and net metering can reduce the price of a residential PV installation. During the billing period, the customer is invoiced for the differential between the power generated by the PV system and the power supplied by the grid. Within over 35 states, laws and regulations mandate "net" electricity reading, which can be beneficial to customers with PV systems. Unlike electricity that is regularly purchased from a utility, PV electricity demands large upfront investment. Tax incentives that help consumers decrease high capital costs include a sales tax exempt status on the sale of a PV system, a property tax break, and state income tax credits. Due to initial investment expenses, solar PV systems are not comparable to conventional hydrocarbon grid-connected electricity sources. However, to satisfy consumers' basic necessities, widespread adoption of alternative energy technologies holds great promise. This paper presents the feasibility analysis for a residential building in Dhaka city. In Bangladesh, the feasibility of the proposed system may be hindered by cost, but this can be overcome through a combination of incentives from the government and utilities. The system is also applicable to commercial structures, telephones, and water pumps for irrigation (Moury and Ahshan, 2009).

It is widely recognized that arrival to power is greatly linked to socioeconomic growth. India has the greatest percentage of the population around the world without electricity, with over 237 million persons needing to access (International Energy Agency). In addition, many Indian house-holds that have ability to get electricity do not have a regular or consistent supply of electricity. According to a modern study by the Council on Energy, Environment and Water (CEEW), in six Indian states (Bihar, Jharkhand, Madhya Pradesh, Uttar Pradesh, West Bengal and Odisha), nearly half of households are without electricity, even though grid connection is available. In addition to expanding the power grid, the price, reliability, and quality of electricity supply need to be urgently addressed (Jhunjhunwala, Lolla, and Kaur, 2016).

With Home Pro, researchers M.J. Khan and M.T. Iqbal conducted a pre-possibility research on autonomous implementation hybrid power systems in Newfoundland. They investigated the use of wind energy and its feasibility, and solar energy and its feasibility, and compared them to various other energy sources, such as diesel engines. The following are the study's results: Renewable electric hybrid systems with hydrogen production cannot compete with hydrocarbon stand-alone or grid-connected energy sources. Furthermore, the demand for clean energy and the development of alternative energy technology indicate that these systems will certainly find broad use. This investigation examined a variety of energy sources (diesel generator, wind, solar) and energy storage (battery and electrolyser tank). HOMER was utilized to find hybrid configuration possibilities and their relevance. As a developing technology for autonomous applications, St. John's, Newfoundland, has conducted substantial research on hydrogen-based systems. The following conclusions can be drawn from this study: Compared to solar energy, Newfoundland's wind resources have great potential, although solar energy is not cost-effective in most situations. Wind-diesel battery systems are currently the most viable choice for autonomous applications. In St. John's, the cost of electricity for a small system (rated at 25 kW per day with a peak output of 5 kW) is about \$0.497 per kilowatt-hour. If the price of fuel cells dropped by 65%, a wind-diesel fuel cell-battery combination would be practical. If the price of fuel cells fell to 15% of their current market price, a wind-fuel cell combination would become more appealing. The capital cost, net current cost, and energy cost per kilowatt-hour would be \$29.475, \$41.425, and \$0.427 per kilowatt-hour, respectively. Larger hybrid systems

would be competitive for isolated populations, and economies of scale might reduce energy costs to grid electricity prices (\$0.07/kW h). Before a wind-fuel cell combination can be considered economically viable, significant advancements in microwind turbine technology and fuel cell research are required (Khan and Iqbal, 2005).

Malin Frisk studied Obtain the optimization with the simulation results of a hybrid renewable energy framework for a Cuban farm. Considering solar, biogas, and wind resources, the planning of optimal system of a system of hybrid renewable energy for use on the Cuban farm Desembarco del Granma was established for three alternative scenarios of biomass supply. A case study was done to assess the energy load and available biomass resources for biogas production on the Desembarco del Granma farm. The scaled annual average electrical loads of the plantation were appreciated to be 264 kWh/day under a peak load of 26.34 kW, whereas the scaled annual average shiftable load was determined to be 76 kWh/day with a peak load of 16 kW. The majority of the thermal load was determined to include of power consumed to heat water and cook food. The estimated heat requirement for cooking was 4.5 kWh per day, however the heat demand for water heating was not calculated. It was expected that solar thermal could meet the heat energy requirement for water heating, but it was not involved in the power system models utilized for this academic work. In the designing, it was expected that the cooking heat demand would be fulfilled by biogas combustion. Due to the conformability of the ideal energy systems produced by HOMER for two of the biomass scenarios, the simulation results from HOMER have been comparable, but only couple of the bioenergy situations were explored. A first scenario depicts the bioenergy currently gathered as well as the biogas production capability of the ranch (include unutilized capacity), while the second situation indicates the amount of bioenergy that would be available if the livestock were constantly collected from the same place. A PV-wind hybrid system with an installed PV capacity of 100 kW, an installed wind power capacity of 30 kW comprised of 10 3-kW wind turbines, a battery bank of 100 batteries (83.4 Ah/24 V), and a 100-kW inverter is by far the most practicable solution for the current bioenergy environment. A PV-biogas hybrid system with a 5 kW PV capacity, a 60 kW biogas generator, and a 10 kW inverter is judged the most feasible solution for the expanded biomass scenario. The electrical analysis indicates that biogas electrification for the current

biomass scenario under the conditions modeled in this work is not economically feasible. Biogas electricity has been demonstrated to be viable if biomass is cultivated, indicating that if the farm installed more biodigesters, biogas electrification would be economically and electrically possible. Low net present costs (NPCOs) are heavily dependent on the amount and cost of electricity that can be pumped into the grid; therefore, an agreement made on the terms of energy sales is essential for the economic viability of the systems. Such an arrangement would make the farm's energy system considerably more cost-effective, Cuba's electrical mix more sustainable by reducing Emissions, and cause a rise in the use of renewable energy and supply security (Frisk, 2017).

Ani Vincent Anayochukwu and Ani Emmanuel Onyeka will build a Photovoltaic cell energy system with a power management to provide electricity (load supply and battery charging) to registration centers in Nigeria. This study models solar photovoltaic systems with energy management and storages system for off-grid voting registration facilities in Enugu State's Nkanu West and Kaura (State of Kaduna, covering the northern half of the country). The operation of the PV battery power system was studied using the developed power control system. In accordance with the control's conclusions, the load and provided energy are utilized rationally and efficiently. Using simulation results from the program Hybrid Optimization Model for Renewable Energy (HOMER), the optimal PV-battery energy system with a daily energy consumption of 2.3 kWh at a peak load of 235 W consists of a 0.91 kW PV system, 9 Hoppecke 24 OPzS 300 batteries, and a 1 kW DC/AC converter. This power system is adaptable to other registration processes, such as national identity or exam registration, and can be deployed in many locations of the country (Ani and Ani, 2014).

In the research Formulation and Construction of a Residential Photovoltaic/Wind Hybrid Energy System, Uur FESL et al. examined hybrid systems that employ several sources of energy. Integration of solar/wind systems has a greater impact on the production of electrical energy. Such systems are referred to as "hybrid systems." In practice, solar-wind hybrid systems are used when uninterrupted power supply is required throughout the year. In hybrid systems, any combination of energy sources, including oil, solar, and wind, can be used to meet energy needs. In this project, solar panels and wind turbines are used in a similar manner. In contrast, this is simply an

addition to the system. The effects of climate and weather on photovoltaic solar panels and miniature wind turbines are obvious. Therefore, neither solar nor wind energy alone is sufficient. Some renewable energy experts believe that a mix of wind and solar power will provide a satisfactory hybrid energy supply. In summer, when solar radiation is strong enough, wind speed is rather modest. In winter, when there are fewer sunny days, the wind speed is highest. During the year, the efficiency of the various renewable energy systems changes. Other words, in order to maintain energy production system, these two systems must support each other. The implemented system uses wind and solar power to meet a portion of the energy needs of a typical residential home. The experimental equipment for hybrid smart house includes two Pv systems and a low power wind turbine. Based on external conditions, system's energy requirements can be fulfilled by wind or solar systems separately, or by both simultaneously. The system control selects which reference to be used charge battery depending on the condition of the energy input. Part of a home's energy needs are met with electricity from wind and solar systems. Professionally developed software on the control board of the installed system determines whether the energy generators are activated or not. (Fesli, Bayir, & Ozer, 2009) found that MPPT system provided most benefit for solar energy.

Gundogdu and Gure terms Research, development, and deployment of a cost-effective photo - voltaic water pumped system for irrigated agriculture was subject of their research. Inside the limits of Batman Province, which has long sunlight period, a new agricultural irrigation system was designed, constructed, and installed using a 2.2-kW photo - voltaic (PV) panel with a smaller amount and reduced cost. The model HSPL/H2200L inverter was adapted to delta voltage of 220 V between its phases and to the output voltage by changing the winding and connection of an asynchronous submersible motor with star connection and 380 V and power of 2.2 kW, which is compatible with the inverter of model HSPL/H2200H. The process of rewinding the motor and the modification of the connection form were described in detail, as well as the analysis of the dimensions of an off-grid solar system and the source of the new voltage level. After installation, real-time statistics on voltage, current and power are collected and published in tables and graphs. Size and cost evaluations are used to detail the benefits this unique, reduced cost irrigation system over conventional systems of comparable performance (Gundogdu and Gure, 2019).

Livingstone et al. presented the modeling and ideal dimensioning of an energy microgrid system have used HOMER inside the city of Bahir Dar, Ethiopia. The impact of feed-in unpredictability on the power distribution system necessitates the development of new smart grid concepts. This study examines the feasibility of incorporating a microgrid as a cooperative unit into the power distribution system in order to enhance proportion of RES. This microgrid, which combines multiple distributed generation networks, storage devices, and electric consumption, is the smart grid's basic concept and backbone. The primary purpose of this project is to model a microgrid in Bahir Dar, Ethiopia, with a combination of photovoltaic, wind, and storage batteries connected to the grid. Either a storage system or a grid system must be utilized to provide an electricity energy to the load. The system is intended to deliver dependable, high-quality power to meet the needs of the city's customers that cannot be met by conventional power generation alone. The average daily electricity demand for residential, institutional, commercial, agricultural and light industrial consumers is estimated at 15,467 kilowatt hours. The software HOMER (Hybrid optimization multi-energy resource) is used to find the optimum component sizes for the microgrid. The simulation findings demonstrate that the grid-connected PV/Wind micro-grid systems with storage battery is sustainable, technically-economically feasible, and environmentally friendly in meeting load requirements in terms of proper sizing of PV panels and wind turbines by using the software HOMER, a microgrid system is depending on renewable energy references such as photo-voltaic and turbines of wind is modeled and sized for the city of Bahir Dar. When constructing a microgrid for a city, numerous factors must be considered. A total daily load of 15,467 kWh is used to calculate the residential, business, and communal loads for Bahir Dar. MATLAB simulations are being used to improve the surface area of microgrid components such photo-voltaic systems, turbines of wind and storages batteries using Homer Pro. The simulation method was collected from the NASA database using the HOMER resource window, and component lifetime, pricing from manufacturer's websites, and accessible solar output, wind velocity, and temperature in Bahir Dar were examined. In addition, the HOMER pro system takes component sizing, system design, system life cycle, NPC, COE, O&M cost, and yearly operational costs into consideration. When establishing the ideal size of the microgrid components to meet the city's total modeled demand, the microgrid power system is taken into account. According to the simulated results, the grid-connected

microgrid system is capable of covering Bahir Dar's total anticipated energy demand and is a suitable solution for the city. (Yenalem et al., 2020).

Parekh, Bindu U.Kansara and B.R. studied the modeling and analysis of a power distribution system using the application HOMER. They describe the modeling results for a Photovoltaic/Wind hybrid system. The program NREL HOMER (Hybrid Optimization Models for Energy Supplies) is being used to simulate and evaluate the Photovoltaic/Wind hybrid system. They find that Photovoltaic/Wind hybrid system-diesel system is feasible with summary of cost, cash flow, electricity generation or emissions, and cost. The total present value (NPV) is \$3,159. PV/battery/diesel configurations are optimal at low wind speeds, wind/PV/battery configurations are optimal at medium wind speeds, and PV/wind/diesel/PV configurations are optimal at high wind speeds. PV and diesel penetration decreases as wind speed increases (Kansara and Parekh, 2011). Figure 2.1 provides a description of the ascending wind and diesel PV hybrid system.

Saad Bin Abul-Kashem et al. explored the viability of domestic solar energy systems and the applicability of a household solar energy system inside Kuching. The solar PV system described in this article is, in concept, a modest photo-voltaic (PV) system that may be deployed in a residential neighbourhood or on a building to generate sufficient electricity to meet a household's daily electrical needs.

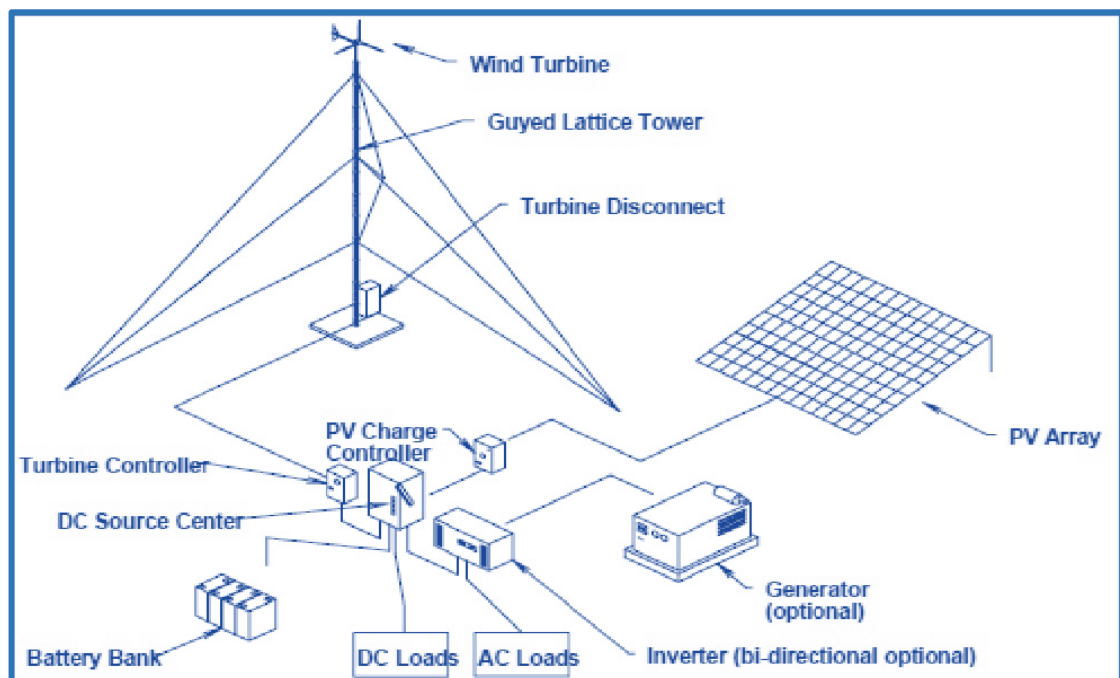


Figure 2.1: Explanation of the ascensional hybrid PV system of wind and diesel

In the Kuching district of Sekama, the relevant data were collected using two methods, one analytical and one experimental. Then, the data collected by the two methods were converted to solar radiation. Additionally, studies were undertaken on the system's potential, capacity, and financial impact. In conclusion, it is possible to establish a domestic PV solar system. To calculate the payback period, Solar Energy was consulted to ascertain the rooftop PV system's power, capability, and cost of installation. This information was obtained by calculating the budget will show of a 1 to 5 kWp PV solar system. The outcomes demonstrate that the commercial benefit produced is consistent across all systems outputs. This study determines the accounting rate of return using a 4 kWp PV solar system. According to the solar consultancy firm, a 4 kWp PV system with grid connection costs approximately RM 40,000 to install. Mr. Tan [24] estimates that this 4 kWp system will cut monthly power expenses by approximately RM 150.00. Therefore, the anticipated accounting rate of return for the entire 4 kWp PV system is approximately 22.22 years. This indicates that solar photovoltaic systems are viewed as a long term expenditure. Nevertheless, the payback period is regarded realistic and appropriate because the solar system can lower electricity costs and carbon footprint over the system's lifetime. In 22 years, the investment becomes lucrative.

This value is decreased if the installed system is eligible for the Feed-in-Tariff (FiT) managed by the Malaysian SEDA. To installations over to 4 kWp, accommodate prices are 0.82 RM per kWh generated. A recommendation was made based on the data to install an energy photovoltaic systems in a Kuching residential neighborhood. This is due to the savings on monthly expenditures and the potential reward once the investment becomes lucrative (Abul et al., 2020).

Saad Bin Abul-Kashem ,Md Bazlul Mobin Siddique and Mujahid Tabassum. They evaluated the methods, advantages, and disadvantages of using technologies and made recommendations depending on existing conditions. In Sarawak, photovoltaic cells are the most environmentally friendly technology that can be used. The Photo-voltaic Geo-graphical Information System Asia (PGISA) was used to study and evaluate the feasibility of using solar cells in Sarawak. The study found the optimal slope, orientation and application of Photo-voltaic cell technology. Tracking technology is required to maximize the amount of solar radiation collected by the panels.

PV cells are inefficient because they waste a large portion of the energy in the system, such as through the inverter and cables. The remaining 75% of Sarawak's energy needs are met by other energy sources. Solar energy, from the other hand, can play an essential part in Sarawak because it has great potential, especially if properly harnessed; however, the initial cost is significant and more research is needed. Solar energy would be a perfect fit due to Sarawak's optimal location in the equatorial zone, according to the findings. If properly deployed, solar energy can replace the current alternative energy supply.

Power to become the strongest alternative energy source for electricity generation. On the other hand, solar energy is costly and time-consuming. It takes seed money to get the system up and running, and enough money to keep it running until it breaks even. Solar energy is a cleanly, safe and inexhaustible form of energy that can drastically reduce energy costs while preventing an increase in greenhouse gas emissions. PV technology is the most effective method of solar energy generation and should be introduced in Sarawak. This study examines the variety of Photovoltaic technological solutions as well as the methods where these techniques can be used to improve efficiency and produce (Tabassum, Kashem, and Siddique, 2017).

A Study focused of public office building in Nepal: A Cost Benefit Analysis (CBA) of Green Building, by Pujan Neupane et al. This study's purpose is to utilize cost-benefit analysis (CBA) to assess the costs and possible advantages of green construction over the project lifecycle. CBA is an economic evaluation method that helps investors and policy makers make better decisions. The case study of a Nepalese government building in Dumre-Bhansar New Town is part of the research. The existing building was retrofitted with energy and water-saving environmentally friendly elements such as photovoltaic arrays and rainwater. Data suggest that going to invest in green construction reduces the lifecycle budget of the building, resulting in a long-term return on public investment. A subsidy policy recommendation facilitates the expansion of the project to the private sector, particularly residential projects. The most notable contribution of this study is the identification of the economic impacts of green construction as well as the introduction of the concept of lifecycle costs utilizing cost-benefit analysis, that also brings attention and choice

easier to the use of green technologies. Figure 2.2 illustrates the stages of cost-benefit analysis (Neupane, Afroze, and Phommasone, 2020).

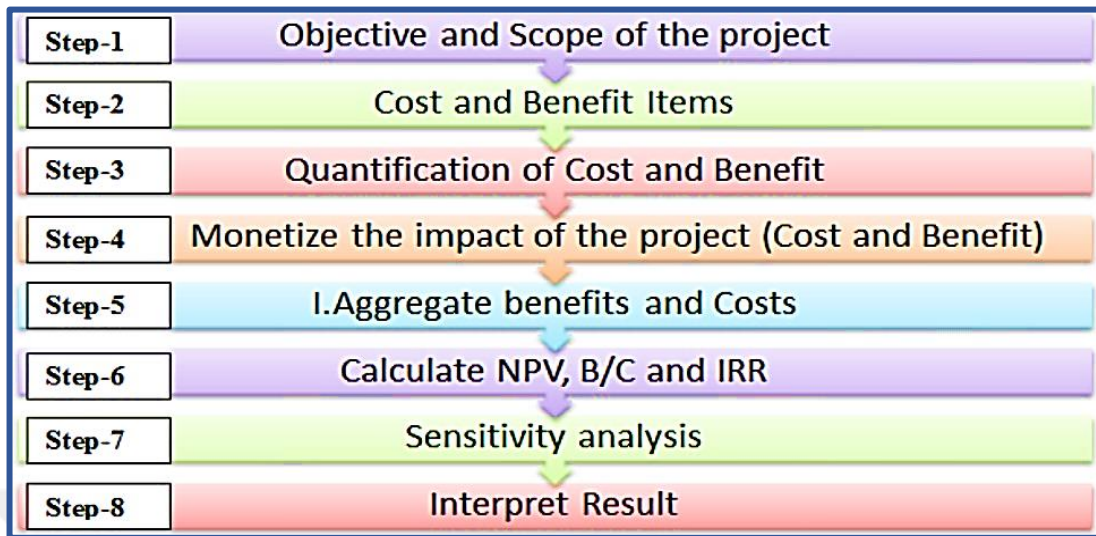


Figure 2.2: The suitable steps of costs benefits analysis of green building

Chrysanthos Maraveas et al. conducted research with the title Intelligent and Photovoltaic Greenhouse Contains: Latest Events and Future Prospects. Smart solar cells systems, modification from certain content qualities such as intelligent coverings, heat load, including the use of Internet of Things (IoT) to lower greenhouse running costs were the focal points. Consequently, the research covered the following topics: intelligent PV systems, enhancing energy conversion efficiency, PGF and other component features, as well as future prospects and perspectives on heat load.

The clever PV (It is a well-known fact that PV modules are the least significant component in the construction of various PV systems) (Roman et al., 2006). Material parameter optimization centered on nanocrystals, semitransparent natural solar cells and lead-based photovoltaics, and 3D printing. Analysis improved our understanding of future possibilities of the electricity greenhouse. The electricity generated by greenhouses with transparent PV roofs is both renewable and cost-effective, making it a sustainable solution. Conservative estimates suggest that replacing conventional energy sources with solar energy would reduce energy costs by 40-60 percent. Figure 2.3 shows the energy flows in a hypothetical greenhouse equipped with optimal semitransparent PV modules. The leveled energy costs show the cost savings.

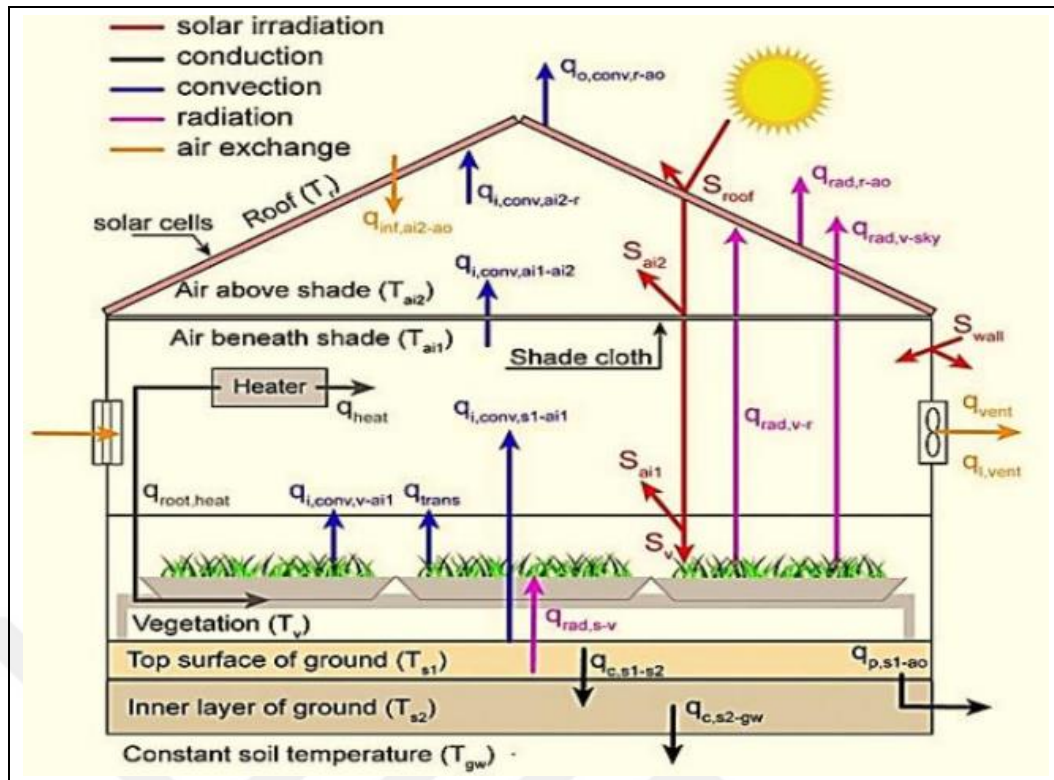


Figure 2.3: Power flows in a supposed specific green-house under optimal semitransparent PV modules

The limited commercialization of technological developments such as transparency and translucent Photovoltaic panels manufactured of Pb nanocrystals and nebulous tungsten oxide sheets also with necessary liquid crystal features, such as repairable color shifts, has been a significant limitation. In terms of smart solar cells, intelligent Internet - of - things components outfitted of temperature, water sensors and humidity have enhanced temperature control, freeze - thaw prevention, management and disease management. Consequently, postharvest losses decreased and outputs and incomes rose (Maraveas et al., 2021).

Ilaria Salernoa and her coworkers suggested an adaptive energy efficiently for intelligent buildings. In addition to architectural aspects like building, automatic shading, and double facade, the effects of the surrounding environment are carefully examined. This issue is approached as a non-linear improvement problem where the dwelling device reduces a reward function, taking into consideration power generation streams to the unit building-specific variables. Standard problem-solving techniques are utilized to solve the issue. To validate the suggested technique, several objective functions and building combinations are considered in computer experiments. Experiments demonstrate that our technique enhances system

performance while giving grid demand flexibility. They have developed an optimization-oriented DSM system for smart buildings (Energy Management System EMS). Standard solutions are used to solve the optimization problem, which is a nonlinear programming model. The DSM system reduces heating and cooling consumption during predefined hours by encouraging users to shift the load. They described how integrating optimization into the building elements not only facilitates load shifting, but also reduces overall heating and cooling demand. They demonstrated the application of the DSM system in several scenarios.

The EMS was initially implemented to cut heating expenses and consumption. The EMS decreased heating use by 14% due to energy conservation. They were able to save 26% on energy costs as a result of lowered expenses. Second, we compared an identical apartment with a conventional outside wall to an equivalent unit with also the DSF. Heating use and power expenses were lowered due to EMS. The unit usage and cost of DSF dropped by 35% and 49%, respectively. Thirdly, employing EMS, we were able to minimize energy expenses by as much as 97 percent in four distinct orientations of individual units. Fourthly, we tested EMS on a device with such a centrally located heat pump HP and a unit to two central and local heat pumps (within the DSF). The second unit was able to conserve some energy (Salerno et al., 2021).

Christopher Perry and Jennifer King investigated " Smart Houses: Using Smart Technologies to Save Energy in Residential Buildings. This study is aimed for energy saving program designers and managers concerned in smart buildings' expense energy reductions. It may also be helpful to building operations staff (including those at IT). It describes how intelligent technologies function in contemporary commercial properties, where they differ from traditional technology, as well as how much energy they can save. Table 2.1 depicts the energy savings generated by smart building systems in the commercial building sector. The paper then presents research studies of grid energy efficiency programs based on smart technologies, followed by expansion proposals. The study suggests that energy efficiency improvement programs that employ smart technologies, especially complete programs as opposed to single-measure or single-system retrofits, could boost the adoption of smart buildings. By committing to give training, manufacturers and trade associations might assist building operators in gaining a better grasp of the

technologies and overcoming their lack of readiness for their adoption. Small and medium-sized business buildings should be the target of programs mandating the adoption of intelligent technologies. Tenants who want to cut their energy expenses by installing a single measure, such as a smart thermostat, could profit, as could owners of individual buildings who lack the financial capacity to modernize. Incorporating smart technologies into a current package of prescriptive rebates is possible with programs. Existing energy-saving tactics (such as LED lighting retrofits) and new technologies (such as daylight sensors) can be integrated to create a cost-effective solution. The program could provide incentives for each individual measure in addition to a bonus for deploying intelligent measures.

Incentives that pay not only for hardware, but also for continuous third-party software services that monitor a building's operation and recommend modifications, would be another method of making smart building technology more accessible. A performance-based program and commissioning obligations to demonstrate the plan's cost-effectiveness could serve as incentives for smart measure packages.

Table 2.1: The energy savings level in various commercial constructions sector depending on smart building techniques

Building type	Floor area (sq. ft.)	Smart building technology	Average energy consumption (kWh/year)*	Percent savings	Average savings (kWh/year)
Education	100,000	Occupancy sensors Web-based lighting control management system	190,000	11%	20,900
Office	50,000	Lighting controls Remote HVAC control system	850,000	23%	200,000
Hotel	200,000	Guest room occupancy controls	4,200,000	16%	260,000
Laboratory	70,000	Air quality sensors Occupancy sensors Real-time ventilation controllers	980,000	40%	390,000
Hospital	120,000	Lighting controls + LED upgrade Data analytics software package	7,900,000	18%	1,400,000

Incentives could pay the costs of remote monitoring and optimization in the first year or upfront. When continual commissioning is required after a building retrofit, a cloud-based EMIS would be a logical fit. A performance-based program strategy could also help larger enterprises with medium and small sizes building investments (e.g. retail shop chain stores and banks). Smart commercial buildings have

significant potential for energy and cost savings, improved building process control, improved tenant comfort and convenience, and increased building value. As program administrators implement novel techniques to incorporating integrating intelligent building techniques into existing and newer program offering, they are beginning to see these benefits. Each technology has its own set of operational benefits, investment possibilities, and energy savings. They generate something new and more powerful when they work together in an integrated system, a home automation that saves energy, runs flawlessly, and promote creative, cost effective energy conservation projects (King and Perry, 2017).

Sotiris Papantoniou et al. evaluated use of a smart building energy management system to integrate many systems into a single monitoring and management system. Figure 2.4 shows many systems using different communication techniques and a variety of traditional and monitoring technologies. The aim of this analysis is to show that the building energy management system (iBEMS) ensures that multiple systems communicate using open communication protocols to communicate important data, while providing a HMI for regulation. In addition to managing the interconnected systems, iBEMS simultaneously retail locations past values for prospective contrast. Figure 2.5 shows the subsystems that can be connected to the building energy management system from different market sectors. The iBEMS allows a building's energy manager to monitor the performance of all systems in real time, examine the system's components, and make decisions that support the proper operation of the system. Utilizing input from sensors placed and external information (such as meteorological data), the iBEMS automatically adjusts the operation of the systems based on programming algorithms. Weather prediction. According to the conclusions of this study, the evolved and suggested iBEMS can significantly support monitoring and management among all connected subsystems. Control system that can be implemented in an iBEMS is shown in Figure 2.6. A summary of the overall structure and the different subsystems has been given.

Because all information is collected at a higher level and distributed to all required stations, the approach resolves the issue of intercommunication between separate subsystems(Papantoniou, Mangili and Mangialenti, 2017).

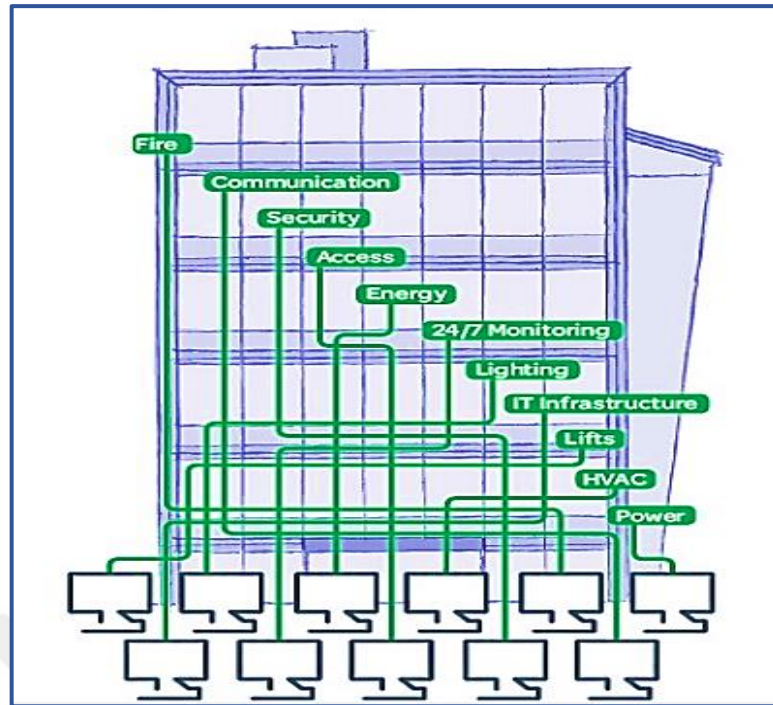


Figure 2.4: Multiple systems using different communication methods which utilize various traditional flows with various monitoring technologies

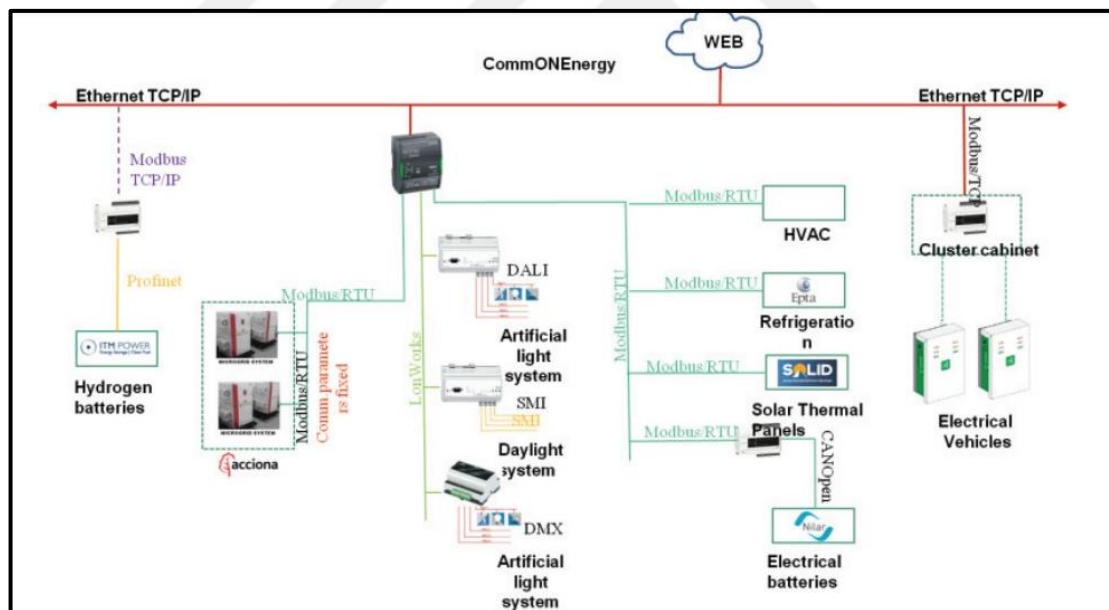


Figure 2.5: The sub-systems of different sectors of specific markets that can be connected to the building energy management system

In recent years, household energy consumption DC has increased due to the remarkable proliferation of appliances powered by direct current (DC) (computers and consumer electronics). Because electric utilities transmit alternating current (AC) rather than direct current (DC), the technology (rectifiers) used to power DC loads is inefficient (DC). In this study, the suitability of typical AC wiring for distributing

DC power to directly supply loads is investigated, focusing on the arcing issue in outlets/switches. Arcing is a common problem in DC systems and must be managed to meet safety requirements and improve system performance. An alternative flat DC wiring method with improved electrical and thermal transition characteristics is proposed for residential wiring to mitigate the arcing problem. The smooth wire solution uses the same raw materials as the arcing solution and improves parasitic values while reducing thermal resistance (Rodriguez-Diaz et al., 2015).

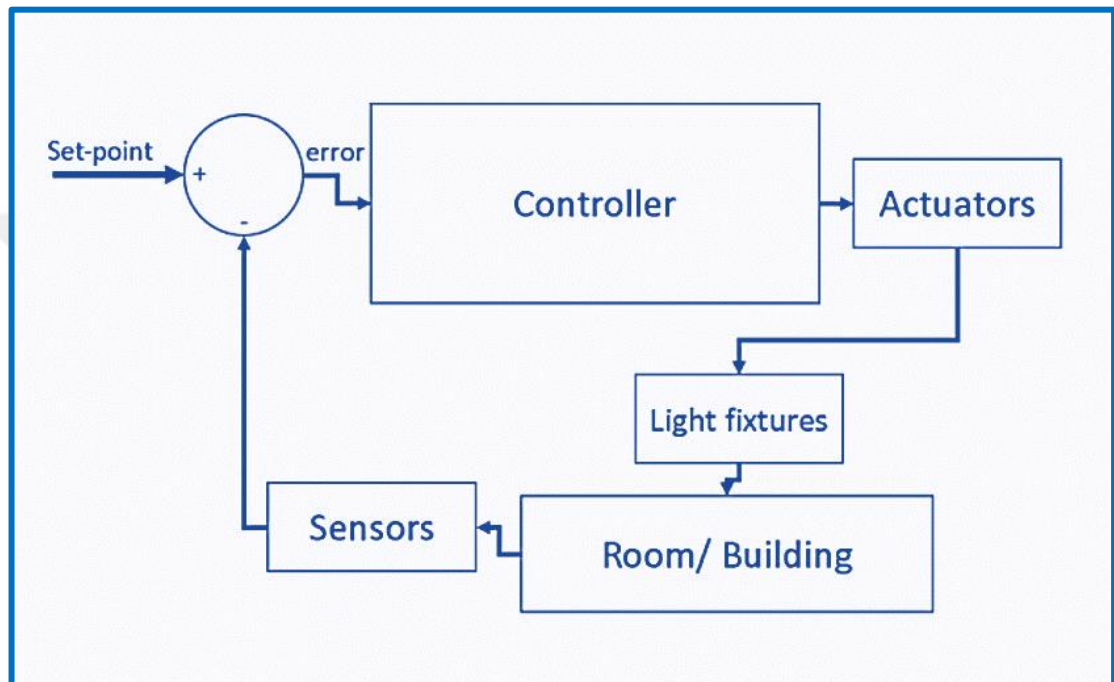


Figure 2.6: The suggested control system that can be applied in the iBEMS

3. METHODOLOGY

Widespread engines are broadly utilized in home devices. When the motor is operated with AC, current noise is generated, causing heating of coils and electro - magnetic troubles that reduce life of the engine (Abdeljawed and El Amraoui, 2022). There is a developing interest in utilizing sustainable power change frameworks for providing power. Such frameworks must be planned with greatest productivity and with least middle stages (Muthuvel, Daniel and Yazhini, 2016).

Families in certain nations consume greater power contrasted with other created nations because of the way that larger part of their family loads are wasteful. Accordingly, cost is expanded given the powerful utilization and turns out to be less reasonable, where the utilities are likewise progressively applying overcharges to clients as a result of direct effects on the network, this is particularly for the situation for low-pay families, where they are apparently closed out from taking part in the energy economy given the punishments and the expenses.

Thus, a convincing method towards decreasing family load is (Veerapaneni, Palaniappan and Cuzner, 2020):

- i. Right off the bat, to change over a part of family electrical loads, for example, LED lighting, cooling, roof fans, and electronic burdens to DC.
- ii. Also, tracking down the ideal methodology for deal with the DC power, for example, in homes.

The proposed PV powered home is simulated using MATLAB Simulink program, the overall system be shown in figure 3.1.

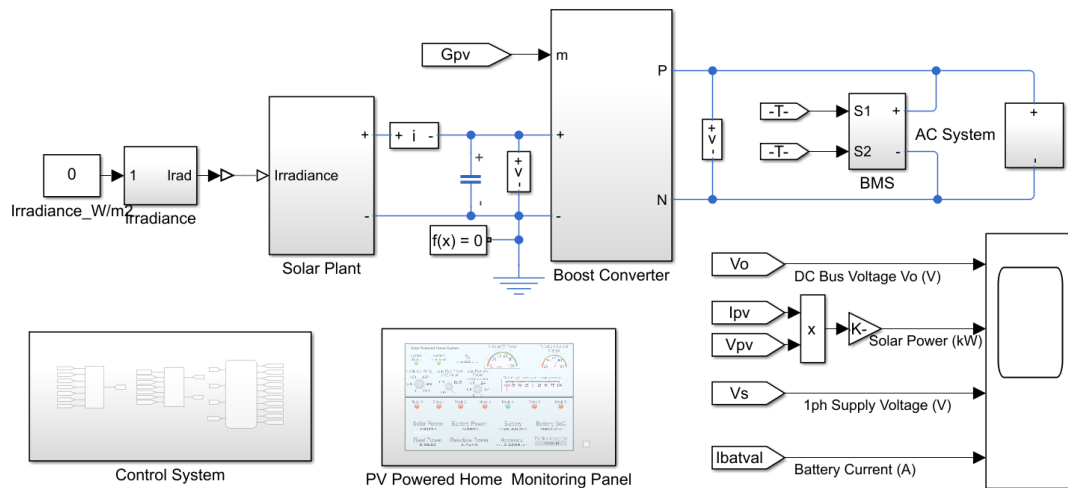


Figure 3.1: Current proposal over all complete model

Main power source in our system is the solar array, which designed to generate all the required energy for the system, and in peak power generation when the produced power becomes more than the load demand the extra energy storing in the battery storage system. Figure 3.2 shows the PV array.

To make the PV array voltage suitable for rated voltage for the home and to perform maximum point tracking, Figure 3.3 shows the DC /DC boost converter that is used.

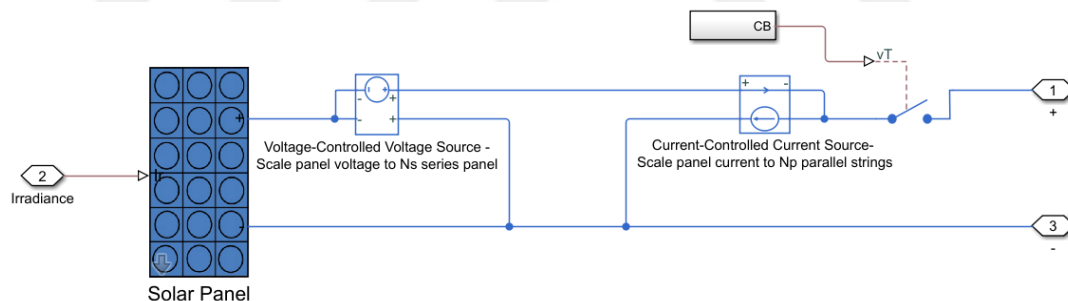


Figure 3.2: Solar array model

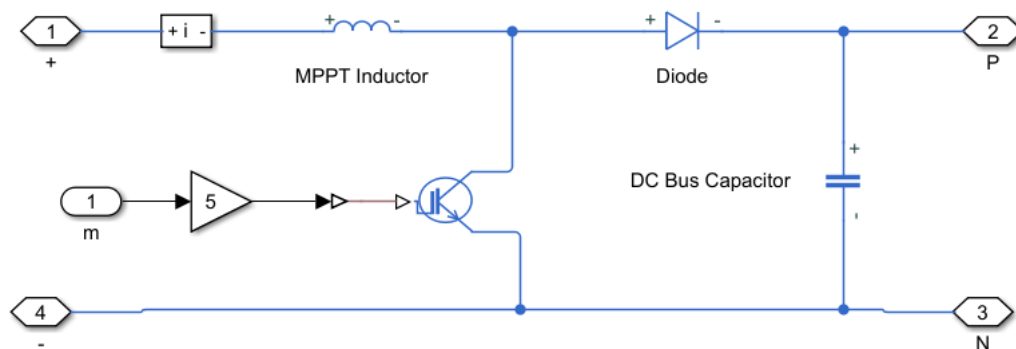


Figure 3.3: DC/DC Boost converter Circuit

Battery management system BMS is one of the main parts in the proposed system, it controls discharging and charging of the battery. BMS is checking battery state of charge SOC to prevent battery empty case, and overcharging protection. BMS circuit as shown in figure 3.4.

Because the famous residence loads in Iraq are AC loads, therefore we use an AC loads connected through a full bridge inverter, total load about 10 KVA. Figure 3.5 shows the AC load.

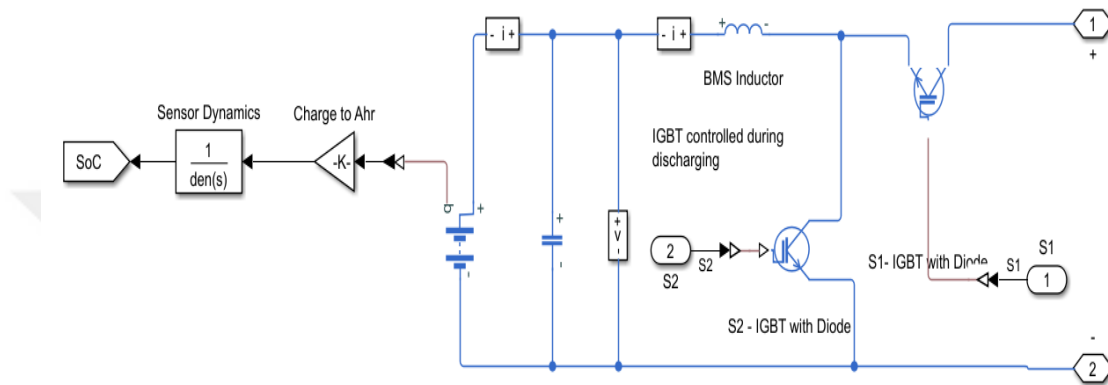


Figure 3.4: Battery management system

To make monitoring of the system easier and practical, a suitable graphical user interface GUI is designed. The GUI contains gauges for solar power, battery SOC, load and solar radiation control knobs and display all power components of the system. GUI is shown in figure 3.6.

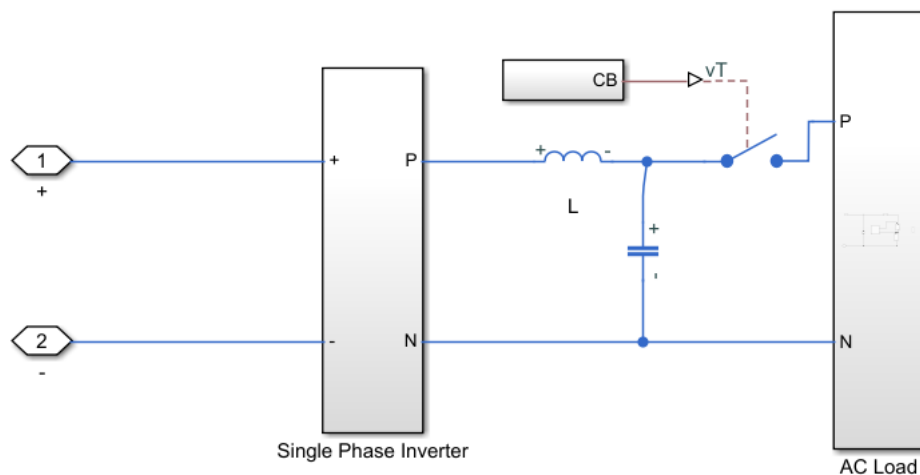


Figure 3.5: Home AC Load

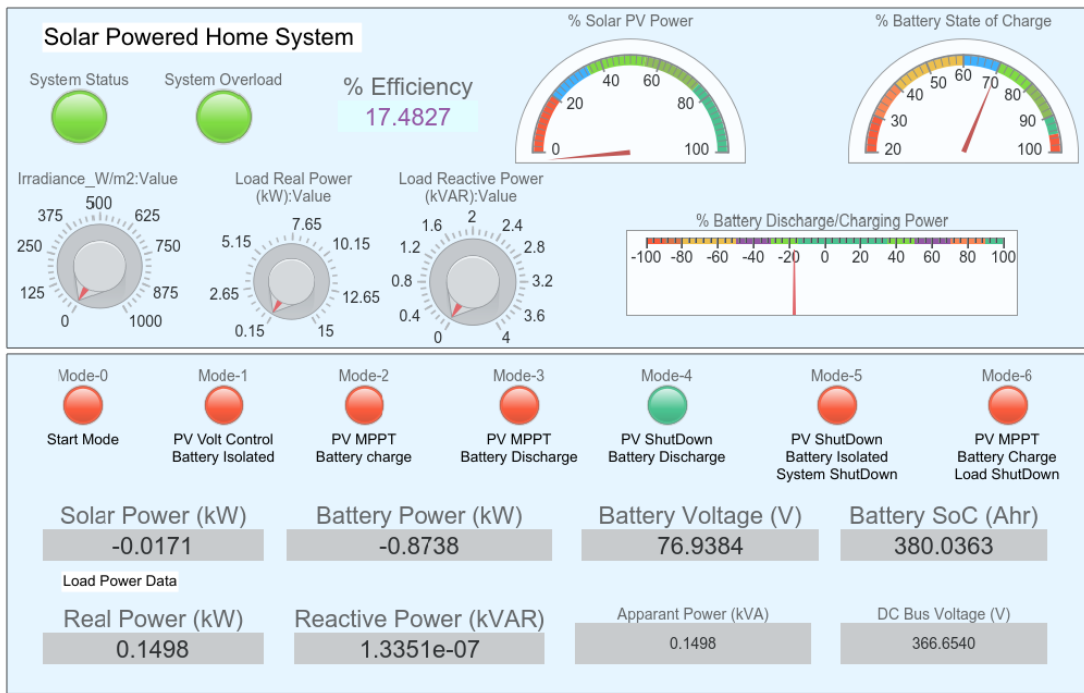


Figure 3.6: Graphic User Interface GUI

4. RESULTS AND DISCUSSION

The suggested PV powered home be simulated for many expected operation conditions depending on solar radiance level and load nature. The operation mode depends on both the connected loads and the irradiance level.

4.1 High Level Soral Radiation

In this case the connected load varying form minimum to maximum allowable capacity. The system three modes:

4.1.1 Battery Charging Mode

Figure 4.1 shows the system control panel in case of battery charging mode, this mode continues until the battery reached full charge status or the load increase more than the PV array capacity.

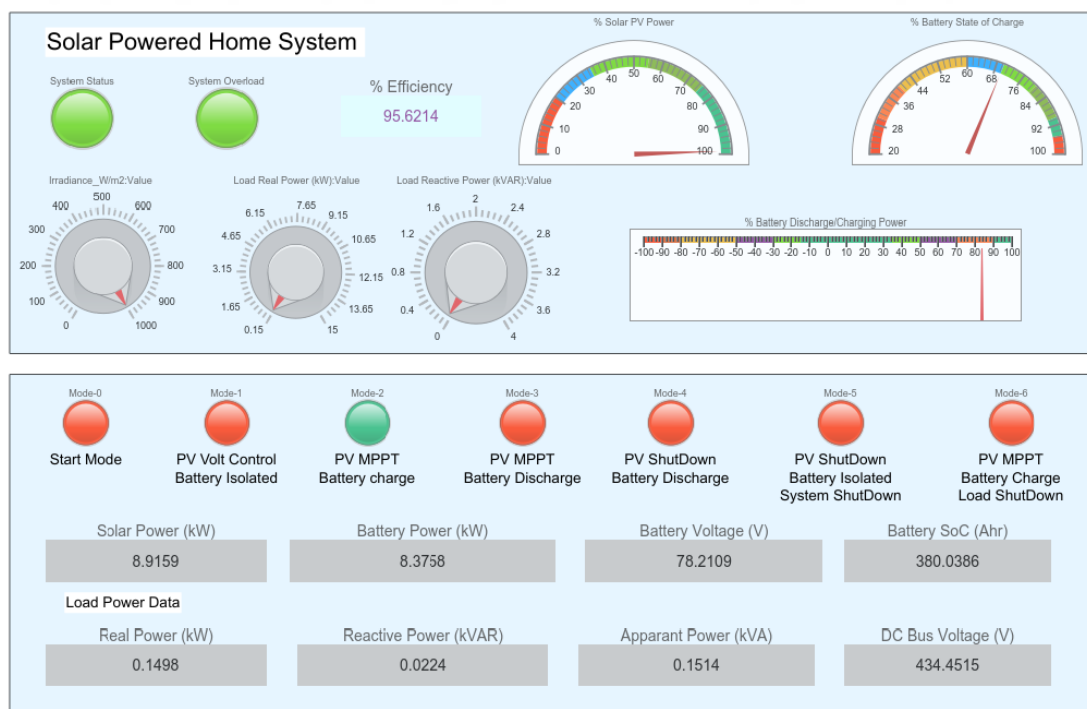


Figure 4.1: Battery charging mode

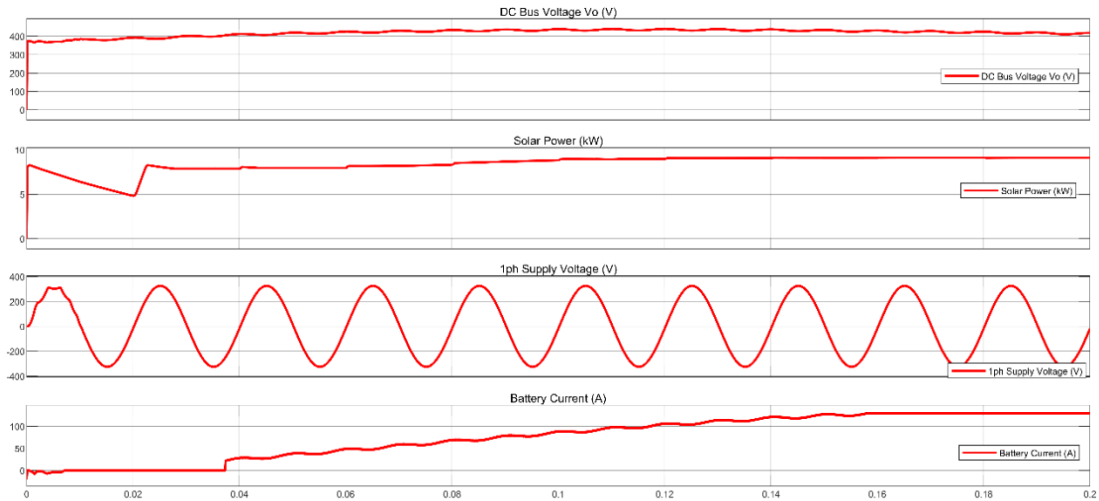


Figure 4.2: System waveforms in battery charging mode

4.1.2 Half loading operating mode

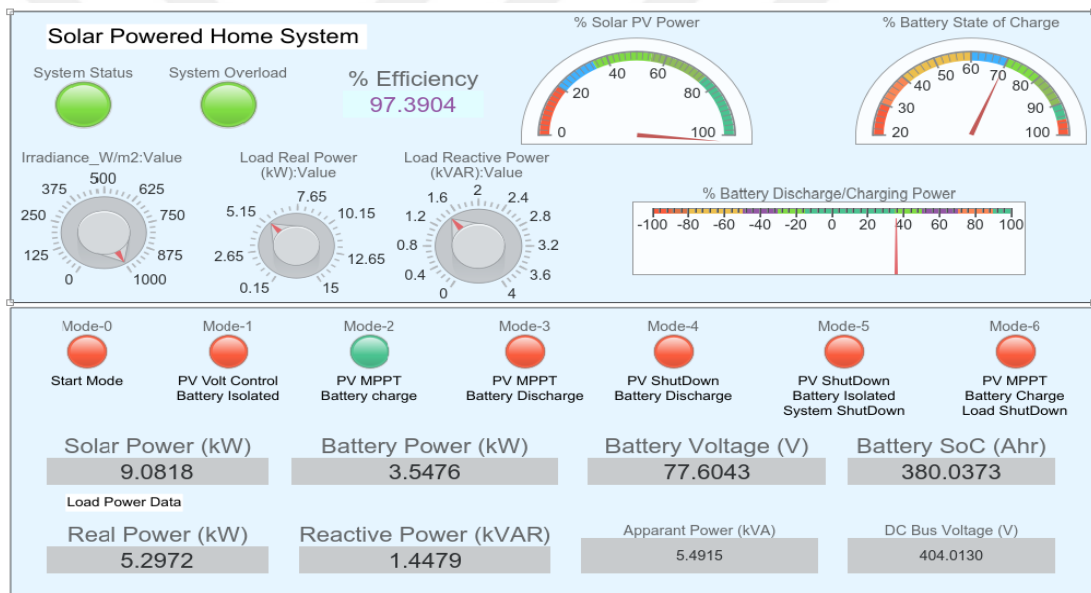


Figure 4.3: Half loading case

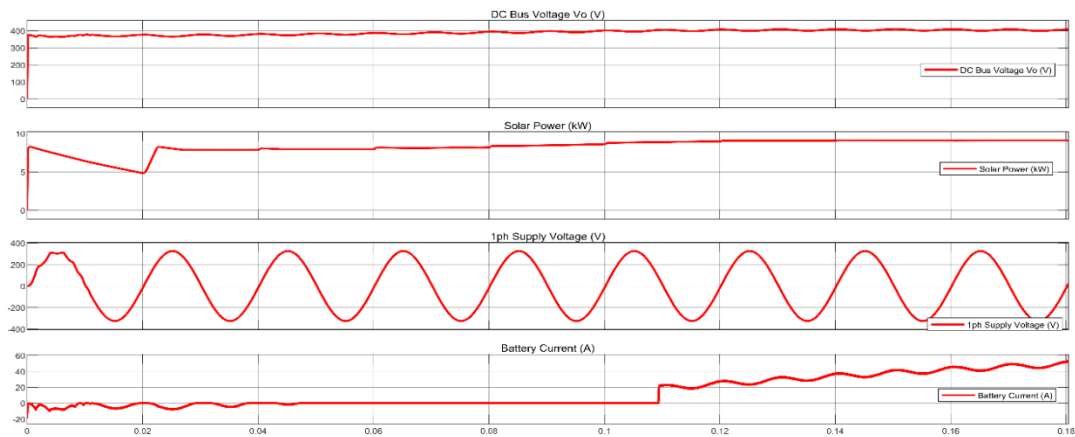


Figure 4.4: System waveforms in case of half loading

4.1.3 Full load operating mode

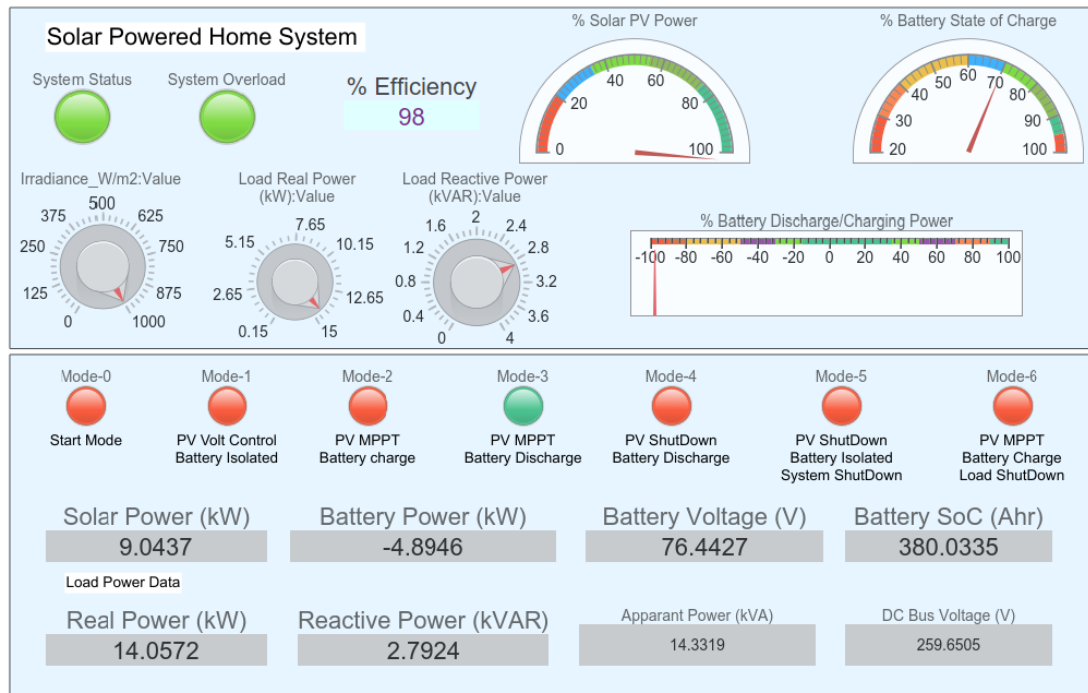


Figure 4.5: Full load operating mode

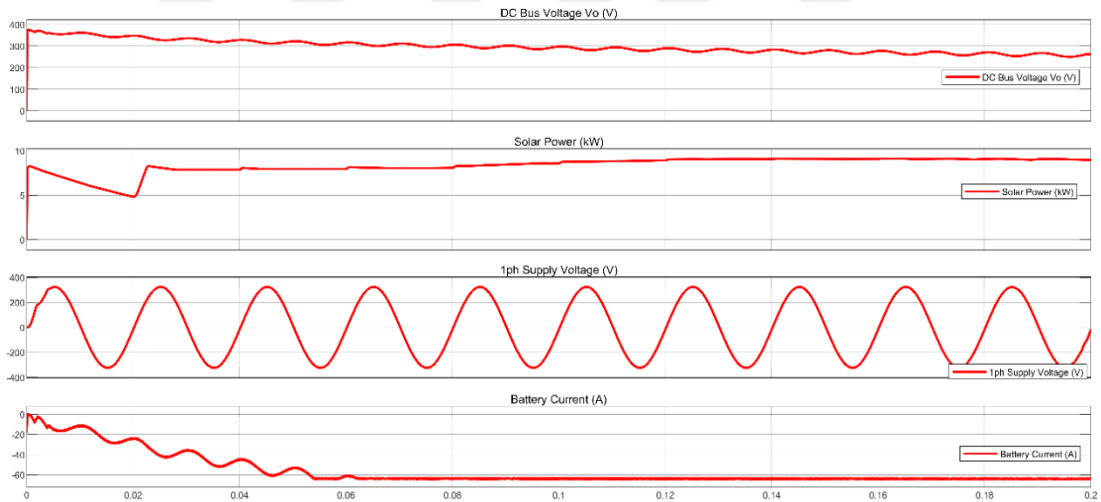


Figure 4.6: System waveforms in case of full load operating mode

4.2 Low Level Solar Radiation

4.2.1 500W/m² - No Load Case

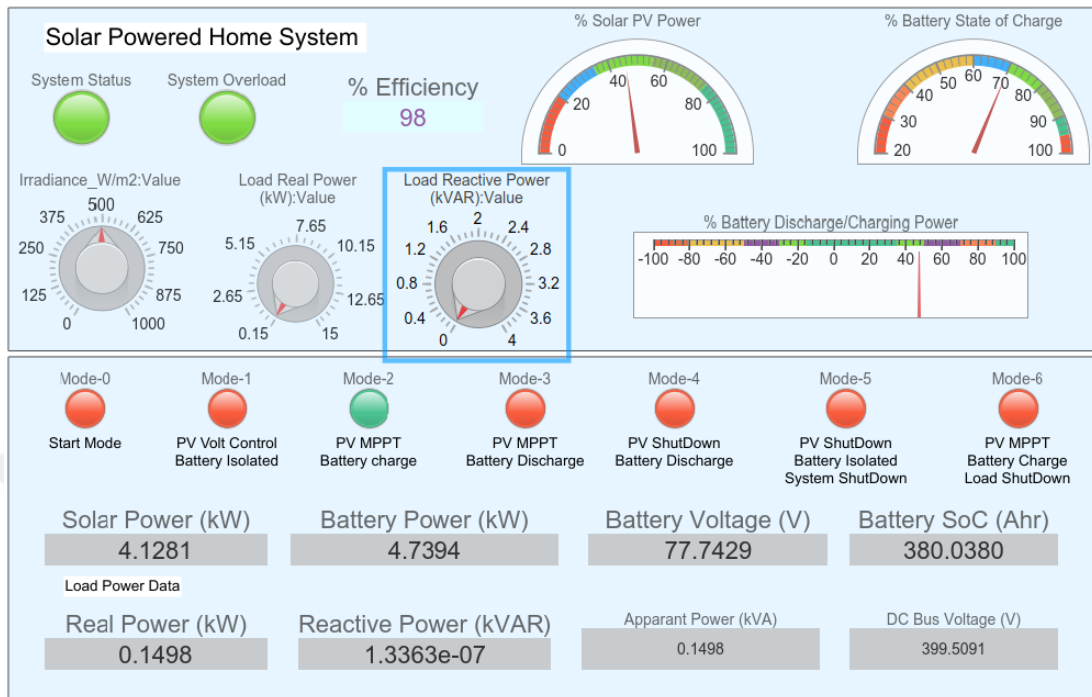


Figure 4.7: 500 W/m² no-load operating mode

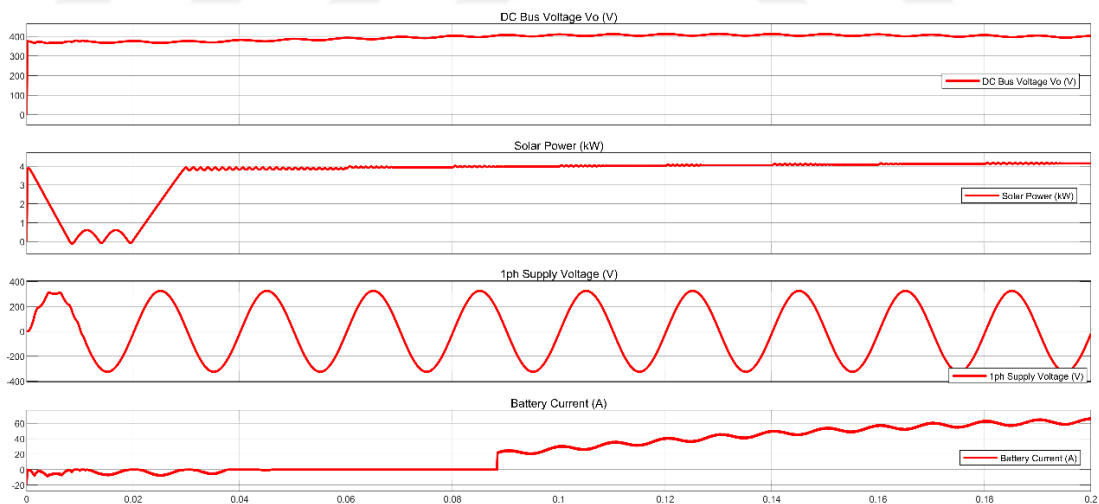


Figure 4.8: 500 W/m² no-load operating mode

3.2.2 500W/m² – Half-Load Case

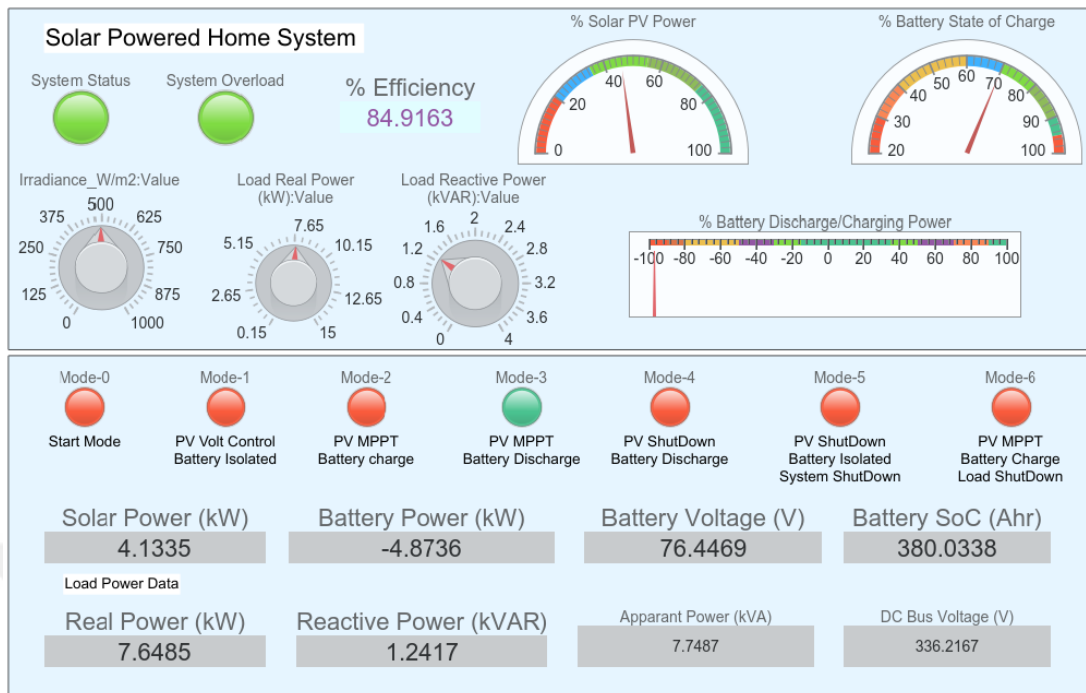


Figure 4.9: 500W/m² – half-load case

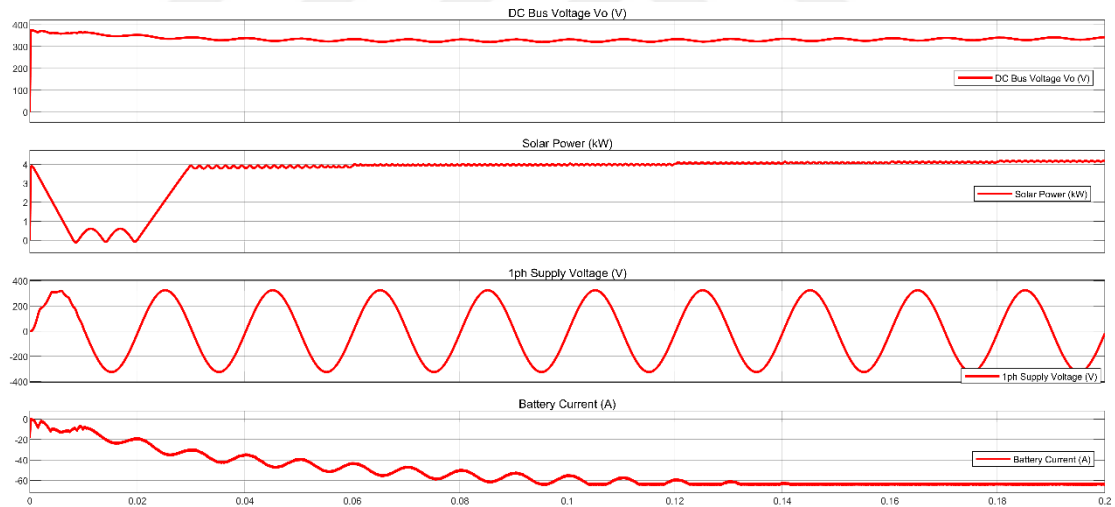


Figure 4.10: System waveforms in case of 500 W/m² and half loading

3.2.3 500W/m² – Full-Load Case

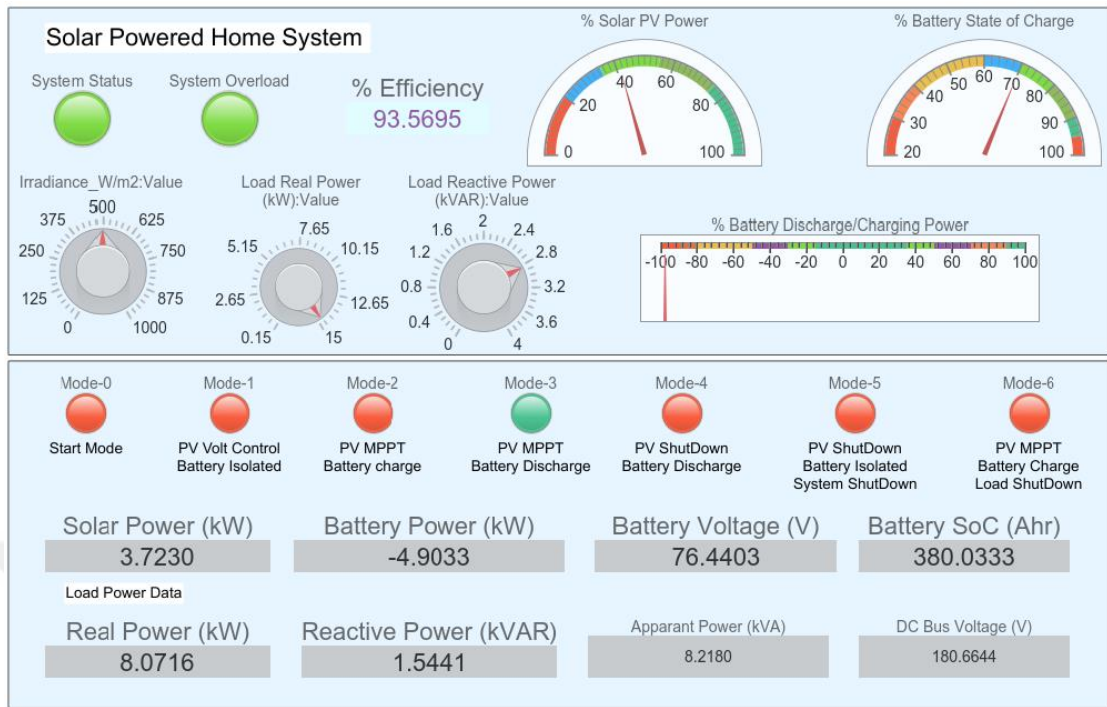


Figure 4.11: 500W/m² – full-load case

3.3 Solar Array Idle Mode

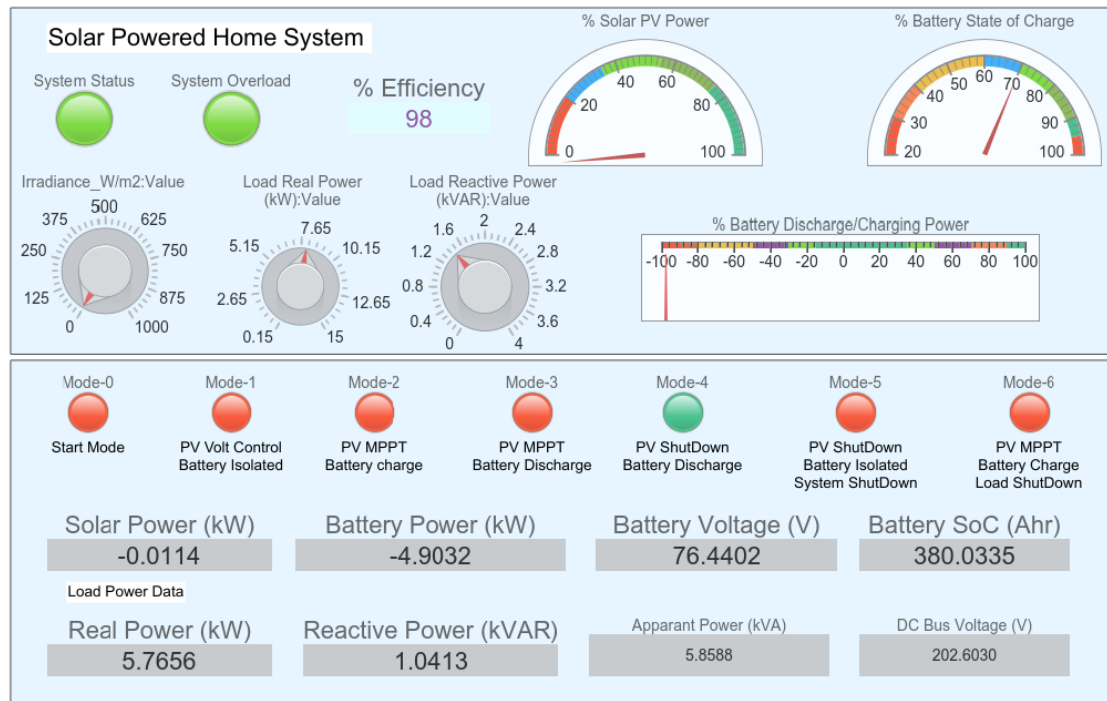


Figure 4.12: Solar array idle mode

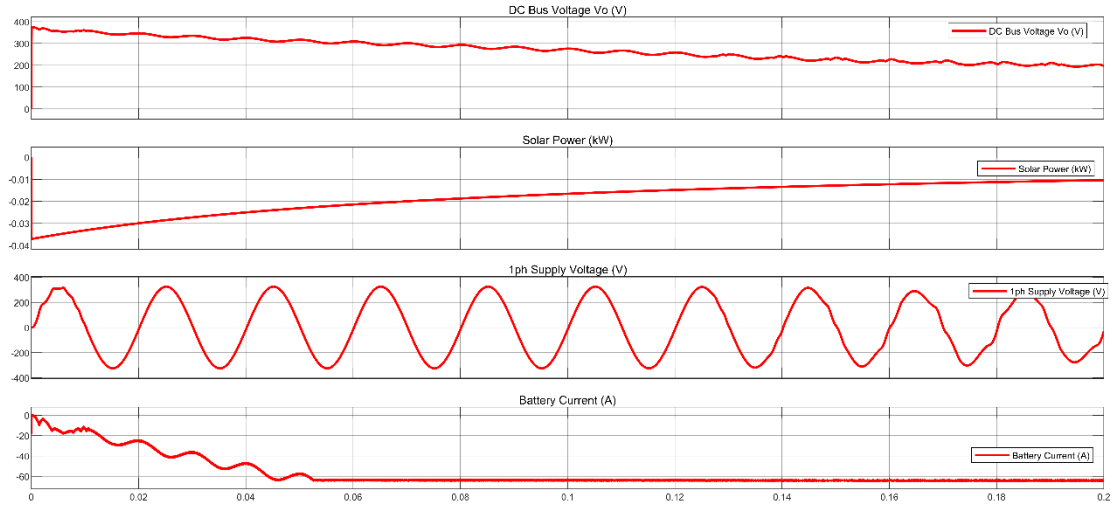


Figure 4.13: System waveforms in case solar array idle

3.4 System Simulation Summary

Table 4.1 contains system parameters summary for all expected operating cases.

Table 4.1: system parameters summary for all expected operating cases

Mode	Irradiance	P_{pv} (W)	P_{Load} (W)	Q_{load} (Var)	$P_{battery}$ (W)	SOC %	Efficiency %
1	640	5.59	5.0	1.0	0	70	95.4
2	1000	9.123	5.0	1.0	4.30	80	99.0
3	380	3.346	4.8	0.97	2.169	70	94
4	0	0	5.0	1.0	5.1	69	93.2
5	0	0	0	0	0	0	0 (system shutdown)
6	1000	9.123	0.0	0.0	9.123	90	98.0

5. RESULTS AND RECOMONDATIONS

5.1 Results

The proposed system is simulated for all expected operating cases such as high solar radiation, low level radiation and in case of no solar radiation such as during night. Also, the loading status took in care (full load, half load and no load).

All simulated cases showed that the system performance was in high efficiency and in all cases the solar system working in maximum power point MPP, which means high power utilization. The proposed system is standalone and therefor a suitable energy storage system is used, battery management process in all simulated cases has a high performance.

For standalone DC powered homes it very important to design the energy storage system carefully so as store energy in such way not to lose any energy amount, and to make battery life as long as possible.

5.2 Recommendations

- i. In order to obtain practical results, it is preferable to design a laboratory model and run it continuously so that the effects of climatic on the efficiency of the network appear to improve it in proportion to the operating conditions.
- ii. The culture of exploiting solar energy and renewable energies is one of the most important things that must be available to any customer who can use renewable energy systems. Therefore, awareness about this culture must be spread and brochures and pamphlets that spread this culture must be printed.
- iii. Building houses that have high thermal insulation is one of the things that support energy savings, especially in hot or cold weather (such as Iraq's atmosphere), and this matter is no less important than the issue of operating solar energy systems at maximum capacity or what is known as MPPT, so it

is important to provide This type of construction as one of the solutions to save energy.



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RESUME

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