

# 14

## Energy

### INTRODUCTION

14.1. India is the fourth largest consumer of energy in the world after USA, China and Russia but it is not endowed with abundant energy resources. It must, therefore, meet its development needs by using all available domestic resources of coal, uranium, oil, hydro and other renewable resources, and supplementing domestic production by imports. High reliance on imported energy is costly given the prevailing energy prices which are not likely to soften; it also impinges adversely on energy security. Meeting the energy needs of achieving 8 per cent–9 per cent economic growth while also meeting energy requirements of the population at affordable prices therefore presents a major challenge. It calls for a sustained effort at increasing energy efficiency to contain the growth in demand for energy while increasing domestic production as much as possible to keep import dependence at a reasonable level.

### ENERGY INTENSITY OF GDP

14.2. Energy intensity, defined as the energy input associated with a unit of gross domestic product (GDP), is a measure of the energy efficiency of a nation's economy. India's energy intensity has been declining over the years (See Table 14.1) and is expected to decline further.

14.3. Falling energy intensity implies that the growth in energy used is less than the growth of GDP, which in turn implies that energy elasticity, that is, the ratio of the growth of energy to the growth of GDP is less than unity. In fact, this elasticity has been declining over the years. Total primary energy–GDP elasticity

**TABLE 14.1**  
**Energy Intensity for Total Primary Energy\***

Period	Energy Intensity (Kgoe/US\$)**
1981	1.09
1991	0.99
2001	0.85
2011	0.62

\* Energy intensity indicated is energy required to produce a unit of GDP.

\*\* kgoe: Kilograms of oil equivalent.

Source: Planning Commission.

was around 0.73 during the period 1980–81 to 2000–01 and it declined to 0.66 in the period 1981–81 to 2010–11. The elasticity of commercial energy is higher than that of total primary energy because of the ongoing shift from non-commercial to commercial energy. However, even this elasticity declined from a level of 1.09 in the period 1980–81 to 2000–01 and to 0.91 during 2000–01 to 2010–11. The decline in share of non-commercial energy could be attributed to increased availability of clean fuels and replacing traditional fuels such as wood and cow dung cakes to meet household energy needs. The Twelfth Plan continues to focus on enhancing household access to cleaner forms of energy with an aim to promote sustainable development.

14.4. A National Mission on Energy Efficiency (NMEE) has been launched to improve energy efficiency in all areas of the economy including power, transport, urban housing, consumer goods and

industries. As a part of Clean Energy Mechanism, which is a global initiative, a number of measures are being planned for improving efficiency in lighting by use of light-emitting diodes (LEDs) and super-efficient appliances. A strategy has also been devised to improve the share of energy-efficient modes of transport. This improvement in efficiency will lead to reduced energy intensity of GDP and lower elasticity of energy against GDP. It is estimated that during the Plan, the elasticity may further improve by about 10 per cent by the end of the Plan.

14.5. Table 14.2 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.

**TABLE 14.2**  
**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.

### EXPANDING ACCESS TO ENERGY

14.6. Higher levels of GDP will obviously require higher levels of energy as an input but in addition to this requirement India's energy planning must allow for the need to expand access to clean energy at affordable prices for the bulk of the population. Village electrification and connection of rural households to electric supply under Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) is a critical instrument. The supply of kerosene/liquefied petroleum gas (LPG) at affordable prices is equally important.

14.7. There is ample evidence of unmet demand in rural areas indicating the need to expand access even as we expand total supply. The NSS 66th Round Survey conducted by National Sample Survey Organisation (NSSO) for 2009–10 shows improvement in access to cleaner forms of energy by households for cooking and lighting purposes as compared to the NSS 61st Round Survey for 2004–05. Access to electricity in this period increased from 92 per cent of urban households to 94 per cent and from 55 per cent of rural households to 67.3 per cent. Since 2009–10, 1.40 crore below poverty line (BPL) households have been provided electricity connection under RGGVY. If we add only the number of BPL households connected during last three years to the NSSO data, the estimated household electrification level as on 31 March 2012 would be of the order of 75 per cent. However, the availability of electricity supply continues to remain an area of concern, particularly in rural areas, where consumers get supplies for less than eight hours a day in certain states. Though 67 per cent of the rural households are reported to have access to electricity in 2009–10, their per capita consumption of electricity is only around 8 units per month, which is just one-third of reported consumption of 24 units in urban areas. This is because of poor quality of electricity supplies and reflects significant unmet demand.

14.8. Achieving universal access to electricity is one of the most important goals and the Government plans to provide electricity to each and every household in the country in the next five years by extending RGGVY programme to every habitation irrespective of the size of the population. Sub-transmission, distribution network and renewable sources will need to be expanded suitably in consultation with the State Governments to realise this objective. Adequate investments in the distribution networks will improve the quality of electricity supply for the existing consumers as well as the targeted consumers in the next five years

14.9. The percentage of all households using LPG as cooking fuel increased from 57 per cent of the households in 2004–05 to around 66 per cent in 2009–10. Access to LPG supplies in rural areas increased from

**TABLE 14.3**  
**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

*Note:* Access to energy data for Census 2011 shows primary energy sources for lighting in 2011 as 55.3 per cent rural, 92.7 per cent urban and 67.2 per cent overall, as against 43.5 per cent rural, 87.6 per cent urban and 55.8 per cent overall in 2001. The difference in NSSO and Census data is possibly due to differences in questionnaire. It will need to be further looked into.

8.6 per cent in 2004–05 to around 15.5 per cent in the year 2009–10. Besides, per capita consumption reported in rural areas was just 0.3 kg per month as compared to 1.8 kg in urban areas. Since the disparity between urban and rural per capita total consumption is much lower it is reasonable to assume that potential in rural areas is much higher, but is left unsatisfied because of insufficient access. Women being the main energy users and primary energy suppliers are worst affected by restricted LPG supply. This poses one of the most difficult barriers to the empowerment of women. Table 14.3 shows the access levels in 2004–05 and 2009–10.

### ENERGY DEMAND AND SUPPLY

**14.10.** The demand for energy during the Plan will increase as the economy grows and as access in rural areas expands. Table 14.4 presents estimates of the total primary energy demand projected to the end of the Thirteenth Plan. The annual average growth rate of the total energy requirement is expected to accelerate from 5.1 per cent per year in the Eleventh Plan to 5.7 per cent per year in the Twelfth Plan and 5.4 per cent per year in the Thirteenth Plan. The faster growth in supply in the Twelfth Plan is in part a reflection of the need to meet suppressed demand.

**14.11.** The demand for non-commercial energy is expected to decline with increasing expansion of the network and access to commercial energy. As shown in Table 14.4, whereas commercial energy is expected to grow at 6.91 per cent in the five years up to 2011–12, non-commercial energy is projected to grow at only 2.6 per cent in the same period. The growth of non-commercial energy is projected to decline to around 1.5 per cent in the next 10 years.

**14.12.** Table 14.5 shows the share of each energy source in total domestic production and also its share (including imports) in the total commercial energy consumption. The most important point to note is that coal remains the dominant source of primary energy. Domestic production of coal and lignite account for two-third of total production of commercial energy in 2000–01 and is projected to be about the same in 2021–22. As a percentage of total consumption of commercial energy, the share of coal and lignite is projected to increase to 57 per cent, from a level of 50 per cent in 2000–01. While share of oil in total commercial energy consumption is expected to decline from 37.5 per cent in 2000–01 to 23.3 per cent in 2021–22, the share of natural gas and liquefied natural gas (LNG) is projected to rise from 8.5 per cent to 13 per cent in the same period. The combined share of oil and natural gas in energy consumption was 24.7 per cent in 2011–12 and is expected to be about the same in 2021–22.

**14.13.** The supply from renewables is expected to increase rapidly from 24,503 MW by the end of the Eleventh Plan to 54,503 MW by the end of the Twelfth and 99,617 MW by the end of the Thirteenth. This fourfold increase in the next 10 years is expected to continue in subsequent years as policies provide a strong incentive for the renewables. Nevertheless the base is small and the share of renewables in total commercial energy used will remain small. It is expected to rise from about 1 per cent in 2011–12 to 1.43 per cent in 2016–17 and just under 2 per cent in 2021–22. Though small, the share of renewable energy in India is comparable with that in many other countries: USA (1.7 per cent), Indonesia (1.4 per cent), Thailand (1.0 per cent) and China

**TABLE 14.4**  
**Trends in Supply of Primary Commercial Energy**

	2000–01 (Actual)	2006–07 (Actual)	2011–12 (Provisional)	2016–17 (Projected)	2021–22 (Projected)
	(in mtoe)*				
<b>DOMESTIC PRODUCTION</b>					
Coal	130.61	177.24	222.16	308.55	400
Lignite	6.43	8.76	10.64	16.80	29
Crude Oil	33.40	33.99	39.23	42.75	43
Natural Gas	25.07	27.71	42.79	76.13	103
Hydro Power	6.40	9.78	11.22	12.90	17
Nuclear Power	4.41	4.91	8.43	16.97	30
Renewable Energy	0.13	0.87	5.25	10.74	20
Total Domestic commercial Energy	206.45	263.28	339.72	481.84	642.00
Non-commercial Energy 1	136.64	153.28 (1.93)	174.20 (2.6 %)	187.66 (1.5 %)	202.16 (1.5 %)
<b>Total</b>	<b>343.09</b>	<b>416.56</b>	<b>513.92</b>	<b>669.50</b>	<b>844.16</b>
<b>IMPORTS</b>					
Coal	11.76	24.92	54.00	90.00	150.00
Petroleum Products	77.25	98.41	129.86	152.44	194.00
LNG	0	8.45	12.56	24.80	31.00
Hydro power	0	0.26	0.45	0.52	0.60
Total Net Imports	89.01	132.04	196.87	267.76	375.60
Total Commercial Energy (growth over the previous five years)	295.46	396.32 (5.01 %)	536.59 (6.25 %)	749.60 (6.91 %)	1017.60 (6.30 %)
<b>Total Primary Energy</b>	<b>432.01</b>	<b>549.60</b> (4.09 %)	<b>710.79</b> (5.28 %)	<b>937.26</b> (5.69 %)	<b>1219.76</b> (5.41 %)

\*mtoe: million tons of oil equivalent.

Source: Planning Commission.

Note: Figures in brackets are annual average growth rates over the previous five years' period.

(0.5 per cent). Brazil at (3.1 per cent) is significantly higher. We have made a good start but there is need to do more.

14.14. Even though domestic production of energy resources is projected to increase, import dependence will continue at a high level. The main area of import will be crude oil, where nearly 78 per cent of the demand will have to be met from imports by the end of the Twelfth Plan. However, import dependence for coal is also estimated to increase from 18.8 per cent in 2011–12 to 22.4 per cent by the end of the Twelfth Plan and 25.9 per cent by the end of the Thirteenth Plan. It is estimated that the import

dependence for coal, LNG and crude oil taken together in the terminal year of the Twelfth Plan is likely to remain at the Eleventh Plan level of 36 per cent. However, this assumes that we are able to realise projected domestic production levels of coal, petroleum and natural gas. If this is not achieved, the level of import dependence would increase further if the GDP growth rates projected are to be maintained.

## ENERGY PRICING

14.15. Energy pricing is an economically important but also politically sensitive issue, which will pose major challenges in the Twelfth Plan. While the political sensitivity of energy prices is self-evident,

**TABLE 14.5**  
**Share of Each Fuel in Total Energy Production and Consumption**

	2000-01 Actual	2006-07 Actual	2011-12 (Provisional)	2016-17 (Projected)	2021-22 (Projected)
(in percentage)					
Share in Commercial Energy Production					
Coal and Lignite	66.38	70.65	68.53	67.52	66.82
Crude Oil	16.18	12.91	11.55	8.87	6.70
Natural Gas	12.14	10.52	12.60	15.80	16.04
Hydro Power	3.10	3.71	3.30	2.68	2.65
Nuclear Power	2.14	1.86	2.48	3.52	4.67
Renewable Energy	0.06	0.33	1.55	2.23	3.12
Share in Total Commercial Energy Supply					
Coal and Lignite	50.36	53.22	53.45	55.41	56.90
Crude Oil	37.45	33.41	31.51	26.04	23.29
Natural Gas	8.49	6.99	10.32	13.46	13.17
Hydro Power	2.17	2.53	2.17	1.79	1.73
Nuclear Power	1.49	1.24	1.57	2.26	2.95
Renewable Energy	0.04	0.22	0.98	1.43	1.97

the economic role of rational energy pricing is not adequately appreciated. Rational energy prices help to balance consumer energy demand with producer supply, providing incentives to reduce consumption on the one hand and to stimulate production on the other. As a general rule, energy prices should be aligned with the global energy prices, especially when large imports are involved.

**14.16.** Misalignment of energy prices poses both microeconomic and macroeconomic problems. At the microeconomic level, underpricing energy to the consumer reduces the incentive to be energy-efficient and also promotes leakage of subsidised products for sale in open market and also (in case of kerosene) adulteration. Underpricing to the producer reduces both the incentive and also the ability to invest in the sector, depressing production and increasing reliance on imports. This obviously undermines energy security. At the macroeconomic level, misalignment either hits producers as stated above, leading to excessive import dependence with implications for the balance of payments, or if producers are sought to be insulated, it necessitates a subsidy, which places a burden on the budget.

**14.17.** Over the years, India's energy prices have become misaligned, and are now much lower than global prices for many products. The extent of misalignment is substantial, leading to large un-targeted subsidies. The implications of price misalignment are discussed in the individual sections relating to different sources of energy.

### ENERGY SECURITY

**14.18.** Energy security involves ensuring uninterrupted supply of energy to support the economic and commercial activities necessary for sustained economic growth. Energy security is obviously more difficult to ensure if there is large dependence on imported energy. This calls for action in several areas.

1. First, and most importantly, the domestic production of coal, oil and gas and other energy sources has to be stepped up. Some of the recent issues in this regard have been availability of land, clearances for environment and forest and implementation of the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006. Uncertainty about

production sharing contracts has also posed problems. Management strategies and procedures will have to be devised for ensuring effective implementation of fuel development projects while meeting the requirements of above policies and legislations.

2. Second, a stable and attractive policy regime has to be provided to ensure substantial private investment including foreign investment in oil and natural gas blocks and new capacities for renewable energy. Producers must have clarity in the price they will receive and an assurance of a stable tax regime. Since oil exploration is a global industry the terms India offers must be comparable with those offered elsewhere. In this context the entire structure of New Exploration Licensing Policy (NELP) contracts for oil and gas need to be reviewed.
3. Third, investments in renewable energies need to be strongly emphasised. By present projections, the share of renewable energy in total energy consumption will only reach 2 per cent by 2021.
4. Fourth, investments in energy assets in foreign countries, especially for coal, oil and gas and uranium should be stepped up.
5. Fifth, to meet any possible disruption in oil supplies, on which we are import-dependent to the extent of more than 80 per cent, storage capacities need to be created. The Organisation for Economic Cooperation and Development (OECD) countries have generally created these capacities to the extent of 90 days of their domestic demand. We have created the capacity for 5 million tonnes. It has, however, not been fully utilised so far. There will be a need to increase this gradually and utilise it fully. Innovative ways will have to be found to fill up these tankages.

### 3.2. POWER SECTOR

14.19. The electric power sector consists of a mix of plants depending on different primary fuels, including conventional sources like coal, lignite, natural gas, oil, hydro and nuclear power; and non-conventional sources like wind and solar power, and agricultural and domestic waste. However, coal remains the dominant primary energy source used in power

generation accounting for 67 per cent of total generation. The power sector is currently at a crucial juncture of its evolution from a dominantly public sector environment to a more competitive power sector, with many private producers and greater reliance on markets, subject to regulation. The performance of the power sector shows many positive features, especially relating to the pace of addition to power generation but there are numerous problems relating to fuel supply which need to be resolved as also problems relating to the financial viability of the operation of the distribution companies (Discoms).

### REVIEW OF THE ELEVENTH PLAN

14.20. The Eleventh Plan was the period in which the Electricity Act of 2003, which was enacted during the Tenth Plan period was to be fully operationalised. The objectives of the Act are “to consolidate the laws related to generation, transmission, distribution, trading and use of electricity, and taking measures conducive for the development of electrical industry, protecting interests of consumers and supply of electricity to all areas, rationalisation of electricity tariff, ensuring transparent policies regarding subsidies, promotion of efficient and environmentally benign policies, constitution of regulatory commission and establishment of Appellate Tribunals”. While substantial progress was made in setting up the institutional structure, there are several important areas where reforms have yet to take place. These are:

1. Open access to consumers, which is mandated under the Electricity Act, remains ineffective due to reluctance of state utilities to comply.
2. Trading of power at very high rates and its purchase by utilities even though not willing to pass on the higher cost in the form of consumer tariffs. This has a distortionary effect and threatens to jeopardise the financial viability of the Discoms.
3. Energy audit of power utilities has not been undertaken.
4. Electricity retail tariffs have remained static for many years because of political pressure, widening the gap between the average tariff and average cost of supply.



5. The distribution companies suffer from serious financial stress. Losses of the distribution utilities remain high. The annual loss of the State power utilities (without subsidy) was ₹33,698 crore during 2007–08 and increased to ₹59,891 crore in the year 2009–10 (provisional). The State Discoms cannot sustain such high losses indefinitely.

### Physical Achievements

14.21. An important gain in the Eleventh Plan was the ramping up of the pace of addition to generation capacity. The Eleventh Plan aimed at a substantial increase with a target for additional capacity of 78,700 MW. Actual achievement in the Eleventh Plan was 54,964 MW. Sector-wise and mode-wise capacity addition achievements are given in Table 14.6. This is 30 per cent lower than the original target, but it is more than twice the addition achieved in the Tenth Plan. More importantly, the pace of capacity creation picked up in the Eleventh Plan,

and there is at present about 90,000 MW of generation capacity currently under construction which would achieve commercial production in the Twelfth Plan. If these projects proceed to completion as scheduled, and a strong effort is made to initiate new projects in the first year of the Twelfth Plan, we could reasonably expect to achieve addition to capacity in the Twelfth Plan of the order of 80,000–1,00,000 MW.

14.22. While the pace of addition to generating capacity is commendable, there has not been comparable progress in delivering fuel and the availability of both coal and gas to the new power plants is not assured. Resolution of this problem must have high priority in the Twelfth Plan.

14.23. The main physical milestones achieved in the power sector during the Eleventh Plan are summarised in Box 14.1.

**TABLE 14.6**  
**Installed Capacity Addition during the Eleventh Plan (in MW)**

Type	Target				Actual			
	Central	State	Private	Total	Central	State	Private	Total
Hydro	8,654	3,482	3,491	15,627	1,550	2,702	1,292	5,544
Thermal	24,840	23,301	11,552	59,693	12,790	14,030	21,720	48,540
Nuclear	3,380	–	–	3,380	880	–	–	880
<b>Total</b>	<b>36,874</b>	<b>26,783</b>	<b>15,043</b>	<b>78,700</b>	<b>15,220</b>	<b>16,732</b>	<b>23,012</b>	<b>54,964</b>

Source: Central Electricity Authority (CEA).

### Box 14.1

#### Achievements in Power Sector during the Eleventh Plan

- Capacity addition during the Eleventh Plan period has been at 54,964 MW which is 69.8 per cent of the original target and 88.1 per cent of the reduced target of 62,374 MW set in the Mid-term Appraisal (MTA). It is more than 2.5 times that of any of the earlier Plans.
- Total installed capacity as on 31 March 2012, including renewable energy sources of the country is 1,99,877 MW. The share of renewable energy capacity is about 12.2 per cent
- Approximately 69,926 circuit km (ckm) of transmission line, 1,50,362 MVA capacity of alternating current (AC) substations and 1,750 MW capacity of high-voltage, direct current (HVDC) substations were added to the existing transmission systems.
- Total number of villages electrified till March 2012 was about 5.6 lakhs, indicating that more than 93 per cent village electrification has been achieved. However, a large number of small habitations still remain unconnected.
- Various activities under different schemes of Bureau of Energy Efficiency (BEE) and Ministry of Power (MoP) have resulted in saving in avoided power capacity of 11,000 MW.
- Works relating to 18 units for life extension aggregating to 1,931 MW and 69 units for repair and maintenance (R&M) aggregating to 17,435 MW have been completed during the Eleventh Plan.

## Electricity Generation

14.24. The Eleventh Plan estimated a terminal year (2011–12) requirement of electricity generation from utilities at 1,038 billion units (BU), implying growth rate of 9.1 per cent (CAGR) per annum over the gross generation level of 670.65 BU in 2006–07 (the terminal year of the Tenth Plan). As against the above, the actual generation from utilities in 2011–12 was 876.88 BU, a shortfall of about 16 per cent, implying an annual growth rate of only 5.51 per cent for power from the utilities. The mode-wise and sector-wise energy generation for 2011–12 is given in Table 14.7. After allowing for captive generation of about 110 BU in 2011–12, the growth rate in total power generation is likely to be 5.7 per cent (CAGR) over the Eleventh Plan period, against the Plan target of 9.5 per cent. This has resulted in a demand–supply gap. On 31 March 2012, it was estimated that the peak deficit gap was 11.1 per cent and energy deficit

was 8.5 per cent. These deficits are lower than the corresponding deficits of 13.8 per cent and 9.6 per cent respectively at the end of the Tenth Plan, but there is a clear need to step up capacities and energy availability as the economy grows.

14.25. The actual cumulative capacity as on 31 March 2012 was 1,99,877 MW, including 24,503 MW of renewable sources of energy, the details of which are given in Table 14.8.

14.26. The Eleventh Plan has clearly succeeded in creating the precondition for achieving much larger addition to capacity in future. The performance of the private sector exceeded targets (see Table 14.6) whereas the Government sector fell short, with the shortfall being the generation in the Central sector. The share of the private sector in the total installed capacity has risen to about 42 per cent

**TABLE 14.7**  
**Mode-wise/Sector-wise Break-up of Generation**

Type	(in Billion Units)			
	Central	State	Private	Total
Hydro (Incl. Bhutan Import)	55.97 (5.28)	71.02	8.81	135.80 (5.28)
Thermal	281.04	296.93	130.84	708.81
(a) Coal	225.18	271.98	87.63	584.79
(b) Lignite	18.76	2.88	6.45	28.09
(c) Gas	37.09	21.27	35.10	93.46
Nuclear	32.29	–	–	32.29
<b>Total</b> (Incl. Bhutan Import)	<b>369.28</b> (5.28)	<b>367.95</b>	<b>139.65</b>	<b>876.88</b> (5.28)

Source: CEA.

**TABLE 14.8**  
**All-India Cumulative Generating Capacity (as on 31 March 2012) (in MW)**

	Hydro	Thermal	Nuclear	RES (MNRE)*	Total
Centre	9,085.40	45,817.23	4,780.00	0.00	59,682.63
State/UTs	27,380.00	55,024.93	–	3,513.72	85,918.65
Private	2,525.00	30,761.02	–	20,989.73	54,275.75
<b>Total</b>	<b>38,990.40</b>	<b>1,31,603.18</b>	<b>4,780.00</b>	<b>24,503.45</b>	<b>1,99,877.03</b>

\* MNRE: Ministry of New and Renewable Energy.

Source: CEA.



of the incremental capacity in the Eleventh Plan. The capacity addition program has benefited from increase in the potential of the domestic equipment suppliers like Bharat Heavy Electricals Limited (BHEL), and also increased imports. BHEL has now the potential to deliver about 15,000–20,000 MW of new capacity per year as against 6,000 MW per year a few years ago. Further, more private-sector equipment manufacturers are also entering the market and the total capacity may increase to about 40,000 MW per year by 2016–17.

### Ultra-Mega Power Projects

**14.27.** The Ultra Mega Power Projects (UMPPs) Programme, which brings in private investment into power generation, was a major initiative of the Eleventh Plan. So far power purchase agreements have been signed for four UMPPs of 4,000 MW each on the basis of competitive tariff-based bidding. They are based in Sasan (Madhya Pradesh), Mundra (Gujarat), Krishnapatnam (Andhra Pradesh) and Tilaiya (Jharkhand). Out of these, one unit of 800 MW of Mundra by Tata Power has been commissioned in March 2012. 12 more supercritical UMPPs are being planned covering Chhattisgarh, Gujarat, Tamil Nadu, Andhra Pradesh, Odisha, Maharashtra and Karnataka. An important element of this programme is the induction of supercritical technology, which is an important shift towards energy efficiency. Unfortunately, some of these projects are plagued with uncertainties regarding fuel supply because they were based on imported coal and changes in government policies in the countries where the coal mines were located have raised the cost of coal whereas the power tariff is based on a competitive bid which does not contain a provision for passing on such increases.

### Super Critical Projects under Construction

**14.28.** Thermal power stations based on present-day subcritical technology have efficiency of about 38 per cent. To improve energy efficiency further, it was decided that new thermal power plants should be based on supercritical technology. Already, eleven supercritical units with a total capacity of 7,400 MW have been installed. Large number of supercritical units are under construction and about 50 per cent

of coal-based capacity addition in the Twelfth Plan is expected to be based on supercritical technology. For the Thirteenth Plan, it has been decided that all coal-fired capacity addition shall be through supercritical units. Higher steam parameters of 565/593 degree centigrade are being adopted for supercritical units which would lead to design efficiency of over 40 per cent and lower CO<sub>2</sub> emissions by about 5 per cent as compared to a typical 500 MW subcritical unit.

**14.29.** Initiatives have been taken by the Government for developing indigenous capacity/capability for manufacturing of supercritical boilers and turbine generators as indigenous manufacturing capacity is considered vital to support large-scale induction of supercritical units envisaged. BHEL has entered into a technology collaboration with M/s Alstom and Siemens for supercritical technology for boilers and turbine generators respectively. BHEL has intimated that it had augmented its manufacturing capacity to 20,000 MW per year by March 2012. Further, setting up of joint ventures (JVs)/subsidiary companies by international manufacturers of supercritical boilers and turbine generators was encouraged. As a result, several JVs have come up in the country for setting up manufacturing facilities for supercritical boilers and turbines generators. Manufacturing capacities which may come up are indicated in Table 14.9. The Government of India has also approved the policy of encouraging domestic production of supercritical plants by bulk-tendering of such units. Two bulk orders—11 × 660 MW supercritical units for National Thermal Power Corporation (NTPC) and Damodar Valley Corporation (DVC) and 9 × 800 MW supercritical units for NTPC—were approved and being implemented.

### Transmission

**14.30.** 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 addition that was planned. When the 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

**TABLE 14.9**  
**Planned Manufacturing Capacity MW Per Annum**

Joint Venture	Boilers	Turbine-Generators	Remarks
L&T-MHI	4,000 MW	4,000 MW	Production for boiler and turbine commenced
Alstom-Bharat Forge	–	5,000 MW	All manufacturing facilities for manufacture of turbines to be completed by June 2013
Toshiba-JSW		3,000 MW	All manufacturing facilities to be completed by April 2013
Gammon-Ansaldo	4,000 MW	–	Probable date of completion of facilities—December 2012 (2,000 MW) and December 2014 (additional 2,000 MW)
Thermax-Babcock and Wilcox	3,000 MW		All manufacturing facilities to be completed by September 2012
BGR-Hitachi Boilers Private Limited	5 Boilers per annum (~3,000 MW)		All manufacturing facilities to be completed by January 2013
BGR-Hitachi Turbine Generator Private Limited		5 Turbine Generators per annum (~3,000 MW)	All manufacturing facilities to be completed by July 2014
Doosan Chennai Works Private Limited	2,200 MW (Both subcritical and Supercritical)		DCW Pvt. Ltd. is 100 per cent subsidiary of Doosan Korea. Company incorporated in India on 20 July 2000 Existing facility—Chennai Additional facility acquired at Mannur village, Kancheepuram district Production from additional facilities to start by Sept-2012.

the achievement of transmission lines at the end of the Eleventh Plan are given in Table 14.10. The addition achieved during the Eleventh Plan is 69,926 ckm which is greater than the scaled-down target.

### Distribution

**14.31.** Distribution is the weakest link in the power system with large losses leading to financial unviability. The cash losses of utilities selling power directly to consumers, after accounting for subsidy from the State Governments, increased from ₹17,620 crore in year 2007–08 to ₹42,415 crore in year 2009–10. The cumulative book losses (on accrual basis) of State Discoms have increased from ₹79,339 crore as on 31 March 2009 to ₹1,06,247 crore at the end of year 2009–10. The net worth of the Discoms has decreased from ₹31,972 crore to ₹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.

**14.32.** Distribution companies have not been able to recover the cost of supply through tariff, and the gap between Average Cost of Supply (ACS) and Average Revenue Realised (ARR) has widened and the same has been increasing over the years. This gap is partly a reflection of lower tariff, but it also reflects high aggregate technical and commercial (AT&C) losses which reduce the average revenue realised. The trends in AT&C for all States are shown in Table 14.11. The position is especially serious in the special category states, which have losses (2010–11, Provisional) varying between 29.17 per cent in the case of Uttarakhand to 74.30 per cent in Jammu & Kashmir. Himachal Pradesh with AT&C loss of 13.53 per cent is an exception. The non-special category states have generally performed better, though the losses are still unacceptably high in several of these, for example, Jharkhand (45.11 per cent), Bihar (49.99 per cent), Chhattisgarh (36.41 per cent), Uttar Pradesh (37.86 per cent), Odisha (44.35 per cent)

**TABLE 14.10**  
**Cumulative Achievement of Transmission Lines at the End of the Eleventh Plan**

Transmission System Type/Voltage Class	Unit	At the End of the Tenth Plan (March 2007)	Addition during the Eleventh Plan	At the End of the Eleventh Plan (March 2012)
<b>Transmission Lines</b>				
765 kV	ckm	1,704	3,546	5,250
HVDC + 500 kV Bi-pole	ckm	5,872	3,560	9,432
400 kV	ckm	69,174	37,645	1,06,819
230/220 kV	ckm	1,10,805	25,175	1,35,980
<b>Total</b>	<b>ckm</b>	<b>1,87,555</b>	<b>69,926</b>	<b>2,57,481</b>
<b>Substations</b>				
765 kV	MVA	0	25,000	25,000
400 kV	MVA	92,942	58,085	1,51,027
230/220 kV	MVA	1,56,497	67,277	2,23,774
<b>Total</b>	<b>MVA</b>	<b>2,49,439</b>	<b>1,50,362</b>	<b>3,99,801</b>
<b>HVDC</b>				
Bi-pole link capacity	MW	5,000	1,750	6,750
Back-to-back capacity	MW	3,000	0	3,000
<b>Total</b>	<b>MW</b>	<b>8,000</b>	<b>1,750</b>	<b>9,750</b>

Source: CEA.

and Madhya Pradesh (41.10 per cent). In contrast, Andhra Pradesh, Gujarat, Punjab, Delhi and Tamil Nadu show relatively good performance in containing AT&C losses.

**14.33.** Due to unsustainable levels of AT&C losses and other inefficiencies in metering, billing and collection, the utilities are not able recover the cost of supply resulting in widening of gap between average cost of supply and tariff. Table 14.12 shows recent trends in financial parameters of major States.

**14.34.** The Comptroller and Auditor General (CAG) of India has carried out a study involving 24 utilities on issues impacting financial health of power distribution utilities in India and has pointed out the need for rationalisation of tariffs charged for various consumers. Unless the measures to contain these inefficiencies are taken, the Discoms will not be able to break even. Further, default in payments, non-metering of consumers, inadequate energy auditing, inadequate investments in upgradation of the distribution system are some of the other issues that need

to be addressed. This situation is a cause of serious concern and remedial steps need to be taken on priority basis in the Twelfth Plan to ensure that utilities generate adequate surpluses to support their ongoing projects.

### Restructured Accelerated Power Development and Reform Programme (R-APDRP)

**14.35.** To address the problems of distribution losses, the Central Government had launched the APDRP scheme in 2002–03 as an Additional Central Assistance (ACA) scheme to finance the modernisation of sub-transmission and distribution networks with the objective to reduce AT&C losses to 15 per cent. This programme was not effective in reducing losses. A Re-structured APDRP was approved as a Central scheme in 2008 with a total outlay of ₹51,577 crore over the Eleventh Plan period. The focus of the programme is on actual, demonstrable performance in terms of AT&C loss reduction. The coverage of the programme is for the urban areas—towns and cities with a population of more than 30,000 (10,000 for

**TABLE 14.11**  
**Aggregate Technical and Commercial Losses of State Power Utilities (within State)**

S. No	State	(in Percentage)			
		2007-08 (Actual)	2008-09 (Actual)	2009-10 (Actual)	2010-11 (Provisional)
<b>Special Category States</b>					
1	Arunachal Pradesh	78.31	74.27	63.14	65.48
2	Assam	36.77	35.37	38.24	45.13
3	Himachal Pradesh	19.52	16.20	17.39	13.53
4	Jammu & Kashmir	73.43	70.69	72.03	74.30
5	Manipur	86.75	83.55	69.23	67.74
6	Meghalaya	39.74	35.27	43.19	37.93
7	Mizoram	38.38	46.43	42.89	42.08
8	Nagaland	51.20	55.85	58.02	55.98
9	Sikkim	46.87	46.81	51.37	46.81
10	Tripura	41.44	40.08	37.52	41.19
11	Uttarakhand	35.37	29.35	28.61	29.17
<b>Non-Special Category States</b>					
1	Andhra Pradesh	20.61	19.39	18.32	16.78
2	Bihar	47.60	41.66	42.39	49.99
3	Chhattisgarh	35.17	37.78	46.62	36.41
4	Goa	17.69	17.81	16.18	15.57
5	Gujarat	26.43	25.46	26.87	18.25
6	Haryana	29.01	28.43	29.50	26.72
7	Jharkhand	54.18	54.23	49.07	45.11
8	Karnataka	31.63	24.79	23.69	23.64
9	Kerala	44.80	34.98	28.81	29.72
10	Madhya Pradesh	46.64	45.78	42.93	41.10
11	Maharashtra	30.67	28.75	27.44	23.47
12	Orissa	41.68	42.20	39.71	44.35
13	Punjab	22.36	19.76	19.97	18.35
14	Rajasthan	40.18	32.99	33.06	25.60
15	Tamil Nadu	19.25	20.19	19.11	18.27
16	Uttar Pradesh	38.89	35.29	36.69	37.86
17	West Bengal	20.67	28.81	26.13	28.87
18	Delhi	34.58	17.92	20.78	15.76

special category States). Private distribution utilities are not covered under the programme which has been a point of criticism by some States. Projects under the R-APDRP scheme were to be taken up in two parts. Part A focused on establishing reliable and automated

system for sustained collection of accurate baseline data, and the adoption of IT in the areas of energy accounting and auditing and consumer-based services. Part B includes projects to strengthen the distribution system, including activities like automation

**TABLE 14.12**  
**Viability of Major State Utilities Not Improving**  
**(Excluding Delhi and Odisha)**

	2007-08 Actual	2008-09 Actual	2009-10 Provisional	2010-11 RE
Energy sold/energy available (%)	72.86	74.55	74.33	76.21
Revenue from sale of electricity (₹ crore)	1,31,220	1,48,605	1,63,475	1,92,827
Total cost of electricity sold (₹ crore)	1,74,452	2,12,292	2,35,701	2,61,467
Commercial losses without subsidy (₹ crore)	33,290	52,452	60,172	59,050
Average cost of supply (paise/kWh)	405.86	464.48	480.37	485.67
Average tariff (paise/kWh)	305.29	325.13	333.17	358.18
Gap between the cost of supply and tariff (paise)	100.57	139.35	147.20	127.49

Source: Power Utilities of various States and UTs.

and validation of baseline system, project evaluations, capacity-building and development of franchisees in the distribution sector and consumer attitude surveys. Projects under Part B would be taken up after the baseline data is established (Table 14.13).

14.36. The status of R-APDRP at the end of the Eleventh Plan is as follows:

- Under Part A of R-APDRP, 1,402 projects at an estimated cost of ₹5,196.50 crore have been approved for 29 States/UTs.
- Part A SCADA projects for 63 towns of 15 States have also been sanctioned at an estimated cost of ₹1,443.48 crore.
- Under Part-B of R-APDRP, 1,086 projects at an estimated cost of ₹24,776.17 crore have been approved for 20 States.

- All Part A projects have been awarded except in one State. These are under implementation and at a stage of advanced progress in several States.
- Part A of R-APDRP is to be completed by utilities in three years after its approval. Presently, there are no projects which have completed three years' time since they were sanctioned. However, it has been observed that State procurement policy and procedures have delayed the appointment of IT consultants in some of the States.

#### Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY)

14.37. RGGVY was launched by the Government of India in April 2005 as a comprehensive scheme for providing access of electricity to all rural households. The scheme involved electrification of all un-electrified villages plus a free connection for

**TABLE 14.13**  
**Details of Year-wise Progress Achieved on Restructured APDRP (as on 31 March 2012)**

Year	Project Sanctioned			Budget Allocation			Actual Releases		
	Part A	Part B	Total	Loan	Grant	Total	Loan	Grant	Total
2008-09	1,947.70	0.00	1,947.70	0	1	1	0.00	350.00	350.00
2009-10	3,183.00	3,059.28	6,242.28	1,650	80	1,730	1,331.46	1.26	1,332.72
2010-11	715.40	12,915.31	13,630.71	3,600	100	3,700	2,246.42	100.00	2,346.42
2011-12	793.88	8,801.58	9,595.46	1,959	75	2,034	1,600.00	67.87	1,667.87
<b>Total</b>	<b>6,639.98</b>	<b>24,776.17</b>	<b>31,416.15</b>	<b>7,209</b>	<b>256</b>	<b>7,465</b>	<b>5,177.88</b>	<b>519.13</b>	<b>5,697.01</b>

Source: Ministry of Power.

**TABLE 14.14**  
**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
<b>Tenth Plan</b>						
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
<b>Eleventh Plan</b>						
2007–08	10,500	9,301	88.6	16	16.21	101.3
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
2010–11	17,500	18,306	104.6	47	58.84	125.1
2011–12	14,500	7,934	54.7	52	34.45	66.2
<b>Cumulative (as on 31 March 2012)</b>	<b>1,12,795*</b>	<b>1,04,496</b>	<b>92.6</b>	<b>275*</b>	<b>194.25</b>	<b>70.6</b>

\* Revised coverage including Phase II projects.

Source: Ministry of Power.

BPL households. The scheme provided a subsidy of 90 per cent of the total project cost and balance 10 per cent of the project cost was to be provided by the Rural Electrification Corporation (REC) as loan. Initially, Phase I of the RGGVY scheme was approved for implementation with a capital subsidy of ₹5,000 crore during the remainder of the Tenth Plan period. Subsequently, the scheme was approved to be continued in the Eleventh Plan with a capital subsidy of ₹28,000 crore. As on 31 March 2012, out of the total of 1,12,795 villages to be covered under RGGVY (including Phase II projects), works in 1,04,496 villages have been completed and only 8,299 un-electrified villages remain; 6,000 villages are targeted to be electrified during 2012–13. In addition, about 10,000 remote villages are to be covered by the MNRE through non-conventional sources. Overall, by the end of Eleventh Plan, out of the total 5,93,732 villages in India (Census 2001), 5,56,633 villages (93.8 per cent) have been electrified as per CEA report. Some of the villages which have been electrified, that is, connected to the grid, have not yet been energised. The gap is primarily in the States of Bihar, Jharkhand, Odisha and Assam. Most of the projects are expected to be completed during 2012 except in the north-eastern region and in areas involving difficult terrain.

14.38. The year-wise targets and achievements for RGGVY during the Tenth and the Eleventh Five Year Plan are given in Table 14.14.

14.39. Studies were carried out to evaluate the socio-economic impact of electrification in Odisha. Other such studies are also underway. The key findings of the studies are:

1. Electrification has altered the household energy mix through substitution of traditional kerosene-based lighting source by electric light. This has resulted in energy and financial savings of households as families would no longer be subject to exorbitant price of kerosene.
2. Security within the villages as well as the quality of living of masses have improved.
3. Electrification has enhanced livelihood generation in the field of agriculture and related activities, small shops and other entrepreneurial activities.
4. Availability of electricity during post-sunset time allowed for extension of study hours for students.
5. Increased mobility and overall comfort, especially for women, have enhanced safe spaces and reduced the drudgery of household chores.



14.40. The RGGVY programme has several deficiencies in implementation. Firstly, nearly 6,000 villages electrified till December 2011 were still not energised due to lack of supporting network or other resources. Secondly, access to electricity in rural areas is still limited, especially in smaller hamlets. The traditional approach to policy and planning in power has assumed gender neutrality, thus failing to recognise that the needs of men and women can differ. Attention needs to be paid to livelihood activities of women and to their concerns of safety, security such as street lighting, healthcare, education and so on. Thirdly, poor financial health of utilities and high cost of power act as a disincentive for States to give new connections. Fourthly, some States do not have supporting network and are unable to provide energisation. Fifthly, a viable revenue model is yet to emerge. This has hindered larger access to new consumers.

14.41. Some of the other areas of concern are:

1. In certain States, even the minimum required hours of supply of six hours to eight hours could not be met.
2. There is a need to upgrade transformer capacity as the current average demand of BPL and above poverty line (APL) consumers is in the range of 300 to 500 watts and 0.5 to 1.15 KW, respectively. There have been several complaints of frequent burning of transformers.
3. The progress of release of APL connections is slow on account of poor supply of electricity, long delays in processing of applications and inadequate transformer capacity.
4. In many States, the distribution company takes a long time for issuing the first bill which can be anywhere between three to six months. Because of this delay, the total bill comes to around ₹1,000 to ₹1,500 which a rural household finds difficult to pay. This leads to a permanent high level of outstanding bills.
5. In most of the operating States, no franchisee was found in any of the surveyed villages and the Discoms had their own mechanism of meter reading, billing and so on.
6. As far as project preparation is concerned, it has been observed that in most cases, the detailed project reports (DPRs) were prepared in a hurried manner and quality was compromised.
7. As far as the socio-economic impact is concerned, it is found that electrification has so far not generated substantial employment opportunities or economic development in the rural areas except in a few cases.
8. The number of actual BPL families in the villages in many cases has been higher than the number indicated in the DPR.

### Status on Open Access

14.42. The Electricity Act, 2003, mandates that non-discriminatory open access for interstate as well as intra-state transmission and distribution networks be provided by the utilities. Effective implementation of open access is crucial for opening up consumer choices as well as encouraging a healthy trading function in the country. The open access at interstate level is fully operational. Starting from 17 BUs of energy transacted through Short-Term Open Access (STOA) at the interstate level in 2004–05, the volume has grown to 55 BUs in 2010–11. While carriage and content separation at interstate level has been largely addressed by design, a point of concern has been the adequacy of carriage. Therefore, adequacy issues with respect to carriage need to be specified. Little progress has been made in the implementing of open access at intra-state transmission and distribution network level.

14.43. An inter-Ministerial Task was constituted under the chairmanship of Member (Energy), Planning Commission in February 2008 to examine the status and make recommendations on the measures for operationalising the provisions of the Electricity Act, 2003 in respect of open access. The Forum of Regulators (FoR) has issued model regulations for intra-state open access in September 2010. Adoption of these model regulations by State Electricity Regulatory Commissions (SERCs) would go a long way in successful implementations of intra-state open access. Further, a Second Task Force was constituted in February, 2010 to review the progress made on the recommendations of the previous

Task Force and suggest further course of action on the issues upon which there was no consensus in the First Task Force. The report of the second task force has been received and States have been asked to take necessary action to implement the recommendations. Recommendations of the Task forces on open access are given in Box 14.2.

**14.44.** At the State level, Discoms need to create distribution control centres and empower them so that open access at the distribution level becomes a reality. The request for open access is given at the State level to the State distribution control centres. If these can be empowered to take a quick decision in accordance with the prescribed guidelines and norms for providing open access, the decisions will not be delayed.

Such an empowerment of the State distribution centres is, therefore, is important for the open access.

### Financial Performance

**14.45.** The approved Eleventh Plan power sector budgetary outlay for the public sector (Central and State sectors) was ₹5,72,648 crore which was 15.71 per cent of the total Plan outlay. Summary of the year-wise investment made during the Eleventh Plan is shown in Table 14.15.

**14.46.** The Table indicates major shortfalls in case of central power sectors. This is primarily because the pace of capacity addition of NTPC and National Hydroelectric Power Corporation (NHPC) has been lower than the expected. The internal and

### Box 14.2 Recommendations of Task Force on Open Access

#### REGULATORY AND SYSTEM CHANGES

1. SERCs to regulate the tariffs of all consumers of 1 MW and above in accordance with the provisions of Sections 42, 49 and 86 of the Act and fix only the wheeling charges (in conformity with section 42, read with section 62 of the Act) and open access surcharge.
2. Tariff to be charged by the discoms for providing standby supply should not exceed the maximum UI rate for the applicable hours plus a 5 per cent administrative charge thereon or alternatively, the bulk consumers may directly handle the UI supplies with the respective State Load Dispatch Centres (SLDCs) and to act as independent entities with financial and operational autonomy.
3. SLDCs should be upgraded in a time bound manner to enable open access, under section 42.
4. SERCs should ensure enabling arrangements such as metering and settlement.
5. Regulators should meet bulk consumers to take proactive action for encouraging open access. Timelines should be provided for the same.
6. The trading margin fixed by the Central Electricity Regulatory Commission (CERC) should apply in a seamless manner in any one transaction emanating from a generating company and terminating with a discom through multiple traders and should not exceed the maximum margin allowed to a single trader.

#### CENTRAL GOVERNMENT

7. To earmark a specified proportion, say, 25 per cent of the Centre's discretionary allocation of 15 per cent of central public sector undertakings' (CPSUs') generating capacity which may be made available for direct sale by CPSUs to open access consumers. As for new and upcoming capacity of CPSUs, 75 per cent of the discretionary quota may be reserved for sale to open access consumers and the sale price should determine by bidding. 75 per cent of the profits made by the CPSUs on this account may be transferred to the respective states where open access consumers are located.
8. Scheme of UI charges should be reviewed to ensure that UI does not become a vehicle for gaming in scheduling. For this a mechanism should be evolved to facilitate corrective measures against gaming including stiff penalties.
9. Commencing from the Twelfth Five Year Plan, the Central Government should release Accelerated Power Development and Reforms Programme (APDRP) assistance only to States that comply with the above and enable consumers to exercise their statutory right to open access. A package of incentives and disincentives should also be formulated by Power Finance Corporation (PFC) and REC for States to operationalise open access.

**TABLE 14.15**  
**Outlay/Expenditure: Centre, States and UTs (₹ Crore)**

Sector	Eleventh Plan Approved Outlay	2007-08 (Actual)	2008-09 (Actual)	2009-10 (Actual)	2010-11 (RE)	2011-12 (RE)	Eleventh Plan Likely Expenditure	Per cent Utilisation
States and UTs	2,25,385	27,243	31,577	34,059	43,749	48,068	1,84,696	81.95
Central Sector	3,47,263	29,596	42,242	44,528	46,746	70,390	2,33,501	67.24
All India	5,72,648	56,839	73,819	78,587	90,495	1,18,458	4,18,197	73.03

Source: Planning Commission.

extra budgetary resource (IEBR) of the power sector CPSUs was 63 per cent of the original Plan targets.

## TWELFTH PLAN PROGRAMME

### Addition to Generation Capacity

14.47. The Working Group on Power has estimated a capacity addition requirement of 75,785 MW corresponding to 9 per cent GDP growth during the Twelfth Plan period. However, in order to bridge the gap between peak demand and peak deficit, and provide for faster retirement of the old energy-inefficient plants, the target for the Twelfth Plan has been fixed at 88,537 MW. As shown in Table 14.16, the share of the private sector in the additional capacity will be 53 per cent, compared to a target of 19 per cent in the Eleventh Plan. Since the growth rate of GDP for the Twelfth Plan is likely to be 8.2 per cent and not 9 per cent, the target for capacity addition contain an element of slack of about 10 per cent.

14.48. The share of power based on non-fossil fuel plants is very low at present and should be

increased over time to promote low carbon growth strategy. The share of coal and lignite in the additional capacity being created during the Twelfth Plan is 79 per cent, up from 76 per cent in the target from the Eleventh Plan which actually ended up at 79 per cent. The projected capacity addition in non-fossil fuel plants covers addition of hydro capacity of 1,0897 MW and nuclear capacity of 5,300 MW. Besides this, 1,200 MW import of hydro power from Bhutan has also been considered. In addition, it is planned to add a grid interactive renewable capacity addition of about 30,000 MW comprising of 15,000 MW wind, 10,000 MW solar, 2,100 small hydro, and the balance primarily from bio mass planned. Details of the projected Twelfth Plan capacity addition, sector-wise and mode-wise, are given in Table 14.16.

### Power Generation

14.49. The Working Group for the Twelfth Plan has estimated a requirement of 1,403 BU by the year 2016-17, after taking into account energy conservation measures and demand-supply management.

**TABLE 14.16**  
**Sector-wise and Mode-wise Capacity Addition (Provisional) during the Twelfth Plan (MW)**

Sector	Hydro	Total Thermal	Thermal Breakup			Nuclear	Total
			Coal	Lignite	Gas/Lng*		
Central	6,004	14,878	13,800	250	827.6	5,300	26,181.6
State	1,608	13,922	12,210	0	1,712.0	0	15,530.0
Private	3,285	43,540	43,270	270	0.0	0	46,825.0
Total (Excluding RES)	10,897	72,340	69,280	520	2,539.6	5,300	88,536.6
Renewables	-	-	-	-	-	-	30,000
Total (Including RES)	10,897	72,340	69,280	520	2,539.6	5,300	1,18,536.6

\* Addition of gas capacity is provisional and will depend upon the availability of gas. This will be reviewed during the MTA.

Without such measures, the generation requirement is projected at 1,463 BU. Even if the moderate level of 1,403 BU is taken as the Twelfth Plan target, the projected growth rate in power generation will be 9.8 per cent.

14.50. The projected change in the mix of generation by fuel supply by the end of 2030 is given in Table 14.17. The share of renewables in electricity generated is expected to rise from around 6 per cent in 2012 to 9 per cent in 2017 and 16 per cent in 2030. However, the share of hydro electricity is expected to fall from 15 per cent in 2012 to 11 per cent in 2030. The share of nuclear power, another clean source from a carbon emission perspective is expected to rise from 3 per cent in 2012 to 5 per cent in 2017 and to 12 per cent in 2030. Taking all these clean energy sources together, the share of hydro, renewables plus nuclear energy is expected to rise from 26 per cent in 2012 to 39 per cent by 2030.

#### Renovation and Modernisation and Life Extension of Thermal Power Plants (R&M and LE)

14.51. Coal-based thermal plants are the backbone of the Indian power sector. Most of the old and smaller size non-reheat type units are on the verge of retirement. R&M and LE is an economical option to supplement the capacity addition programme which was initiated in 1984 as a Centrally Sponsored Programme during the Seventh Plan. It continued till the Eleventh Plan and CEA has recommended for its continuance during the Twelfth Plan also.

#### R&M of Hydro Plants

14.52. The normal life expectancy of hydro plants is about 30–35 years after which they need life extension. Many of the existing hydro power stations could be modernised to generate reliable and higher yield by restoration and modernisation schemes. These involve adopting modern equipments like static excitation, microprocessor-based controls, electric microprocessor, high speed static or numerical relays, data logger, optical instrumentation for monitoring vibrations, air gaps, and silt contained in water and so on. These measures would improve availability of hydro power stations and minimise outages. Routine maintenance activities are not included in these schemes. Only activities which aim at increasing the efficiency of the unit and improve availability or steps required to meet environmental norms, or aimed at renovating obsolete equipment controls and instrumentation, are included in R&M scheme.

#### Exploitation of Hydro Electric Potential

14.53. Hydro power plants, particularly storage-based, are generally planned for their ability to meet peak power demand. Estimated hydro potential in India is about 149 GW including the plants of less than 25 MW capacity. The total capacity developed and under development put together so far is about 32 per cent of this potential. A major part of the unexploited potential is in North-East and Himalayan regions. With the deployment of latest technologies we can harness the remaining potential without damaging the ecology. Table 14.18 shows

**TABLE 14.17**  
Changing Structure of Fuel for Electricity

		Capacity (%)			Generation (%)		
		2012	2017	2030	2012	2017	2030
1.	Coal	56	57	42	70	69	58
2.	Oil	1	1	0	0	0	0
3.	Gas	9	6	3	7	5	3
4.	Hydro	20	15	13	14	12	11
5.	Renewables	12	17	33	6	9	16
6.	Nuclear	2	4	9	3	5	12
	Total Clean Energy (4 + 5 + 6)				23	26	39

**TABLE 14.18**  
**Status of Hydro Electric Potential Development**

(In terms of Installed capacity—above 25 MW)

Region	Total potential	Capacity developed	Capacity Under development	Total Developed+ Under development (%)	Capacity yet to be developed (%)
Northern	52,263	15,479	5,416	20,895 (40)	31,368 (60)
Western	8,131	5,552	400	5,952 (73)	2,179 (27)
Southern	15,890	9,367	570	9,937 (62.5)	5,953 (37.5)
Eastern	10,680	2,908	2,713	5,621 (52.6)	5,059 (47.4)
North Eastern	58,356	1,200	2,852	4,052 (7)	54,304 (93)
All India	1,45,320	34,506	11,951	46,457 (32)	98,863 (68)

the status of hydro potential development in the country (above 25 MW).

### Peaking Power and Reserve Plants

14.54. The generation system must be designed to meet base load as well as peak load of the power system and have the ability to respond dynamically and efficiently to variations in demand within a short time. Since our system has wide variation in demand during peak and off-peak periods there is a need for peaking support with very high ramping rate. Peaking power can be provided by reservoir-based hydro plants or gas-based generation. Apart from the above, an optimal power system should have adequate reserves to meet the contingency of outage of certain operating generation capacity. It is important to set up these capacities to meet peaking power demand. It will be necessary to start up 2,000 MW of peaking gas-based plants, despite the limitations on availability of gas improvement.

14.55. Since it is expensive to carry unutilised capacity, and power from gas is likely to be especially expensive, the ability to meet peak loads is critically dependent on introducing time of day metering with a sufficient difference between peak and off-peak tariffs.

### Pollution and Ash Utilisation

14.56. An important positive development in the power sector is that the utilisation of ash has increased impressively from 9.63 per cent in 1996–97 to 56 per cent in 2010–11. This is the consequence of deliberative planning to reduce adverse environmental impact as the coal-based capacity expanded. There are 13 thermal power stations in the country which have achieved 100 per cent or more ash utilisation during the year 2010–11. The ash generation by coal/lignite-based thermal power stations is estimated to increase to 170 million tons per year by the end of 2010–11 and reach to a level of about 300 million tonnes per year by the end of the Twelfth Plan. The Ministry of Environment and Forests (MoEF) has issued notifications for achieving 100 per cent utilisation of fly ash. The quantity of fly ash which has to be disposed off in ash ponds shall be reduced significantly which will help in addressing problems of pollution. All project developers will have to meet the stringent requirement of environmental norms for setting up thermal power plants to minimise air and water pollution.

### Captive Power Plants

14.57. A number of captive power plants (CPPs), including coal-based power plants of varied type



and size, exist in the country. These are either used in process industries or for in-house power consumption for large units. Capacity addition of around 13,000 MW of captive power is likely to be commissioned during the Twelfth Plan. Surplus power, if any, from CPPs is fed into the grid. The tariff for the surplus power is regulated. The captive power capacity generators find it profitable to supply electricity to the grid as the fixed cost has already been recovered by them from the power supplied for their captive use. The variable costs plus additional margins which is provided by the utility is found attractive by them for supplying power surplus to their use.

14.58. The installed capacity of CPPs has increased from 22,335 MW at the beginning of the Eleventh Plan to 36,511 MW (provisional) in March 2012, adding a total of around 14,000 MW addition of captive capacity during the Plan period.

### Fuel Supply Problems

14.59. Although the pace of creation of generation capacity has picked up considerably, the fuel supply capability has not kept pace and serious fuel supply problems have arisen in the last year of the Eleventh Plan. Since 80 per cent of the additional generating capacity will be coal-based, resolution of coal supply to the power plants coming on stream will be crucial. With 50 per cent of the new capacity being created in the private sector fuel supply agreements have to be legally binding with credible penalties to reassure bankers and other financiers financing the establishment of capacity. The problems of coal supply are discussed in coal sector.

14.60. Availability of gas is also a problem as gas has yet to be ensured for 5,156 MW of gas-based projects commissioned during the Eleventh Plan period which are currently stranded/operating at a very low plant load factor (PLF) due to non-supply of gas. In addition to these projects, at least 2,538 MW of additional gas based capacity is expected to come up during the Twelfth Plan and as mentioned above, there is need for 2,000 MW of gas-based capacity to deal with peaking requirements. The requirement for coal, lignite and gas/LNG for power sector at the end of the

**TABLE 14.19**  
**Fuel Requirement during 2016–17**

Fuel	Requirement	Availability
Coal	730 Million Tonnes	550 Million Tonnes
Lignite	46 Million Tonnes	46 Million Tonnes
Gas/LNG	207 MMSCMD*	102 MMSCMD*

*Source:* Planning Commission estimates based on Working Group Reports on Power and Petroleum and Natural Gas.

\*In addition, about 17,500 MW gas-based capacity is under various stages of construction for which additional gas requirement is about 84 MMSCMD.

Twelfth Plan period has been shown in Table 14.19. Clearly domestic supply of both coal and gas needs to be augmented by imports. Since imports will be at much higher prices, some method must be found to make the higher priced fuel acceptable to generators. If domestic prices cannot be fully aligned with import prices, some resort to price pooling will be necessary and the scope for such price pooling must be urgently explored.

### Expansion in Transmission System and Capacity

14.61. The large expansion in production and consumption of electricity has to be supported by a significant expansion and strengthening of the transmission network. Technological developments for transmission lines of 765 KV and 1,000–1,200 KV are of great relevance to reduce land requirement and transmission losses. Greater reliance will have to be placed on gas insulated substations which need about 20 per cent of the space required for conventional stations. This is an area where public investment can be supplemented by private investment and a good start has been made in the Eleventh Plan. It is important to build a policy framework within which more private sector investments will be forthcoming in the Twelfth Plan. A policy framework for public–private partnership (PPP) and a standardised documentation is being prepared for use by the States.

14.62. A total of about 1,07,440 ckm of transmission lines; 2,70,000 MVA of AC transformer capacity and 12,750 MW of HVDC systems are estimated as needed during the Twelfth Plan. Table 14.20 gives



**TABLE 14.20**  
**Transmission Line at the End of the Twelfth Plan Period**

Transmission System Type/ Voltage Class	Unit	At the end of Eleventh Plan	Expected addition during Twelfth Plan	Expected by end of Twelfth Plan
<b>Transmission Line</b>				
HVDC Bipole lines	ckm	9,432	7,440	16,872
765 kV	ckm	5,250	27,000	32,250
400 kV	ckm	1,06,819	38,000	1,44,819
220 kV	ckm	1,35,980	35,000	1,70,980
<b>Total</b>	<b>ckm</b>	<b>2,57,481</b>	<b>1,07,440</b>	<b>3,64,921</b>
<b>Sub-Station</b>				
765 kV	MVA	2,5000	1,49,000	1,74,000
400 kV	MVA	1,51,027	45,000	1,96,027
230/220 kV	MVA	2,23,774	76,000	2,99,774
<b>Total</b>	<b>MVA</b>	<b>3,99,801</b>	<b>2,70,000</b>	<b>6,69,801</b>
<b>HVDC</b>				
Bi-pole link capacity	MW	6,750	12,750	19,500
Back-to-back capacity	MW	3,000	0	3,000
<b>Total</b>	<b>MW</b>	<b>9,750</b>	<b>12,750</b>	<b>22,500</b>

the transmission programme to be taken up during the Twelfth Plan period and also gives the anticipated cumulative achievement at the end the year 2016–17.

### Creation of a National Grid

14.63. The power system in the country is demarcated into five regions. Four regional grids have been operating in synchronous mode as a single system for the past few years. Only the southern grid is yet to be connected to the rest of the system. The high voltage link to connect southern grid is under construction and likely to be completed by January 2014. Once this is achieved, all the five regional grids will operate as a single system in synchronous mode. This will be the largest single such system in the world, both in terms of the grid size and system capacity of around 2,00,000 MW, though, at a given point of time, actual power flow may be lower than this level.

14.64. The capacity for transfer of power across regions at the end of the Eleventh Plan is shown in Table 14.21. The total capacity to transfer power which is currently about 27,750 MW and this is

expected to increase by 136 per cent to 65,550 MW by the end of Twelfth Plan. The specific line which is under construction for connecting the southern region is the Raichur–Sholapur 765 KV line. In fact, these are two single circuit lines and the total transmission capacity of these two lines would be about 4,200 MW. Three HVDC systems and a number of 765 KV lines and substations shall be implemented during Twelfth Plan. The Aurangabad–Wardha 400 KV QUAD DC, line which is part of the transmission system for evacuation of power from Mundra Ultra Mega Power Project (UMPP) has been planned and designed in such a way that the lines would be converted into a 1,200 KV S/C lines by a later date.

14.65. There is a three-tier structure for load dispatch, namely, State Load Dispatch Centre, Regional Load Dispatch Centre and the National Load Dispatch Centre. The Government of India notified Power System Operation Corporation Limited (POSOCO) as the designated entity to operate RLDC/NLDC with effect from 1 October 2010. A Forum of Load Dispatchers (FOLD) has been

**TABLE 14.21**  
**Inter-Regional Flow of Power at the End of Twelfth Plan Period**

Region	End of Eleventh Plan	End of Twelfth Plan (Tentative)
Eastern/Southern	3,630	3,630
Eastern/Northern	12,130	17,930
Eastern/Western	4,390	12,790
Eastern/North Eastern	1,260	2,860
Northern/Western	4,220	14,420
Western/Southern	1,520	7,920
132/110 KV Lines	600	–
North Eastern/Eastern–Northern/Western	–	6,000
<b>Total</b>	<b>27,750</b>	<b>65,550</b>

constituted as approved by the Forum of Regulators (FOR) in January 2009 for harmonising practices across different load dispatch centres.

#### Evacuation of Power from the North-East

14.66. The North-East has very large potential for producing hydro power—close to 50,000 MW—but the pace of implementation has been poor. The evacuation of power from the North-East poses a major challenge for several reasons. First, the entire capacity has to be evacuated through a narrow strip of about 25 km in West Bengal. Although no forest clearance is needed, land acquisition issues could pose problems, which need to be tackled. Second, the number of hydro power plants coming up in the region, especially in Arunachal Pradesh, is expected to be spread over the Twelfth and Thirteenth Plans but the transmission system has to be devised as a onetime operation and may therefore have redundancy initially. This will increase the costs of transmission. Thirdly, a number of States including Arunachal Pradesh, Tripura and Manipur do not have adequate 132/220/400 KV systems and this may cause problems in evacuation of power. Fourthly, the distribution system is inadequate and consequently leads to large power losses.

14.67. The road map for the development of power sector, strengthening of overall transmission system and sub-transmission system of North-East Region (NER) and Sikkim was brought out in Pasighat Summit of North Eastern Council on 17 January

2007. As a follow-up to the recommendations of the summit, a subgroup under the chairmanship of Member (Power Systems), CEA was constituted to suggest the road map for strengthening the transmission system in the region. Subsequently a comprehensive review was taken at the Member (Energy), Planning Commission level to find out the modalities and source of funding to realise the objective.

14.68. Based on the recommendation of CEA and in consultation with each State of NER and Sikkim, Power Grid has prepared detailed project reports for comprehensive schemes for strengthening of transmission, sub-transmission and distribution system in each state of NER and Sikkim and also for interstate transmission system in NER in June 2010. The estimated cost of the above schemes is about ₹11,348.50 crore. The schemes were to be implemented in two phases by 2015–16. Considering the strategic importance of Arunachal Pradesh and Sikkim, a separate scheme for strengthening of transmission system for these two has been formulated at an estimated cost of about ₹3,014 crore. The Planning Commission has conveyed its in-principle approval to this scheme recently. Funding for this project will be provided jointly by the Ministry of Development of North Eastern Region (DoNER) and from the Non-Lapsable Central Pool of Resources (NLCPR). For the strengthening of transmission systems in the remaining six states, Ministry of Power is exploring the possibility of tying up funds from the World Bank.

14.69. Integration of Indian electricity grid with countries such as Bhutan and Nepal would result in optimisation of electricity resources on a large scale and provision of additional benefits and opportunities to the selling and buying countries. This will enhance hydro-thermal mix in generation, and reduce carbon emission and dependence on fossil fuels. An electric grid interconnection between India and Bangladesh through a Berhampur (India)–Bheramara (Bangladesh) 400 KV DC, 125 km line along with  $1 \times 500$  MW HVDC back to back asynchronous link at Bheramara is being developed for facilitating exchange of power up to 500 MW between the two countries. The capacity of this interconnection can be upgraded in future. The asynchronous link ensures that any fluctuations or disturbances on one side would not affect the other side.

### Challenges in Transmission Sector

14.70. The proposed rapid expansion of the capacity to transfer capacity poses some serious challenges, viz. right of way, flexibility in line loading and regulation of power and improvement of operational efficiency. Following measures may be implemented to meet the above challenges:

- Upgradation of transmission lines
- High capacity 400 KV multi, circuit/bundle conductor line
- High Surge Impedance Loading(HSIL) line
- Compact towers
- Increase in current: High Temperature Low Sag (HTLS)
- Reduction in land for substation
- Regulation in power flow/FACATS devices
- Improvement of operational efficiency with condition based monitoring and private maintenance
- Development of 1,200 KV AC system
- Creating adequate evacuation and transmission facilities for renewable power including construction/strengthening of interstate transmission.

### The Distribution System

14.71. The distribution segment plays a crucial role in the overall functioning of the power sector because it is the part of the system which generates the revenues needed to pay generation and transmission

utilities. The viability of the power sector as a whole is therefore critically dependent on the health of the distribution sector. Unfortunately, as the Eleventh Plan experience amply demonstrates, the financial viability of the system is under severe strain. Poor financial health of utilities has resulted in underinvestment in the distribution network causing poor upkeep and maintenance. Consequently the quality of supply is hampered, leading to customer dissatisfaction and poor recovery. This, in turn, leads to further deterioration of financial health of utilities. This vicious cycle needs to be broken.

14.72. It is absolutely vital that the distribution system is made financially viable during the Twelfth Plan. The key focus of the Twelfth Plan must be to strengthen the performance of the distribution system to achieve improved financial viability of Discoms and to expand access to power in rural areas. This calls for concerted attempts at AT&C loss reduction, introduction of smart grid to allow effective demand side management (DSM), greater private sector participation to achieve management efficiency and so on. Since distribution is entirely the domain of States, the responsibility for improving distribution lies almost entirely with State Governments. The Central Government can incentivise action in a manner which allows the States leeway for experimenting with different ways of obtaining better results.

14.73. The Government had constituted the Shunglu Committee in July 2010 to study issues relating to the financial viability of the Ds and give recommendations on how to improve the situation. The Committee has since given its recommendations. In order to examine these recommendations, and suggest a strategy for the turnaround of the distribution sector in the Twelfth Plan, an Expert Group under the chairmanship of Member (Energy), Planning Commission was set up to look into the problems being faced by the State Discoms.

### Debt Restructuring Policy

14.74. The Expert Group gave extensive recommendations for improving the financial health of the discoms during the Twelfth Plan. Based on the

recommendations of the Expert Group, the Cabinet has approved a debt restructuring plan which can be summarised as follows:

1. a. 50 per cent of the outstanding short term liabilities (STL) as of 31 March 2012 to be taken over by State Governments by way of bonds to participating lenders shall be first converted into bonds to be issued by Discoms duly backed by the State Government guarantee. The State Government will take over the liability during the next two to five years by issuance of special securities in favour of participating lenders in a phased manner keeping in view the fiscal space available till the entire loan (50 per cent of STL) is taken over by the State Government.
  - b. The State Government would provide full support to the Discoms for repayment of interest and principal.
  2. Balance 50 per cent of the STL will be rescheduled by lenders and serviced by the Discoms with a moratorium of three years on principal and would be backed by a State Government guarantee. The best possible terms are to be extended for the rescheduled loans to improve viability of Discoms' operations.
  3. The restructuring/reschedulement of loan is to be accompanied by concrete and measurable action by the Discoms/States to improve the operational performance of the distribution utilities. In order to make the effort meaningful, the State Government/Discoms have to commit themselves and carry out certain mandatory and recommendatory conditions contained in part (c) of the Scheme.
  4. To set up a Transitional Finance Mechanism in support of the restructuring effort of the State Government for their distribution utilities having the following features:
    - a. For providing liquidity support by way of a grant equal to the value of the additional energy saved by way of accelerated AT&C loss reduction beyond the loss trajectory specified under Restructured Accelerated Power Development and Reform Programme (RAPDRP).
    - b. The eligibility of grant would arise only if the gap between ARR and ACS for the year has been reduced by at least 25 per cent during the year judged against the benchmark for the year 2010–11.
    - c. This scheme would be available only for three years beginning 2012–13.
    - d. Incentive by way of capital reimbursement support of 25 per cent of principal repayment by the State Government on the liability taken over by the State Government under the scheme. The amount to be reimbursed only in case the State Government takes over the entire 50 per cent of the short-term liabilities corresponding to the accumulated losses outstanding as on 31 March 2012. Detailed guidelines for the Transitional Finance Mechanism as outlined above would be worked out by the Ministry of Power in consultation with Ministry of Finance.
  5. The Scheme would be applicable to all State Discoms having accumulated losses and facing difficulties in financing operational losses.
  6. For removal of difficulties in interpreting or implementing the Scheme, Ministry of Power may be authorised to issue clarification, after inter-ministerial consultations, wherever required, with the approval of the competent authority.
- 14.75. Effective implementation of the restructuring package during the Twelfth Plan would send a powerful signal that the power sector is on the path of financial viability.
- Restructured APDRP**
- 14.76. The challenge of providing power to all involves considerable investment in distribution. The Working Group for the Twelfth Plan has assessed a total investment requirement for the distribution sector at ₹3.06 lakh crore. Some of the key initiatives proposed during the Twelfth Plan are:
1. The population norms under R-APDRP for including a city under R-APDRP may be relaxed

by lowering the existing population threshold. More extensive coverage will bring uniformity in billing and customer service of the utility across all its service areas. R-APDRP may also cover assistance to private distribution companies.

2. A National Electricity Fund (NEF) had been set up. This will now be operationalised. It will provide interest relief to the distribution utilities to cover loans taken from financial institutions for development of the distribution sector.
3. Utilities and regulators shall make an action plan to eliminate the gap between the average cost of supply and average tariff realised through improved tariff implementation and adoption of multi-year tariff framework.
4. Time of Day (TOD) metering shall be taken up by all the utilities for effective demand side management (DSM).
5. Load shifting arrangement by regulators and improvement in energy efficiency and its measurement by BEE in the agriculture sector shall contribute towards DSM and ease out the pressure on utilities.
6. Open Access shall be provided to consumers with more than 1 MW load in accordance with the Electricity Act, 2003. This was mandatory with effect from 1 January 1 2009 but it has not been operationalised due to reluctance of State Governments and the utilities to give the necessary freedom to large customers to choose their own sources of supply. In fact, under the law, the State electricity regulator should not set tariffs for large customers leaving them to be determined through negotiations.
7. To improve safety, counter theft and improve aesthetics, underground cabling work shall be taken up by the utilities for towns under R-APDRP in selected areas.
8. Moving towards a smart grid in a manner relevant to our needs will be a key focus area in the distribution sector in the Twelfth Plan. A number of pilot projects will be taken up.
9. Phased installation of smart metres, extending SCADA system to 100 more towns, and integration of renewable into the grid.

### **The Role of Private Investment and Participation in Distribution**

14.77. The experience of privatisation in Delhi, Kolkata, Mumbai, Ahmedabad, and Surat shows that transmission and distribution losses can be reduced, network efficiency increased, and service levels improved. The experiences in Bhiwandi, Maharashtra of franchising have also indicated positive gains with network losses going down from 63 per cent to 19 per cent in Bhiwandi and service levels improving. The Franchise model is now being expanded to Nagpur, Aurangabad, Jalgaon in Maharashtra and Agra in Uttar Pradesh. An alternative model is public-private partnership (PPP) in the distribution segment for which necessary concession agreements are being designed. The Twelfth Plan will have to place a major emphasis on expansion of Franchise or PPP or privatisation in different utilities as a strategy to reduce network losses and improve efficiency of service and consumer satisfaction.

### **Separation of Rural Feeders**

14.78. An important initiative to improve the availability of power in the rural areas and have more effective management of power for the agriculture sectors where the requirements may be for limited hours, has been to separate rural feeders for lighting and agriculture loads. This was initiated by Gujarat utilities and has subsequently been taken up by Rajasthan, Andhra Pradesh, Haryana, Uttar Pradesh, Chhattisgarh, Madhya Pradesh, Karnataka, Maharashtra and a number of other States. A World Bank study on the efficacy of these reforms is underway. According to the initial indications, the benefits have been found to be more in the field of improved lighting in the villages with varying degree of success on reducing T&D losses.

### **Universal Electrification**

14.79. The RGGVY was started with an aim to provide electricity connections to all villages and free connections to BPL families (Annexure 14.1). It has certainly provided increased access of power to a large number of households as indicated in paragraph 3.1.8. Clearly, there is still a large population which is not using electricity either because of lack of network in the villages or absence of connectivity to



the household. There are also a large number of habitations left uncovered. To provide power to all during the Twelfth Plan would require dealing with the large backlog in the States of Uttar Pradesh, Bihar, Odisha, Assam and some of the North Eastern States.

**14.80.** Connectivity by itself is only a part of the programme. In many States there is also a real shortage of power. Besides, RGGVY focuses only on household supply and does not address the needs for providing electricity for small industries and agriculture, which need three-phase supply. This, in turn, requires strengthening of the rural network and not just the last mile connectivity to households, which is what RGGVY covers. States are often unable to invest in this. For effective universal access, the RGGVY programme will be restructured.

### Human Resource Development and Capacity Building

**14.81.** The present power scenario demands a very comprehensive and pragmatic approach to attract, use, develop and conserve valuable human resources. Technically trained work force comprising of skilled engineers, supervisors, artisans, managers and so on are required in every sphere of the power supply industry. A growing concern over environmental degradation and depletion of the conventional energy sources has made the task of electricity generation even more challenging and therefore, quality standards of the staff are becoming increasingly vital.

**14.82.** For a capacity addition of about 1,00,000 MW (including renewables) in the Twelfth Plan, the additional work force requirement shall be of the order of 4 lakh out of which nearly 3 lakh will be technical. Therefore, all Central sector utilities, State sector utilities, and IPPs would need to create required training infrastructure for providing O&M training. Additional training infrastructure shall be created by organisations like NPTI and training institutes of other utilities. These should augment their existing training institutes for meeting the increased training requirement of the power sector.

### R&D in Power Sector

**14.83.** The power sector being highly technology-intensive, R&D plays a major role in its

developmental plans. In the present scenario, R&D initiatives are particularly required in four different conventional sectors, viz. generation, transmission, distribution and environment.

**14.84.** Thermal, hydro, renewable energy and distributed generation are the key areas in the generation sector. Design and development of the equipment, real-time simulators and controllers, creation of data bank, automation pilot plant demonstration, development of alternative materials, equipment performance, biological efforts and exploratory studies are required in the transmission sector. R&D initiatives in smart grid and distributed generation are required for improvement of distribution sector. Major PSUs involved should be encouraged to do the necessary R&D. Further clean development mechanism for bulk utilisation of fly ash, control of SO<sub>x</sub>, NO<sub>x</sub> and mercury in coal-based thermal power plants need immediate attention for clean and green energy.

**14.85.** R&D in distribution and rural electrification needs more thrust. The key research areas may be AC/DC micro-grid demonstration for improving reliability and power quality, energy storage scheme for improving the reliability of sensitive loads, development of intra-operable standards and protocol for energy metering, load research, I.T. applications in distribution and smart grid and so on. R&D initiatives are also required for enhancing material strength and durability and for standardisation on their specifications. A key initiative for R&D in the Twelfth Plan may include setting up of a technical cell in CEA, which will focus on best practices, R&D in data collection and specific projects and technical support to States for consultancy and implementation. The research projects will include support to universities.

### Project Implementation

**14.86.** Land is increasingly becoming a scarce resource and availability of land is posing a serious challenge for future power plants. The optimum utilisation of land is therefore crucial. Design changes are required to reduce land requirement. Similarly, availability of water has become scarce. To meet future water demand of thermal power, technical



measures for reducing water consumption, creation of large reservoirs/dams of potential rivers to retain flood water and encouraging coastal power plants will be undertaken.

**14.87.** Achievement of the generation capacity targets depends critically on supporting infrastructure in different transport sectors like railway, highways and roads, inland waterways and gas pipelines. Railways need to enhance their capacity for coal evacuation from coal fields by expanding proposed dedicated freight corridors and also ensure rail connectivity to all ports having coal unloading facilities. Roads and highways need to be augmented for transportation of over dimensional consignments and changes in Motor Vehicle Act may be required to accommodate consignments, with safeguards, of above 49 million tonnes and also include hydraulic axle trailers. Accordingly, load classification for roads and bridges may be reviewed and toll plaza building on highways may be designed keeping these requirements in view.

**14.88.** Coal handling arrangements at ports must be expanded to handle the larger quantities of imported coal required for power stations. Increase of draft, creation of roll-on/roll-off berths and mechanisation shall improve the load handling capabilities of ports. All these ports must be given priority in effective road/rail connectivity.

**14.89.** Adequate manufacturing capacities of main plant equipment including that for large supercritical thermal sets shall be available indigenously to meet the capacity addition requirement of the country during the Twelfth Plan. Regarding balance of plants construction agencies and construction equipment/techniques, the capacities and capabilities have to be further developed and enhanced. There is no shortage of key material except Cold Rolled Grain Oriented Steel, higher grade Cold Rolled Non Grain Oriented Steel and thick boiler steel plates. There is a need to set up plants to produce Cold Rolled Grain Oriented Steel, augment indigenous capacity for tubes and pipes, create short circuit testing facilities for transformers, augment manufacturing facilities for gas-insulated substations and create indigenous

capacity for thicker boiler water plates. It should be possible to set up domestic capacity in these areas which is internationally competitive.

### **Management of Energy Demand and Energy Efficiency**

**14.90.** Improving energy efficiency is an important instrument for containing the demand for energy and several initiatives are possible in this area. The Bureau of Energy Efficiency (BEE) and the Ministry of Power (MoP) had introduced a number of schemes during Eleventh Plan for promotion of energy efficiency in India. The schemes of BEE include Standards and Labelling (S&L), Energy Conservation Building Code (ECBC), Energy Efficiency in Existing Buildings, Bachat Lamp Yojana (BLY), SDA strengthening, Energy Efficiency in Small and Medium Enterprises (SMEs), Agriculture and Municipal Demand Side Management (DSM) and Contribution to State Energy Conservation Fund (SECF). Schemes implemented by the Ministry of Power include Energy Conservation Awards and National Mission for Enhanced Energy Efficiency (NMEEE). These schemes are estimated to have achieved savings equivalent to 11,000 MW of avoided power capacity during the Plan. Details of savings projected to be realised through various measures are given below, along with Plan for the period 2012–17.

#### ***Energy Efficiency in Equipment and Appliances***

**14.91.** Large energy inefficiencies exist in consumer and industrial appliances. The S&L Programme was quite successful during the Eleventh Plan period and it is anticipated that by the end of the Eleventh Plan, total savings in avoided capacity addition would be 7,315 MW. Under this scheme, a large number of appliances were covered initially under the voluntary labelling categories, out of which four appliances/equipment are under the mandatory labelling program. The Eleventh Plan has already envisaged coverage of 21 appliances under S&L. This programme will be continued and expanded during the Twelfth Plan.

#### ***Efficiency in Transport***

**14.92.** As on 2010–11, there were a total of 13.3 million passenger cars in India which consumed about

9 mtoe. An additional 1.1 million passenger cars are added every year. In the transport sector, a labelling scheme is envisaged which is aimed at achieving energy efficiency. This will cover:

- Introduction of fuel economy norms effective from the first year of the Twelfth Plan. This will be mandatory from 2015 under the Energy Conservation Act.
- Technical study for two- and three-wheelers and commercial vehicles (Trucks and Buses) to finalise additional S&L Programme. Norms for these will be modified.

14.93. The targeted energy saving by the end of the Twelfth Five Year Plan is 4.3 mtoe in the sector.

#### *Energy Efficiency in Industries*

14.94. The total commercial energy consumed by industry including SMEs stands at about 40–50 per cent of the total commercial energy consumption in the country. Hence energy efficiency measures would yield substantial benefits in this sector. The projected energy saving potential in the Twelfth Plan is 13.18 mtoe which consists of a saving of 6.2 mtoe from the seven energy-intensive industries (DCs), 1.75 mtoe from SME sector and 5.23 mtoe from thermal power stations sector.

#### *National Mission for Enhanced Energy Efficiency (NMEEE)*

14.95. NMEEE is one of the eight Missions created by India's National Action Plan for Climate Change and is based on the Energy Conservation Act, 2001.

The Mission will enable transactions in energy efficiency. Specific initiatives envisaged by the NMEEE include:

- Perform Achieve and Trade scheme—a market-based mechanism to enhance energy efficiency (see Box 14.3 for details). The scheme is expecting an energy saving of 3.5 million tons of oil equivalent (mtoe) in seven selective industrial sectors and 3.1 million tons of oil equivalents in thermal power stations by 2014–15;
- Market Transformation for Energy Efficiency (MTEE)—CDM roadmap, Standards and Labelling, ESCO promotion, capacity-building;
- Financing Energy Efficiency—tax exemptions, revolving fund, Partial Risk Guarantee Fund; and
- Promotion of performance contracting business model—enabling upgradation of existing buildings, streetlights, municipal pumping and so on through Energy Service Companies which invest in the upgradation and are paid through sharing of the resultant savings in the energy bill.

14.96. Fans and Lights are the major users of electricity in homes and offices across the country. Energy consumption by fans and lights is expected to occur rapidly because of increasing incomes and enhanced access to electricity. During the Twelfth Plan period the introduction of 'super-efficient' lights and fans will be incentivised so as to accelerate their development and adoption to enable lower the rate of growth of electricity demand while enhancing services to households.

#### **Box 14.3**

##### **Perform, Achieve and Trade Mechanism**

The Perform, Achieve and Trade (PAT) mechanism is a market-based mechanism to incentivise improvements in energy efficiency in eight energy-intensive industries (including TPS) by setting up standards and certification of energy saving achieved which can be traded. The vision for PAT scheme during Twelfth Plan covers the following points:

- While implementation of the first cycle of PAT is to achieve the set target of 6.6 mtoe by 2014–15, widening and deepening the scope of PAT during the second cycle of PAT envisages including other energy-intensive sectors like refineries, Chemicals, Petrochemicals, Automobile Manufacturing, Sugar, Glass and so on to reduce the threshold energy consumption limit;
- Fiscal instruments like Partial Risk Guarantee Fund (PRGF) and Venture Capital Fund for Energy Efficiency (VCFEE) which have been proposed in NMEEE for successful implementation of PAT scheme will be expanded in order to provide confidence to the financial institutions and to equity investors to invest in energy efficiency products and companies.

14.97. Major R&D programmes may be initiated in selective areas and selective sectors for developing new customised energy-efficient technology through indigenous development of applications of already available energy efficient technologies/concepts.

14.98. The total projected saving in the year 2016–17, that is, end of the Twelfth Five Year Plan is of the tune of 11.43 mtoe in which 10.41 mtoe is contributed by thermal energy. The rest, which is equivalent to 11.96 BU of electricity saving is estimated at busbar in 2016–17.

### Policy Reforms in the Power Sector

14.99. The Twelfth Plan must push for policy reforms in several areas, the most important of which are listed below:

1. Resolution of fuel supply problems related to availability of coal and gas for the plants expected to come on stream in the Twelfth Plan will be critical. These are discussed in the section on Coal and Gas in this Chapter.
2. The introduction of open access must have top priority. State Governments, SERCs and Discoms need to conform to the Electricity Act, which prohibits tariff regulation for consumers of 1 MW and above. These consumers must be free to purchase electricity through open access in a competitive market. Where cross-subsidy is required, an open access surcharge may be levied. The Act requires phased implementation of open access to all consumers. By the end of the Twelfth Plan, all consumers up to 0.25 MW may be covered.
3. There is a need to develop ancillary power markets and CERC should come out with a framework for implementation of such market. To facilitate further development of power market, jurisdiction issues regarding forward and future market products may be clarified in the policy/Act. Development of markets can be expanded further by permitting short-term procurement for three months in advance by the Discoms. Also, long-term procurement and medium-term procurement by the Discoms may be encouraged and impediments, if any, may be identified and removed.
4. Strengthening of NLDC/RLDCs/SLDCs is vital for effective grid management and for implementation of open access. It is necessary to separate the management of POSOCO from PGCIL. The State Governments must take steps to upgrade and modernise the SLDCs which must be made functional and financially independent in accordance with the Electricity Act.
5. Spinning reserves need to be facilitated for grid stability at the regional level to accommodate infirm renewable energy injection into the grid. The State Governments need to contract additional capacity for this purpose.
6. Suitable incentives for low-cost transmission, linking the renewable energy generation sources, development of smart grid for evacuation and transmission of renewable power and creation of spinning reserves may be done through the National Clean Energy Fund.
7. There is a need to strengthen measures for increasing share of renewable energy over time. SERCs should provide long-term trajectory for renewable purchase obligations and issue relevant regulations within a specified timeframe. Further, for the procurement of renewable power, demand of more than one distribution licensee may be pooled at the State level or jointly among States and procurement through competitive bidding route under section 63(a) of Electricity Act 2003/National Tariff Policy should be made permissible.
8. Power procurement and allocation of power must be done in line with the Tariff Policy and the guidelines/standard bid documents (SBD) issued by Government of India under the Electricity Act, 2003. The National Electricity Policy (2005) may need to be suitably amended to ensure State Governments abide by these provisions.
9. Consumer Grievance Redressal Forum (CGRF) should be made a multi-member set-up comprising representation from all stakeholders. The office of Ombudsman should be funded by the SERCs.
10. Reforms in the distribution sector should include:
  - a. Prepaid metres to those categories of consumers who are chronic defaulters, 100 per

- cent spot billing, spot collection, semi or fully automatic meter reading and standardisation of metering protocols for extensive use of automated meter readings.
- b. Institution of Chief Electrical Inspectorate to Government of India/State Government (CEIG) to be strengthened and to work out a scheme for delegation of authority of mandatory inspection including self-certification to the CEIG to liberalise it from unnecessary controls.
  - c. Separation of rural feeders to control losses and improve power availability. Dedicated feeders may be extended to energy-intensive consumers at their cost.
11. The State Government should clear all the outstanding dues to the utilities, and ensure timely payment of subsidy. State Governments with financially strained Discoms should be encouraged to undertake restructuring of the debt as per the package recently approved by the Cabinet. This includes restructuring of short-term loans of Discoms with poor financial health, sharing by concerned State Governments of the burden of the utilities to the extent of 50 per cent of such short-term loans, provision of special market bonds and relaxation of FRBM norms for the State Governments. Financial restructuring should be supported by regular revision of tariff through adoption of regulations suggested by Forum of Regulators, including automatic tariff adjustment with change in fuel prices and other reform measures to ensure regular revision of tariff and simultaneous investments in reducing AT&C losses.
  12. There is a need for an independent oversight over programmes like RGGVY and R-APDRP on a concurrent basis. These should be incorporated in these schemes for the Twelfth Plan.

### 3.3. COAL AND LIGNITE SECTOR

**14.100.** Coal is the mainstay of India's energy sector accounting for over 50 per cent of primary commercial energy supply in 2010–11. This share will actually increase to 57 per cent over the next 10 years. The gap between the demand and the domestic

supply of coal has made it imperative to augment domestic production both from the public sector and the private sector and to expedite the reform process for realising efficiency gains through increased competition in the sector during the Twelfth Plan. An important feature of the Eleventh Plan was the attempt to augment domestic coal production from captive mines. However, the programme has slipped and expected production from captive blocks fell well short of the projected target of 104 million tonnes in the terminal year of the Plan because only 29 captive blocks could start production out of the 195 blocks allocated so far. The main impediments in the progress of captive mining are reported to be similar to those in other PSU-held blocks like delays in forest and environmental clearances, problems of land acquisition and R&R, allocation of a block to more than one user and so on. CIL will continue to play a major role in meeting the coal requirements of the country but the growth in CIL production will not be enough to meet the rising demand. Hence, efforts need to be made to ensure that additional captive coal blocks start producing in Twelfth Plan to meet the rising coal demand. It is also necessary to plan for larger imports of coal.

### REVIEW OF THE ELEVENTH PLAN

#### Coal Demand and Production

**14.101.** The target for coal production at the end of the Eleventh Plan was initially set at 680 million tonnes and revised downwards to 630 million tonnes at the time of the MTA. The actual achievement was only 540 million tonnes. Since demand in the terminal year (2011–12) of the Eleventh Plan was around 640 million tonnes there was a large demand–supply gap of 100 million tonnes which was only partially met by imports. This has adversely affected the coal supplies to end consumers, particularly the power sector. It is estimated that out of capacity addition of 41,894 MW, around 25,000 MW of coal-based capacity commissioned is being sub-optimally utilised because of inadequate availability of domestic coal.

**14.102.** The widening gap between demand and supply has to be met by imports because of which the share of imports in the total coal demand is likely to

**TABLE 14.22**  
**Details of Coal and Lignite Production**

Sl. No.	Parameter	Tenth Plan 2006–07	Eleventh Plan (2011–12)			Eleventh Plan % CAGR		
			Initial	MTA	Latest	Initial	MTA	Latest
0	1		2	3	4	7	8	9
1	Coal Demand (million tonnes)	474.18	731.10	713.24	640.00	9.53	8.98	6.98
2	Coal Production (million tonnes)	430.84	680.72	629.91	539.99	9.58	7.89	4.62
3	Imports	43.08	51.00	83.33	90.00	3.43	14.11	15.88
4	Imports as per centage of total demand	9.00	6.98	11.68	14.06			
5	Lignite Production (million tonnes)	31.28	54.96	42.59	41.64	12.04	12.04	6.72

Source: Ministry of Coal.

increase to around 14.06 per cent in 2011–12 as compared to just 9 per cent in the year 2006–07. Details of coal imports in Eleventh Plan are given in Table 14.22.

### Lignite Production and Demand

14.103. The Eleventh Plan envisaged lignite production to reach 54.96 million tonnes in the terminal year of the Plan (2011–12) from 31.13 million tonnes in 2006–07 yielding a growth rate of 12 per cent. The projected production of 54.96 million tonnes was expected to come from lignite mines spread in three contributing States with their respective share as 24.23 million tonnes from Tamil Nadu, 22.26 million tonnes from Gujarat and 8.47 million tonnes from Rajasthan. However, actual production in 2011–12 was 43.10 million tonnes combined from all the three states. This shortfall is mainly due to non-starting of several mines under Private and State Sector and due to delay in commissioning of lignite-based power plants and certain mines under the Central Sector. As far as NLC is concerned, thinning of lignite seam thickness and the washout zone encountered in Mine I is the main reason for the shortfall of 2.42 million

tonnes in Tamil Nadu. Similarly, in Barsingsar Mine under NLC at Rajasthan, though the mine is ready in all respects to give full production, it was warranted to limit its production to cope with the demand of its linked TPS which has certain teething problems. The lignite based capacity addition in the Eleventh Plan is 1,490 MW against the target of 2,280 MW.

### Coal and Lignite Reserves

14.104. The inventory of geological resources of India's coal and lignite reserves as on 1 April 2010 has been shown in Table 14.23. This is 15.09 per cent higher than the reported reserves level of 255 billion tonnes in January 2007. Corresponding increase in lignite reserves level is 9.6 per cent from 38.27 billion tonnes reported level in 2007. The accretion of coal resources over the years has been shown in Table 14.24.

### Review of the Central Sector Schemes

14.105. The schemes implemented with budgetary support from the Ministry's plan covered regional/promotional exploration, detailed drilling in non-CIL blocks, Environmental Measures and

**TABLE 14.23**  
**Inventory of Coal and Lignite Reserves as on 1 April 2012**

	Proved	Indicated	Inferred	Total
Coal	118.145	142.169	33.183	293.497
Lignite	6.18	25.76	10.02	41.96

Source: Ministry of Coal.



**TABLE 14.24**  
**Accretion of Coal Reserves**

Reserves as on	Proved Category	Accretion in Proved Category	Inferred Category	Indicated Category	Total Reserves	Reserves Accretion
1 January 2005	92,960	–	1,17,090	37,797	2,47,847	–
1 January 2007	97,920	4,960	1,18,992	38,260	2,55,172	7,325
1 April 2008	1,01,829	3,909	1,24,216	38,490	2,64,535	9,363
1 April 2009	1,05,720	3,891	1,23,570	37,921	2,67,211	2,676
1 April 2010	1,09,798	4,078	1,30,654	36,359	2,76,810	9,599
1 April 2011	1,14,002	4,204	1,37,471	34,390	2,85,862	9,051

*Source:* Coal Directory of India.

Subsidence Control scheme (EMSC), R&D schemes, Conservation and Safety measures and development of transport infrastructure in the coal fields and so on.

### Regional/Promotional Exploration

**14.106.** Exploration for coal and lignite in the country is taken up in stages. In preliminary exploration, geological surveys are undertaken by the Geological Survey of India (GSI) to identify potential coal and lignite areas. Regional promotional exploration aims at widespread drilling to establish broad framework of the deposits to facilitate planning for detailed exploration and subsequent projectisation and mine development. While regional exploration drilling target for Eleventh Plan was 1.94 lakh metres which was revised to 1.47 lakh metres, promotional drilling target was 4 lakh metres. Against the envisaged targets, achievement will be 1.14 lakh metres (about 78 per cent) in case of regional drilling, establishing 7.07 Bt of coal and 2.95 lakh metres (74 per cent) in case of promotional drilling, establishing 20.05 Bt of coal resources.

**14.107.** In case of lignite, regional exploration drilling achievement is likely to be 1.32 lakh metres against a target of 1.48 lakh metres during Eleventh Plan mainly by NLC and by other agencies, viz. GMDC and RSMML establishing 1.85 Bt of lignite resources. Achievement in promotional exploration is likely to be 2.74 lakh metres (78 per cent) against a target of 3.50 lakh metres establishing 3.22 Bt of lignite resources.

**14.108.** 2D HRSS surveys were not a part of the exploration programme of Eleventh Plan. However, in view of trends worldwide, these surveys were considered as a part of regional (promotional) exploration by Subcommittee on Energy Minerals. The National Geophysical Research Institute (NGRI), a premier organisation for geophysical studies in the country, was therefore, inducted to carry out these surveys in coal and lignite bearing areas. It is expected that a total of 31 Line kilometre (L.km) in coal areas and 94 L.km in lignite areas HRSS survey will have been carried out during the Eleventh Plan.

### Detailed Drilling in Non-CIL Blocks

**14.109.** Detailed exploration surveys focus on establishing adequate geological resources data for projectisation and mine development. The blocks outside the purview of CIL have been proposed to be explored in detail for reducing the time lag between offering the blocks to potential entrepreneurs and starting of the operation by them through budgetary support. The cost of exploration, in turn, will be recovered from entrepreneurs who have been allotted the blocks. CMPDI and its contractual agencies including MECL have been able to progress well in detailed exploration activities and are expected to achieve 8.09 lakh metres against a target of 13.50 lakh metres in non-CIL blocks establishing 5.2 Bt of private coal reserves.

**14.110.** Regarding detailed exploration in CIL blocks as against a target of 5 lakh metres, the actual achievement has been 11.2 lakh metres (224 per cent)



of exploratory drilling achieved by CMPDIL and by contractual agencies including MCCL and 9.01 billion tonnes of coal reserves were proved during the Eleventh Plan. SCCL has achieved 2.99 lakh metres of actual drilling against a target of 3.39 lakh metres and estimated 0.91 billion tonnes of coal reserve through detailed exploration.

### Productivity and Benchmarking

14.111. Traditionally, the output per man shift (OMS) has been measured as tonnes in coal mines and it has improved significantly for all the three PSUs operating in coal and lignite mining. While overall OMS in case of CIL improved from 3.54 in year 2006–07 to 4.92 in year 2011–12 this was still lower than the target of 5.54 in the terminal year of the Eleventh Plan. In case of SCCL this has improved from a level of 2.39 to 3.80 over the same period, which is significantly higher than the target of 2.67. This significant improvement in overall OMS level is for both opencast and underground mining operations. This could be due to the outsourcing of some of the activities, particularly in the opencast mining operations. In case of NLC, the improvement is marginal because lignite production level could not increase due to delays in the completion of lignite-based power plants. One of the important areas to improve productivity is benchmarking of operations and equipment productivity. Productivity of equipment and machinery used in opencast and underground mining has significantly improved during the Eleventh Plan period.

### Clean Coal Technologies

14.112. Coal beneficiation is one of the prime clean coal technologies aimed at supplying washed coal to the pulverised coal combustion boilers of power plants. The MoEF's directive aimed at restricting the use of coal of not more than 34 per cent ash content at thermal power stations located far away from pit heads and load centres and critically polluted areas, has also contributed to improvement in economics of operations of such power stations. The CIL envisaged building 20 new washeries with a capacity of 111 mt in the Eleventh Plan. However, coal washing capacity did not grow as planned due to delays in

awarding of contracts to set up washeries by the CIL. The coal washing capacity at the end of the Eleventh Plan is as indicated in Table 14.25.

**TABLE 14.25**  
**Coal Washing Capacity by the end of**  
**Eleventh Plan Period**

	(in million tonnes)	
	Coking Coal	Non-coking coal
Public	24.22	17.22
Private	5.66	78.74
<b>Total</b>	<b>29.88</b>	<b>95.96</b>
Washed Coal Production	7.18	40.95

### Coal Bed Methane

14.113. The potential of Coal Bed Methane/Coal Mine Methane was recognised in a new policy of Government of India in 1997. The Ministry of Coal (MoC) and the Ministry of Petroleum and Natural Gas (MoP&NG) are working together for the development of Coal Bed Methane and the Government has offered 33 blocks in four rounds of bidding for CBM covering 17,416 sq. km of area. One block in Raniganj coalfield has commenced commercial production in 2007 and two blocks are in advanced stage of commencing production. The Director General of Hydrocarbons (DGH) is the regulator for CBM activities in the country. The CBM/CMM clearance house has been established in CMPDIL, Ranchi, in collaboration with United States Environment Protection Agency (USEPA) which will provide information for development of CBM/CMM in India. The current level of production, being only 0.2 mmscmd, is confined mostly to the private sector. There is no separate pricing regime for CBM and the gas prices are determined by the developer, subject to Government approval.

### Research and Development

14.114. A total of 29 R&D projects were implemented during the Eleventh Plan. Out of these, 16 projects have already been completed by September 2012. Remaining 13 projects are likely to slip into the Twelfth Plan period. Some of the major projects under implementation are:

- Development of CMPDI capacity for delineation of viable coal mine methane (CMM)/abandoned mine methane (AMM) blocks in the existing and potential mining areas having partly de-stressed coal in virgin coal seams.
- Recovery and utilisation of coal methane in Jharia and Raniganj coalfields.
- Development of immediate roof fall prediction system in underground mines using wireless network.
- Demonstration of cost-effective technology for dry beneficiation of coal by all airjig.
- Demonstration of coal dry beneficiation system using radiometric technique.
- Assessment of prospect of shale gas in Gondwana basin with special reference to CIL areas.
- Development of indigenous catalyst through pilot-scale studies of coal to liquid (CTL) conversion technology.
- High resolution seismic monitoring for early detection and slope failures in opencast mines.
- Application of Ground Penetrating Radar (GPR).
- Integrated communication system to locate trapped miners in underground mines.
- Development of self-advancing (mobile) goaf edge supports (SAGES) for de-pillaring operations in underground coal mines.

### Conservation and Safety in Coal Mines

14.115. Safety of miners and safe mining operations are of paramount importance in coal mining. These two schemes are under the statutory provisions of Coal Conservation and Development Act (CCDA) and were being implemented as a part of non-Plan scheme during the Tenth Five Year Plan through reimbursement of cess collected under CCDA. The Ministry of Finance has taken a view that cess collected under CCDA is a revenue of the Government of India, which is reimbursed back to coal companies for implementation of these schemes. Therefore, these schemes are treated as Plan schemes during the Eleventh Plan.

### Development of Transport Infrastructure in Coal Field Areas

14.116. Development of infrastructure in coalfields is essential to ensure the timely evacuation of coal produced in mines to the rail heads or railway yards.

Also substantial time is taken by Railways to build the critical rail links and that is affecting the movement of coal to the end users. Four critical rail links that have been pending for years are the Tori–Shivpur–Katholia rail link in North Karanpura coalfield (CCL command area), the Bupdevpur Baroud rail link connecting coal blocks in Mand Raigarh coalfield, the Jharsuguda–Barpalli railway line in IB valley coalfield and the Sattapalli–Bhadrachalam rail link (SCCL command area). Commissioning of these lines would facilitate movement of around 125–130 million tonnes of coal to end users. Construction of Tori–Shivpuri line was delayed due to delays in getting forest clearance. Railways have changed the alignment of the line to bring down the forest land involved and MoE&F has cleared the project recently with certain conditions. Railway Board is yet to approve the implementation of the Bupdevpur Baroud rail link. CIL, State Government and Railways are in discussion to implement other critical links in Mand–Raigarh area in joint venture to facilitate coal movement from the upcoming mines. The SCCL and Railways were not able to sort out the differences in the implementation of Sattapalli–Bhadrachalam link project but this issue has been resolved recently and SCCL has agreed to provide funds to the Railways to implement the project on turnkey basis.

### Environmental Measures And Subsidence Control

14.117. The purpose of this scheme is to improve environmental conditions in old mined-out areas, particularly Jharia and Raniganj coalfields through implementation of a number of schemes for mitigating the damage caused by unscientific mining, carried out before nationalisation of coal mines. Under the scheme, a Master Plan proposal for Jharia–Raniganj coalfields with a total outlay of ₹9,773.84 crore was taken up to deal with fire, rehabilitation of uncontrollable subsidence-prone inhabited areas and diversification of roads/railway lines within command area of BCCL and ECL. Recently, the Cabinet has approved the scheme. For implementation of the Master Plan, Jharia Rehabilitation and Development Authority (JRDA) for BCCL areas and Asansol Durgapur Development Authority (ADDA) areas have been notified as implementing agencies by

the respective State Governments of Jharkhand and West Bengal. A High Powered Central Committee under the Chairmanship of Secretary (Coal) with representatives from other Ministries/Departments, State Governments of Jharkhand and West Bengal and concerned coal companies, has been monitoring the implementation of the Master Plan. Demographic surveys and land acquisition by JRDA and ADDA are in progress.

### Integrated Coal and Lignite Resource Information System (ICRIS and ILRIS)

14.118. ICRIS and ILRIS are coal and lignite resources structured on the UNFC pattern approved in October 2004 and are under progress at different data centres in CMPDI/Singareni and NLC. These projects need to be continued during the Twelfth Plan with enhanced outlays for successful completion, maintenance and regular updating.

### Application of Information Technology

14.119. Information Technology (IT) has been used by the coal industry in India for improving productivity and decision making. Some of the applications already in use are:

- Enterprise resource planning (ERP).
- Real-time trip counting system at opencast mines with latest technologies like GPS, GIS, GSM, RFID, Wi-Fi and so on.
- Proximity warning system for HEMM at opencast mines.
- Truck movement monitoring system at weighbridges and coal handling plants mines with latest technologies like GPS, GIS, GSM, RFID, Wi-Fi, and so on.
- Online underground air and gas monitoring systems (CH<sub>4</sub>, CO, Temperature).
- UG communication system and miners' tracking with warning system for the miners entering the unsafe areas.

14.120. An SAP-ERP system in coal mines in the country has been introduced by SCCL with effect from July 2008 covering business processes related to Purchase and Stores, Marketing and Dispatches, Quality Management, Human Capital Management,

Finance and Accounts, and Costing. The CIL is also in the process of adopting such a system in the near future.

### Financial Performance of Coal Sector

14.121. The approved Eleventh Plan outlay of ₹37,100 crore for MoC was planned to be financed through an IEBR of ₹35,774.37 crore, and a GBS of ₹1,326.00 crore. The budgetary support sought for the Ministry's plan schemes covered regional/promotion exploration, detailed drilling in non-CIL blocks, Environmental Measures and Subsidence Control Scheme (EMSC), R&D schemes, conservation and safety measures and development of transport infrastructure in the coal fields. These schemes were proposed to be funded by subsidence excise duty collected under CCDA, IEBR of CIL and budgetary support. Actual expenditure during the Eleventh Plan is ₹26,337.62 crore which is only 63 per cent of the approved outlay. This comprises ₹26,374.20 crore of IEBR of three PSUs namely CIL, SCCL and NLC and balance ₹1,500 crore GBS for Ministry of Coal funded schemes. The major shortfalls are in the reported expenditure of CIL and NLC whereas SCCL is expected to spend ₹3,707.59 crore against the approved IEBR of ₹3,340 crore. The financial performance of the coal sector is summarised in Table 14.26.

## THE TWELFTH PLAN

### Coal Demand

14.122. Total demand for coal grew by around 6.6 per cent during the Eleventh Plan against domestic production growth of only 4.61 per cent, and the gap was filled from higher imports. The projected GDP growth targeted during the Twelfth Plan will lead to a high demand for coal in the next five years on a business-as-usual basis. However, increased efficiency measures, including introduction of super-critical technology in power plants will reduce the demand for coal. The trend growth for coal demand during the Twelfth Plan is therefore likely to be similar to that in the Eleventh Plan.

14.123. Ministry of Coal has projected two scenarios of coal demand during the Twelfth Plan. Scenario I

**TABLE 14.26**  
**Financial Performance of the Coal Sector**

Sl. No.	Sector	The Eleventh Plan Outlay		
		Approved	MTA	Anticipated
1	CIL	17,390.07	16,090.68	13,460.78
2	SCCL	3,340.00	3,802.07	3,707.59
3	NLC–Power	12,051.41	6,140.61	6,246.36
4	NLC–Mines	2,826.00	2,334.39	1,483.67
5	Total NLC	14,877.41	8,475.00	7,730.30
	<b>Total IEBR</b>	<b>35,607.48</b>	<b>28,367.75</b>	<b>24,898.40</b>
6	Central Sector Schemes	1,326.01	4,225.80	1,416.19
	<b>Total MOC</b>	<b>36,933.49</b>	<b>32,623.55</b>	<b>26,314.59</b>

projects a demand of 1,204 mt in the terminal year of the Twelfth Plan and Scenario II projects 980.5 mt. Scenario I implies 13.5 per cent CAGR and Scenario II implies a growth rate of 8.9 per cent. Scenario II is considered realistic, based on specific consumption in each consuming sector observed in the past few years. From this scenario, total coal demand will reach 980.50 million tonnes, an increase of 186 million tonnes over the Twelfth Plan period as shown in Table 14.27.

**TABLE 14.27**  
**Coal Demand during the Twelfth Plan**

Sector	(in million tonnes)	
	Eleventh Plan (2011–12) Annual Plan Demand Projection	Twelfth Plan (2016–17) Demand Projection Scenario II
	Coking Coal	46.67
Power Utility	412.00	682.08
Power Captive	40.00	56.36
Cement	28.89	47.31
Sponge Iron	30.47	50.33
Others*	81.97	77.22
<b>Total non-coking</b>	<b>593.33</b>	<b>913.30</b>
<b>Grand Total</b>	<b>640.00</b> (6.6 %)	<b>980.50</b> (8.9 %)*

\* Annual average growth rate during the Twelfth Plan period.  
Source: Working Group on Coal and Lignite.

14.124. The total demand by the power sector including that from captive power plants is expected to be 75 per cent of the total coal demand during the terminal year of the Twelfth Plan. The share of the steel sector is expected to be 6.85 per cent of the projected demand and the shares of cement and sponge iron sectors are expected to be 4.8 per cent and 5.1 per cent respectively and balance 7.9 per cent is estimated to be consumed by the brick and others sectors. Cumulative annual growth rate of coal demand during the Twelfth Plan is projected to be around 8.9 per cent. Coal demand for Eleventh Plan and Twelfth Plan is given in Annexure 14.2.

14.125. The total addition to electric generation capacity in the Twelfth Plan is targeted at 88,536.6 MW, which includes 69,280 MW of coal-based capacity. The estimates for coal requirements of the power sector have been computed considering the fact that 40,000 MW of capacity based on Supercritical technology will be added in the Twelfth Plan and efficiency measures are also being taken. Further, power generation capacities were running at very high PLF so far, in view of high demand–supply gap. With the planned increase of new capacities and the pace of setting up new power capacities getting accelerated, the PLF of the power plants is likely to go down. Taking all these factors together, it is estimated that the total demand for coal from the power sector may be 738.44 mt in the terminal year of the Twelfth Plan 2016–17. Taking into account

the requirements of steel, cement and other sectors of the economy, the total coal demand is estimated at 980.50 mt. The quality of coal available from the MCL and IB valley mines has been poor and a large portion of coal during the Twelfth Plan will be provided by these mines. If the overall quality of coal available from domestic mines deteriorates, the total coal demand may go up.

### Coal Production

14.126. The initial years of the Twelfth Plan are likely to see continuing constraints on coal availability reflecting the difficulties experienced in increasing production in the last two years of the Eleventh Plan. Delays in obtaining E&F clearances, land acquisition and R&R issues continue to plague coal production and remedial action is urgently needed. There is an urgent need to take effective measures to step up coal production. The Working Group on Coal in the most optimistic scenario (Scenario II) has suggested domestic production for the Twelfth Plan period from various sources as shown in Table 14.28.

**TABLE 14.28**  
**Coal Production**

Sector	Eleventh Plan (2011–12)	(in million tonnes)
		Twelfth Plan (2016–17) Projection Scenario II
CIL	435.84	615.00
SCCL	52.21	57.00
Captive Blocks	36.04	100.00
Others	15.91	23.00
<b>Grand Total</b>	<b>540.00</b>	<b>795.00</b>

Source: Ministry of Coal.

14.127. The incremental production envisaged in the optimistic Scenario of the Twelfth Plan works out to 255 million tonnes over the production level of 540 million tonnes during the Eleventh Plan. Major contribution has to come from the CIL, which is expected to add incremental production of 185.5 million tonnes yielding a cumulative annual growth rate in coal production of 8 per cent. This is much higher than the actual growth rate of 4.6 per cent achieved in the Eleventh Plan. Details of coal production in

the Eleventh Plan and envisaged production during the Twelfth Plan period are given in Annexure 14.3.

14.128. A number of initiatives are being taken to promote faster extraction of coal. The policy on competitive bidding for allocations of captive blocks has been finalised by the Ministry of Coal and is expected to be made operational during 2012–13. This should result in allocation of new coal blocks.

### Import Requirements

14.129. The level of imports at the end of the Twelfth Plan is projected to increase from 137 million tonnes of Indian quality coal at the end of the Eleventh Plan to 185 million tonnes at the end of the Twelfth Plan based on total coal demand of 980 million tonnes and domestic supply of 795 MT. If domestic supply does not match the target growth rate of 8 per cent per year, the import demand will be higher. The projected level of imports of around 185 million tonnes is large keeping in mind that international trading in coal is only around 900–1,000 million tonnes (15–16 per cent) of the total consumption of over 6,000 million tonnes world over, and there are competing requirements from other countries like China who have large coal-based capacities. The international availability of coal is going to be restricted due to concerns on climate change. International prices of coal are also likely to remain high because of taxes which are being imposed by several coal-producing countries including Australia and Indonesia.

### Underground Mining

14.130. Only 15 per cent of India's coal production is from underground mines. The industry aims to reach a total coal production of 30 per cent from underground mines by 2030. There is a clear trend towards underground mines as this has positive implications for the environment. However, the extraction of coal from the underground mines is lower than that from the opencast mines. In forest areas, underground mining is clearly feasible and will sharply reduce the impact of ecological degradation. It is, however, feasible only if the pool reserves and the seam thickness permits its exploitation accordingly. The share of coal production for underground mines in major coal producing countries is given in Table 14.29.



**TABLE 14.29**  
**Share of Underground Production in Total Production**

Sl. No.	Country	Percentage (%)
1	China	90
2	USA	33
3	Australia	20
4	India	10

14.131. Considering the emerging hurdles in forest clearance and land acquisition in future, serious efforts need to be made to increase the share of underground production considerably by the end of the Twelfth Plan by focusing on long wall technology and productivity in underground mines. Indian coal companies must accept the challenge of transplanting the international best practices with more effective management. CIL can have joint ventures or formulate PPP projects with appropriate terms with renowned international players to shore up the underground production level in the Twelfth and the Thirteenth Plans.

### Lignite Demand and Production

14.132. The Twelfth Plan envisages lignite demand of 68.60 million tonnes in the terminal year 2016–17 of the Plan which includes production from Tamil Nadu, Gujarat and Rajasthan—27.20, 21.60 and 19.80 million tonnes respectively. The additional lignite-based power generation capacity during the Twelfth Plan is envisaged as 2,280 MW. It is stated that projected lignite production of 68.60 million tonnes would almost be adequate to meet the growing demand for various sectors consuming lignite. The projected shortfall would be around 10 million tonnes which needs to be met by either taking up new mines or improving the production levels from the existing mines.

### Coal Pricing

14.133. Globally, pricing of coal is based on gross calorific value (GCV) of coal. The Integrated Energy Policy which was based on the Integrated Energy Policy Report of the Planning Commission, and was approved by the Cabinet in December 2010, had proposed adoption of this pricing system. This was finally implemented in January 2012 with the

Ministry of Coal issuing a notification for pricing of coal on GCV basis with effect from 31 January 2012, replacing the earlier system of pricing on the basis of useful heat value (UHV) which takes into account the heat trapped in ash content also, besides the heat value of carbon content. The revised GCV system has 17 bands of calorific values with a bandwidth of 3,000 kilo calorie each instead of the existing seven grades of A, B, C, D, E, F and G. The revision to GCV is likely to increase the prices of domestic coal to some extent. This is desirable adjustment because domestic thermal coal continues to be underpriced compared to internationally traded coal prices. International coal prices of thermal coal are currently about three to four times higher than domestic coal but this reflects the fact that imported coal is of higher calorific value and better quality. After adjusting for these differences, international coal prices are a little over twice the domestic prices as shown in Table 14.30. It must also be noted that the volume of coal traded is small compared to international production which makes international prices a less reliable guide. Table 14.30 compares domestic coal prices of thermal coal in India with the domestic sale price of thermal coal in other countries. The comparison shows that Indian coal is underpriced even on this basis. It is necessary to plan for a steady upward price adjustment over the Twelfth Plan period.

**TABLE 14.30**  
**Price Comparison of Domestic Coal with other Countries**

Country	Calorific Value K (Cal/Kg)	Price (US \$ per tonne)	Price (in ₹/Mk Cal)
China	5,000–6,000	70	636
USA	5,000–6,000	40	363
India	3,500–4,000	26	342

14.134. The price differential between domestic and imported coal creates distortions in the power sector. Since Coal India is not in a position to provide domestic coal to meet the demand of all power generating units expected to come on stream in the Twelfth Plan, increased reliance on coal imports is



necessary. However, power generators supplying power with PPAs at a regulated tariff will not be able to pass on the higher cost of imported coal. There is a need to consider a mechanism of price pooling under which Coal India undertakes to meet the full FSA requirement using a combination of domestic and imported supplies, pooling the price of its imports with its domestically produced coal to give coal to power generators at a uniform price.

### Coal Movement Constraints

**14.135.** Currently the share of rail in movement of coal in the country is around 52 per cent. The share of other modes of transportation is 15 per cent by merry-go-round (MGR), 7 per cent by belt/rope and 27 per cent by road. Against this, the coal movement matrix in the terminal year of the Twelfth plan (2016–17) is envisaged to show a 58 per cent share of rail, 25 per cent share of road, 11 per cent of MGR and 6 per cent of belt/rope. This includes planning for movement of 800 million tonnes of indigenous coal and coal products and 166 million tonnes of imported coal which is equivalent to about 250 million tonnes of domestic coal. To realise this objective, average wagon requirement is envisaged at 446.4 rakes per day out of which 165.6 rakes per day will be required for imported coal. The annualised growth in rail loading is expected to be 7.1 per cent.

**14.136.** Some of the important identified railway infrastructure projects are at North Karanpura, Mand–Raigarh and at Ib Valley coalfields. These projects were initially proposed during the Eleventh Plan but could not be implemented due to delays in land acquisition and clearance from Environment Ministry. The current status of these projects is given in paragraph 14.116. In addition to these, a few more feeder lines have been suggested for improving rail movement during the Twelfth Plan in potential coalfields. Completion of these projects should have top priority in Railway Planning.

### Coal Quality and Beneficiation

**14.137.** Coal washing is one of the practices being promoted as a measure to encourage implementation

of clean coal technologies. While coking coal washing has been in practice for quite some time in the country, washing of non-coking coal, particularly for power generation, has come into focus only recently. Use of washed non-coking coal has increased many-fold over the last 10 years. Currently coking coal washing capacity is around 29.88 million tonnes comprising of washery capacity of 22.18 million tonnes of CIL, 2.04 million tonnes of SAIL and 5.66 million tonnes of TISCO. However, the actual total washed coal production from all these washeries is much below the capacity at 7.03 million tonnes, with an approximate raw coal feed of 15.5 million tonnes. It has been observed that performance of CIL managed washeries is not satisfactory and the output of washed coal from CIL washeries is only 3.89 million tonnes.

**14.138.** Non-coking coal washing capacity in the country is around 96 million tonnes, comprising of 17 million tonnes of CIL and 79 million tonnes of others. In this case also, the output of washed coal is below capacity at around 36 million tonnes, with a raw coal feed of around 52 million tonnes. Thus, utilisation of existing washery capacity is suboptimal and suitable measures need to be taken to optimally use existing capacity. The CIL proposes to set up 20 more washeries with an aggregate capacity of around 111 million tonnes in the Twelfth Plan.

**14.139.** Considering the need to increase the level of washed coal, it is proposed to enhance washeries capacity in Twelfth Plan period. Coking coal washing capacity is likely to increase from the existing level of around 30 million tonnes in 2011–12 to 49 million tonnes by the end of 2016–17. Similarly the non-coking coal washing capacity is planned to increase from about 96 million tonnes by the end of the Eleventh Plan to around 175 million tonnes by the end of the Twelfth Plan.

**14.140.** There has been some progress in dealing with the problems of oversized coal. Coal companies are establishing Coal Handling Plants (CHPs) and feeder breakers. Coal India Ltd. is now supplying almost 99 per cent of crushed coal to the power sector. Further, deployment of surface miners in different projects

is also helping in producing sized coal for supply to the consumers. A total of 212 CHPs (74 major CHPs and 138 mini CHPs/Feeder Breakers) with a total capacity of about 277 million tonnes per annum are operating in different subsidiary companies of the CIL. Further, 50 surface miners deployed at CCL, SECL and MCL produced about 103 million tonnes of sized coal in the year 2010–11, which has helped augment supply of sized coal.

### Exploration for Coal and Lignite

**14.141.** Coal and lignite exploration efforts should not only aim at expanding the resource base through regional exploration but also at upgrading the known resources remaining under 'Indicated' and 'Inferred' categories through detailed exploration to facilitate their projectisation for mining. Significant accretion of resource in coming years is envisaged in the intermediate and deeper levels (beyond 300m of depth). As such there is also an emerging need to fully bring out the potential of coal resources which are at greater depths, for other forms of exploitation like CBM, underground gasification (UCG) and so on to augment the coal resources.

**14.142.** With ever increasing demand of steel in the country the requirement of coking coal is projected to increase from 69.47 million tonnes to 85.06 million tonnes at the end of the Twelfth and the Thirteenth Plans. There is a need to focus exploration efforts on the prime coking coal resources available beyond 300 m of depth to bring them to 'Proved' category.

**14.143.** Against a target of 1.94 lakh metres for regional exploration during the Eleventh Plan, 1.14 lakh metres (78 per cent) of drilling will be achieved and 7.07 billion tonnes of coal resources are likely to be established. In promotional exploration, against a target of 4 lakh metres of exploratory drilling, 2.72 lakh metres (68 per cent) are expected to be achieved, establishing 20.05 Bt of coal resources. The Twelfth Plan envisages taking up 1.05 lakh metre regional explorations drilling to establish resource base of around 6.8 billion tonnes. The corresponding programme under promotional exploration envisages promotional drilling of 4.80 lakh metre covering an area of 1,204 Sq. Km. to establish resources

of 16.64 billion tonnes. Similarly a drilling target of 54.46 lakh metres is envisaged for detailed drilling in the Twelfth Plan which includes 19.03 lakh metres in non-CIL blocks. The envisaged coal resource establishment under detailed drilling is 76.80 billion tonnes including 16.22 billion tonnes under detailed drilling in non-CIL blocks.

### Royalty on Coal and Lignite

**14.144.** According to a decision taken by the Government, royalty rates have to be revised periodically once in every three years. Based on the above decision, Ministry of Coal had set up a Committee to suggest revision in royalty rates in 2009. The Committee suggested ad-valorem royalty on coal and lignite instead of the earlier system of combination of specific and ad-valorem duty on various grades of coal. The Government has accepted the suggestion and approved the suggested royalty regime based on ad-valorem basis with effective royalty rates of 14 per cent on raw coal prices and 6 per cent on lignite with effect from April 2012.

### Amendment to the Coal Mines Act

**14.145.** The Coal Mines (Nationalisation) 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. This is a limited opening which is helpful but unlikely to attract big investment. Unless large investment and technology in the sector comes in, mining coal by a host of small players would not increase production to desired levels.

**14.146.** Development of large coal blocks holds the key to rapidly increase production. There are political sensitivities in opening up the coal sector to private investment, but it is simply not logical to keep private investment out of coal, when it is allowed in petroleum and natural gas. Besides, the energy security of the country needs full involvement of all concerned in producing coal. Hence, amendment to the Coal Mines (Nationalisation) Act is needed. A Bill to amend the Act for this purpose was introduced in Parliament in 2001 but has not been pursued. Allowing private sector mining does not involve privatisation of Coal India but only entry of new mining

companies. This issue needs to be considered in the interest of energy security.

### **New Initiatives to Expand Coal Availability**

14.147. Given the importance of coal to India's energy security, it is necessary to give priority to a number of policy initiatives in the Twelfth Plan which can address obvious weaknesses:

1. Coal exploration must be stepped up to ensure availability of more coal mining blocks for both private and public sectors. Either CMPDIL ought to be made an independent organisation, or a new independent organisation should be created to develop and maintain the repository of all geological information in the country on the lines of CEA for power sector, or the DGH for petroleum and natural gas sector.
2. To expedite clearances, a coordination committee at the Centre and State level may be set up (single window concept), involving senior representation from the concerned departments for quick environment clearances. Even if statutory clearances can only be given by the relevant agency, the establishment of a coordinative mechanism will expedite the decision-making.
3. Enactment of a central legislation to ensure uniform R&R policy and speedy land acquisition on appropriate terms is absolutely necessary.
4. There is a need to incentivise coal availability from captive coal mining blocks. The decision to allocate all future coal blocks on the basis of transparent bidding should be implemented in the first year of the Twelfth Plan. Further, we must create an institutional mechanism for planning and development of common infra-structural facilities with participation of coal mining companies and the respective State Governments.
5. In several cases, development of captive coal may be in a position to produce coal in excess of their requirement. At present the terms of allocation of coal blocks do not permit sale to a third party except with permission. If they could be encouraged to produce more than their consumptive use it would avoid the need to import much more expensive imported coal. This will

be done by making surplus coal available to CIL subsidiaries at a price which provides adequate incentive for the captive block owners. The principle on which such coal should be priced can be approved by the Cabinet.

6. Coal companies should develop a comprehensive plan for increasing the share of production from underground mines and suitable policy initiatives such as cost plus pricing, fiscal incentives and so on need to be introduced to improve the potential returns currently available from underground mining activities. It is suggested that the share of underground mining be increased from the existing 10 per cent to a considerable level by the end of the Twelfth Plan in the next five years.
7. In view of the availability of increased coal imports for the Twelfth Plan period the Ministry must ensure that mechanisms are in place which will be up and appropriate mix of long-term and spot contracts.
8. A coal sector regulator should be set up on a priority basis.
9. Finally it is not clear whether the present structure on which the operating coal companies are subsidiaries of CIL as the holding company is desirable. The industry would be better served if the subsidiaries were spun off as separate public sector companies encouraged to develop their own strategies of coal development including joint venture activity and acquisition of assets abroad. A High Level Committee should be appointed to examine this option and submit a report within six months.

### **Benchmarking of Productivity**

14.148. The Twelfth Plan envisages an improvement in productivity per person from 4.92 tonnes per person in CIL to 7 tonnes per person and from 3.8 tonnes per person in SCCL to 4.93 tonnes per person. This will still leave India well below other producers, as countries like USA, Australia and China have productivity levels of about 14 tonnes per person for combined underground and opencast mines. The targets set to realise the productivity level mentioned above envisage productivity levels of 14.0 tonnes per person for CIL and 14.83 tonnes per person in SCCL in the terminal year of the Plan for opencast

operations, and only 1.10 and 1.83 tonnes per person for CIL and SCCL, respectively for underground operations. Thrust would be given on improvement of operational efficiency of the coal mining companies by establishing benchmarks for different mining operations and work force productivity comparable with international standard. The productivity norms of different heavy earth moving machinery (HEMM) benchmarked earlier for both availability and utilisation in different coal companies would be examined so that these become comparable with international standards.

### 3.4. PETROLEUM AND NATURAL GAS SECTOR

14.149. Managing the petroleum and natural gas sector will present critical challenges in the Twelfth Plan. The demand for petroleum products is expected to expand while the scope for increasing domestic production is limited. Oil prices in world markets are expected to be volatile but generally high. The oil and gas import bill is likely to be around 6–7 per cent of GDP during the year 2011–12. Unfortunately, domestic prices of certain petroleum products have not been adjusted in line with world prices, with the result that there is large ‘under-recovery’ by the oil sector. Important steps were taken in 2012 to adjust diesel prices and to put a limit on highly subsidised LPG, but even after these adjustments, under-recoveries remain large and the subsidy provided in the budget covers only a fraction of this. Continuing this scale of under-recovery is simply not viable. Prices of sensitive petroleum products like diesel, kerosene and LPG will therefore have to be adjusted periodically to reduce the under-recoveries which are currently borne by the Government and upstream oil companies. This is not consistent with developing a healthy petroleum sector capable of investing in exploration and production.

## REVIEW OF THE ELEVENTH PLAN

### Demand for Petroleum Products

14.150. Demand for petroleum products grew at an annual rate of 4.15 per cent during the Eleventh Plan period which is close to the upper-case scenario that was envisaged at the start of the Eleventh Plan as shown in Table 14.31. The elasticity of POL demand with GDP growth during the Eleventh Plan has been 0.53 which is slightly higher than 0.49 for the Tenth Plan. The use of FO/LSHS and LDO in power, fertiliser and general trade has declined. Also, increased availability of natural gas has replaced naphtha that was extensively used in the fertiliser industry. LPG consumption in India has increased from 10.85 million tonnes in the year 2006–07 to 15.36 million tonnes in the year 2011–12, growing at a rate of 7.21 per cent per annum CAGR.

### Exploration, Production and Refining Sector

14.151. Both oil and gas production targets have slipped by large percentages during the Eleventh Plan period. Against the crude oil production target of 206.73 MMT in the Eleventh Plan, the actual achievement is only 177 MMT, that is, 14 per cent below the target. The actual natural gas production was 212.54 BCM as against the production target of 255.76 BCM, with a shortfall of about 17 per cent of the Eleventh Plan targets. The balance recoverable reserve position as on 1 April 2011 of O + OEG was about 2015 million tonnes, which has increased by 10.5 per cent from 1,847 million tonnes as on 1 April 2007.

14.152. In contrast to the large slippage in oil exploration and production, addition to refining capacity is likely to be 88.42 per cent of the target. Some of the refinery projects like MRPL expansion and Paradip refinery projects have also slipped into the Twelfth

**TABLE 14.31**  
**Consumption of Petroleum Products**

Consumption		2007–08	2008–09	2009–10	2010–11	2011–12	CAGR (%)
Actual		128.95	133.6	137.81	141.75	147.98	4.15
Working Group Eleventh Plan	Base	116.35	119.1	121.99	126.97	131.77	2.93
	Upper	117.56	121.95	127.79	136.59	141.79	4.45

**TABLE 14.32**  
**Physical Performance of Petroleum and Natural Gas Sector**

Sl. No.	Item	Eleventh Plan Target	Actual 2007-08	Actual 2008-09	Actual 2009-10	Actual 2010-11	Actual 2011-12	Total in the Eleventh Plan
1	Crude Oil Production (MMT)	206.73	34.12	33.51	33.69	37.68	38.09	177.09
2	ONGC	140.06	25.94	25.37	24.86	24.42	23.72	124.30
3	OIL	18.99	3.10	3.47	3.57	3.58	3.85	17.57
4	PVT. JVC	47.71	5.08	4.67	5.26	9.68	10.53	35.22
5	Gas Production (BCM)	255.76	32.42	32.85	47.50	52.22	47.56	212.54
6	ONGC	112.39	22.33	22.49	23.10	23.10	23.32	114.33
7	OIL	16.42	2.34	2.27	2.42	2.35	2.63	12.01
8	PVT. JVC	126.95	7.74	8.09	21.99	26.77	21.61	86.20
9	Refining Capacity (MMTPA)	240.96	148.97	177.97	185.39	193.39	213.07	213.07*
10	Hydrocarbon Reserve Accretion (O + OEG)	1,847	-	-	-	-	-	2,014.81#

\* Refining Capacity estimate as on 1 April 2012. # HCRA as on 1 April 2011.

Plan due to delays in providing captive power equipment by BHEL to these refineries. Table 14.32 gives the target and achievements of various physical parameters during the Eleventh Plan period.

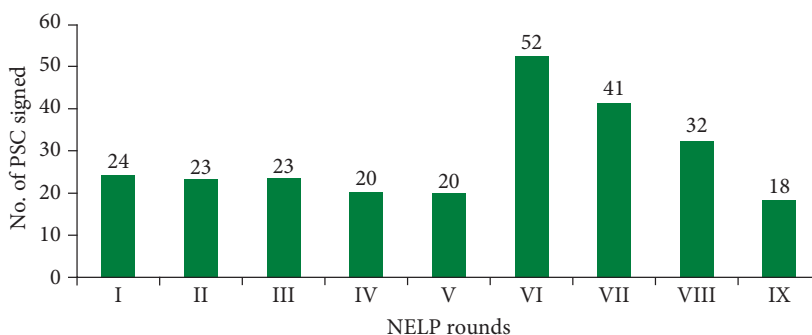
### New Exploration Licensing Policy (NELP) Programme

14.153. The NELP programme is a major initiative aimed at attracting private investment into oil and natural gas. There have been nine rounds of bidding, starting with a first in 1998, and a total investment of US\$ 15.88 billion has been made by various operators in E&P sector till 2010-11. Out of 235 Production Sharing Contracts (PSCs), 73 were signed during the Eleventh Plan period. To step up the pace of

exploration, in the ninth round of NELP (NELP-IX), 34 exploration blocks were offered in October 2010, of which 18 PSCs have already been signed with the awardees. Details of blocks awarded under the nine NELP rounds are shown in Figure 14.1.

### Equity Oil, Gas from Overseas Assets

14.154. Oil PSUs (OVL OIL, GAIL, IOCL, BPCL and HPCL) have invested ₹59,108 crore (US\$ 13 billion) up to 31 March 2011 on acquisition of assets abroad, mainly in oil producing assets. There are nine major production assets in Russia, Sudan, Brazil, Syria, Vietnam, Venezuela and Colombia. Production from overseas oil and gas blocks is presently about 10.22 per cent of India's domestic production. The



**FIGURE 14.1: Exploration Blocks awarded in NELP Rounds**



**TABLE 14.33**  
**Share of Overseas Hydrocarbon Production**

Year	2007–08	2008–09	2009–10	2010–11	2011–12 #
Total Domestic oil and gas (MMTOE)	66.53	66.35	81.19	89.93	85.64
Overseas production of OVL (MMTOE)	8.8	8.78	8.87	9.43	8.75
Overseas production as a percentage of Domestic (%)	13.23	13.23	10.93	10.49	10.22

*Source:* Ministry of Petroleum and Natural Gas/ONGC Videsh Ltd. (#) Prov.

share of overseas vis-à-vis indigenous production of oil and gas is given in Table 14.33.

### Policy Initiatives during the Eleventh Plan

14.155. Various policy initiatives were taken to address the issues relating to attaining hydrocarbon energy security. Major policy initiatives taken by the Government during the Eleventh Plan are as follows.

#### Regulatory Measures

14.156. The Government has set up Petroleum and Natural Gas Regulatory Board with effect from 1 October 2007 to regulate downstream activities of oil and gas sector under the PNGRB Act, 2006. However, the mandate of PNGRB is fairly narrow and deals largely with pipelines. PNGRB is currently empowered to give authorisation to entities for laying, building, operating and expanding any pipeline as common or contract carrier and expanding city gas distribution projects.

#### Allocation of Natural Gas

14.157. Natural gas produced from NELP blocks is subject to Government-prescribed allocation to different uses and also Government approval of the pricing formula. The Government has prioritised allocation of gas produced from NELP blocks in the following order:

- Fertiliser plants producing subsidised fertilisers
- LPG plants
- Power plants
- City Gas Distribution (CGD) for CNG and domestic PNG
- Steel, petrochemicals, refinery, captive power plants and CGD for industrial and commercial customers

14.158. An Empowered Group of Ministers has allocated 93.336 MMSCMD of gas on a combination of firm and fallback basis from the blocks producing gas under NELP.

#### Strategic Storage of Crude Oil

14.159. The Government is in the process of creating strategic crude oil storage capacity for 15 days at Vishakhapatnam (1.33 million tonnes), Mangalore (1.50 million tonnes) and Padur (2.5 million tonnes) through a Special Purpose Vehicle, namely, Indian Strategic Petroleum Reserve Ltd. (ISPRL). The storage would be further upgraded at other suitable locations by an incremental capacity of 12.5 million tonnes during the Twelfth Plan period.

#### Promoting Bio-Fuels

14.160. A programme of 5 per cent blending of ethanol with petrol is already underway with effect from November 2006 targeting 20 States and 4 UTs. Subject to availability, the percentage of blend can be enhanced to 10 per cent as specification for petrol with 10 per cent ethanol blend is already given by the BIS. At present, the EBP Programme is successfully running in 14 States and three UTs; OMCs have been able to contract 55.87 crore litres of ethanol against the requirement of 105 crore litres of ethanol for 5 per cent blending in the entire notified area.

#### Pricing of Petroleum Products

14.161. In 2002, the Government dismantled the Administered Pricing Mechanism, and announced that prices of all petroleum products would be deregulated. This decision, however, was not fully implemented after the prices of crude oil in international market rose sharply leading to increase in international prices of petrol, diesel, LPG and kerosene.



On 25 June 2010 the Government announced that the price of petrol was fully deregulated and the oil companies were free to fix it periodically. However, diesel price deregulation was deferred to be implemented later. Prices of LPG and kerosene remained under price regulation by the Government. The continuance of price control reflects the political sensitivity of the issue despite the evident economic desirability of implementing the Integrated Energy Policy.

14.162. The under-recovery by oil companies because of the inability to adjust oil prices is shown in Table 14.34. The amount of under-recoveries on sensitive petroleum products was ₹1,38,541 crores (excluding the under-recoveries of ₹4,890 crores incurred by OMCs on sale of petrol) in the year 2011–12 including the under-recoveries incurred by OMCs on petrol. The total under-recoveries by the Government and oil PSUs amount to ₹4,43,197 crore during the Eleventh Plan period. That has seriously affected the profitability and viability of the oil marketing companies. The under-recoveries of the oil companies in 2012–13 will rise to ₹1,52,937 crore as per Refinery Gate price effective from 1 July 2012 if prices are not adjusted.

#### Pricing of Natural Gas

14.163. Gas price for NELP Blocks is supposed to be determined through an arm's length process by contractor, and is subject to approval by the Government. Accordingly the price of RIL KG Basin gas was fixed at \$4.2/MMBTU ex-Kakinada in 2007 by EGoM and the price was expected to be valid till March 2014. The purchase price of

long-term LNG imported from Qatar for Petronet LNG has been linked to Japanese Crude Cocktail (JCC) and varies on a monthly basis. It is sold at prices fixed by resellers. Spot RLNG prices are based on market conditions, which are currently hovering around US\$12–13/MMBTU. Following the fixation of the KG basin gas price at US\$4.2 per MMBTU, the administered price of gas from nominated fields awarded earlier to ONGC/OIL, which varied depending on the field, were raised to US\$4.2 per MMBTU, except for the North-East where it is US\$2.52 per MMBTU.

14.164. The NELP of the Government of India provides freedom to price the gas by the operator at a market-determined price for gas produced from the NELP blocks, subject to the Government approving the pricing formula. However, questions have arisen regarding the interpretation of various clauses in the existing contracts. There is a need to review the provision of pricing under PSC to clarify the extent to which producers will have the freedom to market the gas. Clarity is obviously essential if we are to attract private investment into exploration and production. Legally, gas as a resource belongs to the Government and the Government has the right to fix an appropriate price. However, if the intention is to attract private investment into this sector, the Government should state clearly what degree of pricing freedom will be given. Ideally, private investors would expect freedom to price the gas at a level at which there are willing buyers, which in turn will be determined by the price at which consumers can import. On the other hand, the CBM policy envisages a different contractual regime. In order to encourage this

**TABLE 14.34**  
**Under-Recoveries on Petroleum Products**

Petroleum Products	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12
Petrol	2,027	7,332	5,181	5,151	2,227	–
Diesel	18,776	35,166	52,286	9,279	34,706	81,192
Domestic LPG	10,701	15,523	17,600	14,257	21,772	29,997
PDS Kerosene	17,883	19,102	28,225	17,364	19,484	27,352
<b>Total</b>	<b>49,387</b>	<b>77,123</b>	<b>1,03,292</b>	<b>46,051</b>	<b>78,190</b>	<b>1,38,541</b>

Source: PPAC.

emerging source of gas, its pricing should be left to the market without the need for Government approval.

14.165. There are a number of other issues regarding existing PSC. First, questions have been raised regarding investment multiple which determines the profit share of Government and the investor after allowing recovery of investment cost. It has been argued that this incentivises greater capital intensiveness, and a stronger profit share based on production would be better. This assessment needs to be weighed against the argument that the IM enables Government to insulate the contractor at higher levels of investment, which increases the possibility of oil/gas being discovered. There are also concerns on the need to improve the provisions under the PSC to make them more transparent and also fully safeguard the interests of the stakeholders. Second, the existing management system has not led to an effective supervision over the projects. There is a need to consider alternate mechanisms. Several other issues have been raised also. Government has, therefore, appointed a Committee under the chairmanship of Dr. C. Rangarajan, Chairman, Economic Advisory Council to the Prime Minister to review existing PSCs and recommend changes for the future.

14.166. Finally, the Twelfth Plan is likely to see a continuation of high oil and gas prices in the world markets and our dependence on imports for both oil and gas is also likely to increase. There is an urgent need to align domestic oil and gas price to market price for sound development of the sector and to send the right signals to consumers and producers. This would also enable the oil PSUs to generate internal resources to fund new projects and create growth momentum. Price reform along these lines would also permit entry of private companies for marketing of petroleum products which would help expand competition. Price adjustment in the petroleum sector has to be carried out keeping in mind the need for ensuring affordability for the poor and vulnerable sections. This can be done in various ways. It does not require generalised subsidies.

## TWELFTH PLAN STRATEGY

### Demand of Petroleum Products

14.167. Demand of petroleum products is projected to increase at an annual rate of 4.7 per cent during the Twelfth Five Year Plan. This will increase consumption of POL products from 147.98 MMT in 2011–12 to 186.21 MMT by 2016–17. The demand for diesel will continue to be dominant followed by MS and LPG. The demand estimates of petroleum products in Twelfth Plan period are given in Table 14.35.

### Supply of Petroleum Products

14.168. Oil production during Twelfth Plan is likely to increase marginally and then decline by 3.26 per cent by the end of the Plan. As a result, import dependence in petroleum products is expected to increase from 76.6 per cent at the end of the Eleventh Plan to 77.8 per cent by the end of the Twelfth Plan. The crude oil production profile for the Twelfth Plan, based on established reserves, present status of different fields, input implementation schedules and the health of reservoirs is as given in Table 14.36.

### Natural Gas Demand

14.169. The demand of natural gas during the Twelfth Plan is likely to grow by about 19.2 per cent to meet the incremental requirement of power, fertiliser and other industries. The CNG and city gas sector will also see a quantum growth in natural gas use. It is expected that by the end of the Twelfth Plan about 300 cities are likely to be covered under city gas distribution. Yearly estimates of natural gas demand are given in Table 14.37.

### Natural Gas Production

14.170. Domestic production of natural gas during the Twelfth Plan will depend upon the output from gas fields discovered under NELP by various operators. As majority of new gas prospects are in deep water, the investments, technology and pricing of gas for developing these fields would be important. The estimated gas production by different operators has been given in Table 14.38. However, the projected production from Private/JV producers may need to be reviewed during the Plan period, as

**TABLE 14.35**  
**Demand of Petroleum Products**

Products	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	CAGR (%)
1. Petroleum Products ('000MT)							
LPG	15,358	16,986	18,363	19,675	20,857	21,831	7.3
MS	14,993	16,091	17,527	19,083	20,766	22,588	8.5
NAPHTHA/NGL	11,105	12,353	11,417	11,417	11,022	11,022	-0.1
ATF	5,536	6,009	6,587	7,202	7,849	8,540	9.1
SKO	8,229	7,949	7,631	7,326	7,033	6,751	-3.9
HSDO	64,742	65,040	68,654	72,589	76,904	81,599	4.7
LDO	415	400	400	400	400	400	-0.7
LUBES	2,745	2,691	2,772	2,857	2,945	3,036	2.0
FO/LSHS	9,232	7,954	7,902	7,899	7,872	7,872	-3.1
BITUMEN	4,628	5,254	5,541	5,732	5,971	6,114	5.7
PET COKE	6,145	6,765	7,514	8,345	9,268	10,294	10.9
OTHERS	4,869	5,445	6,127	6,109	6,085	6,162	4.8
<b>Total POL</b>	<b>1,47,997</b>	<b>1,52,937</b>	<b>1,60,436</b>	<b>1,68,635</b>	<b>1,76,972</b>	<b>1,86,209</b>	<b>4.7</b>

Source: Ministry of Petroleum and Natural Gas.

**TABLE 14.36**  
**Projection of Crude Oil Production in the Twelfth Plan**

	2012-13	2013-14	2014-15	2015-16	2016-17	Total
ONGC	25.045	28.27	28.002	26.286	25.456	133.059
OIL	3.92	4.00	4.06	4.16	4.20	20.34
Pvt./JV	13.34	13.30	12.70	12.10	11.50	62.94
<b>Total</b>	<b>42.305</b>	<b>45.57</b>	<b>44.762</b>	<b>42.546</b>	<b>41.156</b>	<b>216.339</b>

Source: Ministry of Petroleum and Natural Gas.

**TABLE 14.37**  
**Natural Gas Demand for Twelfth Five Year Plan**

Sector	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	CAGR (%)
Power*	91	135	153	171	189	207	17.9
Fertiliser**	43	55	61	106	106	106	19.8
<i>Demand(Price Elastic) – Sub Total</i>	134	190	214	277	295	313	18.5
City Gas	13	15	19	24	39	46	28.8
Industrial	16	20	20	22	25	27	11.0
Petrochemicals / Refineries/Internal Consumption	25	54	61	67	72	72	23.6
Sponge Iron/Steel	6	7	8	8	8	8	5.9
<i>Demand (Relatively price Inelastic) – Sub Total</i>	60	96	108	121	144	153	20.6
<b>Grand Total Demand</b>	<b>194</b>	<b>286</b>	<b>322</b>	<b>398</b>	<b>439</b>	<b>466</b>	<b>19.2</b>

Source: \*Ministry of Power, \*\*Ministry of Fertilizers.

**TABLE 14.38**  
**Projection of Natural gas production in Twelfth Plan (BCM)**

	2012–13	2013–14	2014–15	2015–16	2016–17	Total
ONGC	25.266	25.472	26.669	28.215	38.676	144.298
OIL	3.30	3.80	4.00	4.27	4.45	19.82
Pvt./JV	23.71	32.38	39.4	40.43	41.46	177.38
Total	52.276	61.652	70.069	72.915	84.586	341.498
Total MMSCMD	143.22	168.91	191.97	199.77	231.74	187.12 (Average)

Source: Ministry of Petroleum and Natural Gas.

the production profile from their exploration acreage gets approved by the Directorate General of Hydrocarbons.

### Exploration Activities

14.171. During the Twelfth Plan period, 13,8974 kilometres of 2D seismic and 82,488 square km of 3D seismic are likely to be acquired by ONGC, OIL and private/JV companies. Also, 1,310 exploratory wells are likely to be drilled during the Twelfth Plan period. These exploratory efforts are likely to result in hydrocarbon reserve accretion of about 727 million metric tonnes of oil and oil equivalent gas in the country. The break-up of exploration programme by ONGC, OIL and Private/Joint Venture companies is given in Table 14.39. The role of DGH as the upstream advisor and supervisor for the Government is very important. Efforts will be made to increase the capacity of the DGH, as also efficiency in decision-making. It can play an important role in obtaining various clearances for the upstream operators from multiple agencies of the Government. This has to be viewed particularly in the light of the fact that a large

number of discoveries made under NELP are yet to be appraised and developed. The DGH needs to monitor their evaluation and development quickly.

### Pricing and Under Recoveries of Petroleum Products

14.172. Although important steps have been taken in the first year of the Twelfth Plan to adjust diesel prices and to cap the subsidy on LPG, this has not eliminated the under-recovery of oil companies. The increase in under-recoveries of OMCs is adversely affecting the financial position of OMCs and may affect mobilisation of funds for new projects during the Twelfth Plan period. Currently, the under-recoveries of OMCs are compensated by the Government from fiscal budget, discount on crude and products by upstream oil companies and part absorption by OMCs. The OMCs are expected to incur under-recoveries of ₹8,32,737 crore during Twelfth Plan period. If no further adjustment occurs, and if global prices stay at present level, the total under-recovery in the Twelfth Plan period will be over ₹8.32 lakh crore which is simply not viable (Table 14.40)

**TABLE 14.39**  
**Breakup of the Exploration Programme for the Twelfth Plan**

Activity	Unit	ONGC	OIL	Private/JV	Total
Seismic Surveys 2D	km	28,170	6,850	1,03,954	1,38,974
Seismic Surveys 3D	Sq Km	24,163	8,364	49,961	82,488
Exploratory Wells	Nos	611	174	525	1,310
Reserves Accretion IIIH	MMTOE	1,080	78.14	728	1,886.14
Ultimate Hydrocarbon Reserve Accretion	MMTOE	360	26	341	727

Source: Ministry of Petroleum and Natural Gas.

**TABLE 14.40**  
**Likely Under-Recoveries on Petroleum\* Products**

	(₹ Crore)					
Sensitive Petroleum Products	2012-13	2013-14	2014-15	2015-16	2016-17	Total
Diesel	86,910	90,820	95,053	99,673	1,04,664	4,77,120
PDS Kerosene	28,880	27,725	26,617	25,552	24,528	1,33,301
Domestic LPG	38,182	42,054	44,931	47,531	49,618	2,22,316
<b>Total</b>	<b>1,53,973</b>	<b>1,60,598</b>	<b>1,66,601</b>	<b>1,72,756</b>	<b>1,78,810</b>	<b>8,32,737</b>

\* Price of Petrol is made market determined. It assumes oil prices at US\$ 100 per barrel with exchange rate of US\$ = ₹55.

### Addition to Refining Capacity

14.173. With grass-roots refineries at Bhatinda (9 MMTPA), Paradip (15 MMTPA) and expansion of some of the existing refineries, the total refining capacity is projected to be around 218.37 MMTPA by the year 2012-13 and is expected to touch 313.57 MMTPA by the end of the Twelfth Plan as shown in Table 14.41. Majority of new refining capacity would be added from expansion of existing refineries at low costs.

### Alternate Sources of Hydrocarbons

14.174. The development of alternate sources of hydrocarbons such as coal bed methane, gas hydrate, shale gas, oil shale and so on are some of the areas which require greater attention. Oil companies would also need to focus on development of renewable energy sources including biodiesel, ethanol, wind, solar, biomass and so on to make the hydrocarbon use for various activities carbon neutral by the companies.

**TABLE 14.41**  
**Projected Refining Capacity during Twelfth Plan (MMTPA)**

	2012-13	2013-14	2014-15	2015-16	2016-17
IOC	54.2	69.2	69.2	74.0	77.0
BPC (Mumbai)	12.0	12.0	13.5	13.5	13.5
Kochi	9.5	9.5	9.5	15.5	15.5
BORL-Bina	6.0	6.0	7.2	7.2	9.0
HPC (MR + VR)	16.5	17.2	17.2	17.2	23.2
Maharashtra Refinery	0.0	0.0	0.0	0.0	9.0
HMEL (GGSRL)	9	9	9	9	9
MRPL	15	15.5	16	16.5	18
ONGC (Tatipaka)	0.066	0.066	0.066	0.066	0.066
CPCL	12.1	12.1	12.1	12.1	18.3
NRL	3	3	3	3	8
Sub Total PSU	137.4	153.6	156.8	168.1	200.6
RIL-DTA and SEZ, Jamnagar	60	60	60	60	60
EOL, Jamnagar	19	20	20	30.8	38
NOCL, Cuddalore	2	6	6	6.1	15
<b>Sub Total Private</b>	<b>81</b>	<b>86</b>	<b>86</b>	<b>96.9</b>	<b>113</b>
<b>Total</b>	<b>218.4</b>	<b>239.6</b>	<b>242.8</b>	<b>265.0</b>	<b>313.6</b>

Source: Ministry of Petroleum and Natural Gas.

### *Coal Bed Methane (CBM)*

14.175. The prognosticated CBM resources in the country are about 92 trillion cubic feet (TCF), out of which only 8.92 TCF has so far been established. The Government of India has awarded 33 CBM exploration blocks. Commercial production of CBM has already commenced in Raniganj (South) in West Bengal. CBM production by the year 2016–17 is expected to be around 4 MMSCMD. This is quite low compared with the resource potential estimated by the DGH. In spite of the fact that more than a decade has lapsed since the award of CBM blocks, the evaluation and development continues to be behind schedule. Efforts are required to enhance the production of CBM through suitable policy measures. There are also delays in approving prices for CBM projects shortly to go into production. This needs to be expedited.

### *Simultaneous Operations of Coal Bed Methane (CBM) and Oil and Gas*

14.176. At present there is no mechanism to work together simultaneously for the exploration and exploitation of coal, coal bed methane, shale gas and oil and gas production in same block/ acreages due to the fact that both coal and oil and gas sectors are governed by different administrative ministries. Regulations and Acts do create conflict of interest for the simultaneous exploration and exploitation of coal, CBM, coal mine methane and also underground Coal gasification along with coal and oil and gas. There is a need for the operators to work under similar contractual regime for simultaneous operations of CBM, Coal and shale gas and CBM, oil and gas and shale gas in the same area. A policy framework for this will need to be developed expeditiously in the year 2012–13 itself.

### *Shale Gas Exploration*

14.177. The Government has initiated steps for development of shale oil and shale gas from on land sedimentary basins. MoU has been signed between Ministry of Petroleum and Natural Gas and Department of State, USA on 6 December 2010 for cooperation in resource assessment, regulatory framework, training and so on. A multi-organisation

team (MOT) has been constituted involving DGH, ONGC, OIL and GAIL for collection of required G&G, geochemical and petro-physical data for assessment of shale oil and shale gas prospects in Indian on land sedimentary basins. The involvement of private sector in this initiative will be enhanced as well. A policy of regulatory framework is to be put in place for shale oil and shale gas development.

### *Underground Coal Gasification (UCG)*

14.178. ONGC has signed an Agreement of Collaboration (AOC) with Skochinsky Institute of Mining, Russia on 25 November 2004 for implementation of Underground Coal Gasification (UCG) project in India. The Vastan Mine block belonging to GIPCL in Surat district, Gujarat has been selected for UCG Pilot project. The total financial implication of the project is about US\$ 15.32 million. ONGC will be asked to complete this pilot at the earliest.

### *National Gas Hydrate Programme*

14.179. An MoU was recently signed in the area of marine gas hydrate research and technology development between the Leibniz Institute of Marine Sciences, Germany and DGH for research on methane production from gas hydrate by carbon dioxide sequestration. The NGHP programme has also been going on for a long time, with no tangible results so far. Efforts will be made for better monitoring and conclusion of this programme at the earliest.

### *Flaring of Natural Gas*

14.180. Currently about 3 per cent of gas produced is flared by the ONGC and Oil India Limited. The total volume of gas flared is estimated to be around 3.5–4.0 MMSCMD. There is a need to stop such flaring through use of this gas by the local industry and/or gathering it either through compression or by liquefaction mode and then re-injecting the gas into pipeline. A separate mechanism to reach a zero flaring of gas and its commercialisation can be developed to stop such wasteful flaring of gas.

### *Focus on Research and Development*

14.181. The need to develop domestic capability in the exploration, production, refining and processing of oil and natural gas has led to the creation of R&D



institutes by oil sector organisations. While in-house institutions can make a significant contribution to the activities of their parent PSUs, they are not subjected to any peer review. They have also been unable to attract private sector business and have remained dependent on captive assignments. On the other hand, the existence of in-house institutions has restrained the PSUs from outsourcing their assignments to outside institutions/niche area experts. The objective should be to ensure that R&D centres of the oil sector PSUs develop into world class institutions, with induction of fresh capital and top scientific personnel.

14.182. Efforts will be intensified to obtain the latest technology from global centres of excellence while at the same time strengthening our own capability. Several alliances were signed with international organisations and Governments during the Tenth and the Eleventh Plan periods. Diplomatic efforts were also made through JWGs and other forms of MEA assistance to increase interaction between Indian and foreign experts. These efforts will be renewed, and fresh initiatives taken. Some of the key areas for R&D development to strengthen domestic capability are in exploration, geo-data processing and interpretation, drilling technology, reservoir

studies, ocean technology, oil and gas production technology, well logging technology, biotechnology and geotectonic, quality improvements of the products, improving energy efficiencies of various processes, and yield maximisation of distillation. The experience of Brazil in having developed scientific and technical know-how as well as manpower domestically, tailor-made to suit their geological requirements is a good example to follow.

14.183. Various oil and gas sector organisations plan to invest ₹6,326 crore during the Twelfth Plan period as R&D of oil and gas sector activities as indicated in Table 14.42. Some of the focus areas in oil and gas sector are:

1. Producing waxy crude
2. Smart horizontal well completions
3. 4D Seismic mapping
4. Long heated insulated pipeline for crude evacuation
5. Improving energy efficiency in refineries
6. Product yield maximisation
7. Exploration of unconventional energy resources, viz. shale gas, CBM, UCG and so on
8. Oil shale and study of gas hydrates in eastern and western offshore areas of India

**TABLE 14.42**  
**R&D Expenditure by Major Oil and Gas Companies**

Company	2009–10 (Actual)		Eleventh Plan (Actual)	Twelfth Plan (Estimated)
	Expenditure ₹ crore	per cent of R&D expenditure/Revenues	Expenditure ₹ crore	Expenditure ₹ crore
Indian Oil	89.65	0.04	317.83	955
BPCL	26	0.02	155.38	429
HPCL	2.1	0	24.5	315
CPCL	0.3	0	7.4	14
RIL	41	0.02	1,640	2,000
EOL	–		12	25
ONGC	219.95	0.34	1,289.32	2,156
OIL	22.49	0.27	108.63	257
GAIL	16.17	0.06	17.23	71
EIL	11	0.54	46	104
<b>Total</b>	<b>428.66</b>	<b>0.06</b>	<b>3,618.29</b>	<b>6,326</b>

Source: Ministry of Petroleum and Natural Gas.

### Infrastructure and Capacity Building

- The unlicensed offshore areas and Deccan basins are technologically challenging due to higher water depths and sub-basalt sediments, respectively. It is important to access latest technology from global centres of excellence to address the specific needs of these balance areas. The Government would endeavour to encourage technology alliances with our upstream companies, and also attract service industries to set up base in India.
- Strengthen and empower technical and scientific manpower for better decision-making and capacity-building in oil sector specifically the E&P companies. Deployment of large qualified workforce will be necessary during the Twelfth Plan for exploration and production sector.
- Both ONGC and OIL would step up efforts, to raise oil and gas production from the near stagnant levels of the past one decade or so. These companies ought to enhance production by reducing their R/P ratios. They would also be encouraged to quickly appraise their entire licensed areas to enhance reserves. In the offshore nominated areas, technology is likely to play an important role. The Government would also encourage them to induct cutting-edge technology in these acreages, often available only as in-house with global players, on risk-reward basis.
- The Integrated Energy Policy had laid down that there is a need for an independent upstream regulator. The Government needs to distance itself from routine contract administration, as well as capex/pricing decisions. As long as the Government itself is the upstream regulator, the reasoning that the DGH provides it technical advice does not lend it independence. Audit issues and contractor-Government conflicts may get much reduced if an independent regulator were to be put in place. Further, in order to make marginal offshore oil and gas discoveries viable, offshore infrastructure needs to be shared between operators. The DGH would issue regulations to encourage operators to collaborate on mutually beneficial terms.
- Development of strategic and commercial gas storages by the E&P and marketing companies to address price volatility, balancing of seasonal gas requirement by various sectors at different locations in the country.
- Development of strategic crude oil storage beyond 5 MMTPA capacity. The Government would be open to private sector involvement in building and operating strategic storage, on the condition of the crude being available for release, at its discretion.
- Strategy for refining capacity additions considering current market situation
- Marketing and distribution infrastructure facilities for the petroleum products
- Additional development of new LNG import and regasification capacity both on the East and the West coasts of India.
- Gas Pipeline transportation infrastructure both on the East and the West coasts and also in southern and northern parts of the country for supply of gas throughout the country.
- Facilitating development of city gas distribution in about 300 identified cities in the country.
- Improving efficiency of operations of various oil and gas sector installations. Benchmarks for refineries, pipelines process plants, buildings and any other installations to be developed by all the organisations and to be monitored periodically.
- Develop capacity building for 5 MMTOE per year of energy from renewables and unconventional hydrocarbon resources. This is with an aim to become carbon neutral for oil sector companies.
- Developing LNG import capacity based on Floating Storage and Regasification units (FSRU) in coastal cities of the country which are not connected to gas pipelines to expedite the city gas supply.
- Deploy the CSR resources for creating health and education infrastructure. Help communities in creating opportunities for clean and sustainable energy supplies for cooking and lighting for better quality of life in areas of operations from CSR funds.

### Reforms Required in the Oil and Gas Sector

14.184. Given the challenges in managing the oil and gas sector, it is necessary to focus on the agenda of critical reforms needed in this sector in the Twelfth Plan period. They are listed below:

- Eliminate the uncertainty that has arisen regarding gas pricing from NELP production sharing contracts by implementing a new design of contracts. The recommendations of the Rangarajan Committee may be an important input in finalising this policy. Appropriate steps should be taken to resolve conflicts in existing contracts where interpretation of the contract terms is open to multiple options.
- Operationalise a road map to move petroleum product prices received by marketing companies to prices aligned with global prices. This may not be possible immediately, but it can be achieved by the end of the Twelfth Plan for diesel and petrol.
- Phasing out subsidies on domestic LPG and PDS kerosene. Subsidised LPG is now capped at nine cylinders per household with the rest being available at market price. Consideration should be given to converting the subsidised supply to an equivalent cash transfer targeted to those who need it.
- Kerosene supplies can be progressively reduced considering improved electricity access provided under RGGVY and LPG connections provided in rural areas.
- Rationalise tax structure in sales of petroleum products considering thermal value for its use in transport, industry, power, households and other sectors. Unified State taxes and removal of tax anomalies for efficient use of petroleum products.
- Incentivise exploration and production of domestic non-conventional fuels like shale gas, CBM, coal mine methane, underground coal gasification and so on.
- Promote development and production of bio-fuels by the oil sector E&P and marketing companies at commercial level. Appropriate policy and integration issues facilitating bio-fuels development be provided by both the State and the Central Governments.
- Expand exploration and production of domestic oil and gas sources for which quick decision-making for awarding and development of NELP blocks is necessary.
- In order to attract efficient E&P companies globally to bid for our acreages, it is vital to provide seismic and other technical data of the acreages on offer. It is proposed that the entire unlicensed sedimentary area be surveyed, so that 100 per cent exploration coverage may be achieved during the Plan period.
- NELP was launched as a stopgap arrangement until a National Data Repository was ready to facilitate an all-year round acreage award policy. The Government will introduce an Open Acreage Licensing Policy so that the target of full exploration coverage by the end of Plan period may be achieved.
- Provide 'Declared Goods Status' for natural gas/LNG so that it is available at uniform price in most of the States.
- Natural gas prices charged to producers must also be determined by market forces. There is a need for clarity on fiscal incentives on exploration of natural gas under NELP. The concept of uniform gas price across consuming sectors also needs to be examined afresh as the desire to keep prices low for certain sectors tends to distort pricing; it is inconsistent with the principle that the price of gas will be determined by market forces.
- Develop a policy framework to exploit shale gas. It is proposed that a new policy for exploration and production of shale gas be launched, and acreage be speedily awarded during the Plan period.
- Coal mining leases acreages often have methane or even oil/gas deposits. Similarly, oil and gas lease/PSC acreages have the possibility of coal/methane production. The Government should put in place a policy for simultaneous exploitation of CBM, coal, coal mine methane, oil and gas in a unified manner wherever such resources are available.
- Acquisition of equity oil and gas abroad including conventional and shale gas assets.
- Contracting LNG imports both on long- and short-term basis considering market price affordability.

### 3.5. NEW AND RENEWABLE ENERGY

14.185. The need to increase total domestic energy production in order to reduce import dependence, combined with the need to move away from fossil fuels in the longer run in view of climate change considerations, points to the need for stronger efforts to increase the supply of energy from renewables.

All over the world, investment in renewable power sources has been increasing. India has been a late entrant into the field of renewable energy, but it is beginning to make rapid strides in this sector with an annual growth rate of 33 per cent in 2010 against the global growth rate of 26 per cent during the same period. It must be emphasised however that these increases are from a very low base since renewables at present account for about 1 per cent of the total commercial energy used. Nevertheless, it is important to make a start and to gain significant experience in this important sector keeping in mind its potential over the longer term.

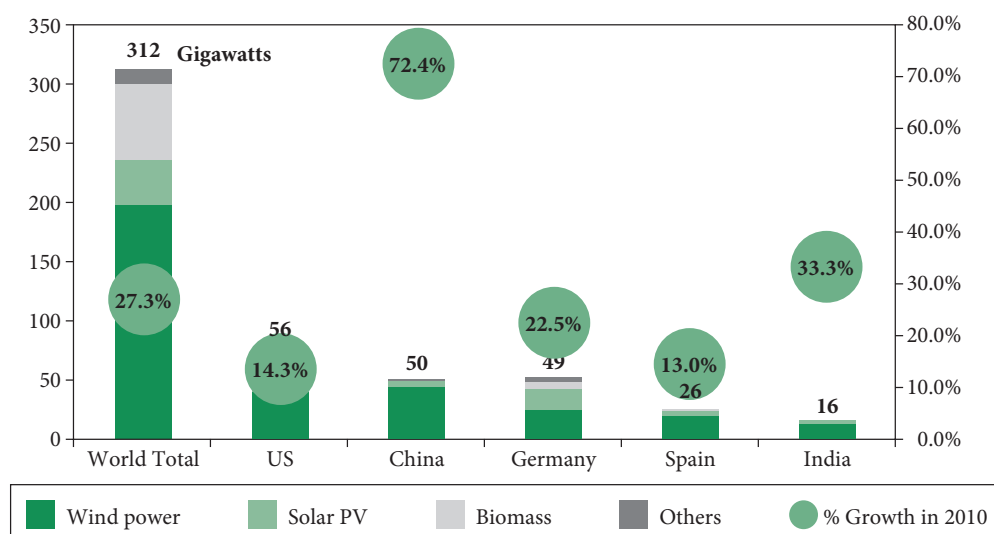
14.186. An important limitation on the extent to which we can shift to renewables is the high unit cost at present, compared with other conventional sources. However, unit costs of renewable energy, especially solar energy, are coming down and the marginal cost of conventional energy based on fossil fuels is likely to remain high and rise. These trends suggest that over the next 7 years the unit cost of energy from renewable sources such as wind and solar may come close to the unsubsidised cost of conventional energy. Since India has a large potential of both wind and solar energy, the exploitation of

this potential should form an important part of our long-term energy strategy.

14.187. The potential for renewable power has been revised upward over time. In the early 80s, India was estimated to have renewable energy potential of about 85 GW from commercially exploitable sources, viz. (i) Wind: 50 GW (at 50 m mast height) (ii) Small Hydro: 15 GW (iii) Bio-energy: 20 GW and (iv) solar radiation sufficient to generate 50 MW/sq. km using solar photovoltaic and solar thermal energy. These estimates have since been revised to reflect technological advancements. Initial estimates from Centre for Wind Energy Technology (C-WET) suggest that wind energy potential at 80 metres height (with 2 per cent land availability) would be over 100 GW. Some studies have estimated even higher potential ranges up to 300 GW. The MNRE has initiated an exercise for realistic reassessment of the wind power potential, whose results are expected by the end of 2013.

14.188. Some of the key issues facing renewable power generations are:

1. **Regional Concentration of Renewable Energy Potential:** Because renewable energy



\* Excludes Hydro.

Source: REN21, Global Status Report, 2011.

FIGURE 14.2: Renewable Power Capacities, Top Five Countries, 2010

is location-specific and not evenly distributed there are problems on scaling up grid connected renewable power. For instance, wind potential is mainly confined to the wind resource rich States of Tamil Nadu, Maharashtra, Gujarat, Karnataka, Rajasthan, Andhra Pradesh and Madhya Pradesh. The States of Gujarat and Rajasthan have excellent solar radiation and the other suitable states for solar power are Andhra Pradesh, Tamil Nadu, Karnataka, Madhya Pradesh, Maharashtra, Orissa and so on. Similarly, small hydro power potential is mainly available with the Himalayan States and north-eastern States. The intermittent nature of Solar and Wind Power in the absence of an adequate balancing mechanism limits the flexibility of the State grid to absorb this power.

2. **Insufficiency and High Cost of Evacuation Infrastructure:** Utilisation of variable renewable energy requires a robust transmission infrastructure from remotely located generating plants to the load centres. Further, combining geographically dispersed renewable energy sources to reduce variability requires much larger, smarter and upgraded transmission network. A recent study conducted by the Power Grid Corporation Ltd. has identified the requirement for strengthening of both intra-state and interstate transmission system for facilitating transfer of renewable energy from renewable-energy-rich potential States to other States as well as for absorption within the host States. The study has estimated that for capacity addition plans for the Twelfth Five Year Plan period, an investment of around ₹30,000 crore would be required for creating renewable power transmission infrastructure.
3. **Regulatory Issues:** Renewable power, especially solar, is significantly costlier than conventional power, thus making its adoption by the cash-starved utilities difficult unless it is incentivised through Renewable Purchase Obligation (RPO) and introduction of Renewable Energy Certificate (REC). This would enable States to procure a fixed percentage of their power portfolio from renewable power.
4. **Financial Barriers:** Renewable energy technologies require large initial capital investments,

making the levelised cost of generation higher than it is for many conventional sources. These technologies need to be supported until technology breakthroughs and market volumes generated are able to bring the tariff down at the grid parity level. Moreover, high technology and project risks perceived by financers for renewable projects make access to low-cost and long-term funding difficult. Thus, there is a need to generate instruments for low-cost and long-term financing of such projects from both domestic as well as overseas resources and also banks to adopt separate exposure limits for renewable energy sector.

5. **Low Penetration of Renewables for Urban and Industrial Applications:** Solar applications for heating water in urban, industrial and commercial applications is one of the most mature and viable renewable energy technologies available worldwide. Better market penetration of such technologies can lead to better demand side management for commercial as well as household usage. With already matured technology and rapidly growing industry, solar water heater installations have witnessed a massive growth throughout the world but the installations in India have remained low on account of poor adoption due to high upfront cost and poor quality standards of collectors. Moreover, the binding regulation in building codes that encourage adoption of such technologies are seldom implemented and only few States have such regulations.

## REVIEW OF ELEVENTH PLAN

14.189. Progress in grid interactive renewable power generation capacity, especially of wind-based power was broadly in line with the targets of the Eleventh Plan. However, actual renewable energy generation has been substantially lower. Wind-based power generation has suffered the most partly also because of the lack of evacuation infrastructure in the resource rich States and partly because of lack of enforcing mechanisms and incentives for operational performance of the wind turbines. Incentives such as Accelerated Depreciation have not yielded the desired results and the recommendation now is to enforce generation-based incentive. Achievement

**TABLE 14.43**  
**Eleventh Plan Power Capacity Addition through Grid Interactive Renewable Power**

Source	Target (MW)	Actual (MW) as on 31st March '2012
Wind	9,000	10,260.00
Small Hydro	1,400	1,419.17
Biomass Power	500	626.00
Waste to Energy	80	46.20
Bagasse Cogeneration	1,200	1,369.70
Solar Power	50	939.74
<b>Total</b>	<b>12,230</b>	<b>14,660.81</b>

Source: MNRE, GoI.

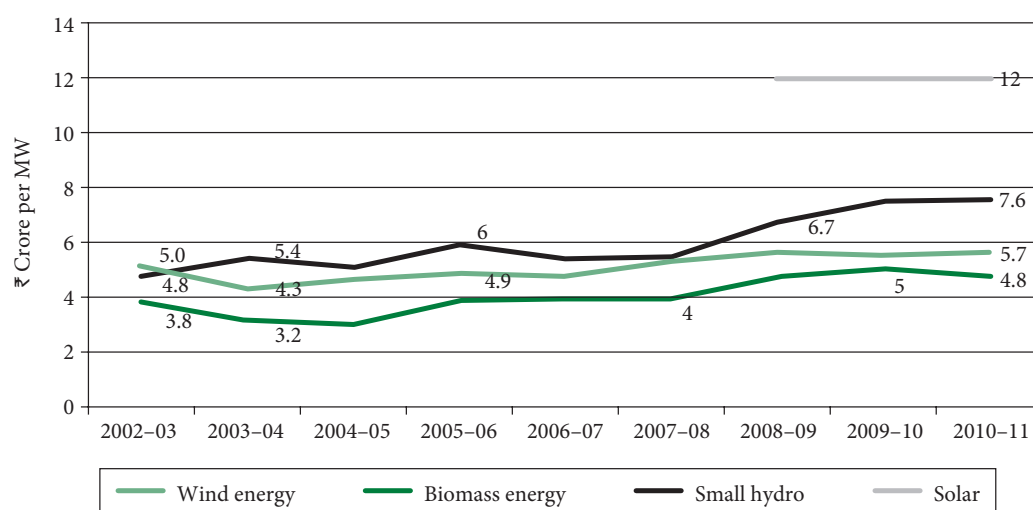
in capacity addition has been satisfactory for most sectors except in waste to power. The details of targets and achievements during the Eleventh Plan for grid interactive renewable power have been given in Table 14.43.

14.190. Solar and wind sectors have been facing following key challenges:

1. Globally, development of storage technologies has not been in line with the technology developments in wind and solar, due to which capacity utilisation of grid connected solar and wind has been relatively poor.

2. Though most of the States have come up with the RPO obligation, proper enforcement and monitoring is an issue.

14.191. Although private investments in wind power have increased, technological improvements and economies of scale have not reduced the costs in the industry. On the contrary, the cost per MW of wind power has increased from ₹4.3 crore/MW in FY 2003–04 to ₹5.7 crore/MW in FY 2010–11 (Figure 14.3). Rising land acquisition costs and turn-key project approach has resulted in the increase of project cost. Small hydro power, in spite of using mature and indigenous technology, has witnessed



Source: MNRE.

**FIGURE 14.3: Cost of Renewable Energy Technologies Per MW**



the same trend partly because of the rise in land costs and partly because of costs associated with delays for obtaining clearances for the sites where project development is difficult.

14.192. The cost of renewable power as against various sources of renewable energy is given in Table 14.44. The cost of wind power is already quite competitive. Solar power is much more expensive but costs are coming down. At the time of selection of the first batch in the Jawaharlal Nehru National Solar Mission (JNNUSM) the tariff for solar P.V. was ₹17.91 per Kwh and for solar thermal it was ₹15.31 per unit. In Batch II the tariff has come down to ₹8.77 per unit for solar P.V. Thus, although renewable power sources are significantly costlier than conventional power, the costs are clearly declining and over the next 5–10 years renewable energy may well be fully in line with the cost of new electricity capacity based on conventional energy sources if no subsidy is involved.

**TABLE 14.44**  
**Cost of Power for Various Renewable Energy Sources**

Source	Estimated initial capital cost (₹ in crore/MW)	Estimated cost of electricity generation (Financial) (₹/kWh)
Small Hydro Power	5.50–7.70	3.54–4.88
Wind Power	5.75	3.73–5.96
Biomass Power	4.0–4.45	5.12–5.83
Bagasse Cogeneration	4.20	4.61–5.73
Solar Power	10.00–13.00	10.39–12.46

*Source:* CERC (Terms and Conditions for Tariff Determination from Renewable Energy Sources) Regulations, 2012 dated 27 March 2012.

### Off-Grid Renewable Power

14.193. Off-grid renewable sector has the advantage that it is potentially much more competitive with conventional power because it avoids the investment in transmission to remote locations. Off-grid renewable power has made progress during the Eleventh Plan, but lack of scalable business models and non-availability of institutional finances have stalled the pace of its progress. Policy interventions are required to incentivise creation of financeable business models like rice husk gasifiers based electricity

generation. The issue of unwillingness of public sector banks to finance small scale off grid renewable based business models need to be addressed. The detailed overview of targets and achievements for the Eleventh Plan for off-grid renewable power has been given in Table 14.45.

**TABLE 14.45**  
**Power Capacity Addition through Off Grid Renewable Power**

Source	Target (MW)	Actual (MW)
Waste to Power (Urban + Industrial)	58.00	85.15
Non-bag Cogen	255.00	336.59
Gasifiers	67.00	63.23
Acro-Gens/Hybrid Systems	1.75	1.14
SPV Systems	20	46.64
<b>Total</b>	<b>401.75</b>	<b>532.75</b>

*Source:* MNRE.

14.194. Progress of the scheme for electrification of remote villages/hamlets through renewable generation has not been satisfactory. Only 57 per cent of the targeted villages have been electrified so far. Initially no target was fixed for the grid solar photovoltaic system during the Eleventh Plan. Under National Action Plan on Climate Change, Jawaharlal Nehru National Solar Mission was launched which aims to install 20GW solar power, 2 GW of off-grid Solar, 20 million sq. metre of solar thermal collector area and 20 million rural households to have solar lighting by 2022. Under off grid solar application scheme of Jawaharlal Nehru National solar Mission, a total target of 100 MW of solar photovoltaic system and power plants for sanctioning was fixed for 2010–11 and 2011–12. Against this the ministry sanctioned projects aggregating to 118.07 MWp. During the Eleventh Plan SPV systems of standalone power projects aggregating to 46.64 MWp capacity were installed against a target of 20 MWp.

14.195. Another thrust area for the Eleventh Plan was 'optimizing energy plantations by raising plants on degraded forest and community land'. A detailed analysis for availability of wasteland in India was carried out based on the information available. IISc,

**TABLE 14.46**  
**Eleventh Plan Financial Allocations and Expenditure: MNRE**

Programme Component	(₹ in crores)	
	BE	Expenditure
Grid-connected and Distributed Renewable Power	1,779	1,839.82
Renewable Energy for Rural Applications	910	910.95
Renewable Energy for Urban, Industrial and Commercial Applications	216	147.28
Research, Design and Development in Renewable Energy	481	340.33
Supporting Programmes	682	559.98
<b>Total</b>	<b>4,068</b>	<b>3,798.36</b>

Bangalore has estimated the waste land available in the country. Suitability of those areas for high yielding plantation and for Juliflora plantation has been estimated but policy models along with implementation guidelines to promote energy plantations have to be worked out.

14.196. The approved outlay for the Eleventh Plan for New and Renewable Energy programmes was ₹10,598.31 crore comprising of GBS of ₹4,068 crore and ₹6,530.13 crore of IEBR. The likely expenditure at the end of Eleventh Plan is ₹3,798.36 crore (Table 14.46).

### TWELFTH PLAN STRATEGY

14.197. Renewable energy has to play an expanding role in achieving energy security and access in the years ahead. The areas on which attention should be focussed during the Twelfth Plan are:

- Grid interactive and ff-Grid/Distributed Renewable Power
- Renewable Energy for Rural Application
- Renewable Energy for Urban, Industrial and Commercial Applications
- Research, Design and Development for New and Renewable Energy
- Strengthening of Institutional Mechanism for enhanced deployment and creation of public awareness.

14.198. The National Action Plan for Climate Change (NAPCC) norms envisage that the share of renewable electricity in the electricity mix which was 7 per cent in 2011–12 should reach 12 per cent

by 2016–17. For this the corresponding renewable power requirement would be 132 BU or 52,000 MW considering the conservative average capacity utilisation factor of 30 per cent. The present installed capacity of renewable power is around 25,000 MW and, consequently, the renewable power capacity addition required for the Twelfth plan would be about 30,000 MW. The component wise break up of physical targets for the Twelfth Plan is given in Annexure 14.4.

14.199. For the Twelfth Five Year Plan, in addition to reorienting various existing policy initiatives, several new measures have been identified that are deemed essential to accelerate the pace of deployment of renewable energy in the country.

### Schemes Spilling from the Eleventh Plan

#### *Grid Connected Renewable Power*

14.200. A capacity addition of 30,000 MW of Grid connected renewable power is proposed of which 15,000 MW is envisaged to come from wind power, 10,000 MW from solar capacity and 5,000 MW from other types of renewable sources. Institutional mechanisms to accelerate adoption of Renewable Power by States in the form of RPOs are sought to be enforced by bringing in an amendment into the Electricity Act, 2003. Accelerated depreciation benefit for wind power projects will come to an end at the end of the Eleventh five year plan. Tariff for Solar power under JNNSM is expected to continue falling due to enhanced indigenisation and local manufacturing. Further, to ensure volumes GBI support will be continued in the Twelfth Five Year Plan. It is also

proposed to restrict the upfront subsidy support for Small Hydro plants to 10 MW size of hydro plants from an existing size of 25 MW.

#### *Off-Grid Distributed Renewable Power*

14.201. An ambitious capacity addition target of 3,400 MW has been proposed, which is almost five times the targets of the Eleventh Plan for off-grid renewables. Cogeneration in non-bagasse industry is supposed to contribute maximum (2,000 MW) of the overall ambitious targets proposed by MNRE. 1,000 MW of off-grid solar capacity addition has been proposed in line with the targets of phase-2 of Jawaharlal Nehru Solar Mission. The financing for incentives for such projects would be sourced from a pool of funds originating out of National Clean Energy Fund, CSR activities and tax-free donations.

#### *Renewable Energy for Rural Applications for Cooking*

14.202. The biogas technology has now reached a stage of becoming robust and mature enough for meeting cooking energy needs with additional advantages of meeting good organic fertiliser needs for sustaining crop yield and productivity and soil health. It is recommended to continue biogas and solar cooker program. Additionally solar cooking could be promoted under mid-day meal programme.

#### *Renewable Energy for Rural Electricity Access*

14.203. Some of the existing models for providing off grid electrification have shown notable response. Consequently, models like Solar home lighting systems through banking system, entrepreneur based biomass gasifier models for providing electricity for lighting, and mini micro hydro systems would continue to be supported.

14.204. Renewable energy has to be seen as a complementary option to the current conventional power generation and it has special characteristics in terms of variability in availability. Solar power is available only during the day and the availability of wind power varies depending upon the time of the year and also intra-day depending on wind conditions. These characteristics imply some special efforts at balancing with other sources to ensure a reliable supply to the grid. Fortunately solar power

is at its peak precisely when demand is highest. However, that may not be the case with wind power. Effective utilisation of such power will require focused efforts towards balancing wind power with other power capacity which can be moderated to stabilise supply and also the development of efficient storage technologies. For this reason, special emphasis needs to be given on pumped water storage hydro plants. Central Government may consider providing assistance to the states for creating spinning reserve at the regional level by setting up of storage technologies. In the long term, other hybrid technology options such as gas with solar/wind, which are at a nascent stage, need to be developed. As the cost of power through conventional generation rise in the long term and technological developments in future increase the commercial viability of hybrid options, the cumulative financial benefits realised from using these options to meet peak demand requirements would outweigh the financial push provided to them in the present scenario.

#### *Off Grid Solution for Industrial, Commercial and Buildings Applications*

14.205. Existing scheme on solar water heaters will continue with a review of capital subsidy. Additionally green building programme and solar city initiative will be expanded to add new cities.

#### **Major New Initiatives**

14.206. The following are some of the new initiatives in the area of renewable energy:

1. **National Institute of Solar Energy:** The existing Solar Energy Centre would be converted into an autonomous institution for undertaking applied research, demonstration and development in solar energy including solar hybrid areas.
2. **National Bioenergy Corporation of India:** National Bio Energy Corporation of India (NBECI) will be set up to implement bioenergy mission including cook stove programme.
3. **Renewable Energy Development Fund:** In order to address the financing constraints for the grid connected as well as the off-grid applications of renewables, it is proposed to create a Renewable Energy Development fund. The fund will plug the gap between the sector financing needs and

the amount that falls short of the banks' obligations to their lending to this priority sector.

4. **National Bioenergy Mission:** Biomass energy for electricity generation has turned out to be one of the most attractive source of power which is scalable, has the largest potential for improving energy access and which can be linked to generating additional rural income. In view of the success of such biomass-based off-grid renewable models in rural areas of Bihar, it is proposed to launch the Biomass Mission with an objective to create a policy framework for attracting investment and to facilitate rapid development of commercial biomass energy market based on utilisation of surplus agro-residues and development of energy plantations.
5. **Renewable Power Evacuation Infrastructure:** Special emphasis will be placed on creating evacuation infrastructure and transmission facilities for renewable power in a time-bound manner to support the large expansion in consumption and production of renewable power. Judicious planning of transmission system, that is, creating pooling substation for cluster of renewable power generators and connecting them with receiving station of STU/CTU at appropriate voltage level, will lead to optimal utilisation of transmission system.
6. **National Biomass Cook Stove Programme:** The proposed initiative plans to universalise access of improved biomass cook stoves by providing assistance in exploring a range of technology deployments, biomass processing and delivery models leveraging public-private partnerships.

### Policy Approach

14.207. The logic of subsidising new initiatives is that once they gain criticality of mass in terms of manufacturing capacity they should be able to survive without receiving any subsidy or fiscal incentives from the government. In keeping with this approach the objective should be to move away to the extent possible from capital subsidies and fiscal incentives to performance based incentives. Attaining the proposed higher deployment levels for wind energy, GBI support will require to be continued during the Twelfth Plan period.

14.208. To ensure lowest cost procurement of renewable energy, particularly wind and solar power should be through an open competitive bidding process. This has proved successful and in line with the ultimate objective of reaching grid parity earlier. This is particularly true of solar, which is at present costly, however it is expected to achieve grid parity in the Thirteenth Plan period in conjunction with the objectives of JNNSM. The competitive bidding process adopted for selection of projects has already resulted in significant reductions in base tariffs notified by CERC. The tariff for solar energy is expected to continue falling due to technological development and focus on indigenisation and local manufacturing for future projects, thus paving way to grid parity in due course of time.

14.209. There is a need to create a special sectoral exposure limit for the renewable energy sector by the banks. Additionally, creation of special instruments like tax-free RE bonds on the line of infrastructure bonds would facilitate low cost and long term lending to the renewable sector. Priority-sector status may also be granted to the renewable sector in view of the social and environmental benefits of the projects. This will act as a major policy push for the off-grid applications, which face maximum barriers in receiving low cost finances.

14.210. India's strategic focus would need to be augmenting of decentralised renewable energy capacity in the rural areas where it is having large social impact. Off-grid renewable energy applications have significant potential of reducing furnace oil/diesel/kerosene consumption in the country and can significantly contribute to oil import substitution. A cluster based approach for village electrification needs to be adopted. Under this approach, tariff-based bidding mechanism for such clusters inviting participation from business models would bring down the tariff by a significant amount. The difference that the consumers in the clusters are willing to pay and tariff discovered through the bidding mechanism can be financed through annual viability gap funding. The choice of technology can be left to the entrepreneurs, which would

encourage entrepreneurs to constantly innovate their products and services to bring down the cost of producing electricity. Such projects would also be encouraged in the areas with grid availability but with lack of reliable supply so that power can be fed into the grid when the grid is energised and can be supplied to households when the grid is down. However, proper regulatory framework needs to be developed which can be adopted at state level, and has clear cut guidelines on monitoring, evaluation, multi-year operation and maintenance and ensures grid compatibility for such projects. Moreover, a sufficient financing mechanism for meeting out the viability gap requirement and an institutional mechanism to create an ecosystem for deployment of such projects needs to be put into place.

14.211. India is the second largest wind turbine manufacturer next to China. The installed manufacturing capacity in India ranges around 6,000 MW per year, with large export potential. The manufacturing base for wind turbines and its components has expanded to 16 manufacturers with 43 models of varying technologies and capacities. Till the year 2000, most of the machines were of 500 kW or lower capacity. Today, there are about 14 models from 5 different manufacturers of capacity 2 MW and above, the largest capacity being 2.5 MW. Larger machines have resulted in a steady increase

in the Capacity Utilisation Factor (CUF) from 10 per cent–12 per cent in 1998 to 22 per cent–25 per cent in 2012. Technology is moving towards better aerodynamic design, use of lighter blades, direct drives, permanent magnet technology, and variable speed gearless operation using advanced power electronics. The health monitoring of wind turbines is now computer-controlled and on real-time basis.

14.212. Improvements in wind turbine technology and its installations at higher hub heights are working towards induction of higher capacity turbines. At the higher hub heights, wind potential is estimated to be substantially higher compared to the normal wind turbines at 40–60 metres hub heights. It is estimated that average capacity factor in USA has grown by about 25–30 per cent over the last decade. Even in India, the low capacity, older machines at highly favourable locations, need to be replaced by newer, and high capacity ones. Higher hub heights will enhance wind energy outputs, and will also be cost efficient.

#### PLAN OUTLAY

14.213. The indicative Twelfth Five Year Plan outlay for the various Ministries/Department in the energy sector is given in the Table 14.47 below:

**TABLE 14.47**  
**Indicative Twelfth Five Year Plan Outlay for the various Ministries/Departments in the Energy Sector**

Sl. No.	Name of the Ministry/Department	Twelfth Plan (2012–17) Projections		
		GBS	IEBR	Total Outlay
1.	Ministry of Power	54,279	3,86,517	4,40,796
2.	Ministry of Coal	4,617	1,08,244	1,12,861
3.	Ministry of Petroleum and NG	5,147	4,36,541	4,41,688
4.	Ministry of Renewable Sources of Energy	19,113	13,890	33,003
	Sub-Total 1-4	83,156	9,45,192	10,28,348
5.	Department of Atomic Energy			
	(Power, Industry and Minerals Sectors)	21,737		
	R&D	19,878		
	Sub-Total DAE	41,615	65,572	1,07,187
	<b>TOTAL (Energy)</b>	<b>1,24,771</b>	<b>10,10,764</b>	<b>11,35,535</b>

**ANNEXURE 14.1**  
**Eleventh Plan Physical Progress of RGGVY Projects under Implementation**

Sl. No	State/UT Name (Number of Districts)	Electrification of Un/De-Electrified Villages (Achievement)	Intensive Electrification of Electrified Villages (Achievement)	No. of Connections to BPL Households (Achievement)
1	Andhra Pradesh (22)	0	25,562	27,02,273
2	Arunachal Pradesh (16)	1,313	825	21,646
3	Assam (23)	7,829	11,672	8,07,290
4	Bihar (38)	22,029	4,267	21,49,834
5	Chhattisgarh (14)	857	10,512	9,15,407
6	Gujarat (25)	0	14,457	8,02,818
7	Haryana (18)	0	2,744	1,94,442
8	Himachal Pradesh (12)	78	1,059	10,078
9	Jammu & Kashmir (14)	148	2,380	44,014
10	Jharkhand (22)	1,7905	5,505	12,72,755
11	Karnataka (25)	61	24,575	8,34,196
12	Kerala (7)	0	37	17,238
13	Madhya Pradesh (32)	504	17,942	7,17,394
14	Maharashtra (34)	0	32,528	11,60,732
15	Manipur (9)	616	401	28,814
16	Meghalaya (7)	1,172	1,537	62,768
17	Mizoram (8)	89	338	14,743
18	Nagaland (11)	79	725	28,514
19	Orissa (30)	14,226	21,207	27,48,137
20	Punjab (17)	0	0	53,925
21	Rajasthan (33)	3,999	29,083	10,43,522
22	Sikkim (4)	25	375	9,366
23	Tamil Naidu (26)	0	9,992	5,02,956
24	Tripura (4)	127	463	80,986
25	Uttar Pradesh (65)	27,759	2,982	10,44,494
26	Uttarakhand (13)	1,511	9,028	2,30,558
27	West Bengal (17)	4,169	18,357	19,26,383
	<b>Total (546)</b>	<b>1,04,496</b>	<b>2,48,553</b>	<b>1,94,25,283</b>



**ANNEXURE 14.2**  
**Sectoral Coal Demand/Off-take for Annual Plan 2012-13**

Sl. No.	Sector	(In Million Tonnes)									
		2006-07	2007-08	2008-09	2009-10	2010-11	2011-12		2012-13	2016-17	
		Actual	Actual	Actual	Actual	Actuals	BE	Provi.	BE		
I	Coking Coal										
	Steel/Coke Oven (indigenous)	17.37	16.99	16.58	15.92	16.80	17.23	16.05	22.00	31.70	
2	Import	17.88	22.03	21.08	23.47	23.20	29.44	30.62	30.00	35.50	
	<b>Sub-Total Coking:</b>	<b>35.17</b>	<b>39.02</b>	<b>37.66</b>	<b>39.39</b>	<b>40.00</b>	<b>46.67</b>	<b>46.67</b>	<b>52.30</b>	<b>67.20</b>	
II	Non Coking										
3	(i) Power Utilities (Gen. Req.)	307.92	332.40	362.08	380.13	405.00	460.00	412.00	512.00	682.08	
4	Cement	19.74	21.27	20.09	20.80	25.98	28.89	28.89	30.24	47.31	
5	Steel DRI	17.47	20.92	19.78	22.89	28.80	30.47	30.47	35.30	50.33	
7	Fertilisers	2.96	2.94	3.09	2.63	85.00	90.00	81.97	100.00	77.22	
8	LTC/Soft Coke*	51.49	57.50	72.54	77.18						
9	Cokeries/Coke oven (NLW)*										
10	BRK and Others										
11	Captive Power	28.13	29.31	32.94	38.47	40.00	40.00	40.00	43.00	56.36	
12	Colly.Consumpt.	0.99	0.93	0.85	0.76			0.73			
	<b>Sub Total Non-Coking:</b>	<b>428.70</b>	<b>465.27</b>	<b>511.37</b>	<b>542.86</b>	<b>584.78</b>	<b>649.36</b>	<b>593.33</b>	<b>720.54</b>	<b>913.30</b>	
	<b>Grand Total(I + II): including middlings</b>	<b>463.87</b>	<b>504.29</b>	<b>549.03</b>	<b>582.25</b>	<b>624.78</b>	<b>696.03</b>	<b>640.00</b>	<b>772.84</b>	<b>980.50</b>	
	Middlings	3.25	3.18	2.61	2.21						

Note: (i) \*Included in BRK and Others.

**ANNEXURE 14.3**  
**Annual Plan 2012-13—Company-wise Production—Ministry of Coal**

Company	2006-07		2007-08		2008-09		2009-10		2010-11		2011-12		2012-13		2016-17	
	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Target	Provi.	Target	Target	Target	Target
ECL	30.47	24.06	28.14	30.06	30.81	33.00	31.00	33.00	31.00	33.00	31.00	31.00	33.00	33.00	45.00	45.00
BCCL	24.21	25.22	25.51	27.51	29.04	30.00	30.20	30.00	30.00	30.00	30.20	30.20	31.00	31.00	37.00	37.00
CCL	41.32	44.15	43.24	47.08	47.52	51.00	49.00	51.00	47.52	51.00	49.00	49.00	55.00	55.00	92.00	92.00
NCL	52.16	59.62	63.65	67.67	66.25	68.50	64.50	68.50	66.25	68.50	64.50	64.50	70.00	70.00	82.00	82.00
WCL	43.21	43.51	44.70	45.74	43.65	45.50	43.80	45.50	43.65	45.50	43.80	43.80	45.00	45.00	45.00	45.00
SECL	88.50	93.79	101.15	108.01	112.71	112.00	113.75	112.00	112.71	112.00	113.75	113.75	117.00	117.00	145.00	145.00
MCL	80.00	88.01	96.34	104.08	100.28	106.00	103.00	106.00	100.28	106.00	103.00	103.00	112.00	112.00	167.00	167.00
NEC	1.05	1.10	1.01	1.11	1.06	1.00	0.75	1.00	1.06	1.00	0.75	0.75	1.10	1.10	2.00	2.00
CIL	360.92	379.46	403.74	431.26	431.32	447.00	436.00	447.00	431.32	447.00	436.00	436.00	464.10	464.10	615.00	615.00
SCCL	37.71	40.60	44.54	50.43	51.33	51.00	51.00	51.00	51.33	51.00	51.00	51.00	53.10	53.10	57.00	57.00
Other Public Sector	1.77	2.02	1.84	3.30	1.81	3.55		3.55	1.81	3.55			18.00	18.00	23.00	23.00
Private—TIOSCO	7.04	7.21	7.28	7.21	7.03	8.40	17.75	8.40	7.03	8.40	17.75	17.75				
Captive	17.61	21.17	29.87	35.03	34.60	38.25	36.15	38.25	34.60	38.25	36.15	36.15	39.80	39.80	100.00	100.00
Meghalaya	5.79	6.54	5.49	5.77	6.97	5.80		5.80	6.97	5.80						
<b>Grand Total</b>	<b>430.84</b>	<b>457.00</b>	<b>492.76</b>	<b>533.00</b>	<b>533.06</b>	<b>554.00</b>	<b>540.00</b>	<b>554.00</b>	<b>533.06</b>	<b>554.00</b>	<b>540.00</b>	<b>540.00</b>	<b>575.00</b>	<b>575.00</b>	<b>795.00</b>	<b>795.00</b>

**ANNEXURE 14.4**  
**Physical Targets of Renewable Programme for the Twelfth Plan**

Programme	Proposed Twelfth Plan Targets
1. Grid-interactive Renewable Power(MW)	30,000
Grid Interactive Solar	10,000
Grid Connected Wind	15,000
Other Renewable Sources	5,000
2. Off-grid/Distributed Renewable Power (MWe)	3,400
Cogeneration from bagasse	2,000
Solar Off-Grid Applications	1,000
Waste to Energy	200
Bio Gas Based Decentralised Power	50
Others (Biomass Gasifiers, Micro-hydel)	150
3. Renewables for Rural applications (Cooking)	
Biogas Plants (million)	0.7
National Biomass Cook stoves Programme (million)	3.5
Solar Cookers (Box type + Dish type)	3.5
Solar Cooking in schools for mid-day scheme (Schools in lakhs)	5.0
4. Renewable Energy for Urban, Industrial and Commercial Applications	
Solar Water Heating Systems (million sq.m of collector area)	6
Solar Air Heating System (sq m.)	
CST based systems for community cooking (sq.m.)	50,000
CST based system for air-conditioning (125 systems, 30TR)	40,000 37,000
CST based systems for process heat (225 systems, 250 sq.m. area each)	53,750
5. Solar Cities	
New Solar Cities in addition to existing target of 60 cities and pending liabilities.	15
Model and Pilot Solar Cities.	
Green Townships.	25
Tourist/Religious/ Important Places	150 100
6. Alternate Fuel Vehicles (in numbers)	2,75,000
7. Power Generation from Hydrogen	
Stationery Power Generation (KW)	4,000
Hydrogen/H-CNG Stations (nos)	10
Demonstration projects for Hydrogen/H-CNG vehicles	500
8. Power Generation from Fuel Cell	10.0
Stationery Power Generation (KW)	10/2,000
Back- up units for telecom towers (MW/nos)	
Fuel cell Vehicles	100

Source: MNRE.