Contents

India's Sugar Industry

The earliest mention of Sugar is found in Indian Writings (Vedic Era) and no such references have been found in contemporary Chinese or European records. So, it was asserted that Sugar originated in India. But Sugar did not originate in India. Sugar plant is indigenous to **New Guinea**[1] and it spread to other parts of South Asia and from there it spread to all over the world.

Production Status in World

Today, India is second largest producer of Sugar in the word after Brazil. The Top 10 Sugar producing countries are shown the in the following table.

Country	Production (tons)
Brazil	672,157,000
India	285,029,000
People's Republic of China	116,251,272
Thailand	66,816,400
Pakistan	50,045,400
Mexico	49,492,700
Colombia	38,500,000
Philippines	32,500,000
Australia	30,284,000
Argentina	29,000,000
World	**1,743,068,525**

[1] Deerr, The History of Sugar Volume II, C & H London

Source: FAO, Data 2009

In the India, Sugar Industry is one of the largest industries only next to textiles and plays a very important role in the Indian Economy. Sugar Industry is agro based and mainly located in the rural areas of the country. The Industry affects the agriculture sector and the people related to it through the forward and backward linkages. It affects the economy of the states such as Uttar Pradesh, which have an economy dominated by the agriculture.

Production Status in India

Top Sugar Producing States in India 2007-08

State	Area	% to All - India	Production	% to All - India
1	2	3	4	5
Uttar Pradesh	2.18	43.08	124.67	35.81
Maharashtra	1.09	21.54	88.44	25.40
Tamil Nadu	0.35	6.92	38.07	10.93
Karnataka	0.31	6.13	26.24	7.54
Andhra Pradesh	0.25	4.94	20.30	5.83
Gujarat	0.21	4.15	15.19	4.36
Haryana	0.14	2.77	8.86	2.54
Uttarakhand	0.12	2.37	7.69	2.21
Punjab	0.11	2.17	6.69	1.92
Bihar	0.11	2.17	3.85	1.11
Madhya Pradesh	0.08	1.58	3.18	0.91
West Bengal	0.02	0.40	1.27	0.36
Orissa	0.02	0.40	1.10	0.32
Assam	0.03	0.59	0.98	0.28
Others	0.04	0.79	1.66	0.48
All India	**5.06**	**100.00**	**348.19**	**100.00**

Area: Milion Hectares
Production: Million Tons

Uttar Pradesh is largest Sugar Producing State in India as per the Agriculture Stats at a Glance 2009 (Ministry of Agriculture). U.P. is followed by Maharashtra, Tamil Nadu, Karnataka and Andhra Pradesh.

India's is second largest sugar producing country of the world. In India, sugar is second largest agro based industry which provides direct and indirect employment to 35 Lakh workers and 4.5 Crore farmers. Only sugar accounts for 7.5% of the gross value of the agricultural production in the country.

In our country, the process of the sugar factories has improved from a process called Khandsari. Sugar was produced in the Khandsari units and the produce was a yellowish colour powder. In the mid of the 20th century this traditional Khandsari was replaced partially by **Open Pan Sulphitation** (OPS) which is actually using **the Sulphur compounds to control the pH** and colour of the Sugar. So this process started giving Crystalline and white sugar. The improved technique is Vacuum Pan Sulphitation (VPS) which is now used in most Modern Sugar Factories.

Quick Facts: Sulphitation

The Sulphitation refers to the practice of using Sulphur compounds (commonly Sulphur Dioxide -SO_2) to control the **pH, Bacteria growth and Color of the produce**. The SO2 in aqueous solution reacts with water to form H2SO3 (Sulphurous Acid) and thus more acidic solution is formed which is favorable in the process. Apart for this SO2 serves as a biocide. The reaction of SO2 with the carboxyl group of the Glucose and Fructose stops them to react with the amino acids (**called Maillard Reaction which is used in preparing food flavors**). Most factories burn the Sulphur to get SO2.

History of Sugar Industry

Since ancient times, Sugar has been produced in the local units in India. The Industry starts with 1903 when the first Sugar Mill was started in India in Bihar, followed by another unit in 1904 in Uttar Pradesh. By mid of the 20th century Sugar Industry expanded and before India's independence there were 138 sugar mills in India. After partition around 67% sugar mills came in share of India and remaining in share of Pakistan.

- In 1930s Sugar was given protection and this industry has been traditionally called a "**Child of Protection**".
- The Industry grew after India's independence. From 143 factories in First Five Year plan, the number rose to 571 in the 11th five year plan. The following table shows the number of mills and production of sugar in India in lakh tons.
- **Please note that 60% mills in India are in Cooperative sector**

Number of Sugar Mills in India and Production		
First Five Year Plan	143	11.3
Second Five Year Plan	174	19
Third Five Year Plan	200	30
Fourth Five Year Plan	228	36
Fifth Five Year Plan	263	40
Sixth Five Year Plan	338	63
Seventh Five Year Plan	392	70
Eighth Five Year Plan	490	110
Ninth Five Year Plan	500	153
Tenth Five Year Plan	506	195
Eleventh Five Year Plan	571 (Including closed Units)	220

Data source Economic Survey, 11th plan figures are unofficial , production : lakh Tons

- **Per Capita Consumption:** Per Capita consumption of sugar in the country is around 45 Gms per day.

The Dogma of Dual Pricing Mechanism

In the above table we see that India's sugar production in 1951-56 period was around 11 lakh tons which became trebled in 3 plan periods. This was because the government of India provided incentives to the higher production and output. But the journey from becoming a below average producer to above average producer of the Sugar saw a lot of fluctuations in the prices, frequent controls and decontrols by the government. To check the frequent rise and fall in the prices of sugar, government introduced dual price mechanism. Under the dual price mechanism, the government fixed the ratio of Levy sugar and free sale sugar quota.

What is Levy Sugar?

Every sugar mill is allocated a command area in its vicinity. This command area varied from 15-25 kilometres radius. The mill is bound to purchase any sugarcane grown in that area and the cane farmers are also expected to sell only to the designated mill. A part of produce of these sugar mills is required to be **sold to the Government**. This part is known as Levy Sugar. The levy sugar is sold to the consumers through fair price shops of the public distribution system.

- The ratio initially was fixed 45:55. This ratio was revised to 28:72 later. Later it was made 10:90 and 20:80 for the current sugar season in 2010.

The Central Government pays the price based upon SMP. SMP stands for Statutory Minimum Price (SMP) which is announced by the Central Government. The states also announce SAP or State Advisory Price which is in most cases higher than the SMP. The sugar mills pay the sugarcane growers a price higher than SAP /

SMP. The rest of the sugar can be sold by the Sugar Mills in open market. However, this is also regulated. The government fixes quota for each sugar mill to control the supply.

Bhargava Formula

Sugarcane (Control) Order, 1966 provides for price(SMP) for sugarcane purchased by sugar mills during each sugar season. Section 5 A of this order provides for payment of additional cane price in accordance with a formula contained in the Second Schedule to the Sugarcane (Control) Order, 1966. This is called Bhargav Formula. The Supreme Court had ruled that the price of levy sugar should include the additional price as indicated in Section 5A of the Sugarcane Control Order, 1966 (known as the Bhargava formula) and the State Advisory Price (SAP) set by state governments. The impact of this Supreme Court order was that the government would have to pay ₹ 14,000 Crore in arrears to sugar mills going back to October 1974.

This controversy was solved in November 2009 by an all party consensus. The new legislation was supported by all parties that had agreed to support legislation to nullify the impact of a Supreme Court order. The new legislation was **Essential Commodities (Amendment) Act, 2010**. Bill for the purpose of this act was introduced & passed on August 9, 2010 by the Lok Sabha. The objective of this act is to amend the Essential Commodities Act, 1955 to clarify the price payable for levy sugar, procured for public distribution system. The act mentions that

The "fair and remunerative price" referred to in clause (a), "manufacturing cost of sugar" referred to in clause (b) and "reasonable return on the capital employed" referred to in clause (d), of this sub-section do not include the pricepaid or payable under any order or any enactment of any State Government and any price agreed to between the producer and the grower or a sugarcane growers' co-operative society.

This provision will be discussed later in this module.

B. B Mahajan Committee

B B Mahajan Committee was set up by the government of India to study the development and growth of India's Sugar industry in comparison to industry in other leading countries. This committee had submitted its report in 1998 and recommended complete decontrol of the sugar so that there is a complete level playing field for imported as well as home produced sugar. Based upon the recommendation of this committee, the government announced to remove the sugar industry for compulsory licensing under the IDA act. It also decided to maintain a distance between two sugar mills a distance of minimum 15 kilometers to avoid unhealthy competition among the factories to procure the sugarcane.

Sugar Decontrol: Recent Issues

The Mahajan committee had mooted the idea of complete decontrol of sugar industry. But the government has always **hesitated** to decontrol sugar. The reasons are manifold, but the prime reasons for NOT adopting the complete decontrol of the sugar industry are as follows:

1. Sugar Industry is an agro based industry and in India the output of agriculture is uncertain. If there is a surplus in the sugar cane crop, control is necessary to prevent the price collapse which may hurt the industry.
2. If there is a short supply of sugarcane, protection of consumer's interest becomes essential for the government.

In 2010, Sharad Pawar, India's Agriculture Minister, who is also widely believed to be the architect of Sugar Sector policies, had made a statement that Government would consider total decontrol of the sugar industry sometime in September 2010 after cane crop and sugar production estimates for 2010-11 crystallize. Despite this the Government has not been able to take a decision on complete Sugar. The sugar industry's wait for an end to stifling restrictions and regulations seems to be eternal. Even as the Prime Minister's Economic Advisory Council, headed by C Rangarajan, had reportedly chalked out a detailed road map for sugar decontrol, the prime minister, instead of acting on it, chose to appoint another committee – headed by Rangarajan himself – to go into all the related issues. This has given rise to more suspicion than it has quelled about the government's real intentions concerning deregulation. The timing of the announcement, coming in the middle of the Assembly election process in three major sugar-producing states viz. Punjab, Haryana and Uttarakhand in 2012, further compounds misgivings, given the sector's deep-rooted politicisation.

As mentioned above, the Sugar sector reform has been probed by umpteen numbers of committees and expert panels. Apart from the historic committees mentioned above, there are two committees viz. the **Tuteja committee** and the **Thorat committee** were installed during the United Progressive Alliance (UPA) rule itself. Most of these committees have unanimously recommended complete decontrol and deregulation of this sector. Senior government functionaries, including several ministers, have been making the right noises over this issue. Yet, the dilly-dallying in taking a final decision continues.

What is Sugar Decontrol?

There are two main elements of the Sugar Decontrol.

1. Abolition of the levy system
2. Dismantling of free-sale quotas

The decontrol proposal mooted by Sharad Pawar had involved the following:

1. Dismantling the monthly release mechanism (by which the Centre decides how much sugar each factory has to sell during a month),
2. Dismantling Levy quotas (requiring mills to supply 20 per cent of their output at below market price for the Public Distribution System)
3. Dismantling cane area reservation (binding growers to particular mills by prescribing a minimum distance between two plants).

Why the government is reluctant of Sugar Decontrol:

- ✓ If the Levy is abolished, the government would need to procure sugar from the open market. This would be done through some processes such as tenders. After procuring the sugar from the open market, the government would require to supply this to State Governments to supply the same to consumers through the PDS. Now, politically, it is not possible to discontinue the sale of sugar through the PDS. A short supply in the market would raise the government subsidy and rise in the supply will also cost to the government.

- ✓ If the Free sale quota is dismantled, it would be an overdue step because it would allow sugar mills the freedom to plan production, inventory and sales. Though the State Governments don't come under the picture of both Levy and Free Sale quota, it is State Governments which may suffer if there is a fluctuation in the cane production and supply. So the cyclical nature of the cane yields and output don't let the government to completely decontrol the sugar.
- ✓ Apart from this, the complete sugar Decontrol would also attract some more relaxations. Examples are withdrawal of administrative restrictions such as stock limits and removal of external trade restrictions (import and export). The above implications are evident from the statement of Sharad Pawar: (Noted from Business Line, Sep 05, 2010)

"No State would be open to the idea of doing away with levy, as that would force them to procure their ration sale requirements entirely through open market purchases at higher prices,"

What does Industry Say about Decontrol?

The Industry believes that end of age old restrictions will **boost competitiveness in the domestic sugar industry** because the Sugar Mills would be allowed to plan and manage production, marketing and inventory. The prices of the Sugar will be market-determined and the investment climate in the industry will improve.

The industry says that this is the ideal time for lifting curbs on this sector, since sugar production is on the upswing and its inventories are building up after surplus output in 2010-11 and 2011-12. The current glut has already depressed domestic sugar prices from the highs they touched in 2009, and unless the right moves are made now it may be difficult to sustain the uptrend through 2012-13. Certainly, previous moves to decontrol sugar – as early as 1971-72 and 1978-79 – were a fiasco, and had to be retracted; but those were different times, when the industry was underprepared for existence without government intervention. Now, for the first time, the entire sugar industry (including the cooperative sector, which accounts for nearly 45 per cent of the total output), feels confident of standing on its own and is, in fact, unanimously demanding freedom from officialdom. A significant lesson that ought to be learnt from past experience is that the decontrol has to be complete; a piecemeal approach, as tried out in the past, will not work. The industry's obligation to part with 10 per cent of its output as levy, at prices lower than the production cost, needs to be done away with. In addition, the curbs on domestic and external trades through monthly release mechanism and export limits need to go.

Importantly, the prices of sugarcane, the chief raw material for sugar production, need to be linked to the ultimate realisation of the industry from the sale of sugar and its by-products — which, in other words, means profit-sharing with the cane farmers. Only then can the industry survive and take its own business decisions, ending the cyclicality in sugar and sugarcane production, and thereby ensuring stable sugar prices for consumers.

At present, the Sugar Industry estimates sugar production of about 26 million tonnes by the end of the current crushing season and a fall in the 2012-13 season. The industry believes the time is ripe for the government to de-regulate the sector. Here are some other important points, which you must note:

- Four committees have so far made comprehensive policy recommendations to decontrol the sector. These bodies were the Sugar Industry Enquiry Commission headed by V Bhargava (1974), another chaired by former food secretary B B Mahajan (1998), one headed by former food secretary S K Tuteja on revitalisation of the sugar industry (2004) and a fourth chaired by the former chairman of National Bank for Agriculture & Rural Development Y S P Thorat on the sugar economy and the way forward (2009).
- All these panels had sought complete decontrol that could be phased over two to five years.
- The Thorat committee had recommended decontrol in three to five years.
- Tuteja panel called for determination of sugarcane price by market forces.
- Thorat's body suggested doing away with sugar release mechanism.
- B B Mahajan committee suggested decontrol from the beginning of the sugar season.

Essential Commodities (Amendment) Act 2010

The Essential Commodities (Amendment) Bill, 2010 was introduced & Passed by Lok Sabha on August 9, 2010 The objective of this bill was to amend the Essential Commodities Act, 1955 to clarify the price payable for levy sugar, procured for public distribution system.

The Essential Commodities Act was passed in 1955. It seeks to provide, in the interests of the general public, for the control of the production, supply and distribution of, and trade and commerce in, certain commodities. Sugar and sugarcane are foodstuffs and thus essential commodities under the said Act.

What are SMP & SAP?

The Central Government pay the price based upon SMP. SMP is the Statutory Minimum Price (SMP) which is announced by the Central Government. The states also announce SAP or State Advisory Price which is in most cases higher than the SMP. The sugar mills pay the sugarcane growers a price higher than SAP / SMP. The rest of the sugar can be sold by the Sugar Mills in open market. However, this is also regulated. The government fixes quota for each sugar mill to control the supply.

What is FRP

Under the system of partial control on sugar, a part of the sugar produced by sugar mills is requisitioned as levy sugar and the balance is allowed to be sold as non-levy (free sale) sugar in the open market. While the price of non-levy sugar is determined by the market forces, the price of levy sugar is fixed by the Central Government.

- For the 2009-10 sugar seasons, the Central Government had fixed an FRP of ₹ 129.84 per quintal linked to a basic recovery rate of 9.5 per cent subject to a premium of ₹ 1.37 for every 0.1 percentage increase in recovery above that level.

The Price to be paid to the sugar producers for procuring levy sugar will be based on the "Fair and Remunerative Price" (FRP) fixed for sugarcane, and will include the manufacturing cost, duties, taxes and reasonable rate of return. Earlier the price was based on the Minimum Price (SMP) for sugarcane, and included the other costs and return.

The "Fair and Remunerative Price" will be announced by the central government, similar to the earlier system of SMP. The Amendment clarified that the central government would not pay any price in excess of that based on FRP for sugarcane. This comes into force from October 2009.

Why this bill?

The principal Act was amended in December 2009 as Essential Commodities Act 2009. Section 3 of this act says that central government, while procuring levy sugar, would not pay any price in excess of that calculated on the basis of the Minimum Price (SMP) for sugarcane set by the central government. However, there was no such explanation of the "fair and remunerative price". This amendment has added an explanation to the bill which seeks to remove the ambiguities and incorporates the "reasonable return on the capital employed in the business of manufacturing of sugar".

Is any substantive change in the Sugar Procurement Policy?

No. The bill just has sought to remove legal ambiguities in the pricing and sale of sugar.

Any impact on State's power to Fix SAP?

There is no impact and they states have the full power to fix the SAP.

A Bitter Sugar Industry Cries for Deregulation. To save the sugar industry from death, the government should remove levy obligation immediately, buy sugar in the open market and promote a futures market

Sugar is the largest agro-based industry located in rural India that directly contributes to rural economic development. It is one of the most environment-friendly industries producing green power and also addressing the energy need of the country through ethanol. India is the largest consumer and second-largest producer of sugar in the world.

Problems of the Sugar Industry

Excessive Controls

Despite two decades of economic liberalisation that sought to end the control era, the domestic sugar industry is still reeling under excessive government controls. For instance, raw material prices are not in industry hands; raw material availability is not in industry hands; sales volume is not in industry hands due to monthly release mechanism; selling prices of sugar are not in industry hands; supply of PDS sugar is at 40% below production cost; stocking of sugar is an obligation on the industry; cash-flow planning is not in industry hands; packaging material of sugar is not in industry hands, export-import of sugar is not in industry hands; stock limit on bulk consumers and traders is applied on domestic sugar and none on imported sugar; and other ad-hoc controls by the central and state governments.

Unfortunately, sugar is the country's only industry that has no control or say in its own fate despite supporting about 50 million farmers and generating employment for about 12% of the total rural population in nine major sugar-producing states. The excessive control on the industry is even disproportionate to its impact on consumers and farmers. Sugarcane accounts for only 2.58% of total gross cropped area, and the share of sugar is just 2.4% and 1.5% of the total consumer expenditure for rural and urban India respectively. Additionally, household consumption accounts for just one-third of the total consumption of

sugar, with institutions and bulk consumers accounting for the remaining two-third. The industry clearly defies any need for so many regulations.

Regulations Breed Cyclicality

Instead of helping anybody, the multiple controls have, in fact, adversely affected all stakeholders: farmers, consumers, manufacturers and the government. Moreover, the present structure has created a situation of 'repetitive cyclicality', restricting industry's growth and its development whereby successive high cane prices induce surplus production, bring down sugar price, affect profitability and lead to cane arrears that, in turn, forces the farmer to cut down cane production. Reduced cane production leads to lower sugar production and, hence, firming up of sugar prices, leading to remunerative cane prices paid to farmers. And this 'repetitive cyclicality' has become a hallmark of the industry, restricting its growth and development.

It is understandable that farmers should be given remunerative and attractive cane price as incentive since cane is a longer-duration and labour-intensive crop. However, government's fixing unviable sugarcane price with no linkage to sugar prices makes it difficult to give reasonable cane price to farmers. The industry has paid around . 55,000 crore in cane price in 2010-11. This will further increase in the current year. Successive increase in cane price leads to repetitive cyclicality and even more intense government regulations on prices, open market sale, exports and imports to control prices. Thus, the industry oscillates between a deficient year and a surplus year.

Levy Sugar Obligation

The sugar industry has to bear 10% levy sugar obligation for providing sugar to the government for public distribution system (PDS) at prices much below the cost of production. The estimated loss to the industry last year on account of this has been around . 3,000 crore.

If the government buys sugar in the open market for PDS, the estimated burden would be around . 3,000 crore. This would be minuscule compared to the overall food subsidy bill of . 70,000 crore.

Release Mechanism & Stocking

There is a regulated monthly release mechanism scheme that governs supply and sale of sugar in the market. Further, stocking of sugar as per the government norms has cost the industry around . 40,000 crore in the previous year, denting industry's margin significantly.

Export Under OGL

Even during the years of surplus production, the sugar industry cannot export its surplus stock under open general licence. It has to abide by the export quota decided by the government, even during surplus years, belying any economic rationale for such an obstructive policy.

Lack of Linkage Among Prices

Curiously, there is no linkage between cane prices paid to farmers, and sugar prices and its by-products (molasses and bagasse). The government should consider linking cane prices to sugar and by-product prices — imputed value of molasses and bagasse — to help the industry and the farmer to strategically plan demand-supply in the market, and reduce volatility in availability of sugar and its prices. Bagasse has a potential of generating 4,000-5,000 mw of power. Stable cane crop production would help in continuous and stable supply of bagasse to power producers. Given the fact that hydrocarbon resources are limited, most of

the developed countries are giving preference to alternative fuel technologies and allowing blending of ethanol with petrol. However, lack of a proper ethanol pricing formula is affecting its use in its blending with petrol. Considering that the country is a fast-growing economy and our energy needs are substantial and also petroleum subsidy at times of high international prices is hurting country's fiscal health, the government needs to finalise ethanol pricing formula at the earliest. Similarly, molasses have a role to play in alcohol industry and also in production of ethanol for blending with petrol.

Immediate Policy Action Needed

The industry is seeking complete decontrol and reforms of the sector in larger interest of all stakeholders. The industry needs immediate policy action to avoid building up of cane arrears and smooth operations of sugar mills in the ensuing sugar season. To begin with, the government should remove levy sugar obligation immediately and buy sugar in the open market. Monthly release scheme should also be dispensed with and the government should itself maintain strategic stock. A transparent and robust forward and futures market for sugar should be promoted. The policy should link sugarcane price with sugar's and its by-products' prices to arrive at a more realistic cane price. A stable export policy under the OGL and removal of stock limits on traders and bulk users will help the industry. Finalising ethanol pricing formula and allowing packaging of sugar in any food grade material would be in the interest of the industry.

Decontrol of the sector is the only way forward lest it gets destabilised under the excessive burden of regulations, and withers away.

Sugar Development Fund

The Sugar Development Fund was established in 1982 under the **Sugar Cess Act**. It was funded by a cess of ₹ 14 per quintal of sugar produced by all factories in India and utilized for advancing loans at concessional rates for rehabilitation and modernization of the Sugar Industry. This fund also involved expenditure in building up the Sugar Buffer Stocks.

National Sugar Institute

National Sugar Institute is located in Kanpur, Uttar Pradesh. It is a Research and Training Institute under the Department of Food and Public Distribution of the Ministry of Consumer Affairs, Food and Public Distribution. It was first established in 1936 by taking over sugar section of Harcourt Butler Technological Institute, Kanpur and was named as Imperial Institute of Sugar Technology. The Imperial Institute of Sugar Technology was placed under the administrative control of the Imperial Council of Agricultural Research. In 1944, with the formation of Indian Central Sugarcane Committee the administrative control of the Imperial Institute of Sugar Technology was transferred to that committee. After the independence of India, the name of the institute was changed to Indian Institute of Sugar Technology.

India's Petroleum Industry

Petroleum is a mixture of a large number of different kinds of Hydrocarbons such as

1. alkanes,
2. cycloalkanes,
3. aromatic hydrocarbons

4. Asphaltics.

The unique mix of molecules of these hydrocarbons provides properties to petroleum such as color or viscosity.

Alkanes:

Alkanes or **paraffin** are saturated hydrocarbons which have only Carbon and Hydrogen molecules in them. The general formula of alkanes is C_nH2_{n+2}. Simplest alkane is Methane CH_4. There is no limit of the carbons atoms that can be linked together and this makes the alkanes a series of linked carbon atoms which is called carbon skeleton and, each bonded with hydrogen atoms. The alkanes are acyclic (straight or branched chains), saturated and are only Hydrocarbons. They are also known as Paraffin. They are chemically less active.

- The varying number of carbon atoms is also responsible for the physical and chemical properties of the alkanes such as boiling/ melting points and viscosity.

The following table represents the simple and complex alkanes with their names and general properties.

Alkane	Formul	Boiling point ℃	Melting point [℃	Physical state
Methane	CH_4	-162	-183	gas
Ethane	C_2H_6	-89	-182	gas
Propane	C_3H_8	-42	-188	gas
Butane	C_4H_{10}	0	-138	gas
Pentane	C_5H_{12}	36	-130	Liquid
Hexane	C_6H_{14}	69	-95	Liquid
Heptane	C_7H_{16}	98	-91	Liquid
Octane	C_8H_{18}	126	-57	Liquid
Nonane	C_9H_{20}	151	-54	Liquid
Decane	$C_{10}H_{22}$	174	-30	Liquid
Undecane	$C_{11}H_{24}$	196	-26	Liquid
Dodecane	$C_{12}H_{26}$	216	-10	Liquid
Icosane	$C_{20}H_{42}$	343	37	solid
Triacontane	$C_{30}H_{62}$	450	66	solid
Tetracontan	$C_{40}H_{82}$	525	82	solid
Pentacontane	$C_{50}H_{102}$	575	91	solid

Please Note:

- Natural Gas primarily contains Methane (CH_4) and the bye products are ethane, propane, butane and pentanes.
- Ethane is parimarily used for production of Ethylene which is **most produced organic compound in the world** and is an important plant hormone.
- Alkanes from pentane to Octane are refined into petrol (Gasolene)
- Alkanes from Nonane to Hexadecane are refined to Diesel and Kerosene.
- The alkanes above hexadecane are refined into fuel oil and lubricating oil.

Cycloalkanes:

- Cycloalkanes are also known as **naphthenes** and they have a ring structure. They are named as Cyclopropane, cyclobutane, Cyclopentane, Cyclohexane etc.
- The Cycloalkanes with more than 20 carbon atoms are called **Cycloparaffins.**

- The cycloalkanes have the same properties as the alkanes but they have "Higher Boiling & Melting points". This is because of the stronger dispersion forces between the atoms known as London Forces.

Aromatic Hydrocarbons

The aromatic Hydrocarbons are unsaturated hydrocarbons which have one or more planar six-carbon rings or benzene rings. The Chemical formula is CnHn.

- The aromatic hydrocarbons burn with a sooty flame.
- Most aromatic hydrocarbons have sweet aroma.
- Many of the aromatic hydrocarbons are carcinogenic.

Petroleum and Petrochemicals permeate in every industry and household and the products of this industry have major impact on all walks of life. Petroleum is important to maintain the Industrial Civilization and is a critical concern. A large fraction of world's energy consumption involves oil.

30 Billion barrels of Oil is consumed every year and this makes it world's largest industry by dollar value.

The petroleum industry can be divided into 3 parts as follows:

1. **Upstream:** This refers to searching for and the recovery and production of crude oil and natural gas and is also known as the exploration and production (E&P) sector.
2. **Downstream:** Downstream sector refers to refining of the crude oil and selling distribution of natural gas and products derived from the crude oil. The products are LPG, Gasolene, Jet Fuel, Petroleum coke, asphalt, lubricants, synthetic rubber, plastics, antifreeze, pesticides , Pharmaceuticals and synthetic fibers.
3. **Transport :** Transport of the Petroleum products is done mainly by pipelines

- Transport of Petroleum products through pipelines was suggested by Mendeleev.
- Transport refers to transport of the crude oil to refinery and refined products to the consumers.

Comparing Sweet, Brent and Sour Crude Oil

Sweet Crude Oil :

- Type of petroleum.
- Contains < 0.5% Sulphur compared to Sour Crude Oil
- Contains small amount of hydrogen sulfide (H_2S) and carbon dioxide (CO_2).
- High quality, low sulfur crude oil used for processing of gasoline
- "Light sweet crude oil" most preferred edition of crude oil since it has a unduly large amount of these fractions that are used to process gasoline (naphtha), kerosene, and high-class diesel.
- The word "sweet" since a gently sweet taste and pleasing aroma due to the little level of Sulfur gives the oil with.

- Producers include:
  - The Appalachian Basin Eastern North America: Pennsylvania Grade Crude Oil.
  - Saskatchewanand Manitoba, the Bakken Formation of North Dakota, Montana,.
  - Some Mid-Continent Oil Field United States
  - The North Sea area of Northern Europe: UK (Brent Crude) and Norway, Iraq

- North Africa: Algeria and Libya .
- Western Africa: Ghana , Nigeria
- Central Africa: Democratic Republic of the Congo, Republic of the Congo, Angola.
- The Far East: Indonesia, China, Malaysia, India, Brunei, Australia, New Zealand and Vietnam.
- South America: Guiana basin, Saudi Arabia and Suriname

Brent Crude Oil :

- Largest of the several key classifications of crude oil comprising of Ekofisk, Brent Crude, Forties, Brent Sweet Light Crude and Oseberg.
- Source: North Sea.
- Manufacturer also known as London Brent, Brent petroleum and Brent Blend.
- Used to price 2/3 of the world's traded crude oil supplies.
- The name "Brent" from the identification strategy of Shell UK Exploration and Prod., working in lieu of ExxonMobil and Royal Dutch Shell, which at first named all of its fields after birds (in this case the Brent Goose).
- Production of Petroleum from Africa, Middle East and Europe flowing West tends to be priced relative to this oil, i.e. it forms a benchmark.
- Though, large parts of Europe now obtain their oil from Russia.
- Characteristics:
- Light crude oil
- Contains approx 0.37% of Sulphur (S) which classifies it as a Sweet Crude Oil
- Appropriate for production of gasoline.
- Usually refined in NW-Europe.
- API gravity of ~38.06 and a specific gravity of ~ 0.835.
- The Trading symbol for Brent crude is LCO

Sour Crude Oil :

- Contains the impurity Sulfur (S) > 0.5%
- The impurities are to be removed before this low quality crude can be refined into gasoline, thus increasing the cost of processing.
- This results in a higher-priced gasoline than that made from Sweet Crude Oil
- Thus Sour crude is generally processed into Heavy Oil such as Diesel and Fuel Oil instead of gasoline to decrease processing cost.
- Can be toxic and corrosive, particularly when it contains high levels of hydrogen sulfide (H2S).
- At low concentrations has the odor of rotten eggs.
- At high concentrations the breathing of hydrogen sulfide (H2S) is right away fatal.
- At even higher concentrations, the hydrogen sulfide (H2S) can spoil the Olfactory Nerve, making the gas in fact odorless and undetectable, whilst paralyzing the respiratory system.

- Its effects on the human body may be alike to that of Gulf War Syndrome (including headaches, dizziness, chronic fatigue, memory problems, birth defects, skin problems and breathing problems viz. asthma).
- Major producers of sour crude oil:
  - North America: U.S. Gulf of Mexico, Alberta (Canada) and Mexico.
  - South America: Venezuela, Colombia and Ecuador.
  - Middle East: Saudi Arabia, Iraq, Kuwait, Iran, Syria and Egypt.

Top Oil Producers

Saudi Arabia is the largest Oil Producing country of the world as per the data of US Energy Administration. The following table shows the top energy producing countries:

Top Oil Producer Countries of the World (2008)		
Rank	Country	Production
1	Saudi Arabia	10,782
2	Russia	9,790
3	United States	8,514
4	Iran	4,174
5	China	3,973
6	Canada	3,350
7	Mexico	3,186
8	United Arab Emirates	3,046
9	Kuwait	2,741
10	Venezuela	2,643
11	Norway	2,466
12	Brazil	2,402
13	Iraq	2,385
14	Algeria	2,180
15	Nigeria	2,169
(thousand barrels per day) Source: US Energy Administration		

✍ Over the past two decades, the growth in Non-OPEC Oil supply has resulted in decrease of the OPEC Market share, which is reduced to **33.3% of world's oil production**, considerably down from its highest 52% in 1973.

☞ **Please note that in terms of production India ranks 22.**

Top Consumer Countries

United States is largest Consumer of Oil in the world, followed by China, Japan and India. Russia is fifth largest consumer of Oil.

Top World Oil Consumers, 2008		
Rank	Country	Consumption
1	United States	19,498
2	China	7,831
3	Japan	4,785
4	India	2,962
5	Russia	2,916
6	Germany	2,569
7	Brazil	2,485
8	Saudi Arabia	2,376

✍ Japan is the largest nonproducing Consumer of Oil.

9	Canada	2,261
10	Korea, South	2,175
11	Mexico	2,128
12	France	1,986
13	Iran	1,741
14	United Kingdom	1,710
15	Italy	1,639
Thousand Barrels Per Day , Source U S Energy Administration		

Top Oil Importers

United States is largest importer of Oil, followed by Japan. India is world's 6th largest importer of oil.

Top Oil Importers		
Rank	Country	Imports
1	United States	12,224
2	Japan	4,903
3	China	3,670
4	Germany	2,325
5	Korea, South	2,210
6	India	1,964
7	France	1,897
8	Spain	1,583
9	Italy	1,519
10	Taiwan	950

Top Oil Exporters

Saudi Arabia is largest exporter of oil in the world, followed by Russia, UAE and Iran.

Top Exporters of Oil		
Rank	Country	Exports
1	Saudi Arabia	8,030
2	Russia	7,017
3	United Arab Emirates	2,475
4	Iran	2,342
5	Norway	2,338
6	Kuwait	2,288
7	Nigeria	2,062
8	Venezuela	1,957
9	Algeria	1,905
10	Angola	1,709

Petroleum Reserves of India: Quick facts

(This data is of 2008-09 and I could not find updated data on ministry's website)

- India has total reserves of **775 million metric tonnes of crude oil** and **1074 billion cubic metres of natural gas**.
- The total number of exploratory and development wells and metreage drilled in onshore and offshore areas during 2008-09 was 381 and 888 thousand metres respectively
- Crude oil production during 2008-09 at **33.51 million metric tonnes.**
- Gross Production of Natural Gas in the country at **32.85 billion cubic metres** during 2008- 09.
- The production of Natural Gas at 50.95% and 0.06% of the total were highest and lowest in Mumbai High and West Bengal respectively during 2008-09.
- The **refining capacity in the country is 177.97 million tonnes per annum** (MTPA)
- The total number of retail outlets of Public Sector Oil Marketing Companies : 35066
- The total number of LPG consumers of Public Sector Oil Marketing Companies as on 1.4.2009 was 105.632 million.
- The number of persons employed (including contract employees) in petroleum industry reached : 139823.
- **In 2009, India had** total reserves of **775 million metric tonnes of crude oil. Out of this 405 is onshore and 369 is offshore. (Onshore>Offshore)**
- **In 2009, India had Total Reserves of 1074 billion cubic metres of natural gas** of which 287 is Onshore and 787 is Offshore**. (Offshore >Onshore)**

Oil and Gas Fields in India

- As on 1.4.09, India had 402 total oil and gas fields. Out of which 16 are only Oil Fields, 125 are ONLY gas Fields and 261 are Both Oil and gas Fields.
- Maximum number of Fields in India are under ONGC (352), followed by Private and Joint ventures (31) and oil India Ltd (19).
- Under ONGC maximum Onshore fields are in Cambay, Gujarat (96), followed by KG Basin , Andhra Pradesh (45), and Upper Assam (31).
- Under ONGC maximum offshore fields are at Mumbai offshore 91.

Following table shows the number of fields under ONGC:

ONGC	Basin	Total Fields
Onshore		
Gujarat	**Cambay**	96
Assam	**Upper Assam**	37
Rajasthan	**Jodhpur**	7
Andhra Pradesh K G Basin	**K G Basin**	45
Tamil Nadu	**Cauvery**	26
Tripura	**AAFB**	9
Nagaland	**A & AA**	3
Offshore		
East Coast	**Cauvery Offshore**	4
	K G Offshore (Shallow)	9
	K G Offshore (Deep)	14
	Mahanadi	3
	Andaman	1
West Coast	**Mumbai Offshore**	91
	Kutch	5

India's Crude Oil Production

In 2008-09, India Produced 33506 thousand tons of Crude Oil. The Onshore production was 11744 thousand tons and Offshore production was 22232 thousand tons.

The following table shows this production.

India's Crude Oil Production (000 tons) 2008-09	
Onshore	
Gujarat	5944
Assam + Nagaland	4673.4 (Maximum)
Arunachal Pradesh	102.4
Tamil Nadu	265
Andhra Pradesh	289
Total	**11274**
Of which	
ONGC	7563
OIL	3468
JV / Private	243
Offshore	
ONGC	17801
JV/ Private	4431
Total	22232
Grand Total	33506

India's Natural Gas Production

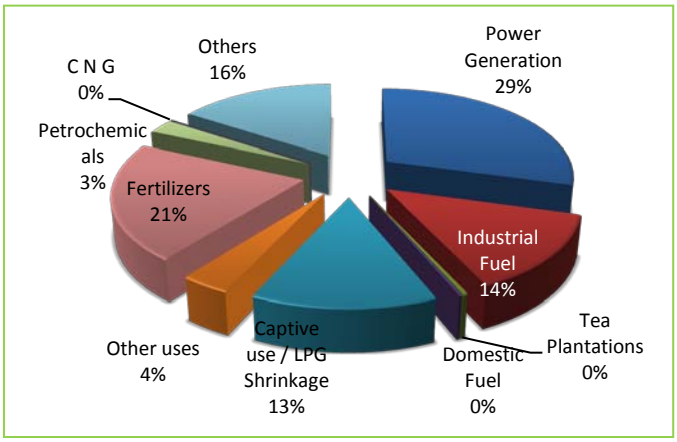
Following table shows the state wise natural Gas Production in India in 2008-09.

State-wise Gross Production of Natural Gas in India (Million Cubic Meters)	
Onshore	
Assam	**2819**
Gujarat	**2605**
Tamil Nadu	**1242**
Andhra Pradesh	**1524**
Tripura	**553**
West Bengal	**20**
Offshore	
Mumbai High	**16738 (Maximum)**
Private	**7348**

Industry wise use of Natural Gas in India

- Around 60% of the natural gas produced in India is used for Energy purpose.
- Out of this, maximum amount is used in Power Generation, followed by Industrial Fuel and LPG use.
- In Non-energy purposes, Maximum amount of Natural Gas is used in India in Fertilizer Industry.
- Following table & Graphics show this purpose of use of natural Gas. .

Use of Natural Gas in India 2008-09 (million Cubic Meters)	
Energy Purpose	
Power Generation	12603
Industrial Fuel	5912
Tea Plantations	154
Domestic Fuel	102
Captive use / LPG Shrinkage	5706
Other uses	1535
Non Energy Purpose	
Fertilizers	9082
Petrochemicals	1105



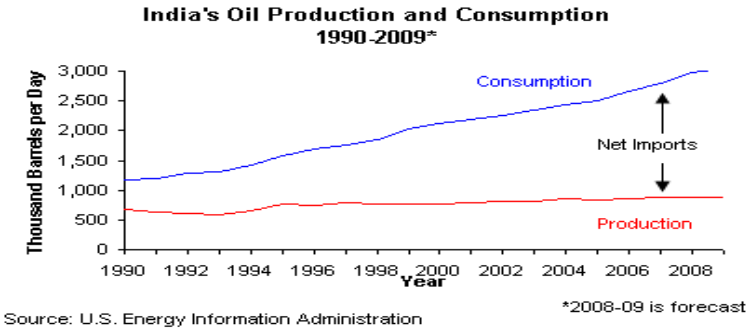
C N G	0
Others	6761
Total	**42960**

Some Other key facts and Data:

- Maximum number of Retail outlets are in Uttar Pradesh (4161), followed by Maharashtra (3089), Tamil Nadu (2896) and Punjab (2599).
- Maximum number of LPG distributors are in Uttar Pradesh (1177), followed by Maharashtra (1000).
- Maximum number of LPG domestic consumers are in Maharashtra (13 crore), followed by Andhra Pradesh (11 Crore) and Uttar Pradesh (10 Crore).

Export and Import of Oil

With around 75 per cent of total oil consumption in the country being met through imports, the dependence on imports for petroleum and petroleum products is very high. India continues to be a net importer of Oil. The following graphics shows this scenario:

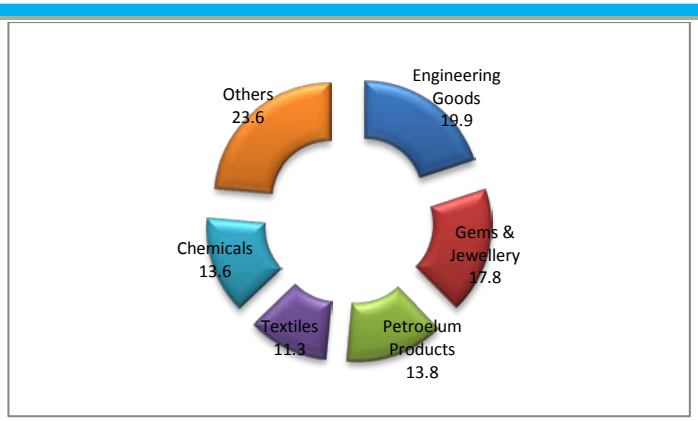


The domestic supply of crude oil remained around 34 million metric tonnes (MMT) and natural gas at about 32 billion cubic metric tonnes (BCM) during the past five years. During 2009-10, the projected production for crude oil is 36.7 MMT, which is about 11 per cent higher than the actual crude oil production of 33.5 MMT in 2008-09. This is primarily due to increase in crude oil production from Rajasthan (2.4 MMT) and the KG deepwater (0.8 MMT). The projected production for natural gas (including coal bed methane [CBM]) for 2009-10 is 50.2 BCM which is 52.8 per cent higher than the actual production of 32.8 BCM in 2008-09. The increase in natural gas production is primarily from the KG deepwater block.

Most of India's crude oil imports come from the Middle East, primarily from Saudi Arabia, followed by Iran. The Indian government expects this geographical dependence to rise in light of limited prospects for domestic production.

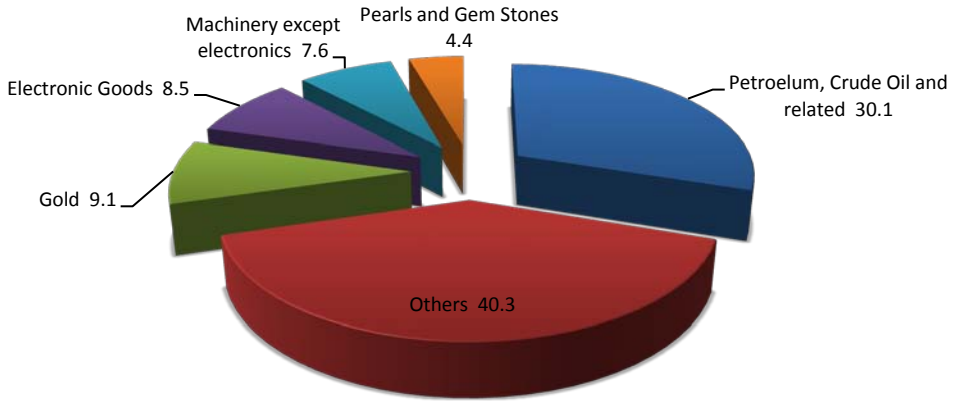
Share of Petroleum in Total Exports

The following graphic shows the breakup of India's exports during the period of April September 2009. With 13.8 % share in the total exports of India, Petroleum remains far below the other products.



Share of Petroleum in Total Imports

With 30.1% share in total imports during April -September 2009-10, Petroleum, Crude Oil and other products are India's largest Import Commodity. The following graphic shows this.



India's Petroleum industry: Historic Landmarks

India's Petroleum industry is more than 140 years old.

- The First well was drilled by The Assam Railway and Trading Company in 1865, just 6 years after World's First Oil Well was drilled in United States in 1859.
- In 1866 Mr. Goodenough of McKillop Stewart company drilled a well near Jaypore near upper Assam.
- Oil was discovered in Digboi in north-eastern part of Assam in 1889 by Assam Railway & Trading Company.
- In 1893 rights were granted to Assam oil syndicated to erect a refinery and led to formation of Assam Oil Company (AOC) in 1899. Assam Oil Company was given responsibility to carry out exploration work in Assam and adjoining areas.
- Before Independence, India's oil sector was controlled by the multinational companies such as Burmah Oil Company, Burmah Shell, ESSO, Caltex, Indo Burma petroleum etc. due to the fact that the production in 1947 was around 0.25 million tons only.
- The Assam Oil Company Ltd. (AOC) was later acquired by Burmah Oil Company Ltd.(BOC).
- In 1937, BOC, Royal Dutch/Shell, and Anglo Iranian Oil Company applied for exploration licensee in India and started geophysical survey.

- However, due to World War II, all activities were suspended.
- Assam Oil Company was later nationalized and now it is a division of the Indian Oil Corporation.
- After Independence, the Petroleum Industry was placed under the jurisdiction of the Central Government and there was a complete NO to private participation.
- **Indo-Stanvac Project :** A JV between GOI and Standard Vacuum Oil Company of US in 1953 gave the **first oil discovery of independent India near Nahorkatiya.**
- This was reiterated in the Industrial Policy Resolution of 1956, that --**Future Development of oil industry will be the responsibility of the state.**
- In the latter half of the 1950s, **Oil and Gas Directorate** was set up under the Geological Survey of India for petroleum exploration.
- In 1956, the Oil and Gas Directorate was converted in Oil and Natural Gas **Commission** and Oil and Natural Gas Commission was finally incorporated as a Public Sector Company as Oil and Natural Gas Corporation in 1994.
- In 1959, the Burmah Oil Company and Government of India entered into a joint venture which was known as Oil India Ltd.
- In 1958, Indian Refineries Ltd was set up. In 1959, Indian Oil Company was established. The Indian Refineries Ltd and Indian Oil Companies Ltd were merged into one entity in 1964 and this gave birth to Indian Oil Corporation.

Early Discoveries Post-Independence.

1. Discovery of Naharkotiya in NE in 1953
2. Ankleshwar in Cambay Basin in 1958
3. Mumbai High in Mumbai Basin in 1972
4. Cauvery in 1958 (Karaikal-1)
5. Jaiselmer sub-basin in 1958 (Manhertibba- 1)
6. Assam-Arakan yoma fold belt in 1973 (Baramura-1)
7. Krishna-Godavari in 1982 (Narsapur-1)

- Some other landmark decisions were taken at that time, which fully nationalized the oil industry in India.
- The Government of India took over the shares of Burmah Oil Company in Oil India Ltd and made it a Public Sector Company.
- Another, Indo Burma Petroleum company was converted to IBP Co. Ltd.
- The Esso and Caltex were converted into Hindustan Petroleum Corporation Ltd and Burmah Shell, in India got a new name Bharat petroleum Corporation Ltd.
- In 1975, the Oil Coordination Committee (OCC) was set up. This was an extension of the secretariat of the Ministry of Petroleum and natural gas.
- In 1977, **Administered Price Mechanism (APM)** was brought into existence. This referred to the supply of raw material to the refineries at point of refining at a predetermined price which was called delivered cost of crude. The finished products were also made available at predetermined priced and that were called ex-refinery prices. This system worked till 1980s when there was an upward swing in the oil prices. The escalating demand made the PSU's overburdened and this started the series of additional imports of crude oil at very high costs. So the need was felt for deregulation and decontrol.
- The Hydrocarbon sector started getting decontrolled in late 1980s and part by part foreign, private investment was made opened in most activities of this sector.

- The year 1991 marked the beginning of Indian Economic Reforms. In 1993, **parallel making of the kerosene and LPG was introduced.** The Downstream sector was first opened for private participation and later refining sector got the emergence of one of the largest players **Reliance Refinery**.
- The decision to move from a the industry to a market driven petroleum sector was the most important decision which resulted in the dismantling of the Administered Price mechanism.
- The dismantling of the APM was followed by **National Exploration License Policy in 1997**. This was started with a view to make India a great investment destination for exploration.
- Under the NELP, the government actively promotes the hydrocarbon blocks and past 8 rounds of NELP have been successfully carried out.
- Today, India's petroleum industry is undergoing new changes. India is a major buyer of the POL products and the government gives thrust to new findings. The Government of India is actively promoted private investments through the auction of the Hydrocarbon blocks in the country and several rounds have resulted in additional production.

Crude Oil & Gas Production in India: Thrust Areas

Oil and Natural Gas Corporation Limited (ONGC) and Oil India Ltd. (OIL), the two National Oil Companies (NOCs) as well as private and joint venture companies are engaged in the exploration and production (E&P) of oil and natural gas in the country. Following are some measures taken to enhance hydrocarbon reserves and increase production:

1. Major thrust on exploration in the new frontier areas like deep water and other geologically and logistically difficult areas and also ensuring continuation of exploration in the existing and unexplored areas.
2. Development of new fields and additional development of the existing fields through implementation of Improved Oil Recovery (IOR) and Enhanced Oil Recovery (EOR) projects in major fields and medium size fields.
3. Implementation of specialized technologies like extended reach drilling, horizontal drilling and drain hole drilling.
4. Obtaining the services of international experts whenever considered necessary.
5. Maintenance of reservoir health through work over operations and pressure maintenance methods.
6. Better reservoir delineation through three dimensional (3D) seismic survey of old fields.
7. Optimization and redistribution of water injection.

New Exploration Licensing Policy (NELP)

Government of India approved the New Exploration Licensing Policy (NELP) in 1997 and it became effective in February, 1999. Since then licenses for exploration are being awarded only through a competitive bidding system and National Oil Companies (NOCs) are required to compete on an equal footing with Indian and foreign companies to secure Petroleum Exploration Licenses (PELs). Eight rounds of bids have so far been invited under NELP.

- Government of India announced NELP in 1997-98 budget.

- It took 2 fiscal years and 2 successive governments to finalize.
- Slurry of tax incentive was promised to prospective investors.
- After several go and halt signs by GOI, NELP finally got Underway in 1999.

Main features:

1. There is Fiscal stability provision in the PSC (Production Sharing Contract).
2. No signature, discovery or production bonus.
3. No customs duty on imports.
4. No mandatory state participation.
5. No carried interest by National Oil Companies (NOC).
6. Freedom to the contractor for marketing of oil & gas in the domestic market.
7. No cess on crude oil production.
8. Royalty to be paid on crude oil & natural gas on Volume basis.
9. Income tax holiday for 7 yrs from start of commercial production.

What are Objectives of NELP?

1. Private participation for Intensive exploration of Indian basins.
2. Provide avenue for opening up of acreages in ultra deep water & frontier areas.
3. To bring-in new & state of art technology in exploration & exploitation.
4. Level playing field to all participating companies.
5. Transparent Bid Evaluation system .

NELP IX

In the first seven rounds of NELP spanning 2000-2009, Production Sharing Contracts (PSCs) for 203 exploration blocks have been signed. Under NELP, 77 oil and gas discoveries have already been made by private/joint venture (JV) companies in 23 blocks.

- **The largest natural gas discovery in the country has been made in KG deepwater**, from where production has commenced in April 2009, which is currently at 60 Million Metric Standard Cubic Metre Per Day (MMSCMD)

In the eighth round of NELP (NELP-VIII), 70 exploration blocks were offered, comprising of 24 deepwater blocks, 28 shallow water locks and 18 on land blocks. On the bid closing date on 12th October 2009, 76 bids were received for 36 exploration blocks against the offer of 70 blocks. 45 companies have participated in NELP VIII including 7 foreign companies.

New Exploration Licensing Policy (NELP-IX) is underway. The Government of India is offering 34 exploration blocks in 10 sedimentary basins covering an area of about 88,807 Sq. Kms. There are 19 onland blocks (out of which 8 type S blocks in most prolific producing basins), 8 Deep water and 7 Shallow water blocks. Under the current offer, an area of 58,336 Sq. Km (65.69%) covering 19 new blocks is being offered for the first time.

NELP to OALP

At the inauguration of **NELP-IX,** India said that NELP would be, most probably, replaced by **Open Acreage Licensing Policy** (OALP). *"Hopefully, there would be no NELP-X. The government will take another year to come up with OALP policy,"* said the Petroleum & Natural Gas Secretary.

In the 9 rounds of NELP, Domestic Companies are actively bidding, but mostly international bidders have not invested in exploration in India. So, the Government of India is willing to review the current NELP terms and is open to various suggestions for different kinds of award polices. The major issue is with **E&P.**

What is E & P?

We know that exploration and extracting oil is called upstream sector of the industry. This is called the E&P (Exploration & Production) business. This business is highly technology driven one and needs huge investments and continuous knowledge up gradation.

All of us are aware that the days of finding easy oil and gas are over. Our country is endowed with about 138 billion barrels of oil and oil equivalent of gas, but these yet to be found resources are believed to be located in the frontier, logistically difficult and geologically complex areas and deep & ultra deep waters. So, in order to search and exploit these resources, the exploitation technologies also need to be innovative.

What is the problem in E & P?

The major problem or hurdle to attract the international investment is that of Data Acquisition. Data means high quality and reliable geo-scientific data. This data is not available in a systematic form for assessment of the underground risk. The problems involve inadequacy / down quality of the data and non-availability / bottleneck to get the raw data.

How the Data Acquisition is important?

There are various organizations in India that acquire geo-scientific data which is relevant and necessary for their activities. This includes data not only for petroleum exploration and development but for other minerals also. It is very important that this data, which is acquired through great effort and at huge expenditure, is properly preserved, easily accessible and gainfully shared for national development.

How the Data is important?

The data generation is a result of the efforts of decades of data acquisition. For a country like ours, the data is a "valuable national asset" and it becomes imperative for us to safeguard and fruitfully utilize this national treasure. Worldwide, the countries save this kind of data through their own NDR and we at home also need to take initiatives in this direction.

What is NDR?

The first step towards resolving the above problem is the NDR. NDR refers to National Data Repository. It is worth note that Government of India in envisaging on an ambitious project to set up a National Knowledge Hub (NKH) also known as National Knowledge Centre (NKC) in E&P (Exploration & Production) area in coming few years. The components of NKH/NKC will be

1. National Data Repository
2. National Processing Centre
3. National Visualization & Application Centre
4. National Training Centre

5. National E&P Knowledge Portal

So, NDR is the first component of NKC.

- The NDR is on a proposed state at present.

The objective of the NDR is to make a repository of reliable exploration and production data for India with provisions for seamless access and on-line data management.

The specific objectives of NDR are as follows:

1. To validate, store, maintain and reproduce high quality and reliable geoscientific data
2. To facilitate efficient data reporting, data exchange, and data trading among existing players including all geoscientific agencies
3. To improve DGH's ability to monitor and control the E&P activities and reporting
4. To encourage new E & P activities by providing high quality and reliable data
5. To strengthen overall geoscientific activities in India
6. To support an open acreage system for an improved Global E & P Business environment in India
7. To provide quality E & P data for Processing, Interpretation and Visualization Centres at DGH

What is OLAP and how it is different from NELP?

One further step after our country has an NDR is to shift from NELP to OLAP. The necessity to shift to OLAP is as follows:

1. To remove the barriers in getting data for evaluation
2. To NOT to make the investors wait for the rounds to happen.

So, the major difference is that under OALP, oil and gas acreages will be available round the year instead of cyclic bidding rounds launched under New Exploration Licensing policy (NELP).

On November 21, 2010, the Ninth International Conference on National Data Repository was organized in New Delhi, in which partners from 27 countries participated. There is a hope that Conference will create opportunity for all E&P players including Oil Companies, Government officials and policy formulators to get insight into what is being done internationally in managing data, as a national treasure and inclusion of similar data of other mineral resources through the establishment of NDRs.

So the needs to shift from NELP to OLAP are summarized as follows:

1. Not availability of Data especially in deep water, ultra deep water and frontier areas.
2. Partial freedom at present to choose blocks.
3. E & P Companies need to wait form rounds.
4. Acreages are retained by the existing players.

What is the Current E & P Scenario in the country?

In India, the exploration began centuries ago. For almost quarter a century the efforts in oil & gas exploration and production was limited to only two companies viz. ONGC and OIL. After NELP-I was launched a decade ago, more than 70 E&P companies working in India today. So, E&P scenario in India has improved satisfactorily, but still there are needs to improve this sector.

Coal Bed Methane Policy

Coal Bed Methane is a natural gas (Methane) absorbed in coal and lignite seams.

- It is called 'sweet gas' because of its lack of hydrogen sulfide.
- Coal bed methane contains very little heavier hydrocarbons such as propane or butane, and no natural gas condensate.
- It often contains up to a few percent carbon dioxide and is an ecofriendly source of energy.

To harness this new source of energy in the country, the Government has approved a comprehensive CBM policy in July, 1997 for exploration and production of CBM gas. As of 2009, 23 CBM Blocks have been awarded through competitive international bidding under first three rounds of CBM policy, under which blocks are being operated by technically competent companies.

✓ First commercial production of CBM commenced in July 2007 with production of about 6,800 cubic metres per day, which has gone upto 1,19,742 cubic metres per day in January 2010.

In the fourth round of CBM Policy, 10 CBM blocks covering an area of about 5,000 sq. km were to be planned to offer.

ONGC

Oil & Natural Gas Commission was established on 14th August, 1956 as a statutory body under Oil & Natural Gas Commission Act (The ONGC Act), for the development of petroleum resources and sale of petroleum products. ONGC was converted into a Public Limited Company under the Companies Act, 1956 and named as "Oil and Natural Gas Corporation Limited" with effect from 1st February, 1994. The Government disinvested around 10% of the equity shares of ONGC in March 2004 through a public offer in the domestic capital market at ₹ 750 per share. After the above disinvestment, the shareholding of the Government in ONGC came down to around 74.15%.

ONGC in Current Affairs:

✓ ONGC registered its **fifth Clean Development Mechanism (CDM)** project with the United Nations Framework Convention on Climate Change (UNFCCC) on September 22, 2009. The project, 'Energy Efficiency of Amine Circulation Pumps at Hazira' involves enhancing energy efficiency achieved in the Amine Circulation Pumps of Hazira Plant. The project will fetch an estimated Certified Emission Reduction (CER) of 4043 per year for a period of 10 years. With this, ONGC achieves a total annual CER of about 1.24 lakh.

✓ **PCRA Award for Oil and Gas Conservation:** ONGC bagged the Best Overall Performance PCRA Award amongst the Upstream Oil Companies for the Oil and Gas Conservation Programmes during the year 2009.

✓ Wind Farm Project of 50 MW at Motisindoli in Kutch district of Gujarat is an initiative of ONGC towards its commitment for environment-friendly and pollution-free energy production.

✓ Cover Green is an ONGC project for revival of coastal vegetation, where 5000 mangrove saplings have been planted along the Coast of Khambat, Gujarat

ONGC Videsh Limited (OVL)

ONGC Videsh Limited (OVL), a wholly-owned subsidiary of ONGC, was incorporated as Hydrocarbons India Private Limited on 5th March, 1965 with an initial authorized capital of ₹ 5 lakh, for the business of international exploration and production. Its name was changed to ONGC Videsh Limited on 15th June, 1989. The authorized and paid-up share capital of OVL as on 31st March, 2007 was ₹. 1,000 crore. The

primary business of the company is to prospect for oil and gas acreages abroad. These include acquisition of oil and gas fields in foreign countries as well as exploration, production, transportation and sale of oil and gas.

- ✓ OVL currently has participation in 39 projects in **15 countries** namely, Vietnam (3 projects), Russia (2 projects), Sudan (3 projects), Iran (1 project), Iraq (1 project), Libya (3 projects), Myanmar (5 projects), Syria (2 projects), Egypt (2 projects), Cuba (2 projects Nigeria Sao Tome Principe JDZ (1 project), Brazil (5 projects), Nigeria (2 projects), Colombia (6 projects), and Venezuela (1 project).
- ✓ OVL's share of crude oil and natural gas production is currently from 9 projects in seven countries, viz., Russia, Sudan, Vietnam, Syria, Colombia, Venezuela and Brazil.
- ✓ Multi-product **Sudan Pipeline** is a joint venture of ONGC Videsh Ltd. (OVL) and Govt. of Sudan. OIL has also a share in it.

Oil India Ltd

OIL is the pioneer in exploration and production of hydrocarbons in India, and traces its roots back to Oil India Private Ltd., formed in 1959 with The Burmah Oil Company Ltd. holding two-thirds of equity and Government of India holding one-third.

Oil India Private evolved into Oil India Ltd., which was an equal partnership between Burmah Oil and Government of India. In 1983 the company became a public sector undertaking of the Government of India.

Prior to the Public Issue, Government holding in OIL was 98.13 % of the paid-up equity share capital of ₹. 214 crore. OIL came up with the Public Issue of 26,449,982 shares from 7th September, 2009 to 10th September, 2009. Upon the completion of the Public Issue, the Government holding of share in OIL has reduced to 78.43%, of fully diluted post-Issue paid-up Equity Share capital of ₹ 240.45 crore.

OIL holds 26% stake in Numaligarh Refinary Limited, Assam, 10% stake in Brahmaputra Cracker and Polymer Limited (Assam Gas Cracker Project) and 23% Participating Interest (PI) in Duliajan - Numaligarh Gas Pipeline (DNPL) project undertaken by M/s Assam Gas Company Limited. OIL also holds 10% stake in 741 Km. long product pipeline in Sudan.

GAIL

GAIL (India) Limited, formerly known as Gas Authority of India Limited was established in August, 1984.

- ✓ Having started as a gas transmission company during the late eighties, it grew organically over the years by building a large network of Natural Gas Trunk Pipelines covering a length of over 7000 km.
- ✓ Natural Gas continues to constitute the core business of GAIL.
- ✓ Today, GAIL has interests in the business of Natural Gas, LPG, Liquid Hydrocarbons and Petrochemicals, the latter being value-added products.
- ✓ **GAIL has also entered in telecom sector by leasing bandwidth available through the OFC which is laid along the gas pipelines for their operation and maintenance.**
- ✓ GAIL (India) Limited led Joint Venture Company (JVC), Brahmaputra Cracker and Polymer Limited (BCPL) is implementing the ₹. 54.61 billion Assam Gas Cracker Project to set-up an Integrated Petrochemical Complex at Lepetkata, District Dibrugarh.

GAIL has formed a number of Joint Venture Companies for city gas distribution as also in other sectors. GAIL has plans of developing CNG infrastructure across the country as well as abroad. The major domestic Joint Venture Companies are as under:

1. Mahanagar Gas Limited (MGL): In Mumbai and Suburbs
2. Indraprastha Gas Limited (IGL): National capital Territory of Delhi
3. Bhagyanagar Gas Limited (BGL): Hydearabd and Vijaywada
4. Tripura Natural Gas Company Limited (TNGCL):Tripura
5. Central U.P. Gas Limited (CUGL):Kanpur and adjacent areas
6. Green Gas Limited (GGL):Agra and Lucknow
7. Maharashtra Natural Gas Limited (MNGL): Maharashtra except Mumbai
8. Avantika Gas Limited (AGL): Madhya Pradesh

Chennai Petroleum Corporation Limited (CPCL)

Chennai Petroleum Corporation Limited (CPCL) is a major company in the refinery sector in India.

1. It was formerly known as Madras Refineries Limited and was formed as a joint venture in 1965 between the Government of India (GOI), AMOCO India Inc.,U.S.A. and National Iranian Oil Company (NIOC), Iran having a share holding in the ratio 74:13:13.

   In 1985, AMOCO disinvested in favour of GOI and the shareholding percentage of GOI and NIOC stood revised at 84.62 and 15.38 respectively. Later, GOI disinvested 16.92% of the paid-up capital in favour of Unit Trust of India, Mutual Funds, Insurance Companies and Banks on 19th May, 1992, thereby reducing its holding to 67.7%. A public issue of CPCL shares was also made in 1994. As a part of the restructuring steps taken by the Government of India, Indian Oil Corporation Limited (IOCL) acquired equity from GOI in 2000-01. Currently, IOCL holds 51.89% while Naftiran Inter-trade Company Limited, (an affiliate of NIOC) continued its holding at 15.40%.

   CPCL has two refineries, with a combined refining capacity of 10.5 Million Metric Tonnes Per Annum (MMTPA).

1. The Manali Refinery in Chennai has a capacity of 9.5 MMTPA and is one of the most complex refineries in India with Fuel, Lube, Wax and Petrochemical feedstocks production facilities.
2. The second refinery at Cauvery Basin, Nagapattinam was set-up initially with a capacity of 0.5 MMTPA in 1993 and later enhanced to 1.0 MMTPA capacity in 2002.

Numaligarh Refinery Limited (NRL)

Numaligarh Refinery was set-up as a grass-root refinery at Numaligarh in the District of Golaghat (Assam) **in fulfillment of the commitment made by Government of India in the historic "Assam Accord",** signed on 15th August, 1985 for providing the required thrust towards industrial and economic development of Assam. It started operation in 2000.

Mangalore Refinery & Petrochemicals Limited (MRPL)

✍ **Mangalore Refinery and Petrochemicals Limited (MRPL) is the first Joint Venture Petroleum Refinery in India**

It was formed in 1987 jointly by M/s Hindustan Petroleum Corporation Limited, a public sector company and M/s Indian Rayon and Industries Limited and its associate companies (A.V. Birla Group), was set up with initial processing capacity of 3.69 Million Metric Tonnes Per Annum. This become operational in 1996 and subsequently expanded to the present capacity of 9.69 Million Metric Tonnes Per Annum in September, 1999.

Indian Oil Corporation Ltd. (IOC)

Indian Oil Corporation Ltd. (IOC) was formed in 1964 with the merger of Indian Refineries Ltd. (Estd. 1958) and Indian Oil Company Ltd. (Estd. 1959).

- It has grown to be India's largest commercial enterprise.

  During 2008-09, IOC posted net profit of ₹ 2,950 crore on an unprecedented turnover of ₹ 2,85,337 crore that too after holding the price line for the four major products – petrol, diesel, PDS kerosene and LPG for domestic use. It made a substantial contribution of ₹ 19,115 crore to the Central Exchequer during April-Dec'09.
- IOC is also the first and the highest ranked Indian company in the Fortune 'Global 500', placed at 105th position by sales in 2009.
- IOC has the distinction of being the first oil company in the country to venture into research and development with the establishment of IOC's R&D Centre in the year 1972.
- IOC assistance of NREL, US, full Life Cycle Analysis (LCA) has been completed for biodiesel produced from Jatropha for application in rail road sector. This is first study of its kind and revealed 12 % reduction in GHG by use of 20 % blended jatropha biodiesel in diesel.
- IOC is globally admired "Energy of India", IOC is spreading its wings, with a well laid-out plan, through vertical integration - upstream into exploration and production, and downstream into petrochemicals, and through diversification into natural gas, besides globalization of its downstream operations.
- IOC has been playing a pioneering role in the development and commercialization of Bio-fuels. In MP, Jatropha Plantation on 241 Hectare of revenue waste land in Jhabua district has been completed during the year 2009-10. In Chhattisgarh, JV company IndianOil-CREDA Bio-fuels Ltd. completed Jatropha Plantation on 653 Hactare of revenue waste land during the year 2009-10.
- IOC was in top five in Business India's Super 100 ranking, ET 500 ranking
- IOC won Reader's Digest Award for most trusted petrol station brand on 28th May'09. It was adjudged the 'Most Trusted Brand' in the Petrol Station Category in India, in a survey by Reader's Digest in collaboration with the reputed research house, Nielsen Media Research.
- Superbrand status: Indane for first time and SERVO for the third time
- Most admired Retailer of the Year in the Rural Retail Category by India Retail Forum - 3rd time in a row
- Business Today-Indicus-PeopleStrong Survey of India's Best Employers, ranks IOC 3rd top company under the 'Core Sector" category IOC - the only PSU among India's 25 best employers in Outlook Business-Hewitt Associates Study.

Hindustan Petroleum Corporation Limited (HPCL)

HPCL is a mega Public Sector Undertaking (PSU) integrated oil company in India, with Navratna status. It has two refineries producing a wide variety of petroleum products- fuels, lubricants and specialty products; one in Mumbai (West Coast) having a capacity of 6.5 MMTPA and the other in Visakhapatnam (East Coast) with a capacity of 7.5 MMTPA.

- HPCL owns and operates the largest Lube Refinery in the country producing Lube Base Oils,

Bharat Petroleum Corporation Limited (BPCL)

BPCL is integrated Oil Company in the downstream sector engaged in refining of crude oil and marketing of petroleum products. It has also diversified into production and marketing of petrochemical feedstock.

- Bharat Oman Refineries Ltd. (BORL) is being promoted by Bharat Petroleum Corporation Ltd. (BPCL) an authorized capital of ₹. 4500 crore and paid-up capital of ₹. 151 crore.

Directorate General of Hydrocarbons (DGH)

The Directorate General of Hydrocarbons (DGH) was established under the administrative control of Ministry of Petroleum & Natural Gas by Government of India Resolution in 1993. Objectives of DGH are to promote sound management of the oil and natural gas resources having a balanced regard for environment, technological and economic aspects of the petroleum activity.

Engineers India Limited (EIL)

Introduction Engineers India Limited (EIL) was established in 1965 to provide engineering and related technical services for petroleum refineries and other industrial projects. It has diversified and excelled in various fields and emerged as Asia's Leading Design, Engineering and Turnkey (LSTK) contracting company in the Petroleum Refining, Petrochemicals, Chemicals & Fertilizers, Pipelines, Offshore Oil & Gas, Onshore Oil & Gas, Terminals & Storages, Mining & Metallurgy and Infrastructure. EIL provides a wide range of technologies for oil & gas processing industry besides a comprehensive range of project related technology and engineering services spanning from project conceptualization to commissioning. EIL also undertakes projects on LSTK basis.

Biecco Lawrie Limited

Biecco Lawrie Limited (BLL), a Government of India Enterprise, under the administrative control of the Ministry of Petroleum & Natural Gas (MOP&NG), was established in 1919 and became a Government Company in 1972. This is a medium sized Engineering Unit with diversified activities having two factories located at Kolkata.

Balmer Lawrie & Company Limited

Balmer Lawrie & Co. Ltd. (BL) was established in 1867 as a Partnership Firm and was incorporated as Private Limited Company in 1924. It was subsequently converted into a Public Limited Company in the year 1936 with its Registered Office at Kolkata. BL is a multi-technology, multi-locational Company with operations spread throughout India and Overseas. The Company's business interest span both manufacturing and services.

National Gas Hydrate Programme

National Gas Hydrate Programme is for mapping **gas hydrates** for utilization as future alternate energy resource by abstracting methane from solids below the sea-beds in deep oceans and the permafrost regions of the world.

The programme was initiated in 1997 with a Steering Committee and a Technical Committee of NGHP. Based on the review of seismic data by the Technical Committee, two areas in Indian waters, one along East Coast and other on West Coast have been identified as "Model Laboratory Areas" for further R&D work. DGH is the coordinator of the programme. Review of various projects under this programme is done by a Steering Committee set up by the Ministry of Petroleum & Natural Gas.

India is a pioneer in the field of gas hydrate. In accordance with the roadmap for the National Gas Hydrate Programme (NGHP), India has already acquired core samples with the help of the US drill ship JOIDES Resolution. In December 2008, a memorandum of understanding (MOU) was signed between the Directorate General of Hydrocarbons and the U S Geological Survey for cooperation on exchange of scientific knowledge and technical personnel in the field of gas hydrate and research. The second NGHP expedition has been planned in 2010 to map the prospects of gas hydrate in Krishna Godavari and Mahanadi deepwater area

Hydrogen Corpus Fund

The Ministry of Petroleum & Natural Gas has set up a Hydrogen Corpus Fund on the use of hydrogen as an auto fuel. The Indian Oil Industry has to work synergistically and in close coordination with reputed technological institutions to make headway in this frontier area. With this object in mind, the Ministry has set up a Hydrogen Corpus Fund of ₹.100 crore with contribution from Oil PSUs/OIDB as follows

1. OIDB - ₹ 40 crore
2. ONGC, IOC, GAIL - ₹ 16 crore each
3. HPCL, BPCL - - ₹ 6 crore each.

Rajiv Gandhi Institute of Petroleum Technology (RGIPT)

With an estimated cost of ₹. 685 crore including the cost of land, the Ministry of Petroleum and Natural Gas (MOP&NG), Government of India set up the Institute at Jais, Rae Bareli district, Uttar Pradesh through an Act of Parliament.

✍ RGIPT has been accorded the eminence of being an " Institute of National Importance".

From 2008-09, it is offering:

1. B.Tech in Petroleum Reservoir Engineering
2. B.Tech in Petroleum Refining Engineering
3. MBA in Petroleum and Energy Management

RGIPT has also initiated setting up of Assam Centre as its constituent unit to educate and train skilled technicians at the certificate and diploma level as per the requirement of Oil & Gas Industry. Govt. of Assam has allotted 100 acres of land at Sivasagar for the Assam Centre of the RGIPT.

Petroleum India International (PII)

Petroleum India International (PII) is a consortium of Public Sector Companies in the petroleum, petrochemicals and engineering sector.

The member companies include Indian Oil Corporation Ltd., Bharat Petroleum Corporation Ltd., Bongaigaon Refinery & Petrochemicals Ltd., Chennai Petroleum Corporation Ltd., Engineers India Ltd., Hindustan Petroleum Corporation Ltd, Oil India Ltd. and Indian Petrochemicals Corporation Ltd. PII was established in 1986 with the common objectives of mobilizing the individual capabilities of its member companies into a joint endeavour for providing technical managerial and other human resources on a global basis.

Petroleum Planning & Analysis Cell (PPAC)

The Petroleum Planning & Analysis Cell (PPAC) was created w.e.f. 1st April 2002 after dismantling of the Administered Pricing Mechanism (APM) in the petroleum sector and abolition of the erstwhile Oil Coordination Committee (OCC). It assists Ministry of Petroleum & Natural Gas (MOP&NG) in administrating the subsidy on PDS Kerosene and Domestic LPG and Freight subsidy for far-flung areas. It also assists in Maintenance of information/data bank and communication system to deal with emergencies and unforeseen situations.

Rajiv Gandhi Gramin LPG Vitarak Yojana

Rajiv Gandhi Gramin LPG Vitarak Yojana (RGGLVY) for small size LPG distribution agencies has been launched on 16.10.2009. The LPG agencies under the RGGLVY will be of small size requiring lesser finance/ infrastructure. The distributor himself will manage the agency with the help of his/ her family member and one or two employees.

Age limit for the distributor to be between 21 and 45 years.

All Agencies under this scheme to be in the joint name of husband and wife. In case of applicants who are single the 'spouse' will automatically become a partner after the marriage. Reservation for SC/ST categories has also been provided for. The selection of the distributor would be by draw of lots from amongst all candidates who have secured more than 80% marks on the criteria of financial capability and education qualifications.

Bio-Diesel Purchase Policy

To encourage production of bio-diesel in the country, the Ministry of Petroleum and Natural Gas has announced a bio-diesel Purchase Policy in October, 2005, which became effective from 1.1.2006. Under this scheme Oil Marketing Companies will purchase bio-diesel for blending with High Speed Diesel to the extent of 5% at identified purchase centers across the country. OMCs would buy bio-diesel at a uniform landed price, which is to be reviewed every six months. The price was ₹ 24.50 per litre till March 30, 2010.

Indian Institute of Petroleum

Indian Institute of Petroleum is one of the instituted of CSIR and is **located at Dehradun**. It was established in 1960 and is dedicated to R & D in petroleum sector.

Indian Oil Institute of Petroleum Management

Indian Oil Institute of Petroleum Management is a Government of India run institute located in Gurgaon, Haryana. It was set up in 1995 by Indian Oil Corporation (IOC).

Mumbai High

Mumbai High is an offshore oilfield 160 kilometers off the coast of Mumbai and under the operations of ONGC. First offshore well was shrunk here in 1974.

Mangla Area

Mangla Area is located on RJ-ON-90-1 (the Rajasthan Block) in Barmer district of Rajasthan. It is being operated by Ciarn Energy and is supposed to have 3.6 billion barrels of oil.

KG D6

D-6 block in the Krishna Godawari basin is in Andhra Pradesh and here Reliance Industries discovered the biggest natural gas reserves in India in 2002. It was also the world's largest gas discovery of 2002

Oil Regions in India

Assam, Tripura, Manipur, West Bengal, Mumbai, Gujarat, Jammu & Kashmir, Himachal Pradesh, Tamil Nadu, Andhra Pradesh, Coastal Kerala, Andaman & Nicobar.

Oil Refineries in India

There were 18 functioning refineries in April 2009, 17 in Public Sector and 1 in private sector. Some of them are described below:

1. **Barauni Refinery, Bihar**
   Located in Bihar and was built in 1964 with the help of USSR.
2. **Bongaigaon Refinery, Assam**
   Located at Bongaigaon, Assam. Bongaigaon Refinery and Petrochemicals Limited (BRPL) is a subsidiary of IndianOil(IOC).
3. **Chennai Petroleum Corporation Limited**
   It has two refineries viz. Manali Refinery Chennai and Nagapattinam refinery in Cauvery Basin.
4. **Digboi Refinery, Assam**
   This is oldest refinery and was set up in 1901 in Digboi , Assam. It was took over later by IOC.
5. **Essar Refinery, Gujarat**
   Essar Refinery is under commissioning at Vadinar, Gujarat. It is a private sector refinery under Essar Group.
6. **Gujarat Refinery, Gujarat**
   Located near Baroda Gujarat and is largest refinery of IOC and largest public sector refinery of India.
7. **Guwahati Refinery, Assam**
   Guwahati Refinery is located at Noonmati Assam. It is owned by Indian Oil Corporation.
8. **Haldia Refinery, West Bengal**
   Haldia Refinery is located in West Bengal
9. **Kochi Refineries Ltd (KRL), Kerala**
   Kochi Refineries Ltd (KRL) is located at Kochi and is owned by Bharat Petroleum Corporation Ltd.
10. **Mangalore Refinery and Petrochemicals Limited, Karnataka**
    Mangalore Refinery and Petrochemicals Limited is now acquired by ONGC and was set up in 1998.
11. **Mathura Refinery, Uttar Pradesh**

Mathura Refinery is owned by Indian Oil Corporation and is located in Mathura. It was alleged for causing white marble of Taj Mahal to yellow./

12. Jamnagar Refinery, Gujarat

The Jamnagar Refinery is owned by Reliance Industries in Jamnagar, Guajarat. It is the largest greenfield refinery in the world.

13. Mumbai Refinery, Maharastra

Mumbai Refinery is located in Mumbai and was promoted by Esso before being aquired by the Government of India.

14. Mumbai Refinery Mahaul. Maharastra

Mumbai Refinery Mahaul is under Bharat Petroleum Corporation Ltd.(BPCL)

15. Panipat Refinery, Haryana

Panipat Refinery belongs to Indian Oil Corporation Ltd.

16. Vizag Refinery, Andhra Pradesh

Visakhapatnam Refinery is of HPCL.

Butcher Island

Butcher Island is also known as Jawahar Deep and is off Mumbai Coast. There lies an oil terminal used by the port authorities to offload it from oil tankers