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A Review on Smart EV Charging and Energy Monitoring Using IoT

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Abstract:

Smart EV charging and energy monitoring using IoT in India is an emerging field that combines electric vehicle technology with Internet of Things (IoT) capabilities to optimize charging processes and improve energy management.

Keywords — Electric Vehicles (EVs), Internet of Things (IoT), Smart Charging, Energy Monitoring.

INTRODUCTION

The integration of Internet of Things (IoT) technology with electric vehicle (EV) charging infrastructure represents a significant advancement in the transportation and energy sectors. This innovative approach, known as smart EV charging, combines IoT devices, sensors, and data analytics to optimize the charging process, enhance energy efficiency, and improve the overall user experience. Smart EV charging systems utilize a network of interconnected devices to monitor and control the charging process in real-time. These systems collect and ana data from various sources, including the EVs themselves, charging stations, and the power grid. By leveraging this information, smart charging solutions can make intelligent decisions about when and how to charge vehicles, taking into account factors such as energy demand, grid capacity, and user preferences.

Smart EV charging and energy monitoring using IoT (Internet of Things) is an innovative approach to managing electric vehicle charging infrastructure and optimizing energy consumption. This system integrates IoT technology with electric vehicle charging stations to provide real-time data collection, analysis, and control. Key aspects of this

technology include real-time monitoring of charging station usage, energy consumption, and grid load through IoT sensors. Dynamic load balancing adjusts charging rates based on grid capacity and demand to prevent overloading. Predictive maintenance enabled by IoT devices monitors charging equipment health, reducing downtime. User-friendly interfaces such as mobile apps and web portals allow users to locate available charging stations, schedule charging sessions, and track energy consumption. Smart pricing models can be implemented based on peak hours and energy availability. The system can communicate with the power grid to optimize energy distribution and support demand response programs. Collected data can to improve charging infrastructure planning and management energy strategies. management capabilities allow operators to monitor and control charging stations, enhancing efficiency and reducing operational costs. By leveraging IoT technology, smart EV

charging and energy monitoring systems aim to improve the efficiency, reliability, and sustainability of electric vehicle charging infrastructure.

India's transition to electric vehicles (EVs) has sparked innovation in smart EV charging and energy monitoring. Leveraging IoT technology, Indian

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companies are developing intelligent charging solutions that optimize energy consumption, reduce peak demand, and promote renewable energy integration. Smart EV charging stations, equipped with IoT sensors and real-time monitoring capabilities, enable efficient energy management and automated billing. Moreover, IoT-based energy monitoring systems provide valuable insights into energy usage patterns, facilitating data driven decision-making. As India targets30% EV adoption by 2030, smart EV charging and energy monitoring solutions will play a vital role in ensuring a sustainable and efficient transportation.

2.Monitoring system in India

clean energy usage. IoT devices monitor solar generation, battery storage levels, and grid power consumption to optimize the use of renewable energy for EV charging.

The Indian smart EV charging ecosystem also emphasizes interoperability and standardization. Efforts are being made to develop common communication protocols and payment systems to ensure seamless user experience across different charging networks. This approach aims to address the fragmentation issues often seen in early-stage EV markets.

In urban areas, smart EV charging systems are being integrated with public transportation hubs to promote multimodal transportation. IoT-enabled charging stations at metro stations, bus depots, and park-and-ride facilities allow commuters to conveniently charge their vehicles while using public transport for part of their journey. The integration of smart EV charging with India's growing smart meter infrastructure is another area of focus. This integration allows for more accurate billing, better load management, and the potential for implementing innovative tariff structures that incentivize off-peak charging.

Lastly, the development of a domestic supply chain for smart EV charging components is being prioritized to support the "Make in India" initiative. This includes the local manufacturing of IoT sensors, communication modules, and charging equipment, which can help reduce costs and create employment opportunities in the EV sector.

3. Energy Monitoring Using IoT System and Approach

Smart EV charging and energy monitoring using IoT systems integrate advanced technologies to optimize electric vehicle charging processes and enhance energy management. These systems employ a network of interconnected devices and sensors to collect real-time data on charging station availability, energy consumption, and grid load. IoTenabled charging stations can communicate with electric vehicles, power grids, and user devices, allowing for efficient scheduling, load balancing, and demand response mechanisms. The collected data to predict charging patterns, optimize energy distribution, and provide valuable insights for infrastructure planning. Users can access real-time information about charging station locations, pricing availability. and through mobile applications, improving convenience and reducing range anxiety. Additionally, these systems can integrate renewable energy sources and energy storage solutions, contributing to a more sustainable and resilient charging infrastructure. By leveraging IoT technology, smart EV charging systems aim to enhance the overall efficiency, reliability, and user experience of electric vehicle charging while supporting the growth of sustainable transportation. Smart EV charging and energy monitoring using IoT in India is gaining significant traction as the country aims to accelerate electric vehicle adoption and improve its energy infrastructure. The Indian government has set ambitious targets for EV adoption, making the implementation of smart charging systems crucial for managing the increased demand on the power grid. In India, smart EV charging systems are being integrated with existing smart city initiatives to create a comprehensive urban mobility solution. These systems are designed to address unique challenges faced by Indian cities, such as high population density, diverse vehicle types, and varying power supply conditions. One key aspect of smart EV charging in India is the focus on renewable energy integration. Many charging stations are being equipped with solar panels and energy storage systems to reduce dependence on the

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grid and promote clean energy usage. IoT devices monitor solar generation, battery storage levels, and grid power consumption to optimize the use of renewable energy for EV charging.

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To address range anxiety and promote EV adoption in rural areas, the Indian government is exploring the concept of mobile charging stations. These IoTenabled mobile units can be deployed to areas with limited charging infrastructure, providing flexible and on-demand charging solutions. Data privacy and cybersecurity are critical concerns in the Indian context. Smart EV charging systems are being designed with robust security measures to protect user data and prevent unauthorized access to the charging infrastructure. This includes encryption of transmission, authentication data secure mechanisms, and regular security audit.

As shown in Table 1.1, various IoT-enabled smart EV charging approaches are summarized.

Table 1.1 Literature Review

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Author Contributions: Pradnya Pramod Narwade (M. Tech Student) developed the system architecture, conducted the research, and prepared the manuscript draft. Prof. V. V. Kulkarni supervised the project, provided technical guidance, and reviewed the manuscript. All authors have read and approved the final manuscript.

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