

HARNESSING SOLAR ENERGY BY FLOATING SOLAR PANELS ON THE LOW TIDE COSTAL REGIONS

A Project Report Phase - II

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Electronics and Communication Engineering

By

**M SADA SIVAIAH (39130384)
B SAI DINESH (39130386)**



**DEPARTMENT OF ELECTRONICS AND COMMUNICATION
ENGINEERING
SCHOOL OF ELECTRICAL AND
ELECTRONICS**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

**JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI -
600 119**

APRIL - 2023



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited with "A" grade by NAAC
Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600 119

www.sathyabama.ac.in

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this project is the bonafide work of **M SADA SIVAIAH**(Reg.No:39130384) and **B SAI DINESH** (Reg.No: 39130386) who carried out the project entitled "**HARNESSING SOLAR ENERGY BY FLOATING SOLAR PANELS ON THE LOW TIDE COSTAL REGIONS**" under our super vision from AUGUST-2022 to APRIL-2023.

Internal Guide

Dr. P. KAVIPRIYA, M.E., Ph.D.,

Associate Professor

Head of the Department

Dr. T. RAVI , M.E., Ph.D.,

Professor

Submitted for Viva voce Examination held on 19.04.2023

Internal Examiner

External Examiner

DECLARATION

We, **M SADA SIVAIAH** (Reg No: **39130384**) and **B SAI DINESH** (Reg No:**39130386**) here by declare that the project report entitled “ **Harnessing solar energy by floating solar panels on the low tide costal regions**” done by us under the Internal Guide of **Dr. P. KAVIPRIYA, M.E, Ph.D**, Professor, Dept. of Electronics and Communication Engineering is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering.

DATE: 19.04.2023

PLACE: Chennai

SIGNATURE OF THE CANDIDATE(S)

1. *sadasivaiah*
2. *Sai*

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ABSTRACT

Burning fossil fuels generates greenhouse gas emissions that act like a blanket wrapped around the Earth, trapping the sun's heat, and raising temperatures. Coal is the most important and abundant fossil fuel in India. It accounts for 55% of the country's energy need. The country's industrial heritage was built upon indigenous coal. Commercial primary energy consumption in India has grown by about 700% in the last four decades. The current per capital commercial primary energy consumption in India is about 350 kgoe/year which is well below that of developed countries. Driven by the rising population, expanding economy and a quest for improved quality of life, energy usage in India is expected to rise. Considering the limited reserve potentiality of petroleum & natural gas, Eco-conservation restriction on hydro project and geopolitical perception of nuclear power, coal will continue to occupy centre-stage of India 's energy scenario. The National Electricity Plan [NEP] framed by the Ministry of Power (MoP) has developed a 10-year detailed action plan with the objective to provide electricity across the country, and has prepared a further plan to ensure that power is supplied to the citizens efficiently and at a reasonable cost. According to the World Resource Institute Report 2017, India is responsible for nearly 6.65% of total global carbon emissions, ranked fourth next to China (26.83%), the USA (14.36%), and the EU (9.66%). I. Close to 74% of the energy demand is supplied by coal and oil. According to a report from the Center for monitoring Indian economy, the country imported 171 million tons of coal in 2013–2014, 215 million tons in 2014–2015, 207 million tons in 2015–2016, 195 million tons in 2016–2017, and 213 million tons in 2017–2018. Therefore, there is an urgent need to find alternate sources for generating electricity. When it comes to addressing climate change, solar energy is one of the leading solutions, and it's here to stay. Over the years, we have witnessed a growing surge in distributed PV solar systems installed on rooftops and solar farms to increase clean energy production. As research and development have continued in this sector, we now have floating solar panels.

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CHAPTER 1

INTRODUCTION

1.1 ABOUT THE SOLAR PANELS

The development of solar energy goes back more than 100 years. In the early days, solar energy was used primarily to produce steam which could then be used to drive machinery. But it was not until the discovery of the "photovoltaic effect " that would allow the conversion of sunlight solar electric energy. Becquerel's discovery then led to the invention in 1893 of the first genuine solar cell which was formed by coating sheets of selenium with a thin layer of gold. And from this humble beginning would arise the device we know today as the solar panel.

Russel Ohs, an American inventor on the payroll of Bell Laboratories, patented the world's first silicon solar cell in 1941. Oh's invention led to the production of the first solar panel in 1954 by the same company. Solar panels found their first mainstream use in space satellites. For most people, the first solar panel in their life was probably embedded in their new calculator - circa the 1970s.

Today, solar panels and complete solar panel systems are used to power a wide variety of applications. Yes, solar panels in the form of solar cells are still being used in calculators. However, they are also being used to provide solar power to entire homes and commercial buildings, such as Google's headquarters in California. Photovoltaic modules use light energy (photons) from the Sun to generate electricity through the photovoltaic effect. Most modules use wafer-based crystalline silicon cells or thin-film cells. The structural (load carrying) member of a module can be either the top layer or the back layer. Cells must be protected from mechanical damage and moisture. Most modules are rigid, but semi-flexible ones based on thin-film cells are also available. The cells are usually connected electrically in series, one to another to the desired voltage, and then in parallel to increase current. The power (in watts) of the module is the mathematical product of the voltage (in volts) and the current (in amperes) of the module.

A USB power interface can also be used.[7] Solar panels also use metal frames consisting of racking components, brackets, reflector shapes, and troughs to better support the panel structure.

1.2 ARRAYS OF PV MODULES :

The unique A single solar module can produce only a limited amount of power; most installations contain multiple modules adding voltages or current to the wiring and PV system. A photovoltaic system typically includes an array of photovoltaic modules, an inverter, a battery pack for energy storage, charge controller, interconnection wiring, circuit breakers, fuses, disconnect switches, voltage meters, and optionally a solar tracking mechanism. Equipment is carefully selected to optimize output, and energy storage, reduce power loss during power transmission, and convert from direct current to alternating current.

1.3 SMART SOLAR MODULES :

Smart modules are a type of solar panel that has a power optimizer embedded into the solar module at the time of manufacturing. Typically, the power optimizer is embedded in the junction box of the solar module. Power optimizer attached to the frame of a solar module, or connected to the photovoltaic circuit through a connector, are not properly considered smart modules.

1.4 MODULE INTERCONNECTION:

Module electrical connections are made with conducting wires that take the current off the modules and are sized according to the current rating and fault conditions. Panels are typically connected in series of one or more panels to form strings to achieve a desired output voltage, and strings can be connected in parallel to provide the desired current capability (amperes) of the PV system. Blocking and bypass diodes may be incorporated within the module or used externally, to deal with partial array shading, to maximize output. For series connections, bypass diodes are placed in parallel with

modules to allow current to bypass shaded modules which would be high resistance. For paralleled connections, a blocking diode may be placed in series with each module's string to prevent shaded strings' internal impedance from short circuiting other strings. Module performance is generally rated under standard test conditions (STC): irradiance of 1,000 W/m², solar spectrum of AM 1.5 and module temperature at The actual voltage and current output of the module changes as lighting, temperature and load conditions change, so there is never one specific voltage at which the module operates. Performance varies depending on geographic location, time of day, the day of the year, amount of solar irradiance, direction and tilt of modules, cloud cover, shading, soiling, state of charge, and temperature. Performance of a module or panel can be measured at different time intervals with a DC clamp meter or shunt and logged, graphed, or charted with a chart recorder or data logger. For optimum performance, a solar panel needs to be made of similar modules oriented in the same direction perpendicular to direct sunlight. Bypass diodes are used to circumvent broken or shaded panels and optimize output. These bypass diodes are usually placed along groups of solar cells to create a continuous flow. Electrical characteristics include nominal power (P_{MAX} , measured in W), open-circuit voltage (V_{OC}), short-circuit current (I_{SC} , measured in amperes), maximum power voltage (V_{MPP}), maximum power current (I_{MPP}), peak power, (watt-peak, W_p), and module efficiency (%).

when not connected to an electrical circuit or system. VOC can be measured with a voltmeter directly on an illuminated module's terminals or on its disconnected cable.

The peak power rating, W_p , is the maximum output under standard test conditions (not the maximum possible output). Typical modules, which could measure approximately 1 by 2 meters (3 ft × 7 ft), will be rated from as low as 75 W to as high as 600 W, depending on their efficiency. At the time of testing, the test modules are binned according to their test results, and a typical manufacturer might rate their modules in 5W increments, and either rate them at $\pm 3\%$, $\pm 5\%$, $+3/-0\%$ or $+5/-0\%$.

CHAPTER 2

2.1 LITERATURE SURVEY

There are existing projects that are using the concept of floating solar on the water surface. Here are a few of the power plants that use this concept and the amount of energy they produce.

2. 2 SAEMANGEUM FLOATING SOLAR POWER PROJECT, SOUTH KOREA

Saemangeum Floating Solar Power Project is a 1,200MW solar PV power project. It is planned in North Joella, South Korea. The project is currently in permitting stage. It will be developed in multiple phases. The project construction is likely to commence in 2021 and is expected to enter into commercial operation in 2022. The second-phase core project to foster Saemangeum as a 'Center of green new deal and new industries' will be pushed for in earnest from this year. The Administrator Yang Choong-mo of the Saemangeum Development and Investment Agency (SDIA) presented a road map for the project on January 12, saying, "We will proceed with the development of Saemangeum that can be actually felt by people." The business plan was laid out in four areas: the development and expansion of renewable energy; promotion of waterfront cities and special economic zones and logistics infrastructure; establishment of tourism/cultural and eco-friendly infrastructure; and active investment attraction of future industries. The SDIA also plans to expand renewable energy by starting construction of inland solar power generation, followed by floating solar power and wind power generation projects within this year. Starting this year, the residents who participated in the inland solar power project will be distributed of profits, as a way to encourage citizen-participatory development. In addition, the agency will endeavor to pass a preliminary feasibility study for a 'Green Hydrogen Production Cluster' equipped

with an integration facility that produces, stores, and utilizes hydrogen.

The goal is to create a self-sufficient city with 25,000 population on the complex development site (6.6 km²). It will also designate the project operator of a special port economic zone, which will accelerate the Saemangeum project, and devise a special airport economic zone creation plan. The agency will also build a tourism leisure complex to establish the infrastructure for tourism, and start construction of Sinsido hotel, which will be used for the World Jamboree, in the first half of this year.

Table 2.1: Saemangeum Floating Solar Power Project

Project Type	Total Capacity (MW)	Active Capacity (MW)	Pipeline Capacity (MW)	Project Status	Project Location	Project Developer
Solar PV	1,200	-	1,200	Permitting	North Jeolla, South Korea	Hanwha Solutions

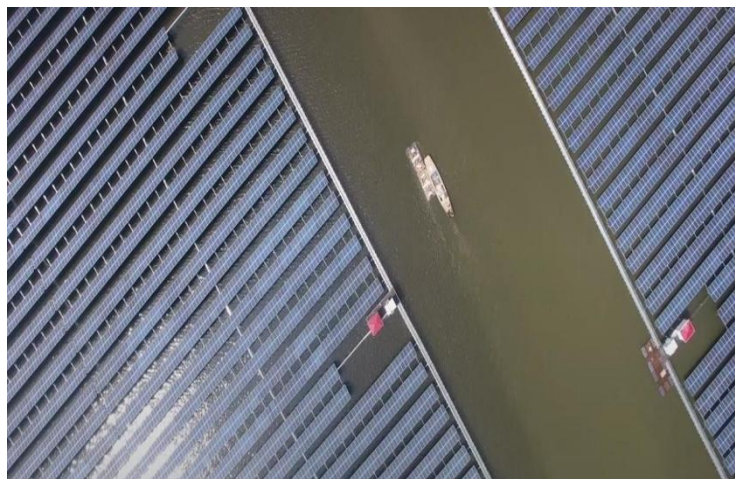


Fig 2.1: Saemangeum Floating Solar Power Project

2.3 HANGZHOU FENAGLING ELECTRICITY SCIENCE TECHNOLOGY'S SOLAR FARM

A 120 MW solar plant located in a fishery near city, in the Chinese province of Zhejiang, was recently completed. The plant, which has secured a tariff of RMB0.95 (\$0.12)/kWh, is the second phase of a 320 MW project owned by Chinese developer Hangzhou reservoirs in Citi, Zhejiang province. The array is the second phase of a 320 MW PV project, following the finalization of the first 200 MW phase in 2017. Chinese inverter maker Shenzhen Star Science and Technology, which supplied its GSL2500C-MV and GSL1250 central inverters for the second phase, recently revealed several details about the plant in a short conversation with pv magazine. "The 320 MW plant has now an expected annual generation of 352 million KWH," said Tammy Tang, Star marketing manager. "The annual revenue from the generated electricity for the owner of the plant is about \$45 million, while the annual fishery income can reach nearly \$5 million."

2.4 CITRATE RESERVOIR FLOATING PHOTOVOLTAIC (PV) POWER PROJECT

The 145 MW ac Carita solar Floating construction was built on the citrate dam. The Carita floating solar power plant development plan starts with the Renewable Energy Mix target set by the Indonesian government as stipulated in the National Electricity General Planning Document 2018-2037 with a target of 23% renewable energy by 2025. Technical aspects of the study are carried out on several aspects such as availability land which will determine the type of PV Land Base or floating. with some technical considerations while floating technology was chosen since has technical and financial advantages for the construction of solar power plants in this location. Subsequently, an evaluation was carried out to determine the potential for irradiation at the location. After obtaining irradiation data and meteorological conditions, a projection of energy production in the location is carried out using the performance ratio parameters on several values to obtain the projection of annual energy production. An evaluation of interconnection was also carried out to find out whether the

construction of the 145 MWac floating solar was safe against the reliability of the 150 kV and 500 kV systems in the West Java system. There are a number of benefits to floating solar panels as expanding populations result in land resources being increasingly allocated to housing, agriculture, and industry. Floating panels can also be more efficient, due to the water's cooling effect, while they also reduce evaporation, saving fresh water for drinking and provide a dual use since water surfaces can be used to generate electricity.



Fig 2.2: Citrate Reservoir Floating Photovoltaic

2.5 CLAY QUARRY LAKE SOLAR PV PARK, CHINA

Clay Quarry Lake Solar PV Park is a 70 MW solar PV Power project. It is located in Anhui, China. The project is currently active. It has been developed in single. The first 11MW system was developed for GCL (Golden Concord Ltd), with construction now complete and grid-connection scheduled for this summer. C&T has grid-connected 85MW of floating PV globally already. The project is expected to produce around 150 million kWh per year. It will be resistant to typhoons and water corrosion, among other harsh environmental factors, said the company. Huaneng Power also plans to build a 2 GW solar plant in Fengcheng, Jiangxi province. The experimental array will include floating PV, agrivoltaics and solar parks on fishponds. The first 320 MW unit will be completed this year, with the rest of the capacity to be installed by 2026.

Table 2.2: Clay Quarry Lake Solar PV Park

Project Type	Total Capacity (MW)	Active Capacity (MW)	Pipeline Capacity (MW)	Project Status	Project Location	Project Developer
Solar	70	70	–	Active	Anhui, China	CECEP Solar Energy Technology

2.6 SEMBCORP'S TUAS FLOATING SOLAR PROJECT

A total of 33,580 solar panels are installed across both sites, providing renewable energy to the grid. The system can produce about 22,025 megawatt hours of power annually, enough renewable energy to power about 4,681 four-room HDB flats. Avoiding over 8,900 tons of carbon dioxide emissions for a year, it is equivalent to planting close to 150,000 trees. A total of 33,580 solar panels are installed across both sites, providing renewable energy to the grid. The system can produce about 22,025 megawatt hours of power annually, enough renewable energy to power about 4,681 four-room HDB flats. Avoiding over 8,900 tons of carbon dioxide emissions for a year, it is equivalent to planting close to 150,000 trees. A total of 33,580 solar panels are installed across both sites, providing renewable energy to the grid. The system can produce about 22,025 megawatt hours of power annually, enough renewable energy to power about 4,681 four-room HDB flats. Avoiding over 8,900 tons of carbon dioxide emissions for a year, it is equivalent to planting close to 150,000 trees. The Sembcorp Tengeh Floating Solar Farm is Singapore's first large-scale floating solar photovoltaic (PV) system. Contributing to Singapore's goal of quadrupling solar energy deployment by 2025, our 60 megawatt-peak (MWp) solar farm was built with over 122,000 floating solar panels across 45 hectares and is one of the world's largest inland floating solar photovoltaic (PV) systems. Deploying highly efficient PV modules and optimized layout to maximize solar power generation, the renewable energy generated from

the solar farm will power Singapore's five local water treatment plants, making our nation one of the few countries in the world to have a 100% green waterworks system.

2.7 Harvesting solar and rain water

Rainwater is collected via a drainage network built between the solar panel arrays and connected to an underground water storage tank that has been constructed using an exocellular system. The modular nature of Geocellular systems means that they can be tailored to suit the specific requirements of any site. The treated rainwater, which has been neutralized and free of contaminants and odour, is primarily used for non-potable purposes to further clean and cool the solar panels on site. By using a water-based cooling system, it allows the panels to yield about two to five percent higher output energy. Like the ground-mounted solar PV panels, floating platforms can also be designed in a way to track the sun in single as well as dual axis, later being slightly difficult to achieve in the case of FSPV. Tracking in a single axis (vertical-axis azimuth tracking) is relatively simple as low resistance is offered by water layer as compared to on land. In some of the initial designs of this type, platform (usually of circular shape) is moored around a central pile and motors are used to rotate it around a vertical axis of the central pile, thereby enabling single-axis rotation to track the sun in single axis. In some other designs, central pile is replaced by a fixed outer ring, which surrounds the floating platform.

Consideration for Solar Powered Rainwater harvesting System: South Africa has an estimated population of 54 million people with an estimated 40% of this population living in rural settlements¹ (MIT, 2016) (Stats SA, 2016). 74% of the people living in these rural areas rely solely upon groundwater, which only accounts for 9% of the total water in use in South Africa, due to a lack of water infrastructure (MIT, 2016). 19% of the rural population does not have access to any clean water supply and 26% of schools, as well as 45% of clinics, have no water access either (MIT, 2016). Rainwater is a clean source of water that can be harvested to solve the need for potable water in rural areas (About, Inc, 2017). Rainwater is regarded as a clean source of water due to its lack of contaminants and hard metals. The rainwater can become acidic depending on the location (EPA, 2017). Though the acidic part of rainwater is bad for metals and machinery, it is suitable for human consumption if filtered properly. The rainwater is polluted

further by flowing from the catchment areas. Pollutants on these catchments areas include leaves, dust particles and droppings of various animals. Due to these pollutants, it is necessary to filter and purify the water according to the SANs 241-2015 standards, in order for the water to be classified as potable water (HarvestH2o, 2017). Rural areas are often found in areas of the country where there is little to none infrastructure in terms of water and electricity supply (ETU, 2017). To overcome this a system design will have to be self-powered and automated



Fig 2.3: Harvesting Solar And Rain Water

2.8 HAPCHEN DAM FLOATING PV POWER PLANT

The floating plant has the shape of a flower and, according to the project developer, will also become a tourist attraction. Scrota previously built a 25 MW floating solar plant on a reservoir in Goheung county, in the South Korean province of Jeollanam, and a 500 kW pilot floating array at the Hapcheon dam itself. The company is also developing a 72 MW project at the Saemangeum sea wall on the Yellow Sea, for which it has also built a new 300 MW factory to produce floaters and frames. In March, the South Korean Ministry of Environment announced a plan

to install around 2.1 GW of floating PV capacity by 2030. The new 2.1 GW program is part of south korea's plan to become carbon neutral by 2050. It will add to the 2.1 GW floating solar complex the south korean government is developing near the saemangeum tidal flats, on the costal of the yellow sea. Hapcheon Dam Floating Solar Power Project is a 40.32MW solar PV power project. It is located in South Gyeongsang, South Korea. The project is currently active. It has been developed in single phase. The project construction commenced in 2020 and subsequently entered into commercial operation in December 2021.

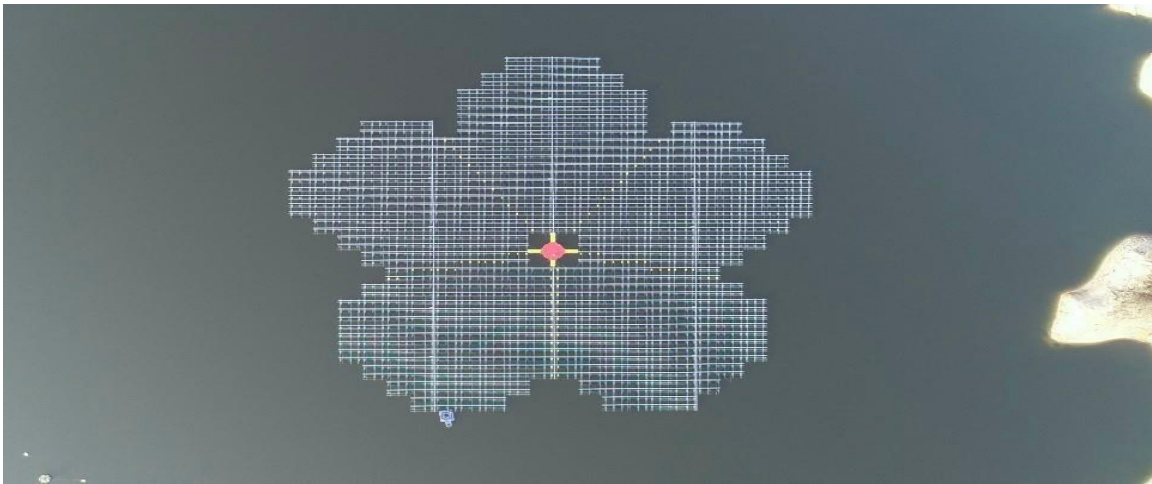


Fig 2.4:Hapchen Dam Floating PV Power Plant

2.9: RAMAGUNDAM PROJECT

The Ramagundam Project's key highlights are its advanced technology and Eco-friendly characteristics. Naresh Anand, the NTPC's Regional Executive Director for the South, commended the workforce at NTPC-Ramagundam on attaining the milestone and reaffirmed NTPC's dedication to sustainable energy. The total commercially operational floating solar capacity in the Southern Region has increased to 217 MW with the full capacity operation of the 100 MW solar PV plant at Ramagundam. Anand stated that the 25 MW and 92 MW floating solar projects at Simhadri, Andhra Pradesh, and Kayamkulam, Kerala, respectively, had already been declared commercially operational by the NTPC Southern Each segment, which is broken up into 40 blocks, has a 2.5 MW capacity. The 100 MW floating solar project at Ramagundam, the largest project of its kind in the nation, has cutting-edge technology and eco-friendly features. There is one floating structure with 11,200 solar panels on each block. One inverter, a transformer, and a high-tension breaker make up the floating structure. The photovoltaic systems are mounted on floaters made of HDPE (High-Density Polyethylene) substance. A unique HMPE (High Modulus Polyethylene) rope is used to secure the overall floating arrangement to the dead weights positioned at the bottom of the balancing reservoir. 33KV subterranean cables are used to evacuate the power up to the current switch yard.



Fig 2.5: Ramagundam Project

2.10 ENVIRONMENT BENEFITS OF THE PROJECT

The minimum amount of land required, mostly for accompanying evacuation plans, is the most apparent benefit from an environmental standpoint. Additionally, the existence of floating solar modules reduces the rate of water evaporation from water bodies, aiding in water conservation. The power plant's floating solar modules would slow the evaporation of water from the reservoir by 32.5 lakh cubic meters annually. The body of water beneath the solar panels would also aid in preserving the surrounding temperature, increasing output and efficiency. Floating photovoltaic (FPV) plants present several benefits in comparison with ground-mounted photovoltaic s (PVs) and could have major positive environmental and technical impacts globally. FPVs do not occupy habitable and productive areas and can be deployed in degraded environments and reduce land-use conflicts. Saving water through mitigating evaporation and improving water security in arid regions combined with the flexibility for deployment on different water bodies including drinking water reservoirs are other advantages of FPVs.

CHAPTER 3

EXISTING SYSTEM

3.1 INTRODUCTION

Finite Element for Floating Photovoltaic Systems. Silica, EVA, glass poly crystalline photovoltaic panels, EVA, and TPT technologies and improvements layer make up the three-dimensional structure of a polysyllabic photovoltaic panel. The PV cell is $156 \times 156\text{mm}$ in size, and the heat transmission form is depicted in Figure 4. The designer's values are presented in Table 1. Dispersion and irradiation are the primary modes of heat transmission in the modules when it is exposed to air. Notton's equation is used to calculate the temperature distribution at the module's edges in Equation 1. where h_{front} is the front radioactive ratio and v is the back radiative factor. In this study, the brightness and wind velocity are considered 1000 W/m^2 and 1 m/s , correspondingly. Because the back of the photovoltaic panel is rarely as well refrigerated as the front, the radioactive ratio is considered twice those of the front. The residual energy is used to increase the operating temperature of panels, while a proportion of solar irradiation is transformed to energy. The received solar energy Q is therefore converted to the produced PV cell's heat. The flow numerical solution is based first on the study and is provided on Equation 2. The brightness at the front edge of related strata is denoted by the letter G . Its absorption coefficient is the layer's optimum parameters. Table 2 lists the settings of Q and other characteristics utilized in the experiment. The average temperature above the lake surface would indeed be lower than the energy on land depending on the cooling impact of the water. This considered a 30°C temperature and humidity on land and a 25°C temperature difference over the surface of the ocean inside this investigation. *Floating PV System.* The integration of photovoltaic power technologies and float technologies has resulted in a perfected photovoltaic float energy production [22]. This fusion is a novel approach to technological advancement. It can enable new photovoltaic facilities that are erected on top of

woodland, agriculture, and buildings as next-generation hardware. A floating system, mooring system, photovoltaic, and submerged cabling make up the PV float facility. Figure 5 represents the flow diagram of the floating PV system: floating device: the model which permits the fitting of the photovoltaic model; mooring device: it can respond to changes in sea levels while remaining in a downward direction; PV device: over the front of the floating network, PV generation hardware, comparable to electric connection points, is placed; and cable underwater: passes produced electricity from the grid towards the photovoltaic system. The technique utilizing equipment and orientation circle, for example, spots the equipment at the predefined buoyancy, wraps the sealed rotation circle around the boundary of circular buoyancy, and utilizes the engine; it has the feature of connecting a spherical rolling pin to the commissure of rotating buoyancy and fixed buoyancy to promote rotation while retaining the movable buoyancy to protect motion resulting from water surface flows.

Monitoring Tilt Position with a Tilt-Variable Framework. A dual-axis tracking-type floating photovoltaic that monitors the angle of tilt was devised in addition to monitoring azimuth angle by rotating an inner circular framework.

Floating Photovoltaic Implementation. Hybrid projects integrating floating photovoltaic modules with hydropower facilities have the potential to generate a significant amount of the globe's overall energies. For a nation with several hydroelectric facilities and dams, floating photovoltaic is a viable option. If the floating photovoltaic farms are placed near hydroelectric stations, operators could utilize current electricity resources including such transmitting cables. For coastal areas, a novel solution combining floating photovoltaic with battery storing and hydroelectric has been developed [25]. To fulfill peak requirements, the intermittent floating photovoltaic energy is combined with a rechargeable power-storing device. Colocation with hydroelectric facilities would assist to increase the generation of such facilities while also smoothing the production curves. By altering hydro-electric.

These devices, whereas photovoltaic structures could substitute for the hydroelectric power shortage in the medium to long run. Floating photovoltaic is a versatile and useful technique.

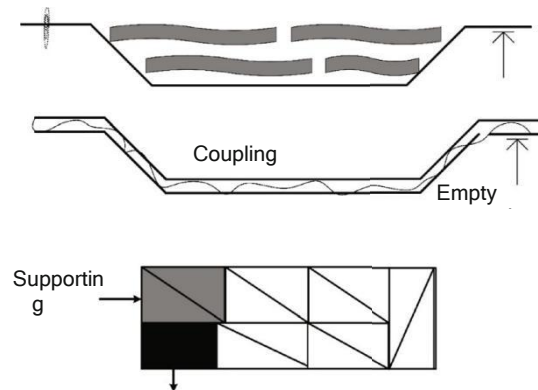


Fig 3.1: Structural Design Of Floating Photovoltaic (FPV) System

Solar photovoltaic components are often mounted utilizing solid mounted systems on the buildings and ground. Because of a lack of available space, a dense population, and a serious hazard of deforestation, interest in installing photovoltaic panels across reservoirs, oceans, lakes, and canals has grown. Photovoltaic panels are erected above water surfaces by applying appropriate technologies to make them float, and these implementations are known as floating photovoltaic plants. Photovoltaic panels' electrical energy generation is largely dependent on incident solar radiation and panel temperature. In FPV devices, shadowing impacts are minimal or nonexistent, and the temperature of the panels could be reduced by placing water beneath them.

3.2 BLOCK DIAGRAM

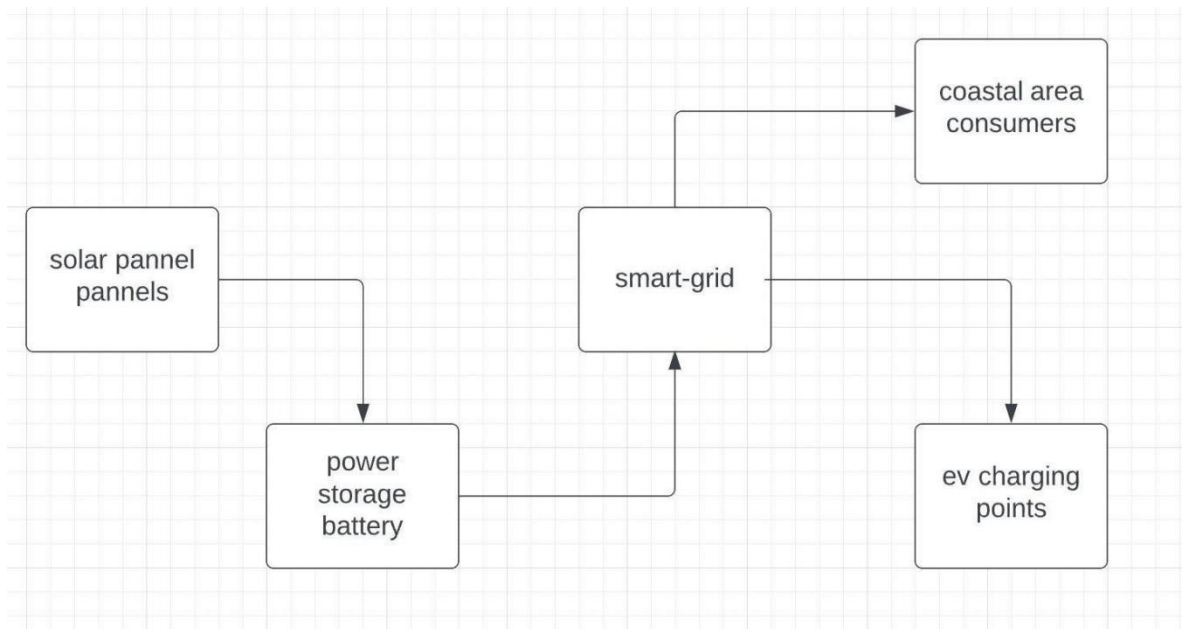


Fig 3.2:Block Diagram of Existing System

3.3 WORKING PRINCIPLE OF EXISTING SYSTEM

To fulfill peak requirements, the intermittent floating photovoltaic energy is combined with a rechargeable power strong device. Colocation with hydroelectric facilities would assist to increase the generation of such facilities while also smoothing the production curves. By altering hydro- electric productivity, floating photovoltaic equipment near a reservoir's dam provides for the unsteady productivity of these devices, whereas photovoltaic structures could substitute for the hydroelectric power shortage in the medium to long run. Floating photovoltaic is a versatile and useful tech- ~~unique~~ Wind turbines are installed in the areas underlying. Appropriate Locations. Although the number of hydro- electric implementations in typically arid regions (Northern Mexico, the Persian Gulf, Central America, Australia, Sahara, etc.) is notably fewer, they are nevertheless there.

Because hydroelectric is a key regional resource, this is the case. Asia has a significant benefit in that it has the maximum density of higher energy dual-power solar/hydro locations in the globe. Tidal flows in Korea and China, canals in Japan, aqueducts in Japan and China are one of the locales, as also rivers in Malaysia, Vietnam, Japan, and Indonesia. *Dry Seasons*. Throughout the dry periods, photovoltaic cells have the maximum performance, whereas wet periods have the largest hydroelectric capacity. As a result, both techniques could be used in tandem. Features to consider while evaluating a location for a floating photovoltaic system are shown in Table 3. Dry periods are usually less problematic. The rafts could remain on the dry banks, giving the structure more power till the water levels can be restored. Considering reservoirs' large open-surface region, this is a good approach to obtain the most out of anything that would have been expensive a lot in regards to displacing houses and actual property

3.4 DISADVANTAGES OF EXISTING SYSTEM

1. Electrical safety and long-term reliability of system components:
Operating on water over its entire service life, the system is required to have significantly increased corrosion resistance and long-term flotation capabilities (redundant, resilient, distributed floats), particularly when installed over salt water.
2. Waves: The floating PV system (wires, physical connections, floats, panels) needs to be able to withstand relatively higher winds (than on land) and heavy waves, particularly in off-shore or near-shore installations.
3. Maintenance complexity: Operation and maintenance activities are, as a general rule, more difficult to perform on water than on land.

CHAPTER 4

4.1 PROPOSED SYSTEM

To build an efficient system to harness the solar energy from the solar panels that are floated on the water surface real low tide regions and transfer the power to coastal areas and powering the charging stations that are located along the coastal highway.

Moreover, among the advantages is the lack of land consumption: this aspect is considerable, especially for the context of the island of Lampshade, where space availability is limited. The number of platforms to meet the island's entire electricity needs is considerably high: however, the occupied maritime area is lower to that required by a maritime concession for offshore wind and can be located at distances greater from the coast, in order to limit their visibility. However, indeed, a considerable aspect concerns the integration of fl-floating PV with other renewable sources to diversify the energy mix: the integration, for example, with another offshore renewable source such as offshore wind or wave energy converters, would allow a better balance of the grid, helping to balance production and consumption and countering peaks.

4.2 SOLAR PANEL

Solar panels are those devices which are used to absorb the sun's rays and convert them into electricity or heat. A solar panel is actually a collection of solar (or photovoltaic) cells, which can be used to generate electricity through photovoltaic effect. These cells are arranged in a grid-like pattern on the surface of solar panels. Thus, it may also be described as a set of photovoltaic modules, mounted on a structure supporting it. A photovoltaic (PV) module is a packaged and connected assembly of 6×10 solar cells. When it comes to wear-and-tear, these panels are very hardy. Solar panels wear out extremely slow. In a year, their effectiveness decreases only about one to two per cent (at times, even lesser). Most solar panels are made up using crystalline silicon solar cells. Installation of

solar panels in homes helps in combating the harmful emissions of greenhouse gases and thus helps reduce global warming. Solar panels do not lead to any form of pollution and are clean. They also decrease our reliance on fossil fuels (which are limited) and traditional power sources. These days, solar panels are used in wide-ranging electronic equipment's like calculators, which work as long as sunlight is available. However, the only major drawback of solar panels is that they are quite costly. Also, solar panels are installed outdoors as they need sunlight to get charged power sources. These days, solar panels are used in wide-ranging electronic equipment's like calculators, which work as long as sunlight is available. However, the only major drawback of solar panels is that they are quite costly. Also, solar panels are installed outdoors as they need sunlight to get charged.



Fig 4.1: Solar Panel

4.3 WORKING OF A SOLAR PANEL

We all know that solar photovoltaic (PV) panels transform sunlight into use able electricity, but few people know the actual science behind the process. This week on the blog we are going to get into the nitty-gritty science behind solar. It can seem complicated, but it all boils down to the photovoltaic effect; the ability of matter to emit electrons when bathed in light. Solar PV panels are comprised of many small photovoltaic cells – photovoltaic meaning they can convert sunlight into electricity. These cells are made of semi- conductive materials, most often silicon, a material that can conduct electricity while maintaining the electrical

imbalance needed to create an electric field. When sunlight hits the semiconductor in the solar PV cell (step 1 in our high level review) the energy from the light, in the form of photons, is absorbed, knocking loose a number of electrons, which then drift freely in the cell. The solar cell is specifically designed with positively and negatively charged semiconductors sandwiched together to create an electric field (see the image to the left for a visualization). This electric field forces the drifting electrons to flow in a certain direction- towards the conductive metal plates that line the cell. This flow is known as an energy current, and the strength of the current determines how much electricity each cell can produce. Once the loose electrons hit metal plates, the current is then directed into wires, allowing the electrons to flow like they need alternating current (AC) electricity to power their buildings. The inverter's function is to turn the electricity from DC to AC, making it accessible for everyday use. After the electricity is transformed into a usable state (AC power), it is sent from the inverter to the electrical panel (also called a breaker box) [step 4], and distributed throughout the building as needed. The electricity is now readily available to power lights, appliances, and other electrical devices with solar energy. Any electricity that is not consumed via the breaker box is sent to the utility grid through the utility meter (our last step, as outlined above). The utility meter measures the flow of electricity from the grid to your property and vice versa. When your solar energy system is producing more electricity than you are using on site, this meter actually runs backwards, and you are credited for the excess electricity generated through the process of net metering. When you are using more electricity than your solar array is generating, you pull supplemental electricity from the grid through this meter, making it run normally. Unless you have gone completely off-grid through a storage solution, you will need to pull some energy from the grid, especially at night, when your solar array is not producing. However, much of this grid energy will be offset from the excess solar energy you generate throughout the day and in periods of lower usage. While the details behind solar are highly scientific, it doesn't take a scientist to convey the benefits a solar installation can bring to a business or property owner. An experienced solar developer can walk you through these benefits and help you explore if a solar solution is right for your business.

Basic Steps in Solar Energy Generation and Transmission

1. Sunlight hits the solar panels, and creates an electric field.

2. The electricity generated flows to the edge of the panel, and into a conductive wire.

3. The conductive wire brings the electricity to the inverter, where it is transformed from DC electricity to AC, which is used to power buildings.

4. Another wire transports the AC electricity from the inverter to the electric panel on the property (also called a breaker box), which distributes the electricity throughout the building as needed.

5. Any electricity not needed upon generation flows through the utility meter and into the utility electrical grid. As the electricity flows through the meter, it causes the meter to run backwards, crediting your property for excess generation.



Fig 4.2: Solar Panels In Water Structure

As presented in this report, the FSPV sector is evolving very rapidly and will become an alternate popular way to generate solar energy very soon. However, very little know-how is available at the moment thus posing many challenges, which need to be addressed properly. Some of the key challenges associated with the FSPV are presented below. Since FSPV plants are installed on water bodies, any variations in water levels induced by monsoon, wind velocity or increase/decrease in water quantity could be problematic for the plants. To avoid this situation, FSPV plants are anchored through mooring systems. The placement of a mooring system must take into account the location, bathysphere, soil conditions, and water-level variations. Mooring systems include quays, wharf,

jetties, piers, anchor buoys, and mooring buoys. Mooring system for a floating platform is generally attached with nylon polyester or nylon nautical ropes that are further tied to bollards on the bank and lashed at each corner. Mooring can be done in the following three ways – bank anchoring, bottom anchoring, and piles.



Fig 4.3: Solar Panel Structure

Floating photovoltaic is a common solar innovation that includes placing solar modules over natural or man made water bodies instead of on land. Depending on their supportive components, floating photovoltaic devices are divided into three categories: Permanent tilt panels required rigid pontoons; monitoring patterns could be erected with or without pontoons; and flexibility matrices do not require a supportive framework in the shape of a pontoon because of their low weight. High-scale MW to GW , small-scale (few kW), and medium-scale kW to MW floating photo- voltaic could also be characterized depending on the size of installation. Permanent floating photovoltaic devices cooled FPV devices, and floating-tracking PV systems could be classed depending on the diverse supportive structural architectures of FPV devices. The net investment expenses of floating-tracking photovoltaic devices are higher than permanent floating photovoltaic installations, but they produce more power.

Solar photovoltaic components are often mounted utilizing solid mounted systems on the buildings and ground. Because of a lack of available space, a dense population, and a serious hazard of deforestation, interest in installing photovoltaic panels across reservoirs, oceans, lakes, and canals has grown. Photovoltaic panels are erected above water surfaces by applying appropriate technologies to make them float, and these implementations are known as floating photovoltaic plants. Photovoltaic panels' electrical energy generation is largely dependent on incident solar radiation and panel temperature. In FPV devices, shadowing impacts are minimal or nonexistent, and the temperature of the panels could be reduced by placing water beneath them. Floating photovoltaic modules have an approximately 12.0 percent better performance than rooftop as well as ground-mounting photovoltaic modules. Pontoons/floats, mooring devices, photovoltaic modules, and electrical adapters and cables are the primary elements of floating photovoltaic devices, as depicted in this diagram.

4.4 SMART GRID

Maybe we have heard of the Smart Grid on the news or from your energy provider. But not everyone knows what the grid is, let alone the Smart Grid. "The grid," refers to the electric grid, a network of transmission lines, substations, transformers and more that deliver electricity from the power plant to your home or business. It's what you plug into when you flip on your light switch or power up your computer. Our current electric grid was built in the 1890s and improved upon as technology advanced through each decade. Today, it consists of more than 9,200 electric generating units with more than 1 million megawatts of generating capacity connected to more than 300,000 miles of transmission lines. Although the electric grid is considered an engineering marvel, we are stretching its patchwork nature to its capacity. To move forward, we need a new kind of electric grid, one that is built from the bottom up to handle the groundswell of digital and computerized equipment and technology dependent on it—and one that can automate and manage the increasing complexity and needs of electricity in the 21st Century.

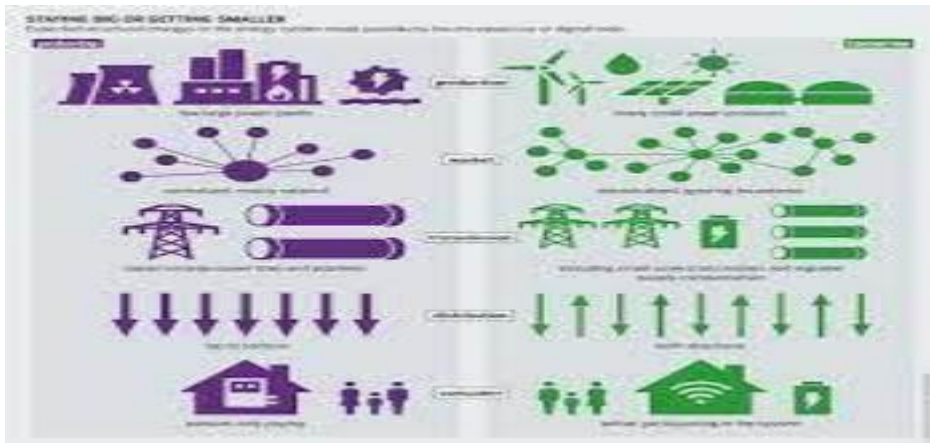


Fig 4.4: Solar Panel Structure

4.5 COMPONENT THAT MAKES A GRID “SMART”

In short, the digital technology that allows for two-way communication between the utility and its customers, and the sensing along the transmission lines is what makes the grid smart. Like the Internet, the Smart Grid will consist of controls, computers, automation, and new technologies and equipment working together. The Smart Grid represents an unprecedented opportunity to move the energy industry into a new era of reliability, availability, and efficiency that will contribute to our economic and environmental health. During the transition period, it will be critical to carry out testing, technology improvements, consumer education, development of standards and regulations, and information sharing between projects to ensure that the benefits we envision from the Smart Grid become a reality.

The benefits associated with the Smart Grid include:

- More efficient transmission of electricity
- Quicker restoration of electricity after power disturbances
- Reduced operations and management costs for utilities, and ultimately lower power costs for consumers
- Reduced peak demand, which will also help lower electricity rate

- Increased integration of large-scale renewable energy systems
- Better integration of customer-owner power generation systems, including renewable energy systems and Improved security.

This is a particular threat in the winter, when homeowners can be left without heat. A smarter grid will add resiliency to our electric power System and make it better prepared to address emergencies such as severe storms, earthquakes, large solar flares, and terrorist attacks. Because of its two-way interactive capacity, the Smart Grid will allow for automatic rerouting when equipment fails or outages occur. This will minimize outages and minimize the effects when they do happen. When a power outage occurs, Smart Grid technologies will detect and isolate the outages, containing them before they become large-scale blackouts. The new technologies will also help ensure that electricity recovery resumes quickly and strategically after an emergency—routing electricity to emergency services first, for example. In addition, the Smart Grid will take greater advantage of customer-owned power generators to produce power when it is not available from utilities. By combining these "distributed generation" resources, a community could keep its health center, police department, traffic lights, phone System, and grocery store operating during emergencies. In addition, the Smart Grid is a way to address an aging energy infrastructure that needs to be upgraded or replaced. It's a way to address energy efficiency, to bring increased awareness to consumers about the connection between electricity use and the environment.

4.6 BATTERY STORAGE

Sometimes two is better than one. Coupling solar energy and storage technologies is one such case. The reason: Solar energy is not always produced at the time energy is needed most. Peak power usage often occurs on summer afternoons and evenings([link is external](#)), when solar energy generation is falling. Temperatures can be hottest during these times, and people who work daytime hours get home and begin using electricity to cool their homes, cook, and run appliances. Storage helps solar contribute to the electricity supply even when the

sun isn't shining. It can also help smooth out variations in how solar energy flows on the grid. These variations are attributable to changes in the amount of sunlight that shines onto photovoltaic (PV) panels or concentrating solar-thermal power (CSP) systems. Solar energy production can be affected by season, time of day, clouds, dust, haze, or obstructions like shadows, rain, snow, and dirt. Sometimes energy storage is co-located with, or placed next to, a solar energy system, and sometimes the storage system stands alone, but in either configuration, it can help more effectively integrate solar into the energy landscape. Battery energy storage systems (BESS) from Siemens Energy are comprehensive and proven. Battery units, PCS skids, and battery management system software are all part of our BESS solutions, ensuring maximum efficiency and safety for each customer. You can count on us for parts, maintenance services, and remote operation support as your reliable service partner. Currently, Siemens Energy offers Blue Vault™ Storage solution for the marine and offshore market and SIESTART for utilities and T&D network operators. For industrial deployment, we offer a customized battery storage solution to meet your unique business need.



Fig 4.5: Battery Storage

4.7 ADVANTAGES OF COMBINING STORAGE AND SOLAR STORAGE

Balancing electricity loads – Balancing electricity loads – Without storage, electricity must be generated and consumed at the same time, which may mean that grid operators take some generation offline, or “curtail” it, to avoid over-generation and grid reliability issues. Conversely, there may be other times, after sunset or on cloudy days, when there is little solar production but plenty of demand for power. Enter storage, which can be filled or charged when generation is high and power consumption is low, then dispensed when the load or demand is high. When some of the electricity produced by the sun is put into storage, that electricity can be used whenever grid operators.

“Firming” solar generation – Short-term storage can ensure that quick changes in generation don’t greatly affect the output of a solar power plant. For example, a small battery can be used to ride through a brief generation disruption from a passing cloud, helping the grid maintain a firm electrical supply that is reliable and consistent.

Providing resilience – Solar and storage can provide backup power during an electrical disruption. They can keep critical facilities operating to ensure continuous essential services, like communications. Solar and storage can also be used for micro grids and smaller-scale applications, like mobile or portable power units.

Firming solar generation – “Firming” solar generation – Short-term storage can ensure that quick changes in generation don’t greatly affect the output of a solar power plant. For example, a small battery can be used to ride through a brief generation disruption from a passing cloud, helping the grid maintain a “firm” electrical supply that is reliable and consistent.

4.8 TYPES OF ENERGY STORAGE

The most common type of energy storage in the power grid is pumped hydro power. But the storage technologies most frequently coupled with solar power plants are electron chemical storage (batteries) with PV plants and thermal storage (fluids) with CSP plants. Other types of storage, such as compressed air storage and flywheels, may have different characteristics, such as very fast discharge or very large capacity, that make them attractive to grid operators. While the need is not new – people have been looking for ways to store energy that is produced at peak times for use at a later moment to reduce imbalances between energy demand and energy production – energy storage is now booming in the sector. Applications are becoming more diverse and widespread geographically with the growth of variable wind and solar energies, decentralization of the power system and the need for resilience in the network. With the output of wind and solar dependent on the local weather, variability can occur on short timescales or the times of generation may not correspond to that of the demand. For example, in the case of solar, the maximum output is normally in the middle hours of the day but the biggest demand peak is often in the evening.

4.9 EV CHARGING POINTS

An electric vehicle charging station is an equipment that connects an electric vehicle (EV) to a source of electricity to recharge electric cars and plug-in hybrids. Some charging stations have advanced features such as smart metering, cellular capability and network connectivity, while others are more basic. For charging at home or work, some EVs have onboard converters that can plug into a standard electrical outlet or a high-capacity appliance outlet. Others either require or can use a charging station that provides

electrical conversion, monitoring, or safety functionality. A connector design was selected in May 2019[17] and tested at the National Renewable Energy Laboratory (NREL) in September 2020. Thirteen manufacturers participated in the test, which checked the coupling and thermal performance of seven vehicle inlets and eleven charger connectors.[20] The final connector requirements and specification was adopted in December 2021 as MCS connector version. With support from Portland General Electric, on 21 April 2021 Daimler Trucks North America opened the "Electric Island", the first heavy-duty vehicle charging station, across the street from its headquarters in Portland, Oregon. The station is capable of charging eight vehicles simultaneously, and the charging bays are sized to accommodate tractor-trailers. In addition, the design is capable of accommodating >1 MW chargers once they are available.[23] A startup company, Watt EV, announced plans in May 2021 to build a 40-stall truck stop/charging station in Bakersfield, California; at full capacity, it would provide a combined 25 MW of charging power, partially drawn from an on-site solar array and battery storage.

4.10 EVSE STANDARDS FOR INDIA

The Ministry of Power has issued the guidelines and standards for India's charging infrastructure for electric vehicles (EVs). Setting up public charging stations will not require a license, as long as it meets the technical and performance standards and the protocols, as laid down by the Ministry of Power and Central Electricity Authority. In fact, for setting up a public charging station, the power distribution company will provide proper connectivity on priority. Electric vehicle supply equipment (EVSE) supplies electricity to an electric vehicle (EV). Commonly called charging stations or charging docks, they provide electric power to the vehicle and use that to recharge the vehicle's batteries. EVSE systems include the electrical conductors, related equipment, software, and communications protocols that deliver energy efficiently and safely to the vehicle. EVSE equipment is classified as Level 1 (120 volts AC), Level 2 (240 volts, AC), and DC Fast Charger (480 volts DC and higher).

Table 4.1: EV Standards

Indian Standards	Description
IS:17017 series of standards	Primarily based on IEC 61851; IEC 62196 and ISO 15118 series of standards.
IS:17017- 1	General Requirements and Definitions of EVSE (Adapted from IEC 61851-1).
IS:17017-21	EV requirements for connection to AC/DC Supply (Adapted from IEC 61851- 21).
IS:17017-22	AC EVSE (Adapted from IEC 61851-22).
IS:17017-23	DC EVSE (Adapted from IEC61851-23).
IS:17017-24	Control communication between DC EVSE and EV (Adapted from IEC61851-24).
IS:17017-Part 2	IEC 62196 Part-1,Part-2,Part-3 Standards for the plugs, socket outlet,vehicle couples and vehicle in lets. These are being adapted as IS:17017 Part 2-A,B and C.
IS/ISO:15118	ISO 15118 Series for communication between the EV and the EVSE. There are seven documents in this series. These are adopted as it is.

The material used for the floating platform must be UV stabilized (UV20) and should be manufactured from appropriate thermoplastic having good environmental stress crack resistance (ESCR) such that the floating platform can withstand a minimum operational period of 25 years without any discoloration. Also, materials used for floating platforms should be chemically resistant to acid, lye, petrol, mineral oil, and most importantly, should not contaminate the water body in any condition in its lifetime.

Additionally, a floating platform, when deployed in water bodies, containing raw water, should be designed in a manner such that it does not restrict the process of gas exchange across the air–water interface. This is why voids of appropriate size must be provided and should be made an integral part of floating platform design.

4.11 WORKING AREA

First we identify the low tidal regions across India using geo mapping and past tidal pattern data to find the best location to deploy the solar panels in the area and to implement the project in this area. Points were analysed by using the open-source database of Landsat satellite imagery. The methodology of using these data sets is described in detail by Pekel, Andrew, Cottam²³ et al. Based on this, permanently dried data points were removed and reservoir area value of the remaining data points was adjusted. Google maps were used for removing the reservoirs located in the protected areas like – wildlife sanctuaries, protected forest areas, etc. Two scenarios as presented in TERI's Analysis Table 2 were used for calculating the potential of each data point. Finally, a web-based user interactive tool was developed (see Chart 14). The tool highlights the prospective FSPV locations, spreading across the country. Size of the bubble depicts the size of the FSPV plant which can be installed on that particular location. Lastly, state-wise potential numbers were populated. Refer Chart 15 for more details on the state-wise potential for FSPV along with the total number of reservoirs on which FSPV can be installed along with cumulative reservoir area



Fig 4.6: Project Area

4.12 SMART GRID CONNECTION

Once the connection is established between the solar panels and the energy storage system then they are connected to the smart grid from where the total coastal area and the EV charging points are powered. And the whole area is self-sustainable by green energy. Plants are often installed on in-land bodies of water and these water bodies are used for a variety of purposes such as drinking water, irrigation, recreation, generation of electricity, etc. Frequently these water bodies are also tagged as 'lifeline', deploying large-scale FSPV plants might have a notable impact on the social development of mankind. This tries to depict some of the potential impacts of deploying large-scale FSPV. A grid-connected system allows you to power your home or small business with renewable energy during those periods (daily as well as seasonally) when the sun is shining, the water is running, or the wind is blowing. Any excess electricity you produce is fed back into the grid. When renewable resources are unavailable, electricity from the grid supplies your needs, eliminating the expense of electricity storage devices like batteries.

In addition, power providers (i.e., electric utilities) in most states allow net metering, an arrangement where the excess electricity generated by grid-connected renewable energy systems "turns back" your electricity meter as it is fed back into the grid. If you use more electricity than your system feeds into the grid during a given month, you pay your power provider only for the difference between what you used and what you produce.



Fig 4.7: Smart Grid Connection

4.13 SERVICE AND MAINTENANCE

The solar panels should be monitored constantly and so that the tides do not damage the panels. The energy storage should be monitored to prevent over heating or any other grid failure Regular servicing should be done to the solar panels so that they can work in peak efficiency without any loss of power. Since FSPV plants are installed on the water surface rather than on land, it is relatively difficult to deal with O&M issues in such conditions. There are certain parts like anchoring and mooring that lie inside the water and are required to be inspected

on a regular basis to ensure the plant's stability. To tailor these, divers are needed, which adds extra cost to O&M. Also sudden fault, instances like of bird dropping, replacement of electrical parts, maintenance of cables and wires, etc., are complex things to handle and require special training to plant personnel. In today's current scenario, industrial and commercial establishments are resorting to solar arrays and industrial PV systems in order to bypass power outage problems associated with grid supply. Be it in the paper, steel, chemical, textile, cement, dairy or the ceramic industry, solar power panels are fast becoming a norm rather than an option in India. This has been given a boost by the presence of open access grids in most states, nationwide.

Most solar panel operation and maintenance (O&M) processes require periodic checks for ensuring optimal performance and security. The frequency and degree of solar array monitoring and solar panel maintenance are reliant on the installation type, system configuration and location of the commercial solar power system in use.

Yearly inspections are recommended by companies providing solar maintenance in India. Apart from inspecting PV systems regularly, it is also important to carry out inspections when their ownership changes.

Solar PV systems' maintenance processes are best carried out by qualified installers or service technicians who are conversant with PV components and their safety procedures. These providers of solar panel maintenance services take care of the full range of PV maintenance processes that include. An authorized solar solutions company offers operations & maintenance services that include preventive and corrective measures. These services involve remote monitoring, inspecting, testing, cleaning, maintaining warranties & claims, repairing and replacing parts. Not only do these measures prevent system breakdowns but they also ensure regular inspection of the systems. To ensure regular inspection, the majority of the top solar providers work on annual maintenance contracts to maintain the generation guarantee provided. ABS Renew Power, being one of the top solar companies in India, provides operations and maintenance services that involve accurate inspection, analysis and quick resolution to the problem. We use

SCADA based technology tools and software to remotely monitor and analyze the problem and recommend a solution.

As mentioned earlier, cleaning components not only involve dusty solar panels but also inverters and other components that tend to get dirty being constantly exposed. Components like wires tend to break easily due to animal intervention or other factors. Replacing or refurbishing services covers wires and other components. We use SCADA Photovoltaic Remote Monitoring Systems to track system performance and monitor real-time data. These monitoring systems help us act immediately and rectify any issue to achieve the desired level of generation. It also helps us stay on par with the top standards of quality testing and data monitoring.



Fig 4.8: Surveillance

CHAPTER 5

RESULTS AND DISCUSSION

5.1 RESULTS

In low-tidal areas, we have successfully carried out the procedure of reducing solar power using floating solar panels. According to our analysis and information from the government agencies, a total of 7,516.6 km of coastline can be supplied with clean and renewable energy. It is possible to install EV charging stations along 382 km of the coastline. According to the research we conducted, other countries like the United Arab Emirates, Australia, New Zealand, Norway, etc. can produce renewable energy by 1) altering module tilt under a constant irradiation level, and 2) varying irradiation intensity at the ideal tilt setup. The irradiation level for the earlier system was kept at 750 W/m², while for the later configuration, the module tilt angle was changed from 0° to 80° by means of a single axis tracker.

5.2 RESULTS INDICATE THAT BELOW

A power loss occurs for every 5° increase in tilt angle under steady illumination of 750 W/m². 3.45 W outside and 2.09 W indoors. In comparison, for the standard condition, efficiency decreases for the indoor condition by 0.54% and for the outdoor condition by 0.76%. On the other hand, the temperature of a solar power cells is increased by 7.52°C in indoor condition and 5.67°C in outdoor condition for every 100 W/m² increase in irradiance.

The Fig 5.1 shows the results of voltage generated from solar panel at 9AM which is 10.7V and there is no elevation of the sun as it is early morning.



Fig 5.1: Panel output at 9 am under no elevation

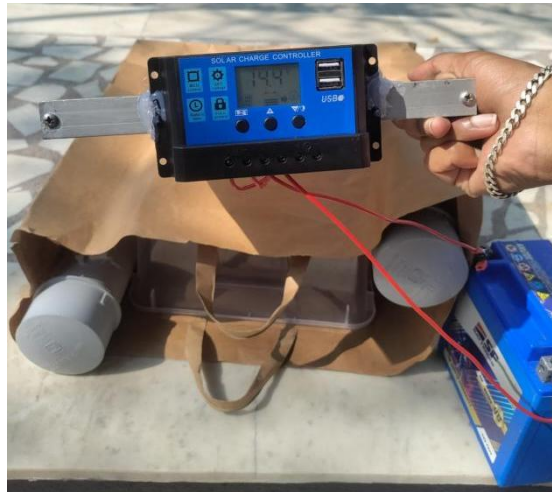


Fig 5.2: Panel at 12 noon under peak sunlight

At noon which is at 12PM the device is under peak sunlight which results in high voltage generation 14.4V as shown in Fig 5.2



Fig 5.3: Panel at 4 pm with no inclination

The Fig 5.3 shows the panel at 4PM with no inclination thus it results in less voltage generation compared to noon 12.6V.

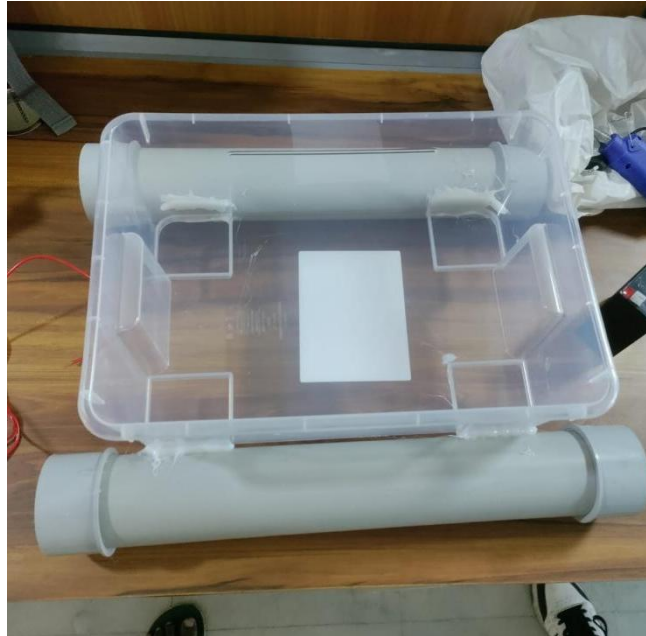


Fig 5.4: Floating station

The Floating Station is designed with PVC pipes and Thermoplastic base which is responsible for floating of solar panel device for generating energy as show in Fig 5.4



Fig 5.5 : Solar charge controller

The solar charge controller checks the voltage generated from the panel and transmits it to a battery as shown in Fig 5.5



Fig 5.6 : Basing on ground setup

The Fig 5.6 shows the entire setup on a ground and ready to initialize the process.



Fig 5.7 : Panel under no sunlight

The Fig 5.7 shows that there is no voltage generated in solar charge controller under no sunlight.

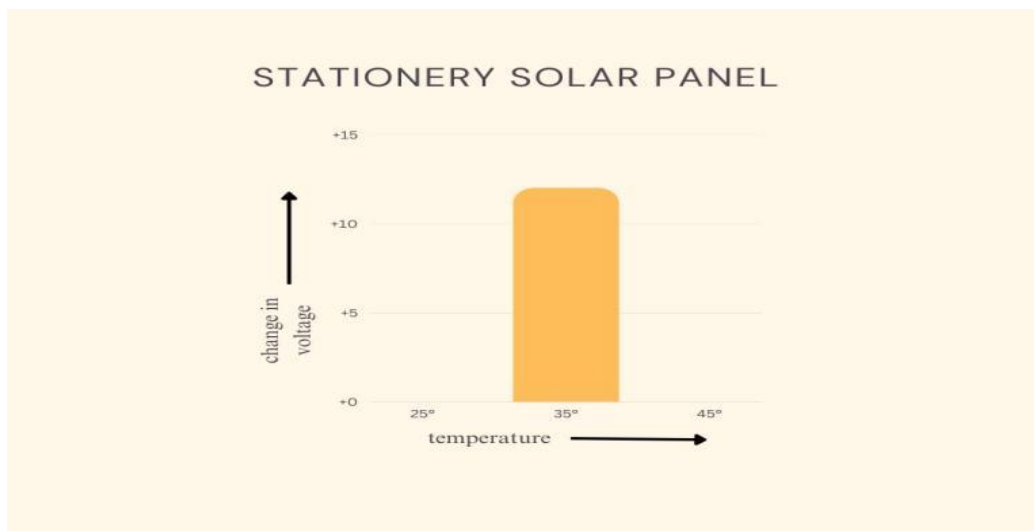


Fig 5.8 : Graphical representation of solar panel

In the graphical representation of X axis represents output voltage in Volts and Y axis represents temperature in Celsius.

Table 5.1: Testing output result

Number of solar panels	<i>Power Output</i>	<i>Area covered</i>
<i>1</i>	<i>265 watts</i>	<i>1.6 m²</i>

5.3 TESTING CONDITIONS

1. Power of every solar panel – 265 watts.
2. Solar panel exposing time with sunlight – 7 hours/day.
3. Panel efficiency of each solar panel – 20 %.

5.4 CONCLUSION

A total of 7,516.6 km of coastal area can be provided with clean and renewable according to our research and data from the government bodies. 382km of coastal highway can we equipped with EV charging stations that can work 24/7. According to the research we have done mothered of generating renewable energy is possible for other nations like UAE,Australia,New Zealand, Norway,etc. The review presented in this paper shows the timeline of concepts and floating solar PV projects that have been established to date. These systems were either constructed for research purpose or commercial use.All grid connected systems are kept a float using pontoons or floats with panels rigidly connected to these floats.

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