

Millimeter
...stay connected

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....Meet the team

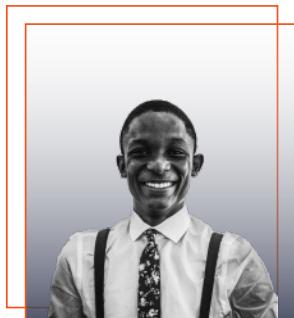
We're a group of college students committed to building our better tomorrow for ourselves.



Nelson Elijah

Technical Lead

Nelson is a hardware and IoT Specialist. Persistent in finding solutions to hardware problems.



Oloyede Jeremiah

Design Lead

Jeremiah is an experienced Graphics Designer and UI/UX Designer with seasoned innovative and problem solving skills.

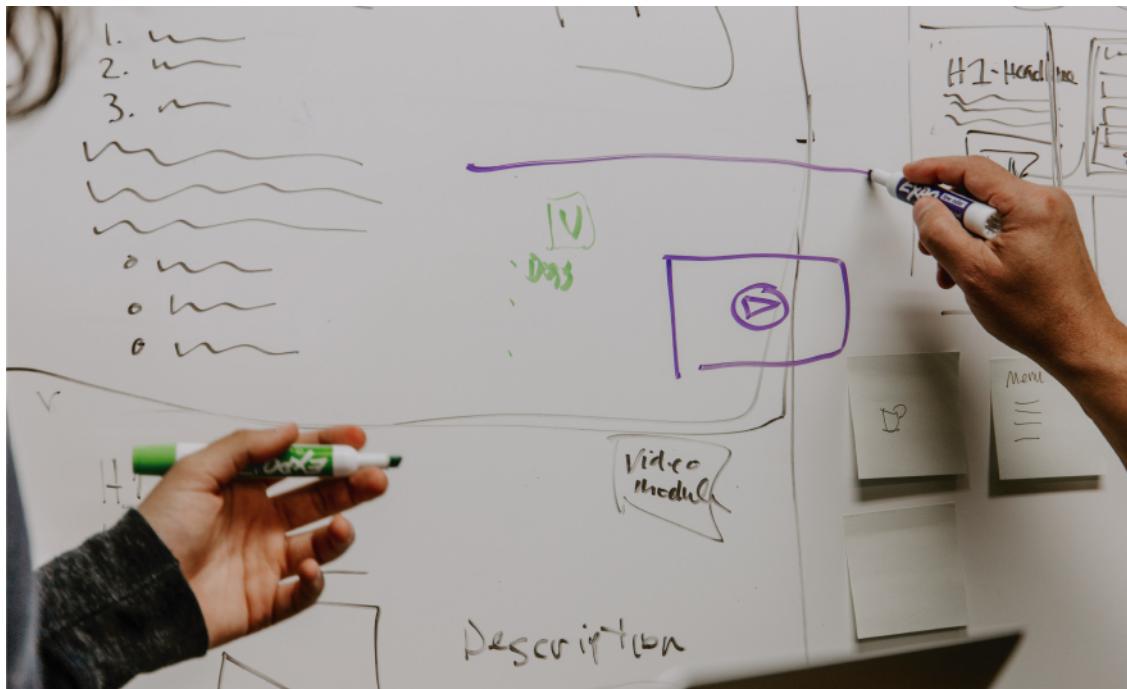


Asikhala耶 Samuel

Ass. Technical Lead

Samuel is a technology enthusiast, an innovator who enjoys creating new means of helping people

....Intro- duction



Inspired by the 2020 Lagos State Smart Meter Hackathon, the product millimeter was forged.

The Lagos Smart Meter Hackathon 2020 is designed to address the huge metering deficit in Nigeria. Estimates from analysts indicate that 85% of Nigerian households are not metered and 60% of households in Lagos. A key impediment is the price of the existing meters. Therefore, this huge market potential is driving the need for hackers, partners, sponsors and manufacturing companies to join us in making meters more affordable, promoting smarter cities and overall, improving our livelihoods. The Lagos State Ministry of Energy and Mineral Resources is the title sponsor of the Hackathon.

The product was borne out of continuous hardwork and a zest to transform the society one solution at a time.

THE PRODUCT

Strictly following the technical specifications provided in the RFP we have come up with the perfect product. The product highlights the following features amongst others.

- AMI COMPATIBLE
- INCLUSIVE SOFTWARE INCENTIVE
- COST EFFICIENCY

....Circuit diagrams

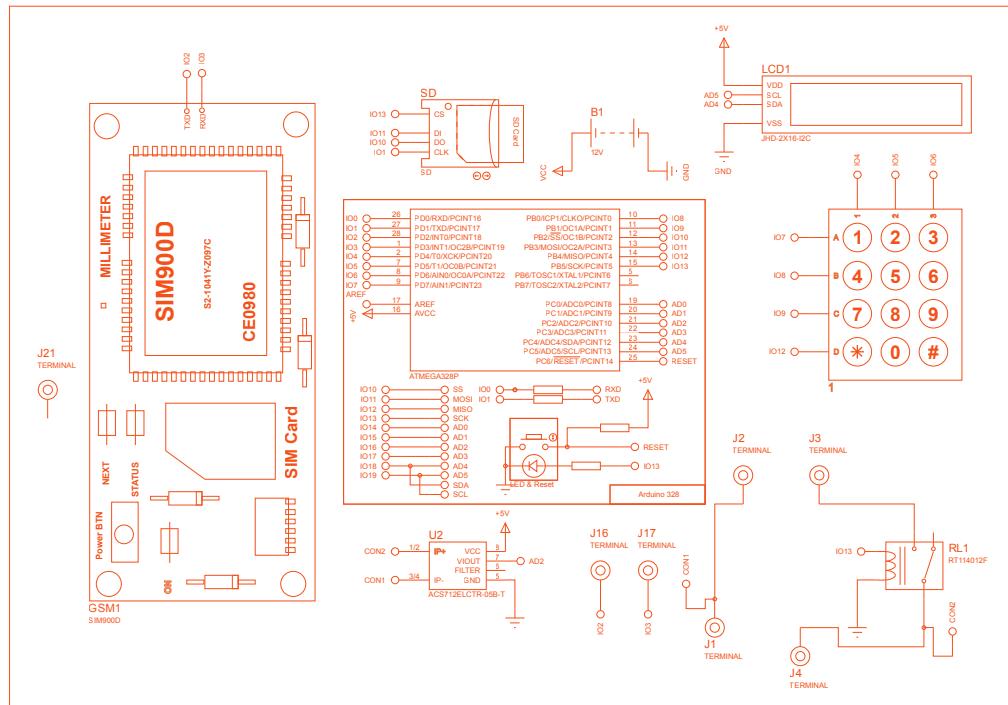


Fig A. Printed Circuit Board Representation

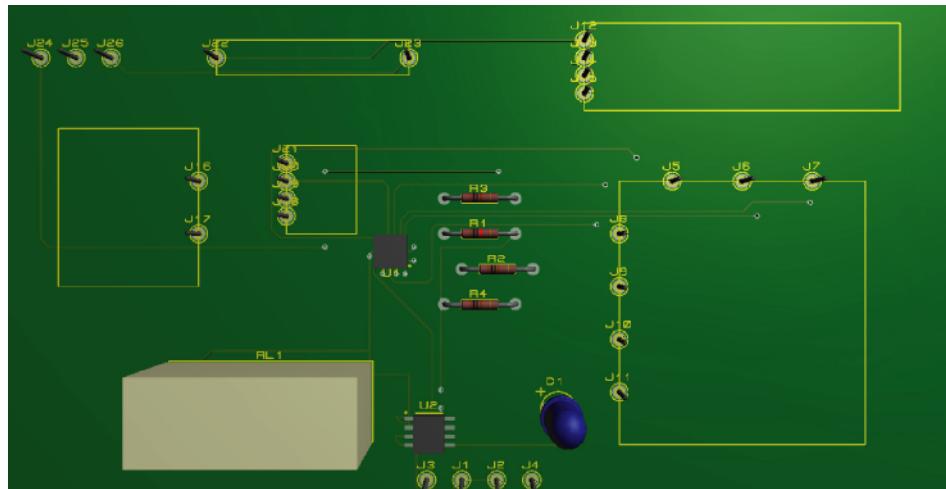


Fig B. Printed Circuit Board 3D Representation

....The casing

To design a cost-effective and yet durable case was one of our challenges in the product design. We opted for stainless steel which has proved to be rust resistant especially when exposed to moisture. Vents were fitted to ensure proper airflow at the same time preventing easy access to rodents or other unwanted entities. The casing accounts for the theft-detection feature at the same time allowing cables of up to 1/0 gauge be passed to the meter. Below is the thought process and sketch of how the case design became what it is.

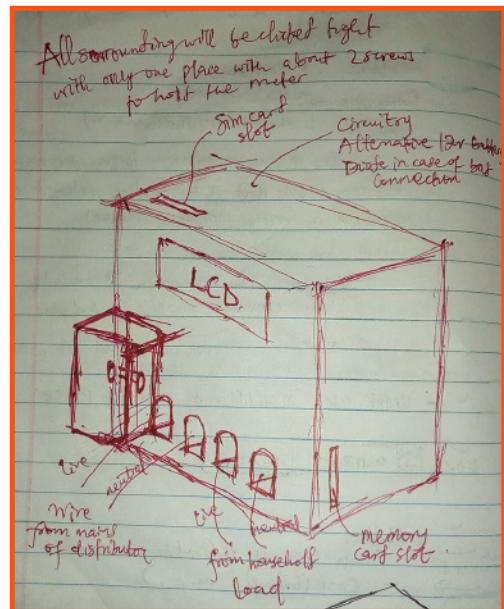


Fig C. Casing Sketch



Fig D. 3D CAD Render

....The software

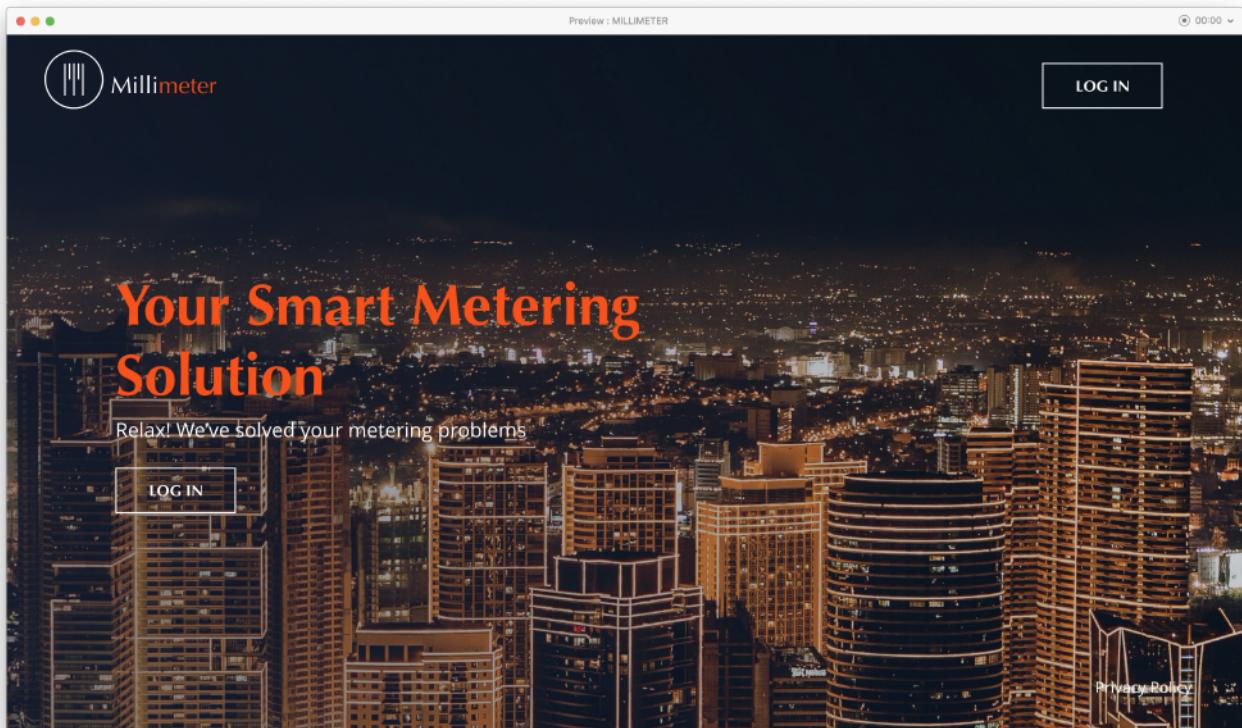


Fig E. Product Landing Page

The User Experience of the Software interface has been designed with ease and simplicity in mind. Right from the landing page, users can find it easy to navigate the site and get the best from our product. The interface has been designed to be used for web browsers with a software application design in progress. This application will be customized for every operating system.

....The software...

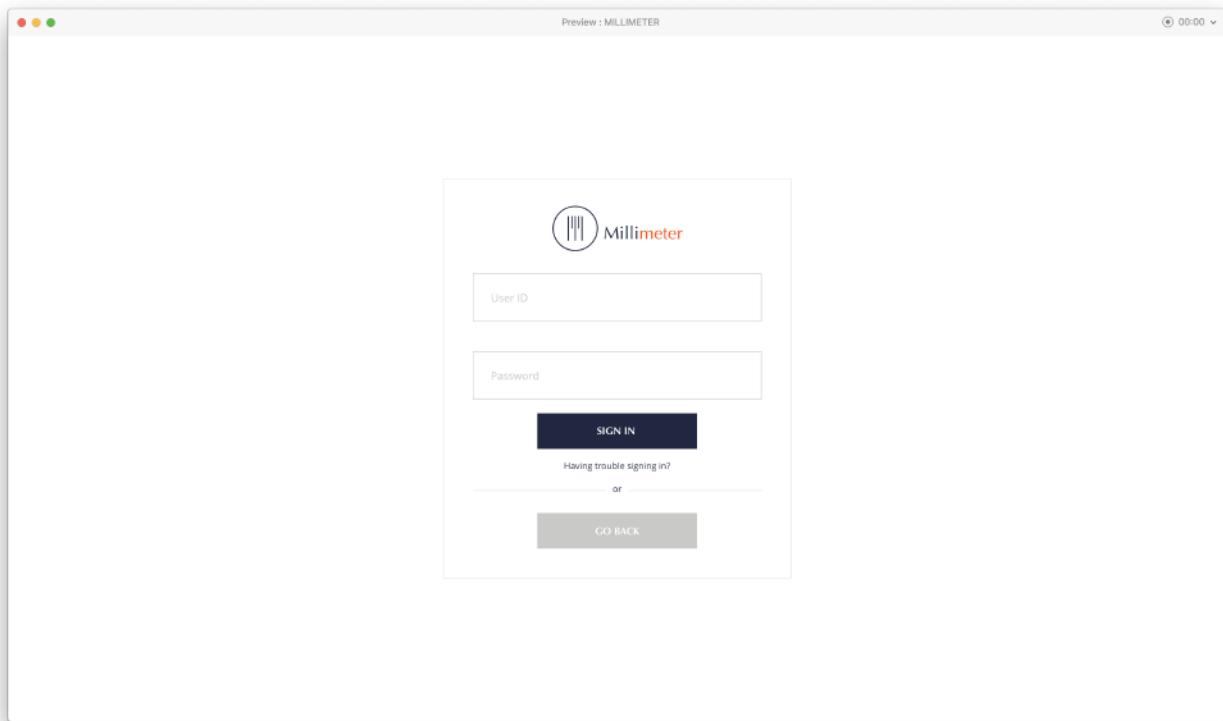


Fig F. Product Login Screen

At installation, our customers are handed a unique User ID and password which they'd use to access their monitoring portal. On login, they would be prompted to change this password for security reasons.

Stakeholder and Administrative Login Feature

Service providers and utility companies on using our product will be handed Login information with a 3-step verification process part of which will involve our consent on first use.

Depending on the User ID, the user will be directed to their respective dashboards straight from our server.

....The software...

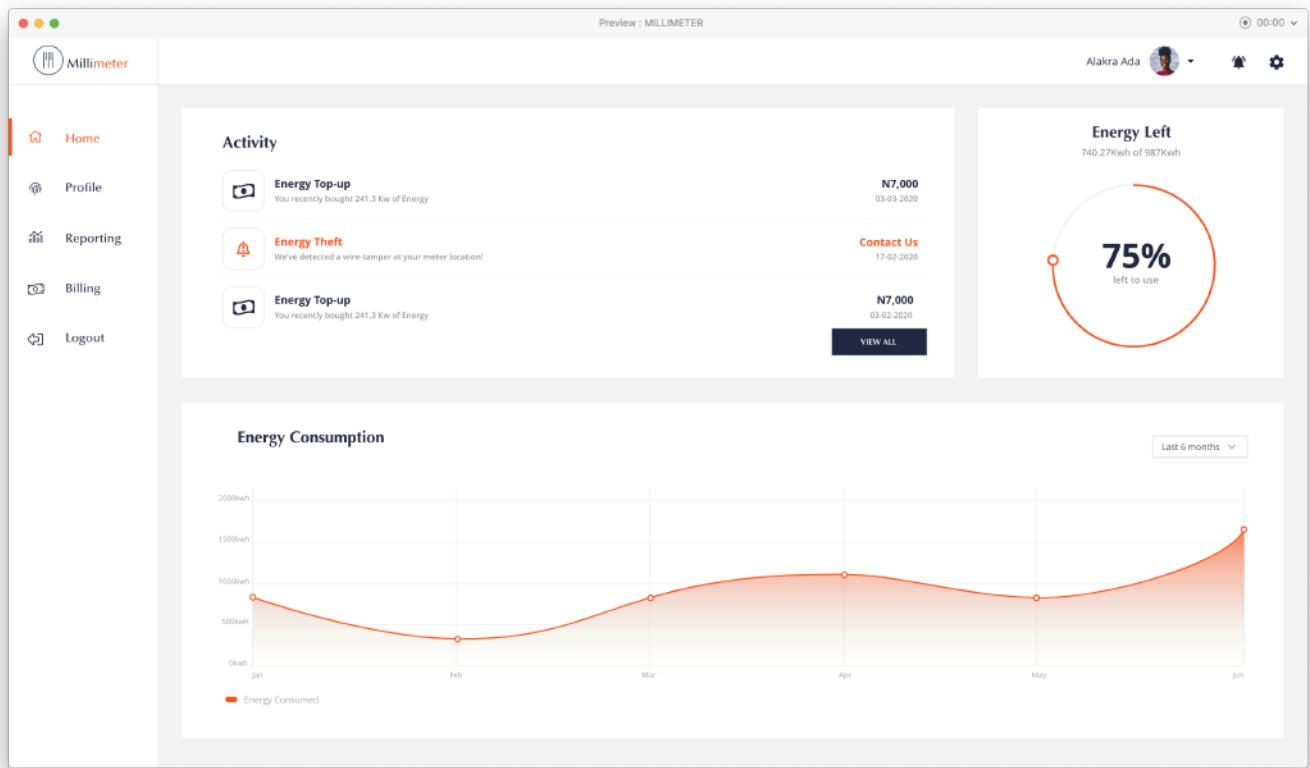


Fig G. Subscriber Dashboard

With inclusivity in mind the interface has been designed so users can retrieve information immediately they log on to the web page. Previous activity taken on their meter is shown. E.g. If their meter was recently tampered or a top-up was made. When internal theft occurs, the user is notified immediately they log in.

The users' energy consumption is described with an easy-to-understand graph. This graph can be customized to any timeline as will be specified by the user. Energy consumption in terms of percentage and Kwh is also shown. These measures allow the user easily retrieve information without much activity.

....The software...

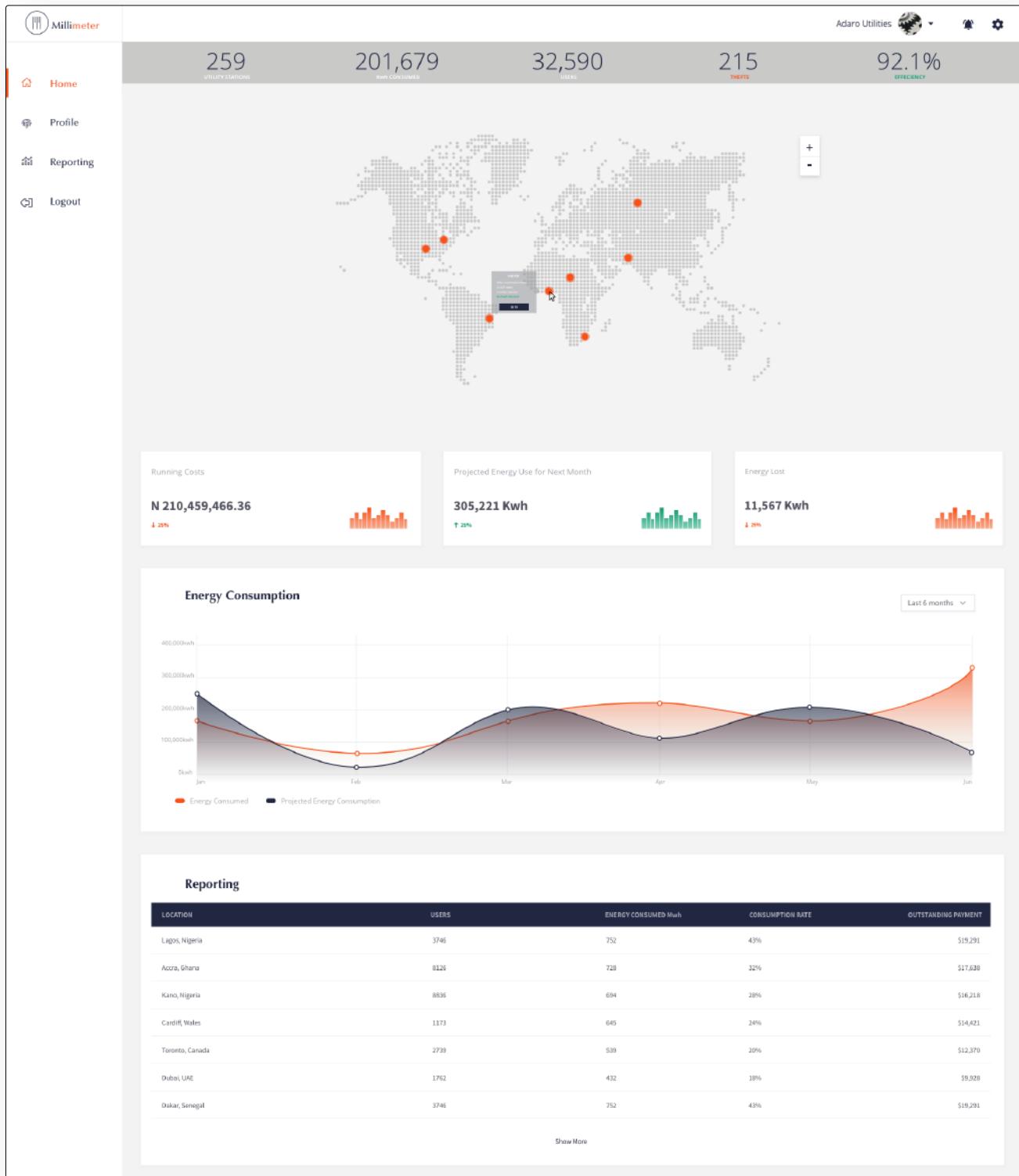


Fig H. Administrator Dashboard

....The software...

The administrator dashboard has been designed to show the most information in the most comprehensive way. The Administrator has access to a wide range of Information; from the rate of energy consumption to quality control in the meters right on the dashboard. The Administrator can view this information against area, per time, or even per user. Information about every user is transmitted in real-time to the website, ranging from the meter state, energy consumed, energy unused and so on. This allows monitoring to become easy and labour-extensive. At the same time, the utility is given boundaries as regards user information. Access is limited to only necessary information including internal and external theft detection. This emphasises service with privacy and information integrity.

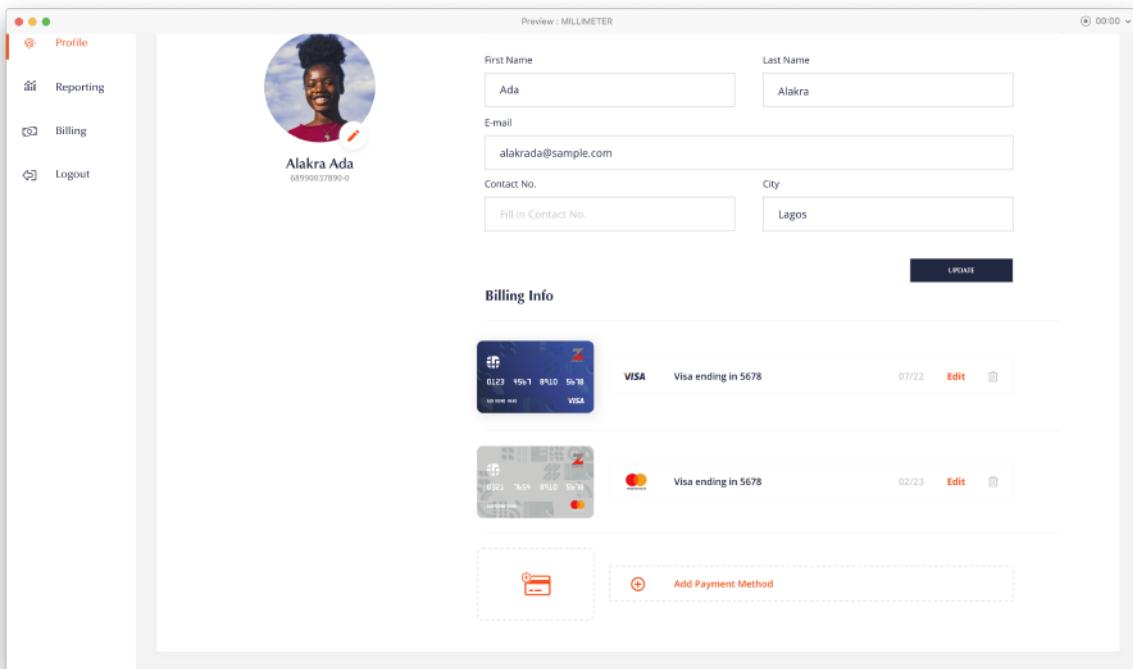


Fig I. Subscriber Profile

In this page, the user is given the opportunity to change his/her information the way they deem fit. Users also have the ability to add card information through a secure means (preferably flutterwave). Paypal is also accepted as a billing method. All this information is stored on our platform to enable easier payment methods. Users don't have to enter the same billing information every time payment is to be made. Nevertheless, users can choose not to save or even delete already stored billing information. This said, users have full-control with their information and this can prove to improve security and usability.

....The software...

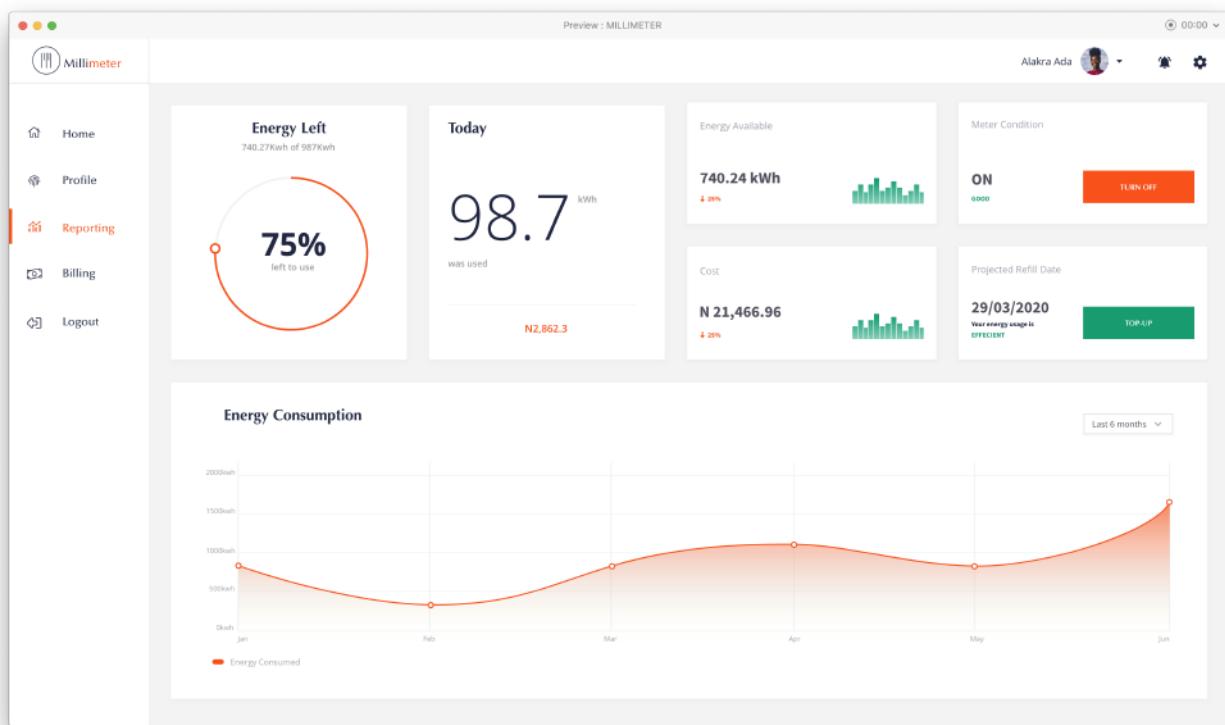


Fig J. Subscriber Report Screen

On this screen, users can get real-time data on the functionality of their smart meter. This ranges from the energy consumption as it tallies with time and cost. Users can see consumption over a certain period as it references with the costs.

Users are also permitted to turn off their meter in this screen. This process is properly designed so users are aware of the implications of the button. A warning comes up and also the user is required to input their security PIN. With these measures, we are sure that the feature ends up being an advantage both for the user and also the Utility company in question.

....The software

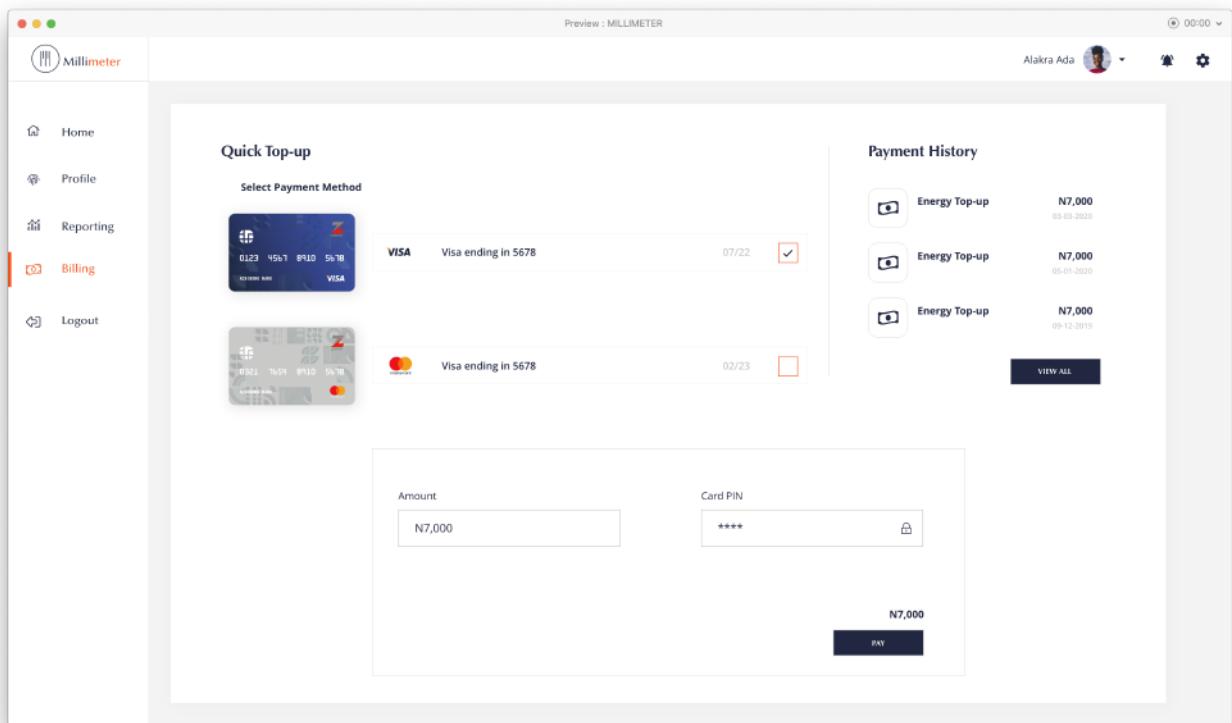


Fig K. Subscriber Billing Screen

As mentioned earlier, the goal of the webpages is to make the interface inclusive and easy to use. With the quick top-up feature, users can easily recharge their meter right from their device. The option is provided for users to save Billing Info and alter it when they deem it fit. This information is highly secured and can only will be used for payment verification at the point of need.

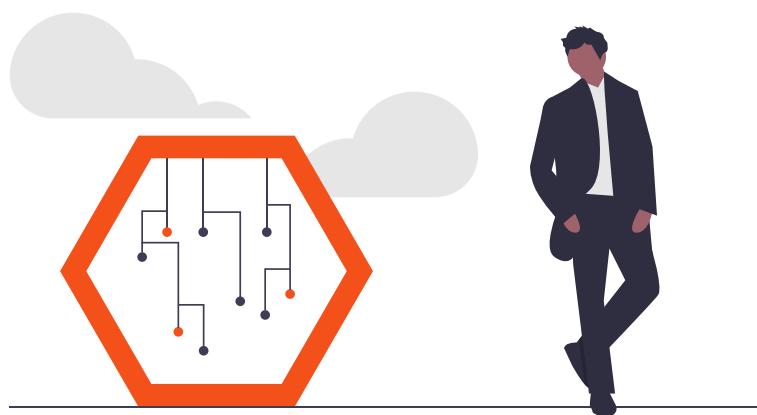
Summary

With thorough research done, the interface has proven to not only assist but increase usability and productivity not just on the side of the utility company, but also with consumers. Truly, our smart meter features will push Lagos towards the Smart City Dream.

....The hardware

SUB-DIVISIONS

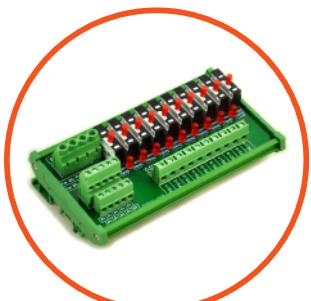
- 01 **Microcontroller**
- 02 **Power Distribution Module**
- 03 **Interactive Display**
- 04 **SD-Card Module**
- 05 **IOT Cloud Communication**
- 06 **Tampering Circuit Scheme**
- 07 **Electrical Metering Module**
- 08 **Virtual Payment System**



....The hardware...

1. Microcontroller

This is the brain of the whole system. It does all calculations, comparisons and manages inputs from other circuits or integrated chips connected to it. Here, we are using an ATmega328PU. It has a good amount of processing power and a substantial volume of EEPROM for perpetual storage.



02. Power Distribution Module

Consists of the voltage, power and current distribution to all parts of the system (Meter). This is a very crucial part in the system as most components and IC's are voltage specific. Hence, their voltage band or threshold mustn't be exceeded to avoid damage to circuit components.

Transformers, Bridges and Capacitors

These are components which aid in the conversion of alternating current to direct current which is suitable for the microcontroller and other circuit components. They are combined to produce a smooth desirable direct current.

5v and 12v regulators

These are regulators that helps control voltage flow to specific parts of the circuits. The 5v regulator is basic for the running of the microcontroller. While the 12v regulator, helps in other circuit components.

Lithium-ion or Lion battery

This provides an alternative power to the circuit and aids in storing data or information when the system is in deep sleep mode. This mode, helps prevents battery redundancy, power consumption and increases circuit efficiency. In deep sleep mode, power distribution is available for about 15 years which is quite durable.

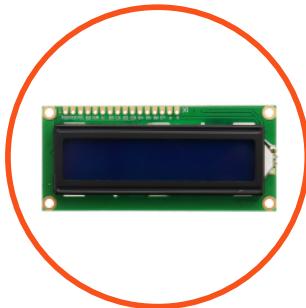
12v Battery

This provides power to the entire circuit and is charged through the direct current gotten from specifics above.

....The hardware...

3. Interactive display

Consists of an LCD (liquid Crystal Display). This creates an interactive medium for the consumer. It displays concise information on regular electricity consumption and also many features such as electrical consumption, balance, units available, tariffs, costs etc.



4. SD-Card Module

This as the name implies, helps in storage of important information and can be analyzed by any application. This information includes daily power consumption, peak power consumption, balance, units etc.

5. IOT Cloud Communication

This is the cutting-edge technology of the smart metering system. It gives the meter its title SMART. It consists of a GPS/GSM/GPRS module, an online DBMS, an online IOT data analysis server and lots more.

GPS/GSM/GPRS module

This is an all in one module that consists of various data communication components. In detail, the GPS (Global Positioning System) section helps in providing location of theft. The GSM (Global System for Mobile Telecommunication) section provides a two-way communication with consumer via text message or calls. It also provides a medium for top-up of balance in case of low balance alert. The GPRS (General Packet Radio Service) section help in sending packets of important data to the web server for big-data analysis, interaction with consumer and plenty others. It also provides a medium of top-up of low balance. Most of all, the module uses a SIM (Subscriber Identity Module) card which creates easy availability to almost any individual to interact with the system.



....The hardware...

5. GPS/GSM/GPRS module contd.

ONLINE DBMS (*Database Management System*)

It provides a medium for storage, retrieval and manipulation(calculation) of data sent by the SMART meter to the cloud.

IOT Data Analysis System

It is one of the main components of the whole metering system. It provides AMI (Advanced Metering Interface) to the whole hardware. It provides an interface for both the Admin (Utilities) and the consumer. It performs lots of calculations, analysis and statistical inputs on the data provided by the SMART meter. Below, is the importance of this analysis.

- Provides Utilities with daily power consumption of consumers on the grid.
- Helps Utilities in estimating the amount of electricity to provide on the grid. This will prevent electrical wastage and increase profit margins of the Utilities.
- Guides consumers and provides regular feedback and tips on controlling their usage of electrical power.
- Increases efficiency on the electrical grid by the application of the analysis gotten from the system. Examples of such systems includes AWS (Amazon web services), THINGSPEAK and more.

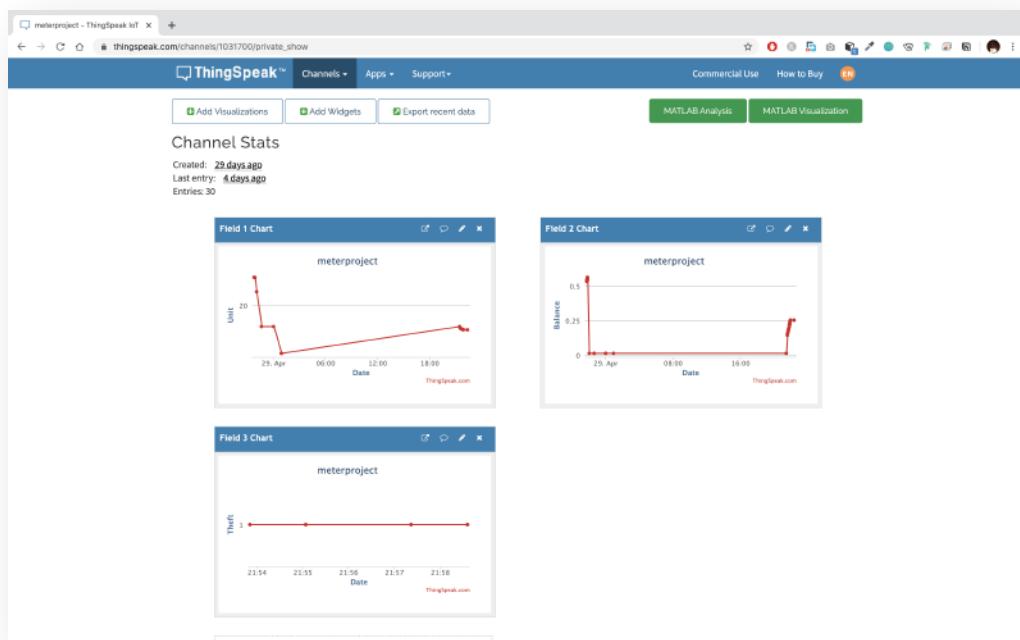


Fig L. Proof of IOT Compatibility using Thingspeak.com

....The hardware...

6. Tampering Circuit Scheme

Nigeria incurs a loss of about #21billion annually from electrical theft and hasn't been able to tackle this. Tampering is one of the most challenges faced by traditional meters. This is an alarming act of deception, deceit and fraud which affects and drains the Utilities of their profit. It also prevents further investors which then leads to poor management of the whole system and electrical grid. There are lots of tampering methods and our SMART meter, is able to tackle a good number.

Case Tampering

This is a type of theft that involves stealing electricity by opening the meter and re-directing the flow of current to elsewhere which wouldn't be read by the meter. To tackle this, our SMART meter has inbuilt sensors which gets alerted and commands the microcontroller to send an alert to the IOT communication medium stating the alert and the location of the theft for accessibility by the Utilities. It then, automatically cuts off the power supply to the affected home until appropriate measures are taken by the Utilities.

Internal and external Theft

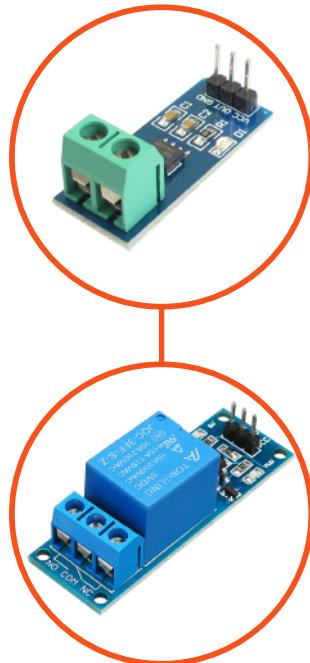
This is done by the meter (microcontroller) itself. It performs internal calculations by analyzing the data from its current sensors. When theft occurs, a false data is read by the microcontroller from these sensors and commands the microcontroller to send an alert to the IOT communication medium stating the alert and the location of the theft for accessibility by the Utilities. It then, automatically cuts off the power supply to the affected home until appropriate measures are taken by the Utilities. Other mediums are continuously being researched to tackle this situation.



....The hardware

7. Electrical Metering Module

It consists of terminals, relays, current sensors and other circuit. Terminals provide the provision for connecting the mains electricity and the household mains to the meter. The relay helps in controlling the flow of electricity. It shuts down the flow of electricity in case of tampering and low balance. Current sensors help in providing necessary data to the microcontroller for calculations and analysis.



8. Virtual Payment System

This provides various media to top-up our SMART meter. Below, are the series of steps for accomplishing payments.

- * Our SMART meter detects an initial limit of low balance of electrical units and sends an alert to the consumer via his platform on the web or his mobile number registered in the system.
- * When the threshold of no availability of units has reached, our SMART meter sends an alert to the consumer while disconnecting the power supply to his or her home.
- * Top-up is done via the web through mobile banking and also GSM communication.
- * Our SMART meter recognizes the top-up, registers this in its system and then, initiates power supply to the individual's home.

....Cost analysis

Strictly following the RFP, the hardware of the product has been designed to minimise costs down to about **\$22.729!** On proper noting, manufacture costs can range between **\$22.729 - \$28.148**. Below is the hardware breakdown.

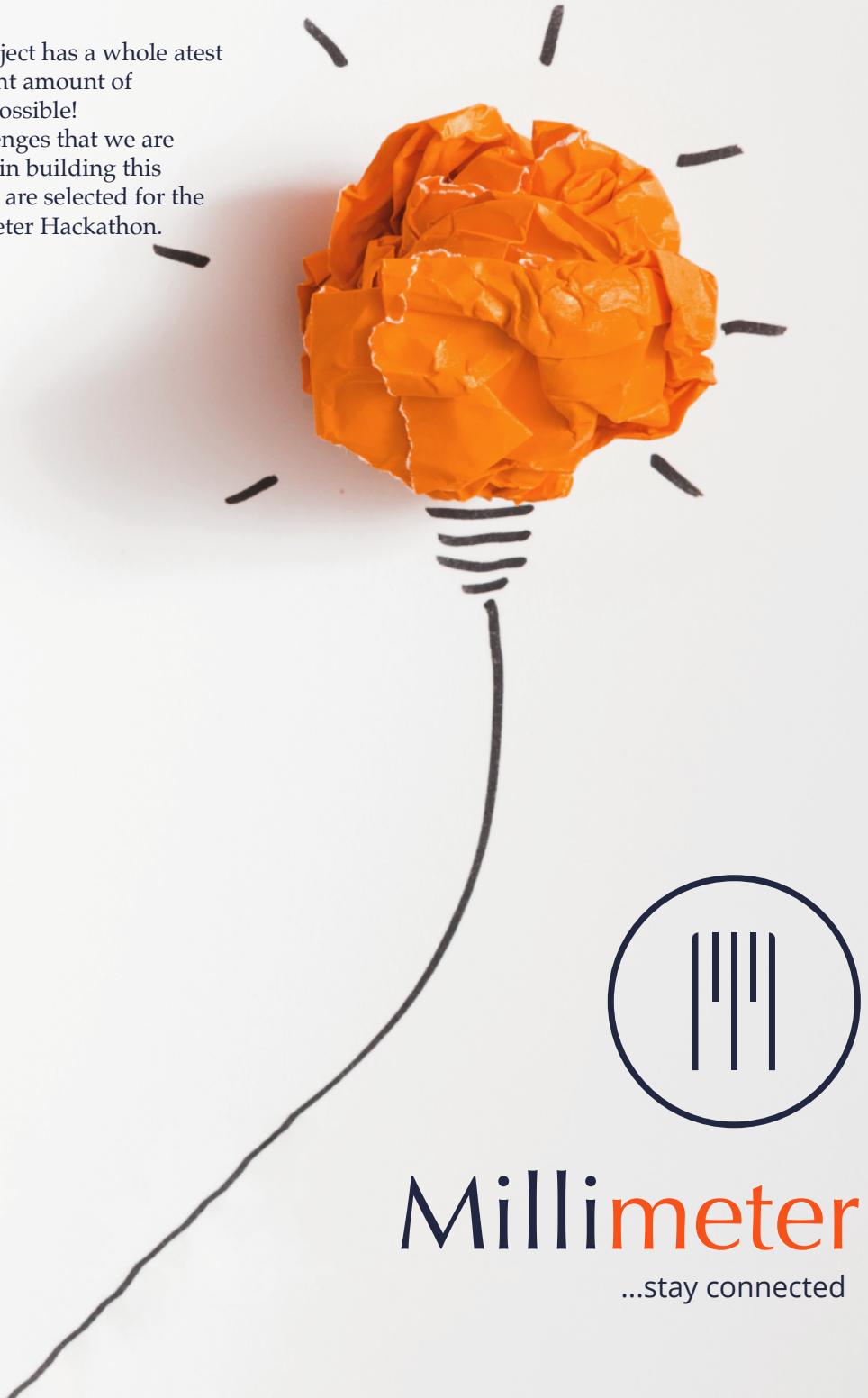
Hardware Costs

<u>Aa</u> Hardware Part	≡ Cost Range
Microcontroller - without boot loader, clip sockets & 16 MHz Crystal	\$1.86 - \$2.34
Power Distribution Module	\$1.17 - \$1.19
Interactive Display	\$1.74 - \$1.84
IOT Cloud Computing	\$1.69 - \$1.75
SD-CARD Module	\$0.34 - \$0.96
Relay	\$0.65 - \$0.81
Current Sensor	\$1.21 - \$1.3
12V Battery	\$6.76 -\$9.44
Lithium Cell Battery	\$1.86 - \$2.59
Coin Battery	\$1.09 - \$1.86
Coin Battery Holder	\$0.35 - \$0.4
Extras	≤ \$4

....Our conclusion

Our AMI Compatible product has been carefully designed and properly illustrated within this document having followed the hackathon guidelines. Alongside this document is a X-min video that puts the final touch to our product description. The link will be provided below.

This document and the project has a whole atest to the fact that with the right amount of commitment, anything is possible! We were faced many challenges that we are proud to say we overcame in building this project and we do hope we are selected for the next round in the Smart Meter Hackathon.



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