HEURISTIC ANALYSIS OF SOLAR-POWERED ELECTRIC VEHICLE CHARGING STATION

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

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CERTIFICATION

This is to certify that this thesis entitled "**HEURISTIC ANALYSIS OF SOLAR-POWERED ELECTRIC VEHICLE CHARGING STATION**" is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

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DECLARATION

This thesis, or any portion of it, has not been presented to any other institution for the granting of a degree or certificate.

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DEDICATION

To Our Parents & Teachers

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LIST OF ABBREVIATIONS

EV	Electric Vehicle
PV	Photovoltaics
MPPT	Maximum power point tracking
V2G	Vehicle-To-Grid
PID	Proportional–Integral–Derivative
ANN	Artificial Neural Networks
SVM	Support Vector Machines
E-cars	Electric cars
O_3	Ozone
PSC	Perovskite Solar Cell
ICE	Internal Combustion Engines
RES	Renewable Energy Resources
UV	Ultra Violet
LED	Light Emitting Diode
DC	Direct Current
AC	Alternative Current

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ABSTRACT

In this research paper, Solar power-based EV Station arrangement has been developed for Dhaka city, Bangladesh. ANN method is used of collect Solar Irradiance. Plant area allocation data set has been prepared with the help of the google earth. The input parameter for the Solar panel are: Normal Power (AC), Energy, Vac, Vdc, Pac, Iac, Fgrid etc. Final calculation shows optimal number of EV charge at a time & charging time on fast 50 kWh & domestic 16.5 kWh charger. Charging station has been arranged system server, control, billing system & remote access. Storages, inverters, MPPT, Anti-Island, has also been noticed in this paper. The proposed Internal AC Natty Grid is most feasible for non-stop power supply to EV charging station. On the grid, created by 3 nos. Fast EV station, single roof top panel array, EV parking lot, storage, large scale solar plant & meter monitored national grid. V2G is the most effectual method that help solar based stable voltage & power supply. As a result, Solar power 1300.902 kWh produce for 22 Acre plant & this power charge 42 EVs at a time. Plant initial cost for 22 Acre land is BDT 21,172,500 tk. To charging Tesla-S model Electric Car, 50 kWh charger 1.5 hrs & 16.5 kWh charger 5 hrs take time fully charged 75 kWh battery. Tesla-S car's battery calculation shows that 230.1651 km running per watt which easily provide stable power supply by our methodological Solar based EV station.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Nowadays we are move towards the renewable energy consumption.

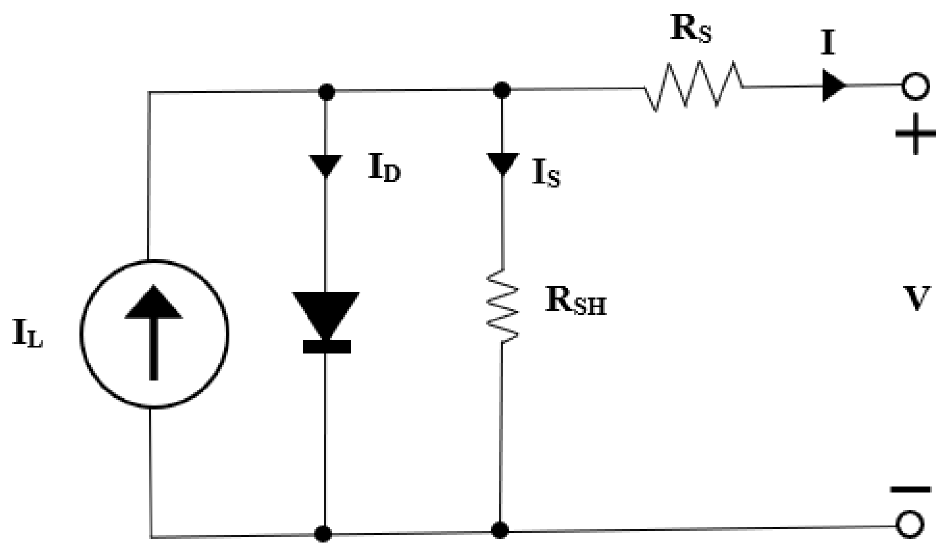

Fig 1.1: Solar Cell Diagram

1st law of thermodynamics, generally known as the principle of sustainability of energy, asserts that energy cannot be generated or destroyed; instead, it can only one shape may be turned into some other. Solar power is the heat and light released by the sun, which is a tremendous source of energy produced by nuclear fusion at its core. The sun's surface receives the energy emitted by the nuclear explosion.

The planet receives around 3,850,000 EJ of solar energy each year, the vast majority of which is light energy. Only a few heat and light systems use heat energy for heating, whereas the others convert or transform light into electrical energy. In the current circumstances, the energy crisis is a significant and crucial issue that must be addressed. It's to see whether more generators can be installed or if more generators can be added.

The usage of fossil fuels for domestic transportation is quickly expanding in the present environment, indicating that a danger is imminent. Contamination of the environment and health risks related to living surroundings are some of the negative repercussions of adopting such vehicles and procedures. In line with this, E-vehicles, which are environmentally friendly, are the upcoming mode of transportation. The usage of electric energy for propulsion is a disadvantage of this form of transportation, since it will add to the current power system setup and infrastructure.

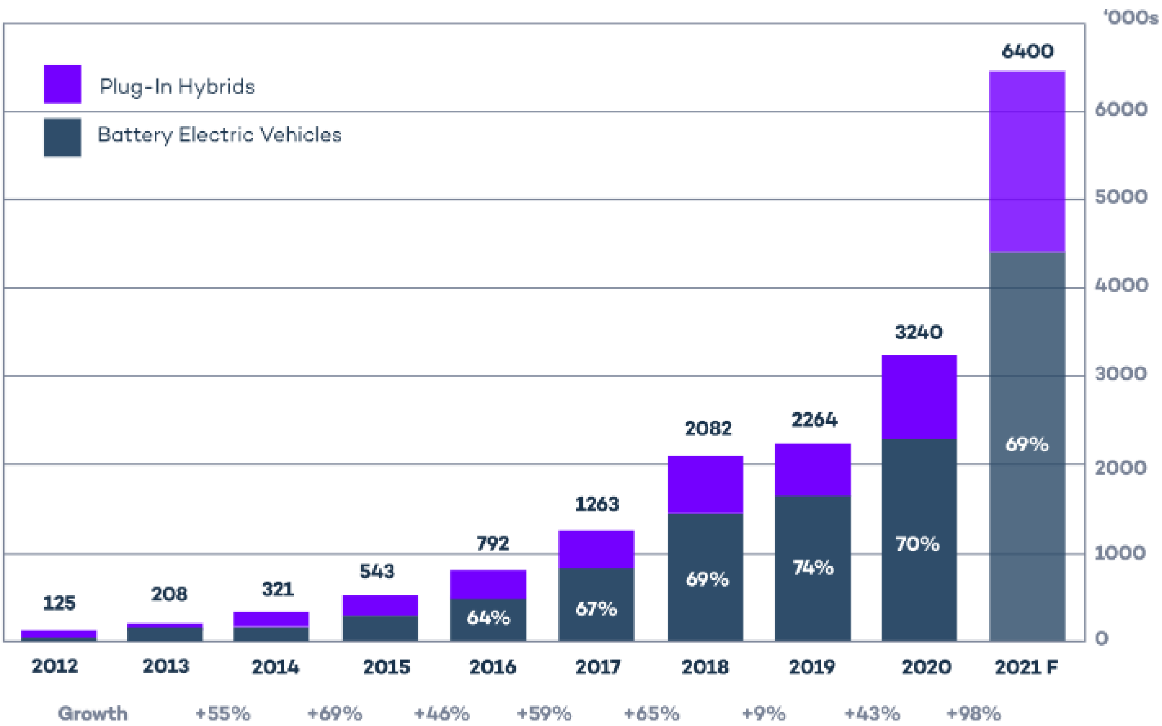

Fig 1.2: EV & Plug-In-Hybrids growth rates

One of several primary issues confronting academics working to provide power and heat to billions of people on the planet is the production of sustainable energy supplies. The ever-increasing global energy demand has aggravated the availability of energy supplies. Furthermore, present coal and oil-based energy generation is harmful to the environment As a result, technology development is required. As address these issues, renewable and clean energy resources should be used. Renewable energy resources have shown indisputable advantages in terms of urgent needs. hereditary and environmental perspectives that might be seen as power's future prospects.

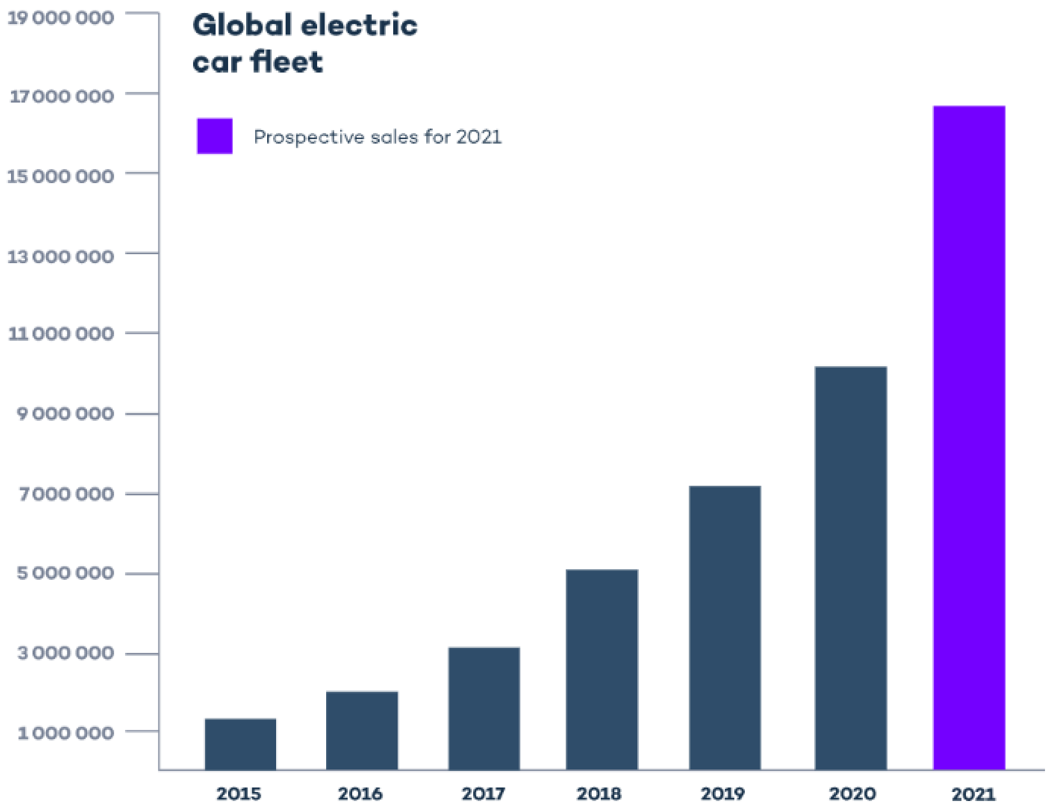

Fig 1.3: EV Sales per year

All types of energies are predicted to account for a large amount of the globe's main energy. By the next couple decades There are several types of renewable energy sources, including as Geothermal, biofuel, tidal, and other renewable energy sources exist, but solar energy are more readily accessible. In this location, this kind is more available than others . Bangladesh, fortunately, has an abundance of natural resources. There is a lot of solar irradiance capacity that can be used to generate renewable energy. a resource for addressing the energy problem Solar energy data may generally be recorded using solar measuring equipment. While these gadgets are not accessible in certain distant or rural areas, they are accessible in some urban areas. Solar installation has a lot of promise. Due to the lack of actual measurements, they are also not generally accessible. The measurement equipment's cost, maintenance, and calibration needs.

EVs are our future vehicle which is more neat & clean. Cleaner air, no congestion pricing, reduced production costs, green power rates, improved performance car, government financing, free transport parking, and less traffic noise all inspire us to live better lives and have a brighter future for all animals on the planet.

1.2 Background Study

Globally, the usage of electric vehicles will avoid additional fifty million tonnes of CO_2 equivalent of GHC releases over the world in 2020. In actuality, all emissions from electric vehicles are created during the manufacturing process, however this reasoning does not apply to internal combustion engines (ICE). In the larger scheme of things, it is reasonable to conclude that the public argument about the environmental effect of EVs vs. ICE automobiles is tilting toward EVs. [1]

While it is true that electric vehicles increase power usage, this might be the energy utilities' saving grace in the future. Electric cars will have installed over 30 TWh of battery storage capacity by the 2040s. For utilities, this implies that EVs provide low-cost energy storage, with no upfront investment and minimal operational expenses.

According to the Stated Policies Scenario, worldwide electric vehicle stock (excluding two- and three-wheelers) would reach around 145 million cars by 2030, accounting for 7% of the global vehicle fleet.

The second and more audacious — forecasts that by 2030, 30 percent of all cars will be electric, with the exception of two-wheelers. In absolute terms, this would imply that worldwide sales would exceed 43 million, nearly twice the Stated Policies Scenario's projection.

1.2.1 Photovoltaics Power

Photovoltaic cell (PV), is a device that uses the photoconductivity to transform sunlight to electricity. Charles Fritts invented the first solar cell in the 1880s. Among those who grasped the significance of this finding was German entrepreneur Ernst Werner von Siemens. Although original selenium cells processed under 1% of light output into electricity, German engineer bruno lange developed a silver selenide photocellcell in its place of copper oxide in 1931.

PV system, provides direct current (DC) electricity that varies with the intensity of sunshine. Inverters are often used to convert this to certain required voltages or alternating current (AC) for practical usage. Inside the modules, many solar cells are linked. Modules are joined together to create arrays, which are then connected to an inverter, which generates power at the specified voltage and frequency/phase for AC.

Photovoltaics were first used simply as a source of energy, from a calculation powered by a voltaic cell to rural houses supplied by an off-grid rooftop PV system. Concentrated solar power facilities were first established commercially in the 1980s. Since then, as the cost of solar electricity has reduced, the number of grid-interconnected solar PV systems has expanded more or less rapidly. Thousands of installations and gigawatt-scale solar power plants have been erected, and more are on the way. Solar PV has quickly evolved into a low-cost, low-carbon technology.

Solar power would provide around 20% of global energy consumption in 2021, according to the International Energy Agency's "Net Zero by 2050" scenario, and solar would be the world's biggest source of electricity. China has the most solar panels installed. Solar power will provide 3.5 percent of the world's energy in 2020, up from less than 3% the previous year. Utility-scale solar power had an unsubsidized levelized cost of energy of roughly $36/MWh in 2020, and installation cost around a dollar per DC watt. [2]

1.2.2 Perovskite Solar cell

A perovskite solar cell (PSC) is a form of solar cell that uses a perovskite-structured molecule as the light-harvesting active region, most typically a hybrid organic-inorganic lead or tin halide-based material. Perovskite materials like methylammonium lead halides and all-inorganic cesium lead halides are inexpensive and easy to make.

In mono junction architectures, solar cell cost savings of laboratory-scale devices using these materials have expanded from 3.8% in 2009 to 25.7 percent in 2021, and in silicon-based tandem cells, to 29.8%, exceeding the maximum efficiency achieved in mono junction silicon solar cells. As of 2016, perovskite solar cells were the extremely fast solar technology. Perovskite solar cells have become economically appealing due to its potential for even greater efficiency and extremely cheap manufacturing costs. Their micro- and macro stability are important challenges and research topics. [3]

1.2.2 History of EV

In 2019, The number of electric vehicle on the road was just 9% higher than in 2018. This was a significant departure from the preceding six years' productivity growth, which ranged from 46% to 69 percent.

The reasons for this transition were sales declines in the two major markets, China and the United States, in the second half of 2019. Despite static growth in the two biggest countries, worldwide EV sales increased, thanks in large part to Europe, which witnessed a 44 percent increase.

In terms of total new automobile registrations, the year 2020 did not show a significant increase. The COVID-19 epidemic, as well as the subsequent economic crisis, had a significant impact on the worldwide automobile industry.

During COVID-19 at the start of the year, the picture for worldwide EV sales in 2020 was fairly uncertain. Despite the epidemic and its consequences, however, the year 2020 turned out to be remarkably good. Worldwide EV sales increased by 43% from 2019 to 2020, with the global electric vehicle industry's market share reaching a new high of 4,6%. [7]

1.3 Problem statement

Consumers should be aware of the CO_2 emissions produced by fossil fuel-powered automobiles, as well as the government's efforts to promote E-vehicles via subsidies. The need for electrical energy is growing at an exponential pace, which is critical for many areas of contemporary living. The same may be seen in the exponential rise of the world's population. As a result, energy sources will play a critical role. Current methods in this area have the potential and priority to decrease greenhouse gas emissions, enhance energy efficiency in homes, workplaces, and enterprises, and promote energy marketing, energy management, conservation, and security. These also include finding practical and cheap alternative energy sources, building cleaner and more efficient vehicles and systems, as well as energy policy and strategy. Excessive fossil fuel exploitation or depletion, as well as environmental deterioration, are the key concerns that the world is now experiencing. To address these issues, renewable energy has lately gotten a lot of attention because of its environmental advantages. Renewable energy will face stiff competition from fossil fuels shortly the near future.

1.4 Objectives

The major goals of the approach "HEURISTIC ANALYSIS OF SOLAR-POWERED ELECTRIC VEHICLE CHARGING STATION" are to investigate the capabilities and use of solar energy for E-cars, hence lowering the cost of electric vehicles. Reducing fossil fuel usage while also protecting the environment. The traditional automobiles alternative energy sources, as well as the possibility for using alternative energy sources vehicle technology like as work on electric/hybrid cars is required. Design or test a plug-in electric-powered vehicle that meets the following goals by converting a normal car with a suitable motor and battery.

The following objectives are:

- Proper usage of solar power consumption by EV
- Modeling of Gird connected EV charging Station
- Automated billing collection model
- EV charger variation
- Energy conversion

1.5 Related Field

Solar, Storage, EV, Smart Grid, Irradiance etc. are related field of this research.

1.5.1 Prediction of Solar Irradiance

Solar radiation estimation has long been a hot issue in the renewable energy industry. Forecasting aids in the development and management of solar systems, as well as provides several financial benefits to power companies. Artificial neural networks (ANN), support vector machines (SVM), and regression moving averages may all be used to forecast irradiance. However, they either lack accuracy due to their inability to capture lengthy reliance or are incompatible with large data due to sustainability. [10]

1.5.2 Solar Powered Mini Grid

Mini-grids are small electrical circuits (between 10 kW and 10 MW) supported by one or more generating sources such as photovoltaic panels, diesel generators, and batteries that may deliver energy 24 hours a day, seven days a week to many clients in a village setting at a low cost.

Several industrialized, rising nations' electric networks began off as mini-grids. After then, the individual electrical systems were linked and merged into a bigger grid. Energy security, affordability to energy, and the depletion of energy supplies are all major concerns nowadays. Mini-grids work on a tiny level and can link to a bigger grid in the upcoming, considering this technology appealing for assuring the dependability of renewables. Because centralized electricity is not practical in many regions owing to modest distributed loads in distant areas, a mini-grid offers a viable option with more stability than self - contained systems. Moreover, transport remains a difficulty for physically remote places, necessitating off-grid solutions in certain cases. Due to the long ranges that interconnectors must travel to reach rural regions from central generating, up to 30% of electricity might be wasted before proceeding to the next phase, lowering the total electrical system's efficiency. As a result, regional mini-grids including on generating provide a viable option. [11]

1.6 Thesis Outline

This proposition is coordinated as follows:

Chapter 1: Introduction

Chapter 2: Data Collection & Acquisition

Chapter 3: Methodology

Chapter 4: Results & Discussions

Chapter 5: Conclusions and Recommendations

CHAPTER 2

DATA COLLECTION & ACQUISITION

2.1 Introduction

In this chapter, collected all data , tables, values. These data collected many ways like ANN analysis, real data by inverter, research paper etc.

2.2 Solar Data

Table 2.1: Solar Power data table

Terms	Value
Normal Power (AC)	47.7 W
Energy (Solar)	3.3 kWh
Vdc	160 V
Pac	46.8 W
Vac	229.2 V
Iac	0.7 A
Fgrid	50 Hz

2.3 Solar Panel Capacity

Table 2.2: Solar Panel Capacity

Terms	Output Power (W)	Pices	Total Output Power (W)
Panel-1	45	2 nos.	90
Panel-2	60	2 nos.	120
Panel-3	100	11 nos.	1100
Panel-4	85	1 nos.	85
Total Capacity			1195 W

2.4 Plant Area

Implemented solar plant, rooftop, parking etc. area selection by Google Earth. In Dhaka city, shortly 22.04 acre area selected for this research. All data are given below by tabular form.

Table 2.3: Plant Area by google earth

Location Name	Area
Tejgoan CSD Godown Rooftop	4.02 Acr
Survey of Bd Rooftop	0.49 Acr
Dep. Of Land Record Rooftop	0.49 Acr
Bd Stationary Office Rooftop	2.56 Acr
BUTEX Rooftop	0.42 Acr
Food Engineering Dhaka polytechnic Rooftop	2.03Acr
Mohakhali Bus Terminal Rooftop	1.08 Acr
Foot over Bridge Rooftop	0.88 Acr
Solar power Plant (Purbachol)	10.07 Acr
Total	22.04 Acr

CHAPTER 3

METHODOLOGY

3.1 Introduction

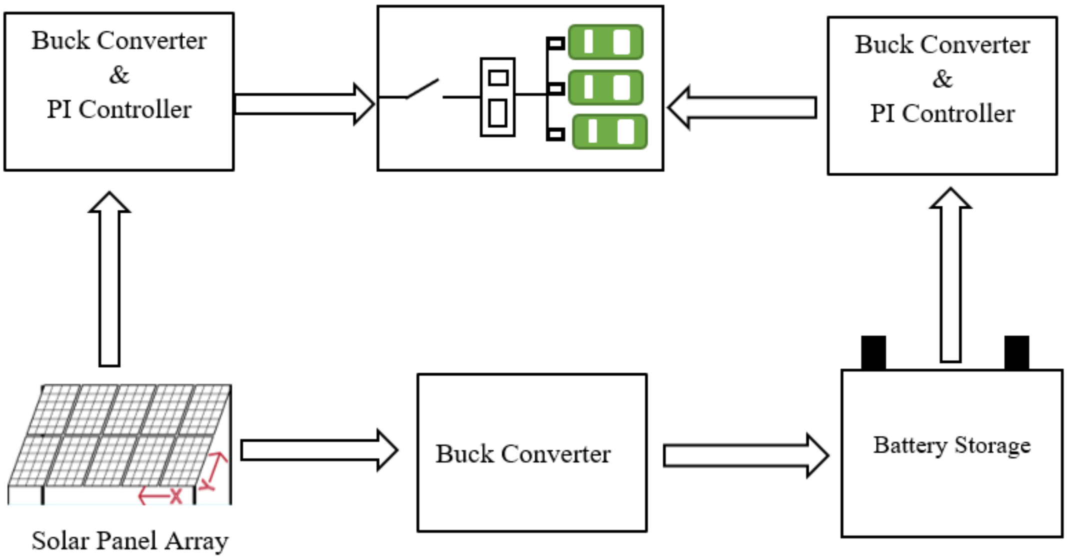

Fig 3.1: Block diagram of solar EV station complex

As methodology, we proposed whole soler power EV charging station block diagram model, Internal AC Natty Grid, Battery Storage, V2G system etc.

For installing mini roof top solar array area selection by Google earth. It also help for launch a large open field type solar plant for area selection and better allocation.

3.2 Solar Plant

Solar power plants harness solar thermal energy, which is copious, readily accessible, intermittent, and inexpensive. Using solar panels, this heat energy is converted into electrical activity. This is a particular sort of solar power plant. Simply said, a huge number of panels are erected in an ideal arrangement to gather solar radiation and convert it into electricity that is sent into the grid. Another sort of solar power plant is the concentrated solar power plant, which is made up of mirrors or lenses that are strategically placed to concentrate gathered heat to a single location. This heat is then used to power a steam turbine, which produces electricity. The most prevalent kind of solar power plant, however, is the classic photovoltaic (PV) option. Each region's solar capacity varies according on sun irradiance and accessible land. Because the source of energy is the sun, which is clean, renewable, plentiful, and affordable, this sort of power plant is considered a renewable choice. Solar PV farms may be installed on the ground or on the roof.

Furthermore, ground-mounted devices might be fixed arrays or equipped with a single or dual-axis tracking system. The modules are typically oriented toward the equator, with a tilt angle somewhat lower than the latitude of the location. To get the best power output, experiment with different tilt angles. Axis trackers are used to maximize performance by allowing panels to monitor the sun as it shifts orientation during the day, as seen in this picture of a solar power plant. Solar panels transform the thermal energy into d.c (DC) power once it has been gathered. Another equipment in the solar array, the inverter, is required to convert this to alternating (AC) energy. Inverters are classified into two types: centralized and strung inverters. Centralized inverters have a greater capacity, often in the region of 1 MW, while inverters have a much smaller capacity, typically in the level of 10 kW.

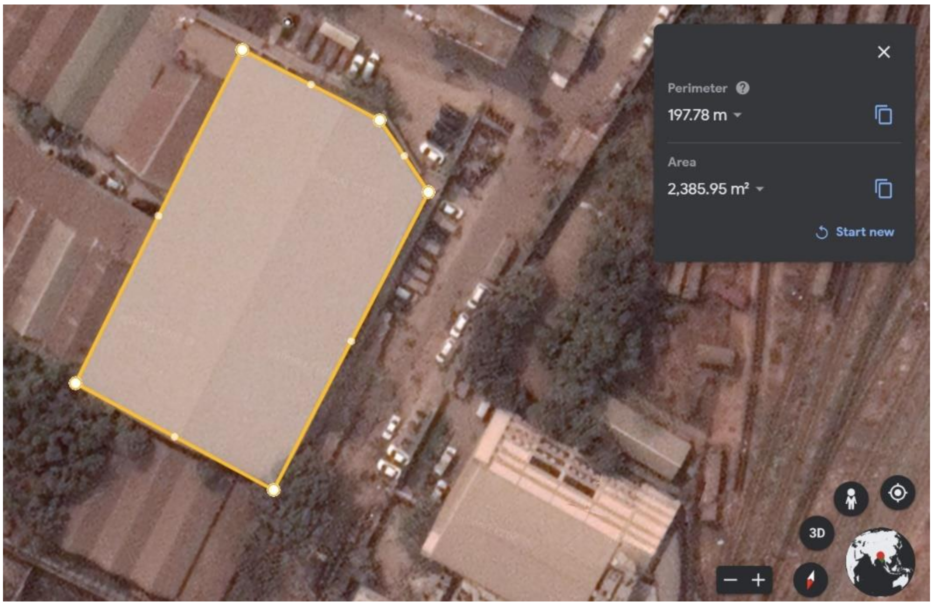

Fig 3.2: Rooftop plant area (a) 0.59 Acre (b) 0.29 Acre

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Solar power plants are often built on large open regions, creating a solar farm that generates a huge quantity of energy. Because it is a restricted and intermittent supply, this sort of power plant meets peak demand. Unless and until storage becomes a viable and long-term solution, this sort of power plant will be restricted to peaking demand rather than baseload demand. The performance of solar power plants is determined by climatic conditions as well as the quality of the equipment employed in the system. Furthermore, regions with greater solar insolation produce more electricity. Furthermore, the efficiency of solar systems varies based on the kind of panels employed. This conversion efficiency is crucial since it affects the system's overall efficiency. Other system losses include those that occur between the DC output and the AC input..

3.2.1 Roof Top Solar Mini Plant

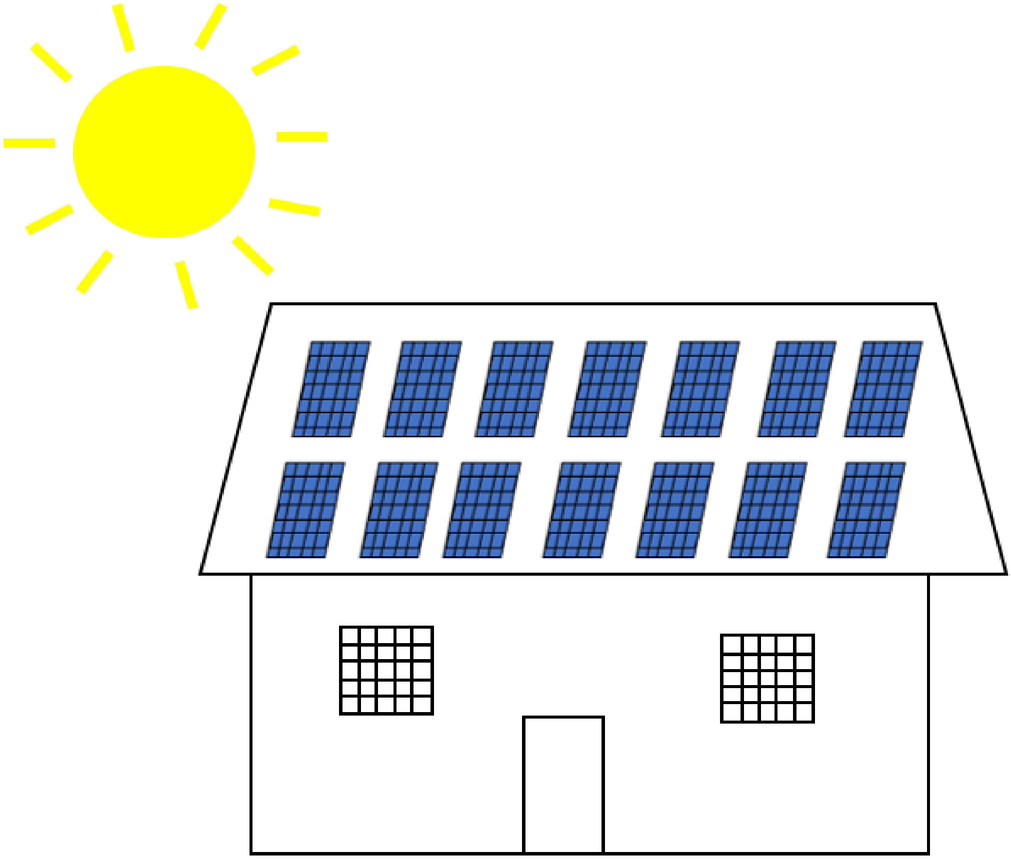

Fig 3.3: Rooftop Solar mini plant

A rooftop solar system, sometimes known as a rooftop solar system, is a kind of rooftop solar system. A photovoltaic power plant, often known as a PV system, is a photovoltaic system with electronically controlled solar rooftop panels put on the roofs of building structures. These panels contribute to the conversion of solar energy from the sun into electrical power. Photovoltaic modules, mounting methods, cables, solar inverters, and other electric appliances are among the key components.

One of the primary reason for investing in a solar power plant is the efficiency gains. Because the tariff rate for solar rooftop panels is 17% and 27% lower than the commercial and conventional tariff rates, respectively. Because rooftop solar panels give electricity to the building, they have to purchase less energy from the grid, and so gross enables you to sell your surplus power to the utility company for even reduced energy costs.

Furthermore, solar power plants are environmentally benign. They do not emit greenhouse gases like CO2 and CO. According to current research findings, if solar energy is widely employed over the next twenty years, it may reduce carbon emissions by 258 million metric tons.

Despite its status as a developing country, India is no stranger to power outages. Despite the fact that India's energy shortage is diminishing by the day, some rural and urban regions continue to have intermittent and inconsistent grid electrical connections. Typically, they are obliged to utilize diesel generators, which harm the environment. As a result, solar rooftop electricity panels may be the best and most cost-effective option in this situation. Solar rooftop panels are eco-friendly since they utilize the sun as their source of energy, and their operating costs are also steady.

A rooftop solar panel has a life expectancy of 25 years. Rooftop solar cells feature no moving components or electronics, and they need no maintenance during their 25-year lifespan—all that is required is to wash the panels with a towel once every 15-20 days.

3.2.2 Open Field Solar Panel Array

The modules that convert ambient sunlight into electricity are known as solar panel arrays. They are made up of a slew of solar modules that are installed on support structures and coupled to provide power to electronic power regulating components.

solar arrays are used in a percentage of infrastructure solar parks. The vast majority are free-field systems that use ground-mounted structures of one of the following types:

3.2.2.1 Permanent Arrays

Several schemes use mounting systems in which the photovoltaic panels are installed at a preset tilt determined to produce the best yearly production profile. The modules are generally placed towards the Pole, with a tilt angle that is somewhat less than the site's latitude. Different tilt degrees may be utilized in certain circumstances, based on regional weather, topographical, or power price regimes, or the arrays might be deviated from the conventional east-west axis to favor morning or evening production.

The usage of arrays, whose tilt angle may be altered twice or four times yearly to enhance seasonal production, is a variation on this idea. They also need a larger land area in order to avoid interior shadowing at the harsher winter tilt angle. Because the enhanced production is usually just a few percent, the higher expense and difficulty of this design is seldom justified.

3.2.2.2 Employs Pole-Mounted 2-Axis Trackers

Solar panels must be oriented properly to the sun's beams to increase the intensity of incoming direct sunlight. To do this, arrays may be created with two-axis trackers capable of monitoring the sun as it moves across the sky on a daily basis and as its elevation varies over the year.

These arrays must be spread apart to avoid co-ordination as the sun moves and the array alignments vary, necessitating the use of additional land. They also need more complicated devices to keep the array surface at the desired angle. The enhanced production may be of the order of 30% in regions with high amounts of direct sunlight, while it is lower in temperate climes or those with higher levels of diffuse radiation owing to cloudy situations. Dual-axis trackers are most typically employed in subtropical locations, and they were initially utilized at utility size at the Lugo plant.

3.2.2.3 Single-Axis Trackers

A third strategy delivers some of the production advantages of monitoring while incurring less costs in terms of land size, capital, and operational costs. This entails following the sun in one dimension — its daily voyage across the sky – but not adapting for the seasons. The axis angle is generally horizontal, but some, such as the solar park at Nellis Air Force Base, slant the axis towards the equator in a southeast configuration — essentially a mix of tracking and fixed tilt.

Solitary monitoring systems have axes that run approximately north-south. Some employ links between rows so that a single actuator may modify the angle of many rows at the same time.

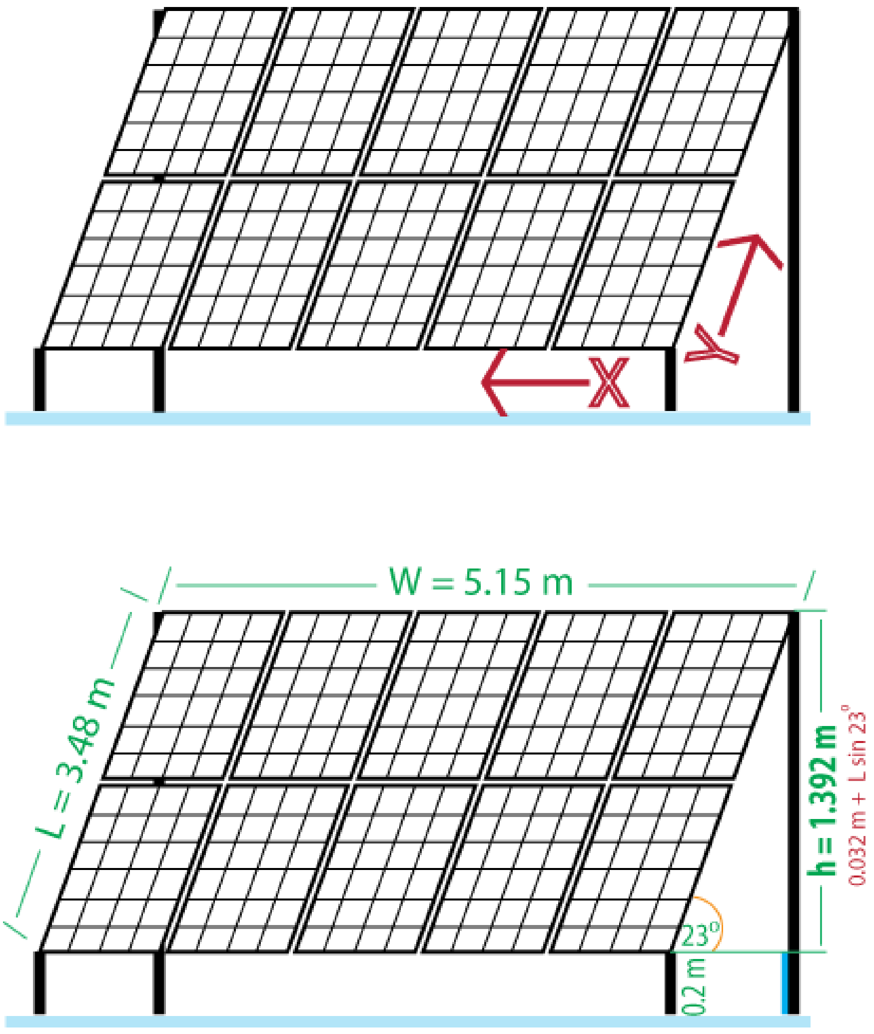

Fig 3.4: Solar Panel Array

Most Largest Solar plants:

Table 3.1: Largest Solar Plant in the World

Solar Plants	MW
Bhadla Solar Park, India	2,245
Huanghe Hydropower Hainan Solar Park, China	2,200
Pavagada Solar Park, India	2,050
Benban Solar Park, Egypt	1,650
Tengger Desert Solar Park, China	1,547
Noor Abu Dhabi, United Arab Emirates	1,177
Mohammed bin Rashid Al Maktoum Solar Park, United Arab Emirates	1,013
Kurnool Ultra Mega Solar Park, India	1,000
Datong Solar Power Top Runner Base, China	1,000
NP Kunta, India	978
Longyangxia Dam Solar Park, China	850
Villanueva Solar Park, Mexico	828
Copper Mountain Solar Facility, United States	802
Mount Signal Solar, United States	794
Rewa Ultra Mega Solar, India	750

3.2.3 Vehicle Parking Slot

Solar parking lot's fundamental concept is to incorporate solar panels into a carpark, which is essentially an open-sided shelter with a roof. Solar underground parking garages may be as little as a single automobile at a home or as large as a business or institutional building. The biggest advantage, of course, is the generation of renewable energy that may be utilized to reduce utility bills on-site, such as in a mall or office complex. Depending on the size, the system may potentially produce surplus electricity of electricity for marketing. A solar carport may also assist lessen the "heat island" impact of parking spaces and contribute to a cooler neighborhood, as well as increase vehicle lifetime by giving shade and shelter.

The solar car park craze coincides with a significant increase in the EPA's attempts to recover brownfields for sustainable energy and green employment. Landfills, like parking garages, are huge areas of land (previous industrial sites with varied degrees of pollution) that have since been paved over or otherwise transformed by human activity, thus it requires putting them to use in the production of clean energy. It is a healthier, less dangerous option to gather fuel from fertile land or aquatic resources that may otherwise be utilized for food supply, leisure, or nature protection.

Fig 3.5: EV Parking Lot

3.3 Charging Station

The twelve potential unit Adapter Power offer is perhaps the foremost wide used power adapter. The twelve potential unit Power offer Adapter could be a throwback to the first days of natural philosophy once 12V was a typical battery output voltage. With the move by the patron to use solid state instrumentality within the automotive then into home was inevitable mutually basic style was universal. The twelve potential unit Power Adapter, additionally

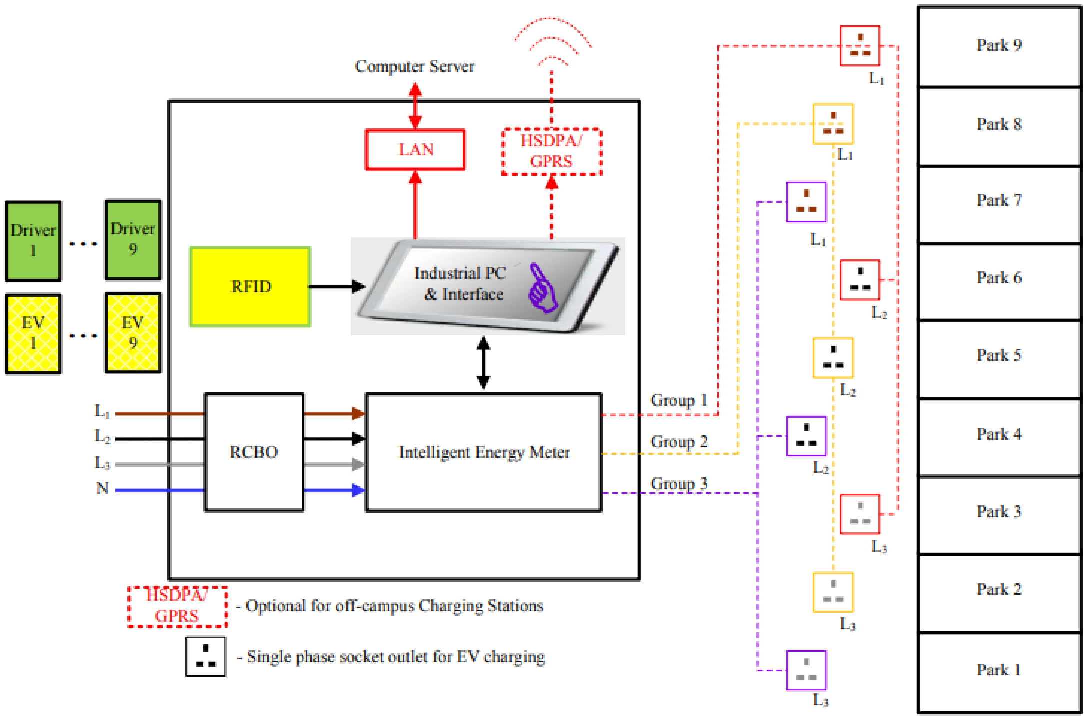

Fig 3.6: Schematic diagram of EV Charging Station

Power Utility:

- Remote controlling
- Supervision
- Statics, billing, alarms, and fleet management are just a few of the features available
- Maintain charging loads in accordance with Natty Grid
- Payment History
- Profile of Charging

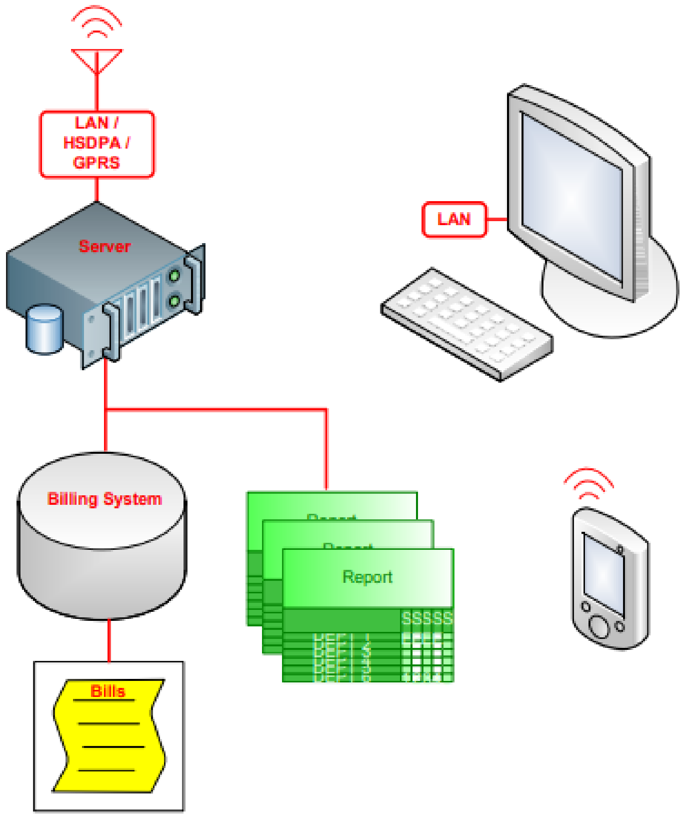

Fig 3.7: Schematic of the system server, control, billing system & remote access

Authorized Customers:

- Determine the needed range
- Locate and reserve the closest charging station
- Estimated end-of-charge
- Current level of charge
- Interruption warning

3.4 Storage

Batteries used throughout solar cell applications must have certain qualities in order to reduce system costs while also fulfilling strict dependability standards connected with Solar photovoltaic implementations.

Fig 3.8: Storage

3.5 Inverter

A crucial inverter with AC and DC connectivity issues, a tracking port, converter separation, and an engaging LCD are all included.

The string inverter (on the left), the generation meter, and the AC disconnect (right). Contemporary artwork from 2013 in Vermont, United States.

Inverters are utilized to convert DC from solar modules to alternating current (AC) in systems intended to supply alternating current (AC), such as grid-connected applications. Power inverters have to provide sinusoidal alternating current (AC) energy that is coordinated to the grid frequency, restrict feed in voltage to no more than the grid voltage, and disengage from the grid if the voltage level is turned off. Because no synchronizing or coordinating with grid supply is necessary, islanding inverters must simply provide controlled voltages and frequencies in a sine waveform.

Table 3.2: Inverter cost & efficiency by power

Type	Power	Efficiency	Market Share	Remarks
String Inverter	up to 150 kW_p	98%	61.6%	Cost 4.91-16.69 Tk per watt-peak. Easy to replace.
Central Inverter	above 80 kW_p	98.5%	36.7%	3.93 Tk per watt-peak. High reliability. Often sold along with a service contract.
Micro-Inverter	module power range	90%–97%	1.7%	28.47 Tk per watt-peak. Ease-of-replacement concerns.
DC/DC Converter (Power optimizer)	module power range	99.5%	5.1%	7.85 Tk per watt-peak. Ease-of-replacement concerns. Inverter is still needed.

Solar inverter might be linked to a series of solar panels. A solar micro-inverter is linked to each solar panel in certain setups. To facilitate maintenance, a circuit breaker is supplied on both the AC and DC sides for safety reasons. AC output may be sent into the public grid through an electricity meter. The total DC watts susceptible to being produced by the solar array are determined by the number of modules in the system. However, the inverter finally regulates the amount of AC watts that may be delivered for usage. A PV system with 11 kilowatts DC of PV modules and one 10-kilowatt AC inverter, for example, will be restricted to the inverter's output of 10 kW. The conversion efficiency for cutting-edge converters approached more than 98 percent in 2019. While string inverters are utilized in small to medium-sized commercial PV systems, central inverters are employed in big commercial and utility-scale systems. The market share of central and string inverters is around 44% and 52%, respectively, with less than 1% for micro-inverters. [6]

3.5.1 Maximum power point tracking (MPPT)

MPPT is a technology used by the grid-connected multilevel inverter to extract the most electricity feasible from a solar array. To do this, the inverter's MPPT technology digitally monitors the solar array's constantly changing peak power and applies the appropriate resistance to determine the best maximum PowerPoint.

3.5.2 Anti-Islanding

Anti-islanding is a protective device that shuts down the inverter instantly, stopping it from producing AC power when the interconnection to the load is lost. This occurs, for example, during a blackout. Without this safeguard, the power supply line would have become an "island" surrounded by a "sea" of unshielded lines, while the solar array continues to deliver DC power throughout the power loss. Islanding is a threat to utility employees because they may not recognize an AC circuit is still powered, and it may prevent equipment from automatically reconnecting. Whole Off-Grid Systems do not need the Anti-Islanding function.

3.6 Internal Natty Grid

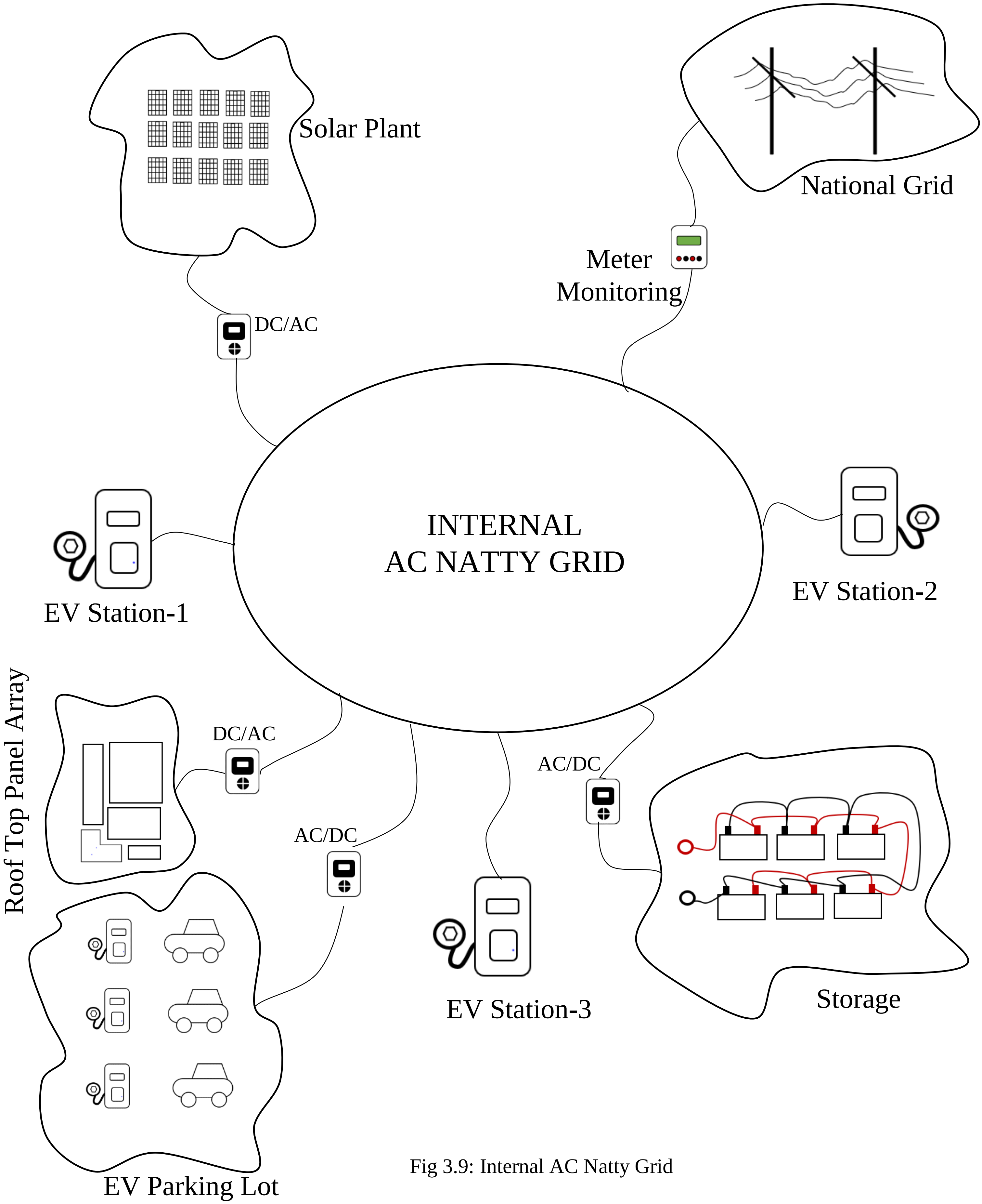

Fig 3.9: Internal AC Natty Grid

3.7 V2G System

Vehicle-to-grid (V2G) refers to the system in which EV interface with the electric grid in order to offer load management services such as returning energy to the grid or slowing their state of charge. Electric vehicles with V2G storage capability can conserve and release power produced from renewable sources such as solar and wind, with consumption that varies based on climate and time of day.

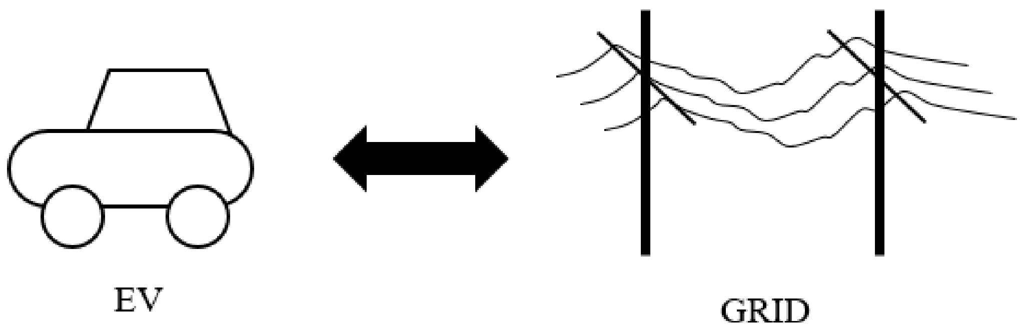

Fig 3.10: V2G System

CHAPTER 4

RESULTS & DISCUSSIONS

4.1 Introduction

All calculations, results & discussions are held in this chapter.
Solar power, back-up storage, charging time, cost etc. analysis & relevant discussions present below. The calculation of EV for Tesla-S model Electric Vehicle.

4.2 Solar Power Calculation

1195 W Panel Output	3.3 kWh
1 W Panel Output	3.3/1195 kWh
100 W Panel Output	$\frac{3.3*100}{1195}$ kWh
	= 0.2762 kWh

1 kW Panel Output= 2.762 kWh……….…….(1)

100 W Solar Panel Area:

Table 4.1: Plant area (100W)

Terms	Length (mm)	Width (mm)	Height (mm)	Area (mm^2)	Area (Acre)
100 W Panel	1066	508	35	18953480	0.004684

Total Area (by google earth) = 22.04 Acre

100 W Solar Panel Area = 0.004684 Acre
So, Total Power Output produce = 470.538 KW (Rated)……………….…(2)
≈ 471 kW
≈ 47's 100W solar panel
From Equ (1) we get,

1 kW Panel Output = 2.762kWh
471 kW Panel Output =(2.762*471) kWh
= 1300.902 kWh…………………..(3)

Select charger:

- 50 kWh
- 16.5 kWh

From Equation (3),

Per Hour Output =1300.902 kWh

Fast charger:
When We Use 50Kwh Charger, This time we can Charge 18 Electric Vehicle at a time
=(18*50) Kwh
= 900 Kwh

Domestic charger:
We Can Use 16.5 Charger & we can Charge 24 Electric Vehicle at a time
=(16.5*24)Kwh
=396 Kwh
So, We Can Charge 42 Vehicles at a time.

4.3 Charging Time

Charging Time (Hours) = Battery Capacity (kWh) / Charging Power (kW)

For Tesla-S Electric Vehicle,

Battery = 75 kWh
For as a charging adapter 50kWh

Charging Time = 75kWh/50kWh
= 1.5 Hrs

For as a charging adapter 16.5 kWh,

Charging Time = 75kWh/16.5kWh
= 4.55 Hrs ≈ 5 Hrs

4.4 Battery Storage Calculation

From the data analysis,

Table 4.2: EV Load Table

Terms	Value
Energy consumption(EV motors)	200 Wh/km
Efficiency of Power Terrain	0.9
Duration of the drive cycle	0.5 hours
Assisting Load	9.241 Wh/km

Let us consider an elementary voltage of 415V.

Energy (avg) = (Energy consumption (EV motors) + Energy (Assisting))* (2-Efficiency of Power Terrain)

Energy(avg) = (200 + 9.241) * (2 - 0.9)
=209.241 * 1.1
= 230.1651 Wh/km

4.5 Cost Analysis

For 100W Solar Panel cost analysis for 1300.902 kWh power produce.

Table 4.3: Panel cost

Terms	Value
Solar Power	1300.902 kWh
Total Panel Required	4705 Pc
Per Watt Solar Panel price	45 Tk
100 Watt Solar Panel price	45*100 Tk = 4500 Tk
Total Solar Panel Cost	(4705*4500) Tk =21,172,500 Tk

4.6 Chapter Summary

In this analysis, we show that if we install 100 W Solar plant for 22 acre land then we produce 1300.902 kWh power. As per marked 1 W panel price 45 Tk Then total panel cost 2 cr 11 lac 72 k 500 Tk only.

We can install mini Solar powered EV charging station based on this 1300.902 kWh plant. we can charge 18's EV on 50 kWh charger & 24's EV on 16.5 kWh charger. Totally, 42's EV recharge at a time.

CHAPTER 5

CONCLUSIONS

5.1 Conclusions

In this solar power based research we learned, feasibility of installing EV charging station. We also know the methodology of Internal AC Natty Grid, Battery Back-up, inverter, meter monitoring, interconnected National Grid. Nowadays, global warming, cumulative $CO_{2,}$ destroy ozone layer etc. problem rapidly growing & becoming uninhabitable in this planet. On the other hand, limitation of non-renewable energy we have to move renewable energy. In this research, generate a methodology to use solar power in EV properly. EV is the most neat, clean, reliable transportation to our future planet. Cost analysis encourage to trust sustainable energy like solar based EV station. Finally, to reduce global warming, cumulative $CO_{2,}$ destroy ozone layer etc. problem & improve environment, proper usage of solar irradiance, Solar-Powered EV Station system is proposed.

5.2 Limitations of the Work

Solar plant initial cost is huge then others. This analysis is small solar powered EV station for Dhaka city.

Photovoltaic arrays may be expensive to set up, leading to a longer duration for energy price reductions to equal early expenditures. Electricity production is solely dependent on a country's exposure to light, which may be restricted by the climate of that country. Solar power plants do not produce the same amount of energy as conventional power plants of comparable scale, and they might be prohibitively costly to construct. Solar energy is utilized to charge batteries, allowing solar gadgets to be used at night. The batteries are frequently huge and hefty, running out of space and requiring replacement on a regular basis. Solar arrays on vehicles only transform 15 percent to 20% of the solar radiation, hence electric vehicles do not have them.

During one hour of charging, the solar panels would only provide roughly 3 miles of electricity. This is wasteful and, at this time, does not understand to utilize upon electric vehicle

5.3 Further Improvements & Future Scope

As future scope on this research, Large scale Solar Powered EV Station which is outside Dhaka city. Possible to expand large area Internal AC Natty Grid & Install some big Solar Plants. In this paper, cost analysis done for only Solar power production. There are several equipment in whole EV station & Grid like inverters, battery, meter, charger etc. cost calculations more encourage to future scope. Solar irradiance forecasting, solar panel allocation could be further improve. Major problem of solar base power is land cost, initial panel cost, grid systems, maintenance will be minimized by better algorithm & proper allocation. Solar based EV station is one of the best method for our environment and future planet. For better future we should be proper usages of solar irradiation & this paper is one step ahead renewable energy.

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