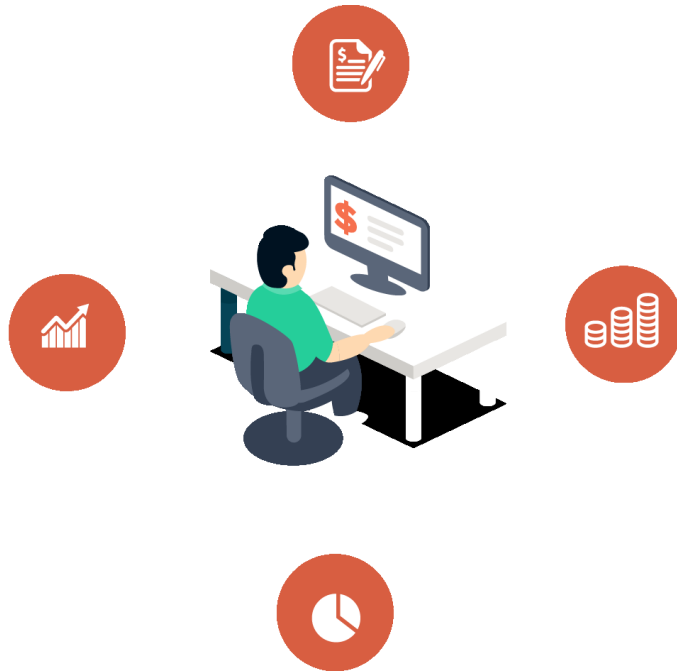


IoT based Smart Energy Meter



Agenda

- Problem Identification
- Motivation & Solution
- Proposal
- Deliverables

Problem Identification

- Approach : Need of smart energy meter in Sri Lanka
- Domestic Purpose - Tariff

Monthly Consumption (kWh)	Unit Charge (Rs./kWh)	Fixed Charge (Rs./month)
0-60	7.85	N/A
61-90	10.00	90.00
91-120	27.75	480.00
121-180	32.00	480.00
>180	45.00	540.00

Table 1: Electricity Tariff

Electricity bill of 180 units

$$\begin{aligned} \rightarrow 90 + 90 &= [(7.85 \times 60) + (10 \times 30) + 90] + [(7.85 \times 60) + (10 \times 30) + 90] = 861 + 861 = 1722.00 \\ \rightarrow 85 + 95 &= [(7.85 \times 60) + (10 \times 25) + 90] + [(7.85 \times 60) + (10 \times 30) + (27.75 \times 5) + 480] = 811 + 1389.75 = 2200.75 \end{aligned}$$

478.75 LKR

Case Study

[illegible][illegible]

If meter reading taken different intervals that will effects the charges as well.

Smart Energy Meter

- The smart energy meter is an advanced energy meter that obtains information from the end users' load devices and measures the energy consumption of the consumers and then provides added information to the utility company and/or system operator.

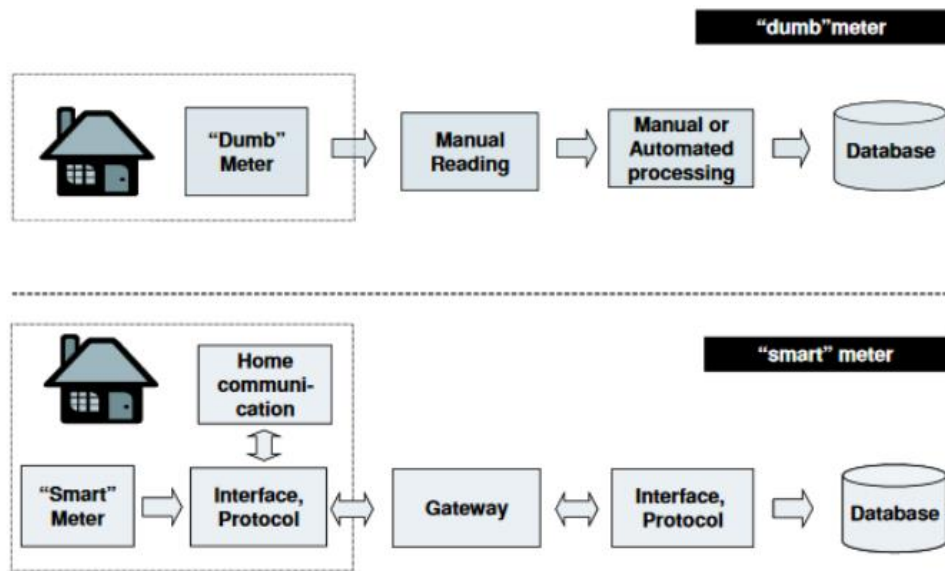


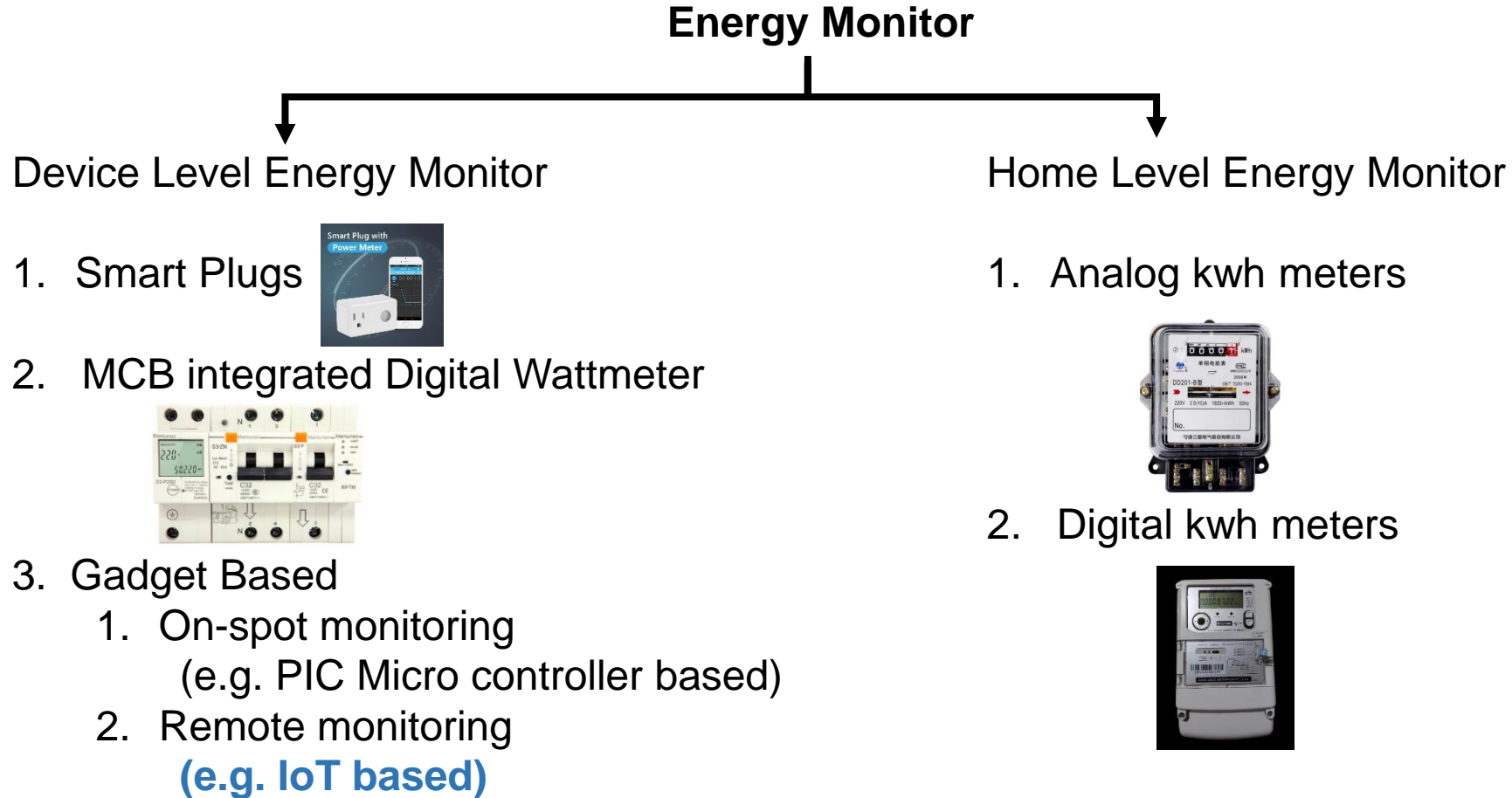
Fig 1. Normal Meter Vs Smart Meter ¹

Why Smart Energy meter?

- As a Service provider and Consumer both benefited
- Real time monitoring of power usage
- Can be integrate with currently installed meter
- Plug and Play capabilities

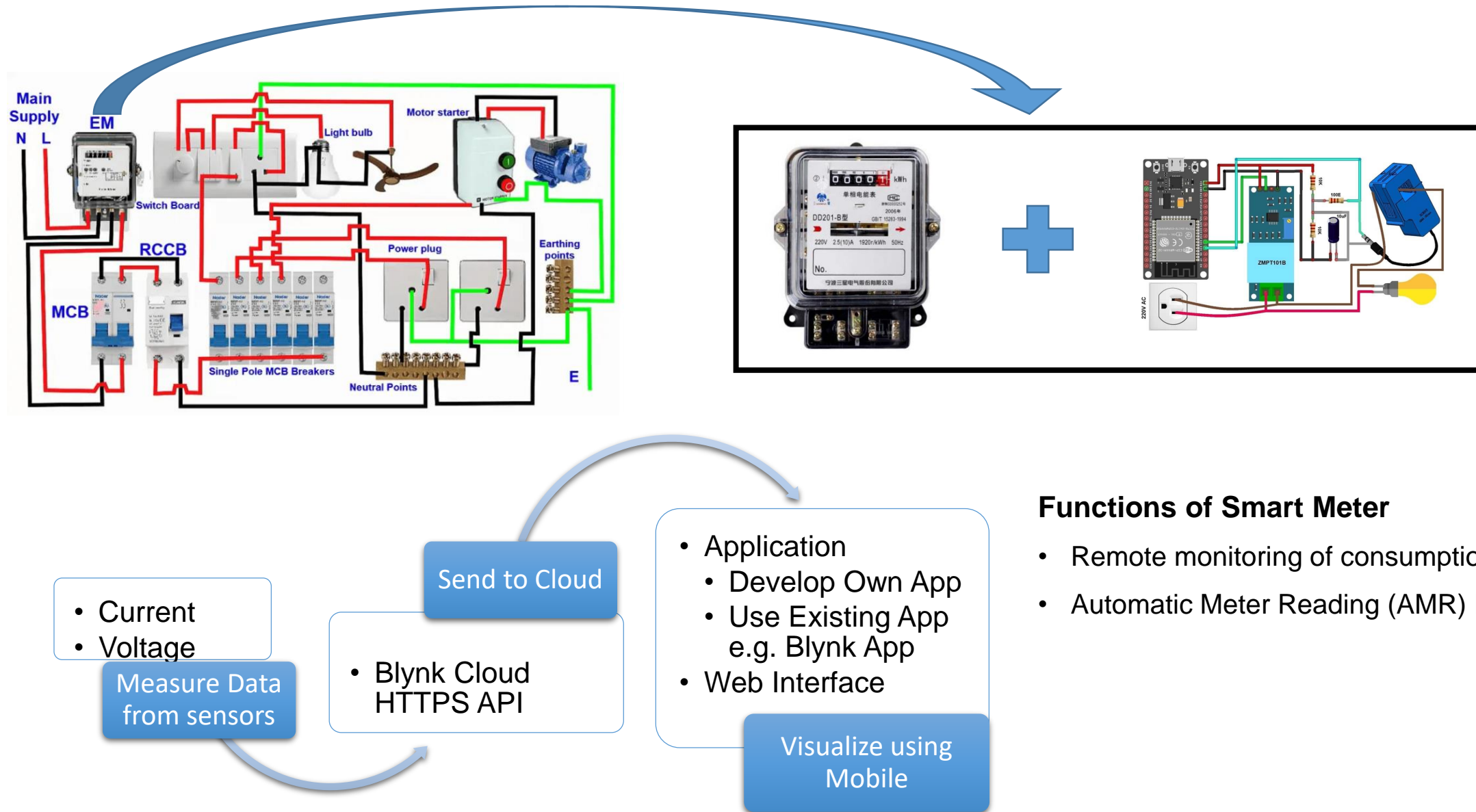
Motivation and Solution

- Generally how to measure/analyze power? Oscilloscope/Power meter



$$\text{Power (P)} = \text{Voltage (V}_{\text{rms}}) \times \text{Current (I}_{\text{rms}}) \times \text{Power Factor (Cos}\theta)$$

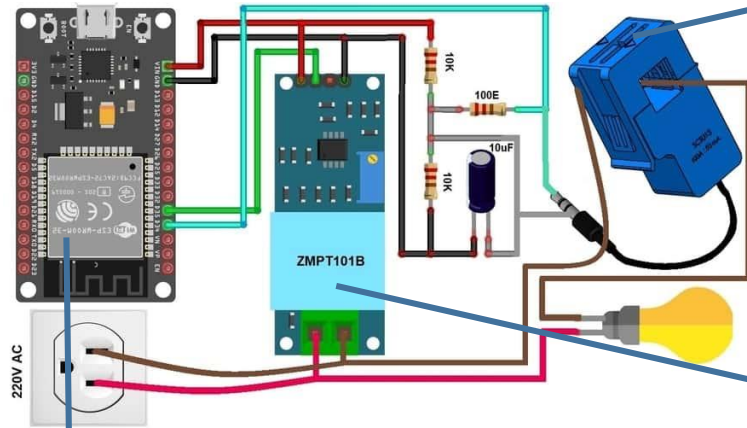
Proposed: IoT based Smart Energy Monitor - Overview



Picture Source:

- <https://theoppowersolutions.com/electrical-wiring-for-a-house/>
- <https://how2electronics.com/iot-based-electricity-energy-meter-using-esp32-blynk/>

Main Components Overview



SCT-013 Current Sensor

- Non - Invasive
- Rated input current : 5A/100A
- Fire resistance
- Work temperature: -25°C ~ +70°C

ZMPT101B Voltage Sensor

- Voltage up to 250 volts can be measured
- Lightweight with an on-board micro-precision voltage transformer
- High precision on-board op-amp circuit
- Operating temperature: 40°C ~ + 70°C
- Supply voltage 5 volts to 30 volts
- Size: 49.5mm x 19.4mm

ESP32 Wi-Fi Module





- Ultra Low Power Solution
- Wi-Fi Key Features
- CPU and Memory
- Advanced Peripheral Interfaces

Sensor selection: **Library Support**, Availability, Linearity, Accuracy, Precision, Size, Operating Temperature

Source:

1. https://www.mcielectronics.cl/website_MCI/static/documents/Datasheet_SCT013.pdf
2. <https://innovators.guru.com/wp-content/uploads/2019/02/ZMPT101B.pdf>
3. https://www.espressif.com/sites/default/files/documentation/esp32_datasheet_en.pdf

Components:

Components	Price (LKR)
ESP32 Board 	1980
ZMPT101B AC Voltage Sensor Module 	560
SCT-013-030 Non-invasive AC Current Sensor 	1270
16X2 I2C LCD Display 	1200
Resistor 10k	10
Resistor 100 ohm	10
Capacitor 10 μ f	50
Total	5080

Additional Test Equipments Needed

Oscilloscope : To monitor, test, verify different type of loads

Multimeter : To verify the sensor measurements

MCB : Protection for the circuits while implementing

Final Deliverables

× Milestones to Complete

- Literature Study
- Implement Device Level Smart Energy Meter
 - Circuit Implementation
 - App Integration
- Test with different loads
- Integrate with Kwh meter

Considerations/Challenges

- × What if there is no network/Wi-Fi coverage?



Potential Enhancements

- × Standards for Product development
 - BS EN IEC 62052-11:2021: Electricity metering equipment. General requirements, tests and test conditions Metering equipment
- × Enclosure Design IP Class: IP54
- × Additional Capabilities in Application
 - Admin mode
 - Service mode
 - Customer mode
- × Imported/ Exported energy monitoring
 - Needed remodel of the proposed design
- × Accuracy /Service Period
- × Power Supply Unit for Gadget
 - Using Transformer
 - Separate power supply unit

