POLYTECHNIC UNIVERSITY OF THE PHILIPPINES

Renewable Energy Generator Embedded with IOT Application in PUP Paranaque Campus

A Design Project Proposal
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By

Ambonan, Rhica Mei B.
Camarig, Jhon Rafael M.
La Suerte, Patrick L

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Chapter 1

THE PROBLEM AND ITS SETTING

Introduction

Renewable energy has become increasingly important in recent years as the world faces an increasing number of environmental challenges. Renewable energy sources can be used to power homes, businesses, and other infrastructure, making them more attractive option for researchers. Renewable energies are also becoming cheaper and greener than traditional forms of energy, which makes them a valuable tool for fighting climate change. The growing trend towards renewable energy is partly due to concerns about global warming and pollution levels; both issues that have increased over time due to human activity. Inconsistent strategies and inefficient resource use result from a lack of integration in resource assessments and policymaking. A comprehensive approach to climate, land-use, energy, and water strategies can help to address some of these shortcomings (Gielen et al., 2019).

The Sun is the most important source of energy for Earth. New technologies are already being used to get power from solar energy. These techniques have been proven to work, and they are usually used as sustainable alternatives to non-hydro developments all over the world. Sun-based energy can meet the world's energy needs if there are quick ways to collect and send it. Solar energy is one of the most appealing energy sources for electricity generation. Typically, solar energy captured during the day must be stored (thermally or electrically) for use at night. The use of energy storage units usually results in higher investment and maintenance costs, as well as an increase in the levelized cost of generated electricity (Ahmadi et al., 2018).

According to the study of (Shaikh, 2017), reviewed the Solar Energy from Sunlight and discussed about its future trends and aspects. It also focuses on the different ways that solar energy can be used and promoted. (Islam et al., 2018) analyzed the current state of solar thermal technologies and research trends and concluded that direct steam generation using solar energy in solar concentrated schemes is the most promising approach.

The efficiency of a renewable energy generator can be improved through the use of an embedded IOT application. An embedded IOT application can monitor the performance of the renewable energy generator and optimize the operation of the device. This can help the renewable energy generator to operate more efficiently and produce more power.

This research demonstrates how solar energy can be converted into electrical energy using solar cells, which can then be used to recharge the batteries of mobile devices anywhere in the world where there is sunlight.

Theoretical Framework

This study is based on the previous investigation of A Solar Powered Electronic Device Charging Station (Da Costa Bentes Júnior et al., 2019). In today's environmentally conscious world, people are becoming more and more interested in different ways to get power. Ideas like this have been in use for several years now without incident. In 1839, Edmond Becquerel found the Photovoltaic Effect Theory, which shows how electricity can be made from sunlight. An electric current would be made by shining light on an electrode that was submerged in a conductive solution.

Photovoltaics, which is often shortened to PV, gets its name from the photovoltaic effect, which is the process of turning light into electricity. In systems that are connected to the power grid, photovoltaic generators, panel protection equipment to stop reverse currents, and an inverter, which changes the energy from direct current to alternating current to keep it compatible with the power grid, are all needed. PV source components come in a variety of sizes and capacities, depending on the applications and products available on the market. As a result, PV component sizing is critical to the operation and reliability of solar PV systems (Adesina et al., 2021).

In 1954, scientists at Bell Laboratories were the first to use this effect. They made a solar cell out of silicon that worked and made an electric current when exposed to sunlight. Soon, satellites in space and smaller things like calculators and watches were being powered by solar cells. Today, electricity from solar cells can be as cheap as electricity from other sources in many places, and large-scale photovoltaic systems are being used to help power the electric grid.

There has been few research on the creation of prototypes for solar-powered mobile phone chargers. A portable solar cell phone charger is a power electronic device that converts solar radiation into electrical energy to charge the cell phone battery (Mudi, 2020). Solar chargers use solar energy to power devices and charge batteries. Solar chargers can charge lead-acid batteries or Ni-Cd battery banks with capacities up to 48V and hundreds of amps. They can also be used with mains-supply chargers during the day to save energy.

Conceptual Framework

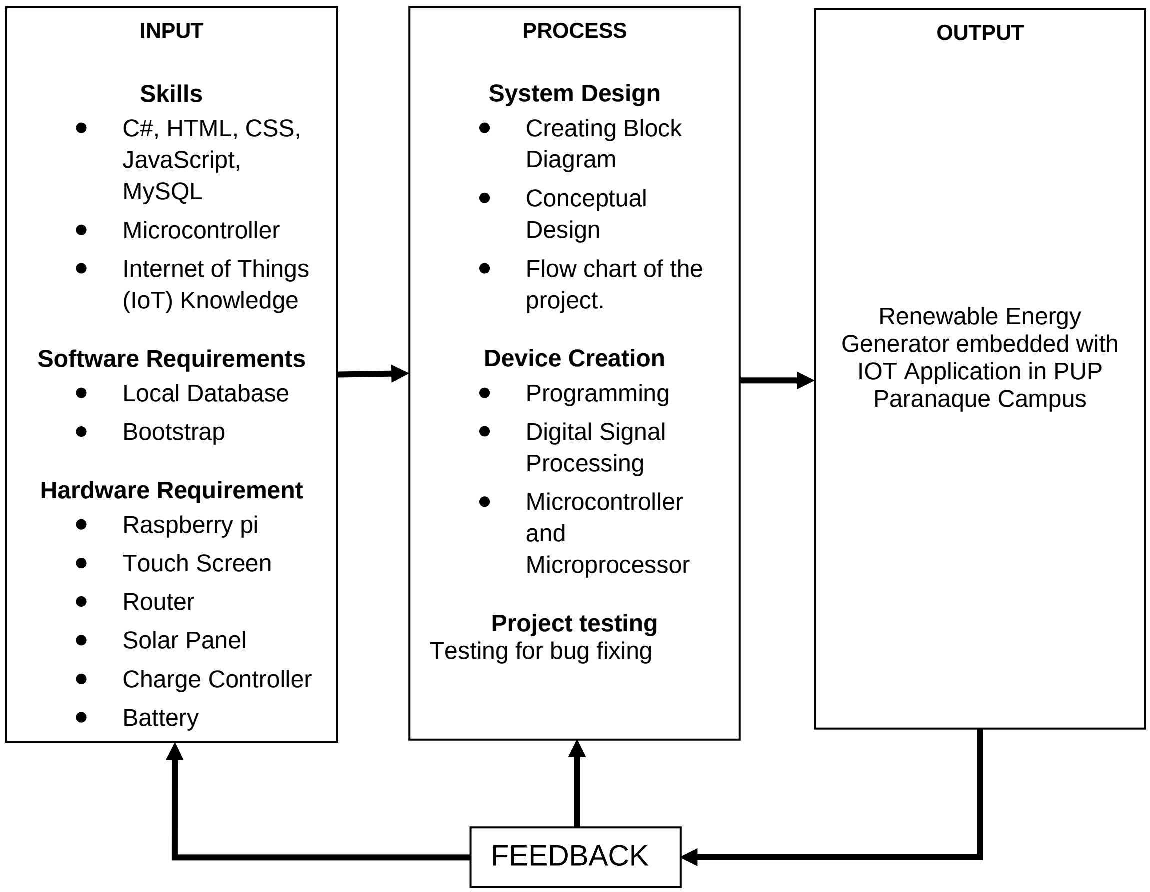
In this study, the theoretical and conceptual information was used to build the conceptual framework. The conceptual model in the figure below shows how the system works and how the research technology is connected to each other.

In the input section contains a list of the required technologies and knowledge to conceptualize the prototype of Renewable Energy Generator Embedded with IOT Application in PUP Paranaque Campus. In developing the software application there are requisite knowledge must include like C#, HTML, JavaScript, Bootstrap, for creating a web-based application and PHP, MySQL for the database of the system. For hardware device the used of Arduino IDE is a software application used to program an Arduino device with the C# language for programming the microcontrollers.

The process frames illustrate the process in making the system, which include system analysis, system design, system development, and system integration testing.

The last part section which the outcome of the product of the research which consist of parts of devices in input frame.

Figure 1. Conceptual Framework Paradigm



Statement of the Problem

1. What are the stages undertaken in the development of Renewable Energy Generator Embedded with IOT Application in PUP Paranaque Campus?

2. What is the evaluation of faculty, professors and students on the prototype to be developed in terms of:

    2.1. performance efficiency,

    2.2. compatibility,

    2.3. security, and

    2.4. portability?

3. Is there a statistically significant difference in the evaluations of the faculty, professors, and students regarding the proposed project when they are grouped according to their profiles?

4. How effective is the proposed system and device in terms of the following parameters:

    4.1. Voltage storage

    4.2. Numbers of device to charge

5. What are the issues and challenges encountered by the users in using the proposed system and device?

6. What are the training programs that can be implemented based on the result?

Hypothesis

There is no statistically significant difference in the evaluations of the experts, library administrators and clients regarding the proposed project when they are grouped according to their profiles. The proposed device is not effective in terms of these parameters' voltage storage and numbers of device to charge.

Scope and Limitations of the Study

Renewable energy generator mobile application and device is a systematic facilities management system explicitly for Polytechnic University of the Philippines Parañaque Campus. As part of this project, we will use solar energy to generate enough power to run an outdoor charging station. This project aims to provide eco-friendly and low-cost electricity to urban and rural areas while reducing the load on the national grid.

The researchers designed the system for the PUP Parañaque Campus faculty, professors and students who primarily enter the premises. The developer is a special kind of user. They can upgrade the whole system depending on the facilities needs inside the campus and the new emerging technology to apply to its facilities. The prototype will be completed in 4 months, beginning in February 2023, and will end in May 2023, with the implementation stage lasting only 2 months, from June 2023 to July 2023. The system mainly involves a mobile-based application that administrators and clients can access.

Significance of the Study

The purpose of this project is to examine the challenge of providing an outside power source for charging devices in an environmentally friendly way to assist minimize the demand of power from other means. We will have to not only develop this gadget but also optimize the project for sale as to create a cost-effective, economically friendly outdoor charging station for most electrical devices.

This project will make it easier to make electricity without using fossil fuels. If our system can charge multiple devices without getting power from the national grid, it will be able to reduce some of the demand for energy, which means less fuel will be used to make electricity over time. As an alternative energy source, solar energy is still being studied and improved. This project will help global research efforts to protect our environment.

The researchers made a system that will provide a free electricity who is inside the campus premises, supply free charge for mobile phones, and easy to use. There are several reasons why this research and system has many potentials if implemented on the Polytechnic University of the Philippines Parañaque Campus. These reasons are listed below:

Specialist of Polytechnic University of the Philippines Paranaque Campus. The specialist’s job will be much easier because they will monitor the device and system's use. The system itself will monitor who uses the device for security records measurements.

Students of Polytechnic University of the Philippines Paranaque Campus. They are the students of PUP Parañaque Campus that will always benefit from the free charging of the proposed project.

Future Developers and Researchers of Polytechnic University of the Philippines Paranaque Campus. The researchers believe that letting future developers and researchers access the system will further make it improve. Updating the system to the latest technology trend might enhance its capabilities and give more services that the faculty, professors, and students will enjoy.

Definition of Terms

This part defines the terminologies utilized in this research. Conceptually and practically, the following terms are explained so that readers can understand them better.

Bootstrap. Is a free and open-source framework for building websites and web apps on the front end. The Bootstrap framework is made up of HTML, CSS, and JavaScript (JS). It makes it easier to make sites and apps that work well on mobile devices.

Bug Fixing. A bug fix is a change made to a system or product to fix a glitch or bug in the programming. There are many kinds of programming bugs that can cause problems when a system is put into place. These bugs may need specific bug fixes that are solved by a development team or another IT team.

Charge Controller. A charge controller controls the voltage and current between the solar array and the battery. This keeps the batteries from being overcharged and stops them from being deeply discharged. So, it also helps to make the battery last longer.

Digital Signal Processing or DSP. Is the process of analyzing and changing a signal to make it work better or more efficiently. It involves using different mathematical and computational algorithms to improve the quality of analog and digital signals.

Embedded System. As its name suggests, Embedded means something that is attached to another thing. An embedded system can be thought of as a computer hardware system having software embedded in it. An embedded system can be an independent system, or it can be a part of a large system. An embedded system is a microcontroller or microprocessor-based system which is designed to perform a specific task. For example, a fire alarm is an embedded system; it will sense only smoke.

Internet of Things (IoT). Is a network of physical objects, or "things," that are built with sensors, software, and other technologies to connect and share data with other devices and systems over the internet. These gadgets range from simple household items objects to complex industrial tools.

Inverter. A device that changes DC electricity into AC electricity for use in stand-alone systems or to supply power to an electricity grid. Larger systems require larger capacity charge controllers with built-in inverter capability.

Local database. If a database is local, it means that it is on the same system.

Microprocessor. Is a computer processor that is on an integrated circuit chip. Also, a processor on an integrated circuit chip that has memory and other circuits.

Microcontroller. Is a highly integrated chip that contains all the components comprising a controller. Typically, this includes a CPU, RAM, some form of ROM, I/O ports, and timers. Unlike a general-purpose computer, which also includes all these components, a microcontroller is designed for a very specific task — to control a particular system. As a result, the parts can be simplified and reduced, which cuts down on production costs.

Programming. Is the process of using logic to make certain computer operations and functions possible. It can happen in one or more languages, which are different in terms of their use, domain, and programming model.

Raspberry pi. A single-board computer, commonly known as an SBC, is a computer built on only one circuit board, and they usually have more features besides just a processor. Typically, SBCs feature connections and other hardware so you can control or interact with the board, such USB and HDMI ports, LEDs, a microSD card slot, or buttons. SBCs are commonly used for modest DIY computer projects such as robots, network-attached storage (NAS) devices, or even connecting a 3D printer to an online interface like OctoPrint.

Solar Panel. Solar cells are arranged in an array on a large, thin panel that is often attached to artificial satellites, rooftops, etc. to make electricity directly from the sun.

Chapter 2

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter will cover four (4) significant topics: the currently existing photovoltaic system, the development of various renewable energy sources, challenges associated with using bare minimum hardware, Implementation after its development. Understanding the basics and practicality of each component that the researchers will use to build a workable and unique Renewable energy generator is essential.

Status of Photovoltaic System from a Global and Local Standpoint

Different projects and technologies have been implemented to address renewable energies. The earthquake and tsunami that struck Japan on March 11, 2011, sparked a lot of discussions and disagreements about the country's national energy policy (Ogimoto et al., 2013). A new feed-in tariff (FIT) program to promote renewable energy, including photovoltaic, was one of the results of this process. Photovoltaic (PV) systems, which became operational on July 1, 2012. The Photovoltaic (PV) market in Japan, which has historically been dominated by residential Photovoltaic (PV) applications, is expected to undergo a complete transformation as a result of this new incentive program. The nonresidential sector, including the newly established players in the Japanese power generation industry, such as megawatt-scale Photovoltaic (PV) power plants, will be driven by the FIT in addition to the residential sector.

The study showed that the tax credit program is even more effective at covering the electrical consumption of densely populated Italian city districts because it only takes into account electricity produced by Photovoltaic (PV) systems that are economically profitable (Erickson et al., 2016).

Spain has a significant reliance on fossil fuels. For this reason, it introduced a bonus system in 2007 with the intention of promoting the creation of renewable energies, particularly photovoltaic solar energy. These production bonuses, which the Spanish government guaranteed, caused an exponential rise in the number of businesses in the market and, as a result, the amount of MWh produced. The aforementioned system of subsidies for photovoltaic (PV) energy was, however, eliminated in 2012 due to the excessive budgetary burden associated with maintaining this "feed-in tariff" system and following several years of institutional instability (Fernández-González et al., 2020).

The Valenzuela Solar, Raslag Solar, and Calatagan Solar solar photovoltaic power plants in the Philippines were visited, and issues with their operation and upkeep were discussed with the Department of Science and Technology and the Department of Energy of the Philippines. Compared to plants using technology from the previous generation, modern PV power plants require less maintenance and have lower operating costs. These facilities can operate for more than 15 years and seem to have a return on investment of about 10 years. Additionally, the Philippines' high insolation makes the production of PV electricity a financially advantageous form of energy (Suarez et al., 2017).

Even though Australia has the highest average solar radiation of any continent in the world, less than 1% of Australia's primary energy needs are met by solar energy. This study aims to determine, at the project level, whether solar photovoltaic (PV) is actually a sustainable option for Australia's energy transition. UQ Solar is a 1.2 MW flat-roof mounted

PV solar array that underwent a life cycle sustainability assessment (LCSA). The results showed UQ Solar performed well in environmental aspects, with the exception of emissions of a few key air pollutants (Erickson et al., 2016).

Development of Different Renewable Energy

This section exhibits the different type renewable energy and how it helps for our climate. Even today, a power plant failure during a disaster result in a power outage or blackout in coastal areas for a few days or even a week. During a disaster, both public and private organizations carry out relief operations and provide food, medicine, shelter, and other necessities of life. For electric power when the utility grid is down, emergency medical services use fossil fuel-based generators. However, that is only for use in an emergency, and using fossil fuels to generate electricity is never a good idea (Erickson et al., 2016).

The creation of a mobile device charging station using solar energy as a source of energy to meet the needs of the population in a sustainable manner was proposed by (Da Costa Bentes Júnior et al., 2019).

A solar-powered charging station is constructed in such a way that devices can be charged outside and in an eco-friendly manner. Solar energy is converted into electricity by this system, which then stores it in a battery bank. The system cannot be used when the batteries need to be charged, and a microcontroller prevents the batteries from being overcharged (Erickson et al., 2016).

A novel mobile phone charging technique utilizing solar panels and hand crank generators is presented. The hand crank generator can be used at night, while the solar panel is useful during the day. Consequently, this dual mode charger can be used in either mode, and neither mode uses any system power (Rahaman et al., 2016).

Abatement of global warming: Renewable energy use does not produce carbon dioxide and other greenhouse emissions that contribute to global warming. The carbon dioxide released when biomass is burned equal amount absorbed from the atmosphere by plants as they are grown for biomass fuel. Access to clean energy sources is improved by making power systems more adaptable to changes in electricity demand and lowering emissions from outdated energy sources. Reducing dependence and spending on imported fuels (Maroma, 2014).

Nearly 20 percent of the electricity used worldwide is for lighting. The amount of electricity produced by nuclear power is comparable to this consumption. According to the most recent International Energy Agency (IEA) estimates, residential and commercial lighting could save more than 2.4 EJ (Exa Joule) annually by 2030. By replacing their outdated streetlights with more modern models, several cities have recently tried to cut down on energy use and emissions. Gas or oil lamps were initially used to illuminate streets (Marimuthu & Kirubakaran, 2015).

Compared to the climate without solar panels, solar panels alone cause regional cooling by converting incoming solar energy to electricity. Specifically in urban areas, this electricity is converted to heat, which raises local and global temperatures and counteracts the cooling effect. However, these processes that alter the global atmospheric circulation have side effects that can change regional climate (Hu et al., 2016).

A system that uses solar power to charge mobile devices was proposed by Sanitha Michail. A rechargeable battery will be used to store solar energy in the proposed system. The system includes a mechanism to control the circuit's excess current flow and guard against battery drain and low voltage operation. This system can charge a variety of low-voltage devices, including mobile phones, and an LCD and micro-controller are used to show the battery's charge (Sanitha Michail, 2021).

A concept for a wearable piezoelectric device that is based on walking and offers an alternative method for charging cell phone batteries was present by (Sanitha Michail, 2021). Additionally, it fulfills a second purpose by acting as a backup torch. The device encourages human metabolism and physical fitness because its mechanism is based on walking. Therefore, it can be considered an e-health device that promotes walking exercise as a way to charge an emergency torch and a mobile phone battery.

A highly effective self-charging power system for mobile electronics that exclusively utilizes human biomechanical energy and consists of a high-output triboelectric nanogenerator and a power conversion circuit. Power to direct current. 60 percent efficient electricity and an energy storage system. This power unit produces a constant direct current. Using only palm tapping as an energy source. 1.044 mW (7.34 W m 3) of controlled and regulated electricity (Niu et al., 2015).

The advanced technique for energy harvesting that this technical paper focuses on uses piezoelectric material. Piezoelectric materials can be used as converters of mechanical energy, typically from ambient vibration, into electrical energy that can be stored and used to power other devices. A piezoelectric substance generates an electric charge in response to mechanical stress. In contrast, applying an electric field result in a mechanical deformation. Piezo-film is capable of producing an electrical density that is high enough to be stored in a rechargeable battery for later use (Runyon, 2019).

Obstacles with using bare minimum hardware

Although photovoltaic technology has been around for years, many issues still need to be resolved before a system can be built that uses it. Particularly when someone is working under strict financial restrictions like the researchers doing this study are. Due to the natural accumulation of dirt and dust, photovoltaic arrays are known to experience power efficiency losses over time. There have not been many studies in various climates on the significance of cleaning in order to maintain efficiencies and the significance of natural cleaning by rainfall. In Portland, Oregon, monocrystalline silicon photovoltaic panels were examined for how natural soiling affected power output and compared to efficiencies following either manual cleaning or rainfall. When cleaning the panels, the masses of particulates on each one were measured, and the results of manual cleaning and natural cleaning by rainfall were contrasted (Smith et al., 2013). The researchers wanted to test the limits of how low-end computers can be used for a computationally intensive system like this. A Raspberry Pi 3b was selected for the prototype building process because it wasn't too expensive and it met the software requirement of having a 64-bit processor. In earlier works, load monitoring has already been done with microcontrollers and single board computers (SBCs). However, there are some drawbacks, including the inability of the system to be accessed from a flexible range due to the limitations of using wire for the media connection (Putra et al., 2018). Despite the fact that mother nature provides this source of energy for free, a number of technical and economic issues still need to be resolved in order to achieve acceptable efficiency from both the perspectives of industrial (gridside) and residential users. Uncertainty and fluctuation in the output power of RESs affect the grid's voltage and frequency. PV modules' low input voltage and low reliability issues when feeding the input terminal of

3-phase GTinverters (GTI). Forecasting of load and solar radiation. Maximizing the lifespan of energy storage modules (Joshi, 2017).

Implementation after its development

Technology advancements are genuinely beneficial to people all over the world. They benefit from it in a variety of ways, including industrial, commercial, business, personal, and even unrelated. To fully understand how the recently adopted device or technology functions, however, a number of steps must be taken. This section discusses a few of the ongoing projects and how they will put their results into practice.

The potential for battery charging in rural areas using small hydropower resources in terms of its technical and financial viability was investigated and examined by (Hermann, 2006). A particular focus was placed on creating a "simple", cost-effective, and failsafe solution that could be easily implemented and adopted in rural areas all over the world. The goal was to create a system that locals could easily use and that needed little upkeep or modification.

To use the available wind energy while traveling to charge low-power electronic devices. When the vehicle is moving faster than 40 km/h, a DC generator with a specific converter provides the voltage needed to charge the devices. Even though there is a speed drop, the proposed circuit's external battery source will continue to charge the devices despite this. While driving, this could be used as an emergency power source to charge electronic devices (Saikumar et al., 2014) .

A solution based on a microwave-harvesting-based system for charging cell phone batteries suggest by (Wang et al., 2016). Where the system transforms the 900MHz microwave signal from the active telecommunication base transmitter into DC voltage and uses the voltage to charge the battery. The design is composed of an antenna and a charge pump as its two main components. The antenna is used to collect and convert radio frequency (RF) signals into electrical signals, and the charge pump voltage doubler aids in converting low alternating current (AC) to DC voltage suitable for charging the phone battery. In this study, the GSM 900MHz microwave frequency band was harvested by spiral antenna and converted into a 5V DC power source using seven stages of voltage doubler. The circuit was tested in Multisim after the components had been identified. Electronic engineers and students use the software program Multisim to virtually design and simulate electronic circuits.

Technology for producing electricity from solar photovoltaics is generally advancing quickly. There is a huge market for this technology, and it has excellent growth potential. Nevertheless, there are still some issues with it. The use of technology, the materials used in solar energy generation, and other areas have some shortcomings, and the entire industry chain has not reached a mature state of development. In order to use the ideal solar photovoltaic power generation technology as soon as possible, we must learn from our mistakes, alter the energy system's excessive reliance on fossil fuels, actively develop renewable energy sources, recognize the true harmony between humankind and nature, and identify reasonable solutions in due course (Li, 2019).

Synthesis of the Reviewed Literature and Studies

The studies listed above will support the creation of a renewable energy generator with embedded IOT. As solar energy becomes more commoditized and integrated into human life, the trend of installing solar charging stations along city streets and highways around the world has the potential to replace traditional filling stations on a large scale.

There is an increasing demand for renewable energy, and technologies that can help generate this type of power are becoming more popular. Using photovoltaic respond to light by converting a portion of it into electricity, which is an extraordinary and useful behavior for photovoltaic systems. Clearly, photovoltaics has a wide range of desirable qualities. Regarding solar, or photovoltaic, cells' capacity to provide a sizable amount of energy in relation to global needs'. The Raspberry Pi's programming codes continue to run under the Linux OS that is stored on the memory card. The impression of the accumulated data in the control station has been done using site formed, and the web servers offered with raspberry pi are Apache, MYSQL, and PHP. One such technology is embedded IOT (Internet of Things). Embedded IOT allows devices to communicate with each other and share data automatically. This makes it possible to collect data about things like wind speed and direction, solar irradiance, temperature readings, water flow rates etc., which can then be used to create a sustainable renewable energy generator. The performance, monitoring, and maintenance of the plant can be significantly improved by using the Internet of Things technology to oversee solar photovoltaic power generation. The global cost of renewable energy equipment is declining due to technological advancement, which is encouraging large-scale solar photovoltaic installations.

Working with the government to implement training and awareness programs for both workers and the general public is the best way to inform the public before the system is made available, ensuring that no one is caught off guard when it is implemented. In addition, educational advertising campaigns outlining system operation ought to be developed to inform the remaining percentage of people who lack the time to attend those seminars.

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