IMAGE PROCESSING IN RENEWABLE ENERGY RESOURCES: OPPORTUNITIES AND CHALLENGES

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Image Processing in Renewable Energy Resources: Opportunities and Challenges

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Image Processing in Renewable:
Energy Resources Opportunities and Challenges

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CONTENTS

PREFACE

The current book attempts to feature a portion of innovative work in the field of image processing applications to renewable energy systems. The chapters in the book describe the use of neural networks in multi-direction dynamic, topographical data frameworks in taking care of the distinctive contemporary issues managed under the space of environmentally friendly power.

This book is beneficial for the researchers to work and focus on the hybrid techniques of GIS, remote sensing, image processing, and its implementation on the setup and applications of renewable energy resources. Due to population growth and modernization, the demand and supply system is unbalanced, which directly affects the environmental condition. Hence, it is required to utilize natural resources wisely so that our demand can be fulfilled without harming the environment. The hybrid techniques are fast and provide financial benefits in terms of a site visit and its proper selection. Designers can plan the complete project virtually with its benefits and losses.

In Chapter 1, Dr. Goyal explains the different problems in rural electrification faced by electricity boards in India. In Chapter 2, Pawar *et al*. try to entice the effect of uncertainty in renewable energy planning and operation. In Chapter 3, computing techniques for the integration of different renewable energy resources are illustrated by Patel and Singal, the layout and configurations of the integrated renewable energy system are introduced, and various computing technologies that are used to evaluate the performance and sizing of the integrated renewable energy system are presented and discussed in detail. The automatic generation control of hydropower plants consisting of three areas was examined in Chapter 4, where an evolutionary algorithm called whale optimization algorithm (WOA) has been utilized for the automatic generation control (AGC) methodology. In Chapter 5, Chatterjee *et al*. illustrate the modelling of a traditional controller called proportional-integral-derivative controller for the automatic generation control in the system of a single area. In this, the PID controller has been used to control these systems by automatic generation control. In Chapter 6, Jain *et al*. analysed the fourteen segments of the Sabarmati riverfront from Subhash bridge to propose bridge 3 (Jamalpur flyover). Image processing software tools such as ArcGIS, QGIS, AutoCAD, Autodesk 3DS Max, Blender, City Engine 2019, ERDAS IMAGINE, Google Open Street Map have been utilized for calculating the sub-indexes and a methodology for conducting similar assessments using a variety of image processing tools has been demonstrated. Singh *et al*., in Chapter 7, estimated solar energy generation by installing a solar farm in the barren land. Various strategies have been designed for land use characterizations which are commonly known as supervised and unsupervised classification.

Here, the supervised method of classification is used as a mode of classification. The land use/cover classification is done by using satellite images of 2000, 2009, 2014, and 2019 through ERDAS IMAGINE 2015 software. It was estimated that a huge amount of energy could be generated by the used solar energy by installing solar farms in the barren land as estimated by the above process. In Chapter 8, Kumar *et al*. analysed the temperature of the solar panel by thermal imaging camera and thermal image analysis. In this, a device has been proposed which can successfully optimize the utilization of the cooling system and increase the efficiency of the panel. Editors include Dr. Rajesh Singh (Professor, Lovely Professional University), Dr. Sachin Mishra (Associate Professor, Lovely Professional University), Dr. Anita Gehlot (Associate Professor, Lovely Professional University), and Dr. Mohit Srivastava (Professor, Chandigarh Engineering College).

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CHAPTER 1

Electrification Problem and Solution in India: A Review

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Abstract: Electrificationplays a key role in theimprovement of any nation as it assumes a fundamental job inareaslike horticulture, industry, transport, business, and household. There are two types of sources for energy generations: non-renewable and renewable. The sources which cannot be rehabilitated or regenerated rapidly are called non-renewable sources, while energythatcan be repeatedly generatediscalled renewable sources. Many countries are dependent on non-renewable energysourcesbecause of extra consumption of electricity, but these sources are limited, expensive, and will be exhausted after a certain time period. The maximum use of non-renewable sources may increase several environmental problems on a global scale.

Nowadays, everyone focuses on renewable sources because today's world is facing massive environmental change due to the different climatic conditions.One of the major causes ofusingrenewable sources is the depletion of fossil fuels which havebeen focused onin the area of energy generation. Renewable Energy (RE) has many benefits, *i.e.*, improvement of public health and environment quality,reduction inthe dependency on fossil fuels, gas, and oil reserves, and stability in fluctuation.

The significant expense of sustainable powersourcesis its limitation,whichcan be taken into consideration by a couple of streamlining proceduresthatare used nowadays. The power utilized for all significant local and modern purposes increases the living expectations and work proficiency. Power is the best innovation of humankind in the event that it is utilized astutely. It is very difficult to work without power. One possible solution to overcome the drawbacks of renewable and non-renewable technologies to employ both types of combination is to minimize the cost of the system. As a result, energy generated from individual renewable sources is not reliable and continuous. Other possible solutions that may overcome the drawbacks of a single renewable energy systemhaveto be considered.The importance of vitality has grown as a result of the demands of day-to-day existence. Therefore, renewable vitality assumes a fundamental job to satisfy the vitality prerequisite of any country.

Keywords: Barriers in India, Energy Administration in India, Solution.

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1. INTRODUCTION

Rural electrification ensures continuous and efficient power in remote areas for domestic and industrial work. Due to the shortage of labor, this will increase productivity at a low cost. [Ministry of Power vide letter No. 42/1/2001-D (RE) dated 05.02.2004 have notified the revised definition of village electrification as under]: "A village would be declared as electrified if [1]:

- Basic infrastructure such as distribution of transformer and lines are provided in the inhabited locality as well as Dalit Basti/hamlet where it exists.
- Electricity is provided to public places like schools, panchayat offices, health centers, dispensaries, community centers, *etc*.
- The numbers of households electrified are at least 10% of the total number of households in the village."

Table **1** represents the state insightful status of rustic zap as of 23/12/16. More than 70% population lives in rural zones in India where the association of matrix is unimaginable.Inthis manner, some independent framework for power age is expected to give the power to unelectrified territories.

Table 1. State-wise Data on Rural Electrification, as of 23.12.19.

S. No.	States/UTs	Total Un Electrified	Electrified Village
1.	Arunachal Pradesh	1578	348
2.	Assam	2892	1808
3.	Bihar	2747	2111
4.	Chhattisgarh	1080	553
5.	Himachal Pradesh	35	28
6.	Jammu & Kashmir	134	32
7.	Jharkhand	2525	1397
8.	Karnataka	39	7
9.	Madhya Pradesh	472	358
10.	Manipur	276	185
11.	Meghalaya	912	670
12.	Mizoram	58	30
13.	Nagaland	82	28
14.	Odisha	3474	1908
15.	Rajasthan	495	400
16.	Tripura	26	15

(Table 1) cont.....

S. No.	States/UTs	Total Un Electrified	Electrified Village
17.	Uttar Pradesh	1529	1459
18.	Uttrakhand	76	7
19.	West Bengal	22	10
	Total state	18452	11363

1.1. Needs of Rural Electrification

Domestic economic levels can be increased through the delivery of energy services to fulfill the needs of cookery and illumination.

- Increase venture competence.
- Reduce labor and time in fetching fuel-wood and water.

Energy is required for many basic needs in every sector like irrigation and fertilization, householdlighting, food processing, cooking, small industry processing, commercialareas, *i.e*., shop, flour mills, social services, water pumping, road lights, *etc*.

i. Agriculture Sector: Irrigation, Fertilization.
ii. Domestic Sectors: Lightning, Food Processing, Cooking.
iii. Industry Sector: Machinery, Mills, Commercials Space.
iv. Social Service: Water Pumping, Health Centre.

2. ELECTRIFICATION IN THE INDIAN CONTEXT

The data indicates the empowerment in power supply during the year 2018-19. The gap between demand and supply of energy has been reduced to 0.7% from 2.2%. The consumption of electricity is increasing at a faster rate in India as compared to other countries of the world due to the increase of population to a larger extent and economic development of our country.

Fig. (**1**) shows that there is maximum consumption of energy in the duration of eight years as compared to its production. It shows that the consumption of energy is increasing rapidly as compared to its production.

Fig. (**2**) presents the current status of the installed capacity of India for total energy generation production with non-renewable and renewable energy sources. It shows that the major portion of electricity generation depends on non-renewable sources (thermal *etc*.), and only 18% of total generation depends on

CHAPTER 2

Analysis of Renewable Generation Uncertainty for Planning and Operation

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Abstract: The continuous demand in energy consumption and relative depletion of fossil fuel reserves has increased the use of renewable energy resources. However, these resources are characterized by their intermittent nature, and hence the uncertainty of these resources has gained importance in analysis and calculation. Traditionally, uncertainty has been dealt with using probabilistic and possibilistic methods, but the probability density function (PDF) method is used when historical data is not properly available. Also, a hybrid of these methods is often used. This chapter provides a brief introduction of various probabilistic and possibilistic methods used for uncertainty analysis in solar and wind energy generation systems. A comparison of various methods used for this purpose has been given in the chapter, which may help choose the best method for a given condition.

Keywords: Renewable Energy Sources, Uncertainty, Analysis of Uncertainty Methods.

1. INTRODUCTION

The usage of renewable energy is increasing in the world day by day. The threat of global warming, which is due to the extensive use of fast depleting fossil fuels, has caused a tremendous rise in the use of renewable energy resources in electrical power systems. The latest tools for handling such resources have maximized the benefits and kept reliability indices within the range. New developments in the forecasting and load management algorithms are supporting this cause [1]. The uncertainty of Renewable Energy Sources (RES) produces

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generation and load inequality [2]. These inequalities have been originated from forecast errors, and they are taken care of with additional generation capacity. Computational algorithms, which include forecasting techniques and large scale stochastic optimization, have been established for the inclusion of appropriate information about uncertainties in the decision-making processes. Renewable energy, considering mainly wind-power and solar-based, accounts for a major portion in this realm. With such remarkable potential, it is estimated that more and more use of solar energy and wind power will be done in the coming decade. Reliability and uncertainty are the major features associated with solar and wind generation [2]. These uncertainties are due to irregular weather conditions against the ever-increasing demand for energy. With a heavy deployment of renewable energy resources, the price has also decreased, but the challenge still persists with regard to grid connectivity. This problem becomes severe day by day owing to large penetration and dispatch irregularities.

These problems are faced both in isolated and grid-connected renewable energy resources. Wind power penetration faces the challenge of variability and intermittent availability. This is due to seasonal wind flow variation rate and solar radiation. It mainly depends upon the geographical location of the plant [3, 4]. Also, the plants may be situated at remote locations, which makes it difficult to fulfill the load demand. The growing amount of DG penetration is exerting pressure on the present distribution system with limited grid capacity. Hence, DG integration attracts high costs with respect to grid investments.

This chapter deals with uncertainty evaluation and analysis for renewable generation required for planning and operation of electrical power systems. Uncertainty characterization, historical data collection, data pre-processing, model development with various approaches, and performance comparison of these methods have been discussed in upcoming sections. Prior to the utilization of these data in various mathematical computations, it is prepared or processed [6]. After data processing, it is utilized for computation. Traditionally, probabilistic and possibilistic methods are used for analysis considering uncertainty [8]. More research in this field has led to the evolution of new methods which have reduced the computational burden of these methods [7, 9].

2. UNCERTAINTY EVALUATION AND PROCESS

2.1. Characterization of Uncertainties

We witness a high level of solar and wind penetration, and this has created novel challenges in the power system operation and control. To meet these challenges, new technical and computational methods have to be devised which can deal with

the uncertainty and variability of renewable energy resources. Wind and solar power is the main concern as hydro-power variability has been studied in detail [1]. The major problems faced in incorporating wind and solar energy systems are the uncertainty and intermittency of these resources [2]. Uncertainty is considered to take care of the difference between the scheduled, and the actual values obtained [3]. PDF or the Probability Density Function is used for this purpose [4].

2.2. Uncertainty Processing

Energy sources like solar photovoltaic and wind power are classified as intermittent, and the energy requirements also tend to vary due to variable possession and changing weather conditions. Therefore, it is necessary to take into account the uncertainties in energy systems. Historically, it is common to adopt deterministic optimization techniques to schedule energy resources because of their simple nature [5]. Data can be obtained from data centers. For renewable energy resources like solar PV and wind energy, historical data is available on various websites like MNRE, NREL, *etc*. Generally, Weibull and Beta PDF are used to estimate solar irradiance per hour and wind speed, and its basis is the historical data. This data is collected from the above sites for a period of about three years.

2.3. Data Pre-processing

The data which is obtained from the various sources cannot be used as it is. It has to be refined and made usable in the problem which is being dealt with. The actual data which is obtained from data centers is not perfect. It has lots of errors, and a lot of data are missing. Also, many techniques which are to be applied to the data may require some special format. Lots of measurement errors, uncertainty, heterogeneity, and non-linearities are present in the actual data received. Detecting all these abnormalities and correcting them is a complex and cumbersome task [6].

Data pre-processing is required to clean the data, which means making the data ready to be operated upon. This helps in a better understanding of data, which is then easy to be worked upon. This process also helps in arriving at better results as the data is refined as per requirement after the process [7]. This improves the data quality.

CHAPTER 3

Computing Technologies for Renewable Energy Sources Integration

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Abstract: The present chapter is focused on various computing techniques used for the performance evaluation of the integrated renewable energy system. Due to the stochastic nature of major renewable energy sources, a single renewable energy source-based system cannot provide an uninterrupted supply of electricity; hence, to attain high energy security, it is necessary to oversize the rating of the generating system, which in turn increases the overall cost of the system. On the other hand, the integrated renewable energy system, which employs the potential of two or more renewable energy sources to satisfy various energy demands, offers a better option than a single renewable energy system in terms of efficiency, reliability, and cost. However, multi-source-based power generation is often more complex due to the involvement of a large number of design parameters and variables. Hence, efficient computing techniques must be used to evaluate the performance of the integrated renewable energy system. In this chapter, the layout and configurations of the integrated renewable energy system are introduced, and various computing technologies used to evaluate the performance and sizing of the integrated renewable energy system are presented and discussed in details. The proposed study will be beneficial to the researchers working on renewable source-based stand-alone power generation for isolated areas.

Keywords: Analytical Method, Artificial Intelligence Method, Bio-energy, Computing Technology, Configurations of the IRES, Energy, Graphical Method, Hybrid Energy System, Hybrid Renewable Energy System, Integrated Energy System, Integrated Renewable Energy System, Iterative Method, Layout of the IRES, Power Reliability, Probabilistic Method, Renewable Energy, Renewable Energy Integration, Solar, Small Hydropower, Wind.

1. INTRODUCTION

Energy is the fifth essential need of human being after air, water, food, and

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shelter, and becomes the basic requirement of all the countries for socio-economic development [1]. Globally, energy needs are rapidly increasing with thesocio-technical activities of human being. Various forms of energy include mechanical, electrical, thermal, kinetic, potential, radiation, nuclear, magnetic, and chemical energy [2]. Among these, electrical energy, which is easy to handle and transport, is the most suitable form for a variety of end-use applications [3]. Electrical power can be generated by utilizing conventional and non-conventional energy sources. Presently, the major contribution to electricity generation is from fossil fuel-based energy resources. The conventional energy sources include fossil fuel-based resources such as crude oil, coal, gas, and nuclear power. The global fossil fuel-based energy resources are draining at a very fast rate and likely to be exhausted in the forthcoming time [4]. Further, the enormous use of these resources for the fulfillment of various human needs has raised the concentration of carbon dioxide (CO_2) in the atmosphere significantly [5]. The population and economic growth continue to be the most significant drivers for increasing anthropogenic CO_2 emissions. About half of the total human-induced CO_2 emissions from 1750 to 2010 have taken place in the last four decades (1970-2010). From the year 2000-2010, the growth in the population remained similar to the previous three decades (1970-2000), while the economic growth has increased sharply. This has substantially increased the anthropogenic greenhouse gases (GHG) emissions in the last decade (2000-2010) [6]. The worldwide CO_2 emissions from 1971 to 2015 are shown in Fig. (**1**) [5]. The estimated share of global anthropogenic GHG from various human activities in the year 2014 is shown in Fig. (**2**) [5]. The sector wise global CO_2 emission from fuel combustion in the year 2015 is shown in Fig. (**3**) [5]. From Fig. (**2**), it can be seen that the use of energy remained the largest source of GHG emissions. From Fig. (**3**), it can be seen that the two sectors are responsible for producing two-third of global CO_2 emissions: (i) transport (24%) and (ii) electricity and heat (42%).

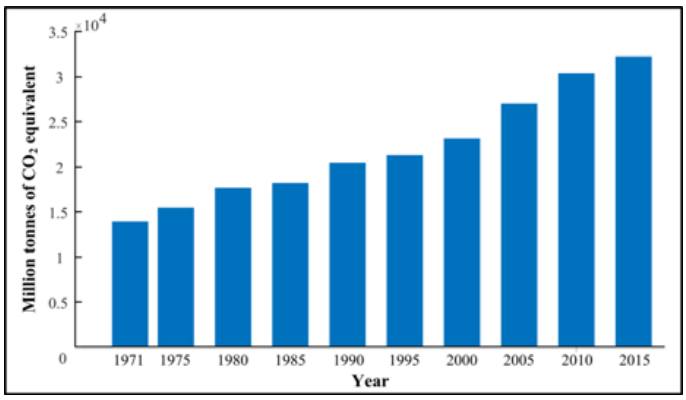

Fig. (1). Global CO_2 emissions [5].

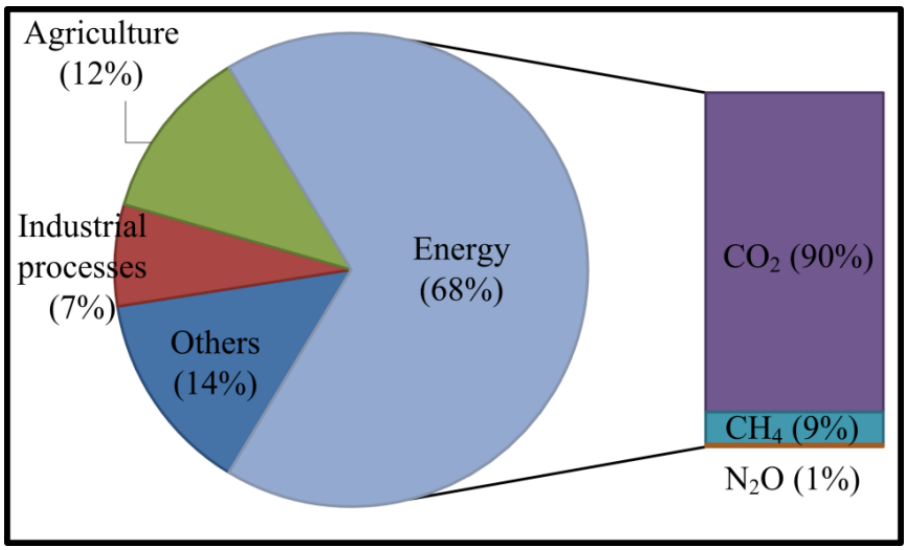

Fig. (2). Estimated shares of global anthropogenic GHG [5].

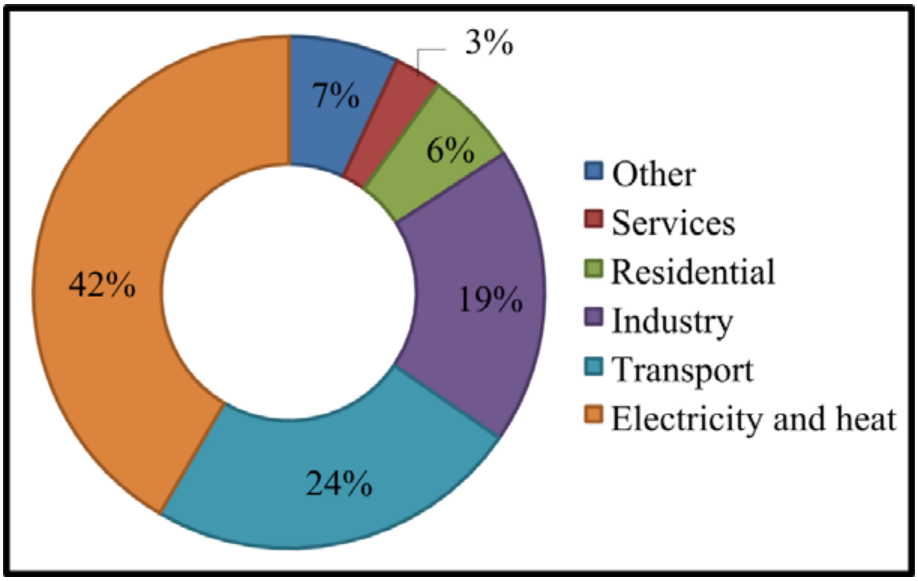

Fig. (3). Sector-wise global CO_2 emissions from fuel combustion [5].

The scientific community around the world has a common consensus that if the use of fossil fuel-based energy resources continue at the current pace, it will amplify the greenhouse effect leading to significant changes in the climate, which could have a major adverse impact on the water supply, food production, and human life through floods, droughts, and cyclones [7]. The human activities

CHAPTER 4

Automatic Generation Control using Whale Optimization Algorithm tuned PID Controller

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Abstract: This research work deals with the automatic generation control of a purely hydro-power system consisting of three areas. It can be done with the implementation of an optimization technique for the tuning of the proposed controller. An evolutionary algorithm called whale optimization algorithm (WOA) has been utilized for the automatic generation control (AGC) methodology. The control methodology has been inserted to eliminate the fluctuation with reference to the load connected with the system. The optimization technique is an important factor in this research work which is used to attain the desired output from the studied system. The deviation in the frequency profile for all three areas has been considered for the analysis of the investigated system. The simulation results yield some investigation based on the transient response, and through the responses, it may be reported that the propounded WOA based PID controller may be inserted in the purely hydro system consisting of three areas for minimizing the fluctuations.

Keywords: Automatic Generation Control, Proportional Integral Derivative Controller, Three-area Hydropower, Whale Optimization Algorithm.

1. INTRODUCTION

The automatic generation control (AGC) is a system for swaying the yield of the crude intensity of the producing components, in which the intensity of the tie line and the frequency of the system are bargained under barely any predetermined points of confinement [1]. In the electrical power system, which is attached, the prospective of ideal execution is alluded to by the AGC. Unequivocally, the exhibition of the attached electrical power system can be processed by the frequency's divergence, which is additionally a purpose of thought of the unevenness between the power provided by the generators as well as its electrical

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burden [2]. The dynamic qualities and system's demonstrating are fundamentally particular from the customary thermal plant because of (a) non-minimum phase traits of hydro turbine, (b) steadiness of the governor, (c) expansion in the transient hang compensator along with theturbine of hydro and (d) visit adjustment in the governor system with variation in the heads along with constants of time of the hydro turbine because of the non-minimum phase qualities. A design of hydro control system is on the precarious edge of insecurity which yields enormous motions naturally [3].

To portray the idea of outlines of power flow of tie line, the influence of the heap succeeding issues has been constantly an extraordinary worrying in the viewpoint of AGC. On specific aspects of AGC, the maximum procured hypothetical investigation and outcomes of the load change on territory frequency have been examined [4]. In the most esteemed task for the output of AGC component for computing the frequency, *i.e*., also of megawatt magnitude, sway issue of the power system (unified) has been initiated by Fosha and Elgard [5].

The fundamental ideas, in relation to the goal framed by the authors Fosha and Elgard [5], are used to develop the automatic generation control structure of a hydro-control electrical power system [6]. An all-out re-establishment design of a two-zone hydro control framework model has been sketched out [7] for inspecting the display of AGC. In the context of this, the utilization of the most noteworthy zenith resonation specific strategy (in optimizing the propounded controller structure for automatic generation control examination of hydro control system) has been considered [8, 9]. The researchers in some other work have utilized a control system based on the valve of the servo motor, in relationship with AGC execution examination of a bound little cut-off hydro control plant structure [10, 11]. The utilization of determinable info concept in the structure of an amazing relative vital subordinate (PID) controller for the automatic generation control part of hydro control plants has been briefed [12]. In contrast, Ding and Saha, in their research work [13], have portrayed the effects of one mechanism called the H∞ methodology in AGC technique to control the profile of the AGC outcome of a design of hydro control framework.

The literature survey has the main focus, which is on the optimization of the self-area, *i.e*., the area control error (ACE). Being a multi-objective problem, the automatic generation control problem is not required to calculate the control techniques which are naturally adaptive. In the case of feedback, there should be the availability of state variables, whereas the multivariable problems should be calculated by the methods for the controlling purpose [14]. The techniques help to update the parameters of the system as well as enhance the capability to track the

conditions of load. In this controlling method, many issues may occur, which are dealt with [15, 16].

Some of the work done on AGC has had an impact on the design of multi-area hydropower systems. Various control methodologies have been invented for controlling the system. Some evolutionary optimization techniques have also come in the research scenario for the tuning purpose and to get the desired output from the investigated system. However, optimization techniques have a number of drawbacks, including the ability to get trapped in local minima, the inability to search, the occurrence of convergence in the early state, *i.e.*, premature state, taking longer to compute, increasing the overall time for the computation, and many others, all of which lead to the development of more advanced and modern evolutionary techniques [17]. For this research work, the whale optimization technique has been implemented for the optimization purpose of the system [18]. This particular algorithm gets inspiration from the characteristic of the whales (of humpback category), which they use for hunting purposes. In this algorithm, there is a generation of the group of solutions, and for the reference purpose, the solution (candidate solution) has been considered as the new position. Parameters that are internal have to be used for the development of the nature of whales. The authors are expecting a relationship, which has to be good, between two important parts: one is the exploration and another one is exploitation. The search for the prey is the main requirement for the algorithm. Among these, there are also some drawbacks for this algorithm; one is the convergence which is taking place prematurely and the second one is the distribution on which the adaptive parameters depend randomly [18].

In this research work, for the automatic generation control of three areas of the hydropower system, the WOA has been implemented for the optimization of the PID controller parameters, which are expected to deliver superior results.

2. AGC MODEL

The hydro-turbines which have non-minimum phase characteristics have to be considered to analyse the operation and the inertia of water affects the operation of the turbine. Initially, if we consider this issue, then it is observed that it is just the opposite of the power's surge [1]. The main reason for the flow of the turbine is the inertia of water which leads to a lag in time for the opening of the gate [1]. The gate's location, which affects the pressure of the turbine, is at the penstock's foot. When the gate gets closed, then the water force decreases, and it leads to the increase of pressure in the penstock (end part), and it can happen in a reverse way also, *i.e.*, when the gates open at that time, the water force will increase which will lead to the same problem.

CHAPTER 5

Performance Analysis of ALFC and AVR Systems using PID Controller

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Abstract: This research work illustrates the modeling of a traditional controller called proportional-integral-derivative controller for the automatic generation control in the system of a single area. The load-dependent equipment is the governor in the automatic load frequency control, while the parameters of the generator, *i.e.*, time constant and the gain, are dependent on load in the automatic voltage regulator system. The values of the parameters do not remain constant when the load varies. These values have to be constant to maintain stability in the system as these will relate to the performance of the ALFC and AVR system. In this research work, the PID controller has been used to control these systems by automatic generation control. Based on simulation results, it may be reported that the conventional controller has done a superior job by yielding better performance index values.

Keywords: Automatic Generation Control, Automatic Load Frequency Control, Automatic Voltage Regulator, Proportional-integral-derivative Controller.

1. INTRODUCTION

The generation of power in any electrical system is concentrated at a few key points, but loads are distributed throughout the system. The electrical load in the electrical power system is continually fluctuating every once in a while. An alteration has to be done in the voltage of the system as well as in the frequency, which is very much needed. As a result, reactive and real power requests are rarely consistent, and the difference in the increase and decrease of the frequency and voltage of the system would be understood.

There is a big impact, due to variation in frequency, on the measurement of the raw power in the system. Accordingly, to keep up a contemporaneous activity of

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different segments, a steady frequency ought to be kept up in the electrical power framework.

Also, a variable frequency activity can influence the activity of water and steam turbine blades'. Since they are planned for a consistent speed *viz.* frequency activity, along these lines, the variation in frequency leads to the extreme quiver witnessed by the turbine blades, which may harm the blades of the turbine.

When high voltages are fed to the electric motors, the speed of the operation increases, which affects the operation of the machinery as well as the instruments that will lead to a reduction of equipment's span of life. Furthermore, whenever a low voltage supply is fed to the system, the drawing of current will be more, and it will lead to an increase in heat. Hence, the variation in voltage should not be allowed as it varies the speed, and this variation in speed affects the equipment's life. By employing the automatic load frequency control (ALFC), the control of the system's frequency and active power can be carried out through the implementation of the governor controlling technology, which will help in maintaining these two parameters while the automatic voltage regulator (AVR) can be employed to sustain the voltage and reactive power of the system. The block diagram combining both ALFC and AVR has been displayed in Fig. (**1**).

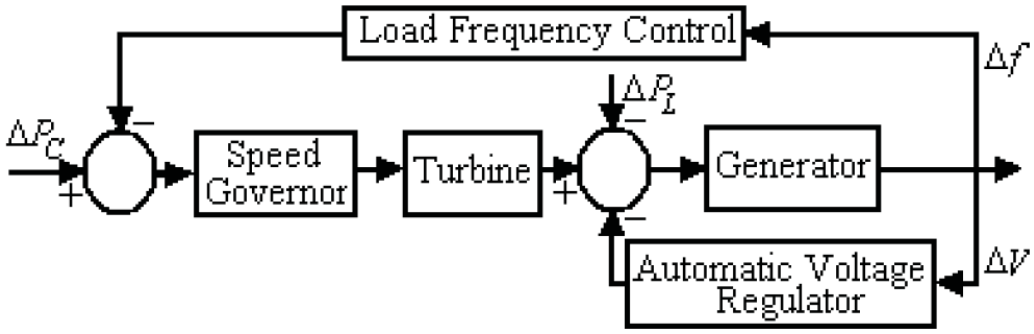

Fig. (1). AVR's and ALFC's Block Diagram.

In addition, the sensitivity of frequency criterion of ALFC circle and the constant of time of generator and generator model's gain in AVR circle differs with the variation of load. The difference in outcome results in transient flimsiness of the framework. Because of the result, there is a variety in the frequency of the system and magnitude of bus voltage. Henceforth, the control of the main voltage, as well as frequency, is essential for the right activity of the electrical power system. As per this chapter, a design of vigorous PID controllers has been carried out to explain AGC issues in a solitary region power system with parametric vulnerabilities.

2. AUTOMATIC LOAD FREQUENCY CONTROL

Within the allowed limits, the desired output power (active power in megawatt) and the system's frequency have to be maintained, and this job is done by the automatic control of the load frequency. The other objectives of the ALFC are to distribute the assigned load of the generators in a proper way as well as to sway the variation in the power of the tie line, which is in between the areas which have to be controlled. There are mainly four segments of the control mechanism of frequency, and these are the technology for the control of the valve, the control on the load frequency, steam turbine, and the sensor to detect the frequency of the system (Fig. **2**).

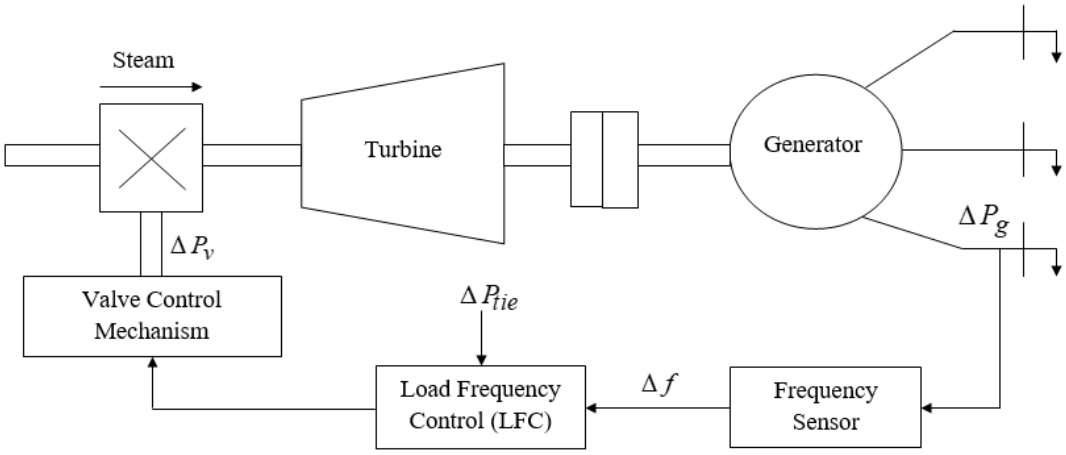

Fig. (2). Automatic load frequency controller's schematic diagram.

There should be a rise in the active power of the generator for supplying the increased load, but the active power cannot be increased suddenly. That is why there is a slowing down of the rotating part of the generator, which leads to increases in the angle of the load. When the speed of the alternator's rotor alters, then the frequency (Δf) also alters and this alteration of frequency is sensed by the sensor to procure correct error signal, which leads to an increase in the setpoints of the alternator and hence it will compensate the alteration in the drop of frequency.

In Fig. (**2**), it may be observed that the variable ΔP_{tie}, which denotes the variation in the power of different generating units and components of the load attached in the electrical power system, and Δf are being boosted up and further converted into an actual command of power, denoted by ΔP_v.ΔP_v is further forwarded to the turbine (prime mover) for increasing the torque of itself. This increase in torque of

CHAPTER 6

Image Processing For Estimating Sustainability of Riverfronts: A Case-Study of Sabarmati Riverfront

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Abstract: The present study performs a sustainability assessment for the Sabarmati Riverfront, India, from the viewpoint of public accessibility. Planned development and redevelopment of riverfronts are a recent phenomenon in the Indian development landscape. However, these riverfronts are rarely assessed after their construction. In this study, the Comprehensive Index of Public Accessibility of Riverfront (CIPAR), which consists of 4 sub-indexes and 12 indicators, has been used for assessing the conditions of Sabarmati Riverfront, Ahmedabad. These four sub-indexes measure (1) spatial accessibility, (2) visual accessibility, (3) corridor continuity, and (4) amenity. This study analyzes the fourteen segments of the Sabarmati riverfront from Subhash bridge to Proposed bridge 3 (Jamalpur flyover). Image processing software tools such as ArcGIS, QGIS, AutoCAD, Autodesk 3DS Max, Blender, City Engine 2019, ERDAS IMAGINE, Google Open Street Map have been utilized for calculating the sub-indexes mentioned above. The different software platforms have been compared. The final CIPAR Index ratings of various sections of the Sabarmati riverfront vary between 12.5 and 32.5, out of a total score of 40. The Sabarmati Riverfront scores well in spatial accessibility but lacks in terms of visual accessibility and corridor continuity. Thus, apart from being the first study for estimating the accessibility of the Sabarmati riverfront, the present study also demonstrates a methodology for conducting similar assessments using a variety of image processing tools.

Keywords: AutoCAD, Blender, CIPAR Index, NDVI, Riverfront Development.

1. INTRODUCTION

1.1. General

Rivers have traditionally played an essential role in the existence of different civilizations in the past. Rivers are still a natural transport system for all existing cultures serving as the backbone of any economy. Riverfront may be defined as that location or part of a city or town directly or indirectly attached to a body of

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water. The primary aim of any structure built on the riverfront should be to boost the economic activity of the surrounding region [1]. Few significant features of riverfront projects include the smart use of amenities, appropriate lighting, and easy access for boat, bike, and pedestrian trails to have a seamless transportation system. Other essential features are the public parks for recreational activities that connect destinations and bring harmony among peoples [2].

Riverfront development projects' performance may be enhanced on various parameters. The primary areas where riverfront projects can be improved are integrating the urban regions and river ecology. Differences in planning approach by the designers and contractors in the development of the project and neglecting the local needs of a specific region often creates conflicts among the locals. Uncertain ecological concepts and the difference in the choice of the use of riverfront areas during the design phase develop issues during the implementation stage. Lack of a seamless transportation system, management between organization levels, and a flexible approach in terms of sustainable development in planning and design are some of the reasons which lead to the failure of a riverfront project. Thus there is a need for the assessment of riverfront projects on multiple parameters [3].

Contemporary riverfront development focuses on promoting the economic development of a city. In India, new riverfront projects face overwhelming issues to accomplish a harmony between the social thoughts of the neighborhood with the fast pace of economic development. Urban improvement projects, incorporating riverfront advancements in India, are commonly completed by the state government organizations, following a top-down methodology [4]. Sabarmati Riverfront is an example of contemporary riverfront project in India. It is that project which sets the benchmark for all the upcoming riverfront projects in India. The Sabarmati riverfront consists of a 7.92 km stretch from Subhash Bridge to Proposed bridge 3. Various proposals have been made in the past for the improvement of the Sabarmati Riverfront. In 1961, French architect Bernard Kohn proposed the advancement of the Sabarmati Riverfront with a space of business, recreational and commercial spaces along both its banks. A riverfront development group was established in 1976 to improve the image of the city with commercial development [5]. In 1992, the Sabarmati river was incorporated under the National River Corporation Plan of India, which provided sufficient funding for the Sabarmati riverfront development. The Sabarmati riverfront project eventually started in 2005 at the expense of ₹ 900 crores. The primary aim of the project was to change the two sides of the riverbank, namely, the east bank and the west bank, into unwinding spaces, business spaces, business parks, private spaces, and different stops and nurseries [5].

Different assessment tools have been presented in the past for the evaluation of the riverfront project. Some of the focus areas in these assessments include the ecological framework for the planning, design, and management of river gateways [6], preliminary assessment of the link between the open spaces and sense of community [7], evaluation of an urban riverfront park which focuses on the amenities provided in the riverfront [8], measuring accessibility and utilization of public spaces [9], and assessing a riverfront rehabilitation project using the comprehensive index of public accessibility [10].

Different studies for the assessment of the Sabarmati riverfront have been carried out in the past. Some of these deal with the socio-economic impact of the Sabarmati riverfront on the life of displaced communities [11], determining women's safety in public spaces [12], evaluating infrastructure projects around the Sabarmati riverfront for economic investment [13], and determining the problems faced by the displaced communities during the implementation of Sabarmati riverfront model [4]. However, there are no studies for the evaluation of the Sabarmati riverfront based on aesthetics, design parameters, physical and crime survey. To the best of the authors' knowledge, no sustainability assessment for the Sabarmati Riverfront has been performed from the viewpoint of public accessibility.

In this present study, the Comprehensive Index of Public Accessibility of Riverfront (CIPAR) has been utilized for the assessment of the Sabarmati riverfront. The CIPAR index is an all-inclusive index based on the consideration that the accessibility of urban riverfronts is significant in terms of realizing the ecological and social benefits of urban riverfronts. This index gives a specific rating for each sub-index, which contributes evenly to a final CIPAR rating. This study analyzes the 14 segments of the Sabarmati riverfront through various image processing software tools such as ArcGIS [14], QGIS [15], AutoCAD [16], 3DS Max [17], Blender [18], CityEngine 2019 [19], ERDAS IMAGINE [20] and Google Open Street Map [21]. These tools have been utilized for calculating the sub-indexes used in CIPAR Index [10]. The rating of different sub-indexes gives information about the transportation types, the height of the buildings, the amount of vegetation and built-up spaces around the riverfront, bank design, cleanliness status, and social impact of various segments on the riverfront project [3].

Thus, the objective of the study is the assessment of the Sabarmati riverfront project through the CIPAR index. Furthermore, this study also aims to develop a methodology utilizing different image processing tools for conducting similar assessments in the future.

CHAPTER 7

Estimation of Solar Energy to be Produced in Changing Land Use of Bina River Basin, Madhya Pradesh

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Abstract: Landuse/landcover (LULC) variations play a significant role in the investigation and monitoring of worldwide alterations. LULC and regular adjustments have generally brought about biodiversity misfortune, deforestation, an unnatural weather change, and increased flood events. With the creation of GIS (Geographical Information System) and remote sensing approaches, LULC planning has specified a valuable and comprehensive approach to enhance the choice of zones intended for industrial, urban, and agricultural regions of an area. Various strategies have been designed for extracting information about the earth's surface by means of image classification, which are commonly divided as supervised and unsupervised classification, based on the availability of reference data. In this chapter, the supervised method of classification has been used to find the available classes. The land use/land cover classification has been done for satellite images of 2000, 2009, 2014, and 2019 through ERDAS IMAGINE 2015 software. It has been identified that land use has undergone major changes from the year 2000 – 2019. The drastic increase of the built-up area or urban area was from 3.12% to 20.25%, an increase in vegetation area was from 8.81% to 19.60%, an increase in water bodies was from 0.24% to 1.12%, while a reduced land cover in agriculture was from 77.24% to 57.44% and a decrease in barren land was from 10.59% to 1.59% from the year 2000 to 2019. This investigation clearly reveals the critical influence of population and its advancement exercises on LULC change. The current examination outlines that GIS and remote sensing are significant advancements for temporal examination and measurement of spatial occurrence, which is generally impractical to endeavor through ordinary planning strategies. Additionally, in this chapter, an attempt has been made to predict the amount of power generation through solar energy by installing solar panels in the identified barren land, which is obtained by image processing technique. It is predicted that 3 MW of power equivalent to around 4800 MWh of solar energy can be generated.

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Keywords: Bina River Basin, GIS, LULC, Remote Sensing, Supervised Classification.

1. INTRODUCTION

Land Use/Land Cover (LULC) are two distinct terms that are regularly applied in the study of the earth's surface. The land cover indicates the physical qualities of the surface of the earth, which includes distribution of soil, water, vegetation, and other characteristics of the land along with those made only by human exercises, e.g., settlements, whereas land-use indicates the aspect by which land has been employed by people and their environment [1]. LULC variations present a significant part in the investigation of worldwide alterations. LULC and regular adjustments have generally brought about biodiversity misfortune, deforestation, an unnatural weather change, and increased flood events. These natural issues are mostly related to LULC changes. In this manner, available data on LULC changes can give an essential commitment to the dynamic of natural management and scheduling of upcoming events. The increasing population and expanding financial necessities have an influence on LULC. This influence brings about spontaneous and unconstrained variations in LULC. The LULC changes are, for the most part, brought about by mishandling of urban, agricultural range, and forest.

There are certain lands that are prone to extreme natural disasters, such as floods, landslides, *etc*. [2]. In conditions of fast and consistently uncounted land-use alteration, the view of the Earth from space gives target details of human utilization of the scene. Over the past years, details from the Earth identifying satellites have become urgent in arranging the Earth's characteristics and structures, supervising regular resources and considering natural change [3]. Sun is the major source of inexhaustible free energy (*i.e*., solar energy) for the planet Earth. At present, new technologies are used to produce electricity from harvested solar energy. These approaches have already been proven and are widely practiced throughout the world as renewable alternatives to conventional non-hydro technologies. Only three renewable energy sources (*i.e*., biomass, geothermal, and solar) can be utilized to yield sufficient heat energy for power generation. Out of these three, solar energy shows the maximum global potential since geothermal sources are restricted to few locations while the supply of biomass is not ubiquitous in nature [4]. This paper utilizes ArcGIS to determine the tremendous possibility of renewable energy systems. The use of a Geographic Information System (GIS) provides an advantage in planning for performing efficient operation and control of the system of any area [5]. With the creation of GIS (Geographical Information System) and remote sensing approaches, LULC

planning has specified a valuable and comprehensive approach to enhance the choice of zones intended for industrial, urban, and agricultural regions of an area. The use of remote sensing information made it conceivable to consider the adjustments in land cover in a shorter duration, demanding little effort and with finer precision in association with GIS that gives a relevant platform to information examination, update, and recovery [6]. Remote sensing has got a significant tool relevant to creating and comprehending the worldwide physical cycles influencing the earth. Late growth in the usage of satellite details is to take the benefit of extending measures of topographical details within reach related to GIS to aid understanding. GIS is a coordinated arrangement of computer hardware and software fit for acquiring, storing, recovering, manipulating, analyzing, and displaying spatial (geographically referenced) data to help advance situated administration and dynamic cycles [7].

2. STUDY AREA

River Bina is a significant branch of River Betwa in the region Bundelkhand, Madhya Pradesh. It begins from Begumganj (Raisen region) and goes into region Sagar (Rahatgarh area) and navigates between Khurai and Bina tehsil before conjunction with waterway Betwa close Basoda town in Vidisha region. Eventually, household water contributes to Khurai, Rahatgarh, and Bina town; railroads necessity at Junction of Bina Railway and mechanical serving for Bina Refinery and desired JP power venture is fulfilled from this waterway adjacent to restricted water system from the stream by direct siphoning. “Bina Complex-Irrigation and Multipurpose Project” has been suggested. In this task, the projected dams are the Madia dam and Chakarpurdam-cum-pickup weir on the Bina waterway, in addition to one each on Dehra and Dhasan streams, branches of waterway Betwa. The watershed viable lies in between 23º18' – 24º15' N latitudes and 78º03' – 78º32' E longitudes having absolute geological territory about 2817 sq.km (Fig. **1**). The southern piece of the watershed is ruled with slopes and undulating geography with forest area. However, the northern piece of the watershed has delicate slopping and fields with prolific agricultural lands [8].

2.1. Land Use Classification

Various strategies have been designed for land use characterizations which are commonly known as supervised and unsupervised classification. The arrangement of land use can be made either by an unsupervised technique in group cases on the basis of relative spectral closeness or by using supervised strategy dependent on the resemblance of cases to the resource of predetermined classes which have

CHAPTER 8

Thermal Analysis of Solar Panel with Proposed Cost-effective Solution to Increase Efficiency

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Abstract: Solar panel heating is a big problem in most of the regions where solar light heats the solar panel and decreases the efficiency of the panel. The research article proposes a novel approach to increase the efficiency of the solar panel by utilizing any method mentioned in the literature survey. The device which is proposed utilizes the same system but in an optimized way. The optimization of the utilization of a solar panel cooling system is necessary to take maximum power from the solar panel. The device proposed can successfully optimize the utilization of the cooling system and increase the efficiency of the panel. Also, this device increases the efficiency of the cooling device so that it can cool the panel efficiently. The temperature of the solar panel is analyzed by thermal imaging camera and thermal image analysis. The thermal image camera is mounted through a servo motor which rotates at a 360^{o} angle and monitors the temperature of the solar panel.

KEYWORDS: IPVTS, Region of interest (ROI), Servo motor, Solar Panel, Thermal image analysis.

1. INTRODUCTION

Solar panels are the best medium of generation of electricity directly through solar lights. This technique does not create any pollution, and it is completely safe to use. Solar panels are also called Photovoltaic cells (PV) because they generate electricity directly from the incident photon particles. Different types of solar panels are available these days with different efficiencies, such as copper indium

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gallium selenide (CIGS) solar cells [1], gallium arsenide (GaAs) solar cells [2], perovskite solar cells [3], and silicon-based solar cells [4]. PV technology is made up of solar cells. Small solar cells cascade with each other in series and make a large solar panel or photovoltaic cell [5]. One of the big disadvantages of solar panels is heat loss. The solar panels can convert approximately 20% of photons to electricity. More than 50% of the energy is converted into heat which affects the efficiency of the solar panel. At a certain time, the efficiency of the solar panel starts decreasing. Silicon-based solar panels are cost-effective and widely used in industries, but the efficiency of this type of solar panel is affected by the excess heat and gives low efficiency. The heat dissipated from the solar cell is the loss of energy, and it increases the operating temperature of the solar cell. Due to an increase in temperature, the efficiency of the solar cell also decreases [6]. In a study, it is defined that if the 1^{o}C operating temperature of any silicon-based solar panel increases, then there is a 0.4 to 0.6% decrease in efficiency [7].

If we consider the worldwide power generation from the report in 2018 [8], then power consumption till 2017 is approximately 13,511.2 million tons oil equivalent, in which solar energy contribution was only 468.8 million tons oil equivalent. According to the report, energy consumption throughout the world is increasing rapidly every year. It is recorded that annual growth in the requirement of power is approximately 27% from 2007 to 2017 in Asian countries. In continents like Africa, North America, *etc*., an increase in demand for electricity is noted. In this respect, it is observed in the report of IEA [9] that the power requirement is continuously increasing, and the prediction of 2040 is also available in terms of different fuels used to generate power. According to the report, the power consumption in 2018 is approximately 27 thousand TWh, as shown in Fig. (**1**). It is predicted that the requirement of power till 2040 will be approximately 41 thousand TWh. The power requirement is 1.5 times greater than the current requirement. Considering the role of renewable energy, only 7 thousand TWh power is generated and it is estimated that 18 thousand TWh electrical power will be generated till 2040. Renewable energy is important and pollution-free. However, the role of renewable energy is less because of its lower efficiency. Considering the sustainable development of renewable power in 2018, it was 7 thousand TWh, and it will be 26 thousand TWh till 2040. The fuels used to generate power are limited on this earth, and it is mandatory for researchers to increase the efficiency of solar panels and other renewable energy sources to achieve the required power. It will save our earth from pollution and save other fuels for use in the future as reserve fuel.

It is observed that solar energy is the most dominating energy, and it also influences other renewable energy sources. Due to solar light and the temperature of solar light, air is circulated in the atmosphere. Therefore, for wind energy, solar

is required. The same applies to tidal energy, hydro energy, ocean energy.

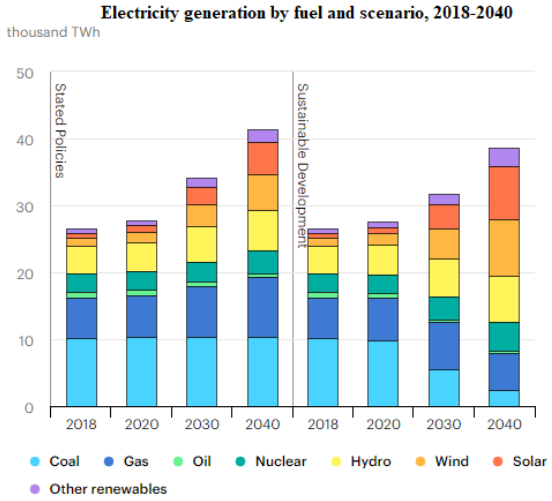

Fig. (1). Electricity generation of different fuels and prediction of 2040 [9].

In Fig. (**2**), the top 10 countries in the world added solar power as one of the important sources of electricity generation. China is at the top, generating 30,100 MW of solar power. The United States of America is at 2nd position in generation, and India is at 3rd position and generating 9,900 MW of solar power. Apart from these top ten countries, the whole world is utilizing solar power, but China alone is generating a huge amount of solar power. As shown in Fig. (**3**), the cumulative solar power capacity of China is 2,04,700 MW which is greater than the United States and India.

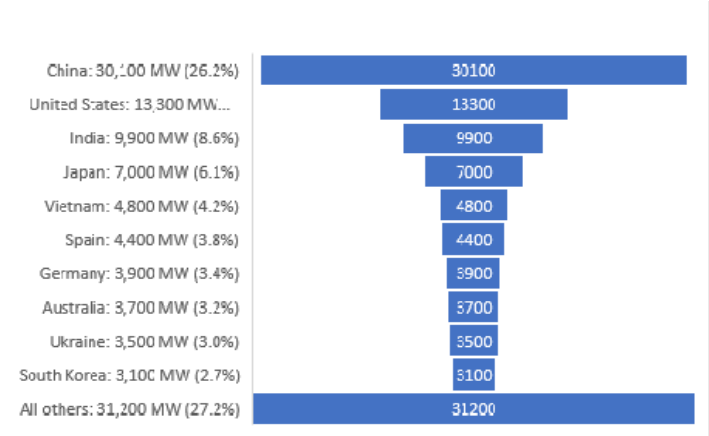

Fig. (2). Top 10 Countries by added solar PV capacity in 2019 [10].

SUBJECT INDEX

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E

F

G

H

I

K

L

M

N

O

P

R

S

T

U

V

W

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RAJESH SINGH

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