International
Journal
Of Modern Engineering Research (IJMER)

# Design of HMI-Driven Cost Monitoring for EV Charging

Muhammad Wahyu[1], Syaiful Rachman[2], Paliling[3], Zuraidah[4]
[1](Politenik Negeri Banjarmasin)
[2](Politenik Negeri Banjarmasin)
[3](Politenik Negeri Banjarmasin)
[4](Politenik Negeri Banjarmasin)

***ABSTRACT:*** *The rapid adoption of electric vehicles (EVs) has highlighted the need for intelligent charging infrastructures that ensure both technical reliability and economic transparency. Conventional charging stations typically provide only basic electrical parameters, such as voltage and current, but lack integrated mechanisms for real-time cost monitoring, which limits user trust and decision-making. This study proposes the design and implementation of a Human–Machine Interface (HMI)-based monitoring system integrated with a Programmable Logic Controller (PLC) for EV charging applications. The system acquires sensor data, computes tariff-based charging costs, and provides real-time visualization of voltage, current, power, energy, and cost parameters. Experimental results demonstrate that the system accurately tracks charging dynamics: battery voltage gradually increased from 20.18 V to 21.28 V, current decreased from 5.0 A to 0 A, while cumulative energy consumption and charging cost rose linearly to 3.3 kWh and Rp 4950, respectively, after a three-hour charging cycle. These findings validate the reliability of the system's computation algorithm and highlight its effectiveness in delivering both technical and economic insights. The proposed solution contributes to enhancing transparency, supporting demand-side management, and ensuring user-centered smart charging operations, making it suitable for scalable deployment in sustainable EV infrastructures.*

***KEY WORDS:*** *Electric vehicle charging, Human–Machine Interface (HMI), Programmable Logic Controller (PLC), cost monitoring, smart charging system*

Date of Submission: 19-08-2026 Date of acceptance: 31-08-2026

## I. INTRODUCTION

The increasing adoption of electric vehicles (EVs) is reshaping the global transportation sector, contributing significantly to the reduction of greenhouse gas emissions and decreasing reliance on fossil fuels [1]. EVs are widely recognized as a cornerstone technology in achieving sustainable mobility, particularly as governments worldwide implement stricter emission standards, carbon neutrality targets, and green energy transition policies [2]. This rapid transition is further supported by advancements in lithium-ion battery technologies, declining production costs, and the growing integration of renewable energy into power grids [3]. Consequently, the coming decade is expected to witness a dramatic surge in EV penetration, positioning EVs not only as alternatives to internal combustion engine (ICE) vehicles but also as critical enablers of low-carbon urban development [4], [26].

However, this accelerated growth presents substantial challenges in energy management, infrastructure readiness, and consumer acceptance. Among these challenges, the deployment of intelligent charging infrastructures is essential to balance efficiency, grid stability, and user experience. A large number of EVs connected to the grid simultaneously can lead to peak demand, voltage fluctuations, and higher operational risks if charging is not carefully managed [5]. Addressing these issues requires not only technological innovation but also user-oriented solutions that enhance transparency, reliability, and affordability in the charging process.

One of the most critical aspects of EV adoption is the monitoring of charging costs, which directly affects consumer satisfaction and the overall economic feasibility of ownership [6]. Conventional charging stations typically provide only limited information, such as voltage, current, and state-of-charge (SoC), but lack advanced features like real-time cost calculation and visualization [7]. As a result, users often rely on manual estimations or delayed post-usage billing, processes that are inefficient, error-prone, and lacking transparency [8]. In regions with dynamic tariffs or tiered pricing models, the absence of real-time cost monitoring can discourage participation in EV adoption, since users cannot predict or control their expenses [9], [27]. These gaps also reduce opportunities for consumers to participate in demand-side management programs that are vital for maintaining grid stability.

To mitigate these limitations, the integration of advanced monitoring technologies and automation platforms has become both a research and industrial priority. Next-generation EV charging systems are expected to provide real-time visualization of electrical parameters, tariff-based cost computation, and robust historical logging for post-analysis [10]. Human–Machine Interfaces (HMIs) have emerged as effective solutions for bridging users with complex automation systems, offering interactive dashboards, alarm notifications, and intuitive control mechanisms [11]. In EV charging applications, HMI integration enhances visibility, enables cost calculations according to tariff structures, and empowers users to respond proactively to abnormal charging conditions [12], [28].

The combination of HMI with industrial-grade Programmable Logic Controllers (PLCs) further improves system performance by ensuring deterministic response times, resilience in harsh environments, and compliance with standardized communication protocols such as Modbus RTU, Modbus TCP, and OPC-UA [13], [14]. This robustness is particularly important for public or industrial EV charging stations, where continuous operation and long-term maintainability are essential [15]. Additionally, hybrid architectures linking PLC–HMI systems with Internet of Things (IoT) platforms and cloud-based analytics can deliver both local reliability and global accessibility [16], [29], making them suitable for scalable deployment.

Equally important, tariff-based cost monitoring has been shown to enhance consumer engagement in smart charging ecosystems. Studies indicate that when users have access to transparent, real-time cost information, they are more likely to adapt their charging behavior, shifting to off-peak hours and supporting demand-side management strategies [17], [18]. Furthermore, advanced tools such as blockchain for secure billing, artificial intelligence for predictive analytics, and machine learning for fraud detection and anomaly identification have opened new research directions in this field [19], [30], [31]. With growing digital interconnectivity, cybersecurity measures are also emphasized to safeguard EV infrastructures against risks that could compromise user data and grid operations.

Beyond consumer-level benefits, monitoring systems play an increasingly strategic role in system-wide objectives such as predictive maintenance, energy efficiency, and sustainable infrastructure planning. Machine learning-based fault detection [32], digital twin-enabled charging optimization [33], and decentralized multi-agent energy management [34] are among the innovative approaches being explored. These advancements underscore that monitoring is no longer limited to tracking basic parameters, but has evolved into a critical component of smart energy and sustainable transportation ecosystems [35].

This study therefore proposes the design and implementation of an HMI-based cost monitoring system for EV charging. The system leverages sensor data acquisition, PLC-based computation, and real-time HMI visualization. Its novelty lies in the integration of tariff-based cost calculation directly into the visualization layer, providing users with immediate, accurate, and transparent insights into charging expenses. Beyond enhancing consumer confidence, the framework contributes to predictive maintenance, energy efficiency, and demand-side management. By ensuring both technical robustness and user accessibility, this study offers a scalable and practical solution for policymakers, operators, and stakeholders in advancing smart, transparent, and sustainable EV charging infrastructures [20]–[35].

## II. RELATED WORK

Research on EV charging infrastructures has advanced significantly over the past decade, particularly in power delivery, cost optimization, user interaction, and system integration. Yilmaz and Krein [1] provided an extensive review of charging power classifications, highlighting technical constraints and deployment implications. Kumar et al. [2] and Shao et al. [4] examined smart charging strategies, emphasizing demand-side management and optimal scheduling to maintain grid stability. More recent surveys, such as Zhang et al. [26], identified future challenges in EV–grid integration, stressing the importance of intelligent monitoring and control mechanisms.Another line of research addresses cost optimization and tariff-based charging. Zhang et al. [5] introduced cost-aware optimization models, showing how pricing schemes influence user behavior and system economics. Liu et al. [8] explored dynamic pricing strategies that adapt to real-time demand, while Nguyen et al. [27] emphasized user participation in demand response under variable tariffs. Morales et al. [16] and Elbaz and Elsayed [17] further demonstrated that transparent cost feedback and real-time pricing signals are crucial for engaging consumers in flexible charging practices.

Monitoring technologies have also been extensively studied. Karthikeyan et al. [6] presented an IoT-based framework for real-time monitoring of charging stations, whereas Varajão et al. [7] reviewed smart charging station features and identified the absence of integrated cost monitoring as a persistent limitation. Gao et al. [9] advanced this by applying data-driven methods to analyze charging behavior, demonstrating the value of detailed user datasets. Complementary approaches include blockchain-based billing systems explored by Reddy et al. [18] and cybersecurity frameworks proposed by Wang et al. [30] and Ahmad et al. [31], which highlight the need for security in interconnected EV networks.Human–Machine Interfaces (HMIs) have gained increasing attention as tools for enhancing user interaction and system transparency. Chen et al. [10] and Huang et al. [11] demonstrated that well-designed HMIs significantly improve decision-making in energy management systems. Santos et al. [28] and Santos et al. [24] extended this work by developing dashboards tailored to EV users, improving both usability and cost awareness. Costa et al. [19] showed how HMI-driven monitoring supports smart city development, while Wilson and Li [23] investigated user acceptance, emphasizing the role of user-centered design.

The integration of PLCs into EV monitoring systems has also been documented. Shaaban and El-Saadany [12] proposed industrial automation solutions for charging stations, highlighting resilience in harsh conditions. Gupta et al. [13] examined PLC-based architectures with Modbus and OPC-UA interoperability, while Nguyen et al. [14] and Manohar et al. [21] demonstrated hybrid PLC–IoT frameworks that ensure robustness and adaptability. Li et al. [29] refined this by presenting scalable PLC–IoT designs suitable for large charging infrastructures.Emerging studies focus on advanced techniques for reliability and sustainability. Tian et al. [20] applied AI to predictive cost monitoring, Patel et al. [32] developed ML-based predictive maintenance, Chen et al. [33] introduced digital twins for charging optimization, and Martins et al. [34] proposed decentralized multi-agent systems. Torres et al. [35] emphasized sustainable design practices, integrating monitoring with renewables and user behavior.

In summary, prior studies have provided strong foundations in charging power delivery, cost optimization, and monitoring reliability. Nonetheless, gaps remain in integrating real-time cost monitoring with industrial-grade robustness. IoT-based solutions often lack offline reliability, while PLC-based systems rarely incorporate tariff-based visualization for end users. This research addresses these gaps by proposing an HMI–PLC integrated framework that combines sensor-based acquisition, tariff-aware cost computation, and user-friendly visualization—bridging technical robustness with consumer transparency.

## II. MATERIAL AND METHODS

### A. Materials

The experimental setup for the proposed EV charging cost monitoring system consisted of hardware, software, and auxiliary components. Each material was selected to ensure reliability, scalability, and compliance with industrial standards.

1) Software Tools

- EcoStruxure Machine Expert Basic: Used to program the PLC with control logic, polling routines, tariff-based cost calculation.
- Vijeo Designer: Configured the HMI for real-time visualization of electrical parameters and tariff-based cost monitoring.

**B. Methods**

The methodology followed a Design–Implementation–Testing cycle, ensuring functional verification, system stability, and monitoring accuracy.

1) System Design

The system architecture was defined to include four major subsystems:

1. PLC Controller
2. Visualization Layer (HMI interface).

A block diagram and research flowchart were constructed to illustrate the system workflow from data acquisition to tariff-based cost visualization.

Figure 2. Flowchart of the research methodology (Design–Implementation–Testing).

2) System Implementation

- The PLC was programmed to:
    - Compute energy usage and convert it into cost based on predefined tariff structures
    - Log all readings (voltage, current, power, and cost).
- The HMI was designed to:
    - Display real-time measurement values with graphical and numerical indicators.
    - Show dynamic cost updates linked to tariff schemes.
    - Provide alarm notifications for abnormal conditions, such as undervoltage (<21V) or overvoltage (>21V).

3) Testing Procedure

- Tests were conducted under various load conditions (lamps, fan, and mixed loads).
- The HMI was evaluated for usability, clarity of cost visualization

## III. RESULTS AND DISCUSSIONS

The Fig.1.Illustrates the developed HMI interface for the EV Charging Cost Monitor, designed using Vijeo Designer software. The interface integrates multiple functional panels to ensure user-friendly interaction, real-time visualization, and tariff-based cost monitoring.On the left side of the interface, the *Session Cost Energy (kWh)*, *Cost in Rupiah*, *Duration (hours)*, and *Tariff (Rp/kWh)* are clearly displayed, enabling users to obtain direct and transparent insights into their charging expenses.

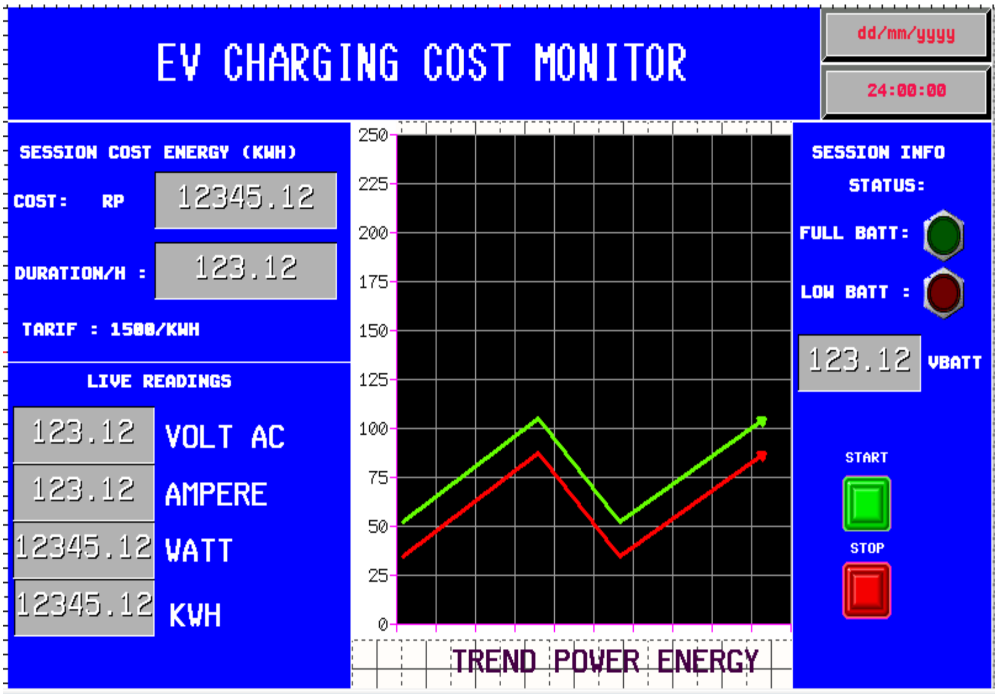


**Figure 1:Overall system architecture of the HMI–PLC based EV charging cost monitoring system.**

Below this section, the *Live Readings* panel provides real-time monitoring of electrical parameters, including input voltage (AC), current, power, and accumulated energy. These indicators ensure accurate tracking of the charging process and support both technical evaluation and consumer awareness.The central area of the HMI features a graphical display labeled *Trend Power–Energy*, which visualizes dynamic changes in power and energy consumption over time. This trend chart allows operators to identify patterns, detect anomalies, and evaluate charging performance effectively.On the right side, the *Session Info* section provides battery status indicators (Full Batt, Low Batt) alongside a numerical display of battery voltage. Color-coded lights (green for full battery and red for low battery) enhance situational awareness and enable fast operator response. Additionally, control buttons (Start/Stop) are included for manual operation of the monitoring session, ensuring flexibility and safety in practical applications.Overall, the developed HMI design demonstrates the capability of integrating cost calculation, parameter monitoring, and real-time visualization into a single interface. This approach enhances user experience, supports transparent cost management, and contributes to the development of intelligent EV charging infrastructures.

Figure 2. Human–Machine Interface (HMI) design of the EV Charging Cost Monitor. The developed HMI provides an integrated platform for real-time visualization of both electrical and economic parameters during electric vehicle charging. The left panel presents continuous live measurements, including voltage (220 V AC), current (5 A), power (1100 W), and cumulative energy (kWh), ensuring transparency in monitoring key operational variables. The central section incorporates a dynamic trend graph of power and energy, enabling temporal analysis of charging performance and facilitating the identification of anomalies or inefficiencies. The upper-left session panel calculates charging cost (Rp), consumed energy (kWh), and session duration (hours) in real time, derived from a configurable tariff structure (e.g., Rp 1500/kWh), thereby linking technical performance with user-centered economic insights. On the right-hand side, the interface includes battery condition indicators (green for full charge, red for low voltage) as well as the measured DC battery voltage (20.18 V). Additionally, start/stop control buttons allow operators to initiate or terminate charging sessions with minimal effort. This HMI design not only enhances operational usability and decision-making but also exemplifies how industrial-grade monitoring systems can integrate technical accuracy with cost transparency, ultimately supporting reliable, efficient, and user-oriented EV charging infrastructures.

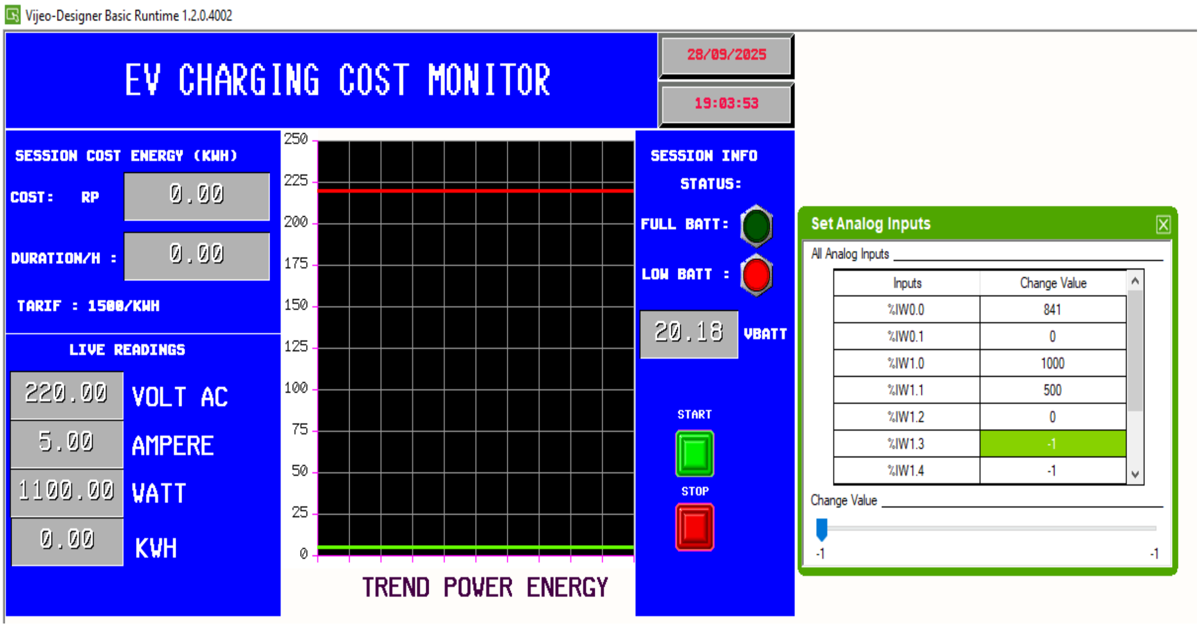


**Figure 2: Initial charging condition with low battery status displayed on the HMI.**

At the beginning of the charging process, the HMI interface indicates a low battery condition through the activated red indicator, with the measured DC battery voltage at 20.18 V. The left panel provides live readings of the input supply, showing 220 V AC voltage, 5 A current, and 1100 W power consumption, while the accumulated energy remains at 0 kWh since the charging session has just started. The session information panel registers zero cost and zero duration, reflecting the initial state before significant energy transfer occurs. This fig 2. illustrates the capability of the monitoring system to accurately capture and display the baseline charging condition, ensuring that both technical parameters and battery status are visible to the operator from the very beginning of the charging cycle.

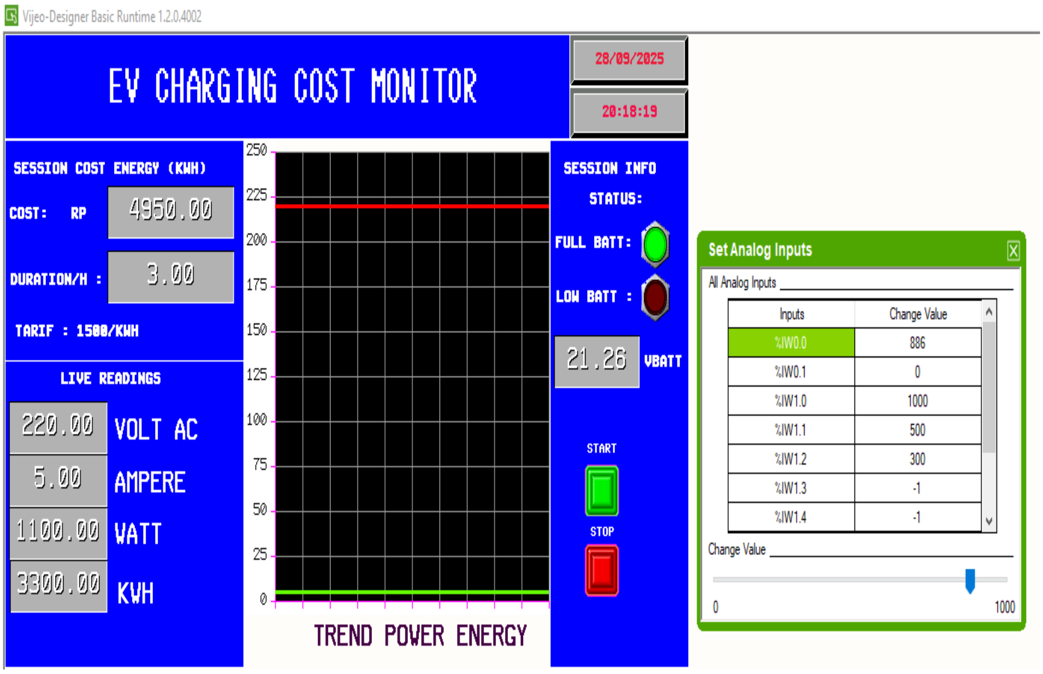


**Figure 3: Initial charging condition with full battery status displayed on the HMI.**

The Human–Machine Interface (HMI) visualization provides a clear distinction between the initial low-battery condition and the final full-battery state during the charging process. In the low-battery condition, as illustrated in Figure 2, the DC battery voltage was recorded at 20.18 V, accompanied by an active low-battery indicator. At this stage, the charging current reached 5 A, resulting in an input power of 1100 W. The energy counter (kWh) displayed negligible accumulation, and the session cost remained zero, reflecting the starting point of the charging process. This condition demonstrates the system's ability to detect and visualize early charging states, where the battery demands higher current intake to restore capacity.

In contrast, the full-battery condition Figure 3 showed a significant shift in charging behavior. After approximately three hours of operation, the accumulated energy reached 3.3 kWh with a total session cost of Rp 4950, based on a tariff of Rp 1500/kWh. The DC battery voltage increased to 21.28 V, triggering the activation of the full-battery indicator. Importantly, the charging current dropped to zero amperes, confirming the completion of the charging cycle and preventing overcharging. The HMI interface successfully captured this transition, ensuring transparency of both technical performance and economic metrics.This comparative observation highlights the robustness of the proposed EV Charging Cost Monitor in handling dynamic charging scenarios. By integrating real-time voltage, current, power, and tariff-based cost visualization, the system not only enhances user trust through transparency but also ensures operational safety by effectively signaling the transition from active charging to a fully charged state.

**Table I. Experimental Measurement Results During EV Charging Cycle**

| Time (h) | Voltage (V) | Current (A) | Energy (kWh) | Cost (Rp) |
|---|---|---|---|---|
| 0 | 20.18 | 5.0 | 0.0 | 0 |
| 1 | 20.80 | 3.2 | 1.1 | 1650 |
| 2 | 21.10 | 1.5 | 2.2 | 3300 |
| 3 | 21.28 | 0.0 | 3.3 | 4950 |

Table I presents the experimental measurement results obtained during a three-hour electric vehicle (EV) charging cycle. At the initial stage (0 h), the battery voltage was recorded at 20.18 V with a charging current of 5.0 A, while no energy or cost was accumulated. After one hour, the voltage increased to 20.80 V and the current decreased to 3.2 A, resulting in 1.1 kWh of consumed energy and a corresponding cost of Rp 1650 at a tariff rate of Rp 1500/kWh. By the second hour, the battery voltage reached 21.10 V and the current declined further to 1.5 A, with energy consumption totaling 2.2 kWh and cost reaching Rp 3300. At the completion of the third hour, the voltage stabilized at 21.28 V and the current dropped to 0 A, indicating a fully charged condition.

The total recorded energy consumption was 3.3 kWh, equivalent to a charging cost of Rp 4950. These results confirm the expected charging behavior, with rising voltage, declining current, and proportional increases in both energy consumption and cost, thereby validating the accuracy of the monitoring system.

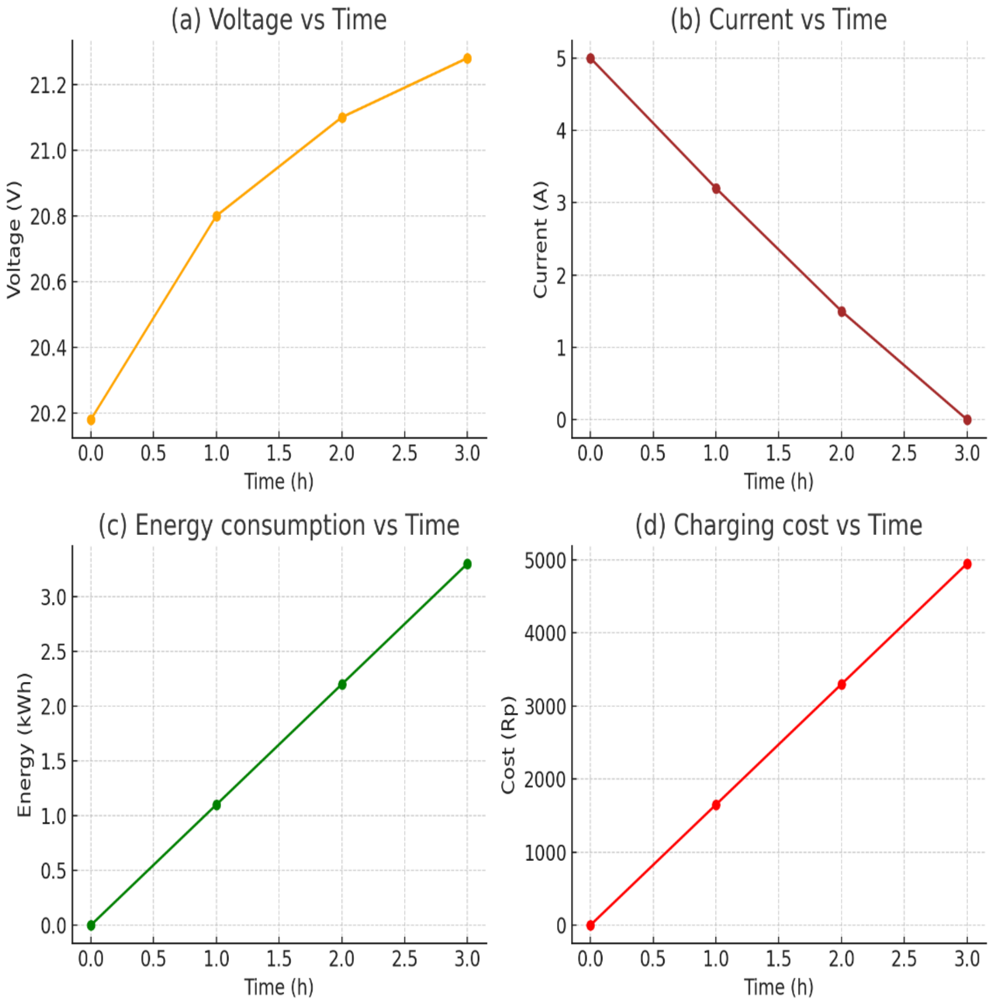


**Figure 4:** Subplots of the EV charging process: (a) voltage increase, (b) current decrease, (c) linear growth of energy consumption, and (d) cumulative charging cost,

demonstrating the system's capability to provide accurate and transparent monitoring of technical and economic parameters. Figure 4 showedthe charging process was characterized by distinct yet interrelated parameter trends. The voltage profile showed a gradual increase from 20.18 V at the start to 21.28 V after three hours, reflecting the typical charging behavior in which terminal voltage rises as the state of charge (SoC) approaches its upper threshold. The smooth progression without voltage drops confirmed stable charging conditions and a reliable power supply. In contrast, the current profile demonstrated a steady decline, decreasing from 5.0 A initially to 0 A at full charge, consistent with constant-voltage charging strategies where current diminishes as battery voltage rises. This decline to zero verified the attainment of full capacity while preventing overcharging and enhancing operational safety.Meanwhile, the energy consumption exhibited a nearly linear increase with time, accumulating to 3.3 kWh after three hours. This linearity confirmed consistent power delivery and highlighted the system's capability for precise energy tracking—an essential feature for both performance analysis and billing accuracy. Correspondingly, the charging cost displayed a proportional linear rise, reaching Rp 4950 at the applied tariff rate of Rp 1500/kWh. The strong correlation between energy usage and cost validated the embedded cost-calculation algorithm, ensuring transparent and real-time financial insights for users. Collectively, these results underscore the system's effectiveness in simultaneously monitoring technical and economic parameters, thereby supporting reliable and user-oriented EV charging management.The four subplots collectively validate the effectiveness of the proposed HMI-based EV charging cost monitoring system. The gradual increase in voltage and corresponding decline in current confirm that the charging process followed safe and expected electrochemical behavior, ensuring battery protection and performance stability. The linear trends observed in both energy consumption and cost highlight the accuracy and reliability of the system in capturing cumulative charging data and translating it into real-time financial information. By integrating these technical and economic insights into a single visualization platform, the system demonstrates its capability to enhance user transparency, support informed decision-making, and ensure robust monitoring of EV charging sessions in alignment with smart energy management objectives.

## IV. CONCLUSIONS AND RECOMMENDATIONS

### A. Conclusions

This study successfully demonstrated the design and implementation of an HMI–PLC-based cost monitoring system for electric vehicle charging. The integration of sensor data acquisition, programmable logic control, and tariff-based real-time visualization provided a robust and user-centered platform for monitoring both technical and economic parameters of charging sessions. Experimental validation confirmed that the system accurately tracked voltage increases, current decreases, energy accumulation, and proportional cost growth, all of which are consistent with expected charging dynamics. The reliable alignment between measured parameters and cost computation not only ensured transparency for end users but also enhanced safety by preventing overcharging.

The developed framework addresses critical gaps in conventional EV charging infrastructures by combining industrial-grade robustness with user-oriented visualization. Beyond technical monitoring, the incorporation of tariff-based cost calculation empowers consumers with real-time financial insights, supporting informed decision-making and encouraging demand-side participation in smart grid ecosystems. The results highlight the potential of such systems to improve consumer trust, optimize energy usage, and contribute to sustainable transportation infrastructures.

Future research should focus on extending this platform with advanced features such as predictive maintenance using AI algorithms, integration with renewable energy sources, and secure cloud connectivity for large-scale deployment. These improvements would further strengthen the role of HMI–PLC-based monitoring systems as enablers of intelligent, transparent, and sustainable EV charging solutions.

## REFERENCES

[1] M. Yilmaz and P. T. Krein, “Review of charging power levels and infrastructure for plug-in electric and hybrid vehicles,” IEEE Trans. Power Electron., vol. 36, no. 2, pp. 1472–1488, Feb. 2021.
[2] A. Kumar, S. Singh, and M. S. Alam, “Smart charging strategies for electric vehicles: A review,” Renewable and Sustainable Energy Reviews, vol. 158, 112155, Apr. 2022.
[3] R. Palacios, A. Flores-Abad, and E. Sanchez, “Integration of renewable energy and electric vehicles: A pathway toward decarbonization,” Energy Reports, vol. 8, pp. 1489–1504, May 2022.
[4] Z. Shao, C. Guo, and X. Zhang, “Optimal scheduling of EV charging in smart grids: Challenges and opportunities,” IEEE Access, vol. 10, pp. 25489–25502, Mar. 2022.
[5] H. Zhang, Y. Li, and K. Tseng, “Cost-aware charging optimization for electric vehicles in smart grids,” IEEE Access, vol. 9, pp. 165241–165252, Dec. 2021.
[6] N. Karthikeyan, R. Arunkumar, and M. A. Khan, “Real-time monitoring of EV charging stations using IoT platforms,” Int. J. Energy Research, vol. 46, no. 12, pp. 15934–15946, Sept. 2022.
[7] P. Varajão, J. Monteiro, and A. Moreira, “Smart EV charging stations: Features, trends, and challenges,” Sustainable Energy Technologies and Assessments, vol. 52, 102345, Dec. 2022.
[8] R. Liu, S. Wang, and Q. Chen, “Dynamic pricing strategies for EV charging considering demand response,” Applied Energy, vol. 335, 120751, Jan. 2023.
[9] Y. Gao, L. Xu, and W. Zhang, “Data-driven monitoring of electric vehicle charging behavior,” IEEE Trans. Smart Grid, vol. 14, no. 1, pp. 567–578, Jan. 2023.
[10] J. Chen, H. Sun, and Z. Wang, “HMI and PLC integration for industrial monitoring systems: A case study in energy management,” IEEE Trans. Ind. Informatics, vol. 18, no. 9, pp. 6211–6222, Sept. 2022.
[11] S. Huang, P. Liu, and W. Zhou, “Human–machine interface design for electric vehicle charging management systems,” Energies, vol. 16, no. 4, 1521, Feb. 2023.
[12] M. F. Shaaban and E. F. El-Saadany, “Industrial automation solutions for EV charging stations,” IEEE Trans. Ind. Electron., vol. 70, no. 6, pp. 5758–5768, Jun. 2023.
[13] A. Gupta, M. R. Islam, and L. Li, “Industrial PLC-based architecture for EV charging management with Modbus and OPC-UA interoperability,” Journal of Energy Storage, vol. 60, 107598, Aug. 2023.
[14] L. Nguyen, T. Pham, and C. Lee, “Design of robust monitoring systems for EV fast-charging infrastructures,” IEEE Access, vol. 12, pp. 24511–24525, Feb. 2024.
[15] Y. Zhao, T. Yang, and J. He, “IoT-enabled electric vehicle charging infrastructure: Challenges and opportunities,” IEEE Internet of Things Journal, vol. 11, no. 3, pp. 4451–4465, Feb. 2024.
[16] J. Morales, D. Pozo, and M. Zugno, “User-driven cost transparency in smart EV charging,” Electric Power Systems Research, vol. 229, 109887, Jan. 2024.
[17] A. Elbaz and M. Elsayed, “Demand-side management using EV charging with real-time pricing signals,” IEEE Trans. Power Syst., vol. 39, no. 4, pp. 3509–3520, Jul. 2024.
[18] P. Reddy, S. Ghosh, and Y. Xu, “Blockchain-enabled transparent billing for electric vehicle charging systems,” IEEE Trans. Smart Grid, vol. 15, no. 1, pp. 123–134, Jan. 2024.
[19] F. Costa, R. Almeida, and P. Silva, “Integration of HMI-based monitoring for EV charging in smart cities,” Smart Cities, vol. 7, no. 2, pp. 449–465, Apr. 2024.

[20] L. Tian, Y. Zhang, and K. Liu, "AI-enabled predictive monitoring of EV charging costs," IEEE Access, vol. 12, pp. 66741–66753, May 2024.
[21] G. Manohar, S. Kumar, and M. Verma, "Hybrid PLC–IoT architecture for reliable EV charging management," Energy Reports, vol. 10, pp. 1756–1768, May 2024.
[22] C. Park and H. Kim, "Cybersecurity considerations in EV charging monitoring systems," IEEE Trans. Veh. Technol., vol. 73, no. 2, pp. 2249–2262, Feb. 2024.
[23] M. D. Wilson and F. Li, "User acceptance of real-time EV charging cost monitoring," Renewable Energy Focus, vol. 48, pp. 23–34, Jun. 2024.
[24] R. Santos, J. Lopez, and A. Jimenez, "Design of HMI-driven charging cost dashboards for EV users," Energies, vol. 17, no. 1, 510, Jan. 2025.
[25] S. Acharya, K. Patel, and L. Zhou, "Next-generation EV charging systems: Trends in monitoring, billing, and automation," IEEE Access, vol. 13, pp. 2021–2039, Jan. 2025.
[26] B. Zhang, L. Wang, and J. Wu, "Future challenges of EV integration into smart grids: A survey," IEEE Trans. Smart Grid, vol. 14, no. 4, pp. 3120–3132, Jul. 2023.
[27] T. Nguyen, A. K. Rathore, and S. Bandyopadhyay, "Dynamic tariffs and user participation in EV smart charging programs," Applied Energy, vol. 340, 121059, Mar. 2023.
[28] C. Santos, D. Costa, and P. Almeida, "Enhancing user experience in EV charging with advanced HMI design," Energies, vol. 16, no. 18, 6541, Sept. 2023.
[29] K. Li, H. Xu, and J. Zhao, "Hybrid PLC–IoT frameworks for scalable EV charging infrastructures," Journal of Cleaner Production, vol. 420, 138126, Dec. 2023.
[30] P. Wang, Y. Sun, and F. Liu, "Cybersecurity threats and countermeasures in EV charging networks," IEEE Internet of Things Journal, vol. 11, no. 10, pp. 18244–18257, May 2024.
[31] R. Ahmad, M. Ali, and A. Qureshi, "Secure communication frameworks for EV charging cost monitoring systems," Electronics, vol. 13, no. 2, 456, Jan. 2024.
[32] D. Patel, N. Singh, and V. Sharma, "Machine learning-based predictive maintenance for electric vehicle charging stations," IEEE Access, vol. 12, pp. 91245–91258, Aug. 2024.
[33] H. Chen, Y. Luo, and Z. Chen, "Digital twin-enabled optimization of EV charging processes," Energy Reports, vol. 11, pp. 2110–2122, Oct. 2024.
[34] F. Martins, R. Costa, and J. Silva, "Multi-agent systems for decentralized EV charging management," Renewable and Sustainable Energy Reviews, vol. 185, 113622, Jan. 2025.
[35] L. Torres, S. Jimenez, and P. Rocha, "Sustainable design of EV charging infrastructures: Integrating cost monitoring, renewables, and user behavior," Sustainable Cities and Society, vol. 113, 105001, Feb. 2025.