

# Oil & Gas

## MARKET & OPPORTUNITIES





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# Oil and Gas Industry in India

Oil exploration in India began in 1867, when oil was struck at Makum, near Margherita in Assam. However, exploration and production (E&P) started in a systematic way only in 1899, after the Assam Oil Company (AOC) was formed. At the time of Independence, India's domestic oil production was just 250,000 tonnes per annum. Under its Industrial Policy Resolution of 1954, the Government announced that petroleum would be considered as a core sector in the country. The Geological Survey of India, carried out extensive reconnaissance surveys and mappings, to locate structures suitable for exploration of oil and gas. However, petroleum exploration in the country received the real thrust only after the setting up of Oil and Natural Gas Commission (ONGC), in 1955.

Several foreign companies have entered the Indian E&P scene since the early fifties. These included Indo Stanvac Project, a joint venture between the Government of India and Standard Vacuum Oil Company for West Bengal onland. In the early seventies, Carlsboms Natomas stepped in for Bengal offshore, Assamerc for Cauvery offshore and Reading and Bates, for Kutch offshore. Later entrants include Shell, for Kerala offshore and Chevronn- Texaco, in Krishna - Godavari offshore.

The first oil and gas pool was discovered in Jwalamukhi (Punjab) and Cambay (Gujarat) in 1958 and Oil India Limited (OIL), was set up in the the same year. The two public sector companies, ONGC and OIL, discovered over 260 oil and gas fields located in Assam, Bombay Offshore Cambay, Cauvery, Krishna-Godavari, Tripura-Cachar and West Rajasthan basins. The discovery of the vast Bombay High field in 1974, in the west coast offshore was the most significant event in India's upstream petroleum sector.

The Government of India, further liberalised the petroleum exploitation and exploration policy in 1991, and invited private companies, both foreign and Indian, to participate in the exploration of oil and gas. Under the

Petroleum Sector Reforms (PSR), the fourth, fifth, sixth, seventh and eighth rounds of exploration bidding were announced between 1991 and 1994. For the first time Indian companies with or without previous experience in E&P activities were permitted to bid. The Government, then announced the Joint Venture Exploration Programme, in 1995. The exploration blocks were located in those areas for which the Petroleum Exploration Licence was with the National Oil Companies (NOCs) and these companies were required to have a 25-40 per cent participating interest from day one. The Government of India has signed Production Sharing Contracts (PSCs) for 28 exploration blocks under Pre-NELP (New Exploration Licensing Policy) rounds, since 1993. Out of these, 10 blocks have been relinquished/ surrendered. At present, 17 exploration blocks are under operation.

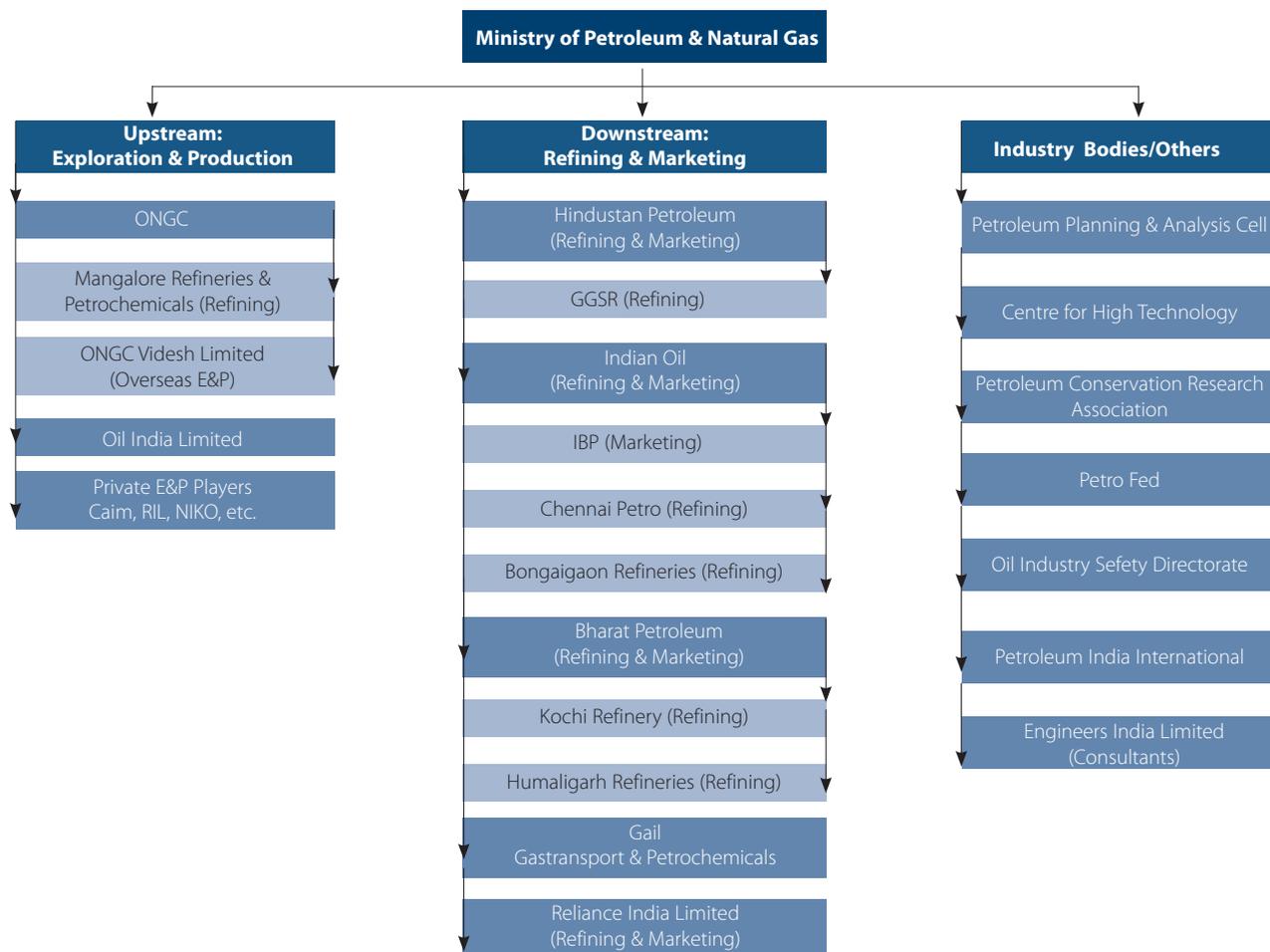
More recent developments in E&P in the country are detailed in the relevant sections in this report.

## INSTITUTIONAL STRUCTURE

### Overview of the Institutional Structure and Leading Companies

The institutional structure of the oil and gas sector in India is given overleaf.

The Ministry of Petroleum and Natural Gas, is the primary agency for regulating this sector in India. It is entrusted with the responsibility of handling legislation and issues related to E&P of oil and natural gas, such as, refining, distribution and marketing; and the import, export, and conservation of petroleum products and Liquefied Natural Gas (LNG). There are several leading Public Sector Undertakings (PSUs) and private players across the value chain.



#### PSUs in Oil and Gas Sector

• Balmer Lawrie & Co. Ltd.
• Bharat Petroleum Corporation Ltd.
• Biecco Lawrie Co. Ltd.
• Bongaigaon Refinery and Petro-Chemicals Ltd.
• Chennai Petroleum Corporation Ltd.
• Kochi Refineries Ltd.
• Engineers India Ltd.
• Gas Authority of India Ltd.
• Oil and Natural Gas Commission (ONGC), Hindustan Petroleum

#### KEY BODIES UNDER THE MINISTRY OF PETROLEUM AND NATURAL GAS

Apart from the PSUs, the Ministry has a range of other organisations working under its umbrella. These include

#### Centre for High Technology, Directorate General of Hydrocarbons (DGH):

The directorate reviews exploration programmes of companies, development plans of commercial discoveries and advises the Government on their adequacy. It also advises the Government, on offering of acreage for exploration to companies and on issues related to exploration and optimum exploitation.

#### Oil Industry Development Board

This Board was formed under the Oil Industry (Development) Act, 1974, to render financial and other assistance and funding of research and development programmes for sustainable development of the oil industry.

### **Oil Industry Safety Directorate (OISD)**

This is a technical directorate under the Ministry that formulates and coordinates the implementation of self regulatory measures, aimed at enhancing safety in the oil and gas industry in India.

### **Petroleum Conservation Research Association (PCRA)**

It was set up in 1976 as a part of the Government's response to the oil crisis of early seventies, to undertake studies to identify the oil potential and to make recommendations for achieving conservation of petroleum products in the economy. It sponsors R&D activities, for the development of fuel-efficient equipment/devices and organises multi-media campaigns, for creating mass awareness for the conservation.

### **Petroleum Planning and Analysis Cell (PPAC)**

This cell was set up subsequent to the dismantling of the Administered Pricing Mechanism (APM) in the petroleum

sector, with effect from 1st April 2002 and the abolishment of Government of India's Oil Coordination Committee (OCC). PPAC assists the Government in discharging some of the functions earlier being performed by OCC, these functions include administration of subsidy on Public Distribution System (PDS), kerosene and domestic LPG and freight subsidy for far flung areas; maintenance of information data bank to deal with emergencies; analysing the trends in the oil prices forecasting petroleum import and export trends and operationalising the sector specific surcharge schemes, if any.

### **Petroleum Federation of India (PetroFed)**

PetroFed was registered in 2002, under the Societies Registration Act of 1860, to coordinate with governments, regulatory agencies and other representative bodies in the petroleum industry, work for global competitiveness of the petroleum industry optimise resources promote safety, healthy environment and energy conservation and coordinate with oil marketing companies, for ensuring compliance of 'Good Business Practices'.

# Leading players in the industry

The key players in the industry are the PSUs operating under the Ministry. These PSUs are involved in a range of operations, from exploration to production, refining, marketing, infrastructure and diverse multi-sector operations. Some of the leading players in the industry are as follows:

## Gas Authority of India Ltd. (GAIL)

GAIL is India's flagship natural gas company, present along all aspects of the natural gas value chain (including E&P, processing, transmission, distribution and marketing). Today, GAIL is spearheading the move to a new era of clean fuel industrialisation and is also expanding its business to become a player in the international market. Its business infrastructure comprises of:

- 5,800 kilometres of natural gas high pressure trunk pipeline, with a capacity to carry 130 Million Metric Standard Cubic Metres per Day (MMSCMD) of natural gas across the country
- 7 LPG processing units, to produce 1.2 Million Metric Tonnes Per Annum (MMTPA) of LPG and other liquid hydrocarbons
- Gas-based integrated petrochemical complex at Pata, with a capacity of producing 310,000 tonnes per annum of polymers
- 1,922 kilometres of LPG transmission pipeline network, with a capacity to transport 3.8 MMTPA of LPG
- 30 oil and gas exploration blocks and 3 coal bed methane blocks
- 13,000 kilometres of optical fibre cable network, offering highly dependable bandwidth for telecom service providers
- Joint venture companies in Delhi, Mumbai, Hyderabad, Kanpur, Agra, Lucknow, Bhopal, and Pune, for supplying Piped Natural Gas (PNG) to households and commercial

users and Compressed Natural Gas (CNG) to the transport sector

- Participating stake in the Dahej LNG Terminal and the upcoming Kochi LNG Terminal in Kerala

Besides, GAIL has been entrusted with the responsibility of reviving the LNG terminal at Dabhol, as well as sourcing LNG. It has established a presence in the CNG and city gas sectors in Egypt, through equity participation in three Egyptian companies, namely, Fayum Gas Company SAE, Shell CNG SAE and National Gas Company SAE. It also has a stake in China Gas Holding, to explore opportunities in the CNG sector in mainland China and a wholly-owned subsidiary company GAIL Global (Singapore) Pte Ltd, in Singapore.

## Oil India Limited (OIL)

OIL is a premier national oil company, engaged in the business of E&P and development of crude oil and natural gas, transportation of crude oil and production of LPG. The company has over 100,000 square kilometres of licence area. Today, it is an integrated upstream petroleum company.

## ONGC

ONGC is India's flagship energy company, which is fully integrated across the hydrocarbon value chain. ONGC is ranked number one amongst E&P companies in Asia and third amongst global E&P companies. It figures in the Fortune Global 500 list of 2007. It also has the distinction of being the first Indian public enterprise to have its Clean Development Mechanism (CDM) projects registered by the United Nations Framework Convention on Climate Change (UNFCCC). Some of the company's achievements include

- Discovery of six of the seven oil producing basins in India
- Establishment of over 75 per cent of the 8.5 billion metric tonnes of in-place hydrocarbon reserves discovered so far in India
- Production of over 1 million barrels of Oil Equivalent per day
- Contribution of around 80 per cent of domestic oil and gas production

ONGC Videsh Limited (OVL), a wholly-owned subsidiary of ONGC, operates exclusively in foreign markets, with the mission to acquire 60 MMTPA of oil and gas by 2025.

### **Bharat Petroleum Corporation Limited (BPCL)**

BPCL is one of India's largest PSU companies. It is involved in the refining and retailing of petroleum products, which include Speed brand of petrol, high speed diesel, auto lubricants, LPG and aviation turbine fuel. BPCL has a number of refineries in India. Some of these include the Mumbai Refinery - 12 MMT capacity, Kochi Refinery - 7.5 MMT and Numaligarh Refinery - 3 MMT. BPCL is also a Fortune Global 500 company.

### **Hindustan Petroleum Corporation Limited (HPCL)**

HPCL is India's second largest oil company and is involved in the refining and retailing of petroleum products. HPCL has a number of refineries in India, including its Mumbai refinery, having a 5.5 MMTPA capacity and its Visakhapatnam refinery, with a 7.5 MMTPA capacity. HPCL is a Fortune Global 500 company.

### **Indian Oil Corporation Limited (IOCL)**

IOCL was formed in 1964 through the merger of Indian Oil Company Ltd. and Indian Refineries Ltd. It is India's largest oil company and is involved in the refining and retailing of petroleum products, including petrol, diesel, lubricants, LPG, auto LPG, aviation turbine fuel, naphtha, bitumen, paraffin, kerosene and mineral turpentine oil. It has a number of refineries. The key locations include Haldia, Panipat, Digboi, Barauni, Guwahati, Mathura and Bongaigaon. It holds controlling stake in CPCL Limited, which operates a refinery at Chennai. The total capacity of the company is about 55.20 MMTPA. IOCL has approximately 16,000 petrol stations. The company is the highest ranking Indian company in the

Under 6 rounds of NELP, 162 were blocks awarded, of which 56 blocks were to private companies and joint ventures

prestigious Fortune Global 500 listing. It is also the 20th largest petroleum company in the world and the number one petroleum trading company amongst the NOCs in the Asia-Pacific region.

Besides, the involvement of several public sector companies in the oil and gas sector, India has witnessed significant activity by the private sector including Indian as well as foreign/transnational companies, especially in the NELP era.

Important private players include, Reliance Industries, British Gas and Cairn Energy. Some of the key developments in the oil and gas industry from the private sector include:

- Reliance Industries struck gas in the offshore Krishna Godavari Basin with estimated reserves of 14 TCF, in 2002 (world's biggest gas discovery of 2002)
- Cairn Energy plc discovered oil onshore in Rajasthan in 2004, with estimated production capability of 100,000 barrels per day (4.9 MMTPA) and has since invested over US\$ 1 billion in the state
- Petronet LNG Limited has a regasification terminal at Dahej. It was the first LNG terminal to get commissioned and it has commenced LNG imports from Qatar
- Shell, a transnational giant and Fortune 500 company, with a focus on petro marketing, natural gas, lubricants, LPG, petrochemicals and solar energy has the Shell Hazira LNG project, the second LNG project to be commissioned in India, with an investment of US\$ 650 million. Its LNG terminal at Hazira which was commissioned recently is expected to support imports. Three more LNG terminals are expected to be commissioned in the near future
- British Gas (BG), a transnational player with interests in natural gas, E&P and city gas projects has primary operations in India, focused on E&P and city gas distribution. It has investments of over US\$ 800 million, in its upstream and downstream activities. BG India, also has 30 per cent stake in Panna Mukta Tapti fields, with combined investment of US\$ 900 million along with its consortium partners
- British Petroleum (BP), another transnational major, also a Fortune 500 company with focus on petro marketing, E&P

and LNG and a leading private player in lubricants has made its presence felt in India. It has signed a Memorandum of Understanding with Hindustan Petroleum Corporation Limited, to set up a 9 MMTPA refinery in Bhatinda, which involves an investment of US\$ 444 million. Possibility of partnership with ONGC and RIL, for deepwater exploration is being examined by BP

- Other players that have set up base in India for various operations include Total, Exxon Mobil, Gaz De France and Chevron

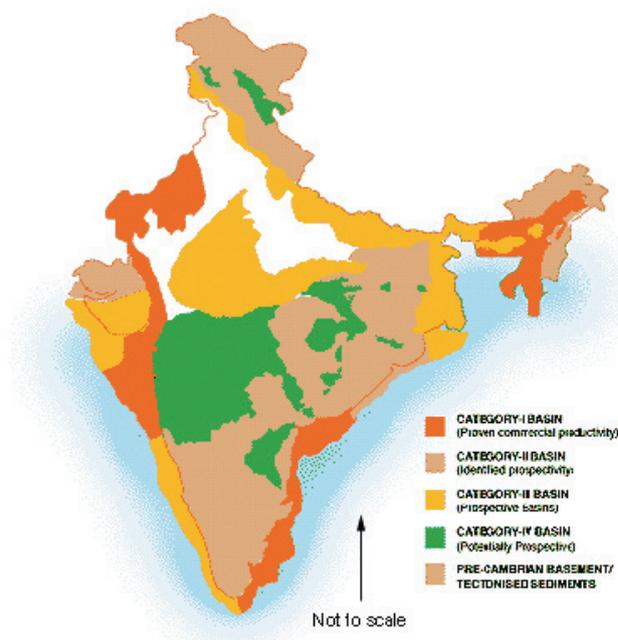
# Reserves and Resources

## INDIA HAS A VAST OIL AND GAS RESOURCE BASE AS DEPICTED BELOW

<b>Sedimentary Area</b>	3.14 million square kilometres (~4 per cent of the world's sedimentary area)
<b>Sedimentary Basins</b>	26 (exploration initiated in 15 basins)
<b>Prognosticated Resources (oil and oil equivalent gas)</b>	205 billion barrels (for 15 basins only)
<b>Established Reserves</b>	61 billion barrels (as of 1st April 2006)

Source: DGH

The total sedimentary area in India is 3.14 million square kilometres, of which onland is 44 per cent and deep water is 43 per cent. The rest is accounted for by shallow offshore. Reserves (balance recoverable) in India\*



Source: Directorate General of Hydrocarbons (DGH)

Reserves	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
Crude Oil (million tonnes)	703	732	741	733	739	786
Natural Gas (billion cubic metres)	760	763	751	854	923	1,101

\*As of 1st April of initial year

Source: Public Sector Undertakings, DGI&S, Kolkata, Ministry of Finance

# Exploration and Production

Of the extensive resource base in India, E&P has been initiated in earnest only in 44 per cent of the area. Since 1980, eight exploration rounds, one round for joint venture and six rounds under NELP have been offered for global bidding. The Government of India, offered 69 small and medium sized oil and gas fields in onshore and offshore to private sector, in 1992 and 1993. Under the first round, **NELP I** Government of India, invited bids on 8th January 1999 for 48 blocks, for exploration of oil and natural gas. The PSCs were signed for 24 exploration blocks. Since then, within a short period, a total of 16 discoveries have been made in two Krishna-Godavari deepwater blocks and one shallow offshore block of Mahanadi – NEC.

Status of Exploration in India	
Initiated	44%
Unexplored	21%
Well Explored	20%
Poorly Explored	15%

Source: DGH

Under the second round, **NELP II**, Government of India, invited bids on 15th December 2000 for 25 blocks for exploration of oil and natural gas. The PSCs were signed for 23 exploration blocks. A total of 5 discoveries have already been made in two blocks, viz. CB-ONN-2000/1 and CB-ONN-2000/2 located in Cambay basin and Krishna Godavari basin.

Under the third round, **NELP III**, Government of India, invited bids on 27th March 2002, for 27 blocks for exploration of oil and natural gas. The PSCs were signed for 23 exploration blocks.

Under the fourth round, **NELP IV**, Government of India, invited bids on 8th May 2003, for 24 blocks for exploration of oil and natural gas. The PSCs were signed for 20 exploration blocks.

In 1990 there were three prolific producing basins and two E&P operators. By 2005, these numbers grew to 10 and 21, respectively

Under the fifth round, **NELP V**, 20 exploration blocks have been awarded to different consortiums/individual companies.

55 exploration blocks were offered under the sixth round, **NELP VI**, on 23rd February, 2006, the highest offering so far, covering an area of 352 thousand square kilometres. The Government of India, had received 165 bids for 52 blocks by the bid closing date. Three deepwater blocks did not receive any bids. A total of 68 companies, including 36 foreign companies and 32 Indian companies, submitted bids either on their own or as joint ventures and 52 deep water blocks have been allocated to 13 companies/consortiums.

A seventh round of exploration, **NELP VII**, is currently under offer. The details of the current exploration status are as presented below:

**Status of Exploration Under the PSC Regime**

	Pre-NELP (1993 – 2006)	NELP- I, II, III, IV & V (2000-06)
2D Seismic Survey (LKM)	24,091	109,305
3D Seismic Survey (SKM)	5,304	67,773
Exploratory Wells (No.)	167	93
PSC Blocks	28	138
Number of discoveries (Up to 15th April 2007)	25	40
Investment made on exploration (US\$ million)	781.65	1,451.18

Source: DGH

Annual Production of Crude Oil, Petroleum Products and Natural Gas

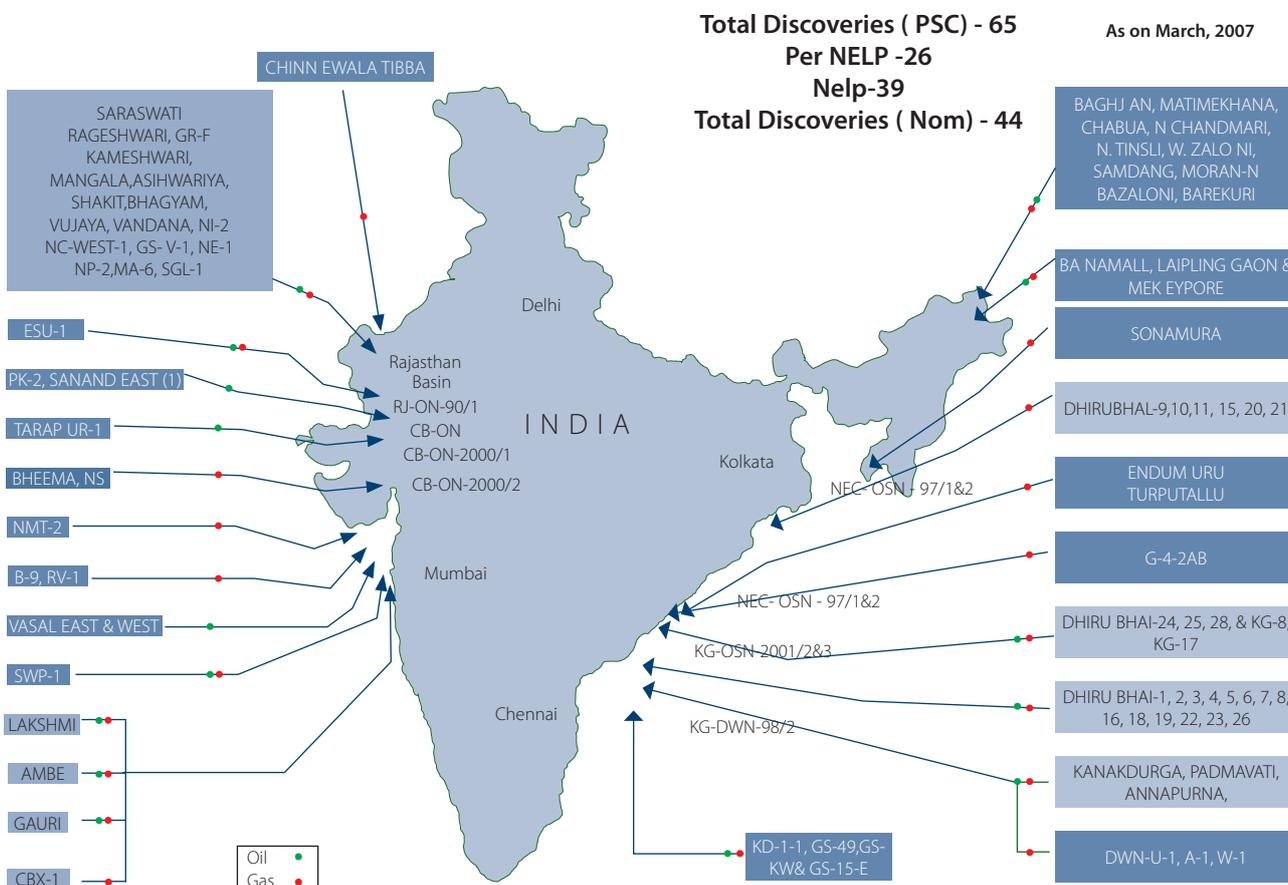
	2001-02	2002-03	2003-04	2004-05	2005-06
<b>Crude Oil (in MMT)</b>	<b>32.03</b>	<b>33.05</b>	<b>33.37</b>	<b>33.58</b>	<b>32.19</b>
ONGC	24.71	26.01	26.06	26.08	24.40
OIL	3.18	2.95	3.00	3.20	3.24
Private/ JV	4.14	4.09	4.31	4.30	4.55
Share of offshore in total	62.9%	65.3%	65.7%	66.7%	64.5%
<b>Petroleum Products (in MMT)</b>	<b>100.00</b>	<b>104.14</b>	<b>113.46</b>	<b>118.58</b>	<b>119.75</b>
<b>Natural Gas (in BCM)</b>	<b>29.71</b>	<b>31.19</b>	<b>32.62</b>	<b>32.37</b>	<b>32.60</b>
ONGC	24.04	24.04	24.24	23.58	22.97
OIL	1.62	1.74	1.89	2.01	2.27
Private/ JV	4.05	5.41	6.49	6.78	7.36
Share of offshore in total	73.6%	72.7%	70.4%	70.4%	69.8%

Source: DGH

Most of the crude oil and natural gas production in India, is offshore. The production of oil and gas in India by operator, is given in the table above.

Of the 65 discoveries made in India, 16 have been appraised, 12 have been commercially established, the Ministry has approved development plans for eight, 11 are under commercial evaluation and the development plans for four, are under scrutiny by the DGH.

Significant discoveries of oil and natural gas have been made in India, from the year 2000 onwards, depicted as follows :



Source: Directorate General of Hydrocarbons

India, has more recently discovered extensive reserves of alternative fuels, such as, Coal Bed Methane (CBM), gas hydrates and shale oil. India has 35,400 square kilometres of coal bearing area and 44 coal and lignite fields in 12 states, with a resource potential of 162 Trillion Cubic Feet (TCF) of CBM. Out of which, 13,600 square kilometres have been opened up for CBM exploration by the DGH and 26 exploration blocks (with a resource base of 50 TCF) have been awarded to E&P agencies.

India, has estimated offshore resources of 1,894 Trillion Cubic Metres (TCM) of natural gas in the form of hydrates. A fresh impetus was given by the Ministry in the form of the National Gas Hydrate Programme (NGHP), in September 2000. Since then, geo-scientific studies on the east and west coasts of India have been carried out and three prospective areas have been mapped. Drilling/coring of gas hydrate was carried out in the east and West Coast and Krishna-Godavari basin. Scientific studies on the cores are under progress. Likewise, resource estimation of oil shale is currently in progress in Assam and expected to be completed by 2008. The Ministry, has also tied up with foreign institutions having experience and expertise in oil shale exploration and exploitation.

#### Petroleum Exploration Licence Areas Under Operation Currently Under NOCs and Private/JV Companies

COMPANY/OPERATOR	Area (square kilometres)	Share
ONGC	575,046.21	53.92%
RIL	329,684.00	30.91%
OIL	38,260.02	3.59%
HOEC	33,922.96	3.18%
CAIRN	30,926.00	2.90%
FOCUS	18,771.16	1.76%
ENI	14,445.00	1.35%
OAO GAZPROM	7,779.00	0.73%
GSPCL	4,843.17	0.45%
GGR	3,155.00	0.30%
ENPRO FINANCE	2,360.00	0.22%
PONEI	1,906.00	0.18%
CANORO	1,444.70	0.14%
TULLOW	1,277.00	0.12%
NIKO	957.00	0.09%
HEPI	859.00	0.08%
ESSAR	430.50	0.04%
GEOPETROL	295.00	0.03%
JOGPL	206.00	0.02%
TOTAL	1,066,567.72	

Source: DGH

- ONGC and OIL are the largest players with about 83 per cent share of the total domestic oil and gas production;
- E&P sector is witnessing increasing private sector participation, both domestic and foreign
- In the last four years, private sector/joint venture companies have made 32 significant hydrocarbon discoveries
- The world's largest gas discovery in 2002 (about 5 trillion cubic metres) was made by Reliance Industries Ltd.
- International E&P companies like Hardy Oil & Gas, Niko Resources and Cairn Energy

# Refining

Today there are 19 refineries in the country, 17 in the public sector and two in the private sector, with an installed capacity of 149 MTPA (as of January 2007)

India has witnessed a spectacular growth in the refining sector over the years.

The refining capacity in the country has grown, from 62.2 MMT as of April 1998 to 149 MMT as of April 2007. It is expected to go up to 235 MMT by 2012. Based on demand estimates, this implies a surplus capacity of 86 MMT by 2011-12 and a potential for exports from the country (Source: PPAC).

## Refining Capacity in India

As of year	Capacity (in MMT)
April 1998	62.2
April 2001	114.6
April 2004	127.0
April 2005	127.4
April 2006	132.5
April 2007	149.0
April 2012 (Forecasted)	235.0

Source: PPAC, Ministry of Petroleum and Natural Gas

In the liberalised scenario, the Government of India, has opened the refining sector to "Joint Sector," as well as, to the private sector for achieving faster growth. About 27 MTPA additional capacity is planned to come up under PSUs. Under joint venture, 43 MTPA capacity will be added in the next 5-6 years. This will be contributed by IOCL's tie up with Kuwait Petroleum Company, for one refinery, HPCL's tie-ups with Oman Oil Company and Saudi Aramco, for two refineries and BPCL's tie-ups with Oman Oil Company

## Playerwise Details (As of 1st April 2006, thousand tonnes)

	Installed capacity	Refinery crude throughput
<b>Public sector</b>		
IOCL	41,350	38,522
BPCL	12,000	10,298
HPCL	13,000	14,229
KRL	7,500	6,939
CPCL	10,500	10,362
BRPL	2,350	2,356
NRL	3,000	2,133
ONGC	78	93
MRPL	9,690	12,014
<b>Private sector</b>		
Reliance	33,000	33,163

Source: Company data

and Shell International, for two refineries. In the private sector, Letters of Intent (LOIs) have been issued for about 41 MTPA refining capacity. The companies to whom LOIs have been issued are, Reliance (15 MTPA), Essar (9 MTPA), Ashok Leyland (2 MTPA), Nippon Denro (9 MTPA) and Soros Foud (6 MTPA). Under the EOU category, about 29 MTPA capacity has been approved.

## OPPORTUNITIES IN REFINING

- *Exports of capital goods:* With such phenomenal growth in this sector, there is ample scope and opportunity for the transfer of technologies required and exports of capital goods to India. The technologies required will be for upgrading the bottom of the barrel, to meet the predominant demand for middle distillates and also to improve the quality of petroleum products, to make them environment friendly.

## Production of Petroleum Products ('000 tonnes)

Products	2001-02	2002-03	2003-04	2004-05	2005-06*
<b>Light distillates</b>	<b>26,539</b>	<b>28,619</b>	<b>31,971</b>	<b>32,865</b>	<b>32,427</b>
LPG	4,778	4,903	5,348	5,570	5,525
Mogas	9,699	10,361	10,999	11,057	10,502
Naphtha	9,180	9,650	11,317	14,100	14,509
Others**	2,882	3,705	4,307	2,138	1,891
<b>Middle Distillates</b>	<b>54,409</b>	<b>55,937</b>	<b>60,018</b>	<b>62,509</b>	<b>64,432</b>
Kerosene	9,681	10,028	10,187	9,298	9,078
ATF/ RTF/ Jet A-1	2,595	3,053	4,289	5,201	6,196
HSD	39,899	40,207	43,316	45,903	47,572
LDO	1,703	2,079	1,659	1,546	923
Others***	531	570	567	561	663
<b>Heavy Ends</b>	<b>19,056</b>	<b>19,584</b>	<b>21,474</b>	<b>23,205</b>	<b>22,891</b>
Furnace Oil	7,488	7,529	8,737	10,560	10,320
LSHS/HHS/RFO	4,739	4,638	4,635	4,410	3,985
Lube Oils	651	684	666	646	677
Bitumen	2,561	2,941	3,397	3,349	3,576
Petroleum Coke	2,784	2,659	2,743	3,162	3,182
Paraffin Wax	45	42	53	64	63
Other waxes	37	3	0	4	3
Others****	751	1,088	1,243	1,010	1,085
<b>TOTAL</b>	<b>100,004</b>	<b>104,140</b>	<b>113,463</b>	<b>118,579</b>	<b>119,750</b>
LPG	2,205	2,370	2,320	2,240	2,185

\*Provisional

\*\*Includes Propylene, C-3, Propane, Hexane, Special Boiling Point Spirit, Benzene, Toulene, Petroleum Hydro Carbon Solvent, Natural Eptane, Methyl Tertiary Butyl Ether, Poly Isobutine, Poly Butadine Feed Stock and Methyl Ethyl Keetone Feedstock

\*\*\*Includes Mineral Turpentine Oil, JP-5, Linear Alkyl Benzene Feedstock, Aromex, Jute Batching Oil, Solvent 1425, Low Sulphur Heavy Fuel HSD, Desulphuration Hydrocracket Bottom and Special Kerosene

\*\*\*\*Includes Carbon Black Feed Stock, Sulphur, Solar Oil, Light Aluminium Rolling Oil and Extracts

Source: PPAC, Ministry of Petroleum and Natural Gas

• *Building refineries, including inland refineries:* India, has a large reserve of trained and highly skilled manpower, available at a relatively lower cost when compared to the advanced countries. The country has also acquired enough experience in the installation and efficient operations of petroleum refineries, in the last 35 years. It is, therefore, estimated that the operating costs will be low and the value-addition in Indian refineries will be high. Thus, setting up of refineries in India for the domestic market as

well as for exports will be economically attractive. Most of the new refineries will be located on the coasts, while the major centres of demand for the petroleum products are in the inland locations, particularly in the North/North-West regions. Therefore, opportunities exist for building inland refineries in the country. The refineries in the country are also allowed forward integration in petrochemicals for better value-addition, which opens up another vast area for investments.

# Demand

As per the estimates by DGH, coal comprises 54 per cent of India's primary energy consumption, while oil comprises about 33 per cent (as of 1st April 2006). The growth in demand is projected to catapult the overall demand to 196 MMT in 2011-12 and 250 MMT in 2024-25. The growing demand-supply gap has led the Indian government to open up E&P to private participants, through NELP and develop a more holistic strategy for acquisition of equity oil abroad. On the gas front, when compared to mature natural gas based economies like, Japan, Korea, and the United States, India is a relatively new entrant. However, the increasing significance of this fuel in the Indian context can be gauged from the fact that, by 2025, the country is expected to leave behind both China and Japan in having the largest natural gas demand in Asia. The demand in each of these countries is expected to be in the range of 350 MMSCMD. The registered demand with GAIL alone, for natural gas in the country is around 260 MMSCMD. The Government of India, has also constituted an Expert Group to assess the realistic demand for natural gas.

Energy Consumption Mix in India	
Coal	54%
Oil	33%
Hydel	8%
NG	8%
Nuclear	1%

In view of the large difference between availability and demand, natural gas supply is allocated by the Government, based upon the Imputed Economic Values (IEVs) of natural gas use. Further, it is fractionated to derive the value added products and heavier fraction, C2/C3, is being used for petrochemicals industry and LPG as a domestic fuel. An allocation of 92.92 MMSCMD has been made so far. Power and fertiliser sectors get

preference, with allocation to power sector amounting to 42.41 per cent and 32.05 per cent to the fertiliser sector. Natural gas to the extent of 11 per cent is also being used as a fuel source in industries and the balance is used for production of LPG and C2/C3.

## Consumption of Petroleum Products in India

Year	Consumption (in MMTPA)
1980-81	30.9
1984-85	38.8
1989-90	54.1
1996-97	79.2
2001-02	100.4
2002-03	104.1
2003-04	107.7
2004-05	111.6
2005-06	111.9
2006-07*	117.5

\*Estimated

Source: PPAC, Ministry of Petroleum and Natural Gas

The consumption growth has slowed down over the past few years due to the substitution of naphtha by LNG.

## Sale of Petroleum Products ('000 tonnes)

Products	2001-02	2002-03	2003-04	2004-05	2005-06*
<b>Light Distillates</b>	<b>29,618</b>	<b>31,755</b>	<b>34,335</b>	<b>35,201</b>	<b>33,497</b>
LPG	7,728	8,351	9,305	10,425	10,304
Mogas	7,011	7,570	7,897	8,251	8,648
Naphtha	11,728	11,929	11,868	13,993	12,262
NGL	27	32	0	0	0
Others	3,124	3,873	5,265	2,712	2,283
<b>Middle Distillates</b>	<b>51,439</b>	<b>52,065</b>	<b>52,023</b>	<b>53,907</b>	<b>54,200</b>
SKO	10,432	10,405	10,230	9,395	9,359
ATF	2,256	2,269	2,484	2,813	3,299
HSDO	36,546	36,644	37,074	39,650	40,152
LDO	1,592	2,063	1,619	1,477	885
Others	613	684	616	572	505
<b>Heavy Ends</b>	<b>19,375</b>	<b>20,306</b>	<b>21,393</b>	<b>22,526</b>	<b>24,223</b>
Furnace Oil	8,451	8,027	8,312	9,136	8,842
LSHS/HHS	4,531	4,711	4,633	4,404	3,890
Lubes/Greases	1,137	1,250	1,427	1,348	2,104
Bitumen	2,584	2,986	3,373	3,339	3,515
Petroleum Coke	1,798	2,563	2,877	3,129	4,432
Paraffin Wax	45	41	41	80	232
Other Waxes	51	13	20	0	96
Others	778	715	710	1,090	1,112
<b>Total</b>	<b>100,432</b>	<b>104,126</b>	<b>107,751</b>	<b>111,634</b>	<b>111,920</b>
Refinery Fuel	7,273	7,650	8,240	8,537	9,125
<b>GRAND TOTAL</b>	<b>107,705</b>	<b>111,776</b>	<b>115,991</b>	<b>120,171</b>	<b>121,045</b>

According to the estimates given by the Integrated Energy Policy Report, Planning Commission of India, 2006, the total energy requirement (including oil, gas, coal, nuclear and hydro energy sources) in the country by 2032 would be 1,651 Million Tonnes of Oil Equivalent (MTOE). This assumes an 8 per cent GDP growth rate through 2032.

## Oil and Gas Demand Forecasts (2032)

	Total Energy	Oil	Gas
<b>Aggregate Consumption (MTOE)</b>	1,651	486	197
<b>Per capita (KGOE)</b>	1,124	331	134

Source: Planning Commission of India 2006

The significant potential for natural gas demand is being driven by the following key factors:

- The share of natural gas in India's energy basket is only around 9 per cent, as compared to the world average of around 24 per cent. More than 50 per cent of natural gas (NG) volume goes to sectors in which it is a substitute to

petroleum products and the rest goes to the power sector where it substitutes coal. The share of NG in the fuel mix, is expected to go up, from the present 8.8 per cent levels to 22 per cent in 2031-32

- Per capita consumption of NG in India is currently amongst the lowest in the world, at 29 cubic metres when compared to the world average of around 538 cubic metres
- Estimates by DGH suggest that by 2024-25, demand of crude oil will outstrip supply by a huge extent.

## Demand and Production of Crude Oil (2001-02 to 2024-25)

Year	Crude Oil (MMT)		Gap
	Demand	Supply	
2001-02	99.70	32.03	<b>67.67</b>
2002-03	114.30	33.05	<b>81.25</b>
2005-06	140.00	33.98	<b>106.02</b>
2011-12	199.60	33.47	<b>166.13</b>
2024-25	376.50	61.4	<b>315.1</b>

Source: DGH

In the coming years the demand for natural gas in the country is also expected to outstrip the supply significantly.

**Demand and Production of Natural Gas  
(2001-02 to 2024-25)**

Year	Natural gas (MMSCMD)		
	Demand	Supply	Gap
2001-02	151.00	81.40	<b>69.60</b>
2006-07	231.00	94.84	<b>136.16</b>
2011-12	313.00	158.05	<b>154.95</b>
2024-25	391.00	170.00	<b>221.00</b>

Source: DGH

Currently, more than 71 per cent of natural gas is used for energy purposes. For non energy purposes, the major industries that are users of natural gas in India are fertilisers and petrochemicals.

**Industry-wise Offtake of Natural Gas in India**

INDUSTRY	2001-02	2002-03	2003-04	2004-05	2005-06*
<b>Energy Purposes</b>	<b>18,234</b>	<b>19,767</b>	<b>20,940</b>	<b>21,328</b>	<b>22,052</b>
Power generation	9,214	10,510	11,478	12,099	11,878
Industrial fuel	2,979	2,939	3,099	3,569	3,780
Tea plantation	147	119	142	142	151
Domestic fuel	485	654	93	343	75
Captive use/ LPG shrinkage	5,339	5,409	4,865	4,944	5,048
Others	70	136	1,263	231	1,120
<b>Non-energy Purposes</b>	<b>9,803</b>	<b>10,197</b>	<b>9,966</b>	<b>9,447</b>	<b>8,973</b>
Fertiliser industry	909	1,027	1,128	1,236	1,175
Petrochemicals	909	1,027	1,18	1,236	1,175
CNG	0	0	1	0	0
Others	937	1,215	948	38	36
<b>GRAND TOTAL</b>	<b>28,037</b>	<b>29,964</b>	<b>30,906</b>	<b>30,775</b>	<b>31,025</b>

\*Provisional

Source: ONGC, OIL, GAIL, DGH

# Marketing and Distribution

Within five years, the proportion of auto CNG and piped gas together would increase from the current level of 2 per cent to about 7 per cent of the total gas demand

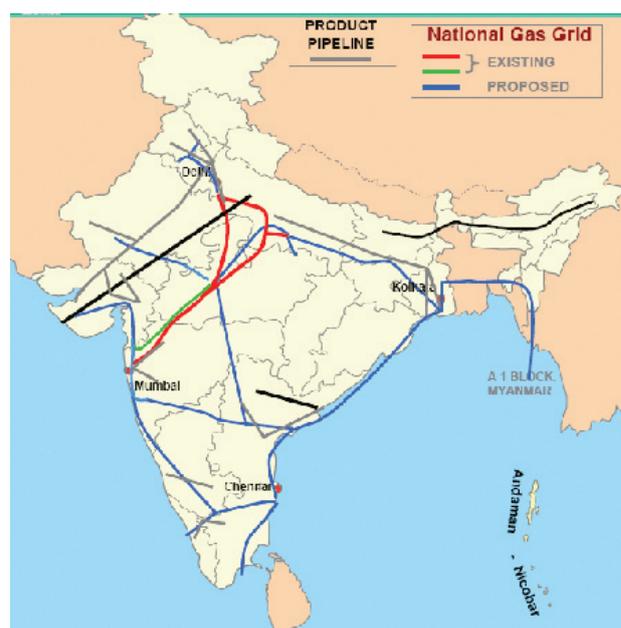
The marketing of petroleum products in India is being done by four major public sector oil companies, namely, IOC, HPCL, BPCL and IBP. Their retail distribution comprises of over 16,000 retail outlets, over 6,000 kerosene agencies and over 5,000 LPG distributorships. A programme for modernisation of retail outlets to bring them at par with international standards, has been taken up by the oil industry.

The requirements of the industrial units are being met by the marketing companies, through direct supplies. The growth of auto CNG and piped domestic gas in major Indian urban centres has sparked off a new demand spurt for NG. The fast pace of growth can be assessed from the fact, that in the next few years, at least 30 cities will be under city-wide gas coverage, as compared to the six cities currently.

Transport of petroleum products into the interiors and the hinterland of the country, from the ports and refinery locations, is undertaken with the help of railways, pipelines, coastal tankers and roads. The approximate percentages of movement by these modes of transportation are as follows; railways- 40 per cent; pipelines- 30 per cent; coastal tankers - 12 per cent; the balance is moved by road. In most of the cases, the petroleum products are ultimately delivered to the point of consumption by road transport.

A National Gas Grid connectivity has been planned in the country, to provide interconnectivity to different gas pipelines. In Southern India, the Government has approved the concept of a Southern Gas Grid. The projected tentative demand of the Southern States has been recently assessed through a joint study by the Southern states at 60 MMSCMD, this is expected to reach about 85 MMSCMD by the year

2010. Hence, there is a potential for utilising 2-3 BCFD of gas in the southern region. In order to meet the demand of southern states' import of gas by pipeline through two LNG terminals- one at Ennore and another at Mangalore, with a provision to enhance the capacity to 5 MMTPA (20 MMSCMD) each, is being contemplated.



Source: DGH

## POLICIES RELATED TO OIL AND GAS IN INDIA

### Investment Policy

The Planning Commission, Government of India brought out a report on Integrated Energy Policy in August 2006, which provides a long-term framework to address energy security of the country. To attain a sustainable economic growth at 8 per cent to 9 per cent per annum, supply of commercial energy is projected to grow in the range of

4.3 per cent to 5.1 per cent per annum over the 2003-04 level. Therefore, the long-term policy directions for oil and gas -sector are built on the following factors:

- Faster exploration of the entire domestic sedimentary basins, to augment domestic availability of oil and gas
- Improvement in oil and gas recovery levels
- Acquisition of equity oil and gas abroad
- Exploitation of alternative fuel sources such as CBM, gas hydrates, hydrogen fuel cells and blending of bio-fuels
- Improvement in energy efficiency and conservation
- Maintenance of strategic reserves in oil and petroleum products

Under the new investment policy for different sectors, announced in July 1991, for facilitating the inflow of foreign capital, a number of policy initiatives have been taken by the Government of India, such as:

- Equity participation in commercial and industrial ventures has been freed from all restrictions and foreign companies can now invest up to 100 per cent of equity in different activities, in the petroleum sector
- Deregulation and delicensing of various petroleum products in the country
- Gradual decontrol of pricing and distribution
- Freedom to form joint ventures for the development of infrastructure and for marketing and refining activities;
- Simplification of the procedure for obtaining industrial licences
- Approvals normally available within 6 to 8 weeks of filing the application. Empowered committees have been constituted to accord various approvals under a fast time-bound schedule
- Under the New Industrial Policy, proposals for foreign investment need not necessarily be accompanied by foreign technology agreements
- Marketing of transport fuels (petrol, diesel and aviation turbine fuel) permitted, subject to meeting minimum investment of US\$ 500 million in the oil and gas sector
- All such proposals, including those proposing investments by NRIs or for 100 per cent export oriented units, are considered for approval by the Foreign Investment Promotion Board (FIPB). In case of composite proposals, i.e., proposals seeking other industrial approvals like industrial licences, technical collaboration, etc. along with approval for foreign investment, the FIPB provides composite clearance

## PRICING

India has traditionally operated under an Administered Pricing Mechanism (APM), for petroleum products. This system is based on the retention price concept under which the oil refineries, oil marketing companies and the pipelines are compensated for operating costs and are assured a return of 12 per cent post-tax on the net worth. Under this concept, a fixed level of profitability for the oil companies is ensured, subject to their achieving their specified capacity utilisation. The administered pricing policy of petroleum products ensures that products used by the vulnerable sections of the society, like kerosene, or products used as feedstock for production of fertiliser, like naphtha, may be sold at subsidised prices.

The APM was dismantled in April 2002. Gradually, the Government of India has moved to market-determined, tariff-based pricing. Free imports are permitted for almost all petroleum products, like kerosene, LPG and lubricants, except petrol and diesel. It is contemplated that, all administered price products will be taken out of the administered pricing regime in a phased manner and the system will be replaced by a progressive tariff regime.

On the pricing front, the government-appointed committee on pricing and taxation of petroleum products, has recommended that the oil companies should shift from an 'import parity based pricing' to a 'trade based pricing'. It has also suggested, the reduction in custom duties on petrol and diesel from 10 per cent to 7.5 per cent and the shifting of excise duty from an ad-valorem levy, to a specific levy.

## POLICY RELATED TO EXPORTS AND IMPORTS

Imports of all petroleum products are permitted under the Open General Licensing (OGL) scheme, except for crude oil, motor spirit, diesel, aviation turbine fuel, furnace oil, bitumen, wherein imports are permitted under freely tradable special import licences. Exports of aviation turbine fuel, bitumen, crude oil, diesel, kerosene, LPG, motor spirit, naphtha and raw petroleum coke are channelised through Indian Oil Corporation Ltd. All other products can be freely exported.

## HYDROCARBON VISION 2025

A ministerial group, set up by the Prime Minister, to give focus on a long-term energy security for India has developed the following vision, for the next 25 years:

- To assure energy security by achieving self-reliance through, increased indigenous production and investment in equity oil abroad
- To enhance the quality of life, by progressively improving product standards to ensure a cleaner and greener India
- To develop hydrocarbon sector as a globally competitive industry, which can be benchmarked against the best in the world, through technology up gradation and capacity building in all facets of the industry
- To have a free market and promote healthy competition among players and customer service
- To ensure oil security for the country, keeping in view strategic and defence considerations

The hydrocarbon vision has been converted into prioritised action agenda for medium and long term implementation in the medium and long term. In brief the main thrust of the activities would be:

- Focus on oil security, through intensification of exploration efforts and achievement of 100 per cent coverage of unexplored basins in a time bound manner to enhance the domestic availability of oil and gas
- Secure acreages in identified countries having high attractiveness for ensuring, the sustainable long-term supplies
- Pursue projects to meet the deficit in demand and supply of natural gas and facilitate availability of LNG
- Maintain adequate levels of self sufficiency in refining (90 per cent of consumption of middle distillates)
- Establish adequate strategic storage of crude and petroleum products in different locations. Create additional infrastructure for distribution and marketing, of oil and gas
- Open up the hydrocarbon market, so that there is a free and fair competition between public sector enterprises, private companies and other international players
- Create a policy framework for cleaner and greener fuels
- Have a rational tariff and pricing policy, which will ensure the consumer getting the petroleum products at the most reasonable prices and requisite quality, eliminating adulteration
- Announce a long-term fiscal policy, to attract required

investments in hydrocarbon sector

- Restructure the oil sector PSUs, with the objective of enhancing shareholder value and disinvest in a phased manner, in all oil sector PSUs
- To develop regulatory and legislative framework, for providing oil/gas security for the country

## POLICY AND REGULATORY FRAMEWORK - OIL

The current upstream regulation is provided by DGH primarily on technical aspects. The midstream and downstream sectors are largely unregulated. However, downstream regulation is proposed to be introduced with the passing of the Petroleum and Natural Gas Regulatory Board Bill. Over the past five to six years, the trend has been towards opening up the sector for greater investments, setting up an independent regulator to monitor post-production activities and enabling a transition from an administered to a market driven mechanism. This also includes de-controlling of most of the petroleum products and allowing private sector companies to market them at the market determined prices.

Another significant trend in oil and gas regulation in India is the opening up of the sector to private and foreign participation. 100 per cent Foreign Direct Investment (FDI) is allowed in exploration, creation of pipeline infrastructure, refining and in downstream retailing. 100 per cent FDI in retailing is allowed, subject to minimum investment of US\$ 445 million in midstream or upstream sectors.

## **POLICY AND REGULATORY FRAMEWORK - GAS**

Over the past six years, the trend in natural gas regulation has been towards opening up the sector for greater investment, setting up an independent regulator to monitor post production activities, and enabling a transition from the administered control regime to a market driven mechanism. Significant regulatory issues, which will impact the gas sector in India, include:

### **Petroleum & Natural Gas Regulatory Board Act, 2006 (PNGRB Act, 2006)**

The Act, envisages setting up a Petroleum & Natural Gas Regulatory Board, 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.

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

The objective of the policy is to promote investments from public as well as private sector in natural gas pipelines and city or local natural gas distribution networks to facilitate open access for all players to the pipeline network on a non-discriminatory basis, to promote competition among entities and to protect the end consumer. A Gas Advisory Board (GAB), will be set up to promote and develop the gas pipeline network in India.

### **Gas Linkage Committee**

The Gas Linkage Committee (GLC), was established to manage the allocation of gas to eligible customers. This was linked with the administered price mechanism, which depressed domestic gas prices for certain sectors. However, new fields under the National NELP, are already exempt from the purview of the GLC and can trade at market prices

### **Infrastructure Status for Gas Pipelines**

Development of gas pipelines and related storage has been granted 'Infrastructure Status'. While, this would be translated into a number of benefits for companies planning on developing gas transmission pipelines, it will also allow for lower gas transmission tariffs, when part of these benefits are passed on to the end consumer.

### **FDI in Natural Gas Sector**

FDI of 100 per cent is allowed in the exploration, pipeline infrastructure, LNG and trading segments, subject to approval. The integrated LNG policy is currently under discussion and is likely to be put in place soon.

# Investment Opportunities and Potential

## OPPORTUNITIES IN THE OIL SECTOR

### Investments under NELP

Though, the recent rounds of NELP bidding are still dominated by public sector, the Government is keen on greater foreign participation under NELP process. DGH has indicated that 70-80 blocks, including those in unexplored states, will be made available in NELP-VII.

### Destination India as refining hub

India's key advantages for developing itself as an export refining hub, includes cost competitiveness, arising mainly out of lower labour costs as compared to developed markets and locational advantages. Geographically, India is strategically located en route to the Middle East's crude consignments for East Asian and Pacific-rim markets. In fact, India possesses surplus refining capacity and has already turned into a net exporter of products. Certain areas of the country have been already demarcated for the development of export-oriented refineries. Dialogues are underway between the Ministry and some oil companies on implementation of the strategy and building supporting infrastructure for exports.

By 2010, the expected worldwide deficit in refining capacity will be around 112 MTPA, because of the shutting down of some of the smaller refineries in developed economies. Smaller refineries in North America and Europe are finding it uneconomical to invest in cleaner fuels because of high compliance cost and cleaner fuel norms. In Japan and Australia, oil majors have rationalised their refining assets because they are becoming uneconomical to operate.

On the domestic supply side, India's current refining capacity stands at around 143 MMT. The domestic refining companies have planned capacity additions to the tune of 90 to 100 MMTPA in the next 4-5 years. This large scale commissioning of capacities, when viewed against the expected demand of 196 MMT, suggests that India's petroleum product exports are slated to rise. It is expected that Reliance Industries' refinery expansion of 580,000 barrels per day at Jamnagar, will only cater to export markets in Europe and North America.

Another development has been the receipt of FDI in a public sector refinery for the first time. HPCL, has entered into a partnership with Mittal Investments, for setting up the refinery-cum-petrochemical complex at Bhatinda, in Punjab. This development might be viewed as the first step towards greater involvement by international oil firms in greenfield projects.

### Increased investment in fuel quality upgradations

Prompted by stringent fuel specifications in the developing countries and the domestic "Auto Fuel Policy" which mandate Euro IV norms by 2010, significant investments have been planned for upgrading existing refineries. IOC has planned investments of US\$ 1.5 billion towards upgradation of its Gujarat refinery, US\$ 3.5 billion for installation of a naphtha unit at its Panipat plant and US\$ 750 million for its Haldia refinery. HPCL and BPCL have planned similar investments for their Vishakhapatnam and Mumbai refineries, respectively. This quality upgradation calls for adopting state-of-the-art technology, requiring huge investments of the order of US\$ 2.5 billion by way of providing reformulated gasoline producing units, hydrocrackers, hydro-treaters, hydrodesulphurisers, etc.

### **Building strategic petroleum reserve through public-private partnership**

The Government has decided to set up strategic crude oil storage reserves at various locations in the country, to provide an emergency response mechanism to mitigate any short-term supply disruptions. Additionally, the Government is also exploring the possibility of increasing the oil stockpile in the country through, various innovative schemes, such as, leasing of storage space to international oil trading companies and building of additional storage terminals through the concessions route.

### **Acquisition of overseas oil assets**

The Ministry of Petroleum and Natural Gas has conceived a more coordinated approach towards acquisition of overseas oil assets, through joint forays and bilateral engagements with other countries, in order to benefit from each other's strengths in areas of technology transfers, R&D, safety and training and also through multilateral engagements such as, the Asian Round Tables, International Energy Forum etc. Recently, India has signed a Memorandum of Understanding with China, for joint bidding of hydrocarbon blocks.

### **Competition in the downstream (retail and institutional) segment**

As per the Petroleum Regulatory Board (PRB) Bill, all upcoming pipelines will have mandatory open access, which will drive competition in the retail and the institutional segment. In anticipation of competition, major oil firms are expanding their retail network and forming alliances with a host of product and services companies to offer non-fuel products and services. In the institutional segment, incumbents are focusing on profitable segments for subsidised products like LPG (commercial and non-domestic), as well as, on specialty products like Hexane.

## **OPPORTUNITIES IN THE GAS SECTOR**

In the last few years, the trend in natural gas regulation has been towards opening up the sector for greater investment, setting up an independent regulator to monitor post-production activities and enabling a transition from the administered control regime to a market driven mechanism. Significant opportunities that exist in the gas sector in India include:

### **Domestic exploration of NG**

The Government sees significant potential in domestic exploration as an option for matching supply with demand. On an average, reserves of more than 70 BCM a year have been discovered over the past decade. NELP provides significant benefits to private players in terms of allowing 100 per cent FDI, a seven-year tax holiday, free marketing rights in the domestic market etc. NELP VII has already been announced, opening up a new set of opportunities for investors.

After the formation of National Gas Hydrate Programme, gas hydrate exploration has also received considerable impetus in India. In 2006, India became the third country after Japan and USA, to engage a specially designed vessel named 'JOIDES Resolution', to carry out drilling activities in Indian waters for collecting cores, for studies of gas hydrates habitation, contents, etc.

### **Liquified Natural Gas (LNG)**

Given the shortages in domestic gas and uncertainties related to international pipelines, LNG is expected to get a boost. However, the lack of a cross-country gas pipeline to enable transmission, the emphasis on coal as the preferred fuel for Ultra Mega Power Plants and the gradual emergence of CBM make it difficult for LNG to compete at present. However, in the long-term, with demand soaring even higher, LNG is likely to be one of the most significant areas of investment in the NG sector. The most attractive areas for investment will be those, where pipeline gas is not expected in the near future.

### **CBM and Underground Coal Gasification Opportunities**

With proven reserves of 765 MTOE and indicated reserves of between 1,260-2,340 MTOE, CBM is expected to be a large opportunity. CBM exploration has already been taken up seriously, with more than 26 blocks awarded so far and more to be taken up. Compression of CBM and marketing as CNG can be exploited in potential industries, as a substitute to conventional natural gas. A related exciting technology is that of Underground Coal Gasification (UGC), which is already being exploited in Russia, at a small level. Given India's large coal reserve, the UGC technology could potentially produce volumes of multiples of India's free

natural gas reserve. For example, Gujarat's coal reserves could produce as much as 70 times of ONGC's current free gas reserves.

### **Natural Gas Hydrates**

Natural Gas Hydrates are a combination of gas and water in solid phase at low temperatures. These hydrates are a potential source of natural gas. Among the locations showing evidence of in-situ hydrates, the most probable occurrence is in Indian Ocean region. Studies are being undertaken in the Indian Ocean region to establish the potential natural gas hydrates. Natural gas hydrates constitute a promising area, where opportunities exist for companies to participate in exploiting this potential source of energy.



### **Exchange Rate Used**

<b>Year</b>	<b>Exchange Rate (INR/US\$)</b>
2000	46.6
2001	48.3
2002	48.04
2003	45.6
2004	43.7
2005	45.2
2006	45
2007	42

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