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Estimation of Potential Capacities for development and energy consumption scenario for fiscal progress

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Abstract— Energy framework incorporates renewable, atomic, and fossil vitality sources as well as electrical, warm, and fuel. Renewable sources at present supply some place between 15 percent and 20 percent of world's aggregate energy request. Renewable energy assets exist over wide land regions. India has an unfathomable supply of renewable vitality assets, and it has one of the biggest projects on the planet for sending renewable vitality items and frameworks. This review paper manages the review of renewable vitality and its commitment in different parts of the India taking into account MNRE reports which demonstrates that the force division in India is profoundly various with changed business hotspots for force era like coal, regular gas, hydro, oil and atomic and also whimsical wellsprings of vitality like sun oriented, wind, bio-gas and horticulture. It is concentrated on that, India's aggregate introduced limit of power era has extended from 105,045.96 MW toward the end of 2001–02 to 1, 57,229.48 MW toward the end of February, 2010. Actually, India positions 6th all around regarding absolute power era. The interest for force has been developing at a quick rate and overwhelmed the supply, prompting power deficiencies despite complex development in force era.

Keywords— Renewable Energy, Bio-sources, PV Technology, Solar energy, Climatic change, Clean Energy Technologies, Energy Forecasts

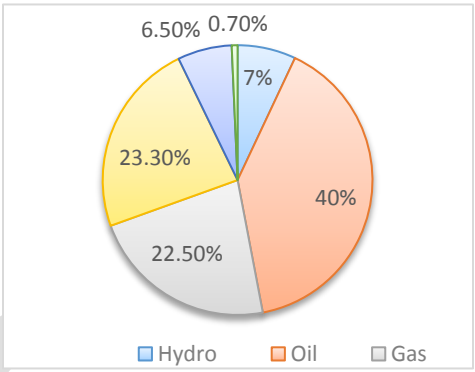
1. INTRODUCTION-

The capability of renewable vitality sources is colossal as it can, on a basic level, meet ordinarily the world's vitality request. Renewable energy sources, for example, biomass, wind, sunlight based, hydropower, and geothermal can give maintainable vitality administrations, in view of the utilization of routinely accessible, indigenous assets. The improvement and utilization of renewable sources can upgrade differences in vitality supply markets, contributing long haul maintainable energy supplies, and therefore helping in lessening nearby and worldwide climatic outflows, and give industrially alluring alternatives to meet particular vitality benefit needs. Renewable vitality is by and large characterized as vitality that originates from assets which are actually recharged on a human timescale, for example, daylight, wind, downpour, tides, waves, geothermal warmth. Renewable vitality replaces routine powers in four unmistakable ranges: power era, air and water warming and cooling, engine energizes, and rustic (off-lattice) vitality administrations.

2. GLOBAL MARKET OVERVIEW-

The supply is dominated by traditional biomass, mostly fuel wood used for cooking and heating, especially in developing countries in Africa, Asia and Latin America. A major contribution is also obtained from the use of large hydropower; with nearly 20 percent of the global electricity supply being provided by this source. New renewable energy sources (solar energy, wind energy, modern bio-energy, geothermal energy, and small hydropower) are currently contributing about two percent. Based on REN21's 2014 report [1]. Renewable contributed 19 percent to our global energy consumption and 22 percent to our electricity generation in 2012 and 2013, respectively. This energy consumption is divided as 9% coming from traditional biomass, 4.2% as heat energy (non-biomass), 3.8% hydroelectricity and 2% is electricity from wind, solar, geothermal, and biomass. In contrast to other energy sources, which are concentrated in a limited number of countries? Rapid deployment of renewable energy and energy efficiency is resulting in significant energy security, climate change mitigation, and economic benefits. In international public opinion surveys there is strong support for promoting renewable sources such as solar power and wind power. At the national level, at least 30 nations around the world already have renewable energy contributing more than 20 percent of energy supply. National renewable energy markets are projected to continue to grow strongly in the coming decade and beyond.

The technologies featured here will make our families healthier, more secure, and more prosperous by improving our air quality, reducing our reliance on fossil fuels, curbing global warming, adding good jobs to the economy and -when they're properly sited protecting environmental values such as habitat and water quality. Working together, policymakers, communities, businesses, investors, utilities, and farmers can help build a sustainable future Conventional energy sources based on oil, coal, and natural gas have proven to be highly effective drivers of economic progress, but at the same time damaging to the environment and to human health. Furthermore, they tend to be cyclical in nature, due to the effects of oligopoly in production and distribution. Approximately 20% of electricity produced globally in 2009 came from renewable sources. Out of this, hydro-power accounted for about 16%. In 2012, 9% of the energy consumed in the USA came from renewable sources. This means the USA depends a lot on non-renewable sources. 30% of the energy from renewable sources came from hydropower, whiles biomass, bio fuels and wood, together accounted for about 49%. —Source: USEIA, Monthly Energy Review, April 2013.



Source	Unit	Installed
Wind Farms	MW	557
Wind Pump	No's	3289
Small Hydro (up to 3 MW)	MW	122
Bio Gasifiers	X 10 6	2.12
Solar PV	KW	825

Table 1- Actual installed renewable based plants in India [22]

3. INDIA AND RENEWABLE ENERGY-

India is a country of agriculture. India has a vast supply of renewable energy resources, and it has one of the largest programs in the world for deploying renewable energy products and systems. Sources of renewable energy available in India: We know where the nonrenewable energies – coal, oil and gas – are located and how these fuels are transported, combusted, and the power transmitted throughout the country over the power grid. Now, let's look at the renewable energies – hydro, solar, wind and biomass – and see where they are found. Considered an emerging economy," increasing GDP is driving the demand for additional electrical energy, as well as transportation fuels. India is a nation of extremes. Poverty remains in areas with no energy services, while wealth grows in the new business hubs. Coal fired generation currently provides two thirds of the generation capacity, and hydropower supplies the other third. India is blessed with vast resources of renewable energy in solar, wind, biomass and small hydro. In fact, the technical potential
of these renewable exceeds the present installed generation capacity. Energy exists freely in nature. Some of them exist infinitely (never run out, called **renewable**), the rest have finite amounts (they took millions of years to form, and will run out one day, called **non-renewable). There are many forms of renewable energy**.
Most of these renewable energies depend in one way or another on sunlight. Wind and hydroelectric power are the direct result of differential heating of the Earth's surface which leads to air moving about (wind) and precipitation forming as the air is lifted. Solar energy is the direct conversion of sunlight using panels or collectors. Biomass energy is stored sunlight contained in plants. Other renewable energies that do not depend on sunlight are geothermal energy, which is a result of radioactive decay in the crust combined with the original heat of accreting the Earth, and tidal energy, which is a conversion of gravitational energy.

4- HYDRO POWER-

Hydropower is the largest renewable resource used for electricity. It plays an essential role in many regions of the world with more than 150 countries generating hydroelectric power. This form uses the gravitational potential of elevated water that was lifted from the oceans by sunlight. It is not strictly speaking renewable since all reservoirs eventually fill up and require very expensive excavation to become useful again. At this time, most of the available locations for hydroelectric dams are already used in the developed world. Moving water has kinetic energy. This can be transferred into useful energy in different ways. Hydroelectric power (HEP) schemes store water high up in dams. The water has gravitational potential energy which is released when it falls. The hydroelectric power refers to the energy produced from water (rainfall flowing into rivers, etc). Consequently, rainfall can be a good indicator to investors looking for a location to implement or build a new hydroelectric power plant in India. It is, in fact, the case, if we compare the map of Annual Rainfall and the "Energy Map of India" on page 6, that hydropower plants are situated in regions of the major rainfall. The dominant annual rainfall is located on the north/eastern part of India: Arunachal Pradesh, Assam, Nagaland, Manipur and Mizoram, and also on the west coast between Mumbai (Bombay) and Mahe. India utilizes twelve primary hydroelectric power plants: Three in Bihar, Punjab, Uttaranchal, Karnataka, Uttar Pradesh, Sikkim, Jammu & Kashmir, Gujarat, and two in Andhra Pradesh.

5. SOLAR ENERGY-

This form of energy relies on the nuclear fusion power from the core of the Sun. This energy can be collected and converted in a few different ways. The range is from solar water heating with solar collectors or attic cooling with solar attic fans for domestic use to the complex technologies of direct conversion of sunlight to electrical energy using mirrors and boilers or photovoltaic cells.

Unfortunately these are currently insufficient to fully power our modern society Because of its location between the Tropic of Cancer and the Equator, India has an average annual temperature that ranges from 25°C – 27.5 °C. This means that India has huge solar potential. The sunniest parts are situated in the south/east coast, from Calcutta to Madras.

State	MW	State	MW
Andaman & Nicobar	5.1	Kerala	12.02
Andhra Pradesh	475.74	Lakshadweep	0.75
Arunachal Pradesh	0.26	Madhya Pradesh	678.58
Bihar	5	Maharashtra	378.7
Chandigarh	5.04	Odisha	66.92
Chhattisgarh	73.18	Puducherry	0.02
Daman & Diu	4	Punjab	300.32
Delhi	6.71	Rajasthan	1264.35
Gujarat	1024.15	Tamil Nadu	562.94
Haryana	12.8	Telangana	392.39
Jharkhand	16	Tripura	5
Karnataka	104.22	Uttar Pradesh	140
Uttarakhand	5	West Bengal	7.21

Table 2- State wise installed solar power capacity [27]

Solar energy has several applications: photovoltaic (PV) cells are placed on the roof top of houses or commercial buildings, and collectors such as mirrors or parabolic dishes that can move and track the sun throughout the day are also used. This mechanism is being used for concentrated lighting in buildings. Photovoltaic (PV) cells have a low efficiency factor, yet power generation systems using photovoltaic materials have the advantage of having no moving parts. PV cells find applications in individual home rooftop systems, community street lights, community water pumping, and areas where the terrain makes it difficult to access the power grid. The efficiency of solar photovoltaic cells with single crystal silicon is about 13 % - 17%. High efficiency cells with concentrators are being manufactured which can operate with low sunlight intensities. Solar thermal power systems use various techniques to focus sunlight to heat an intermediary fluid, known as heat transfer fluid that then is used to generate steam. The steam is then used in a conventional steam turbine to generate electricity. At present, there are three solar thermal power systems currently being developed: parabolic troughs, power towers, and dish/engine systems.

6. WIND ENERGY-

The movement of the atmosphere is driven by differences of temperature at the Earth's surface due to varying temperatures of the Earth's surface when lit by sunlight. Wind energy can be used to pump water or generate electricity, but requires extensive areal coverage to produce significant amounts of energy. India is surpassed only by Germany as one of the world's fastest growing markets for wind energy. By the mid-1990s, the subcontinent was installing more wind generating capacity than North America, Denmark, Britain, and the Netherlands.

The countries that have been fueling wind energy's growth throughout this decade have mainly been in the Northern Hemisphere, in particular Europe, where issues regarding the environment, fuel security and electricity-generating diversity are a priority. Of the 10 countries with the highest installed capacity at the end of 1999, only the United States, India and China lie outside Europe. The ten machines near Okha in the province of Gujarat were some of the first wind turbines installed in India. These 15-meter Vistas wind turbines overlook the Arabian Sea. Now, in 2006, there is an installed capacity of 4,430 MW; however, ten times that potential, or 46,092 MW, exists. The main technical parameter determining the economic success of a wind turbine system is its annual energy output, which in turn is determined by parameters such as average wind speed, statistical wind speed distribution, and distribution of occurring wind directions, turbulence intensities, and roughness of the surrounding terrain. Wind energy is currently one of the most cost-competitive renewable energy technologies. Worldwide, the cost of generating electricity from wind has fallen by more than 80 percent, from about 38 US cents in the early1980s to a current range of 3-6 cents/kWh levelized over a plant's lifetime, and analysts forecast that costs will drop an additional 20-30 percent in the next five years.

States in India (Wind energy Potential)	Gross Potential (MW)
Andhra Pradesh	9063
Gujarat	7362
Karnataka	7161
Kerala	1026
Madhya Pradesh	4978
Maharashtra	4519
Orissa	1520
Rajasthan	6672
Tamil Nadu	4159
West Bengal	32

Table-3: State wise distribution of wind energy in India [1]

7. BIOMASS-

Biomass includes solid biomass (organic, non-fossil material of biological origins), biogas (principally methane and carbon dioxide produced by anaerobic digestion of biomass and combusted to produce heat and/or power), liquid bio-fuels (bio-based liquid fuel from biomass transformation, mainly used in transportation applications), and municipal waste (wastes produced by the residential, commercial and public services sectors and incinerated in specific installations to produce heat and/or power). The most successful forms of biomass are sugar cane bagasse in agriculture, pulp and paper residues in forestry and manure in livestock residues. It is argued that biomass can directly substitute fossil fuels, as more effective in decreasing atmospheric CO2 than carbon sequestration in trees. The Kyoto Protocol encourages further use of biomass energy. In developing countries it still accounts for an estimated one third of primary energy use while in the poorest up to 90% of all energy is supplied by biomass. Bio-energy comes either directly from the land, as dedicated energy crops, or from residues generated in the processing of crops for food or other products such as pulp and paper from the wood industry. Another important contribution is from post-consumer residue streams such as construction and demolition wood, pallets used in transportation, and the clean fraction of municipal solid waste (MSW). Some smaller gasification/engine systems

have been applied relatively successfully in rural India and some other countries. India is very rich in biomass. It has a potential of 19,500 MW (3,500 MW from bagasse based cogeneration and 16,000 MW from surplus biomass). India has 537 MW commissioned and 536 MW under construction. The facts reinforce the idea of a commitment by India to develop these resources of power production as-

a) Andhra Pradesh (200 MW)
b) Bihar (200 MW)
c) Gujarat (200 MW)
d) Karnataka (300 MW)
e) Maharashtra (1,000 MW)
f) Punjab (150 MW)
g) Tamil Nadu (350 MW)
h) Uttar Pradesh (1,000 MW)

The biomass to bio-energy system can be considered as the management of flow of solar generated materials, food, and fiber in our society. These interrelationships are shown in Figure 1, which presents the various resource types and applications, showing the flow of their harvest and residues to bio-energy applications. Not all biomass is directly used to produce energy but rather it can be converted into intermediate energy carriers called bio-fuels. This includes charcoal (higher energy density solid fuel), ethanol (liquid fuel), or producer-gas (from gasification of biomass).

8. OTHER SOURCES OF ENERGY-

There are several other sources of energy as-Geothermal Energy, Tidal Energy, wave energy etc. that contribute in energy demand of India. Waste to Energy ventures taking into account Municipal Solid Waste (MSW), introduced in the nation starting 31st March 2015 is only 154 MW. MSW is a heterogeneous blend of combustibles, natural matter, inert and dampness. Vitality era through biochemical change or burning will rely on upon the levels of isolation and gathering productivity of MSW. This is a key center range of Ministry of Urban Development and also Urban nearby bodies (ULBs) the nation over and subsequently it is expected under all situations that by 2047: India has reasonably good potential for geothermal; the potential geothermal provinces can produce 10,600 MW of power (but experts are confident only to the extent of 100 MW). More than 300 hot spring locations have been identified by Geological survey of India (Thussu, 2000). The surface temperature of the hot springs ranges from 35 C to as much as 98 C. These hot springs have been grouped together and termed as different geothermal provinces based on their occurrence in specific geotectonic regions, geological and structural regions such as occurrence in orogenic belt regions, structural grabens, deep fault zones, active volcanic regions etc., Different orogenic regions are – Himalayan geothermal province, Naga-Lushai geothermal province, Andaman-Nicobar Islands geothermal province and non-orogenic regions are – Cambay graben, Son-Narmada-Tapi graben, west coast, Damodar valley, Mahanadi valley, Godavari valley etc. The most attractive locations are the Gulf of Cambay and the Gulf of Kachchh on the west coast where the maximum tidal range is 11 m and 8 m with average tidal range of 6.77 m and 5.23 m respectively. The Ganges Delta in the Sunderbans in West Bengal also has good locations for small scale tidal power development. The maximum tidal range in Sunderbans is approximately 5 m with an average tidal range of 2.97 m. The identified economic tidal power potential in India is of the order of **8000-9000 MW** with about 7000 MW in the Gulf of Cambay about 1200 MW in the Gulf of Kachchh and less than 100 MW in Sundarbans. The installed capacity of renewable energy has touched 32,269.6 Mw or 12.95% of the total potential available in the country, as on March 31, 2014. With this, the renewable energy, including large hydroelectricity, constitutes 28.8% of the overall installed capacity in India.

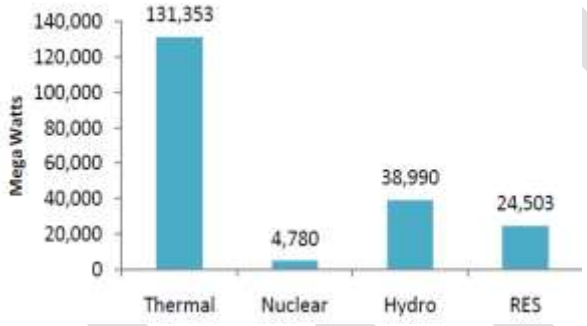


Fig 2- India's Installed Power capacity 2011 (Source: Ministry of Power, Government of India)

9. ENERGY CONSERVATION- DEMAND AND SUPPLY:

Growth in net electricity consumption is expected to be most rapid among the emerging economies of the world, including India. According to the EIA, the annual average increase will be about 4.0 percent from 2002 to 2025.This is the practice that results in less energy being used. It also includes running in the park or outside instead of running on the treadmill in the gym. Energy conservation is great because we can all do this everywhere and anytime.

It is a great behavior we must acquire. The potential of renewable energy sources is enormous as they can in principle meet many times the world's energy demand. Renewable energy sources such as biomass, wind, solar, hydropower, and geothermal can provide sustainable energy services, based on the use of routinely available, indigenous resources. A transition to renewable-based energy systems is looking increasingly likely as the costs of solar and wind power systems have dropped substantially in the past 30 years, and continue to decline, while the price of oil and gas continue to fluctuate.

In fact, fossil fuel and renewable energy prices, social and environmental costs are heading in opposite directions. Furthermore, the economic and policy mechanisms needed to support the widespread dissemination and sustainable markets for renewable energy

systems have also rapidly evolved. The Global Wind Energy Council in its report says that Indian Wind Energy Outlook 09 estimates that there is a potential of around 90,000 MW for power generation from different renewable energy sources in the country, including 48,561 MW of wind power, 14,294 MW of small hydro power and 26,367 MW of biomass. In addition, the potential for solar energy is estimated for most parts of the country at around 20 MW per square kilometer of open, shadow free area covered with solar collectors, which would add to a minimum of 657 GW of installed capacity.

10. DISCUSSION & FUTURE TARGETS –

The incentive to use 100% renewable energy, for electricity, transport, or even total primary energy supply globally, has been motivated by global warming and other ecological as well as economic concerns. The average per capita consumption of energy in India is around 500 W, which is much lower than that of developed countries like the United States, Europe, Australia, Japan, etc. However, this figure is expected to rise sharply due to high economic growth and rapid industrialization. The Intergovernmental Panel on Climate Change has said that there are few fundamental technological limits to integrating a portfolio of renewable energy technologies to meet most of total global energy demand. Renewable energy use has grown much faster than even advocates anticipated [23]. At the national level, at least 30 nations around the world already have renewable energy contributing more than 20% of energy supply. According to the India Renewable Energy Status Reported in 2014 which was released at the Green Summit held in 2014 in Bangalore, the total renewable energy potential from various sources in India is estimated 2,49,188 MW. The untapped market potential for overall renewable energy in India is 2, 16,918.39 MW that shows huge growth potential for renewable energy in India.

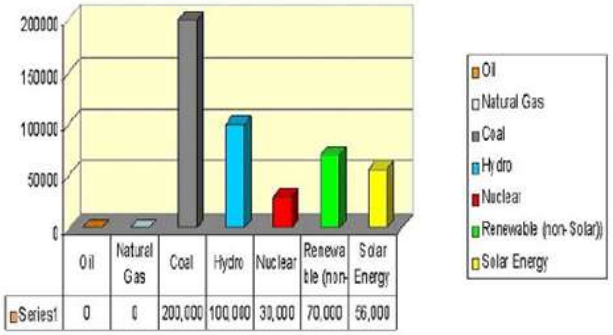


Fig.3- Energy consumption in Power Sector of India by 2030 (CWET)

Source	Approx. Potential (MW)
Biomass energy	19,00.00
Solar energy	20,00.00
Wind energy	47,00.00
Small hydropower	15,00.00
Ocean energy	50,00.00

Table4- Estimates of Potential Capacities from Renewable Sources [1]

Among the creating nations India keeps on being the pioneer took after by China. India had been one of the quickest developing wind markets in the mid-90s however has backed off significantly because of under execution of undertakings, transmission issues, political will and financial instability. India has the world's fifth-biggest power era limit, which at present stands at 243 GW. The force segment in India is exceedingly enhanced with changed business hotspots for force era like coal, normal gas, hydro, oil and atomic and in addition unusual wellsprings of vitality like sun based, wind, bio-gas and horticulture. The interest for force has been developing at a quick rate and surpassed the supply, prompting power deficiencies notwithstanding complex development in force era throughout the years. The organization needs to take an intense position between adjusting financial advancement and ecological supportability. One of the essential difficulties for India would be to adjust its current vitality blend, which is overwhelmed by coal, to a bigger offer of cleaner and practical wellsprings of vitality [2].

Most recent tasks are aiding in the improvement of indigenous examination and mechanical base, mastery, prepared labor and models/gadgets/frameworks in the nation are Hydrogen Energy, Chemical Sources of Energy (Fuel Cells), Battery Operated Vehicles, Geo Thermal Energy, Ocean Energy, Bio-powers. In the previous 30 years sun based and wind power frameworks have encountered quick deals development, declining capital expenses and expenses of power produced, and have kept on enhancing their execution attributes. Indeed, fossil fuel and renewable vitality costs, and social and natural expenses are heading in inverse bearings and the monetary and strategy instruments expected to bolster the far reaching spread and economical markets for renewable vitality frameworks are quickly advancing.

It is turning out to be clear that future development in the vitality division will be principally in the new administration of renewable energy, and to some degree normal gas-based frameworks, not in traditional oil and coal sources. As a result of these improvements market opportunity now exists to both develop and to exploit developing markets to advance renewable vitality innovations, with the extra help of administrative and well known estimation.

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