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RENEWABLE ENERGY POTENTIAL OF INDIA

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Abstract : 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. Indeed, it is the only country in the world to have an exclusive ministry for renewable energy development, the Ministry of Non-Conventional Energy Sources (MNES). Since its formation, the Ministry has launched one of the world's largest and most ambitious programs on renewable energy. Based on various promotional efforts put in place by MNES, significant progress is being made in power generation from renewable energy sources. In October, MNES was renamed the Ministry of New and Renewable Energy. Specifically 3,700 MW are currently powered by renewable energy sources (3.5 percent of total installed capacity). This is projected to be 175,000 MW from renewable energy by 2022.

The key drivers for renewable energy are the following:

1. The demand-supply gap, especially as population increases
2. A large untapped potential
3. Concern for the environment
4. The need to strengthen India's energy security
5. Pressure on high-emission industry sectors from their shareholders
6. A viable solution for rural electrification

.Keywords:

INTRODUCTION

In recent years, India has emerged as one of the leading destinations for investors from developed countries. This attraction is partially due to the lower cost of manpower and good quality production. The expansion of investments has brought benefits of employment, development, and growth in the quality of life, but only to the major cities. This sector only represents a small portion of the total population. The remaining population still lives in very poor conditions.

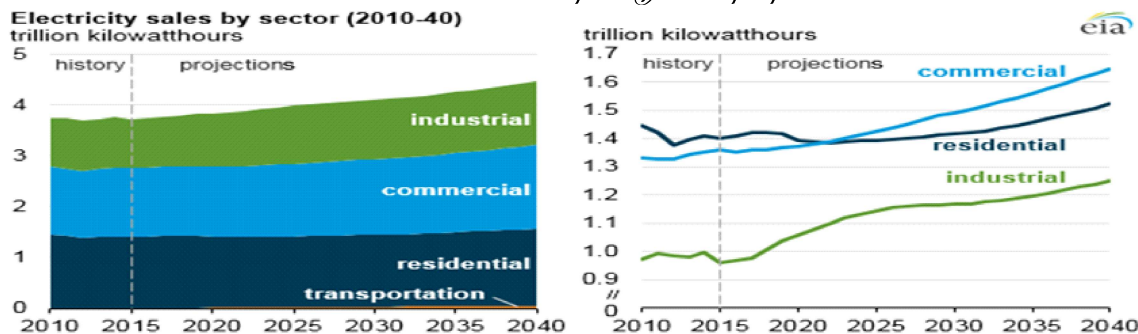
a) Energy consumption and production up to 2040

Since the 1980's, and still currently, India has encountered a negative balance in overall energy consumption and production. This has resulted in the need to purchase energy from outside the country to supply and fulfil the needs of the entire country.

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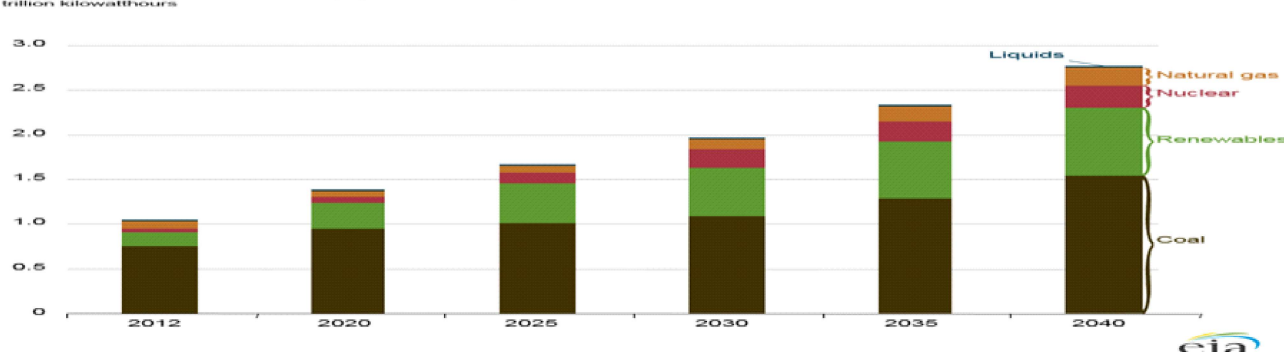


b) The breakdown of energy sources for power production of India in 2040

India is a large consumer of coal, which makes up

more than 57% of its total consumption. However, more than 1/3 of energy consumed comes from renewable resources, predominantly from large hydropower.

Figure 5-13. India electricity generation by fuel source, 2012–40



India relies heavily on coal energy to produce electricity. A strong second is hydro power, followed by natural gas. The consumption of all renewable energies represents fully one third of the total consumption. This is a significant figure, and we will see later that this sector

has a great future.

Following is a table of the actual plants and installations for producing power based on to renewable energies. We will show that only a small fraction of the potential capacity of renewable energies is currently being

Installed Capacity of Power Generation in India			
Thermal	Coal	164636	60.59
	Gas	23,062	8.49
	Diesel	1,200	0.44
	Nuclear	5,780	2.13
Renewable	Hydel	41,267	15.19
	Small Hydro	4,055	1.49
	Wind	23,444	8.63
	Biomass	1,410	0.52
	Bagasse	3,008	1.11
	Waste to Power	115	0.04
	Solar Power	3,744	1.38
	Total	2,71,722	100.00
Data: MW, March 2015			

tapped.

c) Distribution of the different kinds of plants and lines of transportation

As mentioned, India relies principally on coal for 57% of total energy consumption. As we can see on the

map, coal production is extensive and is located in central and north-eastern parts of the country. Hydro power plants are distributed along the west coast from the southern tip to about ¾ the way up the coast, in the extreme north, and some in the east from rivers flowing from the Himalayas.

Renewable Energy Potential of India

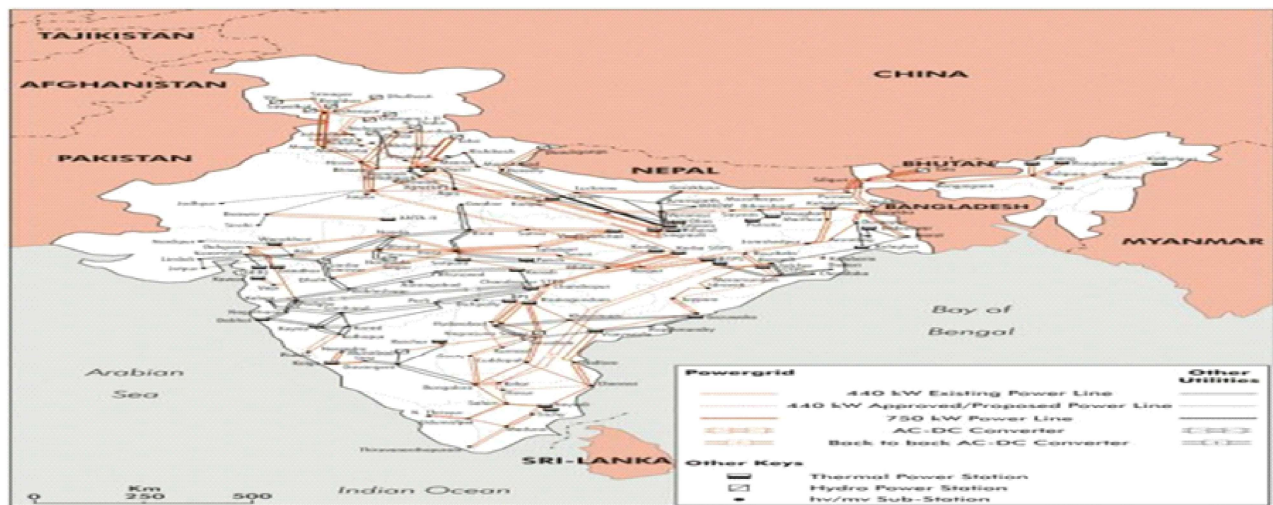
Except for the fact that the gas and products line don't extend, the country has the largest railway network in Asia and the second largest in the world under a single

management. Roads are taking developmental changes to the most remote corners of the country.



d) India Energy grid

Nearly 85% of the villages have been electrified, and there is a nationwide grid for the transmission and distribution of power.



The electric network is extensive throughout India with 440 kW or 750 kW power lines. The main power grid is still concentrated in the north on a north-west/south-east axis, from Afghanistan to the Bay of Bengal and on a second axis from Bombay on the central west coast to the north-east of India, through Bhutan. The above map indicates that new 440kW power lines have been approved or proposed to expand the network further. Those proposed lines will be located mainly on the east coast.

Sources of renewable energy available in India:

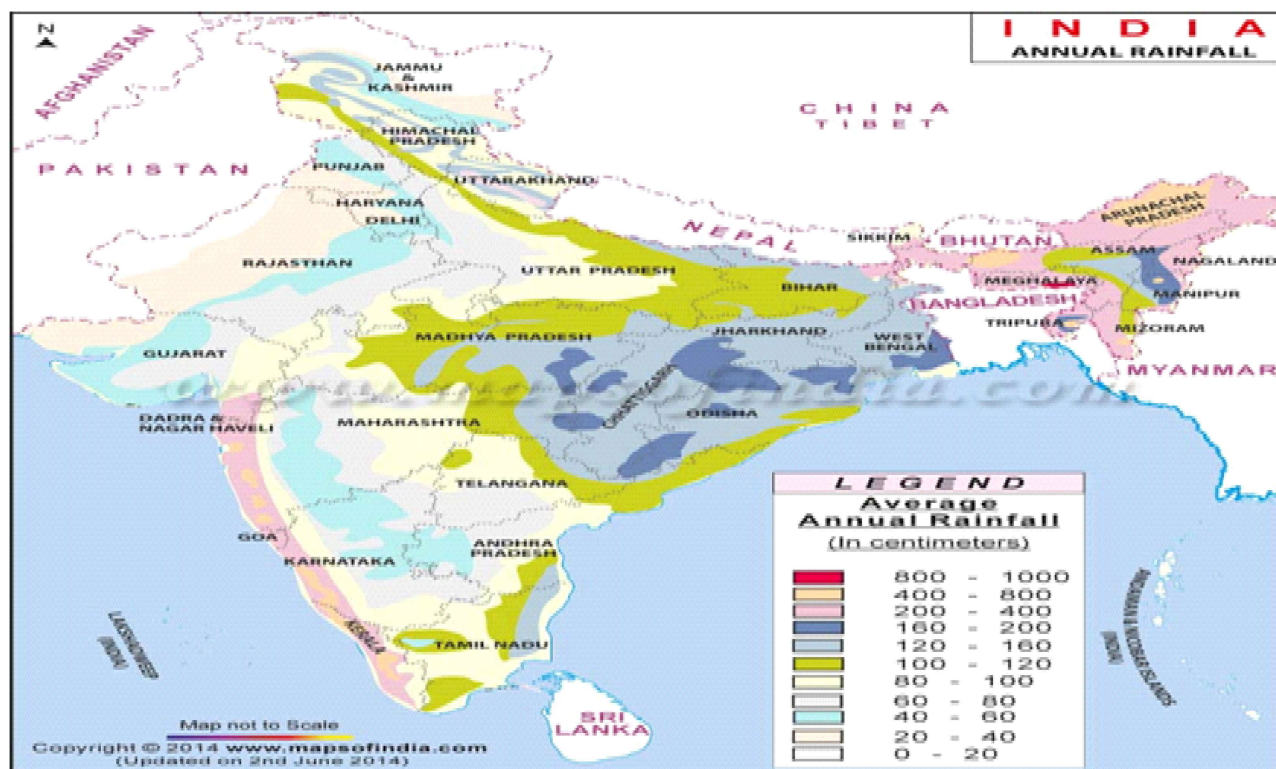
What renewable energies are in the Indian market?

a) Hydro power

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: Bihar (3), Punjab, Uttaranchal, Karnataka, Uttar Pradesh, Sikkim, Jammu & Kashmir, Gujarat, and Andhra Pradesh (2).

Advantages of Hydro power

In India, small hydro is the most utilized renewable energy source for energy production. Some key figures concerning small hydro in India:

- o Less than 25 MW is in the "small hydro" designation
- o There is a potential of 15,000 MW
- o Installed is 1,520 MW to date
- o 4,096 potential sites have been identified
- o Technology is mature and reliable
- o Two types of technology are used:
 1. High-head systems
 2. Low-head systems

b) Solar Energy

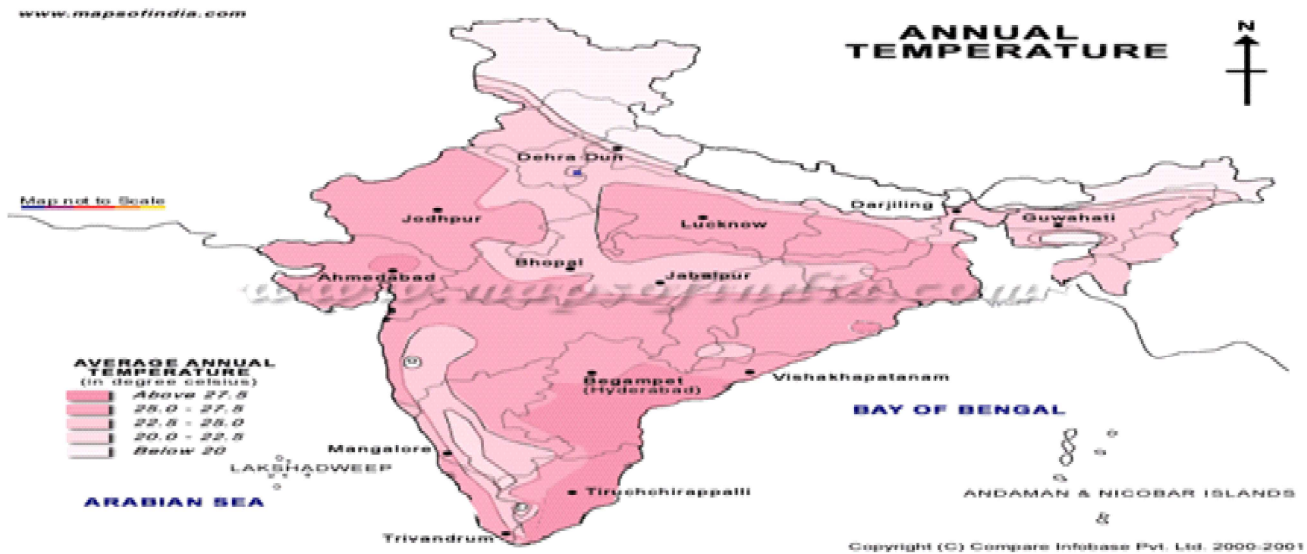
Because of its location between the Tropic of Cancer and the Equator, India has an average annual temperature

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.

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.

Renewable Energy Potential of India



b) Wind 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 ten machines near Okha in the province of Gujarat were some of the first wind turbines installed in India. These 15-meter Vestas wind turbines overlook the Arabian Sea. Now, in 2020, there is an installed capacity of 4,430 MW; however, ten times that potential, or 46,092 MW, exists.

Advantages of Wind Power:

- It is one of the most environment friendly, clean and safe energy resources.
- It has the lowest gestation period as compared to conventional energy.
- Equipment erection and commissioning involve only a few months.
- There is no fuel consumption, hence low operating costs.
- Maintenance costs are low.

Estimated Wind Power Potential in India

The wind power potential on a national level, base data collected from 10 states considering only 1% of land availability, is around 46,092 MW.

State	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
TOTAL	46,092

d) Biomass energy

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 biofuels (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.

Biomass may be used in a number of ways to produce energy. The most common methods are:

- Combustion
- Gasification
- Fermentation
- Anaerobic digestion

India is very rich in biomass. It has a potential of 19,500 MW (3,500 MW from biogas based cogeneration and 16,000 MW from surplus biomass). Currently, 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.

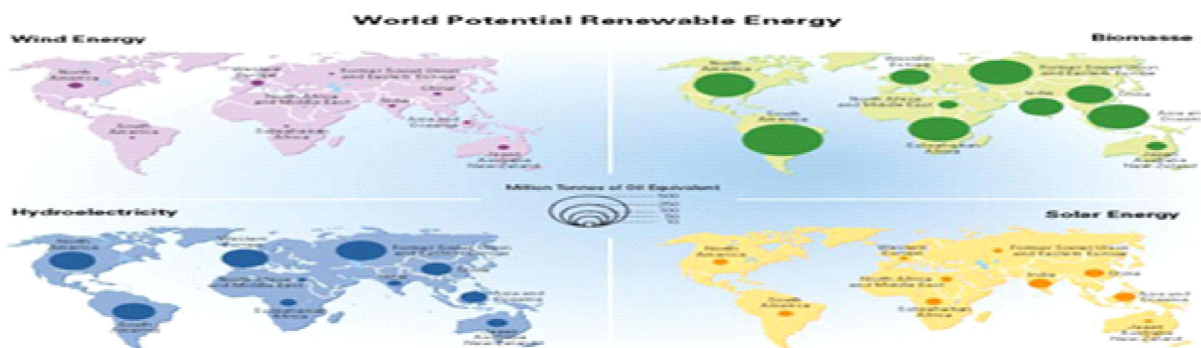
Following is a list of some States with most potential for biomass production:

- Andhra Pradesh (200 MW)
- Bihar (200 MW)
- Gujarat (200 MW)
- Karnataka (300 MW)
- Maharashtra (1,000 MW)
- Punjab (150 MW)
- Tamil Nadu (350 MW)
- Uttar Pradesh (1,000 MW)

Forecasts: What are the general forecasts for the next decades?

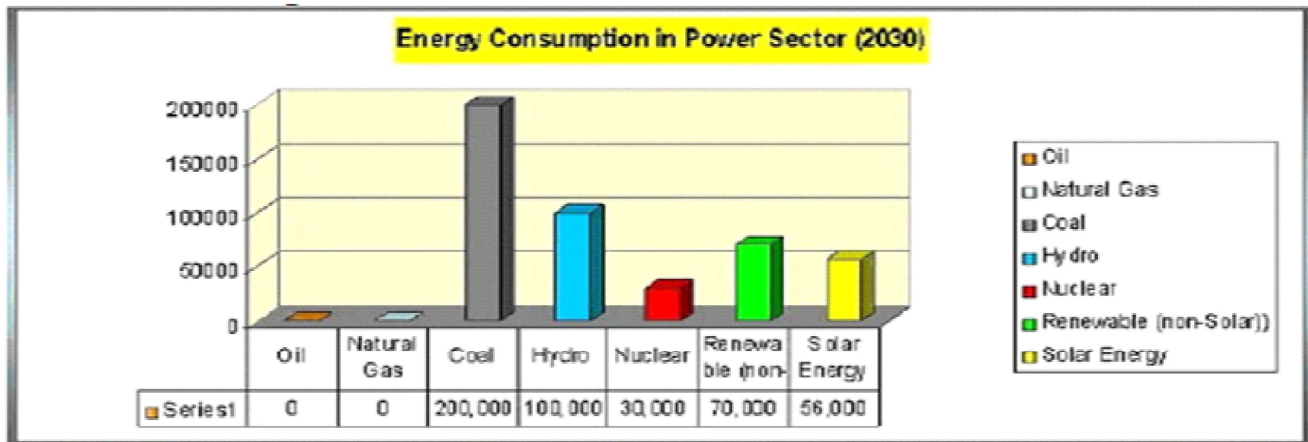
Around the world, a growing number of nations have recognized the economic, social, and environmental benefits of renewable energy and are enacting tax incentives and other policy measures favorable to renewable technologies. In Germany, Japan, Spain, and a handful of other countries, clear government commitments to renewable energy and strong, effective policies have overcome barriers and created demand for these technologies, leading to dramatic growth in renewable industries and driving down costs.

a) The position of India in the world potential renewable energy



Renewable Energy Potential of India

poor households that use less than 30 kilowatt hours per month.



Estimates of Potential Capacities from Renewable Energy Sources (in MWs)

- Source Approx. Potential
- Biomass energy 19,500
- Solar energy 20,000
- Wind energy 47,000
- Small hydropower 15,000
- Ocean energy 50,000

The sum of these renewable resource potentials, 152,000 MW, is greater than the current total installed energy generating capacity of India.

GOVERNMENT REGULATIONS: What is the current commitment of the government regarding renewable energies?

a) Financing Sources and Incentives

- To promote renewable energy technologies in the country, the government has put in place some subsidies & fiscal incentives. The Indian Renewable Energy Development Agency has been set up under Ministry for Non-Conventional Energy Sources and is a specialized financing agency to promote and finance renewable energy projects. Following is a short list of new measures:
- Income tax breaks
- Custom duty/duty free import concessions
- Capital/Interest subsidy
- Incentives for preparation of Detailed Project Reports (DPR) and feasibility reports

Ministry for Non-Conventional Energy Sources mix of fiscal and financial benefits:

- 2/3rd of the project cost subject to a maximum of Rs. 2.00 crore per 100 KW for procurement of modules, structures, power conditioning units, cabling etc. to the implementing agency. The balance cost on land, extension of grid lines, transformers, civil works, foundation and erection and commissioning, etc. is met by the implementing agency.
- Up to Rs.1.0 lakh for the preparation of Detailed Project Report (DPR) for the grid interactive SPV power projects.
- 2.5 percent of its share of project cost, subject to a maximum of Rs.5 lakhs for performance evaluation, monitoring, report writing, etc. to the State Nodal Agency.
- Interest subsidy of up to 4 percent to Financial Institutions including IREDA, Nationalized Banks etc. for captive power projects of maximum capacity 200 KW by industry.

b) Environmental Legislation

2001 Energy Conservation Act

- Focus on energy efficiency
- Standards and labeling
- Designated consumers requirements
- Energy conservation building codes
- Energy conservation fund
- " Bureau of Energy Efficiency

2003 Electricity Act

- Combined several existing pieces of legislation
- Intended to accelerate growth of power sector
- Targets additional 10 percent from renewable by

2012 (1000 MW/year capacity)

- Competitive market-based
- Features include:
 - o National Electricity Policy
 - o Public ownership of transmission companies
 - o Open access in transmission
 - o Freedom for distribution licenses
 - o Establishment of State Electricity Regulatory Commissions
 - o License-free generation and distribution in rural areas

Summary and Conclusion: Could India meet all energy needs with renewable energy?

India is a nation in transition. 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.

The development and deployment of renewable energy, products, and services in India is driven by the need

- decrease dependence on energy imports
- sustain accelerated deployment of renewable energy system and devices
- expand cost-effective energy supply
- augment energy supply to remote and deficient areas to provide normative consumption levels to all section of the population across the country
- And finally, switch fuels through new and renewable energy system/device deployment.

- India is currently experiencing strong economic growth, while at the same time attempting to extend modern power services to millions still in poverty. Expanding electrical capacity is essential. Renewable energy remains a small fraction of installed capacity, yet India is blessed with over 150,000MW of exploitable renewables.
- Tapping India's wind, solar, biomass, and hydro could bring high quality jobs from a domestic resource. Extending the electric grid between all states, and ultimately between neighbor nations will expand international trade and co-operation on the subcontinent.

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