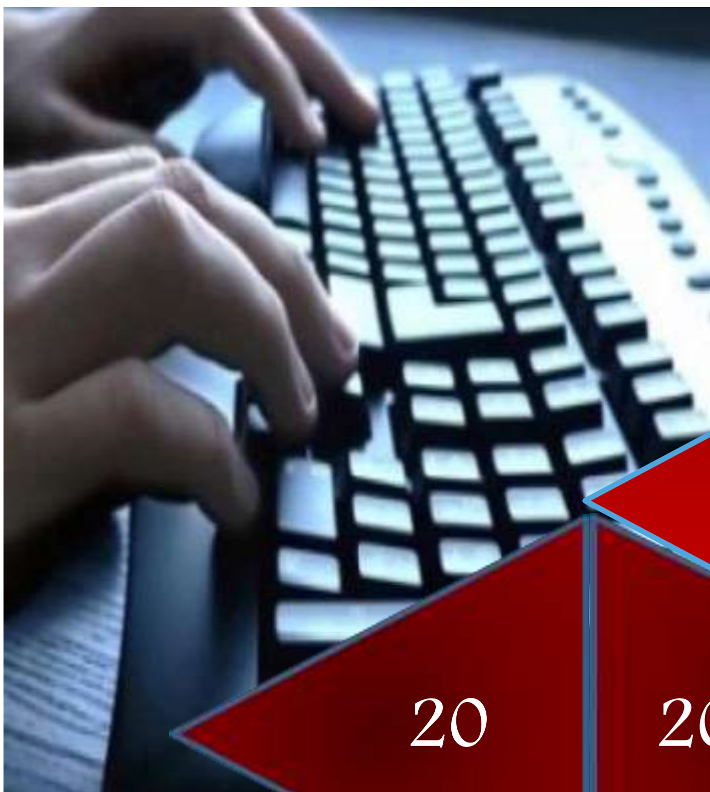
AN ENGINEERING PROJECT SUBMITTED TO THE COLLEGE OF ENGINEERING OF THE UNIVERSITY OF AL-MUTHANNA EN PARTIAL FULFILLMENT OF THE REQUIRMENTS FOR THE DEGREE OF THE BACHELOR OF SCIENCE EN CIVIL ENGINEERING



Preparing a Program to Designing a Concrete Element According to ACI 318-14

20 20

Prepared by:

- *Muna Abbas Hawas*
- *Rahmah Zgaer Mandel*
- *Ahmed Abd-Alreda*
- *Hawraa Mohammed*

Project Supervisor

Assist. Lecturer Alaa Taha Al –Najjar

Graduation Project

College of Engineering, Al-Muthana University

EXAMINATION COMMITTEE CERTIFICATE

We certify that we have read this project titled "**Preparing a program to designing a concrete element according to ACI code**" and, as an Examining Committee examined the students in its content and in what is connected with, and that in our opinion it meets the standards of a project for the degree of Bachelor of Science in Civil Engineering.

Name: Asst. Prof. Dr. Bassim Abbas

(Member)

Date:

Signature:

Name: Asst. Prof. Dr. Hussein Kareem Sultan

(Member)

Date:

Signature:

Name: Mr. Alaa T. Mohammed

(Supervisor)

Date:

Signature:

Name: Asst. Prof. Hussein Yousif Aziz

(Chairman)

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Signature:

Name: Asst. Prof. Dr. Hussein Yousif Aziz

Head of Civil Engineering Department

Date:

Signature:

Ministry of Higher SubjectEducation
and Scientific Research
Al- Muthanna University
College of Engineering
Department of Civil Engineering

Environmental Analysis for Oil-based Power Generation Using Life Cycle Assessment

بحث تخرج مقدم إلى مجلس كلية الهندسة في الجامعة المثنى وهو جزء من متطلبات نيل درجة البكالوريوس في قسم الهندسة المدنية.تم أجراء البحثمن قبل طلبة المشروع:

سجاد أياد ساجت

زين العابدين علي نوري

شهلاء حمزة كريم

بأشراف:الدكتورعصام الياسري

2020- 2019A.C 1441- 1440

EXAMINATION COMMITTEE CERTIFICATE

We, as an Examining Committee in the Department of Civil Engineering at AlMuthanna University, certify that we have read this project entitled **"Environmental Analysis for Oil-based Power Generation Using Life Cycle Assessment"** and, examined the students who performed the project regarding their understanding of its content and that in our opinion it meets the standards of a project for the degree of Bachelor of Science in Civil Engineering.

Name: Dr Ameera Mohammed
(Member)
Date:
Signature:

Name: Dr Huda Mohammed
(Member)
Date:
Signature:

Name: Dr Isam Alyaseri
(Supervisor)
Date:
Signature:

Name: Dr Amjed Mohammed
(Chairman)
Date:
Signature:

Name: Asst. Prof. Dr. Hussein Yousif Aziz
Head of Civil Engineering Department
Date:
Signature:

Ministry of Higher Education an
scientific Research
Al - Muthanna University - College (
Engineering
Department of civil engineering

Subject:- Estimation of manning roughness value coefficient using HEC-RAC hydraulic model for Al Msharah River within Amarah Governorate, Iraq.

An Engineering Project
Submitted to the College of Engineering of Al-Muthanna University in a Partial Fulfillment of the Requirements for the Degree of Bachelor of Science
In
Civil Engineering

Names of students:-
1- Tariq Kareem Katie
2- Rusul Ali Abd Al husen
3- Nawras Mohammad Ouied

Supervised by:-
Ameera Muhamead Awad

2020 1442

EXAMINATION COMMITTEE CERTIFICATE

We certify that we have read this project titled " Estimation of manning roughness value coefficient using HEC-RAC hydraulic model for Al Msharah River within Amara Governorate, Iraq " and, as an Examining Committee examined the students in it's content and in what is connected with, and that in our opinion it meets the standards of a project for the degree of Bachelor of Science in Civil Engineering.

Member

Signature :

Name : : Dr. Huda Mohammed

Date :

Member

Signature :

Name : : Dr. Amjad Muhammad :

Date :

Supervisor

Signature :

Name : Ameera Mohamad Awad

Date :

chairman:

Signature :

Name : Dr Isam Alyaseri

Date :

Head of civil Engineering Department

Signature :

Name **:** Dr. Hussein Yousuf Aziz

Date :

Republic of Iraq

Ministry of Higher Education and Scientific Research

Al-Muthanna University / College of Engineering

Civil Engineering Department

Evaluation of Traffic Light Signal Junctions in Samawah City

A project submitted to the College of Engineering Council - Civil Engineering Department as a partial requirement for obtaining a Bachelor's degree in Civil Engineering

Written by:

Ahmed Nagim

Asraa Mohsen

Hussein Abdulrahman

Supervised by: Dr. Noorance Ali Razzaq

2019-2020

EXAMINATION COMMITTEE CERTIFICATE

We certify that we have read this project titled "**Evaluation of traffic light signal junctions in Samawah city**" and, as an Examining Committee examined the students in it's content and in what is connected with, and that in our opinion it meets the standards of a project for the degree of Bachelor of Science in Civil Engineering.

Name**: Dr. Hayder Kamil Shanbara**
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Date: 30/11/2020
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Date:
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Name: **Dr. Noorance Ali Razzaq**
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Date: 12-8-2020
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Name: **Dr. Mohammed Bali Mahdi**
(Chairman)
Date:
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Signature:
Name: **Asst. Prof. Dr. Hussein Yousif Aziz**
Head of Civil Engineering Department
Date:

UNIVERSITY OF AL-MUTHANA
COLLEGE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING

NUMERICAL SIMULATION THE SOIL COMPACTION USING PLAXIS COMPUTER SOFTWARE

An Engineering Project

Submitted to the College of Engineering of Al-Muthanna University Partial Fulfillment of the Requirements for the Degree of Bachelor of Science

In

Civil Engineering

By

HASSAN AYAD HUSSIEN
MUSTAFA RAED KAREEM
ALI AKBAR KAMEL RAJAF

SUPERVISED BY
Dr. TALIB KAMEL QASSIM AL-SHEAKAYREE

Dhu al-Hijjah **1441**
August **2020**

EXAMINATION COMMITTEE CERRTIFICATE

We certify that we have read the project titled "Numerical Simulation the soil Compaction Using PLAXIS Computer Software " and, as Examining committee examined the students in its content and in what is connected with, and that in our opinion it meets the students of a project for the degree of Bachelor of Science in Civil Engineering.

Assist. Prof. Dr. Bassim .J. Abbass Almusawe

(Chairman)

Ahmed Raad, MSCE

(Member) **(Member)**

Dr. Talib Kamel Qassim Al-Sheakayree

(Supervisor)

Assist. Prof. Dr. Hussein Yousif Aziz
Head of Civil Engineering Department

UNIVERSITY OF AL-MUTHANNA

COLLEGE OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

Simulation and Design of Raft footing Using Computer Program

AN ENGINEERING PROJECT

SUBMITTED TO THE COLLEGE OF ENGINEERING

OF THE UNIVERSITY OF AL MUTHANNA

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR

THE DEGREE OF BACHELOR OF SCIENCE

IN CIVIL ENGINEERING

BY

Zeina Ayad **Mundher Adil**

Raad Aloush **Bayader Muhammad**

SUPERVISED BY

Ass. Prf. Dr. Basim Jabbar Abbas

August, 2020

EXAMINATION COMMITTEE CERTIFICATE

We certify that we have read this project titled "**Simulation and Design of Raft footing Using Computer Program**" and, as an Examination Committee examined the students in it's content and in what is connected with, and that in our opinion it meets the standards for the project of the degree of Bachelor in Science of Civil Engineering.

Name: Mr. Ahmed Raad Al-Adhadh

(Member)

Date:

Signature:

Name:Mr. Mohammed Fadhil Abbas

(Member)

Date:

Signature:

Name: Ass.Prof. Dr. Basim Jabbar Abbas

(Supervisor)

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Signature:

Name: Dr. Talib Kamil Kassim

(Chairman)

Date:

Signature:

Signature:

Name: Ass.Prof. Dr.Hussein Yousif Aziz
Head of civil engineering department:

Date:

UNIVERSITY OF AL-MUTHANNA
COLLEGE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING

MECHANICAL PROPERTIES OF FINE GRAINED SOIL IMPROVED WITH NANO MATERIALS

AN ENGINEERING PROJECT
SUBMITTED TO THE COLLEGE OF ENGINEERING
OF THE UNIVERSITY OF AL-MUTHANNA
IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE
DEGREE OF BACHELOR OF SCIENCE
IN CIVIL ENGINEERING

By:

1-Baneen Hayder **2-Zahraa Mohammed**

3-Nagham Ayad

Supervisor: Lecturer. Ahmed Raad, MSCE

August,2020

EXAMINATION COMMITTEE CERTIFICATE

We certify that we have read this project titled " Mechanical Properties of Fine grained Soil Improved with nano materials" and, as an Examining Committee examined the student in it is content and in what is connected with, and that in our opinion it meets the standards of a project for the degree of Bachelor of Science in Civil Engineering.

Dr.Bassim.J.Abbass Almusawe

(Chairman)

Dr.Talib Al-Sheakayree

(Member)

Mohammed Fadhel

(Member)

Lecturer. Ahmed Raad, MSCE

(Supervisor)

Dr.Hussein Yousif Aziz

Head of Civil Engineering Departmen

Ministry of Higher Education and Scientific Research

Al-Muthanna University/College of Engineering

Civil Engineering Department

Project name:

"A comparative study between normal concrete and ultra-high performance concrete that used in bridge piers"

Prepared by students:

Bashir Faraj , Bedoor Haydar

&

Zaynab Najeh

Class: 4th year stage

Supervisor by:

Asst. Prof. Dr. Hussein Kareem Sultan

2020 AD **1442 AH**

EXAMINATION COMMITTEE CERTIFICATE

We certify that we have read this project titled "**A comparative study between normal concrete and ultrahigh performance concrete that used in bridge piers**" and, as an Examining Committee examined the students in its content and in what is connected with, and that in our opinion it meets the standards of a project for the degree of Bachelor of Science in Civil Engineering.

Name: Alaa Taha Mohammed
(Member)
Date: 12/8/2020
Signature:

Name: Dr. Othman Hameed Zenkah
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Date: 12/8/2020
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Name: Asst. Prof. Dr. Hussein Kareem Sultan
(Supervisor**)**
Date: 12/8/2020
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Name: Asst. Prof. Hussein Yousif Aziz
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Date: 12/8/2020
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Name: Asst. Prof. Dr. Hussein Yousif Aziz
Head of Civil Engineering Department
Date: 12/8/2020
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Ministry of Higher Education and Scientific Research

Al-Muthanna University / College of Engineering

Department of Civil Engineering

COMPARISON STUDY OF HOT AND COLD MIX DESIGN METHODS

A project has been submitted to the Department of Civil Engineering, College of Engineering, Al-Muthanna University as a partial requirement for obtaining a Bachelor's degree in Civil Engineering.

Academic year 2019 – 2020

Prepared by: Taif Abdullah - Qasssim Kadhim - Saif Mohammed

Supervised by: Dr. Hayder Kamil Shanbara

August 2020

EXAMINATION COMMITTEE CERTIFICATE

We certify that we have carried out this project titled "**COMPARISON STUDY OF HOT AND COLD MIX DESIGN METHODS**" and, as an Examining Committee examined the students in its content and in what is connected with, and that is our opinion to meet the standards of a project for the degree of Bachelor of Science in Civil Engineering.

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Name: **Dr Tariq Hussein**

(Member)

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(Member)

Date:

Signature:

Name: **Dr Hayder Kamil Shanbara**

(Supervisor)

Date: 02/12/2020

Signature:

Name: **Dr Mohammed Bali Mahdi**

(Chairman)

Date:

Signature:

Name: **Dr. Hussein Yousif Aziz**

Head of Civil Engineering Department

Date:

Ministry of Higher Education and Scientific Research

Al-Muthanna University

College of Civil Engineering

Subject:- Design and Maintenance of Railway Track

An Engineering project for graduation submitted to the Civil Engineering Department

DONE BY:-

1-Husham Majied

2-Batool Habeeb

3-Khalida Zaki

Supervised by:-

Dr .TARIQ HUSSEIN

2019-2020

EXAMINATION COMMITTEE CERTIFICATE

We certify that we have this read this project titled “Railway track” and, as an Examining Committee examined the students in it’s content and in what is connected with, and that in our opinion it meets the standards of a project for the degree of Bachelor of science in civil Engineering.

Name: **Dr. Hayder Kamil Shanbara**

(Member)

01/12/2020

Date:

Signature:

Name: **Dr. Noorance Ali Razzaq**

(Member)

Date:

Signature:

Name: **Dr. Tariq Hussein**

(Supervisor)

Date:

Name: **Jaber A. Hussein**

(Member)

Date: 20 / 08 /2020

Signature:

Name: **Prof. Dr. Hussein Yousif Aziz**
Head of Civil Engineering Department

جامعة المثنى

كلية الهندسة

قسم الهندسة المدنية

تقييم رماد قشور الارز كمادة بديلة اسمنتية

مشروع تخرج
مقدم الى كلية الهندسة/جامعة المثنى
كجزء من متطلبات نيل درجة البكالوريوس
في علوم الهندسة المدنية

من قبل

جعفر ماجد جاسم   **نور وسام فاضل**

احمد علاوي حسين   **منى جابر عريان**

بأشراف

د. عصام هنداوي هويدي

٢٠٢٠ م

قرار لجنة المناقشة

نحن اعضاء لجنة المناقشة الموقعين ادناه نشهد بأننا قد اطلعنا على بحث التخرج بعنوان **"تقييم رماد قشور الارز كمادة بديلة اسمنتية"** وقد ناقشنا الطلبة في محتوياته وفيما له علاقه به فوجدنا بأنه جدير بالقبول لنيل شهادة البكالوريوس في الهندسة المدنية

التوقيع:

الاسم :

عضو اللجنة

التاريخ:

التوقيع :

الاسم :

عضو اللجنة

التاريخ :

التوقيع :

الاسم :

عضو اللجنة

التاريخ :

التوقيع :

الاسم :

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الاسم :

رئيس قسم الهندسة المدنية المحترم

التاريخ :

وزارة التعليم العالي والبحث العلمي
جامعة المثنى-كلية الهندسة
قسم الهندسة المدنية

" تأثير الركام الخرساني المعاد تدويره على الخواص الميكانيكية للخرسانة "

مشروع خرج

مقدم الى كلية الهندسة /جامعة المثنى

كجزء من متطلبات نيل درجة البكالوريوس في علوم الهندسة المدنية

تقدم به الطلبة: -

فاطمة نجاح جادر   زهراء مكي محمد

حسن قابل عجمي   إبراهيم مهدي

بأشراف الأستاذ: - م. حيدر عرابي

2020 م

قرار لجنة المناقشة

نحن أعضاء لجنة المناقشة الموقعين أدناه نشهد بأننا قد اطلعنا على بحث التخرج بعنوان "أسم المشروع هنا"

وقد ناقشنا الطلبة في محتوياته وفيما له علاقة به فوجدنا بأنه جدير بالقبول لنيل شهادة البكالوريوس في الهندسة المدنية

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التوقيع:

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رئيس اللجنة

التاريخ:

التوقيع:

الاسم: أ.م.د حسين يوسف عزيز

رئيس قسم الهندسة المدنية

التاريخ

Ministry Of Higher Education
And Scientific Research
Al-Muthanna University
College Of Engineering
Civil Engineering of Department

Subject: Comparative Study of Design and Analysis Bridge Style by AASHTO Code and SAP Software

Done by :

1- Maryam Juber Kadim

2- Afrah Saleh Athab

3- Nabaa Qassim Hussein

4-Hussein Kamal Kadim

SUPER VISED BY:

Dr.Hussein Yousif Aziz

August 20 /2020

EXAMINATION COMMITTEE CERTIFICATE

We certify that we have read this project titled "**Comparative Study of Design and Analysis Bridge Style by AASHTO Code and SAP Software**" and, as an Examining Committee examined the students in its content and in what is connected with, and that in our opinion it meets the standards of a project for the degree of Bachelor of Science in Civil Engineering.

Name: Mr. Alaa T. Mohammed
(Member)
Date:
Signature:

Name: Dr. Othman Hameed Zinkah
(Member)
Date:
Signature:

Name: Dr. Hussein Y. Aziz
(Supervisor)
Date:
Signature:

Name: Dr. Hussein K. Sultan
(Chairman)
Date:
Signature:

Name: Asst. Prof. Dr. Hussein Yousif Aziz
Head of Civil Engineering Department
Date:
Signature:

وزارة التعليم العالي والبحث العلمي

جامعة المثنى

كلية الهندسة

قسم الهندسة المدنية

دراسة مقارنة بين تصميم الاسس الحصيرية باستخدام الحسابات اليدوية وبرنامج SAFE

مشروع تخرج مُقدم الى كلية الهندسة / جامعة المثنى

كجزء من متطلبات نيل درجة البكالوريوس في علوم الهندسة المدنية

إعداد الطلبة:

1- خالد علي جياد

2- علي طالب عبد الحسين

3- منتظر حامد عبد الحسين

4- سيف سعد جاهل

باشراف

د. علي خليل الرفاعي

اغسطس، 2020

قرار لجنة المناقشة

نحن أعضاء لجنة المناقشة الموقعين أدناه نشهد بأننا قد اطلعنا على بحث التخرج بعنوان

دراسة مقارنة بين تصميم الاسس الحصيرية باستخدام الحسابات اليدوية وبرنامج SAFE

وقد ناقشنا الطلبة في محتوياته وفيما له علاقة به فوجدنا بأنه جدير بالقبول لنيل شهادة البكالوريوس في الهندسة المدنية

التوقيع:

الاسم: د. علاء سلام

عضو اللجنة

التاريخ: ٣-١٢-٢٠٢٠

التوقيع:

الاسم: م.م ميثاق سعيد

عضو اللجنة

التاريخ: ٣-١٢-٢٠٢٠

التوقيع:

الاسم: د. علي خليل الرفاعي

مشرفا

التاريخ: ٣-١٢-٢٠٢٠

التوقيع:

الاسم: ا.م.د. حسين كريم

رئيس اللجنة

التاريخ: ٣-١٢-٢٠٢٠

التوقيع:

Republic of Iraq
Ministry of Higher Education and Scientific Research
Al-Muthanna University
Civil Engineering Department

Feasibility Study of Installation of PV Solar Power Plant, Case Study: College of Engineering at Al-Muthanna University

AN ENGINEERING PROJECT

SUBMITTED TO THE COLLEGE OF ENGINEERING OF AL-MUTHANNA UNIVERSITY IN A PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF SCIENCE

IN

CIVIL ENGINEERING

By
Manar Abdullah
Israa Sattar

Supervised By
Dr. Huda Mohammed Selman

2020 A.D. **1441 A.H.**

EXAMINATION COMMITTEE CERRTIFICATE

We *certify that we have read the project titled "* ***Feasibility Study of Installation of PV Solar Power Plant, Case Study: College of Engineering at Al-Muthanna University*** " and, as Examining committee examined the students in its content and in what is connected with, and that in our opinion it meets the students of a project for the degree of Bachelor of Science in Civil Engineering.

Dr.Isam Al-yaseri
(chairman)

Hadi Mohammed
(Member)

Amjad Hussein
(Member)

Dr. Huda Mohammed Selman
(Supervisor)

Dr. Hussein Yousif Aziz
Head of Civil Engineering Department

بسم الله الرحمن الرحيم

قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا

إِنَّكَ أَنتَ الْعَلِيمُ الْحَكِيمُ

صدق الله العلي العظيم

الآية (32) سورة البقرة

الاهداء.....

*الى مدينة العلم ....نبي الامة محمد (صلى الله عليه واله وسلم)

* الى باب مدينة العلم......اميرها علي بن ابي طالب (عليه السلام)

* الى من عجزت احرفي عن وصفها......ام قمر بني هاشم (عليهما السلام)

*الى من كانت دعواتها سر نجاحي ...... أمي الحبيبة

*الى من أفنى عمره وزهرة شبابه من أجلنا ...... أبي العزيز

* الى كل من وقف معي وشد ازري .....أخوتي وجميع أصدقائي

* الى الشموع التي تحترق لتضيء دروب العلم ...... اساتذتي

الشكر والتقدير .....

إذا قصرت يدك عن المكافأة فليطل لسانك بالشكر

الامام علي "ع"

الشكر لله أولاً وأخيراً ثم شكري للطيبين من عباده الذين لا استطيع ان اجازيهم لأنهم مثلوا معلماً معطاءً يعجز عنه الشكر ويكل عنه اللسان الدكتورة(هدى محمد سلمان ..اشرافاً وتعلماً) عائلتي (كرماً وعطاءً)

Abstract

Continuous growth in the increase of energy consumption in the world has triggered the issue of energy demand. This has led to a shift towards renewable energy sources. Solar energy is one of the renewable energy sources that will be a leading renewable energy source for electricity generation in the future. Generation of electricity through solar power plant is clean, environment-friendly and reliable. This study is done to evaluate the feasibility of grid connected and off grid connected solar power plants for the vicinity of Faculty of Engineering /Al-Muthanna university , Iraq. This study presents a comparative economic analysis of electricity generation using photovoltaic (PV) cells and conventional gas turbines. The generation cost per kWh was estimated for the two systems. The energy generated by PV cells was estimated using weather data for Al-Muthanna province/Iraq. A sensitivity analysis was carried out on some factors: installation capital cost, conversion efficiency and discount rate. This system has been proposed to provide the Faculty of Engineering with solar energy through the photoelectric system for a period of one hour (8: 30 - 2:30) at a cost of(0.02$) kilowatt hour, which is a low cost compared to the closest alternatives such as fuel-consuming generators, which have a cost(0.05$) kilowatt hour. This system does not cause any pollution to the environment.

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CHAPTER ONE

INTRODUCTION

1.1. Introduction

The sun is an important source of alternative and clean energy since the energy density received from the sun about (1 kW/m^2) at sea level. The process of generating electricity by solar energy does not need fuel, the costs of maintenance of the solar system is low, produce no pollution and no noise. Iraq is located in Asia in the southwestern part surrounded by the north of Turkey, from the south of Saudi Arabia and Kuwait, from the east of Iran and from the west surrounded by Saudi Arabia, Syria and Jordan. Iraq lies between latitudes $29^o5'$ and $37^o22'$ north, and between longitudes $38^o45'$ east and $48^o45'$. Iraq has a very distinguish location near the solar belt countries enables the country to receive a high quantity of solar radiation up to (6.5-7) kilowatt-hours/m^2. Sun brightness ranges from 2,800 to 3,300 hours per year. The highest actual brightness of the sun is in June at 11.4 hours/day, and the lowest brightness in January by 6.3 hours / day [1].

This study was initiated by the concern that fossil fuels are limited resources that will run out sometime in the future depending on how fast we use them. Known world reserves of oil and gas will run out in a little over 40 years at the current rate of consumption. Although new discoveries are still being made, these have not been sufficient to make up for the rate of depletion of the known reserves. The world, however, needs a smooth transition period to shift from oil to alternative sources of energy. The solar photovoltaic (PV) cell is by far the most ideal energy conversion system. It is a device that harnesses the most abundant source of energy, solar radiation. silicon, the second most abundant element (after oxygen) in the earth's crust. It has no moving parts and its output is electricity, the most useful of all forms of energy.

The solar photovoltaic technology has now reached to its commercial acceptance and requires a minimal attention of manpower for its operation and nominal costs are associated for its maintenance. The PV farms are easy to build and require a relatively shorter time for its realization. The only requirement for PV farm development is the proper and accurate solar resource assessment either by conducting the meteorological measurements or using the data from existing historical meteorological stations. The PV technology is being used globally in many countries for power generation. The global PV cumulative installed capacity reached to 229.3 GWp, an addition of 50.909 GWp (an increase of 29%) in 2015 compared to that in 2014, as shown in Fig. 1[2]. In previous years 2012, 2013, and 2014, the annual increase was 43%, 38%, and 28%. Based on national contribution towards PV installation, China remained on top in 2015 with cumulative installed capacity of 43.5 GWp, as shown in Fig. 2 [2]. Germany, Japan, and USA remained at second, third and fourth places with total installed capacities of 39.7, 34.4, and 25.5 GWp while Italy stood at number five with total installed capacity of 18.9 GWp. This study presents a technoeconomic investigation of installed capacity of standalone PV power plants at Al-Muthanna university in Al-Muthanna province/ Iraq. In order to comparison with conventional stations. The metrological data was used to achieve the set objective. The financial analysis is conducted for this site using life cycle cost analysis (LCCA).

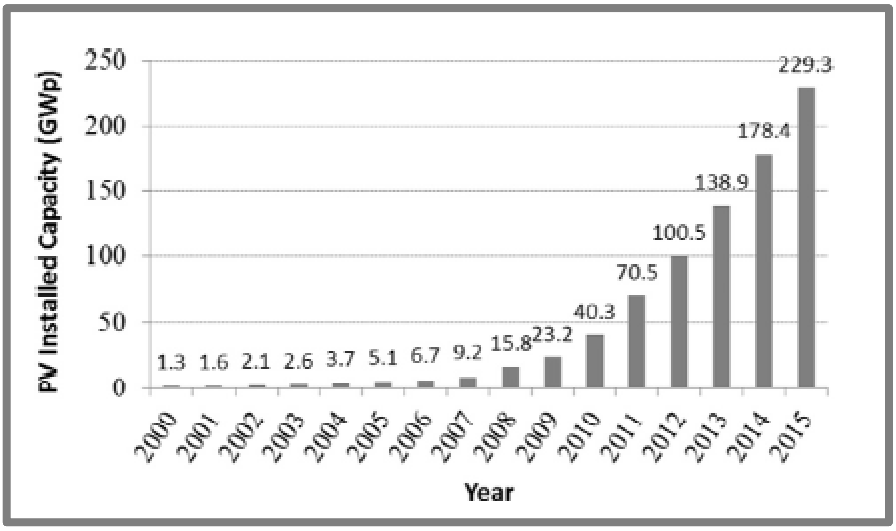

Fig. 1.1. Global cumulative PV installed capacity. [2]

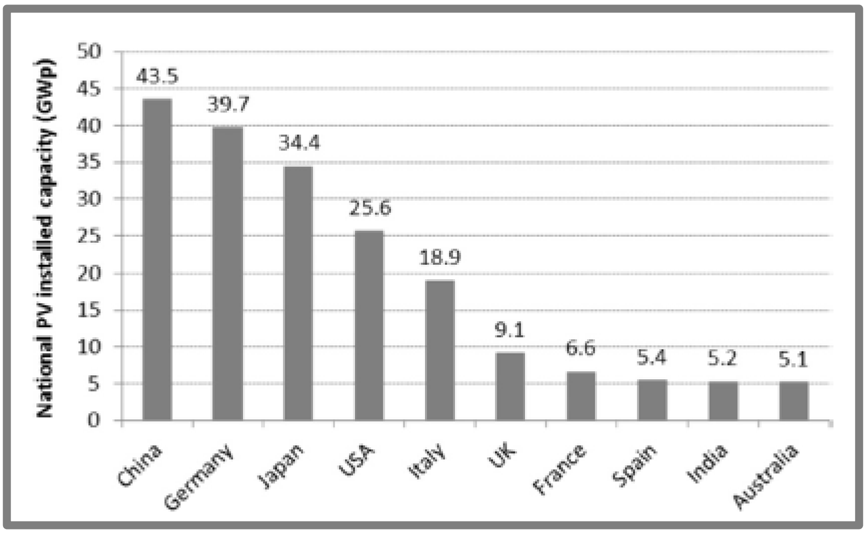

Fig. 1.2. National cumulative PV installed capacity of top ten countries. [2]

1.2. Significance of the Work

One of the most significant effects of the past 40 years in Iraq is the deterioration of the electrical grid and the lack of equipment. Until 2017, the Ministry of Electricity has been unable to equip citizens with electricity more than 12 hours a day in most parts of the country. This sharp imbalance between supply and demand in the processing of electric power caused the transfer of Iraqi citizens to rely on personal and shared generators working with diesel and gasoline

This dependence on generators caused a large consumption of fuel of poor quality, which caused a severe damage to the air quality and the Iraqi environment. The Iraqi citizen has begun to feel the environmental risks associated with pollutants from motor vehicles and generators. Reducing fossil fuel consumption is the biggest challenge that can be passed on by Iraq to the use of renewable energies in electricity generation. Iraq has many renewable energies representing the most important solar energy and promising potential .It is an available energy almost free of charge. Solar energy can be used to produce large amounts of electrical energy via solar concentrators or by using photoelectric cells.

1.3. Research Objectives

The objectives of the present study are appended below:

1. Design and select the type of a solar PV system for the college of engineering at Al-Muthanna University.
2. Cost analysis refers to the total system cost, which includes initial and maintenance costs.
3. The annual cost was calculated to determine the life cycle cost.
4. This study compares the cost of kWh production between conventional gas turbines and photovoltaic stations.

1.4. Research Layout

The research is presented in five Chapters. ***Chapter 1: Introduction*** includes a brief description of the significance of the work and research objectives. ***Chapter 2: Theoretical Aspects and Literature Survey*** presents the area of investigation in the present context, it highlights the uniqueness and salient aspects of the photovoltaic technology, and it lists the investigation done on PV system in different countries. Then, ***Chapter 3*** describes ***Methodology***. The results and discussion of design stand-alone PV system, economic study and financial comparison between this system and conventional station for supplying college of engineering at Al-Muthanna university were discussed in ***Chapter 4: Results and Discussion*** followed by ***Chapter 5: Conclusions and Recommendations***, the general conclusions and directions for future work were reported.

CHAPTER TWO

THEORETICAL ASPECTS AND LITERATURE SURVEY

2.1. Introduction

Photovoltaic systems are solar energy supply systems that convert sunlight directly to electricity. The chief component of a PV system is the solar panel which is formed by putting together several PV cells. Putting together several PV cells forms a PV module; several modules form arrays and several arrays form panels. The modular nature of PV cells makes it possible for them to be used for a wide range of power applications ranging from a few milliwatts in wrist watches and scientific calculators to several megawatts in central power stations. Solar cells are usually made of semiconductor materials such as silicon, gallium arsenide, cadmium telluride or copper indium diselenide [3].

Solar cells come in two major forms based on the nature of the material used in their production. The two main forms are crystalline solar cells and thin film solar cells. Crystalline solar cells, so far, have the highest conversion efficiencies when it comes to photovoltaic cells and the main types are monocrystalline and polycrystalline cells. Thin film cells, although less efficient than crystalline silicon, offer greater promise for large-scale power generation because of ease of mass-production and lower materials cost. The commonest example of thin film cells is the amorphous silicon cell Photovoltaic systems can be grouped into two main groups; namely off-grid systems and grid-connected systems Solar Server [4].

2.2. Setting Conditions

The factors for designing solar photovoltaic system are as follows:

1. Need to consider the use of solar photovoltaic systems places and solar radiation conditions;
2. Need to consider how much load power should be carried by the solar photovoltaic system;
3. For the output voltage of the system, the use of a DC or AC power should be considered;
4. The number of hours per day the systems need to work;
5. If there is no sunlight in rainy weather, how many days should the system supply continuously;

2.3. Works on Solar Technologies around the World

There are huge works, research, thesis, implementation, design consideration and Improvement on solar technologies is going on around the world as well as in our country.

Scientist working on developing the solar panels, like scientist of Korea and California has develop a new way of boosting the efficiency of plastic solar panels by this they make it more competitive to traditional solar panels. Commercial buildings, houses, offices, companies are installing solar system for green energy. Such as the largest solar powered building in Dezhou, Shangdong Province in northwest China [5] .

The largest solar power building in northwest china (Fig. 2.1). This figure shows the largest solar powered building and it will be the venue of the 4^{th} world solar city congress. Fig. 2.2 shows the 100% solar powered building in Taiwan. It has 8,840 solar panels in the roof and can produce

1.14 million kWh/year. By this, it can prevent 660 ton of carbon dioxide to release in the environment [6].

Fig. 2.1. The largest solar power building in northwest china[5] .

Fig. 2.2. 100% solar powered stadium in Taiwan[6].

2.4. Principle

Solar PV Technology converts sun's natural energy to useful electrical energy. Photovoltaic modules are made of mono crystalline / polycrystalline solar cells connected in series and parallel modes [7].

Mono crystalline (Fig.2.3) solar panels are the most efficient type of solar panels but are also the most expensive. Their performance, somewhat is better in low light conditions. Overall efficiency on average is about 12-15%.warranted of this type of panels about 20-25 years [8] .

Solar energy is a type of radiated energy. It can be changed into electrical energy by using energy converters. The converter is a solar cell (Fig 2.4). It will produce new electron-hole pairs when light shines on the P-N knot of the semiconductor, under the function of electric field in the P-N knot, the electron-hole will flow to P zone from N zone, and the electrons flow to N zone from P zone, and produce electric current after connected to the circuit [9].

Fig. 2.3. Mono Crystalline PV Panels [10].

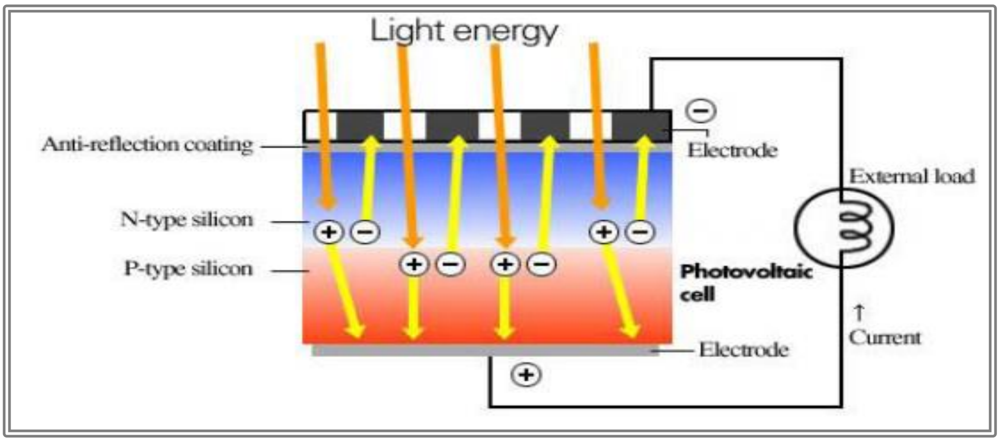

Fig. 2.4. Photovoltaic cell [11].

2.5. Classification of Solar Photovoltaic System.

The types of Solar Photovoltaic System are [12]:

2.5.1. Off-Grid Systems

Classification of Solar Photovoltaic System Off-grid PV systems, as the name implies, are systems that are not connected to the public electricity grid. These systems require an energy storage system for the energy generated because the energy generated is not usually required at the same time as it is generated [13]. In other words, solar energy is available during the day, but the lights in a stand-alone solar lighting system are used at night so the solar energy generated during the day must be stored for use at night. They are mostly used in areas where it is not possible to install an electricity supply from the main utility grid, or where this is not cost-effective or desirable. They are therefore preferable for developing countries where vast areas are still frequently not supplied by an electrical grid. Off-grid systems are usually employed in the following applications; consumer applications such as watches and scientific calculators, industrial applications such as telecommunications and traffic signs and remote habitations such as solar home systems and water pumping applications. A typical off-grid system comprises the following main components:

1. Solar PV Modules: these convert sunlight directly to electricity.
2. Charge Controllers: manage the charging and discharging of the batteries in order to maximize their lifetimes and minimize operational problems
3. Battery Or Battery Bank: Stores the energy generated by the PV modules
4. Inverter: converts the DC current generated by the solar PV modules to AC current for AC consumer load.

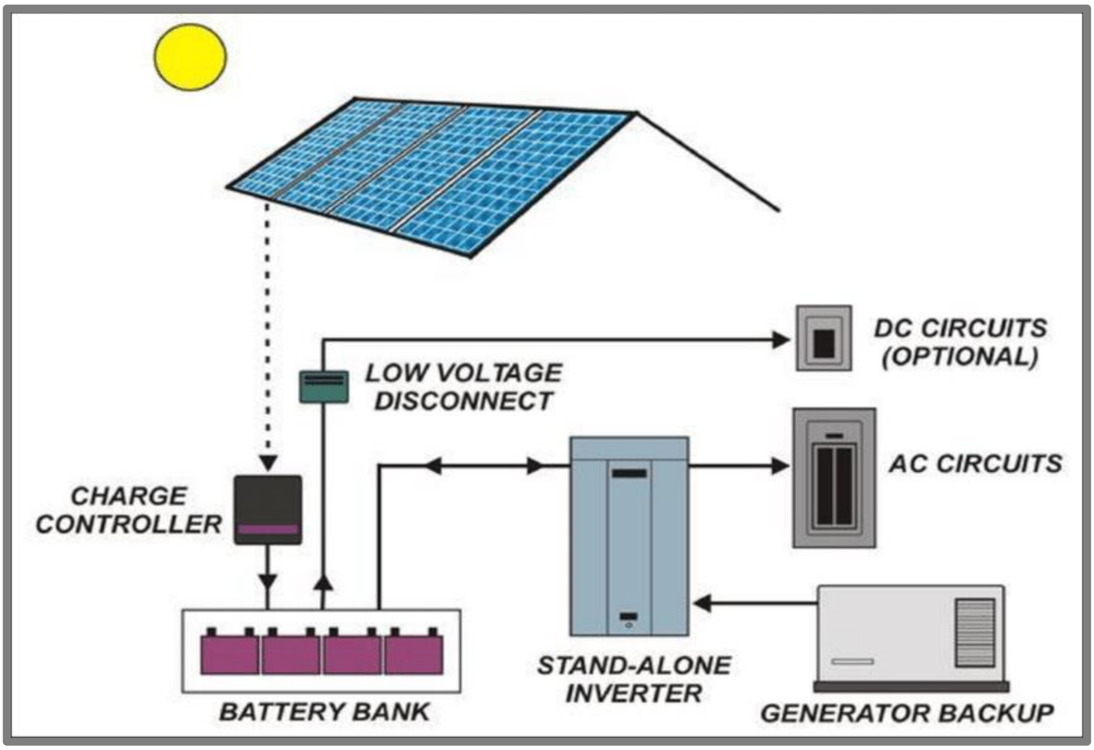

Fig. 2.5. Off- Grid connected PV system [14].

2.5.2. Grid-Connected PV Systems

Grid-connected PV systems are systems connected to a large independent grid usually the public electricity grid and feed power directly into the grid [15]. These systems are usually employed in both decentralized grid-connected PV applications and centralized grid-connected PV applications. Decentralized grid-connected PV applications include rooftop PV generators, where the PV systems are mounted on rooftops of buildings and building integrated system in which the PV systems are incorporated into the building. In the case of residential or building mounted grid connected PV systems, the electricity demand of the building is met by the PV system and the excess is fed into the grid; their capacities are usually in the lower range of kilowatts. A typical grid-connected PV system comprises the following components:

1. Solar PV Modules: these convert sunlight directly to electricity.
2. Inverter: converts the DC current generated by the solar PV modules to AC current for the utility grid.
3. Main disconnect/isolator Switch
4. Utility Grid

Central grid-connected PV applications have capacities ranging from the higher kilowatts to the megawatt range.

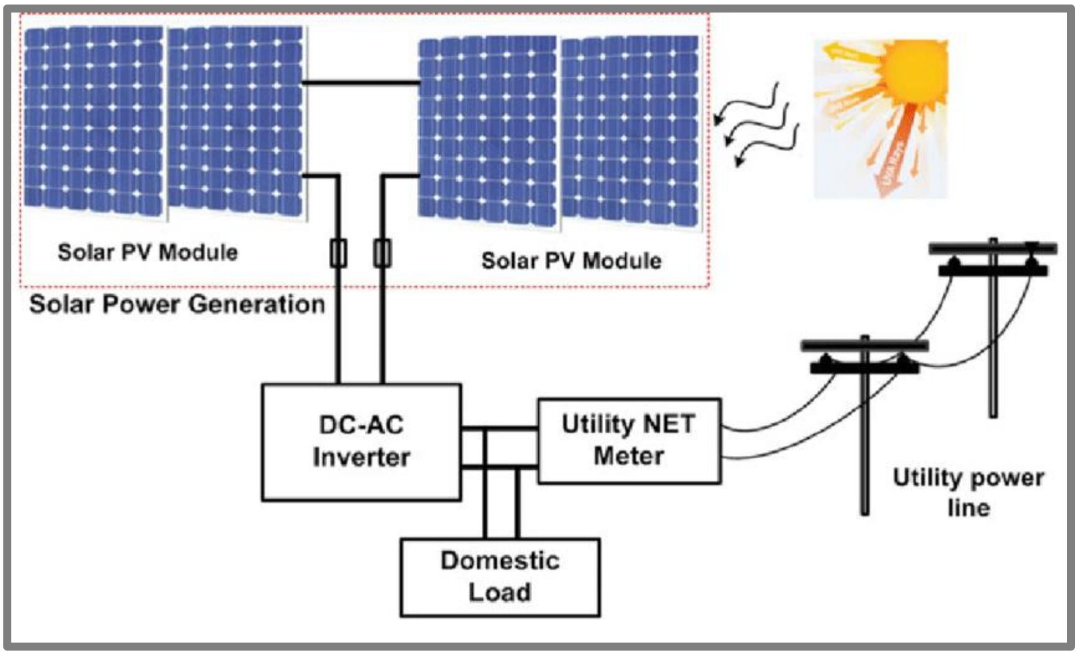

Fig. 2.6. Grid connected PV system without battery backup [16].

2.6. The difference between off grid and on grid solar

The off grid solar system is self-sufficient, but it might underperform and require a backup battery. On the other hand, the on grid system is connected to the local grid, therefore you will not need the battery. You can even sell the surplus energy [17]. Fig. 2.7 illustrates the differences between off grid and on grid.

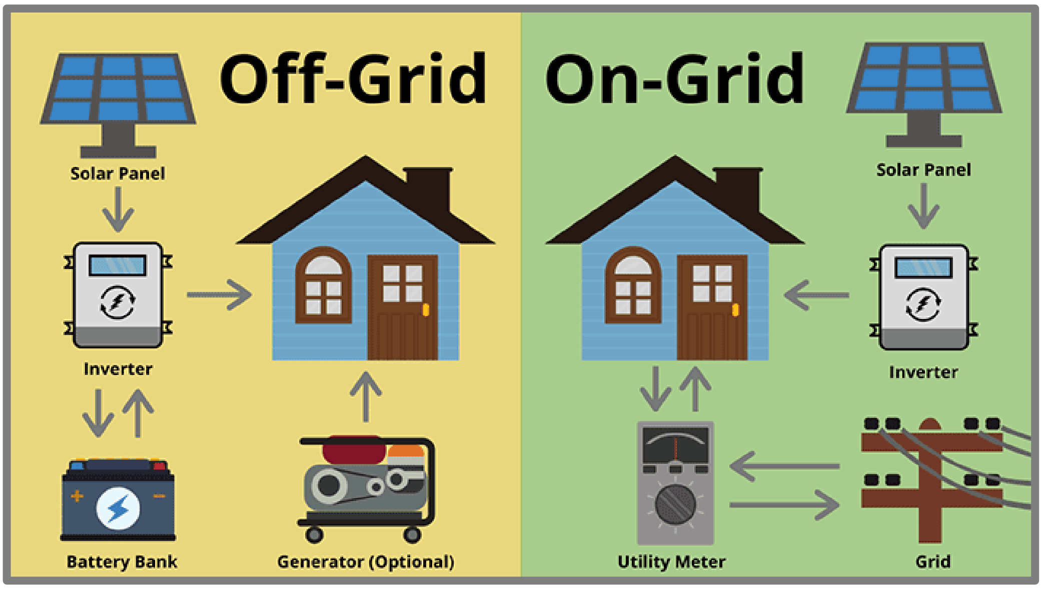

Fig. 2.7. Differences between off grid and on grid [18].

2.7. PV System Design

The stand-alone PV system usually consists of the PV generator with the required mechanical structure, storage batteries, charge controller and DC-AC inverter, in additiome n to wiring cables to the required control and switching devices. The components of PV grid connected is the same of standalone components except the battery and the charge controller. The following subsections introduce the design of each component in the proposed system.

2.7.1. PV Sizing

The solar panel contains a set of PV cells connected in series and parallel, the electrical energy produced by this panel are insufficient to handle medium and large loads of energy. For the purpose of obtaining the voltages required for loads, a set of solar cell panels should be connected in series while the panels are connected in parallel to achieve the required current. However, before starting to calculate the number of series and parallel solar cell panels the following information should be determined:

• The system dc voltage (V_{dc}).

• The average sun hours per day (T_{sh}).

• The average daily demand of energy in watt-hours ($\mathrm{E_d}$).

The first step in calculating the number of solar panels begins by determining the average daily demand of energy ($\mathrm{E_d}$) which is calculated by dividing the average daily demand by the product of efficiencies of all components in the system as given in equation (2.1).

$$E_{rd} = \frac{E_d}{\eta_b \eta_i \eta_c} \qquad \text{………….. (2.1)}$$

Where η_b =battery efficiency

η_i =inverter efficiency

η_c =charge controller efficiency

The average peak power ($P_{ave,peak}$) is then obtained by dividing the required daily average energy demand by the average sun hours of the site per day (T_{sh})as :

$$P_{ave,peak} = \frac{E_{rd}}{T_{sh}} \qquad \text{………….. (2.2)}$$

The system dc current(I_{dc}) is obtained by dividing the average peak power by the system dc voltage as:

$$I_{dc} = \frac{P_{ave,peak}}{V_{dc}} \qquad \text{………….. (2.3)}$$

The number of modules in series (N_{sm}) is then obtained by dividing the system dc voltage by the rated voltage of each module (V_{rm}) as:

$$N_{sm} = \frac{V_{dc}}{V_{rm}} \qquad \text{………….. (2.4)}$$

The numbers of parallel number of module strings (N_{pm}) were obtained by dividing the total dc current of the system by the rated current of one module (I_{rm}) as:

$$N_{pm} = \frac{I_{dc}}{I_{rm}} \qquad \text{………….. (2.5)}$$

The total number of modules (N_{tm}) that form the array is then finally determined by multiplying the number of modules in series by the number of parallel modules as in modules in equation (6), thus giving the required array size.

$$N_{tm} = N_{sm} \times N_{pm} \qquad \text{………….. (2.6)}$$

2.7.2. Battery Bank Sizing

Batteries used in solar systems must be of a deep cycle type so it can be charged and discharged quickly for many times and for several years. Batteries must have high storage capacities to ensure that all loads are operated at night rainy, and dusty days. To determine the required battery size, you must first determine the amount of estimated energy storage (E_{est}) required which is equal to the product of the daily average energy demand and the number of autonomy days (D_{aut}) as:

$$E_{est} = E_d \times D_{aut}$$ …………..(2.7)

A safe energy storage (E_{safe}) is then computed by dividing the obtained estimated energy storage by maximum allowable depth of discharge (D_{disch}) as given by :

$$E_{safe} = \frac{E_{est}}{D_{disch}}$$ ………….. (2.8)

The total capacity of the batteries bank used in ampere-hours (C_{tb}) is calculated by dividing the safe energy storage over the dc voltage given by one battery (V_b) as :

$$C_{tb} = \frac{E_{safe}}{V_b}$$ ………….. (2.9)

The total number of batteries(N_{tb}) can be calculated by dividing the total capacity of the batteries bank used in ampere-hours over the capacity of one battery in ampere-hours(C_b) as shown below :

$$N_{tb} = \frac{C_{tb}}{C_b}$$ ………….. (2.10)

The number of batteries in series (N_{sb}) can now be determined by dividing the system dc voltage by the rated dc voltage of one battery as :

$$N_{sb} = \frac{V_{dc}}{V_b}$$ ………….. (2.11)

The number of parallel battery strings (N_{pb}) can be calculated by dividing the total number of batteries (N_{tb})over the series number of batteries as below :

$$N_{pb} = \frac{N_{tb}}{N_{sb}} \qquad \text{………….. (2.12)}$$

2.7.3. Charge Controller Sizing

The main function of the solar charge controller unit is to control the current values of the solar cells as well as the total current value of the load while ensuring that the voltages generated from the solar cells and load voltage are matched. The most important point in determining the capacity of the solar charge controller unit is its ability to withstand the total short circuit current of the array ($I_{sc}^{A} = I_{sc}^{M} \times N_{pm}$) and a certain safe factor(F_{safe}) The safe factor is necessary in order to allow for a reasonable system expansion. Thus, the desired charge controller current (I_{cc})is given by :

$$I_{cc} = I_{sc}^{M} \times N_{pm} \times F_{safe} \qquad \text{………….. (2.13)}$$

2.7.4. Economic Analysis

The most valuable statistical evaluation tool for the economic behaviour of energy systems is life cycle cost (LC_C) analysis. In renewable energy systems, it covers all system life stages; capital cost and initialization stage, operation & maintenance stage and the replacement stage [19, 20]. The initial capital cost of any system is the cost required for purchasing all system components; this includes PV arrays, storage system, charge controller, inverter and installation (including wiring and other auxiliaries). Operation and maintenance cost (OM_C) include annual periodic expenses for system management, regular maintenance and site supervision. For continuous operation and to ensure efficient system performance, some parts of the system must be replaced periodically. Storage batteries in any PV system need to be replaced every (5-10) years according to the battery type and the operating conditions.

In life cycle analysis, the analysis must be carried out according to the longest life component of all system parts. The optimum life cycle of the PV modules used is around(25)years, whereas the life cycle of the storage batteries can run up to (10)years. Given a maximum life cycle of 25 years, the batteries will need to be replaced every (10) years. For future estimations, two important parameters must be considered; the inflation rate and the discount rate. Inflation rate represents the escalation trend in the costs over the all system life, while the discount rate represents the decrease in the components cost with future mass production.

The PV module costs (PV_C) is($400), while the storage batteries cost (B_C) is $1000. The inverter (Inv_C) and charge controller (C_C) costs $2000 for each one. For the PV arrays life cycle of 25 years and the 10 years battery life, the installation cost(I_C) is 10% of the PV cost while the annual(OM_C) cost is 2% of the PV initial cost. Given an inflation rate (i) of 4% and discount rate (d) of 8%, the system life cycle cost and the unit electrical cost can be estimated.

The annual (OM_C) costs can be calculated depending on the system capital cost taking into consideration the inflation and discount rates, as follows [21];

$$OM_C = 2\%PV_C \times \left(\frac{1+i}{1+d}\right)\left[\frac{1-\left(\frac{1+i}{1+d}\right)^{25}}{1-\left(\frac{1+i}{1+d}\right)}\right] \qquad \ldots\ldots\ldots\ldots\ldots (2.14)$$

Since the battery life is considered 10 years, it must be replaced twice in the system's lifetime. The battery replacement costs are calculated for first time after 10 years and for second replacement after 20 years as follows [21, 22]

$$B_{c1} = B_c\left[\frac{1+i}{1+d}\right]^{10}$$

$$B_{c2} = B_c\left[\frac{1+i}{1+d}\right]^{20} \qquad \ldots\ldots\ldots\ldots\ldots (2.15)$$

The system's life cycle cost can be calculated by adding the PV, battery, battery replacements, inverter, controller, installation, operation and maintenance costs [21].

$$LC_C = PV_C + B_{c1} + B_{c2} + Inv_C + C_C + I_C + OM_C \qquad \ldots\ldots\ldots\ldots\ldots (2.16)$$

The annual life cycle cost (ALC_C) can be estimated as follows [22];

$$ALC_C = LC_C\left[\frac{1-\left(\frac{1+i}{1+d}\right)}{1-\left(\frac{1+i}{1+d}\right)^{25}}\right] \qquad \ldots\ldots\ldots\ldots\ldots (2.17)$$

The unit electrical cost(U_C)in $/kWh can be estimated from the annual life cycle cost and the annual energy generated by the PV system [1].

$$U_C = \frac{ALC_C}{365 \times E_L} \qquad \text{………….. (2.18)}$$

Where E_L is the daily required electrical energy for the household, kWh/day. The costs of Cables, Design, Metering and Control Devices are lamped together as 10% of equipment cost.

All the previous analysis assumed that the college of engineering are fully on for 6 hours 5 days in the week. This hypothesis does not represent the actual classes in the college during the week. In some days, there may be two or one classes or may not exist. Therefore, the proposed design can be changed according to the actual holdings of classes.

For calculating gas turbine unit generation cost the following equation is used

$$R = Z\,(1+i)^n \left[\frac{i}{(1+i)^n - 1} \right] \qquad \text{………….. (2.19)}$$

Where R = Capital recovery cost (Annual) ,

Z = Initial value of the capital assest,

i= Interest rate (discount value), and

n= Usfuel life of the assest

2.8. Advantages and Disadvantages of PV System

Every coin has two sides, for solar photovoltaic system, there are also advantages and disadvantages

2.8.1. Advantages

Three are many advantages as follows:

1. Solar energy is inexhaustible, solar radiation receiving by the surface of the earth is able to meet the global energy demand as 10,000 times.
2. Solar energy exists everywhere. It could supply the electricity power near the place where the energy is produced, there is no long-distance transportation, and the loss of long-distance transmission lines are avoided;
3. Solar energy is without fuel, and has low running costs;
4. No moving parts, not easy to break, easy maintenance, particularly suitable for unattended use.
5. Solar photovoltaic system does not produce any waste, no pollution, no noise pollution, no adverse effects on the environment.
6. Solar photovoltaic system construction period is short, convenient and flexible, and can be increased or decreased depending on the load, any additions or reductions of the solar ca-pacity of the square, avoid wastage.

2.8.2. Disadvantages:

The disadvantages are:

1. Being intermittent and random, electricity production and climatic conditions can not or rarely generate terrestrial applications at night or rainy days;
2. The conversion rate is low, and the system must be run under standard conditions, the received solar radiation intensity is 1000W / m² on the ground. It needs to occupy a large area;
3. Prices are still more expensive. They are higher than conventional power generation from 3 to 15 times and high initial investment.

2.9. Literature review

Photovoltaic cells produce electricity directly from the solar light using semiconductor materials. The PV is a proven technology and has been used for last more than fifty years starting from space applications to now ground based small and large power plants. Due to fast technological development and increasing demands, the cost of PV panels has decreased tremendously. The increasing renewable energy targets have lead equally increasing research and development activities to understand these technologies and improve performance.

The utilization and promotion of renewable sources of energy in the power sector will have two fold benefits. On one hand, it will conserve the fossil fuel for exporting to international market and earn revenue and on the other hand it will result in the reduction of greenhouse gases emissions. This will ultimately safeguard the local and as well as the global environment. Remaining of this section presents the work reported in the literature on different aspects of grid connected PV systems.

Some studies such as **AL-Riah et al.** analyzed the average monthly solar radiation for the period 1971–1985 in three main cities (Mosul, Baghdad and Nasiriyah), which are located in northern, central and southern of Iraq, respectively. The percentages numbers of solar radiation days were calculated for the purpose of evaluating the efficiency of solar systems in those cities [20].

Pietruszko and Gradzki [23] reported an energy yield of 830 kWh from a roof-mounted 1-kWp grid-connected PV system (GCPVS) in Warsaw over a period of one year with performance and the efficiency values between 0.6 and 0.8% and 4% and 5%; respectively.

So et al. [24] presented the experimental results of four each of 3 kW capacity GCPVS installed at the Field Demonstration Test Center in Korea and compared the measured performance parameters with simulated values.

A**yompe et al.** [25] developed real-time energy models for small scale GCPVS and showed that these models are suitable for estimating output power at desired time intervals for smart metering.

Khatib et al. [26] presented operational experience of a 5 kWp GCPVS and found an average performance of 73.12%, daily yield factor of 2.51 kWh/kWp, and capacity factor is 10.47%.

Milosavljević et al. [27] presented the performance data of a 2 kW roof mounted PV plant in Niš, Republic of Serbia and found an energy efficiency of 10.07% which decreased with the increasing ambient temperature. The annual mean values of the performance ratio and capacity factor with transmission integration were found to be 93.6% and 12.88%, respectively.

Sundaram and Babu [28] validated the performance of a 5 MWp grid connected PV plant located in Sivagangai, Tamilnadu, India with theoretically estimated annual energy yield. The measured annual average energy generated by proposed plant was 24,116.61 kWh/day while the estimated value was found to be 24,055.25 kWh/day. The overall absolute average daily capture and system losses were found to be 0.384 h/day and 0.65 h/ day, respectively.

Mondal and Sadrul Islam (2011) [29] conducted a case study in Bangladesh where they identified the potential location of grid-connected solar PV in 14 districts. The study analyzed the feasibility of 1 MWp solar PV using HOMER optimization software. However, this study was discontinued because of very high investment costs. Thus, a comparison based on actual performance and the results of simulation analysis could not be performed to confirm findings.

Another solar PV performance analysis was conducted by **Sharma and Chandel (2013)** [30]. Performance analysis of a 190 kWp solar PV power plant installed in Khatkar-Kalan, India, was carried out and simulation estimations were found to be in close agreement with the actual measured results with an uncertainty of 1.4%. This estimation was performed using PVSYST software. Detailed analysis of the plant’s economic feasibility, however, was not performed.

On the application side, **Nacer et al.** [31] conducted feasibility analysis of GCPVS for dairy farms ranging from 10 to 30 milking cows in Algeria by considering the technical, economic, local characteristics, and legislations. The study revealed that the average energy requirements were between 330 and 560 kWh/cow/year. For the proposed PV systems of varying sizes, the cost of energy was found to vary from 0.008 $/kWh to 0.033 $/kWh in Algeria.

Bey et al. [32] presented the performance evaluation of a GCPVS for supplying the power to a dairy farm and reported that the energy consumption from the grid decreased by 67%, the produced milk increased by 8% and the CO_2 emission decreased by 68%.

Rehman and Sahin [33-35] presented a comparative study of using PV system compared to diesel power system for water pumping and recommended the PV system for this application.

CHAPTER THREE

METHODOLOGY

3.1. Study Area Survey

The middle and south area of Iraq can be considered as one of the world maximum solar radiation regions. In Al-Samawa city the highest solar radiation received during June, July and August about (774,771,706 mW/cm^2) while the lowest solar radiation received in December, November and October about (267,339 and 469 mW/cm^2). Table 3.1 shows the solar radiation in Al-Samawa city [36].

The project began with a literature review of solar photovoltaic systems. This was followed by a simple design and feasibility study to obtain an idea of the amount of energy that will be generated by the system. The draft procedure for the design of stand-alone PV system comprises the following steps:

1. Assessment of the solar radiation data for the location from various institutions such as the American Space Agency (NASA), Ministry of Transportation (General Authority for Meteorology and Seismic Monitoring in Iraq, Climate section).
2. Obtain solar PV information from various solar dealers both locally and internationally. This information should include; type, cost, size, etc.
3. Design the layout of the system.
4. Doing Economic study.

3.2. Load Survey of Al-Muthanna University

Finding out and understanding the total energy consumption of Al-Muthanna University is the first step through designing an Energy Program for this University. This part observed the data of energy consumption figures of Al-Muthanna University. In addition, it collected the data and analyzed the monthly load from April 2020 to June 2020.

The stand-alone PV system is designed to supply electrical power to college of engineering / Al-Muthanna University in Al-Muthanna province/ Iraq. Fig. 3.1 shows the location of Al-Muthanna University from USGS - U.S. Geological Survey.

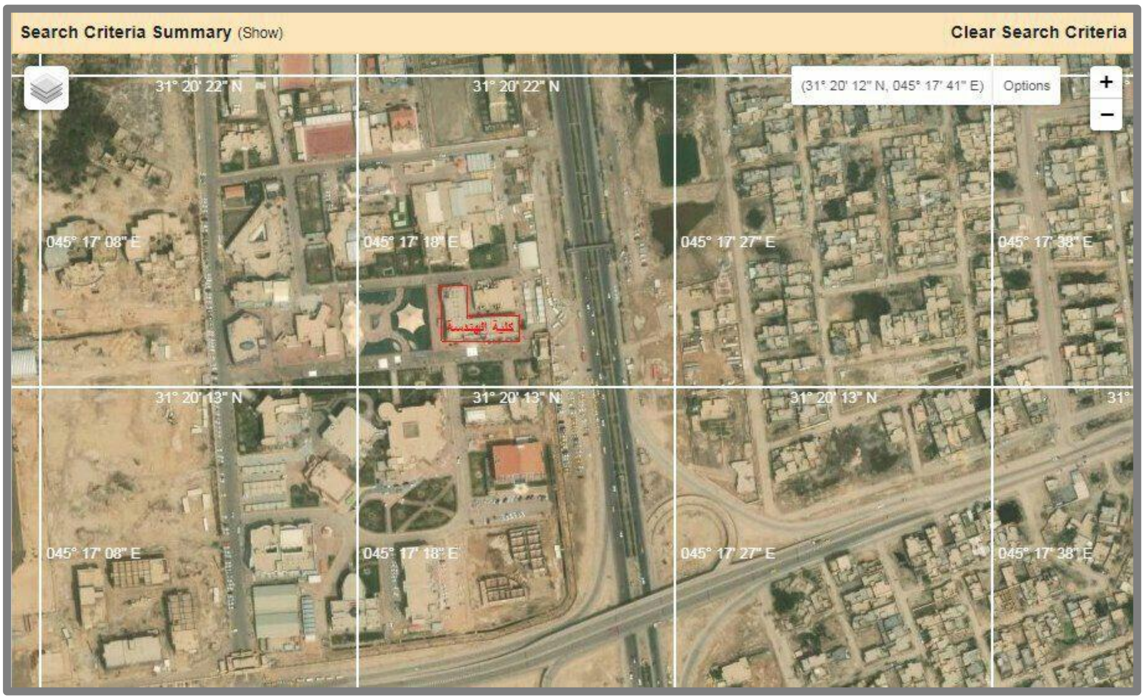

Fig. 3.1 Earth map of engineering college at al-Muthanna University [USGS - U.S. Geological Survey].

3.3. PV system

The PV solar system that used in the companies and homes consists of solar panels, metal structure, batteries, inverter, wires, meters, charge controller, and circuit breakers as shown in Fig. 3.2 and Fig. 3.3. These components are connected together at the work site. The battery comes in a strong, lightweight and corrosion-resistant cover to protect the harsh and severe weather conditions. These systems provides an alternative source of energy in many cases and can be relied upon to provide clean, safe, and reliable energy.

The first step in the process of designing and sizing the PV system is begin by knowing the monthly and annual solar radiation values for the site and the amount of energy to be provided. One of the main things in the design is the process of providing meteorological data (solar radiation and temperature) to the system site (AL-Muthanna) in order to obtain the best design for the solar system. Table 3.1 illustrates the annually solar radiation with different tilt angles.

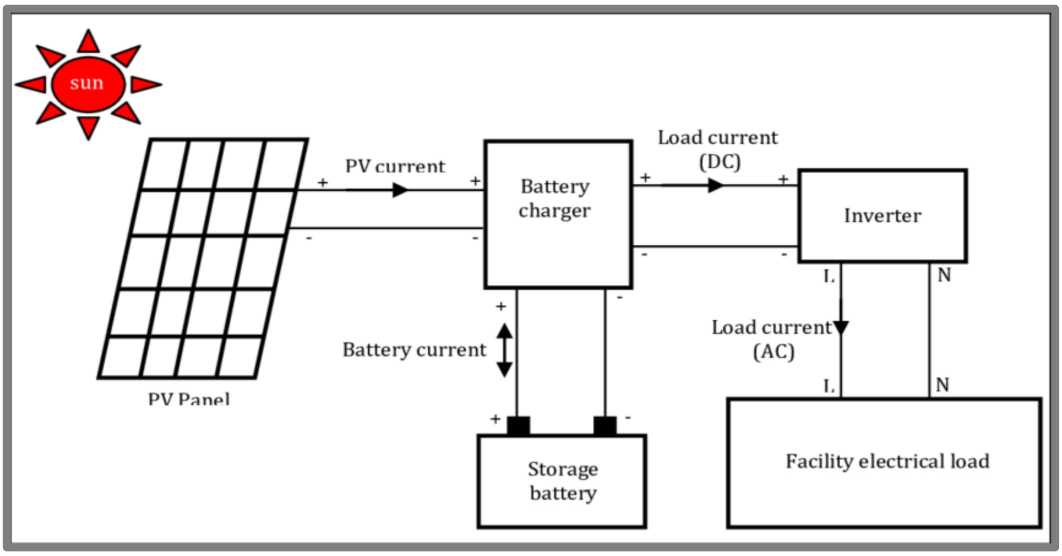

Fig. 3.2. Stand-alone PV system [18].

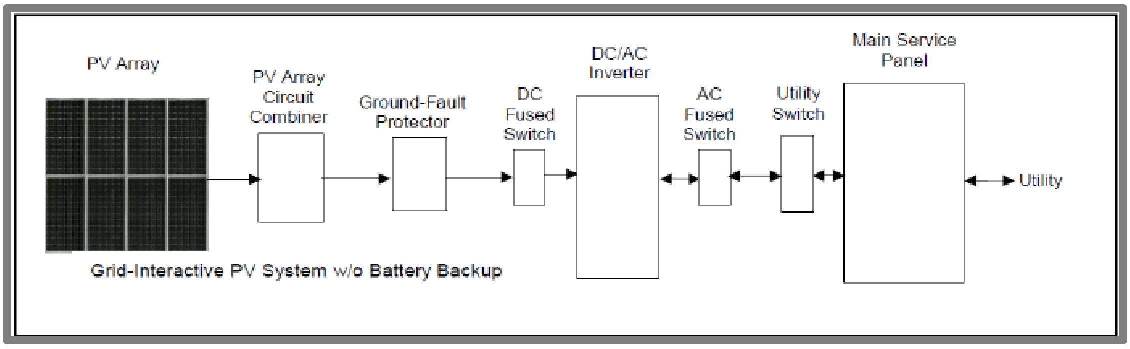

Fig. 3.3. Grid connected PV system [37].

Table 3.1. Average monthly values of solar radiation in Al- Samawah city ($mW/cm^2/day$).

Month	Monthly rate ($mW/cm^2/day$)
January	294
February	383
March	477
April	591
May	690
June	774
July	771
August	706
September	606
October	469
November	339
December	267

Table 3.2 Averages monthly values of maximum and minimum temperature in Al- Samawah city (hours / days) for the period (1981-2012)

Month	Maximum temperature	Minimum temperature	the average
January	17	5.8	11.4
February	13.8	7.5	13.8
March	25.3	11.7	18.6
April	32	17.7	19.3
May	38.5	23.4	31
June	42.9	26.2	34.5
July	44.5	27.9	36.3
August	44.4	27.2	35.8
September	41.3	23.6	32.4
October	34.8	19.1	26.9
November	25.8	12.4	19.4
December	19.3	7.6	13.4
the average	22.1	17.5	24.4

Table 3.3 Average monthly values of theoretical and actual brightness of Al-Samawah city (hours / days) for the period (1981-2012).

Month	Hours of Theoretical brightness	Hours of actual brightness
January	10.2	7
February	11	7.6
March	12	8
April	12.5	8.6
May	13.4	9.5
June	14.02	11.7
July	13.5	11.9
August	13.1	11.6
September	12.1	10.2
October	11.2	8.8
November	10.3	7.5
December	10.01	6.4
Averg	11.9	9.1

3.4. Gas turbine unit generation cost

This study compares the cost of kWh production between conventional gas turbines and photovoltaic system. The electricity generation units used in Iraq are mainly gas turbines units and are used as base load units. Table 3.4 illustrates the cost characteristics of installed gas turbine units [38].

Table 3.4 Cost of kWh production in Iraq

Cost type	Gas turbine
Capital ($/kWh)	250
Operation and maintenance (O&M) ($/kWh)	0.005
Fuel ($/kWh)	0.045

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 College of engineering solar PV system design

4.1 System configurations

There are many possible configurations of solar PV system. Each of these configurations has its own advantages and disadvantages. Depending on the system requirements appropriate system configurations has to be chosen. In our work, at first we considered two possible configurations for college of engineering. The first one is grid connected solar PV system without battery and the second one is standalone solar PV system with battery. In addition, this chapter presents a comparative economic analysis of electricity generation using photovoltaic (PV) cells and conventional gas turbines.

4.1.1. Off- grid connected PV system results

4.1.1.1 PV Sizing

Sizing the panels, i.e. finding the number of the required plates depending on the equation in Chapter 2 from (2.1 - 2.6)

Table 4.1. Summary of PV array sizing.

Required information	
Solar module :Canadian solar inc .,CX6S-320P,320W, $V_{rm} = V_{mp} = 36.8V, I_{rm} = I_{mp} = 8.69A, I_{sc} = 9.26A$	
System voltage $(V_{ds}) = 96V$.	
Average sun-hours for Sammaw $(T_{sh}) = 10$.	
Daily average demand $(E_d) = 50820Wh$.	
Battery efficiency $(\eta_b) = 0.97$.	
Inverter efficiency $(\eta_i) = 0.96$.	
Charge controller Efficiency $(\eta_c) = 0.95$.	
Parameter being determined	**Computed value**
E_{rd}	57447
$P_{ave,peak}$	5744.7
I_{dc}	60
N_{sm}	3
N_{pm}	7
N_{tm}	21

4.1.1.2. Battery Bank Sizing

Find the size of the battery or the total number of batteries, depending on the male equations in Chapter 2 from (2.6 - 2.12)

Table 4.2. Summary of battery bank sizing.

Required information	
Battery module :Rolls, 12-CS-11PS, $C_b = 296$ Ah , $V_b = 12$ V, $D_{disch} = 80\%$. Battery Efficiency $(\eta_b) = 0.97$. Number of Days of Autonomy $(D_{aut}) = 2.5$ Days	
Parameter being determined	**Computed value**
E_{est}	127050
E_{safe}	158813
C_{tb}	45
N_{tb}	3
N_{sb}	8
N_{pb}	6

4.1.1.3. Charge Controller Sizing

Find the charge controller sizing from Equation 2.13 mentioned in Chapter Two.

Table 4.3 Summary of charge controller sizing .

Required information	
Charge controller :Generic universal controller with MPPT converter ,96 V $I_{cc} = 704A$ Charge controller Efficiency $(\eta_c) = 0.95$. Safety factor $(F_{safe}) = 1.25$	
Parameter being determined	**Computed value**
(I_{ccr})	81.37A
Number of charge controller (I_{ccr} / I_{cc})	1

4.1.1.4. Economic Analysis

Finding the economic cost based on the equations mentioned in the second chapter (2.14 -2.18)

Table 4.4. Cost estimate of the PV system Components.

Component	Qty.	Unity cost	Total cost
PV module	21	$400	$8400
Battery	44	$1000	$44000
Controller	1	$2000	$2000
inverter	1	$2000	$2000
Cables	Lot		$2640
First batteries replacement			$301168
Second batter replacement			$20648
OMC			$2667
LCC			$381723
ALCC			$23148
UC			$0.62 /kWh

4.1.2. Grid connected PV system results

4.1.2.1 PV Sizing

Sizing the panels in the grid system from the equations mentioned in the second chapter (1.6 - 6.6)

Table 4.5. Summary of PV array sizing.

Required information	
Solar module :Canadian solar inc .,CX6S-320P,320W, $V_{rm} = V_{mp} = 36.8V, I_{rm} = I_{mp} = 8.69A, I_{sc} = 9.26A$	
System voltage $(V_{ds}) = 96V$.	
Average sun-hours for Sammaw $(T_{sh}) = 10$.	
Daily average demand $(E_d) = 50820Wh$.	
Inverter efficiency $(\eta_i) = 0.96$.	
Parameter being determined	**Computed value**
E_{rd}	52937.5
$P_{ave,peak}$	5393.76
I_{dc}	56
N_{sm}	3
N_{pm}	6
N_{tm}	18

4.1.2.2. Economic Analysis

The economic analysis of the connected system from the equations mentioned in Chapter Two.

Table 4.6. Cost estimate of the PV system Components.

Component	Qty.	Unity cost	Total cost
PV module	18	$400	$7200
Inverter	1	$2000	$2000
Cables	Lot		$2640
OMC			$2286
LCC			$12206.5
ALCC			$740
UC			$0.02 /kWh

4.2. Gas turbine unit generation cost

The cost per kWh generation from gas turbines can be estimated using equition provided in Table 3.4. To calculate the capital cost of kWh production we assume a unit lifetime of (25)years, (3%) discount rate and operation of the unit at its rated power for (8)hours a day,(12) months a year. Therefore,

Operating hours =8*30*12=2280 h/year

Annual cost =250(1+0.03)25[0.03/{(1+0.03)25_1}]=14.4 $/kW

Cost per kWh =14.4/2280=0.0062 $/kWh

Total cost =0.0062+0.045+0.005=0.0563 $/kWh

From the above analysis it can be seen that the generation cost per kWh for the PV system (stand -alone) is higher than that of a gas turbine system for the specified parameters. This is attributed to the high installation cost ($0.62) of the PV system and the low conversion efficiency. Further sensitivity analysis of some parameters, namely the conversion efficiency and installation cost, was carried out.

The results suggest that a reduction in installation cost to (2.5 $/Wp) or an increase in the conversion efficiency of the cell to (20%)would make the generation cost competitive with that of a gas turbine. the generation cost per kWh for the PV system (grid connected) is lower than that of a gas turbine system for the specified parameters. This is attributed to the high installation cost ($0.02) of the PV system However, this system faces multiple problems, including obtaining approval from the concerned authorities, and it remains a large area and other problems.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions:

The generation of electricity in Iraq suffers from severe deterioration, and therefore it is not possible to take full advantage of electrical energy, and this has led to the availability of alternatives and other solutions to compensate for the shortage in electricity. One of these solutions is the possibility of utilizing solar energy to generate electricity. Our study reviewed scientific research in the field of energy application Solar system in Iraq, especially that Iraq is located in a good location to receive solar energy. This system has been proposed to provide the Faculty of Engineering in the Governorate of Al-Muthanna with solar energy through the photoelectric system for a period of one hour (8: 30 - 2:30) at a cost of(0. 26$)kilowatt hour, which is a low cost compared to the closest alternatives such as fuel-consuming generators, which have a high cost for that. Use this system, which is a added system and does not cause any pollution to the environment.

5.2 Recommendations:

1. Survey of solar photovoltaic life cycle impact assessment and load calculation must be done.
2. Reducing system cost using new methods.
3. System’s cost payback analysis must be calculated.

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جمهورية العراق
وزارة التعليم العالي والبحث العلمي
جامعة المثنى
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قسم الهندسة المدنية

دراسة الجدوى الاقتصادية لتنصيب محطة الطاقة الشمسية الكهروضوئية، منطقة الدراسة: كلية الهندسة /جامعة المثنى

مشروع تخرج

مقدم الى كلية الهندسة في جـــــامعة المثنى وهو جزء من متطلبات نيل درجة باكلوريوس في علوم الهندسة المدنية

من قـــــبل
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اشراف
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تموز، 2020 م   ذو القعدة، 1441 هـ

الخلاصة:

ان النمو المستمر أدى الى زيادة استهلاك الطاقة في العالم. وهذا بدوره أدى إلى التحول نحو مصادر الطاقة المتجددة. تعد الطاقة الشمسية أحد مصادر الطاقة المتجددة التي ستكون مصدرًا رائدًا للطاقة المتجددة لتوليد الكهرباء في المستقبل. توليد الكهرباء من خلال محطة الطاقة الشمسية نظيف وصديق للبيئة وموثوق. أجريت هذه الدراسة لتقييم جدوى محطات الطاقة الشمسية المتصلة بالشبكة وغير المتصلة بالشبكة لمحيط كلية الهندسة / جامعة المثنى ، العراق. تقدم هذه الدراسة تحليل اقتصادي بمقارنة توليد الكهرباء باستخدام الخلايا الكهروضوئية (PV) مع توربينات الغاز التقليدية. تم تقدير تكلفة التوليد لكل كيلو واط ساعة للنظامين وأيضا تم تقدير الطاقة المتولدة من الخلايا الكهروضوئية باستخدام بيانات الطقس في محافظة المثنى / العراق. عدد من العوامل تم اخذها بنظر الاعتبار مثل: التكلفة الاقتصادية للتركيب وكفاءة التحويل ومعدل الخصم. تم اقتراح هذا النظام لتزويد كلية الهندسة بالطاقة الشمسية من خلال النظام الكهروضوئي ضمن فترة الدوام الرسمي (8:30 - 2:30) بتكلفة(0.02) دولار كيلو واط / ساعه وهي تكلفة منخفضة مقارنة بالنظام الكهروضوئي المنفصل وبالمولدات المستهلكة للوقود والتي لها تكلفة مقدارها(0.05)دولار كيلو واط / ساعه وان استخدم هذا النظام لا يسبب أي تلوث للبيئة.

وزارة التعليم العالي والبحث العلمي
جامعة المثنى
كلية الهندسة
قسم الهندسة المدنية

مقارنة تأثير أنواع مختلفة من الملدنات الفائقة على قابلية التشغيل ومقاومة الإنضغاط للخرسانة الاعتيادية الوزن

مشروع تخرج مُقدم الى كلية الهندسة / جامعة المثنى
كجزء من متطلبات نيل درجة البكالوريوس في علوم الهندسة المدنية

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باشراف الأستاذ
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آب 2020

قرار لجنة المناقشة

نحن أعضاء لجنة المناقشة الموقعين أدناه نشهد بأننا قد اطلعنا على بحث التخرج بعنوان "مقارنة تأثير أنواع مختلفة من الملدنات الفائقة على قابلية التشغيل ومقاومة الإنضغاط للخرسانة الاعتيادية الوزن"

وقد ناقشنا الطلبة في محتوياته وفيما له علاقة به فوجدنا بأنه جدير بالقبول لنيل شهادة البكالوريوس في الهندسة المدنية

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نحن أعضاء لجنة المناقشة الموقعين أدناه نشهد بأننا قد اطلعنا على بحث التخرج بعنوان (مقارنة تصميم الاعمدة الخرسانية المسلحة بأستخدام برنامج SAP2000)

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