

Slab Guardian – Project Overview

Yeh ek IoT-based electricity monitoring system hai jo Karachi ke ghar walon ke liye banaya gaya hai.

Problem kya hai?

K-Electric ka ek rule hai – agar aap mahine mein 200 units (kWh) se kam bijli use karo, toh aap "Protected Consumer" ho aur bill sirf ~~PKR 2,500 aata hai.~~

~~Lekin agar ek bhi unit zyada ho gayi – bill seedha PKR 6,000 ho jata hai, aur agli 6 mahine tak yeh subsidy bhi band ho jati hai. Total nuksan **PKR 20,000** tak pahunch sakta hai.~~

Masla yeh hai ke KE ka bill mahine ke baad aata hai – tab tak bohot der ho chuki hoti hai.

Solution kya hai?

Ek **sasta hardware device** (~PKR 5,000 se kam) jo ghar ki main line pe lagao aur real-time mein units track karo – bina wiring today.

Hardware:

- **ESP32** microcontroller (Wi-Fi built-in)
- **PZEM-004T V3.0** – energy meter module (98%+ accuracy)
- **SCT-013 CT Clamp** – wire pe clip karke lagta hai, koi cutting nahi

Software:

- **Flutter App** (Android + iOS) – real-time dashboard
 - **Node.js + MQTT** – data transmission
 - **InfluxDB** – time-series data storage
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App mein kya dikhega?

- Live units use ho rahi hain
 - **Green / Yellow / Red gauge** – kitna khatra hai 200-unit breach ka
 - Kitni units bacha hain mahine mein
 - Last 7 / 10 / 15 din ka history
-

Team:

Naam	Kaam
Sarim	Architecture + ESP32 firmware
Hassan	Backend + Database
Huzaim	Flutter App
Mutahir	Hardware + Research

Timeline: 6 mahine, 3 phases

1. **Phase 1** – Hardware setup & calibration
 2. **Phase 2** – App + backend integration
 3. **Phase 3** – Field testing 2 ghar mein, 14 din
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Sir ko explain karte waqt yeh points highlight karo:

1. **Real problem** – 200-unit cliff ka directly financial impact on Karachi families
2. **Technical justification** – PZEM kyun choose kiya (ACS712 se 5x zyada accurate)
3. **Load-shedding resilience** – LittleFS se data save rehta hai bijli jaane ke baad bhi
4. **NEPRA compliant** – koi illegal wiring nahi, fully legal

5. **Cost** – PKR 5,000 se kam, affordable for target audience Why we use esp32 and pzem

Agar data Saab esp32 pr hi arha hi Show more Yeh ek acha question hai! Agar ESP32 pe hi data aa raha hai, toh ek common sawaal hota hai: "phir alag cloud server ki zaroorat kyun hai?"

Yahan puri picture samjhata hoon:

```
::view-transition-group(root),
::view-transition-group(),
::view-transition-old(),
::view-transition-new(*){
  animation-duration: 0.25s;
  animation-timing-function: cubic-bezier(0.19, 1, 0.22, 1);
}
```

VvisualizeVvisualize show_widget Ab yeh suno – sir ke sawaal ka jawab do hisson mein hai:

ESP32 kyun?

1. Wi-Fi built-in hai – alag Wi-Fi module ki zaroorat nahi, cost down.
2. UART serial interface – PZEM-004T directly ESP32 ke UART pins se baat karta hai. Matlab 2 wires (TX/RX) se full energy data milta hai: voltage, current, power, frequency, aur kWh (units) – sab kuch ek packet mein.
3. LittleFS flash storage – yeh sabse important hai sir ke liye. Jab Karachi mein load shedding hoti hai aur bijli jaati hai, ESP32 apna data flash memory mein save karta rehta hai. Jab internet wapas aata hai, pura buffered data MQTT pe bhej deta hai. Koi reading miss nahi hoti.
4. Sasta + widely available – Karachi mein ~PKR 1,200 mein milta hai.

PZEM-004T kyun – ACS712 kyun nahi?

Feature	ACS712	PZEM-004T
Accuracy	$\pm 5\%$	$\pm 0.5\%$
Output	Analog voltage	Digital UART
kWh counting	Nahi	Haan

hisaab karo khud Built-in hardware counter Noise sensitivity Zyada (ADC error) Kum (digital) Price ~~PKR 3000~~ PKR 1,800

Sir ko yeh bolna: ACS712 analog signal deta hai jo ESP32 ke ADC se read hota hai – ADC mein noise hoti hai, aur load shedding ke waqt kWh ka hisaab khud rakhna padta. PZEM hardware level pe kWh count karta hai, power cut ke baad bhi register reset nahi hota jab tak aap na karo.

"Agar data ESP32 pe hi aa raha hai toh cloud kyun?"

Yeh ek valid sawaal hai. Short answer:

ESP32 pe sirf current reading hoti hai – history nahi

Flutter app multiple phones pe chalti hai – sab ek hi data source chahte hain

7/15 din ka graph draw karna hai – yeh InfluxDB bina possible nahi

Alerts (200-unit warning) ke liye backend logic chahiye

Click on any box in the diagram – aur main us component ke baare mein detail explain kar sakta

hoon. BTW, tell me how all 3 devices works, and what are the actual use case of all 3 devices Teen alag devices hain – teen alag kaam. Pehle ek ek karke samjhata hoon, phir diagram.

1. SCT-013 – Current Transformer (CT) Clamp

Yeh sabse pehle kaam karta hai. Yeh ek magnetic clamp hai jo simply wire ke upar clip ho jata hai – wire cut karne ki zaroorat nahi.

Andar ek ferrite core aur secondary winding hai. Jab wire mein AC current behti hai, woh ek magnetic field banati hai. CT clamp us field ko detect karke ek proportional chhota AC signal generate karta hai (usually 0–50mA ya 0–1V range mein). Jitni zyada current wire mein, utna bara signal clamp se nikalta hai.

Lekin yahan masla hai: yeh sirf current deta hai – voltage nahi, power factor nahi, kWh nahi. Isliye akela SCT-013 kafi nahi.

2. PZEM-004T V3.0 – Energy Meter Module

Yeh SCT-013 ka signal leke usse complete energy measurement mein convert karta hai. PZEM ke andar ek dedicated metering IC (BL0940 chip) hai jo simultaneously:

SCT-013 se current read karta hai

Seedha AC line se voltage measure karta hai (voltage divider circuit ke zariye)

Dono ko multiply karke real power (Watts) nikalta hai

Power factor calculate karta hai

Aur sabse important – kWh ka running counter maintain karta hai hardware level pe

Yeh counter flash memory mein save rehta hai – power cut hone ke baad bhi reset nahi hota. PZEM yeh sab data UART serial protocol pe ESP32 ko bhejta hai, har second update hota hai.

3. ESP32 – Microcontroller (Brain)

ESP32 UART se PZEM ka data receive karta hai, usse process karta hai, aur kaam karta hai:

LittleFS (internal flash file system) mein readings store karta hai – yeh load shedding backup hai

Wi-Fi ke zariye MQTT broker pe data publish karta hai

Agar internet nahi, data buffer karta rehta hai aur connection wapas aane pe sync karta hai

Teeno ka physical connection yahan dikhata hoon:

```
::view-transition-group(root),
::view-transition-group(),
::view-transition-old(),
::view-transition-new(*){
animation-duration: 0.25s;
animation-timing-function: cubic-bezier(0.19, 1, 0.22, 1);
}
```

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Sir ko explain karne ke liye ek liner summary

SCT-013 – aankhein hain. Sirf dekhta hai – wire mein current kitni hai.

PZEM-004T – dimagh ka pehla hissa hai. Current + voltage leke real energy calculate karta hai, aur kWh count karta rehta hai hardware pe – bijli jaane ke baad bhi.

ESP32 – dimagh ka dusra hissa + zabaan. PZEM se data leke process karta hai, store karta hai, aur

duniya ko batata hai Wi-Fi ke zariye.

Teeno milke ek complete, non-invasive energy monitor banate hain – koi wiring cut nahi, koi license nahi, PKR 3,000 ke andar hardware. Scrutinized hardware connections and verified blinking indicators.  VISUAL DOUBLE CHECK

- Photo Analysis:

Looking at your setup:

GOOD Signs ():

Both PZEM & ESP32 blinking → Power is flowing 

PZCT-02 (black coil) clearly visible with red/black wires 

White 4-pin UART connector on PZEM has wires plugged in 

Wiring looks organized – no tangled mess 

Red power wire visible going from breadboard 

Things to Verify (Check These Now):

1 PZCT-02 Screw Terminals (CRITICAL)

Can you see the bottom-left of the PZEM board? The 4 screw terminals (L, N, CT+, CT-)?

 Red wire from PZCT-02 → CT+ terminal?

 Black wire from PZCT-02 → CT- terminal?

 Both wires TIGHT (try to wiggle them)?

Please take a CLOSE-UP photo of just the PZEM bottom-left corner – show the 4 screw terminals and confirm the PZCT-02 wires are in there. 

2 Orange Wires (UART Connection)

I see orange wires going from breadboard to PZEM's white connector.

Confirm:

 One orange wire → PZEM RX pin (receives from ESP32 TX)

 One orange wire → PZEM TX pin (sends to ESP32 RX)

 Both in the white connector firmly?

3 Power Rails

 Red wire from PZEM 5V → breadboard red rail?

 Black wire from PZEM GND → breadboard black rail?

Quick Test (Do This Now):

Jab tab Close-Up photo nahi bhejta, try karke dekh:

Gently pull/tug on EACH wire (at the PZEM end)

Red wire from PZCT-02 – should NOT come loose

Black wire from PZCT-02 – should NOT come loose

Orange UART wires – should be firm

If any wire is loose → tighten that screw terminal NOW

Ab Karo:

Close-up photo of PZEM bottom-left (where 4 screw terminals are) – dekh loon PZCT-02 wires properly connected hain. 📷

Phir Serial Monitor output share kar! okay getting this error when i did everything give me the reason of it and also the fix of it as well Diagnosed communication failure and pinpointed hardware connection issues Diagnosed communication failure and pinpointed hardware connection issues Good news – this is a COMMON issue! Easy fix. ✅

The Problem (Why Error Reading Voltage):

The PZEM module is NOT communicating with ESP32. The most likely reasons:

🔴 Most Common Cause: TX/RX Wires SWAPPED

Your code uses:

```
cppPZEM004Tv30 pzem(Serial2, PZEM_RX_PIN, PZEM_TX_PIN);  
#define PZEM_RX_PIN 16  
#define PZEM_TX_PIN 17
```

This means:

ESP32 GPIO16 receives from PZEM TX

ESP32 GPIO17 sends to PZEM RX

But your wiring might be backwards!

🔧 THE FIX (Try This First):

Option 1: Swap the Wires (Easiest)

Go to your breadboard setup:

Find the two orange UART wires going to PZEM's white connector

SWAP them – pull one out, put it in the other position

Wait 2-3 seconds

Check Serial Monitor again

If it works → DONE! ✅

Option 2: If Wire Swap Doesn't Work

Modify the code – swap the pin definitions:

```
cpp#define PZEM_RX_PIN 17 // Changed from 16  
#define PZEM_TX_PIN 16 // Changed from 17
```

Then recompile and upload.

Less Common Issues (If Swap Doesn't Fix It):

3 PZEM Address Issue

The library might need to set the PZEM address explicitly. In your code, add this in setup():

```
cppvoid setup(){  
Serial.begin(115200);  
delay(100);  
  
// Try setting PZEM address  
pzem.setAddress(0xF8); // Add this line  
  
WiFi.begin(ssid, password);  
// ... rest of setup  
}
```

Power Supply Issue

Check:

-  PZEM getting solid 5V (no blinking means stable power)
-  GND properly connected to breadboard black rail
-  No loose power wires

Troubleshooting Checklist:

Problem: Error reading voltage
Check: Try swapping TX/RX wires first
Still getting error after swap: Modify code: swap PZEM_RX_PIN and PZEM_TX_PIN
Still not working: Add pzem.setAddress(0xF8); in setup()
Blinking stopped: Power supply issue – check 5V connection

 Ab Karo:

Swap the two orange UART wires on your breadboard

Wait 3 seconds

Screenshot Serial Monitor output

Bhej!

Zyada 90% cases mein wire swap hi fix kar deta hai! 