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ORIGINAL ARTICLE

AN OVERVIEW OF ELECTRICITY SECTOR AND ITS LINKAGES WITHSOCIAL DEVELOPMENT IN INDIA

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Abstract:

The agriculture is the backbone of Indian economy. The main resource for effective agriculture is timely and adequate supply of water. As a result, irrigation has gained importance. Ground water as a source of irrigation is more important as compared to canal irrigation since farmers have better control over water availability. Thus more than 30% of the farmers are dependent on electric water pumps for irrigation, who are consuming highest electricity as compared to any other fields.

INTRODUCTION

The frequent, intermittent, low voltage supply of power caused significant deficits in agriculture production. This has also created losses to the farmers who are spending their time monitoring the supply of power without which their work cannot start. The highly unreliable power supply with frequent power cuts have not only lowered the efficiency of farmers but also have led to the frustration of the farmer to give up agriculture and move to urban areas for better prospects in the globalized world which will be more dangerous to Indian economy. The angry citizens take to the streets in protesting against the terrible power situation has become a common sight in different parts of the country. Some of the areas receive only an hour of electricity every day. State governments blame Centre for not allocating enough electricity to their states. The Governments try to blame its predecessor. The people do not buy this excuse. Who is to blame for the terrible power situation this summer? Why this situation is araised? Who is responsible for this situation? To answer this question one has to analyze the present situation of electricity production and consumption patters.

Power is on the Concurrent List of the Constitution. Both the Centre and States must share the blame instead of blaming each other. The Centre must take the rap for the shortage in generation of power. The peak power deficit-the gap between demand and supply in the summer of 2010 was 10.8 per cent. The responsibility for distributing available power inefficiently falls on the states. Losses in distribution average over 30% across India. At the Centre, the power, environment, coal and heavy industries ministries have in various ways acted as obstacles to the addition of capacity. In the states, populist governments and spineless electricity regulators have done little to reform ailing distribution networks. The situation is expected to get worse before it gets better. The Central Electricity Authority (CEA), the main advisory body to the Union power minister, has set a target of 100,000 mw of additional power generation in the period of the 12th five-year plan between 2012 and 2017. That is what is needed to meet the power demand of an economy forecast to grow at 9 per cent per annum. The target for the 11th plan (2007-2012) has already been revised downwards from 78,700 mw to 62,374 mw. With a year and a half to go until the end of 2012, only around 50 per cent of that revised target has been achieved. Realistically speaking, the Government will do well to hit 60 per cent of its original target by the end of 2012.

What may also deter private investors in the future is the inability of state electricity boards (SEB) to buy power at commercially viable rates. When India's largest thermal power generator, the Government-owned National Thermal Power Corporation (NTPC) recorded a mere 1 per cent growth in net profits in

2010-11, NTPC made the power stations available, but the SEBs did not draw power from those projects. This led to less generation of power and therefore less revenue. The drawdown in generation by NTPC led to a loss of 13 billion units (bu) of electricity in 2010-11. India's annual generation of power is estimated at around 800 billion units. NTPC's drawdown is 1.6 per cent of this total. If selling power to SEBs is a problem for NTPC, it is likely to be a problem for everyone else.

The combined losses of SEBs currently stands at Rs 70,000 crore. The 13th Finance Commission has forecast this figure rising to over Rs 1 lakh crore by 2014. We cannot sustain the improvement in the quality of power supply unless tariffs are revised. Delhi's distribution companies lose Rs 1.79-1.93 per unit of power supplied to consumers. Planning Commission calculations of the financial performance of distribution companies in 20 major states (excluding Delhi and Orissa) shows that the average loss per unit supplied to the consumer was 90 paise in 2009-10. The loss per unit sold has hovered steadily between 80 paise and Rs. 1.00 between 2005 and 2010. Contrary to popular perception, Indian consumers on an average pay much less for a unit of electricity than countries which are richer, both in terms of income and resources.

India will have to start thinking like a developed country. It is imperative that tariffs are regularized. A committee headed by former Controller and Auditor General V.K. Shunglu is working to recommend ways to reduce losses suffered by distribution companies. On top of the list of recommendations is the need to take action against inactive state electricity regulatory authorities which actually set the tariff.

The regulatory authorities have statutory independence but usually act under pressure from state governments. In Tamil Nadu, for example, tariffs have not been revised for seven years. In Delhi, they have not been revised for three years. That needs to change. Politicians, regulators and citizens need to recognize the need for viable tariffs. The transmission network needs to be strengthened to encourage private investors is the principle of "open access" where they are not captive to any one SEB for sales. SEBs are also free to look outside their state to buy electricity.

The electricity sector in India had an installed capacity of 210.936 GW as of November, 2012 the world's fifth largest. Captive power plants generate an additional 31.5 GW. Non Renewable Power Plants constitute 88.55% of the installed capacity and 12.45% of Renewable Capacity. India generated 855 BU (855 000 MU i.e. 855 TWh [1]) electricity during 2011-12 financial year. In terms of fuel, coal-fired plants account for 56% of India's installed electricity capacity, compared to South Africa's 92%; China's 77%; and Australia's 76%. After coal, renewal Hydropower accounts for 19%, renewable energy for 12% and natural gas for about 9%.[2]

In December 2011, over 300 million Indian citizens had no access to electricity. Over one third of India's rural population lacked electricity, as did 6% of the urban population. Of those who did have access to electricity in India, the supply was intermittent and unreliable. In 2010, blackouts and power shedding interrupted irrigation and manufacturing across the country.[3]

The per capita average annual domestic electricity consumption in India in 2009 was 96 kWh in rural areas and 288 kWh in urban areas for those with access to electricity, in contrast to the worldwide per capita annual average of 2600 kWh and 6200 kWh in the European Union[4]. India's total domestic, agricultural and industrial per capita energy consumption estimate varies depending on the source. Two sources place it between 400 to 700kWh in 2008–2009[5,6]. As of January 2012, one report found the per capita total consumption in India to be 778 kWh. India currently suffers from a major shortage of electricity generation capacity, even though it is the world's fourth largest energy consumer after United States, China and Russia[7]. The International Energy Agency estimates India needs an investment of at least $135 billion to provide universal access of electricity to its population. The International Energy Agency estimates India will add between 600 GW to 1200 GW of additional new power generation capacity before 2050. This added new capacity is equivalent to the 740 GW of total power generation capacity of European Union (EU-27) in 2005. The technologies and fuel sources India adopts, as it adds this electricity generation capacity, may make significant impact to global resource usage and environmental issues[8].

India's electricity sector is amongst the world's most active players in renewable energy utilization especially wind energy. As of December 2011, India had an installed capacity of about 22.4 GW of renewal technologies-based electricity, exceeding the total installed electricity capacity in Austria by all technologies.

India's network losses exceeded 32% in 2010 including non-technical losses, compared to world average of less than 15%. Both technical and non-technical factors contribute to these losses, but quantifying their proportions is difficult. But the Government pegs the national T&D losses at around 24% for the year 2011 & has set a target of reducing it to 17.1% by 2017 & to 14.1% by 2022. Some experts estimate that technical losses are about 15% to 20%, A high proportion of non-technical losses are caused by illegal tapping of lines, but faulty electric meters that underestimate actual consumption also contribute to reduced payment collection. A case study in Kerala estimated that replacing faulty meters could reduce distribution losses from 34% to 29%[3]. Key implementation challenges for India's electricity sector include new project management and execution, ensuring availability of fuel quantities and qualities, lack of initiative to develop large coal and natural gas resources present in India, land acquisition, environmental clearances at state and central government level, and training of skilled manpower to prevent talent shortages for operating latest technology plants[5].

Expanding access to energy means including 2.4 billion people: 1.4 billion that still has no access to electricity (87% of whom live in the rural areas) and 1 billion that only has access to unreliable electricity networks. We need smart and practical approaches because energy, as a driver of development, plays a central role in both fighting poverty and addressing climate change. The implications are enormous: families forego entrepreneurial endeavors, children cannot study after dark, health clinics do not function properly, and women are burdened with time consuming chores such as pounding grain or hauling water, leaving them with less time to engage in income generating activities. Further, it is estimated that kitchen smoke leads to around 1.5 million premature deaths every year, more than the number of deaths from malaria each year. After gaining access to energy, households generate more income, are more productive and are less hungry, further multiplying the Millenium Development Goal's progress." Of the 1.4 billion people of the world who have no access to electricity in the world, India accounts for over 300 million.

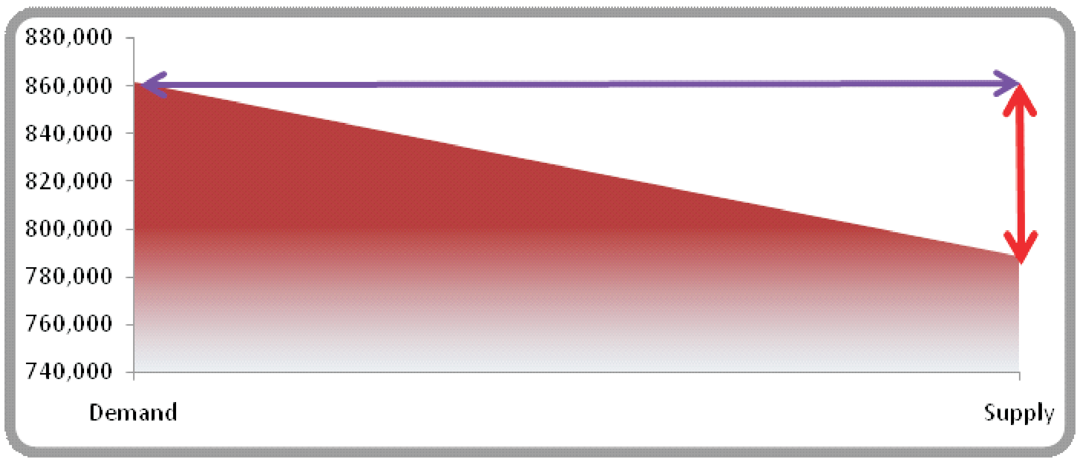
Some 800 million Indians use traditional fuels – fuel wood, agricultural waste and biomass cakes – for cooking and general heating needs. These traditional fuels are burnt in cook stoves, known as chulah or chulha in some parts of India.[9] Traditional fuel is inefficient source of energy, its burning releases high levels of smoke, PM10 particulate matter, NOX, SOX, PAHs, polyaromatics, formaldehyde, carbon monoxide and other air pollutant [10] Some reports, including one by the World Health Organization, claim 300,000 to 400,000 people in India die of indoor air pollution and carbon monoxide poisoning every year because of biomass burning and use of chullahs [11]. Traditional fuel burning in conventional cook stoves releases unnecessarily large amounts of pollutants, between 5 to 15 times higher than industrial combustion of coal, thereby affecting outdoor air quality, haze and smog, chronic health problems, damage to forests, ecosystems and global climate. Burning of biomass and firewood will not stop, these reports claim, unless electricity or clean burning fuel and combustion technologies become reliably available and widely adopted in rural and urban India. The growth of electricity sector in India may help find a sustainable alternative to traditional fuel burning.

In addition to air pollution problems, a 2007 study finds that discharge of untreated sewage is single most important cause for pollution of surface and ground water in India. There is a large gap between generation and treatment of domestic wastewater in India. The problem is not only that India lacks sufficient treatment capacity but also that the sewage treatment plants that exist do not operate and are not maintained. Majority of the government-owned sewage treatment plants remain closed most of the time in part because of the lack of reliable electricity supply to operate the plants. The wastewater generated in these areas normally percolates in the soil or evaporates. The uncollected wastes accumulate in the urban areas cause unhygienic conditions, release heavy metals and pollutants that leaches to surface and groundwater [12] Almost all rivers, lakes and water bodies are severely polluted in India. Water pollution also adversely impacts river, wetland and ocean life. Reliable generation and supply of electricity is essential for addressing India's water pollution and associated environmental issues. Other drivers for India's electricity sector are its rapidly growing economy, rising exports, improving infrastructure and increasing household incomes.

DEMAND TRENDS

As in previous years, during the year 2010–11, demand for electricity in India far outstripped availability, both in terms of base load energy and peak availability. Base load requirement was 861,591 (MU) against availability of 788,355 MU, a 8.5% deficit. During peak loads, the demand was for 122 GW against availability of 110 GW, a 9.8% shortfall [13]. See Graph 1.

Graph 1: Base load requirement and availability of Electricity (2021-2011)



In a May 2011 report, India's Central Electricity Authority anticipated, for 2011–12 year, a base load energy deficit and peaking shortage to be 10.3% and 12.9% respectively. The peaking shortage would prevail in all regions of the country, varying from 5.9% in the North-Eastern region to 14.5% in the Southern Region. India also expects all regions to face energy shortage varying from 0.3% in the North-Eastern region to 11.0% in the Western region. India's Central Electricity Authority expects a surplus output in some of the states of Northern India, those with predominantly hydropower capacity, but only during the monsoon months. In these states, shortage conditions would prevail during winter season [13]. According to this report, the five states with largest power demand and availability, as of May 2011, were Maharashtra, Andhra Pradesh, Tamilnadu, Uttarpradesh, and Gujrat.

Despite an ambitious rural electrification program [14], some 400 million Indians lose electricity access during blackouts While 80% of Indian villages have at least an electricity line, just 52.5% of rural households have access to electricity. In urban areas, the access to electricity is 93.1% in 2008. The overall electrification rate in India is 64.5% while 35.5% of the populations still live without access to electricity [15].

According to a sample of 97,882 households in 2002, electricity was the main source of lighting for 53% of rural households compared to 36% in 1993[16].

The 17th electric power survey of India report claims [17]:

Over 2010–11, India's industrial demand accounted for 35% of electrical power requirement, domestic household use accounted for 28%, agriculture 21%, commercial 9%, public lighting and other miscellaneous applications accounted for the rest.
The electrical energy demand for 2016–17 is expected to be at least 1392 Tera Watt Hours, with a peak electric demand of 218 GW.
The electrical energy demand for 2021–22 is expected to be at least 1915 Tera Watt Hours, with a peak electric demand of 298 GW.
If current average transmission and distribution average losses remain same (32%), India needs to add about 135 GW of power generation capacity, before 2017, to satisfy the projected demand after losses.
McKinsey claims [18] that India's demand for electricity may cross 300 GW, earlier than most estimates. To explain their estimates, they point to four reasons:
India's manufacturing sector is likely to grow faster than in the past
Domestic demand will increase more rapidly as the quality of life for more Indians improve
About 125,000 villages are likely to get connected to India's electricity grid
Currently blackouts and load shedding artificially suppresses demand; this demand will be sought as revenue potential by power distribution companies

A demand of 300GW will require about 400 GW of installed capacity, McKinsey notes. The extra capacity is necessary to account for plant availability, infrastructure maintenance, spinning reserve and losses. In 2010, electricity losses in India during transmission and distribution were about 24%, while losses because of consumer theft or billing deficiencies added another 10–15%.

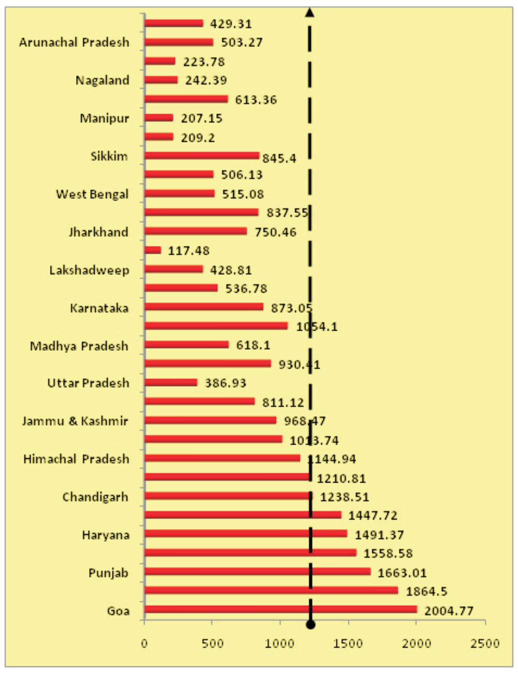
According to two studies published in 2004, theft of electricity in India, amounted to a nationwide loss of $4.5 billion [19,20]. This led several states of India to enact and implement regulatory and institutional framework; develop a new industry and market structure; and privatize distribution. The state of Andhra Pradesh, for example, enacted an electricity reform law; unbundled the utility into one generation, one transmission, and four distribution and supply companies; and established an independent regulatory commission responsible for licensing, setting tariffs, and promoting efficiency and competition. Some state governments amended the Indian Electricity Act of 1910 to make electricity theft a cognizable offense and impose stringent penalties. A separate law, unprecedented in India, provided for mandatory imprisonment and penalties for offenders, allowed constitution of special courts and tribunals for speedy trial, and recognized collusion by utility staff as a criminal offense. The state government made advance preparations and constituted special courts and appellate tribunals as soon as the new law came into force. High quality metering and enhanced audit information flow was implemented. Such campaigns have made a big difference in the Indian utilities' bottom line. Monthly billing has increased substantially, and the collection rate reached more than 98%. Transmission and distribution losses were reduced by 8%.

Power Cuts are common throughout India and the consequent failure to satisfy the demand for electricity has adversely effected India's economic growth [21,22].

ELECTRICITY CONSUMPTION:

Compared to developed countries; (USA, Japan and UK average per capita consumption of about 16000 Kwh) India's per capita consumption is very small. Following graph 2 shows the state wise per capita consumption. Central govt. has ongoing programmme for rural electrification namely “Rajiv Gandhi Gramin Vidhyutikaran Yojna” where in the target for unelectrified households were set as at least one unit of electricity per household per day as a merit good. It is also targeted that Per capita electricity consumption to be elevated up to 1000 Kwh.

The country's annual electricity generation capacity has increased in last 20 years by about 130 GW, from about 66 GW in 1991[23] to over 100 GW in 2001,[24] to over 199 GW in 2012. India's Power Finance Corporation Limited projects that current and approved electricity capacity addition projects in India are expected to add about 100 GW of installed capacity between 2012 and 2017. This growth makes India one the fastest growing markets for electricity infrastructure equipment [25]. India's installed capacity growth rates are still less than those achieved by China, and short of capacity needed to ensure universal availability of electricity throughout India by 2017.



Graph-2- Per capital Consumption (kWh) in 2009-10

As of August 2011, the states and union territories of India with power surplus were Himachal Pradesh, Sikkim, Tripura, Gujrat, Delhi and Dadra and Nagar Haveli

Major economic and social drivers for India's push for electricity generation include India's goal to provide universal access, the need to replace current highly polluting energy sources in use in India with cleaner energy sources, a rapidly growing economy, increasing household incomes, limited domestic reserves of fossil fuels and the adverse impact on the environment of rapid development in urban and regional areas [26].

The table below presents the electricity generation capacity, as well as availability to India's end user and their demand. The difference between installed capacity and availability is the transmission, distribution and consumer losses. The gap between availability and demand is the shortage India is suffering. This shortage in supply ignores the effects of waiting list of users in rural, urban and industrial customers; it also ignores the demand gap from India's unreliable electricity supply see Table 1.

Table 1- Electricity sector capacity and availability in India (Excludes effect of blackouts / power-shedding)

Item	Value (date reported Oct. 2012)
Total installed capacity (GW)	209.27
Available base load supply (MU)	893371
Available peak load supply (GW)	125.23
Demand base load (MU)	985317
Demand peak load (GW)	140.09

According to India's Ministry of Power, about 14.1 GW of new thermal power plants under construction are expected to be put in use by December 2012, so are 2.1 GW capacity hydropower plants and a 1 GW capacity nuclear power plant[24] India's installed generation capacity should top 200 GW in 2012. In 2010, the five largest power companies in India, by installed capacity, in decreasing order, were the state-owned NTPC, state-owned NHPC, followed by three privately owned companies: Tata Power, Reliance Power and Adani Power. In India's effort to add electricity generation capacity over 2009–2011, both central government and state government owned power companies have repeatedly failed to add the capacity targets because of issues with procurement of equipment and poor project management. Private companies have delivered better results[27].

Thermal power

Thermal power plants convert energy rich fuel into electricity and heat. Possible fuels include coal, natural gas, petroleum products, agricultural waste and domestic trash / waste. Other sources of fuel include landfill gas and biogases. In some plants, renewal fuels such as biogas are co-fired with coal. Coal and lignite accounted for about 57% of India's installed capacity. However, since wind energy depends on wind speed, and hydropower energy on water levels, thermal power plants account for over 65% of India's generated electricity. India's electricity sector consumes about 80% of the coal produced in the country. India expects that its projected rapid growth in electricity generation over the next couple of decades is expected to be largely met by thermal power plants.

Fuel constraints

A large part of Indian coal reserve is similar to Gondwana coal. It is of low calorific value and high ash content. The iron content is low in India's coal, and toxic trace element concentrations are negligible. The natural fuel value of Indian coal is poor. On average, the Indian power plants using India's coal supply consume about 0.7 kg of coal to generate a kWh, whereas United States thermal power plants consume about 0.45 kg of coal per kWh. This is because of the difference in the quality of the coal, as measured by the Gross Calorific Value (GCV). On average, Indian coal has a GCV of about 4500 Kcal/kg, whereas the quality elsewhere in the world is much better; for example, in Australia, the GCV is 6500 Kcal/kg approximately [28].

The high ash content in India's coal affects the thermal power plant's potential emissions. Therefore, India's Ministry of Environment & Forests has mandated the use of beneficiated coals whose ash content has been reduced to 34% (or lower) in power plants in urban, ecologically sensitive and other critically polluted areas, and ecologically sensitive areas. Coal benefaction industry has rapidly grown in India, with current capacity topping 90 MT. Thermal power plants can deploy a wide range of technologies. Some of the major technologies include:

Steam cycle facilities (most commonly used for large utilities);
Gas turbines (commonly used for moderate sized peaking facilities);
Cogeneration and combined cycle facility (the combination of gas turbines or internal combustion engines with heat recovery systems); and
Internal combustion engines (commonly used for small remote sites or stand-by power generation).

India has an extensive review process, one that includes environment impact assessment, prior to a thermal power plant being approved for construction and commissioning. The Ministry of Environment and Forests has published a technical guidance manual to help project proposers and to prevent environmental pollution in India from thermal power plants [29].

Installed thermal power capacity

The installed capacity of Thermal Power in India, as of October 31, 2012, was 140206.18 MW which is 66.99% [30] of total installed capacity.

Current installed base of Coal based thermal Power is 120,103.38 MW which comes to 57.38% of total installed base.
Current installed base of Gas Based Thermal Power is 18,903.05 MW which is 9.03% of total installed capacity.
Current installed base of Oil Based Thermal Power is 1,199.75 MW which is 0.57% of total installed capacity.

The state of Maharashtra is the largest producer of thermal power in the country.

Hydroelectric power

India was the 7th largest producer of hydroelectric power in 2008 after Narway 114 TWh and 3.5% the world total in 2008. The potential for hydroelectric power in India is one of the greatest in the world. In this system of power generation, the potential of the water falling under gravitational force is utilized to rotate a turbine which again is coupled to a Generator, leading to generation of electricity. India is one of the pioneering countries in establishing Hydro-electric power plants. The power plants at Darjeeling and Shimsha (Shivanasamudra) were established in 1898 and 1902 respectively and are among the first in Asia.

India is endowed with economically exploitable and viable hydro potential assessed to be about 84,000 MW at 60% load factor. In addition, 6780 MW in terms of installed capacity from Small, Mini, and Micro Hydel schemes have been assessed. Also, 56 sites for pumped storage schemes with an aggregate installed capacity of 94,000 MW have been identified. It is the most widely used form of renewable energy. India is blessed with immense amount of hydro-electric potential and ranks 5th in terms of exploitable hydro-potential on global scenario. The present installed capacity as on 30-06-2011 is approximately 37,367.4 MW which is 21.53% of total Electricity Generation in India. The public sector has a predominant share of 97% in this sector. National Hydroelectric Power Corporation (NHPC),Northeast Electric Power Company (NEEPCO), Satluj jal vidyut nigam (SJVNL), Tehri Hydro Development Corporation, NTPC-Hydro are a few public sector companies engaged in development of Hydroelectric Power in India.

Bhakra Beas Management Board (BBMB), an illustrative state owned enterprise in north India, has an installed capacity of 2.9 GW and generates 12000-14000 million units per year. The cost of generation of energy after four decades of operation is about 20 paise/kWh. BBMB is a major source of peaking power and black start to the northern grid in India. Large reservoirs provide operational flexibility. BBMB reservoirs annually supply water for irrigation to 125 lac (12.5 million) acres of agricultural land of partner states, enabling northern India in its green revolution.

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The present installed capacity as of 31 October 2012 is approximately 39,291.40 MW which is 18.77% of total electricity generation in India[31]. The public sector has a predominant share of 97% in this sector[32]. National Hydroelectric Power Corporation (NHPC), Northeast Electric Power Company (NEEPCO), Satluj jal vidyut nigam (SJVNL), Tehri Hydro Development Corporation, NTPC-Hydro are a few public sector companies engaged in development of hydroelectric power in India. Bhakra Beas Management Board (BBMB), illustrative state-owned enterprise in north India, has an installed capacity of 2.9 GW and generates 12000-14000 MU per year. The cost of generation of energy after four decades of operation is about 20 paise/kWh. BBMB is a major source of peaking power and black start to the northern grid in India. Large reservoirs provide operational flexibility. BBMB reservoirs annually supply water for irrigation to 125 lac (12.5 million) acres of agricultural land of partner states, enabling northern India in its green revolution

Nuclear power

Kudankulam Nuclear Power Plant under construction in 2009. It was 96% complete as of March 2011, with first phase expected to be in use in 2012. With initial installed capacity of 2 GW, this plant will be expanded to 6.8 GW capacity. As of 2011, India had 4.8 GW of installed electricity generation capacity using nuclear fuels. India's Nuclear plants generated 32455 million units or 3.75% of total electricity produced in India[33]. India's nuclear power plant development began in 1964. India signed an agreement with General Electric of the United States for the construction and commissioning of two boiling water reactors at Tarapur. In 1967, this effort was placed under India's Department of Atomic Energy. In 1971, India set up its first pressurised heavy water reactors with Canadian collaboration in Rajasthan. In 1987, India created Nuclear Power Corporation of India Limited to commercialize nuclear power.

Nuclear Power Corporation of India Limited is a public sector enterprise, wholly owned by the Government of India, under the administrative control of its Department of Atomic Energy. Its objective is to implement and operate nuclear power stations for India's electricity sector. The state-owned company has ambitious plans to establish 63 GW generation capacity by 2032, as a safe, environmentally benign and economically viable source of electrical energy to meet the increasing electricity needs of India [34].

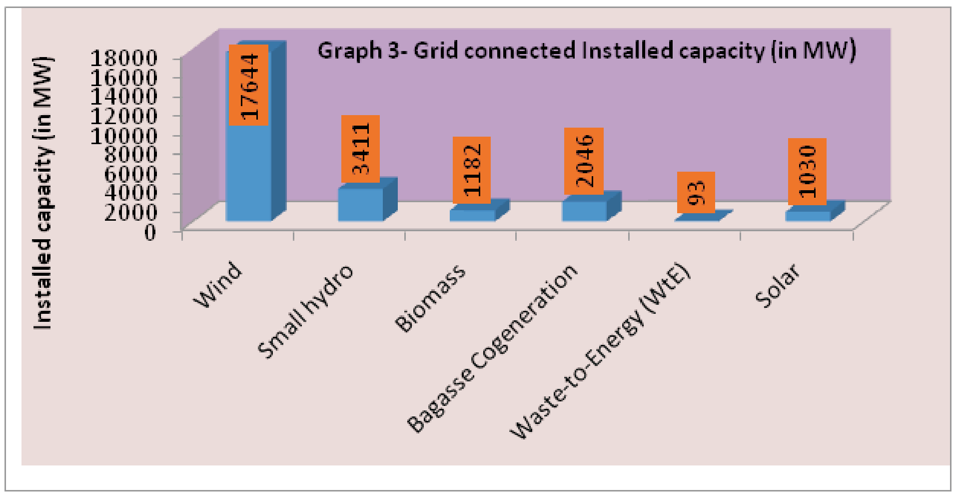
India's nuclear power generation effort satisfies many safeguards and oversights, such as getting ISO-14001 accreditation for environment management system and peer review by World Association of Nuclear Operators including a pre-start up peer review. Nuclear Power Corporation of India Limited admits, in its annual report for 2011, that its biggest challenge is to address the public and policy maker perceptions about the safety of nuclear power, particularly after the Fukushima incident in Japan[33].

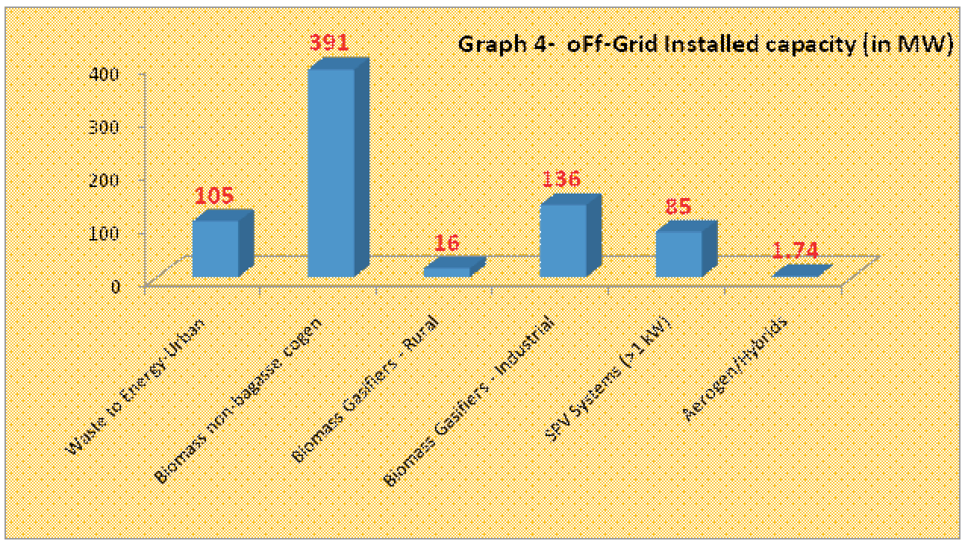
In 2011, India had 18 pressurized heavy water reactors in operation, with another four projects of 2.8 GW capacity launched. The country plans to implement fast breeder reactors, using plutonium based fuel. Plutonium is obtained by reprocessing spent fuel of first stage reactors. India successfully launched its first prototype fast breeder reactor of 500 MW capacity in Tamil Nadu, and now operates two such reactors. India has nuclear power plants operating in the following states: Maharashtra, Gujarat, Rajasthan, Uttar Pradesh, Tamil Nadu and Karnataka. These reactors have an installed electricity generation capacity between 100 to 540 MW each. New reactors with installed capacity of 1000 MW per reactor are expected to be in use by 2012.

In 2011, The Wall Street Journal reported the discovery of uranium in a new mine in India, the country's largest ever. The estimated reserves of 64,000 tonnes, could be as large as 150,000 tonnes (making the mine one of the world's largest). The new mine is expected to provide India with a fuel that it currently imports. Nuclear fuel supply constraints had limited India's ability to grow its nuclear power generation capacity. The newly discovered ore, unlike those in Australia, is of slightly lower grade. This mine is expected to be in operation in 2012. India's share of nuclear power plant generation capacity is just 1.2% of worldwide nuclear power production capacity, making it the 15th Largest nuclear power producer. Nuclear power provided 3% of the country's total electricity generation in 2011. India aims to supply 9% of it electricity needs with nuclear power by 2032. India's largest nuclear power plant project under implementation is at Jaitapur, Maharashtra in partnership with Areva, France.

OTHER RENEWABLE ENERGY

As of December 2011, India had an installed capacity of about 22.4 GW of renewal technologies-based electricity, about 12% of its total [35]. For context, the total installed capacity for electricity in Switzerland was about 18 GW in 2009. The graph below provides the capacity breakdown by various technologies (as of June 30, 2012) see Graph 3. Off grid connected power has got very importance in distributed generation sector. Their connectivity with grid has certain issued but has got certain advantages as well. Graph 4 shows off grid renewal energy installed capacity in India (as of June 30, 2012).

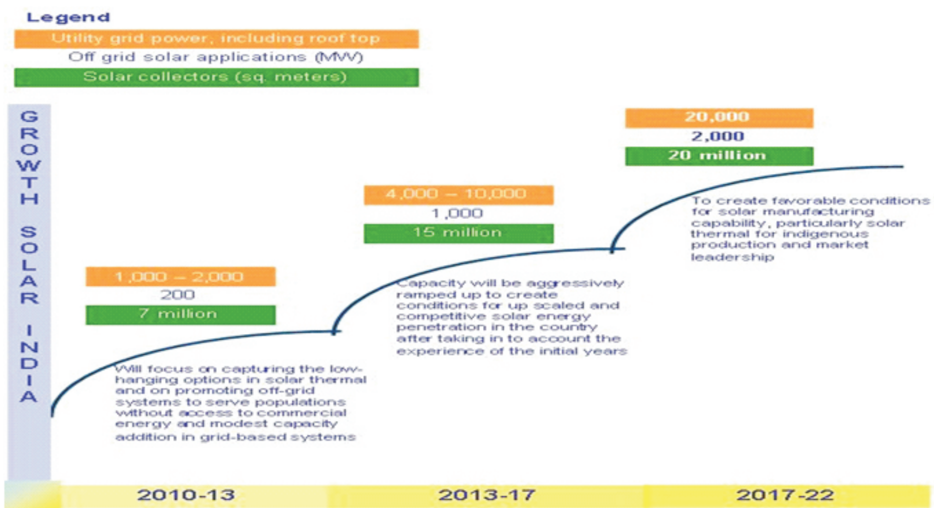




As of August 2011, India had deployed renewal energy to provide electricity in 8846 remote villages, installed 4.4 million family biogas plants, 1800 microhydel units and 4.7 million square meters of solar water heating capacity. India anticipates adding another 3.6 GW of renewal energy installed capacity by December 2012[36]. India plans to add about 30 GW of installed electricity generation capacity based on renewal energy technologies, by 2017.

Solar power

Solar resource map for India is shown below. The western states of the country are naturally gifted with high solar incidence. India is bestowed with solar irradiation ranging from 4 to 7 kWh/square meter/day across the country, with western and southern regions having higher Insulation [37]. India is endowed with rich solar energy resource. India receives the highest global solar radiation on a horizontal surface.



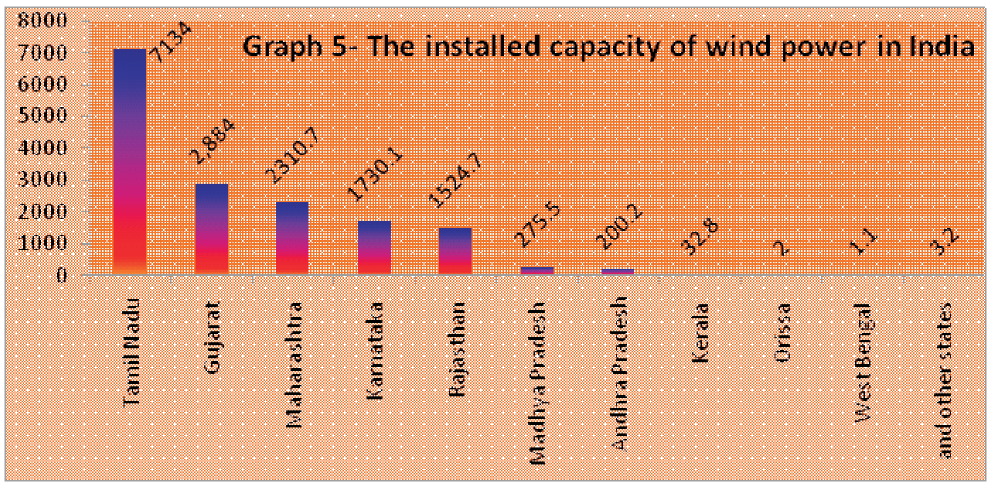
(Solar Resource map of India)

With its growing electricity demand, India has initiated steps to develop its large potential for solar energy based power generation. In November 2009, the Government of India launched its Jawaharlal Nehru National Solar Mission. Under the National Action Plan on Climate Change. Under this central government initiative, India plans to generate 1 GW of power by 2013 and up to 20 GW grid-based solar power, 2 GW of off-grid solar power and cover 20 million square meters with solar energy collectors by 2020[38]. India plans utility scale solar power generation plants through solar parks with dedicated infrastructure by state governments, among others, the governments of Gujarat and Rajasthan.

The Government of Gujrat taking advantage of the national initiative and high solar irradiation in the state launched the Solar Power Policy in 2009 and proposes to establish a number of large-scale solar parks starting with the Charanka solar park in Patan district in the sparsely populated northern part of the state. The development of solar parks will streamline the project development timeline by letting government agencies undertake land acquisition and necessary permits, and provide dedicated common infrastructure for setting up solar power generation plants largely in the private sector. This approach will facilitate the accelerated installation of private sector solar power generation capacity reducing costs by addressing issues faced by stand alone projects. Common infrastructure for the solar park include site preparation and leveling, power evacuation, availability of water, access roads, security and services. In parallel with the central government's initiative, the Gujarat Electricity Regulatory Commission has announced feed-in-tariff to mainstream solar power generation which will be applied for solar power generation plants in the solar park.

Wind power

India has the fifth largest installed Wind Power capacity in the world [40]. In 2010, wind power accounted for 6% of India's total installed power capacity, and 1.6% of the country's power output. The development of wind power in India began in the 1990s by Tamil Nadu Electric Board near Tuticorin, and has significantly increased in the last few years. Suzlon is the leading Indian company in wind power, with an installed generation capacity of 6.2 GW in India. Vestas is another major company active in India's wind energy initiative[41]. As December 2011, the installed capacity of wind power in India was 15.9 GW, , spread across many states of India. The largest wind power generating state was Tamil Nadu accounting for 30% of installed capacity, followed in decreasing order by Maharashtra, Gujrat, Karnatka, and Rajasthan[42]. It is estimated that 6 GW of additional wind power capacity will be installed in India by 2012[43]. In Tamil Nadu, wind power is mostly harvested in the southern districts such as Kanyakumari, Tirunelveli and Tuticorin. The state of Gujrat is estimated to have the maximum gross wind power potential in India, with a potential of 10.6 GW. India has the fifth largest installed wind power capacity in the world. In 2009-10 India's growth rate was highest among the other top four countries. As of 31 March 2011 the installed capacity of wind power in India was 17967 MW, mainly spread across (see Graph 5).



It is estimated that 6,000 MW of additional wind power capacity will be installed in India by 2012. Wind power accounts for 6% of India's total installed power capacity, and it generates 1.6% of the country's power. India's wind atlas is available.

Biomass power

In this system biomass, bagasse, forestry and agro residue & agricultural wastes are used as fuel to produce electricity [44].India has been promoting biomass gasifier technologies in its rural areas, to utilize surplus biomass resources such as rice husk, crop stalks, small wood chips, other agro-residues. The goal was to produce electricity for villages with power plants of up to 2 MW capacities. During 2011, India installed 25 rice husk based gasifier systems for distributed power generation in 70 remote villages of Bihar The Largest Biomass based power plant in India is at SIrohi, Rajasthan having the capacity of 20 MW.i.e. Sambhav Energy Limited. In addition, gasifier systems are being installed at 60 rice mills in India. During the year, biomass gasifier projects of 1.20 MW in Gujarat and 0.5 MW in Tamil Nadu were successfully installed.

This pilot program aims to install small scale biogas plants for meeting the cooking energy needs in rural areas of India. During 2011, some 45000 small scale biogas plants were installed. Cumulatively, India has installed 4.44 million small scale biogas plants.In 2011, India started a new initiative with the aim to demonstrate medium size mixed feed biogas-fertilizer pilot plants. This technology aims for generation, purification/enrichment, bottling and piped distribution of biogas. India approved 21 of these projects with aggregate capacity of 37016 cubic meter per day, of which 2 projects have been successfully commissioned by December 2011[37].

India has additionally commissioned 158 projects under its Biogas based Distributed/Grid Power Generation programme, with a total installed capacity of about 2 MW.India is rich in biomass and has a potential of 16,881MW (agro-residues and plantations), 5000MW (bagasse cogeneration) and 2700MW (energy recovery from waste). Biomass power generation in India is an industry that attracts investments of over INR 600 crores every year, generating more than 5000 million units of electricity and yearly employment of more than 10 million man-days in the rural areas[44,45]. As of 2010, India burnt over 200 million tonnes of coal replacement worth of traditional biomass fuel every year to meet its energy need for cooking and other domestic use. This traditional biomass fuel – fuelwood, crop waste and animal dung – is a potential raw material for the application of biomass technologies for the recovery of cleaner fuel, fertilizers and electricity with significantly lower pollution.

Biomass available in India can and has been playing an important role as fuel for sugar mills, textiles, paper mills, and small and medium enterprises (SME). In particular there is a significant potential in breweries, textile mills, fertilizer plants, the paper and pulp industry, solvent extraction units, rice mills, petrochemical plants and other industries to harness biomass power [44,45].

Problems with India's power sector

India's power sector is gaining new modern skin after the enactment of the Electricity Act 2003. State electricity boards are restructured/unbundled in to three different independent companies. Generation, Transmission and Distribution sectors are under the regulatory regime for protecting the consumer's interest. Traditional distribution planning has passed away, more efficient and reliable interactive distribution networks are coming up with its integration of renewable sources. Indian power sector has unique features and faces many issues. Some are:

· Government giveaways such as free electricity for farmers, partly to curry political favor, have depleted the cash reserves of state-run electricity-distribution system. This has financially crippled the distribution network, and its ability to pay for power to meet the demand. This situation has been worsened by government departments of India that do not pay their bills.

· Shortages of fuel: despite abundant reserves of coal, India is facing a severe shortage of coal. The country isn't producing enough to feed its power plants. Some plants do not have reserve coal supplies to last a day of operations. India's monopoly coal producer, state-controlled Coal India, is constrained by primitive mining techniques and is rife with theft and corruption; Coal India has consistently missed production targets and growth targets. Poor coal transport infrastructure has worsened these problems. To expand its coal production capacity, Coal India needs to mine new deposits. However, most of India's coal lies under protected forests or designated tribal lands. Any mining activity or land acquisition for infrastructure in these coal-rich areas of India, has been rife with political demonstrations, social activism and public interest litigations.

Poor pipeline connectivity and infrastructure to harness India's abundant coal bed methane and shale gas potential.

The giant new offshore natural gas field has delivered less fuel than projected. India faces a shortage of natural gas.

Hydroelectric power projects in India's mountainous north and northeast regions have been slowed down by ecological, environmental and rehabilitation controversies, coupled with public interest litigations.

India's nuclear power generation potential has been stymied by political activism since the Fukushima disaster in Japan.

Average transmission, distribution and consumer-level losses exceeding 30%.

Over 300 million people in India have no access to electricity. Of those who do, almost all find electricity supply intermittent and unreliable.

Lack of clean and reliable energy sources such as electricity is, in part, causing about 800 million people in India to continue using traditional biomass energy sources – namely fuel wood, agricultural waste and livestock dung – for cooking and other domestic needs.[20] Traditional fuel combustion is the primary source of indoor air pollution in India, causes between 300,000 to 400,000 deaths per year and other chronic health issues.

India's coal-fired, oil-fired and natural gas-fired thermal power plants are inefficient and offer significant potential for greenhouse gas (CO2) emission reduction through better technology. Compared to the average emissions from coal-fired, oil-fired and natural gas-fired thermal power plants in European Union (EU-27) countries, India's thermal power plants emit 50 to 120 percent more CO2 per kWh produced[47]

Resource potential in electricity sector

According to Oil and Gas Journal, India had approximately 38 trillion cubic feet (Tcf) of proven natural gas reserves as of January 2011, world's 26th largest. United States Energy Information Administration estimates that India produced approximately 1.8 Tcf of natural gas in 2010, while consuming roughly 2.3 Tcf of natural gas. The electrical power and fertilizer sectors account for nearly three-quarters of natural gas consumption in India. Natural gas is expected to be an increasingly important component of energy consumption as the country pursues energy resource diversification and overall energy security.

Until 2008, the majority of India's natural gas production came from the Mumbai High complex in the northwest part of the country. Recent discoveries in the Bay of Bengal have shifted the center of gravity of Indian natural gas production.

The country already produces some coalbed methane and has major potential to expand this source of cleaner fuel. According to a 2011 Oil and Gas Journal report, India is estimated to have between 600 to 2000 Tcf of shale gas resources (one of the world's largest). Despite its natural resource potential, and an opportunity to create energy industry jobs, India has yet to hold a licensing round for its shale gas blocks. It is not even mentioned in India's central government energy infrastructure or electricity generation plan documents through 2025. The traditional natural gas reserves too have been very slow to develop in India because regulatory burdens and bureaucratic red tape severely limit the country's ability to harness its natural gas resources.

Human resource development

Rapid growth of electricity sector in India demands that talent and trained personnel become available as India's new installed capacity adds new jobs. India has initiated the process to rapidly expand energy education in the country, to enable the existing educational institutions to introduce courses related to energy capacity addition, production, operations and maintenance, in their regular curriculum. This initiative includes conventional and renewal energy. A Ministry of Renewal and New Energy announcement claims State Renewable Energy Agencies are being supported to organize short-term training programmes for installation, operation and maintenance and repair of renewable energy systems in such places where intensive RE programme are being implemented. Renewable Energy Chairs have been established in IIT Roorkee and IIT Kharagpur. Education and availability of skilled workers is expected to be a key challenge in India's effort to rapidly expand its electricity sector.

REFERENCES

1."ALL INDIA REGIONWISE GENERATING INSTALLED CAPACITY OF POWER". Central Electricity Authority, Ministry of Power, Government of India. November 2012.
2. "Power sector at a glance: All India data". Ministry of Power, Government of India. June 2012.
3. Uwe Remme et al. (February 2011). "Technology development prospects for the Indian power sector". International Energy Agency France; OECD.
4. "World Energy Outlook 2011: Energy for All". International Energy Agency. October 2011.
5. "Power Sector in India: White paper on Implementation Challenges and Opportunities". KPMG. January 2010.
6. "The World Factbook". CIA. 2008. Retrieved December, 2011.
7. "India: Overview, Data & Analysis". U.S. Energy Information Administration. 2011.
8. "Analysis of the energy trends in the European Union & Asia to 2030". Centre for Energy-Environment Resources Development, Thailand. January 2009.
9. "Indoor air pollution and household energy". WHO and UNEP. 2011.
10. "Status of Sewage Treatment in India". Central Pollution Control Board, Ministry of Environment & Forests, Govt of India. 2005.
11. "Gujarat govt sets aside Tata's demand for power price hike". The Times of India. December 18, 2011.
12 . Revkin, Andrew C. (9 April 2008). "Money for India's 'Ultra Mega' Coal Plants Approved". The New York Times. Retrieved 1 May 2010.
13 The Electricity Access Database. iea.org
14. "Powering India: The Road to 2017". McKinsey. 2008.
15. "India struggles with power theft". BBC. 15 March 2006. Retrieved 3 January 2010.
16. "Reforming the Power Sector: Controlling Electricity Theft and Improving Revenue" (PDF). The World Bank.
17. Electricity and power shortage holding India back. Free-press-release.com (2007-06-20). Retrieved on 2012-01-13.
18. Range, Jackie. (2008-10-28) India Faulted for Failure to Improve Power Supply. Online.wsj.com. Retrieved on 2012-01-13.
19. Basistha Raj Adhikari (July 2009). "Tehri Dam: An Engineering Marvel". Hydro Nepal 5. doi:10.3126/hn.v5i0.2481.
20. "Annual Report 1991-1992". Department of Power, Govt of India. 1992.
21. "Annual Report 2002-2003". Department of Power, Govt of India. 2003.

22. "Load Generation and Balance Report". Central Electricity Authority, Ministry of Power, Government of India. 2012.
23. Ravi Krishnan (March 2010). "Power Report – India: Can she make the most of her opportunities?". Power Engineering International (PennWell): 16–20.
24. "Ministry of Power". Powermin.nic.in. 2012-10-31. Retrieved 2012-12-18.
25."TECHNICAL EIA GUIDANCE MANUAL FOR THERMAL POWER PLANTS". Ministry of Environment and Forests, Government of India. 2009.
26. Power Sector at a Glance ALL INDIA. Powermin.nic.in. Retrieved on 2012-12-18.
27. "Highlights of Power Sector during month". Cea.nic.in. Retrieved 2012-12-18.
28. "NPCIL Annual Report, 2010–2011". Nuclear Power Corporation of India Limited. 2011.
29. "NPCIL Annual Report, 2009–2010". Nuclear Power Corporation of India Limited. 2010.
30. "India Steps Up Uranium Exploration After Record Discovery". The Wall Street Journal. July 21, 2011.
31. "Year End Review – 2011". Press Information Bureau, Government of India. December 2011.
32. "NEW & RENEWABLE ENERGY, Cumulative deployment of various Renewable Energy Systems as on 30/06/2012". Ministry of New and Renewable Energy, Government of India. June 2012.
33. "Gujarat Solar Power Transmission Project: India". Asian Development Bank. September 2011.
34 Sethi, Nitin (November 18, 2009). "India targets 1,000mw solar power in 2013". Times of India.
35. UNEP wins Energy Globe award. Renewable-energy-world.com. Retrieved on 2012-01-13.
36. "World Wind Energy Report 2010" (PDF). Report. . February 2011.
37. "Facts & Figures, India". Wind Power India. 2011.
38 State-wise Wind Power Installed Capacity In India. windpowerindia.com
39. "Biomass for power generation and CHP". International Energy Agency. 2007.
40"India, Biofuels Annual 2011". United States Department of Agriculture: Global Agricultural Information Network. July 2011.
41. "Geothermal fields of India". Geological Survey of India. 2001.
42. "Development of 3.75 MW Durgaduani Mini Tidal Power Project, Sunderbans, West Bengal". NHPC Limited – A Government of India Enterprise. December 2011.
43"Tidal Energy in India". Energy Alternatives India. 2008.
44 . World Energy Council. 2007. pp. 575–576.
45. Chris Gascoyne and Alexis Aik (February 2011). "Unconventional Gas and Implications for the LNG Market FACTS Global Energy". Pacific Energy Summit.
46. Amol Sharma and Megha Bahree (1 July 2012). "Grinding Energy Shortage Takes Toll on India's Growth". The Wall Street Journal.
47. "Ministry of Power". Government of India. Retrieved December 2011.