

## STUDY AND ANALYSIS OF RENEWABLE ENERGY THROUGH ML ALGORITHMS

Deepak Saket<sup>1</sup>, Dr. Atma Ram Sahu<sup>2</sup>, Lalit Verma<sup>3</sup>

<sup>1</sup>M. tech Student, Department of Energy Technology, Aditya College of technology & Science, Satna, India.

<sup>2,3</sup>Asst. Professor, Department of Energy Technology, Aditya College of technology & Science, Satna, India.

### ABSTRACT

The paper highlights the challenges and opportunities in India's energy landscape, emphasizing the need to reduce reliance on imported oil for enhanced energy security. Despite a lower per capita electricity consumption compared to other developing nations, India anticipates significant growth in the future, impacting industrialization and overall development. The expanding market for carbon fuels is expected to surge due to industrial development and increased manufacturing. To address climate change, India aims to augment its electricity supplies with green energies, promoting sustainability and reducing carbon dioxide emissions. The research explores the demand for renewable energy through time series data analysis, utilizing Python and machine learning techniques, particularly linear regression, to visualize and predict future energy usage scenarios. The study aims to provide insights into the potential of renewable energy in India for sustainable development.

**Keywords-:** Renewal energy, Machine Learning, CO<sub>2</sub> emissions, carbon fuels

### 1. INTRODUCTION

With the rapid growth of the world economy, more people live in urban areas than in rural areas, leading to a substantial increase in energy demand especially in developing countries. The recognition that there is a lack of fossil fuel supplies available for electricity production and climate change due to carbon pollution into the atmosphere has intensified the concern in conserving energy and protecting the earth. Climate change, electricity consumption and foreign oil price volatility have been the focal point of global interest, among other recent topics. Renewable energy sources are currently the most rising energy mix market and provide important opportunities to solve energy efficiency and sustainability concerns. Both countries that are trying to meet the Kyoto Protocol greenhouse gas reduction goal are focusing their energy policies on clean energy and some have also become mainstream in energy production. The energy that we now use is subject to unlimited use and not only to the global inventory of face time, but also the process of energy conversion which generates tangible and intangible waste which have an important impact on the global environment. In order to ensure a secure electricity supply, improve the sustainability of our energy supplies, reduce dependency on fossil fuels and reduce greenhouse emissions, increasing clean energy options has now become the major problem in our contemporary economic and environmental growth.

In view of existing developments, energy demand is therefore increasing. In addition to concentrating on the performance of power plants, each electricity efficiency unit should also be considered to achieve an overall energy-saving impact for renewable resource usage. Consequently, a two-phase Data Envelopment Analysis (DEA) is adopted and two sub-processes are included in a DEA efficiency model to assess the extent of renewable energies management in the OECD countries. In two steps, we calculate management performance (OE) and energy density efficiency (DE). This approach is distinct from previous experiments, which mostly concentrated on evaluating OE. The productivity of power plants is divided into two parts. Management success is no longer restricted by output efficiency but is a wider dimension that encompasses operational practices and energy efficiency. Compared to the conventional single-efficiency model, the sub-process models are well suited to assess consumption efficiency due to the features of the energy industry.

This methodology differs from previous studies, which were mostly focused on assessing OE. Power plant productivity is split into two parts. The effectiveness of management is no longer limited by production performance but is a broader factor, which includes operating practices and energy efficiency. Compared to the traditional one-efficiency model, the sub method models are better suited to evaluate usage efficiency based on energy market characteristics.

#### 1.1 Renewable energy scenario in India

India is one of the countries with high green energy generation. 38 percent of India's built power generating ability was from renewable sources by 27 November 2020. (136.2 GW out of 373.3 GW). In the Paris Agreement India

agreed to a nationally determined goal of 40% of its overall electricity production from non-fossil fuels with end of this decade. In the Central Electricity Authority's plan, the nation aims to achieve an even more optimistic goal of 57 percent of total electricity from renewables by 2027. The 2027 roadmap indicates that India plans to have 275.0 GW of wind energies, 72.0 GW of hydro, 15.1 GW of nuclear power, and almost 100.2 GW of 'other zero emission' outlets. The Government of India has also set a 40GW Rooftop Solar Project (RTP) plan by 2022, including housing rooftop installation. By September 2020, 89.22 GW are still in service, 48.21 GW are being implemented in different phases and 25.64 GW is currently being tendered in various stages.

### 1.1.1 Overview and Future Target

India is operating one of the world's biggest and most aggressive growth projects for green energy. At the 2019 UN climate summit, India declared its clean energy target more than doubling by 2022 from 175.0 GW to 450.1 GW of renewable energy by the same year. New green power sources are expected to rise massively by the nearer 2022 targets, with India's huge wind power doubling by almost 15 times as strong as April 2016. These goals will make India a global leader in the usage of renewables and put India at the heart of the International Solar Alliance "Sunshine Countries" initiative that promotes solar energy growth and production in more than 100 countries worldwide. Energy plays a key position in all countries' economic growth. India ranks second in size, accounting for 17 percent of the total population of the country. The rise in living standards and population in India gives India the third highest energy consumption in the world. Electricity targets for 2022 include 227.0 GW (up from 175.0 GW) of renewable energy sources, including almost 113.0 GW of solar, 66 GW of wind, 10.0 GW of biomass, 5.0 GW of small hydroelectric power, and 31 GW of floating solar and offshore wind power. By the end of 2019–2020, the bid process for the additional 115.0 GW or more required to meet these installed capacity targets set in January 2018 will be completed. Between 2017 and 2022, the government has stated that no new coal-based added capacity greater than 50.0 GW would be needed. Because of their poor purchasing capacity, an improvement in green power generation also raises the residual payment obligations of power purchasers.

Unlike several nations, India did not count big hydroelectric plants as a clean energy goal until 2019 as the hydroelectricity was under the former power ministry, not the ministry of modern and renewable energies. This scheme has improved in 2019 and has also since taken into consideration the capacity of massive hydropower projects. This was done to aid in the export of electricity from large hydropower facilities, and this reclassification enabled these plants to sell their power without being bound by a renewable energy purchasing requirement. The Green Energy Purchase Duty requires state DISCOMs to source their energy from renewable sources in two forms: solar and non-solar. Non-solar green energy is often used to describe the potential of large-scale hydroelectric dams.

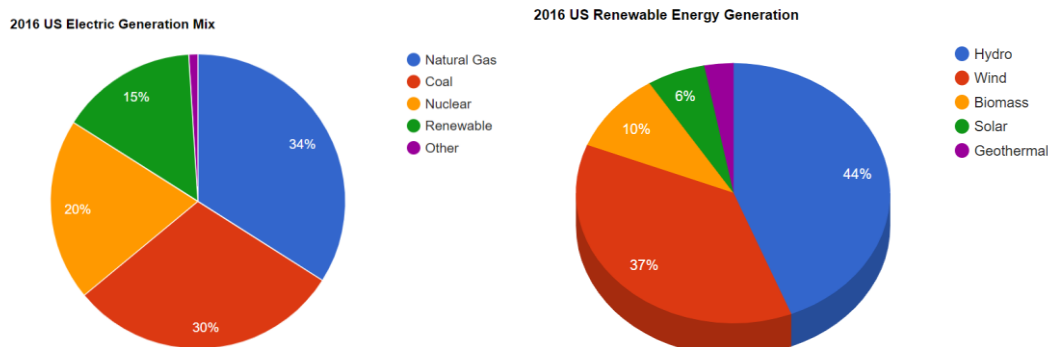
### 1.2 Renewable Energy

Renewable electricity, also called renewable energy, emerges through continuously filling natural sources or systems. Sunlight or breeze, for example, continue to shine and blast, but the availability depends on time and temperature.

Although green energy is mostly considered a recent concept, the usage of natural power for heating, transport and illumination has been used for a long time. Wind has driven vessels to grind grain in the sea and windmills. The sun offered fuel throughout the day and contributed to the kindling of flames. However, people have gradually changed over the past five hundred years to cheaper, more dirty forms of energy like coal and fracked gas. From solar panel rooftops to households that can sell power back into the grid to massive offshore wind turbines, renewable energy expansion is now happening across a wide range of sizes. Even whole rural regions depend on renewable energy for heating and illumination. With the continuing development in renewable energy use, modernizing America's power grid to make it smarter, cleaner, and more streamlined across regions will be a critical goal.

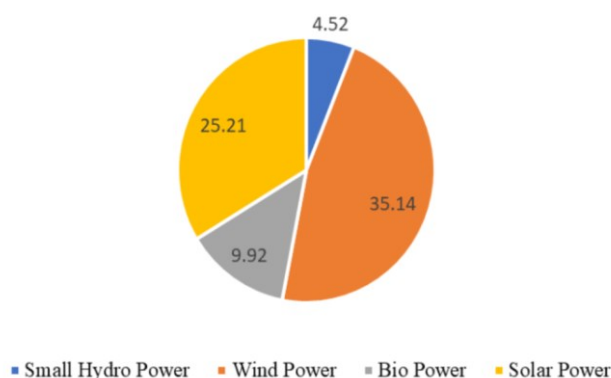
### 1.3 A Comparative Understanding of Renewable Energy in US and India

The figure below present that the resource distribution of the energy in US electricity generation in 2016. Renewable technology offers individuals, businesses and the world with multiple advantages. This example could reveal the acceptance of renewable energy resources in US and just below the Indian scenario has been illustrated.



**Figure 1. 1** renewable energy resources in US-I      **Figure 1. 2** renewable energy Ge in US-II

India's total installed renewable energy capacity as of December 31, 2018. The renewable energy resources as in Indian prospective and the capacity as illustrated below.



**Figure 1. 3** renewable energy resources as in Indian prospective

**Source:** Ministry of New and Renewable Energy and Press Information Bureau, Government of India, compiled by CSIS Wadhvani Chair staff.

The second major source of industrial air contamination in the United States is electricity production. Most of our power comes from biomass, nuclear power and other non-renewable power plants. Our atmosphere is heavily affected by the generation of electricity from these materials, polluting air, land and water. Renewable energy supplies may be used to provide less environmentally compatible power. Electricity from green energies may be generated without the production of carbon dioxide (CO<sub>2</sub>), the leading cause of world climate change. First of all, what is green energy? Renewable energies are electricity extracted from renewable materials, which are refilled over time without depleting the resources of the Earth. These tools are often plentiful and accessible almost anywhere, causing few, if any, disruption to the ecosystem. Examples of electricity from the light, wind and heat contained in the surface of the earth. In contrast, fossil fuels, such as oil, coal and natural gas, are not green because their quantity is limited – they would stop being available as an environmentally sustainable energy source until they are produced. Though manufactured by natural systems, the processes are too sluggish to refill these fuels as fast as people need them, meaning that sooner or later these supplies are lost.

#### 1.4 Electricity Generation and it impact on Health

- ✓ Most of the nations in production of electricity produces acid-related Sulphur dioxide (SO<sub>2</sub>). Sulfur dioxide causes asthma attacks in people and leads to the production of fine particles, often harmful for pulmonary wellbeing, according to the American Lung Association.
- ✓ 29% of nitrogen oxides (NO<sub>x</sub>) that contribute to soil ozone and smog with sunlight are derived from power production. The American Lung Association says that high NO<sub>x</sub> levels increase vulnerability to respiratory infections, particularly among children.
- ✓ Ozone (O<sub>3</sub>) exists normally, where it is useful in the upper atmosphere. In the lower atmosphere, though, pollution causes the urban layer we term smog. The main contributors to soil ozone are automobiles and power production. According to the American Lung Association breathing ozone will contribute to shortness of breath, lung infection, asthma, and an increased likelihood of chronic lung disease for children growing up in places with elevated ozone emissions.

- ✓ Particulate matter is most generally referred to or soot as air contamination. Especially unhealthy is respiratory exposure (e.g., asthma, bronchitis, emphysema) and cardiac diseases.
- ✓ Carbon dioxide (CO<sub>2</sub>) is an environmentally responsible greenhouse gas that leads to global climate change. Long-term consequences of fossil fuel combustion may be much more troubling today than fatalities from air emissions. In the future, tropical diseases could prosper as the temperature of the world warms and fatalities might escalate as a result of severe weather conditions.
- ✓ Mercury is an extremely poisonous metal emitted from coal-fired power stations. Mercury accumulates in fish and other species' fat cells. They are prone to mercury while people consume the fish. Mercury permanently damages the liver and central nervous system, leading to deterioration of engine control, slurred voice, perception of the tunnel and hearing loss. Mercury is particularly dangerous when taken by pregnant women or nursing women because it may induce child defects and developmental defects. When mercury accumulates in biological life, the food chain is actively processed in the atmosphere.

#### 1.4 Renewable energy has more benefits than drawbacks

The optimism is beyond the pessimistic when it comes to green energies. The intimate, corporate or governmental transition to green energy would contribute not only to saving money but also help to create a safer, healthier world for the future. Solar panels are one of the most straightforward ways to transition to a green energy source. It will compare multiple quotes from local, pre-screened installers to see how much your property costs and saves by registering with the EnergySage Solar Marketplace. The quotes even include projections of the greenhouse dioxide emissions that would be reduced over 20 years, equating both planting trees and burning petrol gallons.

#### 1.5 The future of renewable energy

With the global population increasing, energy demand is also growing to fuel our households, industries and cities. Innovation and solar energy growth are crucial to ensuring a balanced energy standard and protecting our world from climate change. Renewable sources already make up 26 percent of world power, but it is predicted that by 2024 it will cross 30 percent, according to the International Energy Agency (IEA). "This is a crucial moment for green energies," said Fatih Birol, the IEA Executive Officer. In 2020, the UK reached a new incredible benchmark in green energies. On Wednesday 10 June, the world celebrated for the first time two months of clean energies solely. This is a big move in the right direction for clean energy.

## 2. LITERATURE REVIEW

Deshmukh et al. (2021), illustrated as the India has set ambitious goals for the installation by 2030 of more than 400 GW of wind and solar energy production with over two thirds of solar power. This paper explores the cost to efficiently run India's grid for power and carbon reduction in 2030 in a range of wind and solar goals (200 GW to 600 GW) and the most viable solutions for that such costs. They found that the lowest carbon offset costs in most cases are systems where solar photovoltaics represent just 25 to 50 percent of the overall renewable goal. This outcome calls for a review of the existing goals for solar majority in India. Saraswat & Digalwar (2021), presented a paper which evaluates traditional and renewable sources of energy for sustainable energy production in India from various viewpoints, including economic, engineering, social, environmental, political and versatile parameters. Arumaraj & Shereef (2021), analyses with redox flow battery (RFB) in EVs in conjunction with a new system of transportation and storage of electric energy. The appropriateness of RFB to be included in the same battery is tested compared to Li-ion battery. For e.g., India uses the budget allotted for the green corridor project as a criterion to conduct the financial viability review. The combined approach makes it easy to use EVs, grid service programmes and absorb RE. The study shows the need for concentrated studies in developing low viscosity RFB electrolytes to achieve the technology's maximum potential. Wang & Liu (2021), presented the scenario of Indian energy situation as a developing nation continues to be troubled with issues such as energy deficits, energy protection challenges and poor energy production. Renewable electricity supplies are the main path for India to resolve this problem. Li & Wang (2021), demonstrated that the various energy systems, hybrid green energy systems offer a promising path to collect the highest possible renewable energy. It has become a common and growing subject in the area of science in the last decade. This paper examines the current application and recent progress in the design and implementation of sustainable hybrid energy systems. Elavarasan (2020), put a novel view of the recent growing public interest in climate change concerns, the share of renewable energy production increases every day. An increased share of renewables would provide us with robust, reliable and environmentally responsible electricity services for the future. Penetration of renewable energies into existing power systems requires considerable study, preparation and growth that are now the world's main priority. In this report, a thorough analysis of the Gujarat state of India has been clarified in depth, as opposed to India, through a case study. Ramesh & Saini (2020), present a scenario of



considerable population of Indians reside in villages and others remain in rural places that are not linked to the grid. It is not possible to extend the grid link to provide electricity to these villages, but a stand-alone hybrid renewables system is a viable alternative. Gulagi (2020), this analysis analyses energy transfer paths. The high-temporal space-resolution linear optimization technique, LUT Energy System Transformation, is used to model the transition energy system from 2015 to 2050 for Bangladesh. Elavarasan (2020), presented an article on renewable energy and generation of electricity. Renewable energies would be humanity's irrefutable future, where carbon demands are met, and its non-renewable counterparts are, by necessity, short-lived in the grand scheme of things. Debates are tantamount to flogging a dead horse, but it now remains to refine the most of certain tools. This research study examines India's technical progress in the area of renewable energy in recent decades. Simultaneously, that would be contrasted with the pace of employment in the same sector in other countries. Madurai Elavarasan (2020), examines India's installed power and reports that Maharashtra State is heavily involved in the Indian energy mix. The State Energy Mix is further examined by contrasting the present and potential aims of the State Action Plan. The fulfilment of the planned 2022 RES capability is a major challenge for the state. In this context, an overview of the capabilities, barriers and threats of the State is addressed. In addition, solid feedback and advice are made to clear the path to the intended goal. For government institutions, the scientific sector, institutional developers, decision makers and stakeholders interested in the creation of a potential renewable energy infrastructure, this can be helpful. Rani (2020), explored through an article which has selection of suitable renewable energy sources that has been an increasingly important topic in recent years and affects environmental and economic growth. To address the problem, some scholars have focused on preferentially implementing decision-making techniques using different fuzzy processes. Saiprasad (2019), In this report, many possibilities are investigated by studying the technoeconomic and environmental effect of a small population in India on RE adoption by optimizing the hybrid renewable energy system (HRES). India's primary goal is to priorities the use of renewable energies (RE) to achieve the techno-economic equilibrium and to generate beneficial environmental effects. Das et al. (2019), published an article over the Development of the hybrid green energy system which has been a difficult challenge to address renewable energy interference and the multi-dimensional (e.g., technological and economic) nature of hybrid systems. Pursiheimo et al. (2019), present an article which utility coupling viewpoint, the future of renewable energy is analyzed by utilizing the global system model. Four possibilities, apart from biomass capacity and electric vehicle market share, are explored in the energy sector with a strong renewable share. In contrast, the company-as-usual example is used for carbon penalties but without absence of non-renewable fuels. In the green scenarios, high taxes for the year 2050 exclude non-renewable energy sources and enable the model to find a cost-effective way from 2010 to 2050. Bose & Sarkar (2019), illustrate in an article during the 2017–18 cycle, 23,375 GW of solar, wind and hybrid power was auctioned by central and government entities. Owing to expectations of low cost of capital products such as solar panels, the auctions have led to historically low offers. Singh, R. (2018), represented an Indian energy situation which has suffered constantly from issues such as energy deficits, energy inequity and energy protection challenges.

### 3. METHODOLOGY

Data analysis is the process of explaining and demonstrating, condensing and recapturing, and analysing data using statistical and/or logical processes on a regular basis. Different empirical approaches provide "a way to draw inductive inferences from data and to distinguish signal (phenomenon of interest) from noise (statistical fluctuations) in data," according to Shamoo and Resnik (2003). In qualitative science, data analysis may include statistical methods, but it often becomes an ongoing iterative process in which data is collected and analysed almost simultaneously. In fact, during the data collection phase, researchers usually look at empirical patterns (Savenye, Robinson, 2004). The style of research is determined by the type of data (field studies, ethnographic material examination, oral history, profile, non-study) and the qualitative approach used (field studies, ethnographic material review, oral history, profile, non-study) (field notes, documents, audiotape, videotape). Maintaining data integrity necessitates an accurate and adequate analysis of study findings. Improper methodological analyses misrepresent science results, perplex casual readers, and have a negative impact on public expectations of research. Shepard (2002; Shepard, 2002; Shepard, 2002; Shepard, 2002) Integrity issues are just as critical when it comes to analysing non-statistical data.

#### 3.1 Considerations/issues in data analysis

- ✓ There are a host of problems that researchers should be aware of in terms of data collection. These comprise:
- ✓ Having the requisite analytical skills
- ✓ Selecting approaches for data processing and appropriate interpretation at the same time
- ✓ Drawing unbiased results
- ✓ Inappropriate review of subgroups

- ✓ Following appropriate discipline standards
- ✓ Statistical value determination
- ✓ Clearly specified and objective calculations of results
- ✓ Providing truthful and precise review
- ✓ Manner of data presentation
- ✓ Environmental/contextual questions
- ✓ Type of data recording
- ✓ Partitioning 'letter' for qualitative data analysis
- ✓ Training of workers analysing
- ✓ Confidence and validity
- ✓ Approach to research

### 3.2 Analyzation of Data

Researchers have been given ample instruction to show a good level of scientific procedure tacitly. Unintentional 'research error' is probably the product of inadequate learning and follow-up. A variety of studies show that this may be the case rather than expected (Nowak, 1994; Silverman, Manson, 2003). Researchers' standard practise is to defer the selection of analytical technique to a 'statistician' analysis unit. Ideally, researchers can have something more than a clear grasp of the reasons for using one study approach over another. This allows researchers to properly supervise employees who perform data analyses and make educated judgments.

### 3.3 Concurrently selecting data collection methods and appropriate analysis

While methods of analysis can vary according to scientific discipline, the perfect stage in the testing phase for deciding suitable analytical technique is early and should not be considered afterwards. "Statistical guidance can be sought at the initial preparation level, according to Smeeton and Goda (2003), so that, for example, the process of sampling or designing a questionnaire is suitable."

#### Reliability

Researchers conducting analyses of either quantitative or qualitative analyses should be mindful of the efficiency and validity problems. Gottschalk (1995), for instance, discusses three variables that may influence the reliability of the evaluated data in the field of content analysis:

- ✓ Reproducibility or the propensity of a category of categories representatives to be equally classified
- ✓ Accuracy or the degree to which a text classification is statistically consistent with a standard or norm
- ✓ The capacity to compromise the quality of data exists where researchers cannot reliably prove that data analysis is stable, reproducible or accurate
- ✓ The validity of the content review report applies to category communication (classification where the raters are designated to text content) and the generalization of findings to theory.

#### Extent of analysis

Raters have to assign each code into a relevant group of a cross-reference matrix by coding texts for content review. Confidence in computer software can contribute to inaccuracies in determining the frequency or word count. "One can accurately count the incidence and frequency of the expression, but does not accurately account for the significance of each use" (Gottschalk, 1995). Further analysis may be appropriate to find new meaningful underlying variables for dimensionality or identity of the data collection. If statistical or non-statistical analytical approaches are used, researchers should be mindful of the potential to compromise the accuracy of results. Although statistic research mostly is done for quantitative data, various analytical procedures, like text, thematic, and ethnographic analyses, are especially tailored with qualitative information. If quantitative or qualitative phenomena are studied, scholars utilize a range of instruments to interpret information in order to verify assumptions, distinguish behavior trends and eventually respond to questions of study. Failure to understand or recognize issues of data processing can undermine the quality of data.

### 3.4 Regression analysis

Regression analysis is a technique for estimating the relationship between a collection of variables. During every regression study, this thesis attempting to determine if there is a relationship between a dependent variable (the outcome or variable that you want to evaluate or preview) and a series of independent variables (factors which may have an impact on the dependent variable). The independent variable is social networking expenditure; you want to see whether it influences sales and, most importantly, if it is worth raising, decreasing, or sustaining. This may use statistical analysis to see how the two variables are related. A good correlation might mean. No association whatsoever

may mean that social network marketing would not affect the revenue. Understanding the interaction between these two factors will allow you to make better choices on the expenditure for social networking. However: It should be noted that regressions should only be used on their own to decide if a connection exists or does not exist between a series of variables, they say little about the cause and effect. Whereas there could be a strong association between expenditure on social media and sales income, it is not feasible to draw conclusive conclusions on the basis of this study alone.

### 3.5 Time series analysis

Time series analysis involves studying time-related patterns to predict future changes in a particular element of interest. Key themes in time series data include stable trends, predictable variations influenced by seasons, and unpredictable intervals with fluctuations unrelated to seasonality, possibly tied to economic or industrial factors. The ability to make informed forecasts based on this analysis holds significant business value. Different templates can be utilized depending on the data used in the process and the desired forecasting results.

### 3.6 Methodology

# Step 1: Dataset Pre-processing

```
{  
# Outline of the data  
data_outline = explore_data(dataset)  
# Determine and delete outliers  
dataset = remove_outliers(dataset)  
# Identify and process missing details  
dataset = process_missing_data(dataset)  
# Apply effective standardization strategies  
standardized_data = standardize_data(dataset)  
# Substitute the mean and median  
dataset = substitute_mean_median(dataset)  
}
```

# Step 2: Model collection

```
{  
# Data discovery importance (classes)  
classes = discover_classes(dataset)  
# Machine-learning (Regression) Sorting algorithm  
regression_model = train_regression_model(dataset)  
}
```

# Step 3: Python Model Implementation

```
{  
# Import Data  
data = import_data()  
# Integrating all templates with Python  
model_result = implement_model(regression_model, data)  
}
```

# Step 4: Classification Results

```
{  
# Accuracy estimation by the operator "Performance"  
accuracy = calculate_accuracy(model_result, ground_truth)  
# Analyses outcomes by precise measurement  
analyze_results(accuracy)  
}
```

#### 4. ANALYSIS AND SIMULATIVE RESULT

In India, the heavy reliance on imported fossil fuels for commercial energy needs poses a vulnerability to geopolitical uncertainties, potentially leading to severe energy shortages and hindering industrial and economic development. To enhance energy security, India needs to decrease its dependency on imported oil by fostering alternative energy sources. Despite a comparatively lower annual per capita electricity consumption, India's growing economy and industrialization project a significant increase in demand. Sustainable renewable energy emerges as a crucial factor in India's industrialization and growth, offering a solution to combat climate change and supplement electricity supply. The escalating demand for renewable energy necessitates a strategic action plan to identify resources, predict usage, and meet the growing needs. Time series data, particularly from solar energy, has been analyzed using Python, providing insights into the present conditions and future prospects of renewable energy. The simulation results offer a visual representation of the Python-based process steps, emphasizing the importance of exploring and predicting renewable energy trends for meeting future demands.

```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import matplotlib.pyplot as plt # Visualization
import seaborn as sns #Visualization
from sklearn import datasets, linear_model
from sklearn.metrics import mean_squared_error, r2_score
pd.set_option('display.max_columns', 500)
```

Fig. 1: Python Library

```
df = pd.read_csv('SolarPrediction.csv')
df.head()
```

	UNIXTime	Data	Time	Radiation	Temperature	Pressure	Humidity	WindDirection(Degrees)	Speed	TimeSunRise	TimeSunSet
0	1475229326	9/29/2016 12:00:00 AM	23:55:26	1.21	48	30.46	59	177.39	5.62	06:13:00	18:13:00
1	1475229023	9/29/2016 12:00:00 AM	23:50:23	1.21	48	30.46	58	176.78	3.37	06:13:00	18:13:00
2	1475228726	9/29/2016 12:00:00 AM	23:45:26	1.23	48	30.46	57	158.75	3.37	06:13:00	18:13:00
3	1475228421	9/29/2016 12:00:00 AM	23:40:21	1.21	48	30.46	60	137.71	3.37	06:13:00	18:13:00
4	1475228124	9/29/2016 12:00:00 AM	23:35:24	1.17	48	30.46	62	104.95	5.62	06:13:00	18:13:00

Fig. 2: Import Dataset

```
#Correlation Plot
```

```
corr = df.corr()
sns.heatmap(corr)
```

```
<AxesSubplot:>
```

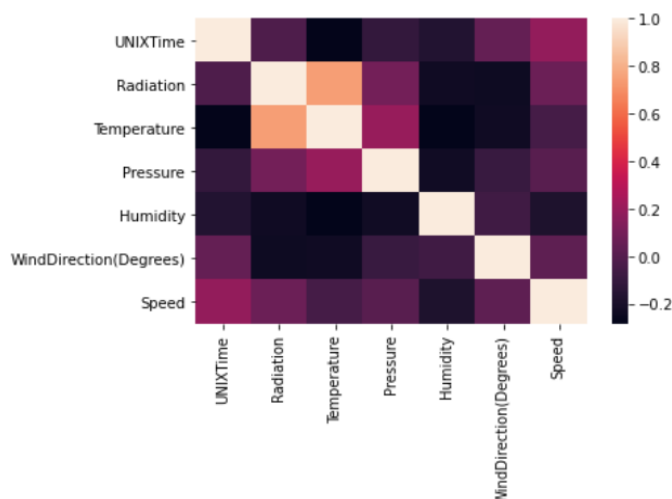


Fig. 3: Correlation plot



## Train Test Split

Split The data Split the data into 3 which are:

- Training Set : this set will be used for training the model
- Validation Set : to check overfitting of the model
- Testing Set : To see how well our model does in the end

```
from sklearn.model_selection import train_test_split
X = df[['Temperature', 'Pressure', 'Humidity', 'WindDirection(Degrees)', 'Speed']] #Independent variable
y = df['Radiation'] #dependent variable

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2)
```

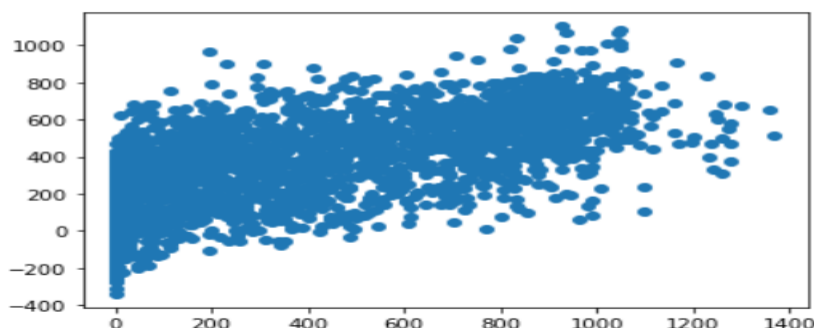
**Fig. 4:** test and train pf data

The provided heat map represents the correlation among key variables in solar data. The dark colors indicate low correlation, while lighter colors signify higher correlation. This visual depiction helps in understanding the relationships between different variables, with darker shades suggesting weaker connections and lighter shades indicating stronger correlations.

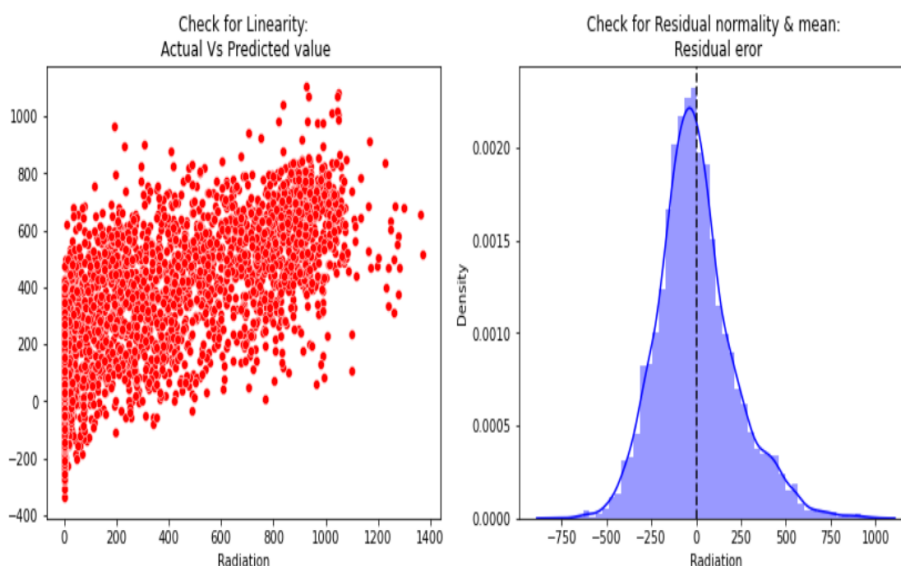
The provided screenshot depicts the division of data into training and testing sets. This separation is essential for machine learning purposes. The training set is utilized to train the model, allowing it to learn patterns and relationships within the data. Meanwhile, the testing set remains unseen by the model during training and is employed to evaluate the model's performance and generalization to new, unseen data. This process helps ensure the model's effectiveness in making accurate predictions on new, real-world data.

## Model Building

```
plt.scatter(y_test, predictions)
<matplotlib.collections.PathCollection at 0x1c21a674f10>
```



**Fig. 5:** Test Prediction



**Fig. 6:** Check for Linearity and residual normality & mean

```
from sklearn import metrics

print('MAE:', metrics.mean_absolute_error(y_test, predictions))
print('MSE:', metrics.mean_squared_error(y_test, predictions))
print('RMSE:', np.sqrt(metrics.mean_squared_error(y_test, predictions)))
```

MAE: 164.01092615992266  
MSE: 46590.01134387128  
RMSE: 215.8471944313182

**Fig. 7:** MAE, MSE, RMSE

The above graph illustrates the comprehensive exploration and prediction of solar radiation patterns using machine learning techniques. The dataset incorporates various parameters such as time, temperature, pressure, humidity, wind direction and speed, Time-Sun-Rise, and Time-Sun-Set.

A noteworthy aspect of this research is the prediction of solar radiation based on sunset and sunrise times. The evaluation of the model's performance is measured through three key metrics: Mean Absolute Error (MAE), Mean Square Error (MSE), and Root Mean Square Error (RMSE).

These metrics serve as crucial indicators of the accuracy of the solar radiation forecasts, providing valuable insights into the effectiveness of the machine learning techniques employed in this exploration.

## 5. FINDINGS OF THE RESEARCH

- India heavily relies on imported oil and natural gas for its commercial energy needs.
- In 2013, India produced almost one billion barrels of oil but imported nearly 1.5 billion barrels of oil and petroleum products, emphasizing its status as a net importer.
- The nation's significant dependence on energy imports poses a risk, as any unexpected reduction in supply could impede industrial and economic growth.
- To achieve energy independence, India must decrease its reliance on foreign oil and increase the utilization of renewable energy sources.
- Despite being a developing country, India has a lower annual per capita energy consumption compared to other South Asian nations.
- Projected increases in energy consumption are expected to be substantial, driven by rapid economic growth and the potential for industrialization.
- Clean energy resources, particularly solar power, have the potential to play a vital role in advancing India's economy and industrial development.
- The overall demand for fossil energy is predicted to rise in the near future, driven by increased industrial and economic activities.
- Expanding the use of renewable energy is crucial for India not only to address climate change but also to meet the growing demand for energy sustainably.

## 6. CONCLUSION AND FUTURE SCOPE

India is urged to cultivate alternative energy sources to reduce its dependence on imported oil and achieve energy stability. Despite a per capita energy consumption lower than developed countries, the nation anticipates a significant rise due to rapid economic and industrial growth. Sustainable renewable energy emerges as a pivotal player in India's industrialization and overall development. With steady economic and manufacturing growth, the demand for fossil energy is expected to surge in the near future. Beyond meeting energy needs, renewable technologies contribute to India's fight against climate change.

The feasibility of renewable energy is reinforced by increased yields from carbon dioxide reduction allowances under clean growth management. The clean energy market has witnessed substantial growth, necessitating a comprehensive action plan to meet demand and support renewable energy development. Understanding the current state and projected applications of renewable energy is crucial for formulating effective strategies. Investigating clean energy as a prospective future supply and demand source is paramount for sustainable development.

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