FEASIBILITY STUDY OF 100KW SOLAR PV SYSTEM USING RETSCREEN

A Project and Thesis submitted in partial fulfillment of the requirements for the Award of Degree of Bachelor of Science in Electrical and Electronic Engineering

By

Jannatul Ferdous Shimu
(ID: 161-33-252)

Rikta pervin
(ID: 161-33-235)

Supervised By

DR. MD. ALAM HOSSAIN MONDAL
Associate Professor
Department of EEE

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING
FACULTY OF ENGINEERING
DAFFODIL INTERNATIONAL UNIVERSITY

December 2019

Certification

This is to certify that this project and thesis entitled **“Feasibility Study of 100KW Solar PV System Using Retscreen.”** is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on 5 January 2019.

Signature of the candidates

____

Name: Jannatul Ferdous Shimu
ID: 161-33-252

____

Name:Rikta pervin
ID: 161-33-235

Countersigned

____

DR. ENGR. MD. ALAM HOSSAIN MONDAL
Associate Professor

Department of Electrical and Electronic Engineering

Faculty of Engineering

Daffodil International University.

The project and thesis entitled **“ Feasibility Study of 100KW Solar PV System Using Retscreen”** submitted by **Jannatul Ferdous Shimu**, ID No: 161-33-252 and Rikta pervin, ID No: 161-33-235, Session: Fall 2019 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering** on 11 January 2020.

BOARD OF EXAMINERS

____

Dr. Engr. … Chairman
Professor
Department of EEE, DIU

____

Dr. Engr. --- Internal Member
Professor
Department of EEE, DIU

____

Dr. Engr. --- Internal Member
Professor
Department of EEE, DIU

Dedicated to

Our Parents

CONTENTS

LIST OF FIGURES

LIST OF TABLES

List of Abbreviations

A	Cross sectional area
ac	Alternating current
CDF	Cumulative Density Function
COE	Cost of energy
Cp	The power coefficient
C	The Weibull scale factor
c	The chord (width) of the blade
$C_{fuel\ eff}$.	The effective price of fuel
$C_{om\ gen}$	The O& M cost
$C_{rep\ gen}$	The replacement cost
D	The rotor diameter
dc	Direct current
DC	Duration Curve
f_{PV}	The PV derating factor
Gsc	The solar constant =1367
$G_{T\ STC}$	The incident radiation at standard test conditions =1000
RETScreen	Clean energy management software
H1	The reference height
KE	The kinetic energy of a stream of air
k	The Weibull shape factor
m	Mass of air parcel
NPC	Net present cost
N	The rotational speed of the rotor
P	Power
PDF	Probability Density Function
Pgen	Output of the generator in this hour
P_{PV}	The power output of the PV array
p	Air pressure
RF	Renewable fraction
RE	Renewable energy
RPM	Revolution per minute
Rgen	The generator lifetime
T	Temperature
T c	The PV cell temperature in the current time step
V	Wind speed (velocity)
V 1	Reference speed
v	The volume of air parcel
Ygen	Rated capacity of generator
Y PV	The rated capacity of PV array
Z	Height above ground level for the desired speed

Zo	Roughness length in the current wind direction
Z1	Reference height
z	The number of the blades
Z’	Elevation
ap	The temperature coefficient of power
s	The solidity of the turbine
r	The density of air

List of Symbols

λ	Wavelength
λ_B	Bragg wavelength
n_{eff}	Effective index
z	Position along the grating
n	Mode index
f	Fundamental Frequency
ω	Angular frequency
M	Modulation Index
T	Fundamental Time Period

ACKNOWLEDGEMENT

First of all, we give thanks to Allah. Then we would like to take this opportunity to express our appreciation and gratitude to our project and thesis supervisor **Dr. Engr. Md. Alam Hossain Mondal, Associate Professor** of **Department of EEE** for being dedicated in supporting, motivating and guiding us through this project. This project can't be done without his useful advice and helps. Also thank you very much for giving us opportunity to choose this project.

We also want to convey our thankfulness to **Dr. Engr. Md. Shahid Ullah, Professor and Chairperson** of the **Department of EEE** for his help, support and constant encouragement.

Apart from that, we would like to thank our entire friends for sharing knowledge; information and helping us in making this project a success. Also thanks for lending us some tools and equipment.

To our beloved family, we want to give them our deepest love and gratitude for being very supportive and also for their inspiration and encouragement during our studies in this University.

ABSTRACT

For permanent development of a country needs electricity in every moment. One of the major obstruction for economic development of Bangladesh is power crisis. At present the scenario of power generation all over the world are mainly dependent on fossil fuel which are not climate friendly and produce greenhouse gas that is responsible for global warming. The reservation amount of fossil fuel are not adequate in Bangladesh. Copiousness of renewable energy sources in the form of solar energy, wind energy provides renewable opportunities of renewable energy based hybrid energy system in coastal areas of Bangladesh. An economical compatibility of hybrid power system model (solar-wind) is presented in this thesis by researching the potentials of the wind and solar energy to meet the energy demand of daffodil international university. This hybrid model is designed by using a software tool named RETSCREEN. This software is utilized to identify the least cost design among a lot of options. To evaluate design embonpoint against the uncertainty regarding to fuel prices, wind speed and the availability of sunlight, a sensitivity analysis is also performed.

CHAPTER 1
INTRODUCTION

1.1 Introduction:

With the help of light or heat, the sun radiates energy. People have been using this energy for many centuries and it is one of many types that is known as a fuel for renewable energy. Photovoltaic (PV) is the field of exploration and preamble of new technologies and impersonations to switch sunlight into a more usable form: electricity. In recent years, the production of photovoltaic cells has significantly increased, almost reduplication every two years since 2002, making it the swiftly growing energy source in the universe. This enhancement in occurrence and consumer demand growth has led to a worldwide interest in developing new steering for photovoltaic technology.

Bangladesh is one of the most deeply replenished countries, with 79 percent of the demography living in rustic bounds .In 1997, the realm's annual energy expenditure per capita was about 77 kg, to advantage beneath the worldwide genuflection of 1474 kg (ADB, 2001). Just about 30 percent of the demography has perception to electricity (BPDB, 2002)[7]. More than 80% of populace lean on trite sources of energy such as firewood, cow dung, and agricultural relics for their energy needs. Superfluous use of firewood is a hazard to the remaining arbor cover, which is only 10% of the total land area (WEC, 2000)[8]. Bangladesh has grandiose provisions for renewable energy, such as solar insulation and biomass. Using these resources seems to be a promising way of improving the attribute of life of rustic villagers. Solar power is not newish in Bangladesh, as since 1996 companies have been trying to market solar energy systems to the overt. Hereto the idea took a lingering time to go in a technologically behindhand bourn like Bangladesh. A number of secular solar energy systems are being used in homes across the bourn in Bangladesh. In this scale, the use of solar energy is highly brawny and salutary as more than 60% of the bourn's areas do not have access to main grid electricity. As part of the rustic Electrification and Renewable Energy Development Project (REREDP)[9], which subsidizes solar energy systems, the World Bank supports a program to make solar energy available to the comprehensive demography in Bangladesh.

1.2 Problem statement

Bangladesh has a huge potential for renewable energy sources such as wind and solar. Though renewable sources have several advantages but solar and wind turbine cannot supply continuously because of their remittent nature. Since the load demand of household changes with time so the changes in solar and wind generation usually not match with the time distribution of load. For this reason there is need additional battery for storing purpose which can give continuous power supply to the consumer. But the cost of battery is high for that the cost of overall system also increase. Moreover, the cost of solar panel and wind turbine is also high and it has high maintenance cost. But the suitable mixture for renewable sources can mitigate the cost and reduce the greenhouse gas emission which is the prime target of this research.

1.3 Objectives

The objectives of this project and thesis are:

i. To investigate the solar energy system.
ii. To study the current condition of solar energy system.
iii. To apply it on real life for the benefits of the rural as well as urban people.
iv. To design a map using RETScreen software for illustrating the factors of power/energy.

1.4 Literature reviews

⇨ There is inadequate capability to generate electricity in Bangladesh and there is evermore an extensive gap between demand and supply. For a decade, our tribe has experienced a momentous power crisis. Power generation in the country depends almost altogether on natural gas, which accounts for 81.4% of the total installed receptivity of 5248MW [1] electricity procreation.

This feasibility study is driven for Rajshahi's 500 KW PV grid system. This model ordains the measly cost system that meets the demand for electricity through hourly simulations of thousands of brawny power systems [2]. This model of fair play payback period and benefit- cost ration for the proposed project based on different rental power plants selling electricity rates of 7 BDT / KWH, 10 BDT / KWH, 13 BDT / KWH, 15 BDT / KWH and 18BDT / KWH with an escalation rate of 5 percent per year. The net annual retrenchment in greenhouse gas discharge is around 658 tons [3].

⇨ Due to urbanization, Saudi Arabia's government has decided to use the striking solar energy brawny of Saudi Arabia as an substitute energy source Under the current circumstances, renewable energy will bring momentous environmental avails by momentously lessening carbon dioxide and greenhouse gas emissions Carbon dioxide and greenhouse gases are the most momentous contributing factors to global warming [4]. Exploration of economic and environmental viability of the 10MW PV power plant in El-shimy in Egypt [5]. A lower credit rate of USD 0.27 was taken into account in the explortion of Co2 retrenchment Credit increases at an annual rate of 5.0 percent with an equiponderant retrechment of one ton of CO2 discharge. The project's payback period can be substantially lessened by increasing the loan to lessen GHG discharge by up to 50% [6].

1.5 Project/Thesis Outline

This Project/thesis is organized as follows: Chapter 1 introduces the background of the solar system, problem statement, objectives of the study and literature review.

In chapter 2, basic theory of energy status and the all power sector in Bangladesh are shown.

Chapter 3 includes the proposed methodology for calculation and evaluation of the output of this thesis.

Chapter 4 presents the result and simulation parts of the thesis with their significance.

In chapter 5, conclusions are drawn and scope of the future studies are proposed.

CHAPTER 2

OVERVIEW OF THE PRESENT POWER SECTORS OF BANGLADESH

2.1 Introduction

An important role in socio-economic development since energy plays, Bangladesh's government gives priority to overall energy sector growth. Over the past decade, the total public sector consumption has been refined to the accrual of the energy sector (NEP, 2004, p.1) of nearly 19 percent[10].

2.2 Energy Status

The electricity generation capacity built is created rise on natural gas of approximately 75%. Natural gas production in 2004-2005 was 13,783 MWh, with a total installed capacity of 4,995 MW (BBS, 2007, p.240). The total electricity production in the same fiscal year was 22.006 million kWh and about 88.83% of the total generation used natural gas as primary fuel (ibid., p. 241). Despite government initiative, commercial energy per capita was equivalent to 210 kg of oil (ADB, 2004, p.2)[11]. According to BPDP data published in June 2006, 42.09% of the population has grid connectivity and per capita electricity consumption in Bangladesh is 162.92 kWh. The electricity is one of the abominable in developing countries Bangladesh's per capita intake of industrial energy.

2.3 Primary Commercial Energy Resources

Bangladesh's natural resources include natural gas, tar, peat, calcareous, hard rock, lignite, silica sand, white clay, and so on. The natural gas plays a major role among other commercial energy sources and Bangladesh has a considerable amount of natural gas reserve. Natural gas accounts for about 70 percent of total commercial energy sources and the rest comes from the output of imported oil, coal and hydropower (NEP draft 2006, p.1). Bangladesh has approximately 14,607 TCF natural gas reserves (BBS, 2007, p.9 http:/www.bpdb.gov.bd/distribution.htm). The gross concentration of coal and peat is roughly 1750 million tons, respectively 170 million tons (Islam, 2001)[12].

In 2002, civil natural gas production symposium meets the demand of the world, but to meet territorial demand, petroleum and coal products must be imported from other countries. Natural gas, petroleum and coal dealings was 456, 465 and 2 trillion BTU gradually in fiscal year 2003-2005 (BBS, 2007, p.151) Commercial energy domestic consumption in the same fiscal year amounted to BTU 163.43 trillion (ibid, p. 252)[13]. Bangladesh has wealthy solar potential and year-round sunlight is available.

2.4 Status of Solar Energy

In Bangladesh, solar thermal energy has been used for centuries to dry washed clothes, raw jute, fish, food grains, vegetables, etc. the approached region for the volatilization of salt water for salt processing and this energy is also used locally in The long-term average sunshine data shows that the bright sunshine in the coastal region of Bangladesh is available for 3 to 11 hours a day. Solar radiation convert across the country from 3.8 kWh / m2/day to 6.3 kWh / m2/day. Bangladesh has a high dynamic for solar fervent and photovoltaic applications, consequent to these results. This measureless potential of solar energy take measures an advantage for off-grid rustric electrification through utilization of photovoltaic nomenclature. hot water production Cooking, drying, and others are the accepted solar thermal applications.the year-round sunlight is available and

Bangladesh has a rich solar potential.

Bangladesh receives 900 X 1018 joules of solar energy per year and the production of solar energy per square meter is 193 W, while demand per square meter is only 0.17 W (Haq et al., 2005, p.3)[14]. It means Bangladesh's surplus of solar energy. The monthly solar radiation in different locations of Bangladesh is given in table 2.1

Table 2.1: Monthly Solar Insulation at different locations of Bangladesh (in kWh/m²/day)

Month	**Dhaka**	**Rajshahi**	**Sylhet**	**Bogra**	**Barisal**	**Jessore**
January	4.03	3.96	4	4.01	4.17	4.25
February	4.78	4.47	4.63	4.69	4.81	4.85
March	5.33	5.88	5.2	5.68	5.3	4.5
April	5.71	6.24	5.24	5.87	5.94	6.23
May	5.71	6.17	5.37	6.02	5.75	6.09
June	4.8	5.25	4.53	5.26	4.39	5.12
July	4.41	4.79	4.14	4.34	4.2	4.81
August	4.82	5.16	4.56	4.84	4.42	4.93
September	4.41	4.96	4.07	4.67	4.48	4.57
October	4.61	4.88	4.61	4.65	4.71	4.68
November	4.27	4.42	4.32	4.35	4.35	4.24
December	3.92	3.82	3.85	3.87	3.95	3.97
Average	4.73	5	4.54	4.85	4.71	4.85

Source: Secondary,www.lged-rein.org/solar/solar_rerc. htm, printed 14.07. 2007

From the table above, maximum solar radiation is available from March to May, while minimum solar radiation is available in December and January.

2.5 Common Application of PV technology for Rural Electrification

There is no access to energy for about 70% of the total population. Bangladesh has a insufficiency of electricity generation and It is not possible to bring the whole country under a single grid network for a developing country like Bangladesh and, moreover, it is not practicable financially and technologically. for rural electrification in order to reduce negative environmental effects of traditional electricity generation. In the late 1980s, commercial application of PV started in Bangladesh, NGOs and educational institutions are taken to incentive amazing use of renewable energy The SHS is an established off-grid electrification technology in Bangladesh's rural areas, whereas the centralized PV system is a relatively new concept of rural electrification[15]. The application of PV technology for rural electrification in Bangladesh is shown in the table 2.2

Table 2.2: Application of PV for Rural Electrification in Bangladesh

Application of PV technology for rural areas	**Modes of electrification**
1. Power supplies to remote villages 2. Lighting and power supplies for remote buildings Battery charging stations	1. Stand alone solar home system 2. Centralized PV system

Source: Secondary, Rahman (2006), p.53

2.6 Organizations Engaged in Dissemination of PV technology

Solar panels are imported from other countries in Bangladesh for PV applications, the solar panel is the cornerstone of the solar PV system and Nonetheless. Local manufacturers produce traditional storage batteries for SHSs. Storage batteries and inverters are imported from exotic countries for large PV applications like the centralized system. Most CCUs are produced locally for SHS applications, and few are imported from outside Bangladesh. Most CCUs are manufactured locally and few are imported from outside Bangladesh, for SHS applications. Some of them will be addressed in this segment that plays a major role in the dissemination of PV nomenclature in Bangladesh[16].

2.6.1 Grameen Shakti

Grameen Shakti is one of Bangladesh's prominent private renewable energy association. Most CCUs are manufactured locally and few are imported from outside Bangladesh, it was arisen in 1996 and its main remittance is to encourage. The Grameen Shakti has set up unit offices in various parts of Bangladesh to promote renewable energy in rural areas, and so far it has 189 unit offices50. Till May, 2006 it has installed 65000 SHS with near 4, 00,000 beneficiaries and so far covered 20,000 villages and 11 remote islands in Bangladesh (ibid). While Grameen Shakti has introduced soft loan credit facilities for rural consumers as SHS is comparatively expensive technology[17].

2.6.2 Infrastructure Development Company Limited (IDCOL)

IDCOL is a non-bank financial institution established as a patent limited company on 14 May 1997 with World Bank facilitation under the Private Sector Infrastructure Development Project. The company's primary goal is to encourage substantial private sector interest in supervise and running, owning and acceptance new infrastructure facilities. IDCOL has access to resources from the WB, GTZ, KfW, SNV-Netherlands Development and the Bangladesh Government (ibid.). Provides the POs with technological, administrative, promotional and training support, this supports renewable energy projects through 15 partner organizations (POs). Such POs are private organizations active in solar technology distribution in Bangladesh. It flourish rural electrification by SHS through the Project for Rural Electrification and Renewable Energy Production (REREDP) (ibid). The REREDP is jointly sponsored by the IDA, GEF, and KfW and set a goal of supporting 200,000 SHSs by 2009 (ibid.). The SHSs are sold (mostly by micro-credit) by POs to Bangladesh's remote and rural households and business entities (ibid). The IDCOL offers PO refinancing services and channel grants to reduce the costs of SHSs (ibid.). It promotes uniform technical specifications and selected list of ingredient for POs for SHS installation[18].

.

2.6.3 Rahim Afrooz

Rahim Afrooz Solar is a Rahim Afrooz group's sister organization. It is effective in SHS-related projects and in Bangladesh's agree PV network. It provides various organizations in Bangladesh with PV-related equipment. Another sister organization produces solar photovoltaic batteries and other applications. Although it imports solar dashboard from foreign countries but the Rahim Afrooz battery. It worked as a local agent for building BPDB and LGED's centralized PV projects. It is currently Bangladesh's maximum deep-cycle battery supplier for SHS. In assistance with local NGOs, it leads to the dissemination of SHS. The Rahim Afroz Battery nowadays introduced the recycling unit of the battery together with its battery production facility. Therefore, after lifespan, the batteries of the SHS systems can be recycled and this is Bangladesh's first battery recycling facility[19].

2.6.4 Bangladesh Advancement Committee (BRAC)

BRAC is one of Bangladesh's commanding organizations in the spread of PV technology. Established in 1972, it intruduce the Sustainable Development Solar

Energy Program in December 1997. Until June 2004, a total of 263,545 kWp power was installed by the BRAC. The BRAC's future goals are to increase the number of SHS sites, develop solar energy complex and institute for solar energy[20].

2.6.5 Rural Electrification Board (REB)

the Rural Electrification Board began its operation, With the dream of rural electrification in 1978. It has successfully finish the rural electrification program in Bangladesh. Through the client cooperative society called Palli Bidut Samati (PBS). Because of REB programs together with BPDB assistance, people in rural areas can now enjoy electricity services. Nonetheless, to provide electricity to remote villages, islands, coastal areas, hilly terrains and other inaccessible parts of the country, REB has introduced decentralized power distribution methods such as standalone SHS. The REB has taken in Bangladesh the following solar electrification projects so far:

i. Renewable Energy Technology Diffusion (Pilot Project) – This project offered electrification by stand-alone and central charging station-based solar systems to Karimpur and Nazarpur district unions. The total system capacity of this project was 62 Wp and the system was connected to different loads such as domestic, industriel, social and health center. the grid electricity network and returned their systems that are relocated to different PBSs ,most of the consumers of that solar system took grid electricity after extension . The GOB and the French government protected this project.

ii. Renewable Energy Technology Diffusion (2nd Phase) – This project will provide upzilla and St. Martin Islands with solar electrification to Austogram, Shingra, Kotalipara, Moheshkhali and Kutubdia. This project is underway and is hidden by the GOB and the German government.

iii. Rural Electrification by Solar Energy — This project has been schematic to provide electricity to customers in 6 REB PBS regions. The destination of the market has been set at about 16,000. It is an ongoing project, funded by the World Bank, IDA and GOB.

So far under the second and third projects REB has installed 1101 and 3415 SHSs respectively up to April ,REB, 2007(Directorate of Renewable Energy,Dhaka, 20.06.07)[21].

2.6.6 Local Government and Engineering Department (LGED)

The grid electricity network and returned their systems that are relocated to different PBSs.The Department of Local Government and Engineering (LGED) commence solar PV electrification through the Sustainable Environmental Management Program (SEMP) funded by UNDP.The Japan International Cooperation Agency (JICA) sponsored cyclone harbor project. The LGED launched the Sustainable Rural Energy (SRE) project as part of the Environment and Forest Ministry's SEMP (SRE, LGED, 5.6.07). The LGED built a total of 15.28 kWp capacity SHS at 1859 cyclone shelters in different littoral areas of Bangladesh under the cyclone shelter programme. A total of 2,625 kWp of solar home lighting systems and two centralized PV systems were constructed by the LGED under the SRE project (ibid.). In addition, the LGED initiated under this initiative the system of solar lanterns for poor rural households. The LGED has finish 10 kW of solar-wind hybrid fixing under the SRE project to electrify remote islands such as St. Martin (ibid.)[22].

2.6.7 Bangladesh Power Development Board (BPDB)

The Bangladesh Power Development Board is the public organization that works to produce. Transmit and distribute electricity across Bangladesh and was founded in 1972. Particularly in the Chittagong hill tracts region, it contributes to the use of PV technology for off-grid rural electrification. As part of the development program for solar electrification, it has PV installations of around 150 kWp. SHS and centralized PV system are included in this installed capacity. It has a future plan to electrify distant off-grid villages and islands through PV technology to improve Bangladesh's blinker of electrification[23].

2.7 Summary

All the power sectors in Bangladesh are listed in this chapter. This chapter analyzes the power sector's holding potential. The power sectors in Bangladesh have many drawbacks. Bangladesh has a wealth of natural resources. But they are not being used properly. If all the faults are overcome, Bangladesh's power sectors will be further strengthened.

CHAPTER 3

METHODOLOGY

3.1 Introduction

RETS Screen is a sustainable software platform for energy design exploration, renewable energy and cooperative initiatives and the implementation of endless energy application resolution. RTS Screen empowers adepts and decision makers to identify, mete and maximize potential technical and financial tolerance of clean energy projects. The announcement resolution software platform allows legislators to properly monitor and test their facilities and help them find additional energy storage / production opportunities. RTS Screen Lucid Energy Management Software (usually shortened to the RTS screen) is a software package produced by the Government of Canada. The RETS Screen Specialist was presented at the San Francisco Clean Energy Ministry 2016.RETS Screen Specialist is the new version of the app that was distributed to Acumenic on September 19, 2016[24].
The program promotes constitutional knowledge, metering and optimization of the technical and financial potential of future renewable energy, Evaluation and Trail of Energy Efficiency and Integration Projects as well as Identification of the Pure Performance of the Facilities and Identification of Energy Saving / Production Opportunities. RTS Screen Expert's "Viewer Mode" is free and allows you to appreciate all the features of the app However, conflicting with previous versions of the RTS screen, a new "advanced mode" is now available on an annual compliance basis (which allows users to save, print, and so on) The RTS Screen Pack is an earlier version of the RTS screen, which includes RTS Screen 4 and RTS Screen Plus. The RTS Screen Pack offers off-grid analytical capabilities. RTS Screen Expert, with the violation of the RETScreen Pack, is an advanced software platform; uses comprehesive and systematic archetypes for project appraisal; and provides bureau explortion capabilities. Including a worldwide climate database of 6,700 ground

stations and NASA satellite data; database of comparison; cost database; database of project; database of hydrology and product. The program has a wide range of interactive training materials, including digital curriculum[25].

3.2 Propossed Model

In this thesis, we used solar PV system. For this, we used RETSCREEN to do the design. The proposed model shown in the figure 3.1 which has 5 steeps such as energy model, cost analysis, GHG analysis, Financial summary, sensitivity and risk analysis

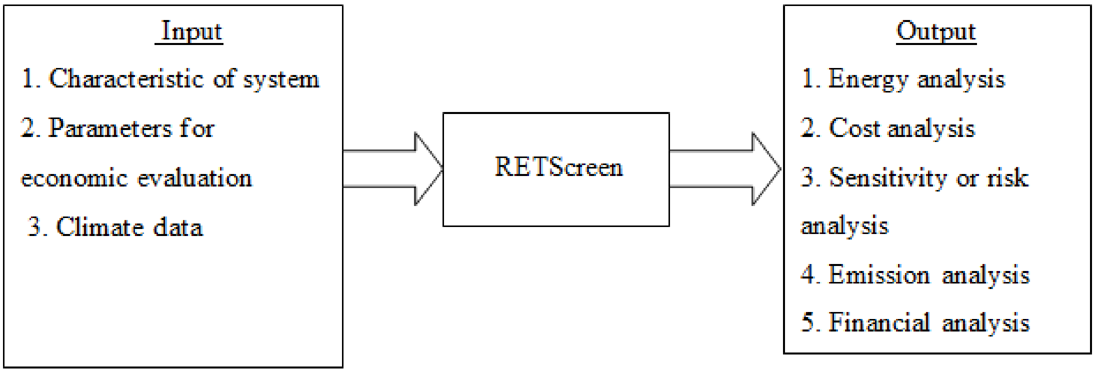


Figure 3.1: Diagram of proposed model[26]

3.3 Wind Energy Resources In Daffodil

Daffodil green campus is the most suitable of green energy because the Daffodil green campus is suitable for harvesting green energy. From October to May the following speed of wind is less then the other months. Besides June to september, the wind speed is high. In table 3.1 shows the monthly average wind speed around the year at Daffodil. The average wind speed in Daffodil is 3.1m/s.

Table 3.1: Average wind speed of every month

Month	Average Wind Speed(m/s^2)
Jan	2.5
Feb	2.5
Merch	2.8

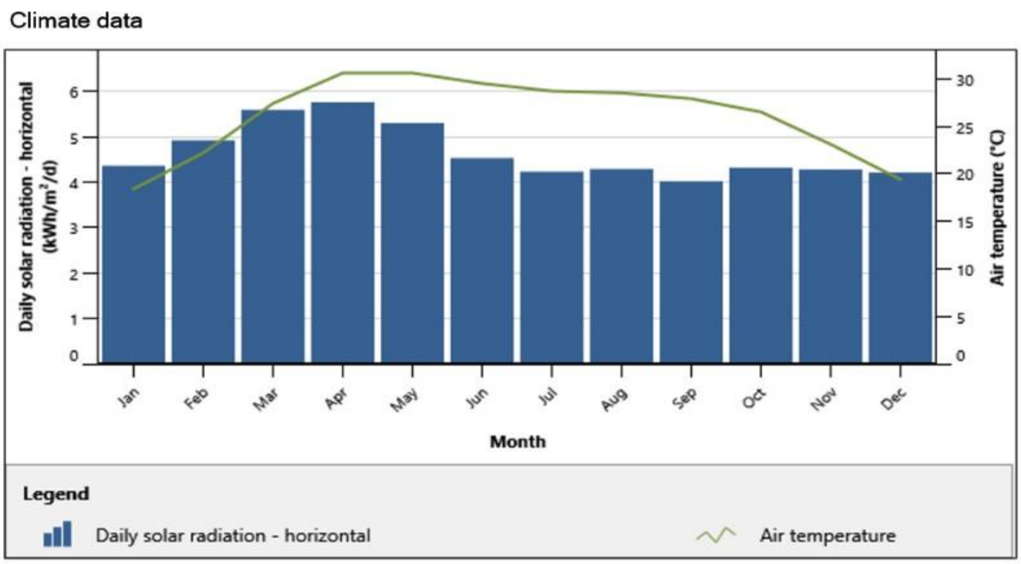
April	3.6
May	3.8
June	4.3
July	4.3
August	3.7
September	3.0
October	2.2
November	2.1
December	2.2
Annual	3.1

3.4 Solar Energy Resources in Daffodil

In daffodil the average daily solar radiation. Air temperature for solar radiation acquired through national renewable energy Lab and NASA surface meteorology and solar energy database is used as into to RETScreen and got around 4.65 kwh/m^2. These data are presenting in table 3.2. Annual daily solar radiation with Air temperature shown at figure 3.2

Month	Air Temperature ^{0}C	Daily Solar Radiation Horizontal KWh/m^2/d
January	18.4	4.36
February	22.2	4.92
March	27.4	5.59
April	30.6	5.76
May	30.6	5.30
June	29.5	4.53
July	28.7	4.23
August	28.5	4.29
September	27.9	4.02
October	26.5	4.32
November	23.1	4.28
December	19.4	4.21
Annual	26.1	4.65

Figure 3.2 Annual Average daily Solar Radiation with Air Temperature



3.5 Load Estimation for Proposed Region

In tis thesis, load estimation for Daffodil University of building AB-1. The basic appliance rating in table 3.3

Table 3.3: Name of Appliances with their ratings

Name of Appliances	Ratings (Watts0
CFL Lamp	
Tube Light	
Fan	
Air Conditioner (1 ton)	
Air Conditioner (1.5 ton)	
Air Conditioner (2 ton)	
Television	
Computer	
Elevator	

3.6 Electricity Demand at Daffodil

There are .. room in Daffodil. It is considered That the average demand of load per room around .. watts. Since it is an educational place. It is also considered the commercial load.

3.7 Economic Feature and Other Cost

The parameters for economic calculator in RETScreen are life cycle in years.

3.7.1 Discount Rate and Inflation Rate

To find the present value of an expected cash flow is going to happen in the future is known as discount rate.

3.7.2 System Fixed Capital Cost

Capital cost means initial cost of a project. It includes inverter, wind turbine, solar panel, preparation cost, labor cost and other various costs.

3.7.3 The Project Life Time

Project lifetime means for how many years the project will be operated. In this project the life time has been taken 20 years.

3.8 Selection of Component

To design the solar PV System we used RETScreen software. The components that we took for simulation are PV-array, solar panel, converter and load. RETScreen simulates the results of on grid arrangements. To select the components, the quality and the availability of the components are given priority. Every Component that are taken to design this model will desire below.

3.9 Summery

This chapter provides a schematic model of proposed methodology. The availability of wind sources and solar source are shown in this chapter. All methods for calculating the cost and costs of all components are given here. Finally, the model has been designed by using RETScreen software.

CHAPTER 4
SIMULATION RESULTS

4.1 Intorduction

In this chapter, there is presented the results of the proposed grid connected PV-solar system for Daffodil. All outputs shown in graphically and tabular form. Also the economic comparison has been made, total annualized cost, energy analysis, risk analysis, emission of GHG analysis. Financial analysis for proposed model.The results of this calculations are given below.

4.2 Power plant

To get the best results, the best combination of power sources is includes. Table 4.1 shows that photovoltaic capacity is 100 KW. Electricity demand is 134 MWH.

Table 4.1 : Optimization results of power plant

Photovoltaic -100KW		
Capacity	100	KW
Electricity	134	MWH

Table 4.2 shows that Electricity exported to grid 134 MWH. Also shows that electricity revenue $ 13396 and GHG Emission reduction is tco_2

Table 4.2 : Target summary of power plant

	Electricity exported to grid	electricity revenue$	GHG Emission reduction tco_2
Proposed case	134	13396	75.5

4.3 Energy analysis

Figure 4.1 shows that the energy production cost- central grid range units$/KWH. Figure 4.1 shows that benchmark value is 0.18KWH. This figure also shows that gas turbine, hydro turbine, reciprocating engine, solar thermal power, steam turbine, biomass, wind turbine, bio gas, natural gas are graphically representation.

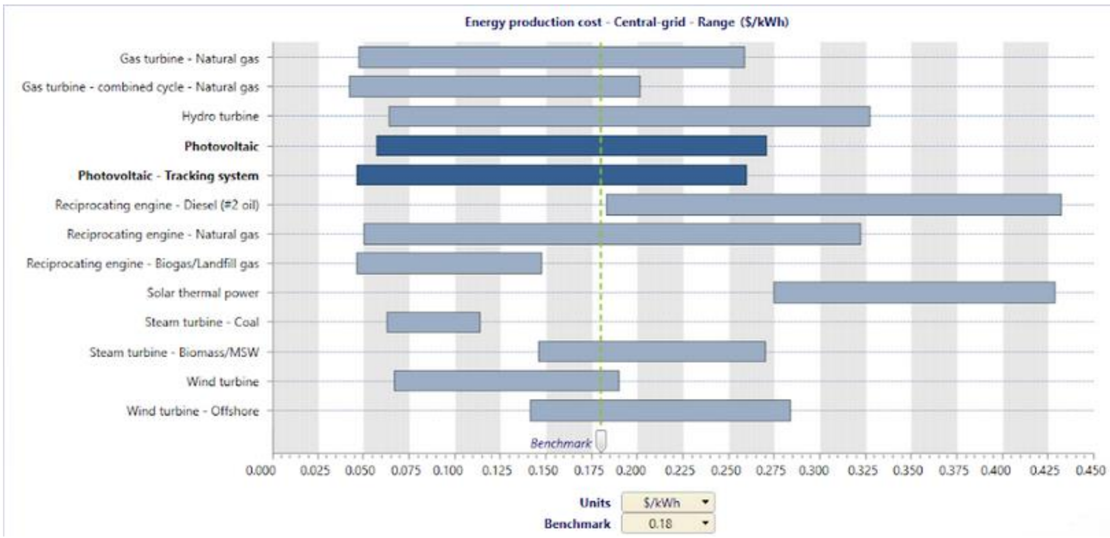


Figure 4.1: Benchmark report

4.4 Cost analysis

The cost summary annual, cumulative cash flow of proposed model shown in the table 4.3 .

Table 4.3: Yearly Cash flow of proposed model

Yearly cash flows

Year #	Pre-tax $	Cumulative $
0	-63,000	-63,000
1	-5,026	-68,026
2	-4,803	-72,829
3	-4,577	-77,406
4	-4,345	-81,751
5	-4,110	-85,861
6	-3,869	-89,730
7	-3,624	-93,353
8	-3,373	-96,726
9	-3,118	-99,844
10	-2,857	-102,702
11	-2,592	-105,293
12	-2,321	-107,614
13	-2,044	-109,659
14	-1,763	-111,421
15	-1,475	-112,896
16	14,958	-97,938
17	15,257	-82,681
18	15,562	-67,118
19	15,874	-51,245
20	16,191	-35,053

Figure 4.2 Annual cash flow of proposed model. Annual cash flow graph represents the 20 years of project life time. After 20years benefits will be shown by the graph. The benefits will be $16191

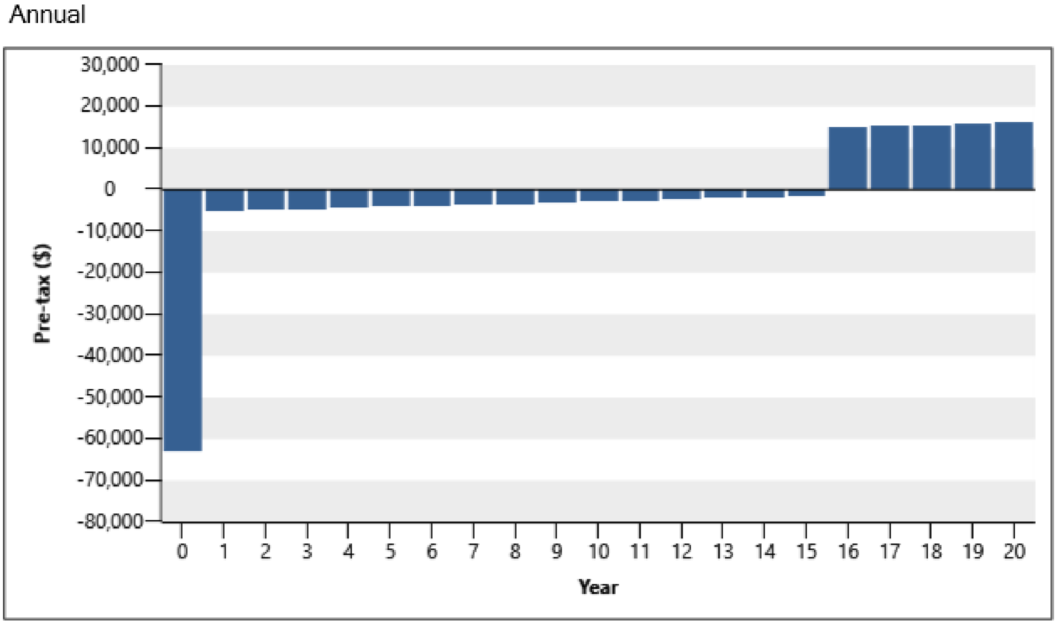


Figure 4.2: Annual cash flow of proposed model

Figure 4.3 cumulative cash flow of proposed model. Cumulative cash flow graph also represents the 20 years of project life time.

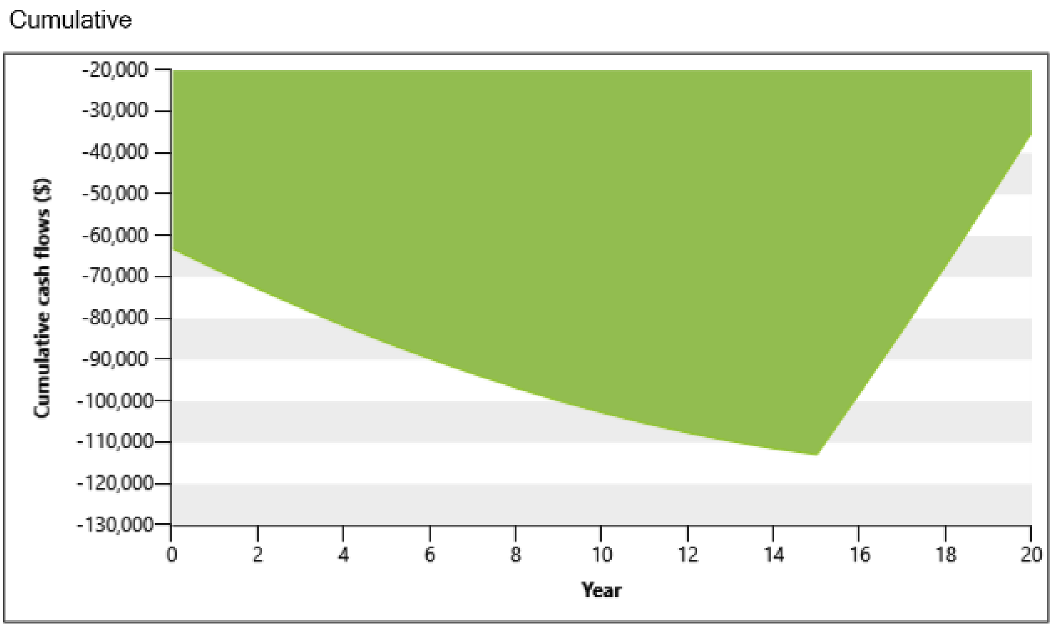


Figure 4.3 : Cumulative cash flow of proposed model.

4.5 Risk analysis

In this table there are so many parameters . The table has shown that the initial costs is $210000,debt ration is 70.0% and the debt interest rate is 7.00%. In this risk analysis, the table has shown that the level of risk is 10%.

Table 4.4 : Table of risk analysis of proposed model

Perform analysis on	Net Present Value (NPV)				
Number of combinations	500				
Random seed	No				
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Initial costs	$	210,000	25%	157,500	262,500
O&M	$	2,500	25%	1,875	3,125
Electricity exported to grid	MWh	133.96	25%	100.47	167.45
Electricity export rate	$/MWh	100.00	25%	75.00	125.00
Debt ratio	%	70.0%	25%	52.5%	87.5%
Debt interest rate	%	7.00%	25%	5.25%	8.75%
Debt term	yr	15	25%	11	19
Median				$	-76,883
Level of risk				%	10%
Minimum within level of confidence				$	-113,560
Maximum within level of confidence				$	-40,548

Figure 4.4 Shows that impact of risk analysis of proposed model. The graph shows that how impact of parameters.

Impact

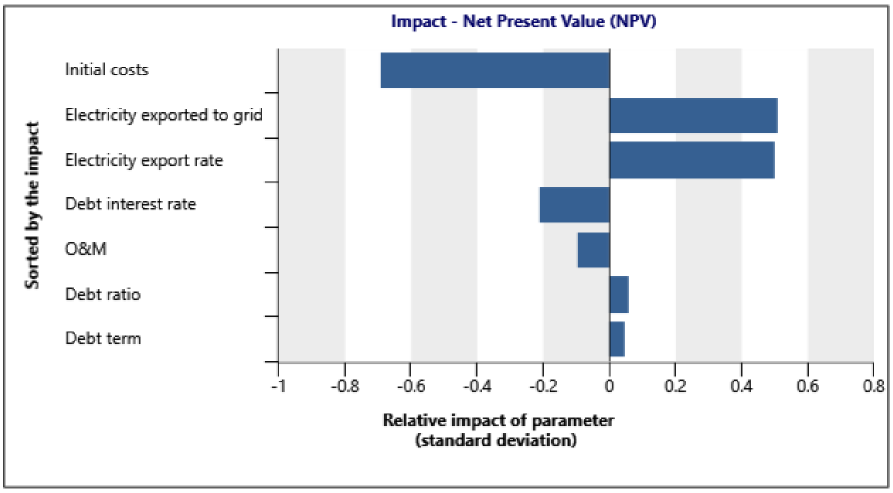


Figure 4.4: Risk analysis of proposed model

Figure 4.5 shows that distribution of risk analysis of proposed model .

Distribution

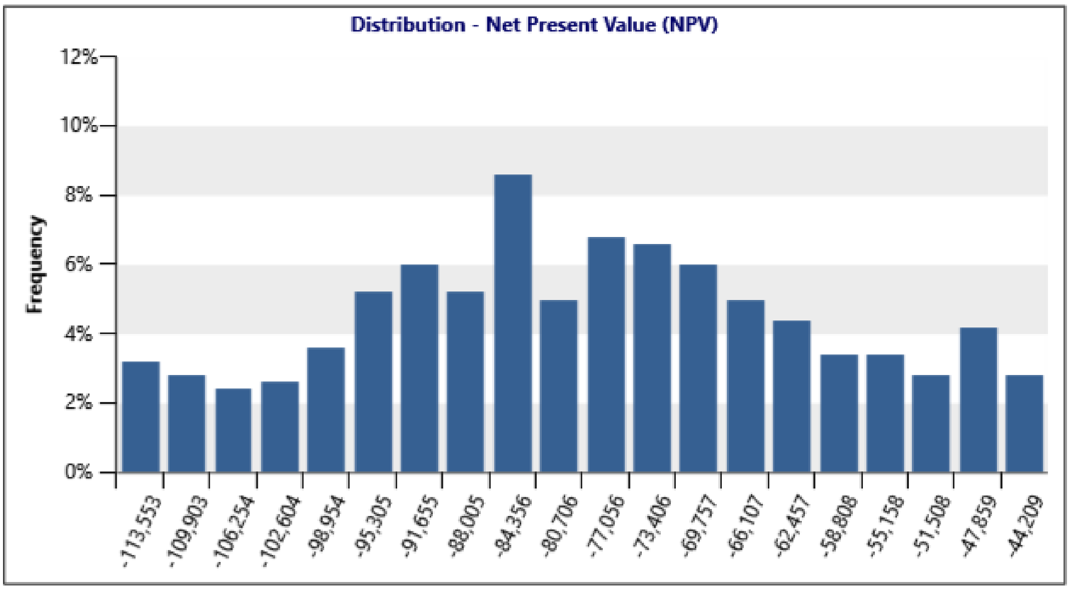


Figure 4.5:Risk analysis of proposed model

4.6: Emission Analysis

Figure 4.6 Total gross annual GHG emission reduction is 93%. The GHG emission is in 2 cases. Cases are base case and proposed case. Both cases GHG emission are 80%.

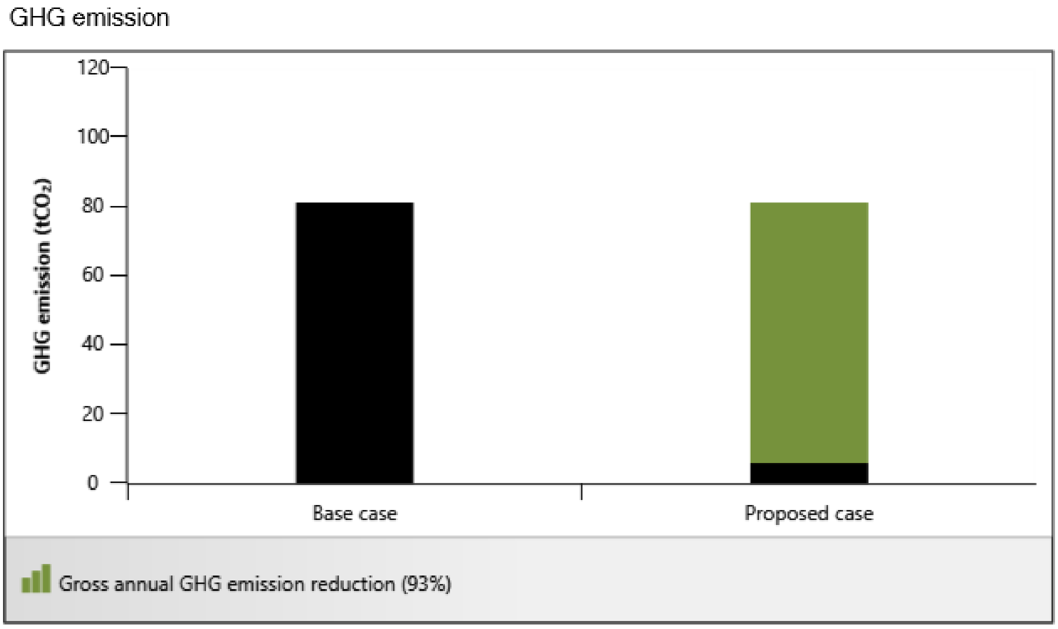
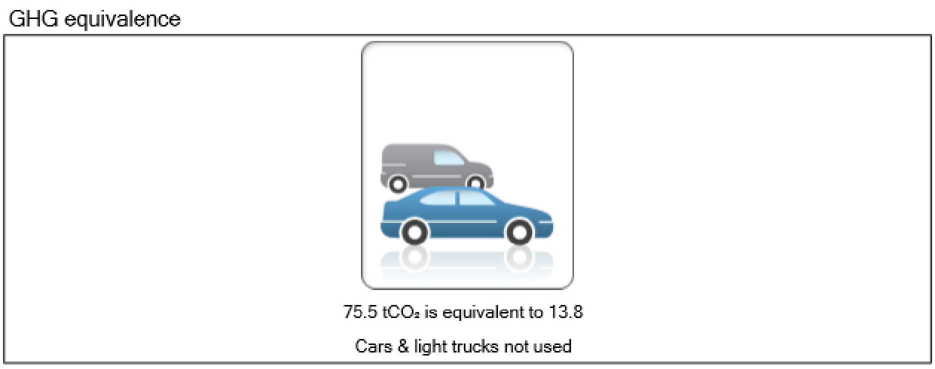


Figure 4.6: GHG emission of proposed model

Figure 4.7 Total gross annual emission reduction is 75.5 % of tco_2 . The base case GHG emission is 81.2% of tco_2 and the proposed case GHG emission is 5.7% of tco_2



GHG emission		
Base case	81.2	tCO_2
Proposed case	5.7	tCO_2
Gross annual GHG emission reduction	75.5	tCO_2

Figure 4.7 : GHG equivalence of proposed model

4.7 : Financial Analysis

Financial analysis has 4 parts .such as financial parameters,Financial viability,Annual revenue,cost/savings/revenue.All this part arrange in one by one.

4.7.1: Financial Parameters

The project life is 20 years . The debt cost is $ 147000 and debt payment per year is in $16140 . All parameters shown in tables 4.5 .

Table 4.5: Financial parameters of proposed model

Financial parameters		
General		
Inflation rate	%	2%
Discount rate	%	9%
Reinvestment rate	%	9%
Project life	yr	20
Finance		
Debt ratio	%	70%
Debt	$	147,000
Equity	$	63,000
Debt interest rate	%	7%
Debt term	yr	15
Debt payments	$/yr	16,140

4.7.2 : Financial Viability

The GHG emission cost per tco_2 is $111. Energy production cost per KWH is $0.18 . Simple pay back period in year is 19.3. All information shown in table 4.6

Table 4.6 : Financial viability of proposed model

Financial viability

Pre-tax IRR - equity	%	-2.5%
Pre-tax MIRR - equity	%	-0.007%
Pre-tax IRR - assets	%	-7.1%
Pre-tax MIRR - assets	%	-4.6%
Simple payback	yr	19.3
Equity payback	yr	> project
Net Present Value (NPV)	$	-76,422
Annual life cycle savings	$/yr	-8,372
Benefit-Cost (B-C) ratio		-0.21
Debt service coverage		0.69
GHG reduction cost	$/t$CO_2$	111
Energy production cost	$/kWh	0.18

4.7.3 : Annual revenue summary

The electricity exported to grid 134 MWH. Electricity export rate per KWH is $0.10 . Electricity export revenue is $ 13396. All information shown in table 4.7

Table 4.7 : Annual revenue summary

Annual revenue

Electricity export revenue		
Electricity exported to grid	MWh	134
Electricity export rate	$/kWh	0.10
Electricity export revenue	$	13,396
Electricity export escalation rate	%	2%

4.7.4 : Cost/Savings/Revenue summary

Total initial costs is $210000. Total annual costs is $18640. And the total annual savings and revenue is $13396 . All information shown in table 4.8

Table 4.8 : Cost/ Savings/ Revenue summary

Costs | Savings | Revenue

Initial costs			
Initial cost	100%	$	210,000
Total initial costs	100%	$	210,000
Yearly cash flows - Year 1			
Annual costs and debt payments			
O&M costs (savings)		$	2,500
Debt payments - 15 yrs		$	16,140
Total annual costs		$	18,640
Annual savings and revenue			
Electricity export revenue		$	13,396
GHG reduction revenue		$	0
Other revenue (cost)		$	0
CE production revenue		$	0
Total annual savings and revenue		$	13,396
Net yearly cash flow - Year 1		$	-5,244

4.8 summary

In this chapter, output data for various models are shown and these gives the comparative results. By analyzing outputs data . It is shown that, the output is feasible. It can reduce cost and GHG emission effectively .

CHAPTER 5
CONCLUSIONS

5.1Conclusions

In short, we can say that the growth rate of solar power is close to that of middle class households and the poorest are still unable to afford it. One more thing we can suggest to expand their search and development areas to get more recent ideas. Some strategies could include:

- Offer small system, so that initial investment amount is reduced.
- Cross subsidies may make SHS more accessible to the poor people.
- Installing Solar system in school, college, market may increase working hour.
- At present there are limited number of supplier & lack of experience in the solar technology market, resulting the high price of Solar system. Again the components are not always available or difficult to source. So it is necessary to increase technology market. So all together can make that possible[27].

Nowadays, the number of solar systems is increasing with the increasing number of health problems. Battery recycling process is a compulsory project for each organization to determine health and environmental issues. Furthermore, at the top of the organization tree, the approved specifications, guidelines, and technologies must be updated frequently to operate with the modern energy world. Again the organization needs to increase their technical training to determine the proper maintenance services under the tree. However, there are allegations that the functionality of the recently installed solar system has certainly worsened since the initial installations. So, one should worry about their value by considering the future perspective of solar energy. However, the rising rate of the solar system is still very impressive and that is what goes to the partner organization. So, we can hope that by increasing their service they will put a actual dominance on the national power generation.

5.2 Limitations of the work

Lack of professional skill for using RETscreen software. The software has so many levels of working opportunities but I don't know all the ways to make it full utilize. In this thesis wind energy is used.But in daffodil wind energy is not used this place.So wind energy is not suitable for this place.

5.3 Future Scopes of the work

In this thesis, only the potential of solar energy at daffodil is included. This analysis can be extended to other places of Bangladesh where the renewable sources are available

REFERENCES

[1] Ahammed, F. & Taufiq, D.A. (2008). Case Study: Applications of Solar PV on Rural Development in Bangladesh. *Journal of Rural Community Development 3*, 93–103.

[2] Akter, N. (1997). Alternative Energy Situation in Bangladesh, A Country Review. *Journal of BRAC, Research and Evaluation Division,* 1-15.

[3] Barua, C.D., Urmee, T.P., Kumar, S., & Bhattacharya S. (2001). A photovoltaic solar home system dissemination model. *Progress in Photovoltaic Research and Applications, 9*, 313–322.

[4] Bashar, S. A. (2009). "Solar power as a prime energy source in Bangladesh?", The Daily Star (thedailystar.net), December 26, 2009. Retrieved from World Wide Web: (http://www.thedailystar.net/newDesign/print_news.php?nid=119244)

[5] Islam, A.K.M.S & Islam,M.(2005).Status of Renewable Technologies in Bangladesh. *Journal of ISESCO Science and Technology Vision*, 1, 51-60.

[6] Islam, M. (2008).Assessment of Renewable Energy Resources of Bangladesh, *EBook Journal,* 1, 1-51.

[7] Khalequzzaman, M. (2007). The Energy Challenge for 21st Century Bangladesh. *Short Note,* Expatriate Bangladeshi 2000, Inc.

[8] Mondol, A.H. (2005). Technical and Socio-economic Aspects of Selected Village Based Solar Home Systems in Gazipur District, Bangladesh, *Journal of SESAM (Sustainable Energy Systems and Management International Institute of Management),*M.Sc. Thesis, University of Flensburg, Germany

[9] Rahman, T. (2006). Solar PV Applications. *Proceedings of the short course on renewable energy technologies,* 40–60. Dhaka, Bangladesh: Bangladesh University of Engineering and Technology, Center for Energy Studies.

[10] World Bank, (2000). "Feasibility Study for a Solar Home Systems Project within the Context of Alternative Options for Rural Electrification"*, Final Report,* Dhaka, Bangladesh.

[11] Bangladesh's Solar Energy by Gordon Feller, Urban Age Institute, January 18, 2008

[12] www.sdnpbd.org/sdi/issues/energy/publications/shakti-ebook1.pdf Ok

[13] www.usaid.gov/bd/programs/energy.html

[14] www.Rahimafrooz.mht

[15] www.pksfbd.org/seminar_fair08/Seminar_day2/GS%20Chitta%20Ranjan%20Chaki.pdf

[16] www.buet.ac.bd/ces/obaid.doc

[17] www.iutoic-dhaka.edu/conferences.php - 58k

[18] www.voiceofsouth.org/2007/10/03/peace work/ - 44k

[19] www.allbusiness.com/solarenergy retrieved on o6 December 2019

[20] www.shakti.com/parking.php retrieved on 12 December 2019

[21] Bangladesh's Solar Energy *by Gordon Feller*, *Urban Age Institute*, *January*

18, 2008
[22] www.reein.org.mht retrieved on 25 November 2019
[23] https://energypedia.info/wiki/RETScreen_Clean_Energy_Management_Software retrieved on 27 November 2019
[24] www.allbusiness.com/solarenergy retrieved on 28 November
[25] EL-Shimy M. Viability analysis of PV power plant in Egypt.Renew Energy 2009;34:2187-96.http://dx.doi.org/10.1016/j.renene.2009.01.010.
[26] Quaschning V, Muriel MB. Solar power –photovoltaics or solar thermal power plants ?.power 2001;82:2-9.
[27] www.allbusiness.com/solarenergy retrieved on o6 December 2019