JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

ENERGY CONSUMPTION AND SUSTAINABLE ECONOMIC GROWTH IN INDIA

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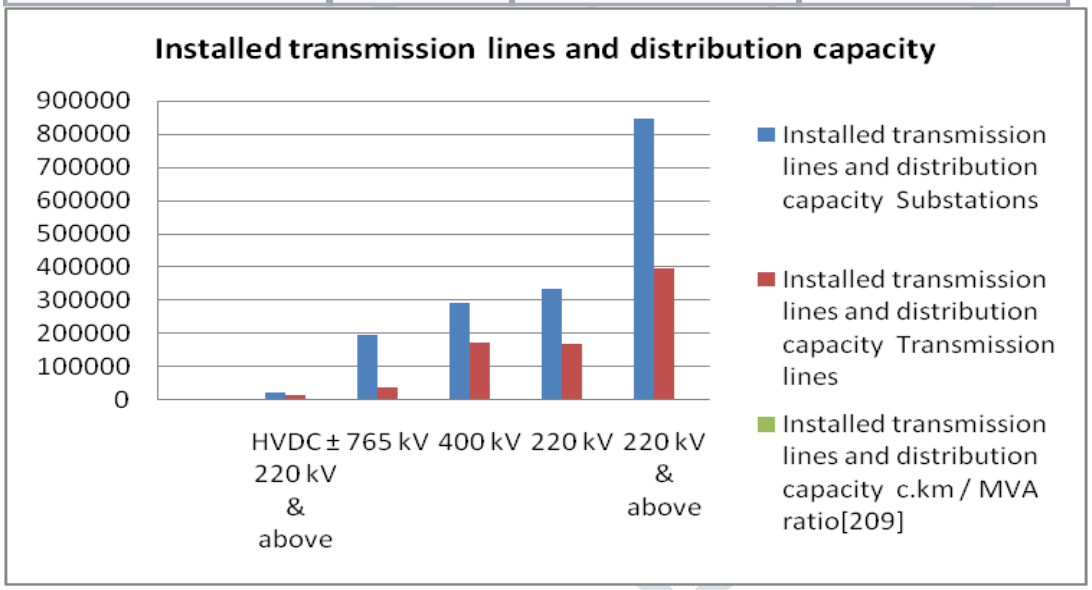
Abstract:- *Energy is a key source of economic growth because many production and consumption activities involve energy as a basic input. In economic terms, energy is an essential variable whose efficient management is a prime consideration in terms of economic growth, but also a key determinant of sustainable development. In recent times, there is an increasing emphasis placed on this factor as its significance is realised and acknowledged. The significance of the energy component and its interdependence with environment and growth is a prime driver of economic growth. It has become central to the new economic models in a world that is struggling with ever increasing environmental challenges such as climate change, global warming, forest depletion, fossil fuel over consumption. The importance of energy increases day by day as climate changes. Primary energy sources emit more pollution and it is necessary to switch to green energy sources. The depletion of resources and the increase in environmental pollution due to the use of energy has required the optimal use of its resources, which in turn requires adequate energy planning to achieve energy security. For the right one planning to optimize its use, an integrated and updated database of production and consumption from different sources i.e. coal, crude oil, natural gas and electricity are needed. The issue of climate change is part of the biggest challenge of sustainable development. Climate policies can be more effective when they are constantly integrated into broader strategies designed to make national development routes more sustainable. The impact of climate variability and associated socio-economic development will influence countries' ability to achieve sustainable development goals. Identifying the relationship between energy consumption and economic growth has important implications for energy saving policies. If energy consumption leads to economic growth, the economy is called dependent energy, indicating that energy is a stimulus for economic growth. As a result, energy saving policies can affect economic development. Chapter four shows the results that economic growth brings to energy consumption in India. This means that the economy is defined as less dependent on energy, which indicates that energy is not a stimulus for economic growth. As a result, energy saving policies can be implemented with little or no negative effect on India's economic development. Taking into account the state of the study's inferences, the following policy implications can be derived. India is fortunate to have rich and varied energy resources, but these are distributed unevenly. India traditionally uses conventional energy resources such as coal, oil, gas, etc. It is necessary to show greater adaptability and enthusiasm in the use of un-conventional resources such as solar, tides, wind, etc.To secure energy, India must take immediate measures such as increasing the share of renewable energy, promoting green energy, effectively implementing energy policy. Renewable energy is the most scalable and seamless option to meet energy demand. Renewable sources are reliable and clean compared to fossil fuels. These energy sources are the best alternative to meet the*

need for energy in a clean environment. Timely changes in non-renewable energy are needed.

A transition from non-renewable to renewable shows a shift from economic development oriented to sustainable growth that is indicative of a fair and environmentally friendly development ethos. There is a gap within the potential of renewable energies and the actual achievement of the country. Our national economy must overcome the limits of technology, the crisis of economic resources, policies and institutions. All un- conventional energy sources are sufficient to provide energy in the future and are free of contamination. It is not only necessary to improve the technology for maximum energy production from these sources, but India must also minimise the energy wastage.

Installed transmission lines and distribution capacity

Capacity	Substations (MVA)	Transmission lines (circuit km)	c.km / MVA ratio[209]
HVDC ± 220 kV & above	22,500	15,556	0.691
765 kV	1,97,500	36,673	0.185
400 kV	2,92,292	1,73,172	0.707
220 kV	3,35,696	1,70,748	0.592
220 kV & above	8,47,988	3,96,149	0.467

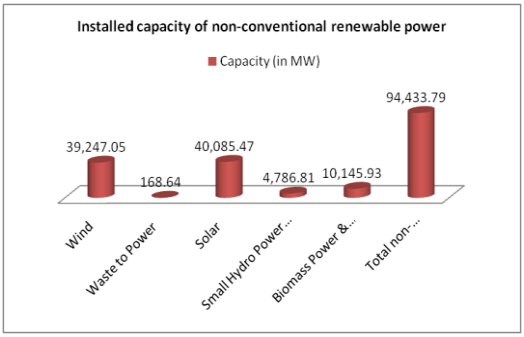


In a developing country such as India, these considerations have played a central role in economic policy formulation and environmental strategy. There is a growing realisation of the need for more studies focused on the inter causal relationship between renewable and alternative energy, its production and consumption and its vital role as a determinant in sustainable human and economic development.

The present study aims to be a step forward in identifying the trends of the energy consumption and sustainable economic growth in India, which are the pressing need of the hour. A sincere attempt has been made to undertake an in depth analysis of this relationship, using various economic tools. It will also suggest ways and means to spur sustainable and equitable growth in the future. India needs energy intensity. Energy intensity is an indicator that shows the efficiency of energy use in the economy. India's energy intensity is more than double that of mature economies, represented by OECD member countries (Organization for Economic Cooperation and Development). India's energy intensity is also much higher than in emerging economies.

Installed capacity of non-conventional renewable power

Type	Capacity (in MW)
Wind	39,247.05
Waste to Power	168.64
Solar	40,085.47
Small Hydro Power Projects	4,786.81
Biomass Power & Gasification and Bagasse Cogeneration	10,145.93
Total non-conventional renewable Power – Grid Connected	***94,433.79***



Sustainable energy, so easily available, disappears after use. Coal and oil can be a good example and these energy sources are limited and generate pollution. Coal produces serious negative externalities. In order to reduce dependence on fossil fuels and mitigate climate change and environmental pollution, India has attached great importance to the development and use of renewable energy sources. This thesis is undertaken in order to study and analyse the multi-faceted problems of energy consumption and its role in sustainable economic growth in India. So, this thesis deals with multiple themes of the energy scenario, energy usage and the different ways in which it is consumed, energy security and their impact on sustainable economic growth. With developmental aspirations and a burgeoning economy, the importance of energy security has increased in India. It has a broader context with unique challenges. It must include a vision on access, affordability and environmental sustainability. The need for energy security is essential for the stability and sustainable economic growth of India.

Energy security has played an important role in human emancipation. Energy security that can be sustainable is one of the focal issues of interest for nations interested in prevailing over the tangled issue that powers development. The International Energy Agency (IEA) has projected a national concept of security of energy that is determined upon stabilizing the supply of crude oil and on domestic prices and crude oil, to guarantee the safe and development in sustainable terms of the energy system and provide the reasons for formulating energy policy in India. Energy security includes the security of supply and demand. The security of the supply indicates the capacity for efficient generation and production of energy from diversified energy sources that include renewable energy. The relationship between energy consumption and economic growth has been the subject of further investigation, as energy is considered one of the driving forces of economic growth in all economies. In the present thesis, the researcher established a dynamic relationship between energy consumption and economic growth at the aggregate and disaggregated level of energy consumption. The total primary energy consumption has been used by the researcher, so that it can be found that whether the consumption of these sources can affect the income level of the country.

This research has studied the relationship of total primary energy consumption and the economic growth rate in India. The review of literature, which is in chapter two deals with the study of existing national and international literature on causal relationship between energy consumption and economic growth. In India, major attempts to analyze the causal relationship between energy consumption and economic growth have been made by Alam and Begum (2011), Asafu (2000), Bhattacharya and Paramati (2016), Behera (2015), Ghose (2002), Ghose (2010), Mallick (2009), Mashis and Mashis (1996), Narula (2016), Nejat and Jomehzadeh (2015), Pachauriand Spreng (2002), PauI and Bhattacharya (2004), Rajeev (2010), Ramakrishna (2013), Ravindranath and Ramakrishna (1997), Rufael (2010), Sharma (2011). Some studies of international literature on relationship between energy consumption and economic growth are Ahsan (1989), Allen and Cooper (1976),Altinay and Karagol (2005), Apergis and Payne (2009), Apergis and Payne (2010), Apergis and Rufael (2010), Barro (1991), Belke, Dobnik and Dreger (2011), Bhattacharyya (2015), Bollen and Hers (2009), Bowden and Payne (2010), Carter (1974), Chang

(2010), Cherp and Jewell (2014), Chontanawat, Hunt and Pierse (2006), Chontanawat, Hunt and Pierse (2008), Cleveland and Costanza (1984), Cohen, Joutz and Loungani (2011), Cox (2016), Ediger and Huvaz (2006), Erol and Yu (1987), Fatai, Oxley and Scrimgeour (2004), Greening, Greene and Difiglio (2000), Gupta (2006), Halicioglu (2009), Hammond (2000), Hung, Hwang and Yang (2008), Ighodaro (2010), Jamel and Derbali (2016), Karanfil (2009), Lee and Chang (2005), Manne and Richels (1990), Mehrara (2007), Ozturk (2010), Richard (2012), Rufael (2004), Scheepers (2007),

Sovacool (2013), Stern (1993), Tang, Tan and Ozturk (2016), Wang (2011), Yao (2014), Zhang and Cheng (2009). After reviewing the literature, it has been observed that the literature on the causal relationship between energy consumption and economic growth is vast, and the importance of the subject has gained significant attention of researcher at national and international front.

Objectives of the Study

The following objectives have been identified for the present study.

1. To study the relationship between energy consumption and economic growth in India.
2. To assess whether energy consumption effects economic growth and vice versa.
3. To find out whether individual components of energy sources influence the growth of GDP.
4. To analyze the sustainability of relationship between energy consumption and economic growth in India.

Sources of Data

The researcher used aggregated and disaggregated data on primary energy consumption, that includes coal, oil and natural gas. The variables used in the study are: GDP (as an indicator of economic growth), total primary energy consumption (Mtoe), coal consumption (Mtoe), oil consumption (Mt) and natural gas consumption (Mtoe). To study the trends in consumption and total energy production and its various components, a semi-logarithmic functional form was estimated and growth rates calculated. All variables are used in their natural logarithmic form. Annual data for 1970-71 to 2016- 17 was obtained from BP Statistical Review of World Energy 2017-18 and World Data Atlas.

Research Methodology

In fact, each specific method or technique is designed to verify at least one of the hypotheses formulated in the present thesis and, in most cases, derive from a specification of the model itself. Therefore, before dealing with research methods and techniques, it is very significant to explore the substance of this research. On the basis of the secondary sources of data composed via several national and international resources, the present study is made.

The researcher used time sequence information over the development frequency of the energy consumption and on the economic growth rate in the country, by which they can explore the relationship between economic growth (GDP) and total primary

energy consumption. The researcher has used D (TOTAL) and D (GDP) are the two endogenous variables, to study the relationship between total primary energy consumption and economic growth. The aim of the time series analysis is to explore in depth the dynamics or temporal structure of data. The researcher has used the Granger Causality series and the regression model in the present thesis.

The researcher is able to see the relationship between total primary energy consumption and economic growth with the help of the Granger Causality Test. In Granger Causality, there have been a variety of methodologies used. Stationary data is the prerequisite for the Granger test. The unit test is used to find

the order of integration in order to know whether a series is stationary or not. The researcher has used the Augmented Dickey Fuller (ADF) test to test the stationary. The next step is to find the optimal lag length. The optimal lag length can be observed by employing the SBC and AIC criterion. Under this method SBC and AIC values of Vector Autoregressive (VAR) model estimated for different combinations of lag length are used. To decide a model the researcher can choose the Akaike Information Criterion (AIC) and also the Schwarz Criterion. The researcher has selected Akaike Information Criterion (AIC) to make a model. The researcher has analyzed the data with lag three unrestricted VAR model. After selecting the best lag model, the next step is the co- integration test. The first objective of the study was to study the relationship between energy consumption and economic growth in India. The researcher has analyzed whether the total primary energy consumption and economic growth and also economic growth and total primary energy consumption, have or do not have a long term relationship, with the use of the Bounds test.

Testing for co-integration is necessary step to check if the modelling empirically meaningful relationships. Although co-integration indicates the presence or absence of Granger Causality, it does not indicate in which direction causality runs between the variables. Therefore, the co-integration test is a necessary prerequisite for implementing the causality test. There are several co-integration tests. In econometrics, the Durbin-Watson (DW) Engle and Granger two-step procedure, the Durbin Watson Co-Integration Regression (DWCR) test, the Error Correction Test, the Dynamic Equation Approach and the VAR approach multivariate by Johansen, the ARDL are used for co-integration. The researcher has used the Autoregressive Distributed Lag (ARDL) Bounds test to examine the co-integration between total primary energy consumption and economic growth.

The (ARDL) bounds test is a co-integration method. After selecting the best lag model, the next step is the co-integration test. In this section, the researcher has analyzed whether the total primary energy consumption and economic growth and also economic growth and total primary energy consumption, have or do not have a long term relationship, with the use of the Bounds test.

The second objective of the study was to inspect the causality between total primary energy consumption and economic growth in India. Furthermore, the cause and effect relationship between the variables was tested using the Wald Granger Block Exogeneity Test. Granger Causality (1969) analyzed that if the variables are co- integrated, it implies that there should be at least one direction of causality between two variables and this causality has been demonstrated by p-statistics. The Granger Causality Test (1969) returns a variable and a lagged value of itself and another variable x. If x is considered significant, it explains a part of the variance of y which is not described by the lagged values of y. This shows that x is causally related to y and is said to cause y dynamically. The unidirectional causality between total primary energy consumption and economic growth shows that only one factor, i.e. total primary energy consumption, causes economic growth. And if causality goes from economic growth to total primary energy consumption, it means primarily that economic growth only causes total primary energy consumption. While bi-directional causality shows that both factors cause each other, i.e. total primary energy consumption causes economic growth which in turn causes total primary energy consumption.

The third objective of the study was to find out whether individual components of energy sources influence the growth of GDP. The researcher used three primary energy sources, namely coal, crude oil and natural gas. Once again, the researcher used the same series to discover the integration amongst the growth rate of three energy components and the GDP growth rate. The fourth objective of the study was to analyze the sustainability of relationship between energy consumption and economic growth in India. For this purpose the researcher has used two concepts, Energy Security In Terms of Production (ESIP) and Energy Security In Terms of Imports

(ESIM). The hike in energy security in terms of production (ESIP) and the decline in energy security in terms of imports (ESIM) points to a decrease in energy dependence and, consequently, a rise in energy security. These relationships were calculated through the use of a linear trend equation with the intercept and slope dummies. These were used to verify the changes in energy security during the study period. To this end, the study period was divided into three sub-periods, i.e. from 1980-81 to 1989- 90, from 1990-91 to 1999-2000 and from 2000-01 to 2015-16. To verify, a linear trend growth model was used with intercept and slope dummies has been used to ascertain any change in trends. The energy security indicator in terms of imports (ESIM), is defined as a connection between energy imports and total energy consumption and the energy security indicator in terms of production (ESIP), is termed as a relationship between energy production and total energy consumption. Energy security requires a drop in ESIM and also a rise in ESIP. The three primary energy components were used by the researcher. These are coal, oil and natural gas. Energy security trends were analyzed by simple linear regression. Regression analysis is a technique used to explore and model the relationship between variables. This indicates the vitality of the linkage between independent and dependent variables. The regression has ANOVA models, ANCOVA models and Linear Probabilities models.

Limitations of the Study

The success of any work depends upon the availability of relevant information and its proper use in terms of processing it, presenting it and exposing it to statistical techniques. There are various limitations faced by many studies and the present study

is not an exception. Limitations are as: (a) This study is based on secondary data, there are always some problems with the data. (b) The data collected in this study contain only the primary energy sources. To more accurately assess the total energy consumption, it is also necessary to take data from other sources. (c) The present study is based only three primary components of energy. (d) To examine the causal relationship between consumption of energy and economic growth, Gross Domestic Product is taken as proxy for economic growth. (e) The study is open for all limitations of the econometric techniques, which are discussed in any standard book of econometrics.

Major Findings

The major findings flowing from the study are:

The chapter three of the thesis has analyzed the overview of energy in the context of India. India's energy policy includes affordable access, greater safety and self sufficiency, higher sustainability and economic growth. 18 per cent of the world's population lives in India, but this high density uses only 6 per cent of primary energy. While coal-based energy generates the most powerful energy sources with 59 per cent, alternative sources such as nuclear, gas, hydroelectric, solar and wind do the rest. The per capita consumption of energy and electricity at 670 kgoe and 1075 KWh
/ year, in that order, is only one third of the world average. Nearly 25 per cent of the population has no access to electricity and 40 per cent without access to clean cooking fuel (NEP 2017). Primary energy consumption in India is the third largest after China and the United States, with a 5.6 per cent share in 2017 (BP Statistical Review 2018). India needs energy to achieve its growth goals in a sustainable way. India ranks fourth among the countries with the highest energy consumption in the world (Energy Information Administration 2018). In the present study, the researcher has studied four objectives. One of the objectives is to study the relationship between total primary energy consumption and the economic growth rate in India.

Next, the chapter four of the thesis has examined the relationship between total primary energy consumption and economic growth, as well as the different forms of energy and economic growth in the context of India. Time series data were taken from 1970-1971 to 2015-16. To calculate the interrelation, empirical models were applied such as the linear regression, the Augmented Dickey Fuller (ADF) test, the Granger

Causality Test and the co-integration test of the Vector Autoregressive (VAR). The results of this chapter showed that the series is stationary or have no unit root at level and first difference form. At the difference form, total primary energy consumption and GDP become stationary with intercept, with the 5% level of significance. The AIC is minimum with 2-5 lag length and SBC is minimum with 1-2 lag length. Thus, the results decide the lag length 1-3 for co-integration. The Bounds test discovered that there is a long-run relationship from total primary energy consumption to economic growth, not economic growth to total primary energy consumption in India. The findings of this test indicate that total primary energy consumption will affect the economic growth in the long run in India. In the long run total primary energy consumption will play a crucial role in the process of development and economic growth.

The empirical result of Granger Causality suggests that there is a unidirectional causality between total primary energy consumption and economic growth in India. And this causality ranges from economic growth to total primary energy consumption. This means that it is the rate of economic growth that drives or stimulates greater primary energy demand in India. Past GDP values can be used to predict total primary energy consumption. Economic growth feeds the rate of primary energy consumption, but the opposite is not good in the context of India. Economic growth contributes to energy consumption. Energy policy in India should contain the consumption of conventional and non-renewable energy, such as crude oil, natural gas as an import of these forms of expensive energy. There should be an effort to exploit renewable energy sources for efficient use, following which the use of these natural resources in India would be economized.

For long-term co-integration, the long-term form of Autoregressive Distributed Lag (ARDL) co-integration was used. The test result indicated that some of the lagged variables of bidirectional commercial causation between total energy consumption and economic growth in India. The researcher studied the causality between total primary energy consumption and GDP using other energy components. Since none of the variables for these variables is statistically unimportant at a probability level of 0.05, they conclude that they are dependent on each other over the long term. This means two-way causality between energy consumption and economic growth, as well

as two-way causality between energy components and long-run economic growth.

Thus, the chapter four indicated the results of unit root, co-integration and Granger causality for total primary energy consumption and economic growth as well as for energy components i.e. coal, crude oil and natural gas. The results has described the long run co-integration from total primary energy consumption to economic growth in India, but no Granger causality from total primary energy consumption to economic growth in the short run. For the components of energy the study explains the co- integration for coal and natural gas consumption in India. But shows no co-integration and Granger causality from crude oil consumption and economic growth in India.

In chapter five, the researcher attempts to discover energy security in terms of total primary energy consumption, and imports from India. The researcher has used total energy imports as a sign of energy security. An increase in imports compared to its production describes energy insecurity and vice versa. The researcher has used two concepts, Energy Security In Terms of Production (ESIP) and Energy Security In Terms of Imports (ESIM). The hike in energy security in terms of production (ESIP) and the decline in energy security in terms of imports (ESIM) points to a decrease in energy dependence and,

consequently, a rise in energy security. These relationships were calculated through the use of a linear trend equation with the intercept and slope dummies. These were used to verify the changes in energy security during the study period. To this end, the study period was divided into three sub-periods, i.e. from 1980-81 to 1989-90, from 1990-91 to 1999-2000 and from 2000-10 to 2015-16. To
verify, a linear trend growth model was used with intercept and slope dummies has been used to ascertain any change in trends. The energy security indicator in terms of imports (ESIM), is defined as a connection between energy imports and total energy consumption and the energy security indicator in terms of production (ESIP), is termed as a relationship between energy production and total energy consumption.

The endeavour in chapter five is to analysis the sustainable economic growth in India. The various trends in energy security have been analyzed by using simple Linear regression using dummy variable. Energy security equation in terms of natural gas production, Y_t= 2.055+0.711D_1+1.010 D_2 and Energy security equation in terms of natural gas consumption, Y_t= 2.025+0.735 D_1+1.142 D_2. In order to estimate energy security for the period of 1980 – 1989, D_1=0, D_2=1, for the period of 1990 – 1999,

D_2=0, D_1=1, for the period of 2000 – 2015, D_1=0 and D_2=1, Y_t= energy security. Energy security equations are Y_t= 5.234+0.252 D_1+0.493 D_2, Yt= 5.214+.272 D_1+.576 D_2 and Yt= 2.772+1.098 D_1+ 2.143D_2 in terms of coal production, consumption and imports respectively. Energy security equations are Y_t= 2.686+0.119D_1+0.179 D_2, Yt= 2.921+.275 D_1+.547 D_2 and Yt= 2.234+.592 D_1+1.159
D_2 in terms of crude oil production, consumption and imports respectively. The R- value and adjusted R-square is significant for all the three components.

Thus, chapter five arrives at the result that energy security when viewed in terms of production (ESIP) is not sufficient as compared to energy security in terms of imports (ESIM) in India. The expansion rate of energy security in terms of imports (ESIM) is more as compared to energy security in terms of production (ESIP) in the results. The growing population growth and urbanization in India puts intense pressure on energy use, urban infrastructure and the environment and the emergence of supply disruptions can cause strong pressures on growth economic. From the previous study, the researcher found that combined coal and oil are together the largest source of energy in India. India has no energy security because energy consumption and energy insecurity shift together. There is a big gap between energy consumption and energy production, energy consumption is more than energy production, which leads to energy insecurity in India.

Policy Implications

The results of this study presented some important policy implications. This study covers the period between 1970-71 and 2021-22. Identifying the relationship between energy consumption and economic growth has important implications for energy saving policies. If energy consumption leads to economic growth, the economy is called dependent energy, indicating that energy is a stimulus for economic growth. As a result, energy saving policies can affect economic development. Chapter four shows the results that economic growth brings to energy consumption in India. This means that the economy is defined as less dependent on energy, which indicates that energy is not a stimulus for economic growth. As a result, energy saving policies can be implemented with little or no negative effect on India's economic development. Taking into account the state of the study's inferences, the following policy implications can be derived:

1) India is fortunate to have rich and varied energy resources, but these are distributed unevenly. India traditionally uses conventional energy resources such as coal, oil, gas, etc. It is necessary to show greater adaptability and enthusiasm in the use of un-conventional resources such as solar, tides, wind, etc.

2) To secure energy, India must take immediate measures such as increasing the share of renewable energy, promoting green energy, effectively implementing energy policy. Renewable energy is the most scalable and seamless option to meet energy demand. Renewable sources are reliable and clean compared to fossil fuels. These energy sources are the best alternative to meet the need for energy in a clean environment. Timely changes in non-renewable energy are needed. A transition from non-renewable to renewable shows a shift from economic development oriented to sustainable growth that is indicative of a fair and environmentally friendly development ethos.

3) There is a gap within the potential of renewable energies and the actual achievement of the country. Our national economy must overcome the limits of technology, the crisis of economic resources, policies and institutions. All un- conventional energy sources are sufficient to provide energy in the future and are free of contamination. It is not only necessary to improve the technology for maximum energy production from these sources, but India must also minimise the energy wastage.

4) Energy policy in India should contain conventional energy consumption, like crude oil and natural gas, since the import of these forms of energy is costly.

5) The government acquires a large sum of oil import and distribution costs at reduced rates, which has greater implications for maintaining a sound macroeconomic environment. However, limited oil consumption can keep the environment clean and the economic position of the macro economy stable. Furthermore, since electricity and lignite contribute to economic growth, the study suggests that the country's policy makers should give them importance and make them optimally efficient.

6) Conserve, preserve and protect the environment and achieve sustainable development of the economy by creating a compromise between energy consumption and conservation.

7) The study suggests the need for effective exploration and consumption of energy resources in India, with a step towards creating a basket of sustainable and renewable domestic fuel.

8) GDP growth fuels the total primary energy consumption rate, but the opposite is not correct with respect to India. India should promote indigenous energy technologies while seeking effective use of national resources so as to improve energy security.

9) India is in a phase of evolution in its growth history. The rapid increase in energy demand and the growing concern about environmental consequences require an efficient use of energy resources.

10) India needs research and technologies for clean energy, including renewable energies, energy efficiency and cleaner, advanced fossil fuel technologies, and government must promote investments in energy infrastructure and energy technologies clean.

11) Environmental considerations and resource management make it necessary to minimize the use of energy from conventional sources by enhancing the energy efficiency and increasing the participation of renewable sources in energy production and use.

12) The use of solid fuel as domestic combustion or biomass, such as cow dung, coal, wood or crop residues, should be used for sustainable energy use.

13) India must make a continuous effort to take advantage of various forms of renewable energy, with newer technologies and energy efficiency for a cleaner, greener and safer place for future generations.

14) India has made significant progress in renewable energy with low-carbon alternatives, but even now, much of the potential in this area remains unrealized.

15) Solar energy is the most important alternative resource in India and has great potential for green energy. India has enormous potential to generate green electricity from renewable energy sources. It

is one of the cleanest energy sources with the least possible pollution or harmful emissions. It further has the potential to minimize dependence on conventional energy sources such as coal, oil, gas and other fuels. Solar-based power generation systems can play an

important role in meeting the energy requirements of Indian industries and also spur economic growth and national development at the same time.

Future Scope of Research

The literature reviewed shows that many researchers pay attention to energy consumption and economic growth, but it is still a poorly studied area. Although evidence and theoretical reasons exist to support the results of this study, there are different directions which are still relatively unexplored and ready for future research. Some suggestions for future research are mentioned below:

1) Future research can be conducted by considering perceptions of economic indicators such as employment, production, etc. It could possibly lead to new discoveries.
2) The study can be conducted in different sectors.
3) There can also be comparative studies between different states and other countries, which could be important directions for future research.
4) This work aimed over the total primary energy consumption and economic growth in India. Further research can be conducted to compute the influence of energy consumption on climate change and Carbon dioxide emissions in India.
5) Another possible area of future research could be the creativities counted by the government to increase the use of renewable energy sources, mainly solar energy in India.

The future scope of the relationship between energy consumption and economic growth is excellent. The results of the study explored the existence of a unidirectional causality between energy consumption and economic growth in India.. The present study is limited to only two variables. For sustainable economic growth, this study has illustrated that India is energy insecure. There is a need for greater planning and attainment of energy security in India. Coal is the dominant source of energy consumption in India. The values of the R square are higher in the case of production and importation of coal, showing the best relationship. The result has shown that oil is a limited resource and will not last forever. India will certainly have to face the energy shortage. The value of the R-square is higher for oil consumption, indicating the growing demand for oil in India. India is exposed to greater geopolitical risks and instability in international prices due to greater dependence on imports. Energy security depends largely on the availability and use of energy. The study found that India is not energy secure because energy consumption and energy insecurity move together. There is a big gap between energy consumption and energy production in India which needs to be urgently addressed. Energy consumption is more than energy production, and this is leading to energy insecurity in India.

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