T.C.

ISTANBUL AYDIN UNIVERSITY

INSTITUTE OF GRADUATE STUDIES

SOLAR SYSTEM AND ANALYSİNG İN AFGHANİSTAN AND CONNECTING TO GRID SYATEM

M.Sc. THESIS

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Department of Electrical & Electronic Engineering

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DECLARATION

I hereby declare that all information in this thesis document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results, which are not original to this thesis.

Khalil Ahmad Mansoury

Dedicated to My Lovely Mother.

FOREWORD

In the name of Almighty ALLAH, the most merciful the most gracious, and may Allah's Peace and blessing be upon our Prophet MUHAMMAD P.B.A. Alhamdulillah after thanking to almighty Allah our creator, I would like to thank my Respectable Family specially My Mother who raised me to become a good person, they always supported me and believed at me, Encouraged me and gave me the strength while I was totally lost. They were patient during my mistakes and my bad times. Today what I have accomplished is because of their effort. I hope I can make them proud and return even some of what they gave me during their Entire lives.

I would like to thank my thesis advisor Prof Dr. MEHMET EMIN TACER for his guidance, support, and help during my work in the thesis. I thank him for everything I learned from him.

I thank all my teachers starting from my school time until today as they had great influence on me and made me love education and I hope I can become one day a good teacher as they were

February 2021 **Khalil Ahamad Mansoury**

(Electrical and Electronics Engineer)

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ABBREVIATIONS

AC	**:** Alternation Current
DC	**:** Direct Current
DPVP	**:** Distpachable photovoltaic plants
DVD	**:** Digital versatile disk
GTO	**:** Gate turn off thyristors
LFS	**:** Line focusing systems
LVRT	**:** Low voltage ride through
MW	**:** Megawatt
MPPT	**:** Maximum Power Point Tracking
PFS	**:** Point focusing systems
RPC	**:** Reactive power compensation
SCADA	**:** Supervisory control and data acquisition
SEGS	**:** Solar electric generating system
STATCOM	**:** Static synchronous compensator
SVC	**:** Static volt ampere reactive compensation
THD	**:** Total Harmonic Distortion
CSP	**:** Concentrated solar powers

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SOLAR SYSTEM AND ANALYSİNG İN AFGHANİSTAN AND GRID CONNECTION SYSTEM

ABSTRACT

Afghanistan is located in the west of Asia, Using and investing in renewable energy production (wind and solar) is considered an effective step in the economic development of Afghanistan. Because of the lack of electricity, people and manufacturing companies are struggling with many problems. Importing electricity from neighboring countries, although able to solve some problems in the short term, has increased dependence on imported energy, and according to statistics since 2003, Afghanistan has spent above 1.3$ billion on imported electricity, which is a major recession on the country's economy.

Afghanistan's over-reliance on imported energy is a strategic challenge for Afghanistan that has both political and economic consequences. Therefore, any effort to reduce Afghanistan's dependence on imported energy and producing domestic and local energy will be considered a good and valuable step. According to research on renewable energy in the country, Afghanistan has a large capacity to produce energy from renewable sources. Due to the statistics from the International Center for Renewable Energy, Afghanistan has **300** sunny days a year, which means that one kilowatt of solar energy can be produced per ten square meters. Taking into account these opportunities, the Afghan Ministry of Energy and Water, in its five-year plan for Afghanistan's energy self-sufficiency, plans to produce about 200 MW of energy from renewable energy sources by 2020. Extensive use of renewable energy technology in Afghanistan can increase domestic electricity generation capacity.

In this thesis, we are analyzing the solar energy grid connection in Afghanistan and we designed one-megawatt power from two different panels and also after that design of two-megawatt power in Herat Afghanistan.

Keywords: *Renewable energy, solar energy in Afghanistan, PVsyst, PV applications, photovoltaics.*

AFGANİSTAN'DA GÜNEŞ SİSTEMİ VE ANALİZİ VE ŞEBEKE BAĞLANTI SİSTEMİ

ÖZET

Şebeke, bir dizi dağıtılmış üretim ünitesi, enerji depolama kaynakları, iletişim bağlantıları ve yerel yüklerden oluşur ve şebekeye bağlı ve şebekeden ayrı olarak iki modda çalışabilir. Ayrı bir modda Mikro Şebeke üniteleri arasındaki güç yönetimi ve yük paylaşımı hem merkezi hem de merkezi olmayan olabilir. Merkezi olmayan bir şekilde, yerel ölçümler ve hızlı iletişim bağlantısının ve güvenilirliğinin olmaması nedeniyle merkezi olmayan yöntemle tercih edilir.

Bu tezde, Microgrid bir güneş türü ve (ayrı inverter) veya PV / batarya ile bir kombinasyon halinde, bağımsız bir şekilde bağlanabilir olduğu düşünülmektedir bataryanın bir türden bir saklama kaynağı dağıtılmış üretim birimlerinin oluşturduğu (ortak bir inverter tarafından). Bu tezin amacı, çeşitli bağımsız güneş üniteleri, bağımsız batarya ve güneş / batarya kombinasyonundan oluşan ağ mikro şebekeleri için yeni bir merkezi olmayan güç yönetimi ve dağıtım yöntemi sağlamaktır. Önerilen yöntemde, her bir şebeke ünitesinin çalışması altı duruma bölünür ve farklı koşullara bağlı olarak, her birim bu durumlardan birinde çalışır. Güneş pillerinin, akünün ve evirici ünitesinin kontrolü performans durumuna göre değişir. Bu yöntemde, değişiklik koşullarının sadece yerel ölçümleri incelenir. Pil şarj oranlarının otomatik olarak dengelenmesi ve pilleri beslemek ve şarj etmek için güneş enerjisi dizisi kapasitesinin optimum kullanımı bu yöntemin en önemli özelliklerinden biridir. Bu yöntem ilk olarak tek fazlı bir şebeke için araştırılır ve daha sonra tek fazlı ünitelerin üç fazlı bir şebekenin farklı fazlarına bağlandığı tek fazlı / üç fazlı karışık ızgaralı şebekeye genelleştirilir. Fazdan başka bir faza güç iletimi ve bir fazın başka bir bulanıktan şarj veya şarj gücü sağlanması, bu yöntemin tek fazlı / üç fazlı kombinasyon modunda bir özelliğidir.

Anahtar Kelimeler: *Yenilenebilir enerji, Afganistan'da güneş enerjisi, PVsist, PV uygulamaları, fotovoltaik.*

1. INTRODUCTION

Afghanistan is a landlocked country with a population of 35 million people, which is in the heart of Asia and is surrounded by Uzbekistan, Tajikistan and Turkmenistan, Pakistan, and Iran. Afghanistan has been at war for more than 40 years and all facilities which were used for electricity generation have been destroyed. Right now, Afghanistan imports its required energy from countries such as Uzbekistan around (220MW), Turkmenistan around (110MW), Tajikistan around (220MW), and Iran (220MW), and the amount of electricity is supplied inside Afghanistan, which is imported and produced in Currently, the demand of the Afghan people has not been met and has caused huge problems, especially in summer and winter. At the same time, Afghanistan's domestic electricity capacity not only meets the energy needs of Afghans, but Afghanistan can also export huge amounts of electricity to other countries and contribute to economic development. At present, Afghanistan has the capacity of (300,000MW) renewable energy such as biomass around (4000MW), hydropower (23.000MW), wind (67000MW), and solar energy (220.000MW). While the required energy for Afghanistan by 2032 will be around 7500MW.Afghanistan is one of the least energy-consuming countries in the world compared to other countries and is therefore among the nations that have the least destructive effects on the environment. The ratiocination that solar energy may be a less costly and easier source of heating and lighting for Afghanistan has been raised at various levels. The main reason given in this regard is the geographical location of Afghanistan compared to other countries. It is said that the country has the necessary facilities to build a dam due to its mountainous nature. Afghanistan is currently not fully independent in terms of energy resources; That is, it pays significant sums to neighboring countries annually for energy imports. Most Afghans live in remote provinces without electricity, and the provinces which have access to electricity, purchase at very high prices, and even between provinces, electricity prices vary by up to 50 cents. Since Afghanistan is a good platform for the growth of solar energy, it is possible to meet Afghanistan's electricity needs by launching solar power projects.

Afghanistan, with its third flat plains in the world and 300 sunny days, can be particularly effective in implementing solar projects. In this thesis, I aim to examine the various dimensions of solar systems and pave the way to produce solar energy. (Ministry of energy and water (2015))

As mentioned earlier, Afghanistan has a huge solar power generation capacity. And the Afghan government has big plans to reap the benefits of solar energy so that in the next ten years in six provinces of Afghanistan by installing solar power plants these six provinces will be able to generate 30 Mw electricity. Some experts believe that if the Afghan government is not able to build large power lines in the country. So, they can generate electricity at a low cost by using solar energy. For example, if we build the KOKCHA power dam with a duration of 5 to 7 years by expensing around one million seven hundred thousand dollar1700000$, we can install solar installations instead, at the lowest cost than that. Currently, due to electricity shortages and lack of transmission lines in most parts of Afghanistan, especially in villages where most households use small solar energy systems for lighting, water pumps, water heaters, and other needs, they use solar energy systems. And the number of households that use solar energy is increasing day by day. To summarize, Afghanistan is a good

- a place to develop solar energy for the following reasons.
- Clean and clean energy without environmental pollution.
- The high capacity that Afghanistan's geography has for energy production.
- Easy and fast installation in all parts of villages and towns.
- Having abundant plains where cultivation is not possible.

Having 300 sunny days, which is approximately 3000 hours a year. It should not be forgotten that Afghanistan is facing some problems with neighboring countries to build power plants on high water resources, and on the other hand, the establishment of such power plants is time-consuming and requires a huge budget. Therefore, the use of solar and wind energy is very desirable for the country for various reasons, such as the lack of need for huge financial resources, easy and free access. As we discussed all types of energy, the capacity of solar energy is more than all other types, and it’s a clean energy friendship with the environment

also easy to install. in this thesis, we will be studying and design solar to produce and increasing electricity in Afghanistan.

1.1 Literature review

To explain the part of sustainable power as an eco-accommodating and easy use the asset for providing the energy interest and other financial improvement purposes, writing a survey on the sustainable power advancement of a few agricultural nations including Afghanistan has been done in this segment. In (Shoaib A, Ariaratnam S (2016)) an examination has been accomplished for two networks in two-stage on the advantages of sustainable power innovations and their effects both financially and socially in Afghanistan. The creators found and showed that by the charge of these two networks with renewables (PV and miniature hydro advancements) the financial accomplishments, for example, work creation, individual security, family cooperation, learning conditions for youngsters, diversion openings, admittance to data, improving medical issue, family unit pay lastly energy manageability and moderateness have expanded. In another examination (Ershad AM, Robert JB, Kevin H (2015)), the creator researched the asset capability of sun oriented and wind power in Balkh and Herat, the two most encouraging areas of Afghanistan. It was established that Solar PV and wind power plants in these two areas can diminish the heap on a wide range of homegrown age plans and imports, particularly if the two assets might have used. Additionally, in the Afghanistan energy area end-all strategy (ADB (2013)), a German organization FICHTNER suggested that conveyed crossover wind, sunlight based, and diesel power plants and off-framework sun-based home frameworks are the most encouraging choices to fulfill the energy need basically in provincial territories of the country.

In (Farooq MK, Kumar S (2013)) the asset capability of environmentally friendly power has been surveyed in Pakistan. The investigation results exhibit that environmentally friendly power sources can enhance the energy needs of Pakistan and can give a practical energy base. It was inferred that misuse of inexhaustible assets can help Pakistan in building up a manageable energy base and simultaneously upgrade the energy security of the country by lessening its

reliance on imported petroleum products. Iran is additionally one of the non-industrial nations which is the greatest maker of oil and gas on the planet that are utilized in the different modern segment, for example, electric force plants. The CO2 discharge is significant and sets the country among the main ten emanating nations. Air contamination in Iran's enormous urban communities is the most basic energy-related toxin. The public authority is attempting to follow energy supportability in Iran by creating environmentally friendly power innovation. The objective is set to 20000 MW (10% of the necessary power) by 2025. Because of the different environmentally friendly power strategy challenges, Iran's energy framework looks a long way from supportable (SK, Abbas Zadeh P (2013)). Essentially, Turkmenistan has tremendous potential for wind and sun-powered electric energy, however, rich gas and oil stores have not empowered the improvement of this area. The power age in Turkmenistan is mostly from nuclear energy stations. In arrangement reports on environmental change relief, the Turkmen Government means to increment sustainable power age, yet an authoritative structure to advance and support interest in environmentally friendly power doesn't yet exist. Then again, the National Program of Turkmenistan recognizes sustainable power advances as adding to meeting a few targets, including natural security and supportability (UNECE (2013)). Tajikistan has one of the world's biggest hydropower potential which gives over 90% of the country's energy interest. The fundamental approach tending to environmental change is the public activity plan for environmental change moderation (2003). Inside this arrangement, the improvement of sustainable power sources, including limited scope hydropower, are in main concerns.

Also, in the objective program for the inescapable utilization of sustainable power sources, the utilization of sustainable power is perceived as a method for accomplishing principal advancement objectives. The second public correspondence to the United Nations Framework Convention on Climate Change (UNFCCC) expressed that Tajikistan has a huge potential for the advancement of little hydropower, and appraisals that the utilization of the current specialized potential for little hydropower would prompt a yearly decrease of 5m to 6m tones of CO2 outflows. There are a few laws and approaches that help the advancement of renewables (Nachmany M, Fankhauser S, Davidová J, et al. (2015)).

Exploration has been done about environmentally friendly power potential in Bangladesh in (Halder PK, Paul N, Joardder MUH, et al. (2015)). The creators presumed that, for providing the expanding request and admittance to present day, dependable, reasonable, and manageable energy administrations, the use of sustainable power sources would assume a positive part in financial and social advancement in Bangladesh.

In the energy strategy of a few Asian and African non-industrial nations is analyzed by introducing their relating GDP and their preset focuses for the reconciliation of RE advancements. It is demonstrated that the conditions of every country and their way of life are straightforwardly reflected in the unobtrusiveness or complexity of their future energy plans and a reasonable and conceivable advancement choice is utilizing Renewable Energy Technologies (RETs). The fundamental issue forestalling the turn of events and usage of such undertakings is the absence of clear approaches and legitimate structures set by the legislatures notwithstanding very convoluted policy-driven issues and clashes and typically restricted monetary methods. It is likewise expressed that significant assistance ought to be offered by created nations, for African countries to conquer the energy neediness issue by creating sustainable power sources.

1.2 Thesis Problem

Afghanistan simply like some other underdeveloped nation faces the tremendous test of giving power to each resident regardless of their area in the nation. Factually 70% of Afghanistan's populace is of country location and these sorts of networks make issues of the expanded expense of broadcast and transmission misfortunes. The public populace of Afghanistan is 30 billion (2016) by just 35% of the populace approaching power which implies that approximately 19,5 million of the populaces don't approach electric force. The pace of urban jolt is 67% however the pace of provincial charge is a horrifying 5% The electric force segment of Afghanistan is perplexed with two head issues;

- Setback in age for example request far surpasses gracefully
- Decreased or poor rustic inclusion

As a feature of the government's objective of expanding admittance to power, the gigantic preferred position of sun-based vitality, for example, non-poison, promptly accessible, ecologically inviting, and simplicity of establishment can be proficiently tapped to help accomplish this objective. All things considered; this exploration work looks for responses to the capability of structure PV force in the area of Herat.

1.3 Thesis Purpose

The fundamental goal of this theory is a proposition which looks to support diminish the electric force deficiency of Afghanistan subsequently expanding the financial improvement of the nation. This will be accomplished by planning, reproduction, and assessment of a photovoltaic force plant utilizing PVsyst programming. Without a doubt, the utilization of PV framework programming as a device for sun-based photovoltaic force plant reenactment can be viewed as a decent decision on account of its broad application in research works by the scholarly world and PV manufacturing companies. The proposed PV plant will be arranged at the Herat area, western Area; this is a result of the good climate situations for sun based photovoltaic park establishment.

1.4 Status of thesis

significance of the postulation is to give a designing-founded proposition to support address the shortfall on power age in Afghanistan. The proposition tries to give a beneficial strategy of electric force age; photovoltaic force plant. At the point when this proposition is actualized, modest proficient, and dependable electric force will be given to a huge number of family units in Afghanistan. This strategy for electric force age has a few favorable circumstances, for example,

- Non-toxin
- The cost of fuel is wiped out
- Financially savvy upkeep
- The assortment of area for the establishment
- Decreased power duties

- Recompense period is significantly less-than vegetation range

1.5 Restriction of Study

Although this examination was led with the furthest consideration, the potential outcomes of inadequacies and impediments are unavoidable. Most importantly, the examination was directed utilizing PVsyst programming consequently the capacity to controller the exploration is restricted to the construction of the product. Additionally, the information utilized is restricted to a time of not over 16 years and the information locating strategy is satellites - founded not ground-founded tools. This presentation and productivity of elements and different parts are maker linked issues like such we can genuinely restrict our exploration. The yield for exploration is vigorously subject to this climate thus a genuine impediment.

1.6 Thesis Summary

This postulation is classified into five parts:

Section one: introducing that part is made of presentation, the problem of the thesis, Thesis point to view, the significance of the Thesis also reviews the proposition. Section two: Solar vitality with its programming Clarification of sunlight-based vitality, historical of sun-based vitality, detachment, Photovoltaic framework, and concentrated sun-based force is made in this area, likewise, focal points of sun-oriented vitality are referenced

- section 3: On-network and off-framework frameworks
- section4: design of PV plant power
- section 5: photovoltaic power plant recreation utilizing PVsyst
- section6: Result and suggestion.

2. SOLAR ENERGY AND ITS APPLICATIONS

2.1 Solar Energy

The Sunshine is viewed as a dark form that creates and transmits a tremendous measure of vitality into the nearby planetary group at a speed of 3.0 x 108m/s2 for example the speed of light. Sunlight based vitality is delivered by a technique called atomic combination where (H) gas is changed over to (He) gas in exceptionally upper temperature to among 106 to 156 0C. In 60 minutes, 4.3 x 1020 J of sun-oriented vitality arrives at the world's climate; this measure of vitality is enough to help the vitality prerequisites of planet earth if a year. Sun based vitality is normally delivered and recharged; consequently, making sun-based vitality part of sustainable power sources.

At the point when the sunlight-based vitality arrives at the world's environment, the greater part is bobbed upheld into space, greens plant retains some for photosynthesis, sun-based vitality helps in dissipation of the water body bringing about precipitation, while the remaining are unutilized. And the unutilized from sunlight-based vitality is enough to give vitality to continue the ever-expanding vitality requests of the world. This can be accomplished principle by utilizing savvy vitality gathering techniques and effective usage of vitality. Worldwide radiations are the sun's radiations that arrive at the world's environment. It is made from three sections known as Direct (pillar) radiations, diffuse radiations, and Albedo radiations. Fig 2.1 shows the worldwide flat radiations of Afghanistan.

2.2 Story of Solar Energy

The foundation of sun-oriented vitality will be can followed on the origin at the close planetary systems. Vitality got from the sun must have been practical to different pertinent structures in humanity and nature, for example, photosynthesis, freshening, safeguarding, enlightenment, fire, and so forth. Different investigations and studies were done in the eighteenth century to change

over sun-based vitality into power; striking between of them was the revelation in 1840 by Alexander additionally MR. Greeley a researcher of French-built up the vapor motor fueled with sun-oriented vitality. The innovation of changing over sunlight-based vitality into electric force by methods for photovoltaic boards was birthed on the Bel Laboratory in 1955 with the accompanying researcher D. Chapin Completer and Pearson.

2.3 Solar System Collector

Sun-powered gatherers are gadgets that ingest the sun's radiations (vitality) and changes over it into different types of vitality for example power. Likewise, sunlight-based gatherers can be depicted as the strategy of sun-based vitality collecting. An ordinary model is the customary sun-oriented water radiator innovation earned at many places in Cyprus; which are yet being utilized now. The different PV force frameworks will be can looking as sunlight-based authorities.

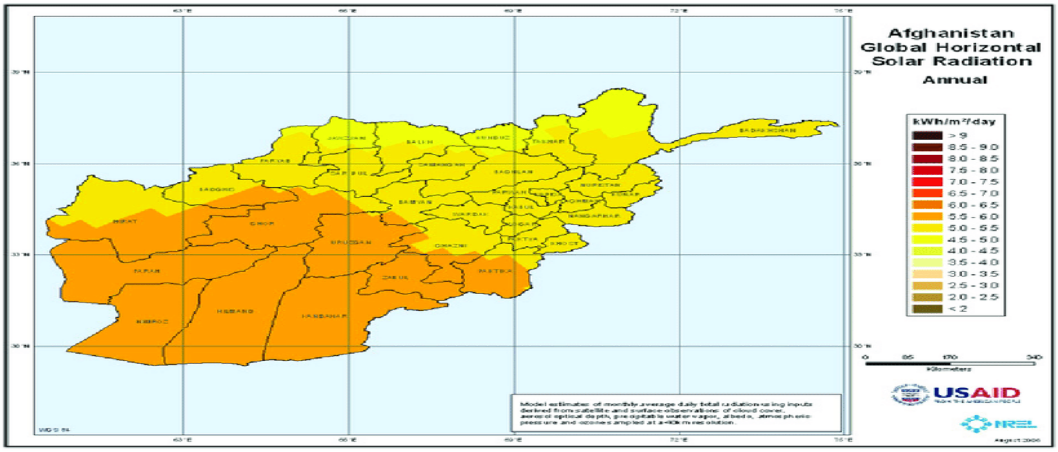

Figure 2.1: Global horizontal radiation of AF

2.4 Photovoltaic Solar Structure

Photovoltaic implies electric voltage brought about by daylight. The photovoltaic framework is the change of sun-oriented vitality in the electrical vitality with utilizing semiconductor cells. Glasslike silicon is utilized to fabricate PV cells on or after semiconductor resources. Also, silicones have various favorable circumstances, for example, sturdy, solid, no cost for commotion also no cost for fuel material create power. The PV life is about 32 years in addition to **(Goodrich's et al.'s 2012).** The private cell is shaped with the mix of N-type and P-type semiconductor materials isolated intersection named p-n intersection. An investigation into PV innovation began once again on hundred years back. Selenium was the main component that can change over sunlight based on power. A researcher Charles Fritts built up the main Selenium-based sunlight-based cell of electric **(Goodrich et., 2012).**

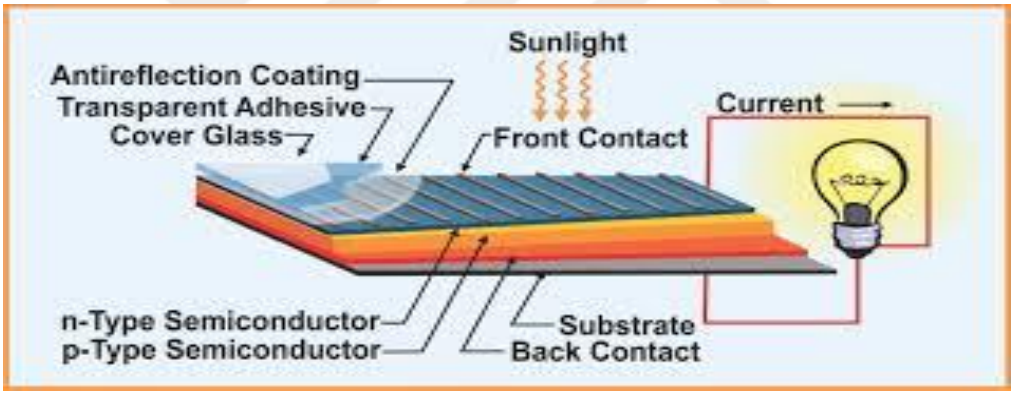

Figure 2.2: Characteristic Photo Voltic Cells (Goodrich et al.2012)

2.5 Pvs Structure Components

Contingent upon the sort of photovoltaics framework or plan necessities, various segments are associated together to establish a photovoltaic framework. These segments are boards, charge regulator, inverter, and capacity unit (battery). Sunlight based water siphons intended for water system purposes do not need inverters because the siphon utilizes direct ebb and flow (dc) power. Likewise, business or network-associated PV framework will require different segments such as transformers and so forth. The previously mentioned segments are

material to independent PV frameworks that give the electric capacity to homes and little workplaces.

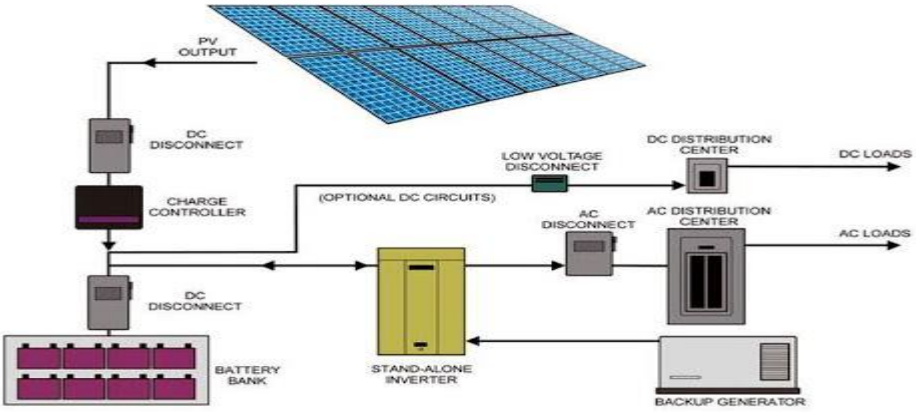

Figure 2.3: PV components structure (Gudaa, 2015)

2.5.1 Photovoltaics panel & modules

PV board is a principle gadget in changes over sunlight-based irradiance into electric force. The board is framed by associating various PV cells with each other. A cluster is framed the time's module is associated also on the arrangement, equal and a blend on arrangement also equal; this association is finished relying upon on necessary yield qualities. PV frameworks are normally operated on products 16 volts **(Gudaa2015).**

2.5.2 Charge Controllers

The control regulator (otherwise called voltage controller) is the middle person gadget among the boards and the other PV framework parts like invertors and unit capacity and inverter. Its motivation is on 12 switches on force stream among of these parts consequently ensuring them. the fundamental capacity of a control regulator is on the battery control voltage.

2.5.3 Inverters

the force delivered with the boards is direct current, in this manner, the inverter can be changed (DC) to rotating currents (AC) and make it reasonable to be utilized by maximum home apparatuses.

2.5.4 Battery Unites & Storing

The capacity units are made from the battery; its capacity is to storing overabundance electric force. These batteries are delegated profound series batteries; they can withstand keeps arraigning and releasing. There is no same as vehicle/vehicle batteries

2.6 Kinds of Pv Structures

PV frameworks are ordered by development type and capacity or reason for the establishment. Essentially, there are three sorts of photovoltaic frameworks; independent, matrix associated, and crossbreed PV frameworks. There are different kinds of PV framework like thru PV framework it doesn't have inverters to change over dc capacity to air conditioning power.

2.6.1 Stand-alone Photo Voltic Structure

Independent photovoltaic frameworks can be classified into 2 gatherings; DC independent or AC independent or DC/AC independent framework. Essentially, independent frameworks are not associated with the utility or matrix. Segments of independent frameworks are module, charge regulators, stockpiling elements, and inverters. Independent frameworks are the maximum well-known sort of PV frameworks around the globe; they are generally introduced in-home and private venture. Nations have been great PV guidelines are transforming most independent frameworks in the matrix interface framework. The metering framework is associated with the homes and lattice, and abundance power from Photovoltaic framework is offered to the utility supplier and increment of intensity request surpasses creation, power is found from the value.

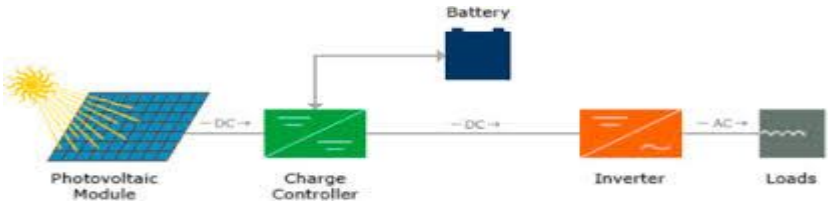

Figure 2.4: horizontal Photo Voltic system (El-Dein et al .,2013)

2.6.2 Network-Thigh photovoltaic Structure

framework associated will be an independent framework and is associated with a network or enormous or average scales photovoltaics plant called Photovoltaic powers plant. This plant is typically uber watt's establishment and spread huge hectares of land. PV generating stations have different parts, for example, power state units on the form the force in the attractive states before associating with the network **(Azoumah et al. 2010).**

2.7 Photovoltaic modules connections

There are 3 different ways for interfacing PV modules; arrangement, equal, and mix of the arrangement, and equal association. Every one of the associating strategies relies upon explicit cluster yield prerequisites. Interfacing modules in arrangement builds the voltage yet keep up current while associating in equal keeps up the voltage, however, expands the current. Equals and arrangement blend relies upon a few factors, for example, cluster power yield, the limit of inverters and force molding segments, and so on **(El-Dein et al., 2013).**

2.8 Parabolic ditch

The illustrative through innovation is made from focal points planned into explanatory shapes. At the focal point of the allegorical shaped mirrors or focal is a cylinder equivalent long to the mirror. The cylinder contains a liquid that ingests sunlight-based vitality (warm) and moves that to the vapor turbine of the powers age or capacity units. Fundamentally allegorical manager innovation is complete of the warm recipient, sun-powered authority (focal points, reflect or exceptionally distributed outward), and capacity unit and generators framework. Fig 9 shows the illustratively formed mirror with a tube containing warm recipients. On account of a pivot of the earth, the sun"s position isn't fixed along these lines illustrative trough framework are consolidated with sun-powered global positioning framework to amplify effectiveness consistently of the day. Engineered oil, liquid, steam is utilized as the warmth recipient and decision relies upon plant structure necessities **(Lovegrove, 2012).** ditch

Figure 2.5: Parabolic ditch (Lovegroves,) 2012

3. GRID CONNECTION AND OFF-GRID CONNECTION

3.1 Grid Connection

A grid is an arrangement of an interconnected system on is utilized on providing a capacity of electricity on the buyer for example as of the purpose at the age of dispersion. It is comprised of the shopper, producing station, substation, and various degrees extent of voltages transmissions lines; from super volt to the volt. Matrix association or framework knotted photovoltaics force plants has expanded massively ended the ongoing year. PV frameworks along with other sustainable power foundations have become noticeable givers in the power age and dissemination **(Wang and XU, 2010).**

This is because of hurtful impacts of petroleum derivatives, for example, ozone harming substance discharge making an unnatural weather change condition. PV vitality is spotless, solid and a non-contamination as such most created nations have expressed or are now putting vigorously in photovoltaic frameworks and different types of a sustainable power sources.

grid connection of photovoltaic frameworks will be can be sorted into 2 segments; broadcast level association and conveyance level association. In the broadcast level association, a concentrated PV park generally by the power in (MW) is appropriately adapted by reasonable gadgets, for example, inverters, transformers, and so on before interfacing with the network, greatest broadcast level associations are complete from business Photovoltaic ranches' power plant with limit past 5 kWp are called dispatchable photovoltaic plant they are purported because they can undoubtedly control yield power of the command at the network administrator **(Wang and XU, 2010)** .on the dispersion levels association, also independent PVs frameworks or little scope business PVs frameworks are attached on the lattice later reasonable molding has been done; housetop PV frameworks can likewise be associated with the matrix in nations having legitimate framework codes, guidelines/controllers or norms. The contrast

among broadcast level association and dispersion level associations is that the last will in general produce network-related 20 requirements such as force quality issues **(Li et al., 2012).**

Table 3.1: Single-phase invite of H-bridge

Total, switches					
State	S1	S2	S3	S4	Output voltage Vo
1	1	1	0	0	Vo
2	0	0	1	1	-Vo
3	1	0	1	0	0
4	0	1	0	1	0

3.2 The three-phase inverter of H-bridge

Three-phase inverters of H-bridge are comprised of 2 sorts; semi extension and full scaffold inverters. 2 switches are associated in the arrangement and 3 of such arrangement association is associated in equal. The exchanging geography for the three stages H-connect inverter relies upon the terminating edge. Fundamentally, the standard of activity of the three-stage inverter is that just one switch can be on among the arrangement association for the term of time. Model Q1 and Q2 can't be on simultaneously neither can Q3 and Q4 be on simultaneously, likewise every one of the three switches at the upper (Q1, Q2, Q3) level or lower (Q2, Q4, Q6) can't on or off simultaneously.

Three stages full scaffold inverter has appeared in Fig 3.2 and It's comprised of six semiconductor switches associated against corresponding with a solitary diode each, the reason for the diode is to give elective way to the current stream.

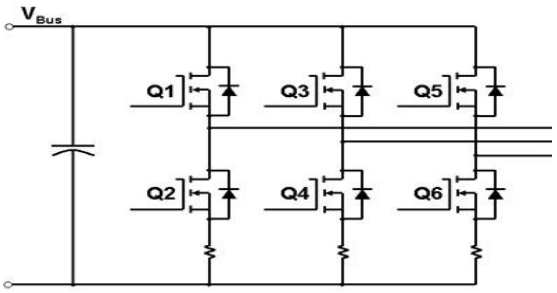

Figure 3.1: full H-bridge inverter of three-phase

Inverter operated in PV frameworks is a fundamental gadget that has numerous capacities such as voltage altering, lattice association, power modality checking. This is inverter is likewise alluded to as a photovoltaic inverter. The photovoltaic inverter screens the state of the photovoltaic cluster and it contains the working situation to upgrade matrix association. The control arrangement outfits Supervisory control and information securing with the accompanying; (MPPT) most extreme force point following management, smooth association with lattice, low voltage ride across, Island mode, kinetic volt-amperes receptive oversight. The photovoltaic inverters haves' defensive frameworks that protect the changes from sporadic current pressure derivative of current by time and voltage stress derivative of voltage by the time by right away blocking setting off a heartbeat.

3.3 Reflexive power indemnity

Reflexing power in photovoltaic has belonged to the properties of modules and inverter type also the climate situation at the area of the plant. Because of these reasons, the yield of photovoltaic frameworks can quickly with climate changes. The huge and quick change can influence the parity and wellbeing of the electrical lattice as receptive force pay (RPC) is expected to tackle this issue. RPC technique helps power modality and restricts space utilization. A few field-demonstrated RPC procedures, for example, static simultaneous compensator static volt-ampere receptive remuneration will help in power factor pay, consonant end, voltage irregularity, over and under-voltage.

Figure 3.2: NR Electric substation

3.4 PV System Powerhouse

Another powerhouse rang PV Digital Step Powerhouse has been provided by NR Electric; this powerhouse has been tried in the field utilizing more than 250 substations and has demonstrated to valuable and proficient when contrasted with the ordinary substation. Photovoltaic computerized step-up powerhouse is applied to little and medium scale sunlight-based parks for electric force matrix incorporation. PV advanced advance up powerhouse is comprised of wise essential gadgets and a system of auxiliary gadgets. Fiber-optic is utilized as a mechanism for information securing and sharing among canny gear. The fiber-optic utilized is of IEC 61850 shows.

Stage checking gadgets can be mentioned in the PV force framework to dissect and screen the dynamic reaction of the framework; this will be accomplished progressively. The yield of the PV framework is extraordinarily reliant on input fuel (daylight); this fuel is a characteristic happening substance and as such the amount is truly not known. PV force forecast is a significant factor to be advised in lattice tied PV framework; this will help in observing and settling the force matrix. Additionally, a power steadiness control system can be introduced to help alleviate transient dependability, load stream, and voltage solidness (Yan et al., 2014).

3.5 Off-Grid joints

Off-framework frameworks offer the likelihood to introduce an immense measure of electric force created essentially from sustainable power sources such wind and sun oriented which will extraordinarily help in controlling exhaustion of ozone layer and as such establish sound natural practices. This will likewise prompt monetary development in basically under-denied and immature nations. An off-lattice framework or system can be characterized as a self-continuing force delivering system without the conversional utility. A blend of hydro, wind, or sun oriented are the essential fuel utilized in the electric force age of off framework. A crossover arrangement of RES and diesel generators are utilized to create power

in crisis circumstances because of disturbance in climate conditions. An off-matrix framework should meet the accompanying conditions:

a. A free framework without outer dependence

b. Proficient creation and utilization framework

c. Accessibility of vitality stockpiling framework (ESS)

d. Utilize generally sustainable power sources

e. The executives of dynamic side

f. Capacity to serve new kinds of burden (Kubalik et al.,2014)

Off-framework and lattice-tied photovoltaic force plants are comparable yet with a couple of contrasts being; after the force is created at the PV cluster, it is changed over to air conditioning power at that point associated with the utility on account of network tied PV frameworks. On account of off-matrix PV frameworks, photovoltaic cluster power is put away in vitality stockpiling frameworks or provided to the shopper through microgrids. Off-lattice PV frameworks is an extremely expansive and questionable region on account of the elements to be viewed as when portraying off-network photovoltaic frameworks. Off-matrix frameworks are for the most part homes, organizations, or networks that are not associated with the fundamental force utility of a nation, this predominantly because of the cost of broadening lattice foundation, area or landscape, and monetary status of the nation.

In a people group where the fundamental/public framework isn't stretched out, a microgrid can be created to control solid force for the network.

A microgrid network an electric vitality matrix comprised of disseminated ages and vitality stockpiling frameworks. Microgrids are either matrix associated or islanded mode. Distributed ages are little to medium size electric force age units that are typically filled by sustainable power sources.

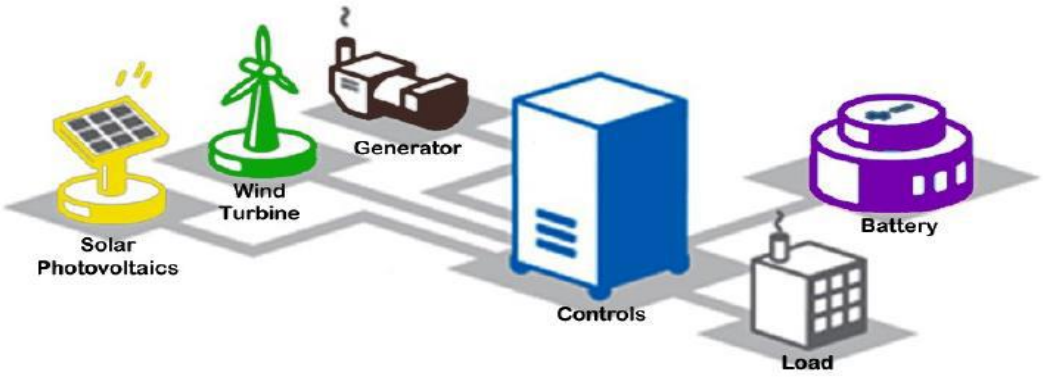

Figure 3.3: Microgrid layouts (Disfani, 2015)

3.6 An attribute in Off-Grid Structure

Force modality which is otherwise called electricity force modality can best be portrayed utilizing the accompanying boundaries in electrical frameworks; waveform, recurrence, and voltage. Force quality can be supposed to be satisfactory if the forced stream is steady and falls inside the approved extent of voltage, waveform, and recurrence. In this manner, the force provided to a purchaser at the purpose of burden association ought to be viable with load power qualities. Any break in these boundaries delivers the nature of intensity helpless which can have to destroy impact on load delivering burdens to breakdown and prompting money related losses (Saini and Kapoor, 2012). The forced nature of an electrical framework is subject to various factors, for example, length of gracefully for example short or long haul, sounds bends, voltage varieties, and homeless people. Music bending is the distortion of a voltage or flow waveforms in electrical frameworks brought about by the presentation of music by the utilization of power electronic converters and non-straight loads. The impacts of sounds in electrical frameworks are power factor decrease, flashing, overheating of an electrical, early breakdown of transformers and continuous force supplies, framework limit decreases because of overheating, electrical fires, harm to touchy burdens, successive electrical switch setting off. Absolute symphonious mutilation is otherwise called THD is the general music present in an electrical framework. The all-out symphonious mutilation of an electrical framework

communicated in voltage terms is a proportion of the square root entirety of RMS voltage of individual segments to principal RMS voltage.

$$THD=\frac{\sqrt{V_1^2+V_3^2+\ldots+V_n^2}}{V_1} \quad (3.1)$$

V1 = RMS volt major part

V3 = RMS volt of the third segment

Vn = RMS volt of the nth segment

Communicating the absolute consonant bending in rate terms will give us:

$$THD=\frac{\sqrt{V_1^2+V_3^2+\ldots+V_n^2}}{V_1} \text{ x } 100\ \% \quad (3.2)$$

3.7 Advantage of Off-Grid Solar Energy Systems

Detaching from your city power organization accompanies a few advantages — almost certainly the accompanying points of interest have an impact on your longing to introduce an off-network photovoltaic framework:

•Independence — Go with an off framework, and you're not, at this point subject to the terms and approaches of the service organization. Escaping from the continuous rate increment might be reason enough to cut ties.

•No Blackouts — When the force is out and every other person has no power, your home will at present have full force. This can be especially significant for individuals with wellbeing conditions that require electronic gadgets or refrigerated medication.

•No Electricity Bills — You'll never again need to give the service organization a cut of your regularly scheduled check after you go off-lattice.

3.8 The disadvantage of Off-Grid Solar Energy Systems

Introducing an off-matrix photovoltaic framework accompanies a few downsides, in any case. Here are a couple of reasons property holders wind up ruling against going off-framework:

•Higher Initial Cost — If you disengage completely from the force organization, you'll need a wellspring of reinforcement power for when the sun isn't sparkling. Including a battery bank and additionally, the generator knocks up your sun-based expenses.

•Limited Solar Energy Storage — Even with reinforcement power, vitality stockpiling is restricted. Allowed a couple of long periods of overcast climate, you may run out of putting away power.

•Energy Efficiency is a Must — When you live off-framework, you must be cautious about your family unit vitality use or you risk not having enough force for your home.

4. STRUCTURE OF PV POWER PLANT IN AFGHANISTAN

4.1 Photovoltaic generating station

A force plant is a mechanical establishment utilized for the electric force age. Force plants otherwise called creating stations, force to be reckoned with, producing plants, power stations utilize various generators to deliver electric force, mechanical vitality is changed over into electrical force by methods for pivoting parts in the generators.

PV generating station then again don't utilize generators yet utilize sun-oriented PV modules to deliver electric force. PV generating station additionally called sun-based parks are comprised of thousands of PV modules, used to create photovoltaic frameworks to deliver enormous scope power either for matrix incorporation or islanded mode. PV generating station produce power by changing over sunlight-based vitality legitimately into power through sun-based cells. The nameplate limit of photovoltaic force plants varies from nation to nation. These varieties are MWp (megawatt-top) which alludes to the Dc power delivered at the exhibit, MWAC is the air conditioner power created at inverter yield lastly MVA is known as super volts-amperes (Landi et al., 2013).

The effective presentation of photovoltaic frameworks relies upon a few factors such as climate conditions (surrounding and cell temperature), the sort of PV modules and inverters, the productivity and STC states of PV module and inverter, and so on. Photovoltaic green power plant configuration is intensely reliant on the nameplate limit of the modules, and inverters proficiency, and climate conditions in the area.

4.2 Herat District

The region of Herat is situated in the western province of Afghanistan. Herat locale has adequate sunlight-based radiation to help the development of photovoltaic force plants. Information sourced from National Aeronautical and

Space Administration (NASA) site utilizing topographical directions; its geological directions are 34° 20' 49" North, 62° 11' 54" East shows normal KONDUZ, JALALABAD, KANDAHAR, MAZAR-E SHARIF, AND HERAT Counts of the month to month normal every day complete radiation, from hourly model assessments of worldwide ... over 3.5 years (April 2002 - September 2005, shows a flying perspective on Heat people group got to from Google maps.

Table 4.1: Community one

Month	**Air temperature °C**	**Daily solar radiation horizontal kWh/m2/d**	**Wind speed m/s**	**Cooling degree-days °C-d**
Jan	23.9	5.68	3.7	425
Feb	24.5	5.92	3.8	405
Mar	23.2	5.46	3.8	410
Apr	22.3	5.26	3.8	366
Ma	22.0	5.18	3.9	374
Jun	22.3	4.87	3.8	369
Jul	22.7	4.74	3.7	392
Aug	22.3	4.82	3.5	380
Sep	21.6	4.99	3.9	350
Oct	21.3	4.58	3.4	351
Nov	21.3	4.64	3.2	351
Dec	22.3	5.17	3.3	382
Annual	22.475	5.109	3.61	4545

4.3 Burden Evaluation

Electric burden utilization fluctuates with time, shopper type, and area of customer. In this way, all-electric force providers should factor in the variety of burden during load assessment. Effective burden assessment of a network should be possible by utilizing past buyer charges (load data) over some time say one year and gathering information of contraptions a purchaser has. The last approach is applied in networks without matrix associations or recently creating networks. Burden data is a piece of information that shows how a network, or a shopper utilizes electric force constantly, day, month, and year. There are a few different ways of defining load information as per the particulars of the candidate. The fundamental elements for load information depictions are measurement (amperes, Kilovolts, cos ϕ), framework area time, and a class of client (private, administrations, industry). The steady accessibility of electric force and the expense of electric force are two significant elements that decide the utilization

examples of clients. The electric burden request of networks in Herat is fragmented into four general classifications:

- Household/homegrown area which incorporates (lighting, TV, Radio, cooler, and so forth.)
- Commercial burdens (flour processing machine, scaled-down shops, unisex hairdressing cantinas, and so on.)
- Community load which comprises of (primary school lighting, workstation, printer)
- Health facility which incorporates (immunization cooler, correspondence radio, TV, magnifying instrument, PC and printer, DVD player, lighting frameworks).

consequences of electrics burden assessment for the 2 networks under investigation in Herat have appeared in Tables 4.2 and 4.3 separately. These are the picked networks where the electric force will be given by methods for PV force plants. The assessed power for the two networks is 500kW for network 1 and 302.232kW for community2, in this way 0.802232MW (802.232kW) altogether. Table 4.2 and Table 4.3 are comprised of the classifications of electric burden customers which establish the networks under examination. Every people group is comprised of the accompanying classifications; Upper class, white-collar class, lower class, Commercial, Administration post, Medical focus, Primary school, Secondary school, Mosque, Small assembling. Tables 4.4 up to Table 4.13 are tests of every class giving point by point clarification of how electric burden assessment for the two networks was accomplished.

Figure 4.1: Herat city google map

Table 4.2: Community one

Type	Number Of households	Required Power kW	Total Power (KW)	Power used Per Day Kwh/day	Total Power Kwh/day
High Class	90	3.252	293.68	16.69	1502.1
Medium Class	60	2.40	144	14.751	885.06
low Class	150	0.051	7.65	0.61	91.5
pasaj	4	2.345	9.88	49.621	198.484
organization	2	0.550	0.585	3.8711	7.7422
Fitness center	2	1.125	1.1	17.51	35.02
Primary school	3	2.680	8.04	12.361	37.083
High school	1	6.560	6.560	41.21	41.21
Mosque	1	0.50	0.50	1.911	1.911
Small company	3	5.02	15.06	29.319	87.957
Total	316		487.055 KW		2888.2472

Table 4.3: Community two

types	NO Of households	Essential Power kW	Total Powers (KW)	Power used Per Day Kwh/day	Tatal powers Kwh/day
High Class	70	3.252	227.64	16.69	1168.3
Medium Class	35	2.40	84	14.751	516.285
low Class	75	0.051	3.825	0.61	45.75
pasaj	3	2.345	7.035	49.621	148.863
organization	2	0.550	1.1	3.8711	7.7422
Fitness center	5	1.125	5.625	17.51	87.55
Primary school	3	2.680	8.04	12.361	37.083
High school	1	6.560	6.560	41.21	42.21
Mosque	2	0.50	1	1.911	3.822
Small campany	1	5.02	5.02	29.319	29.319
Total	197		349.845 KW		2086.9393

Table 4.4: High School

Applications	Use devices	Power	Total power	Hrs/day	Wh/days
light	100	12	1200	7	8400
television	2	120	240	4	960
projector	2	45	90	1	90
Computer	10	200	2000	2	4000
Water drive	1	400	400	8	3200
Total	115	777	3930 W		16650

Table 4.5: Minor Industrial Part

Appliances	Number of uses	Powers	Total powers	Hours/day	W hours/day	
Lamps	6	12	72	4	828	
Mobiles	5	6	30	3	90	
3- phase motors	1	3500	3500	5	17500	
1-phase motors	2	400	1200	4	4800	
Radio	2	15	30	4	20	
Total		4832 W		23238		

Table 4.6: Public Museum

Appliances	Number of uses	Powers	Total powers	Hour/day	Whour/day	
Lamp	10	12	120	4	480	
light	3	12	36	7	252	
television	2	110	220	1	220	
CD player	2	20	40	4	160	
lap tab	3	80	240	2	480	
Total		234 W		1593		

Table 4.7: Health Midpoint

Applications	Use device	power	Total power	Hrs/day	Wh/days
Lamps	20	20	400	10	4000
Mobiles	2	5	10	6	60
TV	1	120	120	8	960
Electric devices	1	45	45	1	45
Lap tab	1	50	50	2	100
element	2	200	400	5	2000
Refrigerator	1	360	360	24	8640
Total		1385W		15805W	

Table 4.8: Secondary School

Applications	Use device	Powers	Total powers	Hours/day	W hours/days
Lamps	40	12	480	8	3840
projector	10	40	400	3	1200
Television	1	140	140	2	280
CD player	1	45	45	2	90
Computer	10	120	1200	3	3600
Total		2265		9010	

Table 4.9: The Family in Upper Class

No	Number of uses	Powers(W)	Total Power(w)	Hours/day	W hour/days
Lamps	10	11	110	5	550
Mobiles	5	5	25	2	50
Radio	2	10	20	12	240
TV	1	120	120	3	360
DVD	1	30	30	3	90
Computer	2	100	200	2	400
Refrigerator	1	500	500	24	12000
Iron	1	1000	1000	1	1000
Water pumps	1	500	500	1	
AC	1	750	750	3	1500
Total		3255ts			

4.3.1 The Average Daily Burden Graph

The greatest power heap of the network happens from 19 hr till 22 hr this is because of a large portion of the Villagers would hope to be at home appreciating radio and TV other than night light use and some little assembling will be working during that time and business.

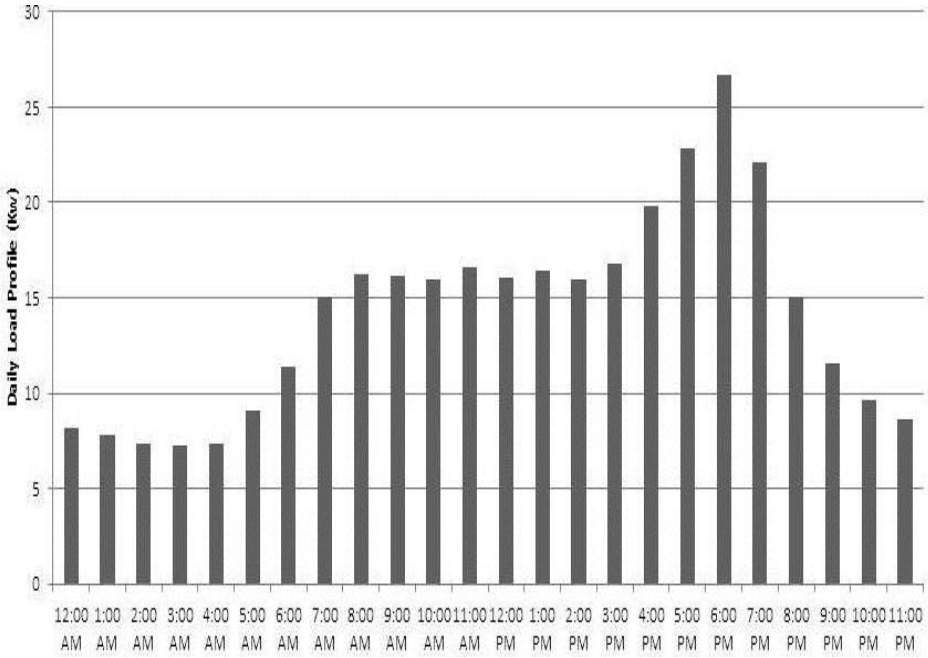

Figure 4.2: Middling Everyday Burdens

4.4 Photovoltaic Power Plant Structure

Sun force or vitality is the fuel utilized in creating power by methods for photovoltaic frameworks. Vitality from the sun comes in two structures; warmth and light. Sunlight based warm advancements utilize the warmth part of the sun's vitality to create power while sun-based PV innovations utilize the light (photons) from the sun is delivering power. The force utilization interest for the two networks determined after burden assessment is 802.232kW/day. From the building viewpoint, it's wrong to create the specific amount of intensity required by a shopper/network in this manner we will structure a 1MW PV power plant; abundance power delivered will be infused into the lattice. Utilization of intensity will increment when force is continually accessible and reasonable. Increment in monetary exercises will likewise prompt increment in power utilization in this way the need to structure 1MW plant.

4.4.1 PV Panel Model

Samsung PV-MBA1BG250 (250W) monocrystalline silicon sun-based board is proposed for the development of a 1MW PV power plant and utilized for reproduction in PVsyst programming.

The datasheet determinations of PV-MBA1BG250 are: STC and PTC power appraisals of 250W and 225.7W individually. Open circuit voltage Voc is 37.8V, cut off Isc is 8.68A, greatest point current and voltage (Imp, Vmp) are 8.15A and 30.7V individually, Nominal working cell temperature is 450C, made of 60 cells, the territory is 1644mm (length) x 992mm (width), weight is 20.2kg and productivity is 15.33% with 5 years surety and 90% and 80% proficiency insurance for 10 and 20 years separately.

The accompanying advances will push us to precise structure the required PV power plant of the 1MW limit.

4.4.2 Energy Required from The PV Panels

Transformation productivity: 75 % gauge the effects of temperature, inverter effectiveness, module bungle, and earth to concoct change proficiency from dc to air conditioning.

PDC(STC): is the dc intensity of the exhibit got by basically including the individual module appraisals under standard test conditions. Pac: AC power.

$$\textbf{PDC,STC} = \frac{\textbf{pac}}{\textbf{conversion efficiency}} = \frac{\textbf{1MW}}{\textbf{0,75}} = 1{,}33\ \text{MW} \qquad (4.1)$$

Capacity of PV panel total WP = P (MW) / (h/day of "peak sun") (4.2)

Capacity of PV panel total WP =1.3MWh /5(h/day) = 0.26MWp

The number of PV modules needed = $\frac{\text{total watt peak rating}}{\text{PV module rated output}}$ (4.3)

The number of PV panels needed = 1.3MW / 250W=5200 modules

Energy (kWh/year) = Pac (kW) x (h/day of "peak sun") x 365 days (4.4)

Energy (kWh/year) =1.3MW X 5 h/day X365days Energy (kWh/year) = 2.3725GW/year.

4.4.3 Selection of Inverter

" Bright tripower 15000TL" inverter is the thing that we chose for our plan. Bright tripower 15000TL is fabricated by System Mess Anlagen Technik, SMA Solar Technology AG 40.

Radiant tripower 15000TL has the accompanying specialized data for the dc input side: the greatest dc power is 15340W, the most extreme information voltage 1000V, most extreme force point voltage go is 360V-800V, appraised input voltage 600V; least info voltage 150V, greatest info current is 40A/12.5A. For the air conditioner yield side; European proficiency and greatest productivities are 97.8% and 98.2% individually, appraised power is 15000W at 230V 50Hz recurrence, ostensible AC voltage at various varieties: 220/380V or 230/400 and 240/415V

$$\text{Size of inverters} = \frac{1\text{Mw} * 120}{100} = 1{,}3\text{MW} \quad (4.5)$$

$$\text{Number of inverters} = \frac{\text{inverter size}}{\text{rated power of an inverter}} \quad (4.6)$$

$$\text{Number of inverters} = \frac{1{,}2\ \text{MW}}{1500\ \text{W}} = 86{,}66\ inverters \approx 87 inverters$$

$$\text{Number of modules in series} = \frac{\text{the maximum open-circuit voltage of the inverter}}{\text{the open-circuit voltage of each PV module}} \quad (4.7)$$

$$\text{Series of the number module} = \frac{600}{37{,}8} = 16 \text{ modules}$$

The size of an exhibit is 16 Modules which are in arrangement 4 of such clusters are associated in corresponding to delivering one line of the inverter.

$$\text{Number of the array in solar in total} = \frac{\text{all number,of modules}}{\text{the number on a module on the array}} \quad (4.8)$$

$$\text{Number of the array in solar in total} = \frac{5200\ \text{modules}}{15\ modules} = 325\ Arrays$$

The chose inverter must be sufficiently enormous to deal with the aggregate sum of watts top necessity, the inverter size ought to be 25%–30% greater than all out watt's prerequisite. Per the specialized data of our picked inverter, the field association of modules to the inverter is as per the following; 15 boards having voltage of 30.8V and current of 8.16A are associated in arrangement to deliver 460.6V voltage and 8.15A current. Four of such cluster associations are associated in corresponding to create a voltage of 460.6V and current of 32.7A, this produces one line of association for one inverter. Per the module-inverter computations, a sum of 87 inverters will be needed to effectively change over dc capacity to air conditioning power. There are various kinds of inverters for different purposes. Models are micro inverters, string inverters, and focal inverters. To decide the best inverter type for an application, a few factors, for example, cost, sort of PV framework; lattice association, independent, half and a half, and so forth should be assessed. Thinking about cost, simplicity of establishment, and proficiency, a 3-stage cord inverter is the best useful choice.

4.5 Plant Area

An aggregate of 5300 boards/modules are utilized in the structure of our PV force plant. Every module has a territory of 1.641m2 (1641mm x991mm) therefore the complete creating region of the plant is 8451.41m2 while the absolute zone of the plant will be greater than the producing region of the plant. The creating region of the plants is a significant factor in deciding the measure of vitality to be delivered and investigating the exhibition of the plant.

Table 4.10: The circuit of the PV module

Kinds	**Sizes**
PV module	260 w
Amount of photovoltaic module	5300 module
Sunny tri enegy 15001TL	15001 w
amount of inverters	88 inverter
Number of the module in sequence	17 module
Scope of collection	16 module
The full amount of collections in solar ground	330 array
Module places	1.641m2
Land-living r for PV module	8450.41m2

5. DESIGN AND SIMULATION OF PVSYST

5.1 PVsyst Software

The PVsyst software recreation part of our examination is isolated in two sections; reenactment for fixed module direction and reproduction for global positioning framework made from the western following, this is accomplished by utilizing PVsyst programming. PVsyst 6.6.9 release is utilized. André Mermoud, alumni (1972) of the college of Geneva in Switzerland is the creator and author of PVsyst programming and PVsyst SA individually. PVsyst is comprised of four areas; starter configuration, venture plan, information bases, and devices. In the undertaking configuration area, there are four subsections or frameworks; network associated, independent, siphoning, and dc matrix. The matrix associated subsection is our territory of concern because the craving of our venture is to plan lattice associated photovoltaic. Utilizing digital television based climatological information by NASA, recreation will be complete to decide every year vitality yield for the two reason situations; the chart for reenactment has appeared in Fig 5.1.

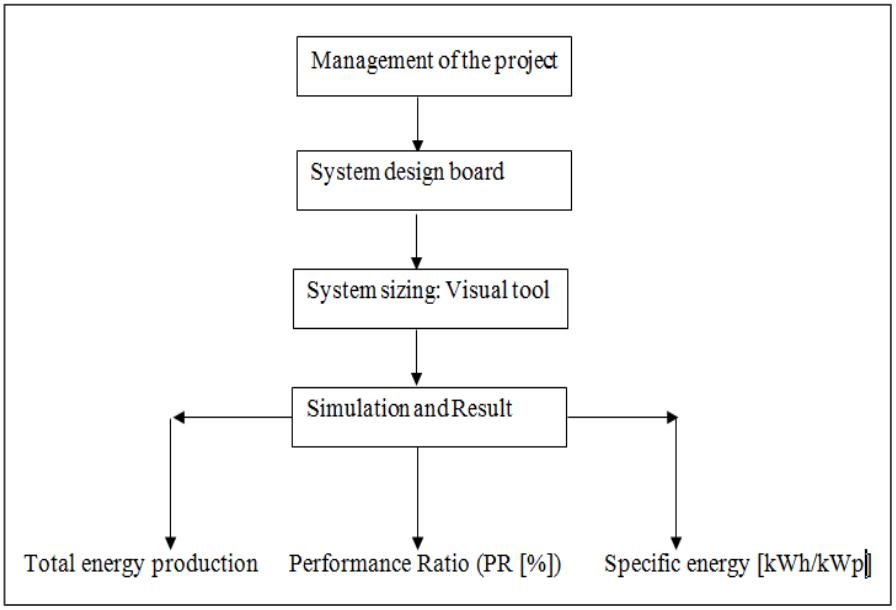

Figure 5.1: Chart of PVsyst Program

5.1.1 Site Location

The Suggested PV plant will be installed at Herat which is in the western Area of Afghanistan Herat area has adequate sunlight-based energy to help the development of PV force plants. Source information from (NASA) site utilizing topographical directions; longitude 62.199074E and scope 34.343044N Calculations of the month to month normal day by day absolute radiation, from hourly model evaluations of worldwide ... over 3.5 years (April 2002 - September 2005. The normal yearly temperature is 23°C in Herat.

5.1.2 Orientation

As per the climate and scene territory of HERAT, the photovoltaic boards will be slanted at a point of 300 to the south at a fixed position. This edge of direction is because of past exploration works; the ideal retention of irradiance is at its top at this edge and as such greatest force is created at the cluster yield.

5.1.3 Horizon

The skyline streak sketch for Herat has appeared in Fig 5.2; it's a chart of the sun's tallness against azimuth edge. There is a relationship between's the sun's tallness at explicit hours of the day and the azimuth edge. The geological site subtleties of Herat are longitude of 62.199074E and scope of 34.343044N elevation 920m and albedo 0.20.

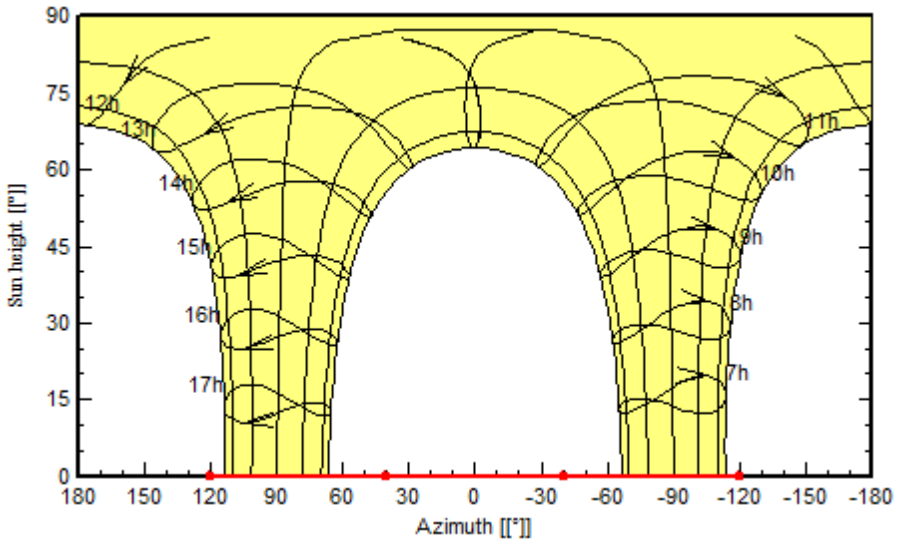

Figure 5.2: Horizontal Mark Sketches for Herat

5.1.4 Full Loss

Exploratory and recreation research by PVsysts throughout the annual ears has prompted standard qualities for definite misfortunes in photovoltaic influence plants. this standard quality can be changed by the fashioner's details. Components that influence misfortunes in PV frameworks are warm misfortune factor, ohmic misfortunes, modules quality, and confusion, dirtying misfortune, IAM Loss, Aging, and so forth. PVsyst sets standard misfortunes are utilized for our reenactment.

5.1.5 Size of System

For our reenactment structure, 1301kWp ostensible force made 5201 module with a zone of 8481.41m2 and 86 gathering of SMA inverter are utilized. The proposed boards and inverters that we need to use in the development Kirehe power plant are chosen for the reenactment. The information gave underneath is produced by PVsyst; no concealing was characterized because the scene of the area of the plant is comprised of more bushes and grasses.

5.2 Simulation and Result

As expressed toward the start of part 5, the reenactment is accomplished for two case situations; fixed module direction and global positioning framework direction. An itemized report is introduced for the two cases; these reports are in the addendum of our theory. In the report a few boundaries are

introduced, the three primary boundaries which portray the created energy and misfortunes in the frameworks are:

• Normalized creation (per introduced kWp)

• New reproduction variation

• Losses graph

5.2.1 Regularized manufacture (per installed kWp)

the diagram in fig 24 of standardized creations per each introduced (kWp); 13002kWp ostensible force. Fig 5.5 showcases three different variables; frameworks misfortunes, assortment misfortunes, valuable vitality delivered which are helpful markers; which decides the presentation of the plant as far as vitality creation. From the diagram, the most elevated helpful vitality created happened in Apr, May, Jul, and Aug, with July footage the most noteworthy; 5.1kWh/kWp/day. The most noteworthy framework misfortunes and assortment misfortunes happened in the time of June and July. Although photovoltaic frameworks rely upon daylight for electric force creation, the warmth vitality related to daylight influences PV framework execution contrarily. This implies for each 10 C of temperature past the STC esteem, the intensity of the board is diminished by - 0.44%/K (Ozerdem,2015). Assortment misfortunes are the misfortunes that happen during the transformation of irradiance into influence, it's a proportion of how much irradiance is gotten, and the amount of that irradiance is changed over into influence. Framework misfortunes additionally happen in the irradiance transformation chain however it's generally brought about by mechanical misfortunes, inverter misfortunes, and so on framework misfortunes can be enormously decreased with the higher module and inverter productivity, quality, and short cabling frameworks. The rate distinction between misfortunes (framework + assortment = 0.72) and valuable vitality created (3.98) is 18.09%; which is a „acceptable“ misfortune in PV frameworks.

5.2.2 Performance Ratio

Exhibition proportion is an amount that is characterized as the proportion of compelling vitality delivered at the cluster yield concerning vitality crop by an ideal PV framework under similar conditions. Normally normal test circumstances (STC) are utilized with a similar measure of irradiance episode on the „global plane“. The exhibition proportion of PV frameworks involves framework and cluster misfortunes. Cluster misfortunes are wiring, jumble, module quality, concealing impacts, photovoltaic transformation rate, IAM. From Fig 5.6, the general exhibition proportion of our framework is 85%; there wasn't a lot of contrast in the month to month execution although the framework and assortment misfortunes for Jun and Jul were impressively elevated.

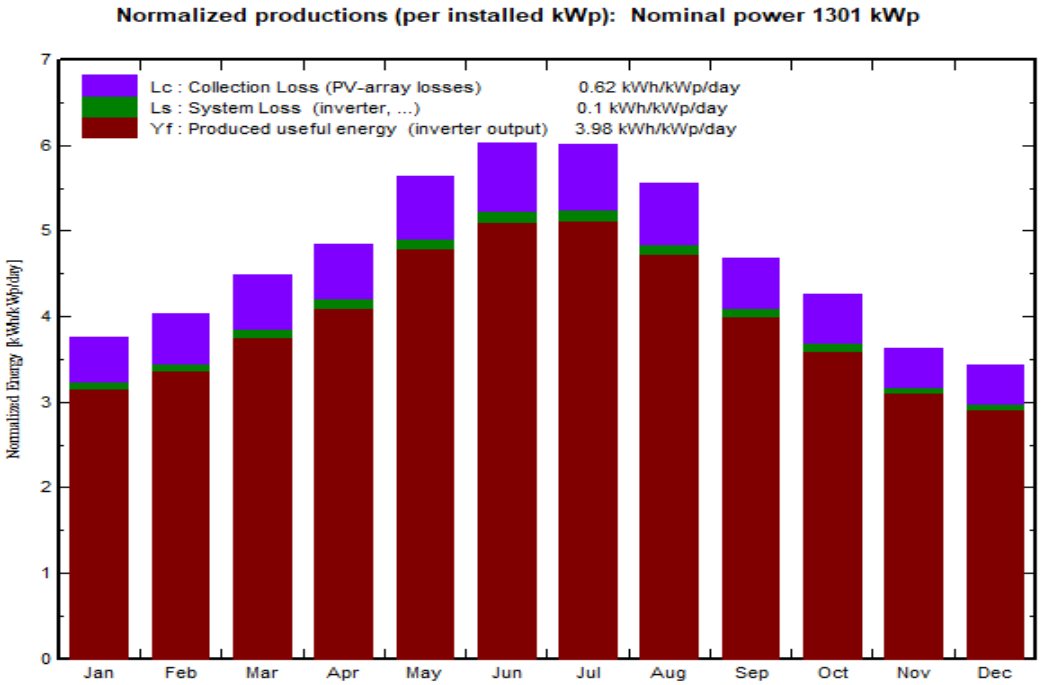

Figure 5.3: Horizontal Slight Power 1302 kWp (Normalize Producing)

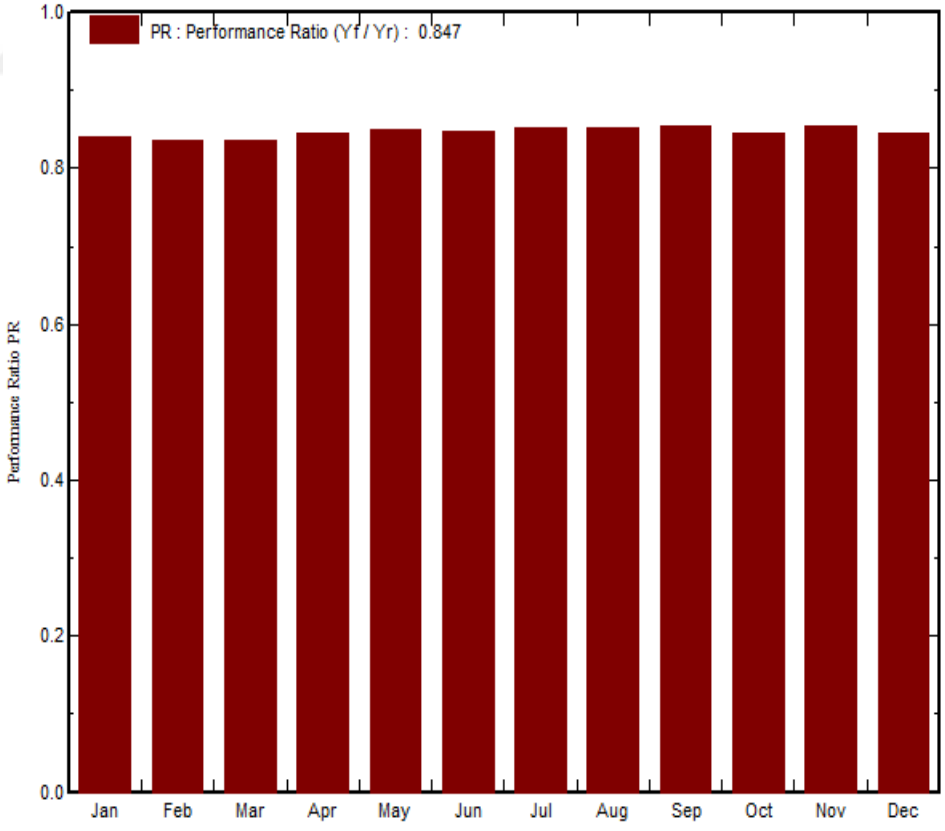

Figure 5.4: Horizontal Slight Power 1302 kWp (Normalize Producing)

5.2.3 New Simulation Variant

Parities and principle aftereffects of our reenactment for the Herat PV power plant has appeared in Table 16. From the table, the greatest month to month vitality creation happened in July; 211856kWh, and least happened in Dec; 120195Wh. The annual successful vitality created at the cluster yield (EArray) is 1938963kWh. Notwithstanding, it ought to be noticed that EArray is dc power. In the wake of changing over the dc capacity to air conditioning power, at that point, we have E-Grid, vitality associated with the framework. The yearly vitality associated with the lattice is 1892337kWh. The distinction between E-Array and E-Grid decides the effectiveness of the inverters (97.5%). The chart of the day by day vitality creation is certain in the index of the postulation, from Jan to Dec.

Table 5.1: The Main Result and balance

GlobHor kWh/m2	**DiffHor kWh/m2**	**T Amb** 0C	**GlobInc kWh/m2**	**GlobEff kWh/m2**	**EArray kWh**	**E_Grid kWh**	PR
Jan1	154.8	73.04	21.29	116.8	111.01	130857	127598	0.841
Feb2	136.5	68.82	22.20	113.0	108.01	125947	122857	0.837
Mar3	153.0	70.42	22.12	139.4	134.40	155328	151456	0.836
Apr4	146.1	71.80	20.82	145.7	141.10	164147	160177	0.847
Ma5	159.2	69.12	20.50	174.9	170.20	197880	193190	0.850
Jun6	158.8	61.47	19.49	180.8	176.50	204409	199479	0.850
Ju7	165.3	63.23	19.20	186.4	181.90	211857	206792	0.854
Aug8	165.4	74.15	19.56	172.2	167.50	195643	191030	0.854
Sept9	148.7	82.11	20.04	140.7	135.70	159859	156159	0.855
Oct10	155.1	77.98	21.02	132.2	126.70	148734	145166	0.846
Nov11	136.9	82.37	20.43	109.0	103.90	124118	121208	0.856
Dec12	142.6	77.60	21.19	106.7	101.30	120195	117239	0.846
Year	1822.4	872.01	201.76	17178	1658.22	1938974	1892341	10.28

5.2.4 Losses Illustration

The misfortune chart to the Herat PV influence plant is represented in Fig 5.7. The misfortune graph is the whole of different misfortunes that happen correct structure irradiance transformation at lattice association of created vitality. Misfortunes that makes up the misfortune outline can be arranged introduction three gatherings; transformation and module misfortunes, conductor and embellishments misfortunes lastly inverter 51

misfortunes. From Fig 26 the yearly vitality created at STC is 2160MWh, however, „real" power infused into the network is 1893MWh yearly; this speaks to 12.37% all-out misfortune in the PV influence plants.

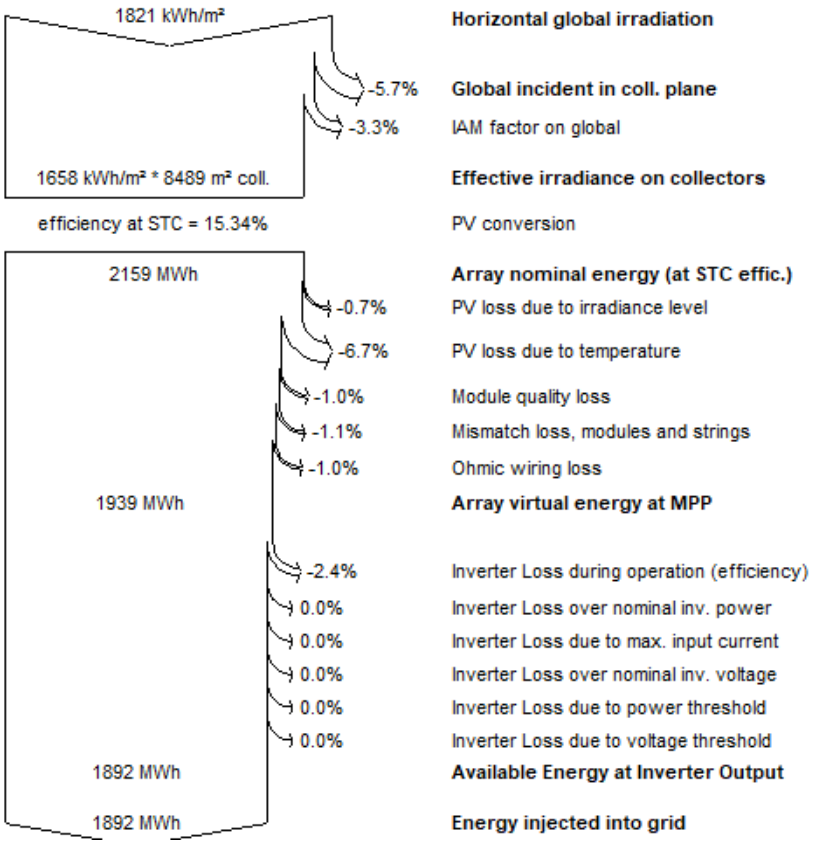

Figure 5.5: Figure of Losses

Table55.2, speaks to point by point framework misfortunes on the month to month premise. The entirety of the different misfortunes is 2047051kWh. This doesn't mean 2047051kWh is a „loss", this is because the fuel; irradiances for PVs frameworks are free, too

ModQual speaks to module superiority misfortune and it represents the level of irradiance that can be changed over to electric influence. Albeit expanding the proficiency of modules will enormously lessen MdQual misfortunes, accordingly, diminishing complete misfortunes in the plant.

Table 5.2: Full loss of System

The loss in module quality **KWh**	Module mismatch loss **KWh**	Ohmic wiring loss **KWh**	The loss in inverter **KWh**	Array energy at maximum power point **KWh**
Jan	135	1467	978	130851	3260
Feb	130	1413	1043	125948	3092
Mar	1603	1746	1523	155337	3882
Apr	1695	1846	1689	164198	4022
Ma	2045	2227	2177	197960	4771
Jun	2115	2303	2436	204563	5085
Ju	2191	2385	2454	211932	5141
Aug	2021	2201	2110	195720	4690
Sept	1648	1795	1444	159866	3709
Oct	1533	1669	1278	148734	3569
Nov	1277	1391	849	124118	2911
Dec	1237	1347	809	120195	2958
Year	20012	21792	18790	1939427	47089

5.3 Tracking Scheme

Sunlight based global positioning framework is an enhancement for fixed module direction, the objective of a wide range of global positioning frameworks is to greatest vitality creation by being in 900 arrangement with the sun consistently to the days. Fundamentally, there are 2 sorts of global positioning framework in PV power plant; single pivot and twofold tomahawks global positioning frameworks. Under these two fundamental kinds of global positioning frameworks; there are various sorts of global positioning frameworks by prudence of geological following models, East-west following, North-south following, vertical or level following, and so forth.

Adding global positioning frameworks to the structure of the plant will expand vitality creation yet will likewise add additional expense to the plant. Instances of sun-oriented PV following force plants are 106MW plant in Punjab, India, and 207MW only pivot global positioning framework in California USA. The different Figs and tables speak to reenactment results for joining two tomahawks global positioning framework East-West edge to the structure of Herat photovoltaic force plant. Similar outcome boundaries got for the fixed edge direction is additionally procured for the two tomahawks global positioning framework, investigation of the two frameworks will decide contrast in levels of

vitality creation between the two frameworks and financial plausibility. The outcomes boundaries below;

- Normalize creation
- Presentation apportions
- Equilibria and fundamental outcomes table
- Damage outline
- Detailed framework misfortunes

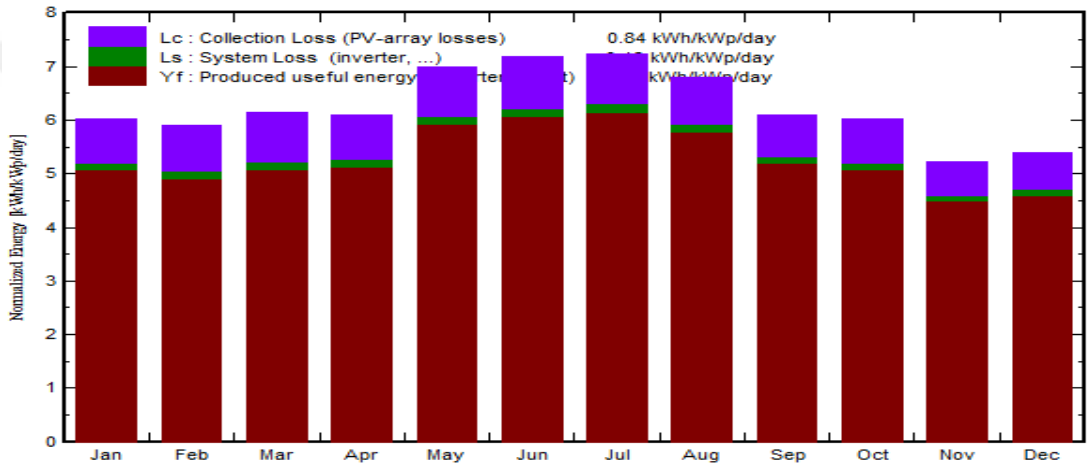

Figure 5.6: The Tracking System Normalizes the Ratio

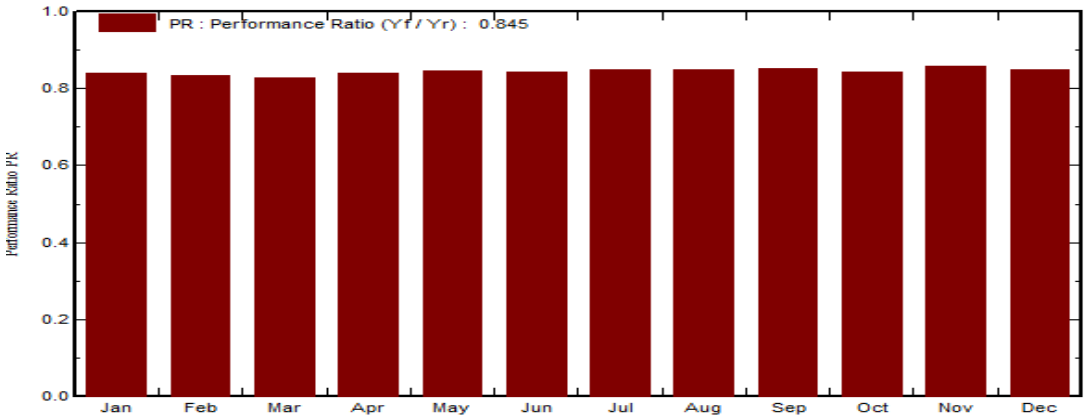

Figure 5.7: The tracking system production ratio

Table 5.3: Key of Consequence for Tracking System and Equilibrium

GlobHor Kilo wath/m2	**DiffHor** Kilo wat/**m2**	**T Am 0C**	**GlobInc** Kilo wat/m2	**GlobEff** Kilo wat/**m2**	**EArray KWh**	**E_Grid** Kilo wat-hr	**PR**
Jan	154.71	73.031	21.281	187.10	183.5	209686	204540	0.841
Feb	136.41	68.8111	22.191	165.30	162.50	183810	179270	0.834
Mar	152.91	70.41	22.111	190.40	187.40	210596	205271	0.829
Ap	146.01	71.791	20.811	183.20	180.40	205552	200475	0.842
Ma	159.11	69.111	20.491	216.20	213.80	244982	239076	0.848
Jun	158.71	61.461	19.481	215.70	213.10	242595	236591	0.844
Jul	165.21	63.221	19.1911	224.50	221.70	254186	247957	0.850
Aug	165.33	74.141	19.55	210.70	207.60	238625	232885	0.850
Sept	148.66	82.101	20.031	182.60	179.30	207389	202485	0.853
Oct	155.01	77.971	21.011	186.70	183.40	209822	204741	0.844
Nov	136.88	82.361	20.421	156.90	153.40	179528		0.860
Dec	142.56	77.591	21.181	167.50	163.70	189987	185466	0.852
Year	1824.1	872.002	20.652	2287.40	2249.50	2576759	2514125	0.857

Table 5.4: Tracking System of Full loss

The losses in quality module **KWh**	the loss Module mismatch **KWh**	the loss in Ohmic wiring **KWh**	The loss in the inverter **KWh**	Array energy at the maximum powerpoint **KWh**
Jan	1712	1864	1478	166022	3940.372
Feb	1594	1735	1517	154418	3717.679
Mar	1841	2005	1930	178241	4387.993
Apr	1952	2125	2191	188787	4681.404
Ma	2484	2705	3114	239998	5981.897
Jun	2489	2711	3366	240277	6312.010
Jul	2599	2830	3391	250944	6309.120
Aug	2356	2565	2807	227737	5544.634
Sept	1839	2002	1747	178182	4116.761
Oct	1852	2017	1806	179404	4202.463
Nov	1497	1627	1127	145368	3293.329
Dec	1525	1661	1150	148098	3415.457
Year	23740	25850	25623	2297477	55903.119

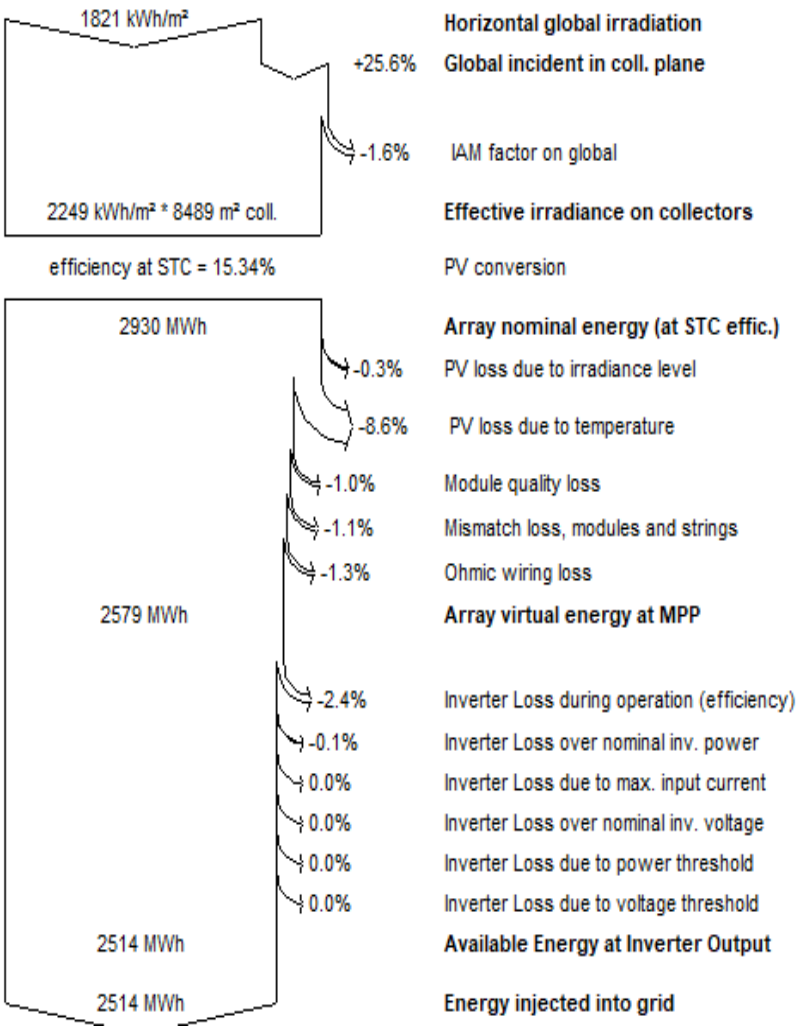

Figure 5.8: The Losses Fig Used for Tracking Installation

5.4 Financial Examination

PV frameworks are frequently measured as a perfect vitality arrangement on is benevolent to condition, be that as it may, then again, PV frameworks are likewise significant in budgetary issues. With viable structure and activity, the PV framework may repay its speculation and have further benefit. Around PV frameworks have lesser price than other kinds of ages. To choose the expense and estimation at a PV framework, a monetary examination is led by architects.

5.4.1 Initial Cost

Budgetary expenses incorporate beginning costs, upkeep costs, fixed expenses, and substitution costs. The introductory expense includes the phase of configuration, building, gadgets, and establishment of the PV framework. The

costs of gear are gotten from producers or vendors. The diverse expense between a framework that is introduced without anyone else and a framework that requires the proficient establishment of the gadgets. At that point, the all-out expense is believed to be the complete expense to be introductory expense toward the start of the life of the framework.

Table 5.5: Financial Brightness

Financial limitation	**stable system**	**Tracking system**
Modules price	910 123€	910 123€
Care price	830 000€	830 000€
Double axis following machine and cabling	zero€	733 914.7 €
Inverters and cabling	261 001€	261 001€
Transference also rising	64 259€	642 259€
Savings price	2 644 259 €	3 144 194 €
Incomes	213 104 €/yr	252 218.2166 €/year
Keep price	35 202€/yr	35 202€/year
all annual price	247 305€/yr	287 905€/yearr
power price	0.12 €/yr	0.133 €/year
Pay back interval	12 years	10 year

Complete sun oriented following packs: 12V Lined Actuator and Distant Controller and Increasing Accessories. Direct Actuator: 12V engine has a gearbox and is appraised to hold up to 331 lbs. that time not affecting. An all-metal lodging and is waters-safe and fixed against dust for tough sturdiness.

Double hub regulator: control double-pivot direct actuators of the brand the sun-powered board to shadow the Sunshine, save the sun-based board consistently face the daylight. Shrewd climate indicator, Material: Mounting shaft is produced using an aroused iron cylinder. Mounting arms are completely produced using Aluminium Impeccable following mounting unit for sun-based board framework, improve sunlight-based force effectiveness.

The expense of one double-pivot sun oriented global positioning framework is $498.00 and n cost Transport and I transformed it in euro it is 423.25 € in this price they will give the link and different parts. 1 double hub sun-powered global positioning framework can hold roughly three modules The absolute module is 5201 module, We can require 1734 double-pivot sun-powered following by taking 5201 modules partition by 3, the complete expense is equivalent 424.250

euros times 1735 modules, the expense of double hub sun oriented following will be 73 3915.5 euros, at that point I summarize the all-out cost, I get venture price of 3 143 184.00 €.

A = (0,05*3143184)/ (1-(1+0,05) power-20) =252217.21622€/yr

we expected that the upkeep cost will be equivalent to it is for a fixed framework because there is the headway in innovation and unwavering quality in gadgets and mechanism, the support price is 35 200€/yr.

Complete annual price =maintenance cost +annuls (5.2)

Complete year expense =35 200€/yr+252 218.21622 €/year=286 419.218 €/year.

vitality expense is 0.133€/kilo wat hr for what it is worth in Herat. The annual vitality creation of the global positioning framework in the PVsyst application it's 2 514 123 Kwh/yr.

5.4.2 The Payback Interval

Restitution time of a plant is the length that can create income from creation to the see the expense of the establishment. A monetary examination from PVssyst places the expense of the plants at 2 644 268 billion euros. And decide the restitution time to the plants, the value the buyer wages for one kWh of intensity will be utilized to decide income age example of the plant. Examination of yearly income age and price of the plants will determine restitution time to plant. Be that as it may, I pick 20 years life expectancy.

Income of fixed system /year = every year energy X price of energy

(5.3)

Income of fixed system /year =1918002 Kwh/yr X 0.133€ /kwh = 255094€

Income of following system /year =2514134Kwh/yr*0,133€/kwh=334379€

(pay back interval for stable system) = $\frac{\text{total investment}}{\text{generated revenue}}$ r

(5. 4)

(pay back interval for tracking system) = $\frac{2643269 \text{ euro}}{249340 \text{ euro}} = 11 years$

The payback interval for tracking system = $\frac{3143184}{326834.69 \, euros} = 10 \, years$

This recompense period it avoids support cost and other expense caused during the activity of the plant.

As an outcome, the global positioning framework is the most ideal alternative since it can expand the measure of power produced by photovoltaic modules even though it is costly as a result of the additional expense of the following engine however you can get benefit in brief circular than fixed framework and also you can have the option to repay the interest in brief timeframe than a fixed framework.

5.4.3 Compare of The Different Panel and Different Load

In the previous sections, we designed one MW solar from PVsyst application with all conditions parameters in this section we want to compare one MW and two MW powers from different types of solar panels at the same location and also in this design we used the different type of inverters we can see in the simulation the result.

In the first design, we used the solar panel Samsung PV-MBA1BG250 (250W) monocrystalline silicon, inverter 15000TL and in this design, we used JAM78S10-440/MR/1500V solar panels and SUN2000-60KL-MO-400Vac.

If simply compare in many factors we can see is changed like there are changed in the number of modules of the panel, the area of two setup system, numbers are the inverter, the losses, the efficiency of the system, and many factors more.

All this change is shown in the simulation and the below graphs after we saw the result of simulation between these two different designs and, we use the most suitable design for setup on that coordinate.

6. RESULT AND COMPARISON

6.1 Conclusion

Given that around 75% of the Afghan populace doesn't have electrical framework power, PVPS will be a significant answer for giving the capacity to a huge number of country Afghans. Winrock International through ACEP presented another greater plan and establishment standard to Afghanistan and built up the main ever public sun-powered rule for PV establishments, which was received by MEW and MRRD. Adherence to this new PV framework configuration code is the key Afghan offices can utilize so that PVPS can be broadly and effectively applied. This can forestall the issues seen with past inadequately structured frameworks that immediately fizzled. The foundation of the KURE Lab at the Faculty of Engineering will keep on preparing future architects and specialists on the hypothesis and utilization of legitimate PV structure, assessment, and usage approaches. These drawn-out endeavors will slowly improve the general quality and dependability of PV frameworks in Afghanistan later.

Sunlight-based vitality keeps on assuming a significant part in the age and circulation of perfect, moderate, manageable, and ecologically well-disposed electric force. Contrasting photovoltaic framework with other sunlight-based vitality-based innovation makes PV frameworks the most encouraging innovation for the electric force age. This is because it is modest and doesn't need bulky establishment measures.

We designed and compared the solar systems of the same capacity that is 1MW. We used panels of different rating in each design, Samsung 250W, and JA Solar 440W, and found out that using panels of higher rating will not just us more power but it will increase the efficiency of the system. Because the 440W panels are more efficient. Using higher rating panels can give us the same output but in less Area. So, it is better to use panels of higher rating to install a maximum amount

of system in a given area. Also, the number of panels is decreased by half when we choose 440W and this will decrease the cost of the system as the price difference between 250W and 440W is not much.

We designed another 2MW and compare its outputs with the 1MW design and we found out that choosing 1MW or 2MW depends on our load demand and the availability of area. We can not install 2MW in the same area as that of 1MW because to do that we would need solar panels of rating around 800W and this will not be a wise choice because 800W panels are a lot expensive and not easily available.

Table 6.1: Comparison

	1MW MBA1BG250 (250W)	1MW JAM78S10-440/MR/1500V (440W)	2MW JAM78S10-440/MR/1500V (440W)
No. of Modules	5,200	2,275	4,570
No. of Inverters	88	13	27
Area Required (m^2)	8450.41	4940	9223
Efficiency of System	84.47%	81.83%	83.43%
Power loss	15.53%	18.17%	16.57%
Cost of System	$777,200	$437,500	$750,000

Based on the above figures, it is easier to find out which system will be efficient. For 1MW, using PV modules of higher rating will save us the cost of installation, maintenance, and less amount of area will be required. On the other hand, using PV modules of lesser rating will lead us to a greater number of panels which in turn, means that we will require more space to install the same 1MW which could have been done in the lesser area had the panels of higher rating been used. Moreover, we can see that the efficiency of the system with a higher number of panels is more, but efficiency is not the only thing to consider while installing a PV system. There are several other factors too such as available area, budget, and rate of return. So, there are certain trade-offs that we need to make while choosing a methodology. In the same manner, if we compare 1MW and 2MW using the same PV module, we can see that 2MW will require a greater area of course but

in the long run, this is the more efficient system as we can get twice the energy in a cost not so greater than the cost of 1MW system.

The goal of this thesis is proposal seeks to increase the electric power supply in Afghanistan and at the same can be solved the huge electric power in Herat thereby increasing the economic development of the country.

This is the reason for the selection and uses of the PVsyst software for the design of solar photovoltaic power plants And the simulation of our design be considered a very good choice and comfortable because it is a very broad program by academics in industry. Afghanistan simply like some other underdeveloped nation faces the tremendous test of giving power to each resident regardless of their area in the nation and monetary status. The public populace of Afghanistan is 30 million (2016) with just 35% of the populace approaching power which implies that approximately 19,5 million of the populaces don't approach electric force.

The primary goal of this theory is a proposition which tries to expand electric force gracefully and at the same time diminish the tremendous electric force deficiency of Herat along these lines expanding the financial advancement of the nation. This should be accomplished in structuring, recreation, and assessment of a 1.33MW PV force plant utilizing PVsyst programming. The exploration was divided into two sections; load assessment of the networks where force is to be given and reenactment utilizing PVsyst.

The result of obtained of Herat province in Afghanistan annually is about 1892339kwh of photovoltaic power plants whereas 2514114kwh in the global position framework. This speaks to a 28.2% expansion of an extremely noteworthy measure of intensity in PV frameworks. Execution proportion of 84% for the two cases and misfortunes of 12.377% - 15.298% are acceptable markers of photovoltaic influence plant under ideal activates. Without a doubt, the utilization PVsyst programming as an apparatus for sun based photovoltaic force plant recreation can be viewed as a decent decision considering its extensive application in research works by the scholarly world and photovoltaic industry players. From the different reenactment results acquired for the two case situations (fixed module and global positioning framework) of our exploration, we can infer that actually and monetarily, the development of a photovoltaic power plant at Herat is possible and represents no threat to the earth.

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APPENDICES

APPENDIX 1

FIXED SYSTEM

Grid-Connected System: Simulation parameters

Project :	**New Project**			
Geographical Site			Country	Afghanistan
Situation	Latitude	34.34 N	Longitude	62.19 E
Time defined as	Legal Time		Altitude	920 m
	Albedo	0.20		
Meteo data:		Meteonorm 7.1, Sat=100% - Synthetic		
Simulation variant :	**New simulation variant**			
	Simulation date	07/04/18 20h03		
Simulation parameters	System type	**No 3D scene defined**		
Collector Plane Orientation	Tilt	30°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	No Shadings			

PV Array Characteristics

PV module	Si-mono	Model	**PV-MBA1BG250**		
Original PVsyst database		Manufacturer	Samsung SDI. Co. Ltd.		
Number of PV modules		In series	15 modules	In parallel	347 strings
Total number of PV modules		Nb. modules	5205	Unit Nom. Power	250 Wp
Array global power		Nominal (STC)	**1301 kWp**	At operating cond.	1159 kWp (50°C)
Array operating characteristics (50°C)		U mpp	410 V	I mpp	2828 A
Total area		Module area	**8489 m²**	Cell area	7413 m²

Inverter		Model	**Sunny Tripower 15000TL-10**		
Original PVsyst database		Manufacturer	SMA		
Characteristics		Operating Voltage	150-800 V	Unit Nom. Power	15.0 kWac
Inverter pack		Nb. of inverters	86 * MPPT 0.80	Total Power	1290 kWac

PV Array loss factors

Thermal Loss factor	Uc (const)	29.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	2.4 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	1.0 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

User's needs : Unlimited load (grid)

Grid-Connected System: Main results

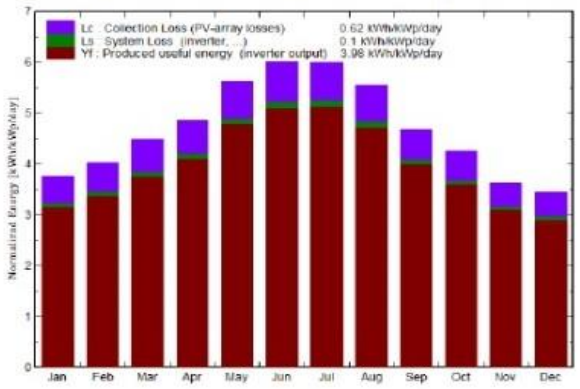
Project : **New Project**

Simulation variant : **New simulation variant**

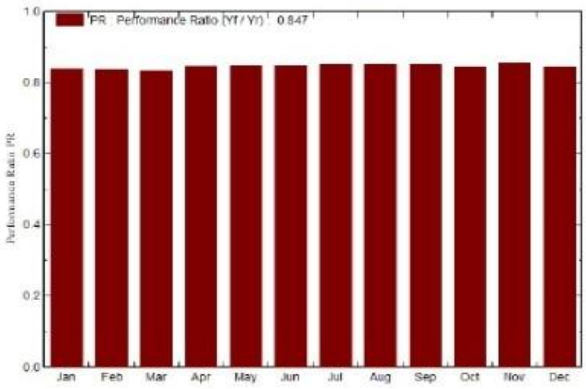
Main system parameters				
System type	**Grid-Connected**			
PV Field Orientation	tilt	30°	azimuth	0°
PV modules	Model	PV-MBA1BG250	Pnom	250 Wp
PV Array	Nb. of modules	5205	Pnom total	**1301 kWp**
Inverter	Model	Sunny Tripower 15000TL-10		15.00 kW ac
Inverter pack	Nb. of units	86.0	Pnom total	**1290 kW ac**
User's needs	Unlimited load (grid)			

Main simulation results				
System Production	**Produced Energy**	**1892 MWh/year**	Specific prod.	1454 kWh/kWp/year
	Performance Ratio PR	84.72 %		

Normalized productions (per installed kWp): Nominal power 1301 kWp



Performance Ratio PR



New simulation variant

Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR
January	154.7	73.03	21.28	116.7	111.0	130.9	127.6	0.840
February	136.4	68.81	22.19	112.9	108.0	125.9	122.9	0.836
March	152.9	70.41	22.11	139.3	134.4	155.3	151.5	0.835
April	146.0	71.79	20.81	145.6	141.1	164.1	160.2	0.846
May	159.1	69.11	20.49	174.8	170.2	197.9	193.2	0.849
June	158.7	61.46	19.48	180.7	176.5	204.4	199.5	0.849
July	165.2	63.22	19.19	186.3	181.9	211.9	206.8	0.853
August	165.3	74.14	19.55	172.1	167.5	195.6	191.0	0.853
September	148.6	82.10	20.03	140.6	135.7	159.9	156.2	0.854
October	155.0	77.97	21.01	132.1	126.7	148.7	145.2	0.845
November	136.8	82.36	20.42	108.9	103.9	124.1	121.2	0.855
December	142.5	77.59	21.18	106.6	101.3	120.2	117.2	0.845
Year	1821.1	871.99	20.64	1716.6	1658.1	1939.0	1892.3	0.847

Legends:
- GlobHor — Horizontal global irradiation
- DiffHor — Horizontal diffuse irradiation
- T Amb — Ambient Temperature
- GlobInc — Global incident in coll. plane
- GlobEff — Effective Global, corr. for IAM and shadings
- EArray — Effective energy at the output of the array
- E_Grid — Energy injected into grid
- PR — Performance Ratio

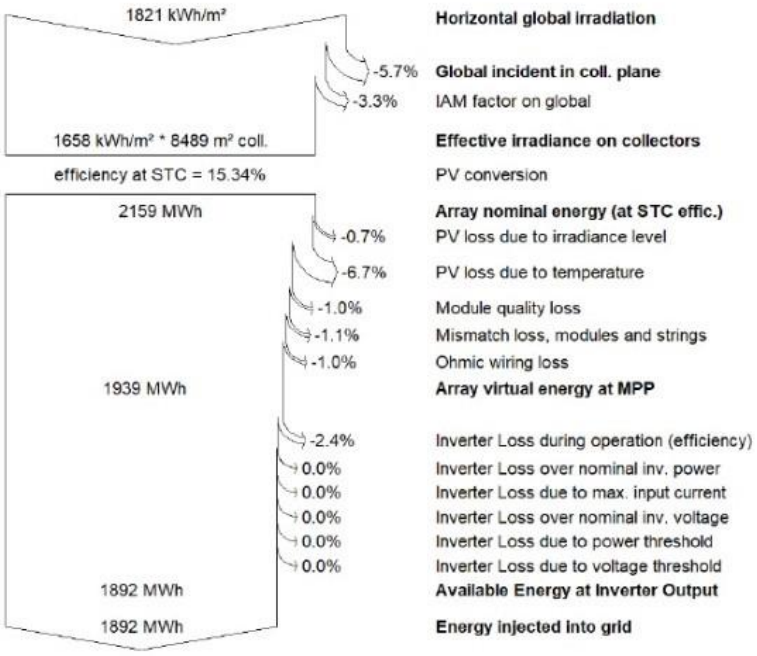
Grid-Connected System: Loss diagram

Project : **New Project**

Simulation variant : **New simulation variant**

Main system parameters	System type	**Grid-Connected**		
PV Field Orientation	tilt	30°	azimuth	0°
PV modules	Model	PV-MBA1BG250	Pnom	250 Wp
PV Array	Nb. of modules	5205	Pnom total	**1301 kWp**
Inverter	Model	Sunny Tripower 15000TL-10		15.00 kW ac
Inverter pack	Nb. of units	86.0	Pnom total	**1290 kW ac**
User's needs	Unlimited load (grid)			

Loss diagram over the whole year



APPENDIX 2

Grid-Connected System: Simulation parameters

Project :	**Herat 1MW**				
Geographical Site	**Herat**			Country	**Afghanistan**
Situation		Latitude	34.34° N	Longitude	62.19° E
Time defined as		Legal Time	Time zone UT+4.5	Altitude	920 m
		Albedo	0.20		
Meteo data:	**Herat**	Meteonorm 7.2 (1981-1990) - Synthetic			

Simulation variant : **New simulation variant**

Simulation date 02/01/21 12h26

Simulation parameters	System type	**No 3D scene defined, no shadings**		
2 orientations	tilts/azimuths	20°/-40° and 10°/-40°		
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	No Shadings			
User's needs :	Unlimited load (grid)			

PV Arrays Characteristics (4 kinds of array defined)

PV module	Si-mono	Model	**JAM78S10-440/MR/1500V**		
Original PVsyst database		Manufacturer	JA Solar		
Sub-array "17*5 @60KTL"		Orientation	#1	Tilt/Azimuth	20°/-40°
Number of PV modules		In series	17 modules	In parallel	55 strings
Total number of PV modules		Nb. modules	935	Unit Nom. Power	440 Wp
Array global power		Nominal (STC)	**411 kWp**	At operating cond.	376 kWp (50°C)
Array operating characteristics (50°C)		U mpp	685 V	I mpp	548 A
Sub-array "18*5 @60KTL"		Orientation	#1	Tilt/Azimuth	20°/-40°
Number of PV modules		In series	18 modules	In parallel	55 strings
Total number of PV modules		Nb. modules	990	Unit Nom. Power	440 Wp
Array global power		Nominal (STC)	**436 kWp**	At operating cond.	398 kWp (50°C)
Array operating characteristics (50°C)		U mpp	726 V	I mpp	548 A
Sub-array "17*5 @60KTL"		Mixed orient.	#1/2: 1/9 strings	Tilt/Azimuth	20°/-40°, 10°/-40°
Number of PV modules		In series	17 modules	In parallel	10 strings
Total number of PV modules		Nb. modules	170	Unit Nom. Power	440 Wp
Array global power		Nominal (STC)	**74.8 kWp**	At operating cond.	68.3 kWp (50°C)
Array operating characteristics (50°C)		U mpp	685 V	I mpp	100 A
Sub-array "18*5@60KTL"		Mixed orient.	#2	Tilt/Azimuth	10°/-40°
Number of PV modules		In series	18 modules	In parallel	10 strings
Total number of PV modules		Nb. modules	180	Unit Nom. Power	440 Wp
Array global power		Nominal (STC)	**79.2 kWp**	At operating cond.	72.3 kWp (50°C)
Array operating characteristics (50°C)		U mpp	726 V	I mpp	100 A
Total Arrays global power		Nominal (STC)	**1001 kWp**	Total	2275 modules
		Module area	**4940 m²**	Cell area	4447 m²

Inverter		Model	**SUN2000-60KTL-M0_400Vac**		
Original PVsyst database		Manufacturer	Huawei Technologies		
Characteristics		Operating Voltage	200-1000 V	Unit Nom. Power	60.0 kWac
				Max. power (=>30°C)	66.0 kWac
Sub-array "17*5 @60KTL"		Nb. of inverters	33 * MPPT 17 %	Total Power	330 kWac
				Pnom ratio	1.25

PVsyst Evaluation mode

Grid-Connected System: Main results

Project : **Herat 1MW**

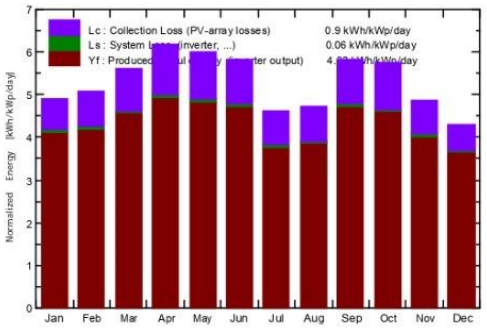
Simulation variant : New simulation variant

Main system parameters	System type	**No 3D scene defined, no shadings**			
PV Field Orientation	2 orientations	Tilt/Azimuth = 20°/-40° and 10°/-40°			
PV modules	Model	JAM78S10-440/MR/1500V	Pnom	440 Wp	
PV Array	Nb. of modules	2275	Pnom total	**1001 kWp**	
Inverter	Model	SUN2000-60KTL-M0_400Vac		60.0 kW ac	
Inverter pack	Nb. of units	13.0	Pnom total	**780 kW ac**	
User's needs	Unlimited load (grid)				

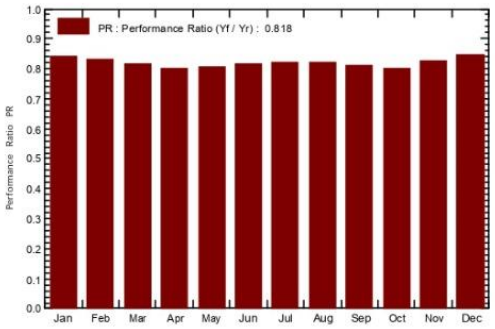
Main simulation results

System Production	**Produced Energy**	**1583 MWh/year**	Specific prod.	1582 kWh/kWp/year
	Performance Ratio PR	81.83 %		

Normalized productions (per installed kWp): Nominal power 1001 kWp



Performance Ratio PR



New simulation variant

Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR
January	126.1	38.3	19.41	152.0	146.9	130.1	128.2	0.843
February	126.7	50.0	22.21	142.0	136.9	119.5	117.8	0.829
March	164.0	78.2	26.41	173.4	167.0	143.7	141.7	0.817
April	183.4	83.6	28.97	185.2	178.4	150.6	148.5	0.801
May	192.0	96.9	30.82	185.8	178.7	152.1	150.0	0.806
June	181.5	101.6	31.09	174.2	167.6	144.0	142.0	0.814
July	148.0	92.8	30.31	142.9	137.3	118.9	117.3	0.820
August	148.0	90.5	29.10	145.9	140.3	121.7	120.0	0.821
September	168.2	76.3	28.91	174.5	168.3	143.4	141.4	0.809
October	159.6	56.6	29.06	177.8	171.7	144.8	142.8	0.802
November	124.1	45.7	24.76	145.6	140.4	122.2	120.5	0.827
December	112.0	41.6	20.81	133.7	128.9	114.7	113.1	0.845
Year	1833.6	852.1	26.84	1933.0	1862.4	1605.7	1583.4	0.818

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_Grid	Energy injected into grid
GlobInc	Global incident in coll. plane	PR	Performance Ratio

PVsyst Evaluation mode

Grid-Connected System: Simulation parameters

Sub-array "18*5 @60KTL"	Nb. of inverters	33 * MPPT 17 %	Total Power	330 kWac
			Pnom ratio	1.32
Sub-array "17*5 @60KTL"	Nb. of inverters	6 * MPPT 17 %	Total Power	60 kWac
			Pnom ratio	1.25
Sub-array "18*5@60KTL"	Nb. of inverters	6 * MPPT 17 %	Total Power	60 kWac
			Pnom ratio	1.32
Total	Nb. of inverters	13	Total Power	780 kWac

PV Array loss factors

Array Soiling Losses			Loss Fraction	2.5 %
Thermal Loss factor	Uc (const)	17.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Array#1	21 mOhm	Loss Fraction	1.5 % at STC
	Array#2	22 mOhm	Loss Fraction	1.5 % at STC
	Array#3	114 mOhm	Loss Fraction	1.5 % at STC
	Array#4	121 mOhm	Loss Fraction	1.5 % at STC
	Global		Loss Fraction	1.5 % at STC
LID - Light Induced Degradation			Loss Fraction	1.0 %
Module Quality Loss			Loss Fraction	-0.3 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %

Incidence effect (IAM): User defined profile

0°	30°	50°	60°	70°	80°	90°
1.000	1.000	1.000	1.000	0.950	0.760	0.000

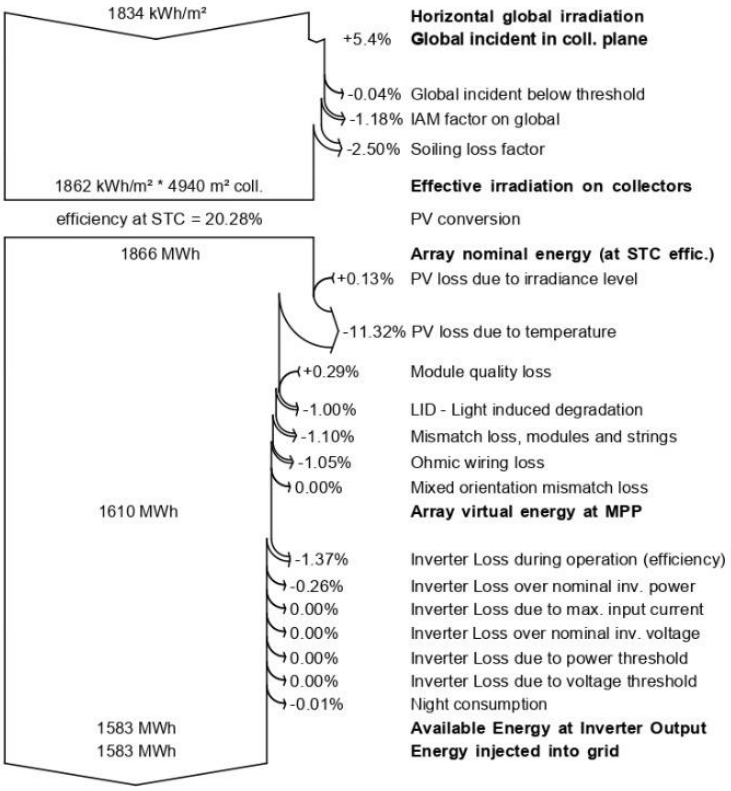
Grid-Connected System: Loss diagram

Project : **Herat 1MW Ceramics**

Simulation variant : **New simulation variant**

Main system parameters	System type	**No 3D scene defined, no shadings**		
PV Field Orientation	2 orientations	Tilt/Azimuth = 20°/-40° and 10°/-40°		
PV modules	Model	JAM78S10-440/MR/1500V	Pnom	440 Wp
PV Array	Nb. of modules	2275	Pnom total	**1001 kWp**
Inverter	Model	SUN2000-60KTL-M0_400Vac		60.0 kW ac
Inverter pack	Nb. of units	13.0	Pnom total	**780 kW ac**
User's needs	Unlimited load (grid)			

Loss diagram over the whole year



PVsyst Evaluation mode

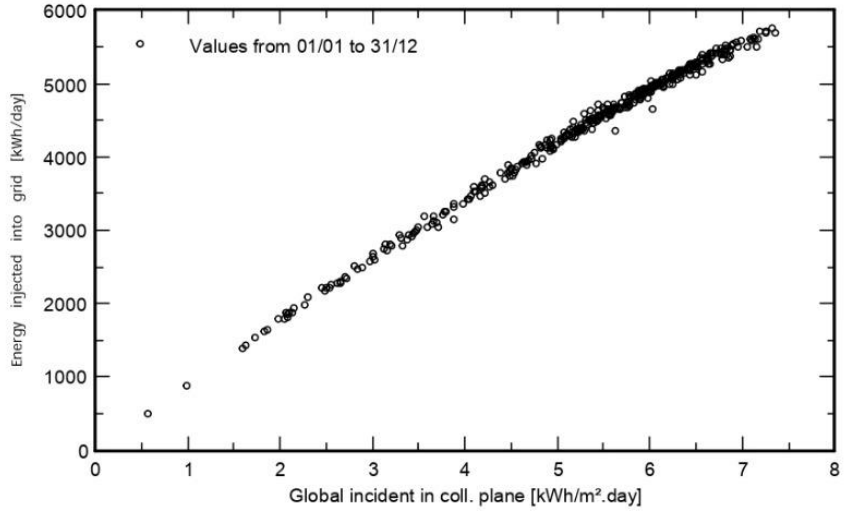
Grid-Connected System: Special graphs

Project : **Herat 1MW Ceramics**

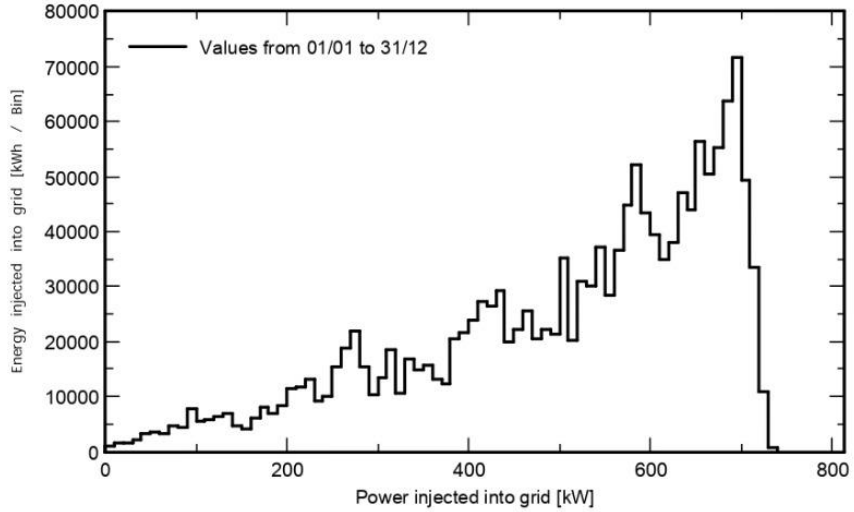
Simulation variant : **New simulation variant**

Main system parameters	System type	**No 3D scene defined, no shadings**		
PV Field Orientation	2 orientations	Tilt/Azimuth = 20°/-40° and 10°/-40°		
PV modules	Model	JAM78S10-440/MR/1500V	Pnom	440 Wp
PV Array	Nb. of modules	2275	Pnom total	**1001 kWp**
Inverter	Model	SUN2000-60KTL-M0_400Vac		60.0 kW ac
Inverter pack	Nb. of units	13.0	Pnom total	**780 kW ac**
User's needs	Unlimited load (grid)			

Daily Input/Output diagram



System Output Power Distribution



PVsyst Evaluation mode

Grid-Connected System: P50 - P90 evaluation

Project : **Herat 1MW**

Simulation variant : New simulation variant

Main system parameters	System type	**No 3D scene defined, no shadings**		
PV Field Orientation	2 orientations	Tilt/Azimuth = 20°/-40° and 10°/-40°		
PV modules	Model	JAM78S10-440/MR/1500V	Pnom	440 Wp
PV Array	Nb. of modules	2275	Pnom total	**1001 kWp**
Inverter	Model	SUN2000-60KTL-M0_400Vac		60.0 kW ac
Inverter pack	Nb. of units	13.0	Pnom total	**780 kW ac**
User's needs	Unlimited load (grid)			

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

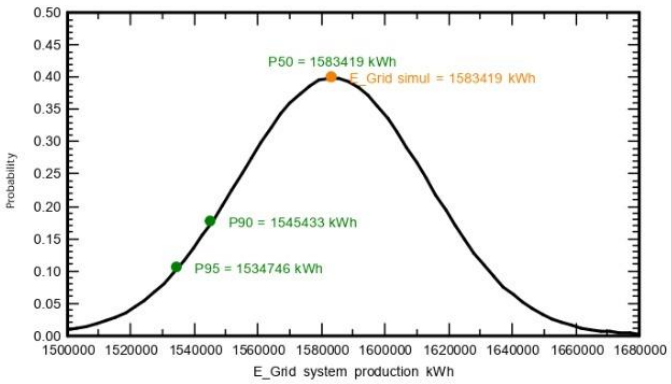
Meteo data source		Meteonorm 7.2 (1981-1990)		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**30 MWh**
	P50	**1583 MWh**
	P90	**1545 MWh**
	P95	**1535 MWh**

Probability distribution



APPENDIX 3

Grid-Connected System: Simulation parameters

Project :	**Herat 2MW**				
Geographical Site	**Herat**			Country	**Afghanistan**
Situation		Latitude	34.34° N	Longitude	62.19° E
Time defined as		Legal Time	Time zone UT+4.5	Altitude	920 m
		Albedo	0.20		
Meteo data:	**Herat** Meteonorm 7.2 (1981-1990) - Synthetic				

Simulation variant :	**New simulation variant**				
	Simulation date	02/01/21 12h04			
Simulation parameters	System type	**No 3D scene defined, no shadings**			
2 orientations	tilts/azimuths	20°/-40° and 18°/-40°			
Models used	Transposition	Perez		Diffuse	Perez, Meteonorm
Horizon	Free Horizon				
Near Shadings	No Shadings				
User's needs :	Unlimited load (grid)				

PV Arrays Characteristics (3 kinds of array defined)					
PV module	Si-mono	Model	**JAM78S10-440/MR/1500V**		
Original PVsyst database		Manufacturer	JA Solar		
Sub-array "17*10 @60KTL"		Orientation	#1	Tilt/Azimuth	20°/-40°
Number of PV modules		In series	17 modules	In parallel	170 strings
Total number of PV modules		Nb. modules	2890	Unit Nom. Power	440 Wp
Array global power		Nominal (STC)	**1272 kWp**	At operating cond.	1161 kWp (50°C)
Array operating characteristics (50°C)		U mpp	685 V	I mpp	1694 A
Sub-array "16*2 @60KTL"		Orientation	#2	Tilt/Azimuth	18°/-40°
Number of PV modules		In series	16 modules	In parallel	20 strings
Total number of PV modules		Nb. modules	320	Unit Nom. Power	440 Wp
Array global power		Nominal (STC)	**141 kWp**	At operating cond.	129 kWp (50°C)
Array operating characteristics (50°C)		U mpp	645 V	I mpp	199 A
Sub-array "17*8 @60KTL"		Orientation	#2	Tilt/Azimuth	18°/-40°
Number of PV modules		In series	17 modules	In parallel	80 strings
Total number of PV modules		Nb. modules	1360	Unit Nom. Power	440 Wp
Array global power		Nominal (STC)	**598 kWp**	At operating cond.	546 kWp (50°C)
Array operating characteristics (50°C)		U mpp	685 V	I mpp	797 A
Total Arrays global power		Nominal (STC)	**2011 kWp**	Total	4570 modules
		Module area	**9923 m²**	Cell area	8933 m²

Inverter		Model	**SUN2000-60KTL-M0_400Vac**		
Original PVsyst database		Manufacturer	Huawei Technologies		
Characteristics		Operating Voltage	200-1000 V	Unit Nom. Power	60.0 kWac
				Max. power (=>30°C)	66.0 kWac
Sub-array "17*10 @60KTL"		Nb. of inverters	17 units	Total Power	1020 kWac
				Pnom ratio	1.25
Sub-array "16*2 @60KTL"		Nb. of inverters	11 * MPPT 17 %	Total Power	110 kWac
				Pnom ratio	1.28
Sub-array "17*8 @60KTL"		Nb. of inverters	49 * MPPT 17 %	Total Power	490 kWac
				Pnom ratio	1.22
Total		Nb. of inverters	27	Total Power	1620 kWac

PV Array loss factors

PVsyst Evaluation mode

Grid-Connected System: Main results

Project : **Herat 2MW**

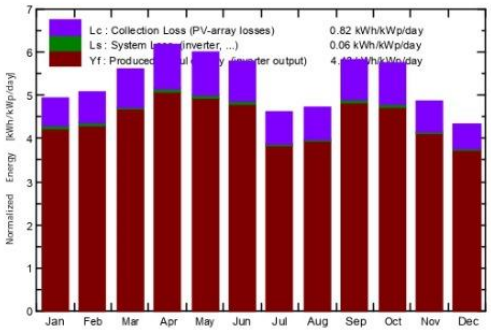
Simulation variant : New simulation variant

Main system parameters	System type	**No 3D scene defined, no shadings**		
PV Field Orientation	2 orientations	Tilt/Azimuth = 20°/-40° and 18°/-40°		
PV modules	Model	JAM78S10-440/MR/1500V	Pnom	440 Wp
PV Array	Nb. of modules	4570	Pnom total	**2011 kWp**
Inverter	Model	SUN2000-60KTL-M0_400Vac		60.0 kW ac
Inverter pack	Nb. of units	27.0	Pnom total	**1620 kW ac**
User's needs	Unlimited load (grid)			

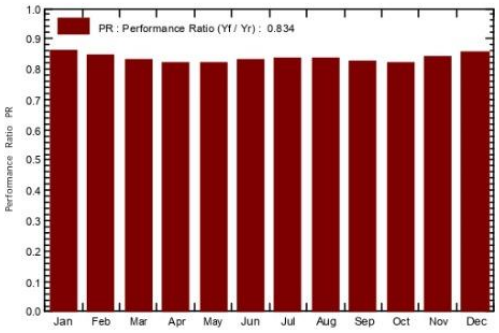
Main simulation results

System Production	**Produced Energy**	**3249 MWh/year**	Specific prod.	1616 kWh/kWp/year
	Performance Ratio PR	83.43 %		

Normalized productions (per installed kWp): Nominal power 2011 kWp



Performance Ratio PR



New simulation variant

Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR
January	126.1	38.3	19.41	153.0	147.9	268.1	264.4	0.859
February	126.7	50.0	22.21	142.5	137.5	245.7	242.3	0.846
March	164.0	78.2	26.41	173.7	167.3	294.9	290.9	0.833
April	183.4	83.6	28.97	185.2	178.4	309.6	305.4	0.820
May	192.0	96.9	30.82	185.6	178.5	311.1	307.0	0.823
June	181.5	101.6	31.09	173.9	167.3	293.6	289.8	0.829
July	148.0	92.8	30.31	142.6	137.1	242.3	239.1	0.834
August	148.0	90.5	29.10	145.8	140.2	248.3	245.0	0.836
September	168.2	76.3	28.91	174.8	168.5	294.6	290.7	0.827
October	159.6	56.6	29.06	178.5	172.4	298.5	294.5	0.821
November	124.1	45.7	24.76	146.4	141.2	251.1	247.7	0.842
December	112.0	41.6	20.81	134.5	129.7	235.4	232.2	0.858
Year	1833.6	852.1	26.84	1936.6	1866.1	3293.4	3249.0	0.834

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_Grid	Energy injected into grid
GlobInc	Global incident in coll. plane	PR	Performance Ratio

PVsyst Evaluation mode

Grid-Connected System: Simulation parameters

Array Soiling Losses			Loss Fraction	2.5 %
Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Array#1	6.7 mOhm	Loss Fraction	1.5 % at STC
	Array#2	54 mOhm	Loss Fraction	1.5 % at STC
	Array#3	14 mOhm	Loss Fraction	1.5 % at STC
	Global		Loss Fraction	1.5 % at STC
LID - Light Induced Degradation			Loss Fraction	1.0 %
Module Quality Loss			Loss Fraction	-0.3 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %

Incidence effect (IAM): User defined profile

0°	30°	50°	60°	70°	80°	90°
1.000	1.000	1.000	1.000	0.950	0.760	0.000

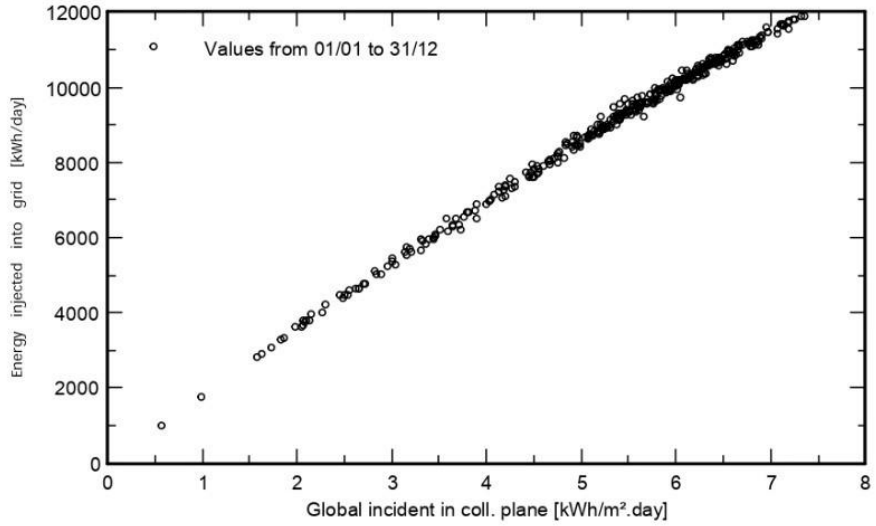
Grid-Connected System: Special graphs

Project : **Herat 2MW**

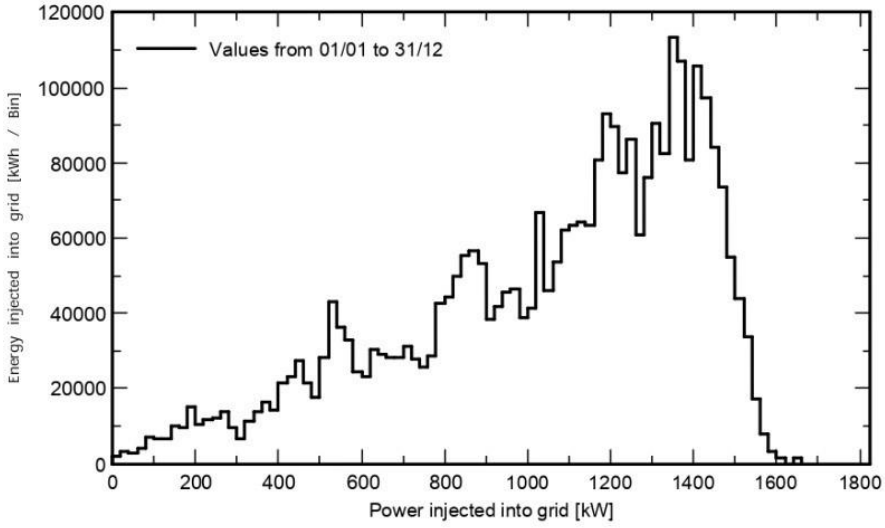
Simulation variant : **New simulation variant**

Main system parameters				
PV Field Orientation	System type	**No 3D scene defined, no shadings**		
	2 orientations	Tilt/Azimuth = 20°/-40° and 18°/-40°		
PV modules	Model	JAM78S10-440/MR/1500V	Pnom	440 Wp
PV Array	Nb. of modules	4570	Pnom total	**2011 kWp**
Inverter	Model	SUN2000-60KTL-M0_400Vac		60.0 kW ac
Inverter pack	Nb. of units	27.0	Pnom total	**1620 kW ac**
User's needs	Unlimited load (grid)			

Daily Input/Output diagram



System Output Power Distribution



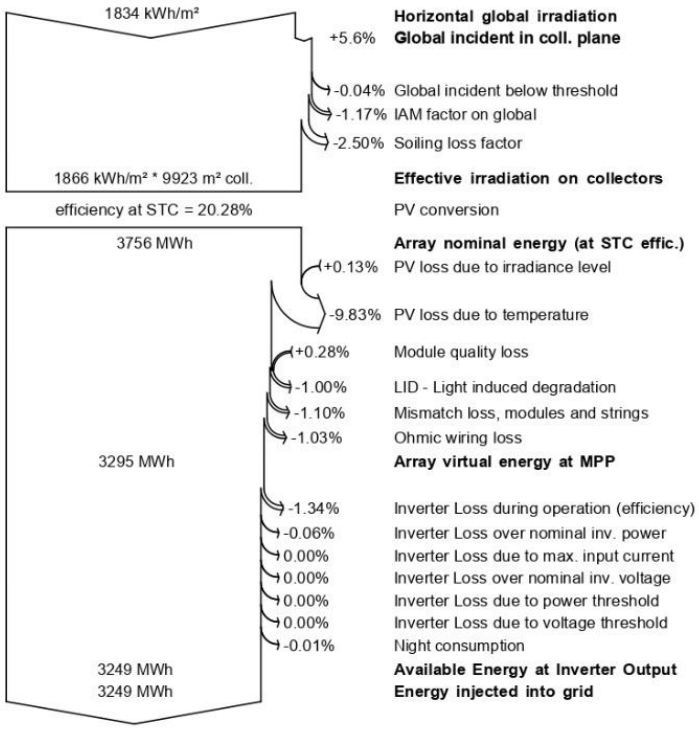
Grid-Connected System: Loss diagram

Project : **Herat 2MW**

Simulation variant : **New simulation variant**

Main system parameters	System type	**No 3D scene defined, no shadings**		
PV Field Orientation	2 orientations	Tilt/Azimuth = 20°/-40° and 18°/-40°		
PV modules	Model	JAM78S10-440/MR/1500V	Pnom	440 Wp
PV Array	Nb. of modules	4570	Pnom total	**2011 kWp**
Inverter	Model	SUN2000-60KTL-M0_400Vac		60.0 kW ac
Inverter pack	Nb. of units	27.0	Pnom total	**1620 kW ac**
User's needs	Unlimited load (grid)			

Loss diagram over the whole year



PVsyst Evaluation mode

Grid-Connected System: P50 - P90 evaluation

Project : **Herat 2MW**

Simulation variant : **New simulation variant**

Main system parameters	System type	**No 3D scene defined, no shadings**		
PV Field Orientation	2 orientations	Tilt/Azimuth = 20°/-40° and 18°/-40°		
PV modules	Model	JAM78S10-440/MR/1500V	Pnom	440 Wp
PV Array	Nb. of modules	4570	Pnom total	**2011 kWp**
Inverter	Model	SUN2000-60KTL-M0_400Vac		60.0 kW ac
Inverter pack	Nb. of units	27.0	Pnom total	**1620 kW ac**
User's needs	Unlimited load (grid)			

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

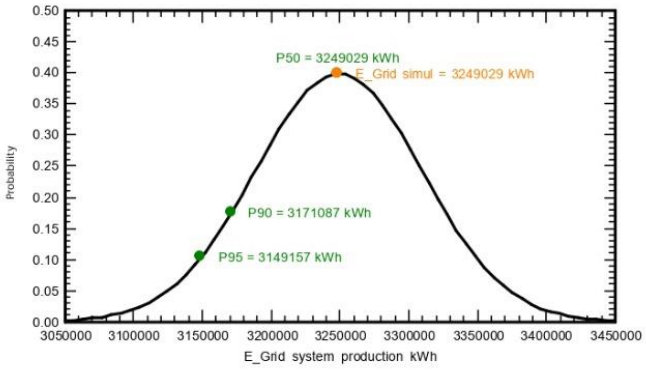
Meteo data source		Meteonorm 7.2 (1981-1990)	
Meteo data	Kind	TMY, multi-year	
Specified Deviation	Climate change	0.0 %	
Year-to-year variability	Variance	0.5 %	

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**61 MWh**
	P50	**3249 MWh**
	P90	**3171 MWh**
	P95	**3149 MWh**

Probability distribution



RESUME

Personal Information

Name: khalil Ahmad MANSOURY

Education

2018-2021 Master Of electrical and electronic, Istanbul Aydin Unıversity, Turkey.

2011-2015 Bachelor Of Civil Engineering, Herat Unıversıty, Afghanıtan

Nationality: Afghan

Work Experience

2011-2017:

Mathematics teacher in Pishtaz olom in Herat afghanistan

2015-2016:

Mathematics teacher in Qalib University in Herat afghanistan

2018-2019:

Mathematics assesstand profesor in istanbul aydin university

2018-2021

Mathematics teacher in Galta education center in istanbul turkeye

Language Skills

Persian	Pashto	English	Turkish
Excellent	Good	Excellent	Good