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RESEARCH ARTICLE

PAST, PRESENT AND FUTURE OF ENERGY IN INDIA

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ABSTRACT

In coming years the world demand of energy supply will increase, and reduction of carbon dioxide emission will be the priority for meeting of the projected feature electricity. India was reported to be the world's second largest country with a total population of 1.35262 billion and 2718.7 million GDP in the year 2017. Over decades, there is increase demand of energy in India because of the exponential growth in the population. This article present detailed information about Indian energy trends based past, present and feature energy and centered on the historical trains of energy, current energy situation, and the feature energy predictions respectively. Majority of energy used in India came from thermal power generation plants. In this paper transforming energy and planned energy scenario was used to predict the feature of the energy in Asian region. The feature energy result shows that in planned energy scenario the total renewable energy share will be 31% in the year 2050 while in transforming energy scenario the total renewable energy percentage will be 75%. And as such, it has become more important than ever to find more reliable systems and shift into sustainable energy.

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INTRODUCTION

The accessibility of energy is important for human growth and is the crucial driver of economic development and good quality life. As the industrial development and population growth continue to skyrocket, the demand of energy will rise even. Agriculture, services and industrial sectors are all power-driven; there is a continually-increasing need for more power to be produced. It is totally believed that the world is endowed with tremendous energy for generating electricity and its uses, from conventional and non-conventional power generating sources. Fossil fuel energy sources are natural energy supplies that are limited in quantity and fast diminishing when used for the used for long decades. They have been produced through many billions years from decaying substance. Whereas use of sustainable energy tends to be environmentally friendly, way of satisfying the rising demands for electricity [1]. According to the BP Statistical Analysis of 2019, India was the world's third largest energy user after China and the US in the year 2018, and its electricity demands continues to rise as a result of the country's intense industrial development, population increase, and transformation for some years back. The significant rise in Asia including India is propelling over the last five decades. India has recorded expansion in overall energy consumption, with a change from fossil fuel to green sources of energy. The shapes of the fossil fuel energy output over the past five decades reveal that coal is greatest in abundant of all fossil fuels energy sources.

However most of the remote communities that have no access to the energy despite high increase in fossil fuel energy use woods, animal waste and crops for cooking and other purposes. Indian electricity production yet to provide steps with rising demand, and continues to face significant energy shortages as a result. This has contributed to greater dependency on imports to satisfy the need for electricity access and demand. With a huge increase in total percentage of renewables, a cleaner and often more reliable energy sources, and substantial increment in the amount of electric vehicles, electric trains and other devices and processes operating on electricity, the proposed future energy plans will looks completely different from the previous one. The feature energy will be supported by many program structures and market, digitalization, electrification and the decentralization. This paper proceeded as follows the first section provide abstract and the second section contains introduction and reviewed information about the existing work, the third section contains the main body highlight general information about India, historical train of energy in India, current energy issues in Asian Region, and feature energy of India, last section of this paper provide conclusion, recommendation and references used.

LITERATURE REVIEW

This review looked at some existing works that are related to the energy past, present and feature of India. Industrials in India happen to be one of the most precarious sectors of the infrastructure that consumed more electricity. India ranks as 5th highest in terms of electrical power generation capacity and is the 6th among the biggest electricity consumer in the word, accounting for almost 3.4% of the

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entire overall energy consumption in the world. For over three last decades, India's demand of energy has grown to 3.6%. The patterns in primary industrial energy output over the past five decades show that coal is the most common of all industrial sources of energy [1]. Considering generation of electricity pans should be follows in order to used resources effectively and reduces non-renewable usage [2]. It was reported in that Energy and electricity requirements will rise to support the population and economic growth and the electricity generation is accomplished primarily by coal power plants. Many models have been developed of electricity demand from rage of years 2015 to 2030. Both scenarios highlight the contributions of the coal, renewables and nuclear sources on the electricity production side, for such a development, energy and climate policies should be scheduled in accordingly [2]. The strain of environmental pollution that adversely affects health, safety, lifestyle, is carried with it by expanded energy consumption and automation to sustain ever industrial development [3]. The electricity generation is primarily by coal thermal power plants, and many efforts are put in place to explore other available options, predominantly sustainable energy, coal maintains the country's predominant source of electricity.

General Information about India: India is the located in the central Asian region and the southern Asian region 21⁰N 78⁰E, and has a total land area of 3,286,927 km² (1,269,090 sq. mi) and it was the third largest economy. India was reported to be the world's second largest country with a total population of 1.35262 billion and 2718.7 million GDP in the year 2017. India is also projected to be the first over populated country in coming year 2030. In recent decades, India has seen good economic performance, allowing for a substantial drop in the level of poverty, with 95% greater access to energy for its population and high prevalence of cleaner energy throughout its economic growth and industrial development in attempt to reduced carbon dioxide emission.

Energy Resources in India: The majority share of all energy come from the usage of coal for the generation of power, and oil share is used for industrial and transportation activities while biomass uses for the dwellings cooking and heating. India produces bioenergy and most of its coal supplies, while natural gas and oil are predominantly imported from other countries. The total energy used in the year 2017 was 882Mtoe with the majority share from the domestic production 554Mtoe. Industries have the highest intern of the total final energy consumption followed by the residential, transport and services respectively as shown in the Fig. 1 below.

Power plants available in India: In order to fulfill its energy needs, India has numerous power generation stations available all over the country. Hydro, nuclear, thermal power plants and other types of renewables have added. Thermal power plants account for high percentage of about 65% of India's power generation capacity, with 45% of total power production made from coal mainly as shown in the Figure below [4].

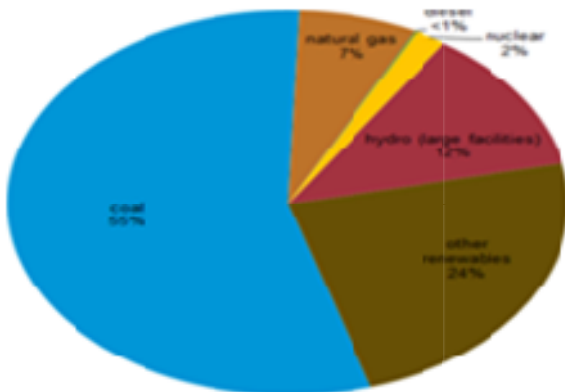


Fig. 1. Indian available power plants sources 2020

Indian Diversity of total electricity mix: Indian energy power system scenario, the total energy mix comprises mainly thermal power, which comprises of gas coal, diesel, while hydro, biomass, and the metropolitan industrial waste, solar and wind power are part of the renewable energy system utilizes.

Energy intensity of India: In the year 2018 Indian energy intensity was reported to be 0.09toe/USD 1000 it is below the global average of 0.17toe/USD 1000 as shown in figure 2. This tells us that the Indian total energy consumption divided by the Growth domestic product is low.

Historical Trends in Energy: This section provide detail information about Indian historical trends in energy based n kilogram of oil used per capita, fossil fuel energy used and renewable energy evolution patents.

Energy use (kg of oil equivalent per capita): Indian energy used per capita consists of all kinds of energy from the import and the local productions and express in kilogram of oil equivalent. As provided in the fig. 3 above the mean value of Indian energy per capita from the year 1971 to 2014 was found to be 384.96 kg. It was observed that the minimum value is 267.31kg in the year 1972 and the maximum value is 636.57kg of oil in the year 2014. The world average based on 132 countries in the year 2014 was 2621.10kg of oil equivalent [4].

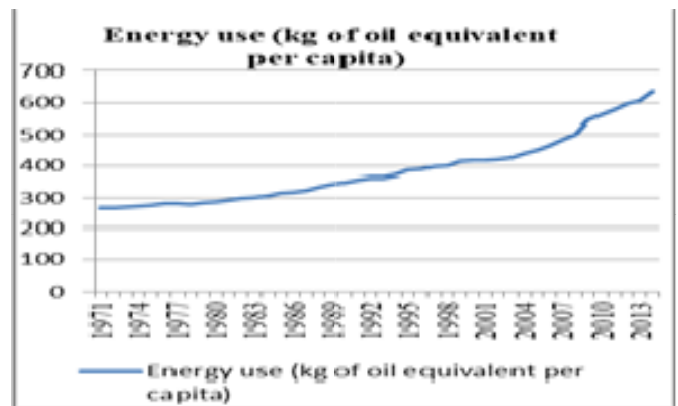


Fig. 2. Energy used (Kg of oil equivalent per capita) [9]

Fossil fuel energy consumption (% of total): The consumption fossil fuel energy in India consists of oil, coal, petrol, and natural gas. It undergoes a series of change from the year 1971 to 2014 as shown in figure 4. The fossil energy increases from 31.12% in 1971 to 73.58% in the year 2014. The overall use of energy relates to the use of primary energy prior to conversion to other end-use fuels.

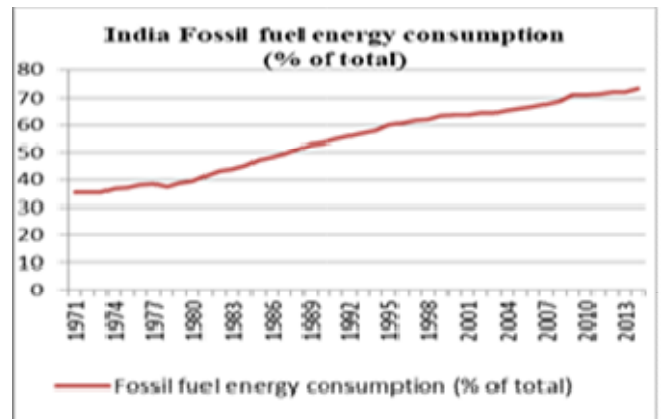


Fig. 3. India fossil fuel energy consumption (% of total) from 1971 to 2014 [10]

Indian total renewable energy development: Indian total renewable energy installed in MW increases exponentially from year 2012 to the year 2018 as shown in figure 4 below. The overall portion of renewable energy in the year 2018 was 118079.409MW and hydroelectric power plant has the total share flowed by the onshore wind energy, solar, bioenergy, renewable municipal waste and concentrated solar power respectively.

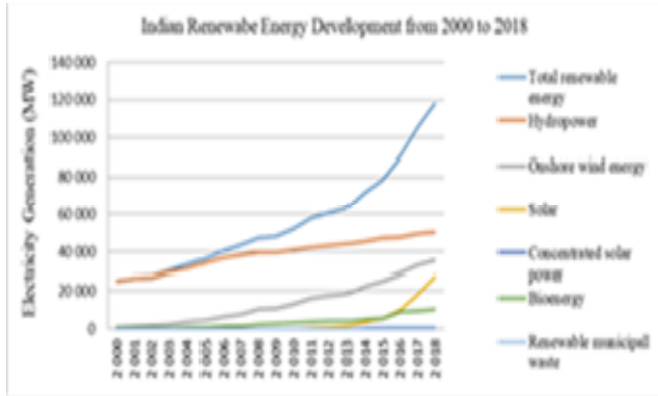


Fig 4: India Total Renewable Energy Deployment from 2000 to 2018 [11]

Hydro power generation: India has total electricity generation of 50081.945MW in 2018 and stand to be the major source of electricity in compare to other renewable energy generation sources. India at present has 197 more than 25MW hydropower plants, including 9 pump storage hydro power plant and ranks 5th in the world in term of hydropower generation capacity.

Wind power: Wind power generation in India is mainly from onshore wind energy with total electricity generation capacity of 941MW in the year 2000 and 35288.1M 2018 as shown in figure below. The wind energy in India being the second largest share of green energy is increasing exponentially through entire data collected from 2000 to 2018.

Solar : As we can see from the fig. 4 above from 2000 to 2018 the capacity of photovoltaic solar and concentrated solar electricity generation increases slightly from 2000 to 2011. In the year 2012 the photovoltaic solar power increases exponentially from 566MW in 2012 to 27355.324MW.

Bioenergy: Bioenergy has been used in India for the generation of electricity as shown in the figure below the total electricity generation from bioenergy changes from year 2000 to 2018. From 2000 the electricity generation increases slightly up to 2012, and also increases gently with very significant changes.

Evolution of renewable energy patents: The trends of total renewable energy share of India from year 2009 to 2016 was discovered during past decades, total renewable energy power generation in India has risen significantly at a faster rate. Over the same period, renewable energy production has also more than doubled, from around 86TWh in the year 2009 and up to over 842TWh in the year 2016. The total share of Indian renewable energy used in the year 2015 is 17% of the total energy production and it's composed of hydropower 10%, wind 3%, solar PV 1% and CSP 0.1% biomass 3%, respectively [6].

Current Energy issues in Asian Region: This section provides current energy issues for Asian region and their reflecting to the India. In Asian region the demand of energy is expected to nearly double by the year 2030. The regional uncertainty issues of the current energy in Asia are defined by the three crucial factors sustainability, economic growth and geopolitics. Asian policy makers are now concern with the assumption underlying, China and United

States of America trade, the position of Middle East and the Russia as the mail crude oil supplies. In 2040 majority of the total world energy will be consume by China and India and their energy frame work would experience significant effect on the energy and the environment. So the priority action plans are guided by the digitalization, electrification and decarbonization. While India's map reveals Critical Uncertainties with a high effect on Severe Weather Threats, Middle East Complexities and Climate Framework, relative to the findings for 2019 and 2020. The segment on Action Goals continues to concentrate on energy conservation and renewable. India The focus region of development continues to be India. In view of India's heavy reliance on oil and gas imports, Middle East trends are seen as having increased influence and volatility. With the Middle East as a major supply of oil and gas, Indian energy leaders are troubled by developments such as US sanctions on Iran, disruption to Saudi Arabian oil facilities and other geopolitical risk factors of Middle East countries. Diversifying the basket of imports Innovative ways have been deployed to produce power in, economically and environmentally sustainable manner. Energy insecurity Prevalence through Asia is compounding the problem, with millions number of people current have on electricity access. The critical uncertainties faced by the India currently are regional itegration, US policy, electrical storage, trade barriers and market design. However, for India to achieve the Feature Energy target of 100% Renewable energy in vision 2015 actions must be taking in to consideration. The needed actions are energy efficiency, energy subsidies, economic growth, mobile cloud and India growth among others.

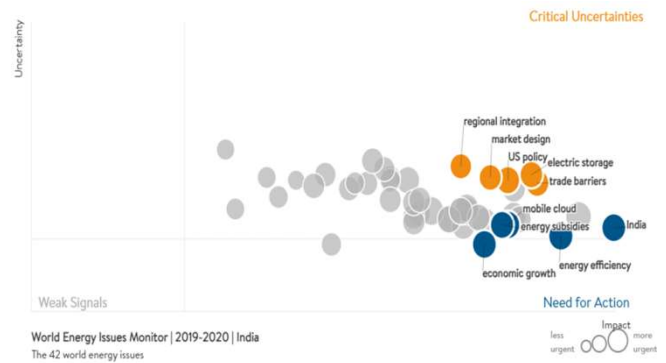


Fig. 6. Indian world energy issue monitors 2020 [13].

Future of Energy in India: This part of the paper will provide details feature energy plans in India based on the energy potentials plans, targets and the energy predictions respectively. In this regard south Asian feature energy plans was modeled based on the two different types of modeling using planned energy scenario and the transforming energy scenario. Energy feature scenarios are alternate views which could be used to analyze the influence of alternative theoretical considerations and to influence the level of efficiency of potential future developments in the energy sector.

Planned Energy Scenario: In this scenario the energy feature energy was considered base on the feature energy plan by considering year 2017, 2030, 2040 and 2050. Based on the outcomes of the projected plan scenario the result shows that in the year 2017 and 2030 the total share of renewable energy are projected to be 24% and the non-renewable share is 76%. However in the year 2040 and the year 2050 the renewable share of the total primary energy will be 31% while the non-renewable energy sources will gain total share of 59% as shown below in Table 1.

Table 1. Planned energy scenario source of data [14]

Technology	Years			
	2017	2030	2040	2050
Renewable share Ej	6.77	11.21	14.43	18.45
Non Renewable Ej	21.33	28.31	53.4	41.14

Fig. 7. below shows the results of projected feature energy using planned energy scenario in Southeast Asian region from 2017 to 2050.

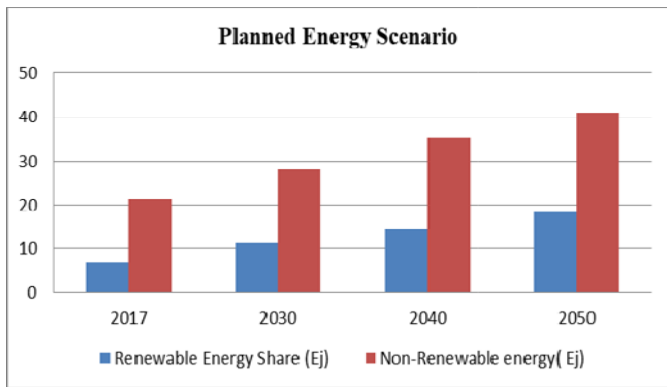


Fig. 7. Planned energy scenario [14]

Transforming Energy Scenario analysis: In the process of Indian's energy transformation scenario analysis by the year 2050, Non-renewable energy will be progressively replaced by clean renewable energy resources base on the significant increases in renewable energy deployment. As shown in the figure below the whole share of renewable energy is anticipated to be 75% and the non-renewable share is 25% because of high share of the renewable energy integration to achieved vision 2050 of reaching zero with renewables.

Table 2. Transforming energy scenario source of data [14]

Technology	Years			
	2017	2030	2040	2050
Renewable share Ej	6.77	15.92	28.64	40.64
Non Renewable Ej	21.33	23.20	19.64	13.66

Fig. 8 below shows the result of projected feature energy using transforming energy scenario in Southeast Asian region from 2017 to 2050.

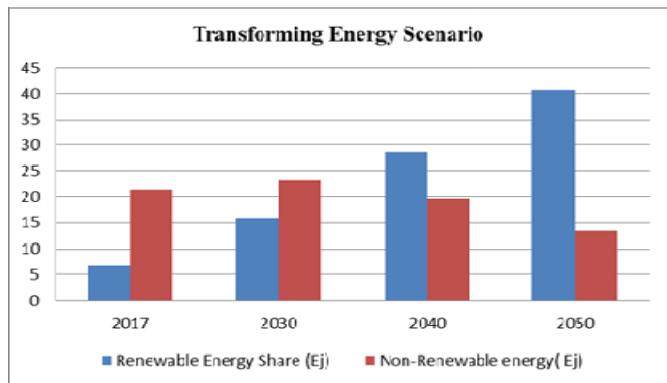


Fig. 8. Transforming energy scenario [14]

CONCLUSION

In this paper, the past, present and future trend of energy in India has been explored. The research finding indicated that, electricity accesses in India increases by 2% from year 2010 to 2018 despite the fact that there is insufficient electrical infrastructure and the energy generation sources for the ever increasing pupations. The present energy situation in India are 95% access to the electricity and 49% access to the clean cooking facilities and 32% access to green energy from overall final energy consumption. The feature energy of India was projected base on the south East Asia energy transformation scenario analysis and it was suggested that by 2050 Indian primary energy consumption will increases up to 75% renewables and 26% non-renewable sources.

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