OPTIMISING THE SUSTAINABLE ENERGY RESOURCES USING INTERNET OF THINGS (IoT): HOW SOLAR ENERGY IS OPTIMISED BY IoT

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Abstract: **Renewable energy sources, as the world knows, is being recognized as the best sustainable energy sources as it is non-polluting that helps to combat the Greenhouse effect on global climate created by use of fossils fuels. Solar power, the most concentrated sustainable source, is soon the future scope and research lies in harnessing the solar energy through the solar panels; irrespective of the type or cost of the cell. But the current scenario for harnessing the substantial energy source mostly lacks in structure and localization. Many solar plants are present in India, but none of them are provided with a technology that could analyze the solar energy produced. But today, we have better advancement in technologies like that of the "Internet of Things (IoT)" that could certainly perform analysis of the system. These are connected to the internet and can be monitored at a global level and analysis of the performance, productivity and efficiency calculated effortlessly and it can also predict possible problems and failure with ease.**

KEYWORDS: Efficiency, solar cell, Internet of Things (IoT), solar energy

I. INTRODUCTION:

Solar energy is one of the widely abundant and freely available energy of the sun. Globally, both public and private sector solar energy companies are working to bring out the ever-increasing growth rate. This has resulted in major solar plants with the several physical assets distributed in widespread as well as remote areas. With these large scale operations, there come the challenges of maintaining performance. When the system becomes too complex, it can cause nightmares to the technicians and grid managements. Advancement made in any way, that could be either in the equipment engineering, or the production techniques can no longer be the only answers to these challenges. The next step should be the remote monitoring technologies together with data analytics. The production and investment returns in the solar energy optimization will be a balancing act between increasing performance, reducing costs, maintaining productivity while sustaining profits and achieving economies of scale. The technological platforms like that of the Internet of Things (IOT) helps in combating these factors by providing access to previously untapped avenues to increasing productivity and maximizing ROI. By installing a simple, fully-integrated system at the centralized are allows us to manage the entire grid system. This gives the ability to the technicians to identify and fix the problems in near real time. IoT can be used in numerous ways, but what we are seeking is the green energy solutions for the most challenging systems. The more research and possible techniques will surely brings out the best outcome to increase the percentage of the green energy used and hence, harnessing the most sustainable energy kind, in an operational way.

II. THE SOLAR ENERGY

Solar energy is one of the sources that offer numerous benefits like it is **Renewable, non-polluting and available planet-wide**, that make it one of the most promising energy forms. Though it contributes to **sustainable development,** also helps in the **job creation** where it is installed.

Likewise, the ease of this technology makes it ideal for installing it in the most of the places like that of rural area or the areas isolated from the network.
This renewable source of energy is also useful for generating electricity on a large scale and delivering it into huge network where the geography of the area provides hours of sun rays till dawn. An example is the rural region of Cajamarca in Peru. The companies like ACCIONA have developed several projects to facilitate electrical self-sufficiency for inhabitants. Solar module usage is continuing because of relatively reduction in cost as well as the technology for cutting edge efficiency building techniques supports the present favorable outlook for solar technology. Solar plants also do not emit polluting gases and are silent.
Another advantage of energy borne from the Sun is its ability to generate local wealth, by lessening energy dependence on abroad. While it is certain that solar energy – like wind – is intermittent and directly depends on the weather and day-night cycles, rapid advances in electricity storage technologies are reducing this dependency and will lead to the increasing share of solar in the energy system.
THE MAJOR BENEFITS ARE:

- Renewable
- Inexhaustible
- Non-polluting
- Avoids global warming
- Reduces use of fossil fuels
- Reduces energy imports
- Generates local wealth and jobs
- Contributes to sustainable development
- It is modular and very versatile, adaptable to different situations
- Can be applied alike for large-scale electricity generation and on a small scale in areas isolated from the network

Solar energy could be obtained either from any media or technique to deliver its power to off-grid or on-grid systems could anyway maintains only limited efficiency. Using tracking and monitoring may be a good idea, but the cost effective solutions is remained to be achieved with optimizing the key factors to maintain its efficiency. Because we are talking about covering 70% of energy sources through this sustainable green energy, we are a step below to achieve our success story for optimizing green energy.

III. PROBLEM IN OPTIMISING EFFICIENCY:

Though solar energy seems to be a sustainable energy there are many factors which affects the solar industry. These are the expensive modules, low efficiency, unreliability and high maintenance costs, etc. Some of these factors are explained below:
Efficiency: The solar power plant output depends on the type of solar cell used. The commercial solar cells have mostly the maximum efficiency of about 10-20%. This efficiency limit is further hampered by the external factors and losses like geography, weather conditions, maintenance, etc.
Unreliability: Solar power generation is remains an unreliable source as it totally depends on sun rays. Due to irregular weather conditions, insufficient generation, efficiency dependence, the energy is totally unreliable.
Costs: Intermittent maintenance and replacement of equipment add up a significant cost in a solar plant
Unplanned approaches & maintenance may end up the losses overall affects the revenue These challenges may be faced by a stakeholder or any large scale firm. We have worked on these factors and assess the need of monitoring these factors, so everything relative could rely on the data rather than physical approach of the system.

IV.HOW THESE CHALLENGES COULD BE OVERCOME …?

These challenges can be effectively addressed by Internet of Things solution, which enables continuous remote monitoring and asset management. The improvement in productivity and profitability of the plant & multifaceted benefits could be gain by a comprehensive IoT infrastructure.

ROLEOF IoT:
IoT is a network of devices connected or embedded with sensors, software's, electronic components, actuators and network connection to perform real time analysis of the given data. It provides an integrated platform where it transmits & stores huge amount of data and perform its analysis with the formulated algorithms. The three major components of IoT are:
Sensors, Big data and cloud computing and machine learning and artificial intelligence

The main goal of this "things"is to react on the data given by the device on the cloud and deliver information to the customers in user friendly formats, such as graphs, reports and tablets.
It provides an ideal platform for companies to get remote monitoring and optimize performance for the solar plant, irrespective of any scale.

Figure 3.1: PC solar pulse

The following benefits of adopting the IoT for Operation & Management of the solar plant are:

- Tracking and analysis of the data from the mounted sensors will help us to monitor physical health of the plant and devices in real-time. A centralized system will provide information on the both hands that of the plant level performance as well as performance of individual devices
- Analysis of the device data that will provide insights into plant and device performance. For eg: simple algorithms can be used to estimate losses such shading loss, soiling loss, transmission loss, Addressing to these key metrics issued in a timely manner will result in an overall increase in equipment reliability and efficiency.
- Analysis of the Detection of malfunctions, degradations and failures in devices such as PV modules, Inverters and Transformers. This will lower down the plant downtime due to device failures.
- Data analytics will lower the equipments failures and repair/replacement cost by drawing the preventive maintenance activities.
- Planned and accurate maintenance schedules will lower the unnecessary delays in any case of device malfunctions, will benefits inventory forecasting.
- IoT application can provide a complete energy portfolio containing all the important KPIs of the plant at micro or macro levels.
- Latest technologies like smart grid, smart meters integrated with IoT platform will help to provide accurate demand forecast and energy distribution in an optimum way. Smart meters precisely measures and the Performa of real time power consumption. Advanced technologies used in Smart grid will ensure reliable and most secure energy distribution, optimize energy consumption. It will make the energy management most efficient and economical at the same time.
- The software solutions used in IoT such as machine learning, Artificial Intelligence, etc. can accurately predict the real time generation and forecast the future generation data. This helps in giving accurate generation estimates and demand management, results a great benefit to buyers and traders

V. HOW IT IS HELPFUL IN OPTIMISATION:

Conventionally, the power has been produced at large scale at huge centers and then distributed. But the idea is to include the generation of power, through the renewable energy sources like solar panels or wind mills.
Solar energy limit is increasing at the rate of approximately 40% around the world. The overall efficiency may take time to increase but as we have discussed, we should set the goals to achieve the solar energy objectives, how this power is optimized.
Now here comes the technology, where in order to achieve the optimized energy. The advancement is more towards embedding the hardware and software engineering, where IoT and sensors come into play. The smart appliances and connected devices can be embedded with Hi-Tech sensors and must be interconnected. The huge amount of data is then collected by those sensors which can be transmitted to the Power Grid. The data collected may include the variables like that of the electricity load and the existing temperature range in a solar panel, so that each and every component must be sensed, measured, formulated and monitored. The data generated is then, collected and uploaded to the cloud for processing. The big data tool is utilized to process and analyze the high corpus of data in real time. Since at this complex structure, the automation process has to be carried out in real time, but it is not supposed to carry such situation manually or even taking the help of computer is good, we can say it's impossible to manage.
The Internet of Things along with the wireless connected sensors, the smart metering, and cloud computing as well helps one not only to generate electricity but to distribute the power to the central grid.
The inclusion of IoT is capable to work for the capturing the energy while the sun's orientation is changing. As we know, the sun's position is continuously changing and is not static. For the better outcomes, the 'web of things' helps to maximize the energy output to balance the panel board to the naturally to the situation of the sun for the duration of the day with the assistance of an IoT framework. A sun tracker (a system based on the microcontroller) calculates the sun's position on the basis of information like scope, longitude and formulates the actual position with the data. The trackers have IoT sensors, guide the process and sends command to control the activity, on board. The segment gets other vital information from the sensors fitted on tracker controller system using conventions like WiFi, Zigbee and so on. Further this information is coordinated to the cloud backend for examination and overall helps in maximizing the solar energy output.
The figure below shows a small project for one of the application of IoT for tracking the sensor, and sending data to the cloud for computing and maintaining the tracker to track the sunlight and helps with the information of the sunlight and how it can be converted to bring to most of the efficient energy output.

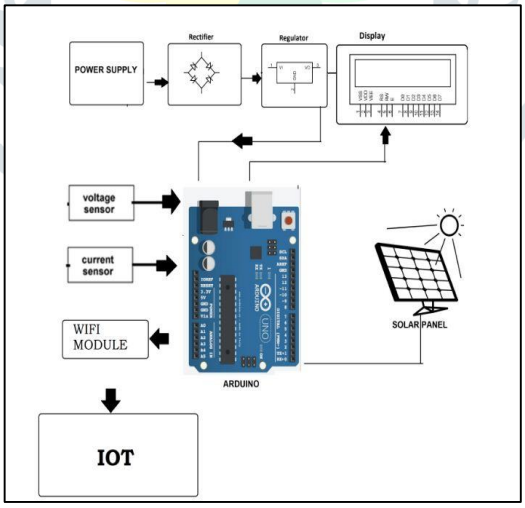

Figure 5.1: Applicative diagram for tracking panel and formulation of data through IoT

VI.FUTURE SCOPE:

IoT is what we recognize as a connected world! We know the most of the applications where the IoT is strongly recommended and fulfill the ease. The Operation & Management (O&M) is the major challenge for the energy optimization for most of the renewable energy. This paper has provided with some application, where the efficiency turns out to be an important factor and most of it is gathered through every nuance of the IoT integrated application. And hence, we get the real time information that we have never taken into account. Through IoT we can monitor our business, home or the smart city, so why not the solar energy production. The future of the technology lies in the IoT in most of the areas. The tools that are offered and integrated IoT is what makes it smart observation, smart metering of the solar plants, formulation and analysis of huge system that took on a large scale. The Public or Private sectors may be working on these techniques to bring out the best for the public and clients and how efficiently they could be working on this technology to use the sustainable energy resources to use in most of the ways. Energy could be a boon if used in optimized way. That's what we can seek from the IoT. IoT can brings a big revolution in every field like that could be environment, utilities, logistics, healthcare, Industry, retails, etc. By using IoT with the integrated system in solar energy generation, you get assurance of your network, devices and applications are completely sync with one another and easy to manage on the cloud devices. And Yes! We can perform the real time monitoring of the devices on the grid, hence we should at least engage the private sectors to bring such IoT adapted devices to revolutionize their approach of delivering the services for the on-grid or off-grid solar energy, so everyone can enjoy the efficient solar energy output.

VII. CONCLUSION

Solar energy is enormously used worldwide for electricity. Scientist and researchers are rigorously working out to bring the best technology to optimize the efficiency and its usage. We have ideas as well as technology, but what matters is the implementation including all attributes. With the development of technologies and inclusion of "things", it has become very easy to induce intelligence within the system. To introduce better monitoring and analytical segments we are in need to provide architecture for connecting the solar panels units to the internet, additionally providing them with the sensors to measure the efficiency. This real time application can be used to lead us with the knowledge about the operations and detect the failure while operating at early stage.

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