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Study of Installation of 5kw Rooftop Solar System

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Abstract:- Rooftop solar power plants offer a multitude of advantages, including self-sufficiency in electricity provision, cost-effectiveness, insulation against potential future increases in electricity tariffs, and sustainable use of otherwise unused roof space. This paper details a specific 5kw solar power plant, designed to harness solar energy efficiently by connecting all level-4 electrical loads to the system. The components utilized include six 325W solar panels, a robust GI structure, an inverter, and a lightning arrester.

Index Terms :- Photovoltaic, Consumption, Rooftop, Solar, Roof -Top, Sustainability.

INTRODUCTION

Solar energy, derived from the radiant heat and energy emitted by the sun, stands as a pivotal force in addressing our global energy needs. This form of energy manifests through various applications such as solar photovoltaics and solar architecture, presenting a viable alternative to conventional methods like solar heating. Historically, the world has heavily relied on fossil fuels like oil, natural gas, and coal to meet its escalating electricity demands. However, the continued use of fossil fuels raises significant environmental and geopolitical concerns.[1]

INDIAN SCENARIO

As of the Gregorian month, India holds the eleventh position globally in solar energy production, marking a noteworthy ascent since August 2014. At that time, government-funded solar power in the country accounted for a modest 6.4MW/yr. Over the years, a substantial increase in capacity has been witnessed, starting from 25.1MW in 2005 to a remarkable surge of 1205MW by 2012. The upward trajectory continued with the addition of 1114MW in 2013 and an additional 313MW in 2014.

By August 2015, India's grid-connected solar power capacity reached an impressive 4.22GW, reflecting the nation's commitment to harnessing solar energy resources. Notably, the cost of solar power has seen a substantial reduction, dropping from Rs. 17.90 per unit in 2010 to Rs. 7 per unit in 2015. Forecasts suggest that solar energy is poised to achieve grid parity by 2017-18, thanks to ongoing technological advancements and intensified market competition. Grid parity implies that the cost of electricity generated from solar energy equals the cost of purchasing power from the grid.

This paper emphasizes the crucial concept of grid parity, especially concerning solar panels, within the Indian solar energy landscape. The Charanka Solar Park, boasting a massive 224MW capacity, was commissioned in April 2012 and stands as the largest solar park in Asia. Rajasthan emerges as a frontrunner, contributing 28.4 percent to India's solar energy generation, while Gujarat closely follows with a 20.4 percent share as of September 2015. This progress underscores India's strides towards sustainable and substantial solar energy contributions within its energy portfolio."[1]

PROJECT SITE

As this project is undertaken by B-Tech students of Electrical Engineering, our group has decided to study the installation of the solar system on the roof of a residential property, at Nandanvan, Nagpur, Maharashtra.[1]



SITE EVALUATION

The initial step, in the process is to conduct an assessment of the site, which allows a solar panel designer to approximately calculate the amount of electricity needed for a building. This evaluation provides information about the rooftops surface area enabling the designer to determine the number of solar panels required based on pre-established dimensions. Following this the next stage involves identifying the dimensions of structures, like water tanks and decorative elements to ensure that a design can be planned effectively to avoid shading issues that could impact panel efficiency. The third phase of evaluating the site involves identifying the location, for placing the inverter and distribution boxes to minimize the length of DC cables. Longer DC cables result in energy losses so an ideal design should ensure that the output from the panels does not have to travel to reach a distribution box. Instead, it should be short in distance to reduce losses. The next step is determining where to position the meter room, for the grid allowing for installation of a net meter and enabling the designer to calculate the AC cable run from the inverter.

Typically, a grid meter is installed at the base of a building so the site assessment should take into account the height of the structure. This is necessary to calculate the cable length needed to connect from the rooftop to the meter room.[3]

PRELIMINARY DESIGN

Once the site details are gathered a designer uses design software, like inventor or Google SketchUp to create a model of the building. This simulation helps in placing the solar panels taking into consideration factors like shadows and various constraints such as solar irradiance, albedo factor and solar angles specific to the rooftop coordinates. By doing an estimate of the number of panels that can be installed on the rooftop is obtained. This allows the designer to provide an estimate of the power output, from these panels once installed[3]

CALCULATION

In this project we are installing a 5KW solar power plant so we can put the load of residential property on it.

- This project provides independency of electrical supply, site and eco-friendly feature.
- Sun is the unlimited source of solar energy.
- No emission of greenhouse gases so pollution free.
- Once the structure of solar panel installed after that the cost is nil.
- Capital cost will reduce.
- Maintenance free. [1]

Project plan of 5kw off grid roof top solar PV System Specifications

Step-1. No of panels required for 5Kw Solar PV system

If one solar panel rates about 325 Watts, then No. of panels required for 5kw,

$$= 2 * 1000/325$$

$$= 15.384, \text{ approx. } 15 \text{ solar PV panels}$$

Step-2. Area : Area requirement for 1 Kw power generation by solar PV system
= 100 Sq ft (shadow free area)

Area required for 5 Kw power generation by solar PV system = $100 * 5 = 500$ sq ft (shadow free area)

Step-3. Number of units generated by 1kw Solar PV system assuming 5 Hrs. of bright sun in a day,

$$(\text{Energy} = \text{Power} * \text{time} = \text{Kw} * \text{Hr.})$$

$$= 1\text{KW} * 5\text{hrs} = 5\text{KWH} = 5 \text{ Units/day}$$

For 5kw solar PV system,

$$= 5\text{KW} * 5\text{hrs} = 25 \text{ KWH} = 25 \text{ Units/day}$$

Step-4. Amount of electricity bill saved using 5 kw solar PV system

Assuming cost of 1 unit electricity = 2.75 Rs

Electricity bill saved/day = units generated in a day * cost of 1 kwh (unit) = 25

$$\text{kwh} * 2.75 \text{ Rs} = 68.75 \text{ Rs}$$

Monthly electricity bill saved ,

$$= 68.75 \text{ Rs} * 30\text{days} = 2062.5 \text{ Rs}$$

Yearly electricity bill saved,

$$= 2062.5 \text{ Rs} * 12\text{months} = 24750 \text{ Rs}$$

Step-5. Return of investment of solar panel/Payback calculations

If cost required for 1Kw of Solar PV system installation is 60000 Rs, then cost required for 5 KW of solar PV system installation = 60000 * 5Kw =300000 Rs

As per MSEDCL (Maharashtra State Electricity Distribution Co. Ltd), 30% subsidy is allowed

on solar PV system installation after 30% subsidy,

the total cost of 5Kw solar PV system installation comes to = 30/100 * 300000 Rs

= 90000 Rs (subsidy discount)

Net initial cost of The System = 300000 – 90000 = 210000 Rs

Step-6. Payback period = net cost of the system / yearly savings

$$= 210000/24750 \text{ Rs}$$

$$= 8.48 \text{ (8 yrs. \& 5 months) –}$$

RECOVERY PERIOD

FUTURE SCOPE AND APPLICATION

Solar panels serve as a versatile solution, applicable not only in residential settings but also in commercial establishments, offering a clean, eco-friendly, and cost-effective source of renewable energy. The utilization of solar energy extends to powering a variety of appliances, including fans, tube lights, exhaust fans, projectors, and more within a department or workspace.

Ensuring optimal performance and longevity of solar panels, regular cleaning is imperative, typically required every 15 days. Enhancing this maintenance aspect, the integration of automatic wipers can streamline and automate the cleaning process, contributing to sustained efficiency over the solar panel's impressive 25+ years lifespan.

To maximize solar energy absorption, a dynamic approach involves incorporating a mechanism for solar panels to detect and align themselves with solar radiation angles. This feature allows for the panels to rotate in synchronization with the sun's movements, ensuring the capture of the maximum available solar energy throughout the day.

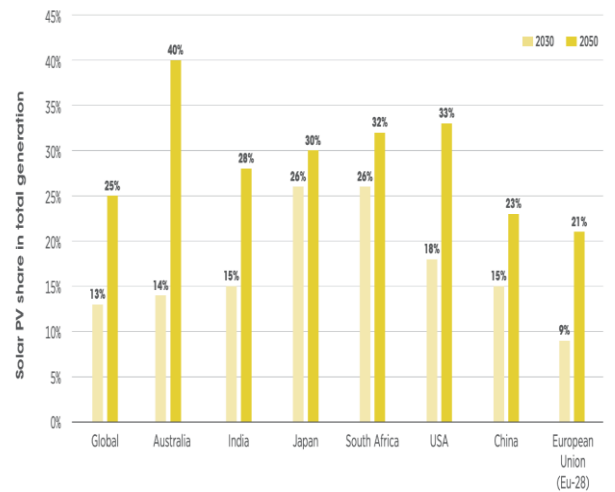
Additionally, for a more efficient power supply, the integration of natural light sources, such as daylight, can be leveraged for lighting purposes. Automation technologies, including efficient wiring and the implementation of Artificial Intelligence (AI), play a pivotal role in optimizing energy consumption and further enhancing the overall efficiency of the solar-powered system. This holistic approach not only addresses energy needs but also underscores the potential for sustainable, automated, and intelligent energy solutions in both domestic and

commercial

settings.

[1]

Figure 17: A higher penetration of solar power in electricity grids is foreseen in various countries by 2030 and 2050



Source: IRENA (2019a)

OBJECTIVE

In the contemporary era, electricity has become an indispensable aspect of daily life worldwide, shaping our routines and defining our modern lifestyle. The escalating dependence on electricity continues to grow steadily. However, this reliance primarily on non-renewable energy sources like coal and oil poses significant environmental challenges, contributing to emissions and adversely impacting the planet.

The drawbacks of depending on non-renewable sources extend beyond environmental concerns. The exponential rise in electricity costs associated with these conventional sources raises economic apprehensions, and the potential financial burden may render the establishment of power stations economically unfeasible.

Moreover, the finite nature of non-renewable sources poses a looming threat to future energy security, with projections indicating their depletion within 30-40 years. To address the pressing issues of cost escalation and environmental pollution, there is a pronounced shift towards harnessing solar energy. The emphasis lies in transitioning from non-renewable to renewable sources, thereby mitigating environmental impact, fostering sustainability, and ensuring a more resilient and enduring energy infrastructure.[2]

ADVANTAGES AND DISADVANTAGES

Advantages of Rooftop Solar Systems:

1. **Renewable Energy Source:**
 - Solar energy is a clean and renewable source of energy, harnessing sunlight to generate electricity without producing greenhouse gas emissions.
2. **Reduced Electricity Bills:**
 - By generating your own electricity, you can potentially reduce or even eliminate your reliance on the grid, leading to lower electricity bills.
3. **Environmental Benefits:**
 - Solar power helps reduce dependence on fossil fuels, lowering carbon emissions and contributing to environmental sustainability.
4. **Low Operating Costs:**
 - Once installed, solar systems have relatively low operating and maintenance costs compared to traditional power sources.
5. **Energy Independence:**
 - Solar panels provide a degree of energy independence, reducing reliance on centralized power systems and the volatility of energy prices.
6. **Government Incentives:**
 - Many governments offer financial incentives, tax credits, or rebates to encourage the adoption of solar technology, making it more economically viable.
7. **Increase Property Value:**
 - Homes equipped with solar panels often have higher resale values, as potential buyers may find the prospect of lower energy costs appealing.
8. **Net Metering:**

Some regions offer net metering, allowing excess electricity generated by the solar system to be fed back into the grid, earning credits or reducing future electricity bills.[2]

Disadvantages of Rooftop Solar Systems:

1. **High Initial Costs:**
 - The upfront cost of purchasing and installing solar panels can be relatively high, although it has been decreasing over the years.

2. **Dependency:**
 - Solar power generation is weather-dependent. Cloudy days and lack of sunlight can reduce the efficiency of solar panels, affecting energy production.
3. **Space Requirements:**
 - A sufficient roof space is needed for an effective solar installation, and not all roofs are suitable for accommodating solar panels.
4. **Aesthetic Impact:**
 - Some individuals may find the appearance of solar panels on rooftops less aesthetically pleasing, potentially affecting the curb appeal of a property.
5. **Intermittent Energy Production:**
 - Solar power is intermittent, producing energy only when the sun is shining. Energy storage solutions (e.g., batteries) can help address this issue but add to the overall cost.
6. **Energy Storage Costs:**
 - To ensure a continuous power supply, especially during periods of low sunlight, additional investments in energy storage solutions (e.g., batteries) may be required.
7. **Technical and Maintenance Challenges:**
 - While solar panels have low operating costs, they still require periodic maintenance, and technical issues may arise that need professional assistance.
8. **Geographical Limitations:**
 - The efficiency of solar panels can vary based on geographical location, climate, and the angle of sunlight. Some regions may not be as conducive to solar power generation.[2]

CONCLUSION

In conclusion, the transformative potential of solar energy is vast, offering a sustainable solution to meet our global energy requirements. While initial investments in solar energy development may seem substantial, it's crucial to recognize that these expenses represent a one-time commitment with enduring benefits. Once a solar power plant is installed, the maintenance is virtually negligible, and the panels boast an impressive lifespan of 25+ years.

This project has been instrumental in achieving the following objectives:

- Rigorously calculated the load through a comprehensive audit, providing valuable insights into the total energy consumption across different levels.

- Implemented a 5kw solar plant to seamlessly integrate our energy needs with the power of the sun, thereby reducing dependence on the grid and mitigating the associated high costs
- Initiated a strategic shift from traditional tube lights to energy-efficient LEDs, accompanied by the utilization of efficient wiring practices, contributing to overall energy conservation.
- This initiative marks a significant stride towards embracing renewable energy sources. By reducing costs and fostering an environment free from pollution, this project exemplifies the broader impact that transitioning to solar energy can have. It serves as a beacon, guiding us towards a sustainable and cleaner future, reinforcing the

importance of embracing renewable energy alternatives for the well-being of our planet. [1][3]

ACKNOWLEDGMENT

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REFERNCES

[1] ROOFTOP SOLAR INSTALLATION: A CASE STUDY

[2] A STUDY ON VARIOUS INSTALLATION OF SOLAR PV SYSTEM

[3] A BRIEF STUDY OF AN INSTALLATION OF A ROOFTOP SOLAR PV SYSTEM IN INDIA

