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PETROLEUM & NATURAL GAS

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GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

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The domestic production of crude oil which stood at 35.684 million tonnes in 2017-18 decreased by 0.9% as compared to that of the output of the corresponding previous year. The production of natural gas (utilised), on the other hand, increased to 32,649 million cu meters (MMSCM) in 2017-18 which is about 2.36% more as against the production in 2016-17. Indian refinery industry has done well in establishing itself as a major player globally and has emerged as a refinery hub. India is the second largest refiner in Asia after China and is the fourth largest in the world. After the addition of 3.1 MMTPA, 2.3 MMTPA and 8.2 MMTPA refinery capacity at BPCL, Kochi; HPCL Mittal Energy Ltd (HMEL), Bhatinda; and RIL (SEZ), Jamanagar; respectively, the country's refining capacity has touched 247.566 MMTPA as on 01.04.2018.

Energy is a key driver of economic growth of any country. 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 7.3% averaged growth in GDP at constant (2011-12) prices for the period from 2015-16 to 2017-18, which is the highest among the major economies of the world.

India continue to remain one of the fastest growing economies in the world. As per a report of the United Nations titled: World Economic Situation and Prospects 2018, 'the outlook for India remains largely positive, underpinned by robust private consumption and public investment as well as ongoing structural reforms.

Current hydrocarbon demand is much more than the domestic crude oil and natural gas production. India is the 3rd largest consumer of energy (primary) after China and USA.

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; India needs to plan to either limit its consumption or try to augment production. The country has ambitious plans to increase domestic oil & gas production and exploit all possible forms of energy to the fullest. 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 country, 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. The Government has formulated path breaking policies to revolutionise the E&P sector which inter-alia includes Gas Pricing Reforms; Policy Framework for Early Monetization of CBM; Discovered Small Field Policy; Reform Initiatives to Enhance Domestic Production; Hydrocarbon Exploration and Licensing Policy (HELP) coupled with operationalisation of Open Acreage Licensing Policy (OALP); Monetisation of Ratna offshore field; Permission of Extraction of CBM to Coal India Limited & its subsidiaries in coal Mining area; Policy for the Grant of extensions to Pre-NELP Exploration Blocks; Hydrocarbon Vision 2030 for North East; National Seismic Programme of Un-appraised areas; National Data Repository (NDR), etc.

RESERVES/RESOURCES

As on 1.4.2018, the total balance recoverable reserves of crude oil were estimated at 594.49 million tonnes, out of which 317.82 million tonnes (53.46%) are in onshore and 276.67 million tonnes (46.54%) in offshore areas. ONGC (nomination) has the largest share of 73% in reserves of crude oil with OIL (nomination) and PSC regime contributing 13% and 14%, respectively.

The balance recoverable reserves of natural gas as on 01.04.2018 were placed at 1,339.57 billion cu m, out of which 516.22 billion cu m (38.54%) are in onshore and 823.35 billion cu m

(61.46%) in offshore areas. PSC regime has the largest share of 49% in natural gas reserves followed by ONGC (nomination) and OIL (nomination) at 42% and 9%, respectively (Table-1).

Table – 1 : Proved and Indicated Balance Recoverable Reserves of Crude Oil and Natural Gas in India as on 1.4.2018

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

Area	Crude oil	Natural gas
India	**594.49**	**1339.57**
Onshore	**317.82**	**516.22**
Andhra Pradesh	7.94	59.89
Arunachal Pradesh	1.74	1.26
Assam	160.34	161.65
Gujarat	118.20	58.23
Jharkhand*	-	8.11
Madhya Pradesh*	-	31.91
Nagaland	2.38	0.09
Rajasthan	17.99	54.85
Tamil Nadu	9.16	39.11
Tripura	0.07	35.20
West Bengal*	-	65.92
Offshore	**276.67**	**823.35**
Western offshore	236.25	312.52
Eastern offshore	40.42	510.83

Source: *Indian Petroleum and Natural Gas Statistics, 2017-18, Ministry of Petroleum and Natural Gas, Govt. of India.*

Note*: (i) Total may not tally due to rounding off.*

(ii) Western offshore 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 31.3.2018, there were in all 430 oil/gas fields including offshore areas under these companies in the country.

In Public Sector, ONGC's (Nomination) jurisdiction extended to 228 fields – Cambay basin (Gujarat) - 82 oil/gas fields; Upper Assam (Assam) - 34 fields and Assam & Assam Arakan (Assam) - 5 fields; Jodhpur (Rajasthan) - 6 fields; Krishna-Godavari basin (Andhra Pradesh) - 60 fields; Cauvery basin (Tamil Nadu) - 28 fields; Assam & Assam Arakan (Tripura) - 10 fields and Assam & Assam Arakan (Nagaland) - 2 fields; and Vindhyan basin (Madhya Pradesh) - 1 field; besides, 84 offshore fields in the Mumbai (79 fields), Kachchh (3 fields) and Cambay basin (2 fields) in West Coast and 23 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 76 oil/gas fields – Cambay basin in Gujarat (40 fields); Assam-Arakan in Arunachal Pradesh (1 field) & in Assam (2 fields); Krishna Godawari in Andhra Pradesh (1 field); Jharia & Bokaro in Jharkhand (1 field each) (CBM); Sohagpur in Madhya Pradesh (2 fields) (CBM); Rajasthan (12 fields); Cauvery in Tamil Nadu (1 field) and Raniganj East basin in West Bengal (2 fields) (CBM) in onshore areas. In offshore areas, these companies covered 2 fields in Cauvery basin and 4 fields in Krishna-Godavari basin on the East Coast and 4 fields in Mumbai basin and 3 fields in Cambay basin on the West Coast.

During 2017-18, ONGC was associated with Hydrocarbon Resource Re-assessment studies for all 26 sedimentary basins including Deepwaters and the reports were submitted to DGH.

ONGC was the major stakeholder in National Seismic Programme (NSP) with 40,835 Line Kilometer (LKM) target out of the total target of 48,243 LKM. The 2D seismic data acquisition work has already commenced in 10 sectors, i.e., Saurashtra, Rajasthan, Mahanadi, Deccan Synclise, Bhima, Kaladgi, Vindhyan and Himalayan Foreland areas in October 2016; Ganga, Cuddapah-Krishna Godavari in June, 2017; and South Rewa Damodar-Chhattisgarh in October 2017. A total of 14,621.16 LKM of 2D data was acquired (besides ONGC's routine 2D/3D survey) during 2017-18. In total, the Company has acquired 19,655 LKM of data. Processing and interpretation of data is under progress.

During the year, ONGC was pursuing basement exploration across most of the operational areas as a frontier exploration play and drilled 24 wells including 11 wells with primary

objective as Basement. Encouraging results have been obtained in Wells GK-28-11, N-24-4, N-24-5, HY-11X in Western Offshore; Wells Padra-114, 116, 117, 119, 120 in Cambay basin; Khoraghat-42 and BJAB in A&AA basin. Wells BH-76 and SMH-1 drilled in Western Offshore Basin flowed oil from Basement. Cauvery basin is coming up as an important area for Basement Play with encouraging results in Mattur West-I and Pundi-8.

Besides, ONGC has prioritised HP-HT/Tight/ Deeper plays in KG, Cauvery, Western Offshore Basin and Assam & Arakan Fold belt. During the year 2017-18, onland Well PD-3 in Periyakudi field, Cauvery Basin became the first HP-HT well to be put on production. Another Well BTS-3 in KG onland Basin has been successfully drilled and tested for gas in commercial quantities. In addition, the Company after acquiring the operatorship of NELP block KG-ONN-2003/1 has submitted the FDP of two discoveries made in the block. Further, the Company acquired 80% stake and operatorship from Gujarat State Petroleum Corporation Limited (GSPCL) in the block KG-OSN-2001/3.

During the year 2017-18, ONGC has made 12 discoveries (1 in NELP, 11 in Nomination acreages). Of these, 5 are new prospects and 7 are new pool discoveries. The major success during the year was an oil discovery from Well WO-24-3 (WO-24-C) which has indicated potential of about 29.74 MMtoe of In-Place Hydrocarbon Volume in the discovery area. The Company has monetised two onland discoveries (West Matar-1: Cambay Basin, Mattur West-1: Cauvery basin) and efforts are being continued to bring other discoveries on production. Accretion to In-place Hydrocarbons (3P-Proved, Probable and Possible), from the company operated fields in India stood at 185.84 MMtoe, out of which about 79 percent accretion has been due to exploratory efforts.

Oil India Ltd carried out 2D & 3D seismic survey to identify new prospects in the Petroleum Mining Lease (PML) areas and NELP Blocks. It has drilled 14 exploratory wells in PML areas and continued exploratory efforts in the NELP Block, KG-ONN-2004/1, KG onland basin by drilling 3 Wells including one High Pressure-High Temperature (HPHT) well. During the year, OIL made 4 oil & gas discoveries in the Upper Assam Basin and established first commercial oil production from new formation (Narpuh) in Upper Assam Basin. OIL has already initiated steps for quick appraisal, development and production from these discoveries. During the year, OIL has achieved Reserve Replacement Ratio (RRR) of 1.34. A state-of-the-art cableless seismic data acquisition system has been inducted. This will help in seismic data acquisition in logistically difficult areas, river bed areas, township areas etc.

The details of exploration carried out and discoveries found during the year 2017-18 are described in General Review on "Exploration & Development".

PRODUCTION

Petroleum (Crude) Oil

Production of petroleum (crude) oil in the country at 35.684 million tonnes in 2017-18 registered a nominal decrease of 0.9% as compared to that in the previous year. Bulk of the total production, i.e., 71.81%, was shared by the Public Sector companies (nomination regime). Private Sector companies (PSC regime) accounted for the remaining 28.19 percent (Table-2).

Offshore areas continued to be the largest producer of petroleum (crude) oil in 2017-18 with a share of 50.85% in the country's output. Next in order were Rajasthan with a contribution of 22.10%, Gujarat with 12.87 % and Assam with 12.18 percent. The remaining 2% of the production was contributed by Andhra Pradesh, Arunachal Pradesh and Tamil Nadu.

During 2017-18, the production of petroleum (crude) oil increased in Tamil Nadu by 21.48%, Andhra Pradesh by 16.67% and Assam by 3.38% as compared to the previous year. Whereas, there was a decline in production in Arunachal Pradesh (10.71%), Rajasthan (3.39%), offshore areas (1.5%) and Gujarat by 0.3% (Table-2).

Natural Gas (Utilised)

The production of natural gas (utilised) including CBM at 32,649 MMSCM increased by 2.36% in 2017-18 as compared to that in the previous year. As much as 80.58% of the total production came from the Public Sector compnies

Table – 2 : Production of Petroleum (Crude) Oil, 2015-16 to 2017-18 (By States)

(Quantity in '000 tonnes)

State	2015-16	2016-17	2017-18 (P)
India	**36942**	**36009**	**35684**
Public Sector (Nomination)	25587	25477	25625
Private Sector (PSC regime)	11355	10532	10059
Andhra Pradesh	295	276	322
Arunachal Pradesh	58	56	50
Assam	4185	4203	4345
Gujarat	4458	4605	4591
Rajasthan	8602	8164	7887
Tamil Nadu	255	284	345
Offshore	19089	18421	18144

Source: *Indian Petroleum and Natural Gas Statistics, 2016-17 & 2017-18, Ministry of Petroleum and Natural Gas, Govt. of India.*

Note: *(i) The value of fuel minerals production is not received from source agency, hence not reflected*
(ii) Total may not tally due to rounding off

Table – 3 : Production of Natural Gas (Utilised), 2015-16 to 2017-18 (By States)

(Quantity in MMSCM)

State	2015-16	2016-17	2017-18 (P)
India	**32249**	**31897**	**32649**
Public Sector (Nomination)	24014	25025	26311
Private Sector (PSC regime)	8235	6872	6338
Andhra Pradesh	619	868	959
Arunachal Pradesh	29	28	30
Assam	3025	3128	3220
Gujarat	1490	1580	1607
Rajasthan	1338	1277	1442
Tamil Nadu	1011	983	1208
Tripura	1332	1430	1440
West Bengal** (CBM)	393	564	735
Offshore	23012	22039	22008

CBM: Coal-bed Methane

Source: *Indian Petroleum and Natural Gas Statistics, 2016-17 & 2017-18, Ministry of Petroleum and Natural Gas, Govt. of India.*

***** *Includes Jharkhand and Madhya Pradesh.*

Note: *(i) The value of fuel minerals production is not received from source agency, hence not reflected*
(ii) Total may not tally due to rounding off

(nomination) whereas the remaining 19.42% was the share of the Private Sector companies (PSC regime) during the year 2017-18 (Table-3).

Offshore areas continued to be the largest producer of natural gas (utilised) in 2017-18 with a share of 67.41%. Next in the order were Assam with a share of 9.86%, Gujarat 4.92%, Rajasthan 4.42%, Tripura 4.41%, Tamil Nadu 3.70%, Andhra Pradesh 2.94% and West Bengal (CBM), Madhya Pradesh (CBM), Jharkhand (CBM) & Arunachal Pradesh together accounted for the remaining 2.34%.

During 2017-18, Statewise analysis revealed that the production of natural gas (utilised) increased in West Bengal (CBM) by 30.32% followed by Tamil Nadu by 22.89%, Rajasthan by 12.92%, Andhra Pradesh by 10.48%, Arunachal Pradesh by 7.14%, Assam by 2.94%, Gujarat 1.71% and Tripura by 0.70%. Decline in production was recorded marginally in offshore area by 0.14% as compared to the previous year.

INDUSTRY

Indian Refinery Industry has done well in establishing itself as a major player globally. India, is the second largest refiner in Asia after China. During 2017-18, Bharat Petroleum Corporation Ltd (BPCL), Kochi; HPCL Mittal Energy Ltd (HMEL), Bhatinda; and RIL (SEZ), Jamnagar have added refinery capacity of 3.1 MMTPA, 2.3 MMTPA and 8.2 MMTPA, respectively. The total refining capacity of 23 units in operation in the country reached to 247.566 MMTPA in 2017-18 (Table-4).

Out of these 23 refineries, 18 are in Public Sector, 3 are in Private Sector and two are as a Joint Venture. Out of the total refining capacity of 247.566 MMT, 142.066 MMT has been accounted for the Public Sector, 17.3 MMT by Joint Venture and the balance 88.2 MMT has been reported by the Private Sector. During 2017-18, refinery crude throughput in terms of crude oil processed increased to 251.935 million tonnes from 245.362 million tonnes in 2016-17 (Table-4).

As per annual report of MoPNG, capacity augmentation to the tune of 23.75 million tonnes has been planned which is likely to be implemented by 2022 at brownfield refineries that are IOCL, Barauni (3 MMTPA); IOCL, Guwahati (0.2 MMTPA); IOCL, Bongaigaon (0.35 MMTPA); IOCL, Mathura (1.2 MMTPA); IOCL, Haldia (0.5 MMTPA); HPCL Visakhapatnam (6.7 MMTPA); HPCL, Mumbai (2 MMTPA); CPCL, Nagapattinam (8 MMTPA); and BORL, Bina (1.8 MMTPA). The Green field refinery that is coming up in the near future is Hindustan Petro Chemical Ltd, Barmer, Rajasthan (9 MMTPA).

Besides, Public Sector Oil Companies, IOCL, BPCL and HPCL are planning to set-up India's biggest integrated Refinery-cum-Petrochemical complex with proposed refining capacity of 60 MMTPA on the West Coast in Maharashtra through a Joint Venture Company, Ratnagiri Refinery and Petrochemicals Limited.

The production of petroleum products during 2017-18 at 254.405 million tonnes witnessed a growth of 4.46% over that of the year 2016-17. Production of various petroleum products from refineries and fractionators during 2015-16 to 2017-18 is provided in Table-5.

CONSUMPTION

The total consumption of petroleum products increased to 204.922 million tonnes in 2017-18 from 194.597 million tonnes in 2016-17, showing an increase of 5.3%.

Increase in consumption was reported in the case of Waxes (39.6%), LDO (16.7%), LSHS (11.5%), Motor spirit (10.1%), Petroleum Coke (9.3%), ATF (8.9%), Lubes/Greases (8.9%), LPG (8.0%), HSDO (6.6%) and Bitumen (1.1%) during 2017-18 as compared to that of the year 2016-17, whereas, the consumption showed a decline in SKO (28.8%), Furnace oil (5.7%) and Naphtha (5.2%) during the same period.

The consumption of various petroleum products from 2015-16 to 2017-18 is furnished in Table-6.

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 has vigorously initiated exploration & development for tapping alternate sources, viz. coal-bed methane, gas hydrates, oil shales, underground coal gasification, etc. in the country.

Table – 4 : Installed Capacity and Crude throughput in Refineries

(In '000 tonnes)

Refinery	Annual installed capacity (as on 1.4.2018)	Refinery Crude throughput		
		2015-16	2016-17	2017-18 (P)
Total	**247566**	**232865**	**245362**	**251935**
Public/Private Sector & Subsidaries	**142066**	**127087**	**137388**	**145234**
IOCL, Guwahati, Assam	1000	904	864	1024
IOCL, Barauni, Bihar	6000	6545	6526	5819
IOCL, Koyali, Gujarat	13700	13820	13994	13811
IOCL, Haldia, West Bengal	7500	7776	7689	7655
IOCL, Mathura, Uttar Pradesh	8000	8860	9230	9240
IOCL, Bongaigaon, Assam	2350	2442	2486	2402
IOCL, Digboi, Assam	650	562	533	666
IOCL, Panipat, Haryana	15000	15282	15638	15654
IOCL, Paradeep, Odisha	15000	1817	8230	12730
BPCL, Mumbai, Maharashtra	12000	13371	13541	14054
BPCL (formerly KRL), Kochi, Kerala	15500	10712	11820	14095
HPCL, Mumbai, Maharashtra	7500	8013	8510	8641
HPCL, Visakhapatnam, Andhra Pradesh	8300	9220	9335	9635
CPCL, Manali, Tamil Nadu	10500	9100	9725	10289
CPCL, Narimanam, Tamil Nadu	1000	544	531	500
Numaligarh Refinery Ltd, Numaligarh, Assam	3000	2520	2683	2809
MRPL, Mangaluru, Karnataka	15000	15532	15965	16130
ONGC, Tatipaka, Andhra Pradesh	66	67	86	80
Joint Venture	**17300**	**17116**	**16882**	**15538**
Bharat Oman Refineries Ltd, Bina[@]	6000	6402	6360	6708
HPCL Mittal energy Ltd, Bathinda[#]	11300	10713	10521	8830
Private Sector	**88200**	**88662**	**91093**	**91163**
RIL, Jamnagar, Gujarat	33000	32428	32823	33153
RIL, Jamnagar (SEZ), Gujarat	35200	37133	37351	37317
Nyara Energy Ltd (NEL),Vadinar, Gujarat	20000	19101	20919	20693

Source: *Indian Petroleum and Natural Gas Statistics, 2017-18, 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: *(i) CPCL and BRPL are subsidiaries of IOCL; NRL of BPCL; and MRPL of ONGC*

(ii) Crude throughput in terms of crude oil processed

(iii) Total may not tally due to rounding off

Table – 5: Production of Petroleum Products from Refineries and Fractionators, 2015-16 to 2017-18

(In '000 tonnes)

Product	Production		
	2015-16	2016-17	2017-18 (P)
Total Petroleum Products	**231923**	**243551**	**254405**
From Refineries	**227907**	**239256**	**249797**
From Fractionators	**4016**	**4294**	**4608**
LPG	10568	11326	12380
Motor Spirit	35321	36593	37784
Naphtha	17861	19946	20006
Kerosene	7503	6041	4408
ATF	11789	13831	14594
HSD	98588	102484	107904
LDO	429	629	562
Furnace oil	9468	9694	9019
LSHS/HHS/RFO	259	268	468
Lube oils	1037	1029	1036
Bitumen	5157	5185	5277
Petroleum coke	13322	13936	14754
Others	20622	22589	26215

Source: *Indian Petroleum & Natural Gas Statistics, 2017-18, Ministry of Petroleum & Natural Gas, Government of India.*
Note*: (i) Total may not tally due to rounding off*
(ii) Others include VGO, Benzene, MTO, CBFS, Sulphur, Waxes, MTBE & Reformate, etc.

Table – 6 : Consumption of Petroleum Products, 2015-16 to 2017-18

(In'000 tonnes)

Product	2015-16	2016-17	2017-18 (P)
1. Light distillates	**57743**	**61441**	**65322**
(a) LPG	19623	21608	23343
(b) Motor Spirit	21847	23765	26175
(c) Naphtha	13271	13241	12549
(d) Others	3002	2827	3254
2. Middle distillates	**88517**	**89042**	**93526**
(a) SKO	6826	5397	3845
(b) ATF	6262	6998	7623
(c) HSDO	74647	76027	81073
(d) LDO	407	449	524
(e) Others	375	172	461
3. Heavy ends	**38414**	**44114**	**46074**
(a) Furnace oil (FO)	6482	7046	6644
(b) LSHS	150	104	116
(c) Lubes/Greases	3571	3470	3779
(d) Bitumen	5938	5936	6004
(e) Petroleum coke	19297	23964	26192
(f) Waxes	173	182	254
(g) Others	2802	3411	3084
Total (1+2+3)	**184674**	**194597**	**204922**

Source: *Indian Petroleum & Natural Gas Statistics, 2017-18, Ministry of Petroleum & Natural Gas, Government of India*
Note: *(i) Consumption includes sales by oil companies, own consumption & direct private imports*
(ii) Total may not tally due to rounding off

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 seam contains 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.

As per annual report of MoPNG for 2017-18, the estimated resources of CBM are of the order of 2,600 billion cu m (91.8 Trillion cubic feet) spread over in 11 States in the country. 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 CBM blocks on Nomination basis and 1 block through Foreign Investment Promotion Board (FIPB) route] in four rounds of bidding to National, Private & Joint Venture Companies. These CBM blocks are in the States of Andhra Pradesh, Assam, Chhattisgarh, Gujarat, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu and West Bengal. Currently 13 CBM blocks covering an area of 5,269.5 sq km are active. CBM in-place reserves of about 280.3 BCM (9.9 TCF) have been established by different operators as on 01.04.2017.

Within the next few years, CBM is expected to emerge as a new source of natural gas production in the country. Commercial production of CBM in India has already commenced w.e.f. July 2007 in Raniganj (South) block in West Bengal operated by M/s Great Eastern Energy Corporation Limited (GEECL). Currently, commercial production has reported from 3 CBM blocks, i.e., Raniganj (South) operated by Great Eastern Corporation Ltd (GEECL), Raniganj (East) operated by EOGEPL (Essar Oil & Gas Exploration & Production Limited) and Sohagpur (West) operated by RIL. In addition to this, incidental CBM gas was also produced during testing of CBM wells in Jharia CBM block operated by ONGC and Sohagpur (East) operated by RIL. By the end of 2018-19, it is envisaged that 2 more blocks, i.e., Jharia & North Karanpura will commence commercial CBM production.

As on March 2018, average daily CBM production was around 2.01 MMSCMD from 5 CBM blocks which includes test gas production from 2 CBM blocks and commercial production from 3 CBM blocks.

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.

In India, gas hydrate research and exploratory activities are being steered under National Gas Hydrate Programme (NGHP). Under 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.

NGHP-Expedition-01 exploration programme was carried out in 2006 for mapping gas hydrate zones in Krishna-Godavari, Kerala, Konkan, Mahanadi and Andaman offshore areas. A total of 39 holes was drilled at 21 sites 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 was conducted successfully in Eastern offshore from 09.03.2015 to 31.07.2015. A total of 42 wells was drilled at 25 sites in Krishna-Godavari and Mahanadi areas in sand reservoirs for gas hydrates. NGHP-02 has discovered significant gas-hydrate-bearing sand reservoir system in the Krishna-Godavari area. Further extensive studies are being carried out to assess the gas hydrate resource potential, reservoir characterisation, reservoir delineation & geo-mechanical modelling for seafloor and

wellbore stability and identification of sites for pilot production for testing. KG deep offshore 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.

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 coal. Studies have indicated that these coals and carbonaceous shale constitute the principal source rocks that have generated the hydrocarbons produced from the region.

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 agencies have made different estimates of shale gas and oil in the Indian sedimentary basins.

i) M/s Schlumberger: 300 to 2100 TCF of shale gas resource for the country.

ii) Energy Information Administration (EIA), USA in 2011: 290 TCF of shale gas in 4 basins (Cambay Onland, Damodar, Krishna-Godavari Onland & Cauvery Onland).

iii) Energy Information Administration (EIA), USA in 2013: 584 TCF of shale gas and 87 billion Barrels of shale oil in 4 basins (Cambay Onland, Damodar, Krishna-Godavari Onland & Cauvery Onland).

iv) ONGC: 187.5 TCF of shale gas in 5 basins (Cambay Onland, Ganga Valley, Assam & Assam Arakan, Krishna-Godavari Onland & Cauvery Onland.

v) Central Mine Planning and Design Institute (CMPDI): 45 TCF of shale gas in 6 sub-basins (Jharia, Bokaro, North Karanpura, South Karanpura, Raniganj & Sohagpur).

vi) United States Geological Survey (USGS) has also estimated technically recoverable shale gas resources of 6.1 TCF in 3 basins (Cambay Onland, Krishna-Godavari Onland & Cauvery Onland). Further, USGS has indicated that these basins have also potential for shale oil.

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 (PEL)/Petroleum Mining Lease (PML) blocks awarded under the nomination regimes. As per policy guidelines, ONGC and OIL have to carry out Shale Gas and Oil exploration in 50 and 5 blocks, respectively for assessment under Phase-I. ONGC is carrying out Shale Gas and Oil exploration activities in Cambay, Cauvery, Krishna-Godavari and Assam & Arakan Basins. Oil India Ltd is carrying out Shale Gas and Oil exploration activities in Assam and Rajasthan basins. So far, ONGC has drilled 22 wells in 18 blocks in four basins and out of these, 5 are exclusive shale gas wells. ONGC has drilled 14 wells in Cambay Basin, 3 wells in KG Basin, 3 wells in Cauvery Basin and 2 wells in A&AA Basin. OIL

Ltd has drilled 2 wells in Upper Assam Basin and 1 well in Jaisalmer Basin and further studies are underway.

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 Underground Coal Gasification (UCG) in coal/ lignite-bearing areas in the country. A policy, 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. 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.

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 Skochinsky Institute of Mining (SIM), Russia. The Agreement of Collaboration (AoC) between ONGC and 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. 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. The 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 Programme

The Government through Oil Marketing Companies (OMCs), is implementing Ethanol Blended Petrol (EBP) Programme under which, OMCs sell ethanol blended petrol with percentage of ethanol up to 10%. In order to augment the supply of ethanol, the Government in December, 2014 introduced the administered price mechanism. The Government continued to administer ethanol prices for the EBP Programme taking into account various factors, such as, firming of sugar prices, falling crude prices and consequent under-recoveries of OMCs. These factors from time to time led to revision of ethanol ex-mill price.

The Government has also opened alternate route for ethanol production from other non-food feedstocks besides molasses, like cellulosic and lignocellulosic materials including petrochemical route. This decision has facilitated in significantly improving the supply of ethanol from 38 crore litres in ethanol supply year 2013-14 to 111 crore litres in 2015-16 (till 30.11.2016). However, in the ethanol supply year 2016-17, about 66.51 crore litres of ethanol could be procured due to lower sugarcane production in the Country.

In order to improve the availability of ethanol, the Government increased the ex-mill price of

ethanol for the sugar season 2017-18 and has fixed the administered price of ethanol for the EBP Programme during ethanol supply period from 1st December 2017 to 30th November 2018 at ` 40.85 per litre. Additionally, GST and transportation charges will also be payable. For the ongoing ethanol supply year 2017-18, the suppliers have offered highest ever quantities of 139.5 crore litres during a single supply year.

2G Ethanol Programme

Oil PSUs are also working in the direction of setting up 12 no. of Second Generation (2G) ethanol Biorefineries in 11 States with an objective to boost production of ethanol in the country. These 2G Ethanol Biorefineries are being set up in Punjab, Haryana, Uttar Pradesh, Gujarat, Maharashtra, Madhya Pradesh, Karnataka, Andhra Pradesh, Odisha, Bihar and Assam.

A few of the Oil PSUs have completed Detailed Feasibility Report (DFR) of their projects and are planning to commence the mechanical erection works at the earliest subject to a few statutory approvals & clearances. Foundation stone of the first Biofuel refinery to be set up by Hindustan Petroleum Corporation Limited in Bathinda, Punjab, has been laid. One of the Oil PSUs viz. Numaligarh Refinery Limited (NRL) has obtained Environmental Clearance for setting up its plant in Numaligarh (Assam) on 06.11.2017.

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 01.01.2006. However, no biodiesel could be procured till 2014. 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 10.08.2015, 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.

The Government, vide Notification dated 29th June, 2017 has allowed direct sale of Biodiesel (B-100) for blending with High Speed Diesel to all consumers in accordance with the specified blending limits and the standards specified by the Bureau of Indian Standards. During the period April-November, 2017, biodiesel quantity procured was 43,551 KL vis-à-vis 34,910 KL procured during the same period in 2016 which showed an increase of 25%.

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. The Government had also formulated a CBM Policy in 1997 and implemented the same in 2000 providing attractive fiscal and contractual

framework for exploration and production of CBM.

In order to bridge the gap between energy supply and demand, GoI has adopted multi-pronged strategy for giving momentum to exploration and production (E&P) 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 01.04.2018, a total of 101 blocks was active comprising 10 Pre-NELP, 66 NELP and 25 Small & Medium Size Field PSCs. Recently, 30 contracts (7 in shallow water and 23 in onland areas) under Discovered Small field were also signed. The details of the blocks awarded under Pre-NELP, NELP and DSF are highlighted in Table-7.

Major policy drives and initiatives have been ushered in by the Government in upstream hydrocarbon segments in India in the last couple of years to provide impetus to the investment climate and to scale up domestic production. The Government has formulated path-breaking policies to revolutionise the E&P sector. The Policy-wise details have been enumerated as below.

Table - 7: Details of Exploration Block Awarded

Round	No. of blocks awarded	No. of blocks relinquished	No. of blocks active	Currently Active Area
Pre NELP	28	18	10	8965.64
Pre NELP (small & medium sized discovered field)	28	03	25	3709.46
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	42	10	8554
NELP-VII	41	29	12	19278
NELP-VIII	32	22	10	6667
NELP-IX	19	4	15	13017.36
Total	**310**	**209**	**101**	**82604.22**
DSF Round	30	-	30	776.75
G. Total	**340**	**209**	**131**	**83380.97**

***Source**:India's Hydrocarbon Outlook, 2017-18, Directorate General of Hydrocarbons.*

A. Exploration

1. 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. 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; and operational freedom to the operator.
- **Pricing and Marketing Freedom** – A major incentive for investment.

- **Single Licence** 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 has 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**.**

Under HELP, the Government has obtained "Expression of Interest" for 57 blocks which are carved out by the bidders under Open Acreage Licensing Policy (OALP) in the first window from 1st July, 2017 to 15th November, 2017. Out of these blocks, 55 blocks were to be offered in January, 2018 for international competitive bidding process.

2. National Data Repository (NDR): National Data Repository (NDR) is a pre-requisite and key component for making Open Acreage Licensing Policy (OALP) operational, it enables the investor to view the surface and sub-surface geological, geophysical and other technical data. NDR has been launched on 28th June, 2017 and is managed by DGH. Entire country's E&P data will be uploaded in NDR so that any interested party from around the globe could access these data before deciding to invest in India. As on 31.03.2018, 18 Lakh Line kilometre (LKM) of 2D Seismic data, 6.5 Lakh Sq km of 3D Seismic data and 14,415 wells log data have been loaded in NDR system.

3. Policy for E&P, Data Assimilation, Disclosure, Sharing, Accessibility & Dissemination through National Data Repository (NDR) at DGH : The objective of this policy is to assimilate, preserve and regulate the E&P data generated by various companies over the last several decades and these are held within the National Data Repository (NDR) in order to enable systematic disclosure, sharing and dissemination and to standardise the norms for accessibility within the overall provisions of the Oilfields (Regulations and Development) Act 1948 and the Petroleum and Natural Gas Rules 1959, Government policies and other guidelines as may be applicable. NDR Data policy is a precursor to award of blocks under Hydrocarbon Exploration and Licensing Policy. It will provide a unique platform to view, analyse, purchase data for all E&P companies, institutions, research agencies, etc.

4. Encouraging E&P Activities in North-East India: The Government of India released the Hydrocarbon Vision Document 2030 for NE region on 09.02.2016 with the aim of preparing a roadmap for the next 15 years to increase the production of oil and gas in north-east India and outlining the necessary investment in the Hydrocarbon Sector to increase exploration activities, etc.

5. Discovered Small Field Policy (DSF): To reduce the import dependency of hydrocarbons, to effectively exploit the untapped established reserves and increase indigenous production, Marginal Field Policy was announced. The policy was later rechristened as Discovered Small Field Policy, under the broad policy framework of the new Hydrocarbon Exploration and Licensing Policy (HELP) with several liberal features. 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 Licence for Conventional & Non-conventional Hydrocarbon:** Single licence 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:** Contractor will be allowed to carry out exploration during entire contract duration.
- **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.

As per Annual Report of MoPNG for 2017-18, the DSF policy is further being strengthened for securing energy needs of the country. It will be helpful in achieving the target of reduction in energy import dependency by 10% by the year 2022. The First bidding round under the Discovered Small Field Policy was launched on 25th May 2016 in New Delhi thereby offering 67 discovered small fields in 46 contract areas of ONGC and OIL for international bidding. The policy aimed at monetising these discoveries in a time bound manner is expected to boost domestic production of Oil and Gas. A total of 30 contracts under DSF for 43 discovered small fields was signed with 20 companies. The Government is in the process of launching second bidding round under DSF with the proposal of enhancing scope of the Policy to include fields from the PSC regime as well.

6. Re-assessment of Hydrocarbon Resources: A Multi-organisation Team (MOT) has been constituted on 21st January 2014 to carry out re-assessment of hydrocarbon resources of India in all its 26 sedimentary basins which is being undertaken by ONGC in association with OIL and DGH. The project started on 1st September 2015 and was completed on 30th November 2017. The prognosticated conventional hydrocarbon resources in 26 sedimentary basins of the country are of the order of 41.87 billion tonnes (oil and oil equivalent of gas), which is about 49% increase as compared to earlier estimates of 28.08 billion tonnes.

7. National Seismic Programme (NSP) of Unapprised Areas: Almost half of India's sedimentary areas is yet to be apprised. The Government has taken up an ambitious programme of undertaking 2D seismic survey of entire un-apprised areas. National Seismic Programme was launched on 12th October, 2016. Under the programme, the Government has approved the proposal for conducting 2D seismic survey for data Acquisition, Processing and Interpretation (API) of 48,243 Line Kilometres (LKM). OIL has been assigned to carry out 2D seismic API of 7,408 LKM falling in NE 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. During 2017-18, 16,135 LKM of data has been acquired.

8. Non-exclusive Multi-client Geoscientific Survey: MoP&NG vide letter dated 20.05.2014 has approved the Policy for Geoscientific Data Generation for Hydrocarbons in Indian Sedimentary Basins and the agreement to carry out Non-exclusive Multi-client Geoscientific Surveys/Activities relating to Hydrocarbons. This project aims to get quality data in offshore basinal areas and to acquire high quality geophysical/seismic data for sedimentary basins. The Directorate General of Hydrocarbons (DGH) will administer the Policy on behalf of Government of India and GoI will continue to be the owner of the data acquired under this Policy.

This policy has replaced the earlier profit sharing model with the payment of one time fees to the government, i.e., $10,000 USD which will encourage competent private players to undertake G&G activities and sell the data to earn profits by submitting a copy of data with the DGH. This policy initiative will encourage deployment of cutting edge technology by private players which will lead to generation of quality data for better assessment of Indian sedimentary basins.

So far, proposals have been submitted for 3 areas, MoD & MoHA clearances have been received for 2 areas and issuance of provisional letter of consent is on the final stage.

B. Production

1. Policy for the Grant of Extension to the Production Sharing Contracts (PSC) signed by Government of India awarding Pre-NELP Exploration Blocks: The Government has approved a policy for grant of extension to the Production Sharing Contracts (PSC) signed by Government of India awarding Pre-NELP Exploration Blocks to enable and facilitate investment to extract the remaining reserves. This policy will enable the contractors to extract the additional reserves by implementing new technologies through fresh investments.

The recoverable reserve from these blocks is estimated to be more than 426 million barrels of oil equivalent.

2. Policy for Grant of Extension to Production Sharing Contracts (PSCs) signed by Government awarding small and medium-sized discovered fields to private Joint Ventures: To enable optimal recovery of oil and gas 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. This policy provides for a uniform, non-discretionary framework for extension of contract for a period of 10 years both for oil and gas. The primary objective of this policy is to continue uninterrupted production from oil and gas reserves engaged under PSC model and to ensure a stable business environment to Contractors and E&P operators of the PSC regime. 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 from petroleum during extension period will also be 10 percent higher than the normal percentage.

3. Policy for Testing Requirement: The Government has approved a policy on Testing Requirement for discoveries made under NELP blocks to resolve existing dispute on this issue and to bring transparency and uniformity in decision making for future. The policy is expected to monetise the stuck up discoveries that were withheld, on account of failure of operators to conduct the Drill Stem Test (DST), which otherwise might have got relinquished. This initiative has helped in monetisation of resources of the order of ` 75,000 crore.

4. Policy Framework for Relaxations, Extensions and Clarifications at the Development and Production Stage under PSC Regime for early Monetisation of Hydrocarbon Discoveries: To ease out rigidities in the functioning of PSC regime, the Government approved this policy framework. These reforms have helped in moving ahead with discoveries with associated reserves worth around ` 30,000 crore and have also helped in resolving around 40 pending issues in different contracts.

C. Unconventional Hydrocarbons

1. Permission of Extraction of CBM to Coal India Limited (CIL) & its Subsidiaries in Coal Mining area: The Government has permitted Coal India Limited & its subsidiaries to undertake CBM operations in the coal mining lease areas held by them. This decision will not only help augmenting CBM gas production in the country but will also make the mines safe for operations.

2. Policy Framework for early Monetisation of CBM: The Government notified the marketing and pricing freedom for CBM with a purpose to develop alternate sources of natural gas and promote gas economy. Measures to streamline operational issues were also notified. CBM may now be sold on arm's length basis while discovering the market price, subject to the stipulations brought out in the notification. This is with an objective that best possible price is realised for the benefit of all the parties linked to the Contract.

3. 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 lignite-bearing areas in the country. UCG is a method of extraction of energy from coal/lignite resources which are otherwise regarded as uneconomical to work through conventional mining methods. For this purpose, a policy on lines broadly similar to the existing policy for Coal-bed Methane (CBM) development on revenue sharing basis will be adopted for purpose of offering the blocks through competitive bidding.

4. Policy Guidelines of Exploration and Exploitation of Shale Gas and Oil: In order to promote Shale Gas and Oil exploration in India, 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 (PEL)/Petroleum Mining Lease (PML) blocks awarded under the nomination regimes. NOCs have identified 55 blocks for Assessment Studies during the Phase-I of three years.

D. Marketing and Pricing

1. Marketing and Pricing Freedom for New Gas Production from Deepwater, Ultra-deepwater and High Pressure-High Temperature Areas: The Government announced a policy in March 2016 for all discoveries in Deepwater (DW), Ultra-deepwater (UDW) and High Pressure-High Temperature (HPHT) areas which commenced commercial production from 1st January 2016 and all future discoveries due to the challenging cost and technology-intensive operations. The policy is aimed at exploiting oil and gas resources in DW, UDW and HPHT areas and to incentivise gas production from these discovered, difficult areas. Pursuant to this policy, producers will be allowed marketing including pricing freedom subject to a ceiling price based on landed price of alternate fuels, which is calculated once in 6 months and applied prospectively for the next 6 months. 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.

2. New Domestic Natural Gas Pricing Guidelines Date of Notification: The Government approved the New Gas Pricing Formula in October, 2014 leading to resolution of this long pending issue. The new gas pricing guidelines has struck a fine balance between the requirements of both producing and consuming sectors and a ceiling based on the landed cost of the alternate fuel has been imposed. The pricing is notified for every six months by Petroleum Planning and Analysis Cell of MoP&NG.

To incentivise gas production from difficult areas, such as, High Pressure-High Temperature reservoirs and deepwater & ultra- deepwater areas, the government has accorded marketing & pricing freedom. The marketing freedom so granted would be capped by a ceiling price.

E. Other Initiatives

1. Monetisation of Ratna Offshore Field: ONGC has initiated necessary action for development of the Field after cancellation of Letter of Award to Essar Oil Limited and Premier Oil Limited. Field Development Plan (FDP) for the fields under development has been approved by the ONGC Board. Sanctioned capital investment for development of the field is about `4,000 crore with estimated oil and gas production of about 7 MMT of oil and 0.88 BCM of gas by 2035-36. The Government would realise the revenue through cess and royalty from the field.

Strategic Crude Oil Storage

In order to provide energy security and as a buffer from supply side disruption of crude oil, the Government of India has established Strategic Petroleum Reserve (SPR) facilities, having a total capacity of 5.33 million tonnes at three locations 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 named Indian Strategic Petroleum Reserves Ltd (ISPRL), a subsidiary Company of OIDB.

The GoI has filled storage facility at Visakhapatnam. For filling up Mangaluru SPR facility, ISPRL and ADNOC (of UAE) signed a restated Definitive Agreement on Oil Storage and Management on 10th February 2018. Under the Agreement, ADNOC will fill 5.86 million barrels of crude oil in the Mangaluru SPR facility at its own cost. The Strategic Petroleum Reserve of Phase-I is estimated to supply approximately 10 days of India's crude requirement according to the consumption during 2016-17.

Thus, the need for additional crude oil storage is being felt in the light of increasing requirement of crude oil. During the Budget Statement 2017-18, the Government announced proposal for construction of SPRs under Phase II at two new locations and the Ministry is working towards obtaining required approvals to set up these SPRs at Chandikhol in Odisha and Padur in Karnataka.

WORLD REVIEW

The world proved reserves of crude oil and natural gas at the end of 2017 were estimated at 239.3 billion tonnes and 193.5 trillion cu m, respectively (Tables - 8 & 9). The largest share of reserves of world crude oil is available in Middle East (45.7%) followed by South & Central America (21.4%), North America (14.3%), Europe & CIS (8.9%), Africa (7.0%) and Asia Pacific (2.7%).

Table – 8 : World Proved Reserves of Crude Oil* (By Principal Countries)

(In billion tonnes)

Country	Reserves
World: Total	**239.3**
Algeria	1.5
Angola	1.3
Azerbaijan	1.0
Brazil	1.9
China	3.5
Canada	27.2
Ecuador	1.2
Iran	21.6
Iraq	20.1
Kazakhstan	3.9
Kuwait	14.0
Libya	6.3
Mexico	1.0
Nigeria	5.1
Norway	1.0
Qatar	2.6
Russia (Federation)	14.5
Saudi Arabia	36.6
UAE	13.0
USA	6.0
Venezuela	47.3
Other countries	8.7

Source: *BP Statistical Review of World Energy, June 2018.*
** At 2017 end.*

Table – 9 : World Proved Reserves of Natural Gas* (By Principal Countries)

(In trillion cu m)

Country	Reserves
World : Total	**193.5**
Algeria	4.3
Australia	3.6
Azerbaijan	1.3
Canada	1.9
China	5.5
Egypt	1.8
India	1.2
Indonesia	2.9
Iran	33.2
Iraq	3.5
Kazakhstan	1.1
Kuwait	1.7
Libya	1.4
Malaysia	2.7
Myanmar	1.2
Nigeria	5.2
Norway	1.7
Qatar	24.9
Russia (Federation)	35.0
Saudi Arabia	8.0
Turkmenistan	19.5
UAE	5.9
Ukraine	1.1
USA	8.7
Uzbekistan	1.2
Venezuela	6.4
Other countries	8.2

Source: *BP Statistical Review of World Energy, June 2018.*
** At 2017 end.*

Of the total world reserves of natural gas, Middle East possesses the largest share (40.9%) followed by Europe & CIS (32.2%), Asia Pacific (10.0%), Africa (7.1%), North America (5.6%) and South & Central America (4.3%).

The world crude petroleum production in 2017 marginally decreased to 4,358 million tonnes from 4,361 million tonnes in 2016. USA with share of 14% followed by Saudi Arabia & Russia (13% each), Iran, Iraq & Canada (5% each), China & UAE (4% each) and Kuwait, Brazil & Mexico (3% each) were the principal producers of crude petroleum in 2017.

The world production of natural gas increased to 3,834 billion cu m in 2017 from 3,712 billion cu m in 2016. USA with share of 19% followed by Russia (18%), Iran (6%), Qatar (5%), Canada & China (4% each) and Australia, Norway & Saudi Arabia (3% each) were the major producers of natural gas in 2017 (Tables - 10 &11).

The world consumption of oil (which includes biogasoline, biodiesel and derivatives of coal and natural gas) in 2017 was estimated at 4,621.9 million tonnes oil equivalent, while that of natural gas (excludes natural gas converted to liquid fuels but includes derivatives of coal as well as natural gas consumed in gas-to-liquids transformation) was 3,670 billion cu m. The share of India in the world consumption of oil and natural gas was 4.81% (222.1 million tonnes oil equivalent) and 1.48% (54.2 billion cu m), respectively, during 2017.

FOREIGN TRADE

Exports

Exports of natural gas increased significantlly by 91% in 2017-18 to 70,838 tonnes from 37,072 tonnes in 2016-17. Exports of natural gas were mainly to Korea, Rep. of (45%), Chinese Taipei/ Taiwan (37%), Nepal (18%) and very small quantity to Bhutan (Table -12).

Exports of petroleum products were at 66.76 million tonnes valued at ` 2,25,139 crore during 2017-18 (P) which showed an increase of

Table – 10 : World Production of Crude Petroleum (By Principal Countries)

(In million tonnes)

Country	2015	2016	2017
World : Total	**4347**	**4361**	**4358**
Algeria	67	68	67
Angola	87	86	82
Argentina	28	27	25
Azerbaijan[a]	42	41	39
Brazil	131	135	141
Canada	191	192	209
China[b]	215	200	192
Colombia	52	46	45
Ecuador	29	30	29
Egypt	35	34	32
India[c]	37	36	36
Indonesia	39	42	40
Iran	182	216	234
Iraq	197	218	222
Kazakhstan	79	78	86
Kuwait[d]	148	153	146
Libya	20	19	28
Malaysia	31	32	31
Mexico	134	127	115
Nigeria	106	91	95
Norway	96	98	97
Oman	49	50	48
Qatar	82	83	80
Russia	533	549	546
Saudi Arabia[d]	568	587	562
UAE	176	182	176
UK	45	47	46
USA	588	564	600
Venezuela	136	123	108
Other countries	224	207	201

Source: *World Mineral Production, 2013-2017.*
a:- Including natural gas liquids.
b:- Including oil from shale and coal.
c:- Years ended 31 March following that stated.
d:- Including shares of production from the Neutral Zone.

Table – 11 : World Production of Natural Gas (By Principal Countries)

(In billion cu m)

Country	2015	2016	2017
World: Total	**3691**	**3712**	**3834**
Algeria	81	91	91
Argentina	43	45	45
Australia	77	97	114
Canada	154	157	155
China	135	137	147
Egypt	43	40	49
India[a]	32	32	32
Indonesia	76	75	72
Iran	189	203	224
Kazakhstan	45	47	53
Malaysia	63	68	71
Mexico	60	52	49
Netherlands	52	50	44
Nigeria	50	45	47
Norway	117	117	124
Oman	31	32	30
Pakistan[b]	42	42	42
Qatar	175	177	176
Russia	633	639	691
Saudi Arabia[c]	99	105	111
Tanzania	37	48	51
Thailand	40	39	38
Trinidad & Tobago	39	34	34
Turkmenistan	72	67	62
UAE	56	60	60
UK	40	42	42
USA[d]	766	729	735
Uzbekistan	58	53	53
Venezuela	37	38	38
Other countries	349	351	354

Source: *World Mineral Production, 2013-2017.*
Note: So far as possible the figures in this table exclude flared or reinjected gas.

a:- Years ended 31 March following that stated.
b:- Years ended 30 June of that stated.
c:- Including one-half of the output of the Neutral Zone.
d :- Dry gas.

1.9% in quantity terms and 15.52% increase in value terms against the exports of 65.51 million tonnes valued at ` 1,94,893 crore during 2016-17.

Imports

Imports of crude petroleum increased marginally to 218.10 million tonnes in 2017-18 as compared to 214.89 million tonnes in 2016-17. Imports were mainly from Iraq (21%), Saudi Arabia (17%), Iran (10%), Nigeria & Venezuela (8% each), UAE (7%), Kuwait (6%), Mexico (4%) and Angola & Oman (3% each). Imports of natural gas increased significantly to 20.18 million tonnes in 2017-18 from 17.78 million tonnes in 2016-17. Main suppliers were Qatar (49%), Nigeria (15%), Australia (9%), Angola (7%), Equatorial Guinea (5%), Oman (3%) and Egypt, UAE & USA (2% each) (Tables - 13 & 14).

Imports of petroleum products were at 35.89 million tonnes valued at ` 86,946 crore during 2017-18 (P) which showed a decrease of 1.09% in quantity terms and 21.49% increase in value terms against 36.29 million tonnes valued at ` 71,566 crore during 2016-17.

Table – 12 : Exports of Natural Gas (By Countries)

Country	2016-17		2017-18 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**37072**	**1521058**	**70838**	**2946152**
Chinese Taipei/Taiwan	-	-	26336	1264133
Korea, Rep. of	30185	1247170	32000	1152884
Nepal	6339	250761	12418	521335
Bhutan	547	22787	84	7800
Maldives	1	340	-	-

Table – 13 : Imports of Petroleum (Crude) (By Countries)

Country	2016-17		2017-18 (P)	
	Qty ('000 t)	Value (``'000)	Qty ('000 t)	Value (``'000)
All Countries	**214886**	**4742189329**	**218104**	**5630977139**
Iraq	37759	779032785	45740	1129911517
Saudi Arabia	39339	917248878	36163	983583200
Iran	27140	597667031	22598	578771029
Nigeria	17709	452749918	18115	528462985
UAE	19308	455059562	14294	394236269
Venezuela	21439	369226719	18349	377510453
Kuwait	9154	197427807	12860	340855968
Angola	5935	143841481	7369	198535211
Mexico	7003	123825591	8021	177332449
Oman	485	10429939	5683	155626872
Other countries	29615	695679618	28912	766151186

Table – 14: Imports of Natural Gas
(By Countries)

Country	2016-17		2017-18 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**17783327**	**402490252**	**20176813**	**523664504**
Qatar	10065500	228671231	9969158	265484187
Nigeria	2309662	47688519	3004489	71089772
Australia	1405809	34853239	1748797	47139851
Angola	415342	9036428	1354273	34088026
Equatorial Guinea	1008882	23135749	1034287	23800235
Oman	323826	6876548	508746	13295764
USA	424361	10377244	347505	10528031
Egypt	-	-	386255	9928192
France	-	-	246215	9070324
UAE	565249	11051333	334076	7672780
Other countries	1264696	30799961	1243012	31567342

FUTURE OUTLOOK

Energy is considered as of the key inputs for economic development of any country. India is expected to be one of the fastest growing economies of the world in the near future. With the population anticipated to grow in the future and improvements in socio-economic developments, energy demand is expected to rise consequently. India, with about 17% share in the world's total population accounts for only 5.6% of global energy consumption and this amply indicates the scale of future growth in energy demand. India will be the biggest contributor to energy growth demand globally in the years to come and hydrocarbons is an important component of India's energy basket in future. By 2035, India is likely to be among the fastest growing oil and gas markets, with oil demand almost doubling to ~10 million barrels per day and gas demand tripling over the same period. Thus, India is poised to play a significant role in the Global energy space.

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. As per the draft National Energy Policy, 2017 put out by NITI Aayog, the share of oil and gas in energy consumption in the country during 2015-16 was 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 anticipates that the production of oil and gas has potentials (ambitious case) to reach 61 Mtoe and 124 BCM by 2040.

As per annual report of MoPNG for 2017-18, 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 has 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 has undiscovered potential for hydrocarbons. The total prognosticated hydrocarbon resources are estimated at about 41,878 million tonnes in the sedimentary basins of the country, out of which 10,454 MMT in-place reserves have been established by ONGC, OIL and Private/JV companies as on 1.4.2017, which means about 75% hydrocarbon reserves is 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 are 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 has several basins that are prospective for shale gas. In the later years of the IEO2016 Reference case, shale resources may provide nearly one-quarter of India's total natural gas production.

As per British Petroleum (BP) Energy Outlook 2018, India's natural gas consumption will rise and almost triple by 2040 and projected energy consumption will reach 1921 MTOE by 2040 as the largest growth market for global energy by 2040.

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.

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 Petroleum Reserve, to assure supplies at times of supply disruption, is estimated to supply approximately 10 days of India's crude requirement according to the consumption during 2016-17. The SPR capacity need to be augmented on considering the 90-day consumption requirement of strategic and commercial storages.

Apart from above, Oil India Ltd 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 to ensure energy security for the country, to grow by enhancing own E&P portfolio and decrease risks in existing E&P portfolio. In addition to acquisition of conventional assets, OIL would also look towards acquisition of non-conventional assets, such as, oil sands, shale gas, shale oil, gas hydrate, etc.

While E & P business shall continue to be OIL's core focus, selective diversification into midstream, downstream and renewable energy segments is

planned in order to balance the existing portfolios. The proposed diversification will be towards pipelines, wind/solar energy, City Gas Distribution (CGD), LNG, refineries etc.

As per Perspective Plan 2030 for ONGC's growth over the next two decades, there are plans/proposals to double production over the plan period with 4-5% growth against the present growth rate of 2%. In physical terms the aspirations under Perspective Plan 2030 aims for (i) Production of 130 MMtoe of oil & oil equivalent gas (O + OEG) per year and accretion of over 1,300 MMtoe of proven reserves; (ii) Grow ONGC Videsh Limited (OVL) six fold to 60 MMtoe of international O+OEG production per year by 2030; (iii) Production of more than 20 MMtoe of O+OEG per year in India from new unconventional sources, such as, shale gas, CBM, deepwater and HPHT (High Pressure & High Temperature) reservoirs; (iv) Over 6.5 GW power generations from nuclear, solar and wind and 9 MTPA of LNG; and (v) Scaling up refining capacity to over 20 MMTPA and targeted investments to capture downstream integration in petrochemicals.