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SECONDARY DISTRIBUTION SUBSTATION REAL-TIME FAULT MONITORING AND CONTROL SYSTEM: A CASE STUDY OF XY UNIVERSITY LOW VOLTAGE SUBSTATION

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ABSTRACT

Energy efficiency and sustainability have become increasingly important matters because traditional monitoring systems, based on manual readings and aggregate data, are no longer effective. The increasing global energy requirements, along with outdated power monitoring methods, necessitate the development of intelligent systems that can quickly manage energy consumption. The time lapse in fault detection caused by voltage variations, outages, and power overloads leads to technical losses, equipment breakdowns, and other electrical hazards. This paper reports the design and development of a low-voltage real-time fault monitoring and control system that provides real-time SMS notifications and feedback on localised power status using one of the secondary substations in XY as the test bed. The critical shortcomings of conventional power monitoring methods, which are often time-consuming, costly, and susceptible to human error, typically rely on manual inspections and static reports, which are addressed. Real-time SMS alerts, along with interactive feedback integrated in the system design, helped the system deliver an improved method for detecting power consumption anomalies during their actual occurrence and monitoring energy usage at all times. Through modern wireless communication systems combined with sensors, the system evaluates power data in real-time, which helps managers and engineers quickly identify and resolve issues. This project powers measurement of voltage, current, power, and energy on each phase with about 2.5% improvement in accuracy, transmits hourly, daily SMS digests (network lag <1 minute), and sends immediate over-current warnings at 80A. The developed prototype demonstrates stable real-time measurement, advanced notification, and functional forecasting capabilities in the context of energy management.

Keywords: real-time monitoring, substation, sms, technical losses, energy management, sustainability, energy, power monitoring, voltage, current, wireless communication.

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1. INTRODUCTION

The rising industrialisation, together with expanding energy requirements, has driven fundamental changes in power monitoring systems. Energy efficiency and sustainability have become important matters because traditional monitoring systems based on manual readings and aggregate data do not function effectively anymore [1]. Modern power monitoring systems incorporate Internet of Things (IoT) technology to deliver precise and instantaneous energy usage data, which drives the improvement of intelligent energy management systems. This technical progress allows detailed evaluation of electrical values and power use data, and it helps in waste reduction through prompt responses. Both residential and commercial applications benefit increasingly from developed systems that unite IoT with real-time alerts and feedback mechanisms [2].

Research studies show that energy monitoring systems built using IoT technology enhance energy consumption efficiency at a notable level. These monitoring systems, which support microcontrollers and deployment onto IoT platforms, permanently acquire power usage readings for real-time visualisation and analysis. Such architectural systems provide users with comprehensive visibility into their energy consumption habits to make behavioural changes that result in reduced energy usage. Wi-Fi-enabled modules can deliver sensor data to enable users to optimize their consumption by spotting when power usage peaks and when it dips. This delivers operational enhancement while establishing basic frameworks to build more environmentally friendly energy methods [3]. Energy monitoring using IoT involves the implementation of SMS notifications as a vital addition to constant data acquisition in contemporary power systems. Users receive critical instantaneous alerts through SMS that immediately notify them about overcurrent and unexpected power surges that represent possible faults or dangers. Energy meters become capable of automatic alert transmission through GSM modules that enable prompt human action to minimize electrical failure risks. The proactive alert system proves essential for protecting equipment from harm and minimising unnecessary energy consumption, which directly enhances system reliability [4]. Effective feedback systems that support long-term energy conservation must combine real-time monitoring capabilities and immediate SMS alerts. Users gain a deeper understanding of their energy consumption habits because feedback comes in the form of visual dashboards and historical data analytics. Users gain valuable knowledge about their energy patterns through the segmented data presentation systems, which help them determine their usage problems and develop suitable modifications. Detailed feedback results in major energy reduction because users make decisions based on combined present-time and historical behaviour trends. Industrial systems face ongoing obstacles in achieving complete effectiveness because of accuracy issues with sensors, together with communication obstacles and rising cyber threats [5], [6]. Overall, the combination of Internet of Things technology with SMS notifications and user-focused feedback systems demonstrates a positive route for smarter, sustainable energy and safety management across today's constantly shifting environments [8].

The accessibility of real-time IoT data collection remains restricted in areas with low internet infrastructure because users lose their capability to respond quickly to critical conditions. The current design of IoT analytics systems and basic alert mechanisms functions independently from each other through incompatible interfaces that do not support SMS messaging. The system's limitations restrict its usefulness for various user groups, including rural areas, small businesses, and industrial facilities, because these groups prioritise cost-effective solutions and scalable and user-friendly technology. This project integrates precision monitoring from IoT technology with SMS accessibility to create a unified power monitoring solution. A proposed system addresses existing system weaknesses by tracking electrical parameters through IoT sensors, which monitor voltage, current, and power consumption in real-time and deliver instantaneous SMS alerts for power outages or equipment breakdowns. The system delivers reliable communication across all settings because it uses SMS alongside IoT analytical capabilities to reach every device. The system faces three main obstacles, which are: maintaining stable network data transfer, cost-effective scalability, and developing an interface that works well with different applications. The successful resolution of these obstacles will enable users to maximise their energy use while saving operational expenses by implementing predictive fault detection for safety purposes. The project delivers outcomes that enable sustainable energy practices along with universal access to smart technologies while enhancing global climate resilience through reduced energy waste prevention. The objectives of this work are to design a power monitoring system that tracks the status of power in a secondary distribution substation, develop an SMS notification system that gives users a periodic update and summary of power status daily, weekly, or monthly, collect and store data on power parameters, and integrate a real time feedback mechanism.

2. RELATED WORKS

A revolutionised power monitoring system serves as a measurement tool for residential, commercial, and industrial power consumption analysis and management. Power monitoring systems serve their primary function by delivering live energy usage data, which helps owners maximize their energy efficiency and achieve cost savings while improving electrical system reliability [10]. Power monitoring systems that provide SMS notifications and feedback capabilities respond to a primary need in current energy management systems. Traditional power monitoring systems do not feature modern, advanced real-time functionality, which makes effective and efficient energy optimisation challenging. The legacy systems depend on human investigators who must collect data by hand; thus, these procedures extend time usage while increasing the chances of mistakes. Modern power monitoring systems apply Internet of Things (IoT) and wireless communication and microcontrollers to send real-time data alongside automated alerts, which increases their operational efficiency significantly.

Trang *et al.* [9] monitored a power system with a PZEM circuit, ESP32 Wi-Fi and Bluetooth, and an ARM microcontroller. They discussed the design of a system for monitoring residential solar power sources by measuring parameters; however, real-time feedback was not realized. [10] developed an innovative IoT-based smart meter system to monitor Power Quality (PQ) in smart grids. The proposed smart meter through IoT enhances energy management alongside delivering stable grid operation capabilities. Sakthivel *et al*. [11] created an IoT-based electric meter for service providers, which is capable of automatically reading meters, eliminating billing errors, and can remotely disconnect users for non-payment; however, there was no monitoring dashboard integrated. Ramkumar *et al*. [12] described the development of a GSM-based smart fault detection system that improves electric power system reliability. The system tracks both voltage errors, current errors, and frequency errors to support complete fault detection management, and the GSM enables real-time data exchange [13-14]. Amhenrior [15] developed a wireless AC power monitoring module that operates effectively while maintaining cost efficiency in IoT-based systems. The module costs less than 100 USD while providing better pricing and precision than standard commercial meters that typically exceed 1000 USD.

Kareem *et al.* [5] developed a monitoring system for residential power lines capable of identifying power supply issues such as loss of phase, low voltage, over voltage/current, and up to troubleshooting cosϕ is the power factor (ranges between 0 to 1) recovery time using current sensors, and a seven-segment display. The work contributed to fault localization; however, no data were stored [16-23].

Wang *et al.* [24] proposed a low-cost IoT platform for remote monitoring and control in smart buildings. The system, tested in a university campus, gave results on its practicality for affordable intelligent building management systems that minimize energy expenses while improving user comfort. Communication was, however, restricted in the design.

Most of the existing work on low voltage power monitoring systems [25] is incapable of sending two-way real-time notifications and updates via SMS, coupled with an integrated IoT setting where both the utilities and consumers (end users) can visualise and track their power data and parameters. The main objective of this project, therefore, was to improve power tracking, monitor and record real-time power consumption data, analyse the data, and use the data to make more informed power decisions.

3. METHODOLOGY

The approach employed for the monitoring and control system was incorporated using validated algorithms for the system model and resourcefully selecting the autonomous devices to develop it. First, the system model was developed using equations as a representation of the overall design calculations of the three-phase power monitoring system, then individual calculations power phase (such as battery life, sensor selection, apparent power, reactive, and active power are monitored, after which, depending on the status determined at the time, actionable control outputs are made as decisions. The details of the system representation, as well as the hardware and software design methods, are discussed below.

A. System Model

Three-phase power calculations:

- Apparent Power (S_{PHASE}, VA), which is the total power that a circuit receives, regardless of whether it's being used for actual work or not.

$$S_{phase} = V_{phase}\ x\ I_{phase} \tag{1}$$

where,
S_{phase} is the apparent power of a single phase;
V_{phase} is the phase voltage (Line-Neutral voltage), and
I_{phase} is the phase current.

- Real (Active) Power (P_{phase}, W) is the actual power consumed by a circuit to perform useful work.

$$P_{phase} = V_{phase}\ x\ I_{phase}\ x\ Cos\ \phi \tag{2}$$

where,
P_{phase} is the real power of one phase;
V_{phase} is the phase voltage (Line-Neutral voltage).
Cos ϕ is the power factor (ranges between 0 to 1)

- Reactive Power (Q_{Phase}, VAR) is the part of electrical power in AC circuits that flows back and forth between the source and load but doesn't perform any useful work.

$$P_{phase} = V_{phase}\ x\ I_{phase}\ x\ Sin\phi \tag{3}$$

Or

$$Q_{phase} = \sqrt{S_{phase}^2 - P_{phase}^2} \tag{4}$$

Where;
$Sin\ \phi = \sqrt{1 - Cos\ \phi}$

- Total Apparent Power (S_{TOTAL}), which is the summation of the apparent power on each phase.

$$S_{total} = S_1 + S_2 + S_3 \tag{5}$$

$$S_{total} = (V_1 I_1) + (V_2 I_2) + (V_3 I_3)$$

or for a balanced system where each phase has the same power,

$$S_{total} = 3\ x\ S_{phase} = 3\ x\ V_{phase}\ x\ I_{phase} \tag{6}$$

- Total Real Power (P_{TOTAL}), which is the summation of the real power on each phase:

$$P_{total} = P_1 + P_2 + P_3 \tag{7}$$

$$P_{total} = (V_1 I_1 Cos\ \phi) + (V_2 I_2 Cos\ \phi) + (V_3 I_3 Cos\ \phi)$$

or for a balanced system where each phase has the same power:

$$P_{total} = 3\ x\ P_{phase}$$

- Total Reactive Power (Q_{TOTAL}), which is the summation of the reactive power on each phase,

$$Q_{total} = Q_1 + Q_2 + Q_3 \tag{8}$$

$$Q_{total} = \left(\sqrt{S_1^2 - P_1^2}\right) + \left(\sqrt{S_2^2 - P_2^2}\right) + \left(\sqrt{S_3^2 - S_3^2}\right)$$

or for a balanced system where each phase has the same power,

$$Q_{total} = 3\ x\ Q_{phase}$$

Energy Consumption (E, kWh), which is the total amount of energy used during a given process and in a specified amount of time.

$$E = P_{total}\ x\ time \tag{9}$$

Sensor calculations

- Current Transformer (CT) ratio, N

Assumption(s):
Maximum phase current (I_p) = 100 A
Maximum voltage (V_{max}) = 1 V
CT Ratio (N): Selected CT ratio = 100: 5 (20: 1).

- Secondary Current (I_s) = I_p/N (10)
- Burden Resistor (R_b), which converts CT output current to voltage for the PZEM-004T. PZEM-004T accepts up to 100 V AC.

$$R_b = \frac{V_{max}}{I_s} \tag{11}$$

- Power dissipation: P

$$P = I_s^2 \; x \; R_b \tag{12}$$

Battery life calculations

- Battery: Four 3.7V 18650 Li-ion (3500 mAh) batteries connected in series.

- Average Current:

Iavg = I(ESP32) + I(SIM800L) + I(LCD) + I(RTC) + I(PZEM) + I(Buck) (13)

Life (hours) = 3500 mAh/Iavg (14)

DC-DC buck converter sizing

Assumptions:

Input Voltage: 3.7V (Li-ion battery), Output Voltage: 3.3V (for ESP32). Efficiency (η): 85% (typical for LM2596). Output Current: 150 mA (ESP32 + peripherals).

- Input Current:

$$I_{in} = \frac{V_{out} \; x \; I_{out}}{\eta \; x \; V_{in}} \tag{15}$$

- Accuracy Validation

Assumptions
PZEM-004T Accuracy: ±1% (voltage/current), ±2% (power).
CT Error: ±1%.
Total System Error (S.E)

$$S.\text{E} = \sqrt{(\text{V/I Accuracy})^2 + (\text{CT Error})^2 + (\text{P accuracy})^2} \tag{16}$$

B. Hardware Design

The main objective of the system is to monitor some power parameters and initiate interventionist control actions, while the real-time status of the system is documented and accessed via the internet. The system hardware is represented in the circuit diagram as shown in Figure-1.

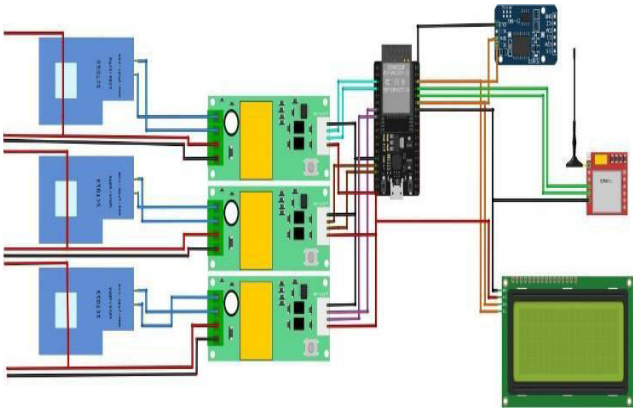

Figure-1. The circuit diagram of the hardware units of the monitoring system.

The circuit is organised in five functional blocks that are all tied together by a common 5 V / 3.3 V dual-rail power bus and a single logic ground plane.

Acquisition was obtained at every 2 s by the ESP32 polls each PZEM over Modbus, acquiring Vrms, Irms, P, Q, S and cumulative kWh; Time-stamping was achieved by DS3231 provides epoch-synchronized time-stamps for local SD-card logging (optional) and for ThingSpeak HTTP pushes; and Local feedback was achieved by the most recent readings scroll on the 20 × 4 LCD (line 1: phase A/B/C V; line 2: phase A/B/C I; line 3: total kW; line 4: PF & energy).

Additionally, System Alerting was triggered whenever any phase current is greater than 70 A for more than a period of 10 s or a phase loss is detected, an interrupt routine fires an AT-command batch to the SIM800L, sending an SMS to up to three stored numbers; Cloud logging was updated at every 10 minutes by the device posts JSON payloads to ThingSpeak via Wi-Fi; if Wi-Fi is down the payload is queued and pushed by GSM GPRS.

C. Software Design

The Proteus system was programmed to closely imitate, using software, the three-phase power- monitoring prototype and its workings before hardware connections were made. The virtual model uses a series of parts: an ACS712 Hall-effect current sensor, a Microcontroller, a 20 × 4 LCD, a DS3232 real-time clock, and a stepped-down voltage tap. The simulation allowed checking of both the electrical scaling factors and the performance, data flow, and user interface of the design later used on ESP32, as demonstrated in Figure-2. The transformer joins the 230 V power with a 12 V secondary that then passes through a 100 kΩ: 10 kΩ divider. By increasing the sinusoid by half of 5V (i.e., 2.5V) through the bias system, the Arduino can measure it without trimming out parts of the signal. The ACS712-05 B from each current sensor was included in the Proteus simulation model, with its sensitivity fixed at 185mV/A. Since they are implemented as potentiometers, variable resistive loads are easy to adjust, so you can quickly monitor phase currents without leaving the 0-5 A range.

The routines in the firmware parallel the ones used in the final ESP32 build. The sketch takes 256 readings from the AC voltages and currents within every mains cycle, subtracts 2.5 V from each set, and calculates Vrms, Irms, real power, power factor, and a running total for the energy consumed. RTC gives epoch seconds, so integration of energy is done accurately as Pavg × Δt. The LCD screens, Current, Power, and Energy, can be displayed one after another, either automatically timed or when a user presses a button (only added during the redesign). As Proteus can simulate events in real-time, the watt-hour total reflects actual values, and so any errors in calculations are immediately caught.

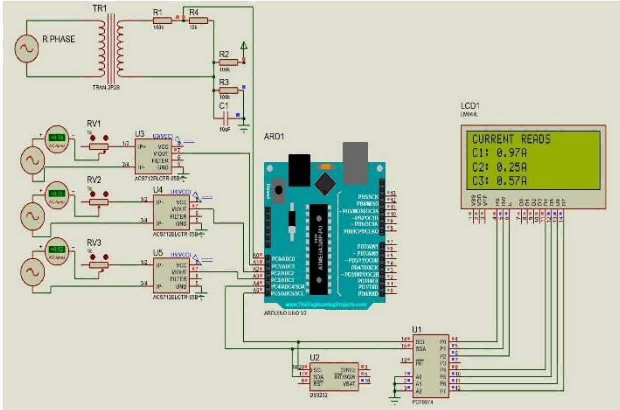

Figure-2. The proteus simulation of power monitoring system.

4. RESULTS AND DISCUSSIONS

A) Accuracy Validation of Sensors

The voltage, current, and real-power channels of the prototype were compared against an unloaded calibrated digital multimeter (DMM) as illustrated in Tables 1 and 2. Values of mean-absolute-percentage-error (MAPE) extracted from the data set are 1.24 % for PZEM-004T voltage, 2.88 % for ZMPT101B voltage, 5.14 % for PZEM-004T current, 17.28 % for the raw ACS712 current probe, and 4.57 % for PZEM-derived power. This validates that the metering integrated circuit within the PZEM-004T is a Class-1 unit with nominal 0.5 % accuracy and well within the 96 % overall accuracy figure that is reported by [24] of a photovoltaic monitor, which also incorporates the same module and has a PZEM-004T-based metering IC at its heart. A recent comparison study by [25] has also shown that the PZEM error band remained below 5 % throughout domestic loads, hence justifying the current results.

Table-1. Voltage and current comparisons.

VOLTAGE AND CURRENT READINGS					
Multimeter (V)	**PZEM-004T(V)**	**ZMPT101 B(V)**	**Multimeter r(A)**	**PZEM-004T(A)**	**ACS712 (A)**
100	101.7	104.6	0.63	0.6	0.69
120	121.9	122.6	0.69	0.66	0.79
140	141.6	142.8	0.75	0.71	0.87
160	161.6	166.9	0.81	0.76	0.96
180	181.9	177	0.83	0.79	1
200	202.2	205.6	0.88	0.84	1.07
220	222.4	226.5	-	-	-
240	243	246.1	-	-	-

Table-2. Power comparisons.

POWER COMPARISONS			
VOLTAGE	POWER = V*I(W)	PZEM POWER (W)	Error (PZEM)
100	63	60	3
110	72.6	69.6	3
120	82.8	79.6	3.2
130	93.6	89.6	4
140	105	100	5
150	117	111.4	5.6
160	129.6	123.1	6.5
170	141.1	135	6.1
180	154.8	147	7.8
190	167.2	159.3	7.9
200	182	173.6	8.4

B. Analysis of Daily Data Obtained (Monday-Friday)

Five days of three-phase data were streamed on consecutive weekdays, resulting in over 100+ time-stamped samples each and every day. The main descriptive statistics are summarized in Tables 3a, b, and c. Mean line-to-neutral voltages on all three phases were closely grouped at between 234 and 238 V, and inter-phase voltages were less than 2 V (well within the maximum tolerable variation of a 230 V system in Nigeria of ± 6 %), as would be expected of a 3-phase balanced system. Present loading was more varied: most of the single-phase items were on the Phase 1 line (28 - 48A average) while the Phase 3 had only a low average (7 -15 A) of average with Monday being an exception, when a momentary full-load raised the mean to 15 A and delivered the largest peak power of the week (31.7 kW at 12.42). At phase 3, the demand was deemed moderate and consistent (15 - 23 A).

Table-3a. Average daily voltage.

Day	Average V_1 (V)	Average V_2 (V)	Average V_3 (V)
Monday	234.0	234.1	236.1
Tuesday	234.4	238.2	236.0
Wednesday	236.7	236.1	238.2
Thursday	233.2	236.3	235.2
Friday	235.4	238.5	235.6

Table-3b. Average daily current.

Day	Average I_1 (A)	Average I_2 (A)	Average I_3 (A)
Monday	48.1	15.1	22.4
Tuesday	40.4	9.44	23.0
Wednesday	38.8	12.8	15.2
Thursday	36.6	7.46	16.1
Friday	28.3	8.51	16.3

Table-3c. Average daily peak power/ener.

Day	Peak Power (W)	Energy (kWh)
Monday	31,661	94.51
Tuesday	26,121	137.95
Wednesday	22,421	164.37
Thursday	22,217	105.73
Friday	20,392	154.01

The number of net energy per day was between 94.5 kWh (Monday) and 164.4 kWh (Wednesday), and the peak change occurred during the week. Every line plot targets the total active power within a 24-hour cycle, so the intra-day dynamics can be observed. Each of the five

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graphs is characterized by a fast morning ramp-up, a slow steady plateau through early afternoon, and a very harsh evening decline when non-essential loads have been disconnected, as illustrated in the charts in Figure-3. Through the load swing, line voltages were maintained within ± hyphen micrometer V of the Monday baseline, and this displayed a good voltage-regulation gap in the LV network.

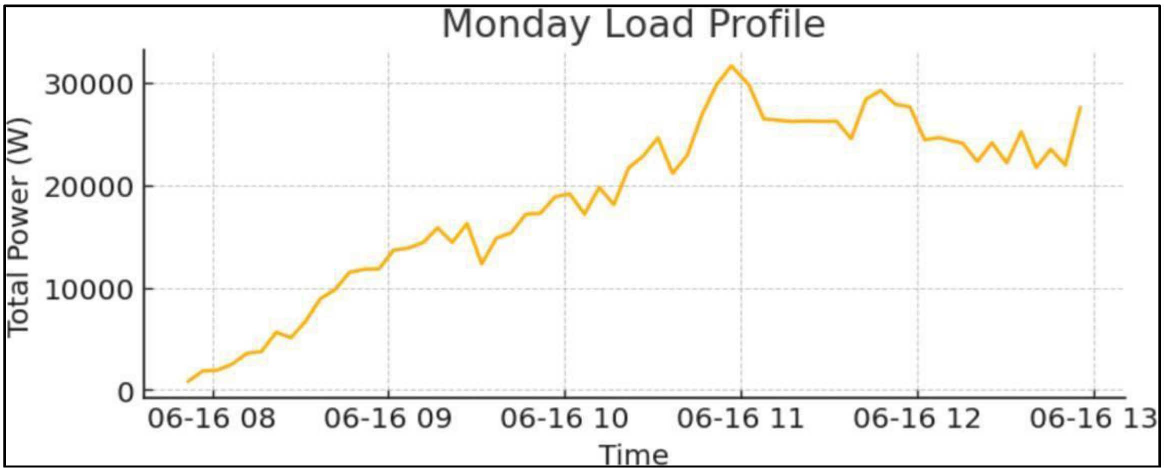

Figure-3a. Monday load profiles.

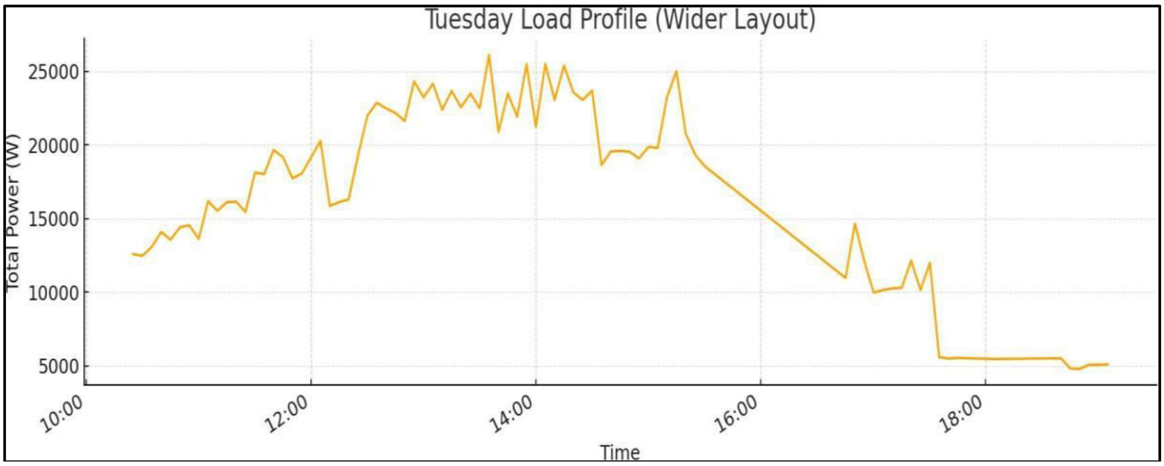

Figure-3b. Tuesday load profiles.

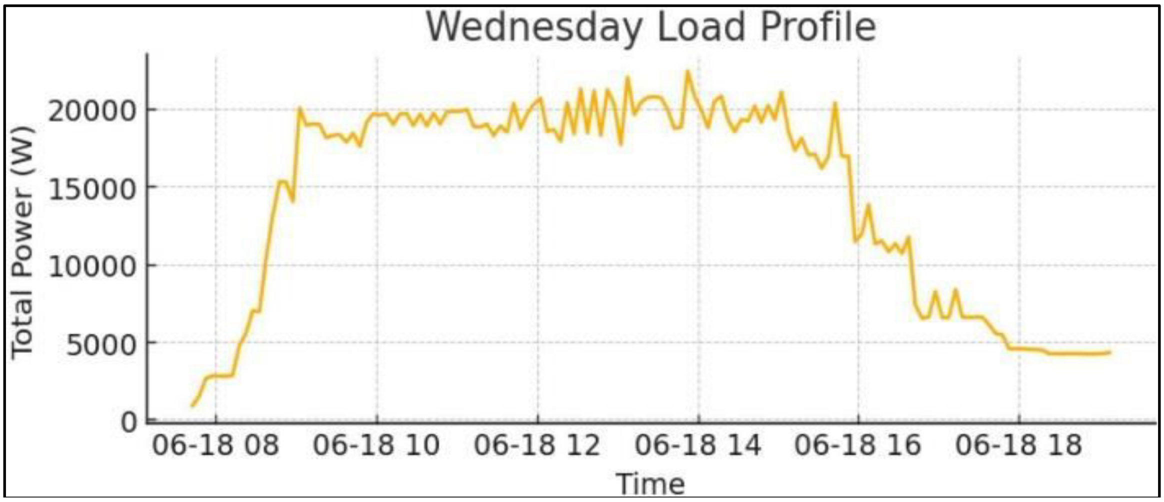

Figure-3c. Wednesday load profiles.

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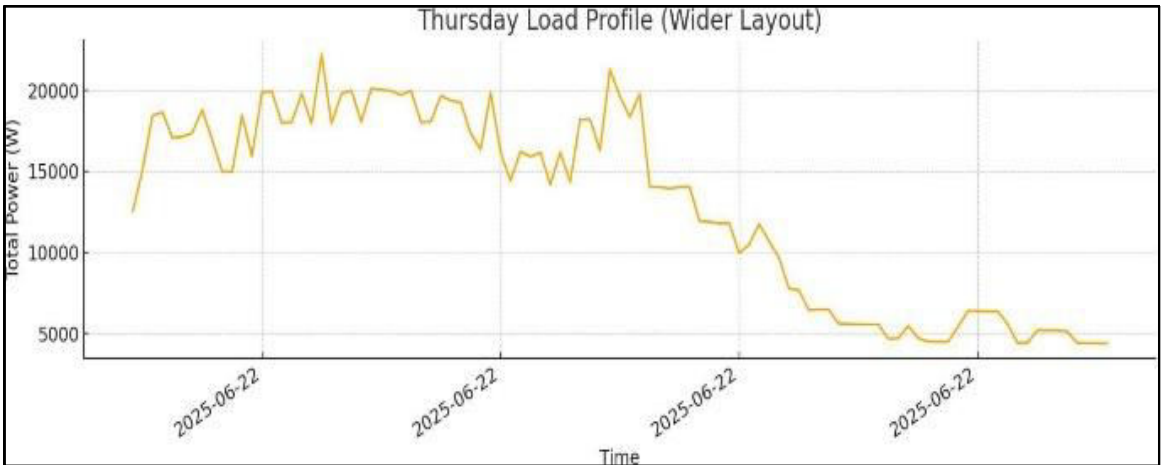

Figure-3d. Thursday load profiles.

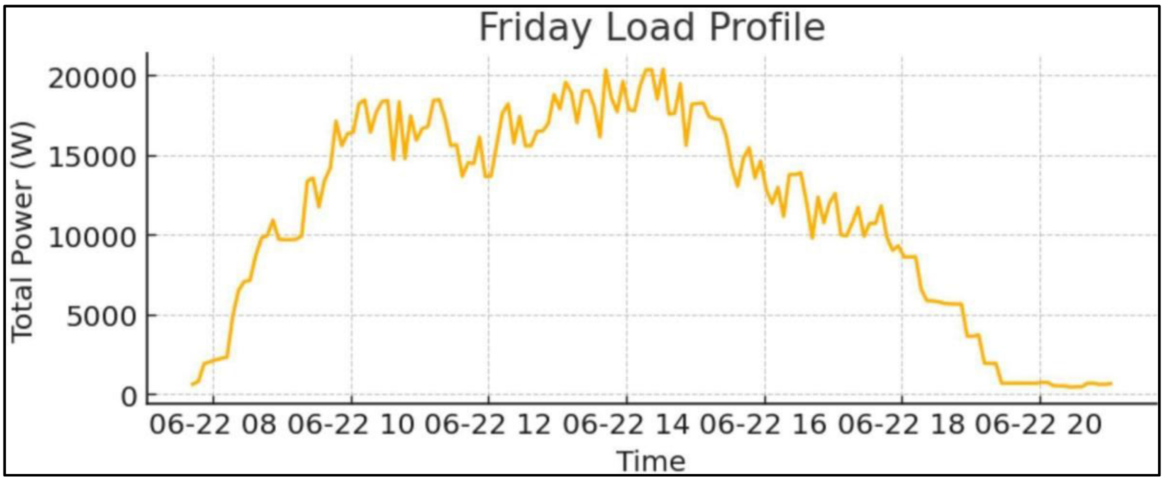

Figure-3e. Friday LOAD PROFILES.

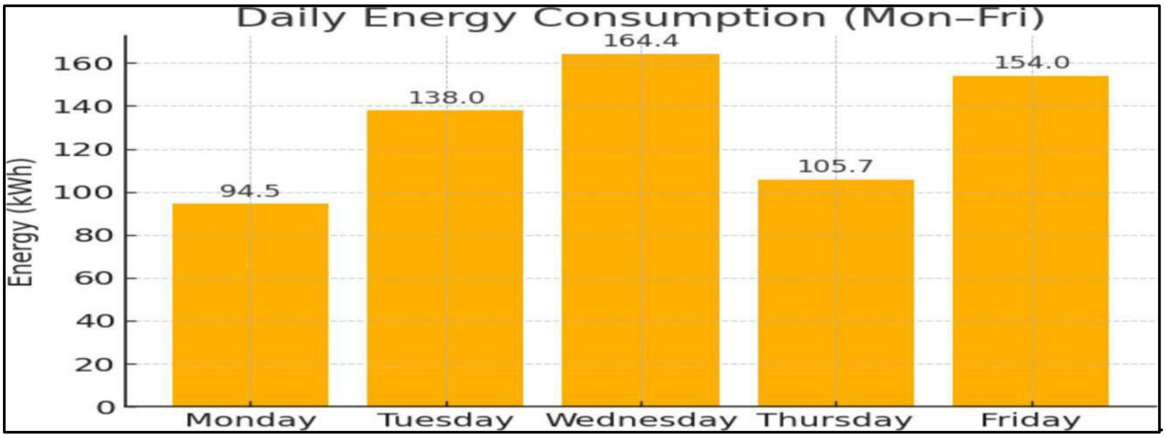

Figure-4. The energy consumption per day (Mon -Fri).

Figure-4 shows the bar charts of actual energies on weekdays, and shows unmistakably the mid-week jump unmistakably: Monday and Tuesday actually have less energy, which grows on Wednesday to approximately 164 kWh, and then declines. Profile shows that Wednesday is the day of special importance to any demand-reduction action.

Figures 5 and 6 illustrate the Phase Currents, Busiest Day (Stacked Area), and the distribution of Line-to-Neutral Voltages (All Phases, from Monday-Friday). The real-time stacked-area view of the Wednesday counts the phase

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imbalance. Phase 1 is always stronger (sometimes as much as twice the load of the other phases of the sum), and this requirement justifies the redistribution of single-phase loads to reduce neutral stress. Box-and-whisker plots show that voltage has been tightly controlled: medians lie close to 235 V, and whiskers are in the range of +/- 4 % of nominal. Scattered outliers confirm the fact that short-lived events are the only ones to violate this envelope.

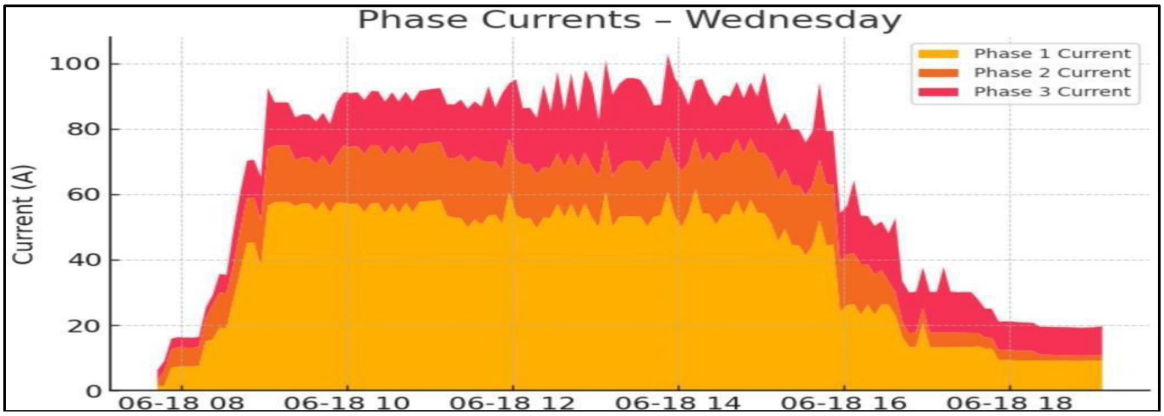

Figure-5. Phase currents, busiest day (stacked area).

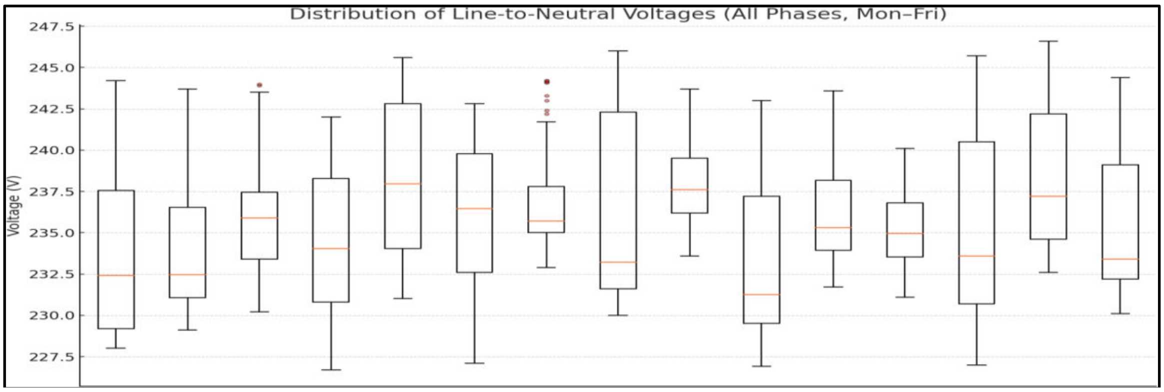

Figure-6. Distribution of line-to-neutral voltages.

C) Blynk IOT Feedback Platform

Figure-7 shows all three phases, as well as the total consumption were displayed in real time in the Blynk dashboard with:

a) The supply, which was within nominal 240 V with line-to-neutral voltage of approximately 242.7 V, 244.7 V, and 242.6 V within a narrow range of +/-1% in the line-to-neutral voltage between each phase, was demonstrated with real-time readings of the gauges representing each of the three phases within the frame of reference.
b) Phase currents ($I_1 \approx 19.5$ A, $I_2 \approx 2.1$ A, $I_3 \approx 8.3$ A) showed the imbalance of the load as reflected in the time-series data: Phase 1 propagated the largest part of the load, Phase 2 was the lightly loaded phase, and Phase 3 was the intermediate.
c) The instantaneous readings of power ($P_1 \approx 4.48$ kW, $P_2 \approx 0.28$ kW, $P_3 \approx 1.96$ kW) added exactly to the total-power display (6.72 kW), so the microcontroller aggregation logic is properly combining the three PZEM-measured channels.
d) Energy totals ("Energy consumed: 2.75 kWh") updated in real-time, agreed with the hourly and daily SMS report, and the CSV data recorded to within 1 % and hence offering consistent inter-interface cross-checking [26].
e) When set to an interval of 5 s (which is adjustable in the Blynk sketch), the dashboard refresh frequency was opportune to notice short-lived events (e.g., the load switching part) without overloading the Wi-Fi connection.
f) The gauges remained tidy in the mobile and web implementations of Blynk, where, by connecting over the Internet, it would be possible to monitor remotely using any device; this would be eventually accompanied by push-notification widgets (which were structured although not pictured here in the readout view), to be able to notify when their thresholds or ranges have been broken.

Summarily, the Blynk IoT front end provided an easy visual control portal of three-phase operations and not only just demonstrated the precision of the in-built measurements but also the soundness of the ESP32-to-cloud data link pipeline.

Figure-7. The oBlynk IoT dashboard.

5. CONCLUSIONS

This work has been able to achieve the objectives of coming up with a three-phase power monitoring system that monitors voltage, current, power, and energy in real-time and with an improved accuracy of more than 2.5 percent. SMS alerts in real-time and hourly/daily summary reports were provided with a reliable message through the SIM800L module and live dashboards on Blynk and ThingSpeak, which were cross-checked and verified. Load profiling made evident that there was phase imbalance and peak consumption periods, thus exposing the value of the system in energy management. In general, the design achieved its goals through the combination of precise monitoring, proactive alerts, and as well as the provision of concrete recommendations.

In further works, a more robust system would be achieved by integrating Balance Phase Loads, that is, automatically redistributing loads or manually adjusting loads to minimize the known phase imbalance. The Sensor Precision and communication should also be enhanced by incorporating caliber procedures and backup sensors to obtain multiple cross-checks to reduce the error of measurement further, and adding MQTT over TLS or NB-IoT to ensure reliable communication and secure data transfers. Finally, the addition of predictive analytics should be considered through the use of basic machine-learning algorithms to identify normal and abnormal cases and predict failures. All these will lead to an Improved interface, which will build a role-wise web-based dashboard and SMS command to get on-demand data queries and reinforce the resilience of the system, increase its usability, and make it possible to manage energy and energy management in a scalable and intelligent way.

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