# Environmental Impact of Energy Utilization in India

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***Abstract :*** The energy sector of India is one of the important sectors affecting socio-economic, monetary and cultural growth. The electricity generating capacity and distribution network is also among the largest in the world. It is also the 3rd largest energy consumer in the world and the growth has been exponentially high over the years. The progress of manpower with the ever-growing population to improve the living standard and industrialization of the developing countries is directly proportional to the consumption of the energy. Energy usage and its major ecological impacts are examined from the angle of economic advancement, including foreseen examples of future energy utilize and consequent natural issues in India. A few angles identifying with energy usage, sustainable energy source, energy proficiency, condition and practical advancement are inspected from both present and future points of view. India is an energy importing nation; the greater part of the energy prerequisite has been provided by imports. Domestic oil and lignite reserves are limited and lower grades of the same causes significant pollution to the environment. Because of expanding energy utilization, air pollution is turning into an extraordinary natural worry for the eventual fate of the nation. In such a manner, sustainable energy source assets give off an impression of being a standout amongst the most productive and viable answers for supportable energy improvement and natural pollution prevention in India. India's land area has a few favourable circumstances for broad utilization of the greater part of these sustainable energy sources.

***Index Terms* – Global Warming, Energy Security, Emissions, Green House Gas, Ozone depletion, Renewable potential**

## I. INTRODUCTION

Modern society on earth is intensely reliant on fossil fuels, for example, oil, gas and coal, and is probably going to stay subject to them for quite a bit of this century (Odell, 2009). Consistently we radiate in excess of 20 billion tons of carbon into the atmosphere by consuming non-renewable energy sources, half of which is absorbed in the oceans and by vegetation, and half of which stays in the environment (Comby, 2008). The effect on human and ecosystem possibly unsalvageable (Schellnhuber et al, 2006). Likewise, as fuels exhaust and demand expand, so supplies turn out to be more vulnerable to disruption. As per the International Energy Agency (IEA, 1999), 'The world is in the beginning stage of an unavoidable transition to a sustainable energy system that will be to a great extent subject to sustainable assets'.

In 2009, US President Barack Obama stated, "To genuinely change our economy, ensure our security, and spare our planet from the assaults of environmental change, we have to, at last, make perfect, sustainable power source the productive sort of energy. In the 2007 European Union (EU) nations resolved to set a coupling focus on that 20% of the EU's aggregate energy supply should originate from renewable by 2020 (European Union Committee, 2008). For the UK the target is 15%, just about a seven-fold increment in the share of renewable in hardly over 10 years (HM Government, 2009). Among the numerous ecological effects of development, the one with the most dangerous consequence presently is global warming, which demands changes from government, industry and public. Worries about the local and worldwide environment situation are rising everywhere throughout the world. Global warming is the result of long-term build-up of ozone-depleting substances ($CO_2$, $CH_4$, $N_2O$ etc.) in the higher layer of the atmosphere. The emanation of these gases is the aftereffect of concentrated naturally unsafe human exercises, for example, the consuming of petroleum derivatives, deforestation and land utilize changes. This is for the most part acknowledged to be the reason that normal worldwide temperatures have expanded by 0.74 °C in the last 100 a long year. Worldwide temperatures are set to ascend by a further 1.1 °C in a low emissions situation, and by 2.4 °C in a high emissions situation, before the end of the century's. It is important to decrease Green House Gases (GHG) emanations by half or more keeping in mind the end goal to balance out worldwide focuses by 2100. The Tyndall Center has proposed that a 70% diminishment in $CO_2$ outflows will be required by 2030 to avert temperature ascending by in excess of 1 °C. Ozone-depleting substances fell by about 14.6% between the 1990 base year and 2004, however, have ascended by around 1 % since 2002, generally as of late in view of expanded oil and gas utilization.

Renewable energy is derived from sources which are naturally replenished or are practically inexhaustible. It is described as 'clean', 'green' or 'sustainable' forms of energy because of their minimal environmental impact compared to fossil fuels. According to National planning policy framework (NPPF) renewable and low-carbon energy: Includes energy for heating and cooling as well as generating electricity. bioenergy is utilized economically and the carbon discharged will be reused into the up and coming age of developing plants. The degree to which bioenergy can dislodge net outflows of $CO_2$ will rely upon the effectiveness with which it can be delivered and utilized. Bioenergy plants have brought down outflows of $SO_2$ than do coal and oil plants, however, they may deliver more particulate issue.

## II. LITRETURE REVIEW

Over the next 20 years, policymakers, industry and government officials will need to invest US $2.5 trillion for electricity generation. Electricity from renewable energy sources produces between 90-99% less greenhouse gases (GHGs) compared with coal-fired plants and causes 70-90% less pollution. Emphasizing the renewable energy sources compared to fossil fuels and coals might help in mitigating the environmental impacts from the fossil fuels, especially from air pollution and GHGs. Nevertheless, all forms of electricity generation have their impacts. To achieve a low-carbon future, we need to understand the effects of different renewable energy resources. Renewable energy is the derivative of the natural sources those could be continuously and sustainably replenished. Renewable energy comes from wind energy, solar energy, biomass energy, biogas energy, geothermal energy, hydropower and offshore wind, wave, and tidal energy. These materials are used in generating renewable energy, such as gallium, indium, neodymium, dysprosium, cadmium, tellurium, and selenium. These materials have been introduced and used recently, which implies that there are limited or no chances of recycling system yet. A large-scale solution to facilitate the recycling of these materials needs to be designed and implemented to avoid environmental hazards and problems in the future. Hydropower's environmental impacts depend on where the installation is located. For example, a large hydropower installation can result in GHG emissions when it swamps and kills vegetation. Carbon dioxide ($CO_2$) is released in such situation along with methane ($CH_4$), a GHG that is about 30 times more capable than $CO_2$ at retaining heat within the atmosphere. Solar panels are designed to absorb the rays and heat of sun to generate energy to be used for electricity or heating. Without a storage device such as battery and adverse weather condition like cloudy weather, Solar energy can't operate. Solar energy is useful, but more research must be done in order to enhance the efficiency and effectiveness. In sum, renewable energy installations are crucial to keep the global warming under control and the environmental impacts of conventional and unconventional energy sources should be studied rigorously to implement the best eco-friendly option and to utilize the maximum potential of the discussed energy source.

## III. RESEARCH GAP

The main purpose of energy utilization in developing countries like India is to increase access to modern (renewable) energy so as to improve the quality of life of the people in three-dimensional areas, which are social, economic and environmental, rooted in sustainable development. The body of ideas aforementioned and presented herein, influences this research to concentrate to answer the question: How can access to modern(renewable) energy impact the socioeconomic and environmental conditions of the rural and urban life of people in developing country like India. The research task hence sought to identify potential renewable energy sources which can impact the communities under study. It was undertaken through a qualitative research method, precisely, interviews of community members, literature review and project experts to investigate the following three research sub-questions.

1. India has a lawfully restricting focus under various acts mentioned to lessen its discharges of the ozone-depleting substances and has declared its expectation to put itself on a way towards a decrease in $CO_2$ outflows of 80% by around 2050.

2. Maybe in light of the fact that GHG discharges can be more promptly measured than different effects, they have pulled in most consideration from scientists and strategy producers however GHG outflows are only one of a range of parameters that ought to be considered in surveying ecological effects

3. Others are ozone exhaustion, water utilization, lethality, eutrophication of lakes and waterways, and asset consumption, and the point of this paper is to survey the environmental impact of energy utilization as a method for assessing the dangerous effect of non-renewable energy in the process of urbanization and development.

## IV. RESEARCH METHODOLOGY

Content analysis is a generally utilized qualitative research method. As opposed to being a solitary strategy, current utilization of content analysis demonstrates three unmistakable methodologies: conventional, summary, directed. Every one of the three methodologies are utilized to translate significance from the content of content information and, henceforth, stick to the naturalistic worldview. The real contrasts among the methodologies are coding plans, inceptions of codes, and dangers to reliability. In the traditional content analysis, coding classes are gotten specifically from the content information. With a coordinated approach, analysis begins with a hypothesis or important research discoveries as direction for starting codes. A summative content analysis includes tallying and comparison, generally of catchphrases or content, trailed by the understanding of the hidden setting. The authors outline logical systems particular to each approach and strategies tending to reliability with speculative cases drawn from the zone of end-of-life care.

## V. ENERGY PERSPECTIVE

The energy consumption of India is set to grow 4.2% a year by 2035. India is Asia's second largest energy consumer after China surpassing Japan in the year 2008. This quick increment in demand is because of the high monetary and economic advancement rate of India. The assessed measure of investments for the production, distribution and transmission during 2006- 2016 is around $53 billion. India is going to invest additional $200 to 300 billion US for its renewable energy infrastructure between 2020-2030.The government has attempted measures to pull in domestic and foreign investments and furthermore to exchange operational privileges and rights to achieve the ambitious target of 275 GW of renewable capacity installed by 2027.

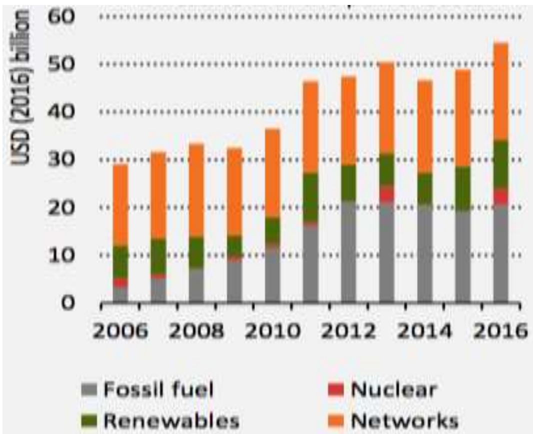


Fig. 1
Investment in Power Sector of India
Source: BP Statistical Review 2017

Table 5.1
Primary Energy Consumption of India
(Mtoe: Million-ton oil equivalent)
Source: IEA, July 2017

| Years | Energy Consumption (Mtoe) |
|---|---|
| 2010 | 537.1 |
| 2011 | 568.7 |
| 2012 | 611.6 |
| 2013 | 621.5 |
| 2014 | 663.6 |
| 2015 | 685.1 |
| 2016 | 723.9 |

Table 5.2
Fuel Consumption of India
Source: Government of India

| Year | Oil (million tons) | Natural gas (billion cubic meters) | Coal (million tons) | Hydro & Nuclear Electricity (GWh) |
|---|---|---|---|---|
| 2010 | 33.69 | 47.50 | 532.04 | 125316 |
| 2011 | 37.68 | 52.22 | 532.69 | 140524 |
| 2012 | 38.09 | 47.56 | 539.95 | 163000 |
| 2013 | 37.86 | 39.83 | 556.40 | 146497 |
| 2014 | 37.79 | 35.41 | 565.77 | 169076 |
| 2015 | 37.46 | 33.66 | 612.44 | 165346 |

India is an energy importing nation; most of the energy necessity has been provided by imports. In 2013, India's net imports are nearly 144.3 million tons of crude oil, 16 Mtoe of LNG and 95 Mtoe coal totalling to 255.3 Mtoe of primary energy which equals 42.9 percentage of total primary energy consumption. By the year 2030, India’s dependence on energy imports is expected to exceed 53% of the country's total energy consumption. Coal has the greatest offer in absolute essential energy utilization. Because of the broadening endeavours of energy sources, utilization of natural gas is brought and implemented in a large manner. India has huge stores of coal, especially of lignite and coking. The proven coal reserves are around 125.9 billion tons. The evaluated total possible reserves are approximately 301.6 billion tons. Critical advancements have been recorded in primary energy generation and energy utilization after independence. In the recent period (2006-2017), primary energy utilization has expanded by 10%, every year.

Table 5.3
Energy Consumption of India (in Tera watt hour, TWh)
WWS: Wind, Water and Sunlight
Source: Government of India

| Years | Thermal | Nuclear | REs | Hydro | WWS | Total |
|---|---|---|---|---|---|---|
| 2011-12 | 708.43 | 32.29 | 51.23 | 130.51 | 181.74 | 922.45 |
| 2012-13 | 760.45 | 32.87 | 57.45 | 113.72 | 171.17 | 964.49 |
| 2012-14 | 792.05 | 34.23 | 65.45 | 134.85 | 200.37 | 1026.65 |
| 2014-15 | 877.94 | 36.10 | 73.56 | 129.24 | 202.81 | 1116.85 |
| 2015-16 | 943.01 | 37.41 | 65.78 | 121.38 | 187.16 | 1167.58 |
| 2016-17 | 993.00 | 37.90 | 81.90 | 122.30 | 204.20 | 1236.40 |

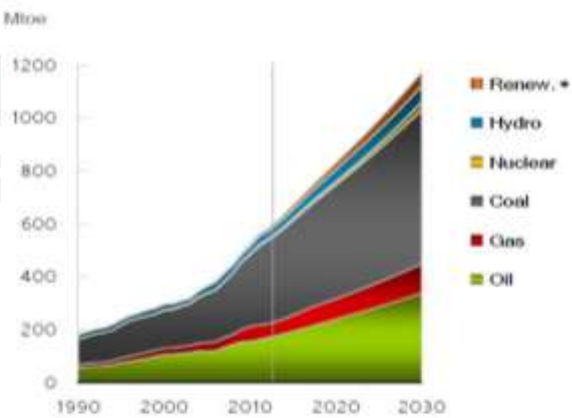


Fig. 2
India’s Primary Energy Demand Prediction
Source: BP Energy Outlook 2030

At the year-end of 2017, installed and generation capacity has reached 340.53 GW and renewables capacity is 32.2% of the total. By the year 2030, the primary energy demand will reach 1200 Mtoe. Figure 2 depicts the findings related to India’s primary energy production target.

## VI. ENVIRONMENTAL IMAPCT OF ENERGY UTILISATION

India has experienced major economic changes in the 1990s'; the 1991 economic liberalization of India and subsequent reforms (privatization of state enterprises, price liberalization and integration in the global economy) has enabled Indian market to move and develop at a faster rate. India's population has come to 1.32 billion and stays one of the fastest growing.

Air quality in the urban cities is a primary cause for concern in India. The pollutants like particulate matter (PM), sulphur dioxide ($SO_2$), nitrogen oxides ($NO_x$), carbon monoxide (CO), and ozone ($O_3$) often exceed the National Ambient Air Quality Standards (NAAQS). According to the World Health Organization (WHO), 37 cities from India feature in the top 100 world cities with the worst $PM_{10}$ pollution, and the cities of Delhi, Raipur, Gwalior, and Lucknow are listed in the top 10 (WHO, 2014).

More than 100 cities under the national ambient monitoring program exceed the WHO guideline for $PM_{10.}$ Air pollution from energy usage in the nation is because of the ignition of coal, lignite, oil, petroleum gas, wood and horticultural and animal wastes. Then again, owing fundamentally to the quick growth of primary energy utilization and the expanding utilization of household lignite, $SO_2$ emissions, specifically, have increased quickly in the recent years in India. The significant contributors of $SO_2$ emissions are the power sector, contributing over half of the aggregate discharges. As given in Table 6.2, $SO_2$ and $CO_2$ concentrations in the vent and flue gas of the coal-based power plants are extremely high and differ between the variation of Sulphur content in the fuel. Despite the fact that the $NO_2$ emissions are lower than $SO_2$ emissions in India, they have in like manner expanded quickly, following the development of energy necessities.

Table 6.1
Emission standards for coal-fired power plant

| | |
|---|---|
| Particulate Matter | 350 mg/Nm$^3$ for <210 MW |
| | 150 mg/Nm$^3$ for >210 MW |

Table 6.2
Pollutant Concentration in coal-based power plant
Source: Nature of air pollution, emission sources, and management in the Indian cities, IIT Kanpur

| Pollutant | Time Weighted Average | Concentration in Ambient Air | |
|---|---|---|---|
| | | Industrial, Residential, Rural and other Areas | Ecologically Sensitive Area |
| Sulphur Dioxide ($SO_2$) | Annual* | 50 | 20 |
| Nitrogen Dioxide ($NO_2$) | Annual* | 40 | 30 |
| Particulate Matter (size less than 10µm) | Annual* | 60 | 60 |
| Particulate Matter (size less than 2.5µm) | Annual* | 40 | 40 |
| *Annual arithmetic mean of minimum 104 measurement at a particular site taken twice a week 24 hours at uniform intervals | | | |

## VII. RENEWABLE ENERGY SOURCES IN INDIA

India has substantial reserves of renewable energy sources and is running one of the largest and most ambitious renewable capacity expansion programs in the world. Renewable energy production represented about 60.98 GW in 2017 and renewables are playing a crucial role as a domestic energy source. More up to date inexhaustible power sources are anticipated to develop quickly by 2022 targets, including a dramatically increasing of India's substantial breeze control limit and a right around 15-overlay increment in sun-oriented power from April 2016 levels. More than two-thirds of this production is supplied by Wind and Solar power; another one-third is supplied by biomass and hydropower. On the other hand, government projections for the near future indicate a progressive decrease in the use of wood, animal wastes and other combustible energy sources. The reasons for this are the expected rise in living standards as well as limits on deforestation. In the following sections, each renewable energy resource is discussed briefly.

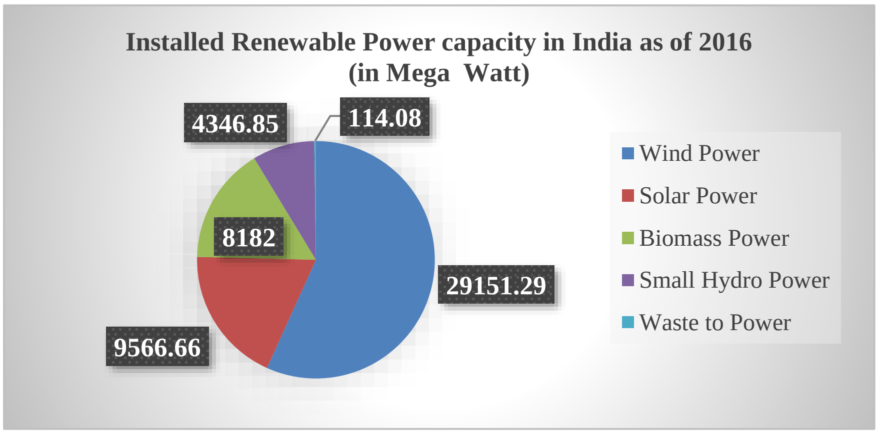


Fig. 3
Source: Ministry of New and Renewable Energy, GOI

From various sources such as wind, solar, biomass there is a high potential for generation of renewable energy. The total capacity for renewable power generation in the country as on 31.03.16 is estimated at 1198856 MW which includes wind power potential of 102788 MW (8.57%) at 80m hub height, wind power potential of 302235 MW (25.21%) at 100 m hub height, SHP (small-hydro power) potential of 19749 MW (1.65%), Biomass power of 17,538 MW (1.46%), 5000 MW (0.42%) from bagasse-based cogeneration in sugar mills, 2556 MW (0.21%) from waste to energy and solar power potential of 748990 MW (62.48%).

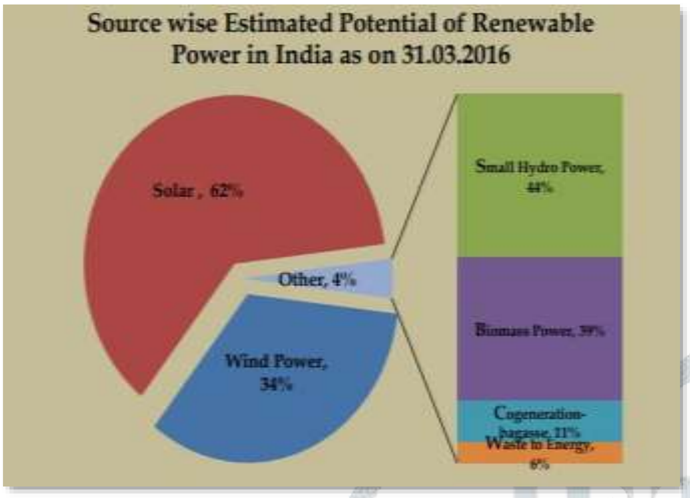


Fig. 4

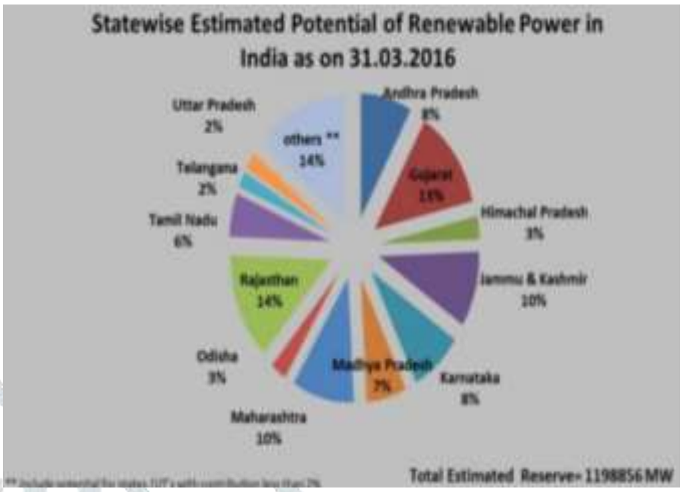


Fig. 5

Source: Energy Statistics 2017
Ministry of Statistics and Programme Implementation, GOI

The estimated potential of renewable power according to the geographic distribution as on 31.03.2016 reveals that Rajasthan has the highest share of about 14% (167276 MW), followed by Gujarat with 13% share (157158 MW) and Maharashtra with 10% share (119893MW), mainly on account of solar power potential.

**7.1 Wind Power**

The development of wind power in India began in the 1990s and has increased substantially in the last few years. Although a relative newcomer to the wind industry compared with Denmark or the US, domestic policy support for wind power has led India to become the country with the fourth largest installed wind power capacity in the world. As of 28 February 2017, the installed capacity of wind power in India was 29151.29 MW, mainly spread across Tamil Nadu, Maharashtra, Gujarat, Rajasthan, Karnataka, Andhra Pradesh, and Madhya Pradesh. Wind power accounts for 10% of India's total installed power capacity. India has set an ambitious target to generate 60,000 MW of electricity from wind power by 2022.

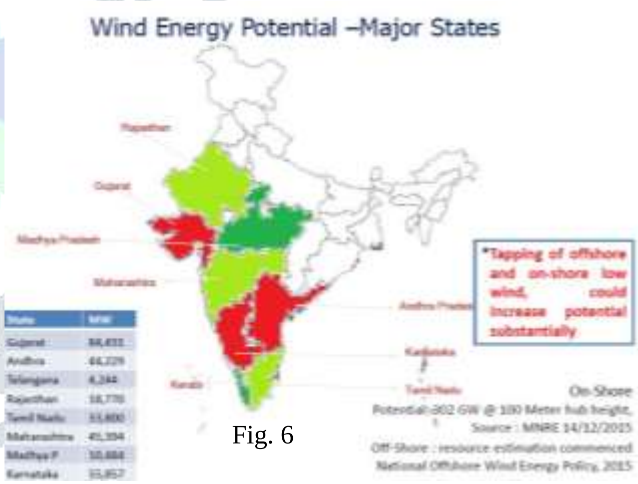


Fig. 6

**7.2 Solar Power**

According to National Institute of Solar Energy in India current solar power installed capacity of India is 4879 MW (0.6% of the estimated potential). Solar radiation is high 4.5-5.5 kWh/m$^2$ in most of the regions (>300 days of Sunshine) i.e. High radiation areas, Large tract of wasteland. Many environmental advantages from Solar energy technologies (SETs) as a conventional energy sources providing sustainable development environment. Major contribution is related to the reduced $CO_2$ emissions and absence of any air emissions or waste products during their operation. Concerning the environment, the utilization of SETs has extra positive ramifications, for example, lessening of the discharges of the ozone depleting substances (predominantly $CO_2$, NOx) and anticipation of dangerous gas outflows ($SO_2$, particulates), recovery of corrupted land; decrease of the required transmission lines of the power matrices; and change of the nature of water assets (Various,2000). In respect the socio-economic perspective the advantages of the misuse of SETs contain: increment of the local/national energy independency; arrangement of noteworthy work openings; enhancement and security of energy supply, Energy

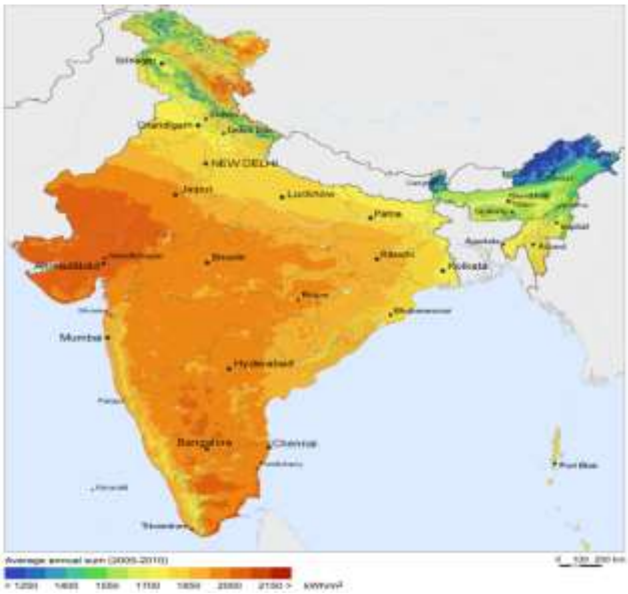


Fig. 7
Solar Potential of India

Security, quick deployment, distributed potential, support of the deregulation of energy markets; not constrained by location.

**7.3 Hydro Power**

India's hydroelectric potential is assessed to be 148,701 MW. An extra 6,780 MW from small hydro plans (with limits of under 25 MW) is assessed as exploitable. 56 destinations for pumped capacity and storage schemes with a total capacity of 94,000 MW have additionally been distinguished. Due to opposition from the local tribal community the following river beds are not well developed of the central India region; the Godavari, Mahanadi, Nagavali, Vamsadhara and Narmada.

Government sector represents 92.5% of India's hydroelectric power generation. The, Northeast Electric Power Company (NEEPCO), National Hydroelectric Power Corporation (NHPC) Satluj Jal Vidyut Nigam (SJVNL), THDC, and NTPC-Hydro are part of public sector undertakings in India. The private division is likewise anticipated that would develop with the improvement of hydroelectric power generation potential in the Himalayan mountain ranges and in the north-eastern states of India. Indian organizations have additionally built hydropower projects in Bhutan, Nepal, Afghanistan, and different nations.

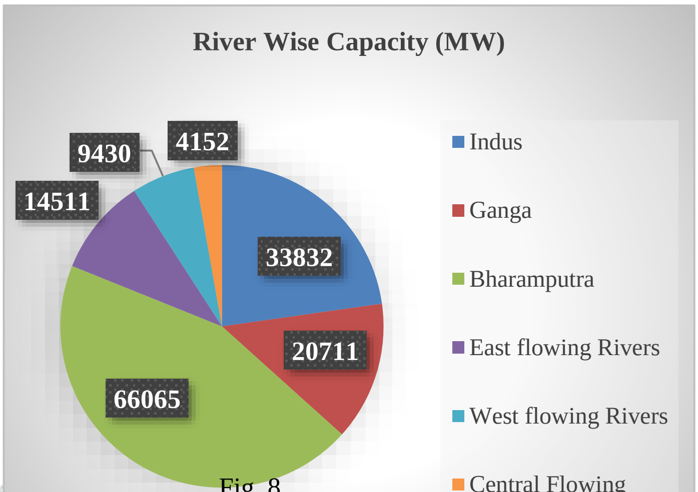


Fig. 8
Hydro Power potential in different rivers
Source: CEA

Bhakra Beas Management Board (BBMB), a state-owned undertaking in north India, has a capacity of 2.9 GW. The cost of generation after four decades of activity and operation is around 27 paise (0.41¢ US) per kWh. BBMB helps in supply of water to 12.5 million acres of land (51,000 km2; 19,500 sq mi) for irrigation and cultivation process.

**7.4 Biomass Energy**

It is generated from the organic matters, a sustainable & renewable source of energy which is used to create different forms of energy mainly electricity. Biomass in Indian, a vital network, essential for remote towns and urban bunches with decentralized habitat. Biomass related undertakings gets a venture of about $ 9251 million consistently, prompting power age of 5000 million units. Service of New and Renewable Energy (MNRE) has set the national target is to accomplish 10 GW of introduced biomass control by 2022. India has a capability of around 18 GW of vitality from Biomass. Presently, around 32% of aggregate essential vitality utilized as a part of India is gotten from Biomass. Over 70% of the nation's populace relies on biomass for its vitality needs. India has 5+ GW limit biomass-controlled plants: 83% are lattice associated while the staying 17% are off-framework plants. The off-framework plants are separated between cogeneration plants that don't use bagasse, biomass gasifiers for provincial applications and biomass gasifiers for warm applications in industry. Around 70 Cogeneration ventures are under execution with surplus limit collecting to 800 MW.

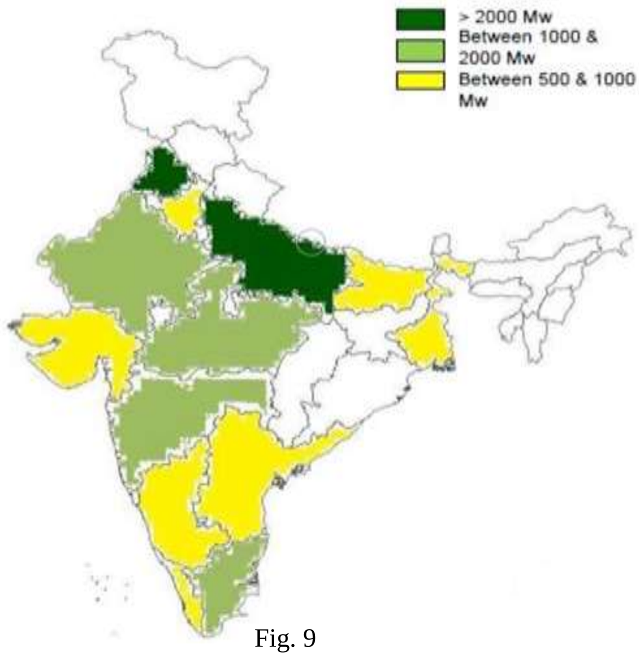


Fig. 9
Biomass Energy potential of India
Source: Ministry of New and Renewable Energy, GoI

**VIII. Conclusion**

India is an energy-importing country, because domestic fossil reserves are limited and insufficient. Recently, considerable attention has been focused on the energy resources by the government in India. The Indian government's investment needs in the energy sector for the period 2002–2015 will be around US $165 billion and of this, about 82% constitutes total planning investments. A major dilemma now faced by India is how to invest in new electric power capacity. Therefore, India has to adopt new long-term energy strategies to reduce the share of fossil fuels and to increase the share of renewables in the primary energy consumption.

India has a major potential for energy efficiency improvements. Exploitation of this potential could reduce environmental emissions and improve security of supply. The potential for renewables is also significant. India's main renewable energy sources are wind and solar power. The use of fuelwood and animal wastes will decline in share and absolute terms as India becomes more prosperous, as has happened in all other IEA countries, because of the convenience of using oil, gas or even electrical heating and cooking where these options are available. If the use of biomass is to be sustained in future, then measures will at some stage have to be phased in to support it. In this respect, India could benefit from other countries' experiences. Several issues must be considered in this context. First, fuelwood must be used in a sustainable manner. India carries out afforestation programmes in deforested, arid areas for environmental reasons; these must not be jeopardized and forest exploitation and wood harvesting must occur in a controlled manner. Second, waste incineration for electricity generation should be considered as a renewable option in the future, but this should be done using appropriate technology to ensure high health and environmental standards, in particular with respect to air emissions. On the other hand, in India's situation, where government expenditure has to be tightly controlled, it is of great importance that the most cost-effective resources are developed. Therefore, the government should attempt to develop competitive renewables first, and base support for renewables, if necessary, on cost-effectiveness. The government should investigate which options are viable without financial support. This may be the case for certain hydro projects and for solar thermal applications. The potential of these and other renewable energy sources should be evaluated regularly. For those renewables that need support, bidding procedures should be implemented to ensure that the most cost-effective renewables are supported.

In recent years, progress has been made in both fields. New energy efficiency legislation and regulations are under preparation that will go some way towards using this potential. India now has a clear target for wind and solar power generation, and numerous wind projects were submitted under various missions.

## IX. Acknowledgment

We extend our deep sense of gratitude and indebtedness to our mentor Prof. Promod Kumar Painuly, faculty at School of Business, UPES, Dehradun and Dr Ninad Bodhankar, faculty at Pt. Ravishankar Shukla University, Raipur for their incessant encouragement, cooperation and support that enabled us to continue this work. The guidance and help not only provided us with invaluable insight about the topic but, also kept us in good spirit throughout the course of this research article on "Environmental impact of Energy Utilisation in India".

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