

Report of the Working Group on Petroleum & Natural Gas Sector for the XI Plan (2007-2012)



Ministry of Petroleum & Natural Gas

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Executive Summary

1.1 Economy & Energy

- 1.1.1 Efficient, reliable and competitively priced energy supplies are prerequisites for accelerating economic growth. For any developing country, the strategy for energy development is an integral part of the overall economic strategy. Efficient use of resources and long-term sustainability remains core objective of economic planning. Sustainability would take into account not only available natural resources and issues related to ecological balance but also established delivery mechanisms, the technological constraints that are prevalent in the system and immediate compulsion to meet the priority needs of the economy, economic equity and self-reliance. Simultaneous and concurrent action is, therefore, necessary to ensure that the short-term concerns do not detract the economy away from the long-term goals.
- 1.1.2 Realisation of high economic growth aspirations by the country in the coming decades, calls for rapid development of the energy market. The energy resources available indigenously are limited and may not be sufficient in the long run to sustain the process of economic development translating into increased energy import dependence. The base of the country's energy supply system is tilted towards fossil fuels, which are finite. This has serious long-term implications as the emerging patterns of energy consumption, which is heavily skewed towards oil and gas, bring to focus many ecological and environmental issues.
- 1.1.3 India meets nearly 30 percent of its total energy requirements through imports. With the increase in share of hydrocarbons in the energy supply/use, this share of imported energy is expected to increase. The challenge, therefore, is to secure adequate energy supplies at the least possible cost. Although growth of the energy sector is moderate and has, to some extent, served the country's social needs, it has put tremendous pressure on the Government's budget.

1.2 International Scenario

- 1.2.1 Projected global oil consumption is expected to register a substantial growth over the present levels. Recently published energy reports project incremental demand of about 38 million barrels per day (mbpd) in 2030 over 80 mbpd level in 2003. Most of this incremental demand will emanate from developing countries including China and India where oil consumption is expected to grow at the rate of 3.8 and 2.4 percent respectively as against the world average of 1.4 percent. Non-OPEC (Organisation of Petroleum Exporting Countries) production, though showing an upward trend, will not be sufficient to service this incremental demand emphasising, once again, the continued dependence of the world on OPEC oil for its energy requirements.
- 1.2.2 High oil and gas prices have prompted increased investments in the exploration and production (E&P) sector posing new challenges for the sector in the form of increased cost of operations due to high service costs, exposure to logistically difficult terrain and shortage of technical manpower. Global refining scenario indicates very little to negligible addition in capacities in major developed consuming markets like the USA and the European countries. Developing countries like the Middle East, China and India are fast emerging as refining hubs. Needless to say that capacity augmentation in these regions would also result into possible integration of both the refining and petrochemicals business.

- 1.2.3 Natural gas has been rightly termed as the fuel of the 21st century. Natural gas, the third largest contributor to the global energy basket, is projected to increase at a rate faster than any other energy source. In the global context, natural gas market era has truly begun during the last 5 years. The global gas markets are fast integrating, commercial models are undergoing rapid changes, and the market structures are evolving and fast changing. Leading this growth in global gas sector are the Asian markets with special investment focus on countries like China and India.
- 1.2.4 It is indeed difficult to predict what will happen to oil prices over a five year period but current assessments indicate that oil prices will remain high. This will exert downward pressure on the economy, both directly and also through their impact on world economic growth. Currently, the impact of high oil prices on the world economy has somewhat been offset because the industrialised countries have adjusted to these higher oil prices. Sustained conditions of high oil prices, however, will eventually create macro-imbalances in the world economy making it vulnerable to any future 'oil shock'. Simulations with macro-models suggest that if oil prices increase sharply in future, growth rate could be compromised by between 0.5 and 1.0 percentage points below the levels projected with present levels of oil prices.
- 1.3 Indian Scenario**
- 1.3.1 India is and shall remain heavily dependent on coal for about half of its primary commercial energy requirements with the other half being dominated by oil and gas put together. The Indian hydrocarbon industry is currently passing through a challenging phase. Increasing concern for energy security, increasingly stringent environmental regulations, emergence of natural gas and soaring crude oil and natural gas prices have thrown up both challenges and opportunities to the Indian oil and gas industry.
- 1.3.2 Projected high domestic demand for petroleum products is expected to push investments into the refining sector. India, with 18 refineries, currently has a surplus refining capacity which has placed India amongst net petroleum product exporter countries. Increasingly stringent fuel specifications have put pressure on the old and non-compliant refineries to upgrade their refinery configurations to produce compliant fuels. The Government is seriously considering promoting India as a competitive refining destination to service export market for petroleum products as also integrating it with the petrochemical and chemicals businesses to produce and export higher revenue generating value added products.
- 1.3.3 Exceptionally high crude oil prices in the international market and an almost stagnant domestic crude oil production has caused a drain on country's foreign exchange reserves. The Government is committed to mitigating these challenges and has, in fact, met with accelerated domestic exploration through its New Exploration Licensing Policy (NELP) policy initiative. Some of the world class oil discoveries have recently been reported from blocks offered under the NELP regime. Five NELP rounds have resulted into 110 PSCs being signed and the Sixth round offering 55 exploration blocks is still underway. Besides augmenting domestic reserves, India has successfully ventured overseas to acquire oil and gas assets and entered into long-term Liquefied Natural Gas (LNG) contracts as measures for enhancing energy security.
- 1.3.4 Creating sustainable transportation system through cross-country crude oil and petroleum product pipelines in the next few decades, with the objective of preserving environment and protecting human health and safety would be a real challenge for the petroleum industry.

1.3.5 Persistence of high oil prices and dependence on imported oil leaves India with some difficult choices to make. The choice is between (a) passing on the price increase to the consumer; (b) rationalising taxes and other levies on petroleum products; and (c) making the National Oil Companies (NOCs) bear the burden. Although the Government has resorted to a combination of all above three options in the past, each of these options has its own drawbacks. In the long run, the only viable policy to deal with high international oil prices is to rationalise the tax burden on oil products over time, remove anomaly, if any, in the existing pricing mechanism, realize efficiency gains through competition at the refinery gate and retail prices of petroleum products, and pass on the rest of the international oil price increase to consumers, while compensating targeted groups below the poverty line as much as possible.

1.3.6 With the advent of LNG and progressive de-control of gas prices, the natural gas sector in India has progressed and achieved some degree of maturity. It has managed to receive progressively growing attention from global companies and has made rapid strides during the last five years. Current natural gas policy dispensations have created numerous challenges for the gas sector. Major among them are the demands of competing consumer industries, ensuring competition and open access in the pipeline transportation and distribution networks, reducing the supply demand gap that exists today.

1.4 Thrust Areas for the Petroleum and Natural Gas Sector

1.4.1 The following thrust points, discussed under respective industry segment, merit consideration for the healthy overall development of the oil and gas industry.

Exploration & Production

- Increasing domestic production by attracting investments, both private and public, in the upstream sector. This needs to be attempted by involving industry participants in formulating an investor friendly E&P investment regime.
- Taking all steps to increase the production from ONGC's (Oil and Natural Gas Corporation) assets including their maturing field.

Refining

- Equipping domestic refining industry both existing and planned to successfully meet the challenge of producing fuels complying with prescribed environment friendly specifications which are increasingly becoming stringent.
- Promoting India as a competitive and economically viable refining destination to service both the domestic as well as the export market.

Pipelines

- Increasing the coverage of pipelines throughout the country.
- Leveraging the inherent advantages of using pipelines to transport products and enhancing the pipeline infrastructure in product pipelines.
- Building a sound gas transportation infrastructure to support the projected growth of the gas market. Setting up of a regulator under the Petroleum and Natural Gas

Regulatory Board Act, 2006 (PNGRB Act 2006) to regulate the downstream oil and gas sector, including gas infrastructure, is expected to provide clarity and comfort to investors interested in India's gas transportation sector.

Marketing

- Steps need to be undertaken by all stakeholders to curb adulteration.
- Maintaining viability of retail outlets by synergy among public sector oil marketing companies in setting up of new retail outlets.
- Introduction of automation of retail outlets throughout the country.

Alternate Fuels

- Promoting use of ethanol-blended petrol and bio-diesel throughout the country.
- Exploring and exploiting country's CBM resource.

Research and Development

- Promoting Research and Development (R&D) activities through provision of incentives and funds.

Energy Conservation

- Encouraging energy conservation through campaigns aimed at sensitising the people about the significance of efficient use of energy.

Addressing Workforce Challenges

- Proactive planning for sustained availability of knowledge workers for the entire oil and gas industry.

1.5 Acknowledgements

1.5.1 The Working Group thanks all the Members from the Government, public and private sector, autonomous/industry bodies and their representatives of the Working Group on Petroleum and Natural Gas for the XI Plan for their contribution, cooperation and support throughout the preparation of this report. Thanks are due to Shri Anil Razdan, Additional Secretary, Shri Prabh Das, Shri Ajay Tyagi, Shri Narsimha Raju, concerned Joint Secretaries in the Ministry, Shri P K Sinha, Joint Secretary & Financial Adviser, Shri C.B. Singh, Joint Adviser (F) and their teams for giving valuable inputs to the Working Group from time to time. The Working Group thanks the officials of Petroleum Planning and Analysis Cell (PPAC), Petroleum Conservation and Research Association (PCRA) and Petroleum Federation of India (PetroFed) and their team members for their inputs and support. Thanks also to the members of the various working Sub Groups for timely preparation of the Working Sub Group Reports.

1.5.2 To summarise, the task of achieving an average growth rate in Gross Domestic Product (GDP) between 8 and 9 percent as being projected by the Government for the XI Plan could be feasible, provided necessary policy interventions are made in one of the important sectors like oil and gas which is the back bone of the economy. Keeping the above points in view the Report of the Working Group on Petroleum and Natural Gas

Sector for the XI Plan has analysed the emerging trends and factors influencing the oil and gas sector and outlined the action plan for the aforesaid period 2007-2012. Terms of Reference (TOR) of the Working Group are at Annexure - I. The report is the outcome of various deliberations held by various Working Sub Groups constituted for the purpose, which comprise members from the private as well as public sector. The terms of reference of the various Working Sub Groups are at Annexure – II (a) to II (c).

2 Overview of Petroleum & Natural Gas Sector

2.1 Background

2.1.1 Energy is essential for living and vital for development. Affordable energy¹ directly contributes to reducing poverty, increasing productivity and improving quality of life. Likewise lack of access to reliable energy is a severe impediment to sustainable social development and economic growth. For any developing country, the strategy for energy development is an integral part of the overall economic strategy. Efficient use of resources and long-term sustainability remains core objective of economic planning. Sustainability would take into account not only available natural resources and issues related to ecological balance but also established delivery mechanisms, the technological constraints that are prevalent in the system and immediate compulsion to meet the priority needs of the economy, economic equity and self-reliance.

2.1.2 Simultaneous and concurrent action is, therefore, necessary to ensure that the short-term concerns do not detract the economy away from the long-term goals.

2.2 Global Scenario

2.2.1 It may be worthwhile to examine how large energy consuming but resource deficit countries have tackled these issues. Their experience could be relevant in devising an appropriate energy policy for India.

2.2.2 In Asia, Japan and China are the largest consumers of energy. In Japan, the energy policy objectives can be summarised as the “3 Es” namely:

- Energy security,
- Economic development and
- Environmental sustainability.

2.2.3 Japan’s objective is to achieve the three goals simultaneously, although they often contradict one another and the government recognizes the possibility of trade-offs between them. Owing to conscious policy since early 70s, Japan has been able to (a) reduce energy consumption through conservation, (b) reduce oil consumption through diversification, (c) increase use of natural gas over coal (Japan is deficit in both resources) due to favourable impact on environment, (d) increase nuclear energy and maximize renewable resources. As a result of their efforts energy mix of Japan has changed with oil having been diversified into nuclear, natural gas and coal.

2.2.4 It is understood that China has recently finalized its XI Five Year Plan. The central tenet relating to energy policy places priority on energy conservation with a target to decrease energy consumption by 20 percent by 2010 and pursue logical and reasoned development of the coal sector. It also suggests diversification of energy sources by aggressive development of electricity, accelerated development oil and natural gas and development of renewable energy sources.

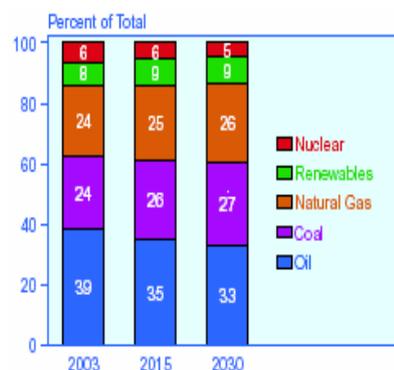
¹ In UK, households that spend less than 10 percent of their income on heating their homes are officially stated to suffer from fuel poverty.

2.2.5 Thus, it may be seen that both the countries have devised a long-term plan keeping in mind the available resources with the country. Besides, wherever resources are deficit, efforts are being made to reduce dependence on them. Details of approaches adopted by Japan and China are discussed under 13.5. Annexure III: Energy Policy in Asian Economies.

Global Oil Scenario

2.2.6 World oil use is expected to grow from about 80 million barrels per day (mbpd) in 2003 to 98 mbpd in 2015 and 118 mbpd in 2030 as per Energy Information Administration (EIA), International Energy Outlook (IEO) 2006.

2.2.7 In the IEO 2006 reference case, world oil prices rise from \$31 per barrel (in real 2004 dollars) in 2003 to \$57 per barrel in 2030, and oil's share of total world energy use falls from 39 percent to 33 percent. Shift in energy mix over the period of time is shown in the chart.



2.2.8 To meet the projected increase in world oil demand, total petroleum supply in 2030 will need to be 38 mbpd higher than the 2003 level of 80 mbpd. Of this, China is projected to consume additional 9.4 mbpd, US 7.5 mbpd and Asia (other than China & India) 6 mbpd. The balance growth is expected in South America, Africa and Middle East. As per the same report India is expected to consume additional 2.2 mbpd. OPEC producers are expected to provide 14.6 mbpd of the increase. Higher oil prices cause a substantial increase in non-OPEC oil production—23.7 mbpd, which represents 62 percent of the increase in total world oil supplies over the projection period. In addition, unconventional resources (including biofuels, coal-to-liquids, and gas-to-liquids) are expected to become more competitive. In 2003, world production of unconventional resources totalled only 1.8 mbpd. Unconventional resource supplies are expected to rise to 11.5 mbpd and would account for nearly 10 percent of total world energy supply in 2030.

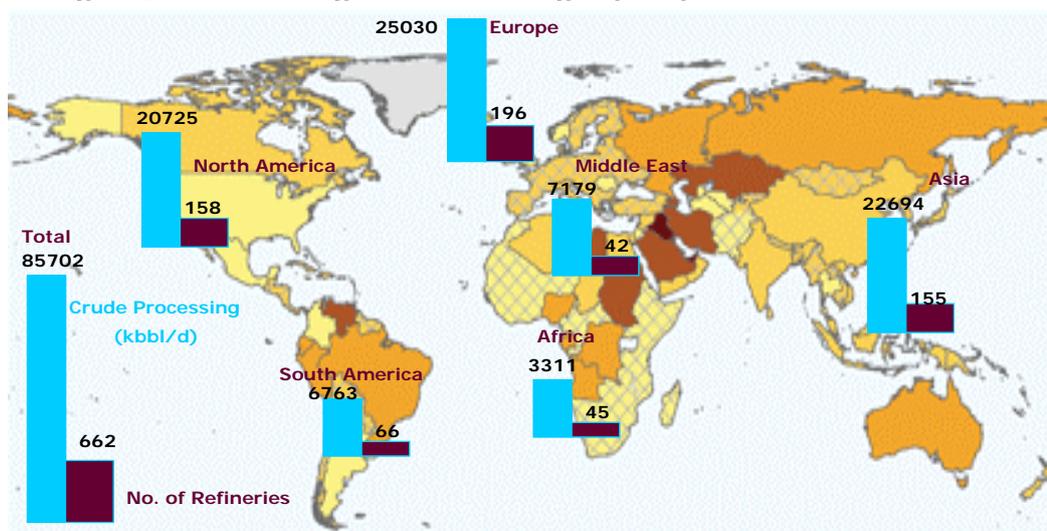
Global E&P Scenario

2.2.9 E&P activities world over are on the rise with spurt in crude oil and natural gas prices in international market. Consequently, increase in demand-supply gap in E&P services and availability of technical manpower, are new challenges for E&P companies. The shortage of rigs, seismic survey crews and technical manpower is increasing the E&P costs. However, despite these constraints, the rise in crude oil and natural gas prices is motivating E&P companies to search for hydrocarbons in frontier and logistically difficult areas including deepwater. Few issues of importance in the current international petroleum scenario are discussed below:

- **Deep-water exploration in the world:** World over oil companies are venturing in this frontier area, particularly in Gulf of Mexico, North Sea and Western Offshore Africa.

² Current Indian demand (during 2005-06) is about 112 MMT or 2.24 Mb/d

Figure 2.1: Current Region-wise Refining Capacity and No. of Refineries



- **Pursuing development and production from established/ageing fields:** Technological innovations are made to reduce E&P costs and increase recovery. Identification of cutting-edge technology is a key to developing ageing fields.
- **Privatization of energy sector in developing regions like East Asia and Pacific, Latin America, CIS, South Asia:** Such opportunities need to be assessed as these regions are historically, ideologically, politically and culturally, similar to India.
- **Strategic alliances to reduce/share risks in marginal field exploration and development:** Companies have already entered into such alliances in acreages in India. The experience can be extended to preferred partners in overseas ventures.
- **End-product marketing by oil companies engaged in E&P:** Major oil companies are vertically integrated with all the three sectors of petroleum industry - upstream, downstream and marketing.
- **Asset/Activity based E&P management through multi-disciplinary teams:** In 1990s, major E&P companies and some NOCs started reorganizing themselves into asset based small companies. This structure, with a multi-disciplinary team of geoscientists and engineers, has turned some of the marginal producing properties commercially viable. Besides, a trend of strategic alliance with service companies has also emerged so that the service companies are now directly participating in E&P activities by providing technological solutions to field specific problems.
- **Information technology for strategic advantage:** Prodigious growth in information technology is being utilized by multi-disciplinary teams for Data-warehousing/interpretation etc. and seamless online connectivity for timely quality decision-making.
- **R&D:** Efforts in R&D are focused towards continuous improvement in efficiency and cost-effectiveness of E&P techniques besides attaining a technological edge over competitors and solving new technological challenges.

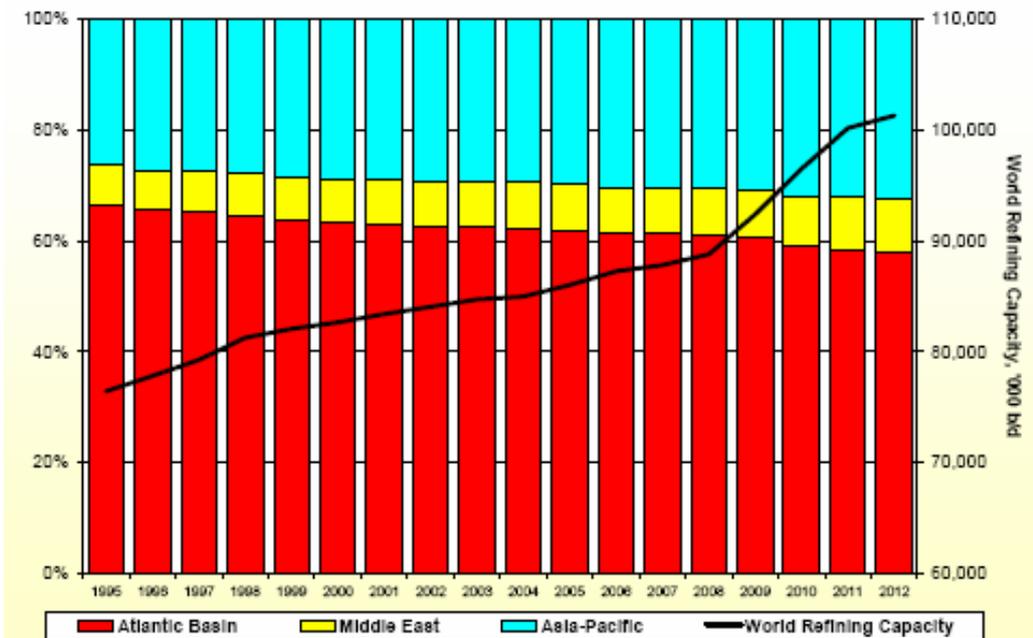
Global Refining Scenario

2.2.10 Global refinery scenario particularly that of Asia is turning attractive. In Europe, there has been no substantive addition in the refining capacities. At a number of places refineries are being closed down because of environmental concerns and uneconomic size. In the US, refining capacity has increased marginally. In Central Asia, the refineries are old and require a huge dose of investment. The only area, which has seen a spurt in refining capacity, is the Middle East, India and China. The average annual growth rate of refining capacity in the last one decade in the world is 1.2 percent. Most of this capacity addition has been in Asia-Pacific region, which contributed about 56 percent of the capacity addition. The current regionwise refining capacity is shown in the Figure 2.1.

2.2.11 The next five years are projected to be crucial for refineries. Cracking margins are expected to remain strong with strong forecast for oil demand growth coming from Asia Pacific and the US and move throughout the world towards cleaner fuels. It is expected that early movers could benefit strong margins for several years.

2.2.12 Figure 2.2 shows the trend in refining capacity additions in the Atlantic Basin, Asia Pacific and Middle East Regions. It may be seen from the graph that over a period of time the refining capacity share of the Atlantic Basin is reducing and the share of Asia Pacific region is increasing. This is in line with the trend of maximum refining capacity being added in the Asia Pacific region. The world refining capacity at the end of 2010 is expected to be about 94 mbpd and around 102 mbpd in 2012. The significant expansion of capacity forecast for China and India would have the effect of pulling the locus of

Figure 2.2: Region-wise Trend in Refining Capacity Additions



world refining more toward the Asia-Pacific region.

2.2.13 Thus, there appears to be an excellent opportunity for capacity augmentation in the Asia Pacific region. Asia, including India and China, are projected to account for half the incremental consumption. Asia in general is projected to be the centre of growth for the next few decades. This perhaps is an opportune moment for the domestic refining

industry to take up this challenge and make India a major refining destination. The viable route, therefore, would be to export surplus products and value-add by production of petrochemicals/polymers and other chemicals. New refineries would necessarily need to meet the projected fuel standards of developed countries to access those markets. Further, India has a geographical advantage due to proximity to source of oil and emerging markets.

Global Natural Gas Scenario

- 2.2.14 The oil and gas producers and users across the world are sitting up and revisiting their strategies in view of the increasing prices. The issue of energy security and broad-basing the energy portfolio has become every country's priority.
- 2.2.15 Natural gas, accounting for 24 percent of the total global primary energy supply, is the third largest contributor to the global energy basket. Natural gas consumption is expected to increase at an average of 2.4 percent per year from 2003 to 2030 as per EIA, IEO 2006. Among the end-use sectors, the industrial sector remains the largest consumer of natural gas worldwide, accounting for 52 percent of the total incremental demand for natural gas between 2003 and 2030. Natural gas is also expected to remain an important energy source in the electric sector, particularly for new generating capacity.
- 2.2.16 In a global context the natural gas era has truly begun during the last five years. With cross border gas trade becoming a Hobson's choice for gas producers who aspire to achieve real business growth, the global gas markets are fast integrating, the commercial models are undergoing rapid changes and the market structures are evolving and fast changing. More importantly, the Asian gas markets are leading the growth in global gas sector, with special investment focus on countries like India and China.
- 2.2.17 Integration of Global Gas Markets has by far been the most significant development during the period 2002-07. LNG has been one of the key drivers of this integration. With an almost 75 percent increase in liquefaction capacities from 87 MTPA to more than 150 MTPA over the past 10 years, the share of LNG in global gas trade has grown from 14 percent to 26 percent. This has also been supported by the fact that there is a continuous lowering of cost across the LNG value chain, which has transformed the LNG economics. This has contributed to establishing LNG as a major viable and flexible option. By meeting the buyers' expectations through price and contractual flexibilities, price review option and destination flexibility, LNG trading has emerged as a truly global and mature business.
- 2.2.18 At the same time, trans-national gas pipelines have continued to be a dominant gas supply option, especially between contiguous nations, and have emerged as a dominant integrating factor. The Russia–Poland–Central Europe pipeline, the Blue Stream project connecting Russia and Turkey via the Black Sea, the idea of a Northern Trans–Europe Gas pipeline connecting Russia to Finland and the UK via the Baltic Sea indicate the integration on the European side. On the Asian side, the Iran-Pakistan-India Pipeline, the Myanmar-India Pipeline and the Turkmenistan-Afghanistan-Pakistan-India Pipeline are receiving the highest attention from the concerned Governments.
- 2.2.19 Thus, integration of gas markets has become a necessity primarily due to five important reasons :

- a) Firstly, gas has emerged as an important alternative source of energy. The Reserve to Production ratio of gas at 67 years continues to be ahead of oil at 40 years. There is therefore an economic imperative for faster monetization of gas reserves from a commercial perspective of the producing nations.
- b) Secondly, the top 15 gas producing nations, except the US, having 78 percent of the global gas reserves, account for only 27 percent of the global consumption. Therefore, they have an inescapable need to look for marketing their gas globally.
- c) Thirdly, there is an overall globalization trend in all businesses, backed by an Information Technology boom and 24 X 7 communication links.
- d) Fourthly, the Asian boom has a very important role to play in this area. The gas markets in China and India are shaping out to be major drivers of growth. With China's energy demand growing by 15 percent and India's by 7.8 percent, these two Asian giants are projected to be the leading gas consumers by the year 2020.
- e) Finally, the spiralling oil prices and the uncertainty on the pricing front are helping to shape the gas market. In this regard, two interesting trends in the oil sector need a special mention:
 - The rate of growth of world oil supply is constantly reducing and a flatter trend in the future is becoming apparent.
 - The oil prices might settle at comparatively higher levels.

2.2.20 The implications of this integration through global gas trades, propelled by the five factors mentioned above, are far reaching - economically, strategically and, indeed, politically too.

2.2.21 The most integrated gas market today is the European market. The effective integration of sources and markets in Europe not only resulted in physical demand being met but also ensured the lowest gas prices amongst the gas importing nations. The European Union (EU) Gas Directive took decisive shape during 2002-07, driving the gas market reforms of the member nations. The Energy Charter Treaty Secretariat based in Belgium has been playing an active role in enabling smooth trade among the EU Nations.

2.2.22 The focus now is on the integration of the Asian markets, which would provide the major platform for growth for the global gas sector. Asia today accounts for 70 percent of the total LNG trade; Japan and Korea are meeting their entire gas requirement through imports. Natural gas accounts for 3 percent of China's primary energy consumption and 9 percent of that of India. These two countries today account for less than 3 percent of the global gas consumption. But, with greater integration of the natural gas markets at a global level, the share of natural gas consumption in China and India together is expected to account for more than 17 percent of the total global natural gas consumption by the year 2020 as has been reported in the Energy Intelligence Agency Global Energy Forecast 2004.

2.2.23 Therefore, the next 15 years should be very exciting years for both India and China for the development of their gas sectors through integration with global gas markets. The following table provides an overview of the expected trend in the LNG Trade:

Year	LNG Global Trade (MMTPA)	% Share in World Gas Trade
2003	110	23 percent
2010	180-220	29-31 percent
2020	315	38 percent

2.2.24 Oil and gas policy, a subset of energy policy, will follow from the assessment of available domestic resources, requirements of growing economy, needs of the citizens, and the emerging global environment. Towards this end, the action taken by the Planning Commission in finalizing the report of the Integrated Energy Policy (IEP) wherein the assessment of the resources and their likely availability of supplies have been dealt with in details. However, the overview of the petroleum and Natural Gas sector in India is as under:

2.3 **Indian Scenario:**

2.3.1 The structure of primary energy consumption in India shows that coal (51 percent) dominates as the major energy source. Hydrocarbons (45 percent) is the next available energy provider of the nation. Natural gas is fast emerging as an alternative; it meets around 9 percent of the primary energy needs. Considering the global trend of shift in energy mix from oil to gas, the share of gas in consumption pattern, in the Indian context, is also likely to increase gradually in the days to come.

2.3.2 Currently, India's consumption (111.9 MMT in 2005-06) of petroleum products is only about 1/5th of world's average per capita consumption. In the X Plan (2002-07), the growth in consumption is expected to be around 2.6 percent per annum. In India, the indigenous production of crude oil has not been increasing in tandem with the consumption/demand of petroleum products. Government of India, under the NELP program, has already given a number of blocks for exploration, to various national and international agencies.

2.3.3 The hydrocarbon industry has been passing through very turbulent and challenging times for the last few years. The increasingly stringent environmental regulations, emergence of natural gas and soaring crude prices have thrown up challenges to the oil industry on one hand and opportunities on the other hand, such as gas business. Although natural gas is now being used as transport fuel the liquid fuels have traditionally remained the mainstay of hydrocarbon industry. There has been emphasis and quest for cleaner alternatives and CNG has merged as an alternative fuel.

2.3.4 The crude oil and gas reserves as on April 1, 2006 stand at 756 MMTOE and 1,075 BCM respectively. In 2005-06, crude oil and natural gas production by ONGC, OIL and Pvt/JV companies was about 32.19 MMT and about 32.20 BCM respectively.

Surplus Refining Capacity and Potential for an Export Hub

2.3.5 India has at present 18 refineries with refining capacity at 132.47 MMTPA. At the end of the X Plan (2007) the refining capacity is expected to reach 148.97 MMTPA against the consumption of about 114 MMTPA thereby resulting into surplus of refining capacity. India's export performance has also been very impressive. India has turned into net exporter of petroleum products from 2001-02 and during the year 2004-05 the net

exports were 8.7 MMT. During the year 2005-06, India exported 21.50 MMT of products mostly comprising of Naphtha, Petrol, Aviation Turbine Fuel (ATF) and Diesel. By these exports about Rs. 46,785 crore of revenue was generated by the refining sector. Thus, the Ministry and companies are taking initiative for exploiting the potential for an export hub in India for petroleum products based on the export opportunities available in South East and East Asian countries.

Status of Product Pipelines

- 2.3.6 Cross-country pipeline networks, preferred as a cost-effective, energy-efficient, safe and environment friendly mode for transportation of crude oil and petroleum products, have been playing a vital role in meeting India's energy demand. They are now a key constituent of the country's infrastructure, transporting crude oil from import terminals as well as domestic sources to inland refineries, and finished products from refineries to major consumption centres.
- 2.3.7 Creating sustainable transportation system through cross-country pipeline in the next few decades with the objective of preserving environment and protecting human health and safety would be the great challenge for the petroleum industry. As on 1.4.2006 India has around 7,696 km of product pipeline in the country with total capacity of around 55.58 MMTPA. In addition there are 1850 km of LPG pipelines with a capacity of 3.83 MMTPA. During 2005-06, capacity utilization of product pipeline in the country was around 60 percent only. The share of product movement through pipeline was only 32 percent of total POL (Petroleum Oil and Lubricants) consumption as compared to more than 62 percent in developed countries.

Improvement in Auto Fuels

- 2.3.8 With the introduction of improved auto-fuels, the quality of fuels in India is better than in most countries of the region. The following programme for introduction of improved fuels has been implemented in the country as decided by the Government.
- Euro-III Petrol & Diesel has been introduced from 01.04.05 in all 11 identified cities (Delhi/National Capital Region, Mumbai, Kolkata, Chennai, Bangalore, Hyderabad, Ahmedabad, Pune, Surat, Kanpur and Agra).
 - Introduction of Bharat Stage – II (BS-II) Petrol throughout the country by 01.04.05.
 - Introduction of BS II Diesel in all states except Rajasthan, West U.P., Uttaranchal, Madhya Pradesh, Punjab, Himachal Pradesh, and Jammu & Kashmir by 1.4.2005.
 - Introduction of BS II Diesel in the above states in a phased manner completed by 1.10.2005.

Globalisation and Diversification Efforts

- 2.3.9 The Indian economy is set to grow at the fastest rate ever in the coming decades with a major thrust being to manufacturing and services sector as well as formation of Special Economic Zones (SEZs). India, traditionally an import dependent country, has set forth a clear agenda for development of the energy sector in the coming decades with a clear emphasis on stepping up the steam on domestic production while simultaneously pursuing various import options. The government policy clearly emphasises the need for

energy security through diversification of energy resources while integrating with the global trends to emerge as an important player in the global arena.

- 2.3.10 In view of unfavourable demand–supply balance of hydrocarbons in the country, acquiring equity in overseas oil and gas assets is one of the important components of enhancing oil and gas security. The Government is encouraging oil PSUs to aggressively pursue equity oil and gas opportunities overseas. OVL has made an investment commitment of over US\$ 5 billion and has an oil and gas production of 6.6 MMTOE (Oil and oil equivalent gas) in the year 2005-06. OVL has a target to produce 20 MMTPA of O+OEG by 2020. OIL, IOC and GAIL are also engaged in acquiring overseas E&P assets. In addition, private Indian companies like RIL and Essar are also pursuing E&P opportunities abroad.
- 2.3.11 In the context of energy diversity, natural gas is expected to play a major role in diversifying the energy options. New domestic finds and LNG imports have made the market quite vibrant in recent times.
- 2.3.12 Retail & Marketing companies took big strides in new growth areas during the X Plan period towards globalisation and diversification in to related areas. Among these, initiatives are upward integration into E&P, diversification to natural gas and forward integration into petrochemicals business. Companies are gearing themselves for setting up mega petrochemical hubs with world scale plants. Companies are also progressing well in tapping opportunities in neighbouring countries for export of its products and services.

Pricing Policy

- 2.3.13 The country has been witnessing sharp and spiralling increase in international oil prices combined with considerable volatility since the end of 2003. Another trend being noticed in the international market in recent months is that the prices of some sensitive petroleum products have been moving faster and with greater volatility than the prices of crude, depending on seasonal and regional demands for these products globally.
- 2.3.14 The prices of crude oil in the international market have increased steeply. The crude oil price of Indian basket has gone up from about \$23 per barrel during March 2002 to \$ 55.72 per barrel for April 2005 to March 2006 average. The average for April 2006 to October 2006 is \$66.25 per barrel representing an increase of about three times.
- 2.3.15 Considering the impact of the price increase on common man and economically vulnerable sections of the society, Government has not increased the domestic prices of sensitive petroleum products in line with international prices. Holding the price-line has taken its toll on public sector oil marketing companies. Oil Marketing Companies (OMCs) namely, Indian Oil Corporation (IOC), Hindustan Petroleum Corporation (HPCL), Bharat Petroleum Corporation (BPCL) and IBP Ltd, as a result have suffered losses.
- 2.3.16 Government has taken several measures to contain the increase in domestic prices. From March 2005, customs and excise duty on PDS Kerosene and Domestic LPG has been made nil. Customs duty on petrol and diesel has been reduced from 20 percent in March 2004 to 10 percent currently. Ad valorem excise duty for diesel has been reduced from 14 percent in March 2004 to 8 percent. For petrol, the reduction has been larger from 30 percent in March 2004 to 8 percent at present. In addition to the tax relief, Government is also directly absorbing a part of the burden. Government has decided to issue oil bonds to the oil marketing companies to compensate them for their losses.

- 2.3.17 Several experts have forecast an era of high oil prices to continue. With the country's high oil import dependence, it is necessary that petroleum products be priced in a consistent manner under a long-term policy. It is also essential that economic pricing is blended with social responsibility so that the oil sector continues to function and service the oil needs of the economy.

Natural Gas Sector:

- 2.3.18 India is fast emerging as the focal point for the future development of the Asian natural gas market. In recent years, the Indian gas sector has received a progressively growing attention from global companies and has made rapid strides. The rapid growth of the Indian economy in the X Plan has greatly contributed to the development of the Indian energy sector as a whole and provided a major trigger for the growth of the gas sector as well. While gas occupies only about 9-10 percent of the total energy basket, primarily due to supply constraints all these years, the scenario is fast changing.

- 2.3.19 With the advent of LNG and progressive de-regulation of the gas prices, the natural gas sector in India is moving towards certain degree of maturity with better understanding of the pricing mechanisms. Reflecting this, the first spot cargo of LNG brought in by GAIL truly launched India on the global gas map with global suppliers showing serious interest on the Indian gas sector.

Gas Infrastructure

- 2.3.20 On the supply side, there are two LNG terminals at Dahej and Hazira in Gujarat which are already operational with a total existing capacity of 7.5 MMTPA. The third terminal in Dabhol with a capacity of 5 MMTPA is under commissioning. There is another terminal at Kochi which is taking a final shape for implementation.

- 2.3.21 In terms of transmission pipelines, there is an existing network of 6,300 km including the Hazira-Vijaipur-Jagdishpur (HVJ) network, Dahej-Vijaipur Pipeline (DVPL) and other regional networks. During the X Plan, pipelines like the DVPL, Kelarus-Malanpur Pipeline, Thulendi-Phulpur Pipeline got commissioned. A number of pipelines, including those by the private sector, are at various stages of implementation and are likely to be implemented during the XI Plan.

- 2.3.22 The city gas distribution sector has simultaneously grown with the gas sector growth. From coverage of just 2 cities at the beginning of the X Plan, the city coverage has grown to 10 in 2005-06 across the western, northern and southern regions of the country. Currently, there is a total city gas distribution network of about 6,000 km. As far as Compressed Natural Gas (CNG) supplies are concerned, there are 278 stations dispensing CNG in the country and the number is expected to continuously grow in the coming years.

Pricing of Natural Gas

- 2.3.23 In the beginning of the X Plan period, under the Administered Pricing Mechanism (APM), gas produced from the nominated fields of ONGC and OIL was priced at Rs.2,850 per 1000 Standard Cubic Metre (SCM) uniformly for all customers except in North East, wherein the customers were charged a price of Rs.1700 per 1000 SCM. Even the gas procured by GAIL from JVs and sold under APM was similarly priced, with the subsidy being met by ONGC.

- 2.3.24 With effect from 1.7.06, the gas pricing for APM gas was changed. It has been decided in the public interest that all available APM gas would be supplied only to the power and fertilizer sector consumers against their existing allocations along with the specific end users committed under Court orders and small consumers below 50,000 SCMD, at the revised price of Rs. 3,200/MCM and calorific value of 10,000 Kcal/cubic meter.
- 2.3.25 All other consumers would be supplied natural gas at market related price depending on the producer price being paid to joint venture and private operators at landfall point, subject to a ceiling of ex-Dahej RLNG (re gasified LNG) price of US \$ 3.86/MMBTU for 2006-07. In case of reduction in availability of this gas in future, the supplies to APM consumers would be reduced on a pro-rata basis.
- 2.3.26 The price of gas for the North–Eastern region will be pegged at 60 percent of the revised price for general consumers. Thus, the consumer price for the North-East region has been increased from the existing price of Rs. 1,700 to Rs. 1,920/MCM. Also, w.e.f. 1.07. 2006, ONGC will get a fixed producer price of Rs. 3,200/MCM till Government takes final decision on their prices. Producer price for OIL will be considered as equal to that of ONGC.

Free Market Gas

- 2.3.27 Under this category falls the gas supplied by the JV/Private sector, re-gasified LNG and new gas supplies by ONGC and OIL. It may be noted that the gas supplies by the JV/Private sector are governed by the provisions under the PSCs. Similarly, the gas produced under NELP would be governed in terms of the NELP provisions. Imported LNG is priced as per the pricing formula agreed between the LNG supplier and importer for long term supplies, and as per the spot price for spot purchases. Of course the gas transportation charges would be regulated by the Regulatory Board being setup under the PNGRB Act, 2006.

Import Dependence and its Impact

- 2.3.28 Presently, about 45 percent of primary commercial energy needs are met from oil and gas. Of this, over 70 percent of domestic oil consumption is imported mainly from Middle East. Gas imports started in 2004-05 and in 2005-06 about 19 percent of the gas consumption was met from imports. Import dependence is likely to increase considering low accretion to domestic oil and gas reserves. In fact, the case of India is not typical and several oil consuming countries face similar situation. It is expected that global oil dependence on OPEC will continue to rise with countries competing for scarce resources.

2.3.29 The import bill for crude oil over last few years is as under:

Particulars³	2002-03	2003-04	2004-05	2005-06 (P)	2006-07 (April-Sep)
Quantity in MMT	82.0	90.4	95.9	99.4	53.6
Value					
\$ Billion	15.8	18.3	26.0	38.8	25.2
Rs Crore	76,195	83,528	1,17,003	1,71,702	1,15,985
Average Price in \$/bbl	26.22	27.56	36.99	53.21	64.03
Increase over 02-03					
In \$/bbl		1.34	10.77	26.99	
In \$ Billion		2.5	10.2	23.0	
In Rs Crore		7,333	40,808	95,507	

2.3.30 The country has spent foreign exchange to the tune of about \$ 39 billion in 2005-06 towards the import of crude oil. The projected outgo of foreign exchange on account of import bill of Crude Oil in 2006-07 will remain high. The crude oil payments are in fact more than double for every barrel of crude in 2005-06 over 2002-03. This is a high price to pay for our dependence. Unfortunately, even in the future this position does not appear to improve. Given our track record in domestic E&P, our situation is likely to deteriorate.

2.3.31 Oil price vulnerability may affect GDP growth and has the potential to disrupt future development. Obviously India needs to shift focus from short-term management of energy requirements and pricing to long-term energy policy in light of core objectives indicated above and particularly in light of recent price spikes in the international oil markets. The challenge then is to ensure supply of energy at affordable price within available resources. Policy direction and intervention need to reorient the approach to match circumstances.

Industry Structure

2.3.32 Economic theory suggests that larger the number of companies operating in a sector, the more competitive it is and greater the productivity gains. Though at the same time economists have difficulty in finding perfectly competitive markets and particularly so in oil and gas. This is so because oil is intertwined with national interests and energy is recognized as fundamental for economies to function. In fact it is easier to find regulation and control in oil sector more so in the developing countries.

2.3.33 Given the nature of oil & gas, the current price scenario and future projections reveal that oil will increasingly be concentrated in hands of few nations, it appears, that there could be mounting resistance in moving towards a free market as visualized above. One of the biggest hurdles that India faces today is a lack of political consensus on free pricing of

³ Source: PPAC

sensitive petroleum products. Any approach that does not recognize the geopolitical nature of oil and the current domestic level of consensus would eventually fail.

- 2.3.34 At the same time, companies under the state dominate the oil industry in the country today. These companies follow government policies and directions and are accountable to the parliament. Besides, the C&AG (Comptroller and Auditor General) verifies their books of accounts and CVC oversees their commercial transactions. The present pricing structure is determined by the Government policy. Even if one argues that the state is operating a monopoly, it would be a public monopoly with all the attendant controls and accountability in place.
- 2.3.35 Competition in Indian markets can come if the state cedes its ground to other players. As privatization of Navratnas is not an option, reduction in PSU market share would have to happen organically, which could take some time, provided there is strong consensus on free pricing of sensitive petroleum products, which fully translates in the market place.
- 2.3.36 There is also a need to recognize that competition is a tool to improve efficiency and service standards but not an end in itself. The objective could be still achieved, within the present constraints.
- 2.3.37 In the oil sector currently there are mainly four companies in the marketing of products namely IOC, BPC, HPC and RIL besides players like Essar and Shell. The Herfindahl-Hirschman Index (HHI), which is square of the market share of the companies, for India (see note at 13.6 Annexure – IV) with the existing companies is higher than the desired number of HHI (range 1000-1800). However, with the pricing becoming free the market share will align itself in some desired ratios, which is expected to bring HHI to a reasonable level. Most competitive markets have five strong players. Thus, the current structure of the oil sector could continue. In suitable environment, the current structure will deliver a competitive market. This could be reviewed at the time of appraisal of the XI Plan.
- 2.3.38 In addition, the Government could do the following to achieve higher efficiency and service standards:

At the National Level

- Encourage exports from the country compelling refineries to compete world wide, meet global standards and meet requisite quality specifications.
- Create a domestic petroleum product market through a commodity exchange.
- Amalgamate individual state markets in one nation wide market with unified state taxes, remove state tax anomalies, provide level playing field to domestic production vis-à-vis direct imports (which can be imported without state taxes), and introduce a uniform VAT which provides full set-off for local levies such as octroi and entry tax.

At the Corporate Level

- Benchmark operation with world standards, the top refineries and make suitable improvements.
- Ensure inter-PSU competition, particularly at the retail level. It could be contended that this action would lead to duplication of assets. But then competition always does

that, for instance say the airline industry where infrastructure has been duplicated. Duplication of assets is a natural corollary to competition.

- Exponential expansion of e-commerce transactions, which promotes competition and enhances welfare by reducing transaction and search costs.

3 Performance Review of X Plan Period

3.1 Introduction

3.1.1 At the beginning of the X Plan period, the oil and gas sector was deregulated with the dismantling of Administered Pricing Mechanism (APM). Earlier, the exploration and development activities were dominated by the NOCs, mainly ONGC and OIL. However, Private/JV companies were provided an equal opportunity to get into E&P business after implementation of NELP. Similarly the refining and marketing sector also saw the entry of private players in the oil and gas sector during the X Plan period. Moreover, private/JV companies have emerged as significant players in hydrocarbon sector during X Plan period.

3.1.2 The likely achievement during X Plan period has been computed by taking actual performance upto 2005-06. Annual plan target/anticipated achievements in 2006-07 have been added.

3.2 Hydrocarbon Reserve Position

3.2.1 Total prognosticated resources of the country have been estimated at about 28 billion tonnes. As on 1.4.2006, the balance recoverable reserve position of Oil plus cccccc Oil Equivalent of Gas (O+OEG) is about 1,856 MMT, which has increased by 25 percent from 1,485 MMT in 2002-03 mainly due to contribution of major discoveries by private/JV companies and NOCs. The details are as under:

	Initial In Place(MMT)			Ultimate Reserves (MMT)			Reserves (MMT) *		
	Oil	Gas	O+OEG	Oil	Gas	O+OEG	Oil	Gas	O+OEG
ONGC	4,563.84	1,688.32	6,252.16	1,287.84	942.28	2,230.12	561.48	523.01	1,084.49
OIL	688	251	939	209	170	379	80	110	190
Pvt/JV	548.77	933.59	1,482.36	155.85	511.76	667.61	115.05	466.94	581.99
Total	5,800.61	2,872.91	8,673.52	1,652.69	1,624.04	3,276.73	756.53	1,099.95	1,856.48

* Note : Reserves denote balance recoverable reserves of hydrocarbons

Hydrocarbon in-place Reserves Accretion

3.2.2 The likely achievement in hydrocarbon in-place reserve accretion during X Plan period is approximately 1,797 MMTOE as against the X Plan target of 785-914 MMTOE, which is almost double. The share of Private/JV companies is about 58 percent while ONGC and OIL in-place reserve accretion share accounts for 36 percent and 6 percent respectively. The details of hydrocarbon in-place reserves accretion during X Plan period are given below.

Company	X Plan Target	Achievement up to March 2006	Likely achievement in X plan	IX Plan Actual	Likely percent Achievement against X Plan target	percent Achievement against IX Plan Actual
ONGC	561-576	507.27	671.27	481.80	116.5	139.3
Oil India Ltd.	108-118.5	81.22	103.72	83.46	87.5	124.3
Pvt. / JV companies	114-214	858.43	1038.43	229.87	485.2	451.7
TOTAL	785-914	1446.92	1813.42	795.13	198.4	228.1

Oil and Gas Discoveries

3.2.3 During the first 4 years of X Plan, 82 oil and gas discoveries were made by ONGC, OIL and Private/JV companies. Most of the gas discoveries were made in Krishna-Godavari Basin, off the East coast of India. Participation of private players in oil and gas exploration under NELP has changed perception about prospectivity of Indian Sedimentary basins. Indian deep water areas are now considered to be prospective.

3.3 Crude Oil and Natural Gas Production

3.3.1 During X Plan, the likely achievement in production of crude oil and natural gas is 167.79 MMT and 158.38 BCM respectively, which is higher than the IX Plan's actual production and marginally less than the X Plan's target. The details of production targets vis-à-vis achievements during X Plan are in the table.

Company	Activity	X Plan Target	Achievement up to March06	Likely achievement in X plan	IX Plan Actual	% Achievement	& Achievement against IX Plan Actual
ONGC	Oil & condensate production(MMT)	130.03	102.95	130.171	129.05	100.2	100.9
	Gas Production (BCM)	112.11	93.37	115.69	117.21	103.2	98.1
	Production O + OEG (MMTOE)	242.14	196.32	245.175	246.26	101.6	99.6
Oil India Ltd.	Oil & condensate production (MMT)	18.70	12.38	15.88	16.10	84.9	98.7
	Gas Production (BCM)	12.61	7.91	10.27	8.59	81.5	119.5
	Production O+OEG (MMTOE)	31.31	20.29	26.16	24.69	83.5	105.9

Company	Activity	X Plan Target	Achievement up to March06	Likely achievement in X plan	IX Plan Actual	% Achievement	& Achievement against IX Plan Actual
Pvt. / JV companies	Oil & condensate production (MMT)	20.66	17.25	21.55	17.79	104.3	121.2
	Gas Production (BCM)	52.77	26.04	32.82	15.66	62.2	209.6
	Production O + OEG (MMTOE)	73.43	43.29	54.37	33.45	74.0	162.6
GRAND TOTAL	Oil & condensate production (MMT)	169.39	132.59	167.60	162.94	99.0	102.9
	Gas Production (BCM)	177.48	127.32	158.79	141.46	89.5	111.8
	Production O + OEG (MMTOE)	346.87	259.90	326.704	304.40	94.1	107.0

3.3.2 The reasons for the shortfall in oil and gas production are - fire at Mumbai High process platform, non-commensurate drilling results necessitating the revision of geological models, less production from IOR/EOR projects than the targets of Feasibility Report (FR), increase in water cut and less than anticipated performance in few fields.

Implementation of IOR/EOR Projects

3.3.3 18 schemes of IOR/EOR have been approved to increase recovery factor from ageing oil and gas fields of ONGC. The IOR/EOR schemes under implementation include 5 offshore, 10 onshore Improved Oil Recovery and 3 Enhanced Oil Recovery schemes as given below:

- a. 5 Offshore IOR Projects: Mumbai High North Redevelopment, Mumbai High South Redevelopment, Neelam (completed in July, 2005), Additional Development Heera Pt-I (completed in December, 2005) and Additional Development Heera Pt.-II.
- b. 3 EOR Projects in Gujarat: Insitu Combustion Balol (completed in November 2001), Insitu Combustion Santhal (completed in December 2001) and Extended Polymer Sanand (completed in September 2002).
- c. 7 IOR Projects in Gujarat: Santhal Infill (completed in November 2003), Gandhar (completed in July, 2005), Kalol, North Kadi Phase-I, Sobhasan, Jotana (completed) and North Kadi Phase-II.
- d. 3 IOR Projects in Assam: Lakwa Lakhmani, Rudrasagar and Galeki.

3.3.4 The estimated cost of 18 schemes is about Rs. 11,649 crore and expected oil gain of about 120 MMT by 2030. One scheme, namely, Lanwa is yet to be approved by ONGC. 8 schemes namely in-situ Combustion Balol, in-situ Combustion Santhal, Extended Polymer Sanand, Additional Development Heera Pt-I, Santhal Infill, Jotana, Gandhar and

Neelam have been implemented by ONGC. As on 1.4.2006, the actual cumulative incremental oil production from IOR/EOR projects was about 22.65 MMT as compared to expected oil production of 31.4 MMT, which is about 72 percent of the planned cumulative incremental crude oil production. The actual investment by ONGC on these IOR/EOR projects was of the order of Rs. 9,518 crore (89 percent) as against the Plan expenditure of Rs. 10,684 crore till March, 2006.

3.4 Implementation of New Exploration Licensing Policy (NELP)

3.4.1 Government of India has been inviting private investment in exploration of oil and gas in the country since 1980s. However, initial efforts to attract private investment were limited to offshore areas only. Since 1991, Government of India offered exploration blocks almost on a regular basis for both onshore and offshore areas and announced six bidding rounds till 1995. A New Exploration Licensing Policy (NELP) was formulated in 1997-98 which provides a level playing field to the private investors by giving the same fiscal and contractual terms as applicable to NOCs for the offered exploration acreages.

3.4.2 Under NELP, PSCs for 110 exploration blocks have already been signed. It is estimated that oil and gas in-place reserves accretion under NELP is approximately 510 MMTOE from 16 discoveries. Reserve accretions under NELP have upside potential of further increases after appraisal of all the hydrocarbon discoveries. In first five rounds of NELP, the expected investment is of the order of US\$ 5 billion. Under NELP, 30 discoveries have already been made by private/JV companies.

3.4.3 Sixth round of NELP was launched on 23rd February, 2006 by offering 55 exploration blocks comprising 25 onland blocks, 6 shallow offshore blocks and 24 deepwater blocks. A total of 165 bids were received from private/foreign companies as well as NOCs for 52 exploration blocks. The summaries of exploration blocks awarded under each of the bidding rounds and subsequently signed are given in the following table.

Parameter	NELP-I	NELP-II	NELP-III	NELP-IV	NELP-V
No. of blocks offered	48	25	27	24	20
No. of blocks bid for	28	23	24	21	20
No. of bids received	45	44	52	44	69
No. of blocks awarded	25	23	23	21	20
No. of PSCs signed	24	23	23	20	20
Signed on	April, 2000	July, 2001	February, 2003	February, 2004	December/September, 2005
Area Awarded (Sq. km)	1,94,735	2,63,050	2,04,588	1,92,810	1,15,180

3.5 Implementation of Coal Bed Methane (CBM) Policy

3.5.1 CBM is natural gas (methane) adsorbed in coal and lignite seams and is an eco-friendly non-conventional source of energy. Coal is both the source and reservoir rock for CBM. A saturated CBM reservoir could contain up to five times the amount of gas contained in

a conventional gas reservoir of comparative size, temperature and pressure. CBM production is done by simple de-pressurization and de-watering process. To harness this new source the Government of India approved a comprehensive CBM policy in July, 1997 for exploration and production of CBM gas. As in case of NELP, the attractive contractual and fiscal terms offered include: no upfront payment, no signature bonus, no participating interest of Government, award of blocks through global bidding, no customs duty on imports, freedom to market gas in domestic market etc.

First and Second Round of CBM Policy

- 3.5.2 Under the first round of CBM, Contracts for 5 blocks falling in the States of Jharkhand (2) Madhya Pradesh (2) and West Bengal (1) were signed in July 2002. Two blocks each were awarded to ONGC–IOC consortium and Reliance Industries Limited (RIL) and one to Essar Oil Limited. Contracts for two CBM blocks in West Bengal and Jharkhand were signed with ONGC and Coal India Limited (CIL) in February 2003. These two blocks were awarded to the ONGC-CIL consortium on nomination basis. One block in West Bengal was awarded to M/s GEECL through FIPB route in May 2001 before implementation of the CBM policy.
- 3.5.3 Under the second round of CBM, 9 blocks falling in the States of Jharkhand, Chhattisgarh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Rajasthan and Gujarat were offered under international competitive bidding in May 2003. A total of 14 bids for 8 CBM blocks were received. 8 CBM blocks were awarded and contracts were signed on 6 February 2004. The exploratory efforts carried out by the operators have resulted in establishment of 6 TCF of CBM gas in 4 CBM Blocks. Production from these blocks is expected to commence in 2007-08.

Third Round of CBM

- 3.5.4 Under the third round of CBM, 10 blocks were offered on 23rd February 2006 falling in the six States of Andhra Pradesh, Chattisgarh, Jharkhand, Madhya Pradesh, Rajasthan and West Bengal. Bid closing date was 30th June, 2006. A total of 26 companies including 8 foreign companies and 18 Indian companies bid either on their own or as consortia. All the blocks have attracted multiple bids. Evaluation of the bids has been completed. The award of these blocks was made on 5th October, 2006.

3.6 Equity Oil and Gas from Abroad

- 3.6.1 In view of unfavourable demand–supply balance of hydrocarbons in the country, acquiring equity in overseas oil and gas assets is one of the important components of enhancing energy security. The Government is encouraging oil PSUs to aggressively pursue equity oil and gas opportunities overseas. OVL has made an investment commitment of over US\$ 5 Billion and has an oil and gas production of 6.6 MMTOE in the year 2005-06. OVL has a target to produce 20 MMTPA by 2020.
- 3.6.2 OIL, IOC and GAIL are also engaged in acquiring overseas E&P assets. OIL–IOC combine has an exploration block in Libya apart from being OVL partners. GAIL has interest in one Myanmar offshore block. OVL has signed an MOU with the Mittal Group for leveraging their presence in some hydrocarbon rich countries such as Kazakhstan. Some of the major E&P opportunities being pursued by OVL at present are in Ecuador, Thailand, Venezuela, etc. In addition, private Indian companies like RIL and Essar are also pursuing E&P opportunities abroad. The X Plan achievement of OVL in terms of oil and gas production is as under:

Year	X Plan Targets			Actual *		
	Crude Oil (MMT)	Natural Gas (BCM)	O + OEG (MMTOE)	Crude Oil (MMT)	Natural Gas (BCM)	O + OEG (MMTOE)
2002-03	-	0.23	0.23	0.18	0.07	0.25
2003-04	-	0.60	0.60	3.35	0.52	3.87
2004-05	-	0.80	0.80	3.71	1.35	5.06
2005-06	1.20	1.26	2.46	4.87	1.75	6.62
2006-07	4.00	2.05	6.05	4.73	1.71	6.44
Total	5.20	4.94	10.14	16.83	5.41	22.24

* Figures for 2006-07 are anticipated production

Lessons Learnt during X Plan

3.6.3 The following lessons on the exploration front were learnt during X Plan period while attempting to meet the objectives/goals for the X Plan.

- New reserves were added from the areas, which were relinquished by other operators such as Rajasthan and KG Basin. This indicates that exploration is a continuous process.
- Companies adopting new technologies such as high resolution 3D survey benefited.
- No major discoveries have been made by ONGC/OIL. However, private/JV companies have shown better exploration efficiency.
- Increasing the reserve portfolio by improved exploration efficiency and better interpretation skills is the need of the hour.
- Increasing knowledge-building efforts needed to promote acreages in the frontier basins/sectors to attract investment.
- Adoption of state-of-the-art technology for widening the exploration base, both laterally and vertically, to logistically difficult and geologically complex areas including deep waters. Considering the geological and financial risk in such ventures, strategic partnerships/alliances may be preferred.
- Strategic shift towards stratigraphic and strati-structural traps with enhanced 3D seismic coverage and more intellectual inputs are becoming necessary for realizing considerable potential from additional plays in the already probed areas.
- Extensive and intensive efforts are needed to be put in for augmenting the gas reserves.
- Establishment of E&P and archival database is required to offer blocks through Open Acreage Licensing Policy (OALP).

3.6.4 On the oil and gas production front, the following needs focused attention:

- Faster development of already discovered reserves.
- Development of isolated and marginal fields as these may be economical in a high price scenario.
- Continuation of IOR/EOR schemes to augment the recovery/production since a majority of the producing oil fields have reached the decline stage.
- To avoid geological surprises, proper planning and development of effective monitoring system for implementation of Improved Oil Recovery (IOR) Projects.
- Adoption of life cycle concepts for field development to optimize inputs and reduce costs.
- Enhancing productivity by drilling high angle, multilateral, drain holes and horizontal wells for all the fields as carried out in some of the offshore fields.
- Development of cluster of marginal fields in offshore conditions by creating common facilities/utilizing nearby existing infrastructure.

3.7 Consumption of Petroleum Products during X Plan

3.7.1 It has been observed that actual materialization of demand has not been in line with the projections in spite of reasonable growth of the economy. X Plan had projected CARG of 3.7 percent for oil during the plan period (2002-07) under base case and CARG of 5.7 percent under the upper case. However, as per actual data available for first four years of X Plan, CARG achievement may be only 2.6 percent⁴. The details are as follows:

Year	X Plan Projections	Actual Consumption	Variation
2002-03	107.1	104.1	- 3.0
2003-04	111.2	107.7	- 3.5
2004-05	113.6	111.6	- 2.0
2005-06	118.7	111.9	- 6.7
2006-07 (P)	123.5	114.0	- 6.5

3.7.2 The product wise details are at Annexure V.

3.7.3 Lower materialization is attributed to following reasons:

- Substitution of POL demand by NG/LNG especially after commissioning of Dahej terminal of PLL.
- Structural change in GDP composition with now over 55 percent share being that of services which is less energy intensive compared to industry and agriculture sectors;

⁴ Indian Demand has grown only by 2 percent from 2001 till 2005 as per BP Statistical Review of World Energy June 2006. Consumption (BP statistics includes refinery fuel & loss in demand) has grown from 107 MMT to 115.7 MMT respectively. The demand above is net of F&L.

- Other factors like high oil prices coupled with conscious efficiency improvement, improvement in roads, electrification of railways etc.;
- Low growth in POL is likely to continue with huge natural gas find in various parts of the country especially in the East-Coast and entry of many players for bringing LNG through imports with a view to provide competitive and clean fuel which is expected to change the pattern of energy consumption in the country in the near future.
- Opening of Auto sector to LPG, expansion of CNG to new cities, Government's thrust on development of National and State highways and rural connectivity with the urban mainstream and resultant thrust to increased road movement activities will all add to changes in consumption pattern of POL different from the past.

3.8 Refining Capacity

3.8.1 The refining capacity at the beginning of the X Plan was 114.67 MMTPA. X Plan document placed capacity in the range of 138 MMTPA (under Scenario – I - Keeping in view the competitive environment in the deregulated scenario, current low refining margins, the slow down of the product demand and the fact that the companies would need to make substantial investments in quality upgradation projects, only expansion projects under implementation may fructify during the X Plan) to 155 MMTPA (under Scenario – II - If the product demand grows at a higher rate, then in addition to the capacity expansion projects under implementation, one or two new grass-root projects may also get completed during the X Plan) by the end of the Plan. Accordingly, increase in capacity was expected to be in the range of 23.33 MMTPA to 40.33 MMTPA.

Refining Capacity Additions

3.8.2 Compared to the above projections, the likely achievement in refinery capacity at the end of the X Plan will be 148.97 MMTPA or an increase of 34.30 MMTPA. Clearly, the targets have been adequately met. The details of refinery capacity addition are as under:

S. No.	Refinery	Beginning of X Plan	Additions during X Plan	Beginning of XI Plan
	Public Sector			
1	IOC, Digboi	0.65		0.65
2	IOC, Guwahati	1.00		1.00
3	IOC, Koyali	13.70		13.70
4	IOC, Barauni	4.20	1.80	6.00
5	IOC, Haldia	4.60	1.40	6.00
6	IOC, Mathura	8.00		8.00
7	IOC, Panipat	6.00	6.00	12.00
8	CPCL, Chennai	6.50	3.00	9.50
9	CPCL, Nagapatinam	0.50	0.50	1.00
10	BRPL, Bongaigaon	2.35		2.35
11	HPC, Mumbai	5.50		5.50
12	HPC, Visakh	7.50		7.50

S. No.	Refinery	Beginning of X Plan	Additions during X Plan	Beginning of XI Plan
13	BPC, Mumbai	6.90	5.10	12.00
14	KRL, Kochi	7.50		7.50
15	NRL, Numaligarh	3.00		3.00
16	ONGC, Tatipaka	0.08		0.08
17	MRPL, Mangalore	9.69		9.69
	Total Public Sector	87.67	17.80	105.47
	Private Sector			
18	RIL, Jamnagar	27.0	6.00	33.00
19	EOL, Jamnagar		10.50	10.50
	Total Private Sector	27.00	16.50	43.50
	Grand Total	114.67	34.30	148.97

3.8.3 Some planned additions did not materialize during the X Plan due to change in demand supply dynamics (IOCL Gujarat, 2.0 MMTPA and KRL Kochi refinery, 2.0 MMTPA) while others faced shortage of land requiring relocation of existing facilities (HPCL Mumbai refinery, 2.4 MMTPA).

3.8.4 The mid-term appraisal of the X Plan indicated a refining capacity of 141.70 MMTPA at the end of X plan, against which the likely achievement is 148.97 MMTPA i.e. an increase of 7.27 MMTPA.

3.9 Investments

E&P - Financial Outlays of Upstream NOCs during X Plan

3.9.1 Likely achievement of Rs. 78,329.43 crore during X Plan period is anticipated as against the target of Rs. 51,968.95 crore for NOCs i.e. ONGC, OIL and OVL. The projects of upstream NOCs were financed through internal resources only. The company-wise details are as under.

Company	X Plan Target	Achievement up to March 2006	Likely achievement in X plan	IX Plan Actual	% Achievement	% Achievement against IX Plan Actual
ONGC	33418.95	34788.28	49142.56	19989.00	147.0	245.8
OVL	13550.00	17746.78	24401.03	200.00	180.1	12200.5
ONGC + OVL	46968.95	52535.06	73543.59	20189.00	156.6	364.3
OIL	5000.00	2996.89	4785.84	2218.00	95.7	215.8

Company	X Plan Target	Achievement up to March 2006	Likely achievement in X plan	IX Plan Actual	% Achievement	% Achievement against IX Plan Actual
GRAND TOTAL	51968.95	55531.95	78329.43	22407.00	150.7	349.6

Refining and Marketing

- 3.9.2 Out of the total targeted X Plan investment of Rs. 36,572 crore for Refinery and Marketing, Rs. 26,445 cores are to be invested in refining for capacity augmentation, quality upgradation, de-bottlenecking and revamps in various refineries, while the balance of Rs. 10,127 crore is for marketing and pipelines projects. An investment of Rs. 17,674.75 crore is likely to be realized in the refining sector in the X Plan period. The major shortfalls in investment are due to deferment of the following projects.

Project	Investment Rs Cores
Grassroots refinery of IOCL in Paradip,	1917
Provision of OHCU at IOCL Haldia	1247
Punjab refinery project of HPCL/ GGSRL	1930
Bina refinery project of BPCL/ BORL	873
Expansion/modernization of Kochi Refinery	1383

- 3.9.3 Though part expenditure has been incurred on the major projects indicated above, some of these projects are now slated for implementation during the XI Plan period. Investments in grassroots Paradip Refinery (IOCL), Punjab Refinery (HPCL/ GGSRL), Bina Refinery (BPCL/BORL) and KRL Kochi were deferred because of delays in finalization of tax concessions by the state governments, demand supply considerations and Auto Fuel Policy requirements. If these projects are excluded from the analysis, the likely investment at the end of the X Plan is about 95 percent of the targeted investment. It may be noted that the targeted/likely investment amounts mentioned here do not include investment in respect of private sector refineries.

Natural Gas Sector

- 3.9.4 In the X Plan, 4 LNG terminals were envisaged, entailing an investment of Rs. 7,000 – 9,400 crore (US\$ 1.5 to 2.0 billion). Besides, transmission and distribution pipeline investments were envisaged in the range of Rs. 13,000 crore to 15,000 crore (a total investment of Rs. 20,000 crore to Rs. 25,000 crore). This investment was based on the overall supply scenario from both domestic and international sources. While the domestic scenario was more predictable, the imported gas scenario had certain

uncertainties. The imported gas supply projected in X Plan period and the actual achievements are given below :

Source	2002-03	2003-04	2004-05	2005-06	2006-07
LNG projected	NIL	NIL	20	40	50
LNG Actual	NIL	NIL	8	18	18-20
Transnational Pipelines	NIL	NIL	NIL	NIL	10
Trans'n'l P/L Actual	NIL	NIL	NIL	NIL	NIL

3.9.5 In the context of the shortfall of about 40 MMSCMD in supplies from cross border sources, the investment achieved is also expected to be lower. The expected actual investment in the X Plan is about Rs. 10,500 crore to Rs.12,000 crore. The shortfall is due to investment in only two terminals as against four terminals proposed. Besides, the pipeline investments are in the range of Rs.6,000 to 7,000 crore vis-à-vis the target of Rs 13,000 crore to 15,600 crore. The transnational pipeline supply is not even envisaged in the XI plan.

3.9.6 Against the approved outlay of Rs. 7,500 crore for GAIL, an expenditure of Rs. 6,999.83 crore is anticipated. In addition the X Plan had an outlay of Rs. 7,443.81 crore for petrochemical projects against which an expenditure of Rs. 7,619.77 crore is likely to be made during the X Plan.

Sector	Target for the X Plan	Anticipated expenditure for X Plan	Percent achievement
Exploration & Production	59468.59	85329.26	143.49
Refining & Marketing	36572.24	26352.90	72.06
Petrochemicals	7443.81	7619.77	102.36
Engineering	171.0	57.53	33.64
Total	103656.00	119359.46	115.15

3.9.7 Thus, the overall achievement in the oil and gas sector was about 115 percent of the approved X Plan outlay.

4 Review of Policy Measures

4.1 Marketing and Distribution of Petroleum Products

Distribution of Petroleum Products

- 4.1.1 The current demand of POL in the country is 112 MMTPA, which is projected to grow up to 132 MMTPA by 2011-12 in base case projections of XI Plan. The refining capacity of 132 MMTPA is projected to grow to about 200 MMTPA during the same period.
- 4.1.2 The landscape of country's POL distribution has undergone a change with surplus availability situation in most of the products. Imports/exports of products are taking place on need/economic considerations. Based on supply-demand balances, companies are entering into bilateral agreements for product exchanges and sharing infrastructure on commercial considerations. New infrastructure is being created to fulfil the demand-supply gap based on rationalization and with a holistic view. After the enactment of the PNGRB Act 2006, the provisions of the Act shall govern the entities.
- 4.1.3 Since logistic costs play a significant role in commercial consideration, with growing competition, each company is trying to reduce costs of production, transportation, overheads, etc. Expansion of pipeline network is taking place for reducing transportation costs and product losses. It is expected that each company will therefore try to expand its pipeline network in accordance to the Government policy guidelines and provisions of the Act including the market/retail service obligations and other regulations under the Act. The balance products would continue to move by rail/road. The railways are putting efforts to modernize/upgrade and phase out four wheeler with BTPN wagons.
- 4.1.4 Technological intervention by industry to ensure product quality and quantity across supply chain has been initiated. Automation is being carried out at retail outlets and terminals/depots. Further, tracking the movement of tank trucks through Global Positioning System (GPS) is also being implemented. This ensures smooth operations, which get tracked for any scrutiny and minimises human intervention in the processes.
- 4.1.5 Several policies like blending of ethanol/bio-diesel, marketing of different grades of POL products in different cities etc necessitate infrastructure build-up and technology adoption by the OMCs.
- 4.1.6 The policy for blending of ethanol with petrol and of bio-diesel with diesel throughout the country will have an impact on the petrol and diesel demand. Similarly, usage of CNG/Auto LPG in transport vehicles has started affecting consumption of petrol/diesel. The surplus petrol/diesel may have to be exported. Keeping in view the above the following policies have been examined.

Marketing of Petrol/Diesel, Kerosene and LPG

Petrol/Diesel

- i. The oil sector has been deregulated since April 2002, with the dismantling of APM, and currently there are many players including private oil companies in the marketing of petrol/diesel. The major existing policy is with respect to grant of marketing rights for transportation fuels.

As per the existing policy any new player willing to market transportation fuels in India is required to invest or express intention to invest a minimum of Rs.2,000 crore in the hydrocarbon sector, i.e., E&P, pipelines, terminals, etc. or the new player may produce 3 MMT of crude to market the fuel. This policy is an essential requirement to prevent fly-by-night operators entering the market, and may therefore be continued.

- ii. The norms for setting up of retail outlets in low service areas (5.6 percent) and remote areas (5.3 percent) by all the entities such as OMCs, private companies and Multinational Companies (MNCs) should continue in order to make available petrol/diesel in such areas.
- iii. Adulteration is a menace, which needs to be tackled by all concerned through technological and other interventions. Various steps to curb adulteration have been initiated. These include introduction of tamper-proof locks, use of GPS in tank-trucks, introduction of marker system for adulterants like kerosene, retail automation, third party certification, etc.
- iv. Automation of retail outlets (ROs) selling more than 200 KL per month has to be completed by March 2007. All the new regular ROs to be commissioned after March 2007 with anticipated volume above 200 KL per month should have automation.
- v. ROs selling more than 100 KL per month would be covered under third party certification by March 2007 and all the other regular ROs by March 2009. Effective April 2007, all new regular ROs may be covered under third party certification and commissioned.
- vi. In order to check the en-route malpractices, all the company owned/dealer owned/contractor tank trucks would be covered under monitoring of movement through GPS by March 2007.
- vii. The marker system introduced in kerosene can detect adulteration upto 1. percent. To start with, it has been decided to implement marking of kerosene all over the country with effect from 1.10.2006. It was also decided to provide test kits to RO dealers to enable them to test petrol/diesel at the time of receipt at the RO. Independent testing/separate audit would also be carried out. The estimated industry expenditure for marker system is around Rs.1,000 crore during the next 5 years. Introduction of marker in naphtha may be implemented in the next phase.
- viii. With competition having set in, there is a lot of focus on the customer needs. Companies have started offering better forecourt services, non-fuel products at ROs, usage of credit/debit/fleet cards with attractive loyalty programmes to attract and retain customers and volumes. Innovative methods to improve customer relationship are being introduced. With more and more ROs being commissioned and with lowering of per pump throughput, companies may scout for opportunities in non-fuel retailing to enhance dealers and company income levels.

Kerosene

- i. Respective State Governments are responsible for making dealer-wise PDS kerosene allocation every month taking into account the State-wise allocation received by them from the Government of India as per the existing allocation norms. This is advised to the oil companies who in turn are responsible for placing the

product accordingly. It is also imperative that by the 25th of each month the total allocation for the month is lifted by the dealers.

- ii. The low price of PDS kerosene, being heavily subsidized, is a temptation to unscrupulous elements in the system to divert this fuel for adulteration with diesel, which is priced much higher. The study made by NCAER has pointed out the diversion of PDS Kerosene to be in the order of about 38 percent. This prevents the fuel from reaching the targeted population.
- iii. Subsidised kerosene may be made available only to BPL families and various options to improve the delivery of subsidy need to be examined. A pilot project for introduction of smart card system in three districts, Nalanda (Bihar), Nainital (Uttaranchal) and Latur (Maharashtra), would be launched with effect from 1.1.2007. PDS kerosene may be allocated to the States only for BPL families using the BPL data as used by the Department of Food & Public Distribution under TPDS for food grains. Kerosene for APL families may be made available at free market price as per requirements. The Government need not allocate kerosene for APL families, which may be distributed through the existing mechanism of OMCs on commercial considerations. However, there is a need to strengthen the mechanism for marketing of free market kerosene.

LPG:

- i. Domestic LPG, like kerosene, is subsidized by the Government. The subsidy is available to all users of the domestic LPG, irrespective of their economic status. Domestic LPG carries non-merit subsidy as it is not perceived as a fuel for the poor. There is a case for gradually increasing the prices of domestic LPG to reflect the market prices.
- ii. The price difference between the domestic LPG and non-domestic LPG (Bulk or packed) is a cause of diversion of domestic LPG to non-domestic use, like hotels, restaurants, and automotive sector. In order to eliminate/reduce diversion of domestic LPG to automotive sector and other commercial usage, oil industry has initiated measures like refill audit to control the diversion.
- iii. Auto LPG dispensing facilities have been set up in select areas to control pollution and to reduce/eliminate diversion of domestic LPG to automotive sector. This measure has yielded results and Auto LPG sales have gone up substantially in the last two years. In order to further encourage use of auto LPG, Auto LPG Dispensing Stations (ALDS) may be set up on priority in big towns which are not likely to receive CNG in the short to medium term. Such investments, of course, would be driven by commercial considerations.
- iv. Government has approved a scheme for different colour coding of domestic and non-domestic cylinders to prevent diversion of domestic LPG cylinders. This scheme may be implemented expeditiously, and put into effect by 2007-08.

4.2 Marketing & Distribution of Natural Gas

Policy for Development of Natural Gas Pipelines and City or Local Natural Gas Distribution Networks Policy

4.2.1 The draft of the policy has been discussed at length with the industry and has been developed in line with the PNGRB Act, 2006. The policy is likely to be soon approved by the Government. The salient features of the draft policy are given below.

- i. All the natural gas and city or local distribution pipelines will be laid in accordance with the authorization granted by the Regulatory Board under a transparent mechanism. Dedicated pipelines laid to supply gas to specific consumers originating from regulated pipelines will not require the authorization.
- ii. Regulator shall develop a comprehensive set of technical standards and safety standards as well as a code for grid connectivity.
- iii. Progressive unbundling of common carrier transmission activity and gas marketing/city/local gas distribution network.
- iv. The designed pipeline capacity to be at least 33 percent more than the maximum capacity requirement of the proposer and those who tie up for capacity. Such capacity would be made available on 'open access and non discriminatory' basis at transportation rates laid down by the Board.
- v. The Board may consider different exclusivity periods for setting up of city gas distribution networks and for marketing of gas by the entity developing such networks.
- vi. Authorization to the proposer may be cancelled with forfeiture of his security deposit, if the conditions of the authorization are not adhered to or the project is delayed beyond the stipulated milestone(s).
- vii. Once the project is commissioned the bid-bond would convert into a performance bond and would provide the guarantee for satisfactory compliance of the conditions stated in the authorization during the life of the project.
- viii. The transportation tariff for the transmission pipeline or city or local natural gas distribution network as also the manner of determining such tariff will be laid down by the Board.
- ix. The Government to prepare long term perspective plan for creating gas pipeline network in consultation with the Board, State Governments, oil and gas industry, gas consuming industries and other stake holders. The plan will be kept in view while authorizing/approving new pipelines.
- x. A National Gas Advisory Board (NGAB) shall be constituted to advise the Government on all matters relating to this policy.
- xi. To compliment and supplement the domestic investment, FDI upto 100 percent is permitted in laying natural gas pipelines under automatic approval route.

- xii. State Governments to ensure various statutory and other clearances on a fast track basis.
- xiii. State Governments shall prepare their plans for developing the city or local gas distribution networks, prioritizing the cities or local areas.

4.3 Auto Fuel Policy

- 4.3.1 As per the approved road map under Auto Fuel Policy, introduction of Euro-III equivalent norms in the entire country from 01.04.2010 together with Euro IV equivalent emission norms in the 11 major cities of Delhi, Mumbai, Kolkata, Chennai, Bangalore, Hyderabad, Ahmedabad, Pune, Surat, Kanpur and Agra was to be reviewed in the year 2006, after the implementation of Bharat Stage-II emission norms in the entire country and Euro III equivalent emission norms in these eleven major cities w.e.f. 01.04.2005. Euro-II/III norms have been introduced effective 1.10.2005.
- 4.3.2 Ministry of Environment and Forest (MoEF) had taken over the Air Quality Monitoring (AQM) project in line with the Cabinet decision on Auto Fuel policy. MoEF has constituted a new Steering Committee under the Chairmanship of Secretary, MoEF and Technical Committee under the Chairmanship of Chairman CPCB. The Steering Committee to conduct and monitor air quality studies in 6 cities of India as phase-I and the Technical Committee to provide technical guidance and support to these studies.
- 4.3.3 The new Technical Committee revised the methodology for these studies and the revised total cost of the Air Quality Studies in 6 cities, Emission factor development for vehicles and source profiling for other sources is Rs.22.20 crore. IOC R&D signed revised MoCs for AQM studies in Delhi, Bangalore and Pune during the month of March 2006. In-use vehicles emission factor determination project is being undertaken by ARAI, Pune and has already completed large portion of the testing. CPCB signed MoCs for the AQM projects in Mumbai, Chennai and Kanpur. ARAI, Pune and IIT Mumbai will undertake source profiling of vehicular emissions and other sources respectively. It is expected that the interim report of these studies will be available by March 2007. On completion of these studies, the government would conduct review. It is not expected that delay in review will materially effect the implementation of the road map approved under the Auto Fuel Policy.

Major Issues

- 4.3.4 Implementation of better specifications requires the refineries to incur huge capital expenditure. For implementation of Euro III/IV fuel specifications, the PSU refineries would incur significant expenditure over next 3-4 years. Being a mandated project with no corresponding incremental revenue these projects place significant burden on refining companies. The projects being undertaken for the purpose of green fuels need to be incentivised which could be in form of tax rebates or higher depreciation. At the same time these projects should attract nil custom and excise duties to reduce the overall cost.
- 4.3.5 It may be recalled that the present projected production indicates a huge surplus in both petrol and diesel necessitating exports. It has been mentioned elsewhere in the report that for refineries to access developed markets would need to meet the latest environmental product specifications applicable in such markets. Providing incentives would also enable refineries to export products to the developed nations.

- 4.3.6 The schedule for introduction of BS IV across the country needs to be drawn, as BS IV vehicles cannot use BS III fuel even temporarily and like BS III vehicles using BS II fuel.
- 4.3.7 Alternative fuels road map needs to be put in place giving adequate time to all the stake holders. While oil companies have geared up to implement sale of 5 percent ethanol-blended-petrol and 5 percent bio-diesel-blended-diesel in the country, availability of ethanol and bio-diesel on a sustained basis at commercially viable prices has been a major issue.
- 4.3.8 India has joined UN ECE WP-29 1998 agreement and is now a full member from April 2006. The 1998 agreement envisages creation of Global Technical Regulations (GTR) for harmonized standards across the world both in terms of driving cycle for emission measurement and safety regulations. It is therefore, proposed that an Apex group may review this in conjunction with the road map proposed in the Auto Fuel Policy to identify the gap areas.
- 4.3.9 Indian auto industry would be using various technology options such as particulate trap, Selective Catalytic Reduction (SCR), DeNox catalyst etc for meeting the BS IV regulations. It is necessary that the auto industry is geared to provide the same in time and in line with the proposed schedule. Similarly, matching fuel quality as per the Euro IV fuel specifications would have to be supplied by the oil industry in the 11 cities and on major connecting highways.
- 4.3.10 The Auto Fuel Policy identified the need for controlling emissions through improved I&M practices, vehicle retiring policies, better traffic management, stricter PUC, etc. However, till date limited progress has been made without having mandated any practice. There is urgent need to introduce these policies.

4.4 **Safety & Environment Management**

E&P - OIL

- 4.4.1 During the plan period, efforts would be made to improve the Health Safety and Environment (HSE) management in order to match the best global practices so as to provide occupationally healthier work force, reduced accident rates, cleaner and greener product with reduced discharges.
- 4.4.2 Thrust areas to achieve the above objective would be to review the existing HSE management system and attempt to keep it at par with global practices in the areas of HSE management and to adopt the international standards to excel performance in areas of occupational health management.
- 4.4.3 In order to make the E&P operations compatible with the environment and reduce discharges and emissions, the following would be attempted/put in place during the XI Plan period:
- Establishing self imposed discipline by oil companies in environment management system for all oil and gas field installations and drilling rigs based on international standards to ensure improvements towards reducing discharges and emissions to internationally acceptable levels;
 - Eco-rating of major installations and compulsory environmental audits;

- Pro-active measures to prevent marine pollution and to effectively combat oil spills;
- Benchmarking at par with international oil majors with respect to environmental practices;

4.4.4 By strictly adhering to recently developed Quality, Health, Safety and Environment (QHSE) management system work procedures and plans, maintenance schedules of various equipments and machinery, need based training, and providing necessary inputs and resources following area of environment management will continue to receive constant attention.

Natural Gas

4.4.5 The role of safety in the gas sector assumes importance as also the safety aspects in the various sub-activities of gas sector, i.e. gas handling, processing/extraction of value added products, storage, transportation, distribution and utilization. The safety aspects are also important in respect of LNG import terminals, handling of cryogenic LNG tankers, and use of LNG in the transport sector.

Safety System and its Management

4.4.6 The responsibility of the respective organization or individuals who would handle natural gas or its derivatives play a major role in maintaining and managing the safety systems so as to eliminate or minimize the risks which may be posed if not adequately monitored and managed. The basic and essential elements which need to be observed by the designers and operators involved are:

- Process reviews and adherence to standards, codes, practices and statutory laws by the owners and designers;
- Design procedures to ensure safety of the installation;
- Proper risk management studies and adherence to them;
- Process awareness among the operators;
- Proper awareness campaigns to educate the uses of gas (CNG);
- Proper maintenance of the equipments and installations;
- Training to minimize the human factors in the incidents;
- Safety audits and corrective actions;
- Proper communication channel of the system managers with the local administration and local population;
- Proper investigation procedure;
- Crisis/Disaster Management Plans/Coordination Plans
- Customer service and faster response time;

- 4.4.7 The above elements, if properly and fully adopted, with an objective of continuous up-gradation of the safety systems to ensure and enhance safety, would go a long way in minimizing the risks of the gas handling systems. Whereas all safety standard, practices and provisions would minimize the risk of mishap/incident, the crisis management plans would need to be very effective to contain and minimize the damages in case any incident does happen.
- 4.4.8 It is of paramount importance for any organization to organize the overseeing of the safety, occupational health and environment aspects, as they are the integral part of safety. To promote highest level of safety in operations, aspects like health of employees and a clean environment, need to be looked in totality, as these elements are integral to any activity or installation in the gas sector. The basic responsibilities of such a body in an organization may include safety audits, safety inspections and subsequent follow-up of checklist points, guidance to projects on the improvement in safe practices etc.
- 4.4.9 MoPNG constituted a Safety Council assisted by Oil Industry Safety Directorate (OISD) in 1986. OISD is involved in formulating and implementing a series of self-regulatory measures aimed at removing obsolescence, standardizing and upgrading the existing standards to ensure safer operations. The standards developed by OISD so far are mainly aimed at the hydrocarbon industry. Even though the standards are self-regulatory in nature, following of these standards by the industry at the design stage would go a long way to ensure safer operations in gas installations.

Use of CNG in Automotive Sector

- 4.4.10 Use of CNG as an automotive fuel is being encouraged and propagated due to environmental considerations in the cities, where gas is available. After careful consideration of the international practices and the experience of the industry, national safety standard has been adopted for CNG installation by the statutory bodies. Further, implementation of OISD recommended practices need to be considered and overseen in view of the extensive use/storage of CNG in pressurized containers in automobiles. The OISD standard on safety requirements for compression, storage, handling and refuelling of natural gas for use in automotive sector, needs to be followed by the CNG sector. The standard lays down the minimum safety requirements at installations handling natural gas for dispensing into vehicles and minimum checks required in the vehicles by refuelling stations.

City Gas Distribution

- 4.4.11 Use of natural gas in the domestic sector, especially in the urban areas, would gain further importance during the XI Plan period due to the flexibility and the advantage of natural gas over competing fuels. Safety of such distribution systems would need to be emphasized. Besides adhering to the international codes and practices for the design and operation of such systems (such as ASME/ANSI B31.8), it would be desirable to develop indigenous safety codes for city gas distribution and follow the same.

Refining and Marketing

- 4.4.12 Companies in the petroleum sector are committed to conducting business with a strong environment conscience for sustainable development, safe workplaces and enrichment of the quality of life of their employees, customers and the community at large. Best procedures and practices of the industry are in place at all operating units and installations to take care of safety, occupational health and environmental hazards.

These facilities are periodically reviewed, audited and upgraded for continuous excellence. The environment management systems at the refineries, pipelines and major marketing installations are certified under ISO- 14001 standards.

Role of Regulatory Agencies in Safety Management

- 4.4.13 The regulatory framework for the gas industry in the country will ensure a uniform standard for all the natural gas based installations and gas pipelines in the country. Though this framework implementation of the minimum set of safety standards for the gas industry would be required it would, however, be desirable for the owners of facilities to take proactive measures in these matters to provide adequate safeguards to its working personnel and environment.

4.5 Subsidy Structure

- 4.5.1 In addition to direct Government subsidy on LPG and kerosene, oil PSUs are sharing the burden of subsidizing sensitive petroleum products namely petrol, diesel, domestic LPG and PDS Kerosene. The Government has enunciated the principle of equitable burden sharing to cushion the impact of high international oil prices on domestic retail selling prices. Thus all stakeholders viz. the Government, oil companies including the upstream PSUs and consumers share the burden of price increase equitably.

- 4.5.2 In refining operations cost of crude constitutes over 85 percent of the total product cost. Due to high oil import dependence (about three-fourths of our crude requirement is imported) in this era of high oil price, our import bill has burgeoned. In 2005-06, the crude import cost had increased to about Rs.172,000 crore or by about 50 percent over 2004-05. In 2006-07, the import bill is expected to be significantly higher. Therefore higher crude prices necessitate adjustment in retail selling prices of sensitive petroleum products. The impact is so large, that oil price vulnerability can be a great dampener to our GDP growth and has the potential to disrupt not only future development but also our fiscal position significantly.

- 4.5.3 The Government is committed to protect the economically vulnerable and weaker sections of the society by providing life-line energy at affordable prices. During 2006-07, the projected burden is of the order of Rs 73,500 crore based on prices prevailing during April-May 2006. Oil PSUs will continue to shoulder the largest share in the total under recoveries during 2006-07. The upstream companies will bear Rs. 24,000 crore giving up most of their incremental revenues and the downstream companies will shoulder about Rs. 9,000 crore through implementation of trade parity concept, lower customs duty for petrol and diesel and commercial discounts. The Government on its part will provide financial support through bonds of Rs 28,300 crore. Thus the Government and its oil companies will shoulder about 87 percent of the total burden.

- 4.5.4 However, as stated above, the current scenario cannot be sustained for any length of time and radical solutions are called for.

Subsidy on Domestic LPG

- 4.5.5 The subsidy for domestic cooking gas should be phased out gradually or at least substantially reduced. As recommended by the Rangarajan Committee, a one-time upward adjustment in the price of domestic LPG by Rs.75 per cylinder may be made. Beyond this one-time increase, it is necessary to gradually increase the price of domestic LPG so that the retail price adjusts completely to the market level eliminating the subsidy

altogether as early as possible. Strong political consensus is needed for implementing the same.

Subsidy on PDS Kerosene

4.5.6 As in case of Domestic LPG, the subsidy on PDS Kerosene also needs to be pruned. There have been no price increases during the X Plan period or for now over four years, a situation perhaps not seen even during the APM regime. In addition there are several reports that indicate that subsidised kerosene supplies are being diverted denying the benefit to the intended groups. In view of this, the Government has recently, in principle, accepted the recommendations of the Rangarajan Committee that subsidy on PDS Kerosene should be restricted to BPL families, for which detailed implementation modalities are being finalised. This will help in reducing the subsidies by 41 percent.

4.5.7 The only fool proof mechanism for preventing leakage and diversion is to move towards a system of single price at the point of sale by oil companies to the wholesale dealer with the subsidy being passed on to eligible BPL households directly.

Subsidy on Petrol and Diesel

4.5.8 Though it has been a consistent assumption that petrol remains the fuel of the relatively better off, the position has been changing. 71 percent of non-transport vehicles⁵ are two wheelers, which run on petrol. Besides two wheelers continue to sell roughly 7 times every car sold within the country. Two wheelers essentially provide mobility to the aspiring class, the climbers and the middle class. Yet, there is a case for passing on the full price impact to these consumers with realignment of excise duties as has been discussed elsewhere in the report.

4.5.9 Diesel continues to remain the basic transportation fuel. While moderation in price is required, it cannot be subsidised. Non-revision in price of diesel alone can increase the fiscal deficit.

4.5.10 In case of both petrol and diesel regular and small adjustments in price are recommended, failing which we may be forced to correct prices in one go bringing about a price shock. Furthermore, if we are to reduce consumption of oil products, price signals must be transmitted to the consumers so that they can make adjustments on their side as well.

4.6 Regulatory Environment

Objective

4.6.1 Different sectors of the Indian economy have progressively moved towards the market-driven regimes in the past few years. In the sectors requiring regulatory intervention, viz., electricity, telecom, etc, statutory regulators have been established. Not only has this facilitated much-needed investments in these sectors and their orderly growth, the consumers have benefited on account of availability of better services and products at competitive prices.

⁵ As on 31.3.2003, Total registered two wheelers- 4.75 crores; total non-transport vehicles- 6.70 crores. Data as per Department of Road Transport & Highways

4.6.2 The PNGRB Act, 2006, notified by the Government on 3.4.06 provides for the setting up of a Regulatory Board with the objective to regulate the refining, processing, storage, transportation, distribution, marketing and sale of petroleum, petroleum products and natural gas excluding production of crude oil and natural gas so as to protect the interests of consumers and entities engaged in specified activities relating to petroleum, petroleum products and natural gas and to ensure uninterrupted and adequate supply of petroleum, petroleum products and natural gas in all parts of the country and to promote competitive markets and for matters connected therewith or incidental thereto. The Act, inter alia, provides for a legal framework for downstream gas sector regulation, and development of the natural gas pipelines and city or local gas distribution networks.

4.6.3 Regulatory reforms permit and encourage market forces to enhance competition and produce a more competitive and efficient industry structure. Natural gas pipelines and city gas distribution lines, being part of the backbone infrastructure of the economy, need a robust regulatory framework in order to curb monopolistic tendencies among the owners while ensuring a fair price to the consumers and fair return to the owner/producers.

Functions of the Regulatory Board

4.6.4 The Board shall have the following functions:

- a) Protecting consumer interest by fostering competition and fair trade amongst the entities;
- b) Register entities to:
 - i. Market notified petroleum and petroleum products and natural gas subject to the contractual obligations of the Central Government.
 - ii. Establish and operate LNG terminals;
- c) Authorize entities to:
 - i. Lay, build, operate or expand common carrier or contract carrier pipelines;
 - ii. Lay, build, operate or expand city or local natural gas distribution network;
- d) Declare pipelines as common carrier or contract carrier;
- e) Regulate, by regulations:
 - i. Access to common carrier or contract carrier pipelines so as to ensure fair trade and competition amongst entities;
 - ii. Transportation rates for common carrier and contract carrier pipelines;
 - iii. Access to city or local natural gas distribution networks so as to ensure fair trade and competition amongst entities;
- f) In respect of notified petroleum, petroleum products and natural gas:
 - i. Ensure adequate availability;

- ii. Ensure display of information about the maximum retail prices fixed by the entity for consumers at retail outlets;
 - iii. Monitor prices and take corrective measures to prevent profiteering by the entities;
 - iv. Secure equitable distribution for petroleum and petroleum products;
 - v. Provide by regulations and enforce, retail service obligations for retail outlets and marketing service obligations for entities;
 - vi. Monitor transportation rates charged by natural gas pipelines by common carrier or contract carrier and the price charged by a local distribution company and take corrective action to prevent profiteering by the provider entities;
- g) Levy fees and other charges as determined by regulations;
- h) Maintain a data bank of information on activities relating to petroleum, petroleum products and natural gas;
- i) Lay down the technical standards and specifications including safety standards in activities relating to petroleum, petroleum products and natural gas, including the construction and operation of pipeline and infrastructure projects related to downstream petroleum and natural gas sector and for this purpose specify a pipeline access code under regulations to establish a framework for third party access to pipelines;
- j) Perform such other functions as may be entrusted to it by the Central Government to carry out the provisions of this Act.

Strengthening of DGH for Upstream Regulation

- 4.6.5 Government of India has delegated certain powers vested in it under Oilfields (Regulation and Development) Act, 1948 and Petroleum and Natural Gas Rules, 1959, as amended from time to time, to the Directorate General of Hydrocarbons (DGH). The objective of the delegation of statutory powers is to empower DGH so that it can effectively oversee the ever increasing E&P activities in India with more areas coming under exploration with successive rounds of NELP and CBM. Delegation of powers to DGH mainly covers monitoring of upstream activities including CBM operations, review and monitoring of exploration and development programmes, reservoir monitoring with a view to optimize hydrocarbon recovery, maintain data repository, lay down norms for declaration of hydrocarbon discoveries and monitor Government revenue such as royalty and profit petroleum.
- 4.6.6 To exercise this delegated powers, DGH, with the approval of Central Government will prepare transparent guidelines. However, in respect of the contracts, signed by the Government, DGH will exercise the powers in accordance and consistent with respective contracts.
- 4.6.7 The Government has also amended Rule 19 of the P&NG Rules to enable the Government/DGH to get all data from licensees/lessees, free of cost as and when they are acquired and become available. All non-proprietary data can be disclosed by the

Government at any time and proprietary data can be disclosed with the consent of the licensees/lessee at any time and after 5 years from the date from which such data become available or termination of license/lessee whichever is earlier at the discretion of the Government.

4.6.8 The above steps have been taken by the Government to promote E&P activities in the country, strengthen DGH with more powers and enable creating a National Data Repository (NDR) by facilitating DGH to get data from NOCs and private companies for all acreages held by them from time to time. This will also encourage effective use of available data in the country in promoting efficient E&P operations.

4.6.9 At the beginning of the X Plan period, the oil and gas sector was deregulated with the dismantling of APM. Earlier, the exploration and development activities were dominated by the NOCs, mainly ONGC and OIL. However, Private/JV companies were provided an equal opportunity to get into E&P business after implementation of NELP. Similarly the refining and marketing sector also saw the entry of private players in the oil and gas sector during the X Plan period. Moreover, private/JV companies have emerged as significant players in hydrocarbon sector during X Plan period.

4.7 **Report of the Expert Committee on Integrated Energy Policy**

4.7.1 Trade Parity Principle for Pricing of Products: The Government has already implemented trade parity pricing for petrol and diesel on the recommendations of the Rangarajan Committee, which is weighted average of the import parity and export parity prices in the ratio of 80:20. The principle of trade parity pricing will apply for the refinery gate price as well as for determining the retail price. In case of subsidised products, namely PDS kerosene and domestic LPG, the customs duty is 'nil' and therefore the issue of trade parity does not apply to these products.

4.7.2 Option of Short Term Hedging and Long Term Crude Oil Contract: As part of the risk management strategy, several oil companies are already undertaking short term hedging for crude oil and petroleum products. The oil companies while procuring crude oil use a mix of long term contracts and spot purchases. They do this to optimize on their product requirements. Further, this Ministry accepts the suggestion of government adjusting the ad-valorem taxes and levies in a tax neutral manner especially in the period of high oil prices. This ministry has already taken this issue with Ministry of Finance.

4.7.3 Petroleum and Natural Gas Regulation - Functions of the Regulator: The downstream sector entered the transition phase during the X Plan and the Government took the initiative to put together a regulatory framework, which took shape during most of the X Plan period and finally, the PNGRB Bill was enacted in early 2006. The process of selection of a Regulator has kick-started as a sequel to PNGRB Act 2006. The regulator shall be responsible for bringing in transparent and competitive regime in creation of pipeline infrastructure and retailing. The regulator is also expected to lay down market service obligations and it is expected that during the XI Plan period, these objectives would be met.

4.7.4 Upstream Regulator: At present, Government is regulating upstream activities through DGH. Recently, DGH has been delegated with adequate powers under the Oil Fields (Regulation and Development) Act (ORDA), 1948 and Petroleum and Natural Gas Rules to exercise independent powers for regulating the upstream sector. Thus, E&P sector is managed on the basis of an established legal system.

- 4.7.5 Subsidy: Government is initiating dual pricing of PDS kerosene by separation of consumers into two groups, viz. BPL and non-BPL, as per the criteria of the Planning Commission. While BPL families will continue to draw subsidised PDS kerosene, non-BPL families will have to purchase kerosene at market-determined prices. This process would be completed within a reasonable time frame. Thus, PDS kerosene subsidy, after it is targeted to BPL families, could be directly met from the Union Budget in a transparent manner. As regards domestic LPG, the Rangarajan Committee had recommended raising the price of domestic LPG by Rs.75 per cylinder initially and then gradually adjusting the price so as to eliminate subsidy all together on the grounds that subsidy to non-poor segments of the society is clearly indefensible. For that reason, the current circumstances call for complete removal of subsidy rather than change in mode of subsidy disbursement. We may consider eliminating subsidies on Domestic LPG.
- 4.7.6 Bidding out of Subsidies: Bidding out of subsidies is considered operationally challenging as no company would be in a position to service all customers in an area, or take over customers of another company. There may be logistics issues involved due to infrastructure constraints.
- 4.7.7 Assessment of the Sedimentary Basins: MoPNG expects that over 88 percent of sedimentary basinal area would be licensed out for exploration by the end of XI Plan. This is expected to accelerate the exploration to the extent that all resources viz. funds, workforce, technology and logistics are expected to be put to test. The policy environment and regulatory regime is being strengthened to enable facilitation of such rapid opening up of the sector.
- 4.7.8 Gas Hydrates: DGH is implementing the National Gas Hydrates Programme (NGHP) as per the laid down road map. DGH has acquired core samples from offshore areas through scientific cooperation program with the USA. India thus became the third country in the world to do so. This activity will help in assessment of gas hydrates resource potential in Indian waters. After assessment of resource potential, major challenge for the project will be to develop technologies for exploitation of gas hydrates in collaboration with Indian/foreign scientists. Globally, gas hydrates is at R&D stage only.
- 4.7.9 Oil Shale: During XI Plan, resource estimation for oil shale in India and identifying suitable technologies to exploit the potential of oil shale has been planned.
- 4.7.10 Provide Level Playing Field for Foreign Operators: Under NELP, licences for exploration are awarded through a competitive bidding system and NOCs are required to compete on an equal footing with Private Indian and foreign companies to secure exploration acreages. Similarly, Government approved a CBM policy in July 1997 for exploration and exploitation of CBM gas. Under this policy also, a level playing field in CBM exploration has been provided to NOCs and private companies, both Indian and foreign.
- 4.7.11 All Non-dedicated Transportation and Distribution Assets to be Common Carrier: The PNGRB Act 2006 has laid down provisions for declaring transportation and distribution networks as common or contract carrier. However, non-dedicated assets could be made available with mutual consent on commercial terms between the entities.
- 4.7.12 Follow International Best Practices: Government has already announced the policy for declaration of hydrocarbon discoveries, which is being implemented by DGH. As of now the DGH performs the functions of an upstream regulator, which essentially relates to implementation of contractual obligations under the PSCs. The issue of adopting best international practices by the DGH can be considered for implementation.

- 4.7.13 Mumbai High Crude Price Discovered through an Open Auction: This could be considered wherein Government can mop up incremental revenue and this option may be extended uniformly for all domestic oil fields.
- 4.7.14 Declared Goods Status for NG/LNG: Oil companies have time and again requested for treating gas and crude as 'declared goods'. This helps in rationalisation of tax rates and the administration of taxes is much easier. This also saves potential litigations on the subject of rates and applicability of rates and thus saves oil companies from undue inconveniences and litigation costs. The Working Group supports this point of view.
- 4.7.15 LNG Imports: The benefits of long term contracts of LNG are demonstrated in the PLL Dahej Project. It is an endeavour of MoPNG and the oil companies to continue to establish such long term linkages in the XI Plan period.
- 4.7.16 Strategic Reserves : Taking into account the oil security concerns of the country, the Government has decided to set up 5 MMT strategic crude oil storages at various locations in the country viz. Mangalore (1.5 MMT), Vizag (1.0 MMT) and Padur near Udipi (2.5 MMT). The proposed facilities would be managed by Indian Strategic Petroleum Reserve Limited (ISPRL), a special purpose vehicle, owned by OIDB.
- 4.7.17 Natural Gas Allocation and Pricing: MoPNG has been regulating the allocation and pricing of gas produced by the NOCs by issuing administrative orders from time to time. Gas produced by the JVs and by NELP operators is governed by the respective PSCs. The consumer price of APM gas has been revised by the Government w.e.f. 1 July 2006 on an ad-hoc basis, subject to the determination of producer price of ONGC and OIL by the Tariff Commission. It was also decided that for the APM gas consumers, other than power and fertilizer sector consumers, the gas price would be progressively increased over the next three to five years to reflect the market price. This policy will continue during the XI Plan period. A specific volume of gas produced by NOCs would continue to be administered as regards price, to benefit specified sectors like fertiliser and power. The MoPNG is committed to allow market determined pricing mechanism for the domestically produced gas, as has been committed to producers in the PSCs. As such MoPNG does not envisage any alternate pricing mechanism for domestic gas in the XI Plan period.
- 4.7.18 Gas Pipeline Network: The Government is formulating a Gas Pipeline Policy, which envisages the progressive development of a transmission and distribution pipeline network, as also the growth of city or local gas distribution networks in a competitive environment, involving both the public sector and the private sector. The objective of the policy is to promote investment and to facilitate open access for all players to the pipeline network on a non-discriminatory basis, promote competition among entities thereby avoiding any abuse of the dominant position by any entity. Appropriate regulations on various matters would be notified by the Regulatory Board under the PNGRB Act, 2006.
- 4.7.19 Diplomacy to Access Overseas Hydrocarbon Reserves: Government is taking necessary steps as and when required to get access to overseas hydrocarbon reserves.
- 4.7.20 Ensuring Energy Security: During XI Plan, thrust areas identified include acquiring overseas assets, development of alternate resources (CBM and UCG), faster development of existing reserves and accelerated exploration in the country thereby ensuring energy security.

4.7.21 Merge PCRA with Bureau of Energy Efficiency (BEE): PCRA was created way back in 1973 at the initiative of oil companies. PCRA has been contributing to the energy conservation relating to the petroleum sector. BEE has come into being just about five years back and is gathering momentum in conservation of energy in the power sector. Lot of scope exists for conservation plan and schemes in the oil and natural gas sector. Therefore, PCRA should maintain separate identity and keep pursuing the conservation measures in the petroleum sector. Instead of merging both the entities it would be more appropriate to take advantage of synergy between the two entities for getting benefit to the economy. Towards this end more rigorous efforts towards energy efficiency and oil conservation may be necessary. There is a need for more intensive focus through enhanced energy auditing, labelling etc for all the industries.

4.7.22 Boosting Energy Related R&D: MoPNG agrees, in principle, that energy R&D deserves to be given special attention and added attention may be given with regards to funds' generation. While creating the proposed National Energy Fund (NEF), the funding and the rebate structure needs to be deliberated in detail by all stakeholder and analysed for its impact before hand as the R&D expenditure of most of the major energy firms are too low and may not even exceed 0.1 percent of their turnover.

4.8 **Dr. C Rangarajan Committee Report**

4.8.1 The Government on 26th October 2005 had set up a committee to look into the various aspects of pricing and taxation of petroleum products with a view to stabilizing/rationalizing their prices, keeping in view the financial position of the oil companies, conserving petroleum products, and establishing a transparent mechanism for autonomous adjustment of prices by the oil companies. Based on the deliberations in the meetings, the following three areas were identified by the committee for detailed study in order to meet the objectives set out in the terms of reference:

- Alternative models for pricing of petroleum products;
- Taxes and duties on crude oil and petroleum products;
- Subsidies on PDS kerosene and domestic LPG.

4.8.2 The recommendations made by the committee can be divided broadly into three groups. The first set of recommendations relating to pricing of petrol and diesel are the following:

- i. Shift to a trade parity pricing formula for determining refinery gate as well as retail prices;
- ii. Government to keep at arms length from price determination and to allow flexibility to oil companies to fix the retail price under the proposed formula; and
- iii. Reduce effective protection by lowering the customs duty on petrol and diesel to 7.5 percent.

4.8.3 This set of recommendations should be implemented as an integrated package as selective implementation will create more distortions.

4.8.4 The second set of recommendations relates to pricing of domestic LPG and PDS kerosene, viz:

- i. Restrict subsidized kerosene to BPL families only;
- ii. Raise the price of domestic LPG by Rs. 75/cylinder;
- iii. Discontinue the practice of asking ONGC/GAIL/OIL to provide upstream assistance, but instead collecting their contribution by raising the OIBD cess from the present level of Rs. 1,800/MT to Rs. 4,800/MT; and
- iv. Government to meet the balance cost of subsidy from the budget. The 'PDS Kerosene and Domestic LPG Scheme 2002' will have to be suitably amended for this purpose.

4.8.5 This set of recommendations should also be implemented as an integrated package as partial implementation will not yield sustainable results.

4.8.6 The third set of recommendations relates to restructuring of excise duties from the present mix of specific and ad-valorem to a pure specific levy and calibrating the levies at Rs. 5.00 per litre for diesel and Rs. 14.75 per litre for petrol.

4.8.7 The Government has accepted the following major recommendations of Dr. Rangarajan Committee.

Pricing of Petrol and Diesel

- Pricing formula for Petrol and Diesel has been changed to trade parity which would be a weighted average of the import parity and export parity prices in the ratio of 80:20
- Principle of trade parity pricing will apply for the refinery gate price as well as for determining the retail price.
- The relative weights of exports and imports in estimating the trade parity price will be reviewed and updated every year.
- The Government has moved towards providing flexibility to oil companies to fix retail prices autonomously. However, the current international scenario is not conducive to pricing freedom with oil prices recording historical high every successive month. The Government is committed to provide full freedom when international prices stabilize.

Rationalization of Customs Duty

- Custom duties on petrol and diesel have been reduced to 7.5 percent from 10 percent.
- Customs duty on crude has been retained at 5 percent.
- Customs duty on industrial products other than petrol and diesel may be retained at 10 percent in order to protect domestic producers who suffer sales tax as compared to direct importers.

Burden Sharing by the Government

- The Government has decided to share the burden of not making full adjustment in domestic retail prices due to high oil prices through the principle of equitable burden

sharing wherein Rs 28,300 crore would be borne in the form of oil bonds during 2006-07.

Adjustment of Subsidy on Kerosene

- The Government has accepted in principle to restrict supply of PDS kerosene to BPL households.
- In computing the quantum of subsidy entitlement of states on PDS kerosene, BPL households' estimates of the Planning Commission will be used and a uniform criteria and estimation methodology will be applied.

Recommendations found Non-implementable at the Current Stage

- 4.8.8 Some of the recommendations have been found non-implementable in the current scenario of abnormally high prices. Freight equalisation has been continued for the present. Besides full price increases required have not been passed through in periods of volatile international prices. Rationalization of excise duty and sales taxes remains. Further the differential in retail prices is being equitably shared rather than met fully from the fiscal budget in a transparent manner.

Other Recommendations

Restructuring of Excise duties

- 4.8.9 Adjusting excise duties to a higher or a lower level has arguments on both sides. Those proposing higher level of duties have argued that prices of the petrol and diesel need to be consciously kept high to provide appropriate price signal to the consumers. India being oil import dependent, we need not encourage consumption. At the same time, funds collected through excise can be utilized to meet funding for social schemes.
- 4.8.10 The counter argument has been that lower taxation will reduce the burden of the consumers. A country like India needs to strike a balance between diverse objectives. Taxation on subsidised products is already minimal with no excise duty on PDS Kerosene and domestic LPG. Consumption of these products is restrained through allocations and lower new connections. In case of petrol and diesel, there is no restraint on consumption except may be indirectly through higher prices. Therefore, as far as excise duty on petrol and diesel is concerned, there is merit in high taxation. Similar practice is followed across Europe by developed countries.
- 4.8.11 As regards, advalorem components in excise duty, an 8 percent rate does not appear excessive though it does compound price increases to a certain extent. From the taxation point of view, it is necessary to maintain price as well as quantity buoyancy.
- 4.8.12 Rangarajan Committee has pointed out that large disparity between excise duties of petrol and diesel needs to be rectified. This is contrary to the global trend where the excise levies on both products are more or less equal. Indeed, in some countries, diesel is costlier than petrol. The contrarian trend in our economy leads to inefficient substitution of one fuel for another.
- 4.8.13 Though, in principle, high taxation can be supported it is necessary to realign taxes between transportation fuels – petrol, diesel and ATF keeping in mind the ability of the

consumers to shoulder the burden. The current excise duties along with its consumers is indicated in the table below:

Transportation Fuel	Excise Duty⁶	Consumers
Petrol	Rs.13/Ltr + 8 percent (Rs 15.18/litre)	Mainly owners of two wheelers and cars
Diesel	Rs.3.25/Ltr. + 8 percent (Rs 5.20/litre)	Trucks, public transport, railways and farmers
ATF	8 percent (Rs 2.66/litre)	Airline travellers

- 4.8.14 It may be seen that the current policy seems to favour airline travellers who perhaps can afford higher taxation in contrast to people who travel by buses in public transport or on rail. Clearly, there is a case to realign excise duty considering the consumers. ATF could be taxed at the highest level with petrol being taxed at a lower level. Diesel being the lifeline of commerce should attract moderate taxation, but the least of the three transportation fuels.

Restructuring of State Sales Taxes

- 4.8.15 Rangarajan Committee observes that sales tax collection from oil sector have consistently been contributing to a third or more of the total sales tax collections of the states thereby burdening the consumers as well as building an undesirable dependency at the state level too for revenues on a single sector. Further, heavy sales tax levies lead to a high degree of cascading. The Empowered Committee of State Finance Ministers deliberating on the implementation of VAT should also be entrusted with the task of evolving a uniform policy on sales tax levies on petroleum products.
- 4.8.16 Further, on irrecoverable local taxes, the best solution would be to persuade the concerned State Governments/local bodies to withdraw such levies in view of their distortionary impact. Alternatively, the State Governments/local bodies may be encouraged to replace the entry tax/octroi by a surcharge on sales tax on finished petroleum products. The State Government can compensate the local body out of the surcharge it collects. However it has been reiterated that the most desirable option is to eliminate all such duties.
- 4.8.17 The Ministry agrees with the observations and recommendation of the Rangarajan Committee, that the state tax⁷ rationalization is an urgent need. Though, most states have adopted VAT, there is no uniformity amongst the tax rates and procedures between various States. In addition, taxes from local bodies distort the playing field. Government may bring pressure on the States to eliminate irrecoverable taxes such as octroi and entry taxes and if required convert these taxes to recoverable taxes.

⁶ Excise duty as on 1.8.2006, includes education cess.

⁷ State taxes includes Sales tax, CST, Entry taxes, surcharge and Sales Tax, purchase tax etc.

4.8.18 At a time when the country is entering into Free Trade Agreements (FTAs) with different countries to form a larger market, it is ironical that we have a fragmented market within the country. It is absolutely essential to have a common market for oil products based on VAT throughout the country. VAT should provide set-off for local taxation such as entry tax and octroi, in case these taxes are not eliminated.

4.8.19 The lasting solution lies in implementing a unified Goods and Services Tax (GST) across the country on petroleum products. The Government has already announced their intent to put in place a GST structure by 2010. It is hoped that GST would cover the full gamut of taxes and provide set-off for taxes, including service tax, on inputs whether at the municipal level, state level or central level while placing imports at par with domestic production.

Eliminate Subsidy on Domestic LPG

4.8.20 The subsidy for domestic cooking gas should be phased out gradually or at least substantially reduced. As recommended by the Rangarajan Committee, a one-time upward adjustment in the price of domestic LPG by Rs.75 per cylinder may be made. Beyond this one time increase, it is necessary to gradually increase the price of domestic LPG so that the retail price adjusts completely to the market level eliminating the subsidy altogether as early as possible. Strong political consensus is needed for implementing the same.

Adjust PDS Kerosene Subsidy

4.8.21 The observation that the only fool proof mechanism for preventing leakages and diversion is to move towards a system of a single price at the point of retail sale for all consumers with the subsidy being passed on to BPL consumers through alternative mechanisms. We may explore methods to provide direct subsidy amount to the consumers, with full price applicable at the retail point.

4.8.22 Further in view of the enhanced programme for rural electrification (Rajiv Gandhi Grameen Vidyuthikaran Yojana), the need for subsidizing kerosene over the medium term needs to be reviewed.

4.9 [Dr. V. Krishnamurthy's Report on Restructuring of Petroleum Sector](#)

4.9.1 The Advisory Committee on Synergy in Energy (ACSE) headed by Dr. V. Krishnamurthy had three terms of reference. The committee was to examine:

- i. the core competence of PSUs to assess their competitiveness;
- ii. analyse options to leverage their strength to optimally fulfil their required contribution to national objectives of energy security, accelerated growth, sustained development and social objectives of government policy; and
- iii. Identify the most appropriate structure of oil PSUs to secure these ends.

Core Competencies

4.9.2 ACSE has observed that oil PSUs need to focus on their respective core competencies. Non-core activities in the upstream sector need to be farmed into separate companies/subsidiaries. The focus of upstream companies should be primarily on E&P, without distraction and dissipation of energy and resources in other activities. ACSE

suggests that domestic E&P needs to be intensified by applying latest technology in frontier basis and deep-water areas. R&D institutes of ONGC should be suitably strengthened. PSU refineries need to undertake measures for up-gradation of technology, size and benchmark their operations with international norms.

- 4.9.3 The Ministry agrees with the recommendation that oil PSUs should focus on their core competence. Considering the recent track record of ONGC in E&P, it appears that ACSE's recommendations that ONGC focus on E&P are appropriate. In fact one of the urgent requirements of the nation is to find more oil. The refineries have been advised to benchmark their operation against their global peers. CHT along with an international consultant has recently evaluated PSU refineries. Suggestions made are being evaluated and would be implemented wherever found commercially beneficial.

Appropriate Structure

- 4.9.4 On the question of appropriate structure, ACSE has recommended that merger of PSUs may not be advisable and that the strengthening of the existing structure through policy changes and management/structural improvements may be considered. Further, ACSE has recommended that CPCL, BRPL and IBP should be integrated within IOC while KRL should be integrated with BPCL. NRL however should maintain its separate identity. On MRPL, ONGC's subsidiary, no direct reference has been made, though indirectly, it has been recommended that the focus of upstream companies should primarily on E&P, without distraction and dissipation of energy and resources in other activities.

- 4.9.5 In line with the recommendations, IOC has already initiated moves for merger of IBP and BRPL with itself. Similarly, KRL has been merged with BPC. NRL's identity is being strengthened and OIL has been granted permission to raise its stake in NRL to 26 percent.

Leveraging Strength of Oil PSUs

- 4.9.6 As regards the management, ACSE has suggested that government nominee directors on the board of PSUs should play proactive role by effectively reviewing the projects for synergising creations of infrastructure.
- 4.9.7 The committee has placed additional responsibilities on government nominee directors, which it expects to optimize facilities and projects across companies. For this purpose, it is necessary that the Government directors interact amongst themselves on a regular basis while being guided by government policies. This Ministry agrees with this suggestion.

Other Recommendations

- 4.9.8 ACSE has advised that strategic reserve quantity may be increased to at least 10 MMT. ACSE has recommended putting in place a comprehensive energy policy, measures for improvement of energy efficiency etc. encouraging coal in order to reduce dependence on oil, investment in coal gasification, etc and promoting use of nuclear energy, solar energy, wind power, etc. The Government has taken in-principle decision to construct 15 MMT of strategic storage in phases.

5 Thrust Areas for XI Plan Period

5.1 Major Thrust Areas for XI Plan Period

5.1.1 The major thrust areas for the XI Plan which seek to address the challenges being faced by the industry are outlined below :-

Exploration & Production

5.1.2 **Increasing Domestic Oil and Gas Production:** To realise the vision of the President of India, the nation needs to graduate from energy security and move towards energy independence. Increasing domestic production is paramount in realising this vision. Bringing more and more acreage under exploration specially those in the frontier areas/basins, adoption of state-of-the-art E&P technology, faster development of discovered reserves, development of marginal fields, continuation of IOR/EOR schemes, establishment of a National Knowledge Hub in India, ensuring availability of knowledge workers for the upstream sector etc. are some of the steps that need to be undertaken to boost domestic production.

5.1.3 **Increasing Production in ONGC's Assets:** Good news is that the share of private sector in total domestic production is increasing; bad news is that the projections indicate a steep decline in production from aging assets owned by Government E&P companies. The situation may be corrected, inter alia, by undertaking multi-pronged measures such as development of isolated marginal fields, faster development of discovered reserves and leveraging technology to enhance productivity of existing fields.

Refining

5.1.4 **Processing Sour and Heavy Crude:** With growth in awareness about sustainable global development, today Governments can ignore the environmental damage caused by fossil fuel consumption only at their own detriment. Fuel specifications used in different applications have continuously undergone changes and, with time, are expected to become more and more stringent. Indian refineries need to gear up to meet this challenge and in order to remain competitive the refineries need to be upgraded to process low-cost high-sulphur heavy crude to produce fuels conforming to international specifications. The refineries also need to understand the importance of continuously improving the fuel quality for complying with the domestic environmental regulations.

5.1.5 **Maximising Export of Petroleum Products:** India is expected to emerge as a serious exporter of petroleum products with substantial surplus capacity. The actual capacity addition would, however, depend upon several factors including growth in domestic demand, duty structure which would impact import and export possibilities, refining margin, and export potential for the products. Factors adding to the viability of export oriented refineries include setting up in Special Economic Zone (SEZ) areas, differential in sweet and sour crude and import of crude oil and petroleum products being handled through large vessels bringing down the transportation cost. Goes unsaid that Indian refineries will have to produce fuel of international quality suitable for exports which contributes to sound environmental management.

Pipelines and other Infrastructure

5.1.6 **Improving Pipeline Connectivity:** Healthy development of the oil and gas industry hinges on the concurrent development of a commensurate support infrastructure.

Therefore, encouraging investments in ports, petroleum product pipelines, storage terminals, etc. forms part of the overall plan of industry development. Due to its inherent advantages, product pipelines are preferred over other competing transportation modes such as railways and road. There is an urgent need, therefore, to enhance coverage of pipelines throughout the country, depending, of course, upon relative economics.

- 5.1.7 **Encouraging Laying of Gas Transportation Infrastructure:** Transportation of gas within the domestic market is done through gas pipelines. Availability of a robust gas transportation infrastructure is crucial for development of the natural gas market. There is a need to create gas infrastructure and at the same time ensuring co-ordinated development across the entire value chain. Setting up of a Regulator under the PNGRB Act 2006 to regulate the downstream oil and gas sector, is expected to provide clarity and comfort to interested investors in the gas transportation sector.

Marketing

- 5.1.8 **Minimizing Adulteration:** Adulteration is a menace which needs to be tracked by all concerned through technological and other interventions. Steps need to be undertaken by all stakeholders to curb adulteration. Steps already initiated include introduction of tamper-proof locks, automation of retail outlets, monitoring the movement of tank trucks through Global Positioning System (GPS), introduction of marker system for adulterants like kerosene, and third party certification of retail outlets.
- 5.1.9 **Maximizing Automation:** Ensuring product quality and quantity across supply chain is necessary in a competitive environment. Automation is being carried out at retail outlets and terminals/depots. This is necessary to minimise human intervention in the processes. Efforts are, therefore, needed to maximize automation.
- 5.1.10 **Maintaining Retail Outlet Viability:** Increased competition amongst marketing companies has seen a spurt in rollout of retail outlets throughout the country resulting in decline in outlet throughput. In order to maintain viability of outlets, it is essential for the public sector oil marketing companies to have synergy amongst them in setting up of new retail outlets.

Pricing and Subsidies

- 5.1.11 **Pricing of Sensitive Petroleum Products:** Efforts may be made to move towards providing flexibility to oil companies to fix retail prices of petrol and diesel autonomously. In case of domestic cooking gas, subsidy may be phased out gradually as recommended by the Rangarajan Committee report. For kerosene, direct subsidy may be provided to the consumers, particularly those below the poverty line, with full price applicable at the retail point.
- 5.1.12 **Unified State Taxes and Removal of Tax Anomalies:** Amalgamate individual state markets into one nation wide market with unified state taxes, remove state taxes anomaly, provide level playing field to domestic production vis-à-vis direct imports and introduce a uniform VAT which provides full set off for local levies such as octroi and entry tax.

Emerging New Sources of Fuels

- 5.1.13 The quest for energy security through increased supplies of conventional sources such as oil and gas needs to be supported with an impetus being given to the development of

unconventional sources of energy like Coal Bed Methane (CBM), Gas Hydrates, and Coal Liquefaction etc. Clean coal technologies such as underground coal gasification (UCG) and conversion of coal to liquid hydrocarbon etc, hold great potential for India as it is rich in coal resources. There is a need to aggressively pursue the promotion of bio-diesel and ethanol blended petrol with higher blending ratios.

- 5.1.14 Exploring and exploiting country's CBM resource has already gained momentum with the recent conclusion of the third round of CBM bidding. For exploring the gas hydrate potential in the Indian deepwaters, a National Gas Hydrates Programme has been undertaken by the Government since 1997 with active participation from oil and gas companies, research organisations and DGH. Oil shale another source of unconventional oil is said to be present in the North-East region in substantial volumes.

Research and Development

- 5.1.15 Considering the complex nature of initiatives required the policy framework needs to be in a position to offer very attractive incentives to the sectors, which proactively get themselves engaged into the R&D activities relating to various sources of energy with particular emphasis on areas of conservation and improvement in energy efficiency. There is, therefore, a need to provide incentive and or funding for undertaking rigorous R&D activities.

- 5.1.16 Given the importance of dramatically improved new vehicle fuel economy in the coming decade, R&D on highly efficient vehicles and technologies such as fuel cells, hybrid-electric drive-trains, and light-weight materials should be expanded. New generation of vehicles should expand its focus to developing both cleaner and more efficient vehicles by adopting aggressive emissions goals to complement its fuel economy goals.

Energy Conservation

- 5.1.17 Timely actions by the Government through policy interventions have provided a favourable climate to foster rational use of energy. From being a tool to stabilize the temporary disruptions caused by the oil crisis, energy conservation has now become an important issue. Enhancement of energy efficiency is a universally accepted development goal. Energy efficiency and Demand Side Management/conservation must occupy a central position in the national strategy. For effectiveness of the programme there is a need to introduce the target at national level say 1 percent saving per annum each through conservation measures and efficiency improvements or varying percentage depending upon the sector/industry. A rupee invested in energy efficiency will save more energy than a rupee invested in energy supply.

6 Demand - Supply Gap Analysis for XI Plan Period

6.1 Demand for Petroleum Products

6.1.1 Various groups have estimated long-term demand projections for oil for the country from time to time. Some of the main projections are contained in:

- India Vision 2020,
- India Hydrocarbon Vision 2025
- Energy Information Administration (EIA) and
- International Energy Agency (IEA)

6.1.2 While the projections by IEA and EIA are based on lower GDP growth rates and are in the range of 230 MMT to 264 MMT, India Hydrocarbon Vision (IHV) 2025 projects the demand for the year 2025 in the range of 235 MMT to 368 MMT. The details of projections made by different groups are given in Annexure – VI.

Projections for XI Plan

6.1.3 Oil industry in the country has undergone major transformation in the past few years. From deficit situation till 1999-2000, the country is now net exporter of petroleum products. Globalization of Indian economy along with high international oil prices which are a pass-through in the bulk sector has induced improvement in energy efficiency and shift of demand from liquid to natural gas/LNG wherever possible. Further, improvement in road infrastructure and better vehicles has had a sobering effect on the demand for road transportation fuels. Besides, there is growing contribution from the services sector in country's GDP composition.

6.1.4 Low demand in transport fuels like MS and HSD is also due to factors like expansion of city gas distribution networks i.e. CNG which has grown from just under 50 TMT sales in 2000-01 to around 0.5 MMT in 2005-06 recording a CARG of 60.9 percent. Besides, introduction of Metro in Delhi and its expansion to the National Capital Region (NCR), Mumbai and Bangalore will have significant impact on demand for MS/HSD in future. Hence, it is estimated that POL demand would continue to grow at moderate rate of growth during XI Plan also.

6.1.5 In future, blending of MS by ethanol and introduction of bio-diesel may also have a significant impact, though not on the demand per se but in increasing the production surplus of unblended MS and HSD.

Approach Adopted to Estimate Future Demand

6.1.6 The following two approaches have been considered for assessing the oil requirements for future.

- **Top-down Approach:** Overall energy requirements with share of various fuels in the primary commercial energy basket (considered by Planning Commission and reported in IEP) by linking GDP with energy elasticity.

- **Bottom-up Approach:** End use approach considering the impact of various parameters. While assessing the requirements factors like impact of gas, vehicle population growth, improved fuel efficiency, technological improvements in engine designs, impact of auto LPG, CNG expansion, impact of Metro rail, impact of high oil prices, conservation/efficiency improvement issues, aviation policy of the Government, growth of passenger and cargo traffic, fleet expansion plan of airlines, National Highways Authority of India (NHAI) road construction projects, Railways freight policy, electrification plans of railway tracks and construction of freight corridor etc. have been considered.

Declining Elasticity

- 6.1.7 Factor discussed above have resulted in weakening the relationship between GDP growth and POL growth. Demand elasticity is declining as can be seen in the table below:

Particulars	VII Plan	VIII Plan	IX Plan	X Plan*
POL Growth (percent)	6.9	6.8	4.9	2.7
GDP Growth (percent)	6.0	6.8	5.5	7.8
Demand Elasticity	1.15	1.0	0.89	0.35
*2002-06				

- 6.1.8 One of the major reasons for declining elasticity is far higher contribution of services sector compared to past while contribution from the manufacturing sector has more or less remained the same, but it too has improved its efficiency. Year-wise composition of GDP for past few years is given below:

Year	Agriculture	Industry	Services
1990-91	32.2	21.9	47.8
2000-01	23.9	22.0	54.1
2004-05	20.5	21.9	57.6
2005-06	19.9	26.1	54.0

- 6.1.9 It is expected that the trend witnessed in POL consumption to intensify, with high oil price acting as a catalyst towards further reducing consumption and improving efficiency. The dominance of services sector is also anticipated to continue in the XI Plan.

Projected Demand

- 6.1.10 Based on the above analysis the demand of petroleum products have been estimated in two scenarios – Base Case and Upper Case. In Base Case, the consumption in the terminal year of the XI Plan, i.e. in 2011-12 is estimated at 132 MMT indicating a growth of 2.9 percent per annum. The year wise details are given below.

X Plan	XI Plan					
2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	CARG
114.034	116.089	119.098	121.987	126.973	131.767	2.93%

- 6.1.11 In the Upper case, the demand is estimated to grow by 4.45 percent to 142 MMT. The demand under upper case scenario is as follows:

End of X Plan	End of XI Plan					
2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	CARG
114.034	117.555	121.951	127.789	136.593	141.793	4.45%

- 6.1.12 The year wise, product wise figures are given in Annexure – VII.
- 6.1.13 It may be mentioned that since the oil prices are expected to remain at a high level in future, alternate sources of energy are likely to become increasingly economically viable. In projections impact of such alternatives has not been considered and the actual materialization may be different from the one projected now. In addition, policy initiatives, which encourage energy efficiencies, could lower the oil demand growth even further. Some possibilities in the transport sector are discussed in Annexure VIII.

Projections for 2016-17 and for 2021-22

- 6.1.14 Projections beyond XI Plan are more difficult as uncertainties increase proportionately. Since demand is a function of so many factors, none of which can be accurately determined today, including future technologies, state of the economy, development of alternatives and new products, geopolitical developments etc., assumptions made for working out projections can easily undergo a radical change. Besides, in the context of extremely volatile crude and product prices in the international markets, predicting energy demand is hazardous. Hence, long-term projections made below are just a rough estimate, indicative and directional and may be used with caution.
- 6.1.15 Demand for terminal years of XII Plan are estimated to be as under:

PRODUCTS	Base Case		Upper Case	
	2016-17	CARG	2016-17	CARG
LPG	16.905	5.8	16.905	5.8
MS	13.501	4.0	14.558	4.6
NAPHTHA/NGL	17.364	8.4	17.364	8.4
ATF	7.187	4.0	9.283	5.0
SKO	6.787	-2.6	6.787	-6.3
HSD	58.910	4.0	61.891	4.5
LDO	0.569	0.0	0.569	0.0

PRODUCTS	Base Case		Upper Case	
	2016-17	CARG	2016-17	CARG
LUBES	2.792	1.5	2.862	2.0
FO/LSHS	14.224	0.5	16.451	1.9
BITUMEN	5.315	3.0	5.849	4.0
PET. COKE	6.972	4.0	10.889	8.0
OTHERS	9.687	7.0	15.883	12.0
TOTAL	160.213	4.0	179.291	4.8

6.1.16 The projected demand is higher mainly on account of higher consumption of naphtha mainly in petrochemical plants projected to come up by that time.

6.1.17 Indicative demand in the terminal year of XIII (2021-22) Plan is estimated at 190.3 MMT for Base Case and 212.9 MMT under Upper Case.

6.2 Demand Supply Gap for Petroleum Products

Demand of Petroleum Products

6.2.1 The demand of petroleum products considered is as given by Sub-Group on demand estimation. The total demand for the XI and XII Plan period is as given below.

						MMT
Case	2007-08	2008-09	2009-10	2010-11	2011-12	2016-17
Base	116.1	119.1	122.0	127.0	131.8	160.2
Upper	117.6	122.0	127.8	136.6	141.8	179.3

Product availability

6.2.2 For estimating the petroleum product availability, the data obtained from various refineries have been taken into consideration. Product availability estimated (including non-refinery sources⁸) is as under:

Product	2007-08	2008-09	2009-10	2010-11	2011-12
LPG	9.1	9.7	9.3	11.0	12.8
Naphtha	15.0	14.8	15.0	17.5	18.8
MS	13.7	17.5	27.7	28.9	30.5
ATF	6.8	7.4	9.3	10.6	11.0
SKO	10.6	11.3	10.7	10.3	11.3

⁸ About 4.2 MMT is expected from non refinery sources, of which about 2 MMT is LPG.

Product	2007-08	2008-09	2009-10	2010-11	2011-12
HSD	58.0	62.6	74.5	84.1	92.3
LDO	1.0	1.0	0.8	0.8	0.6
LOBS	0.8	0.8	0.8	1.1	1.1
FO/LSHS	14.8	15.6	15.6	10.9	9.5
Bitumen	3.7	3.9	4.0	4.0	4.4
Coke	4.1	5.4	8.3	11.0	12.8
Others	5.6	6.5	9.6	11.0	13.2
Total	143.3	156.4	185.6	201.1	218.3

6.2.3 Projections indicate that domestic production of petroleum products would exceed the upper case demand of the XII Plan by end of XI plan itself by a large margin. By the end of XII Plan production of petroleum products is slated to increase to 286 MMT.

Surplus/ (Deficit)

6.2.4 Based on the product availability and demand estimates as given above the product-wise surplus/ (deficit) situation has been estimated and given below.

Base Case					
Product	2007-08	2008-09	2009-10	2010-11	2011-12
LPG	(1.73)	(1.55)	(2.42)	(1.20)	(0.01)
Naphtha	4.61	5.28	4.52	6.33	7.23
MS	4.37	7.65	17.43	18.26	19.42
ATF	2.47	2.63	4.15	5.01	5.13
SKO	1.76	2.80	2.47	2.36	3.59
HSD	15.87	18.82	29.18	37.19	43.92
LDO	0.00	0.00	0.00	0.00	0.00
LOBS	(1.63)	(1.72)	(1.70)	(1.48)	(1.52)
FO/LSHS	1.17	1.63	2.76	(2.40)	(4.38)
Bitumen	(0.06)	(0.05)	(0.17)	(0.41)	(0.23)
Coke	(0.66)	0.67	3.59	5.79	7.11
Others	0.71	1.16	3.80	4.64	6.29
Total	26.88	37.32	63.60	74.08	86.54

Upper Case					
Product	2007-08	2008-09	2009-10	2010-11	2011-12
LPG	(1.73)	(1.55)	(2.42)	(1.20)	(0.01)
Naphtha	5.70	5.02	4.52	6.27	7.22
MS	3.67	7.96	17.23	17.79	18.93

Table 8.8: Petroleum Product surplus/(deficit) during XI Plan (MMT)					
Upper Case					
Product	2007-08	2008-09	2009-10	2010-11	2011-12
ATF	2.45	2.17	3.32	3.96	3.76
SKO	1.18	1.90	1.28	0.91	1.90
HSD	15.71	18.80	28.75	36.11	42.56
LDO	0.00	0.00	0.00	0.00	0.00
LOBS	(1.63)	(1.72)	(1.70)	(1.48)	(1.52)
FO/LSHS	1.01	1.34	1.96	(3.35)	(5.48)
Bitumen	(0.10)	(0.13)	(0.29)	(0.58)	(0.45)
Coke	(0.66)	0.67	3.59	3.79	5.43
Others	0.16	(0.00)	1.56	2.24	4.19
Total	25.76	34.46	57.80	64.46	76.52

6.2.5 While estimating surplus/deficit scenario it is assumed that MS would be sold throughout the country blended with 5 percent ethanol from 2007-08.

6.2.6 The refineries need to maximize production of LPG, LOBS and bitumen to an extent, from the national standpoint. Further caution needs to be exercised while converting bottoms to higher end products as large deficits in industrial fuels is projected. The bottom upgradation plan needs to be realigned to local demand. Even globally, as noted elsewhere in the report, large deficit is predicted for FO and LSHS.

6.2.7 In addition the refineries must consider the change in refinery gate price to trade parity for MS and HSD. The ratio of import parity and export parity will undergo a change every year depending upon the past experience. If ratio of exports increases then, domestic realization for MS and HSD will fall accordingly. Refinery projects require factoring the above conclusions.

6.3 Demand for Natural Gas

6.3.1 Gas demand in India continues to be influenced by the cost economics vis-à-vis alternative fuels pertaining to each of the end use sectors, primarily power and fertilizer, as also the dynamics of these sectors. The current natural gas consumption is primarily shared by the power and fertilizer sector to the tune of 40 percent and 29 percent respectively. This is followed by the petrochemicals – 9 percent, city gas (CNG/PNG) – 4 percent, LPG/other liquid hydrocarbons – 4 percent and sponge iron/steel sector – 3 percent.

6.3.2 Various agencies have made assessments in the past regarding natural gas. The same are at Annexure – IX. For arriving at the future demand for natural gas, sectorwise analysis has been carried out as under:

Power Sector Analysis

6.3.3 The power sector would continue to be one of the major consumers for natural gas. The Ministry of Power has set a target of 70,000 MW generation for the 5 year period ending 2012, the terminal year of the XI Plan. The current thermal power generation is about 90,800 MW, of which 12 percent (10,900 MW) is gas based. The gas-based power

plants, which would definitely be coming up during the XI Plan period, have a capacity of 1,889.2 MW; the requirement of gas for the same is likely to be 7.5 MMSCMD. Department of Power has made a projection of additional 33,655 MW of gas based power projects, which may come up in the XI Plan. On an optimistic note, 40 percent of these plants have been assumed to come up in the XI Plan period. This would translate into roughly 12,700 MW of power generation, requiring around 50.82 MMSCMD gas.

- 6.3.4 The present requirement of gas for the existing gas-based power plants is 68.19 MMSCMD. Adding gas requirement of 7.50 MMSCMD and 50.82 MMSCMD, as explained in the above Para, the total gas requirement by the end of XI Plan period is likely to be 126.57 MMSCMD. Assuming that the gas requirement increases in the same proportion every year, the projected gas demand for the power sector for the XI Plan period would be as under:

	2007-08	2008-09	2009-10	2010-11	2011-12
Gas Demand	79.7	91.2	102.7	114.2	126.57

Fertilizer Sector Analysis:

- 6.3.5 It has been well established that natural gas is the most cost effective fuel vis-à-vis other liquid fuels for fertilizer plants. During the year 2004-05, gas based fertilizer (urea) production accounted for 66 percent of the total fertilizer production. Naphtha and FO/LSHS based production accounts for the balance 34 percent. Requirement of gas for fertilizer sector is expected to increase in the years to come, not only for meeting the current shortfall being faced by the existing gas based urea units but also on account of conversion of Naphtha and FO/LSHS based units to NG/LNG, de-bottlenecking of existing urea units, setting up of new and expansion of existing urea units and revival of closed urea units of Hindustan Fertilizers Corporation Ltd (HFCL) and Fertilizer Corporation of India (FCI). All non gas based urea units will be converted to gas within the next three years. Under the above scenario, the total requirement of gas for the fertilizer sector by the end of XI Plan period is expected to be 76.26 MMSCMD. The break-up of gas requirement year wise and the corresponding production capacity of urea is given below :

	2007-08	2008-09	2009-10	2010-11	2011-12
Urea Production Capacity (Lakh tones)	226.16	226.16	259.66	329.35	329.35
Gas Demand (MMSCMD)	41.02	42.89	55.90	76.26	76.26

City Gas Distribution

- 6.3.6 This is another sector which has a high growth potential. World-wide, city gas distribution has grown hand in hand with the gas sector development in terms of supply infrastructure and transmission infrastructure. With the expected growth in the gas supply and the simultaneous creation of gas inter-state transmission infrastructure in India, this sector is bound to grow in the XI Plan period. With the emphasis on clean environment, this sector would get the necessary thrust in the coming years. In line with

this, various players, primarily led by GAIL, have drawn up ambitious plans to roll out city gas infrastructure across a number of cities in the country. From the existing coverage of 10 cities, the coverage is expected to grow to 40 cities in the next 5-7 years. This sector can be expected to grow at double digit rates in the later part of the XI Plan period. The current demand estimates in this sector is about 11 MMSCMD in 2006-07 and 12.08 MMSCMD in 2007-08. Assuming a conservative annual growth of 8 percent, the demand would go up to about 12.93 MMSCMD, 13.83 MMSCMD, 14.8 MMSCMD and 15.83 MMSCMD in 2008-09, 09-10, 10-11 and 2011-12 respectively.

Petrochemicals/Refineries/Internal Consumption and Sponge Iron/Steel and other Industries

- 6.3.7 The current demand as per the industry estimates in the Petrochemicals/Refineries and Internal Consumption (of Gas Industries) sectors is about 25.37 MMSCMD in 2005-06. These industries are estimated to grow in line with country's projected economic growth. Hence an annual growth rate of about 7 percent is assumed during the XI plan period, which would result in a demand of 33.25 MMSCMD by the terminal year of the XI Plan.
- 6.3.8 Similarly, the sponge iron/steel sector is also expected to grow at the same rate of 7 percent from the current level of 6 MMSCMD, reaching a level of 7.86 MMSCMD by the terminal year of the XI plan.
- 6.3.9 Based on the above analysis, the consolidated demand estimate is presented below:

	2007-08	2008-09	2009-10	2010-11	2011-12
Power	79.70	91.20	102.70	114.20	126.57
Fertilizer	41.02	42.89	55.90	76.26	76.26
City gas	12.08	12.93	13.83	14.80	15.83
Industrial	15.00	16.05	17.17	18.38	19.66
Petrochemicals/ Refineries/Internal Consumption	25.37	27.15	29.05	31.08	33.25
Sponge iron/Steel	6.00	6.42	6.87	7.35	7.86
Total	179.17	196.64	225.52	262.07	279.43

Gas Supply Outlook

- 6.3.10 On the gas supply side, the domestic supplies would be primarily driven by the expected supply from the KG basin by RIL in 2008-09. The supply projected by ONGC in the Plan period is expected to fall from 47.28 MMSCMD in 2007-08 to 32 MMSCMD in 2011-12. Supply from Private players/JVs is expected to increase from 23.26 MMSCMD to about 57.22 MMSCMD in 2011-12. This increase from private players is primarily due to the 40 MMSCMD gas supply addition from RIL from 2008-09 onwards. DGH has projected expected additional supplies of 20, 30 and 40 MMSCMD from RIL fields in 2009-10, 2010-11 and 2011-12 respectively and 54 MMSCMD from GSPC in each of the above years. How much of these additional supplies would actually fructify would actually determine the prospects of the domestic supply scenario and would have a profound influence on the overall demand-supply balance.

- 6.3.11 In the analysis, these additional supplies have been considered under scenario II, an optimistic scenario. Keeping the above aspects in view, the total projected gas supplies would be 80.54 MMSCMD in 2007-08 expected to grow to 108.3 MMSCMD in 2011-12 under scenario I (Normal Scenario). In Scenario II (Optimistic Scenario), the supplies would grow from 80.54 MMSCMD in 2007-08 to 202.30 MMSCMD in 2001-12. The detailed supply projections under the two scenarios are presented in table below :

Sources	'07-08	'08-09	'09-10	'10-11	'11-12
ONGC + OIL (A)	57.28	58.42	55.69	54.67	51.08
Pvt./ JVs (As Per DGH) (B)	23.26	61.56	60.28	58.42	57.22
Projected Domestic Supply (A+B)	80.54	119.98	115.97	113.09	108.30
Additional Gas Anticipated (C)			74	84	94
Total Projected Supply Scenario 1 (A+B)	80.54	119.98	115.97	113.09	108.30
Total Projected Supply Scenario 2 (A+B+C)	80.54	119.98	189.97	197.09	202.30

- 6.3.12 The estimated gap between domestic gas production and supply is mainly on account of internal use by the producers themselves, technical flaring and gas shrinkages.
- 6.3.13 Looking at the overall demand projections and even the most optimistic scenario of expected domestic supplies, it is very clear that there would be a supply shortfall. Therefore, there is a need to step up imports in the coming 5 years. There is already an import of LNG to the tune of 18 MMSCMD by PLL at Dahej. This is being supported by the commencement of LNG supply from the Hazira Terminal of Shell which is, however, yet to stabilize. To augment the shortfall, the country is already pursuing imports, both through the LNG route and the transnational pipeline route.

LNG/ Supplies through Transnational Pipelines.

- 6.3.14 LNG is already an accepted resource in the country. The 5 MMTPA Dahej terminal of PLL is operating at full capacity. The Hazira terminal of Shell with a capacity of 2.5 MMTPA is operational but is yet to stabilize. The Dahej terminal is set to expand to 10 MMTPA by 2010-11. Besides, the planned Kochi terminal of PLL with a capacity of 2.5 MMTPA (expandable to 5 MMTPA) is expected by 2010-11. The 5 MMTPA Dabhol terminal is projected to be fully operational by 2009-10. To begin with the supplies would be 1.2 MMTPA, which would increase to 2.1 MMTPA in 2008-09 to cater to the Dabhol Power plant. This terminal would also throw up a merchant sale volume of 2.9 MMTPA in 2009-10 when long term LNG is contracted. Given the non-stabilisation of Shell Hazira terminal as yet, it has been assumed that Shell terminal would operate at 2.5 MMTPA capacity during the XI Plan period. The confirmation of Mangalore LNG terminal could be a possibility and 1.25 MMTPA imports could perhaps be expected at this terminal by 2011-12. Given this scenario, the LNG supply is projected to reach a level of 23.75 MMTPA by the year 2011-12 (Potentially it can add up 83.12 MMSCMD supplies at full capacity).

- 6.3.15 Though there is a possibility of supply of about 18 MMSCMD of gas from the Myanmar through the proposed Myanmar–India Pipeline in 2010-11/2011-12, this has not been considered for analysis purpose due to the uncertainties involved. Given the present level of inter-Governmental discussions on the other two pipelines, viz., Iran-Pakistan-India pipeline and Turkmenistan-Afghanistan-Pakistan-India Gas Pipeline, no gas supplies have been projected through these pipelines during the XI Plan period. The overall LNG supply projections are given below :

LNG Supply Source	07-08	08-09	09-10	10-11	11-12
Dahej	5.00	5.00	7.5	10.00	10.00
Hazira	2.50	2.50	2.50	2.50	2.50
Dabhol	1.20	2.10	5.00	5.00	5.00
Kochi	-	-	-	2.50	5.00
Mangalore	-	-	-	-	1.25
Total LNG Supply (MMTPA)	8.70	9.60	15.00	20.00	23.75
Total LNG Supply (MMSCMD)	30.45	33.60	52.50	70.00	83.12
<i>Assumptions 1) Hazira expansion to 5.0 MMTPA is not considered in XI plan. 2) Mangalore terminal is expected to be partially commissioned in 2011-12.</i>					

- 6.3.16 The import plans of various companies would to a great extent augment the supplies to meet the demand shortfall. Given the two scenarios of supply, the total supply including LNG is expected to increase from 100.99 MMSCMD in 2007-08 to a level of 181.42 MMSCMD in 2011-12 under Scenario I (Normal Scenario). Under Optimistic Scenario II, the total gas supply is expected to increase from 100.99 in 2007-08 to 275.42 MMSCMD in 2011-12, especially driven by the additional supply of RIL and GSPC from 2009-10 onwards.

6.4 Demand – Supply Gap for Natural Gas

- 6.4.1 It is expected that there would be a demand–supply gap (shortfall in supply) to the extent of 67.98 MMSCMD in 2007-08 which would fall to 42.81 MMSCMD in 2008 – 09 in both the scenarios. From this level, the gap would increase steadily to 91.13 MMSCMD by 2011-12 in Scenario I, whereas under Scenario II, the gap would by and large be bridged from 2009-10 onwards and there is expected to be a demand–supply balance during the last 3 years of the XI Plan period. The overall demand–supply balance is presented below :

Supply	07-08	08-09	09-10	10-11	11-12
Projected Domestic Supply (ONGC /JV/ PVT) (A)	80.54	119.98	115.97	113.09	108.30
Additional anticipated supply (B)			74	84	94
LNG (C)	30.45	33.60	52.50	70.00	83.12
Total Supply (A+C) Scenario 1	110.99	153.58	168.47	183.09	191.42

Total Supply (A+B+C) Scenario 2	110.99	153.58	242.47	267.09	285.42
Demand (MMSCMD)	179.17	196.64	225.52	262.07	279.43
Demand Supply Gap I	68.18	43.05	57.05	78.97	88.03
Demand Supply Gap II	68.18	43.05	-16.95	-5.03	-5.97

Impact of Price of Natural Gas/LNG on Demand and Supply:

- 6.4.2 Traditionally, India has remained as a supply constrained economy, with controlled prices of gas. During the X Plan period, LNG supplies commenced in 2004, which brought in option of higher priced import and it was accepted by the Indian market. Government has also taken steps towards a market mechanism, by freeing up all new production from control, while restricting controlled gas prices to only power, fertilizer and small consumer sectors. Further, supplies from fields like Panna–Mukta and Tapti fields have also been at negotiated prices. Import of spot LNG into the country at the levels of US\$ 8-9 per MMBTU and its acceptance by the customers has opened a truly market driven price discovery. In the Indian context, the power and fertilizer sectors have always been considered as price sensitive sectors. Controlled prices have kept these sectors under a low price regime while the world market was moving towards a high priced regime in tandem with the upward movement in the crude prices. With the supply scenario looking up as projected elsewhere in this report, there is an increasing realization that the end use sectors would be slowly but steadily integrating with this trend. Assuming that all the projected domestic production of gas materializes as above, and the demand also grows as projected there may be no gas shortage by the end of XI Plan.
- 6.4.3 The fertilizer sector has made detailed analysis of the competing resources – liquid fuels vs. gas and has decided to switch over entirely to gas during the course of the XI Plan given the economics of gas. The fertilizer ministry had indicated that in addition to APM gas, there would be acceptance of market determined price of gas for the urea plants. Power Ministry has drawn up plans for 33,654 MW of gas based projects with the qualifying statement that the generation capacity would be dependent on gas availability at reasonable prices. They have also not made a sensitivity analysis. Gas availability is not going to be an issue as the supply prospects are very bright in the XI Plan. As the prices of the new gas would be market determined, there is likely to be a price discovery mechanism and Indian market would be integrating with the global trends. Like in the fertilizer sector, the power sector would also be moving towards a market determined mechanism, as the gas availability from domestic and international sources surge in the country and a market system operates, leading to a logical market linked/acceptable price discovery.

Gas Availability from Transnational Pipelines

- 6.4.4 Transnational pipelines and gas availability through these sources have been predicted during the X Plan period also. But these did not materialize due to various geo-political and economic reasons. During the X Plan period active discussions at the highest level took place in the government as well as the company level. Accordingly two pipelines are at an advanced stage of discussion – Iran-Pakistan-India Pipeline and the Myanmar-India Pipeline. In the case of Myanmar-India Pipeline, there is a likelihood of gas supply to the tune of 12 MMSCMD and 16 MMSCMD in the years 2010-11 and 2011-12. This necessarily includes gas from the overseas partners of this project, as India partners'

share of gas would be too low to make it commercially viable by itself. In the light of the past experience in such pipelines, it is more appropriate to include such projections, only when some kind of finality is reached between the partners. Otherwise, it would distort the picture. At this stage, no such finality has been arrived at and hence the projections do not include the gas supplies from transnational pipelines.

Projected Gas Demand for 2012-17 and 2017-22

- 6.4.5 The IEP has projected gas demand of 682 MMSCMD by 2031-32 in an 8 percent growth scenario with the assumption that power sector would have 20 percent power generation based on gas (from current 12 percent level), 100 percent urea production based on gas and 7 percent growth of other sectors. But the policy also qualifies the projection by saying that relative prices of fuels would decide the growth trend. Indian gas market is still in a stage of transition. The Working Group has assumed that the gas sector would move towards a market determined pricing mechanism during the XI plan period. At this point in time when gas is still under controlled prices for power and fertilizer sector and is expected to move through a period of transition, it would not be reasonable to assume a growth trend and project gas demand beyond 2011-12. So after careful consideration, the projections for gas demand have not been made for 2012-17 and 2017-22. As the market attains a certain degree of maturity with transition towards market determined prices and competing alternate fuels lead to a more realistic market price, which is expected to take place during the XI plan, a detailed study could be carried out to project demand for the longer term.

7 Towards Oil and Gas Security

7.1 Towards Oil Security

7.1.1 The National Common Minimum Programme (NCMP) emphasizes the need to put in place policies to enhance the country's energy security. The efforts made by the Ministry of Petroleum & Natural Gas (MoPNG) in enhancing the oil & gas security of the country include - facilitating increase in domestic oil and gas production under NELP, acquiring oil and gas acreages abroad, facilitating LNG imports, taking initiative to import gas through transnational pipelines, diversifying crude oil supply sources, taking steps to build strategic crude oil storage and focus on alternative sources of energy.

7.2 Bio-fuels Programme

7.2.1 The MoPNG has taken several initiatives to promote blending of bio-fuels such as ethanol/bio-diesel in petrol/diesel. The steps taken so far, experience/issues and the future plans are detailed in the following paras. The role of MoPNG in the bio-fuels programme is limited to facilitating the blending of bio-fuels with petrol/diesel and marketing of the blend.

Ethanol-Blended Petrol (EBP) Programme

7.2.2 With a view to reducing dependence on imported oil by way of encouraging use of indigenous sources of energy and to provide a supportive role to the sugarcane farmers, MoPNG vide notification dated 12.9.2002 had introduced the scheme of mandatorily supplying 5 percent ethanol blended petrol (EBP) in 9 major sugar producing States and 4 contiguous Union Territories (UTs) w.e.f. 1.1.2003. However, the programme could be implemented only in a staggered manner because ethanol was not available in a consistent manner and at reasonable prices. MoPNG issued an amending notification dated 27.10.2004 making sale of EBP mandatory in 10 States and 3 UTs if the price of sourcing indigenous ethanol for supply of ethanol-blended petrol is comparable to the price of indigenous ethanol for alternative uses; the delivery price of ethanol at the locations is comparable to the import parity price of petrol at that location; and the indigenous ethanol industry is able to maintain uninterrupted supply of ethanol for EBP programme at such prices.

7.2.3 In terms of the notification dated 27.10.2004, the public sector oil marketing companies (OMCs) invited tenders for purchase of ethanol and finalized the contracts for ethanol supplies for the areas in Uttar Pradesh, Punjab, Tamil Nadu, Andhra Pradesh, Karnataka and Maharashtra. The programme could not be taken up for implementation in the remaining notified States/UTs on account of court cases and other administrative problems. The main issues which have affected the programme are availability and pricing of ethanol.

Availability of Ethanol

7.2.4 The indigenous availability of ethanol on a sustained basis to meet the requirement of EBP programme has been an issue ever since the programme was launched in January 2003. Various industrial associations dealing with alcohol/ethanol, viz., Indian Sugar Mills Association (ISMA), All India Distillers' Association (AIDA), and Indian Chemicals Manufacturers Association (ICMA) etc. have been making varying projections about the availability of ethanol in the country.

Pricing of Ethanol

- 7.2.5 As per the existing practice, OMCs mix ethanol with petrol at their marketing depots for marketing the blend. The blending process is not considered as 'manufacturing'. The all-taxes-and-duties-paid ethanol is mixed with the excise duty-paid petrol, with the final blend carrying no excise duty. As the final selling price of EBP has been kept same as that of petrol, while procuring ethanol, OMCs considers that the delivered price of ethanol at the mixing depots is not more than that of petrol so that they do not suffer any under recoveries on account of selling EBP. With this broad principle in mind, OMCs have been procuring ethanol through public tenders. At present, OMCs are procuring ethanol @Rs.18.75 per litre at ex-factory locations producing ethanol excluding all taxes and duties. But various associations of ethanol manufacturers want the price to be escalated upwards based on the ethanol production cost. On the other hand, OMCs want the ethanol price to be comparable with the price of petrol at supply locations.

Coverage of whole country except for NE States, J&K, A&N Islands and Lakshadweep with effect from 1.11.2006

- 7.2.6 MoPNG reviewed the availability of ethanol with ethanol manufacturers and based on the confirmation given by the ethanol manufacturers about availability of ethanol on a long term, MoPNG issued a notification on 20th September 2006 that oil companies shall sell 5 percent ethanol-blended-petrol in the entire country (except the North East States, Jammu & Kashmir, Andaman & Nicobar and Lakshadweep Islands), subject to commercial viability, with effect from 1.11.2006. The OMCs have issued public tenders for procuring ethanol for the programme from indigenous producers for a period of three years extendable by two years. Most of the State Governments have yet to notify the local taxes/levies on ethanol meant for blending with petrol and also are yet to issue excise licences to oil companies for ethanol storage. OMCs have already built necessary storages for storing ethanol at blending locations.

State Taxation Issues

- 7.2.7 Despite very clear court rulings distinguishing the role of State Governments relating to potable and industrial alcohol, and limiting their role vis-à-vis the latter, the State Governments have been imposing a lot of licensing and procedural requirements on industrial units producing industrial alcohol, besides levying a plethora of taxes and restricting inter-state movement of the product. The EBP programme, being a national scheme, calls for whole-hearted cooperation from the State Governments. All the concerned State Governments may ensure that no procedural restrictions on the industries relating to production/manufacture/storage/ transportation/distribution/sale of ethanol meant for doping in petrol are put so that the implementation of the EBP programme is not jeopardized.

Time-frame for Increasing the Ethanol Content to 10 percent

- 7.2.8 After stabilization of 5 percent EBP sales, ethanol content in petrol would be considered for increasing to 10 percent by the end of XI Plan, subject to ethanol availability and commercial viability of blending.

Bio-diesel

- 7.2.9 Bio-diesel is another bio-fuel which has been receiving the attention of the Government. A Committee set up under the Chairmanship of Dr. D.N. Tiwari, former Member,

Planning Commission, on “Development of Bio fuel”, in its report dated April 2003 had recommended launching of a National Mission on Bio-diesel. The proposed National Mission inter-alia envisaged large scale plantation of Jatropha, a large shrub found countrywide and adapted to arid/semi-arid conditions, for generating the environment friendly fuel which can be blended with diesel. The Ministry of Rural Development has been made the nodal Ministry to implement the National Mission on bio-diesel.

- 7.2.10 As per the work allocation, different Ministries will look after different aspects of the bio-diesel programme. On its part, MoPNG formulated a bio-diesel Purchase Policy in October, 2005, effective 1.1.2006. This policy is a statement of intent on purchase of bio diesel by the OMCs. This policy, inter alia, identifies 20 purchase centres of the public sector OMCs all over the country where these companies would purchase bio-diesel which meets the standards prescribed by the Bureau of Indian Standards (BIS), from those bio-diesel manufacturers who register with them after satisfying the technical specifications, at a specified delivered price fixed for a period of six months at a time by the OMCs. At present, the procurement price is Rs.26.50 per litre (delivered at purchase locations inclusive of all taxes) upto December 2006.
- 7.2.11 OMCs have not been able to purchase any bio diesel at any of the identified locations till now. It has been reported that the production of cost effective non-edible oil seeds (like Jatropha, Karanja, Pongamia, etc.) in India as of now is significantly low and therefore production of bio-diesel in India based on indigenously grown non-edible oil seeds is insignificant. The processors setting up production facilities with small/medium/large scale are seeking higher price only because their inputs (vegetable oil) are of a higher cost for obvious reasons. Since plantations of non-edible oil seeds trees like Jatropha, etc., have been taken up only in recent years on a significant scale, the situation may improve after 2-3 years when these start yielding oil seeds and at that time bio-diesel is likely to be cost effective with reference to petro-diesel.
- 7.2.12 Even the limited quantities of bio-diesel which have been made available to the OMCs for trial purposes were priced between Rs. 35/- to Rs. 52/litre at various locations. Even if the excise duty and sales tax / VAT were to be completely waived off on bio-diesel, its delivered price at identified locations would still be much higher than Rs.26.50 per litre, the price up to which mixing of bio-diesel with diesel has been found to be commercially viable at present.
- 7.2.13 Keeping in view that bio-diesel production/availability is likely to improve in the next 2-3 years the entire country may be progressively covered with sale of 5 percent bio-diesel-blended-diesel by the end of XI Plan i.e. 31.3.2012. Bio-diesel content could be considered for increasing to 10 percent thereafter depending on the experience gained, availability of bio-diesel and commercial viability.
- 7.2.14 There is a need for coordinated action amongst different Ministries for making the bio-diesel blending programme a success. Planning Commission/Ministry of Rural Development may ensure plantation of Jatropha/Karanja and production/availability of bio-diesel for blending with diesel as per the above schedules.

7.3 **Strategic Storage**

- 7.3.1 Oil security can be viewed from either of the standpoints namely short term or long term. In the long run, increasing the sources of crude on which the country has complete control can only enhance oil security. For this purpose, we have employed several strategies, which include enhancing domestic E&P through NELP, increasing domestic

production through IOR/EOR, and acquiring equity oil abroad by empowering our Navratnas. In the short term, to tide over supply disruptions, the country is constructing strategic crude oil storages.

- 7.3.2 The Government has taken in principle decision to construct 15 MMT of strategic storage in phases. 5 MMT storage is being built during the 1st phase. Currently, under ground crude storages are being built at the following sites:

1 MMT at Visakhapatnam

2.5 MMT at Mangalore

1 MMT at Padur a site near Mangalore

- 7.3.3 As regards funding, the core critical sovereign reserve being strategic reserve must be funded by the government. Therefore, strategic crude oil storage is being funded by the Government through OIBD and is being implemented by Indian Strategic Petroleum Reserves Limited (ISPRL), a SPV under OIBD. It is expected that the project would be completed within the XI Plan.

Secondary Storages

- 7.3.4 Secondary storages can help alleviate supply disruptions as well. These could be added in the XI and the XII Plan as distinct from commercial storages of oil companies and be funded through participation of oil companies on voluntary/mandated basis. In addition innovative financing models including funding through public private partnership using other than budgetary support could be explored for secondary storages.

Usage

- 7.3.5 The use of strategic storage has attracted interest from several quarters. Normally, sovereign reserves have been held to cover short-term supply disruptions with the explicit understanding that they would not be used for price stabilisation. There appears little historical experience of use of strategic reserve for price stabilisation based on which any credible inference can be drawn. Though, during 2005, the OECD countries released strategic reserves after the hurricane damage, the release had calming effect on the oil markets. We see no harm in India experimenting with price stabilisation to gain experience and examine whether the reserves could be put to alternative uses. For this purpose, specific guidelines are required to be developed before the crude storage can be used for price stabilisation. In any case a world supply disruption is likely to invite action from most countries holding strategic reserves to release their oil.

7.4 Conservation of Products

- 7.4.1 Industrial, transport and commercial sectors in India consume more than 80 percent of its petroleum products while the rest is consumed in domestic and agricultural sectors. In view of the above, while campaigns for conservation in domestic and agricultural sectors would continue, Petroleum Conservation and Research Association (PCRA) proposes to focus on industrial, transport and commercial sectors in the coming Five Year Plan in order to make the target groups aware of the technologies/tips to conserve petroleum fuels and thus contribute towards reducing India's huge crude oil import bill. R&D projects on petroleum conservation taken up through leading research institutions of the country have shown encouraging results for saving potential of petroleum products. The

proposed campaigns on successful R&D projects, Energy Audit and Driver Training Program would act as a strong interface between the industry and PCRA. Apart from the conventional means of communication to the target groups, PCRA will lay emphasis on making short films highlighting the success stories on select R&D projects, Energy Audits and Driver Training Program in order to motivate similar clients in the market.

- 7.4.2 Research project taken up on fuel wastage at traffic red light due to idling of vehicles in Delhi brought out an amazing fact that the nation loses an amount of Rs. 994 Crore per annum due to idling of vehicles at 600 traffic intersections in the city of Delhi only. Another study carried out on deriving the most fuel-efficient speed on 3 most popular cars in India showed that 45 km per hour is the speed for achieving the best fuel efficiency in small segment cars in India. The study also brought out that the non-effective period for idling stop based on fuel consumption for these 3 most popular cars in India is 26 seconds on average. This means, by switching off the engine at idling for more than 26 seconds at 600 traffic intersections in Delhi only can save major parts of Rs. 994 crore per year.
- 7.4.3 Energy Audit carried out on 110 DG sets of India's oil giant ONGC resulted in a saving potential of 2,136 kilolitre of HSD oil per annum that is equivalent to Rs. 10.3 crore per annum. Driver Training Program carried out for 1,406 drivers of RSRTC (Rajasthan State Road Transport Corporation) resulted in an overall improvement in kilometre per litre from 5.0 to 5.09. In terms of financial saving, RSRTC has already recorded a savings of Rs. 6 crore per annum as a result of Driver Training Program of PCRA.
- 7.4.4 TV and Radio would continue to remain as major tools for communication and PCRA proposes to produce effective TV and Radio spots and run these on popular TV and FM Radio channels. Panel discussions will be held on TV channels involving experts from related fields. Apart from the electronic media, PCRA plans to extend its campaign on outdoor publicity through hoardings/electronic display boards/kiosks at prominent and strategic locations throughout the country.
- 7.4.5 Outdoor publicity will be taken up aggressively in the next Five Year Plan based upon its effectiveness. PCRA is in the advanced stage of putting up hoardings on conservation message at ROs of all OMCs, viz. IOCL, HPCL, BPCL and IBP. PCRA envisages bringing about an attitudinal change in the minds of the drivers to follow conservation tips displayed at ROs, where they spend on average 5 minutes refuelling their vehicles.
- 7.4.6 PCRA also envisages bringing about the much needed attitudinal change by involving children in its campaigns. It plans to educate children through various mediums in their educational curriculum. Internet medium would be another platform PCRA proposes to focus on in the next Five Year Plan.
- 7.4.7 On an average PCRA spends Rs. 10 crore every year on education campaign. During next Five Year Plan, PCRA proposes to spend Rs. 12 to 15 crore every year for the activities mentioned above. Thus, PCRA's estimated budget for next five years would stand at a range of Rs. 60 to 75 Crore for educational campaigns.

Other Areas of Conservation

- 7.4.8 In addition, as a part of the Government's response to the oil crisis of early 1970s, the PCRA was set up in 1976 to undertake studies to identify the potential and to make recommendations for achieving conservation of petroleum products in various sectors of the economy. It sponsors R&D activities for the development of fuel-efficient

equipment/devices and organizes multi-media campaigns for creating mass awareness for the conservation of petroleum products. Fuel oil utilization studies, energy audits, synchronization of traffic signals, boiler modernization scheme, introduction of equipment bank concept, use of energy vans, development of oil consumption norms, model depot projects, driver training programs, demonstration clinics/workshops/exhibitions, consumer meets, educational films/TV spots, hoarding/electronic display, distribution of printed literature, R&D projects are other activities.

7.4.9 Further, soft loan and subsidies are given by OIIB for conducting energy audits, purchase of energy audit equipments/instruments, upgradation of maintenance facilities at garage, LIP rectification, foot valve replacement, upgradation of testing facilities to foot valve manufacturers for promoting oil conservation. The oil industry is also promoting the use of alternative sources of energy to the maximum extent possible. Many petrol pumps are provided with SPV system. Some oil company colonies have solar water heaters, solar cookers, solar lanterns, gobar gas plants, improved choolhas, efficient kerosene stoves and lanterns. In some select villages in the districts of Solan, Sultanpur and Jaisalmer Wind mills are also being considered. All these will act as stimuli for others to emulate.

7.4.10 Petroleum conservation, then becomes our joint responsibility be it the industries, individual citizens, organizations, oil companies or the Government. Each one of us has a specific and significant role to play.

7.5 **Alternative Sources of Energy**

7.5.1 The national endeavour to bridge the ever-increasing gap between demand and supply of petroleum products in India by intensifying the exploratory efforts for oil and gas in the Indian sedimentary basins and abroad needs to be supported by other unconventional sources of energy like Coal Bed Methane, Gas Hydrates, Coal Liquefaction, etc.

Coal Bed Methane

7.5.2 Exploration Programme in already awarded 16 CBM blocks and another 10 CBM blocks have been offered under the third CBM round will continue during XI Plan period. In four blocks of CBM, where CBM gas reserves of 6 TCF have already been established, may witness production of CBM during the Plan period.

7.5.3 MoPNG will offer CBM blocks in future CBM rounds in consultation with the Ministry of Coal. Under the fourth CBM round, DGH have tentative plans to offer CBM blocks from Assam, Arunachal Pradesh, Orissa, Jharkhand, Madhya Pradesh, Gujarat and Tamil Nadu. Once the areas for CBM blocks are earmarked in consultation with Ministry of Coal, DGH will come out with more rounds of CBM blocks.

7.5.4 ONGC envisages producing about 1.24 BCM of CBM gas and share of CBM gas of Private/JV companies is about 2.54 BCM during XI Plan period. The break-up is given as under:

Organization	2007-08	2008-09	2009-10	2010-11	2011-12	Total
ONGC	0.30	0.78	0.78	0.78	0.75	1.24
Pvt./JV	0.16	0.48	1.12	2.00	3.20	2.54
Total	0.46	1.26	1.90	2.78	3.95	3.78

Gas Hydrate Resources

National Gas Hydrates Programme

- 7.5.5 Gas hydrates, generally found in the deep sea, are basically methane molecules trapped in ice. At present, there is no commercial production of gas hydrates in any part of the world and the technology is only at R&D stage.
- 7.5.6 The National Gas Hydrate Programme (NGHP) was initially started in 1997 by MoPNG with participating agencies i.e. ONGC, GAIL, DGH, OIL, National Geophysical Research Institute (NGRI), National Institute of Oceanography (NIO) and Department of Ocean Development (DOD). This programme was conceived by the Government for exploring for gas hydrates in the Indian deep waters, being a future source of unconventional hydrocarbons. The programme was reconstituted in year 2000 by MoPNG to give a greater thrust in this direction, by making Director General, DGH as Technical Coordinator of the programme, Secretary (P&NG) as Chairman of Steering Committee and six technical working sub-groups, constituted by involving scientists/engineers from above mentioned organizations.
- 7.5.7 Till date, a large number of seismic data covering offshore areas of the country has been studied including special processing of large data for identification of gas hydrates signatures.
- 7.5.8 Based on these studies, three areas in KG Basin, Andaman Sea and west coast were identified for further scientific investigations. A road map was also prepared for NGHP. As per the road map, detailed geo-scientific investigations were carried out in the KG Basin and Kerala-Konkan basin by NGHP through National Institute of Oceanography (NIO). Based on the results of seismic data studies and geo-scientific investigations, ten sites in Mahanadi, KG and Kerala-Konkan basins and Andaman Sea have been short listed for drilling/coring of gas hydrates in the deepwaters. The drilling/coring for gas hydrates is a very specialized activity and India will be only third country in the world to do so, after USA and Japan. The services for such specialized activity are not available commercially in the world. With sustained efforts by DGH, with IODP and USA, the drillship JOIDES Resolution along with all the scientific equipment and scientists onboard has collected samples in Indian offshore. From April, 2006 to August, 2006, under an agreement between DGH and a US consortium of companies.
- 7.5.9 After obtaining the gas hydrates cores several scientific studies are being carried out onboard the ship and will also be carried out in several laboratories in India, USA and Canada for which separate agreements have been signed by DGH and corresponding agencies. The studies will lead to understand gas hydrates characterization in Indian offshore areas and also in carrying out resources estimates, as well as R&D in this field.
- 7.5.10 During drilling/coring by drill ship presence of huge quantities of Gas Hydrates has been detected in one of the wells in KG Basin. A specialized core repository is also being constructed in Panvel, Mumbai for storing all the valuable gas hydrates cores for future studies. Overall, a good progress has been made in exploration for gas hydrates in the country, under NGHP. Pilot test production is planned to be carried out in India by 2009-10 after developing a suitable mathematical and simulation model.
- 7.5.11 The production of gas from gas hydrates itself is the biggest challenge faced by the world scientific community. The basic challenge is to find out a suitable technology to first dissociate the gas hydrates present in the solid form below the seabed in deep-sea

conditions, as well as the permafrost regions of the world. Another challenges faced, is to produce the dissociated gas from gas hydrates at a commercial rate and thirdly the whole activity presently is uneconomic, as it is to be carried out in deep waters.

- 7.5.12 Presently no commercially proven technology exists for production of gas from gas hydrates, any where in the world. Research work in this regard is going in a few countries involved in gas hydrates R&D, including India. Therefore, giving any time frame for production of gas from gas hydrates is practically not possible at present. However, as per current plan we may be able to do some progress on commercial exploitation of gas hydrates, beyond year 2010, if commercial quantities of gas hydrates are found in Indian offshore, which will be known only after completing the proposed drilling/ coring activity presently under progress.

Underground coal gasification (UCG)

- 7.5.13 Underground coal gasification (UCG) is the in-situ gasification of coal in the seam. It is achieved by injecting oxidants, gasifying the coal and bringing the product gas to surface through boreholes drilled from the surface. The gas is then used for power generation, feedstock for chemical fertilizers and industrial heating.
- 7.5.14 UCG was first developed as a large-scale gas production process in the 1960's and recently trial schemes have been evaluated in many countries including China, India, Australia, South Africa, the USA and UK. The revival of interest in UCG is a direct result of improved technology, security of supply and a realization that gas from underground coal gasification offers substantial cost reductions for production and CO₂ capture.
- 7.5.15 ONGC and GAIL have been exploring the possibility of exploiting coal gas by UCG technology. ONGC has signed a draft agreement of collaboration with the National Mining Research Centre Skochinsky, Institute of Mining (Russia) and Coal India Ltd. for its UCG project. According to ONGC estimates, free gas recoverable reserves in the Ahmedabad-Mehsana block alone are around 230 BCM. It has plans to drill 100 wells and install 4 stage enriched air compressors to generate 1.5 MMSCMD of gas. The ultimate aim is to set up a 200 MW power unit.
- 7.5.16 GAIL has planned a UCG project in Rajasthan. The company is tying up with Ergo Exergy Technologies Inc., Canada, for sourcing in-situ lignite gasification technology for its project. GAIL also intends to set up a coal gasification plant based on Shell technology in Talcher (Orissa) for which a techno-economic feasibility study has been carried out. The estimated project cost works out to Rs. 2,400 crore. The Syngas produced from this gas can be an attractive option for the urea plants around the same location.
- 7.5.17 A Coordination Group has been formed in the Department of Fertilizer, Ministry of Chemicals and Fertilizers to look into the possibility of UCG utilization in Fertilizer sector. DGH is a member of this Group. Work in this respect is expected to commence soon. By 2010-11, ONGC has plan to produce 2.7 MMSCMD of gas through UCG process and envisages to produce about 2.99 BCM of UCG gas during XI Plan period.

Conversion of Coal to Liquid Hydrocarbon

Coal Liquefaction Project

- 7.5.18 During the X Plan, pre-feasibility study on Catalytic Two Stage Liquefaction (CTSL) technology of M/s Axens NA, USA on coal liquefaction process has been completed. As a parallel action, another study of similar nature has also been carried out on Direct Coal Liquefaction (DCL) Technology of M/s HTI, USA in order to select the best suitable technology for the North-east coal for liquefaction. Feasibility study will be carried out on the selected technology in the Phase- II program.
- 7.5.19 In this program, process optimization test will be carried out in a pilot plant to confirm liquid product yield, quality and then take up product upgrading tests. This will be followed by a process guarantee run in a large pilot plant (3 Tonnes per day capacity or more) in order to avoid risk of scaling up of pilot plant results to commercial size. If necessary, OIL may look for co-operation from M/s China Shenouah Coal Liquefaction Company who has not only constructed a 6 Tonnes per day pilot plant but is going ahead to construct a 4 MMTPA commercial plant to start production by the year 2008.
- 7.5.20 Meanwhile, to confirm availability and assured supply of coal in Assam, Arunachal Pradesh and Meghalaya for a commercial plant, OIL is in constant touch with Coal India Limited (CIL). A Joint Task Force between OIL and CIL has already been formed to study various aspects. OIL plans to carry out a feasibility study and looking for a suitable technology depending on economics and gas availability.

Oil Shale

- 7.5.21 Oil shale exists worldwide in large quantities, in Australia, Brazil, Canada, China, France, Russia, Scotland, South Africa, Spain, Sweden and USA. The largest share of oil shale reserves of about 1,000-1,600 billion barrel exists in US, while in India the reserves are estimated to be about 100 billion barrels.
- 7.5.22 The term 'oil shale' is a misnomer. It does not contain oil nor is it commonly shale. The organic material is mainly kerogen, and the 'shale' is usually a relatively hard rock, called marl. Properly processed, kerogen can be converted into a substance somewhat similar to petroleum. However, it has not gone through the 'oil window' of heat (nature's way of producing oil) and therefore, to be changed into an oil-like substance, it must be heated to a high temperature. By this process the organic material is converted into a liquid, which must be further processed to produce oil which is said to be better than the lowest grade of oil produced from conventional oil deposits, but of lower quality than the upper grades of conventional oil.
- 7.5.23 There are two conventional approaches to oil shale processing. In one, the shale is fractured in-situ and heated to obtain gases and liquids by wells. The second is by mining, transporting, and heating the shale to about 450°C, adding hydrogen to the resulting product, and disposing of and stabilizing the waste. Both processes use considerable water. The total energy and water requirements together with environmental and monetary costs (to produce shale oil in significant quantities) have so far made production uneconomic. The available production of oil shale from some countries is given as under:

Table 6.2: Oil Shale Production in Various Countries (bbl/day)			
	1996	1999	2002
Estonia	7000	3000	5500
Brazil	3000	3900	3100
China	1200	N/A	2000
Australia	N/A	100	900

7.5.24 In India, shale formation is exposed to the surface in the region of Belt of Schuppen falling in Assam, Arunachal Pradesh and Nagaland areas towards south of the oil fields of OIL.

7.5.25 Main constraints in oil shale production in North East region are logistically difficult terrain, non-availability of roads, large power requirements for the plant and consequent environmental issues. Detailed mapping, extensive sampling to ascertain the distribution, quantity and quality of oil shale in North Eastern part of India may be carried out for assessment of oil shale resources in the region.

8 Targets for XI Plan Period

8.1 Exploration and Development of Oil and Gas

Exploration

8.1.1 Liberalization policies adopted in E&P sector and continuation of offer of exploration acreages under NELP and CBM through international competitive bidding process shall ensure exploration of about 1.245 million sq. km of basinal area during the XI Plan period. By the end of XI Plan, exploration area offered will be about 80 percent of the total sedimentary basinal area and entire sedimentary basins may be opened up for exploration by 2015 as against the target of Hydrocarbon Vision by 2025.

8.1.2 Under the nomination regime, there was certainty of getting exploration blocks of choice but under NELP, exploration blocks are awarded based on quantitative bidding parameters such as work programme committed and Government's take offered by the bidder. Consequently, availability of exploration acreages will have an element of uncertainty and accordingly exploration programme in terms of seismic surveys and drilling will only be indicative.

8.1.3 Exploration programme has been given as under:

ACTIVITY	UNIT	ONGC	OIL	Private/JV	Total
Seismic surveys 2D	kM	54,359	10,865	63,200	128,424
Seismic surveys 3D	Sq. km	76,398	6,350	67,825	150,573
Exploratory drilling (metreage)	kM	1,817.83	572.95	832	3,222.78
Exploratory wells	Nos.	651	149	300	1,100
Reserves accretion IIH	MMTOE	1,000.7	153.74	975	2,129.44

Development Program

8.1.4 Oil discoveries made in Rajasthan by Cairn Energy India Pty Limited, gas discoveries in KG basin and other oil and gas discoveries made by NOCs will be undertaken during XI Plan. During XI Plan period ONGC and OIL have plans to implement IOR/EOR in the ageing fields, develop marginal and isolated fields and faster development of new discoveries made. The development wells to be drilled by ONGC, OIL and Private/JV companies during XI Plan are as under:

	2007-08	2008-09	2009-10	2010-11	2011-12	Total
ONGC	231	233	200	176	160	1,000
OIL	35	38	51	56	68	248
Pvt./JV	96	129	93	58	36	412
Total	362	400	344	290	264	1,660

8.1.5 Oil and gas discoveries made so far under the PSC regime are being monitored with respect to time frame provided in respective PSC.

8.2 Crude Oil and Natural Gas Production

8.2.1 Based on the established reserves, present status of different fields, input implementation schedules and health of reservoirs, the crude oil and gas production profiles for XI Plan is prepared as given below:

Table 9.3: Proposed Crude Oil and Natural Gas production during XI Plan						
Crude Oil Production (MMT)						
	2007-08	2008-09	2009-10	2010-11	2011-12	Total
ONGC	27.16	28.00	29.00	28.53	27.37	140.06
OIL	3.50	3.55	3.73	3.91	4.30	18.99
Pvt./JV	10.57	10.78	9.76	8.75	7.85	47.71
Total	41.23	42.33	42.49	41.19	39.51	206.76
Natural Gas Production (BCM)						
	2007-08	2008-09	2009-10	2010-11	2011-12	Total
ONGC	22.10	22.53	22.77	22.99	22.00	112.39
OIL	3.13	3.21	3.25	3.28	3.56	16.43
Pvt./JV	8.55	22.55	22.11	21.47	21.07	95.74
Total	33.78	48.29	48.13	47.73	46.63	224.56

8.2.2 Crude oil production of 206.76 MMT during XI Plan period is about 23 percent higher than the X Plan likely achievement of 167.70 MMT. The increase in crude oil production will be mainly due to contribution by private company, Cairn Energy Pty Ltd., which will produce about 5-6 MMT per annum from Rajasthan.

8.2.3 Natural gas production during XI Plan will be about 224.56 BCM, which is about 41 percent increase as against likely natural gas production of about 158.79 BCM in X Plan period. This increase in gas production is mainly from K-G basin production of 40 MMSCMD by RIL. The gas production may further increase by development of GSPC discoveries and other RIL's discoveries in KG basin.

8.2.4 Based on the envisaged inputs, it is estimated that overall reserve accretion during the X Plan in terms of oil plus oil equivalent of gas will exceed the production volumes during the same period, thus, resulting in Reserve Replacement Ratio (RRR) of more than unity.

E&P Strategies to Enhance Oil & Gas Production

- i. Level playing field to public sector and private sector players including foreign players and provision of comparable incentives to all E&P companies.
- ii. Pursue extensive exploration in non-producing and frontier basins for knowledge building and new discoveries, including in deep-sea offshore areas.
- iii. Establishment of a 'Knowledge Hub' in India.

- iv. Strengthening of DGH and upstream oil and gas regulations.
- v. Convergence of nomination regime into NELP Regime.
- vi. Faster development of oil and gas discoveries.
- vii. Development of isolated and marginal fields and creation of surface facilities.
- viii. Provide infrastructure status to E&P companies and competitive fiscal terms to attract significant investments in the sector.
- ix. Optimize recovery from ageing oil and gas fields.
- x. Continue to offer more CBM exploration blocks.
- xi. 100 percent speculative survey to carve out exploration blocks.
- xii. Efforts to get methane gas through in-situ gasification of coal.
- xiii. Continuation of R&D efforts to exploit the potential of gas hydrates.
- xiv. R&D efforts and feasibility to understand the potential of oil shale.
- xv. Availability of trained manpower and expertise in E&P sector.
- xvi. Continue technology acquisition and absorption along with development of indigenous R&D and to ensure adequacy of finances for R&D required for building knowledge infrastructure.
- xvii. Make E&P operations compatible with the environment and reduce discharges and emissions.
- xviii. Continue to acquire acreages abroad for exploration as well as production.

8.3 Equity Oil and Gas Abroad

Imperatives

- 8.3.1 Oil security for a nation, that is, aspiring to be an economic power, is very vital. Equity oil abroad may lessen our dependence on a few suppliers and increase our inter-dependence on a global basis. Considering the oil demand scenario vis-à-vis domestic production level on the one hand and low crude oil reserve replenishment trend and high risk of domestic exploration on the other, a major focus of NOCs/Indian private companies would be to venture abroad to access exploration blocks and producing properties for equity oil. Access to equity oil through equity participation in producing property development projects in the short term in non-OPEC developing areas (Asia, Latin America, Africa) as well as in politically friendly countries with large oil potential (Middle East, Russia and FSU countries) needs to constitute a part of risk capital investment.

Strategic Options

- i. Focus on producing property ventures in the short term;

- ii. Purchase of equity share of companies as a part of reserves portfolio management;
- iii. Focus on exploration acreages in short to medium term;
- iv. Promoting upstream sector services to establish international credibility;

Crude Oil and Natural Gas Production from Overseas

8.3.2 The physical targets for oil and gas production during XI Plan period are given below:

		2007-08	2008-09	2009-10	2010-11	2011-12	Total
Crude Oil Production (MMT)	OIL	0.25	0.5	1.0	1.53	1.6	4.88
	OVL	7.02	6.53	5.97	5.76	5.35	30.63
	TOTAL	7.27	7.03	6.97	7.29	6.95	35.51
Natural Gas Production (BCM)	OVL	1.75	1.82	1.93	1.97	2.2	9.67

Establishment of National Knowledge Hub

8.3.3 Setting up of National Knowledge Hub (NKH) in India is essential in order to protect past investment (made in the form of data acquisition), promote growth by encouraging greater participation by providing access to quality data in an integrated and synergetic environment, provide level playing field for small players and establish a link among all E&P companies and academia. Creation of National Data Repository (NDR), which is an important component of National Knowledge Hub, is also a part of charter.

8.3.4 National Knowledge Hub will host the NDR and also be a centre of excellence for knowledge sharing and training centre, hosting domain applications and visualization centre for use by the industry.

- i. The National Knowledge Hub (NKH) will comprise the following for use by the industry
- ii. The National Data Repository (NDR)
- iii. The National G&G Processing Centre (NPC)
- iv. The National Visualization and Application Centre (NVAC)
- v. The National Training Centre (NTC)
- vi. The National E&P Knowledge Portal (NKP)

8.3.5 The benefits through National Knowledge Hub (NKH) will be as under:

- i. Enable evaluation of the total hydrocarbon potential of the country by integrating geo-scientific data;

- ii. Protect past investment, attract investments and thus promote desired growth in future by leveraging on modern technology;
- iii. Improve the efficiency of hydrocarbon prospecting in the country by providing integrated and synergetic environment;
- iv. Create geo-scientific ambience and link among the geo-scientists, petroleum engineers both from industry and academia to strengthen over-all geo-scientific activities in India.

Incentives for Upstream Sector

8.3.6 Presently 1.09 million Sq. kM. area is under exploration, which is about 35 percent of Indian sedimentary basinal area of 3.14 million Sq. kM. About 70 percent exploration area is either deepwater and in frontier basins. During XI Plan period, most of the discoveries is likely to come from logistically difficult areas and where no production evacuations facilities are in existence. Exploration companies have to invest heavily on development of surface facilities such as pipelines gas/oil collecting stations and platforms. In addition, oil companies will have to invest higher amounts on oil and gas production from ageing fields to maintain current level of production. To keep momentum of increased development activities in E&P sector, requirement of fiscal incentives is inevitable.

8.3.7 In view of above and as an imperative to realize substantial investment in E&P sector the following incentives need consideration:

- i. Granting of infrastructure status to the E&P sector under the Income Tax Act, 1961;
- ii. Incentives for replacing surface facilities;
- iii. Incentives to establish technology hub for service providers in E&P sector.

Major Indicative Physical Parameters for the XI Plan vis-à-vis Likely Achievements in X Plan

8.3.8 The major indicative physical parameters for the XI Plan vis-à-vis likely achievements in X Plan are as follows:

Parameter	X Plan Target	Likely Achievement In X Plan	Indicative Physical Parameters for XI Plan
Seismic Surveys			
2 Dimensional (GLK / LK)	98,327	64,867	128,424
3 Dimensional (Sq kM)	48,305	63,947	150,573
Exploratory Drilling			
No. of Wells	871	944	1,100
Development Drilling			
No. of Wells	883	1,191	1,660
Hydrocarbon			
In-place Reserves Accretion (MMT)	785-914	1,813.42	2,129.44

Parameter	X Plan Target	Likely Achievement In X Plan	Indicative Physical Parameters for XI Plan
domestic			
Production Oil (MMT)			
Domestic:	165.24-169.38	167.70	206.76
Overseas:	5.2	16.83	35.51
Total	170.44-174.58	184.57	242.27
Production Gas (BCM)			
Domestic:	167.43-176.50	158.79	224.56
Overseas:	4.94	5.41	9.67
Total	172.37-181.44	164.2	234.23
Production Oil & Gas (MMTOE)			
Domestic:	332.67-345.88	326.53	431.32
Overseas:	10.14	22.24	45.18
Total	342.81-356.02	348.77	476.5
CBM Gas Production (BCM)	-	-	3.78
UCG Gas Production (BCM)	-	-	2.99

8.4 Refining Capacity Additions

Refining Capacity Additions in XI Plan

- 8.4.1 At the beginning of XI Plan (2007-08), the domestic refining capacity is expected to be 148.97 MMTPA. Considering the projects under implementation and the project under various stages of approval, the refining capacity in India is expected to go up to 235 MMTPA during the XI Plan based on the information furnished by the various companies. The capacity addition in XI Plan period is expected to be about 92 MMT. The details of refining capacity additions are given at Annexure – X. however, the year-wise additions to refining capacity are given below.

Year	2007-08	2008-09	2009-10	2010-11	2011-12
Capacity Addition	9.73	36.00	15.51	15.67	15.08

- 8.4.2 Based on the year wise refining capacity addition as given above, the year wise refining capacity available during XI Plans as on 1st April will be as follows:

2006	2007	2008	2009	2010	2011	2012	CARG(%)
132.47	148.97	158.70	194.70	210.21	225.88	240.96	12.35%

8.4.3 The details of refinery capacity additions, year wise are as under:

Table 9.8: Year-wise & Company-wise Refining Capacity during XI Plan		
Capacity Additions During XI Plan		
YEAR	REFINERY	MMTPA
2007-08	Indian Oil Corporation Limited, Panipat	3.00
	Hindustan Petroleum Corporation Limited, Mumbai	2.40
	Hindustan Petroleum Corporation Limited, Visakh	0.83
	Essar Oil Limited, Jamnagar	3.50
	Sub Total	9.73
2008-09	Chennai Petroleum Corporation Limited, Chennai	1.00
	Reliance Petroleum Limited, Jamnagar (New)	29.00
	Nagarjuna Oil Corporation Limited	6.00
	Sub Total	36.00
2009-10	Indian Oil Corporation Limited, Haldia	1.50
	Bharat Petroleum Corporation Limited, Bina	6.00
	Chennai Petroleum Corporation Limited, Chennai	0.70
	Kochi Refineries Limited, Kochi	2.00
	Mangalore Refinery & Petrochemicals Limited, Mangalore	5.31
	Sub Total	15.51
2010-11	Hindustan Petroleum Corporation Limited, Visakh	6.67
	Hindustan Petroleum Corporation Limited, Bhatinda	9.00
	Sub Total	15.67
2011-12	Indian Oil Corporation Limited, Paradip	15.00
	Oil & Natural Gas Corporation Ltd. Tatipaka	0.08
	Sub Total	15.08
2007-12	TOTAL XI PLAN	91.99

8.4.4 However, the actual capacity additions would depend upon several factors including domestic demand, duty structure which would impact import and export possibilities, refining margin, and export potential for the products. However, in view of the likely surplus scenario, the companies depending upon the commercial viability of the project may review their projects and capacity additions. We could expect the refining capacity to turn out to be in the range of 190 MMT to 200 MMT leaving a scope of exports in the range of 45 MMT to 55 MMT.

8.4.5 The benefits of surplus refining capacity are at Annexure – XI. However, the factors like setting up in SEZ areas, differential in sweet and sour crude and import of crude oil and petroleum products being handled through large vessels to bring down the cost of transportation may also add to the viability of the export oriented refineries. Keeping this in view the refineries will have to make processing facilities for processing of 100 percent heavy/sour crude.

Refining Capacity Additions in XII Plan

- 8.4.6 Further into the future projections are complex as assessing the refining capacity additions particularly in the era of surpluses, during the XII Plan period is tricky. However a very rough assessment indicates that a capacity of 67.24 MMTPA (comprising of 43.30 MMTPA in public sector and 23.94 MMTPA in private sector) is expected to be added. With this capacity addition the total refining capacity in the country is likely to reach 302 MMTPA by the end of XII Plan as indicated below:

1st April	2007	2012	2017	CARG (%)
Refining Cap (MMT)	148.97	240.96	302.27	10.29%
Public Sector	105.47	158.96	202.25	9.17%
Private Sector	43.50	82.00	100.02	12.99%

- 8.4.7 But actual materialization would depend upon the commercial viability of the refineries, actual materialization and growth in international oil demand during XI Plan.

8.5 Crude Oil Requirements and Imports

- 8.5.1 Crude oil imports have been estimated based on the crude processing as indicated by refineries and net indigenous crude availability. It is estimated that by the end of XI Plan period the imported crude requirements would be 195.49 MMT. Imported crude oil requirement goes up substantially during the plan as indigenous crude production increases only marginally while the refining capacity is increasing substantially. Clearly, infrastructure would have to cater to higher imports. It is expected that there will not be any constraints in meeting future imported crude oil requirement.

Particulars	2007-08	2008-09	2009-10	2010-11	2011-12
Processing	148.5	162.7	193.0	211.6	235.0

Particulars	2007-08	2008-09	2009-10	2010-11	2011-12
Imports	107.27	120.37	150.51	170.41	195.49

Self Sufficiency

- 8.5.2 Based on estimated indigenous crude oil production, production from non-refinery sources and demand estimates for base case, the self sufficiency of products for the XI Plan period is as given below.

Particulars	2007-08	2008-09	2009-10	2010-11	2011-12
Self Sufficiency percent	27.8	26.0	22.0	19.47	16.8

- 8.5.3 Due to stagnant indigenous crude oil production and increasing demand the self-sufficiency is estimated to decline during the XI Plan period from 27.8 percent in 2007-08 to 16.8 percent in 2011-12.

Imports/Exports of Products

- 8.5.4 The production of products is projected to increase to 218 MMT by the end of XI Plan and to 286 MMT by the end of XII Plan. As a result of large capacity additions expected in the XI Plan period, the surplus/deficit situation will undergo a major change.

- 8.5.5 The projected import and export requirements are projected below for both the cases.

Table 9.13: Year-wise Import/Export of petroleum products					
Base Case (MMT)					
Particulars	2007-08	2008-09	2009-10	2010-11	2011-12
Import	4.07	3.32	4.28	5.49	6.13
Export	30.95	40.64	67.88	79.56	92.68
Upper Case (MMT)					
Particulars	2007-08	2008-09	2009-10	2010-11	2011-12
Import	4.11	3.40	4.40	6.60	7.46
Export	29.87	37.86	62.20	71.06	83.98

- 8.5.6 The export of petroleum products from India show a very high growth and India could become a major petroleum product exporter. There is a possibility of simultaneous import and export of some products due to economic situation, logistics etc. Based on the supply demand situation the following may be noticed:

- i. LPG continues to be in deficit. However by the end of the XI Plan the deficit comes down to a very low level.
- ii. Products like LOBS and Bitumen would continue to remain in deficit.
- iii. FO and LSHS will become substantially deficit in the last two years of the XI Plan. This is due to the fact that many new refineries and modernization of existing refineries envisage setting up of cokers resulting in substantial decrease in production of heavy products like FO and LSHS and converting them into distillate products. In the process there is a marked increase in production of petroleum coke.
- iv. For all other products like Naphtha, MS, ATF/SKO, and HSD the country will have huge surplus.

- 8.5.7 Globally too, heavy products appear to become deficit by the same time, indicating the need for building in some flexibility in the refineries so that only those products are produced which have a ready market.

Caveats

- 8.5.8 By the end of XI Plan, the export of petroleum products is projected to be in the range of 84 MMT to 93 MMT, though this number could be lower, if some refineries commence production in the next Five Year Plan. In any case, the export of petroleum products from

India shows a very high growth. There is a possibility of simultaneous import and export of some products due to economic situation, logistics etc. While India could become a major petroleum product exporter, export infrastructure would need to be created.

- 8.5.9 Further, for India to emerge as a serious exporter it is necessary that the refineries that are now expanding or coming up, particularly the coastal refineries, ensure that they can meet the latest fuel specifications of the developed world. This could mean Euro V standards for products exported to Europe by 2009. By 2010, all diesel sold in the US would require to be ultra low sulphur (15 ppm sulphur at retail end or just 5ppm at refinery gate).
- 8.5.10 While planning for domestic requirements, the refineries must consider the change in refinery gate price to trade parity for MS and HSD. The ratio of import parity and export parity will under go a change every year depending upon the past experience. If ratio of exports increases then, domestic realization for MS and HSD will fall accordingly. Refinery projects require factoring the above conclusions.
- 8.5.11 Projected world production balances indicate an interesting change. While currently the world appears to be deficit in light and middle distillates and surplus in heavy ends, due to new deep processing capacity, by 2010, the production balance switches to show large surpluses in light and middle distillate but huge deficit in heavy ends. Domestic demand-production profile indicates a similar situation for the domestic refinery where both FO and LSHS could have a deficit of over 4 MMT in the base case or over 5 MMT in the high case. New refineries thus would need to carefully plan their slates. In any case a little flexibility in varying the slate would enable them to produce what is profitable – either for domestic requirement or for exports.
- 8.5.12 Finally, new crude production is heavier, and with high sulphur content. New refineries should be able to run only on such crude while existing refineries must plan expansions and facilities to process larger quantities of heavy, high sulphur and acidic crude.

Sustainability of Imports and Crude Oil Availability

- 8.5.13 Crude oil proved reserves position of the major crude oil producing countries is as follows:

Country	At end 2005 ('000 mn bbls	Share of total (%)	R/P ratio
Iraq	115.0	9.6	> 100 years
Kuwait	101.5	8.5	> 100 years
UAE	97.8	8.1	97.4
Iran	137.5	11.5	93.0
Kazakhstan	39.6	3.3	79.6
Venezuela	79.7	6.6	72.6
Saudi Arabia	264.2	22.0	65.6
Libya	39.1	3.3	63.0
Azerbaijan	7.0	0.6	42.4
Sudan	6.4	0.5	46.3

Country	At end 2005 ('000 mn bbls)	Share of total (%)	R/P ratio
Nigeria	35.9	3.0	38.1
Total World	1200.79	100.0	40.6

Source: BP Statistics 2006

8.5.14 A comparison between anticipated world crude oil production (as projected by EIA in International Energy Outlook 2005) and India's crude imports is given below.

			Million b/d
Year	World Oil Production	Crude Imports by India	Percent
2010	94.3	3.6	3.8

8.5.15 It may be noted that the above crude imports are based on crude throughput in Indian refineries with a substantial product export. If crude throughput to meet only the indigenous demand on overall basis were considered the requirements would be reduced to that extent. In such a case the scenario would be as below.

			Million b/d
Year	World Oil Production	Crude Imports by India	Percent
2010	94.3	1.9	2.0

8.5.16 As seen from the above, it is expected that there will not be any constraints in meeting future imported crude oil requirement. A point though on quality of crude is in order. Increasingly, the global production of crude is veering towards heavier, high sulphur and acidic crude. Refineries would do well to build in ability to process such types of crude at 100 percent level.

⁹ Oil & Gas Journal has estimated the world reserves even higher at 1292.5 billion barrels. "Worldwide Look at Reserves and Production," Oil & Gas Journal, Vol. 103, No. 47 (December 19, 2005), pp. 24-25.

9 Manpower Planning for XI Plan and beyond

9.1 Planning for Sustained Availability of Knowledge Workers for the Oil and Gas Industry

9.1.1 “People are the greatest asset” is an oft-repeated phrase. There is no doubt that in many industries, including oil and gas industry, the next major competitive edge will be in sustaining availability of skilled people resources. Companies that learn to continuously develop human resources not only stand a greater chance to survive, but will also be more profitable.

9.1.2 Acknowledging the concern voiced by the oil and gas industry about the possible shortage in the future of knowledge workers for the entire industry, this section analyses this situation. Although part of the same industry value chain, the upstream and the downstream sectors, grapple with different sets of HR challenges. But one of the common challenges being faced by both the sub sectors is planning for sustained availability of knowledge workers.

9.1.3 Computer technology has brought short-term benefits that have allowed the oil and gas industry to reduce technical manpower requirements at a rate that has partly offset the decline in demand in the industry. But the future improvements in efficiency from the technical revolution will not be sufficient to offset the impending loss of senior expertise over the coming decade.

9.1.4 The existing educational institutions are now inadequate to ensure industry stability and security. The gap between the availability and demand for trained manpower is likely to be substantial unless concerted efforts are made to increase the throughput and therefore number of quality institutes to impart desired training/education. Investment for the development of qualified human capital is therefore most essential if the targets set forth in the “Hydrocarbon Vision 2025” are to be achieved.

Upstream Oil and Gas Sector

9.1.5 Globally, numerous significant oil and gas discoveries have been reported in the past 5 years which will result in enhanced E&P activity in coming years. In 2006 alone, over 26 countries announced their awards. All this translates into significant amount of workforce requirements particularly in areas of Petroleum Engineering, Production Engineering, Drilling Crews and Geoscientists.

9.1.6 India has also witnessed an increase in E&P activities. India is the fourth largest oil consumer in the Asia-Pacific region and the Indian oil and gas sector accounts for more than 30 percent of India’s total import bill. Imports are set to increase further as evidenced by the growth of key sectors using oil and natural gas for their energy requirements, unless substantial discoveries are made in India. The Government of India has awarded over 110 blocks through international competitive bidding under five previous rounds of NELP. The area opened up in NELP VI is more than twice the area opened for exploration in NELP V, demonstrating government’s intentions to actively explore for hydrocarbon reserves.

9.1.7 Against a backdrop of rising demand locally as well as globally and intention of the government to actively explore further, a boom is expected in the Indian E&P sector. As a consequence of this, all the resources in the sector will need to be augmented. The scarcity of service providers and rigs is commonly known. That has resulted in

astronomical rise in the rates demanded by the service sector. The infrastructure like logistics, ports, roads, rail links, roads, etc available for exploration and development of reservoirs is available with constraints. The human resource scenario has already reached an increasingly competitive stage and in future the industry may struggle to maintain the required level of E&P activities due to lack of trained manpower. The gap on account of demand-supply mismatch may get further aggravated by the exodus of these critical skills from the domestic industry on account of international requirements. The development of the sector has reached at major crossroads. If the bottlenecks to development are not found solution to, the investments and in turn the energy security of country would cause to be compromised.

- 9.1.8 The Government is sensitive to the requirement of the oil and gas industry as a whole and the upstream industry in specific, for trained and skilled manpower. The local upstream industry as well as the global industry looks at India as a source of skilled and cost optimal manpower. In order to help plan actions that will result in servicing this demand, Ministry of Petroleum & Natural Gas in August 2006, got a study done through PetroFed on the subject. The findings of the report relating to shortage of knowledge workers indicated a substantial supply-demand gap in the skills.

Skill Shortage in the Upstream Sector

1. Geologists, geophysicists, loggers, tool-pushers, drillers, petro-physicists and production engineers are considered a global commodity rather than that belonging to a country. In these sets of critical skills a significant shortfall is expected in the next 10 years.

Most of these skills are in excess today in India, however, in view of the significant E&P activity expected the projected demand in India will far exceed the supply of talent. The peak shortfall across all key skills is expected be about 8,700 in year 2016, if remedial action is not taken immediately. This makes the situation of talent gap in India far more acute.

2. **Not enough talent is available to the sector at the entry level:** The E&P sector faces a critical challenge in attracting the young talent. The Indian education sector prepares around 400+ students in E&P related geo-science courses. Of the students passing out of petro-technical streams only 56 percent join E&P companies with 12 percent of these being recruited for overseas positions. The entry to E&P sector is limited to 56 percent due to the low awareness of the job opportunities in the sector at the entry level and the perceived higher attractiveness of other sectors mainly IT, Telecom (29 percent of students move to other such sectors).
3. The Indian industry will require an additional 800 petro-technical students by 2017 (600 of these by 2012). This will require an increase in the number of students taking up education related to this sector. However, the sector faces the following challenges in attracting young talent:
 - **Low Industry Awareness:** College as well as school students are not aware of the career paths and opportunities available in the E&P sector (short term and long term) and how they compare with career in other sectors.
 - **Low Industry Attractiveness:** Generally tougher working conditions and low attractiveness of the field job, coupled with a favourable alternative job market scenario make the E&P sector low on attraction for employees at all levels.

Suggested Action Plan

9.1.9 The report identified suggested some action points for the Government, the organizations and the education sector.

Government

- Implementing a plan to communicate the attractiveness of the industry to the public at large, especially students.
- Undertaking periodic reviews of the manpower requirements in the industry in association with the Ministry of Human Resource and Development.
- Establishing higher number of educational institutions across the country and updating the course curriculum offered as per industry requirements.
- Institutionalisation of Industry-Academia interface with proper monitoring and review controls.

Organizations

- High degree of collaboration between the industry and educational institutions.
- Actively participate in communication campaigns aimed to draw young talent to the E&P sector.

Educational Institutes

- Expand training programmes to address emerging skills shortage.
- Expand current capacities (intake in E&P related courses) as well as set up new courses.
- Institutionalize feedback mechanisms to industry and professionals' opinion on how to improve effectiveness of the educational system catering to the E&P industry.

Downstream Oil and Gas Sector

9.1.10 Phase-wise deregulation of the downstream sector in India has attracted private investments making it a very competitive industry. This new era of a competitive market has forced government enterprises to revisit their strategies, including those related to human resources. Downstream players have accordingly chalked out ambitious plans to support the economic growth targets of the country. Realization of all these plans needs to be supported by adequate mobilization of knowledge workers.

9.1.11 Refining industry is set to grow at a rapid pace with the Government seriously considering promoting India as a competitive and economically viable refining destination. Plans of the Government to developing specific suitable locations within India as Petroleum Chemicals and Petrochemicals Investment Regions (PCPIR) goes a step further to suggest integration of petrochemical business with the proposed or existing refinery capacities. Globally, Middle East, India and China are the only areas which have seen a spurt in refining capacity additions in recent years. In India, the refining capacity is slated to grow over two times in the next decade or so. Marketing

and distribution of refined petroleum products will be another challenge facing the downstream industry.

- 9.1.12 In view of the expected activities in the downstream sector in India, the demand for skilled manpower is expected to far exceed the availability of talent. In addition pull from overseas as well as domestic job opportunities due to higher compensation, attrition, ageing workforce etc are some factors, which may result in scarcity of talent in the downstream industry in India.
- 9.1.13 Demand for personnel in the Petroleum sector is growing at such an alarming rate that the supply of knowledge workers in all disciplines is not expected to keep pace with the requirement. Within the downstream sector this applies more to the refining segment as compared to the marketing segment largely due to the requirement of specialised skill-sets for the refining segment. Although compensation levels in the downstream sector are comparable with competing industries, its structuring, in this largely government dominated industry, makes it unattractive.
- 9.1.14 Today the sector is witnessing widespread movement of talent from the government to the private sector. The large differential between the employee compensation may be one of the reasons. What is not very encouraging for the sector is that a lot of talent is flowing out of the country to destinations such as the Middle East which are fast developing their refining capacities. Retention of mid-career talent will be a severe challenge for the oil & gas industry in India during the next decade. NOCs in particular are highly vulnerable as they hold the highest number of trained human resources available in the industry, which is being sought out by private players. Also, oil and gas industry is facing competition from other industries like IT and BPO for qualified talent.

Suggested Action Plan

- 9.1.15 Skilled manpower, especially at entry level, is projected to be in shortage. It is imperative that special education and training institutes are brought up in order not only to service the domestic industry needs but also to leverage upon the available educated manpower and turn them into petroleum workforce for meeting even the global demand.
- 9.1.16 To avoid the collapse of "the engine that drives the economy," petroleum professionals must help create a broad-based, nationwide effort to educate key stakeholders regarding the nation's energy future, provide outreach to the public and to students, and beef up in-house and university-led R&D. The success of this mission will require cooperation and collaboration on an unprecedented scale by key stakeholders across the spectrum - but industry itself must be willing to gear up, commit needed funds to match governmental outlays, and work with others to develop and deliver a long-range plan.

Setting up of Rajiv Gandhi Institute of Petroleum Technology (RGIPT)

- 9.1.17 The gap between the availability and requirement of trained manpower is likely to be substantive unless concerted efforts are made to increase the number of quality institutions to impart the desired education/training. The existing institutes namely Indian School of Mining (ISM), Dhanbad, Maharashtra Institute of Technology (MIT), Pune, Indian Institute of Technology (IIT), Kharagpur, and Banaras Hindu University (BHU) etc. are unable to meet the burgeoning requirements of Petroleum sector.
- 9.1.18 Therefore, it has been proposed to set RGIPT at Peeparpur in Sultanpur District of Uttar Pradesh, RGIPT is proposed to be an institute of excellence in the petroleum sector

which will provide the manpower to meet the requirement in India and globally. The institute will cater to the educational and training requirement of all segments of the petroleum Industry in the upstream, midstream and downstream sectors. The proposed institute is envisaged to serve as a benchmark for training and education in the field of petroleum technology covering the entire hydrocarbon value chain by imparting quality education. It will also play a prominent role in promoting and co-coordinating R&D in the domain of petroleum and natural gas. The setting up of the proposed Rajiv Gandhi Institute of Petroleum Technology (RGIPT) will thus go a long way in catering to the requirements of the petroleum industry in the years to come.

- 9.1.19 “RGIPT Society” comprising of all the stakeholders is being registered to enable early acquisition of land as waiting for the cabinet approval in this regard may delay the whole process. The society will cease to exist as soon as the proposed RGIPT Act comes into effect.
- 9.1.20 Out of the total estimated requirement of funds of Rs.416 crore for setting up of RGIPT, it is estimated that Rs.174 crore would be required during the XI Plan starting from the year 2009-10. While Rs.59.50 crore would be required during 2009-10, Rs.58.5 crore and Rs.56 crore would be required during 2010-11 and 2011-12 respectively. It is also estimated that Rs.191 crore would be required during XII Five Year Plan while Rs.51 crore would be required during XIII Five Year Plan.

9.2 Servicing E&P Activities in India

- 9.2.1 E&P service providers have played a key role in enabling success for E&P operators worldwide. Since the late 1990s, the balance in technology development and intellectual property has clearly shifted towards service providers. E&P companies leverage on latest technologies and specialist services of oilfield service providers to reduce underground risks thereby improving chances of success in E&P operations.
- 9.2.2 Efforts of Government of India to reduce dependence on expensive imported crude oil, through increased domestic production has kick-started a number of initiatives like NELP, Open acreage policy, speculative surveys, CBM policy to intensify exploration activities in the country. Growth in such activities has led to multi-fold growth in demand for technology and oilfield services. Demand for rigs have risen globally in response to relatively high energy prices and the service companies are operating at their fullest capacity. Oilfield services other than rig supply are also facing similar situation. Availability of services in India is becoming constrained and expensive.
- 9.2.3 E&P service providers are facing constraints in providing services to Indian E&P companies, viz. high fiscal levies, complex and time consuming regulatory processes, and weak infrastructure and logistics in providing services efficiently. Only a few international service companies in the field of drilling, seismic data acquisition, processing, mud logging etc. have established themselves in India. This has left very limited choice of service providers available to E&P companies with maximum unfavourable impact on small operators in the current scenario.
- 9.2.4 The E&P industry is already facing the bottleneck of services on cost, quality and timeliness front. Unless the country is prepared to facilitate growth of service industry to be able to address to the above described growth in service requirement, the development of E&P industry and energy security would be compromised.

10 Research & Development Focus during XI Plan

10.1 Internationalization of R&D

10.1.1 Internationalization of R&D is not a new phenomenon. When expanding internationally, firms have always needed to adapt technologies locally to sell successfully in host countries. However, it was traditionally the case that R&D was reserved for the home countries of the Transnational Companies (TNCs). Now a number of new features are emerging in the internationalization process. TNCs are setting up R&D facilities outside developed countries that go beyond adaptation for local markets. Increasingly, in some developing and South-East European and CIS countries, TNCs' R&D is targeting global markets.

10.1.2 Till date, only a small number of developing countries and economies in transition are participating in the process of R&D internationalization. However, some locations are now perceived as attractive for highly complex R&D. This indicates that it is possible for countries to develop the capabilities that are needed to connect with the global R&D systems. From a host-country perspective, R&D internationalization opens the door not only for the transfer of technology created elsewhere, but also for the technology creation processes itself. This may enable some host countries to strengthen their technological and innovation capabilities.

10.1.3 Innovative activity is essential for economic growth and development. Moreover, sustainable economic development requires more than simply "opening up" and waiting for new technologies to flow in. It demands continuous technological effort by domestic enterprises, along with supportive government policies. With the increasing knowledge intensity of production, the need to develop technological capabilities is growing. Greater openness to trade and capital flows does not reduce the imperative of local technological effort. On the contrary, liberalization, and the open market environment associated with it, have made it necessary for firms — be they large or small, in developed or developing countries — to acquire the technological and innovative capabilities needed to become or stay competitive.

10.2 Drivers of Global R&D.

10.2.1 Global R&D expenditure has grown rapidly over the past decade to reach some \$677 billion in 2002. The top ten countries by such expenditure, led by the United States, account for more than four-fifths of the world total. Only two developing countries (China and the Republic of Korea) feature among the top ten. However, the share of developed countries fell from 97 percent in 1991 to 91 percent in 2002, while that of developing Asia rose from 2 percent to 6 percent. A conservative estimate is that TNCs account for close to half of global R&D expenditures, and at least two-thirds of business R&D expenditures (estimated at \$450 billion). In fact, the R&D spending of some large TNCs is higher than that of many countries. Six TNCs (Ford, Pfizer, DaimlerChrysler, Siemens, Toyota and General Motors) spent more than \$5 billion on R&D in 2003. In comparison, among the developing economies, total R&D spending came close to, or exceeded, \$5 billion only in Brazil, China, the Republic of Korea and Taiwan Province of China. The world's largest R&D spenders are concentrated in a few industries, notably IT hardware, the automotive industry, pharmaceuticals and biotechnology.

10.3 R&D in developing countries

- 10.3.1 The share of host developing countries in the global R&D systems of TNCs is rising, but unevenly. Only a few economies have attracted the bulk of the R&D activity. Developing Asia is the most dynamic recipient. In the case of R&D expenditures by majority-owned foreign affiliates of United States TNCs, for example, the share of developing Asia soared from 3 percent in 1994 to 10 percent in 2002. The increase was particularly noticeable for China, Singapore, Hong Kong (China) and Malaysia.
- 10.3.2 Indian petroleum sector has graduated from a mere producer to designer of new products and processes. This important sector is a strategic partner in the eternal journey of the Indian industry into 21st Century. In order to be a catalyst in the entire development cycle, R&D policy for petroleum sector ought to be industry friendly. It must include attributes, which should effectively inculcate the culture of academia-industry interactions, export orientation, competitiveness apart from the development of human resources.
- 10.3.3 R&D activities would require close interaction between industry and research organisations. Involvement of the industry was considered essential in the areas of selection/prioritisation of R&D projects, becoming the stake holder for the R&D projects, project formulation and monitoring the progress of the projects and implementation of the findings of R&D works etc.
- 10.3.4 There has to be paradigm shift in the approach for carrying out R&D. As is well known, R&D functions are very dynamic, and concepts and strategies change very often. Without taking risk in R&D efforts no break-through will be achieved.
- 10.3.5 India is spending around Rs.200-250 crore on R&D efforts in the hydrocarbon sector having an annual turnover of around Rs.400,000 crore. There is an urgent need to increase expenditure in R&D, keeping in proportion to the turnover of the industry.
- 10.3.6 There is huge scope for improvement in the hydrocarbon sector through R&D. Emphasis is required to encourage a culture of R&D in the oil industry. The benefits of R&D could be multiplied by ensuring close interaction between refining industry and research institutions. In the industry, there is also scope for collaborative R&D.
- 10.3.7 Today Indian refining industry is facing new challenges which includes surplus capacity, volatile refining margins, stringent fuel specifications, emergence of alternatives such as fuel cells, hydrogen etc. Besides the need for improving energy efficiency is increasingly becoming paramount. There have been concerns over depleting crude oil resources and we ought to look at ways and means to enhance recovery rate while at the same time look at alternative energy sources.
- 10.3.8 As the country takes its place in the global arena, India has to match world-class technologies and indeed turn from consumers to providers of technologies. A high oil price provides great incentive in coming up with alternatives. Further, it has been statistically proved that innovation is not prerogative of large corporation but small companies could be equally innovative. This provides scope for a comprehensive R & D program.
- 10.3.9 R&D could be tackled at two levels - (a) at the level of educational institutes, universities and colleges and (b) at the industry level.

- 10.3.10 To build a culture of R&D in the educational institutes, encouragement is needed to undertake basic research in the hydrocarbon sector on specified areas relating to their fields through government grants. These grants could come from OI&B. Institutes like IITs and engineering colleges could take up research in their departments to further their knowledge base as well.
- 10.3.11 At the corporate level, R&D thrust should be driven by business level strategy i.e. in refining - technology to upgrade heavy petroleum residue to clean fuels, alternative source of energy/technology which can replace fossil fuel, process/catalyst improvement etc. and in the upstream- improving extraction ratio, E&P evaluation etc.
- 10.3.12 Keeping this in view, following areas are identified for R&D in the hydrocarbon sector during the XI Plan:

10.4 **Exploration & Development**

- 10.4.1 Most of the R&D activities carried out in India prior to the NELP regime were undertaken by the two National Oil Companies i.e. ONGC & OIL. The R&D activities included areas like Drilling, Production, Geological & Geophysical, Reservoir Engineering etc and were specific to company's requirement. ONGC however, by virtue of its nation wide operations, did carry out certain R&D activities in the national interest. This included estimation of prognosticated resources for the entire country. In order to supplement R&D efforts, DGH has also taken up R&D projects. Some of the important R&D projects in the exploration & production sector are as under:
- Projects with Alberta Research Council (ARC): Review of Sedimentary Basins in India to estimate the prognosticated reserves of Oil & Gas in India and establishment of data repository in India.
 - Projects with Energy Resources & Development Unit (ERDU) of the Department of Trade & Industries, UK are Study on Frontier Basins in India and suggesting utilization of available technologies for optimizing the exploration of hydrocarbon resources from these areas and Evaluation of Development plans involving new technologies
 - R&D Project for Gas Hydrates is also being carried out under the National Gas Hydrate Programme (NGHP). The potential challenge for this project is to produce gas from gas hydrates. Recently, DGH has collected core samples of gas hydrates in offshore areas for resource assessments.
 - Underground coal gasification (UCG) is the in-situ gasification of coal in the seam. ONGC and GAIL have been exploring the possibility of exploiting coal gas by UCG technology. By 2010-11, ONGC has plan to produce 2.7 MMSCMD of gas through underground coal gasification process and envisages to produce about 2.99 BCM of UCG gas during XI Five Year Plan period.
 - Oil Shale: Detailed mapping, extensive sampling to ascertain the distribution, quantity and quality of oil shale in North Eastern part of India may be carried out for assessment of oil shale resources in the region.
 - Coal Liquefaction Project by OIL: During the X Five Year Plan, Pre-Feasibility Study (PFS) on Catalytic Two Stage Liquefaction (CTSL) technology of M/s Axens NA, USA

on coal liquefaction process has been completed. OIL has now earmarked about Rs.250 Crore during XI plan period for commercialization of this process.

- Research and Development in Exploration & Production Technology by ONGC

10.4.2 ONGC has institutionalised Research and Development in exploration and production (E&P) and related sectors and established seven separate R&D institutions to undertake specific activities in key areas of exploration, drilling, reservoir management, production technology, ocean engineering, safety and environment protection. Further, regional laboratories established at various Assets and Basins of the ONGC support these institutes.

10.4.3 ONGC R&D institutes are equipped with laboratories, computer processing systems and computer workstations, and utilize specialized multi-disciplinary expert teams. These institutes also leverage research through international and national consortia, alliances and joint industry programs.

10.4.4 Significant benefits that are envisaged from these R&D efforts, inter alia, include - delineation of lateral extension of proven play and accretion of additional reserves, establishment of shallow and deeper new plays in proven areas adding to new reserves, better reservoir delineation through 3D-3C and 4D seismic, online monitoring of proven producing fields towards maximization of ultimate recovery while managing good health of the reservoir over its entire life cycle, improved oil recovery from the heavy oil belt etc.

10.5 Natural Gas Sector

10.5.1 In the light of the expected growth in the natural gas sector during the XI Plan, R&D and technology development and transfer efforts in the natural gas sector assumes a very important dimension. Technologies in deepsea exploration, gas transportation by sea, on-board re-gasification, gas to liquids (GTL) are some of the major technologies which need active pursuit. There are also other R&D projects that are planned by GAIL during the XI Plan (2007-2012) :

- Pilot Plant for Separation of Light Hydrocarbon Mixtures by Adsorption Process:** GAIL, in collaboration with IIT-Kanpur, has developed an adsorption process for separation of light hydrocarbon mixtures. A pilot plant is planned to be set up at GAIL, Pata in association with EIL, R&D for undertaking field trials.
- Pilot Scale Testing of Coke Inhibitors for Gas Cracker Furnaces with IIT, Kanpur:** GAIL has set up a pilot Gas Cracker at Petrochemical Plant, Pata for testing coke inhibitors. Pilot scale experiments are partially complete. It is planned to carry out more number of experiments for testing coke inhibitors.
- Underground Coal Gasification: General License Agreement with M/s Ergo Exergy for UCG Technology:** Underground Coal Gasification has been identified as a thrust area. A General License Agreement with M/s. Ergo Exergy, Canada is planned for Underground Coal Gasification (UCG) Technology till pilot stage to produce syn-gas and subsequently power. The agreement shall be valid for 10 years.
- Development of Catalyst and Process for the Conversion of Waste Plastics, LPW to Value Added Liquid Fuels with IIP, Dehradun:** GAIL and IIP, Dehradun have signed a contract agreement in June 2006 for developing catalyst and process

for conversion of waste plastics (HDPE/LLDPE/LDPE waste) and Low Polymer Wax to liquid fuels (BTX/Diesel/Gasoline). Completion time of the project is 2 years from the date of signing of contract agreement.

- v. **Contribution to Hydrogen Corpus Fund set up by MOP&NG:** Hydrogen Corpus Fund has been set-up by MOP&NG with contributions from OIDB, IOC, ONGC, HPCL, BPCL and GAIL for development of hydrogen based technologies. IOC R&D is the overall coordinator of research work while OIDB is the fund manager. GAIL will be undertaking R&D projects in hydrogen storage, transportation and dispensing.
- vi. **Development of APPS Package for Natural Gas Pipelines with IIT- Chennai:** The objective is to upgrade the developed leak detection package with IIT-Madras to a complete Application Software (APPS) package for natural gas pipelines.

10.6 Refining Sector

10.6.1 The need for self reliance in the petroleum sector led to the creation of engineering, design and R&D institutions like EIL and national laboratories (IIP, NCL). Subsequently R&D centres were created in major Public sector oil companies like IOCL, EIL, CPCL and BPCL to enhance the technological knowledge base. Other institutions like Oil industrial Development Board (OIDB), Centre for High Technology (CHT) were created to ensure effective coordination and planning. All this contributed significantly towards technological self reliance in the petroleum refining industry. Research and development activities got a fillip in 1995 with setting up of an expert committee under Dr. S. Ganguly to review the technological gaps and make recommendations to make Indian refineries more flexible, technologically competitive and productive. The committee emphasized on close interaction between refining industry and research institutions to improve their effectiveness.

10.6.2 Keeping in view the future concerns of the downstream petroleum sector, the areas of research identified in the eleventh five year plan are presented below.

- i. **Coal to Clean Fuels (CTL):** Coal Gasification offers a potential route of using available resources more cleanly and efficiently. India having abundant reserves of coal need to have a serious look at coal gasification technology. The residue material in our refineries such as coke, asphalt, pitch, visbroken tar etc could also be potential candidates for gasification. Gasification of such material opens entire range of opportunities for the refiners in terms of generating steam, power, hydrogen, methanol, ethanol, DME, FT fuel etc.
- ii. **Gas to Liquid Technology (GTL):** GTL involves Fischer Tropsch (FT) processes which become viable at crude oil prices of above US \$ 30/bbl. It may also be possible to sell half of the products as high value chemicals, such as 1-alkenes, at double of the liquid fuel price, which will make FT synthesis viable at even lower crude oil prices. Various reports say GTL is profitable in the US\$15 to 25 per bbl oil (Brent) range. A key deterrent to the profitability of a new GTL plant is the capital cost. However, number of studies have compared the full GTL & LNG trains and found that modern units with US\$ 20,000 - 30,000/bbl cost, GTL is competitive with LNG. The research issues that need to be addressed are indigenisation of the coal/coke gasification and gas liquefaction technology with stress on adaptability to available feed stock, scale up and improvement in performance both with respect to economics as well as environment. China is reported to have already gone ahead in

this direction by tying up with SASOL to establish coal to liquid fuel capabilities in China.

- iii. **New Heavy Oil Upgrading Process:** Heavy oils relatively have high carbon to hydrogen ratio. Thus, one way of upgrading heavy oils is through “carbon rejection.” (E.g. delayed coking). This involves removing some carbon atoms, thereby leaving the remaining oil with a higher ratio of hydrogen to carbon and, hence, a lighter oil. Other way of upgrading heavy oils is through “hydrogen addition”. This involves hydrogen addition, which increases hydrogen to carbon ratio and produces light oil. Until now, hydrogen addition has lagged behind carbon rejection, accounting for an estimated one-fifth of global residue upgrading capacity. However, with the advent of a new heavy oil upgrading technology, hydrogen addition is poised to take a great leap forward. By using proprietary mixing devices between hydrocarbons and hydrogen, the process achieves high conversion rates at lower temperature and pressure. The technology is based on catalytic hydro-cracking, which converts larger molecules and other hetero atom molecules into naphthenic oil fractions, while nitrogen, sulfur and heavy metals are reduced and/or eliminated. From an overall energy viewpoint, one of the great virtues of the process is that it uses hydrogen in an extremely efficient way. At current market prices, it adds at least \$4 worth of added value for each \$1 of hydrogen utilised.
- iv. **Alternative Energy Source - Hydrogen as a Fuel/Fuel Cell:** Hydrogen, a fuel for the future can be produced from biomass using gasification, fermentation or aqueous form reforming process. This can be taken up for further research and development. IOC-R&D has been identified as nodal agency by MoP&NG for hydrogen research within oil and gas sector in India which is focusing on use of H₂-CNG blends in Automotive Vehicles with carburettor system. Production of hydrogen from alternative source rather than conventional production from fossil fuel need to be developed as the future road map to achieve hydrogen economy in the country. Thus this project needs to be suitably taken up for development.
- v. **Petrochemicals and Polymers:** R&D activities in the areas of poly-olefins/petrochemicals are also needed to be initiated. Activities under this programme will necessarily be to create facilities and expertise for long-range process/product development; catalyst design, development and evaluation, development of different grades of polymers and copolymers depending upon market demand etc. A product Application & Development Centre for polymers is required to be set up at a suitable location. The main function of this centre would be development of new products, forecasting emerging application, technical support to customers / end users etc. Set up of such R&D Centre would certainly provide impetus to the refinery and petrochemical integration.
- vi. **Catalyst and Technology Development for Gas oil Desulphurisation:** De-Hydro Desulphurisation (DHDS) catalyst developed by IOCL – R&D) is being scaled up. IOCL is putting up new Diesel Hydro Treating (DHDT) at BRPL through their in-house efforts and will use their own desulphurisation catalyst. In view of clean fuel requirement due to implementation of BS-II, Euro-III and subsequently implementation of Euro-IV specification in selected cities effective 2010 as per the Auto Fuel Policy of GoI, this project shall be pursued further. Alternative technologies for desulphurization of diesel and gasoline streams such as oxidative desulphurization, adsorptive desulphurization and desulphurization through bio-catalytic routes shall also be taken up.

- vii. **Future Fuels, Lubricants and Additives from Biomass and Non-Edible Vegetable Oils:** Processes from renewable resources such as non-edible vegetable oil and biomass should be exploited to produce future fuels including gasoline, jet fuels and diesel. Technology for fast pyrolysis of biomass should be developed with subsequent upgrading of bio oil within the current refinery units

10.7 R&D – Way Forward

- 10.7.1 **R&D Expenditure in Hydrocarbon Sector:** India is spending around Rs.300-370 Crores per annum on R&D efforts in the Hydrocarbon Sector. Whereas, the annual turnover of only the oil PSU is more than Rs.500,000 crores. This is substantially lower compared to the research expenditure in developed countries which spend about 1% of the turnover towards research and development.
- 10.7.2 **Mission Oriented Approach:** Indian R&D has to compete more and more with world-class technology provided by international licensors. Piecemeal approach towards technological development instead of total value chain integration has resulted in widening of the gaps in core technologies. The need of the hour is to follow a mission-oriented approach on co-operative basis in which nationally identified technology for development shall be considered in totality including all aspects like catalyst development, design, instrumentation, vendor development etc.
- 10.7.3 **Involvement of Private Sector in R&D:** Presently, most of the funding for R&D comes from government or the public sector. Under the present scenario when private sector is also playing a significant role in the growth of petroleum industry, we must ensure funding of research coming from private sector also.
- 10.7.4 **Incentives for usage of indigenous technology:** Attractive incentives to the first users of indigenous may help in curbing the tendency to go for outright import of technology. The incentives can be in form of excise/tax benefits, financial contribution from OIDB or a government corpus fund to cover the commercial risk being taken by the first user.

11 Investment Requirement and Infrastructure Development

11.1 Exploration and Production Sector

Infrastructure Development

- 11.1.1 The main infrastructure development activities relating to the E&P sector are building up process platforms, laying of pipelines, oil and gas collecting stations and other surface facilities for evacuation of crude oil and natural gas from field areas to delivery points.
- 11.1.2 Infrastructure development activities in E&P sector are highly dependent on the location of oil and gas fields either onland or offshore, size of the reservoir, prevailing prices of crude oil and natural gas as well as techno-economic consideration of the development plan of the discoveries. Due to the uncertainties involved in the E&P business, realistic assessment of infrastructural development activities cannot be made in advance.
- 11.1.3 After the implementation of NELP, operators now have freedom to market oil and gas produced from their blocks. Under the provisions of NELP the operator enjoys certain incentives such as cost recovery of admissible expenditure as per production sharing contract and 'nil' customs duty on import of select items. Recent oil and gas field development activities in the KG basin and Rajasthan are currently being undertaken by the private operators. Similarly, NOCs are also taking up the infrastructure development projects. Some of the surface facilities developed by ONGC in offshore and onland areas need replacement in a phased manner during XI Plan period.
- 11.1.4 With increased E&P activities, oilfield service companies have been encouraged to establish their service centres in India taking advantage of India's growth in information technology (IT) sector as well as advantage of manpower. During XI Plan period, establishment of E&P service provider hubs can be envisaged.
- 11.1.5 Exploration companies have to invest heavily on development of surface facilities. In this regard, Government also has the responsibility of facilitating the operators by providing necessary permission and incentives for infrastructure development. In view of encouraging investment in E&P infrastructure and as an imperative to realize substantial investment in E&P sector, the Working Group supports demand for grant of infrastructure status to the E&P sector.

Plan Outlay and Internal Resource Generation for NOCs

- 11.1.6 With the implementation of NELP and CBM Policy, exploration cost in the country is directly financed by E&P companies. Government of India need not incur any expenditure on E&P, at the same time Government is benefited by way of getting profit petroleum share, royalty and other taxes, once the commercial production commences from the licensed areas. Major NOCs, viz. ONGC, OIL and ONGC Videsh Limited (OVL) are financing E&P activities through their own generated internal resources or financing through loans.
- 11.1.7 The gap between internal resources generation and capital expenditure is expected to be made up through extra-budgetary financing by way of loans from Banks/Financial Institutions, carry forward surplus from previous period and increase in commodity prices.

- 11.1.8 The plan outlay and internal resources for domestic E&P activities to be carried out by major NOCs is as under:

	Plan Outlay (Rs. Crore)	Internal Resources (Rs. Crores)
ONGC	82,670	70,525
OIL	10,176	10,176
OVL	58,674	29,971
Total	15,1520	11,0672

- 11.1.9 OVL has a plan outlay of Rs. 58,674 crore for investment in overseas E&P activities. The internal resource generation by OVL will be around Rs. 29,972 crore. The gap between plan outlay and internal resources generation is expected to be made up through loan provided by ONGC and international financing.

- 11.1.10 In addition to above, investment by Private/JV companies on E&P may be around US\$9 billion during XI Plan period. This investment may increase further in event of discoveries and development plans undertaken thereafter by private/foreign companies.

11.2 Refining and Marketing Sector

- 11.2.1 India's oil markets are expected to grow, albeit relatively slow, in future. Large investments are required to meet the demand for oil products. The level of investments required is quite high and in the current circumstances where the oil PSUs equitably share the burden of high oil prices, the public sector companies would be stretched to meet the investment requirements through their internal and extra budgetary resources. It is estimated that the refining and marketing companies in the public sector would require an investment of about Rs. 92,000 crore in refining, marketing and associated infrastructure under their Plan expenditure.

LPG Import Infrastructure

- 11.2.2 The LPG demand projections for the XI Plan are given at Annexure VII. The LPG demand, both for base case and upper case, are the same.

Years	Demand (TMTPA)
2007-08	10,853
2008-09	11,246
2009-10	11,683
2010-11	12,183
2011-12	12,770

- 11.2.3 The indigenous LPG production by the terminal year of the XI Plan period i.e. 2011-12 would be about 12,762 TMTPA, out of which availability from RIL would be about 1,600 TMTPA. The indigenous availability projections include availability to the tune of about 1,740 TMTPA from the three grassroots refineries at Paradip, Bina and Bhatinda proposed under the XI Plan period. Therefore, the overall availability of LPG in the country by the end of XI plan is projected to be almost equal to the projected demand.

11.2.4 However, in a market driven economy, RIL and other private companies may have their own strategy for marketing of LPG and the possibility of the same not being available to OMCs cannot be ruled out. Under such a scenario, it may become pertinent to analyse the LPG import infrastructure and to assess whether it is adequate to support the increased import requirement during the XI Plan period and beyond.

11.2.5 In addition to the existing LPG import facilities, following additional LPG import facilities are proposed / under construction :

- Cavern Storage of 60 TMT at Vishakapatnam by M/s. SALPG expected to be commissioned by July, 2007. With its commissioning, while the tankage at Vishakapatnam will improve, the throughput capacity is likely to remain same due to logistics considerations.
- LPG import terminal at Ennore by IOC with storage of 30 TMT and rated capacity of 600 TMTPA. This facility is expected to be commissioned during 2008-09.

11.2.6 With commissioning of the above facilities, the total LPG import infrastructure for PSU oil companies by 2008-09 will be as under :

LPG Import Facility	Tankage (TMT)	Rated capacity (TMTPA)	Max. achievable capacity (TMTPA)
Kandla	30	600	1000
Mangalore	16	600	1200
Ratnagiri	20	200	300
Tuticorin	4	100	200
Vishakapatnam	60	600	600
Haldia	34	600	900
Ennore	30	600	900
TOTAL	194	3300	5100

11.2.7 From the above table, it may be analysed that the present and proposed LPG import infrastructure is adequate for handling LPG import requirement of the country by the terminal year of the XI Plan period considering that the entire production of indigenous LPG including at RIL, Jamnagar is available for domestic use. The LPG import capacity will be adequate even without the production at RIL, Jamnagar as well as non availability of LPG from the three new refineries at Paradip, Bina and Bhatinda.

11.2.8 Considering the Regional balance of supply demand during the terminal year of the XI plan, following scenario emerges :

Region	Demand (TMT)	Availability (TMT)	Variance
North West	7532	7689	(+) 157
East	1567	2072	(+) 505
South	3671	3001	(-) 670
Total	12770	12762	(-) 8

- 11.2.9 It can be seen from the above that whereas the overall availability almost matches with the demand projections, regional imbalances with respect to availability v/s demand are projected with deficit in Southern Region and surplus availability in the East. This situation also will require operation of LPG import terminals to facilitate coastal movements to South from West and East. Further, in case RIL product is not available and commissioning of new refineries is delayed, LPG imports to the tune of about 3,400 TMTPA will be required.
- 11.2.10 As brought out at para 11.2.6 above, the LPG import capacity in the country after commissioning of LPG import terminals at Vizag and Ennore will be about 3,300 TMTPA with maximum achievable capacity of about 5,100 TMTPA. Therefore, LPG import capacity will be adequate to meet the import requirement by the end of XI Plan even with RIL product not being available. However, in such an event, following constraints may be encountered by the OMCs:
- At present around 2 MMTPA is pumped in the Jamnagar-Loni LPG pipeline to meet the deficit in Northern Region. Out of this quantity, around 1.7 MMTPA is pumped from RIL, Jamnagar and balance around 0.3 MMTPA from Kandla. The maximum pipeline pumping capacity ex-Kandla is presently about 0.7 MMTPA. Therefore in the event of product not being available from RIL, Jamnagar, the pipeline movement will be adversely affected necessitating movement of product to Northern Region plants by road and therefore, incurring higher cost. To avoid such a situation, capacity augmentation of Kandla Samakhiali Pipeline section upto 1.5 MMTPA on Jamnagar – Loni LPG pipeline needs to be taken up. This would facilitate imports at Kandla to meet the deficit in Northern Region through pipeline.
 - Utilisation of some of the import locations like Ratnagiri, Haldia and Vizag beyond their rated capacity will not be economical from logistics considerations.

Port Infrastructure to Support POL Traffic

- 11.2.11 The Department of Shipping usually works out the port-wise volume of traffic for the Plan period. However the following points need to be considered while carrying out any projection in respect of POL related traffic at the ports.
- It is expected that POL traffic through the Kandla port would increase after the refinery projects under implementation in the State of Gujarat are complete and the fertilizer industry switches from Naphtha to gas as feedstock in line with their fertilizer policy. In that eventuality exports of POL through Kandla port will increase.
 - Similarly, traffic projections at Paradip, Haldia, Ennore and Chennai would require to be in line with the refinery expansion projects planned in the country during the XI Plan period. There may be diversion of traffic between Paradip and Haldia depending upon the progress in implementation of the refinery projects.
 - While planning up-gradation of ports, the requirement of night navigation/berthing facility should be reviewed in detail. The provisioning for night navigation and adequate berthing facility would reduce the turn-around time and would lead to more efficient use of port facilities.
 - Intensive dredging programme may be embarked upon at ports in order to maintain/improve draft in navigation channels and port berthing facilities so that ships of larger size can be handled at the ports.

11.3 Natural Gas Sector

11.3.1 With the enactment of the PNGRB Act 2006 and the expected setting up of a Regulator during 2006-07, the natural gas industry is poised for a major growth. This is supported by the supply side expectations from both domestic and international sources, as described in the earlier chapter on Supply Outlook. Under the normal and optimistic scenario, the total supply from all sources would be 191.42 MMSCMD and 285.42 MMSCMD respectively by the terminal year of the XI Plan, as compared to the current level of 110.89 MMSCMD. This projected trend in supply supported by a strong demand would require parallel investments in the building of re-gasification and pipeline transmission and distribution Infrastructure, in order to facilitate faster monetization of gas reserves, to ensure smooth flow of LNG supplies into the country and to reach a wide spectrum of consumers across the country.

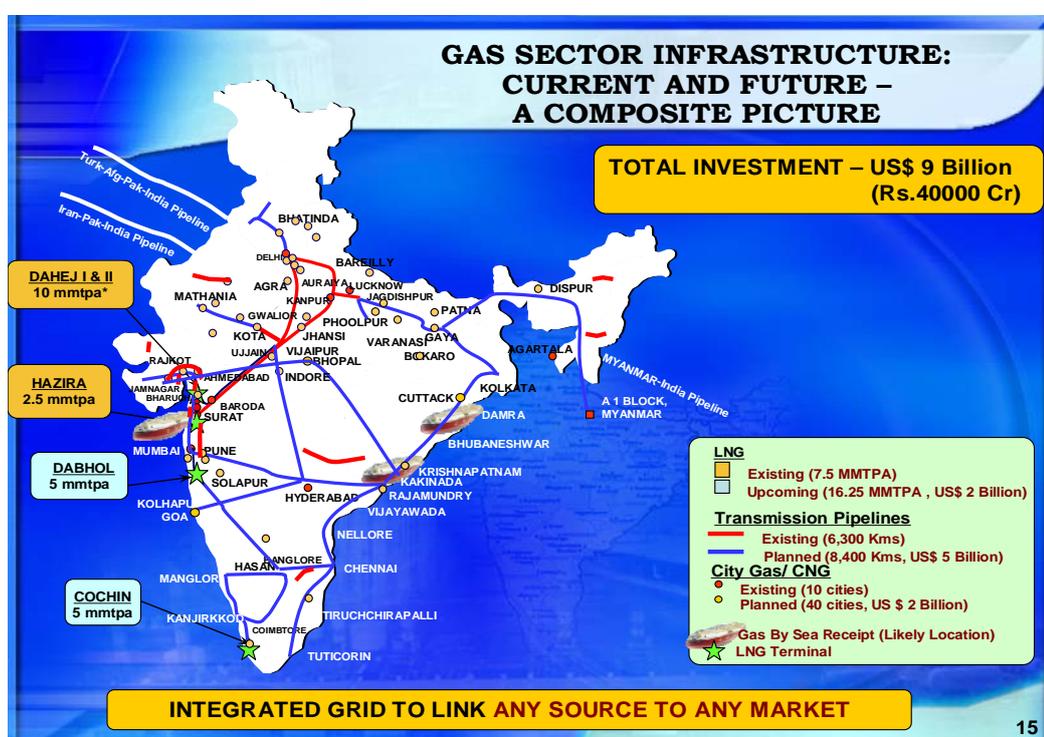
11.3.2 The key growth drivers for the Indian gas market are gas pricing, infrastructure, regulation and end-use sector reforms. Gas pricing is moving towards a market determined pricing mechanism and Indian gas market is aligning with the global trends. Regulatory framework is being put in place. As regards the end-use sector reforms, the same are taking place at varying paces in different sectors.

11.3.3 The gas supply options for the Indian market are numerous and the relevant ones in the context of the XI Plan are as below:

INDIAN GAS SECTOR: SUPPLY OPTIONS	
New Domestic Discoveries (East Coast)	
	<ul style="list-style-type: none"> ▪ Offshore Finds (Reliance, GSPC)
Transnational Pipeline Imports (North –West and North-East)	
	<ul style="list-style-type: none"> ▪ Iran - Pakistan -India ▪ Turkmenistan – Afghanistan – Pakistan –India ▪ Myanmar –India
Additional LNG Imports (West Coast)	
	<ul style="list-style-type: none"> ▪ Dabhol ▪ Kochi ▪ Dahej Expansion ▪ Mangalore
Supply–Demand to be Driven by Key Growth Drivers	

11.3.4 On the LNG front, the expected re-gasification investments would be driven by the expansion of the Dahej LNG terminal from the current 5 MMTPA capacity to 10 MMTPA by 2009-10. The Dabhol LNG terminal capacity build-up is expected to be 1.2 MMTPA and 2.1 MMTPA in 2007-08 and 2008-09 respectively and reach the full capacity of 5 MMTPA by 2009-10. The investments in Kochi Terminal of PLL would be in full swing in the first three years of the XI Plan and the terminal is expected to be operational in 2010-11 at a capacity of 2.5 MMTPA which would grow to 5 MMTPA by the terminal year of the XI Plan. The Mangalore terminal is expected to be partially commissioned by the terminal year with an initial supply of 1.25 MMTPA. These plans translate into a total investment of Rs.9,220 crore during the XI plan.

11.3.5 On the investment in transmission pipeline front, there are a number of plans by different players in the industry. GAIL has drawn up major plans for creation of the inter-state transmission grid in line with the emergence of gas sources on the west and east coasts of the country. The total investments of GAIL for creation of pipeline infrastructure in the XI Plan is expected to be in the order of Rs.11,120 crore. This primarily includes ongoing projects like Dahej–Uran Pipeline (DUPL), Vijaipur–Kota Pipeline (VKPL), Jagoti–Pitampur Pipeline (JPPL) and Dabhol–Panvel Pipeline (DPPL). The planned investments include the Jagdispur–Haldia Pipeline (JHPL), Dadri–Nangal Pipeline (DNPL), Kochi–Coimbatore–Bangalore Pipeline, Mangalore–Bangalore–Chennai Pipeline, and link pipelines to the envisaged transnational pipelines. Besides, there are other private players who have obtained Right of Usage (ROUs) and planned some inter-state pipelines. Such pipelines include Kakinada–Uran–Ahmedabad Pipeline, Hyderabad–Goa Pipeline, Kakinada–Bhopal–Jamnagar Pipeline and Kakinada–Cuttack–Haldia Pipeline and Vijaywada–Chennai Pipeline. The total expected investment in these inter-state pipelines is about Rs.21,000 crore.



11.3.6 In terms of the distribution pipelines, there are very good prospects of expansion and many players are expected to participate in the growth of this sector. From the current coverage of 10 cities, the city gas distribution network is expected to grow to about 40 cities all over the country in line with the expected emergence of supply sources. The total investment in this sector is expected to be in the order of Rs.9,000 crore in the XI Plan.

11.3.7 Putting all these investments together, the gas sector is predicted to see a total investment of about Rs.40,000 crore during the XI Plan period with gas transmission pipelines taking a major share of about 53 percent, while LNG re-gas terminals and city gas distribution infrastructure taking a share of 24 percent and 23 percent respectively. (These investments do not include upstream investments in E&P). The details of the year-wise projected investments in the gas sector during the XI Plan and the Infrastructure map of India are presented below:

Supply	07-08	08-09	09-10	10-11	11-12	Total
LNG Terminals*	1,620	2,300	1,800	1,000	2,500	9,220
Gas Transmission Pipelines*						
-GAIL	2,046	1,110	2,892	3,309	1,764	11,121
-Others**	2,000	2,000	2,000	2,000	2,000	10,000
City Gas Distribution Infrastructure*	1,000	1,500	2,000	2,000	2,500	9,000
Total	6,666	6,910	8,692	8,309	8,764	39,341

Note 1: Out of GAIL's total investment plan of Rs.12,159.25 crore, Rs.11,121 crore is only for gas transmission pipelines during the XI plan.

Note 2: In addition to the pipeline connectivity planned by GAIL for non gas based fertilizer plants, the other units (Goa, Mangalore, Tuticorin) are expected to be covered under private sector initiatives, investment for which is provided for above.

11.3.8 The summary of investment for the XI Plan is as under:

Sl.No.	Name of the PSU/Organisation	Total Plan Outlay (in Rs.Crore)
1	OVL	58674
2	ONGC	82670
3	OIL	10176
4	GAIL	12159
5	IOC	45215
6	H PCL	32285.
7	BPCL	12553
8	CPCL	3825
9	BRPL	2020
10	MRPL	8561
11	NRL	498
12	Balmer Lawrie	205
13	Biecco Lawrie	34
	Organisation	Investment Outlay of Plan Budget of Government
	Rajiv Gandhi Institute of Petroleum Technology (RGIPT)	174
	GRAND TOTAL	269,049

11.3.9 Government has proposed to set up RGPIT, an institute of excellence in the petroleum sector to cater to the educational and training requirements of all segments of the petroleum industry. Out of the total estimated requirement of funds of Rs.416 crore for

setting up of RGPIT, it is estimated that Rs.174 crore would be required during the XI Plan period starting from the year 2009-10.

11.3.10 Activity-wise break-up of the XI Plan expenditure by Oil PSUs is as follows:

XI Plan Break Up	Rs Crore
Upstream	159,161
Refining	81,545
Gas	13,079
Marketing	6,080
Crude Pipelines/Crude Oil Terminal	4,230
R&D (including in upstream)	1,418
Others including RGIPT	3,536
TOTAL	269,049

11.3.11 The above investments are based on the information received from various companies and does not include investment in the oil and gas sector by the private sector. However, these investments may undergo some change at the time of finalisation of the Annual Five Year Plans.

12 Conclusions & Suggestions

12.1 Exploration & Production Sector

- i. Opening up of 80 percent of India's sedimentary basinal area for exploration.
- ii. Crude oil production of 206.76 MMT in XI Plan, which is 23 percent higher than the likely achievement of the X Plan.
- iii. Natural gas production of 224.56 BCM in XI Plan, which is 41 percent higher than the likely achievement of X Plan.
- iv. Pursue extensive exploration in non-producing and frontier basins for knowledge building and new discoveries, including in deep-water offshore areas.
- v. Establishing a 'Knowledge Hub' in India.
- vi. Undertaking 100 percent speculative survey in the course of the XI Plan.
- vii. Strengthening of DGH and upstream regulation in oil and gas sector.
- viii. Faster development of oil and gas discoveries.
- ix. Development of isolated and marginal fields and creation of surface facilities.
- x. Provide infrastructure status to E&P companies and competitive fiscal terms to attract significant investments in the sector.
- xi. Optimize recovery from ageing oil and gas fields.
- xii. Continue to offer more CBM exploration blocks.
- xiii. Efforts to obtain methane gas through in-situ gasification of coal.
- xiv. Continuation of R&D efforts to exploit the potential of Gas Hydrates and Oil Shale.
- xv. Availability of trained manpower and expertise in the E&P sector.
- xvi. Continue to acquire acreages abroad for exploration as well as production

12.2 Natural Gas Sector

- i. The Indian gas market is poised for growth. The pace of growth would be determined by the increase in supply of natural gas, investments in creation of related infrastructure and in the downstream sectors, viz, power, fertilizer, city gas distribution, etc.
- ii. There are a number of gas demand projections based on economic and end use methodologies. All such projections indicate robust growth in gas demand over the XI Plan period. Demand is projected to rise from 179 MMSCMD in 2007-08 to 279 MMSCMD by the year 2011-12.

- iii. The domestic supply of gas during the XI Plan period is expected to rise sharply as compared to the X Plan period mainly due to the recent discoveries in the K-G Basin. The domestic gas supply figure estimates are 80 MMSCMD in 2007-08 going up to 202 MMSCMD by 2011-12 as an optimistic scenario.
- iv. Successful outcome in some of the NELP blocks would further augment the domestic gas supply in the XI Plan period.
- v. Import of LNG which commenced in 2004 for the first time is projected to increase to 23.75 MTPA (83.12 MMSCMD) during the XI Plan period with new LNG regasification terminals being set up in the country.
- vi. Over the long term, gas imports as LNG and through transnational pipelines, as and when they materialise, would play the role of bridging the gap between demand and supply of natural gas in the country.
- vii. Gas sector would require large investments in setting up of terminals, pipeline infrastructure, processing facilities and city gas networks. It has been projected that around Rs. 40,000 crore would be required during the XI Plan period by the natural gas sector.

Major Gas Sector Challenges

- 12.2.1 The planned growth in the XI Plan would require that the government and the gas sector players identify and meet the challenges in terms of policy as well as strategic initiatives. The gas sector challenges are envisaged in the following areas :
- Gas pricing
 - Technology
 - Import substitution
 - Sector policy developments
 - Creation of infrastructure
 - Institutional support structure
- 12.2.2 Gas Pricing: While gas pricing was a major issue during the X Plan period, currently it is now fairly established that gas/LNG is a competitive alternative vis-à-vis other fuels. It is important that the price acceptance is established across sectors including power. End use sector reforms and competitiveness must go hand in hand with gas sector development.
- 12.2.3 Technology: Energy security being an important issue for the country, there is a need to step up efforts on the technology front so that viable alternatives are established. Promising technologies like gas from deep-sea, gas from coal, gas hydrates and gas storage in the upstream side, CNG by ships and on-board LNG re-gasification in the mid-stream side and Distributed Power/Combined Heat and Power (CHP) in the downstream side are some of the important and potential technologies that need to be pursued during the XI Plan period.

- 12.2.4 Gas Imports: Import dependence to bridge the gap in demand and supply is expected to continue in the XI plan. Transnational pipelines pose a number of geo-political challenges. There is also a need for an international charter to address legal/regulatory issues in such cross border transactions. In the case of LNG, while the experience of Indian market has been fairly good, integration with global pricing regime and management of risks (market/price/political) would be an important challenge for companies in all the cross-border options.
- 12.2.5 Sector Policy: A concrete sector policy needs to take shape during the first year of the XI plan. The Petroleum and Natural Gas Regulatory Board needs to address the gas pipeline policy and the city gas distribution policy which would provide the necessary thrust for triggering gas sector investments. At the same time, as the country expands the infrastructure across the country, there would be a need to develop both technical and safety standards – related to transmission and distribution pipelines/other related infrastructure. In addition, government policy to provide infrastructure status to gas sector projects and declared goods status for natural gas can give the necessary fillip to growth of the gas sector.
- 12.2.6 Creating Infrastructure: Gas sector poses unique challenges as every investment needs a parallel and complementary investment across the gas value chain. There is a need to create upfront infrastructure while at the same time ensuring co-ordinated development across the entire gas value chain. Financing and structuring of deals in such large investments is also a major requirement. At the same, developing the indigenous manufacturing base in turbines, CNG kits, compressors, gas based automobiles etc would have major bearing on the sector development.
- 12.2.7 Institutional support infrastructure: To support such a major growth in the sector, there would be a need to develop a strong training infrastructure to produce trained manpower.

12.3 Refining Sector

- 12.3.1 Competitive Market: In the oil sector currently there are mainly four companies in the marketing of products namely IOC, BPC, HPC and RIL besides players like Essar and Shell. The Herfindahl-Hirschman Index (HHI) for India with the existing companies is higher than the desired number of HHI. However, with the pricing becoming free the market share will align itself in some desired ratios, which is expected to bring HHI to a reasonable level. Most competitive markets have five strong players. Thus, the current structure of the oil sector could continue. In a suitable environment, the current structure will deliver a competitive market. This could be reviewed at the time of appraisal of the XI Plan.
- 12.3.2 In addition, the Government could do the following to achieve higher efficiency and service standards:

At the National Level

- i. Encourage exports from the country compelling refineries to compete globally, meet global standards and meet requisite quality specifications.
- ii. Create a domestic petroleum product market through a commodity exchange.
- iii. Amalgamate individual state markets in one nation-wide market with unified state taxes, remove state tax anomalies, provide level playing to domestic production vis-à-

vis direct imports (which can be imported without state taxes), and introduce a uniform VAT which provides full set off for local levies such as octroi and entry tax.

At the Corporate Level

- i. Benchmark operations with global best practices adopted by world's top refineries and make suitable improvements.
 - ii. Ensure inter-PSU competition, particularly at the retail level. It could be contended that this action would lead to duplication and wastage of resources. But then competition always does that, for instance, the airlines industry where infrastructure has been duplicated. Duplication of assets is a natural corollary to competition.
 - iii. Exponential expansion of e-commerce transactions, which promotes competition and enhances welfare by reducing transaction and search costs.
- 12.3.3 Demand of Petroleum Products: The demand of petroleum products have been estimated in two scenarios – Business as Usual or Base Case and Upper Case. In Base Case, the consumption in the terminal year of the XI Plan i.e. in 2011-12 is estimated at 132 MMT indicating a growth of 2.9 percent per annum. In the Upper case, the demand is estimated to grow by 4.45 percent to 142 MMT. It may be mentioned that since the oil prices are expected to remain at a high level in future, alternate sources of energy are likely to become increasingly economically viable. In our projections impact of such alternatives has not been considered and the actual materialization may be different from the one projected now.
- 12.3.4 The refineries need to maximize production of LPG, LOBS and bitumen to an extent, from the national standpoint. Further caution needs to be exercised while converting bottoms to lighter products as large deficits in industrial fuels is projected. The bottom upgradation plan needs to be realigned to local demand. Even globally, as noted elsewhere in the report, large deficit is predicted for FO and LSHS.
- 12.3.5 Refining capacity additions: The actual refining capacity additions would depend upon several factors including domestic demand, duty structure which would impact import and export possibilities, refining margin, and export potential for the products. However, in view of the likely surplus scenario, the companies depending upon the commercial viability of the project may review their projects and capacity additions. We could expect the refining capacity to turn out to be in the range of 190 MMT to 200 MMT leaving a scope of exports in the range of 45 MMT to 55 MMT.
- 12.3.6 Auto Fuel Policy: The Auto Fuel Policy identified the need for controlling emissions through improved I&M practices, vehicle retiring policies, better traffic management, stricter PUC, etc. However, till date limited progress has been made without having mandated any practice. There is an urgent need to introduce these policies.
- 12.3.7 R&D focus: To build a culture of R&D in our educational institutes we may encourage them to do basic research in the hydrocarbon sector on specified areas relating to their fields through Government grants. These grants could come from OIDB. Institutes like IITs and engineering colleges could take up research in their departments to further their knowledge base as well.
- 12.3.8 At the corporate level, R&D thrust should be driven by business level strategy i.e. in refining - technology to upgrade heavy petroleum residue to clean fuels, alternative

source of energy/technology which can replace fossil fuel, process/catalyst improvement etc. and in the upstream- improving extraction ratio, E&P evaluation etc.

12.4 **Marketing Sector**

12.4.1 Existing Policies to Continue: The oil sector has been deregulated since April 2002, with the dismantling of APM, and currently there are many players including private oil companies in the marketing of petrol/diesel. The major existing policies like grant of marketing rights for transportation fuels, setting up ROs in remote and far flung areas etc need to continue.

12.4.2 Steps to Control Adulteration: Adulteration is a menace, which needs to be tackled by all concerned through technological and other interventions. Various steps to curb adulteration have been initiated. These include introduction of tamper-proof locks, automation of retail outlets, monitoring the movement of tank-trucks through GPS, introduction of marker system for adulterants like kerosene, third party certification of retail outlets, etc.

12.5 **Others**

12.5.1 Setting up of Rajiv Gandhi Institute of Petroleum Technology (RGIPT): Investment in the development of qualified human capital is essential if the targets set forth in 'Hydrocarbon Vision 2025' are to be achieved. The gap between the availability and requirement of trained manpower is likely to be substantive unless concerted efforts are made to increase the number of quality institutions to impart the desired education/training. The existing institutes namely Indian School of Mining (ISM), Dhanbad, Maharashtra Institute of Technology (MIT) Pune, Indian Institute of Technology (IIT), Kharagpur, and Banaras Hindu University (BHU) etc. are unable to meet the burgeoning requirements of the petroleum sector.

12.5.2 The proposed RGIPT at Peeparpur in Sultanpur District of Uttar Pradesh, as an institute of excellence in the petroleum sector, will provide the manpower to meet the requirement in India and globally.

13 Annexure

13.1 Annexure I – Constitution of the Working Group

CONSTITUTION OF THE WORKING GROUP

No. M-13026/9/2006-Pet.

Government of India

Planning Commission

(Power & Energy Division)

Yojana Bhawan, Sansad Marg,

New Delhi, the 20th April, 2006.

ORDER

Subject: Constitution of a Working Group on Petroleum & Natural Gas Sector for formulation of the XI Plan (2007- 2012).

It has been decided to constitute a Working Group on Petroleum & Natural Gas in the context of preparation of XI Plan (2007-2012). The Composition and Terms of Reference of the Group will be as follows:

A. Composition:

Secretary, Ministry of Petroleum & Natural Gas – Chairman.

Members:

Representatives of the Ministries

1. Adviser (Energy), Planning Commission
2. Representative of Ministry of Surface Transport
3. Representative of Department of Economic Affairs, Ministry of Finance
4. Representative of the Department of Industrial Policy and Promotion
5. Representative of Ministry of Power
6. Representative of Department of Chemicals & Petro-Chemicals

7. Representative of Department of Fertilizers
8. Representative of Ministry of Environment & Forest
9. Representative of Department of Commerce
10. Joint Adviser (Petroleum), Planning Commission
11. Joint Secretary and Financial Adviser, Ministry of Petroleum & Natural Gas – Member-Secretary

PSUs

1. Chairman & Managing Director, Oil and Natural Gas Corporation Ltd.
2. Chairman & Managing Director, Oil India Ltd.
3. Chairman & Managing Director, Indian Oil Corporation Ltd.
4. Chairman & Managing Director, Bharat Petroleum Corporation Ltd.
5. Chairman & Managing Director, Hindustan Petroleum Corporation Ltd.
6. Chairman & Managing Director, Gas Authority of India Ltd.

Private Sector Representatives

1. Representative(s) of CII, FICCI, ASSOCHAM and TERI - one each
2. Representative of Reliance Industries Limited.

B. Terms of Reference

- I. The terms of reference of the Working Group will be as under:
 1. To review the IEP Report and to suggest measures to operationalise its recommendations during the XI Plan Period.
 2. To review the recommendations of Dr. C. Rangarajan's Committee on Pricing and Taxation of Petroleum Products and to suggest measures to make them operational during the XI Plan.
 3. To review the recommendations of Dr. V. Krishnamurthy's report on Restructuring of Petroleum Sector and to suggest measures to make them operational during the XI Plan.
 4. To review the likely achievement during the X Plan period in meeting the targets set for exploration, production of crude oil & natural gas, addition to refining capacity and investments. An analysis of the reasons for shortfalls, if any, may be highlighted.
 5. To recommend an industry structure that would enhance number of players, promote competition, provide a consistent and transparent pricing regime and raise conversion, transportation, & end use efficiency.
 6. To review the subsidy structure in the Petroleum & Natural Gas Sector and to suggest measures to make them transparent and targeted.

7. To estimate demands, year-wise, of crude oil, natural gas and petroleum products for the period from 2007-08 to 2011-12 and from 2012-13 to 2016-17 and also for 2021-22, taking into account the likely developments in the related sectors.
 8. To suggest a programme for appraisal of the Indian Sedimentary basins to the extent of 60 percent by 2011-12 and 85 percent by 2016-17 in order to have coverage of 100 percent by 2025 to be in line with India Hydrocarbon Vision-2025.
 9. To suggest target for reserve accretion for XI Plan period with a view to increasing the R/P ratio.
 10. To estimate year-wise targets of production for the period from 2007-08 to 2011-12 and 2016-17 for crude oil, natural gas and petroleum products.
 11. To estimate gaps between demand and supply of crude oil, natural gas and petroleum products for the said periods and to suggest measures to bridge these gaps.
 12. To estimate the import requirements of crude oil, natural gas/LNG, petroleum products for the said period and the feasibility and sustainability of imports thereof.
 13. To evolve policy measures for Demand Side Management and Conservation of Petroleum Products.
 14. To review the approved/under implementation refining capacity additions/ expansions and to suggest the refining capacity at the end of XI & Twelfth Plans.
 15. To review the existing policy of Marketing and Distribution of Petroleum Products and Natural Gas and to suggest policy measures to accelerate competition.
 16. To review the Bio-fuels programme and to suggest measures for their development.
 17. To suggest measures for assuring oil security for the country.
 18. To review the Auto Fuel Policy and to suggest measures for achieving the prescribed environmental norms.
 19. To review the status of Gas Hydrates, CBM, Underground Coal Gasification & Hydrogen Energy and to suggest measures for their development.
 20. To review and suggest R & D programme for the Petroleum & Natural Gas Sector for the XI Plan.
 21. To assess the investment requirements for the XI Plan in the Petroleum & Natural Gas Sector.
 22. To assess the infra-structural support, viz. raw materials, transportation including port facilities, construction facilities etc. in the light of possible production capacities in other public/private sectors that would be required for implementation of the development plans.
- II. In order to assist the Working Group in its task, separate Sub-Groups on specific aspects may be formed by the Working Group. These sub-Groups will furnish their reports to the Working Group.
- III. The Chairman of the Working Group may-co-opt other Experts as may be considered necessary.

- IV. The Working Group will submit its report to the Planning Commission latest by the 30th September, 2006.
- V. Non-official members of the Working Group shall be entitled to payment of TA/DA from Planning Commission as per SR 190 (a). Official members will be paid TA/DA by their respective Departments/Organizations as per the rules of entitlement applicable to them.
- VI. The name(s) of representative(s) of various organizations as per the above composition may be communicated to the Member-Secretary of the Working Group under intimation to Shri Surya P. Sethi, Adviser (Energy), Planning Commission.
- VII. Shri R.C. Mahajan, Joint Adviser (Petroleum), Planning Commission, Room No. 218, Yojana Bhavan, Tel No. 23096743, will be the Nodal Officer for this Working Group in the Planning Commission and further query/correspondence in this regard may be made with him.

(K.K.Chhabra)

Under Secretary to the Government of India

To

Chairman & Members (including Member-Secretary) of the Working Group.

Copy for information to:

1. P.S. to Deputy Chairman/MOS (Plg.)/Members/Member-Secretary, Planning Commission.
2. All Principal Advisers/ Advisers/JS (SP & Adm.)
3. Prime Ministers' Office, South Block, New Delhi
4. Information Officer, Planning Commission
5. For general information in Yojana Bhawan through e-mail

(K.K.Chhabra)

Under Secretary to the Government of India

13.2 Annexure II (a) – Constitution of Working Sub Groups

CONSTITUTION OF WORKING SUB GROUPS

It was decided to form following Working Sub-Groups:-

1. Working Sub Group on Demand:
 - Members
 - a. Mr. V P Joy - Director
 - b. Mr. Vijay Sethi - Convenor
 - c. Others – Members from all OMCs, private sector, Ministry of Surface Transport, Ministry of Railway, GAIL and Petronet LNG
 - TORs
 - a. Item 6, 7, 8, 9 and relevant portion of 13.

2. Working Sub Group on Production:
 - Members
 - a. Mr. Ravi Capoor - Director
 - b. Mr. A R Tamankar - Convenor
 - c. Others – Members from all refineries including stand alone refineries and those of private sector,
 - TORs
 - a. Item 6, 7, 8, 9 and relevant portion of 13.

3. Working Sub Group on R&D:
 - Members
 - a. Dr. K.S. Balaraman - Executive Director(CHT)
 - b. Mr. R K Malhotra - Convenor
 - c. Others – R&D Groups of Refineries/OMCs and Rep. of EIL
 - TORs
 - a. Item 11, 12 and relevant portion of 13.

4. Working Sub Group on Project Implementation:
 - Members
 - a. Director (Projects) - EIL
 - b. Head of MMC (EIL) - Convenor
 - c. Others – Members from all OMCs/Refineries as desired
 - TORs
 - a. Item 4 and 10.

5. Working Sub Group on Restructuring Petroleum Sector:
 - Members
 - a. Mr. Ravi Capoor - Director
 - b. Inputs from Petrofed, FICCI, and CII.

 - TORs
 - a. Item 3.

6. Working Sub Group on Pricing:
 - Members

- a. Mr. V P Joy - Director
 - b. Mr. Ram Singh - Convenor
 - c. Representative from Deptt. of Economic Affairs.
- TORs
- a. Item 2 and 5
7. Working Sub Group on Energy Policy:
- Members
 - a. Mr. A K Arora, DG(Petrofed) - Convenor
 - b. Representative from FICCI
 - c. Representative from CII
 - TORs
 - a. Item 1

The Terms of Reference of the Working Sub Groups are as under :

Terms Of Reference of Sub Group On Refining

1. To review the IEP Report and to suggest measures to operationalise its recommendations during the XI Plan Period.
2. To review the recommendations of Dr. C. Rangarajan's Committee on Pricing and Taxation of Petroleum Products and to suggest measures to make them operational during the XI Plan.
3. To review the recommendations of Dr. V. Krishnamurty's report on Restructuring of Petroleum Sector and to suggest measures to make them operational during the XI Plan.
4. To review the likely achievement during the X Plan period in meeting the targets set for refining capacity and investments. Any analysis of the reasons for shortfalls, if any, may be highlighted.
5. To review the subsidy structure in the Petroleum and Natural Gas Sector and to suggest measures to make them transparent and targeted.
6. To estimate demands, year-wise, of crude oil and petroleum products for the period from 2007-08 to 2011-12 and 2012-13 to 2016-17 and also for 2021-22, taking into account the likely developments in the related sectors.
7. To estimate year-wise targets of production for the period from 2007-08 to 2011-12 and 2016-17 for crude oil and petroleum products.
8. To estimate gaps between demand and supply of crude oil and petroleum products for the said periods and to suggest measures to bridge these gaps.

9. To estimate the import requirements of crude oil and petroleum products for the said period and the feasibility and sustainability of imports thereof.
10. To review the approved/under implementation refining capacity additions/expansions and to suggest the refining capacity at the end of XI & Twelfth Plans.
11. To review the Auto Fuel Policy and to suggest measures for achieving the prescribed environmental norms.
12. To review and suggest R&D programme for the Petroleum and Natural Gas Sector for the XI Plan.
13. To assess the investment requirements for the XI Plan in the Petroleum Sector.

13.3 **Annexure II (b) –Sub Group on E&P**

Subject : **Sub-Group on Exploration & Production of Hydrocarbons to assist Working Group on Petroleum & Natural Gas for XI Plan**

It has been decided to constitute a Sub-Group on 'Exploration & Production of Hydrocarbons' to assist Working Group on Petroleum & Natural Gas in the context of preparation of the XI Five Year Plan with the composition as indicated below:

Convener - JS (Exploration)

Members

A Representatives from Ministries:

Ministry of Petroleum & Natural Gas

- i) DG, DGH
- ii) Director (E I)
- iii) Director (E II) - Member Secretary

b) Ministry of Finance - One

c) Ministry of Environment & Forest - One

d) Ministry of Industry - One

e) Planning Commission - One

f) Ministry of Coal - One

(for Coal Bed Methane)

B Representative of PPAC & OISD - One each

C Public Sector Undertaking (PSUs)

- a) ONGC, Director (Exploration)/Director (Operations)/ Director (Finance)
- b) OIL – Director (Exploration & Dev.)/ Director (Operations)
- c) GAIL – Director (Project)/ Director (Planning)
- d) OVL – Managing Director
- e) EIL – One Representative
- f) GSPC – One representative

D Private Sector and Others

- a) Representative of CII
- b) Representative of Reliance Industries Limited
- c) Representative of Cairn Energy India Pty Ltd.
- d) Representative of British Gas

13.4 **Annexure II (c) –Sub Group on NG and Marketing**

Subject: Sub-Group on Natural gas and Marketing to assist Working Group on Petroleum & Natural Gas for XI Plan

1. Working Sub Group on Marketing and Distribution of Natural Gas:
 - Members
 - a. Mr. Ajay Tyagi - Joint Secretary(M)
 - b. Mr. Swami Singh - Director(NG) - Convenor
 - c. Others – Members from Department of Expenditure, Department of Economic Affairs, Department of Road Transport and Highways, Department of Commerce, Department of Chemicals & Petrochemicals, Department of Fertilizers, GAIL, ONGC, OIL, TERI, Gas Industry Group and Petrofed

2. Working Sub Group on Marketing & Distribution of Petroleum Products:
 - Members
 - a. Mr. Ajay Tyagi - Joint Secretary(M)
 - b. Mr. Pramod Nangia - Director(M)
 - c. Mr. K. Rajeswara Rao - Addl. Director(M), PPAC - Convenor
 - d. Others – Members from all OMCs, private sector, Department of Expenditure, Department of Economic Affairs, Department of Road Transport and Highways, Department of Commerce, Department of Chemicals & Petrochemicals, Department of Fertilizers, PCRA, RIL, ASSOCHAM, FICCI, CII and Petrofed

Terms Of Reference of Sub Group On Marketing & Distribution of Natural Gas:

1. To review likely achievement during the X Plan period in meeting the targets set for production of Natural Gas. An analysis of the reasons for shortfall, if any, may be highlighted.
2. To review pricing structure of Natural Gas and to suggest measures to make them more transparent and market determined.
3. To estimate demands, year-wise, of Natural Gas for the period from 2007-08 to 2011-12 and from 2012-13 to 2016-17 and also for 2021-22, taking into account the likely developments in the related sectors.
4. To estimate year-wise targets of production for the period from 2007-08 to 2011-12 and 2016-17 for Natural Gas.
5. To estimate gaps between demand and supply of Natural Gas for the said periods and to suggest measures to bridge these gaps.
6. To estimate the import requirements of Natural Gas/LNG for the said period and the feasibility and sustainability of imports thereof.
7. To review the existing policy of Marketing and Distribution of Natural Gas and to suggest policy measures to accelerate competition.
8. To assess the investment requirements for the XI Plan in the down-stream Natural Gas Sector.

Terms of Reference of Sub Group on Marketing & Distribution of Natural Gas:

1. To evolve policy measures for Demand Side Management and Conservation of Petroleum Products.
2. To review the existing policy of Marketing and Distribution of Petroleum Products and to suggest policy measures to accelerate competition.

To review the Bio-fuels programme and to suggest measures for their development.

13.5 **Annexure III - Energy Policy in Asian Economies**

ENERGY POLICY IN ASIAN ECONOMIES

We have examined experiences in Japan, a developed country with virtually no energy resource and China, now the second largest energy consumer and a developing country with some similarities with India.

A comparison of available resources with Japan and China is as follows:

Energy Resources available with Japan & China and their Consumption in 2004¹⁰

Particulars	Japan		China	
	Reserves	R/P Ratio	Reserves	R/P Ratio
Oil in Billion Tons	Nil	Nil	2.3	13.4 yrs
Gas in TCM	Nil	Nil	2.23	54.7 yrs
Coal in Billion Tons	0.36	*	114.50	59 yrs
Oil Consumption in MMT	242		309	
Gas Consumption in BCM	72		39	
Coal Consumption in MTOE	121		957	

* As negligible production, RP ratio is in excess of 500 years

Japan

Japan's energy policy objectives are summarised as the "3 Es":

- Energy security,
- Economic development and
- Environmental sustainability.

Japan's objective is to achieve the three goals simultaneously, although they often contradict one another and the government recognizes the possibility of trade-offs between them. Details of Japan's efforts are at the Attachment.

The changes in energy mix may be seen in the table below:

¹⁰ Source: BP Statistical Review of World Energy, 2005

Particulars	1980		2002		Growth Percent
	MTOE	Percent	MTOE	Percent	
Coal	59.6	17.2	100.0	19.3	2.4
Oil	235.7	68.0	255.5	49.4	0.4
NG	21.4	6.2	66.4	12.8	5.3
Nuclear	21.5	6.2	76.9	14.9	6.0
Others	8.4	2.4	18.1	3.5	3.6
Total	346.5	100	516.9	100	1.8

Through conscious policy, Japan has been able to reduce energy consumption through conservation, reduce oil consumption through diversification, increase use of natural gas over coal (Japan is deficit in both resources) due to favourable impact on environment, increase nuclear energy and maximize renewable resources. As a result of their efforts energy mix of Japan has changed. Oil has been diversified into nuclear, natural gas and coal.

China¹¹

China has recently finalized its XI Five-year plan. The central tenants relating to energy policy are:

- Place priority on energy conservation: targeted decrease in energy consumption by 20 percent by 2010
- Primary reliance on Coal: pursue logical and reasoned development, improve recovery and extraction rates, reduce impact on environment, promote reorganization of the coal industry, create some coal companies with production capacity of 100 MT/year, standardize technologies for high efficient and clean burning of coal, develop coal to liquid technologies, promote use of clean coal and use low grade coal for electricity generation.
- Diversification of energy sources
 - Electricity – Aggressive development: Develop high efficiency and environment friendly large scale thermal power plants, promote clean coal based electricity generation, moderately develop natural gas based plants and aggressively promote nuclear power generation through construction of 1 million KW class reactors
 - Oil and Natural Gas – Accelerated development: Intensively exploit off shore areas, major oil & gas basins and new onshore areas, promote exploration of coal bed methane, oil shale, oil sands, methane hydrates and other non conventional types of oil/gas, create large integrated bases for refining particularly in areas of high consumption, less efficient refineries would be closed

¹¹ Source: China's "XI Five-Year Guidelines" with Focus on Energy Policy, Yue Zhang, IEEJ, April 2006

- Renewable energy – Develop greatly: Promote renewable energy production/consumption through favourable fiscal policies, tax structures, investment policies and a compulsory market share for renewable energy, greatly enhance wind power generation by the construction of thirdly 100,000 kW class wind farms, increase the production of biomass energy, bio-ethanol and bio-diesel and promote the use in the production of solar energy, geothermal energy and ocean power generation.

Thus, it (may be seen that) both the countries have devised a long-term plan keeping in mind the available resources with the country. Besides, wherever resources are deficit, efforts are being made to reduce dependence on them. China, due its similarities with India, offers better inputs for developing our energy policy and their specific targets can also help in setting direction for our country. It is interesting to note that it is placing reliance on coal as primary source of energy while at the same time encouraging efficiency, and energy conservation.

Japan: Policy Initiatives¹²

Japan is the fourth largest energy consumer in the world. In 2001, total primary energy supply (TPES) was 520.7 Mtoe, up by 19 percent from 1990 levels. Japan's dependence on oil has decreased from 58 percent in 1990 to 49.2 percent in 2001. In 2000, coal accounted for 19.2 percent, followed by nuclear (16 percent), natural gas (12.4 percent), hydro (1.4 percent), combustible renewable and wastes (1 percent), geothermal energy (0.6 percent) and other renewable (0.2 percent). Oil use was replaced mainly by natural gas whose share increased from 9.9 percent, nuclear power from 12.1 percent and coal from 16.9 percent.

Every 3-4 years, the government publishes the Long-Term Energy Supply and Demand Outlook, the first having been published in 1967 and the latest (10th Outlook) in July 2001. The Outlook shows the forecast impact of energy policies and measures in place, the difference between their impact and the various objectives as well as how to tackle the difference. The Outlooks are prepared by the Advisory Committee for Natural Resources and Energy whose role is to advise the Ministry of Economy, Trade and Industry

Japan's principal challenge in the energy sector is supply vulnerability because it is an archipelago and lacks domestic energy resources. Several measures to ensure energy security have, therefore, been strongly promoted since the first and second oil crisis, and at present include the following key policies:

- **Energy efficiency:** Implemented by a Law Concerning the Rational Use of Energy (energy conservation standards and the so-called Top-Runner Programme); financial support to energy efficiency (promoting Home and Business Energy Management Systems, tax incentives for the introduction of energy-efficient equipment, etc.); and information dissemination.
- **Diversification of energy supply sources:** Implemented by further diversification away from oil; fuel-switching in the power sector (from coal to natural gas); further use of natural gas, nuclear power and renewable (renewable portfolio standard); and energy R&D.
- **Development of resources:** Through development of methane hydrates. Originally Japan hoped to increase "Japanese-flag crude oil" to such a level that it accounts for approximately 30 percent of Japan's total crude oil imports. JNOC¹³ was set up nearly 40 years ago to find and secure gas and oil supplies for resource-poor Japan, only to bleed 720 billion yen (\$6.9 billion) of red ink in mostly dry wells in 305 projects across the globe¹⁴. Under these conditions, Japan decided in August 2000 to withdraw the long-term target of increasing the Japanese-developed crude oil to account for 30 percent of Japan's total crude oil imports and worked out a new policy measure aimed at establishing a core oil development company or companies that can maintain and expand its business on its own to assure stable and efficient oil supply.

¹² Source: *Energy Policies of IEA Countries, JAPAN, 2003 Review*

¹³ The government provided financial assistance through the government-owned Japan National Oil Corp. (JNOC) to private oil & gas exploration and development projects overseas in the form of equity capital investment, loans and guaranteeing debts.

¹⁴ *Daily times, March 20, 2005: Japan National Oil Corp to be disbanded.*

- **Oil stockpiling and emergency policies:** Implemented by Petroleum Stockpiling Law; Petroleum Supply and Demand Optimisation Law and IEA's Co-ordinated Emergency Response Measure.
- **International co-operation for enhancing energy security:** Implemented by enhancing energy security through IEA, APEC, ASEAN+3 and bilateral contacts, in particular with Asian energy-consuming countries; and promotion of cooperation with oil and gas-producing countries.

13.6 **Annexure IV - Herfindahl-Hirschman Index (HHI)**

HERFINDAHL-HIRSCHMAN INDEX (HHI)

A competitive market is one with a sufficiently large number of firms competing with one another that prices are kept at levels that reflect social costs. Since market power usually leads to high prices and/or low quality, and often stifles future innovations, it hurts consumers and should be restricted. There are numerous ways to obtain market power. If there are only a few firms in a market, so concentration is high, then each firm will have some market power to charge a high price. When the market is highly concentrated, it is also easier for firms to coordinate their pricing behaviour so a high level of prices can be maintained. Market power may also exist even with many small firms in the market, when there is a dominant firm. A common way of obtaining more market power is through mergers and acquisitions.

In merger analysis, the next step would be to calculate market shares of the parties involved and the concentration level of the market. When measuring concentration, the Herfindahl-Hirschman Index (HHI) is often used by the US antitrust agencies. The HHI is the sum of the squared market shares of all the participants. For example, if there are three firms in the market, with market shares 50 percent, 30 percent, and 20 percent, respectively, then the HHI is: $50^2+30^2+20^2=3,800$. As a result, a monopoly market has an HHI equal to 10,000. A competitive market has an HHI that is low. Unlike other indexes (for example, the four-firm concentration ratio), the HHI assigns greater weights to the market shares of the larger firms, in accord with their relative importance in the market.

A market is characterized as unconcentrated (HHI below 1,000), moderately concentrated (HHI between 1,000 and 1,800), and highly concentrated (HHI above 1,800). To get a sense of these thresholds, an HHI of 1,000 corresponds to ten firms of equal size, and an HHI of 1,800 corresponds to five and half firms of equal size. Although the exact numerical cut-off does not have precise justifications, it provides a broad framework for further analysis. In practice, the US antitrust authorities change in the HHI from the pre-merger level is very dramatic and there is other evidence that suggests that a post-merger price increase is likely. Such analysis linking market concentration to market power is often called structural analysis. Antitrust analysis has evolved over time with the development of economic theories and empirical methods.

13.7 Annexure V - Year Wise, Product Wise Comparison of Actual & X Plan Projections

Year wise Comparison of X Plan Demand															
												(Figs. In TMT)			
PRODUCT	02-03			03-04			04-05			05-06			2006-07		
	X Plan	Actual	Var (+/-)	X Plan	Actual	Var (+/-)	X Plan	Actual	Var (+/-)	X Plan	Actual	Var (+/-)	X Plan	OE	Var (+/-)
LPG	8776	8351	-425.1	9528	9305	-223	10310	10245	-65	11,123	10304	-819	11,966	10494	-819
NAPHTHA	10823	11962	1138.8	10723	11868	1145	8668	13993	5325	9,128	12262	3134	9,128	8983	3134
MS	7620	7570	-50.1	8202	7897	-305	8813	8251	-563	9,419	8648	-771	10,067	11333	-771
ATF	2370	2271	-99.1	2445	2484	39	2523	2813	290	2,605	3298	693	2,691	3630	693
SKO	11000	10404	-595.8	11000	10230	-770	11000	9395	-1605	11,000	9359	-1641	11,000	9414	-1641
HSD	42146	36645	-5501.3	44508	37074	-7434	46966	39650	-7316	49,555	40152	-9403	52,324	40583	-9403
LDO	1500	2064	563.6	1500	1619	119	1500	1477	-23	1,500	885	-615	1,500	905	-615
FO/LSHS	13184	12738	-445.9	13520	12945	-575	13876	13540	-336	14,253	12733	-1520	14,653	2421	-1520
BITUME	2808	2986	178.4	2892	3373	481	2979	3340	361	3,069	3515	446	3,161	13454	446
LUBES	1202	1250	48.1	1245	1427	182	1283	1336	53	1,342	2104	762	1,386	3592	762
OTHERS	5668	7885	2217.0	5668	9529	3861	5668	7596	1928	5,668	8658	2990	5,668	9225	2990
TOTAL	107097	104126	-2971.4	111231	107751	-3480	113586	111634	-1952	118662	111920	-6742	123544	114034	-6742

13.8 Annexure VI - Demand Projections by Various Agencies

Demand Scenario for Petroleum Products - India
(By Various Agencies/Organisations)

Year	Projections by the Various Agencies/Organisations						
	EIA (2004)			IEA (2004)	IHV-2025 (2000)	India Vision-2020 (2002)	
	Reference Case	High Case	Low Case			BAU	BCS
Base Year	2001 (105 Mt)	2001 (105 Mt)	2001 (105 Mt)	2000 (102 Mt)	1998-99 (91 Mt)	1997 (83 Mt)	
2004-05	119	122	115	122	132	121	112
2009-10	139	149	129	145	175	153	135
2014-15	157	194	154	171	226	193	162
2019-20	219	254	189	201	288	245	195
2024-25	264	324	204	230	368	309	235
2029-30				271			

EIA – Energy Information Administration, USA

BAU – Business as Usual

IEA – International Energy Agency

BCS – Best Case Scenario

IHV – India Hydrocarbon Vision 2025

As the available projections by the various agencies are for different years, the same have been interpolated or extrapolated to bring them to common years and have been converted into MMscmd for the purpose of comparison.

13.9 **Annexure VII - Demand For Petroleum Products During The XI Plan & Beyond**
DEMAND FOR PETROLEUM PRODUCTS DURING THE XI PLAN & BEYOND

Year-wise/product-wise demand Projections for XI Plan; both under Base Case and Upper Case are as under:

Summary of XI Plan Demand Projections							
Base Case	TMT						
PRODUCTS	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	XI Plan
	(OE)						CARG
LPG	10494	10853	11246	11683	12183	12770	4.0
MS	8983	9377	9828	10242	10667	11097	4.3
NAPHTHA/NGL	11333	10425	9517	10441	11138	11588	0.4
ATF	3630	4335	4774	5187	5569	5907	10.2
SKO	9414	8830	8510	8222	7962	7729	-3.9
HSD	40583	42210	43797	45328	46871	48419	3.6
LDO	905	951	951	849	786	569	-8.9
LUBES	2421	2453	2487	2521	2556	2592	1.4
FO/LSHS	13454	13601	13959	12806	13327	13874	0.6
BITUMEN	3592	3772	3961	4159	4367	4585	5.0
PET. COKE	4736	4736	4736	4736	5210	5731	3.9
OTHERS	4489	4893	5333	5813	6337	6907	9.0
TOTAL	114034	116437	119098	121987	126973	131767	2.93
Upper Case							
PRODUCTS	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	XI Plan
	(OE)						CARG
LPG	10494	10853	11246	11683	12183	12770	4.0

MS	8983	9330	9775	10442	11197	11605	5.3
NAPHTHA/NGL	11333	10077	9517	10441	11138	11588	0.4
ATF	3630	4356	5227	6011	6612	7274	14.9
SKO	9414	9414	9414	9414	9414	9414	0.0
HSD	40583	42374	43818	45751	47952	49776	4.2
LDO	905	951	951	849	786	569	-8.9
LUBES	2421	2453	2487	2521	2556	2592	1.4
FO/LSHS	13454	13754	14250	13611	14277	14982	2.2
BITUMEN	3592	3808	4036	4279	4535	4808	6.0
PET. COKE	4736	4736	4736	4736	7210	7411	9.4
OTHERS	4489	5449	6494	8052	8734	9006	14.9
TOTAL	114034	117555	121951	127789	136593	141793	4.45

13.10 **Annexure VIII - Potential for Reducing Oil Demand Through Vehicle Fuel Economy Improvement**

POTENTIAL FOR REDUCING OIL DEMAND THROUGH VEHICLE FUEL ECONOMY IMPROVEMENT¹⁵

Cars, trucks and other transport vehicles account for about 75 percent of road transportation fuel use (petrol and diesel) and about 1/3rd of total consumption of petroleum products in the India.

Unlike the low prospects for increasing domestic oil production, there are very good prospects for reducing oil demand and cutting future oil imports by raising the efficiency of our vehicles. A wide range of technologies are technically proven and readily available, including engine modifications such as variable valve control or friction reduction, weight reduction, better engine and transmission controls, aerodynamic drag reduction, and tire improvements. Many of these technologies are already used to some degree in other countries but only in a relatively small fraction of new vehicles. Widespread adoption of these commercially available measures could improve the average fuel economy of new vehicles by 40–65 percent within a decade.

Technologies for Passenger Vehicle Fuel Economy Improvement

Technology Fuel Economy	(Percentage)* Improvement
Weight reduction	10–30
Aerodynamics	4–10
Variable valve control	12–16
Direct injection spark ignition	5–23
Other engine refinements	5–10
Improved transmissions	6–14
Hybrid powertrain—near and mid-term	40–80
Hybrid powertrain—longer term	100–200

*Improvements relative to US average mid-1990s passenger vehicle at 25 MPG.

In addition these evolutionary improvements, vehicle manufacturers around the world are developing and starting to manufacture innovative hybrid electric vehicles. These vehicles feature a relatively small internal combustion engine along with an electric drivetrain including an electric motor and battery for storing electrical energy. The hybrid electric vehicles produced so far exhibit 50–85 percent greater fuel efficiency compared to typical new cars in their size class, although not all of this improvement is due to the hybrid drivetrain. Improving fuel economy does add to the first cost of a vehicle. But the value of the fuel savings usually more than offsets this first cost premium.

¹⁵ Adapted from STRATEGIES FOR REDUCING OIL IMPORTS: EXPANDING OIL PRODUCTION VS. INCREASING VEHICLE EFFICIENCY, Howard Geller, April 2001, American Council for an Energy-Efficient Economy

Policies for Improving the Efficiency of New Vehicles

A combination of policies including: tougher regulations; financial incentives; continued R&D; and consumer education and marketing should be adopted to ensure that vehicles sold during the next few decades are “gas sippers” rather than “gas guzzlers.”

Tough Fuel Economy Standards

Tougher average fuel economy standards are essential for significantly increasing new vehicle efficiency across the fleet.

Current fuel economy standards should be averaged for each category and set. Thereafter they may be increased by 8 percent per year during the XI Plan and 5 percent beyond the end of XI Plan. The average fuel economy of all new cars, commercial vehicles and two wheelers would increase by about 45 percent by 2012. Vehicle manufacturers will protest and say “it can’t be done” or “it will cost a fortune,” but would comply as experience in the US indicates when the original US CAFE standards were debated. But the car manufacturers complied with the original standards at reasonable cost and with high consumer acceptance.

Financial Incentives

Tougher fuel standards should be complemented by financial incentives that facilitate compliance. Financial incentives should provide both positive and negative signals—helping to build consumer demand for high-efficiency vehicles while penalizing those who purchase inefficient vehicles.

Relatively inefficient cars—those with a composite fuel economy rating below the Average may be subject to a “gas guzzler tax.” The tax, for instance, could be an additional 8 percent excise duty for vehicles at efficiency of above 90 percent of the average and increases to a maximum of additional 24 percent excise as fuel economy drops. Similar principle may also be applied to other vehicles including commercial vehicles and two wheelers, category wise. The additional revenue could be used to pay for incentives offered to buyers of high-efficiency vehicles.

High first cost is a major obstacle to the widespread production and sale of hybrid and fuel cell vehicles. Tax incentives could be offered in order to stimulate mass production and support initial sales of these innovative vehicles. The amount of the tax incentive (or most of the incentive) should be based on the fuel economy achieved. Also, vehicles should have relatively low pollutant emissions as well as high fuel efficiency in order to be eligible for a tax incentive.

Labeling and Promotion

Complementing stronger standards and financial incentives, the government could introduce energy labelling to high fuel efficiency and low-emitting vehicles. This would make it easier for consumers to identify “greener vehicles,” and for manufacturers or others to promote “buying green.” Energy labelling may be based on a combination of fuel economy and tailpipe emissions, recognizing the best vehicles in each category but also giving all vehicles an absolute score so that buyers could compare vehicles across categories.

Research and Development

Given the importance of dramatically improving new vehicle fuel economy in the coming decades, R&D on highly efficient vehicles and technologies such as fuel cells, hybrid-electric drivetrains, and lightweight materials should be expanded.

Potential Fuel Savings and Other Benefits

Tougher fuel economy standards and other complementary policies would provide a wide range of benefits in addition to lowering our oil import dependence. Consumers could save while carbon dioxide emissions would drop. Further, improving vehicle efficiency would reduce emissions of hydrocarbons and other air pollutants, making it easier for urban areas to meet ambient air quality standards.

Conclusion

Growing oil imports pose a serious threat to our national security and economic well-being. Imports now account for over 75 percent of our oil use and are expected to exceed 90 percent by 2030. High and growing oil import dependence adds to our trade deficit, leaves the Indian economy vulnerable to oil price spikes, and increases our oil dependence.

13.11 **Annexure IX – Demand Projections By Various Agencies for Natural Gas**

**Demand Scenario for Natural Gas - India
(By Various Agencies/Organisations)**

Year	Projections by the Various Agencies						
	EIA (2004)			IEA (2004)	IHV-2025 (2000)	India Vision-2020 (2002)	
	Reference Case	High Case	Low Case			BAU	BCS
	Base Year	2001 (62 MMscmd)	2001 (62 MMscmd)	2001 (62 MMscmd)	2000 (67 MMscmd)		
2004-05	74	77	74	91	195	89	87
2009-10	93	101	93	140	277	115	111
2014-15	124	132	109	189	329	149	142
2019-20	155	171	132	228	358	194	177
2024-25	195	225	155	259	391	258	226
2029-30				295			

EIA – Energy Information Administration, USA

BAU – Business as Usual

IEA – International Energy Agency

BCS – Best Case Scenario

IHV – India Hydrocarbon Vision 2025

As the available projections by the various agencies are for different years, the same have been interpolated or extrapolated to bring them to common years and have been converted into MMscmd for the purpose of comparison.

13.12 **Annexure X - Refining Capacity at Beginning Of XI Plan****REFINING CAPACITY AT BEGINNING OF XI PLAN**

SI. No.	REFINERY	MMTPA
	PUBLIC SECTOR	
1	Indian Oil Corporation Limited, Digboi	0.650
2	Indian Oil Corporation Limited, Guwahati	1.000
3	Indian Oil Corporation Limited, Koyali	13.700
4	Indian Oil Corporation Limited, Barauni	6.000
5	Indian Oil Corporation Limited, Haldia	6.000
6	Indian Oil Corporation Limited, Mathura	8.000
7	Indian Oil Corporation Limited, Panipat	12.000
8	Hindustan Petroleum Corporation Limited, Mumbai	5.500
9	Hindustan Petroleum Corporation Limited, Visakh	7.500
10	Bharat Petroleum Corporation Limited, Mumbai	12.000
11	Kochi Refineries Limited, Kochi	7.500
12	Chennai Petroleum Corporation Limited, Chennai	9.500
13	Chennai Petroleum Corporation Limited, Nagapatinam	1.000
14	Bongaigaon Refinery & Petrochemicals Limited, Bongaigaon	2.350
15	Numaligarh Refinery Limited, Numaligarh	3.000
16	Oil & Natural Gas Corporation Limited, Tatipaka	0.078
17	Mangalore Refinery & Petrochemicals Limited, Mangalore	9.690
	TOTAL PUBLIC SECTOR	105.468
	PRIVATE SECTOR	
18	Reliance Petroleum Limited, Jamnagar	33.000
19	Essar Oil Limited, Jamnagar	10.500
	TOTAL PRIVATE SECTOR	43.500
	GRAND TOTAL	148.968

CAPACITY ADDITION IN XI PLAN

S.NO.	REFINERY	MMTPA
	PUBLIC SECTOR	
1	Indian Oil Corporation Limited, Haldia	1.50
2	Indian Oil Corporation Limited, Panipat	3.00
3	Indian Oil Corporation Limited, Paradip	15.00
4	Hindustan Petroleum Corporation Limited, Mumbai	2.40
5	Hindustan Petroleum Corporation Limited, Visakh	7.50
6	Hindustan Petroleum Corporation Limited, Bhatinda	9.00
7	Bharat Petroleum Corporation Limited, Bina	6.00
8	Chennai Petroleum Corporation Limited, Chennai	1.70
9	Kochi Refineries Limited, Kochi	2.00
10	Mangalore Refinery & Petrochemicals Limited, Mangalore	5.31
11	Oil & Natural Gas Corporation Ltd. Tatipaka	0.08
	TOTAL PUBLIC SECTOR	53.49
	PRIVATE SECTOR	
12	Reliance Petroleum Limited, Jamnagar (New)	29.00
13	Essar Oil Limited, Jamnagar	3.50
	Nagarjuna Oil Corporation Limited	6.00
	TOTAL PRIVATE SECTOR	38.50
	GRAND TOTAL	91.99

CAPACITY ADDITION IN 12TH PLAN

S.NO.	REFINERY	MMTPA
	PUBLIC SECTOR	
1	Indian Oil Corporation Limited, Koyali	4.30
2	Indian Oil Corporation Limited, Mathura	3.00
3	Indian Oil Corporation Limited, Panipat	6.00
4	Mangalore Refinery & Petrochemicals Limited, Mangalore	15.00
5	Mangalore Refinery & Petrochemicals Limited, Kakinada	7.50
6	Mangalore Refinery & Petrochemicals Limited, Rajasthan	7.50
7	Essar Oil Limited, Jamnagar	18.00
	TOTAL	61.30

YEAR WISE CAPACITY ADDITION IN XI PLAN

YEAR	REFINERY	MMTPA
2007-08	Indian Oil Corporation Limited, Panipat	3.00
	Hindustan Petroleum Corporation Limited, Mumbai	2.40
	Hindustan Petroleum Corporation Limited, Visakh	0.83
	Essar Oil Limited, Jamnagar	3.50
	Sub Total	9.73
2008-09	Chennai Petroleum Corporation Limited, Chennai	1.00
	Reliance Petroleum Limited, Jamnagar (New)	29.00
	Nagarjuna Oil Corporation Limited	6.00
	Sub Total	36.00
2009-10	Indian Oil Corporation Limited, Haldia	1.50
	Bharat Petroleum Corporation Limited, Bina	6.00
	Chennai Petroleum Corporation Limited, Chennai	0.70
	Kochi Refineries Limited, Kochi	2.00
	Mangalore Refinery & Petrochemicals Limited, Mangalore	5.31
	Sub Total	15.51
2010-11	Hindustan Petroleum Corporation Limited, Visakh	6.67
	Hindustan Petroleum Corporation Limited, Bhatinda	9.00
	Sub Total	15.67
2011-12	Indian Oil Corporation Limited, Paradip	15.00
	Oil & Natural Gas Corporation Ltd. Tatipaka	0.08
	Sub Total	15.08
	TOTAL XI PLAN	91.99

13.13 **Annexure XI- Value Addition & Other Benefits of Surplus Capacity****VALUE ADDITION & OTHER BENEFITS OF SURPLUS CAPACITY****Value Addition**

The value addition, in the refinery, averaged about 27 percent since 2000 and ranged from 17 percent to 36 percent over last 6 years. This gain accrues to the country for every ton of product produced. Considering that the country imported crude worth Rs 1,71,702 crore (\$ 38.8 billion) worth of crude during 2005-06 (P), the value addition on imported crude alone was about Rs 29,200 crore (\$ 6.6 billion) considering a value addition of just 17 percent during the year. The value addition made by a refinery may be abstracted from the import data¹⁶ and value. The average crude price and product price since 2000 is as follows:

Figures in Rs/MT

Particulars	00-01	01-02	02-03	03-04	04-05	05-06
Avg. Imported Crude Price	8898	7674	9293	9233	12205	17272
Value of Crude need per MT of product after Fuel & Loss (8 percent)	9610	8288	10036	10036	13266	18774
Avg. Imported Product Price	13050	10526	12180	12561	16863	21902
Value addition	3440	2238	2144	2525	3597	3128
Value addition percent	36 percent	27 percent	21 percent	27 percent	27 percent	17 percent

Other Benefits**Downstream & Infrastructure Development**

Refinery capacity addition has several direct and indirect benefits both - economic and social - for the country and the society at large. Refineries are capital-intensive projects, which require engineering design, materials, and labour. Development of the project itself induces economic activity in the region. After the completion, the refinery provides employment directly and indirectly through the services and materials that it consumes. The regions tax collections improve.

Impact on Prices of petroleum products

Surplus capacity, in general, is expected to put a downward pressure on domestic prices of petroleum products. The reason for such price movement is competitive pressure on the exporters to maximize

¹⁶ Source: PPAC data

their revenue. In effect, larger the surplus capacity, greater the sobering effect on domestic prices. While this process would have normally happened in a free pricing regime, introduction of trade parity has achieved the same by administrative means.

Enhanced Energy Security

Addition in refining capacity enhances energy security by building greater flexibility in meeting the energy needs of the country. It is important to have the option to process crude or import product, for an energy importing country like India. This is so because crude markets are generally larger, more stable and retain global government focus in contrast to product markets, which are significantly smaller, lack depth and therefore more volatile.

13.14 **Annexure XII- Abbreviations**

Abbreviations	
2D/3D	Two/Three Dimensional
ACSE	Advisory Committee on Synergy in Energy
AIDA	All India Distillers' Association
ALDS	Auto LPG Dispensing Stations
ANSI	American National Standards Institute
APL	Above Poverty Line
APM	Administered Price Mechanism
ASME	American Society of Mechanical Engineers
ATF	Aviation Turbine Fuel
AQM	Air Quality Monitoring
BIS	Bureau of Indian Standards
BPL	Below Poverty Line
BS-II	Bharat Stage II
CARG	Compounded Annual Rate of Growth
CBM	Coal Bed Methane
CHP	Combined Heat and Power
CIS	Commonwealth of Independent States
CNG	Compressed Natural Gas
CPCB	Central Pollution Control Board
CTL	Coal to Liquid (Coal to Clean Fuels)
CTSL	Catalytic Two Stage Liquefaction
DCL	Direct Coal Liquefaction
DG	Diesel Generator
DHDS	De-Hydro Desulphurisation

DHDT	Diesel Hydro Treating
DVPL	Dahej-Vijaipur Pipeline
E&P	Exploration and Production
EBP	Ethanol Blended Petrol
EOR	Enhanced Oil Recovery
FDI	Foreign Direct Investment
FO	Fuel Oil
FSU Countries	Former Soviet Union Countries
FT	Fischer Tropsch
FTA	Free Trade Agreements
G&G	Geological and Geophysical
GDP	Gross Domestic Product
GPS	Global Positioning System
GST	Goods and Services Tax
GTL	Gas to Liquid
GTR	Global Technical Regulations
HDPE	High Density Polyethylene
HHI	Herfindahl-Hirschman Index
HR	Human Resources
HSD	High Speed Diesel
HSE	Health Safety and Environment
HVJ	Hazira-Vijaipur-Jagdishpur
IEP	Integrated Energy Policy
IOR	Improved Oil Recovery
ISPRL	Indian Strategic Petroleum Reserves Limited
IT	Information Technology

K-G Basin	Krishna-Godavari Basin
LDPE	Low Density Polyethylene
LLDPE	Linear Low Density Polyethylene
LNG	Liquefied Natural Gas
LOBS	Lube Oil Base Stock
LPG	Liquefied Petroleum Gas
LSHS	Low Sulphur Heavy Stock
MNCs	Multinational Companies
MoEF	Ministry of Environment and Forest
MoPNG	Ministry of Petroleum and Natural Gas
MS	Motor Spirit
NCMP	National Common Minimum Programme
NCR	National Capital Region
NDR	National Data Repository
NEF	National Energy Fund
NELP	New Exploration Licensing Policy
NGAB	National Gas Advisory Board
NGHP	National Gas Hydrate Programme
NHAI	National Highways Authority of India
NKH	National Knowledge Hub
NKP	National E&P Knowledge Portal
NOCs	National Oil Companies
NPC	National G&G Processing Centre
NTC	National Training Centre
NVAC	National Visualisation and Application Centre
OALP	Open Acreage Licensing Policy

OECD	Organisation for Economic Co-operation and Development
OMCs	Oil Marketing Companies
ORDA	Oil Fields (Regulation and Development) Act
P&NG	Petroleum and Natural Gas
PDS	Public Distribution System
PNG	Piped Natural Gas
PNGRB Act, 2006	Petroleum and Natural Gas Regulatory Board Act, 2006
POL	Petroleum Oil and Lubricant
PSC	Production Sharing Contract
PSUs	Public Sector Undertakings
PUC	Pollution Under Control
QHSE	Quality, Health, Safety and Environment
R&D	Research and Development
ROs	Retail Outlets
ROU	Right of Usage
RRR	Reserve Replacement Ratio
RSRTC	Rajasthan State Road Transport Corporation
SEZ	Special Economic Zone
SCR	Selective Catalytic Reduction
SKO	Superior Kerosene Oil
SPV	Special Purpose Vehicle
TPDS	Targeted Public Distribution System
TNCs	Transnational Companies
TV	Television
UCG	Underground Coal Gasification
UTs	Union Territories

VAT	Value Added Tax
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Units	
BCM	Billion Cubic Metre
KL	Kilo Litre
kM	Kilometre
mbpd	Million barrel per day
MCM	Thousand Cubic Metre
MMBTU	Million British Thermal Units
MMSCMD	Million Standard Cubic Metre per Day
MMT	Million Tonne
MMTOE	Million Tonne of Oil Equivalent
MMTPA	Million Tonne per Annum
MW	Mega Watt
O+OEG	Oil plus Oil Equivalent of Gas
Rs	Rupees (Indian)
SCM	Standard Cubic Metre
TCF	Trillion Cubic Feet
TMT	Thousand Metric Tonne

Companies/Institutions/Agencies	
ARAI	Automotive Research Association of India
BHU	Banaras Hindu University
BORL	Bharat Oman Refinery Limited
BP	British Petroleum
BPC/BPCL	Bharat Petroleum Corporation Limited

BRPL	Bongaigaon Refinery and Petrochemicals Limited
C&AG	Comptroller and Auditor General
CHT	Centre for High Technology
CIL	Coal India Limited
CPCL	Chennai Petroleum Corporation Limited
CVC	Central Vigilance Commission
DGH	Directorate General of Hydrocarbons
DOD	Department of Ocean Development
EIA	Energy Information Administration
FCI	Fertilizer Corporation of India
GAIL	GAIL (India) Limited
GEECL	Great Eastern Energy Corporation Limited
GG SRL	Guru Gobind Singh Refinery Limited
GSPC	Gujarat State Petroleum Corporation
HFCL	Hindustan Fertilizers Corporation Limited
HPC/HPCL	Hindustan Petroleum Corporation Limited
IBP	Indo-Burma Petroleum
ICMA	Indian Chemicals Manufacturers Association
IOC/IOCL	Indian Oil Corporation Limited
IIT	Indian Institute of Technology
ISMA	Indian Sugar Mills Association
ISM Dhanbad	Indian School of Mining Dhanbad
ISO	International Organisation for Standardisation
KRL	Kochi Refineries Limited
MIT Pune	Maharashtra Institute of Technology
MRPL	Mangalore Refinery and Petrochemicals Limited

NCAER	National Council for Applied Economics Research
NGRI	National Geophysical Research Institute
NIO	National Institute of Oceanography
NRL	Numaligarh Refinery Limited
OIDB	Oil Industry Development Board
OIL	Oil India Limited
OISD	Oil Industry Safety Directorate
ONGC	Oil and Natural Gas Corporation
OPEC	Organisation of the Petroleum Exporting Countries
OVL	ONGC Videsh Limited
PCRA	Petroleum Conservation and Research Association
PLL	Petronet LNG Limited
PPAC	Petroleum Planning and Analysis Cell
RGIPT	Rajiv Gandhi Institute of Petroleum Technology
RIL	Reliance Industries Limited