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Utilization of Abandoned Mine Area using Solar Panels

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Abstract: ***During and after the mining activities, rehabilitation and restoration is a big issue, mainly attributed to the stakeholders associated with it. The local people are often unemployed as some or all of their cultivable lands are acquired with a compensation of a fixed amount. Thereafter, mining activities ends and people often prefer to start agriculture over again. The problem is the employment of the locality and the standard of living remains constant and sometimes may even degrade due to worsening effect of global warming and thus unpredicted weather adversities., which hinders crop growth. With the depleting mineral resources in the country, most mines are generally abandoned and left unattended after their use, which in turn results in serious social problems that degrade the sustainable development of these areas. The mining industry has recently favoured the use of renewable and sustainable ways to counter this problem. This study assessed the abandoned mine area in Ramnagar Pandaveswar area having population of about 5000 people and a total area of about 1938264m^2. Through state-of-art research and innovation, I tend to use this part of the land effectively for generating Solar Energy using photovoltaic system arrangement which will not only increase the standard of living, but also exponentially increase employment and suffice the energy needs throughout.***

Keywords: renewable; sustainable; abandoned mine area; employment; photovoltaic system; solar energy;

I. INTRODUCTION

In many cases, after working for a few years, many companies abandon the mines without reclaiming it and shift off to other areas. The mine is thus left unused, barren. The idea of this proposal revolves around using the abandoned mine benches to its maximum utility. Since the abandoned mine benches are devoid of the nutritious topsoil which supports irrigation and farming, henceforth the former activities also can't be carried out. A lot of sunlight falls over the benches and with increasing demand of power and electricity, utilizing the solar energy is of utmost importance. Thus, instead of leaving the land barren, we propose our idea of using the abandoned land for generating Solar Energy which supports the motion of Developing the Rural India as well as Green and Clean India

II. THEORY

A. *Requirement Of Green Energy*

1) The energy policy of India is largely defined by the country's expanding energy deficit and increased focus on developing alternative sources of energy, particularly nuclear, solar and wind energy.
2) India ranks 81 position in overall energy self-sufficiency at 66% in 2017.
3) Part of waste lands (32,000 square km) when installed with solar power

Solar power PV system plants can produce 2400 billion kWh of electricity (two times the total generation in 2013-14) with land productivity/yield of 0.9 million INR per acre (3 INR/kWh price) which is at par with many industrial areas and many times more than the best productive irrigated agriculture lands.

B. *Why solar Energy has Been chosen as the Solution?*

1) The main power sources of for generating electricity are the fossil fuels (gas, oil, coal) and due to the usage of fossil fuels, greenhouse gases (CFC, CH4, O3, but mainly CO2) emit into the atmosphere which is responsible for global warming as well as the environmental pollution.
2) There is an alarming energy crisis worldwide as fossil fuel reserves decrease and the ageing power plants are going to close in near future.
3) Solar energy is clean and renewable. It doesn't emit carbon dioxide during operation. Solar energy is a renewable energy resource that does not generate pollution and has become an increasingly valuable way to diversify the nation's energy options.
4) Solar energy is readily available anywhere and everywhere in the earth. It can be used it to generate electricity at the point of consumption, so sometimes it is called a point power source.

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C. What Can be Done?

1) After Mining has been done in an area, the company may abandon the area and move to a new one without reclaiming the area back to its original state, which means, leaving out a barren mined area, with abandoned.

2) Generally, the left out land, without being reclaimed, is of no use practically. In the absence of the nutritious topsoil, no vegetation can occur nor irrigation can be done, hence it is rendered useless.

3) We plan to employ solar energy by the application of solar panels in the abandoned benches to generate electricity and supply to the nearby localities.

4) Thus, not only assisting the Electric Supply company and saving costs and resources, but also promoting green energy in one of the best ways and hence using the land for a general society welfare purpose.

D. Detailed Analysis on Electric Layout & Different Parts of It

The full layout of the solar plant is generalized and simplified to a single line diagram which is shown in the figure below. The whole system comprises of solar panel, combiner box, array junction box, Inverter-converter arrangement, battery bank and finally the supply system. General working procedure is like this :

1) Sun light (photo) strikes on PV panel.

2) Generate a photo current in the form of DC.

3) Charge controller is used to maintain the charge of PV panel so that it generates a maximum charge.

4) Inverter circuit is used to convert DC load current in to AC load current.

5) AC load current feed in to a load circuit

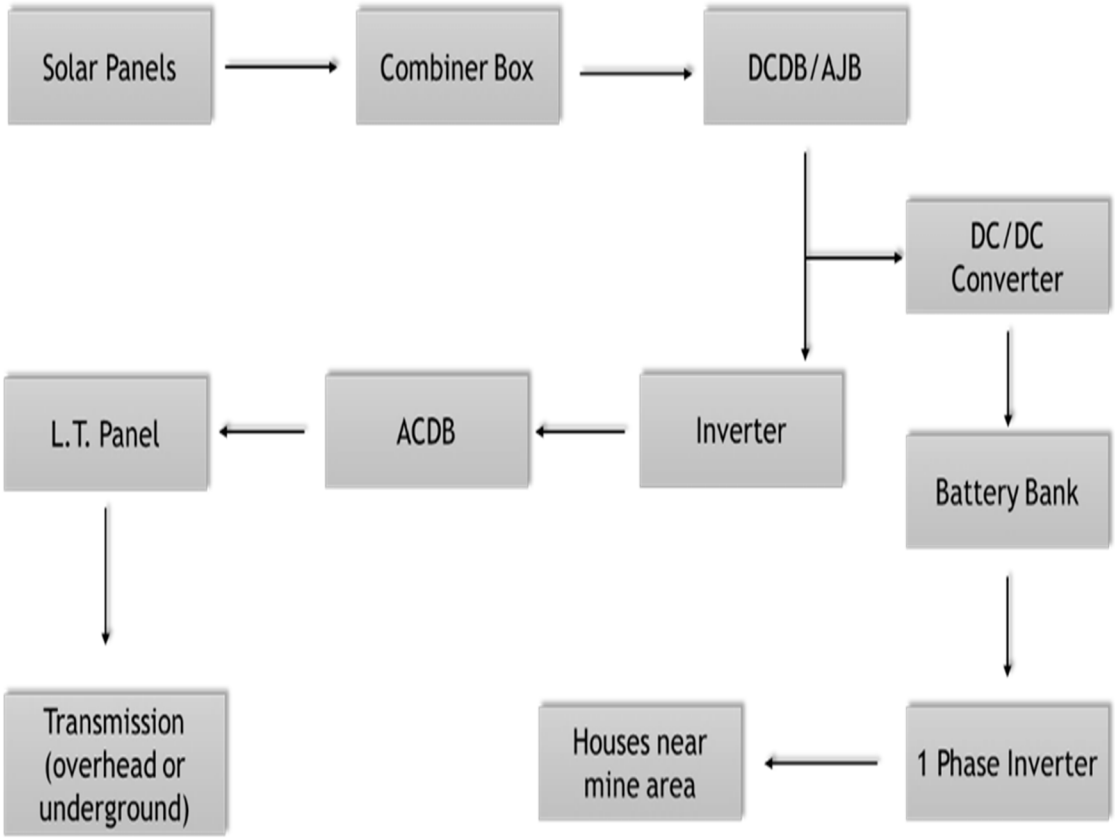

Figure 1:Schematic Diagram of The Plant

E. Different Parts of the Layout

1) *Solar Panel:* A photovoltaic (PV) module or Solar module is a packaged, connected assembly of photovoltaic solar cells which absorb sunlight mainly the photon as a source of energy to generate electricity. There is mainly three types of solar panel used in todays world

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Type	Advantage	Disadvantage
Monocrystalline	Monocrystalline panels are generally constructed from high-quality silicon, giving them the highest performance rates in the industry, usually up to 21 percent. By comparison, monocrystalline panels outperform thin film by four to one. They also make wise use of space, so they offer a high power yield per square foot. These panels perform better in low-light conditions than their poly-counterparts.	Because they are high-quality, these panels are also costly. Circuit break down is common when the panel is obstructed or shaded. The manufacturing process produces significant waste. The panels perform best in warm weather, with performance decreasing as temperatures increase.
Polycrystalline	High temperature ratings are slightly lower than those for monocrystalline panels; however, the difference is minor, making these types of panels a good option for many homeowners. The manufacturing process produces little waste, and the technology allows for a cost-effective panel.	Efficiency is lower, typically between 13 and 16 percent, which is not nearly as high as the ratings for monocrystalline panels. The panels require more space when installed to produce the same electrical output as a panel constructed from monocrystalline.
Thin film	These panels are lightweight, they are generally immune to problems from shading or obstructions and low-light conditions generally don't hinder their performance. These panels are easy to mass produce, so they are an affordable option.	Efficiency. Most thin-film panels score very low in terms of performance. These panels generally require a lot of space. Due to the number of panels required for this type of system, associated costs are also higher because you'll need to purchase more support elements, cables and so forth to accommodate the system. In most cases, thin-film panels don't last long and quickly succumb to the effects of weatherization.

Table 1: Types Of Solar Panel And Their Advantage And Disadvantage

1) *AJB:* An Array Junction Box is used to connect the photovoltaic strings and the combined DC power is fed to the photovoltaic inverter. It includes photovoltaic string protection, overvoltage protection and a DC output switch isolator.
2) *ACDB:* AC distribution board (also known as panel board or breaker panel) is a component of an electricity supply system which divides an electrical power feed into subsidiary circuits, while providing a protective fuse or circuit breaker for each circuit.
3) *LT Panel:* It is an electrical distribution board that receives power from solar panels and distributes the same to various electronic devices and distribution boards. Such panels are used in industries both for internal and external use and, therefore, they are quite rugged to withstand different climatic conditions. Our LT panels are designed to work with low electricity consumption that makes them cost effective
4) *Inverter-Converter Arrangement:* A solar inverter or PV inverter, is a type of electrical converter which converts the variable DC output of solar panel into a utility frequency alternating current (AC) that can be fed into a electrical grid or used by a local, off-grid electrical network. It is a critical balance of system component in a photovoltaic system, allowing the use of ordinary AC-powered equipment. Solar power inverters have special functions adapted for use with photovoltaic arrays, including maximum power point tracking and anti-islanding protection. On the other inverter like 1 phase inverter which is used to convert dc to ac is also used here this whole thing is the inverter converter arrangement.
5) *Battery Bank:* These Are a series of battery connected to series or parallel to each according to the power requirement. A dc/dc converter is used so that the voltage can be lifted up in such a manner so that the suitable threshold charging dc current is used to charge the battery bank.

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F. Methodology of Layout

Methodology that can be used for the evaluation of the project site or the reclaimed land given to us and to create the layout report include various attributes like

1) *Shadow Analysis:* It is important to analyse shading caused by surrounding objects and/or vegetation. Shadow Analysis is the major parameter based on which we get the capacity of plant.
2) *Capacity, Optimum Tilt:* Based on the Shadow Analysis or capacity given by our users We take the capacity of a site and calculate the optimum tilt of modules to get maximum sunlight from sun for energy generation through photovoltaic module.
3) *Stringing:* Series, parallel: Based on the voltage range of modules & inverters the string sizing (Number of modules in Series & parallel) will be determined.
4) *Table Size:* Based on the strings, table size is finalized & same size of the table is kept to insure the repeatability of the racking arrangement for easy sourcing.
5) *Inverter Location:* Inverter location is generally governed by optimized cable lengths to keep losses as minimum as possible.
6) *Lightning Arrester Placement:* Lightning Arrester is positioned to cover the complete installed area factoring in the shadow of Lightning Arrester.

III. METHOD AND RESULT

A. Determination OF Plant Capacity

The solar plant capacity is determined by going through a selective case study of a reclaimed mine and by using two completely different condition. For determining the plant capacity we take a sample area of Ramnagar Pandaveswar where total population is on an around 5000 and the total area available after the mining activity or the abandoned area is 1938264m^2 . For generalization Suppose In every house on an average 4 people live.

That implies (5000/4=) 1250 house is there in the locality.

Daily Basic Requirements In a house:

1) 4 Bulbs – Each 60 Watt
2) 2 Fans – Each 80 Watt
3) 1 Tube light - 60 watt

Total Wattage: 500 W taking into account other appliances

Total using hour per day : 15hrs average

Energy used per day per house = 7.5 kWh.

Total KW-h energy used per day of the area =(7.5×1250)= 9375 kWh=9.4 MWh.

And In a year = (9.4×365) = 3431 MWh.

B. Peak Demand Analysis

The peak load or Peak demand of Electrical supply depends on the time of the day as we can see from the graph. During the initial hours of the day, midnight and dawn, the demand is least as lights are off in households, but as the day advances and sun goes down, after noon the demand increases as now not only the offices but also the households switch on their lights and illuminating appliances which draws more electricity.

Most of us also switch on our ACs during the night only so it adds on to the demand. As time approaches midnight, the demand again subsides as we can see.

Peak Demand : 500 × 1250 = 625 KW(As the max load or peak load will generate when all houses in the locality use all the electrical equipment in their respected houses)

Determination of the Capacity of the Battery Bank

Now if we use 120 Volt Battery Bank such that there is 10 number of 12V battery(50Amp) connected in series and there exist n number of such branch connected in parallel. So,

12×10×n×50 = (Peak Demand)/Inverter Converter Efficiency = 625×103/ .8 = 80468.75 kW

n = 120

Therefore the charging Power which will be supplied from the plant itself must be greater than 720KW i.e. 800KW.

1) *Formulation Of the Plant Capacity:* To formulate the plant capacity we consider two case in the first one we determine the plant capacity based on the energy requirement of the locality and the second we determine the plant capacity based on the area available.

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a) Case 1

i) Let us assume that the plant has a capacity of α MW

ii) So, α * 15 * 365 * 1000 = 7.5 * 1250 * 365 = Yearly energy requirement of the locality.

iii) Therefore, the plant capacity, α = 0.625 MW

iv) Now Dimension of solar panel : One 350 watt solar panel has the dimensions (1955 x 992 x 40) mm

v) So, Depending upon 0.625MW plant the number of solar panel required is:

vi) (0.625* 1000000 / 350) = 1786 and the total Area required : (1786 x 1.955 x .992) = 3500 m^2 approx.

vii) Area we have in Pandaveswar is 1938264m^2 then we are using for solar panel installation only 0.18% of the total area.

b) Case 2

i) Total area we have amounts to 1938264m^2. At first we assume that for agriculture and other purposes we left 75% of the total area. Then we have rest 25% of total area, i.e, 484566 m^2. This area then can be used for the solar plant installation now as the solar plant does not include include not only solar panel but also accessary like inverter, substation etc. so that space is also included in the area.Out of the above 25%, around 40% is used for other installation like inverter, substation, transformer, grid etc. for solar installation the are left is 290739m^2 (60%).

ii) Then number of solar panel can be installed maximum : (290739 / 1.955 * 0.992) = 149915

iii) Total watt = 350 * 149915 ≈ 50MW

This the Capacity of the Plant depending upon the area available for solar power plant.

C. Cost Analysis

Cost Of the power plant depends upon various factor and most of is depends upon the site characteristics.

1) Case 1

a) The cost analysis for case 1 that is plant with 1786 solar panel set.

b) One 350 watt solar panel cost = INR 10,307

c) Total panel cost = 10307 * 1786 = INR 1.84 Crore

d) AJB or Combiner box cost approx. = (1786/7 *10000) = INR 24 Lakh.

2) Case 2

a) The cost analysis for case 2 that is plant with 149915 solar panel set.

b) One 350 watt solar panel cost = INR 10,307

c) Total panel cost = 10307 * 149915 = INR 152.52 Crore

d) AJB or Combiner box cost approx. = (149915/7 *10000) = INR 21.4 crores

3) *Variable Costs:* Cable cost (100m solar cable cost around 6698 + overhead line or under ground transmission wire cost + local ac line cost etc.), so this is a variable quantity.

Structural Cost (Frames for panels, ware house for other electrical equipment, electric poles and tower). And the maintenance Cost which includes panels automatic cleaning system.

D. Revenue Generation

Since the Mine chosen, i.e., Pandaveswar is taken as the case study is in West Bengal, we have taken the live dynamics of WBSEDCL, whose tariff plan charges INR15/KVA/MONTH.

Total kWh per day of the area = (7.5 * 1250) = 2175 kWh.

Total kWh per MONTH of the area = (2175 * 30) = 281250 kWh or 5062500 KVA

Revenue Generated per month = 5062500 * 15 = INR 7.6 Crore

Per Year = 7.6 * 12 = INR 91.125 Crore. Therefore the capital invested is well recovered and our revenue gives a good value above the particular break-even ratio, thus incurring a very stable turnover. This not only suggests the viability of the proposition, but also serves the society in a very positive way which is the need of the hour. National Grid Concept and its Procurement in the project : Once the power is generated can never be stored in any storage due to the high generation capacity and as storage efficiency is very low. So every power plant where electricity is generated is connected with the homes and businesses around the country, energy passes through the grid's pylons and cable. National Grid is a interconnected network between various generating point so if power is once generated and fed into the national grid it can be wasted and the concept of storage that power and its cost is also excluded. As every state grid pay price to the energy supplier for supplying the electric power un this case the solar plant will also supply the extra power after fulfilling the demand of the locality to the national grid.

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IV. CONCLUSION

Till now the conventional post mining activities are performed which made employment, revenue and utilization of resources as a constant parameter. But after the mining has been done, these local workers who had been offered a job at the beginning of end up losing their job. The land often remains abandoned after closure of surface openings. The local people either remain unemployed, or go back to their previous source of income, mostly agriculture, or look for other options which ultimately degrades the quality of life and stops development. Thus I propose my idea of using the reclaimed land for generating Solar Energy which supports the motion of Developing the Rural India as well as Green and Clean India. Keeping in view the socio-economic conditions of the country, we are well settled in apposition to tackle the challenges that the projects might have and throw light to the benefits it will have to the society and utilize reclaimed mined out areas using solar energy.

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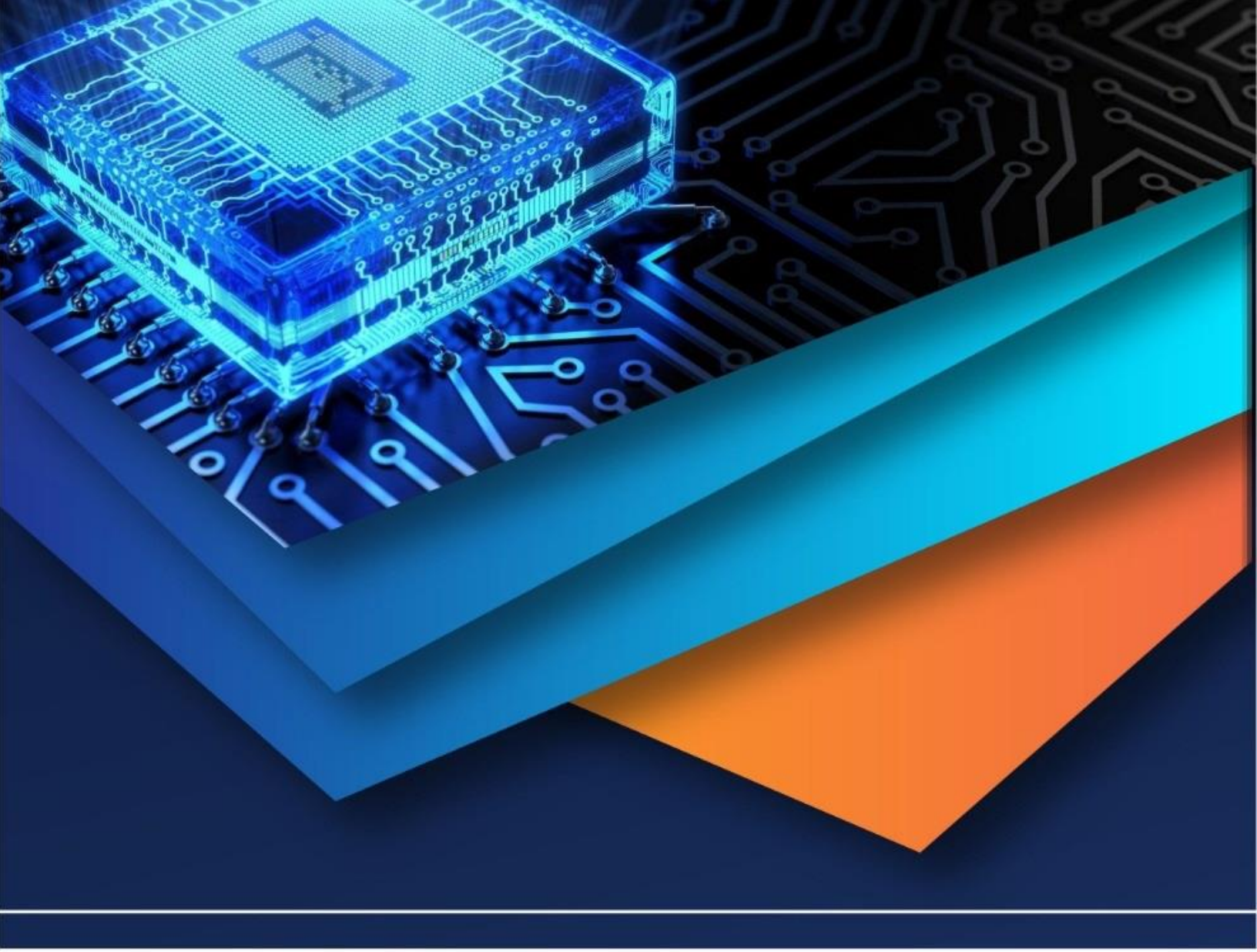

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