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A Study of Factors Influencing Renewable Energy Resource Management: Challenges and Opportunities for India

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Abstract
The global economy has shifted its paradigm from agricultural, manufacturing to service-driven, all-inclusive economy. The international market dynamics, geo-political conditions, trade and commerce, strategic alliances, diplomacies and government reforms have long-lasting impact on the various national economies. The industrialization, urbanization, explosion of population, and infrastructure developments have led to exploitation of natural resources beyond the limits. It also caused the air pollution to the great extent. Delhi City is the example in this regard. India is a developing economy. It needs development but not at the cost of causing harm to nature, environment. Economy and ecosystem both are equally important for India. India consumes 1, 137.00 bn kWh energy every year (World Data, 2022). It is likely to grow. In order to cater the diverse needs of energy, renewable energy is an alternative to continue growth and sustain. Naturally, the governments, industries, and other stakeholders have to concentrate on renewable energy. However, there are certain factors influencing the growth, consumption, investment, production, utilization, efficiency of renewable energy resource management. The present article aims to identify the factors influencing renewable energy (Solar, Electric, Ethanol etc.**)** in terms of challenges and explore the opportunities from Indian perspective and context. It is high time to find out the best ways to sustain without causing harm to environment. In this study, primary data were used to collect information using a self-made questionnaire, and the data were processed using SPSS 25.0.
Keywords: *Renewable Energy, Energy Resources, Electric Industry, Renewable Resources, Resource Management, Power Sector in India*

1. INTRODUCTION

Trade goods and the most important component of economic activity is energy. Consumption and production are two broad categories by which economic activity can be divided. Especially in developing and underdeveloped countries, energy is a scarce resource. Economists contend that energy is both an input into economic processes and an intermediate good whose demand is classified as derived demand. Energy is thus a prerequisite for the growth of the economy. The importance of energy in economic development processes, economic growth, consumption, demand, supply and living standards are theorized and emphasized by contemporary economists. Energy consumption and economic growth have a clear and predictable relationship, according to economists. However, the conventional energy source is used heavily, which is having a negative daily impact on the supply. Due to the high demand and necessity of conventional energy for modern consumption, it affects both price and production. However, it causes a problem with environmental pollution, results in a significant rise in infrastructure and management costs, and exacerbates the shortage of conventional energy sources. As a result, many traditional energy sources are imported. Foreign direct investment has withdrawn more as a result of its effects (Ahmar, 2018). It causes an energy crisis and is essentially a conflict between insufficient energy resources and an excessively high demand for energy. Although renewable sources can also be used to produce energy, their share is currently very small and will remain so, at least for the near future. The circumstances of energy production and the uses to which it is put all have a significant impact on the link between energy and economic growth. Due to the production and supply issues with conventional energy sources, more and more countries are becoming interested in using various forms of renewable energy. As compared to conventional energy sources, renewable energy has more advantages and is more widely used. In India, where there are 1.22 billion people, 300 million people do not have access to electricity, a problem that is not limited to rural areas but also affects urban areas. Individuals and the government are promoting renewable energy sources to address the issue of electrifying both rural and urban areas in order to promote sustainable development.

1.1. BACKGROUND OF THE STUDY

Energy in physical science refers to the ability to perform work. For instance, lifting, accelerating, heating, etc. (Akinwale Y, 2017). While it is a crucial input in the production process, "energy" also refers to all energy commodities, energy resources, consumption, and production, as well as an essential component of consumption.

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1.1.1. ENERGY SOURCES

There are essentially two categories of energy sources. These are:
1. Conventional energy, non-renewable energy, finite resources or industrial energy sources
2. Unique energy sources, renewable energy, undeniable resources or alternative energy sources.

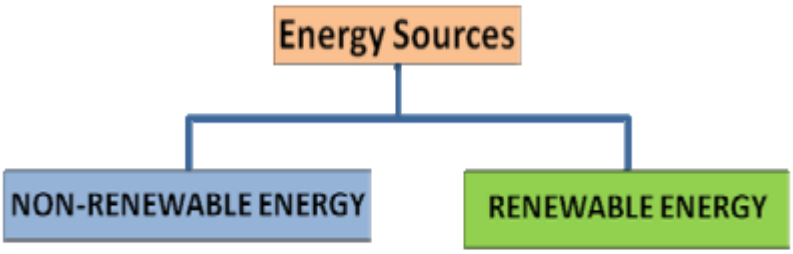

Fig.1. Energy sources

- **Coal:** Non-renewable energy resources are traditional energy sources that have developed in nature more than a year or for quite a while and won't be quickly supplanted when spent. Coal, petroleum gas, oil, power, thermal power, and so on are a couple of models.
- **Energy:** One of the main energy sources, coal is utilized for various purposes, including the warming of homes, as a fuel for boilers and steam motors, and for the creation of power by nuclear energy stations. A natural resource cannot be created again and is not renewable. The coal cannot be returned to its original form after use.
- **Gas:** This is one more customary wellspring of energy. Coal, oil, atomic, and hydroelectric energy are utilized to create power. It is a fundamental human need. The energy from LPG sources is produced from petroleum gas sources.
- **Nuclear energy:** Uranium is used in nuclear fission to produce energy. Because uranium loses value after use, it is a nonrenewable resource.
- **Oil:** Petroleum is extracted from a well on land and in the water. It will make use of the service sector and electricity production.

Non-commercial sources of energy, renewable energy, inexhaustible resources, or alternative forms of energy (Azar G. C., 2017). These sources come from the natural processes continuously. Since most of renewable energy is determined either straightforwardly or in a roundabout way from the sun, wind, and can never run out, it is alluded to as renewable energy. The various kinds of renewable energy include:

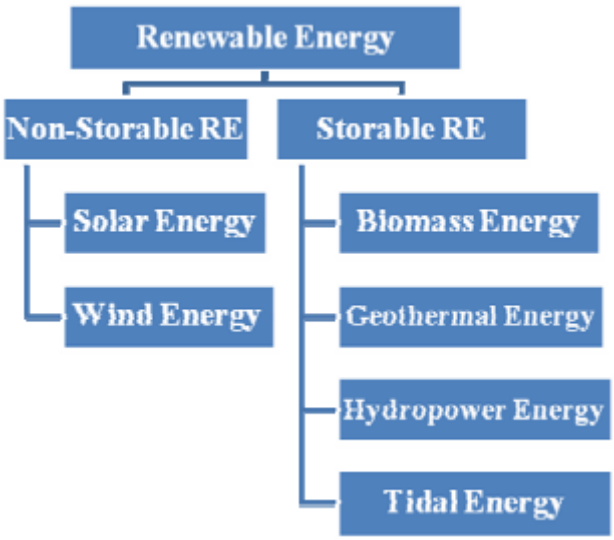

Fig.2. Renewable Energy

The energy that the earth gets from the SUN is known as sun based energy. The sun is an essentially boundless and sans cost wellspring of energy. Home warming, lighting, cooking, and power are completely given by sunlight-based energy.

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All energy structures on earth get from it. Advancements that have been made to completely use sunlight based energy it tends to be utilized as sun powered nuclear power or sun oriented photovoltaic energy, individually. Sun oriented nuclear power can be utilized to cook, heat the air, dry materials, and that is only the tip of the iceberg. Sunlight based photovoltaic energy can be changed over into power for running engines, siphons, and illuminating structures and homes. Solar energy is undoubtedly one of the best alternatives because it is a pollution-free, environmentally friendly energy source (Bala-Subrahmanya MH, 2010).

- **Wind Energy:** Another non-traditional energy source that uses solar energy is wind energy. It is employed to produce electricity. India is a country with a lot of hilly, coastal, and desert areas, so wind energy is very important there. It is used to pump water in rural areas. The advantage of wind energy is that it produces electricity continuously while being completely pollution- and environmentally-friendly. It is the most practical method of energy and environmental preservation.
- **Biomass Energy:** Waste from plants and an animal that is used to produce energy is known as biomass. Biomass energy, for example, creature fertilizer and plant squander, can be utilized to deliver fuel, power, light, and intensity. Biomass energy is thusly gotten both straightforwardly from plants and by implication from creature squander (Bhattacharyya, 2012).
- **Hydroelectric Energy:** It is one of the energy sources that is produced from swiftly moving water and is renewable. It does not produce any pollution. The turbines are spun by the flowing water, which in turn produces electricity.
- **Co-generation Energy:** Co-generation is the process by which fuels, such as natural gas, are used to run sugar mills' thermal and electrical generators simultaneously.
- **Tidal Energy**: As the mass of water moves inward and outward, tides generate energy. It is possible to use it to produce electricity using hydroelectric dams. In India, it has not received high priority.
- **Geothermal Energy:** The earth's hot interior provides geothermal energy. As one moves closer to the centre of the earth, the temperature rises by 300 c per km on average. Drilled holes can be used to extract the dry steam, wet steam, or hot water produced by geothermal energy, which can then be used to generate electricity or for other heating needs.

As a result, renewable energy is more economical, environmentally friendly, and sustainable. It also preserves natural resources and reduces health issues.

1.2. SIGNIFICANCE OF THE STUDY

Renewable energy (RE) produced from natural resources like the wind, sun, water, and biomass has the potential to satisfy a variety of evolving energy needs. Traditional uses of RE sources include heating, cooking, producing steam, propulsion of ships, and powering grain mills. The same sources which are commercially exploited have the capacity to deliver contemporary energy end-use services without having an adverse impact on the environment. Apart from being environmentally sustainable, using RE has a number of advantages (Chen, 2018). By supplying additional energy in rural areas and meeting existing demands, RE aids socioeconomic development. It can offer decentralized energy supply to the household, local business, and agricultural sectors. Utilizing RE productively in rural areas can also boost income levels, create job opportunities, and enhance quality of life. Through off-grid electrification and captive consumption in industries, RE has proven to be a potentially practical option for improving access to energy in many places. In addition to developing local manufacturing capacities, RE sources diversify the energy supply markets and ensure long-term sustainable energy supplies.

1.3. OBJECTIVES OF THE STUDY

1. To investigate the consumption of electricity affects the advancement of renewable energy technologies
2. To determine how electricity production affects technological innovation
3. To gain access to the effects of technology advancements related to renewable energy sources or contributions to the primary energy.

2. LITERATURE REVIEW

2.1. Use of Renewable Energies In India

Ciriminna et al. **(2018**) have explored the utilization of sun powered energy for the distant of Sicily. As per the creators, these islands have made various notable advances in the utilization of sun-oriented energy, including the utilization of sun-based power for water desalination. They likewise referenced that eliminating current hindrances is important for a higher entrance of REs in the Sicilian islands.

Franzitta et al. (2020) have used REs to analyze the Maltese islands' electrical energy sector in an effort to make it more sustainable. The authors suggested using offshore solar-PV systems and wave energy systems together to generate

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electricity. As indicated by them, introducing 60 MW of seaward sun powered PV plants will create around 4.4% of Malta's yearly energy needs, while introducing 130 MW of wave homesteads will deliver around 5.7% of Malta's energy necessities.

Kougias et al. (2020) have researched how to use renewable energy sources to build a sustainable energy system on isolated Mediterranean islands. According to the authors, the cost of producing electricity will go down as REs are used more frequently in islands. They added that there would be numerous economic and environmental advantages from using indigenous REs more frequently in place of conventional fossil fuels. The year 2019 saw the publication of a list of best practices for EU islands that are undergoing the energy transition. Successful initiatives from ten islands across all of Europe are presented. It is mentioned that island communities will find the new EU's clean energy package interesting because it places citizens at the centre of the energy transition. A concentrate on involving islands as test locales for inventive energy arrangements was delivered. The report advocates for "brilliant islands," which give a coordinated strategy to island improvement. The report examinations issues connected with savvy frameworks for shrewd energy arrangements, power capacity, energy-effective road lighting, and foundation for electric vehicles.

2.2. Use Different Renewable Energies

Argiriou et al. (2019) have explored the Greek sun powered warm market. The nation has one of the most evolved sun oriented warm business sectors on the planet, as indicated by the creators. The motivations on the interest and supply sides, quality affirmation systems, as well as the useful job of the producers, were referenced as a portion of the variables adding to its prosperity.

Karagiorgas et al. (2018) have talked about the utilization of modern sun oriented nuclear power in Greece. The creators noticed that new modern sun oriented warm applications offer benefits concerning economy, climate, and energy. While depicting eight fruitful sun powered warm applications in the Greek business, they additionally noticed that future applications have great potential in ventures like agro-food, materials, synthetic substances, and drinks.

Raboni et al. (2018) have researched the production and utilizations of biogas in Europe. The creators guaranteed that the EU's top makers of biogas are Germany, Britain, Italy, and France. Moreover, they noticed that while biogas is created in landfills and sewage treatment offices in Britain, anaerobic assimilation (or co-absorption) of natural matter is the reason for biogas creation in Germany.

3. RESEARCH METHODOLGY

The energy sector is the subject of this study, with special attention also paid to renewable energy sources, as well as its various components, including energy consumption, total investment and quantity. Patents are filed over time. Primary data was gathered for this study (Hartley, 1984).

3.1. Area of the Study: We gathered the information from these businesses: Adani Renewable, Hindustan Power, and Tata Power Solar Systems Ltd.

3.2. Sample Size: 200 employees of the study's chosen companies.

Guarantee that these stages ought to be viewed as dependable information assortment instruments prior to utilizing data from optional sources like data sets and sites. There are primarily 3 factors in this review. These factors incorporate power utilization, power creation, portion of power delivered from sustainable sources, portion of inexhaustible sources in complete essential energy supply, sustainable power utilization and speculation put resources into sustainable power. Then again, the reliant variable in the review is the quantity of patent applications for creative sustainable power advances. Utilizing Stata, a measurable investigation device, this study inspected the impact of the free examination variable on the reliant variable. Furthermore, the analyst utilized Stata to perform two essential tests for this review, including clear investigation and ADF. ARDL model is additionally used to complete the exploration relying upon the examination factors. The tests are upheld by information that produce results, which are broke down and examined to come to a result covering the primary subjects of the examination (Hazelton, 2014).

The condition that has scrutinized in this study is as per the following:

$PRE = \alpha+\beta_1 EC+\beta_2 EP+\beta_3 SEPR_S+\beta_4 CRTPES+\beta_5 REC+\beta_6 REI+\varepsilon$

Where PRE = Patents filed for Renewable Energy Innovation
α = Intercept
EC = Energy consumption
EP = Energy production
SEPRS = Share of electricity production from renewable sources
CRTPES = Contribution of renewable to total primary energy Supply
REC = Renewable energy consumption
REI = Renewable energy investment.

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4. DATA ANALYSIS

4.1. Descriptive Statistics

Graphic insights have been applied on Stata to inspect the factual qualities and to sum up the significant measures of information that were assembled for this exploration. The outcomes from Table 1 are shown in the list below.

Table: 1 Descriptive Statistics

Variables	Observations	Mean	S.D.	Mini.	Max.
Solar	20	90.70364	27.98473	63.8487	152.843
Electric	20	7.63531	81.83766	62.3787	163.372
Ethanol	20	47.4692	62.63722	19.3484	729.263

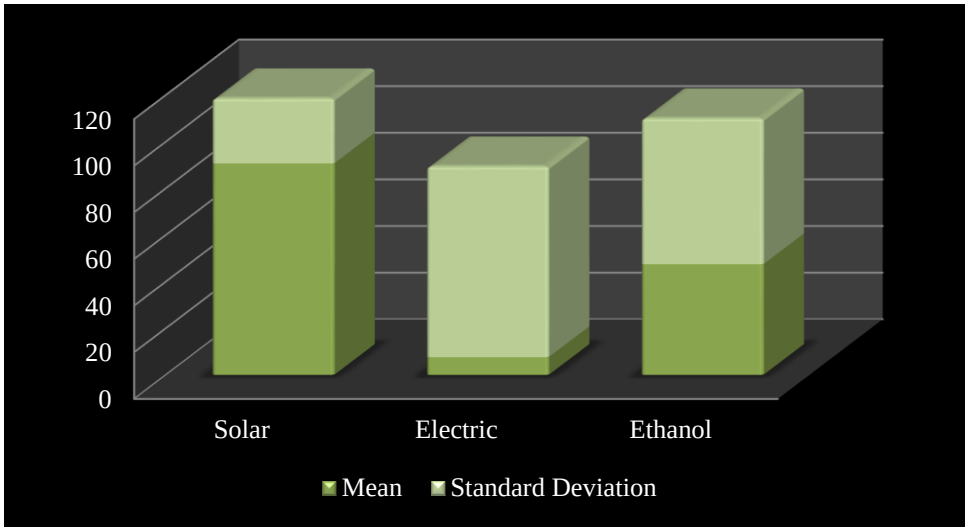

Fig.1: Descriptive Statistics

The mean and standard deviation of each component are vital numbers since they address the normal and the units from which the mean goes astray in the information, separately. The mean and standard deviation values were utilized to get the information for the factors, which range a 20-year time frame from 1989 to 2016. The typical energy utilization throughout the span of the 20-year time frame for the variable "power utilization" was 80.6 billion kWh, which was higher than the objective of 27.2 units. For the variable of power creation, throughout the span of the 20-year time frame, energy creation found the middle value of 56.4 billion kWh, which was higher than the anticipated 49.26 units (Kardooni, 2016). In India, 11.29% of the power made more than a 30-year time span came from sustainable sources by and large. This value is found to have wandered from 4.37 units for the variable Piece of Force Creation from Inexhaustible Sources. A normal of 2319,000 toe of the complete essential energy supply, which included commitments from renewable sources, differed from 541 units throughout the 20-year time frame, as indicated by the variable "Commitment of renewable to add up to essential energy supply." The typical utilization of renewable energy throughout the span of the 30 years was 8.8 trillion W/H, which was higher than the objective worth of 5.87 units. For the variable of interest in renewable energy throughout the 20-year time frame, it was noticed that the normal venture was 16,000,000,000 billion US dollars. The last component is the quantity of patent applications for creation in RET, which on normal were 8,711.

The Augmented Dickey-Fuller test has been utilized in order to determine whether each variable is stationary (Klunne, 2010). The specialist attempted to decide if there is a pattern or on the other hand in the event that the information is fixed on the grounds that this exploration paper contains information from monetary markers. The presence of the unit root fills in as the test's invalid speculation. The results of this test are displayed in Table 2 underneath for every variable. The P-esteem, which demonstrates whether the invalid speculation is dismissed or accomplished, is the worth that should be considered when deciphering the aftereffects of the ADF test. Since the invalid speculation is dismissed (P = 0.03), the information for power utilization are viewed as moving or non-fixed. In view of the P-worth of (P = 0.9879), the information for the creation of power in India don't display a pattern, it are fixed to demonstrate that the information. Since the invalid speculation is dismissed (P = 0.00), the information for the Portion of Power Creation from Renewable Sources are viewed as moving or non-fixed. In view of the P-worth of (P = 0.76), the information for India's commitment of renewable energy to add up to essential energy supply don't exhibit a pattern, showing fixed information data about Renewable

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Vol 3 Issue 2 (2023)

4.2. ADF Test

Table 2: ADF Test

Variables	Test Statistic	P-value
Solar	2.746	0.0423
Electric	0.341	0.9382
Ethanol	4.072	0.0778

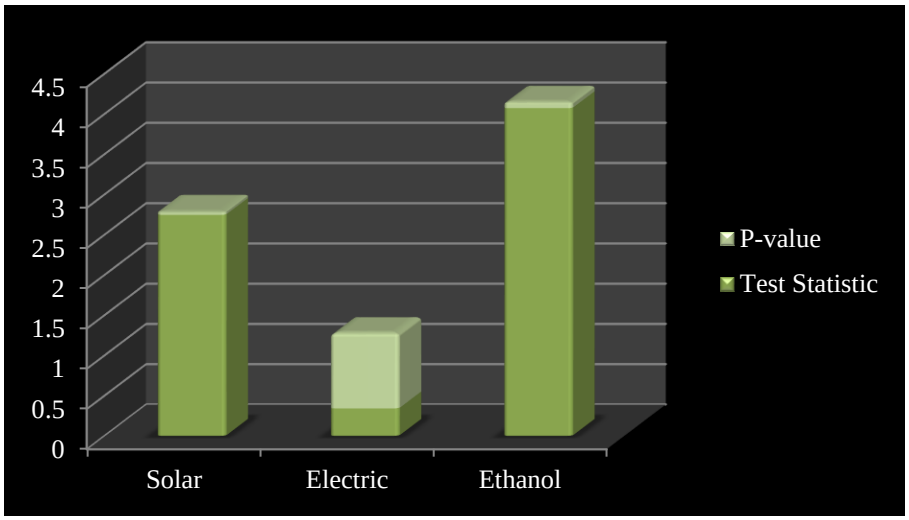

Fig.2: ADF Test

In view of the P-value of (P = 0.07), the information for electric in India don't show a pattern, it are fixed to demonstrate that the information. In light of the P-worth of (P = 0.99), the information for Renewable Energy Interest in India don't show a pattern, it is fixed to demonstrate that the information. At long last, in view of the P-worth of (P = 0.93), the information for Licenses petitioned for Development in Renewable Energy in India doesn't show a pattern, it is fixed to demonstrate that the information (Lin, 2019).

4.3. ARDL Model

This exploration paper has utilized an auto-backward dispersed slack model to test the effect of elements on advancement in RET with blended request of mix, considering the way that two of the factors in the reasonable model are non-fixed while the leftover are fixed (presence of unit root). These are Stata's results, which are recorded after that (Table 3). The Table 4 recognizes the significance of the general model as well as impact of every part on the standard variable that is Headway for RET. Moreover, there are furthermore potential gains of R-square and Changed R-square that aide in unraveling the general model in a capable way. For the variable of Force Usage, there is no verifiable significance which shows that in India power use doesn't influence the mechanical improvement of environmentally friendly power assets (P = 0.233). Power creation in India sufficiently influences mechanical headway of environmentally friendly power assets given the P = 0.000. Its different coefficient regard shows that it will accomplish 630 units of progress being developed for RET expecting that a single unit extend the pointer. For the variable of Piece of Force Creation from Sustainable Sources, there is no verifiable significance which exhibits that it doesn't impact the mechanical headway of sustainable power assets (P = 0.224). For the variable of Responsibility of inexhaustible to amount to fundamental energy supply, there is no quantifiable significance, which exhibits that it does not influence the mechanical improvement of sustainable power assets (Liu, 2019).

Table: 3 ARDL Model

Variables	Coefficient	P-VALUE
Solar	83.66432	0.425
Electric	36.74683	0.000
Ethanol	93.46642	0.324

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Vol 3 Issue 2 (2023)

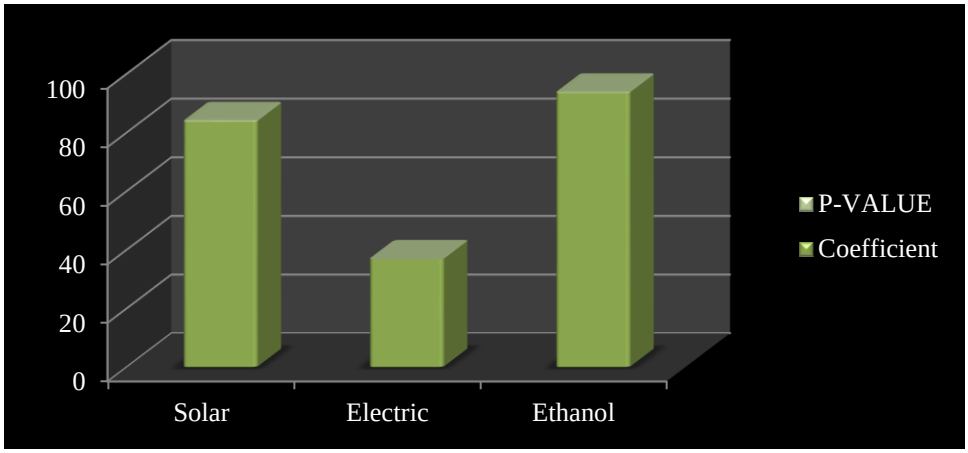

Fig.3.

Table 4: Hypothesis Assessment Table

S.NO	Hypothesis Statement	P-Value	Result
1	Consumption of electricity affects the development of renewable energy technologies.	0.253	Rejected
2	Renewable energy source technological innovation is influenced by the production of electricity.	0.000	Accepted
3	Renewable energy source technological innovation is influenced by the percentage of electricity generated from renewable sources.	0.256	Rejected
4	Technology advancements related to renewable energy sources are influenced by their contribution to the primary energy supply as a whole.	0.973	Rejected
5	Sustainable power Consumption affects the development of renewable energy technologies.	0.436	Rejected
6	Investment in renewable energy has an impact on technological advancements related to renewable energy sources.	0.932	Accepted

(P = 0.133). Considering that P = 0.002, Renewable Energy Interest in India decidedly affects mechanical headway of renewable energy sources. As per its particular coefficient esteem, a one-unit expansion in the indicator will result in a -8.48 unit change in Development for RET.

In spite of certain variables not measurably affecting development for RETS, it is found that the general model is critical. Subsequently, it tends to be presumed that each of the elements effectively affect mechanical advancement in the field of renewable energy (Tabrizian, 2019). As per the model's R-square worth, the elements can precisely anticipate 89.98 of the varieties in the basis variable.

4.4. Hypothesis Evaluation Table

The appraisal of the speculation is displayed in Table 4 underneath founded on the quantitative discoveries of this examination paper

5. DISCUSSION

The traditional techniques for energy creation unfavorably affect the climate. In any case, as ecological maintainability has become more significant, there has been a requirement for economical innovations that hurt the climate less or not by any stretch of the imagination. Worldwide businesses have likewise concurred that despite the fact that these creation strategies are more costly, utilizing greener techniques for creation ought to be liked (He et al., 2019). In this way, in such way, the survey has zeroed in on the rising example of the advancement of environmentally friendly power all through the world. It has seen that for a long time, the interest for the energy creation, at this point moreover the interest around here as well as the various pieces of environmentally friendly power, similar to its obligation to the fundamental wellsprings of energy, have extended. To conclude how the example of sustainable power creation is extending, this study has similarly centered on the degree of energy creation from inexhaustible sources (WISIONS, 2010). One of the most significant focuses with respect to the utilization of renewable energy is that, when contrasted with energy delivered utilizing traditional techniques, homegrown and business clients who don't create renewable energy all alone notification no distinction while utilizing the renewable energy (Dincer and Yuksel, 2019). As patterns have developed, an ever increasing number of individuals are starting to incline toward renewable energy sources as well as limited scale energy creation frameworks for their homes, organizations, and ventures, which permits them to be naturally maintainable as well as practical simultaneously.

6. CONCLUSION

It is observed that there are certain challenges for energy producer, which now and again utilize customary energy creation strategies ideal. This study emphasizes on a few factors to look at whether the recognized factors affect development in the energy area and the expansion in patent enrollment. The outcomes showed that the general model of the review, created in the wake of auditing the significant writing, was significant and that the examination performed from it was fitting (Bhattacharyya S. a., 2014). The consequences of the concentrate likewise exhibit that main sun based energy; power age and ethanol altogether affect development in this industry. Different variables, for example, the extent of sustainable power utilized in power age, the commitment of sustainable power to essential sources, power utilization and particularly environmentally friendly power utilization, do not affect mechanical advancement in this specific industry.

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