Indian Minerals Yearbook 2019

(Part- III : Mineral Reviews)

58th Edition

PETROLEUM AND NATURAL GAS

(ADVANCE RELEASE)

GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

Indira Bhavan, Civil Lines,
NAGPUR – 440 001

PHONE/FAX NO. (0712) 2565471
PBX: (0712) 2562649, 2560544, 2560648
E-MAIL: cme@ibm.gov.in
Website: www.ibm.gov.in

October, 2020

22 Petroleum and Natural Gas

The domestic production of crude oil and Condenstate which stood at 34.203 million tonnes in 2018-19 decreased by 4.15% as compared to that of the output of the corresponding previous year. The production of natural gas (utilised) also decreased to 32,057 million cu. meters (MMSCM) in 2018-19 which is about 1.8% less as against the production in 2017-18. 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. The country's refining capacity has touched 249.366 MMTPA as on 01.04.2019. With increase in the domestic refining capacity, which has overtaken domestic consumption, country became a net exporter of petroleum products.

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 the third largest energy consumer in the world after China and USA. India's primary energy demand is expected to grow at a CAGR of 4.2 % during 2017-2040, much faster than any major economy in the world. Oil and Gas sector within the energy mix play a predominant role as over one-third of the energy required is met by hydrocarbons. Growing economy and population growth are the main drivers for oil & gas demand, which every year are on a steady rise. 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. Year 2018-19 witnessed landmark reforms being ushered in to revitalise the Indian E&P sector with focus mainly to increase exploratory efforts, maximise domestic production and simplify contractual terms in the upstream Hydrocarbon sector. Reforms, such as, Enhanced Recovery policy, policy framework to streamline the existing issues of Production Sharing Contracts, policy for unconventional hydrocarbons and recent reforms in Open Acreage Licensing Policy have revitalised the investor confidence in the Government's resolve to provide a stable polity, robust institutional framework and investor-friendly regime in the E&P sector. The Government has also been engaging with various stakeholders to understand their concerns and taking appropriate remedial policy measures.

RESERVES/RESOURCES

As on 1.4.2019, balance recoverable reserves of crude oil were estimated at 618.94 million tonnes, out of which 341.33 million tonnes (55%) are in onshore and 277.60 million tonnes (45%) in offshore areas. ONGC (nomination) has the largest share of 70% in reserves of crude oil with OIL (nomination) and PSC regime contributing 12% and 18%, respectively.

The balance recoverable reserves of natural gas as on 01.04.2019 were placed at 1,380.64 billion cu m, out of which 888.34 billion cu. m (64%) are in offshore and 492.30 billion cu. m (36%) in onshore areas. PSC regime has the largest share of 50% in natural gas reserves followed by ONGC (nomination) and OIL (nomination) at 41% and 9%, respectively (Table-1).

Table – 1 : Proved and Indicated Balance Recoverable Reserves of Crude Oil and Natural Gas in India as on 1.4.2019

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

Area	Crude oil	Natural gas
India	**618.94**	**1380.64**
Onshore	**341.33**	**492.30**
Andhra Pradesh	3.36	63.57
Arunachal Pradesh	9.74	1.64
Assam	158.62	170.71
Gujarat	119.63	59.45
Jharkhand*	-	8.10
Madhya Pradesh*	-	31.55
Nagaland	-	0.09
Rajasthan	40.71	63.03
Tamil Nadu	9.21	38.00
Tripura	0.07	23.24
West Bengal*	-	32.91
Offshore	**277.60**	**888.34**
Western offshore	235.27	323.19
Eastern offshore	42.34	565.15

Source: *Indian Petroleum and Natural Gas Statistics, 2018-19, 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 31.3.2019, there were in all 459 oil/gas fields including offshore areas under these companies in the country.

In Public Sector, ONGC's (Nomination) jurisdiction extended to 231 onshore fields – Cambay basin (Gujarat) - 82 oil/gas fields; Upper Assam (Assam) - 35 fields; Assam & Assam Arakan (Assam) - 5 fields; Jodhpur (Rajasthan) - 6 fields; Krishna-Godavari basin (Andhra Pradesh) - 62 fields; Cauvery basin (Tamil Nadu) - 28 fields; Assam & Assam Arakan (Tripura) - 10 fields; Assam & Assam Arakan (Nagaland) - 2 fields; and Vindhyan basin (Madhya Pradesh) - 1 field; besides, 85 offshore fields in the Mumbai (80 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.

Under PSC regime, companies were engaged in 80 oil/gas fields – Cambay basin in Gujarat (47 fields); Assam-Arakan in Arunachal Pradesh (1 field), Assam (2 fields) & Tripura (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 (18 fields); Cauvery in Tamil Nadu (3 fields) and Raniganj in West Bengal (2 fields) (CBM) in onshore areas. In offshore areas, the companies covered 2 fields in Cauvery basin and 10 fields in Krishna-Godavari basin on the East Coast and 4 fields in Mumbai basin and 5 fields in Cambay basin on the West Coast.

ONGC has been assigned the responsibility, under National Seismic Programme (NSP), to carry out 2D seismic Acquisition, Processing & Interpretation (API) of 40,835 LKM of data (out of the total target of 48,243 LKM) in unappraised areas of Indian sedimentary basins. The volume of work assigned to ONGC was increased to 42,211 LKM by DGH in June, 2018. As on 31.03.2019, ONGC has acquired 32,319 LKM of seismic data (76.6 % of total revised target of 42,211 LKM) and processed about 13,346 LKM of complete seismic lines.

During the year 2018-19, ONGC has made 13 oil & gas discoveries (8 in onland and 5 in offshore areas). Of these, 6 are new prospects and 7 are new pool discoveries. Significant among these are the

breakthrough first-time discoveries in Bengal Basin (Well Asokenagar-1) and Vindhyan Basin (Well Hatta-2) that have opened up both these basins for further exploration and upgradation. Gas discovery in Kachchh Offshore NELP block GK-OSN-2009/1 in well GKS091NFA-1, made in Cretaceous (Igneous intrusive), is also a major breakthrough for opening a new play for exploration. This discovery has potential of 7.34 BCM gas volume. ONGC has monetised 5 of the onland discoveries (Babejia-2, Rokhia-75 & Baramura-31: A&AA Basin, Bantumilli North-2 & Suryaraopeta West-1: KG Basin) and efforts are underway to bring other discoveries on production as early as possible. As on 01.04.2019, accretion to In-Place Hydrocarbons (3P-Proved, Probable and Possible), from the ONGC operated fields in India, stood at 137.05 MMtoe, out of which about 70% accretion has been due to exploratory efforts. Total in-place reserve accretion during 2018-19 in domestic basins, including the ONGC's share in PSC JVs, stands at 157.30 MMtoe (20.25 MMtoe from JVs).

ONGC has completed shale gas/oil exploration in 21 of the 50 nomination PML blocks located in Cambay, KG, Cauvery and A&AA basins, for assessing the shale gas/oil prospectivity. As on 31.03.2019, 26 shale assessment wells (8 exclusive and 18 dual objective wells) in 21 PML blocks have been drilled and the required data has been evaluated for shale gas/ oil assessment. So far, 4 interesting zones in 3 exclusive Shale assessment wells in Cambay Basin and one zone in an exclusive well in KG Basin have been hydro fractured to assess the shale gas/oil prospectivity.

ONGC is also operating 4 CBM blocks (Jharia, Bokaro and North Karanpura in Jharkhand; and Raniganj in West Bengal) where exploration activities have been completed. Developmental activities are at an advanced stage in three of these blocks viz. Bokaro, Jharia and North Karanpura.

ONGC has also played a significant role in G&G studies for the identification of sites, on-board and Post-expedition studies for both NGHP-01 and NGHP Expedition-02. With the focus on the pilot production testing, the gas hydrate reservoirs discovered during NGHP-02 (Block KG-DWN- 98/5) have been delineated and Geocellular modelling for the gas hydrate rich reservoir has been completed to get detailed cell wise geophysical/reservoir parameters around the proposed site for pilot production test.

During the year, ONGC has drilled 25 wells including 13 exploratory wells with Basement as primary or secondary objective. Deliberate search of hydrocarbons in the Mesozoic sequence of Kachchh Saurashtra block of western offshore basin has led to discovery of a new hydrocarbon-bearing play in the fractured dolerite intrusives which flowed gas in substantial quantity extending the exploration frontier around the area. Encouraging results obtained through drilling of a number of new prospects this year in the Padra field of Cambay Basin and the UAS block of A&AA basin has further enhanced the scope of basement exploration. Development initiatives taken up for exploitation of the fractured Precambrian reservoirs in the Thirunagari and Pundi fields of Cauvery basin have been met with expected results encouraging sustenance of scope for basement exploration and exploitation. ONGC has also identified 25 prospects from G&G interpretation for basement exploration which are being finalised.

Besides, ONGC has prioritised HP-HT/Tight/ Deeper plays in KG, Cauvery, Western Offshore Basin and Assam & Arakan Fold belt. During 2018-19, in GS-OSN-2004/1 block of Western Offshore Basin, exploratory HPHT well "GSS-041-NAA#C" has been successfully drilled and tested in Jhuran formation (Mesozoic) to be gas-bearing. In KG offshore, HPHT Well "YS-6-2#sub" has been successfully drilled and hermetically tested on 28.03.2019. The HPHT well is being taken up for testing. In Cauvery Basin, HPHT well "ABAA_KKL" has been drilled and after testing three objects, the well was abandoned. Further, the HPHT well "VNAC" in Cauvery Basin has been concluded and the testing of the well is being taken up. In A&AA Basin, three HP wells in Khubal field had been drilled and tested with result of gas indication. Further, three HP wells in Kunjaban field have been taken up for drilling & testing for Lower Bhuban Formation.

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 11 exploratory wells in PML areas in

Assam and Rajasthan and continued exploratory efforts in the NELP Blocks RJ/ONN/2004/2 and KG-ONN-2004/1 by drilling 01 (one) well and 03 (three) wells respectively including one High Pressure- High Temperature (HPHT) well in KG block. During 2018-19, OIL made 2 (two) gas discoveries in the Upper Assam Basin and 1 (one) gas discovery in KG basin, the first HPHT well. It has initiated steps for quick appraisal, development and production from these discoveries. During the year, it has achieved Reserve Replacement Ratio (RRR) of 1.12.

The details of exploration carried out and discoveries found during the year 2018-19 are covered in General Review on "Exploration & Development".

PRODUCTION

Crude Oil and Condensate

Production of Crude Oil and Condensate in the country at 34.203 million tonnes in 2018-19, registered a decrease of 4.15% as compared to that in the previous year. Shortfall in production was mainly due to declining production from old and marginal fields, delay in completion of some projects in western offshore, unplanned shutdown of wells, processing platform/plants, pipelines and Bandh & blockade in Assam region. Bulk of the total production, i.e., 71% was shared by the Public Sector companies. Private Sector companies accounted for the remaining 29 per cent (Table-2).

Offshore areas continued to be the largest producer of Crude Oil and Condensate in 2018-19 and had a share of 49% in the country's output. Next in order were Rajasthan with a contribution of 22%, Gujarat with 14% and Assam with 13 per cent. The remaining 2% of the production was reported by Andhra Pradesh, Tamil Nadu and Arunachal Pradesh.

During 2018-19, the production of Crude Oil and Condensate increased in Tamil Nadu by 14% and Gujarat by 1% as compared to the previous year. Whereas, there was a decline in production in Andhra Pradesh by 8%, Arunachal Pradesh (16%), Assam (1%), Rajasthan (3%) and offshore areas (7%) (Table-2).

Natural Gas (Utilised)

The production of natural gas (utilised) at 32057 MMSCM decreased by 1.8% in 2018-19 as compared to that in the previous year. Shortfall in production in some fields was mainly due to decline of production from old and marginal fields, shutdown of plants of major customers, underperformance of wells, issues and resistance from local groups for development projects in onland areas and unplanned shutdown of wells, processing platforms/plants, pipelines. Offshore areas continued to be the largest producer of natural gas (utilised) with a share of (68%). Next in the order were Assam with a share of (10%),

Table – 2 : Production of Crude Oil and Condensate, 2016-17 to 2018-19 (By States)

(Quantity in '000 tonnes)

State	2016-17	2017-18	2018-19 (P)
India	**36009**	**35684**	**34203**
Public Sector (Nomination)	25477	25625	24336
Private Sector (PSC regime)	10532	10059	9867
Andhra Pradesh	276	322	296
Arunachal Pradesh	56	50	42
Assam	4203	4345	4310
Gujarat	4605	4591	4625
Rajasthan	8164	7887	7667
Tamil Nadu	284	345	395
Offshore	18421	18144	16868

Source: *Indian Petroleum and Natural Gas Statistics, 2017-18, Ministry of Petroleum and Natural Gas, Govt. of India and data sheet maintained by IBM according to data received from Ministry of Petroleum and Natural Gas.*
Note: *(i) The value of production is not received from source agency, hence not reflected.*
(ii) Total may not tally due to rounding off.

Tripura (5%) and Gujarat, Rajasthan & Tamil Nadu (4% each). Andhra Pradesh, Arunachal Pradesh, Jharkhand (CBM), Madhya Pradesh (CBM) and West Bengal (CBM) together accounted for the remaining 5% of the total production. As much as 84% of the total production came from the Public Sector companies whereas the remaining 16% was the share of the Private Sector companies during the year 2018-19 (Table-3).

During 2018-19, Statewise analysis revealed that the production of natural gas (utilised) increased in Madhya Pradesh (CBM) by 79% followed by Andhra Pradesh (9%) and Tripura (8%) as compared to the previous year. Decline in production was recorded in Arunachal Pradesh by 60% followed by West Bengal (CBM) (42%), Jharkhand (CBM) (25%), Gujarat (16%), Assam & Rajasthan (4% each), Tamil Nadu (3%) and offshore area (1%) 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 2018-19, Bharat Oman Refineries Ltd, Bina has only added refining capacity and the total refining capacity of 23 units in operation in the country reached to 249.366 MMTPA in 2018-19. 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 249.366 MMT, 142.066 MMT have been accounted for the Public Sector, 19.1 MMT by Joint Venture and the balance 88.2 MMT have been reported by the Private Sector. During 2018-19, refinery crude throughput in terms of crude oil processed increased to 257.205 million tonnes from 251.935 million tonnes in 2017-18 (Table-4).

As per annual report of MoPNG, refining capacity augmentation to the tune of 27.95 million tonnes in the country 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); NRL, Numaligarh (6 MMTPA); and CPCL, Nagapattinam (8 MMTPA). The Green field refinery that is coming up in the near future is HPCL Rajasthan Refinery Limited (HRRL), Barmer, Rajasthan (9 MMTPA).

Table – 3 : Production of Natural Gas (Utilised), 2016-17 to 2018-19 (By States)

(Quantity in MMSCM)

State	2016-17	2017-18	2018-19 (P)
India	**31897**	**32649**	**32057**
Public Sector (Nomination)	25025	26311	26815
Private Sector (PSC regime)	6872	6338	5242
Andhra Pradesh	868	959	1046
Arunachal Pradesh	28	30	12
Assam	3128	3220	3083
Gujarat	1580	1605	1349
Jharkhand (CBM)**	3	4	3
Madhya Pradesh (CBM)**	7	200	357
Rajasthan	1277	1442	1378
Tamil Nadu	983	1208	1167
Tripura	1430	1440	1552
West Bengal (CBM)**	555	531	310
Offshore	22038	22010	21800

Source: *Indian Petroleum and Natural Gas Statistics, 2017-18, Ministry of Petroleum and Natural Gas, Govt. of India and data sheet maintained by IBM according to data received from Ministry of Petroleum and Natural Gas.*

(CBM)**: *Coal-bed Methane*

Note: *(i) The value of production is not received from source agency, hence not reflected.*

(ii) Total may not tally due to rounding off.

Table – 4 : Installed Capacity and Crude Throughput in Refineries

(In '000 tonnes)

Refinery	Annual installed capacity (as on 1.4.2019)	Refinery Crude throughput		
		2016-17	2017-18	2018-19 (P)
Total	**249366**	**245362**	**251935**	**257205**
Public/Private Sector & Subsidiaries	**142066**	**137388**	**145234**	**150976**
IOCL, Guwahati, Assam	1000	864	1024	863
IOCL, Barauni, Bihar	6000	6526	5819	6661
IOCL, Koyali, Gujarat	13700	13994	13811	13505
IOCL, Haldia, West Bengal	7500	7689	7655	7965
IOCL, Mathura, Uttar Pradesh	8000	9230	9240	9737
IOCL, Bongaigaon, Assam	2350	2486	2402	2513
IOCL, Digboi, Assam	650	533	666	676
IOCL, Panipat, Haryana	15000	15638	15654	15281
IOCL, Paradeep, Odisha	15000	8230	12730	14616
BPCL, Mumbai, Maharashtra	12000	13541	14054	14773
BPCL (formerly KRL), Kochi, Kerala	15500	11820	14095	16051
HPCL, Mumbai, Maharashtra	7500	8510	8641	8671
HPCL, Visakhapatnam, Andhra Pradesh	8300	9335	9635	9773
CPCL, Manali, Tamil Nadu	10500	9725	10289	10271
CPCL, Narimanam, Tamil Nadu	1000	531	500	423
Numaligarh Refinery Ltd, Numaligarh, Assam	3000	2683	2809	2900
MRPL, Mangaluru, Karnataka	15000	15965	16130	16231
ONGC, Tatipaka, Andhra Pradesh	66	86	80	66
Joint Venture	**19100**	**16882**	**15538**	**18189**
Bharat Oman Refineries Ltd, Bina[@]	7800	6360	6708	5716
HPCL Mittal energy Ltd, Bathinda[#]	11300	10521	8830	12473
Private Sector	**88200**	**91093**	**91163**	**88041**
RIL, Jamnagar, Gujarat	33000	32823	33153	31752
RIL, Jamnagar (SEZ), Gujarat	35200	37351	37317	37393
Nyara Energy Ltd (NEL),Vadinar, Gujarat	20000	20919	20693	18896

Source: *Indian Petroleum and Natural Gas Statistics, 2018-19, 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.

Besides, Public Sector Oil Companies, viz., IOCL, BPCL and HPCL, incorporated a new joint venture, namely, Ratnagiri Refinery and Petrochemicals Ltd (RRPCL), for setting up India's biggest integrated Refinery-cum-Petrochemical complex with proposed refining capacity of 60 MMTPA in Ratnagiri district on the West Coast in Maharashtra.

The production of petroleum products during 2018-19 at 262.361 million tonnes witnessed a growth of 3.13% over that of the year 2017-18. Production of various petroleum products from refineries and fractionators during 2016-17 to 2018-19 are provided in Table-5.

CONSUMPTION

The total consumption of petroleum products increased to 213.216 million tonnes in 2018-19 from 206.166 million tonnes in 2017-18, showing an increase of 3.4%. Increase in consumption was reported in the case of LSHS (218%),Waxes (44%), LDO (14%), Naptha (10%), Bitumen (10%), ATF (9%), Motor spirit (8%), LPG (7%) and HSDO (3%) during 2018-19 as compared to that of the year 2017-18, whereas, the consumption showed a decline in Petroleum Coke (17%), SKO (10%) and Furnace oil & Lubes/Greases (6% each) during the same period.

The consumption of various petroleum products from 2016-17 to 2018-19 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.

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

Table – 5: Production of Petroleum Products from Refineries and Fractionators, 2016-17 to 2018-19

(In '000 tonnes)

Product	Production		
	2016-17	2017-18	2018-19 (P)
Total Petroleum Products	**243551**	**254405**	**262361**
From Refineries	**239256**	**249797**	**257430**
From Fractionators	**4294**	**4608**	**4931**
LPG	11326	12380	12786
Motor Spirit	36593	37784	38039
Naphtha	19946	20006	19786
Kerosene	6041	4408	4072
ATF	13831	14594	15479
HSD	102484	107904	110535
LDO	629	562	702
Furnace oil	9694	9019	9598
LSHS/HHS/RFO	268	468	434
Lube oils	1029	1036	949
Bitumen	5185	5277	5803
Petroleum coke	13936	14754	14676
Others	22589	26215	29503

Source: *Indian Petroleum & Natural Gas Statistics, 2018-19, 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.

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 Ministry of Petroleum & Natural Gas for 2018-19, 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, 10 CBM blocks (8 blocks in development/production phase and 2 in exploration phase) are active. CBM in-place reserves of about 280.3 BCM (9.9 TCF) have been established by different operators as on 01.04.2018.

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 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, has been reported. 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. During 2018-19, CBM production was around 710.46 MMSCM from 5 CBM blocks.

Table – 6 : Consumption of Petroleum Products, 2016-17 to 2018-19

(In'000 tonnes)

Product	2016-17	2017-18	2018-19 (P)
1. Light distillates	**61441**	**66053**	**72109**
(a) LPG	21608	23342	24907
(b) Motor Spirit	23765	26174	28284
(c) Naphtha	13241	12889	14131
(d) Others	2827	3648	4787
2. Middle distillates	**89042**	**93551**	**96379**
(a) SKO	5397	3845	3459
(b) ATF	6998	7633	8300
(c) HSDO	76027	81073	83528
(d) LDO	449	524	598
(e) Others	172	476	493
3. Heavy ends	**44114**	**46562**	**44728**
(a) Furnace oil (FO)	7046	6605	6195
(b) LSHS	104	116	369
(c) Lubes/Greases	3470	3884	3668
(d) Bitumen	5936	6086	6708
(e) Petroleum coke	23964	25657	21346
(f) Waxes	182	199	286
(g) Others	3411	4015	6157
Total (1+2+3)	**194597**	**206166**	**213216**

Source: *Indian Petroleum & Natural Gas Statistics, 2018-19, 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.

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 were drilled at 25 sites in Krishna-Godavari and Mahanadi areas in sand reservoirs for gas hydrates. NGHP-02 has discovered two world class gas hydrate reservoirs, namely, Block KG-DWN-98/5 and Block KG-DWN-98/3. Based on the post-expedition studies and review by international experts, the site located in KG-DWN-98/5 has been found suitable for pilot production test during NGHP-03 expedition for which various studies like sand control measures, well design, reservoir and production simulation modelling as prerequisite for the pilot production have been completed.

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) ONGC in August, 2013 has estimated Shale Gas resources of 187.5 TCF for 5 basins, namely, Cambay, Krishna-Godavari, Cauvery, Ganga and Assam.

(ii) Central Mine Planning and Design Institute (CMPDI) in July, 2013 has estimated Shale Gas resources of 45.8 TCF for one basin, namely, Gondwana.

(iii) United States Geological Survey (USGS) in January, 2011 estimated Technical Recoverable Shale Gas of 6.1 TCF in three basins, namely, Cambay, KG and Cauvery.

The Government of India on 14.12.2013 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. In phase II and III, ONGC is to carry out exploration in 75 and 50 blocks respectively. Oil India is to carry out exploration in 5 blocks each in Phase II and III. So far ONGC has drilled 23 wells in 19 blocks. Presently, shale exploration activities are in progress in Cambay and KG Basins where two wells [exclusive shale assessment well NDSGA (NADA#37) in Cambay Basin and dual objective well NGSAA (Nandigam South#1) in KG Basin] are under drilling.

Underground Coal Gasification

Underground Coal Gasification (UCG) is a method of converting unworked 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. 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. With a vast proven reserve of coal, India has the potential to use UCG technology to effectively utilise coal. 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 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 Gujarat Industries Power Company Limited (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. Due to inability to continue with UCG project, GIPCL expressed to withdraw from the Vastan UCG project. ONGC has done lot of ground work in this project and invested a lot of resources on UCG. A memorandum has been received from Ministry of Coal (MoC) on 31.10.2018, regarding allotment of the Vastan block to ONGC for testing of UCG pilot. MoC has sought confirmation from ONGC under UCG Policy terms and conditions, issued by MoC vide Notification dated 26.09.2016, i.e., for full tenure 33 years of contract in 4 phases of exploration, pilot assessment, development and production.

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 ethanol derived from molasses and other non-food feedstock for blending with petrol and biodiesel derived from inedible oils, tree borne oil seeds and oil waste for blending with diesel. The Government has notified National Policy on Biofuels 2018 on 8th June, 2018 which is expected to give boost to the biofuel programme of the country.

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 decided to procure ethanol produced from other non-food feed stocks besides molasses, like cellulosic and lignocellulosic materials including petrochemical route. It was also decided to administer the price of ethanol under EBP Programme. For ethanol supply for the year 2018-19, the Government has fixed the price of ethanol as follows:

a) From C-Heavy molasses at ₹ 43.46 per litre.

b) From B-Heavy molasses / partial sugarcane juice at ₹ 52.43 per litre.

c) Price of ethanol for the mills, who will divert 100% sugarcane juice for production of ethanol thereby not producing sugar, has been fixed at ₹ 59.19 per litre. If a sugar mill produces ethanol with a combination of B-Heavy molasses and sugarcane juice, the ethanol price derived from B-Heavy molasses route shall be payable by OMCs.

Further, the Government has also allowed production of ethanol from damaged food grains. OMCs are offering differential pricing of ₹ 47.13 per litre to incentivise this route.

For the previous ethanol supply year 2017-18 (from 1st December, 2017 to 30th November, 2018), the blending quantity of ethanol with petrol was 149.54 crore litres and the average blend percentage was 4.19% which is the highest in the history of EBP Programme.

Subsequent to amendment in Industries (Development & Regulation) Act, 1951, giving control on production, movement and storage of ethanol to the Central Government, Central Government has been regularly interacting with the State Governments and other stakeholders to resolve the bottlenecks in smooth implementation of EBP Programme. Till now, Nine States have already implemented the amended provisions. The Government has also reduced the GST rate on ethanol meant for EBP Programme from 18% to 5%.

2G Ethanol Programme

Subsequent to opening up of alternate route, i.e., Second Generation (2G) route for ethanol production, OMCs are in the process of setting up 12 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 Oil PSUs have prepared Detailed Feasibility Report (DFR) for some 2G Bio-Ethanol plants. One of the Oil PSU viz. Numaligarh Refinery Limited (NRL), has formed a Joint Venture named Assam Bio-refinery Private Limited with M/s Chempolis Oy of Finland and M/s Fortum 3 BV of Netherlands in June, 2018. The ground breaking ceremony of 2G Ethanol project in Bargarh, Odisha, proposed to be set up by Bharat Petroleum Corporation Limited (BPCL), was held on 10th October, 2018. Oil PSUs have obtained environment clearance in respect of their projects at Assam, Odisha and Punjab.

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 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 May to October, 2018, Purchase Orders have been issued by Oil Marketing Companies for supply of 8.14 crore litres of biodiesel with provision for extension for three months. As on 30th November, 2018, OMCs have procured 8.2 crore litres of Biodiesel.

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.

During 2015, the Government brought out a new policy for small fields known as Discovered Small Field (DSF) policy, 2015 for providing a unique opportunity to Indian investors/companies for development of discovered hydrocarbon resources under revenue sharing contract mechanism wherein the terms are liberalised.

Considering the constraints experienced in the different contractual regime, a new policy, namely, Hydrocarbon Exploration and Licensing Policy (HELP) was launched in 2016 with objectives to open up the E&P sector for new entrants and foreign players so as to enhance domestic oil & gas production, bring in substantial investment and new technologies and generate sizable employment. The said policy would further enable transparency in the system and reduce regulatory discretion thereby improving the 'Ease of Doing Business" in E&P Sector. This policy was implemented through Open Acreage Licensing programme (OAP), where the continuous bidding rounds are conducted on the investor selected blocks. To provide further impetus to the Sector, a major overhaul to the policy was introduced in February 2019, wherein the Government decided to forego the revenue share commitment from the operators at the time of bidding in case of Category-II and Category-III basins in India.

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. Under NELP regime, nine rounds of bids have so far been concluded during 1999-2012, in which production sharing contracts for 254 exploration blocks have been awarded and signed. Two DSF bidding rounds have been carried out till date and 53 contract areas have been awarded, resulting in entry of over 20 new players in Indian E&P sector. The maiden bidding round under HELP, implemented through OALP, received an overwhelming response with 55 blocks getting awarded covering an area of ~60,000 sq km.

As on 01.04.2019, a total of 196 blocks (88 under PSCs and 108 under RSCs) are active comprising 9 Pre-NELP, 24 Small & Medium Size Field PSCs, 55 NELP, 53 Discovered Small field and 55 OALP (under HELP Policy). The details of the blocks awarded under various policy/regime are highlighted in Table-7.

The Government's prime objective is to enhance domestic oil & gas production, reduce import dependency and achieve energy security. Therefore, the oil & gas regulatory ecosystem has been overhauled to achieve conducive business environment and to foster investments in the E&P sector. 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. Through the various initiatives, the Government envisages to accelerate E&P activities that would provide impetus to expeditious production of oil & gas. Some of the notable policy reforms in the year 2018-19 have been enumerated below —

1. Hydrocarbon Exploration and Licensing Policy (HELP): Hydrocarbon Exploration and Licensing Policy (HELP) notified on 30th March, 2016 and formally put in operation w.e.f. 1st July, 2017 with notification of Open Acreage Licensing Policy (OALP). This policy is a paradigm shift from Production Sharing Contract (PSC) regime to Revenue Sharing Contract (RSC) regime which completely overhauls the regulatory regime for the future Exploration and Production (E&P) activities by reducing the regulatory burden based on the principle of 'Ease of doing business'. It provides for single Licence for exploration and production of conventional as well as non-conventional Hydrocarbon resources, pricing & marketing freedom, reduced rate of royalty for offshore blocks etc. OALP provides that potential investors/companies can carve out exploration acreages of their choice and submit Expressions of Interest round the year. Bidding is carried out every 6 months. Under OALP, 55 Blocks having an acreage area of 59,282 sq km have been awarded in Bid Round-I in October, 2018. Under OALP Bid Round-II, bid for 14 blocks having an acreage area of 29,233 sq km was launched on 7th January, 2019. Under OALP Bid Round-III, 23 Blocks having an acreage area of 31,722 sq km were proposed for bidding through International Competitive Bidding (ICB) 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

Table - 7: Status of Exploration Block Awarded

Round	No. of blocks awarded	No. of blocks relinquished	No. of blocks active	Present Area
Pre NELP	28	19	9	7646.40
Pre NELP (small & medium sized discovered field)	28	4	24	2238.56
NELP-I	24	21	3	4372.85
NELP-II	23	21	2	657.05
NELP-III	23	19	4	4176.50
NELP-IV	20	16	4	1438.29
NELP-V	20	16	4	526.26
NELP-VI	52	42	10	7129.13
NELP-VII	41	30	11	14010.82
NELP-VIII	32	25	7	4217.00
NELP-IX	19	9	10	11904.00
Total	**310**	**222**	**88**	**58316.86**
DSF Round-I	30	-	53	776.75
OAPL-I	55	-	55	59282
DSF Round-II	23	-	23	2999.68
Total	**108**	**-**	**131**	**63058.43**
G. Total	**418**	**222**	**219**	**121375.29**

***Source**:India's Hydrocarbon Outlook, 2018-19, Directorate General of Hydrocarbons.*

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 31st March, 2019, 20.9 lakh LKM of 2D seismic data, 7.3 lakh SKM of 3D seismic data, 16,366 wells and log data, 33,031 well reports, 14,464 Seismic reports have been uploaded on NDR.

3. 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.

During 2018-19, E&P sector witnessed the successful culmination of Discovered Small Field (DSF) Bid Round-II, Contract signing of 55 contracts under OALP Bid Round-I and commencement of OALP Bid Round-II and III. DSF Bid Round-II was successfully concluded with signing of 23 contracts with 14 companies out of which 8 were new entrants to the sector. It is envisaged that 0.015 MMT oil production will commence from 2020-21 from DSF-I fields and 0.020 MMT oil production from 2022-23 onwards from DSF-II fields. A total of 55 Revenue Sharing Contracts were signed under OALP Bid Round-I covering an area of 59,282 sq km.

4. Policy Reforms in Exploration and Licensing Policy for Enhancing Domestic Exploration and Production of Oil & Gas: To increase exploration activities; to attract domestic & foreign investment in unexplored/unallocated areas of sedimentary basins; to enhance domestic production of oil & gas from existing fields; and to promote ease of doing business by streamlining & expediting the approval processes, the Government of India notified the following policy reforms on 28th February 2019 which include:

a) Categorisation of Sedimentary Basins.

b) Increasing exploration activities in unexpected areas.

c) To incentivise enhanced gas production, marketing & pricing freedom has been granted for those new gas discoveries whose Field Development Plan (FDP) is yet to be approved. Fiscal incentive to be provided on additional gas production from domestic fields over and above normal production.

d) To enhance production from existing nomination fields of ONGC and OIL, enhanced production profile will be prepared by both PSUs.

e) Measures are being initiated for promoting ease of doing business through setting up Empowered Coordination Committee for expediting statutory clearances and creation of Alternate Dispute Resolution mechanism for amicable resolution on disputed issues.

5. Policy Framework to Promote and Incentivise Enhanced Recovery Methods for Oil & Gas: The Government notified the Policy on 10th October 2018 to promote and incentivise Enhanced Recovery (ER)/Improved Recovery (IR)/ Unconventional Hydrocarbon (UHC) production methods/techniques through fiscal incentives in the form of partial waiver of royalty & cess and an enabling ecosystem to improve productivity of existing fields and enhance overall production of domestic hydrocarbons. The strategic objective of the Policy is to build a supportive ecosystem through industry-academia collaboration and to support and encourage E&P Contractors to deploy ER/IR/UHC methods/techniques in existing fields to enhance domestic production. The Policy provides for systemic assessment of every field for its ER potential, appraisal of appropriate ER techniques and fiscal incentives to de-risk the cost involved in ER Projects and to make it economically viable. The policy will also provide leverage to companies to invest in state-of-the-art technology, research facilities and develop a platform for knowledge sharing. An ER Committee has been formed pursuant to the policy vide

MoPNG Notification dated 14.01.2019. The ER Committee has been constituted to, inter alia, approve the ER projects towards availing fiscal incentives under the ER Policy. Also, vide the same notification, six premier Indian institutes have been designated to carry out screening studies of ER methods for the E&P operators.

6. Exploration and Exploitation of Coal-bed Methane (CBM) from Areas under Coal Mining Lease allotted to Coal India Limited (CIL) and its Subsidiaries (Notification dated 11th April 2018)**:** The Cabinet Committee on Economic Affairs chaired by the Prime Minister has accorded approval for issuing a notification amending Clause 3(xiii) of the notification dated 03.11.2015 issued by the Ministry of Petroleum & Natural Gas under Section 12 of the Oil Fields (Regulation and Development) Act, 1948 (ORD Act, 1948). Due to this amendment, relaxation is granted under the Petroleum & Natural Gas Rules 1959 (PNG Rules, 1959) to Coal India Limited (CIL) and its subsidiaries for not applying for grant of licence/ lease under the PNG Rules, 1959 for extraction of Coal-bed Methane (CBM) under their Coal-bearing Areas. On 8th May 2018, Ministry of Petroleum & Natural Gas has approved the consolidated terms and conditions for grant of exploration and exploitation rights to Coal India Limited (CIL) and its subsidiaries for CBM.

It is expected that it will expedite the exploration and exploitation of CBM, enhance the availability of natural gas and reduce the gap in demand and supply of natural gas. Production of CBM from existing coalfields will further ensure safe mining practices. The increased CBM development activities will generate employment opportunities and business opportunities to gas-based industries.

7. Policy Framework for Streamlining the Working of the Production Sharing Contracts: The Government notified the policy for expeditious development of hydrocarbon resources by streamlining the working of PSCs in August, 2018. Policy includes extending exploration period by 2 years and appraisal period by one year for operational blocks in North-Eastern Region (NER) besides allowing marketing including pricing freedom for natural gas to be produced in future in NER; sharing of the statutory levies including royalty & cess in Pre-NELP Exploration Blocks and to be cost recoverable with prospective effect; extending tax benefits under Section 42 of Income Tax, 1961 to operational blocks under Pre-NELP discovered fields with prospective effect for the extended period of Contract.

8. Policy Framework for Streamlining the Operations, Relaxation of Timelines and Delegation of Powers to Director General, Directorate General of Hydrocarbons (DGH) under Production Sharing Contracts (PSCs): The objective of this policy, notified on 25th June 2018, is to streamline the operations under Production Sharing Contracts (PSCs) so that there will be no impact on the field development or production activities done by the operator which will eventually lead to no impact on the operator's investment and profitability. The following guidelines have been approved under the policy—

(a) This policy will allow entry to next exploration phase pending resolution on amount payable for unfinished minimum work programme (MWP) against submission of bank guarantee for differential amount in operational blocks.

(b) Grant of area extending beyond contract area for appraisal prior to development area.

9. Policy Framework for Exploration & Exploitation of Unconventional Hydrocarbons under Existing Production Sharing Contracts, Coal-bed Methane Contracts and Nomination Fields: The Government notified, on 1st August 2018, the policy to encourage the existing Contractors to unlock the potential of unconventional hydrocarbons including shale oil/ gas and CBM in the existing acreages under PSCs, CBM contracts and Nomination fields subject to conditions stipulated in policy document. This policy will enable the realisation of prospective unconventional hydrocarbon reserves in the existing Contract Areas which otherwise would

remain unexplored and unexploited. E&P activities for unconventional hydrocarbons are expected to spur new investment; provide impetus to economic activities; boost additional employment generation; induction of new, innovative and cutting edge technology; and facilitate forging new technological collaboration to exploit unconventional hydrocarbons.

10. National Seismic Programme (NSP) of Unapprised Areas: Almost half of India's sedimentary areas are 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). This programme has achieved 76% completion by acquisition of 36,688 LKM in the year 2018-19 and is expected to be completed by 2019-20. The seismic data acquired through NSP has been utilised by E&P companies in carving out blocks in ensuing OALP bid rounds.

11. 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 potential of India in all its 26 sedimentary basins which is being undertaken by ONGC in association with OIL and DGH. The prognosticated conventional hydrocarbon resources in 26 sedimentary basins of the country have been reassessed to the order of 41.87 billion tonnes of oil and oil equivalent of gas (O+OEG), which showed about 49% increase as compared to earlier estimates of 28.08 billion tonnes.

STRATEGIC CRUDE OIL STORAGE

Keeping in view India's high import dependence for oil & gas and country's energy security, MoPNG took up construction of crude oil reserve facilities as a buffer to deal with any situation of supply chain disruption due to external reasons. A Special Purpose Vehicle (SPV) named Indian Strategic Petroleum Reserve Limited (ISPRL), a subsidiary Company of Oil Industry Development Board (OIDB), was created on 16th June, 2004. Under phase-I of SPR programme, the Government through ISPRL has built Strategic Petroleum Reserve (SPR) facilities with 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). The total reserve of Phase-I of SPR is currently estimated to supply approximately 10 days of India's crude requirement. The facilities at Vishakhapatnam and one compartment of Mangaluru storage facility have already been filled with crude oil and commissioned with Sovereign crude procured through funds provided by the Government. A Definitive Agreement was signed on Oil Storage and Management between ISPRL and Abu Dhabi National Oil Company (ADNOC) of UAE for filling of Second compartment at Mangaluru SPR facility. Under the Agreement, ADNOC would store 5.86 million barrels of crude oil in one of the caverns of the Mangaluru SPR facility. The first cargo of ADNOC crude oil was received on 21st May, 2018. This was followed by two more shipments of 2 million barrels each. One was received on 6th October, 2018 and the final shipment on 3rd November, 2018.

The SPR facility at Padur is an underground rock cavern with a total capacity of 2.5 MMT having four compartments of 0.625 MMT each. The Padur facility has been commissioned in December, 2018. The crude oil from Mangaluru Cavern B was transferred to Padur for commissioning through 36 km pipeline from Mangaluru to Padur. The Union Cabinet approved the filling of Strategic Reserves at Padur, Karnataka by overseas National Oil Companies (NOCs) and pursuant to the decision, ISPRL signed a Memorandum of Understanding with Abu Dhabi National Oil Company Limited on 12th November, 2018 for storage of crude oil in two compartments (total approximately 9.6 million barrels) of Padur Phase I storage.

In order to further augment India's preparedness during emergency oil shortage situation, the Government under Phase-II gave 'In Principle' approval for establishing two additional SPR facilities at Chandikhol (4 MMT) in Odisha and Padur (2.5 MMT) in Karnataka including dedicated SPM's for the two SPR's. The 'In Principal' approval is for taking up the project under PPP model to reduce budgetary support of Government of India. On completion of 6.5 MMT storage envisaged in Phase II, there will be an additional storage capacity created to cover another 12 days of crude oil requirement. Thus, the total cover would be approximately 22 days.

WORLD REVIEW

The world proved reserves of crude oil and natural gas at the end of 2018 were estimated at 244.1 billion tonnes and 196.9 trillion cu. m, respectively (Tables - 8 & 9). The largest share of reserves of world crude oil is available in Middle East (46.4%) followed by South & Central America (20.9%), North America (14.5%), Europe & CIS (8.8%), Africa (6.8%) and Asia Pacific (2.6%).

Of the total world reserves of natural gas, Middle East possesses the largest share (38.3%) followed by Europe & CIS (33.9%), Asia Pacific (9.2%), Africa (7.3%), North America (7.1%) and South & Central America (4.2%).

The world production of crude petroleum in 2018 marginally increased by 2% to 4,473 million tonnes from 4,372 million tonnes in 2017. USA with share of 16% followed by Saudi Arabia (13%), Russia (12%), Iran, Iraq & Canada (5% each), China & UAE (4% each) and Kuwait & Brazil (3% each) were the principal producers of crude petroleum in 2018.

The world production of natural gas increased to 4,048 billion cu. m in 2018 from 3,865 billion cu. m in 2017. USA with share of 21% followed by Russia (18%), Iran (6%), Qatar, Canada & China (4% each) and Australia, Norway & Saudi Arabia (3% each) were the major producers of natural gas in 2018 (Tables - 10 & 11).

The world consumption of oil (which includes biogasoline, biodiesel and derivatives of coal & natural gas) in 2018 was estimated as 4,662.1 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 3,848.9 billion cu. m. The share of India in the world consumption of oil and natural gas was 5.13% (239.1 million tonnes oil equivalent) and 1.51% (58.1 billion cu. m), respectively, during 2018.

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

(In billion tonnes)

Country	Reserves
World: Total	**244.1**
Algeria	1.5
Angola	1.1
Azerbaijan	1.0
Brazil	2.0
China	3.5
Canada	27.1
Iran	21.4
Iraq	19.9
Kazakhstan	3.9
Kuwait	14.0
Libya	6.3
Mexico	1.1
Nigeria	5.1
Norway	1.1
Qatar	2.6
Russia (Federation)	14.6
Saudi Arabia	40.9
UAE	13.0
USA	7.3
Venezuela	48.0
Other countries	8.7

Source: *BP Statistical Review of World Energy, 2019.*
** At 2018 end.*

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

(In trillion cu. m)

Country	Reserves
World : Total	**196.9**
Algeria	4.3
Australia	2.4
Azerbaijan	2.1
Canada	1.9
China	6.1
Egypt	2.1
India	1.3
Indonesia	2.8
Iran	31.9
Iraq	3.6
Kazakhstan	1.0
Kuwait	1.7
Libya	1.4
Malaysia	2.4
Myanmar	1.2
Nigeria	5.3
Norway	1.6
Qatar	24.7
Russia (Federation)	38.9
Saudi Arabia	5.9
Turkmenistan	19.5
UAE	5.9
Ukraine	1.1
USA	11.9
Uzbekistan	1.2
Venezuela	6.3
Other countries	8.4

Source: *BP Statistical Review of World Energy, 2019.*

** At 2018 end.*

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

(In million tonnes)

Country	2016	2017	2018
World : Total	**4355**	**4372**	**4473**
Algeria	68	67	65
Angola	86	82	75
Argentina	27	25	26
Azerbaijan[a]	41	39	39
Brazil	135	141	139
Canada	192	209	224
China[b]	200	192	189
Colombia	46	45	46
Ecuador	30	29	28
Egypt	34	32	33
India[c]	36	36	34[e]
Indonesia	42	40	39
Iran	216	236	220
Iraq	218	222	226
Kazakhstan	78	86	90
Kuwait[d]	153	146	147
Libya	19	44	55
Malaysia	32	32	31
Mexico	127	115	107[e]
Nigeria	91	96	98
Norway	98	97	91
Oman	50	48	49
Qatar	83	80	79
Russia	549	546	556
Saudi Arabia[d]	587	559	578
UAE	182	176	178
UK	47	46	50
USA	564	600	702
Venezuela	120	108	77
Other countries	206	201	202

Source: *World Mineral Production, 2014-2018.*

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	2016	2017	2018
World: Total	**3720**	**3865**	**4048**
Algeria	91	93	92
Argentina	45	45	40
Australia	97	114	131
Canada	157	159	167
China	137	148	160
Egypt	35	42	50
India[(a)]	32	33	32[e]
Indonesia	75	72	74[e]
Iran	199	220	240
Kazakhstan	47	53	55
Malaysia	68	70	67
Mexico	52	49	46*
Netherlands	50	44	36
Nigeria	46	48	49
Norway	117	124	122
Oman	32	30	35
Pakistan[(b)]	42	42	41
Qatar	177	176	176
Russia	639	691	728
Saudi Arabia[(c)]	105	109	112
Tanzania	48	51	59
Thailand	39	38	37
Trinidad & Tobago	34	34	37
Turkmenistan	63	59	62
UAE	60	62	65
UK	42	42	41
USA[(d)]	729	746	832
Uzbekistan	53	53	57
Venezuela	37	39	33
Other countries	370	379	372

Source: *World Mineral Production, 2014-2018.*
Note: So far as possible the figures in this table excludes; *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.

FOREIGN TRADE

Exports

Exports of natural gas decreased significantly by 59% to 73,574 tonnes in 2018-19 from 1,79,552 tonnes in 2017-18. Exports of natural gas were mainly to Nepal (59%), China (41%) and very small quantity to Bhutan (Table -12).

Exports of petroleum products were at 61.10 million tonnes valued at ₹ 2,67,697 crore during 2018-19 (P) which showed a decrease of 8.58% in quantity terms and 18.77% increase in value terms against the exports of 66.83 million tonnes valued at ₹ 2,25,388 crore during 2017-18.

Imports

Imports of crude petroleum increased marginally by 4% to 226.45 million tonnes in 2018-19 as compared to 218.10 million tonnes in 2017-18. Imports were mainly from Iraq (21%), Saudi Arabia (18%), Iran (11%), UAE & Venezuela (8% each), Nigeria (7%), Kuwait & Mexico (5% each) and USA & Angola (3% each). Imports of natural gas increased significantly by 7% to 21.54 million tonnes in 2018-19 from 20.18 million tonnes in 2017-18. Main suppliers were Qatar (48%), Nigeria (13%), Angola (7%), Australia, Oman & USA (6% each), Equatorial Guinea (4%) and UAE & Trininad (2% each) (Tables - 13 & 14).

Imports of petroleum products were at 33.35 million tonnes valued at ₹ 1,13,665 crore during 2018-19 (P) which showed a decrease of 5.95% in quantity terms and 28.62% increase in value terms against 35.46 million tonnes valued at ₹ 88,374 crore during 2017-18.

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

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**179552**	**6315314**	**73574**	**3802681**
Nepal	92851	3879975	43473	2042389
China	-	-	30000	1756919
Bhutan	438	18321	99	3254
Korea Rep of	32000	1152884	-	-
Taiwan	54263	1264133	-	-
Other countries	-	-	2	119

Figures rounded off

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

Country	2017-18 (R)		2018-19 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
All Countries	**218104**	**5630977107**	**226452**	**7981583190**
Iraq	45740	1129911517	46613	1558440332
Saudi Arabia	36163	983583200	40336	1497301105
Iran	22598	578771029	23907	842803832
UAE	14294	394236269	17492	668481783
Nigeria	18115	528462985	16830	662965238
Venezuela	18349	377510453	17322	507305281
Kuwait	12860	340855968	10783	379802106
Mexico	8021	177332449	10285	298182492
USA	1446	39507901	6407	252293142
Angola	7369	198535211	6242	229434632
Other countries	33149	882270124	30235	1084573247

Figures rounded off

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

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**20176813**	**523664504**	**21544664**	**738878610**
Qatar	9969158	265484187	10261371	376228500
Nigeria	3004489	71089772	2780447	81741706
Angola	1354273	34088026	1511723	49464501
Australia	1748797	47139851	1246812	43756563
Oman	508746	13295764	1296098	43067771
USA	347505	10528031	1233773	36523245
Equatorial Guinea	1034287	23800235	878171	27884442
UAE	334076	7672780	366983	16726422
Trinidad	65130	1375511	366622	11374741
Malaysia	253065	5554740	262864	8589699
Other countries	1557287	43635607	1339800	43521020

Figures rounded off

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. China, US and India together accounted for more than two-thirds of the global increase 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.

As per the BP World Energy Outlook 2019, India's primary energy consumption is set to rise from around 754 MMtoe in 2017 to 1,928 MMtoe in 2040 (4.2% CAGR). While our energy basket remains primarily fossil fuel-based, led by coal, the role of renewables in the national energy basket is likely to see a quantum leap in the longer term driven primarily by increasing penetration of solar energy. Despite the healthy outlook for renewables the energy mix is still massively dependent on fossil fuels. Within fossil fuels, while the country benefits from abundance of cheap coal, reliance on imports for securing our oil and gas requirements is not likely to change anytime soon. 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 shares of oil & 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 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, 100% Indian sedimentary area is to be appraised. 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 & Forest which remains unapprised. This means, about half of the Indian sedimentary basins have the undiscovered potential of hydrocarbons. The total prognosticated hydrocarbon resources is estimated at about 41.87 billion tonnes in the sedimentary basins of the country, out of which about 10,680 MMT in-place hydrocarbon volume of oil and oil equivalent gas, as on 1st April, 2018, has been estimated by ONGC, OIL and Private/JV companies. About 74% of resources are under "yet to discover" category. Out of 10,680 MMT of oil and oil equivalent gas of in-place volumes, the ultimate reserves which can be produced are about 4,095 MMT of oil and oil equivalent gas. The balance recoverable reserves are of the order of 1,812 MMT of oil and oil equivalent gas. 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% per 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 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 by 2030.

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 is estimated to supply approximately 10 days of India's crude requirement. In order to further augment India's preparedness during emergency oil shortage situation, the Government gave 'In Principle' approval for establishing two additional SPR facilities at Chandikhol (4 MMT) in Odisha and Padur (2.5 MMT) in Karnataka including dedicated SPM's for the two SPR's. On completion of 6.5 MMT storage, there will be an additional storage capacity created to cover another 12 days of crude oil requirement. Thus, the total cover would be approximately 22 days. 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. 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, the aspirations in physical terms 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.