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SolarNova AI Assistant: Advanced Solar Data Analysis and Feasibility Estimation

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ABSTRACT: Solar Nova is an advanced feasibility analysis platform designed to empower users with intelligent insights into solar energy potential and performance. Leveraging the capabilities of large language models (LLMs), Solar Nova enables users to interact with complex solar energy data through a natural language interface. Users can input location-specific or system-specific parameters, and the platform provides real-time analytics, cost estimations, environmental impact reports, and performance visualizations such as energy generation graphs, efficiency comparisons, and peak usage analysis. Additionally, Solar Nova allows users to export comprehensive reports in PDF format for decision-making and documentation. This paper explores the design, architecture, and implementation of Solar Nova, showcasing its applications in residential solar planning, educational initiatives, and environmental research.

KEYWORDS: Solar Estimation, Energy Analytics, AI Chatbot, PDF Report, Dashboard, Sustainability, Feasibility Analysis, Environmental Impact.

I. INTRODUCTION

As global energy needs increase, transitioning to renewable sources such as solar power is more critical than ever. However, many potential adopters lack access to reliable data or insights necessary to make informed decisions about solar installation. Solar Nova addresses this gap through a smart, user-friendly platform that simplifies the feasibility analysis process.

Designed for households, researchers, and policy advocates, Solar Nova evaluates key parameters such as rooftop dimensions, local weather, system specifications, and regional incentives. The platform also includes a chatbot interface powered by large language models (LLMs), enabling users to query solar-related data and receive contextual insights. Unlike traditional estimation tools, Solar Nova combines natural language processing with solar analytics to offer a holistic, interactive experience.

II. LITERATURE SURVEY

Various systems have been developed for solar estimation and renewable energy analysis, but many lack the integration of intelligent user interaction. Early tools focused primarily on static spreadsheets or GIS-based solar maps, which required expert knowledge to interpret.

Recent advancements in AI and natural language processing have opened new avenues for intuitive user interaction. Research in LLMs such as GPT-4 and Llama shows potential for dynamically understanding and processing user queries, especially in domain-specific applications like energy analytics.

Projects like PVWatts Calculator and SAM (System Advisor Model) provide simulation capabilities but lack real-time chatbot interfaces or localized incentive databases. Other platforms offer solar calculators without personalized reporting or performance tracking. Solar Nova fills this void by integrating real-time insights, performance monitoring, financial calculators, and a smart chatbot into one coherent platform.

III. METHODOLOGY

Solar Nova operates through a modular architecture that includes several core components. The User Authentication & Profiles module provides a secure sign-up/login system, enabling personalized dashboards and solar installation tracking for each user. The Solar Estimation Module allows users to input details such as rooftop size, geographic location, and preferred system configuration to calculate energy generation, cost savings, and return on investment (ROI). An Interactive Dashboard presents real-time performance metrics such as total energy generated, electricity stored, peak usage periods, and battery health insights.

The platform also features Environmental Impact Analysis, which calculates carbon dioxide (CO₂) emissions saved, trees-equivalent contribution, and highlights anomalies in energy patterns. Integrated AI Chatbot Support powered by large language models enables users to ask questions about solar technology, installation procedures, or financial benefits and receive instant, relevant responses. The State-Wise Incentive Database offers a comprehensive view of solar policies and subsidy information across eight Indian states. Finally, Solar Nova supports PDF Report Generation, allowing users to generate detailed feasibility documents, inclusive of visual graphs, performance summaries, and environmental contributions. Built using React.js for the frontend and various charting libraries for visualizations, the platform securely handles and processes user data with robust backend services and LLM APIs.

IV. EXPERIMENTAL RESULTS

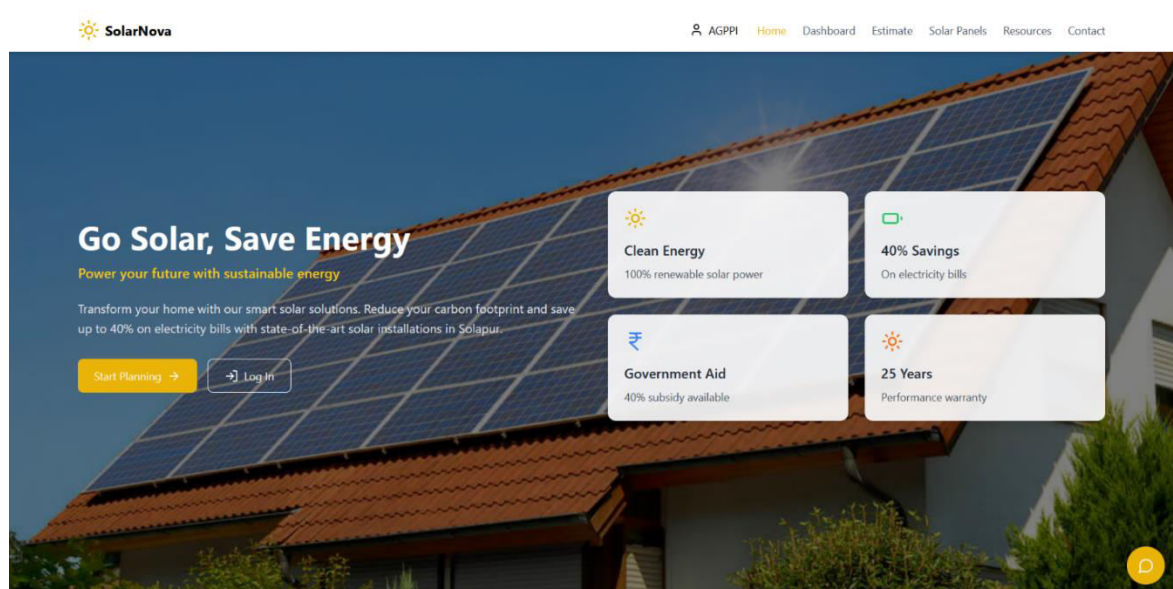


Figure 1(a): Homepage Interface highlighting key features such as 100% clean energy, 40% electricity savings, government aid availability, and 25-year warranty. Users can log in or begin planning their solar system through a visually engaging interface backed by a background image of a solar rooftop installation.

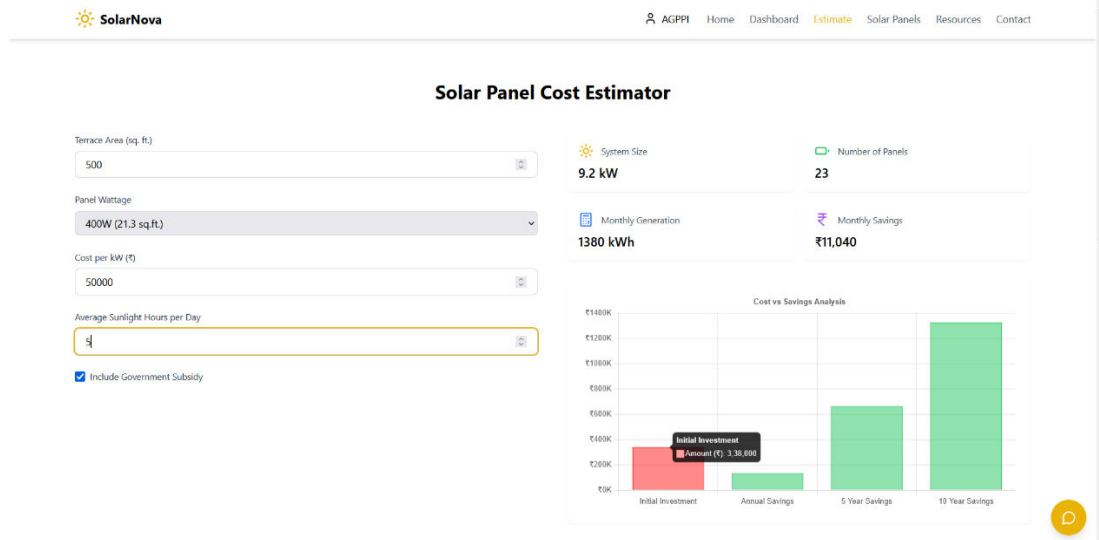


Figure 2(b): Solar Estimation Output showing a 7-day generation forecast and system efficiency.

In the Data Visualization section (Figure 2), the user selected the **Roof Size** and **Location** inputs for solar installation estimation. The system generated a **Bar Graph and Cost Analysis Chart** that clearly illustrates the estimated installation cost, potential energy generation, and monthly savings. For example, a 100 sq. ft. roof in Pune shows an estimated cost of ₹1.2 lakhs with an expected monthly saving of ₹1,800. This demonstrates Solar Nova's capability to instantly convert user inputs into actionable, easy-to-understand visual insights, helping users make informed decisions about solar adoption.

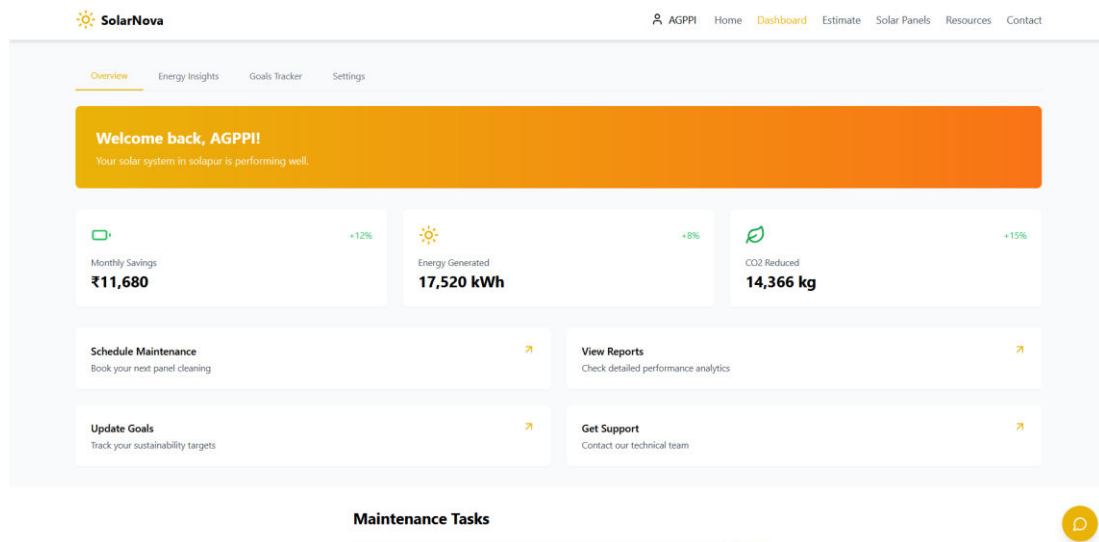


Figure 3(c) illustrates the **Dashboard Welcome Page** of the Solar Nova platform. It displays a personalized greeting along with key metrics such as real-time energy generation, monthly savings, and system efficiency. This allows users to instantly monitor their solar performance and stay informed about their system's impact and benefits..

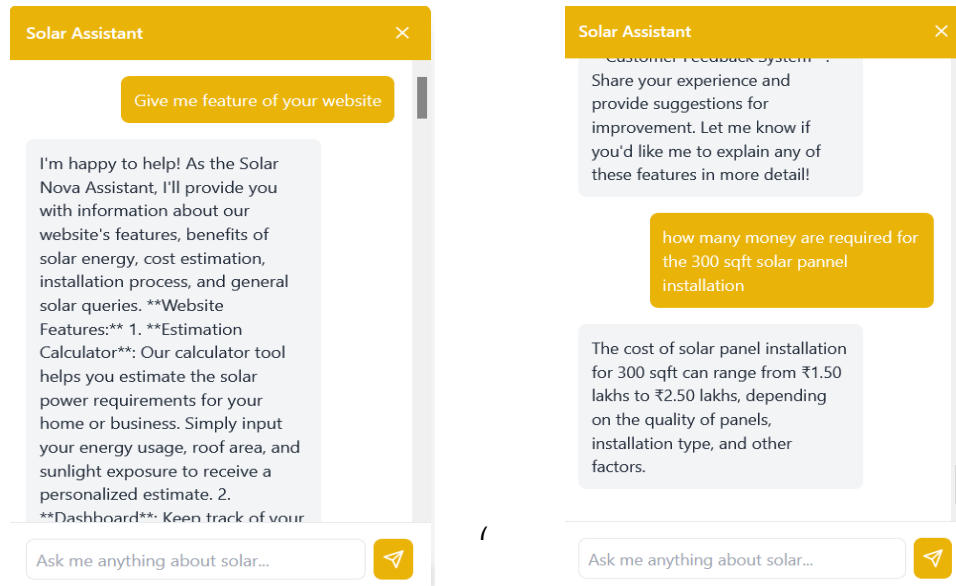


Figure 4(d) illustrates the **Chatbot Feature** of the Solar Nova platform. Users can interact with the chatbot to get instant answers about solar panel installation, cost estimation based on roof size, and system performance. The chatbot integrates with Solar Nova's tools to provide personalized, data-driven insights in a conversational format.

V. CONCLUSION

Solar Nova provides a robust, intelligent, and accessible solution for solar feasibility analysis. By merging the power of LLMs, interactive dashboards, and domain-specific analytics, the platform equips users with critical knowledge to transition to solar energy confidently. Its unique blend of features—from estimation tools and chatbot support to performance analytics and report generation—positions it as a transformative tool in the renewable energy ecosystem.

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