3rd International Conference on Emerging Technologies in Computer Engineering: Machine Learning and Internet of Things (ICETCE-2020), 07-08 February 2020, (IEEE Conference Record # 48199)

A Survey on IOT Based on Renewable Energy for Efficient Energy Conservation Using Machine Learning Approaches

R.Rahin Batcha
Research Scholar, Dept. of CSE,
Annamalai University,
Chidambaram, Tamil Nadu 608002, India
batchabaksha@gmail.com

M. Kalaiselvi Geetha
Professor, Dept. of CSE,
Annamalai University,
Chidambaram, Tamil Nadu 608002, India
geesiv@gmail.com

***Abstract*— The Internet of Things has a vision in which the web extends into this present reality which is followed by daily posts. The IoT allows articles to be detected or remotely controlled over existing system frameworks, opening doors for the unadulterated incorporation of the physical world into PC-based frameworks and providing improved efficiency, accuracy, and monetary advantage despite reduced human mediation. This breakthrough has various applications, such as urban communities focused on solar power, smart cities, micro matrices, and lights on Solar Road, etc. AI is when calculations decode gigantic knowledge arrangements to the PCs so that they can function without specific programming. This, for the most part, focuses on the development of different PC programs which may change when exposed to new information. During this period renewable vitality developed at a rate faster than some other time in history. These days people groups confronting the issue of confinement of non-sustainable power sources, so to take care of this issue the best arrangement is to utilize sustainable power sources like solar oriented vitality. Solar dependence is the planet's fastest-growing sustainable power source, steadily increasing by a standard of 40 percent in the overall limit. AI can be utilized in Probabilistic Energy Forecasting. The fundamental reason behind this is to gauge the likelihood appropriation of solar oriented power age from more than one solar-based ranch all the while. In this paper, we examined -the study on how IOT assumes a significant job in solar-powered vitality and how AI approaches are utilized in solar oriented vitality.**

Index Terms*—Renewable Energy, Solar Energy, IoT, Machine Learning.

I. INTRODUCTION

A. Renewable Energy

Assumes a key job in the economy and condition. The sustainable power source is perfect, reasonable, and solid, and can counter neediness and environmental change. Sustainable power source, likewise named as elective vitality, just implies the vitality that is delivered from sources other than the essential vitality supply, the non-renewable energy sources (coal, gaseous petrol, oil). On the off chance that you'd like to comprehend sustainable power source more just as figure out how you can help the condition an extraordinary wellspring of data can be found on a sustainable power source blog, there are some great ones on the web for you to peruse[10]. The vitality business is considered as exceptionally capital concentrated alongside the enormous effect on work. All the more significantly, a long time from now, there probably won't be any petroleum products left. Consequently, the sustainable power source field guarantees a great deal as far as supportability and employments prospects just as business vitality. Our planet is honored with various characteristic wellsprings of vitality, for example, daylight, air, wind, and different assets, in any case, its use must occur in a fitting path for both human welfare and nature.

Solar-powered is the planet's fastest-growing sustainable power source, steadily increasing by a standard of 40 percent in the overall limit. Numerous vitality organizations, which are among the most vitality-competent and worthwhile wellsprings of sustainable power available, are expanding to deliver solar focused. Today solar-powered vitality organizations have more alternatives to making the most of their hardware than any other time in recent memory. Saddling the intensity of advanced change with IoT can solve regular difficulties related to complex lattices of vitality and make supervising boards and yielding vitality much simpler. The introduction of an IoT framework for solar-based vitality organizations will help satisfy the needs of customers and improve productivity generally. It is never again an issue of whether to endeavor IOT computerized change, but instead how to do it effectively. This solar-powered vitality IOT framework is as of now programmable and can: a) give portable investigation, b) empower solar oriented ranch control, c) distinguish and cure flaws, d) upgrade control under various concealing conditions, and e) lessen inverter homeless people. [10].

B. Solar Energy

Solar vitality is spotless green energy that comes from sunshine, or at times, from solar heat. Introducing solar power systems in a private setting includes, for the most part, installing a solar-based photovoltaic or solar-powered warm frame on the rooftop [10].

Definition of photovoltaic: Photo = "light" and photons = vitality particles originating from daylight; voltaic = creating a voltage or volts. Shortening = PV

978-1-7281-1683-9/20/$31.00 ©2020 IEEE

Solar-powered vitality is an inexhaustible free source of vitality that is reasonable and unlimited, unlike limited and non-renewable sources of energy. It is also a non-contaminating source of vitality and, while generating control, it does not discharge any ozone-depleting substances. Solar power will boost the maximum or partial use of vitality. Using solar focused power means lowering your bills for health and putting cash aside. Low and subtle support, introducing solar panels increases the value of your home.

The following are explanations of rising solar power systems components.

1. *Solar panels:* Solar boards, otherwise known as photovoltaic modules, consisting of a progression of solar-based cells which converts light from the solar power into DC. A solar-based board is a tough piece of hardware that worked to harsh atmospheric conditions a decade ago. These could involve highs, hurricanes and high wind burning. [14].

Fig. 1. Different types of Solar Panels

TABLE 1. DIFFERENCES BETWEEN MONO CRYSTALLINE, POLY CRYSTALLINE & THIN FLIM SOLAR PANELS

	Mono Crystalline	***Poly Crystalline***	***Thin Film (CIS/CIGS)***
Efficiency of Standard Modules	15-20%	13-16%	10-12%
Best Cell Efficiency Research	25.0%	20.4%	20.4%
Area Required to 1 Kwp	6-9 m2	8-9 m2	9-12m2
Standard Warranty Period	25 years	25 years	10-25 years
Very economical	0.75 $/W	0.62 $/W	0.69 $/W
Temperature Power	Execution drops 10-15% at high temperatures	Less temperature safe than Mono-Crystalline	Relatively low effect on execution
More Info	Most established cell innovation and most broadly used	Less silicon squander in the generation process	Tend to corrupt quicker than crystalline-based sun based boards

2. *Solar hot water:* 30% of complete ozone-depleting substances families produce is because of water warming. Solar based water radiators can significantly lessen vitality bills with no natural effects. Introducing solar-based high temp water likewise diminishes our reliance on petroleum products. The innovation for solar oriented water radiators is completely extraordinary to a photovoltaic lattice associated framework. For instance, solar oriented warmers utilize a level plate with gatherer boards or emptied cylinders to ingest the warmth from daylight and Afterwards raise water temperature [11]. Fig 2 shows how a solar water heater is made using solar panels.

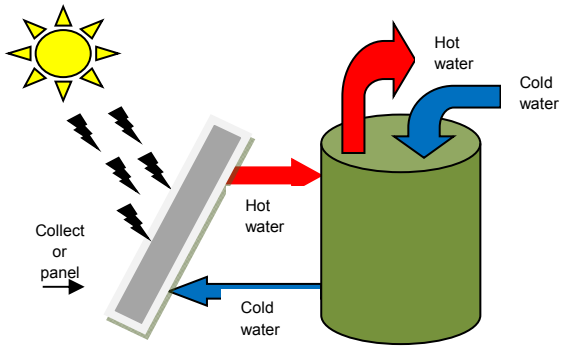

Fig. 2. Passive Solar Water Heating

3. *Solar pumping:* Solar controlled water bore siphons give a perfect water conveyance arrangement in zones where mains power isn't effectively available [12]. As a result, they are widely used in homes and outback stations in India to supply the farmers with bore water, as shown in fig 3.

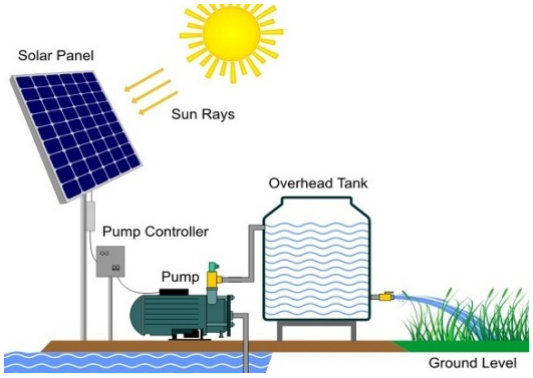

Fig. 3. Solar Pumping

4. *Batteries:* Batteries are gadgets that convert the vitality of the compound into electric vitality. They are grouped by the way they apply and the way they develop. The primary applications are in deep cycles, vehicles, pontoons and. profound cycle batteries can drearily charge and discharge. Profound cycle batteries are best suited for systems of solar-powered PV. Basic battery types are overwhelmed (wet), gel, AGM (dry), and lithium-particle. Dry or wet / overflowed alludes to the fluidity of an electrolyte [13]. A dry cell implies that the electrolyte is a powerful electrolyte for powder. A wet cell means that the electrolyte is fluid and can float inside the cell packaging without reservation.

For electrical devices, toys, radios, workstations, and cell phones, dry cell batteries discover to use. In general, batteries were only in independent power frameworks, such as the housetop solar-based power frame or the wind turbine frame. Be that as it may, independent power frameworks can have a structure to run with no battery reinforcement. In an independent power framework, the house doesn't interface with the power matrix (the dissemination of power through high-strain links). It's a Network "down." This means that the independent power system is the home-accessible sole source of vitality. In an independent solar power system, the vitality collected during the daytime stores in a battery bank for use at night time. Once in awhile batteries coordinate into matrix associate frameworks as reinforcement. Progressively batteries frameworks are a piece of lattice associate solar-based power frameworks as shown in fig 4. The new age of lithium-particle based batteries has diminished in cost significantly.

5. *Power and solar inverters:* As shown in fig 4, a solar-based inverter is a gadget to change direct flow power (DC) from solar-oriented boards (AC). However, a power inverter does the same but the source is a battery. Current air conditioning is the standard current which makes all family machines operate. The inverter changes the battery bank's DC intensity to 240 Volts, 50 Hz AC. Two kinds of inverters exist the Sine Wave Inverter and the Modified Sine Wave Inverter. A Modified Sine Wave Inverter can effectively monitor some family machines and power appliances. It is less expensive but it gives some loads, such as PCs, microwaves, laser printers, tickers, and cordless instrument chargers. Practically all quick to use inverters are "Sine Wave Converted" For the most part, they are about 70 percent proficient, so if you are using a Modified Sine Wave Inverter in your frame, anticipate some notable power misfortunes. The purpose of a Sine Wave Inverter is to complement and even boost the capacity of service organizations. We recommend a sine wave inverter to operate in better quality electronic hardware. Effectiveness currently stands at about 94 percent and the strength from these tools is of a higher caliber than any place on the planet that regulates the system. As a rule, a top-notch inverter has an auto-start assembly, tuning capabilities, and a great rock-solid power transformer.

6. *Solar regulators/ controllers:* A controller is an electronic gadget that controls the charge source voltage, as shown in Fig 4. Controllers prevent any cheating on the batteries. The controller stops the progression of intensity from the solar oriented boards to the batteries at the point when the batteries are completely charged. Besides, a device stops any power stream coming from the batteries during the evening. Equally, the controller ensures that the batteries charge at the right voltage. To measure a controller's Amp rating you should obey this clear condition:

Amps x Volts = Watts.

So, if you have a 175W panel at 24 volts the calculation is:

Amps x 175 = 24

Then the regulator should be at 175/ 24= 7.3 Amps.

7. *Battery chargers:* Battery chargers are used to the generator or primary capacity as shown in fig 4 to give DC capacity to revive batteries. Numerous types of battery chargers exist, including solar-powered chargers [13]. They fluctuate in the amount of time they take to charge batteries and how they handle the batteries while they are charged.

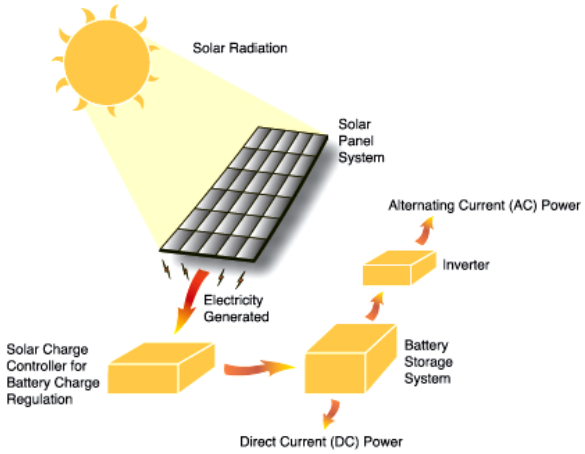

Fig. 4. Solar Energy Saving Process

C. *Internet of Things (IoT)*

The Internet of Things otherwise known as IoT is a stage or setting in which gadgets are connected using the Web. It is essentially the system management of physically associated gadgets, vehicles, structures, and other brilliant items (e.g. wearable, analytical gadget, kitchen machines, etc.) implanted with hardware, programming, sensors, actuators, and system network to empower the "brilliant objects" to collect and trade information..

Smart Home Market in India: In India smart homes are becoming well known; especially in urban areas of the metro. The reception of savvy homes is consistently expanding by 15-18 percent in urban communities at level 1, and by 5-10 percent in urban areas at stage 2 and stage 3 in India.. India is as of now a hotbed for solar-based vitality unrest. Because of more profound Internet infiltration and the rising worries about home security during the consistently raising wrongdoing rates in India, the market for brilliant homes has been developing relentlessly. Keen home costs more than homes without savvy highlights. Be that as it may, with the expansion in winning force and an expansion in the number of working couples with double wages in metro urban communities, brilliant homes will create more enthusiasm with time. Home mechanization is particularly pragmatic in India. Home mechanization advertises in India was evaluated at around INR 8800 Cr in 2017 and is relied upon to cross INR 30,000 by 2022. With the selection of savvy homes, there will be brilliant urban areas later on.

D. *Machine Learning*

The worldwide solar-based photovoltaic (PV) introduced limit in 2013 was 138.9 GW and it is required to develop to more than 455 GW by 2020. Notwithstanding, solar-powered power plants still have various impediments that keep it from being utilized on a bigger scale. One restriction is that the

power age can't be completely controlled or gotten ready for ahead of time since the vitality yield from solar oriented control plants is variable and inclined to changes subject to the force of solar-based radiation, overcast spread, and different elements. Another significant impediment is that solar-based vitality is just accessible during the day and batteries are as yet not a financially feasible stockpiling choice-making cautious the board of vitality age vital. Furthermore, as the introduced limit of solar-based power plants develops and plants are progressively introduced in remote areas where area information isn't promptly accessible, it is getting important to decide their ideal sizes, areas, and setups utilizing different strategies. AI methods give arrangements that have been more fruitful in tending to these difficulties than physically created specific models. Precise figures of solar-based control creation are a fundamental factor in making the sustainable power source innovation a practical and suitable vitality source. AI procedures will accurately determine the age of the solar power plant at a higher rate than existing traditional solar power forecasting techniques.

II. LITERATURE REVIEW

A study conducted by Ricardo Aler, et.al [1] investigated different AI strategies for solar-based vitality estimation using NWP models recorded from the NOAA / ESRL Global Ensemble Forecast System (GEFS) for different hubs located in a lattice. On the one side, three distinctive relapse techniques (direct SVM, RBF-SVM, and GBR) were used to generate deciding models and to assess the impact of the number of lattice hubs on predictive accuracy. Then again, given the enormous number of highlights in this area, three diverse characteristic determination techniques have been tried (direct relationship, Relief F, and a neighborhood data investigation calculation). The findings of the study show that non-straight strategies accumulate fewer errors than direct ones. GBR and RBF-SMO both work, although RBF-SMO gives some minor over fitting when the amount of lattice emphasis is enormous. Likewise, on account of the best performing strategy (GBR), anticipating precision will, in general, improve as the quantity of GEFS matrix hubs utilized as information increments, even past the 4 or 5 nearest hubs. In spite of what was normal, highlight choice was not ready to improve the solar-based vitality forecast, although, with RBF-SMO, the nearby data calculation can acquire comparative expectations with a portion of the properties.

In a study lead by M. Z. Hassan, et.al [2] To predict solar-oriented radiation, they initially adopt a simple least-square relapse technique. Straight least-squares relapse is a straightforward and ordinarily utilized strategy to evaluate the connection between a ward or reaction variable, at that point next take a gander at different classes of managed learning strategies utilizing Support Vector Machines (SVM). SVMs, which grow hyper planes in a multidimensional space, have taken the prevalence for order and relapse analysis late in the day. The accuracy of SVM relapses depends on the selection of an acceptable component capability and parameters. We found three different SVM component works in our work: a linear kernel, a polynomial kernel, and a section of Radial Basis Function (RBF). The ideal parameters of the RBF component were found to be ÿ= 0.035. The results show that the RBF piece often performs better than the various techniques.

In a study conducted by Cong Feng, et.al [3] in this paper, an estimation technique based on hourly closeness (HS) was developed to enhance the transient 1HA GHI determination. GHI was independently estimated by the created HS-based strategy using a two-layer AI-based MMFF technique at every hour. In the second layer of the MMFF models, a few mixing calculations were used, the ideal mix of which makes the final ideal HS-based model. A numerical trial was carried out to allow productivity by using solar-oriented knowledge of 1 year with six highlights. The technique of determining 1HA GHI based on HS has shown prevalent execution from various points of view, contrasted and across the board strategies.

In a study conducted by Monika Cristian Gyozo Haba [4], exhibited a proposition for an AI technique for checking and distinguishing the circumstance when solar-based boards in a PV stage are in a diminished activity status because of inclusion of solar-based boards with the day off, mud or other optical blocking materials. Early recognizable proof of such circumstances can cause rapid upkeep exercises to bring the activity parameters to ordinary esteems. Even if the tests and results are applied for the situation when solar-powered boards are protected with a day off, the technique can be spread out to be used in various cases. Extra studies may attempt to test various combinations of electrical and environmental parameters for use as highlights in the ML strategy. Since these unusual states of reduced activity status will occur only at specific times of the year (e.g. snowfall is limited to the winter season) or in certain geographical locations (dust storms specifically to districts in the vicinity of deserts), techniques to replicate these conditions will be considered to improve the expectation model.

In a study carried out by the Miss. Neha S. Deshmukh, et.al [5] Mechanizing the solar-oriented photovoltaic plant is significant to advance the use of sustainable energy sources. The proposed framework examined, implemented effectively and effectively achieved the robotization objective. By this proposed method, the proprietor of solar-oriented PV plants has continuously refreshed the yield of the project, with no compelling reason to visit the plant except where certain issues have been found. By using this clever solar-powered PV framework customer reduces the time required for managers to plant and clean the solar-based PV display as a result of remote control. Remote observation also decreases the time and effort required for manual monitoring of solar-oriented PV plants. In the proposed framework, the structure of solar-based trackers creates greater power due to an expanded direct presentation of solar radiation.

In research, carried out by L. In this paper Barazane, et.al [6] is planning a minimum effort checking framework for most extreme Power following in a photovoltaic module. The IoT procedure is used to continuously screen information on a site, for example Vpv, Ipv, VL, IL and D. This breakthrough makes it conceivable to boost photovoltaic generator screening, presentation, and support. The expected system will break down and/or check the status of estimated parameters in a photovoltaic framework. This appears to be used mostly to

monitor the development of the greatest on-line yield power. A few options will be discussed later, for example location of problems and sensor manipulation, receiving cautionary alerts if the frame is damaged and remote monitoring..

In a study conducted by Abeera Javed, et.al [7] suggests a model of solar powered irradiance expectation that predicts solar based irradiance using Machine Learning methods, including Linear Regression, Regression Trees and Vector Machine Support. The model uses noteworthy climate information considering parameters such as temperature, wind speed, ambient weight, and air humidity and forecasts potential solar-powered irradiance. The results show that the RBF part of SVM ensures better results. Thereafter, it is generally more and more solid among various strategies used in this article. Also, the link diagram shows a solid relationship between Global Horizontal Irradiance and wind speed, air temperature, environmental weight, and relative stickiness. Each of the above-mentioned four parameters has a solid R estimate and ranges between [0.75-1]. The proposed model can assist vitality providers in the ideal arrangement of solar-based vitality frameworks; the arrangement can help control dispersion frameworks inadequately foreseeing source control and use exchange-vitality sources as well.

In a study conducted by Aaftaab Moosa, et.al [8] solar power has gained tremendous significance in recent years as a spotless, inexhaustible and an elective source of vitality. By 2030 it is projected to be one of the least expensive sources of energy, so we have several years to create an opportunity for cultural change. In any case, the output of a solar power plant is actively subject to climate design and daytime climatic capacity. Through developing a defining model, they evacuate these vulnerabilities and thus lead to the development of the use of solar-based vitality, which will put together data on the ability to switch from non-renewable sources to solar-based sources as an important source of vitality, thereby decreasing establishment-related expenses and helping to drive progress to inexhaustible wellspring of vitality. An exact forecast of these changing examples can enable solar-based to control organizations conveniently supplement their generation deficits, in this way sparing the significant expense of buying power from the market at last.

A study conducted by Faizan Jawaid, et.al [9] over the previous year's solar-powered control has increased a huge significance as a sustainable, clean, and elective wellspring of vitality. Notwithstanding, the yield of a solar oriented power plant vigorously relies upon climate examples and time. An exact expectation of day by day solar oriented control by displaying these different examples can enable solar-powered to control organizations conveniently supplement their creation shortages, subsequently sparing the significant expense of obtaining power from the market at last. In this way, show the capacity of AI relapse methods, particularly fake neural systems to precisely anticipate the everyday mean solar-based catalyst to a high level of exactness. Notwithstanding utilizing climate and season explicit qualities, they additionally propose and set up the adequacy of utilizing solar powered points (azimuth and pinnacle) to build the precision of such expectations. After 10 years of solar-oriented irradiance and climate information collected for the city of Los Angeles, USA, they accepted their models. This work is an initial phase in proposing locations which are generally reasonable for solar power age.

Table 2 shows that the different surveys and different techniques used to determine forecasting monitoring and prediction.

TABLE 2 LITERATURE SURVEY ON FORECASTING, MONITORING, AND PREDICTION.

	Author Name	*Year*	*Paper Title*	*Problems*	*Technique Used*
Forecasting	Ricardo Aler, Ricardo Martín, José M. Valls, and Inés M. Galván	2015	A Study of Machine Learning Techniques for Daily Solar Energy Forecasting Using Numerical Weather Models	Predicting solar energy from NWP computed from GEFS, the Global Ensemble Forecast System	Direct SVM, RBF-SVM, GBR, Direct Relationship, Relief F, & A Neighborhood Data Investigation Calculation [1].
	M. Z. Hassan, K.M.E. Ali, ABM Shawkat Ali, Jashnil Kumar	2017	Forecasting Day-ahead Solar Radiation Using Machine Learning Approach	The big challenges of incorporating renewable energy into the grid are their unreliable and unruly power generation.	Linear Kernel, a Polynomial Kernel, and a Radial Basis Function (RBF) piece [2].
	Cong Feng, Jie Zhang	2018	Hourly-Similarity Based Solar Forecasting Using Multi-Model Machine Learning Blending	With solar power increasingly penetrating power systems, forecasting becomes critical in power system operations.	Hourly Closeness (HS) Based 1HA GHI Determining Technique [3].
Monitoring	Monika Cristian Gyozo Haba	2019	Monitoring Solar Panels using Machine Learning Techniques	Reducing carbon dioxide emissions accused of having triggered major climate change	AI technique for checking and distinguishing the circumstance with day off, mud or other optical blocking materials [4].
	Miss. Neha S. Deshmukh, Prof. D. L. Bhuyar	2018	A Smart Solar Photovoltaic Remote Monitoring and Controlling	Limitation of non-renewable energy sources	Automation of the solar photovoltaic power generation, Robotization [5].
	L. Barazane, N. Rouibah, A. Mellit, and B. Hajji, A. Rabhi	2019	A low-cost monitoring system for maximum power point of a photovoltaic system using IoT technique	Monitoring, supervising and performances evaluation	A minimal effort checking framework for most extreme Power [6].

Predicting	Abeera Javed, Bakhtiar Khan Kasi, Faisal Ahmad Khan	2019	Predicting Solar Irradiance Using Machine Learning Techniques	In the power sector, connecting grids to solar energy systems has brought an unprecedented shift. Nevertheless, the intervention poses challenges like intermittency which affects the overall management of energy supply and demand.	Noteworthy climate information considering parameters [7].
	Aaftaab Moosa, Hamza Shabir, Huzefa Ali, Rishikesh Darwade and Balasaheb Gite	2018	Predicting Solar Radiation Using Machine Learning Techniques	Non-renewable energy is harmful to the environment; its use is always high and will soon diminish.	To build the determining model to evacuate vulnerabilities and consequently help in advancing the use of solar-based vitality [8].
	Faizan Jawaid, Khurum NazirJunejo,	2016	Predicting daily mean solar power using machine learning regression techniques	Solar power firms immediately offset their production shortfalls, thus avoiding high buying costs.	The adequacy of utilizing solar powered points (azimuth and pinnacle) [9].

III. CONCLUSION

This discussion is talked about the solar-based vitality forecast, monitor and predicting resource. Solar oriented energy forecasting and resource assessment is an imperative content for solar light-based vitality experts, tending to a basic hole in the center writing of the field. As significant boundaries to solar oriented vitality usage, for example, materials cost and low transformation proficiency, keep on falling, issues of irregularity and dependability have gone to the fore. An investigation from solar-powered task designers and their agents on the exactness of long haul asset projections and matrix administrators' worries about factor momentary power age have made the field of the solar-based gauging and asset evaluation urgently significant. This volume gives a definitive voice on the subject, consolidating commitments from a universally perceived gathering of top creators from both industry and the scholarly world, concentrated on giving data from basic logical essentials to down to earth applications and stressing the most recent innovative improvements driving this order forward.

REFERENCES

[1] Ricardo Aler, Ricardo Martín, José M. Valls, and Inés M. Galván, "A Study of Machine Learning Techniques for Daily Solar Energy Forecasting Using Numerical Weather Models" (2015), Springer International Publishing Switzerland, DOI: 10.1007/978-3-319-10422-5_29.

[2] M. Z. Hassan, K.M.E. Ali, ABM Shawkat Ali, Jashnil Kumar, "Forecasting Day-ahead Solar Radiation Using Machine Learning Approach" (2017), 4th Asia pacific world congress on computer science and engineering, DOI:10.1109/ APW ConCSE.2017.00050.

[3] Cong Feng, Jie Zhang, "Hourly-Similarity Based Solar Forecasting Using Multi-Model Machine Learning Blending" (2018), IEEE Power & Energy Society General Meeting (PESGM), DOI: 10.1109/PESGM.2018.8586091.

[4] Monika Cristian-Gyozo Haba, "Monitoring Solar Panels using Machine Learning Techniques" (2019), 8th International Conference on Modern Power Systems (MPS), DOI: 10.1109/MPS.2019.8759651

[5] Miss. Neha S. Deshmukh, Prof. D. L. Bhuyar, "A Smart Solar Photovoltaic Remote Monitoring and Controlling" (2018), the Second International Conference on Intelligent Computing and Control Systems (ICICCS), DOI: 10.1109/ICCONS.2018.8663127

[6] L. Barazane, N. Rouibah, A. Mellit, and B. Hajji, A. Rabhi, "A low-cost monitoring system for maximum power point of a photovoltaic system using IoT technique" (2019), International Conference on Wireless Technologies, Embedded and Intelligent Systems (WITS), DOI:10.1109/WITS.2019. 8723724.

[7] Abeera Javed, Bakhtiar Khan Kasi, Faisal Ahmad Khan, "Predicting Solar Irradiance Using Machine Learning Techniques" (2019), 15th International Wireless Communications & Mobile Computing Conference (IWCMC), DOI: 10.1109/IWCMC.2019.8766480.

[8] Aaftaab Moosa, Hamza Shabir, Huzefa Ali, Rishikesh Darwade and Balasaheb Gite, "Predicting Solar Radiation Using Machine Learning Techniques" (2018), the Second International Conference on Intelligent Computing and Control Systems (ICICCS), DOI: 10.1109/ICCONS. 2018. 8663110.

[9] Faizan Jawaid, Khurum NazirJunejo, "Predicting daily mean solar power using machine learning regression techniques" (2016), Sixth International Conference on Innovative Computing Technology (INTECH), DOI: 10.1109/INTECH.2016.7845051

[10] https://www.energymatters.com.au/components/renewable-energy/

[11] https://www.energymatters.com.au/solar-hot-water/

[12] https://www.energymatters.com.au/solar-water-pumps/

[13] https://www.energymatters.com.au/residential-solar/battery-systems/

[14] https://energyinformative.org/solar-cell-comparison-chart-mono-polycrystalline-thin-film/