Infrastructure- Part 1

Energy Sector

Energy is a vital input into production. If India wants to maintain its 9% growth rate it must ensure uninterrupted power supply to all its industries, agricultural and domestic purposes. Rapid economic growth cannot be achieved by if energy is not available at reasonable costs. This is possible only with appropriate long term planning, adequate investments to generate power for future requirements with support from appropriate policies. With this objective in mind Central Electricity Regulatory Commission (CERC) and State Electricity Regulatory Commissions were set up.

The Twelfth Five Year Plan lays special emphasis on development of infrastructure including Energy. The total infrastructure costs during Twelfth Five Year plan is estimated at 56.3 Lakh Crore (About US $1.00 Trillion). This could be feasible primarily enlarged private sector participation that is envisaged during 12th Plan. Public Private Partnership (PPP) and more transparent regulatory mechanisms that will induce Private investors to increase their participation the share of private sector participation increased from 22 per cent in 10th Plan to 38 per cent in the 11th Plan. It is expected to be 48 per cent share during 12th Plan period.

Per capita consumption of electricity in India is very low at 778.71 KWh compared to other development Canada 17053 KWh, USA 13647, Australia 1174, Japan 8072, and China 2471 in the year 2008.

2. Energy Resources in India:

Though the energy resources in India compared to other countries in South Asia is reasonably good, its rank in the world countries is still far from satisfactory. The following table shows the production capacities of power under different sectors in India. Under Public sector both state (39.3%) and central (28.7%) together 68.1% is the installed capacity of power produced in public sector, where as private sector contributes 31.8%. The total installed capacity of power produced is 2,28,721 M.Watts in India as on September 2013. However annual peak electricity load is around 1,53,000 M.Watts. which lower than the installed capacity.

Table1: Total Installed capacity of Power in India (As on 30-09-2013)

Sector	MW	Per Cent age
State Sector	90,062.14	39.37
Central Sector	65,732.94	28.73
Private Sector	72,926.66	31.88
Total	**2,28,721.73**	**100**

The demand projection of India by the end of XII and XIII Five Year Plans is almost domicile the present day capacity which requires must larger forces to implement the post the projection in the pipeline as well as to attract a healthy investment in energy sector both in public and private sector.

Table 2: Demand Projections of Indians Power Sector

Year	Energy Requirement (M.U.)	Annual Peak Electricity Load at Power Stations Bus Bars (MW)
2011-12	9,68,659	1,52,746
2016-17	13,92,066	2,18,209
2021-22	19,14,508	2,98,253

Table 3: The power production according to different fuel:

S. No	Fuel	M. Watts	Per Cent age
1	**Thermal**	1,55,968	68.18
	a) Coal	1,34,388	58.75
	b) Gas	20,380	8.91
	c) Oil	1199	0.52
2	Hydro	39,788	17.39
3	Nuclear	4780	2.08
4	Renewable	28,184	12.32
5	Energy		
6	Sources		
Total		**2,28,721**	**100**

The power production accruing to different fuels is shown in table 3. Power production in the country is mostly thermal energy with 68.18 percent of the total of which coal based fuel is respect of 58.75 percent.

Next to thermal hydropower constitutes 17.39 percent and 12.32 percent of renewable energy. Nuclear energy is first 2 percent of the total energy produced.

Table 4: States of India by installed by power capacity:

Rank	State/Union Territory	Total Installed Capacity	Thermal				Nuclear	Hydro	Renewable energy*
			Coal	Gas	Diesel	Total			
—	India	233,929.94	138,213.39	20,380.85	1,199.75	159,793.99	4,780.00	39,893.40	29,462.55
1	Maharashtra	32,505.98	20,239.27	3,475.93	0.00	23,715.20	690.14	3,331.84	4,768.80
2	Gujarat	26,269.12	15,738.27	4,978.99	17.48	20,734.74	559.32	772.00	4,203.06
3	Tamil Nadu	20,716.52	8,626.23	1,026.30	411.66	10,064.19	524.00	2,182.20	7,946.13
4	Andhra Pradesh	17,285.48	8,573.48	3,370.40	36.80	11,980.68	275.78	3,734.53	1,294.49
5	Uttar Pradesh	14,274.57	10,682.95	549.97	0.00	11,232.92	335.72	1,859.45	846.48
6	Rajasthan	14,059.12	7,679.72	775.03	0.00	8,454.75	573.00	1,548.32	3,483.05
7	Karnataka	13,940.66	6,158.39	0.00	234.42	6,392.81	254.86	3,599.80	3,693.19
8	Madhya Pradesh	12,902.35	8,503.89	257.18	0.00	8,761.07	273.24	3,223.66	644.38
9	West Bengal	8,708.82	7,216.87	100.00	12.20	7,329.07	0.00	1,248.30	131.45
10	Haryana	8,251.81	6,082.03	560.29	3.92	6,646.24	109.16	1,373.21	123.20
11	Punjab	7,614.95	3,790.88	288.92	0.00	4,079.80	208.04	3,029.53	297.58
12	Delhi Territory	7,500.79	4,556.37	2,116.01	0.00	6,672.38	122.08	690.33	16.00

13	Odisha	7,381.79	5,115.06	0.00	0.00	5,115.06	0.00	2,166.93	99.80
14	Chhattisgarh	6,864.91	6,388.49	0.00	0.00	6,388.49	47.52	120.00	308.90
15	Damodar Valley Corporation	6,838.86	6,555.60	90.00	0.00	6,645.60	0.00	193.26	0.00

Installed capacity wise Maharashtra, Gujarat, Tamil Nadu, and Andhra Pradesh occupy the top four ranks, whereas, if these states are ranked according to peak availability of power, these in the order of can be ranked 1) Maharashtra 2) Andhra Pradesh and 3) Gujarat and 4) Madhya Pradesh. Installed capacity will not always match with the availability of Power in the state. In India the availability of Power during peak period is only 1,40,964 M.Watts as against the installed capacity of 2,33,929 M.Watts (2013).

Table 5: Anticipated Power Supply Position in the Country during 2013-14:

State/Region	Energy				Peak			
	Requirement	Availability	Surplus(+)	Deficit (-)	Requirement	Availability	Surplus (+)	Deficit(-)
	(MU)	(MU)	(MU)	(%)	(MW)	(MW)	(MW)	(%)
Punjab	50850	40819	-10031	-19.7	12200	9075	-3125	-25.6
Rajasthan	59770	50747	-9023	-15.1	9300	8135	-1165	-12.5
Uttar Pradesh	97785	80203	-17582	-18.0	14400	11606	-2794	-19.4
Chhattisgarh	21410	21484	74	0.4	3120	3236	116	3.7
Gujarat	76808	81510	4702	6.1	11850	11832	-18	-0.2
Madhya Pradesh	59431	63112	3681	6.2	9494	11432	1939	20.4
Maharashtra	118455	106880	-11575	-9.8	18250	19738	1488	8.2
Andhra Pradesh	**109293**	**99398**	**-9895**	**-9.1**	**15955**	**13985**	**-1970**	**-12.4**
Karnataka	75947	58345	-17602	-23.2	11925	8663	-3262	-27.4
Kerala	22384	16824	-5560	-24.8	3731	2813	-918	-24.6
Tamil Nadu	99765	73323	-26442	-26.5	14970	9871	-5099	-34.1
Bihar	15268	12361	-2906	-19.0	2750	1954	-796	-29.0
Jharkhand	8609	8022	-587	-6.8	1285	1381	96	7.5
Orissa	27130	26911	-219	-0.8	3800	4238	438	11.5
West Bengal	48489	58965	10476	21.6	8045	8338	293	3.7
Assam	7.31	5647	-1384	-19.7	1368	1046	-322	-23.5
All India	**1048533**	**978301**	**-70232**	**-6.7**	**144225**	**140964**	**-3261**	**-2.3**

Renewable Energy:

Renewable energy is important for a nature keeping in view the sustainable of power generation to ensure uninterrupted supply of Power 24 x 7 days in a week.

Wind Power:

The development of wind power in India began in the 1990s, and has significantly increased in the last few years. Although a relative newcomer to the wind industry compared with Denmark or the United States, India has the fifth largest installed wind power capacity in the world. In 200-10 India's growth rate was highest among the other top four countries.

As of 31 December 2013 the installed capacity of wind power in India was 20149 MW, mainly spread across Tamil Nadu (7154 MW), Gujarat (3,093 MW), Maharashtra (2976 MW), Karnataka (2113 MW), Rajasthan (2355 MW), Madhya Pradesh (386 MW), Andhra Pradesh (435 MW), Kerala (35.1 MW), Odisha (2MW), West Bengal (1.1 MW) and other states (3.20 MW). It is estimated that 6,000 MW of additional wind power capacity will be installed in India by 2014. Wind power accounts for 8.5% of India's total installed power capacity, and it generates 1.6% of the country's power.

Solar Energy: Jawaharlal Nehru National Solar Mission:

India has planned harnessing solar energy potential in a big way. In January 2010, as one of the mission under the National Solar Mission (JNNSM) was launched. Broadly, the mission aims, to install 20 GW grid-connected and 2GW off-grid solar power, 20 million sqm of solar thermal collector area; and 20 million rural households to have solar home lightening by year. The Mission support research, developments and innovation to achieve grid-parity in the shortest time frame. The Mission will be implemented in three phases. The first phase is up to March 2013, the second till March 2017 and the third phase will continue till March, 2022. Around 1000MW of grid connected solar power capacity has already been set up. The reverse bidding process adopted under the mission has led to a significant reduction in solar power tariff within one and half year of its implementation**.**

Bio-Mass Energy:

The International Energy Agency (IEA) estimated that the percentage of bio mass energy within the total share is set to treble from 10 per cent at present to 30 per cent by 2050. In most of the developing economies, a poor bio mass resource governance results in the loss of bio mass energy resources. Bio mass energy resources are much cheaper and abundantly available, if properly managed and will save a huge foreign exchange by way of reducing importing fuel either gas or coal. Begasse a waste from sugar cane, Municipal bio-degradable wastes and bio-diesel are major sources of Bio Mass energy resources. The Bio-mass energy installed capacity in India in 509.69 M.W.

Geothermal Energy:

Geo thermal energy exists in natural hot waste springs which can be harnessed:

The following are the sources of geo thermal energies:

- Himalayan Province – Tertiary Orogenic belt with Tertiary magnetism
- Areas of Faulted blocks – Aravalli belt, Naga-Lushi, West coast regions and Son-Narma lineament.
- Volcanic arc – Andaman and Nicobar arc.
- Deep sedimentary basin of Tertiary age such as Cambay basin in Gujarat.
- Radioactive Province – Surajkund, Hazaribagh, Jharkhand. Cratonic province – Peninsular India

Hydro Power

In this system of power generation, the potential of the water falling under gravitational force is utilised 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. Hydro Power generation costs are cheaper, compared to thermal and nuclear and hence preferred. 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, 6,780 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 of 31 October 2012 is approximately 39,291.40 MW which is 18.77% 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, Satluj jal vidyut nigam , Tehri Hydro Development Corporation, NTPC-Hydro are a few public sector companies engaged in development of hydroelectric power in India.

Bhakra Beas Management Board, illustrative state-owned enterprise in north India, has an installed capacity of 2.9 GW and generates 12000-14000 MU[1] per year. The cost of generation of energy after four decades of operation is about 20 paisa/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 12.5 million (12.5 million) acres of agricultural land of partner states, enabling northern India in its green revolution.

Andhra Pradesh state with 3,750 M.Watts installed capacity hydro power tops other states.

Tidal wave energy

Tidal energy technologies harvest energy from the seas. The potential of tidal wave energy becomes higher in certain regions by local effects such as shelving, funnelling, reflection and resonance India is surrounded by sea on three sides, its potential to harness tidal energy is significant.

Energy can be extracted from tides in several ways. In one method, a reservoir is created behind a barrage and then tidal waters pass through turbines in the barrage to generate electricity. This method requires mean tidal differences greater than 4 metres and also favourable topographical conditions to keep installation costs low. One

report claims the most attractive locations in India, for the barrage technology, are the Gulf of Khambhat and the Gulf of Kutch on India's 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, West Bengal is another possibility, although with significantly less recoverable energy; the maximum tidal range in Sunderbans is approximately 5 m with an average tidal range of 2.97 m. The report claims, barrage technology could harvest about 8 GW from tidal energy in India, mostly in Gujarat. The barrage approach has several disadvantages, one being the effect of any badly engineered barrage on the migratory fishes, marine ecosystem and aquatic life. Integrated barrage technology plants can be expensive to build.

In December 2011, the Ministry of New & Renewable Energy, Government of India and the Renewable Energy Development Agency of Govt. of West Bengal jointly approved and agreed to implement India's first 3.75 MW Durgaduani mini tidal power project. Indian government believes that tidal energy may be an attractive solution to meet the local energy demands of this remote delta region. The power that can be generated from tidal waves is very meager

Hydrogen Energy

Hydrogen Energy program started in India after joining the IPHE (International Partnership for Hydrogen Economy) in the year 2003. There are nineteen other countries including Australia,USA, UK, Japan are members. This globe partnership helps India to set up commercial use of Hydrogen gas as an energy source. A National Hydrogen Energy Road Map (NHERM) was prepared under the guideline of NHBE 2005 and was accepted by NHBE in 2006. This will implemented through Public Private Partnership.

Non-Renewable (Conventional):

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.[61]

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.[62]

Installed Thermal Power capacity

The installed capacity of Thermal Power in India, as of 2013, was 1,55,968.18 MW which is 68.1 % of total installed capacity.

- Current installed base of Coal Based Thermal Power is 134,388 MW which comes to 58.75% of total installed base.
- Current installed base of Gas Based Thermal Power is 20,380. MW which is 9.% of total installed capacity.
- Current installed base of Oil Based Thermal Power is 1,199.75 MW which is 0.5% of total installed capacity.

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

Nuclear Power plant:

Nuclear power is the fourth-largest source of electricity in India after thermal, hydroelectric and renewable sources of electricity. As of 2012, India has 20 nuclear reactors in operation in six nuclear power plants, having an installed capacity of 5780 MW and producing a total of 29.66 GWh of electricity so far since installed,while seven other reactors are under construction and are expected to generate an additional 6,100 MW**.**

Gas for Power Sector

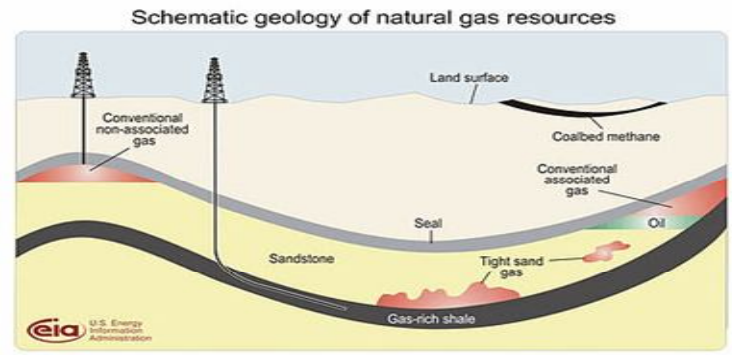
The present Gas based power capacity in India stands at 14876 MW, which is about 10% of the total installed capacity. For running this capacity 66 mmscmd of gas is required, and about 40 mmscmd of

gas has been allocated for the same. To make the situation worse the actual availability of gas is always less than the allocated quantity.

Some of the gas based power projects have been shelved while a few are pending commissioning due to unavailability of gas. The operational projects still run at sub optimal PLF due to gas shortage. It has been estimated that if the existing capacity could be run at 77% PLF, about 3500 million units of electricity per month could be added.

Shale gas

Natural gas that is found trapped within shale formations. Shale gas has become an increasingly important source of natural gas in the United States since the start of this century, and interest has spread to potential gas shales in the rest of the world. In 2000 shale gas provided only 1% of U.S. natural gas production; by 2010 it was over 20% and the U.S. government's Energy Information Administration predicts that by 2035, 46% of the United States' natural gas supply will come from shale gas.



Indian Reserves- Shale gas

India's shale gas reserves are not comparable to the reserves of USA, Canada, and China which occupy the top 3 nations in the World having highest shade gas reserves.

Companies including Reliance Industries Limited (E&P), RNRL, Vikas WSP Limited have expressed interest in exploring in India, which is estimated to hold 63 trillion cubic feet of recoverable shale gas. Reliance Industries paid a reported US$1.7 billion for a 40% share in Atlas Energy's leasehold in the **Marcellus** shale gas play in the eastern US. A complication to shale gas in India is that the government-issued leases for conventional petroleum exploration do not include unconventional sources such as shale gas. India identified shade gas reserves in Cauvery basin in Gujarat, Assam basin and the Godawari basin.

During US President Obama's visit to India in November 2010, India and US decided to cooperate in the fields of clean-tech and shale gas. "We agreed to deepen our co-operation in pursuit of clean energy technologies, including the creation of a new clean energy research centre here in India, and continuing our joint research into solar, biofuels, shale gas and building efficiency," Obama said.

Problems of harvesting shale gas in India:

India's move for exploiting **shale gas** resources in the country has been red-flagged by The Energy and Research Institute (TERI) stating that in a water-stressed country like ours, rapidly approaching water scarcity conditions, the results might not be as dynamic as it had proved for the U.S.

The latest policy brief "Shale Gas in India: Look before You Leap" explores the question of shale gas being a game changer in the context of India. It explains the nature of shale gas, the technology for its extraction from underground sources, and its potential for India. It also highlights overseas acquisitions of this resource by Indian companies even before it is sourced domestically, and then examines the viability of the technology in India. One of the key determinants of the viability of this technology is the availability of large quantities of clean water. The policy brief points out that conventional gas can occur by itself or in association with oil. Coal bed methane (CBM), which is extracted from coal beds, is also an unconventional gas and, in terms of depth, occurs much closer to the land surface than other similar gases.

However, shale rock is sometimes found 3,000 metres below the surface. Therefore, after deep vertical drilling, there are techniques to drill horizontally for considerable distances in various directions to extract the gas-rich shale. A mixture of water, chemicals, and sand is then injected into the well at very high pressures (8,000 psi) to create a number of fissures in the rock to release the gas. The process of using water for breaking up the rock is known as '**hydro-fracturing' or 'fracking'.** The chemicals help in water and gas flow and tiny particles of sand enter the fissures to keep them open and allow the gas to flow to the surface. This injection has to be done several times over the life of the well.

The number of wells to be drilled for shale gas far exceeds the number of wells required in the case of conventional gas and the land area required is a minimum of 80 to 160 acres.

National Grid

- A National Power grid based in a power plant
- All the regional grids have interconnected and total transfer capacity and total internal inks by June 2013 is about 31,000 MW.
- Interregional power transfer capacity of the national is plant increased to 66000 MW at end of the XII Plan.

Transmission:

A Programme for construction of 88,515 ckm transmission lines for evacuation of power from generating stations was envisaged at the beginning of the Eleventh Plan based on the target for capacity target was scaled down to 62,374 MW at the time of the Mid-Term Appraisal (MTA), the target for transmission was scaled down to 68,673 ckm. Details of the achievement of transmission lines at the end of the Eleventh Plan are given in Table 14.10. The additional achieved during the Eleventh Plan is 69,926 ckm which is greater than the scaled-down target.

Distribution:

Distribution is the weakest link in the power system with large losses leading to financial unavailability. The cash losses of utilities selling power directly to consumers, after accounting for subsidy from the State Government, increased from Rs.17,620 crore in year 2007-08 to Rs.42,415 crore in year 2009-10. The cumulative book losses (on accrual basis) of State Discoms have increased from Rs.79,339 crore as on 31 March 2009 to Rs.1,06, 247 crore to Rs.14,786 crore as on 31 March 2010. While some of the States have shown improvements in the financial health of their utilities, others are yet to demonstrate the impact of the policy initiatives.

Ultra Mega Power Projects:

- UMMPS Promoted with a view to all providing reasonable rate ensuring past capacity addition facilitating the empower of 40000 MW in tariff based international completive biddinf route.
- 9 UMPPs proposed to set up as follows.

1. SASA ultra Megapower project in MP. Col pitched
2. Mundra Ultra Power project In Gujarat In Coastal
3. Krishna Patnam UMPP in AP coastal
4. UMPP in Jharkhand Coal in pitched.
5. UMPP in Chhattisgarh coal pitched
6. UMPP in Orissa coal pitched
7. UMPP in Tamil Nadu
8. UMPP Maharashtra coastal
9. UMPP in Karnataka coastal
10. Out of 9 propjets 4 UMPPs at SASAN, MUNDRA, Krishnapatanam, and Tilaiya in Jharkhand have been awarded and trab formed to the developers through the tariff based competitive bidding.
11. National Electricity policy (BNEA)

- Notified under the Government under the act the tariff as the policy as the notified.
- 23 states have set up special coast under the section as the153 electricity act 2003.
- 32 states/UTs established consumers Grievances reddressal forums

Problems with India's power sector:

India's electricity sector faces many issues. Some are:

Government giveaways such as free electricity for farmers, partly to curry political favour, 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.

Lack of clean and reliable energy sources such as electricity is, in part, causing about 80 crore (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. 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 (CO_2) 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% more CO_2 per kWh produced.

Average **transmission, distribution and consumer-level losses** exceeding 30% which includes auxiliary power consumption of thermal power stations, etc.

Over 30 crore (300 million) people in India have no access to electricity. Of those who do, almost all find electricity supply intermittent and unreliable.

TABLE 6: Household Access (%):

Energy Source	61st Round 2004-05			66th Round 2009-10		
	Rural	Urban	Total	Rural	Urban	Total
Electricity	54.9	92.3	65.2	67.3	93.9	75.5
LPG	8.6	57.1	21.9	15.5	66.2	31.2

Table 7: Energy Intensity

S. NO	Country	Energy Intensity (Kgoe/US$)
1	United Kingdom	0.102
2	Germany	0.121
3	Japan	0.125
4	Brazil	0.134
5	USA	0.173
6	China	0.283
7	South Korea	0.189
8	India	0.191

Source: World Energy Outlook 2011.

Table 7: Shows energy intensity of some select countries for the year 2010, with GDP measured in terms of 2010 USD purchasing power parity (PPP). India's energy intensity using PPP GDP is 0.191, which is on par with the world average but higher than most of the European countries. China's energy intensity is roughly 1.5 times that of India.

Review of Power sector in Eleventh Plan:

- Open access to consumers, which is mandated under the Electricity Act, remains ineffective due to reluctance of state utilities to comply.
- Trading of power at very high rates and its purchase by utilities even thought not willing to pass on the higher cost in the form of consumer tariffs. This has a distortionary effect and threatens to jeopardize the financial viability of the Discoms.
- Energy audit of power utilities has not been undertaken.
- Electricity retail tariffs have remained static for many years because of political pressure, widening the gap between the average tariffs and average cost of supply.
- The distribution companies suffer serious financial stress. Losses of the distribution utilities remain high. The annual loss of the State power utilities (without subsidy) was Rs.33, 698 crore during 2007- 08 and increased to Rs.59, 891 crore in the year 2009-10 (Provisional) . The State Discoms cannot sustain such high losses indefinitely.

Table 8: Status on RGGVY Progress during the Tenth and the Eleventh Plan:

Year	Un-electrified Villages (No.)			BPL Households (lakh)		
	Target	Achieved	%Achieved	Target	Achieved	%Achieved
Tenth Plan						
2005-06	10,000	9,819	98.2	3	0.17	5.7
2006-07	40,000	28,706	71.8	40	6.55	16.4
Eleventh Plan						
2007-08	10,500	9,301	88.6	16	16.21	101.13
2008-09	19,000	12,056	63.5	35	30.85	61.7
2009-10	17,500	18,374	105.0	47	47.18	100.4
2010-2011	17,500	18,306	104.6	47	58.44	125.1
2011-12	14,500	7,934	54.7	52	34.45	66.2
Cumulative (as on 31 March 2012)	1,12,795	1,04,496	92.6	275	194.25	70.6

Power sector during XI Plan:

The eleventh plan target of 680 million tonnes of coal production has fallen short by nearly 140 M .tonnes. The gap of 100 M.T.s was shortly met importing coal. The coal mines (Nationalization) Act 1973, does not allow private companies to mine coal for sale to third parties though captive mining is allowed for specified end use sectors. Useless large investment and technology in the sector comes in, mining coal by small player would not increase production to derived levels. However there are political sensitive's in opening up the coal sector to private investment. It is also not logical to keep private investments art of coal. When it is allowed in petroleum and natural gas. A bill was introduced to annual coal mines Act in 2001, but was not passed. Allowing private sector mining does not involve privatization of coal India but only entity of new mining companies.

XII Plan

A target of 88,000 M.Watt is fixed during XII Plan period. This was actually a revised target as the Planning Commission has reduced the target from 1,0,000 M.W to 88,000 M.W in view of depressive growth rate performance during 12th Plan. Every one per cent increase in Gross Domestic Product (GDP) requires power capacity to grow by 0.9 per cent in India. Power is one of the eight core infrastructure sectors, which have a combined weight of 38 per cent in the Index of Industrial Production (IIP).

National Electricity Policy, 2005:

The government of India notified the National Electricity Policy (NEP) in February 2005. It stipulates power for all and annual per capita consumption of electricity to rise to 1,000 units by 2012. This entails provision of adequate reliable power, at affordable cost with access to all citizens. NEP has the following main features:

1. The policy envisages the following objectives : (a) access to electricity by all households by 2010, (b) power demand to be fully met by 2012, (c) peaking shortage to be overcome, (d) supply of reliable and quality power at specified standards in an efficient manner at reasonable rates, (e)

per capita availability of electricity to be increased to over 1,000 units by 2012, (f) minimum lifeline consumption of 1 unit/household/day as a merit good by 2012, (g) financial turnaround and commercial viability of electricity sector, and (h) protection of consumer's interests.

2. Central Electricity Authority (CEA) to notify first National Electricity Plan with a perspective up to a Twelfth Five Year Plan (2012-17). The Plan prepared by CEA to be used by prospective generating companies, transmission utilities and transmission/distribution licenses as reference document.
3. Village electrification and household electrification to achieve the target of completing household electrification by 2010.
4. Creation of adequate generation capacity with a spinning reserve of at least 5 per cent by 2012 with availability of installed capacity at 85 per cent.
5. Full development of hydro potential. Provision of long-term finance for these projects.
6. Choice of fuel for the thermal generation to be based on economic of generation and supply of electricity.
7. Development of national grid.
8. Cost of recovery of service from consumers at tariff reflecting efficient costs to ensure financial viability of the sector.
9. Provision of support to lifeline consumers (households below poverty line having consumption of 30 units per month) in terms of tariffs.
10. Availability based tariff (ABT) to be extended to state level for better grid discipline through economic signaling.
11. Special emphasis on time-bound reduction of transmission and distribution losses.
12. Measures to promote competition aimed at consumer benefits.
13. Reliability and quality of power supply to be monitored by State Electricity Regulatory Commissions (SERCs).
14. Exploitation of non-conventional energy sources such as small hydro, solar, biomass and wind for additional power generation capacity.
15. Transmission capacity to have redundancy level and margins as per international standards.
16. Adequate transmission financial support for reforming power utilities.
17. Support for adoption of IT system for ensuring correct billing to consumers.
18. Speedy implementation of stringent measures against theft of electricity.
19. Demand side management through energy conservation measures.
20. Special attention for developing training infrastructure in the field of regulation, trading and power market.

Accelerated Power Development and Reforms Programme (APDRP):

With the initiative of the Government of India and of the States, APDRP was launched in 2001, for the strengthening of sub-transmission and distribution network and reduction in Aggregative Technical and Commercial. The main objective of the programme was to bring AT&C losses below 15 percent in 5 years in urban and in high-density areas.

The APDRP programme has been restructured by the Government of India, in order that reliable and verifiable baseline data of revenue and energy in APDRP project areas in attained over an IT platforms and that AT&C loss reduction in achieved on a sustained basis. The Restructured APDRP (R-

APDRP) was launched by Ministry of Power (MoP), Government of India in July 2008 as a Central Sector Scheme under Eleventh Five Year Plan (2007-12). The scheme comprises of two parts.

Part A of the scheme is dedicated to establishment of IT-enabled system for achieving reliable and verifiable baseline data system in all towns with population greater than 30,000 as per 2001 Census (10,000 for Special Category States). Installation of SCAD/DMS for towns with population greater than 4 lakh and annual input energy greater than 350 MU is also envisaged under Part A. 100 percent loan is provided under R-APDRP for Part A projects and shall be converted to grant on completion and verification of same by third Party independent evaluating agencies (TPIEA) appointed by MoP. MoP has earmarked Rs.10,000 crore for R-APDRP Part A.

Part B of the scheme deals with regular sub-transmission and distribution system strengthening and up gradation projects. The focus of Part B is on AT&C loss reduction on sustainable basis. 25 percent loan is provided under Part B projects and up to 50 percent of scheme cost in convertible to grant depending on extent of maintaining AT&C loss level at 15 percent level for 5 years. For special Category States, 90 percent loan is provided by Government of India for Part B projects and entire Government of India loan shall be converted to grant in 5 tranches, depending on the extent of maintaining AT&C loss level at 15 percent level for 5 years. MoP has earmarked sanctioning of schemes up to Rs. 40,000 crore under R-APDRP Part B. Of this, up to Rs. 20,000 crore would be converted to grant depending of franchises through Part C of the scheme. Few pilot projects adopting innovations are also envisaged under Part C.

Captive Power Generation:

The electricity Act, 2003 dispenses with the requirement of approval/clearance of any authority for setting up a captive generating plant. The new law (as amended) also ensures non-discriminatory open access for transmission of electricity generated from a captive generating plant to the destination of its use, subject to availability of transmission capacity. The surcharge and cross subsides are being progressively reduced in manner as may be specified by the State Regulatory Commission. Any per son setting up a captive power plant can also establish and maintain dedicated transmission lines.

The industrial sector is the largest consumer of electricity. Besides purchasing power from the utilities, a number of industries, viz. aluminum, cement, fertilizer, iron, steel, paper, sugar etc. have their own captive power plants either to supplement the electricity supply from the utilities or for generating electricity as a by-product through co-generation. Captive power plants are being set up by industries to meet their own power requirements to enable them to tide over problems due to power shortage and poor quality of supply.

In accordance with the guidelines issued by the Ministry of Power, the following categories are eligible to install captive power plants.

1. A consumer of electricity.
2. A group comprising more than one consumer as a joint venture.
3. An actual user of power but not a consumer.
4. A group of actual users of power, but not consumers, as a joint venture.
5. If the captive plant falls under the category of hydro or co-generation plant, such plant may be permitted, irrespective of its size and the power supply position in the state.

6. If the captive power plant is based on coal or liquid fuel or gas and if the state is deficit in power supply, the installation of the plant could normally be allowed and the plant can be permitted to have a capacity up to a 200 percent of the requirement of the host industry.
7. If the captive power plant is based on coal, liquid fuel or gas and the state is surplus in power, the installation of such captive plants can still be considered in cases where the state/SEB cannot guarantee uninterrupted supply or stipulated quality of supply (within prescribed voltage and frequency variations) required by the industry or a particular process. Further, captive generation may also be permitted if it is found,, after a review of costs and tariffs, to be more economical than grid supply.
8. Banking facilities may also be provided to the captive plants so that available capacities are utilized to the extent possible and when required. The rates for banking may be determined on mutually agreed terms.
9. Units in Special Economic Zones (SEZs) and industrial estates may be allowed to set up captive power plants liberally.

New Tariff Policy:

There exists considerable in the average tariff rate of electricity supply to domestic and industrial consumers. Under the provisions of the Electricity Act, 2003, Central Government has notified the tariff policy, evolved in consultation with the State governments, CERC and various stakeholders. To promote competition, the policy provides that all future requirements of power should be procured competitively, except in the case of one-time expansion of existing projects, or where a state-controlled publicly owned company has been identified as the developer. A transmission period of five years has been indicated for achieving the goal of developing generation and transmission projects in the public sector also through competitive bidding only. The policy lays down a timeframe for rationalization of electricity tariffs and mandates reduction of the cross subsides to within a band of ± 20 percent by the end of year 2010-11. The policy clearly states that provision of free electricity and, in most of the cases, depletion of the wasteful consumption of electricity is not desirable, as it through open-access in distribution, the policy provides methodology for calculating cross-subsidy surcharge and its time bound reduction. It also lays down the mechanism for arranging back-up supply for such consumers.

Power Transmission Network and National Power Grid:

Transmission of electricity is defined as bulk transfer of power over a long distance at a high voltage, generally of 132 kv and above. The entire country is divided into 5 regions for transmission systems, namely Northern Region, North-Eastern Region, Eastern Region, Southern Region and Western Region. The interconnected transmission systems within each region is called the regional grid.

The government of India has an ambitious mission of power for all by 2012. This mission would require that installed generation capacity should be at least 2,00,000 MW by 2012 from the present level of 1,14m000 MW. To be able to reach this power to the entire country an expansion of the regional transmission network and inter-regional capacity to transmit power would be essential. The latter is required because resources are unevenly distributed in the country and power needs to be carried great distances to areas where load centers exist.

State Level Reforms:

Many States have enacted their State Electricity Reforms Acts, which provide, inter alia, for unbundling and corporation of SEBs. Setting up of SERCs etc. the SEBs in these State have been unbundled and corporatized. Distribution has been privatized in Odisha and in Delhi. The States of Andhra Pradesh, Karnataka, Madhya Pradesh , Uttar Pradesh and West Bengal have enacted and Maharashtra has drafted theft legislations making penal provisions regarding theft of electricity stringent. The State of Kerala has also drafted a similar ordinance.

The above mentioned reform measures were initiated by the States at a time when the status of metering was not very encouraging, the billing and collection was very poor and T&D losses were very high. Consequent upon reform initiates, signs of improvement on these and other operational levels are visible. The States have been taking concrete steps towards installation of metres. There has been an improvement in terms of billing and collection in many states, especially in Andhra Pradesh and Haryana. Tariff orders passed by Regulatory Commissions reflect a trend towards tariff rationalization. Tariff authorities across the country are now working on problems of across subsidies in tariffs.

Initiative to Attract Private Investments:

The present policy of the Government seeks to attract significant private sector investments in the Indian power sector. The key initiatives in this regard are the following :

1. Private sector has been permitted to set up coal, gas or liquid-based thermal projects, hydro projects and wind or solar projects of any size.
2. Foreign equity participation has been brought under automatic approval route for generation, transmission and distribution of power generation in hydroelectric, oil-based and coal/lignite-based power projects.
3. Role of the Central Government has been curtained and the State Governments and State Electricity Boards (SEBs) have been empowered to negotiate directly with developers, facilitating speedy clearances for the investors.
4. Ancillary sector such as coal has been significantly deregulated. 100 percent foreign equity is permitted.
5. State Governments have agreed to allow the gradual entry of the private sector in distribution.

FDI in the Power Sector:

The Government has announced significant new policy initiatives to attract foreign investment in this sector.

In explanation and production sharing contracts. Foreign investment in it permitted up to 100 percent in small-sized oil fields: 60 percent for unincorporated joint ventures and 51 percent for incorporated joint ventures; and 100 percent for exploitation and production of blocks identified under the new Exploration Licensing Policy.

The level of FDI in oil reforming sector under automatic approval has been raised from 49 percent to 100 percent. For gas fields developed in the private sector, promoters are free to market the gas at market-related prices.

FDI is permitted up to 74 percent in infrastructure related to marketing of petroleum products.

As per the new policy, foreign investors can enter into a joint venture with an Indian partner for financial and/or technical collaboration and also for setting up of renewable energy based power generating projects. The liberalized foreign investment approval regime aims at facilitating foreign investment and transfer of technology through joint ventures. Government of India is encouraging foreign investors to set up renewable energy based power generation project on build own-operate basis.

100 per cent F D I Permitted in Power Sector:

The minister of State for Power Shri Jyotiraditya Scindia informed Lok Sabha on 13th Dec, 2012 that as per extent policy, Foreign Direct Investment (FDI) up to 100% is permitted in the power sector, under the automatic route, for:

1. Generation and transmission of electric energy produced in hydro electric, coal/lignite based thermal, oil based thermal and gas based thermal power plants;
2. Non-Conventional Energy Generation and Distribution;
3. Distribution of elective energy to households, industrial, commercial and other users; and
4. Power Trading.

   Accordingly, any foreign power company can enter power sector through FDI route. Further, several global power plant equipment manufacturing companies from Japan, Europe and USA have formed Joint Ventures with Indian Companies for establishing manufacturing base in India for the manufacture of supercritical boilers/turbine generators and technology transfer. The companies are Mitsubishi Heavy Industries Ltd., Japan with L&T at Gujarat; Hitachi, Japan with BGR at Tamil Nadu; Toshiba, Japan with JSW at Tamil Nadu; Alstom, France with Bharat Forge at Gujarat; Ansaldo Caldie, Italy with Gammon at Tamil Nadu; Babcock & Wilcox, USA with Thermax at Maharashtra; Hitachi Power Europe GmbH (Germany) with BGR at Tamil Nadu. Doosan, Korea (100% FDI) has come to establish its manufacturing facilities on their own strength in Tamil Nadu.

Response from the Private Sector:

Development of the power sector involves enormous requirements of capital. In the early 1990s, there was a concerted effort to attract private investment into electricity generation. Many contracts were signed with potential independent power producers (IIPs). However, this approach encountered hurdles owing to the financial difficulties of SEBs.

The initial responses of domestic and foreign investors to the policy of private participation in the power sector has been encouraging. However, many projects encountered unforeseen delays in the finalization of power purchase agreements due to environmental clearances, matching transmission networks and legally enforceable contracts for fuel supplies. One of the most important impediments to private participation has been the bankruptcy of the monopoly purchasers the SEBs.

Further, the high tariff of power from some of the commissioned independent power projects (IPPs) due to factors such as high cost of liquid fuels, risk factors involved and unrealistic forecast for further growth of demand etc. have prevented full utilization of available capacities. With the power sector reforms already set in motion, these problems are expected to be sorted out in due course.

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Questions:

1. Critically examine the Indian Power Sector and suggest ways to improve the energy production in India.
2. Uninterrupted Power Supply to Indian Industry, Services and Agriculture will attract more investments and thereby increase economic growth. Substantiate the above statements with facts and figures.
3. India requires around 2,98,000 MWatts of Power of installed capacity by 2022 i.e. by end of 13^{th} Five Year Plan. Is it possible with the present pace of its development strategies, whether India can achieve the targeted power by 2022? If not what should India do?
4. The percentage of renewable energies in India's Power sector is just 12 per cent of total power generated. Its target of solar energy production for the next 10 years is 20,000 M.Watts. What hinders the India's planning bodies as well as its implementers to attain self sustenance in the energy sector.
5. Thermal power's share of India's Power production is about 68 per cent of the total power generated. With severe shortage of coal production and limited reserves, cost of Imports of energy fuel affecting the economy, what would be the fate of India's Power sector in the next decade?

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Annexure 1:

Renewable energy installed capacity in India (as of 31 December 2013)

Type	Technology	Installed capacity (in MW)
Grid connected power		
	Wind	20149.50
	Small hydro	3763.15
	Bagasse Cogeneration	2512.88
	Biomass	1284.60
	Solar	2180.00
	Waste-to-Energy (WtE)	99.08
Total		29989.21
Off-grid, captive power		
	Biomass non-bagasse cogenaration	509.69
	Biomass Gasifiers-Industrial	141.67
	Waste to Energy – Urban	119.63
	SPV Systems (>1 kW)	144.38
	Biomass Gasifiers – Rural	17.05
	Aerogen/Hybrids	2.15
Total		944.75

Annexure 2:

Electricity Consumption:

The Per capita Consumption (K Wh) in 2009-10 was as follows:

State	Per capita Consumption (K Wh)
Goa	2004.77
Puducherry	1864.5
Punjab	1663.01
Gujarat	155.8
Haryana	1558.
Haryana	1491.37
Delhi	1447.72
Chandigarh	1238.51
Tamil Nadu	1250.81
Himachal Pradesh	1144.94
Andhra Pradesh	1013.74
Jammu & Kashmir	968.47
Rajasthan	811.12
Uttar Pradesh	386.93
Uttarakhand	930.41
Madhya Pradesh	618.1
Maharashtra	1054.1
Karnataka	855
Kerala	536.78
Lakshadweep	428.81
Bihar	117.48
Jharkhand	750.46
Orissa	837.55
West Bengal	515.08
Andaman and Nicobar Islands	506.13
Sikkim	845.4
Assam	209.2
Manipur	207.15
Meghalaya	613.36
Nagaland	242.39
Tripura	253.78
Arunachal Pradesh	503.27
Mizoram	429.31
Average	853.05