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DESIGNING of PV SOURCE of EV CHARGING USING SOLAR PRO

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Abstract:

As the world embraces sustainable energy solutions, integrating solar PV systems for Electric Vehicle (EV) charging is a promising avenue to reduce greenhouse gas emissions and promote green mobility. This paper outlines the methodology and key considerations for designing an efficient PV source for EV charging using the Solar Pro Solar Pro platform. The design process includes assessing solar potential, load analysis for EV charging needs, solar panel selection, system configuration, and financial viability estimation. Compliance with local regulations and safety standards is essential for a successful and sustainable PV-powered EV charging solution. This approach contributes to reducing the carbon footprint of transportation, aligning with the global push toward cleaner, greener transport systems.

Keywords **—Solar PV Systems, EV Charging, Solar Pro Solar Pro, Sustainability**.

I. INTRODUCTION

In an era defined by the growing urgency to address climate change and reduce greenhouse gas emissions, the integration of sustainable energy solutions is paramount. Transportation, a significant contributor to global emissions, stands at the forefront of this transition. Electric vehicles (EVs) have emerged as a promising alternative to traditional internalcombustion engine vehicles, offering cleaner and more environmentally friendly mobility.

The true potential of EVs in mitigating climate change and promoting green mobility can be fully realized when coupled with renewable energy sources. In this context, the integration of solar photovoltaic (PV) systems for EV charging represents a compelling avenue. Such a synergy not only reduces the carbon footprint of transportation but also contributes to a cleaner and more sustainable energy ecosystem.

This paper outlines a comprehensive methodology for designing efficient PV-powered EV charging systems, leveraging the capabilities of the Solar Pro Solar Pro platform.

The approach encompasses an assessment of the solar potential at the site, load analysis to determine EV charging requirements, meticulous solar panel selection, and system configuration. Furthermore, it delves into the critical aspect of compliance with local regulations and safety standards to ensure the success and sustainability of PV-powered EV charging solutions.

II. EV charging in workplace using PV

In order to Implement charging of EV using PV at workplace following factors should be considered.

- Solar radiation: One of the most important factors in measuring solar efficiency is solar radiation. Solar radiation measures the amount of solar energy (solar radiation) that reaches the earth's surface at a particular location. This is usually measured in units such as watts per square meter (W/m2). This information can be obtained from local weather stations, solar databases.

- Path and Angle: The position of the sun in the sky changes throughout the day and seasons due to the rotation of the Earth. The solar analysis measures the direction and angle of the sun relative to the site. This information is necessary to determine the orientation and tilt of the solar panels better so that they can absorb more energy.

- Shade Analysis: Shadows cast nearby objects such as buildings, trees, or other obstructions can significantly affect solar PV system performance Shade analysis helps identify potential shadow sources and assess their impact on solar system performance. Solar path models and image analysis software are used for this purpose.

- Weather and climate factors: Local weather and climate play a major role in solar power. Cloud cover, precipitation, and other weather factors can affect the amount of sunlight an area receives. Historical weather data and weather statistics are considered when calculating energy production.

- Available Space: Available space is one of the most important criteria for installing solar panels. The analysis takes into account the size and orientation of the site. Rooftops, open ground, or other areas are examined to determine how many objects can be installed and how they should be arranged.

1.PV system design

Fig1: logo of Solar Pro

Solar Pro is a sophisticated simulation software for PV systems. The Solar Pro is able to simulate electricity generation under different conditions varied by each system so that it allows system designing based on precise data. It Simulate electricity generation precisely with consideration for various elements of the PV system and display the result comprehensively. Additionally, since the calculated data come out with a persuasive and graphical look, it can be also utilized for presentations and education related to PV system generation.

1.1 Features of Solar Pro:

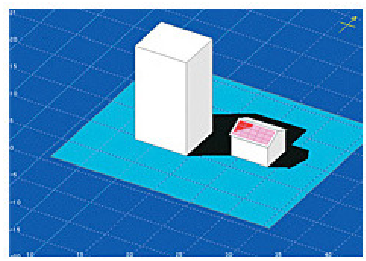

Fig2: 3D CAD Model

Simulation including the shadow influence by surrounding buildings and objects allows users to check optimal settings and module designs before system installation.

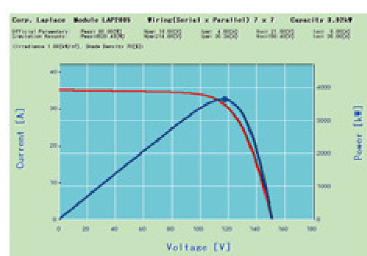

Fig3: I-V Curve

The Solar Pro calculates the I-V curve of solar modules accurately and quickly based on the electric characteristics of each manufacturer's product.

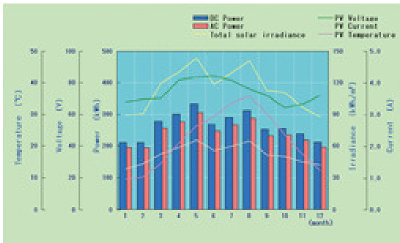

Fig4: Electric Power Calculation

The Solar Pro calculates the amount of generated electricity based on the latitudes, longitudes, and the weather conditions of the installation site. This leads precise simulation results.

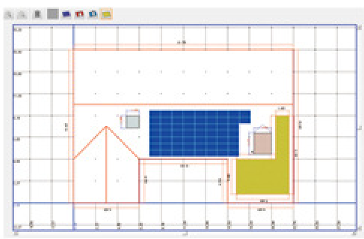

Fig5: Support for Designing

The Solar Pro determines necessary component for installing PV system automatically based on the settings.

2.Solar Angles and Estimation of Solar Orientation

To find Tilt angle, we calculate the following angles.

Sun’s position:

Sun’s position at any time is given by two angles Altitude angle (β_N) and Azimuth angle (Φ_s).

Altitude angle:

The altitude angle is the angle between the sun and the local horizon directly beneath the sun.

$\beta_N = 90^\circ - L + \delta$

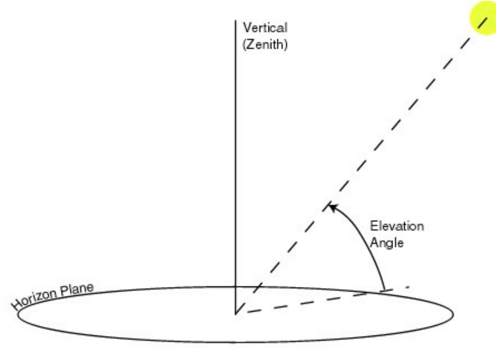

Fig6: The altitude angle of the sun at solar noon.

Azimuth angle:

The angle between local horizon beneath the sun and due South. Azimuth angle towards East are taken positive while towards West are negative.

cos[AZ] = [sin(Al) * sin(L) - sin(D)]/[cos(Al) * cos(L)]

AZ = Azimuth angle
Al = Altitude angle
L = latitude
D = Declination

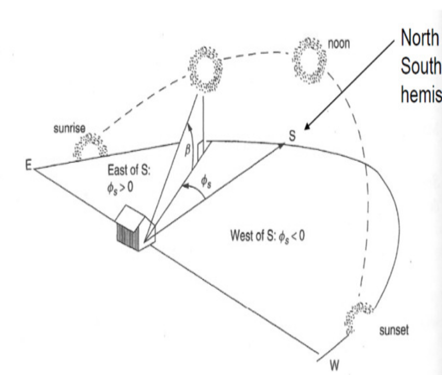

Fig7: The sun’s position can be described by its altitude angle β_N and its azimuth angle Φ_s. By convention, the azimuth angle is considered to be positive before solar noon.

Calculation of Azimuth and Altitude angles

In order to calculate Altitude and azimuth angles, we need to know solar declination angle, latitude angle and hour angle.

Solar declination angle (δ):

The angle between the light rays from the Sun and the Earth’s equator.

δ = 23.45 x sin [360/365 * (d - 81)]

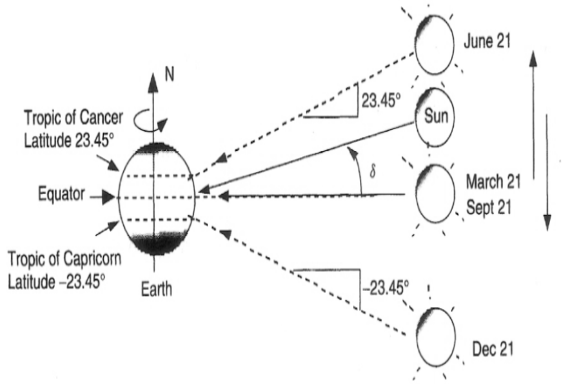

Fig8: An alternative view with a fixed earth and a sun that moves up and down. The angle between the sun and the equator is called the solar declination.

Hour angle:

The hour angle is the number of degrees that the earth must rotatebefore the sun will be directly over your local meridian (line of longitude).
HRA = 15° [LST-12]

Zenith Angle:

The angle between the sun's rays and the vertical direction.It is the complement to the solar altitude or solar elevation, which is the altitude angle or elevation angle between the sun's rays and a horizontal plane.

$$Z=90°-AL$$

Fixed Tilt Angle for Each Day:
Tilt = $|L-D|$
Tilt = $90 - \beta_N$

Find the optimum tilt angle for a south facing photovoltaic module in Ahmedabad (latitude = 23.02) at solar noon on January 1$^{st.}$ has been calculated

Angle of Declination: (1st of January is d=1)

$\delta = 23.45° * \sin[360/365 * (d-81)]$
$\delta = 23.45° * \sin[360/365 * (1-81)]$
$\delta = -23.01°$

Altitude angle:
Latitude angle of Ahmedabad (L) = 23.02°

$\beta_N = 90° - L + \delta$
$\beta_N = 90° - 23.02° + (-23.01°)$
$\beta_N = 43.97°$

The tilt angle that would make the suns rays perpendicular to the module at noon would therefore be,

Tilt = $90 - \beta_N$
Tilt = 90 – 43.9°
Tilt = 46.03°

3.Simulation

Site Assessment:
Input site-specific data, such as local weather data, shading analysis, and terrain characteristics. This information is essential for accurate simulation.

Load Assessment:
Calculate the energy requirements for EV charging. Consider factors like the EV's battery capacity, charging frequency, and the energy efficiency of the charging equipment. This information will help to determine the required PV system size.

System Configuration:
Select the type and model of solar panels and inverters the plan to use in the project. Input the technical specifications of these components.

PV Array Design:
Use the Solar Pro's tools to design the layout of the PV array on your site. This may involve specifying the number of panels, their orientation, tilt angle, and shading mitigation strategies.

Electrical Design:
Design the electrical components of the system, including wiring, inverters, and the connection to the electrical grid or the charging station for EVs.

Simulation and Performance Analysis:
Run the simulation to predict the solar system's performance. This will typically generate output data such as energy production estimates, expected monthly or annual savings.

Financial Analysis:
Use the simulation results to assess the financial viability of the project

Reports and Documentation:
Generate detailed reports and documentation that summarize the design and simulation results. These documents can be useful for permitting and financing purposes.

Optimization:
Review the simulation results to identify potential improvements or optimizations in solar system design. This might involve making adjustments to panel placement, components, or other factors.

4.Results

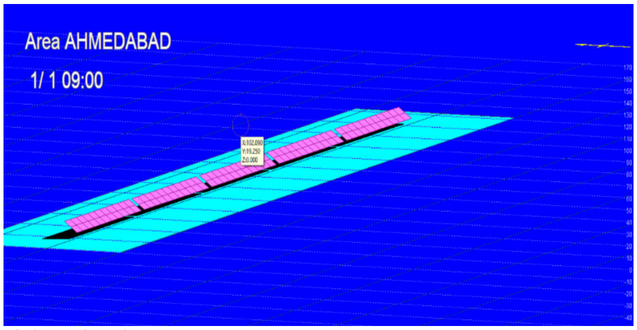

Fig9: Designed PV source

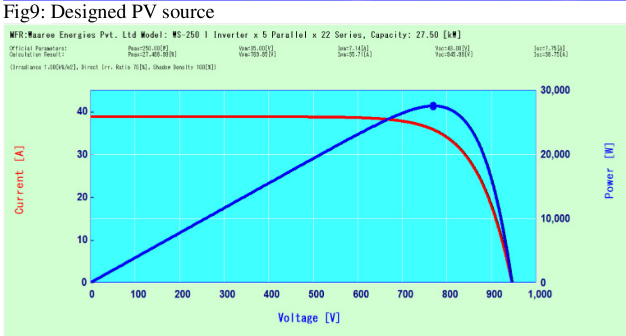

Fig10: I-V curve & P-V curve

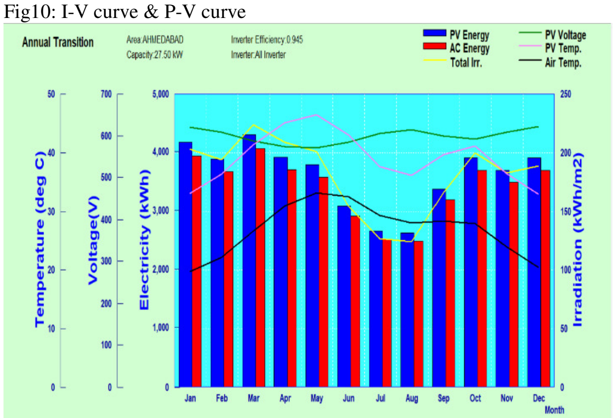

Fig11: Annual Transition of Ahmedabad.

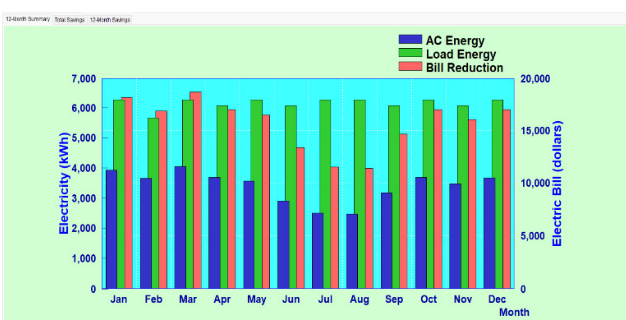

Fig12: Economic Graph

Report Type						
Term	AC Energy	Specific AC Energy	Load Energy	Bill Reduction	Selling Price	Buying Price
Unit	kWh	kWh/kWp	kWh	dollars	dollars	dollars
Jan	3952.7	143.73	6299.2	18182	11858	18872
Feb	3677.92	133.74	5689.6	16918	11034	16873
Mar	4070.8	148.03	6299.2	18726	12212	18683
Apr	3707.3	134.81	6096	17054	11122	18452
May	3587.99	130.47	6299.2	16505	10764	19456
Jun	2921.79	106.25	6096	13440	8765	19709
Jul	2522.98	91.74	6299.2	11606	7569	21160
Aug	2489.82	90.54	6299.2	11453	7469	21213
Sep	3200.15	116.37	6096	14721	9600	19263
Oct	3703.31	134.67	6299.2	17035	11110	19271
Nov	3502.3	127.36	6096	16111	10507	18780
Dec	3699.52	134.53	6299.2	17018	11099	19277
Max Value	4070.8	148.03	6299.2	18726	12212	21213
Max Term	Mar	Mar	Jan	Mar	Mar	Aug
Mean Value	3419.71	124.35	6180.67	15731	10259	19251
Sum Value	41036.57	1492.24	74168	188768	123110	231009

Fig13: Monthly report

5.Benefits of EV and PV.

1.Precision and Accuracy:

Solar Pro utilizes complex algorithms and local weather data to make precise predictions about a system's performance. This ensures that the PV system is designed to optimally meet your EV charging requirements.

2. Efficiency Optimization:

These Solar Pro tools allow you to fine-tune your PV system for maximum efficiency. You can factor in variables like panel placement, tilt, and azimuth to capture the most sunlight and improve energy production.

3.Financial Modeling:

Many Solar Pro Solar Pro options offer financial analysis, helping you assess the return on investment, payback period, and potential energy savings. This data is valuable for justifying the initial investment.

4.Comparative Analysis:

You can compare different design scenarios and equipment choices, enabling you to select the most cost-effective and energy-efficient solution for your specific needs.

5.Environmental Benefits:

By using this Solar Pro, you can design a system that minimizes your carbon footprint by harnessing renewable energy for EV charging, contributing to sustainability.

CONCLUSION

PV modules are key components of a photo-voltaic system where sunlight is converted into direct current (DC) electricity. solar energy is a renewable energy source, does not produce greenhouse gas emissions or other harmful pollutants, and can provide energy independence to households and businesses. Solar Pro software enables us to optimize the solar power system to meet the energy demands of electric vehicles efficiently. The combination of innovative software like 'Solar Pro' and a commitment to clean energy is a testament to our dedication to creating a greener and more efficient future for all.

The design process involves careful consideration of various factors, including the geographical location, solar panel efficiency, battery storage, and charging infrastructure. 'Solar Pro' simplifies these complex calculations and ensures the optimal configuration of the PV system.

Designing a PV source for EV charging using solar power aligns with the global shift toward cleaner and more sustainable energy solutions. It not only benefits the environment but also offers practical advantages in terms of cost savings, energy independence, and grid resilience. As technology continues to advance and solar energy becomes more accessible, the future looks bright for solar-powered EV charging.

It is a forward-thinking and sustainable solution that offers numerous benefits for both the environment and users. this approach presents a promising future for clean transportation and energy.

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