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PETROLEUM AND NATURAL GAS

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GOVERNMENT OF INDIA
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22 Petroleum and Natural Gas

The domestic production of crude oil which stood at 36.009 million tonnes in 2016-17 decreased by 2.55% when compared to the output in the corresponding period of last year. Whereas, the net production of natural gas decreased to 30,866 million cu meters in 2016-17 which is about 4.29% less as against the production in 2015-16. India has emerged as a refinery hub and is the second largest refiner in Asia after China and is the fourth largest in the world. After the addition of 2.09 MMTPA and 1.0 MMTPA refinery capacity at BPCL, Kochi and HPCL, Mumbai, respectively, the country's refining capacity has touched 233.966 MMTPA as on 01.04.2017.

Energy is a key driver of economic growth. Efficient, reliable and affordable energy is essential for sustainable development and inclusive growth of the overall economy of India. India is at present the fastest growing economy of the world with 7.1% growth in GDP at constant (2011-12) prices during 2016-17 (1st Revised Estimate) over the year of 2015-16.

Due to rapid economic expansion, India has become world's fastest growing energy market. India surpassed Russia to become the 3rd largest energy (primary) consumer in the world after China and USA during 2015. Oil & gas accounted for around 35% share in India's energy consumption.

The energy needs of the country are increasing continuously, while the indigenously available energy resources are limited and may not be sufficient in the long run. With India's growing energy demands, reliance on imports and limited domestic fossil fuel resources, the country has ambitious plans to increase domestic oil & gas production and exploit all possible forms of energy to the fullest. The government has taken several initiatives for increasing exploration and production of all domestic hydrocarbons viz. petroleum, natural gas, coal bed methane and shale gas/oil as well as distribution, marketing and pricing of petroleum products.

India's energy security is primarily about ensuring continuous availability of commercial energy at competitive prices to support its economic growth and meet the lifeline energy needs of households with safe, clean and affordable forms of energy. Keeping in view the vast and ever increasing energy requirements of the economy, several initiatives have been taken for increasing production and exploitation of all domestic petroleum resources. Government has taken several policy initiatives and reforms in the Hydrocarbon Sector which include, inter alia, new Hydrocarbon Exploration and Licensing Policy (HELP); Discovered Small Field Policy; marketing and pricing freedom for new gas production from Deepwater, Ultra Deepwater and High Pressure-High Temperature areas; extension of Production Sharing Contracts for small and medium size fields; linking the transparent new gas pricing formula to the global market; early monetization of hydrocarbon discoveries; policy on testing requirements for discoveries in New Exploration Licensing Policy (NELP) block; reassessing the hydrocarbon potential in India's sedimentary basin; and setting up of National Data repository.

RESOURCES

As on 1.4.2017, the total balance recoverable reserves of crude oil were estimated at 604.10 million tonnes, out of which 324.24 million tonnes (54%) are in onshore and 279.86 million tonnes (46%) in offshore areas . ONGC (nomination) has the largest share of 72% in reserves of crude oil with OIL (nomination) and PSC regime contributing 13% and 15%, respectively.

The balance recoverable reserves of natural gas as on 01.04.2017 were placed at 1,289.81 billion cu m, out of which 479.71 billion cu m (37%) are in onshore and 810.10 billion cu m (63%) in offshore areas. PSC regime has the largest share of 49% in natural gas reserves with ONGC (nomination) and OIL (nomination) at 41% and 10%, respectively (Table-1).

Table – 1 : Proved and Indicated Balance Recoverable Reserves of Crude Oil and Natural Gas in India as on 1.4.2017

(Crude oil in million tonnes; natural gas in billion cu m)

Area	Crude oil	Natural gas
India	**604.10**	**1289.81**
Onshore	**324.24**	**479.71**
Andhra Pradesh	8.15	48.31
Arunachal Pradesh	1.52	0.93
Assam	159.96	158.57
Gujarat	118.61	62.28
Jharkhand*	-	8.02
Madhya Pradesh*	-	32.11
Nagaland	2.38	0.09
Rajasthan	24.55	34.86
Tamil Nadu	9.00	31.98
Tripura	0.07	36.10
West Bengal*	-	66.45
Offshore	**279.86**	**810.10**
Western offshore@	239.20	302.35
Eastern offshore	40.67	507.76

Source: *Indian Petroleum and Natural Gas Statistics, 2016-17, Ministry of Petroleum and Natural Gas, Govt. of India.*

Note: Total may not tally due to rounding off.
@: Includes Gujarat offshore.
**: Relates to Coal Bed Methane (CBM).*

EXPLORATION & DEVELOPMENT

The Oil and Natural Gas Corporation (ONGC) and Oil India Limited (OIL), the two National Oil Companies (NOC) and a few private and joint venture companies were engaged in exploration and production activities of oil and natural gas, including coal-bed methane, shale gas/oil, etc. in the country.

As on 31.3.2017, there were in all 448 oil/gas fields under these companies in the country including offshore areas.

In Public Sector, ONGC's (Nomination) jurisdiction extended to 358 fields – Cambay basin (Gujarat) – 85 oil/gas fields; Upper Assam – 38 fields and Assam & Assam Arakan – 7 fields; Jodhpur (Rajasthan) – 8 fields; Krishna-Godavari basin (Andhra Pradesh) – 64 fields; Cauvery basin (Tamil Nadu) – 29 fields; Assam & Assam Arakan in Tripura - 10 fields and Assam & Assam Arakan in Nagaland –2 fields; Vindhyan basin (Madhya Pradesh) - 1 field; besides, 84 offshore fields in the Mumbai offshore; 4 in Kachchh and 2 in Cambay basin in West Coast and 24 offshore fields in Cauvery and Krishna-Godavari basins (shallow and deep) in East Coast. OIL (Nomination), a Public Sector Company, was engaged in 19 fields – Upper Assam basin in Assam (14 fields) and Arunachal Pradesh (1 field); Jaisalmer basin (3 fields) and Bikaner-Nagaur basin (1 field) in Rajasthan. Private/Joint venture companies (PSC regime) were engaged in 71 oil/gas fields - Cambay basin (Gujarat) at 38 fields; Assam-Arakan (Arunachal Pradesh) at 1 field; Assam-Arakan (Assam) at 2 fields; Jharia & Bokaro (Jharkhand) at 1 field (CBM) each; Sohagpur (Madhya Pradesh) at 2 fields (CBM); Rajasthan at 10 fields; Cauvery (Tamil Nadu) at 1 field and Raniganj East basin (West Bengal) at 2 fields (CBM) in onshore areas. In offshore areas, these companies covered 2 fields in Cauvery basin and 5 fields in Krishna-Godavari basin on the East Coast and 3 fields in Mumbai basin and 3 fields in Cambay basin on the West Coast.

Exploratory efforts of ONGC during 2016-17 resulted in 23 oil and gas discoveries (13 in onshore and 10 in offshore areas) in domestic fields (operated by ONGC). Out of these, 12 discoveries were made in the new prospects, whereas 11 were new pool discoveries. Of the above 23 discoveries, 4 discoveries have been made in New Exploration Licencing Policy blocks. A total of nine of these discoveries have already been put to production and efforts are being continued to bring other discoveries also on production in the near future. The Company also drilled 100 exploratory wells with good Hydrocarbon exploration success. The significant discoveries are - Kesanapalli West (KG Basin), Suphayam and Dayalpur (Upper Assam). Suphayam and Dayalpur have opened up new exploration targets by establishing multilayered hydrocarbon occurrences. With Jabera discovery, ONGC has brought Vindhayan Basin into the oil reserve map of India. With these 23 discoveries, the Company accreted 64.32 MMtoe of 2P reserves in the domestic fields.

The ultimate reserve (2P) accretion of oil and oil equivalent gas (O+OEG) in 2016-17 in domestic assets of ONGC was 64.32 million tonnes.

Oil India Ltd has made ten (10) oil and gas discoveries in the Upper Assam Basin during the

year 2016-17. The discovery of oil & gas in a well has opened up new avenue for exploration and exploitation of oil & gas within the respective area of the well and the adjoining areas.

The details of exploration carried out and discoveries found during the year 2016-17 are given in General Review on "Exploration & Developmment"

PRODUCTION

Petroleum (Crude)

Production of petroleum (crude) in the country at 36.009 million tonnes in 2016-17 registered a nominal decrease of 2.55% as compared to that in the previous year. Bulk of the total production, i.e. 70.75%, was shared by the Public Sector companies. Private Sector companies accounted for the remaining 29.25 percent (Table-3).

Offshore areas continued to be the largest producer of petroleum (crude) in 2016-17 with a share of 51.15% in the country's output. Next in order were Rajasthan with a contribution of 22.67%, Gujarat with 12.79 % and Assam with 11.67 percent. The remaining 1.72% of the production was contributed by Andhra Pradesh, Tamil Nadu and Arunachal Pradesh.

During 2016-17, the production of petroleum (crude) increased in Arunachal Pradesh by 1.7%, Assam by 0.4%, Gujarat by 3.2% and Tamil Nadu by 8.8%. Whereas, there was a decline in production in Andhra Pradesh (6.4%), Rajasthan (5.1%) and offshore areas by 3.5% as compared to the previous year.

Natural Gas (Utilised)

The production of natural gas (utilised) at 30,866 m cu m decreased by 4.29% in 2016-17 as compared to that in the previous year. Offshore areas continued to be the largest producer of natural gas (utilised) with a share of 70.17%. Next in the order were Assam with a share of 9.44%, Gujarat 4.92%, Tripura 4.63%, Rajasthan 3.93%, Tamil Nadu 3.13%, Andhra Pradesh 2.70%, West Bengal 1.01% and Arunachal Pradesh accounted for the remaining 0.04% of the total production.

Statewise analysis revealed that Andhra Pradesh, Gujarat, and Tripura recorded an increase in production whereas, offshore area, Arunachal Pradesh, Assam, Rajasthan, Tamil Nadu and West Bengal recorded decrease in production of natural gas in 2016-17 as compared to that of previous year.

During 2016-17, the production of natural gas (utilised) increased in Andhra Pradesh by 34.7%, Gujarat 1.9% and Tripura by 7.3%. The decline in production was recorded in Arunachal Pradesh by 58.6%, Assam by 3.7%, Rajasthan by 9.3%, Tamil Nadu by 4.4%, West Bengal by 20.2% and offshore area by 5.9% as compared to the previous year.

As much as 78.91% of the total production came from the Public Sector companies whereas the remaining 21.09% was the share of the Private Sector companies during the year 2016-17 (Table-4).

Domestic prices of petroleum (crude) in 2014-15 to 2016-17 are furnished in Table-5.

INDUSTRY

During 2016-17, Bharat Petroleum Corporation Ltd (BPCL), Kochi and Hindustan Petroleum Corporation Ltd (HPCL), Mumbai have added refinery capacity of 2.09 MMTPA and 1.0 MMTPA, respectively. The total refining capacity of 23 units in operation in the country was about 233.966 million tpy in 2016-17. In 2016-17, refinery crude throughput increased to 245.362 million tonnes from 232.865 million tonnes in 2015-16 (Table-6).

In the coming years, about 92.35 million tonnes of additional refining capacities in both brownfield and greenfield expansion are reportedly planned or expected to come on stream. As per annual report of Ministry of Petroleum & Natural Gas, capacity augmentation to the tune of 17.35 million tonnes are planned/being implemented at brownfield refineries that are IOCL, Haldia (0.5 MMTPA); IOCL, Bonaigaon (0.35 MMTPA); BPCL, Kochi (6.0 MMTPA); HPCL, Mumbai (2.0 MMTPA); HPCL Visakhapatnam (6.7 MMTPA); and BORL, Bina (1.8 MMTPA). Out of these, about 3.9 MMTPA of refinery capacity have already been added during FY2017.

The new refineries that are under implementation and coming up in the near future are Nagarjuna Oil Corporation Ltd, Cuddalore, Tamil Nadu (6.0 million tonnes) and Hindustan

Table – 3 : Production of Petroleum (Crude), 2014-15 to 2016-17 (By States)

(Quantity in '000 tonnes; Value in ₹'000)

State	2014-15		2015-16		2016-17 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**37461**	**680882633**	**36950**	**671594812**	**36009**	**654491413**
Public Sector	25676	466681148	25594	465190734	25476	463045993
Private Sector	11785	214201485	11356	206404078	10533	191445420
Andhra Pradesh	254	4616646	295	5361853	276	5016514
Arunachal Pradesh	76	1381359	58	1054195	59	1072372
Assam	4466	81173002	4185	76065610	4202	76374598
Gujarat	4652	84553696	4461	81082123	4605	83699436
Rajasthan	8848	160819240	8602	156347999	8164	148387011
Tamil Nadu	241	4380361	261	4743877	284	5161919
Offshore	18924	343958329	19088	346939155	18419	334779563

Source: *Ministry of Petroleum & Natural Gas and MSMP, March 2017.*

Table – 4 : Production of Natural Gas (Utilised), 2014-15 to 2016-17 (By States)

(Quantity in million cu meters; Value in ₹'000)

State	2014-15		2015-16		2016-17 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**33657**	**278347698**	**32249**	**266703357**	**30866**	**255265765**
Public Sector	24745	204644317	24014	198598854	24356	201427235
Private Sector	8912	73703381	8235	68104503	6510	533838530
Andhra Pradesh	541	4474139	619	5119209	834	6897287
Arunachal Pradesh	34	281184	29	239834	12	99240
Assam	2959	24471309	3025	25017137	2914	24099154
Gujarat	1527	12628485	1490	12322491	1519	12562324
Rajasthan	1178	9742211	1338	11065431	1214	10039936
Tamil Nadu	1192	9857993	1011	8361099	967	7997213
Tripura	1140	9427946	1332	11015810	1429	11818012
West Bengal (CBM)#	228	1885589	392	3241890	313	2588547
Offshore	24858	205578842	23013	190320456	21660	179130972

 # Includes Jharkhand and Madhya Pradesh *CBM: Coal-bed Methane*

Source: *Ministry of Petroleum & Natural Gas and MSMP, March 2017.*

Table – 5 : Prices of Petroleum (Crude), 2014-15 to 2016-17

(In ₹ per tonne)

Grade	Market	2014-15	2015-16	2016-17 (P)
Indigenous*	Onshore	37089	22149	23831
Indigenous*	Offshore	40129	24453	26078
Indigenous*	Offshore & Onshore	39215	23799	25433

Source: *Indian Petroleum & Natural Gas Statistics, 2016-17 for indigenous crude prices.*

**Relates to basic prices of petroleum crude which is all inclusive of Gross (pre-discount) price and linked to international crude prices, though ONGC net price realization has been lower due to sharing of under-recoveries of OMCs by extending discount, as per the directives of MoPNG.*

Table – 6 : Installed Capacity and Crude Throughput in Refineries

(In '000 tonnes)

Refinery	Annual installed capacity (as on 1.4.2017)	Refinery Crude throughput		
		2014-15	2015-16	2016-17 (P)
Total	**233966**	**223242**	**232865**	**245362**
Public/Private Sector & Subsidaries	**135066**	**121183**	**127087**	**137388**
IOCL, Guwahati, Assam	1000	1006	904	864
IOCL, Barauni, Bihar	6000	5944	6545	6526
IOCL, Koyali, Gujarat	13700	13285	13820	13994
IOCL, Haldia, West Bengal	7500	7650	7776	7689
IOCL, Mathura, Uttar Pradesh	8000	8515	8860	9230
IOCL, Bongaigaon, Assam	2350	2403	2442	2486
IOCL, Digboi, Assam	650	591	562	533
IOCL, Panipat, Haryana	15000	14191	15282	15638
IOCL, Paradeep, Odisha	15000	-	1817	8230
BPCL, Mumbai, Maharashtra	12000	12821	13371	13541
BPCL (formerly KRL), Kochi, Kerala	12400	10356	10712	11820
HPCL, Mumbai, Maharashtra	7500	7408	8013	8510
HPCL, Visakhapatnam, Andhra Pradesh	8300	8770	9220	9335
CPCL, Manali, Tamil Nadu	10500	10251	9100	9725
CPCL, Narimanam, Tamil Nadu	1000	531	544	531
MRPL, Mangaluru, Karnataka	15000	14632	15532	15965
NRL, Numaligarh, Assam	3000	2777	2520	2683
ONGC, Tatipaka, Andhra Pradesh	66	51	67	86
Joint Venture	**15000**	**13526**	**17116**	**16882**
Bharat Oman Refineries Ltd, Bina[@]	6000	6209	6402	6360
HPCL Mittal energy Ltd, Bathinda[#]	9000	7318	10713	10521
Private Sector	**80000**	**88533**	**88662**	**91093**
RIL, Jamnagar, Gujarat	33000	30867	32428	32823
RIL, Jamnagar (SEZ), Gujarat	27000	37174	37133	37351
Essar Oil Ltd,Vadinar, Gujarat	20000	20491	19101	20919

Source: *Indian Petroleum and Natural Gas Statistics, 2016-17, Ministry of Petroleum & Natural Gas, Government of India.*

@: Bharat Oman Refineries Ltd (BORL) is a joint venture company promoted by BPCL and Oman Oil Company Ltd (OOCL).

#: HPCL Mittal Energy Ltd is a Joint venture company promoted by HPCL and Mittal Energy Investment Pvt. Ltd.

Note: *1. CPCL and BRPL are subsidiaries of IOCL; NRL of BPCL and MRPL of ONGC.*

2. Production from IOCL refinery at Paradip in Odisha was started in January, 2016.

3. Total may not tally due to rounding off.

Petro Chemical Ltd, Barmer, Rajasthan (9.0 million tonnes). HPCL has signed an agreement with the Rajasthan government to set-up the joint venture refinery at Pachpadra, Barmer.

Besides, Public Sector Oil Companies, IOCL, BPCL and HPCL are planning to set-up India's biggest refinery on the West Coast. The proposed refinery would have a capacity of 60 MMTPA which will be built in 2 phases (40 +20 MMTPA). A MoU has been signed by IOCL, BPCL and HPCL for West Coast Mega Refinery at Ratnagiri district in Maharashtra.

Production of various petroleum products from refineries and fractionators during 2014-15 to 2016-17 is provided in Table-7.

CONSUMPTION

Total consumption of petroleum products increased to 193.7 million tonnes in 2016-17 from 184.7 million tonnes in 2015-16, showing an increase of 4.9%.

Increase in consumption was reported in the case of Waxes (50.9%), Petroleum Coke (20.5%), ATF (11.8%), LDO (10.3%), LPG (9.8%), Furnace oil (9.2%), Motor spirit (8.8%) and HSDO (1.8%) during 2016-17 as compared to that of the year 2015-16, whereas, the consumption showed a decline in LSHS (30.7%), SKO (20.9%), Lubes/ Greases (6.1%) and Naptha (0.7%), during the same period.

The consumption of various petroleum products from 2014-15 to 2016-17 is furnished in Table-8.

ALTERNATIVE SOURCES

With the ever-increasing dependence on petroleum imports due to stagnant domestic production and spiralling growth in demand, the Government is encouraging the development of alternative sources of hydrocarbons. The Government, as a measure to offer a fillip for tapping alternate sources, has vigorously initiated exploration & development for coal-bed methane, gas hydrates, oil shales, underground coal gasification, etc. in the country.

Coal-bed Methane

Coal-bed Methane (CBM), an eco-friendly natural gas stored in coal seams, is generated during the process of coalification. The coal and lignite seams contain varying amounts of methane depending on the rank of the carbonaceous matter, the depth of burial and the geotectonic setting of basins. CBM exploration and exploitation has an important bearing on reducing the greenhouse effect. The extraction of CBM through degassing of the coal seams prior to mining of coal, is a cost-effective means of boosting coal production and maintaining safe methane level in working mines.

India has the fifth largest proven coal reserves in the world and thus, holds significant prospects for exploration and exploitation of CBM. The prognosticated CBM resources in the country are about 92 TCF (2600 BCM) in 12 states of India. In order to harness CBM potential in the country, the Government of India formulated CBM Policy in 1997, wherein CBM being Natural Gas is explored and exploited under the provisions of Oil Fields (Regulation and Development) Act, 1948 and Petroleum & Natural Gas Rules, 1959. With the announcement of said policy, CBM development gained momentum which laid the foundation of commercial exploitation of CBM in India. The said policy provided level playing platform for exploration and commercial exploitation of CBM by national and international entrepreneurs.

CBM blocks were offered through international competitive bidding for exploration and production of CBM in the country for the first time in May 2001. So far, under the CBM policy, the Government has awarded 33 CBM blocks [including 2 blocks on Nomination and 1 block through Foreign Investment Promotion Board (FIPB) route] in four rounds of bidding to National, Private & Joint Venture Companies. These 33 block cover 16,613 sq km out of the total available coal-bearing areas for CBM exploration which is 26,000 sq km. These CBM blocks are in the states of Andhra Pradesh, Assam, Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Telangana and West Bengal.

In India, most CBM exploration and production activities are pursued by domestic Indian companies. The total prognosticated CBM resources for the awarded 33 CBM blocks is about

Table – 7: Production of Petroleum Products from Refineries and Fractionators, 2014-15 to 2016-17

(In '000 tonnes)

Product	Production		
	2014-15	2015-16	2016-17 (P)
Total Petroleum Products	**221136**	**231923**	**243551**
From Refineries	**217141**	**227907**	**239256**
From Fractionators	**3994**	**4016**	**4294**
LPG	9840	10568	11326
Motor Spirit	32325	35321	36593
Naphtha	17391	17861	19946
Kerosene	7559	7503	6041
ATF	11103	11789	13831
HSD	94428	98588	102484
LDO	358	429	629
Furnace oil	11248	9468	9694
LSHS/HHS/RFO	671	259	268
Lube oils	946	1037	1029
Bitumen	4632	5157	5185
Petroleum coke	12448	13322	13936
Paraffin Wax	51	65	85
Others	18137	20557	22504

Source: *Indian Petroleum & Natural Gas Statistics, 2016-17, Ministry of Petroleum & Natural Gas, Government of India.*
Note: Total may not tally due to rounding off.

Table – 8 : Consumption of Petroleum Products 2014-15 to 2016-17

(In'000 tonnes)

Product	2014-15	2015-16 (R)	2016-17 (P)
1. Light distillates	**50944**	**57743**	**61336**
(a) LPG	18000	19623	21537
(b) Motor Spirit	19075	21847	23765
(c) Naphtha	11082	13271	13174
(d) Others	2787	3002	2860
2. Middle distillates	**82933**	**88517**	**89283**
(a) SKO	7087	6826	5397
(b) ATF	5723	6262	6998
(c) HSDO	69416	74647	76015
(d) LDO	365	407	449
(e) Others	342	375	424
3. Heavy ends	**31643**	**38414**	**43126**
(a) Furnace oil (FO)	5584	6482	7077
(b) LSHS	377	150	104
(c) Lubes/Greases	3310	3571	3353
(d) Bitumen	5073	5938	5939
(e) Petroleum coke	14557	19297	23254
(f) Waxes	156	173	261
(g) Others	2586	2802	3137
Total (1+2+3)	**165520**	**184674**	**193745**

Source: *Indian Petroleum & Natural Gas Statistics, 2016-17, Ministry of Petroleum & Natural Gas, Government of India.*
Note: *Consumption includes sales by oil companies, own consumption & direct private imports.*

62.4 TCF (1767 BCM), of which, so far, 9.9 TCF (280.34 BCM) have been established as Gas in Place (GIP).

The vast majority of the best prospective areas for CBM development are in Eastern India, situated in Damodar Koel valley and Son valley. CBM projects exist in Raniganj South, Raniganj East and Raniganj North areas in the Raniganj coalfield, the Parbatpur block in Jharia coalfield and the East & West Bokaro coalfields. Son valley includes the Sonhat North and Sohagpur East and West blocks.

Within the next few years, CBM is expected to emerge as a new source of natural gas production in the country. India has emerged as the fourth country in the world capable of producing CBM on commercial scale. Currently, commercial production has commenced from Raniganj South CBM block operated by M/s. GEECL since July 2007. As on March 2017, CBM production is around 1.45 MMSCMD from 4 CBM blocks which includes incidental production from 1 CBM block Jharia which is operated by M/s ONGC and commercial production from 3 CBM blocks, namely, Raniganj South, Raniganj East & Sohagpur West. The projected CBM production is expected to be around 3.4 MMSCMD by 2018-19.

Gas Hydrates

Gas hydrates are formed when gas and water mixtures are subjected to high pressure and low temperature conditions in the sea, usually in water depths of more than 800 m, within sediments just below the sea bottom. They are also formed in some permafrost region of the world. The gas hydrates also act as a cap under which natural gas can get accumulated. Gas hydrates can be an unconventional energy source of the future. World over production of gas from gas hydrate is in research & development stage. USA, Japan, Russia, China, Germany and Korea are deeply involved in developing viable technology that could enable to exploit these proved gas hydrate reserves.

In India, gas hydrate research and exploratory activities are being steered by the Ministry of Petroleum & Natural Gas under National Gas Hydrate Program (NGHP). The presence of gas hydrate has been established in Krishna-Godavari, Mahanadi, Gulf of Mannar and Andaman Basin.

Under National Gas Hydrate Programme (NGHP), technically coordinated by Directorate General of Hydrocarbons (DGH), various R&D studies are in progress to develop vast resources of gas hydrates in western and eastern offshore and Andaman offshore areas. It is a consortium of National E & P Companies, namely, ONGC, GAIL, OIL and national research institutions NIO, NIOT and NGRI. There are numerous potential offshore areas of gas hydrates in KG, Mahanadi and Andaman deepwaters which are under different stages of development.

NGHP-Expedition-01 exploration program was carried out in 2006 for mapping gas hydrates zones in Krishna-Godavari, Kerala Konkan, Mahanadi and Andaman offshore areas. A total of 39 holes at 21 sites were drilled and the physical presence of gas hydrate was established predominantly in Krishna-Godavari, Mahanadi and Andaman Basin in clay dominated complex geological settings.

NGHP-02 commenced on 3rd March 2015 and was completed on 28th July 2015. A total of 42 wells was drilled at 25 sites in Krishna-Godavari and Mahanadi areas in sand reservoirs for gas hydrates. LWD was completed in 25 wells in 4 areas A, B C & E. Coring and wire line logging was carried out in 17 wells in areas ‘B’ ‘C’ & ‘E’. NGHP-02 has discovered significant gas-hydrate-bearing sand reservoir system in the Krishna-Godavari B, C and E areas. Area A, which is in the Mahanadi deepwater basin, has several sand zones devoid of gas hydrates. Two distinct gas hydrate accumulations in Krishna-Godavari Basin were identified, of the two, one is approximately 20 to 100 m thick and is of layer-type found at depths close to 400 m and the other accumulation is a fracture-type unit of variable thickness found usually at shallow levels.

NGHP Expedition-02 results have been encouraging and further extensive studies are to be carried out to assess the gas hydrate resource potential, reservoir characterisation, reservoir delineation & geo-mechanical modelling for seafloor and wellbore stability & identification of sites for pilot production for testing. KG deep offshore Area ‘B’ & ‘C’ contain gas hydrate

accumulations which can be suitable sites for future gas hydrate production testing under NGHP Exp-03. NGHP-3 aims at carrying out pilot production testing of at least one site in Indian deepwater environment.

Two NGHP R&D projects under direct funding by OIDB were approved in the 15th Steering Committee. The first NGHP R&D project of KDMIPE, ONGC with IIT-Kanpur entitled "Modelling and Simulation of Methane Extraction from Gas Hydrates via Simultaneous Depressurisation and CO_2 Injection" was taken up with an aim to design a simulator with all dynamic variables and estimate methane release per unit time. The second project of NGRI entitled, "Carbon Dioxide & Methane Hydrate Phase Stability in Sandy and Clay Environment: Laboratory Studies" approved under NGHP funding was formulated to carry out the CO_2 phase stability experiments using synthetic sand & clay particles and to find out the rate of methane yield due to depressurisation.

The challenges faced for commercial exploitation of gas from gas hydrates are more or less similar all over the world. Extracting methane from gas hydrate in marine environments is relatively a new path. Japan has taken a lead in this direction. From the progress being made by the Indian NGHP, steps are underway to mitigate anticipated challenges in the Indian context. The NGHP expeditions are an appropriate line of research investigation which could help the country move forward by harnessing this yet elusive resource.

Shale Oil/Shale Gas

Oil Shales are usually fine-grained sedimentary rocks containing relatively large amounts of organic matter from which significant quantities of shale oil and combustible gas can be extracted by destructive distillation. An oil shale, which has a very high proportion of organic matter in relation to mineral matter, is categorised as coal. Oil shales occur in many parts of the world ranging from small occurrences of little or no economic value to those of enormous size that occupy thousands of square miles and contain many billion barrels of potentially extractable shale oil.

With the continuing decline of petroleum supplies accompanied by increasing costs of petroleum, oil shale presents opportunities for supplying some of the fossil energy needs of the world in the years ahead. North-East India is endowed with rich deposits of coal, found in the Barail Formation of Tertiary Age. Carbonaceous shale occurs interbedded with the coal. Studies have indicated that these coals and carbonaceous shale constitute the principal source rocks that have generated the hydrocarbons produced from the region.

DGH had entered into an MoU with IOCL, R&D Centre, Faridabad on 3rd January 2013 for a tenure of 3 years with an aim to develop Oil Shale as alternate source of energy. During 2015-16, a team comprising of representatives from DGH along with a geologist and a scientist from IOCL's R&D Centre, Faridabad visited Tikaka colliery, Margherita coalfield, Assam collected Oil Shale samples to study the hydrocarbon potential of these samples at IOCL, R&D centre, Faridabad. In view of the positive outcome of the ongoing studies carried out by IOCL, R&D centre, it was strongly felt that this MoU should be extended for another three years on same terms and conditions with an aim to (a) finish the extensive studies on the samples in hand which may shed light on the potential of shale available in the Assam colliery and (b) study the Oil shale samples available in other parts of the country.

Shale gas can emerge as an important new source of energy in the country. India has several Shale Formations which seem to hold shale gas. The Shale Gas Formations are spread over several sedimentary basins, such as, Gangetic plain, Gujarat, Rajasthan, Andhra Pradesh and other coastal areas in the country including hydrocarbon-bearing ones - Cambay, Assam-Arkan & Damodar Basins have large shale deposits. Various developmental activities are going on in Gandhar area of Cambay Basin, KG Basin,Cauvery Basin and Assam & Assam Arkan Basin.

The Government of India on 14.10.2013 has notified the policy guidelines for exploration and exploitation of shale gas and oil by National Oil Companies (NOCs) in their onland Petroleum Exploration Lease /Petroleum Mining Lease blocks

awarded under the nomination regimes. As per policy guidelines, ONGC and OIL are required to carry out exploration in 50 and 6 blocks, respectively for assessment under Phase-I.

Oil India Ltd is presently carrying out shale gas and oil exploration in two onland basins, namely, Assam & Arakan and Jaisalmer basin. It has identified six Blocks, viz. Dibrugarh PML, Chabua PML, Dumduma PML, Jaisalmer PML, Jairampur PEL & Deomali PEL and started G&G evaluation. It has completed G&G evaluation of four Blocks i.e, Dibrugarh, Chabua, Dumduma and Jaisalmer and submitted the report to the management for peer review before finalisation. Jairampur Extension PEL and Deomali PEL are situated in thrust best area of Upper Assam basin which have paucity of G&G data. In this regard, OIL has planned to drill three core holes up to a maximum depth of 2000 m in these two areas to acquire additional G&G information.

ONGC is presently carrying out shale gas and oil exploration in four onland basins, namely, Cambay, KG, Cauvery, Assam and Assam-Arakan. A total of twelve exploratory locations for shale gas and oil are available for drilling in 2016-17 and subsequent year. In addition, coring and other data collection are planned in suitable exploratory wells in identified blocks. ONGC has drilled 18 wells so far and one well is under drilling. So far 69 cores have been collected in 17 wells. During the current year 2015-16, ONGC has completed coring and other data collection programme in six wells (four in Cambay and one each in KG and Cauvery basins) in different blocks. These data will help in assessment of the shale gas and oil potential of respective blocks. Three of these wells were drilled in Cambay basin exclusively for shale gas and oil. Besides, the drilling of above mentioned shale gas and oil wells, ONGC has also carried out hydro-fracturing in one well JMSGA which was drilled in 2013-14.

In order to accelerate shale gas and oil development in the country, a two-day "International Shale Gas and Oil Workshop" was organised by DGH on 28th to 29th January 2016 in New Delhi. The broad objectives of the workshop were two-fold: (a) devise policy framework for facilitating and regulating shale development in India and (b) establish favourable regulatory and fiscal environment for stakeholders to promote investment and infrastructure development.

Underground Coal Gasification

Underground Coal Gasification (UCG) is a method of converting unworked coal (coal still in the ground) into a combustible gas which can be used for industrial heating, power generation or the manufacture of hydrogen, synthetic natural gas or diesel fuel. With a vast proven reserve of coal, India has the potential to use UCG technology to effectively utilise coal. UCG is a new well-proven technology of coal extraction that is being investigated and implemented around the world and that avoids most of the challenges of coal mining. Development of UCG is envisaged to provide for energy security.

The Government has approved a policy framework on 16.12.2015 for development of UCG in coal/lignite-bearing areas in the country. A policy, broadly similar to the existing policy for Coal Bed Methane (CBM) development, will be adopted for offering the blocks through competitive bidding. An Inter-Ministerial Committee (IMC) under the Ministry of Coal with members from concerned Ministries will be responsible for identification of the areas, deciding about blocks to be put to bidding or awarding them to PSUs on nomination basis. During the course of the next two years, some explored blocks will be identified for offer. Subsequently, additional blocks will be identified for offer in the long term.

ONGC has taken up Vastan Mine block site belonging to GIPCL in Naninaroli, Surat district, Gujarat as an R&D Pilot Project to establish UCG technology in collaboration with M/s Skochinsky Institute of Mining (SIM), Russia. The Agreement of Collaboration (AoC) between ONGC and M/s National Mining Research Center-Skochinsky Institute of Mining (NMRC-SIM), Russia to co-operate in the Services, Operations, Development and Research related to UCG in India has been renewed up to March 4, 2020. All the ground work and inputs for construction and implementation of UCG Pilot Project at Vastan, were completed in 2009. Further, development and project execution will be carried out by a joint venture between GIPCL and ONGC for Underground Coal

Gasification purposes. Besides, two sites, viz. Tadkeshwar in Gujarat and Hodu-Sindhari & East Kurla in Rajasthan identified jointly by ONGC & Neyveli Lignite Corporation Limited and one site viz. Surkha in Bhavnagar district, Gujarat identified jointly by ONGC & GMDC have been found suitable for UCG exploration. Once the technology is established in India, UCG will emerge as a major clean coal utilisation technology capable of providing significant impact in our country in the near future.

Biofuels

Biofuels seek to provide a higher degree of national energy security in an environment friendly and sustainable manner by supplementing conventional energy resources, reducing dependence on imported fossil fuels and meeting the energy needs of India's vast population by use of even non-food feedstocks. Government has been promoting and encouraging production and use of (a) ethanol derived from sugar molasses and/or second generation biofuels (biomass, agricultural waste, etc.) for blending with petrol and (b) biodiesel derived from inedible oils, tree borne oil seeds and oil waste for blending with diesel.

Ethanol Blended Petrol (EBP) Programme

The Government of India launched EBP Programme in January, 2003 for sale of 5% ethanol blended Petrol. In order to support the domestic industry, the Government decided during 2013 to source ethanol from domestic sources only. Currently EBP programme is being carried out in 21 States and 4 UTs under which oil marketing companies (OMCs) are mandated to sell EBP with up to 10% ethanol. Mechanism for procurement of ethanol by OMCs to carry out EBP programme was approved on December 10, 2014. In order to give a stimulus to this programme, the ethanol procurement price was enhanced and delinked from the crude price being offered in the past. The government has also opened alternate route like cellulosic and lingo cellulosic materials, including Petrochemical route. On 10.12.2014, the Government, inter alia, decided to fix the delivered price of ethanol in the range of ₹ 48.50 per litre to ₹ 49.50 per litre, depending upon the distance of distillery from the depot/installation of the OMCs. Further, OMCs have been directed to sign MoU with the State governments for a comprehensive system for uninterupted inter-depot transfer of ethanol within and outside the State.

OMCs also eased the procurement process for the benefit of suppliers including floating monthly EOIs. A Steering Committee and Working Group on Biofuels was set-up.

All these steps helped in supply of 111 crore liters of ethanol during the ethanol supply year 2015-16 (till 30.11.2016). Blending to the tune of 10% was carried out in six States during major part of 2015-16 based on ethanol availability.

Further, Oil Public Sector Undertakings are establishing 12 nos. of Second Generation (2G) Ethanol plants across 11 states with an objective to enhance ethanol production in the country to meet the enhanced blending target. Foundation stone for the first Biofuel refinery by Hindustan Petroleum Corporation Limited at Bathinda, Punjab was laid on December 25, 2016.

Biodiesel Blending Programme

Biodiesel is a mixture of fatty acid easters having properties similar to diesel. It is derived from transesterification process which involves reaction of vegetable/animal fats and oils with alcohol preferably methanol. The properties of biodiesel are such that it can be mixed with any diesel fuel. Experiments for extraction work of biofuel from various plant seeds have been carried out in the country. Of these, *Jatropha curcas* has been found most suitable for the purpose. The R&D studies indicated that it enhances the life of the engine and results in less pollution.

To encourage production of Biodiesel in the country, the government announced the "Biodiesel Purchase Policy" in 2005, which became effective from 1st January 2006. However, no biodiesel could be procured till 2014. With renewed focus on Biofuels, the Government on 16.01.2015 allowed direct sale of biodiesel by manufacturers/suppliers of biodiesel/their authorised dealers and Joint Ventures (JVs) of OMCs as authorised by MoP&NG to all consumers. On 10th August, 2015, the Government has allowed sale of biodiesel (B100) by private manufacturers to bulk consumers. Also, retailing of biodiesel blended diesel by Public Sector OMCs

was started on the same day. Currently, biodiesel is being sold by OMCs in more than 750 retail outlets.

POLICIES AND CONTRACTS

One of the landmark outcomes of the Liberalisation Policy vis-a-vis Petroleum Sector is the impetus for participation of foreign and other Indian Companies in exploration and development activities. The Government further sent signals of encouragement to the National Oil Companies to aggresively pursue oil and gas opportunities overseas.

The New Exploration Licensing Policy (NELP) and the Coal Bed Methane (CBM) Policy were formulated by the Government of India, with Directorate General of Hydrocarbons (DGH) as the nodal agency, during 1997-98 to provide a level playing field to both the Public and Private Sector Companies in exploration and production of hydrocarbons. NELP has steered steadily towards a healthy spirit of competition between National Oil Companies and private companies.

The Government had initiated bids under the NELP in February 1999 to accelerate and expand exploration of oil and gas in the country. Under NELP, acreages are offered to the participating companies through the process of open international competitive bidding. The first round of offer of blocks was launched in 1999 and most of the ninth round awards were concluded in 2012.

In order to explore and produce new sources of natural gas from coal-bearing areas, the Government had formulated a CBM Policy in 1997 and implemented the same in 2000 providing attractive fiscal and contractual framewotk for exploration and production of CBM which is an environment-friendly clean gas fuel similar to conventional natural gas.

In order to bridge the gap between energy supply and demand, GOI has adopted multi-pronged strategy for giving momentum to exploration and production activities for hydrocarbons in the country. The major steps taken in this regard include offering of exploration blocks in Indian sedimentary basins through NELP, development of alternate sources of hydrocarbon, such as, CBM and Shale Gas, Research & Development for new sources, such as, Gas Hydrate and carrying out E&P operations in safe and environment-friendly manner.

The Government has issued "Policy Guidelines for Exploration and Exploitation of Shale Gas and Oil on 14th October, 2013. Under this Policy, the right to exploration and exploitation of Shale Gas & Oil will lie with the National Oil Companies (NOCs) holding Petroleum Exploration Licence (PEL)/Petroleum Mining Lease (PML) granted under the nomination regime.

Considering the constraints experienced in the different contractual regime, it was proposed that the award of acreages for hydrocarbon exploration & production in future will be under a uniform licencing policy covering all types of hydrocarbons, with new fiscal terms ensuring ease of operation for E&P companies.

During Pre-NELP era, 28 Exploration blocks and 28 small/medium sized discovered fields were awarded to private companies where ONGC and OIL have the rights for participation after hydrocarbon discoveries. Nine rounds of bids have so far been concluded under NELP, spanning 1999-2012, in which production sharing contracts for 254 exploration blocks have been signed. As on 01.04.2017, a total of 111 blocks are active comprising 12 Pre-NELP, 73 NELP & 26 Small & Medium Size Field PSCs. The details of the blocks awarded are highlighted in Table-9.

Table - 9: Details of Exploration Block Awarded

Round	No. of blocks awarded	No. of blocks relinquished	No. of blocks active	Currently Active Area
Pre NELP	28	16	12	9475.41
Pre NELP (small & medium discovered field)	28	02	26	3713.86
NELP-I	24	21	3	12870.01
NELP-II	23	20	3	1064.96
NELP-III	23	19	4	4176.5
NELP-IV	20	16	4	1438.29
NELP-V	20	15	5	2863
NELP-VI	52	41	11	17971
NELP-VII	41	27	14	21830
NELP-VIII	32	18	14	8543
NELP-IX	19	4	15	13017.36
Total	**310**	**199**	**111**	**96963.39**

***Source**:India's Hydrocarbon Outlook, 2016-17, Directorate General of Hydrocarbons, Ministry of Petroleum & Natural Gas.*

Major policy drives and initiatives have been ushered in by the Government in upstream hydrocarbon segment in India in the last couple of years to provide impetus to the investment climate and to scale up domestic production. Many others policy measures/guidelines are under consideration or implementation by the Government. A few of these are listed below:

1. Discovered Small Field (Marginal) Policy: It was observed that many discoveries made in Nomination blocks have not been monetised and are categorised as Marginal fields. The Government of India in October 2015 announced Marginal Field Policy which was later rechristened as Discovered Small Field Policy. It will boost production and provide increased revenue to both government and contractor. Highlights of this Policy are as follows:

- **Revenue Sharing Contract:** A simple and easy to administer contractual model requiring minimum regulatory burden for field monetisation
- **Single License for Conventional & Non-conventional Hydrocarbon:** Single license to explore and extract all hydrocarbon resources, including CBM, Shale gas/oil, tight gas, gas hydrates and other resources to be identified in future.
- **No restriction on exploration activity during contract period**
- **Eligibility for Bidding:** Up to 100% participation by foreign companies, Joint Ventures will be allowed.
- **Crude Oil & Gas Pricing and Sale:** Contractor will be free to sell the crude oil and natural gas exclusively in domestic market through a transparent bidding process at arm's length.
- **Oil Cess & Royalty:** No oil cess will be applicable on crude oil production however, Royalty rates will be as under NELP regime.
- **Customs Duty:** Customs duty exemptions for specified goods and services will be available for contract areas .

2. Marketing and Pricing Freedom for New Gas Production from Deepwater, Ultra Deepwater and High Pressure- High Temperature Areas: Much of unexploited oil and gas resources are in the Deepwater, Ultra Deepwater and High Pressure-High Temperature Areas and recognising the need for incentivising gas production from such difficult areas, the Government of India on 21.03.2016 notified marketing including pricing freedom for gas produced from all discoveries which are yet to produce commercial production as on 01.01.2016 and to all future discoveries in Deepwater, Ultra Deepwater and High Pressure-High Temperature areas. Continuing further reforms in pricing, on 21.03.2016, the government approved marketing and pricing freedom for Gas discoveries in Deepwater and Ultra Deepwater areas which are yet to commence commerical production as on 01.01.2016 and all such future discoveries. Further, the policy aims to improve the economic viability of discoveries already made in such difficult areas and would lead to early monetisation of future discoveries as well.

3. New Domestic Natural Gas Pricing Guidelines: In order to strengthen the developing Gas market in the country, the Government of India started pricing reforms for the Natural Gas Sector by approving new gas pricing scheme in October 2014. This policy is based on the prevailing hub prices of United States, Mexico, Canada, European Union and Russia. The price has revision cycle of six months and will be applicable to all sectors uniformly. With a view to protect the interests of the Consuming Sector as well as paying heed to the requests from Producing Sector, a ceiling based on the landed cost of the alternate fuel has been imposed. The ceiling price in US $ per MMBTU (GCV) shall be calculated as lowest of the (i) landed price of imported fuel oil (ii) weighted average import landed price of substitute fuels and (iii) landed price of imported LNG. The landed price-based ceiling will be calculated once in six months and applied prospectively for the next six months.

4. Hydrocarbon Exploration and Licensing Policy (HELP): On 10 March 2016, the Government accorded approval to the Hydrocarbon Exploration and Licensing Policy (HELP) which is based on new contractual model i.e. Revenue Sharing. As the model is centered around a matrix of biddable revenue share vis-a vis level of production by the Contractor itself, it is expected to eliminate the

areas of disputes related to cost recovery, Investment multiple calculation, cost of unfinished work programme, rigidities of timelines, delays in implementation of FDP, etc. The implementation of Revenue Sharing Contract (RSC) model is envisaged to minimise regulatory burden for the sake of ease of doing business, and increase the ease of business in India for both National and International contractors. Major highlights of HELP are as follows:

- **Open Acreage Policy** – option to select the exploration blocks without waiting for formal bid round.
- **Revenue Sharing Model** – simple, easy to administer- no cost recovery - no micro-management by the Government - operational freedom to the operator.
- **Pricing and Marketing Freedom** – Major incentive for investment.
- **Single License for Exploration and Production of Conventional as well as Non-conventional Hydrocarbon Resources.**
- **Exploration Allowed throughout the Contract Period.**
- **Increase in Exploration Phase** – Exploration Phase for onshore areas have been increased from 7 years to 8 years while that for offshore areas have been increased from 8 years to 10 years.
- **Reduced Royalty Rates for Offshore Blocks.**

5. Policy for Extension of Production Sharing Contracts (PSCs): To enable optimal recovery of oil and gas reserves from fields after expiry of PSC, the Government of India on 10 March 2016 has approved a policy for grant of extension to the Production Sharing Contracts for 28 Pre-NELP discovered (small and medium size) fields. The policy aims at bringing out clear terms of extension so that the resources can be expeditiously exploited in the interest of energy security of the country and improving the investment climate.

This policy provides for a uniform, non-discretionary framework for extension of contract for a period of 10 years both for oil and gas. During the extension period, it is proposed to increase the Government take by way of charging normal royalty and cess in place of concessional royalty and cess charged during the original contract period. The profit petroleum during extension period will also be 10 percent higher than the normal percentage.

6. Policy for Testing Requirement: The Government has approved a policy on testing requirements for discoveries made under New Exploration and Licensing Policy (NELP) Blocks on 29.04.2016 in order to resolve the disputes related to testing requirements and to monetise the stuck up discoveries. This decision was implemented on 13.05.2015. The contractors are now allowed to carry out the pending drill stem test on the discoveries and submit the results in a specified time line. Testing is being carried out on all concerning/applicable discoveries which were stuck up earlier.

7. Policy Framework for Relaxations, Extensions and Clarifications at the Development and Production stage under PSC Regime for Early Monetisation of Hydrocarbon Discoveries: To address various issues and concerns regarding PSCs, the policy framework was notified in November 2014. As a result of implementation of these guidelines, more than 40 long pending PSC related issues have been resolved.

8. Exploration in Mining Lease Areas: The Government of India has formulated a policy to allow exploration in Mining Lease Areas with cost recovery subject to establishment of commerciality. Till 31.03.2016, 15 hydrocarbon discoveries (14 Oil & 1 Gas) have been notified in the Mining Lease (ML) areas after announcement of the above policy. Document of Commerciality (DoC) for one Discovery D-55, from the Block KG-DWN-98/3 has been submitted.

9. Policy Guidelines of Exploration and Exploitation of Shale Gas and Oil: Shale Gas and Oil Policy was announced on 14 October 2013 and under this Policy the right to exploration and exploitation of shale gas & oil has been granted to the National Oil Companies (NOCs) holding Petroleum Exploration License (PEL)/Petroleum Mining Lease (PML) granted under the nomination regime. NOCs have identified 55 blocks for Assessment Studies during the Phase-I of three years. Further, NOCs will identify 80 blocks under Phase-II of three years and 55 blocks in Phase-III.

10. Policy Framework for Development of Underground Coal Gasification in Coal and Lignite bearing Areas in India: The Union Cabinet in December 2015 has approved a policy framework for development of Underground Coal Gasification (UCG) in coal and energy from coal/ lignite resources which are otherwise regarded as uneconomical to work through conventional mining methods. A policy on lines broadly similar to the existing policy for Coal Bed Methane (CBM) development on revenue sharing basis will be adopted for offering the blocks through competitive bidding.

OTHER INITIATIVES

Site Restoration Guidelines for Petroleum Operations: The Government of India has constituted a committee for formulation of Site Restoration guidelines for petroleum operations. The recommendations of the committee members have been finalised and adopted for submission to the Ministry.

Standing Committee on Petroleum Industry Practices: The Government of India has constituted a Standing Committee to identify the areas requiring codification of "Good International Petroleum Industry Practices (GIPIP)" and to prepare national codes for petroleum operations. Subsequent to several deliberations with stakeholders, the Standing Committee has approved and adopted the report and the same has been submitted to the Ministry.

Encouraging E&P Activities in North-East India: To encourage hydrocarbon exploration and production activities in the North-East (NE) Region of India, the Government of India carried out special study with consultant for framing Hydrocarbon Vision Document 2030 for NE India. The vision document was released on 09.02.2016. This vision document aims to prepare a roadmap for the next 15 years to increase the production of oil and gas in north-east India and outline the necessary investment in the Hydrocarbon Sector to increase exploration activities, expand the Piped Natural Gas (PNG) network and ensure availability of petroleum products, including LPG, in the remotest corners of the region. For implementation of the action plans that emerged from this vision document, an Executive Council has been formed consisting of government officials and industry stakeholders as its members.

Multi-client Geo-scientific Surveys: Seven proposals have been received for generation of approx. 107,386 LKM 2D Seismic data, under the policy for Geo-scientific data generation for hydrocarbons in Indian sedimentary basins, through Non-exclusive Multi-client Geo-scientific surveys/ activities. All the seven proposals have received clearances from Ministry of Defence (MoD) and Ministry of Home Affairs (MoHA). M/s Electromagnetic Geoservices ASA, Norway, started data acquisition in West Coast of India.

Re-assessment of Prognosticated Hydrocarbon Resources of India: A Multi-Organisation Team (MOT) has been constituted to carry out re-assessment of hydrocarbon resources of India in all its 26 sedimentary basins. The project is to be carried out by ONGC in association with OIL and DGH. Work has been initiated at seven work centres of ONGC for eight priority basins. Entire work for all 26 sedimentary basins is expected to be completed by November, 2017.

Appraisal of Unappraised Sedimentary Areas: Out of the total sedimentary area of 3.142 million sq. km, an area of 1.502 million sq. km is yet to be appraised. To appraise unappraised areas, MoP&NG has formulated a plan to conduct 2D seismic surveys in all sedimentary basins of India where no/scanty data is available. ONGC and OIL have been entrusted with the task of surveying these areas. OIL has been assigned to carry out 2D seismic API of 7,408 LKM falling in North Eastern part of India and ONGC has been assigned to carry out 2D seismic API of approx. 40,835 LKM seismic data in inland part of 22 sedimentary basins of India.

National Data Repository (NDR): To consolidate and store all the geo-scientific data available in the country and to create a base for Open Acreage Licensing Policy, GoI has taken initiative to build National Data Repository (NDR) for Oil and Gas Industry in India. Initial population of data is in progress and the priority data pertaining to reassessment of 26 sedimentary basins is being loaded. As on 31.03.2016, a total of 169,144.77 LKM 2D Seismic data, 15,716.28 SKM 3D Seismic data, 237 wells and logs data and 618 wells report has been loaded in NDR.

Strategic Crude Oil Storage

Taking into account the oil security concerns of India, the Government has also decided to build a Strategic Crude Oil Reserve of 5.33 million tonnes at three locations in the country viz. Visakhapatnam, Andhra Pradesh (1.33 million tonnes), Mangaluru, Karnataka (1.5 million tonnes) and Padur, Karnataka (2.5 million tonnes) through a Special Purpose Vehicle (SPV) named Indian Strategic Petroleum Reserves Ltd (ISPRL), a subsidiary Company of OIDB. The storage facility at Visakhapatnam has already been filled up and one half of Mangalore storage facility has also been filled. The storage facility at Padur has also been completed. ISPRL signed a Definitive Agreement with Abu Dhabi National Oil Company (ADNOC) of UAE for Oil Storage and Management for the second half of Mangalore storage facility.

The Strategic Petroleum Reserve of Phase-I is estimated to supply approximately 10.5 days of India's crude requirement according to the consumption during 2015-16. Thus, the need for additional crude oil storage is being felt in the light of increasing requirement of crude oil and subsequently, construction of storage facilities at Chandikhol in Odisha and at Bikaner in Rajasthan, under Phase II of Strategic Petroleum Reserve Programme, have also been proposed.

Table – 10 : World Proved Reserves of Crude Oil* (By Principal Countries)

(In billion tonnes)

Country	Reserves
World: Total	**240.7**
Algeria	1.5
Angola	1.6
Brazil	1.8
China	3.5
Canada	27.6
Iran	21.8
Iraq	20.6
Kazakhstan	3.9
Kuwait	14.0
Libya	6.3
Nigeria	5.0
Qatar	2.6
Russian Federation	15.0
Saudi Arabia	36.6
UAE	13.0
USA	5.8
Venezuela	47.0
Other countries	13.1

Source: *BP Statistical Review of World Energy, June 2017.*
** At 2016 end.*

WORLD REVIEW

The world proved reserves of crude oil and natural gas at the end of 2016 were estimated at 240.7 billion tonnes and 186.6 trillion cu m, respectively (Tables - 10 & 11). The largest share of reserves of world crude oil is available in Middle East (45.74%) followed by South & Central America (21.11%), North America (14.33%), Europe & Eurasia (9.06%), Africa (7.02%) and Asia Pacific (2.66%).

Of the total world reserves of natural gas, Middle East possesses the largest share (42.55%) followed by Europe & Eurasia (30.39%), Asia Pacific (9.38%), Africa (7.66%), North America (5.95%) and South & Central America (4.07%).

The world crude petroleum production in 2016 marginally increased to 4,377 million tonnes from 4,353 million tonnes in 2015. OPEC countries, namely, Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, UAE

Table – 11 : World Proved Reserves of Natural Gas* (By Principal Countries)

(In trillion cu m)

Country	Reserves
World : Total	**186.6**
Algeria	4.5
Australia	3.5
Azerbaijan	1.1
Canada	2.2
China	5.4
Egypt	1.8
India	1.2
Indonesia	2.9
Iran	33.5
Iraq	3.7
Kazakhstan	1.0
Kuwait	1.8
Libya	1.5
Malaysia	1.2
Myanmar	1.2
Netherlands	0.7
Nigeria	5.3
Norway	1.8
Qatar	24.3
Russian Federation	32.3
Saudi Arabia	8.4
Turkmenistan	17.5
UAE	6.1
USA	8.7
Uzbekistan	1.1
Venezuela	5.7
Other countries	8.2

Source: *BP Statistical Review of World Energy, June 2017.*
** At 2016 end.*

and Venezuela had a share of about 42.13% (Libya & Equatorial Guinea and Gabbon have been excluded) in the world crude oil production in 2016. Saudi Arabia, Russia & USA (13% each), China, Iran & Iraq (5% each), Canada & UAE (4% each) and Kuwait, Brazil, Mexico & Venezuela (3% each) were the principal producers of crude petroleum in 2016.

The world production of natural gas also marginally increased to 3.715 trillion cu m in 2016 from 3.696 trillion cu m in 2015. OPEC countries had a share of 18.28% (include Algeria, Iran, Nigeria, Qatar, Saudi Arabia, UAE and venezuela only) in the world natural gas production in 2016. USA (20%), Russia (17%), Iran & Qatar (5% each), Canada & China (4% each) and Australia, Norway & Saudi Arabia (3% each) were the major producers of natural gas in 2016 (Tables - 12 & 13).

The world consumption of oil in 2016 was estimated as 4,418.2 million tonnes, while that of natural gas was 3,212.9 million tonnes oil equivalent. Consumption of oil and natural gas in India in the same period was 212.7 million tonnes (with 4.81% share) and 24.9 million tonnes oil equivalent (with 0.78% share), respectively.

FOREIGN TRADE

Table – 12 : World Production of Crude Petroleum (By Principal Countries)

(In million tonnes)

Country	2014	2015	2016
World : Total	**4216**	**4353**	**4377**
Algeria	69	67	69
Angola	83	89	88
Argentina	28	28	27
Azerbaijan$	42	42	41
Brazil	121	131	135
Canada	186	191	192
China#	211	215	207
Colombia	49	53	49
Ecuador	28	29	29
Egypt	35	35	34
India*	37	37	36
Indonesia	39	39	37
Iran	174	182	216
Iraq	160	197	219
Kazakhstan	81	79	78
Kuwait@	151	149	153
Malaysia	29	31	32
Mexico	144	134	127
Nigeria	113	112	99
Norway	93	96	98
Oman	47	49	50
Qatar	84	79	79
Russia	525	533	549
Saudi Arabia@	543	568	586
UAE	167	176	182
UK	40	47	48
USA	543	587	564
Venezuela	138	136	124
Other countries	256	242	229

Source: *World Mineral Production, 2012-2016.*
@ Including shares of production from the Neutral Zone.
 # Including oil from shale and coal.
** Year ended 31st March following that stated.*
$ Including natural gas liquids.

Table – 13 : World Production of Natural Gas (By Principal Countries)

(In billion cu m)

Country	2014	2015	2016
World: Total	**3612**	**3696**	**3715**
Algeria	83	85	91
Argentina	41	43	45
Australia	67	77	97
Canada	151	154	157
China	130	135	137
Egypt	49	44	42
India*	34	32	31
Indonesia	76	76	75
Iran	186	189	202
Kazakhstan	43	45	46
Malaysia	65	63	67
Mexico	64	60	52
Netherlands	69	51	47
Nigeria	45	50	45
Norway	109	117	117
Oman	30	31	32
Pakistan**	42	42	42
Qatar	177	181	181
Russia	639	633	639
Saudi Arabia***	102	105	109
Tanzania	1	37	46
Thailand	42	40	39
Trinidad & Tobago	42	40	34
Turkmenistan	69	72	69
UAE	58	56	62
UK	39	41	28
USA#	733	766	749
Uzbekistan	57	58	63
Venezuela	29	32	34
Other countries	340	341	337

Source: *World Mineral Production, 2012-2016.*
** Year ended 31st March following that stated.*
*** Year ended 30th June of that stated.*
**** Including one half of the output of the natural Zone.*
 # Dry gas.

Exports

Exports of natural gas decreased considerably in 2016-17 to 36,241 tonnes from 1,25,303 tonnes in 2015-16. Exports of natural gas were mainly to Korea Rep (83%), Nepal (15%) and Bhutan (2%) (Table -14).

Exports of petroleum products were at 65.513 million tonnes during 2016-17 which showed a decrease of 8.22% against the exports of 60.539 million tonnes during 2015-16.

Imports

Imports of crude petroleum increased considerably to 214.89 million tonnes in 2016-17 as compared to 202.31 million tonnes in 2015-16. Imports were mainly from Saudi Arabia & Iraq (18% each), Iran (13%), Venezuela (10%), UAE (9%), Nigeria (8%), Kuwait (4%) and Angola (3%). Imports of natural gas increased significantally to 17.78 million tonnes in 2016-17 from 14.38 million tonnes in 2015-16. Main suppliers were Qatar (57%), Nigeria (13%), Australia (8%), Guinea (6%) and UAE & Trinidad (3% each) (Tables - 15 & 16).

Imports of petroleum products were at 35.413 million tonnes during 2016-17 which showed an increase of 20.22% against 29.456 million tonnes during 2015-16.

Table – 14 : Export of Natural Gas (HS Code 271111)
(By Countries)

Country	2015-16		2016-17 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**125303**	**3731079**	**36241**	**1494437**
Korea, Rep. of	-	-	30185	1247170
Nepal	10233	398931	5509	224481
Bhutan	65	5115	547	22787
Singapore	115006	3327034	-	-

Source: Department of Commerce, Ministry of Commerce & Industry.

Table – 15 : Import of Petroleum (Crude) (HS Code 270900)
(By Countries)

Country	2015-16		2016-17 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
All Countries	**202314**	**4293999334**	**214887**	**4742189327**
Saudi Arabia	39592	878771259	39339	917248878
Iraq	35695	700406963	37759	779032785
Iran	13616	278154035	27141	597667031
UAE	14806	356408563	19308	455059562
Nigeria	22971	588802998	17709	452749918
Venezuela	22721	369980764	21439	369226719
Kuwait	11173	233432772	9154	197427807
Angola	7222	172784989	5935	143841481
Malaysia	3284	84170753	5107	132524489
Mexico	5757	90049283	7003	123825591
Qatar	4435	96960768	4666	111057417
Other countries	21043	444076187	20328	462527649

Source: Department of Commerce, Ministry of Commerce & Industry.

Table – 16 : Import of Natural Gas (HS Code 271111)
(By Countries)

Country	2015-16		2016-17 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**14376925**	**437824399**	**17783327**	**402490232**
Qatar	9504899	296343149	10065500	228671231
Nigeria	1518750	48770090	2309662	47688519
Australia	713026	18971936	1405809	34853239
Guinea	338942	9192022	1008882	23135749
UAE	113397	2996086	565249	11051333
Trinidad	218372	5635812	445307	10706520
USA	-	-	424361	10377244
Angola	-	-	415342	9036428
Oman	480207	14358294	323826	6876548
South Africa	413438	12998746	215413	5202005
Other countries	1075893	28558264	603976	14891416

Source: Department of Commerce, Ministry of Commerce & Industry.

FUTURE OUTLOOK

Energy is considered as of the key inputs for economic development of the Country. India is poised to play a significant role in the Global energy space, as it is likely to account for 25% of the rise in global energy demand by 2040. Our Country's energy demand is expected to rise at a compounded annual growth rate (CAGR) of 3.5% till 2040 as it advances on the path of development.

As per draft National Energy Policy, 2017, the shares of oil and gas in energy consumption in the country during 2015-16 were 26% and 6.5%, respectively. It is expected that in the medium term while the share of oil may not come down, share of gas would rise. Based on the present extent of knowledge of the hydrocarbons potential, the said policy anticipated that the production of oil and gas has potential (ambitious case) to reach 61 Mtoe and 124 BCM by 2040.

As per annual report of MoPNG for 2016-17, Indian sedimentary basins need intensive exploration efforts for enhancing crude oil & natural gas supply in the country. The hydrocarbon potential has been witnessed where exploratory inputs have been expended. As of now, only 48% of the basinal areas have been appraised. About 4% sedimentary basinal area has been declared as "NO GO area" by Ministry of Defence/Ministry of Environment & Forests which remains unappraised. This means, about half of the Indian sedimentary basins have undiscovered potential for hydrocarbons. The total prognosticated hydrocarbon resources are estimated at about 28,000 million tonnes in the sedimentary basins of the country, out of which 11,241 MMT in-place reserves have been established by ONGC, OIL and Private/JV companies as on 1.4.2016, which means about 60% hydrocarbon reserves are yet to be discovered. Thus, Indian sedimentary Basins have ample hydrocarbon potential for future exploration and production.

In recent years, the government has committed itself to a number of economic and structural reforms that are aimed at achieving strong growth in GDP over the medium to long term range. As regards petroleum products, the government's efforts are to reduce subsidies on petroleum products which in due course is expected to temper demand for liquid fuels. In the IEO2016 Reference case, consumption of petroleum and other liquid fuels in India is likely to more than double, from 3.6 million b/d as in 2012 to 8.3 million b/d in 2040, as its GDP correspondingly would quadruple over the period.

Natural gas production in India, on the other hand, would grow by an average of 1.3%/year in the IEO2016 Reference case, from 1.4 TCF as in 2012 to 2.1 TCF in 2040. India faces several

production challenges. For example, a large portion of its current production comes from aging western offshore fields, and production volume from the Krishna-Godavari Basin - located off India's eastern coast - has failed to meet the desired expectations. India has several basins that are prospective for shale gas. India's Oil Ministry has announced that the Government will unveil a shale gas and oil policy in the near future and begin selling shale gas development blocks, although no awards have been made to date. In the later years of the IEO2016 Reference case, shale resources may provide nearly one-quarter of India's total natural gas production.

Presently, domestic refining capacity is higher than the country's demand for petroleum products. This surplus capacity may be a source for high foreign exchange earning and will assure energy security. The surplus refining capacity in North India and in the North-East holds the potential for supplying petroleum products to the neighbouring countries.

As per Hydrocarbon Vision 2030 for North East, the Vision aims at doubling Oil & Gas production by 2030, making clean fuels accessible, fast tracking projects, generating employment opportunities and promoting cooperation with neighbouring countries and targets an investment of ₹1.30 lakh crore till 2030 in North East India.

The country is deficient in oil resources and most of the domestic requirements are met through imports and this trend is likely to continue in the near future as well. Petrochemical Sector is closely linked to availability of feedstock from refineries. To exploit the logistical advantage of imported crude supplies, there are potential for capacity expansion and setting up of Greenfield refineries, preferably at coastal locations.

Strategic storage of crude and petroleum products, to assure supplies at times of supply disruption, are available only for 5.33 MT which need to be augmented on considering the 90-day consumption requirement of strategic and commercial storages.

Apart from above, as Oil India Ltd, has significant presence in the North East part of India and presently operating in the Upper Assam basin which happens to be one of the most prolific basins in India, it will concentrate efforts in the North East to achieve continued reserve accretion.

To enhance recovery, water injection and other EOR/IOR technologies would have to be adopted which has the ability to liberate additional production capacity of around 0.32 to 0.35 MMTPA of crude over the next 12 to 15 year period.

It is expected that Oil India Ltd will continue to pursue acquisition of prospective overseas E&P opportunities. In addition to acquisition of conventional assets, it would also look towards acquisition of non-conventional assets, such as oil sands, shale gas, shale oil, gas hydrate, etc.

Selective diversification into midstream, downstream and renewable energy segments, such as, pipelines, wind/solar energy, CGD, LNG, refineries, etc. would also be planned to balance the existing portfolios.