PROJECT REFERENCE NUMBER: 46S_BE_2472

TITLE OF THE PROJECT: Hybrid Power Grid based on IoT

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KEYWORDS: Hybrid Grid, Smart meter, Energy theft, Energy Trading Platform

INTRODUCTION: The growing energy demand and the rise of electric vehicles have created a need for an efficient power grid management system. However, the conventional grid structure lacks the ability to collect and interpret data. To address these challenges, the project aims to develop a hybrid microgrid infrastructure.

The hybrid microgrid infrastructure will cater to modern-day needs in three main areas:

1. Energy Trading between Neighbour's: The infrastructure will enable the trading of energy between neighbouring entities. This peer-to-peer energy market allows surplus energy to be sold to those in need, promoting decentralization and the use of local renewable energy sources.

2. Advanced Electricity Distribution System: The project will implement an advanced electricity distribution system that moves away from the traditional centralized model. By incorporating a distributed energy generation and distribution system, the grid will achieve better load balancing, improved resilience, and reduced reliance on long-distance transmission.

3. Hybrid Grid for Renewable Sources: The infrastructure will efficiently integrate renewable energy sources into the grid. This involves using energy storage systems, smart grid technologies, and advanced control systems to manage the intermittent nature of renewable energy generation.

4. Energy theft detection: This project aims to overcome the energy theft by sending an alert message to the substation when an unregistered user taps electricity from a transformer line

Key components of the project include smart meters for data collection, robust communication and control systems, and energy storage systems. These components will enable real-time monitoring, load balancing, and coordination between energy producers and consumers.

OBJECTIVES:

1. Developing a hybrid smart power grid and managing power distribution efficiently is a crucial step towards a more sustainable and resilient energy system. The integration of smart technology and renewable energy sources into the power grid can bring many benefits, including reduced carbon emissions, improved grid stability, and cost savings for energy consumers. However, theprocessof implementingahybridsmart power grid canbecomplexand challenging.

2. An energy trading platform based on IoT has the potential to transform the energy sector byproviding an efficient, secure, and transparent way to buy and sell energy. By leveraging IoT technology and smart contracts,energy trading can become more efficient, cost-effective,and sustainable.

3. Integrating smart meters into the energy system and providing a real-time dashboard can provide valuable insights to energy producers and consumers. Smart meters are devices that can measure energy consumption in real-time, providing accurate and up-to-date information on energy usage.By integrating smart meters into the energy system and providing a dashboard that displays real-time data, both producers and consumers can benefit from increased visibility and control over their energy usage

METHODOLOGY:

Developing a current transformer (CT) sensor circuit to measure energy consumption in a house, transformer line, and distribution line involves a few steps.

Firstly, a CT sensor circuit needs to be designed and constructed. This circuit will measure the current flowing through a wire using a CT sensor and convert it into a voltage signal. The voltage signal can then be amplified and processed to obtain the energy consumption.

The CT sensor circuit needs to be integrated with a NodeMCU ESP8266 board to collect real-time energy consumption data. The NodeMCU is an open-source firmware and development kit that facilitates IoT (Internet of Things) applications. It is an affordable and easy-to-use platform for collecting and sending data to the cloud.

Once the NodeMCU is set up with the CT sensor circuit, it is necessary to set up a cloud service to store and manage the energy consumption data. This can be achieved by using cloud platforms like Blynk. These platforms provide services like data processing, and data analysis.

Next, code needs to be written on the NodeMCU to read data from the CT sensor and send it to the database in real-time. The NodeMCU can be programmed using ArduinoIDE. The code needs to be written to read the voltage signal from the CT sensor, process it, and send it to the cloud database.

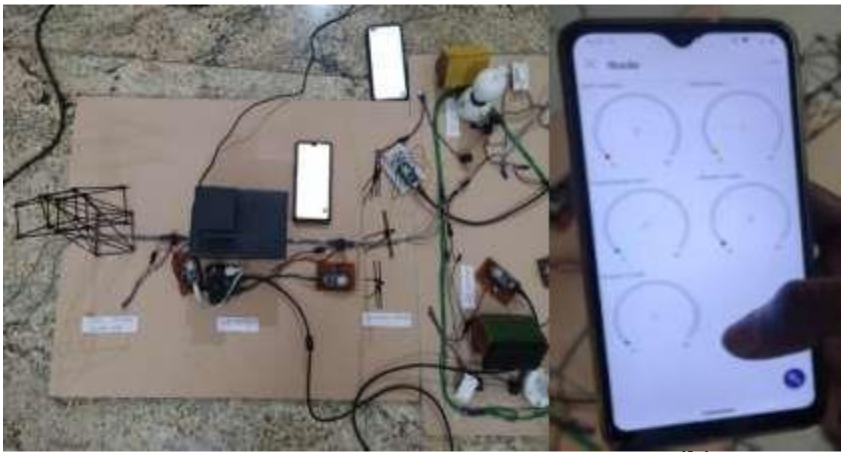
Finally, a web dashboard needs to be created to display energy consumption data in a user-friendly manner. The dashboard needs to be connected to the cloud database to retrieve real-time data. The dashboard can be created using tools like Blynk. The dashboard can display energy consumption data in the form of graphs.

RESULTS AND CONCLUSION:

The main features of the project are node distribution, theft detection, Energy Trading Platform and Smart meters. The figure below shows the overall integration of micro and main grid that is thehybrid grid.

Figure 1: Hybrid Grid (Implemented Model)

The figure above is the expected working model of the project, where the main grid consists of the High tension power lines, substation, and Electric poles with 4 residential houses (only House 1 and house 2 is connected to main grid). The house 4 will tap the electricity from the transformer lines. The micro grid is between the House 1, house 2 (consists a solar panel who transfer the electricity to houses who are connected to micro grid) and House 3. With the help of energy trading platform the house 2 who has a solar panel can transfer the electricity.



(a) (b)

Figure 2: (a) Main grid model (b) Main grid Web dashboard

The figure 2 shows the main grid and it consists of High Tension power line, substation, Electric poles, 2 residential houses connected to the main grid. There will be nodes connected between the High Tension power line, substation, electric poles and residential houses which makes up the main grid. The figure shows the dashboard of the main grid which consists the reading of thenodes between the High tension power line, sub station, transformer lines, house 1 and house 2.

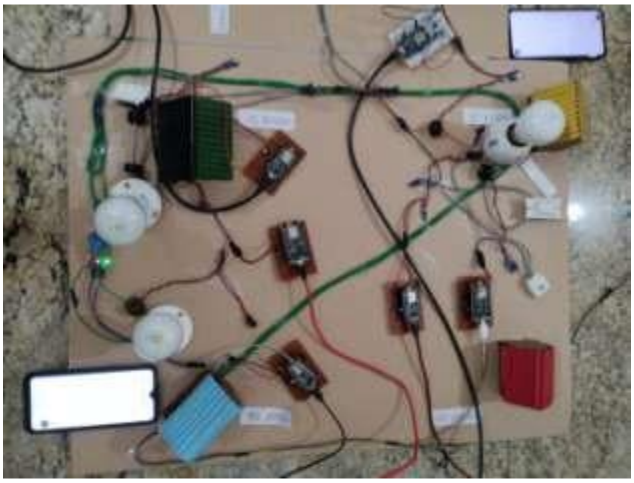


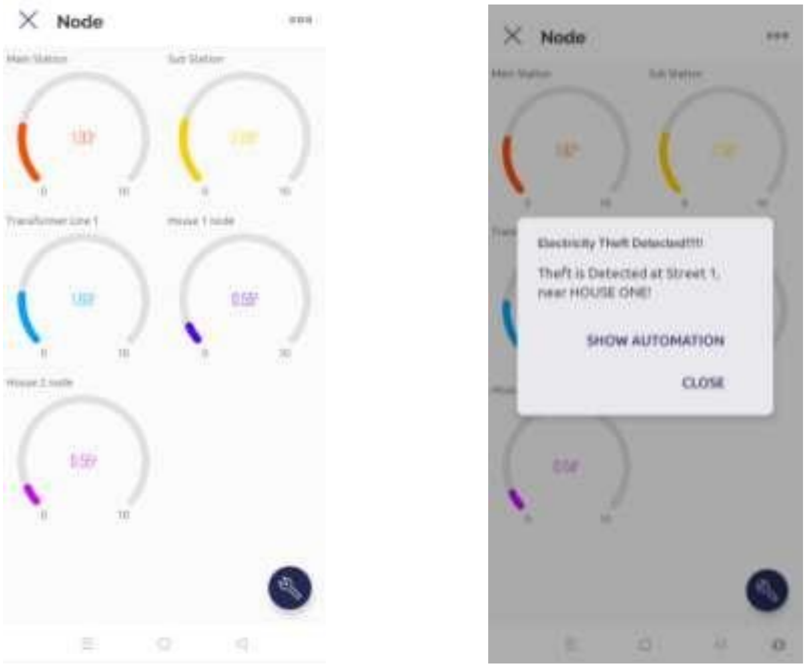
Figure 3: Micro Grid

The figure 3 shows the micro grid model where house 1, house 2 and house 3 are connected to the micro grid with the help of this connection by using energy trading platform we can trade the electricity between the houses connected to the micro grid.

1. ENERGY THEFT

Energy theft happens in the main grid where the house 4 which is not connected to the main grid tries to tap the electricity from the transformer line an alert message will appear in the node main grid dashboard which helps to find the place where the theft has happened. This is shown in the figure 4.

(a)



(b) (c)

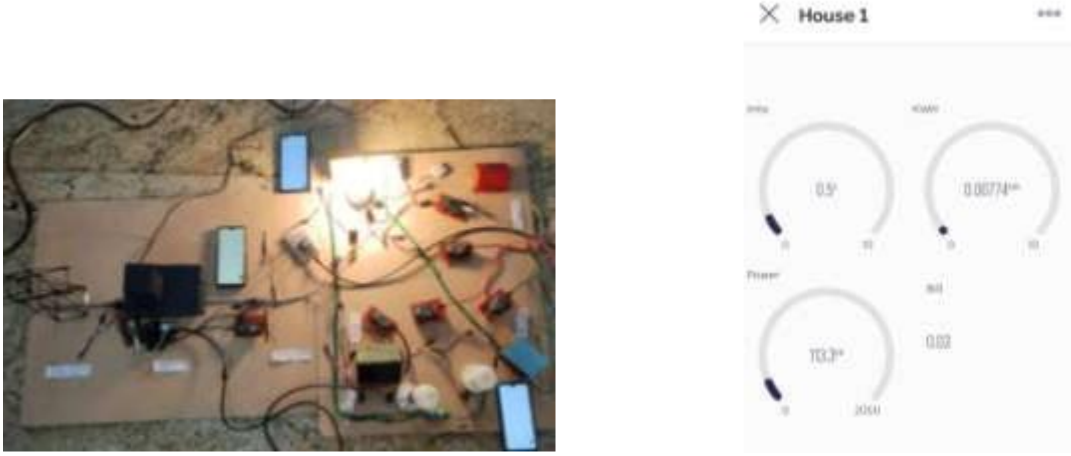
Figure 4: (a) Energy Theft (b) Node dashboard readings when energy theft happens (c) Notification where energy theft has happened

2. SMART METERS

(a) (b)

Figure 5: (a) Smart Meters of house 1 (b) Smart Meters of house 2

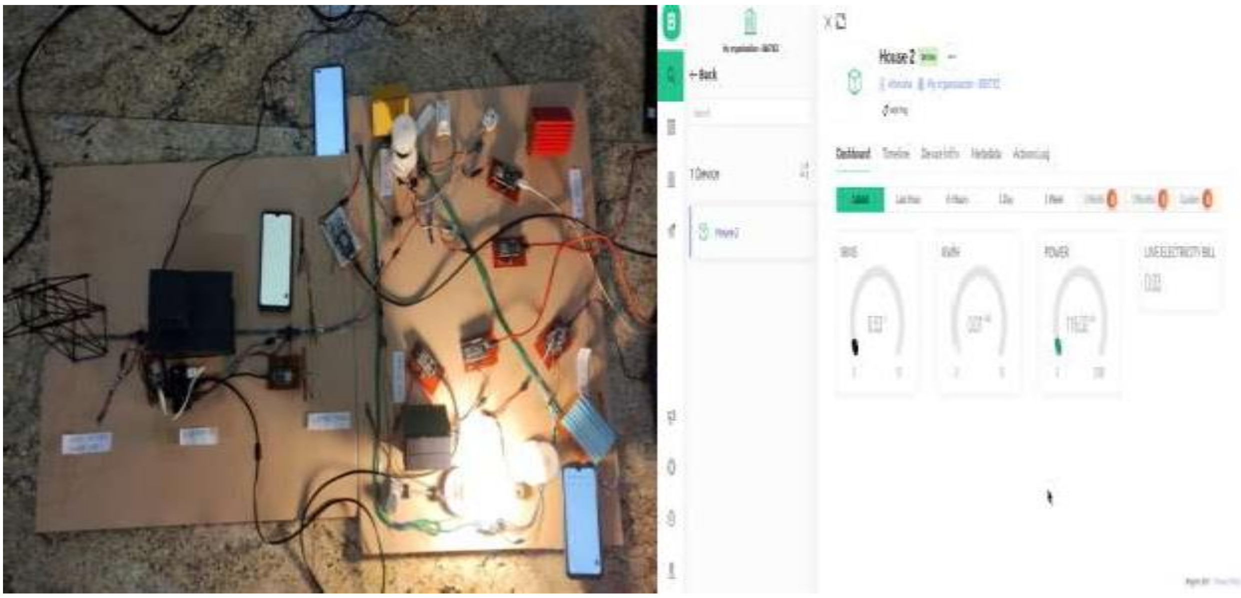
The figure 5 shows the smart meters of the house 1, house 2. Where all the smart meters displaysthe Power consumption, Irms value, Kwh and the live electricity bill.



(a) **(b)**

Figure 6 : (a) House 1 is utilizing the electricity(b) dash board of House 1 when utilizing electricity

In Figure 6 the house 1 bulb is ON and it is consuming the electricity the details of it with the live reading of the electricity bill and the energy consumption is shown in the dashboard of the smart meter of the house 1.

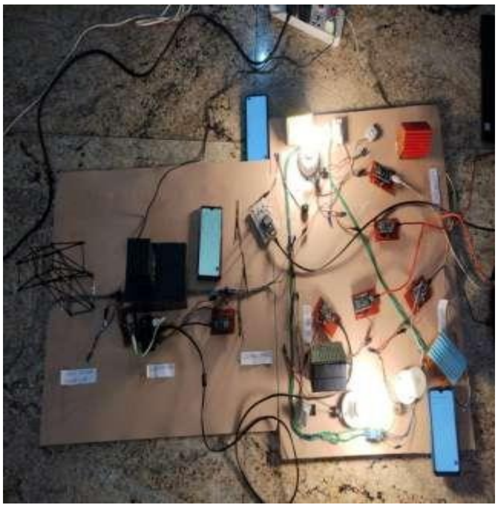


(a) **(b)**

Figure 7: (a) House 2 is utilizing the electricity (b) dash board of House 2 when utilizingelectricity

In Figure 7 the house 2 bulb is ON and it is consuming the electricity the details of it with the live reading of the electricity bill and the energy consumption is shown in the dashboard of the smart meter of the house 2.

3. NODE



(a)

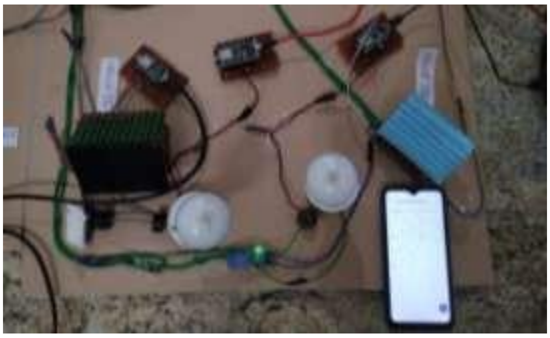
(b)

Figure 8: (a) House 1 & 2 is utilizing the electricity(b) dash board of node when House 1 & 2 utilizing electricity

The figure 8 shows the Node readings when both house 1 and house 2 are utilizing the electricity. Here in the Node dash board the High Tension power line, substation and electric polesare having the same reading and that reading has been equally distributed to the both the houses that is house 1 and house 2 when the bulbs of both the houses are ON. This shows the equal distribution of the electricity within the main grid.

4. ENERGY TRADING PLATFORM

The Figure 9 shows the energy trading platform of the house 3 where house 3 can request forthe power supply for particular time and the amount for the same time will be calculated. Firstly Energy trading platform should be open then select the desired time (here 1 minute is set) for the power supply then click on the ON button as shown in the Figure 9(f) and the relay will closed providing the power supply to the house 3. After 1 min the relay will open and power supply will stop. The bill amount can be seen on the Smart meter dashboard of the House 3.

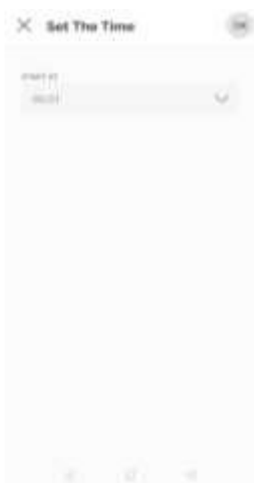


(a) Before the energy trading

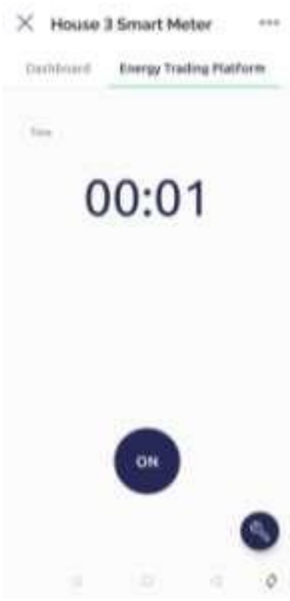
(b) Smart Meter of House 3

(c) ETP of House 3

(d) Select the time for supply



(e) Here 1 minute is selected



(f) Tap on the button ON

(h) The bulb will turn on for 1 min

Figure 9: (a)-(h) Complete Process of Energy trading Platform.

SCOPE FOR FUTURE WORK:

1. Reading the electrical parameters of high tension lines can be improved by implementing advanced sensors and instrumentation technologies. These sensors can accurately measure voltage, current, power quality, and other relevant parameters. Remote monitoring and telemetry systems can be utilized to collect data from these sensors in real-time, eliminating the need for physical access to the lines.

2. Integration of a payments section within the energy trading platform involves user registration and authentication processes to ensure secure access. Energy meters can be integrated with the platform to track participants' energy consumption and generation. A transaction management system can handle energy trading transactions, recording energy credits and debits for accurate billing. A secure payment gateway can be integrated, offering various payment options such as credit cards, bank transfers, or digital wallets.