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Web Based Solar Panel Estimation and Load Analysis

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Abstract: *With increasing energy demand and environmental concerns, solar energy offers a sustainable alternative to conventional power sources. This paper presents a web-based application for estimating daily energy consumption and designing an appropriate solar power system. Users input appliance details, including power ratings and usage hours, and the system calculates total energy demand in kilowatt-hours (kWh). Based on this, it determines the required number of solar panels considering panel capacity and available sunlight. The application also provides cost estimation, including panels, inverter, optional battery, and installation expenses, along with basic financial analysis such as payback period. The platform offers a user-friendly interface to support households and organizations in planning and adopting solar energy solutions.*

Key Words: *Solar Energy, Load Analysis, Battery Sizing, Charge Controller, Payback Period, Web Application*

I.INTRODUCTION

The demand for electrical energy has increased significantly due to industrialization and modernization. Conventional energy sources such as coal and petroleum are depleting and contribute to environmental pollution. Solar energy provides a clean and renewable alternative that can meet future energy demands.

However, designing a solar system requires accurate estimation of load, system components, and cost. Traditional methods involve manual calculations or complex simulation software, which are not suitable for non-technical users.

To address this problem, a web-based solar estimation system is proposed. The system simplifies calculations and provides a complete solution including load analysis, solar sizing, battery calculation, and financial evaluation

II.EXISTING SYSTEM

In existing systems, solar estimation is performed using manual calculations, simulation tools, or basic online calculators. Software such as PVsyst and HOMER provides accurate results but requires technical expertise.

Most existing tools focus only on solar panel sizing and ignore critical components such as battery storage and charge controllers. Additionally, these systems do not provide detailed cost analysis or payback period calculation.

Due to these limitations, existing systems are either too complex or too limited for practical use by common users.

III. PROPOSED SYSTEM

The proposed system is a Web Based Solar Estimation and Management System designed to overcome the limitations of existing methods.

The system includes:

- Load analysis
- Solar panel sizing
- Battery sizing
- Charge controller selection
- Cost estimation
- Payback period calculation

It also includes a role-based workflow system:

- Developer → system management
- Admin → branch and stock management
- Employee → site survey and calculations
- Customer → request and payment

This integrated approach makes the system practical and efficient.

IV. METHODOLOGY

The system follows a step-by-step methodology:

Load Calculation

$$Energy = Power \times Hours \times Quantity$$

Solar Capacity

$$SolarCapacity = \frac{DailyEnergy}{PSH \times Efficiency}$$

Battery Sizing

$$Battery = \frac{Energy \times Backup}{Voltage \times Efficiency}$$

Controller Selection

$$Controller = \frac{PanelPower}{Voltage}$$

Payback Period

$$Payback = \frac{TotalCost}{AnnualSavings}$$

V.SYSTEM ARCHITECTURE

The system follows a three-tier architecture:

- Frontend: HTML, CSS, JavaScript
- Backend: Node.js
- Database: MongoDB

The system uses Role-Based Access Control (RBAC) to manage different users and ensure secure operations.

VI.UNITS

The International System of Units (SI) is used as the primary system of measurement in this work. All electrical and solar parameters are expressed in standard SI units to maintain consistency and clarity throughout the analysis. Wherever necessary, commonly used practical units are also included for better understanding.

In solar energy systems, power is measured in **watts (W)** or **kilowatts (kW)**, and energy consumption is expressed in **watt-hours (Wh)** or **kilowatt-hours (kWh)**. Solar panel capacity is typically represented in kilowatts peak (kWp), which indicates the maximum power output under standard test conditions. Solar radiation is measured in **kilowatt-hours per square meter per day (kWh/m²/day)**.

Battery capacity is expressed in **ampere-hours (Ah)**, while voltage is measured in **volts (V)**. The current rating of the charge controller is measured in **amperes (A)**. Time-related parameters such as usage duration and backup time are expressed in **hours (h)**.

For economic analysis, cost is represented in **Indian Rupees (₹)**, and electricity tariffs are expressed in **₹/kWh**. The payback period is calculated in **years**.

Proper unit consistency is maintained in all equations to ensure dimensional correctness. Mixed units are avoided, and all calculations follow standard engineering conventions.

VII.HELPFUL HINTS

A. Figures and Tables

B. References

References should be numbered consecutively in square brackets such as [1], [2], [3], and cited in the text accordingly. Each reference must correspond to a source listed in the reference section at the end of the paper. When citing multiple references, use separate brackets like [1], [2].

The reference list should include complete details such as author names, title, journal or book name, volume, issue, and year of publication. Only relevant and credible sources such as textbooks, IEEE papers, and official documentation should be included.

C. Abbreviations and Acronyms

All abbreviations and acronyms must be defined at their first occurrence in the text. For example:

- PV – Photovoltaic

- PSH – Peak Sun Hours
- RBAC – Role-Based Access Control
- ROI – Return on Investment

Once defined, the abbreviation can be used throughout the document. Avoid using abbreviations in the title unless necessary. Standard abbreviations such as SI, AC, and DC do not need to be defined.

D. Equations:

All equations used in the paper must be clearly written using an equation editor and numbered sequentially. Equation numbers should be placed on the right side within parentheses.

$$Energy = Power \times Time (1)$$

All variables used in equations must be defined either before or immediately after the equation. Units must be consistent to avoid confusion. Equations should be referenced in the text as "(1)," "(2)," etc.

VIII.RESULTS AND DISCUSSION

The system successfully calculates:

- Energy consumption
- Solar panel capacity
- Battery size
- Controller rating
- Total cost
- Payback period

Compared to existing systems, the proposed system provides:

- Higher accuracy
- Better usability
- Complete system design

Fig1:login page

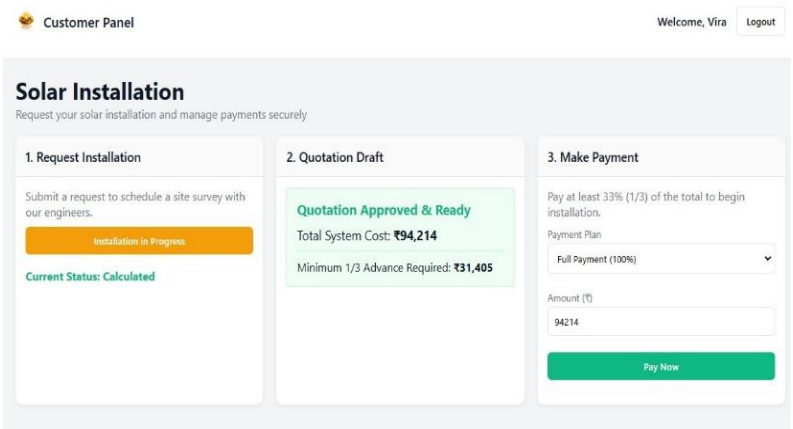

Fig2: customer panel

IX.PUBLICATIONPRINCIPLES

The contents of this paper are intended to contribute to the advancement of knowledge in the field of renewable energy and web-based system design. The proposed Web Based Solar Estimation and Installation Management System combines engineering calculations with modern software technologies to provide a practical and scalable solution for solar energy adoption.

The following principles have been considered during the preparation of this paper:

1.Technical-Contribution:

The paper presents a comprehensive approach to solar system estimation by integrating load analysis, solar panel sizing, battery sizing, and charge controller selection. Unlike traditional systems, it also includes financial analysis such as cost estimation and payback period, making it a complete solution.

2.Originality-of-Work:

The proposed system is developed as a unique combination of solar engineering principles and web-based workflow management. The inclusion of role-based access control and a structured installation lifecycle ensures originality in implementation.

X.CONCLUSION

The proposed Web Based Solar Estimation System provides a comprehensive solution for solar system design and analysis. It integrates technical calculations with financial evaluation and workflow management. The inclusion of battery sizing and controller selection improves system accuracy and reliability. The system is user-friendly and suitable for real-world applications, making it an effective tool for promoting solar energy adoption.

XI. ACKNOWLEDGMENT

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