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Load Scheduling Algorithm for Smart Home Energy Management System

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Abstract: *Consumers' daily increased use of power appliances is causing an imbalance between supply and demand in the energy market, which is a developing worry. To prevent substantial supply-side shortages and boost energy efficiency, demand-side energy management is a crucial strategy. The focus of energy management is on bringing down the price of electricity as a whole rather than limiting consumption by opting to use less energy during peak usage times.A localised, total loss of poweris expected to be replaced by regulated partial load shedding in accordance with consumer preferences via the construction of a Smart Energy Management System. Under the suppositions of a demand response event, the upper limit on demand limitation with various scenarios, and modifying the priority assigned to each appliance, experimental work is executed. SEMS incorporates cost-optimization algorithms based on user comfort levels with sensory information elements and usage time. An IoT environment for data analytics and archiving has been constructed, together with a home area network with dependable ZigBee connectivity.*

Keywords: Smart Home Energy Management System

I. INTRODUCTION

Power usage can be measured by modern electricity meters fairly accurately. Nevertheless, it necessitates laborious manual reading that relies on human resources. In conventional metering systems, managing outages and recovering in the case of a problem detection take a lot of time. So, we must upgrade our current metering system. Smart meters provide a workable solution with integrated communication capabilities in this situation. The utility Centre and customers can exchange information in both directions thanks to smart meters.Hence, within the framework of the smart grid, which enables complete automation of numerous operations linked to power usage, Infrastructure for advance metering is necessary.

Moreover, Demand response programmes and load management tasks on the consumer end arethe core emphasis of Demand Side Energy Management (DSEM). The DR programme encourages consumer participation during peak hours by offering them financial and economic benefits, balancing the load profile curve in the process. Furthermore, by having control over each item, load management enables the consumer to reduce electricity costs. Electrical appliances and gadgets in the home and building environment should, however, have Smart energy management capabilities in order to regulate power supply effectively.

Due to the current situation's increased energy consumption and growing concern over the dangers of the environment, using renewable energy sources is of considerable interest to the modern community. In addition, it is quite questionable whether renewable energy sources like solar and wind will be available.Due to the extensive usage of renewable energy sources and smart grid environments, the system is more challenging to manage energy in.

II. METHODOLOGY

The production of renewable solar PV electricity is a plentiful and promising source of energy worldwide.It is influenced by the tropical region, environmental factors, meteorological characteristics, such as irradiation, wind direction, wind speed, temperature, humidity, and primarily, the time of day when the sun rises and sets. So, its primary drawback that it is highly erratic and intermittent remains the efficient use and management of these resources is essential for meeting the consumer's rising energy demand. The energy sector has made significant strides in the digital world with an IoT ecosystem for trustworthy data collecting, remote monitoring, and controlling.

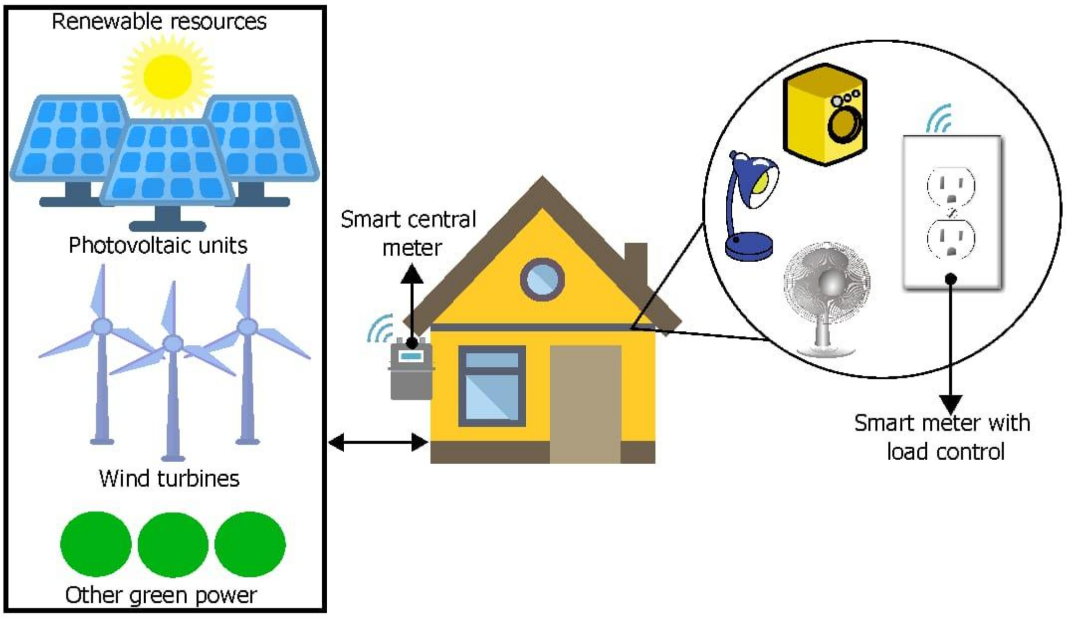

Figure 1: Overview of SEMS

At the moment, conventional energy meters are used in the creation of power monitoring and billing technologies. Individual residences have these meters placed to track their electrical energy usage. An someone who examines the energy meter in each residence records the energy used and computes the invoices. This procedure takes a long time and is quite ineffective. In addition, manual computations can be inaccurate, and the process as a whole cannot be scaled due to the sheer volume of labour needed. Consumers' ignorance of their routine behaviour is the main issue. Consumers' monthly feedback is insufficient to accurately gauge how much energy is used by appliances. The majority of the issues with conventional energy meters are resolved by intelligent, network-based smart meters.

On the other hand, a number of projects are being worked on to implement the demand-side energy management system. In order to avoid peak usage, the consumer might alter their pattern of power consumption by taking into account the time of usage and Utilities rate. In our earlier work, we presented an enhanced SEMS for a smart grid environment taking DR events into account. Authors of literature place a strong emphasis on planning and managing in-home equipment to offer financial benefits for domestic energy management. To preserve individual user happiness and appliance priority, the authors of a recent paper offer an integrated environment to control appliance demand, specifically(HVAC) in a commercial structure.

III. COMPONENTS REQUIRED

1. ARDUINO UNO (ATMEGA 328P)
2. XBEE MODULE
3. CURRENT TRANSDUCER (LEM 55A)
4. VOLTAGE TRANSDUCER (LEM 25P)
5. RELAY MODULE

3.1 ARDUINO UNO (ATMEGA 328P)

One of the many Arduinos, it is the one that is most frequently used. It is newcomers' top preference. It is simple to learn. An ATmega328 regulator powers it. The most significant feature of this type is that the control chip, an ATmega328, is put on the holder of the interwoven circuit's "IC" rather than being fixed to the board. This type contains 14 digital anchorages (I/ O), 6 of which can be utilised as anchorages to control the "PWM labours." As soon

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as you switch slides, go back, and fix your work on the board. The ATmega328 regulator is similar in design. The ATmega32u4controller, the first-ever model of Arduino motherboard, features a special point that includes an integrated USB connect or require the usage of a second processor. The point makes it possible for the panel to instantly look as a keyboard and mouse when it is connected to your device, making it ideal for creating colourful operations that let you operate your PC.

Figure 1: Arduino UNO (ATMEGA 328P)

Pinout diagram

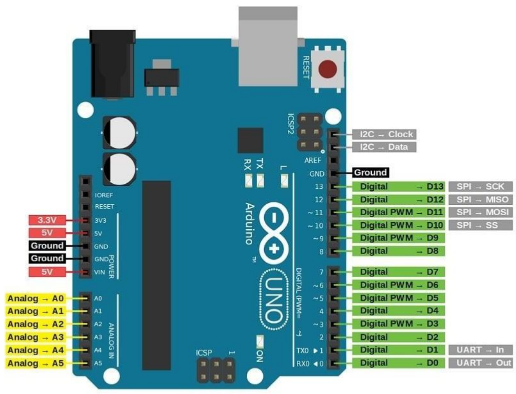

Figure 2: Pinout diagram of Arduino UNO (ATMEGA 328P)

- **Vin:**The Arduino board's input voltage when it is powered externally (as opposed to 5 volts via the USB connection or another type of regulated power supply). This pin can be used to access voltage that has been supplied via the power jack or to feed voltage to it.
- **5V:**This pin provides a regulated 5V output from the board's regulator. The board can receive power from the USB connector (5V), the DC power port (7–12V), or the board's VIN pin (7–12V). Bypassing the regulator by applying power to the 5V or 3.3V pins can harm your board. We do not suggest it.
- **3.3V:**An internal regulator-generated 3.3-volt supply. A 50-mA maximum current consumption is allowed.
- **GND:** Ground pin.
- **Reset:** Resets the micro controller.
- **IOREF:** The microcontroller's voltage reference is provided by this pin on the Arduino board. The IOREF pin voltage can be read by a properly constructed shield, which can then choose the proper power supply or enable voltage translators on the outputs to operate with 5V or 3.3V.

3.2. XBEE Module

The Xbee ship is a radio with an embedded system that connects devices wirelessly at the end point. The element that enables communication between the smart plug and the gateway is this ship. The Xbee ship should process all data sent to and received from the device. A variety of wireless communication protocols, including Zigbee, are supported by the Digi International-produced XBee radio series 2. Digi International's terminal programmes XCTU are used to programme the XBee radios. An Xbee Radio Series2 is shown in figure 2.

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Figure 3: Xbee module

3.3. Current Transducer (LEM 55A)

An electronic tool called a current transducer is used to gauge the electrical current moving through a conductor. It is frequently used to monitor and manage the flow of energy in industrial applications and power systems.

In order to measure and analyze the electrical signal, current transducers transform the electrical current flowing through the conductor into a proportionate electrical signal. They are often made to be non-invasive, which means that the conductor being measured does not need to be directly touched. Numerous applications, such as motor control, energy management systems, power quality monitoring, and renewable energy systems, make extensive use of current transducers.

Figure 4: Current Transducer (LEM 55A)

3.4 Voltage Transducer (LEM 25P)

In order to monitor and convert AC or DC voltages into a standardized DC voltage or current output that can be used by other electronic devices or systems, a voltage transducer is a piece of technology. The voltage transducer is a highly helpful device for measuring and keeping track of voltage levels since its output signal is proportional to the input voltage.

Figure 5: Voltage Transducer (LEM 25P)

3.5. Relay Module

The relay is the device that turns on or off the contacts to turn on or off the other electric control. The circuit breaker is taught to disconnect the designated area when it encounters an intolerable or unpleasant circumstance.So, protecting the system from danger.

Figure 6: Relay Module

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IV. ADVANTAGES

Load scheduling algorithms are designed to optimize the use of energy resources in a smart energy management system. The use of a smart socket module in such a system can offer several advantages, including:

- **Energy efficiency**: Load scheduling algorithms can help to cut down on energy use by making the best use of energy resources. Smart socket modules can be used to control the power consumption of individual appliances, ensuring that they only consume energy when necessary.
- **Cost savings:** By reducing energy consumption, load scheduling algorithms can also help to reduce energy bills. Smart socket modules can be used to monitor and control energy usage, allowing homeowners to identify and reduce energy waste.
- **Increased comfort and convenience:** Load scheduling algorithms can be designed to ensure that appliances are only used when needed, reducing the risk of overloading circuits and improving overall safety. Smart socket modules can also be used to automate the use of appliances, making it easier for homeowners to manage their energy usage.
- **Reduced environmental impact:** By optimizing energy usage, load scheduling algorithms can help to reduce the environmental impact of energy production. This can be particularly important in areas where energy production is heavily reliant on fossil fuels.
- **Flexibility:** Load scheduling algorithms can be designed to be flexible, allowing homeowners to adjust their energy usage based on their specific needs. Smart socket modules can also be used to remotely monitor and control energy usage, providing greater flexibility and convenience.

Overall, the combination of load scheduling algorithms and smart socket modules can offer a range of benefits for smart energy management systems, including increased energy efficiency, cost savings, improved comfort and convenience, reduced environmental impact, and greater flexibility.

VI. BLOCK DIAGRAM

The block diagram for smart socket module is shown in figure 7 as follows.

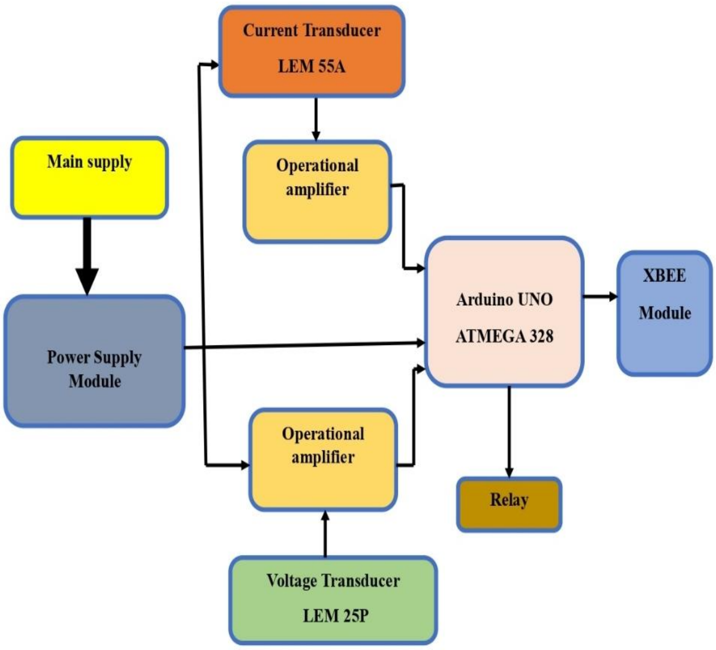

Figure 7: Functional Block Diagram of Smart Socket Module

VII. FLOW CHART

A Smart Home Energy Management System is a technological solution that enables homeowners to monitor and control their home's energy usage. One important feature of a smart home EMS is the ability to schedule loads

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according to priority levels. The scheduling of loads in a smart home EMS involves assigning priority levels to different devices and appliances in the home based on their importance and the homeowner's preferences. For example, a refrigerator and lighting may have a higher priority level than a washing machine or a TV.

The EMS can then use this information to automatically adjust the usage of each device based on the priority level. For instance, if the demand for electricity is high, the EMS can reduce the power consumption of lower priority devices or delay their operation until a later time. To achieve this, a smart home EMS typically uses various sensors and algorithms to monitor energy consumption in real-time and forecast future usage patterns. This information is then used to make decisions on load scheduling and energy management.

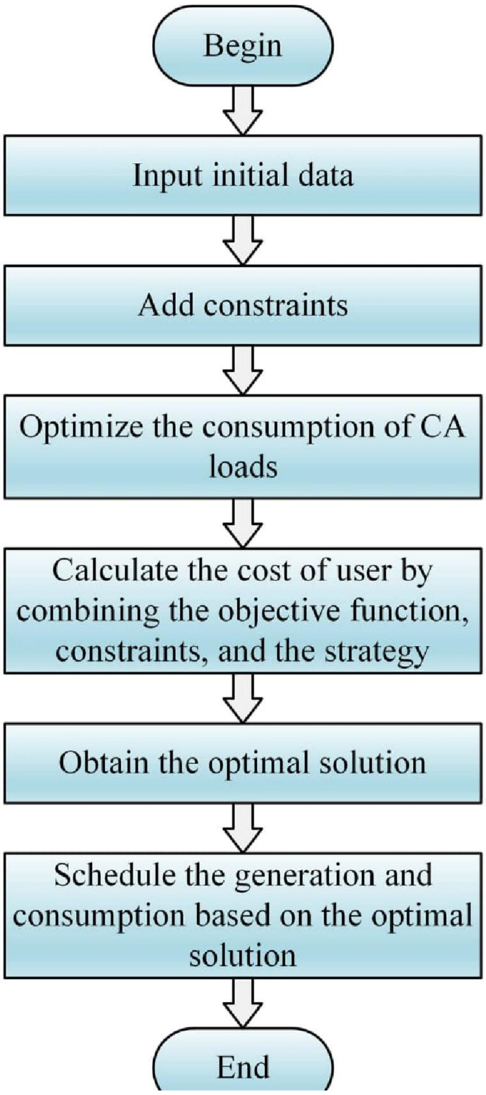

Figure 8: Flow Chart of SEMS

VIII. ALGORITHM

The microcontroller unit linked to the smart socket computes and transmits the RMS current, voltage, real power, and power factor information. The coordinator instructs the smart socket to transmit signals to relays telling them to change the status of the appliances in response. Additionally, the coordinator sends signals to smart sockets, which then offer any necessary warnings about appliance consumption.

The features inside the smart socket will be detailed in more detail in the following part. Figure 9 shows the algorithm flowchart, and its function is as follows.

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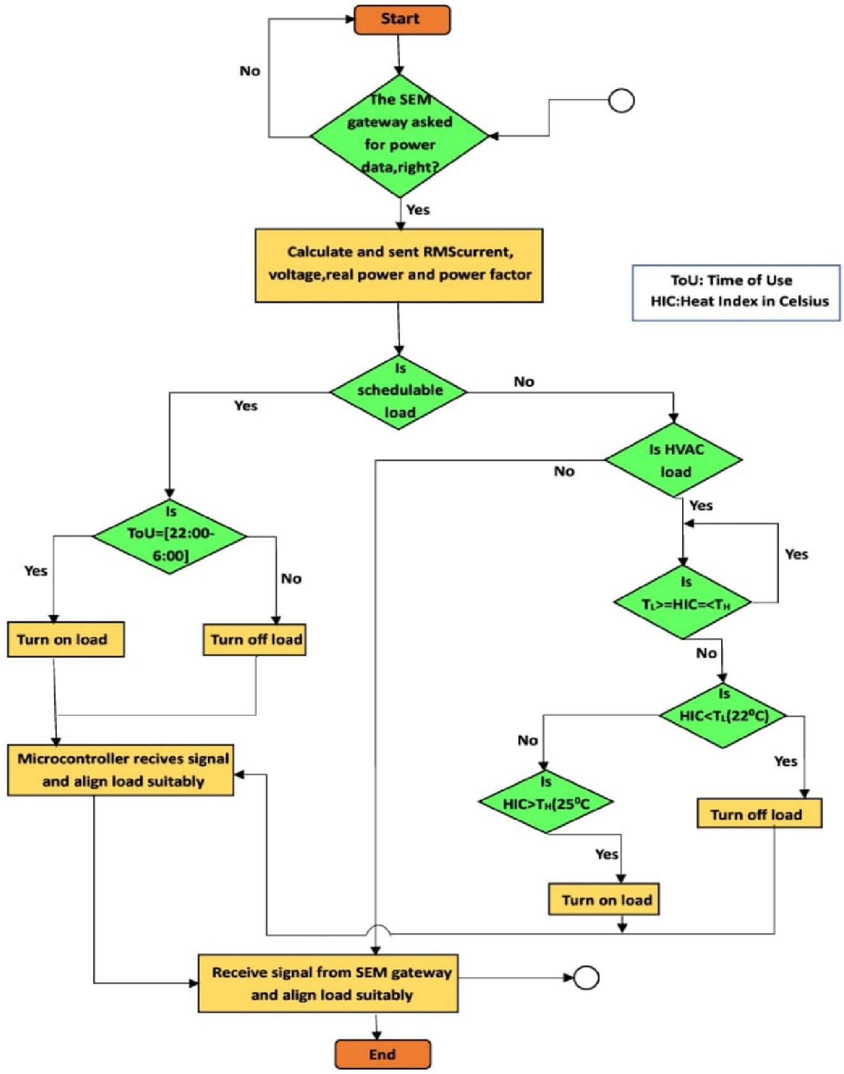

Figure 9: Flowchart of algorithm for Smart Socket Module

IX. RESULT ANALYSIS

As shown in Figure10, the experimental setup makes use of three identical smart sockets, which are general-purpose sockets designed for switching loads in response to received control signals. Used in sub-metering applications to assess the fundamental electrical characteristics of the associated loads. The module includes an ATMEGA328 microprocessor, Voltage sensor and Current sensor,a 20A relay module for switching operation and an XBee series-2 module for a two-way conversation.

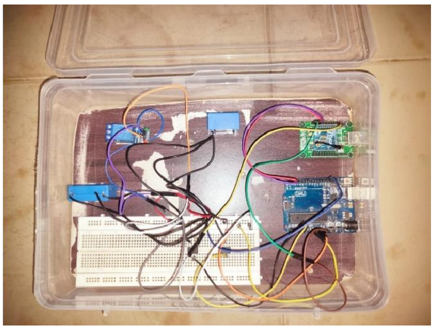

Figure10: Experimental setup of Smart Socket Module

A smart socket module is an electronic device that can be plugged into a regular electrical outlet, and it can be remotely controlled or programmed to turn on or off, or adjust its power consumption. In a demand-side management system, smart socket modules are used to optimize the use of electrical power by households or businesses.

The primary purpose of a demand-side management system is to balance the electricity supply and demand by reducing peak load or shifting the demand to off-peak hours. This is accomplished by controlling the power consumption of appliances and devices connected to the electrical grid.

When a smart socket module is integrated into a demand-side management system, it can be remotely controlled by a central server or a mobile app. The server can send signals to the smart socket module to turn on or off the power, or adjust the power consumption of a connected device. This can be done based on pre-set schedules or in real-time, in response to changes in the electricity demand.

Alternatively, the system can be programmed to shift the power consumption of certain appliances to off-peak hours, when the electricity is cheaper and the demand is lower. For instance, the system can turn on a dishwasher or a washing machine at night, when the energy cost is lower and there is less demand for electricity.

Overall, smart socket modules can play a significant role in demand-side management systems by allowing households and businesses to optimize their energy consumption, reduce their electricity bills, and contribute to a more sustainable energy future.

X. CONCLUSION

Hardware setup for the SEMS prototype is built and developed, and tests are run to show how well the algorithm for power optimisation included into the controller function. In between the smart socket device and the SEM controller, wireless ZigBee connectivity is constructed with XBee series-2 modules. The new adjustable priority functionality, which takes into account three different loads, is demonstrated in the initial test. Also, a provision exists to alter the priority ranking of an item in accordance with consumer demand. Also, the SEM controller, which plans the operation of a SEM, uses cost optimisation methods. Additionally, the SEM controller employs cost optimisation algorithms to plan the use of a certain appliance during off-peak times. In order to reduce the cost of power, it takes into account the ToU tariff and uses the lower slab rate. LED indications and a buzzer alert the consumer to the increased usage of electricity that occurs during peak hours. Lastly, a secure online portal connected to an IoT environment is established to allow access to the data on individual load power usage.

REFERENCES

[1]. "Optimal scheduling of home appliances with renewable energy sources in smart grid" by S. L. Song, H. J. Lee, and J. H. Choi. Energy and Buildings, vol. 81, pp. 498-507, 2014.

[2]. "Intelligent scheduling of residential loads for demand response in smart grids" by R. N. Chiang and C. L. Huang. IEEE Transactions on Smart Grid, vol. 4, no. 4, pp. 1958-1965, 2013.

[3]. "Load scheduling algorithm for residential demand response programs" by Y. H. Huang, J. Wu, and K. N. Li. IEEE Transactions on Power Systems, vol. 29, no. 3, pp. 1203-1212, 2014.

[4]. "A novel energy management system based on demand response and load scheduling for residential consumers" by L. Zhang, Y. Xu, and L. Wu. Applied Energy, vol. 150, pp. 246-257, 2015.

[5]. CK Rao, SK Sahoo, M Balamurugan, FF Yanine- Intelligent Computing in Control and Communication…, 2021.

[6]. "Load scheduling in smart grid with renewable energy resources and plug-in electric vehicles" by C. Y. Chung, T. N. Shiue, and C. H. Tseng. IEEE Transactions on Smart Grid, vol. 4, no. 2, pp. 1125-1132, 2013.

[7]. "Smart sockets for demand response and distributed energy management in smart grids" by M. R. B. Guerra, C. A. Duque, and C. A. O. Nascimento. Energy and Buildings, vol. 160, pp. 123-133, 2018.

[8]. "A review of demand side management strategies for residential households in smart grid" by Y. Guo, Q. Gao, and J. H. Oh. Energy and Buildings, vol. 156, pp. 365-377, 2017.

[9]. "Demand response through smart sockets: A survey of the state of the art" by C. A. Duque, M. R. B. Guerra, and C. A. O. Nascimento. Renewable and Sustainable Energy Reviews, vol. 94, pp. 840-853, 2018.

[10]. "Implementation of a smart socket-based demand response system for residential buildings" by S. H. Hong, J. Kim, and J. Y. Choi. IEEE Transactions on Smart Grid, vol. 5, no. 2, pp. 795-802, 2014.

[11]. "Smart socket based intelligent energy management system for demand side management in smart grids" by M. R. B. Guerra, C. A. Duque, and C. A. O. Nascimento. IEEE Transactions on Industrial Informatics, vol. 13, no. 3, pp. 1085-1093, 2017.