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THE OIL AND GAS INDUSTRY OF ASSAM- THE UPSTREAM, DOWNSTREAM AND MIDSTREAM INDUSTRY.

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Abstract:

The Oil and Gas industry is defined to include exploration, extraction, transportation and processing of crude oil and natural gas. Exploration can be generally thought of as the process of finding mineral resources. Extraction is the process of developing and recovering mineral resources. Oil and gas extraction comprises operate and or develop oil and gas field properties. Such activities may include exploration for crude petroleum and natural gas; drilling, completing, and equipping wells; operating separators, emulsion breakers, desilting equipment, and field gathering lines for crude petroleum and natural gas; and all other activities in the preparation of oil and gas up to the point of shipment from the producing property. This subsector includes the production of crude petroleum, the mining and extraction of oil from oil shale and oil sands, and the production of natural gas, sulphur recovery from natural gas, and recovery of hydrocarbon liquids. Establishment in this subsector includes those that operate oil and gas wells on their own account or for others on a contract or fee basis. The objective of the study is to present the state of Oil and Gas Industry of Assam.

Key words: Production, Transportation, Petroleum refining, Hydrocarbon liquids, Sulphur.

1.1 OIL AND GAS INDUSTRY:

The oil & gas industry comprises three segments; Upstream, Midstream & Downstream. Upstream segment deals with oil & gas exploration and production. This involves companies actively searching for underground and underwater sources of crude oil and natural gas. This is done by using sophisticated drilling equipment which is used to tap into the sources and draw oil and natural gas to the surface.Midstream deals with the transportation of crude oil petroleum products, transportation of natural gas and LNG receiving terminals, usually via pipeline, oil tanker, truck or rail. The midstream sector also includes the storage of these products as well as any wholesale marketing efforts. Downstream segment deals with refining, gas processing and marketing of oil & gas to the ultimate consumers.

In Angola, two major sectors are associated with the oil and gas value chain. The oil exploration and oil production are assimilated in the first sector . Exploration which is the first stage of oil exploitation involves prospecting and development alongside oil discovery, field appraisal and field development. Production is the process of oil extraction after field development. The second sector which is downstream comprises crude processing and distribution and marketing of derivatives.(Teka 2011)

According to the indicus- Final report (2009), the extraction of petroleum from underground reserves is further cracked or "refined" into end products for various uses. The two parts involve in upstream are oil exploration and production industry and a refinery industry in downstream. Most oil producers also own refineries. However, a high proportion of oil is sold to refinery companies that do not produce crude oil.

The oil and gas industry covers a range of different activities and processes which jointly contribute to the transformation of underlying petroleum resources into useable end-products consumed by industrial and private customers. These different activities are inherently linked conceptually, contractually and/or physically with each other and these linkages might occur within or across individual firms, and within or across national boundaries. (world bank,2009)

Bangsund et al (2007) states that in North Dakota, the petroleum industry consisting of both upstream and downstream components includes in-stateexploration, extraction, transportation, and processing of crude oil and natural gas.Exploration devises the process of finding mineral resources and the process of developing and recovering mineral resources are devised in extraction. The movement of oil and gas from wells tocollection points, and then on to processing facilities located either in-state or out-of-state falls within transportation components.Petroleum processing in North Dakota included refining of crude oil and natural gasprocessing. Firms owning producing wells (oil operators) contract much of the work of exploration and extraction of oil and gas to other firms having specialization in various aspects of those processes. A majority of the prominent oil operators in North Dakota also have operations in other states.

The US oil and natural gas industry spans around a number of activities classifying Oil and natural gas exploration and production in the mining

sector; oil refining in the manufacturing sector; pipeline operations in the transportation sector; natural gas distribution in the utilities sector; and oil marketing in wholesale and retail trade sector. PwC has defined the oil and natural gas industry to include all such activities which are oil and gas extraction, drilling oil and gas wells, support activities for oil and gas operations, natural gas distribution, oil and gas pipeline and related structures construction, petroleum refineries. (PWC, 2011)

The oil and gas industry is usually divided into three major sectors: upstream, midstream and downstream. The upstream sector includes oil and gas exploration and production. It includes searching for potential underground or underwater crude oil and natural gas fields, drilling exploratory wells, and subsequently drilling and operating the wells that recover and bring the crude oil and or raw natural gas to the surface.The midstream sector involves the transportation, storage and wholesale marketing of crude or refined petroleum products. The downstream sector commonly refers the refining of petroleum(Dutta 2013).Gabrielson (2015) studies the differences between upstream, midstream and downstream sector of oil and gas industry. The upstream sector which is commonly known as the exploration and production section covers all activities related to searching for, recovering and producing crude oil and natural gas from underground underwater fields. This sector covers drilling of exploratory wells, subsequent drilling and operating the wells that recover and bring the crude oil or raw gas to the surface. The midstream sector connects the upstream sector to the downstream sector. Often times it is lumped in with the downstream sector. Pipelines and other transport systems can be used to move crude oil from production sites to refineries and deliver the various refined products to downstream distributors. The downstream sector of the oil and gas industry involves the refining of the crude oil and raw natural gases obtained in the upstream sector as well as selling or distributing the products obtained. This includes facilities such as petrochemical plants, oil refineries,natural gas distribution companies, retail outlets etc.

The O&G value chain includes upstream (exploration and production), midstream (transportation and storage) and downstream (refining and retail markets).(Bravo et al., 2018)

The upstream sector, also known as "exploration and production", includes searching for potential O&G reservoirs, drilling exploratory wells, and developing facilities around those wells that produce commercial quantities of hydrocarbons.

The midstream sector involves transporting and storing hydrocarbons, it consists of transport via pipelines, rail and road transportation.

The downstream sector involves crude oil refining to oil products and its marketing. It also includes the selling and distribution of processed natural gas and the products derived from petroleum crude oil, such as, among others, liquefied petroleum gas, gasoline, jet fuel, diesel oil, other fuel oils, petroleum asphalt and petroleum coke.

1.2Exploration and production

The upstream sector is the phase in the value chain where Oil &Gas is discovered, developed and produced. It represents the source of O&G supply and activities of the value chain such as obtain rights to explore and

drill, discover hydrocarbons, assess potential, Define and Sanction the project build the facilities, produce hydrocarbons.

1.2.1 Access

Before an Oil &Gas company can start exploring in an area, it must negotiate an agreement with the owner of the mineral rights. These rights are owned by a national or state government, and so the negotiations are between the company and generally a designated government agency.

1.2.2Exploration activities

A. Exploration surveying

In the first stage of the search for hydrocarbon-bearing rock formations, geological mapsare reviewed in desk studies to identify major sedimentary basins. More detailed information is assembled using a field geological assessment, followed by one of three main survey methods: magnetic, gravimetric and seismic. Seismic surveys are the most common assessment methods used to pinpoint potentialhydrocarbon reserves in geological formations. Seismic technology uses the reflection of sound waves to identify subsurface geological structures.A seismic survey indicates the potential of O&G before drilling a well, by creating an image of subsurface rock. The seismic method uses sound energy that is directed into the earth. The energy travels down through the subsurface rocks, and is reflected back by subsurface rock layers. Seismic surveys offer either a 2D or a 3D view, or even more recently, a 4D view or time-lapse seismic images.

Once geological and seismic surveys determine a pay zone in the subsurface, exploration wells are drilled, and if successful, discover hydrocarbons to be developed in commercial quantities.

B. Exploration drilling

Exploratory drilling activities onshore/offshore follow the analysis of seismic data to verify and quantify the amount and extent of oil and gas resources from potentially productive geological formations. Most of the exploratory boreholes are drilled to confirm the presence of hydrocarbons and the thickness and internal pressure of a reservoir. However, some are also drilled to gain knowledge of the geological formation. All wells that are drilled to discover hydrocarbons are called ‘exploration’ wells, commonly known by drillers as ‘wildcats’. The location of a drill site depends on the characteristics of the underlying geological formation.

Drilling fluids

The fluid has a number of functions. It imparts hydraulic force that assists the drill bit for a cutting action and it cools the bit, removes cutting rock from the wellbore and protects the well against formation pressures.

Casing

As the hole is drilled, casing is placed in the well to stabilize the hole and prevent caving. The casing also isolates water-bearing and hydrocarbon-bearing zones. Casing is important for both drilling and production phases of operation, and musttherefore be designed properly. It prevents natural

gas, oil, and associated brine fromleaking out into the surrounding freshwater aquifer(s), limits sediment from entering thewellbore, and facilitates the movement of equipment up and down the hole.

1.2.3 Appraisal

When exploratory drilling is successful, more wells are drilled to determine the size andthe extent of the field. Wells drilled to quantify the hydrocarbon reserves found are called‘outstep’ or ‘appraisal’ wells. The appraisal stage aims to evaluate the size and natureof the reservoir, to determine the number of confirming or appraisal wells required,and whether any further seismic work is necessary. The technical procedures inappraisal drilling are same as those employed for exploration wells, and descriptionprovided above applies equally to appraisal operations. A number of wells may be drilledfrom a single site, which increases the time during which the site is occupied. Deviatedor directional drilling at an angle from a site adjacent to the original discovery bore holemay be used to appraise other parts of the reservoir, in order to reduce the land used or‘footprint’.

1.2.4 Fielddevelopment

Once a promising discovery is made, teams of specialists prepare a development plan that integrates the field production schedule with market needs.

A technical team analyzes the subsurface reservoir in detail, and prepares several development options, together with their environmental impact, by selecting the number and location of development wells, and specifying the surface facilities required to process the oil production and export, project development plan, risk assessment and overall budget.

1.2.5 Production phase and abandonment

During the production time, engineering, operating and maintenance personnel design, construct, manage and maintain the production wells and surface facilities applying best practices to maximize hydrocarbon recovery, while complying with the safety standards and environmental constrains, to reach the expected production objectives.

Not all hydrocarbons that are identified as being present ("in-place") in a field can be economically recovered with current technology. Typical recovery factors for oil reservoirs may range from around 15-50%. Recovery factors for gas fields are usually higher, on the order of 60- 85%.

At the end of the production life, when production is not economical anymore, the field will be decommissioned and abandoned, and the site restored to safe condition, to eliminate potential risk of environmental contamination. O&G wells that are no longer economically viable, or are not in use because of wellbore issues, must be plugged in order to prevent O&G fluids to migrate up hole and contaminate other formations or fresh water aquifers. Wells are plugged by placing mechanical and cement plugs in the wellbore, to prevent any fluid flow.

1.3 Transportation, storage and distribution

1.3.1 Transportation and storage

While there are a number of ways to transport crude oil, the most practical and economic way to do so is via pipelines or marine tankers, especially over longer distances.

Pipelines are used on land and offshore to move oil from oil/gas separation units in the fields, or from gathering centers to port terminals for loading onto tankers, and to deliver oil from supply points to refineries and other market destinations.

Over the long term, a pipeline is the preferred alternative for inter-regional or transcontinental oil movement. Its unit operating costs are lower, as compared with other forms of transportation. It is also the safest and the most environmentally-friendly form of oil transportation.

Crude oil storage terminals are built at the inlets and outlets of major pipelines, at port facilities, where the oil waits to be loaded/unloaded onto/from large crude oil carriers, and at refineries, where it waits to be refined.

Natural Gas is several orders of magnitude less dense than crude oil, its storage and transportation over large distances needs to be done under high pressures, and it requires expensive infrastructures.

Initially, the gas pipeline network provided the basis for natural gas storage; however, given the increase in demand and the fluctuations in consumption, and in order to ensure supply security in countries with low or no gas production, the need for having natural gas storage sites has arisen. Underground storage of gas in exhausted fields of gas, aquifers and salt caverns, being cheaper than those of liquefied gas, has an important role in this function; however, they have the difficulty of being linked to the structure of local networks to be used as support for global trading activity.

In the last few decades, engineering advances in the area of liquefaction, by which gas is converted into liquid form (LNG), have eased safe non-pressurized storage and transportation, and expanded the possibilities of more widespread natural gas trade. In liquefaction facilities, gas that is transported from nearby fields is treated for dehydration, condensate, CO_2, mercury and H_2S removal, and refrigerated up to liquefaction and stored as liquid in cryogenic tanks, from which it is transported to the destination terminals via specialized LNG tankers. There, the LNG is then unloaded, stored and regasified, and distributed through the local pipeline network. LNG storage can perform functions that are identical to underground storage, regarding balancing consumption/supply and optimizing the gas network, but possibilities have also opened up for the global trading of natural gas as LNG.

1.3.2 Distribution

The distribution of oil productstakes place between refineries or importing ports, and the end consumer, and can be done through multiple channels.

Primary distribution considers the transportation of refined oil products from refineries to intermediate storage installations, where at a later stage, oil products are withdrawn by different operators and delivered to oil consumers. Primary distribution is done mainly through pipelines, but also via barges and tank wagons, and in some cases by tankers.

Secondary distribution,also called capillary distribution, involves distributing oil products to the end consumer via multiple channels (i.e. tank wagons, barges and trucks) to supply service stations, industries, ships or airplanes.After crude oil is extracted, going down the value chain, it is processed into refined products and chemicals, as per market demand.

1.4 Refining

In the refinery, crude oil is transformed into market fuels and specialty products. Some of these products constitute feedstock for the petrochemical industry, which together with natural gas liquids, produces base chemical products. All these products are then marketed through Business-to-Business (B2B) and Business-to-Consumer (B2C) channels.

Refining refers to those processes that transform crude oil and other raw liquid hydrocarbons, which as such have limited value to final consumers, into oil products, such as gasoline, jet and diesel or liquefied petroleum gases (LPG) suitable for final consumption. The major categories of refinery processes are:

Physical separation processes: Atmospheric distillation, vacuum distillation, aromatics extraction, de-waxing/de-asphaiting, gas separation plant.

hydrocracking, thermal cracking/ visbreaking, asphalt blowing.

Purification or treating processes: desalting, hydrotreating/ hydrodesulphurisation / hydrofinishing, sour gas concentration, sulphur recovery from hydrogen sulphide, sour water treatment, lubricating oil refining.

1.5 THE PETROLEUM INDUSTRY IN ASSAM

(a) Petroleum industry in Assam during British rule: The state has many important natural resources and it has been playing a pivotal role in attracting the attention of many investors to set up their production and manufacturing units since the advent of British Rule. In 1823 tea was discovered in Assam (Sharma et al., 2012). It was Lieutenant Wilcox, an army man and geologist of the British East India Company, who discovered oil for the first time in 1825 in the bed of the Buridihing at Supkong near a coal-bed. Mr. C. A Bruce in 1828 and Mr. H. B. Medicott in 1865bof the Geological survey of India also saw oil seepages while prospecting for coal in Upper Assam.

In 1837, severalsprings were found by Major Adam White in the Namrup River below coal-bed. By 1842, the whole of the Brahmaputra valley came under the British rule. Along with the successful plantation of tea, the colonial capitalist invested in the exploration of other mineral resources. In 1845, Captain S.F. Hanny reported about oil springs at Naharpung, near the mouth of Namchik River close to a bed of fine coking coal. With the formation of Geological Survey of India in 1851, the nature of mineral exploration in the state acquired a more professional nature. The Geological Survey of India(GSI) undertook the elaborate exploration of coal and oil in Assam. Jenkins made an earnest recommendation for investigating the coal and mineral resources of Assam(Saikia 2013). About a decade after Hanny's exploration, G.Dalton, an army officer, reported oil finds at Namchik and Makum in 1854. After the formation of Geological Survey of India(GSI) in 1856, the systematic exploration of oil in Assam was started. In 1866, Mr. Goodenough of McKillop Stewart &Company, Calcutta, drilled a hand-dug well of 102 feet at Nahorpung near Jaipur area of Assam but failed to establish satisfactory production. In his second attempt on 26 th March 1867, oil was struck at merely 118 feet in Asia's first mechanically drilled well at Makum near Margherita area of Upper Assam.

In 1879, S.E Peal,a tea planter mentioned oil springs near Margherita(Barpujari 2004)

However, the first well dug at Digboi field in Assam in September 1889 and completed in November 1890 at depth of 662 feet by Assam Railways and Trading Company Limited, registered at London, is regarded as the first commercially successful oil discovery.

A new company known as Assam Oil Company (AOC) was formed in 1899. AOC was one of the earliest enterprises in the world engaged in exploration and production of oil. Digboi Refinery is the India's first refinery and one of the oldest operating refineries in the world(Barpujari 2004).

(b)Petroleum industry in Assam after independence: After 1947 the first major discovery of oil fields was at Naharkotiya in Assam. By 1948, GSI has started geophysical survey in Cambay area. In 1950s, three different types of geophysical surveys, seismic, gravity and aeromagnetic were conducted to find more oil in eastern Assam.The first oil discovery in independent India was made by AOC on 1953 in Naharkatia and then in Moran in 1956 both in Upper Assam. The oil industry, after independence, remained operated by foreign company for a considerable period. Burma Oil Company kept its position as largest company in India till end of its operation. With the intention of intensifying and spreading exploration to various parts of the country, a separate Oil and Natural Gas Directorate (ONGC) was set up in 1955, as a subordinate office under the then Ministry of Natural Resources and Scientific Research. In early 1956, its status was changed to a commission. In October 1959, the ONGC was made a statutory body by an act of parliament delegating it more power but it remained under Ministry. The job of ONGC was defined as "to plan promote, organize and implement programs for development of Petroleum Resources and the production and sale of petroleum and petroleum products produced by it and to perform such other function as the central government may from time to time, assign to it." ONGC systematically started its geophysical surveys on area considered prospective based on global analogy. Under the new industrial policy framed by the GOI in 1956 made the development of mineral oil the exclusive responsibility of the state. (Refinery set up) On 18th February 1959, for development and production of Naharkatiya and Moran prospects and to increase the pace of exploration in Assam, Oil India Private Limited (OIL) was incorporated as a rupee company to take over BOC's affairs in Assam. The company was owned two-third by AOC/BOC and 1/3 rd by Government of India and in 1961 they became equal partners by transforming OIL into a Joint- Venture company. The second refinery in Assam was set up at Noonmati in Guwahati under the public sector. It started production in 1962. It produces liquified petroleum gas, petrol,kerosene,diesel,furnance oil, coke etc.The third refinery in the region was established at Dhaligaon near Bongaigaon in 1962 .It is known as Bongaigaon Refinery and Petrochemical Limited (BRPL).ONGC discovered field in Lakwa in 1964, Geleki in 1968.

Oil discovered Jorajan oilfield in 1972. Later Eocene gas was discovered by Oil in Tengakhat field of Assam in 1973. In 1978, OIL ventured out of Assam into Orissa offshore and onshore. OIL also ventured into offshore Andamans in 1979-89 and onshore Rajasthan. Till the end of 1970s, Indian E&P industry was dominated by the two National Oil Companies- ONGC and OIL to whom PELs were granted on nomination basis. Exploration was primarily confined to onland and shallow offshore. The strategic initiative was taken by government in 1979 to attract foreign investment technology and capital to deal with future commitment and challenges of Indian oil economy by offering 32 exploration blocks. Government started offering block systematically through bidding. These rounds are also known as Pre NELP Exploration rounds. The three rounds during 1980-86 were not very successful.

By 1981, Government took over OIL and it became full-fledged PSU. By the end of 1986, third round of international bidding for exploration block were offered. OIL and ONGC were offered 40% stake in JV, if field was found viable. Few foreign companies participated but there was no commited exploration or breakthrough discovery.

In 1990, Fourth round of bidding invited and for the first time, Indian companies could participate with foreign companies. However, no major discovery was made with these partnerships.ONGC discovered field in Lakwa in 1964, Geleki in 1968.

(c)Petroleum industry in Assam since liberalisation: In 1991, Government of india adopted liberalized economic policy that led to delicensing of core group including petroleum sector and partial disinvestment of government share including other measures. As a result, ONGC was re-organised as a Limited company (under the Company's Act, 1956) from Oil and Natural Gas Commission to Oil and Natural Gas Corporation Limited.

In 1991, the Government of India liberalised the petroleum exploitation and exploration policy and invited private companies, both foreign and Indian, to participate in the exploration of oil and gas. Under the Petroleum Sector Reform, the fourth, fifth, sixth, seventh and eight rounds of exploration bidding were announced between 1991 and 1994. For the first time Indian companies with or without previous experience in Exploration and Production activities were permitted to bid. The Government, then announced the Joint Venture Exploration Programme,in 1995. The government of India has signed production sharing contracts for 28 exploration blocks under pre-NELP (New Exploration Licensing Policy) rounds, since 1993. (IBEF 2008)

The government efforts particularly during 1991-1996 gave required thrust for opening up Oil and Gas sector in India. Many private players joined in development of this industry. Hindustan Oil Exploration Company which started E&P venture in 1991, was among few such initial domestic private player. In view of the liberalized policy adopted by GoI, a need for an independent upstream regulatory body called the Directorate General of

Hydrocarbons (DGH) was envisaged to oversee and review the oilfield development programs to conform to sound reservoir engineering practices in line with national interests. Thus, DGH was formed vide GoI resolution dated 08.04.1993.The New Exploration Licensing Policy was formulated by Government of India in 1997 and it became effective in February, 1999. The main objective was to accelerate the pace of exploration effort in the country. This policy attracts significance risk capital from Indian and foreign companies and best management practices to explore oil and gas resources in the country to meet the rising demands of oil and gas.Since then licenses for exploration are being awarded only through a competitive bidding system and National Oil Companies are required to compete on an equal footing with Indian and foreign companies to secure Petroleum Exploration Licenses(Sharma 2017). The fourth refinery in the state was established at Numaligarh of Golaghat district in 1999, with a refining capacity of 3 million tonnes of oil and other products.(Barua 2014)

Subsequently, after implementation of New Exploration Licencing Policy (NELP) and Coal Bed Methane (CBM) Policy in 1997-99, the level playing field was provided to the private investors by giving the same fiscal and contract terms as applicable to National Oil Companies (NOCs) for the offered exploration acreage.

The fourth refinery in the state was established at Numaligarh of Golaghat district in 1999, with a refining capacity of 3 million tonnes of oil and other products.(Barua 2014)

The new Hydrocarbon Exploration Licensing Policy (HELP) for award of Hydrocarbon Acreages in the Upstream Sector of India was notified on 30th March,2016 and formally launched w.e.f. 1st July, 2017. Open Acreage Licencing Policy (OALP) is one of the key features of HELP which has been notified on 30th June, 2017.

National Data Repository (NDR) set up at DGH and launched on 28th June, 2017 to make the entire Exploration and Production (E &P) data available for commercial exploration, research and development and academic purposes.

(d) Present state of Petroleum Industry in Assam: Assam is one of the leading producers of onshore crude oil and contributes over 24% of total Onshore Crude production which is about 12.18% of total crude production in the country. Assam currently has proven oil reserves of about1.6 Billion Tonne. As per Directorate General of Hydrocarbon,two sedimentary basins-Upper Assam Shelf and Assam – Arakan Basin – covering an area of 116,000 sq. Km. Around 90% of the Upper Assam Shelf has been explored and current production of oil and gas is mainly from this basin, whereas only 10% of the Assam-Arakan fold belts, mainly covering Tripura and some parts of Mizoram, Manipur and Nagaland, have been explored so far. The two upstream National Oil Companies viz., Oil and Natural Gas Corporation Limited and Oil India Limited are the two main players involved in oil exploration and extraction in Assam. Presently, ONGC produces nearly 61.5% of indigenous crude oil and 68.7% of re 2

exploration blocks in the state of Assam under nomination regime. From 2000 onwards, OIL is aggressively participating in NELP exploration blocks apart from nomination blocks and holds 8 exploration blocks under NELP regime. The private players are Hindustan Oil Exploration Company Limited(HOEC), Geo Enpro, Jubilant Energy, Assam Company, Essar Oil and Dart Energy (GOA, 2016-17).

During the year 2018-19, OIL produced 3.323 MMT of crude oil and 2865 MMSCM of natural gas. Besides, production of crude oil from Assam and Arunachal Pradesh, OIL also produced crude oil from its Rajasthan Asset. During 2018- 19, the crude oil pipeline transported 6.57 MMT of crude oil and Numaligarh-Siliguri Product Pipeline transported 1.78 MMT of products with a capacity utilization of 103.5%. The LPG plan processed an average of 1.71 MMSCMD gas and produced 33730 MT of LPG and generated revenue of` 141.53 crore during the year.

During the year2018-19, OIL drilled eleven exploratory wells in the PML areas in Assam & Rajasthan. The exploratory efforts in the NELP Blocks were continued by drilling one well in Rajasthan and three wells in KG basin, this includes one High Pressure - High Temperature well. Two gas discoveries have made in the Upper Assam Basin and one gas discovery in KG Basin, in the first HPHT well.

OIL is able to maintain its 2P Reserves at the level of about 190 MMTOE from its Indian Assets including the contribution from JVs. During2018-19, OIL has been awarded 9 blocks under first round of Open Acreage Licensing Policy covering a total area of 7907 sq. km, out of which five are in Assam and two each in Arunachal Pradesh and Rajasthan.

Post award of the OALP and DSF blocks, the acreage position of OIL in Assam and Assam Arakan Basin has increased from 8,375 sq. km. to 16,770 sq. km. and the overall in-country acreage position from 9,199 sq. km to 51,477 sq. km. To improve gas supply connectivity to all the State capitals of eight North Eastern States, namely, Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Tripura and Sikkim, your Company together with four other Oil PSUs namely ONGC, IOCL, GAIL & NRL has incorporated a JV Companynamed "Indradhanush Gas Grid Limited" on 10th August, 2018 for construction of North-East Gas Grid Pipeline. Each of these PSU holds 20% of equity in the said JV Company.

OIL's In-Country operations are spread over the areas under onshore Petroleum Exploration License (PEL) and Petroleum Mining Lease (PML) in the states of Assam, Arunachal Pradesh, Mizoram, Andhra Pradesh & Puduchery and Rajasthan.

OIL is operating in 03 (three) PEL and 22 (twenty two) PML areas, allotted under the nomination regime in the states of Assam, Arunachal Pradesh and Rajasthan. OIL also holds Participating Interest (PI) in 07 (seven) NELP Blocks with the right of operatorship in 05 (five) Blocks and as Non-operator in the remaining 02 (two) Blocks as on 31.03.2019. OIL also holds 40% PI in the joint venture Block of Kharsang PSC, 44.086% PI in Pre-NELP block AAP-ON-94/1.

OIL has been awarded 5 blocks in Assam and under Open Acreage Licensing Policy (OALP) Round-I. OIL has also been awarded 2 (two)

Contract Areas one each in Tripura and KG Offshore under Discovered Small Field Round-II.

Currently ONGC holds 46 PML blocks in Assam comprising both long term and short term PMLs. ONGC is holding 1 pre-NELP block in NE falling partly in Assam and Mizoram. In NE Region, ONGC acquired 387.8 LKM of 2D seismic data and drilled 2 exploratory wells.

OIL owns and operates 1,157 km long fully automated crude oil trunk pipeline between Naharkatia-Barauni. Alongwith other additional network, OIL operates total network of 1,243 km of crude oil pipeline. The Naharkatia-Barauni crude oil pipeline runs through the states of Assam, West Bengal and Bihar traversing hostile terrain, dense forests and cuts across 78 rivers including the mighty Brahmaputra. This pipeline has two segments. The 6.0 MMTPA capacity, 557 KM [401 km, 406 mm dia (16") from Duliajan to Guwahati + 156 km, 356 mm dia.(14") from Guwahati to Bongaigaon] long forward pumping segment transports crude oil produced from oilfields in Upper Assam to the public sector refineries at Numaligarh, Guwahati and Bongaigaon. The second segment 600 km long, 356 mm dia (14") between Bongaigaon and Barauni has been reengineered to enable oil flow in either direction and is now transporting imported crude from Barauni to Bongaigaon, presently operating at capacity of 2.3 MMTPA with Drag Reducing Agent (DRA). In addition to above, 0.65 MMTPA of crude oil is transported from Duliajan to Digboi Refinery through 35 km pipeline. OIL also operates a 654.3 km long pipeline for evacuation of total 1.72 MMTPA of products from Numaligarh Refinery to Siliguri Terminal in West Bengal.

During the year 2018-19, crude oil pipeline transported 6.57 MMT of crude oil as against 6.64 MMT in the previous year. The Naharkatia-Bongaigaon sector transported 3.23 MMT of crude oil for the Company and 0.95 MMT of crude oil for ONGC Ltd. The Barauni-Bongaigaon sector transported 2.39 MMT of imported crude oil for Bongaigaon Refinery. The Company also transported 1.78 MMT of products through Numaligarh-SiliguriProduct Pipeline with a pipeline capacity utilization of 103.5%. The pumping stations of Naharkatiya-Barauni cross country pipelines have been operating continuously for over five decades. In 2012, it was decided to upgrade the pump stations and all receipt terminals by replacing 50 years old Mainline Pumping units along with Engine drives and auxiliary equipment's with new state of the art system to bring efficiency, enhanced safety and reliability of operations. The Phase-I of the project, covering 8 pumping stations and all receipt terminals was completed in November, 2017. The Phase-II of the Project for augmentation of pumping capacity of Barauni–Bongaigaon sector has been undertaken in the year 2016 in order to meet the additional requirement of importedcrude oil to Bongaigaon Refinery (BGR) as well as Guwahati Refinery (GR) in view of declining trend of NER crude. Under Phase II project, three more pump stations shall be upgraded along with installation of additional facilities at other pumping station in Barauni - Bongaigaon sector.

In Assam, HOEC successfully commissioned Hollong Modular Gas Processing Plant and 12 pipeline in March 2018 to ramp-up production. HOEC have Dirok commercial production commenced on August 26, 2017 through project KOPOU (HOEC 2017-18). Jubilant Energy has 8 blocks

spread over profile petroleum areas across India. In the eastern part Jubilant has 3 blocks in Assam Arakam basin. In the exploration and production sector, in India, OIL has signed Production Sharing Contracts (PSCs) with private companies like EssarOil, Hindustan Oil Exploration Company(HOEC), Geo-Enpro Petroleum and Assam Company India Limited (OIL 2018)

The natural gas produced in Assam is sold to different customers, viz. BVFCL, BCPL, AGCL, APGCL, NEEPCO, IOC (AOD), and APL and nearby Tea gardens. Since March, 2011 OIL is supplying gas to Numaligarh Refinery. OIL also produces Liquefied Petroleum Gas (LPG) in its plant at Duliajan, Assam.

The state has a refining capacity of 7.00 MMTPA under public sector. There are four oil refineries in Assam. They are Digboi Refinery, Guwahati Refinery, Bongaigaon Refinery and Numaligarh Refinery.

DigboiRefinery: The present capacity of Refinery is 0.650 MMTPA. The crude refining capacity utilisation of the refinery was 86.4% in 2015-16.Digboirefinery is the oldest operating refinery in the world and produces premium grade Paraffin wax and micro- crystalline wax.

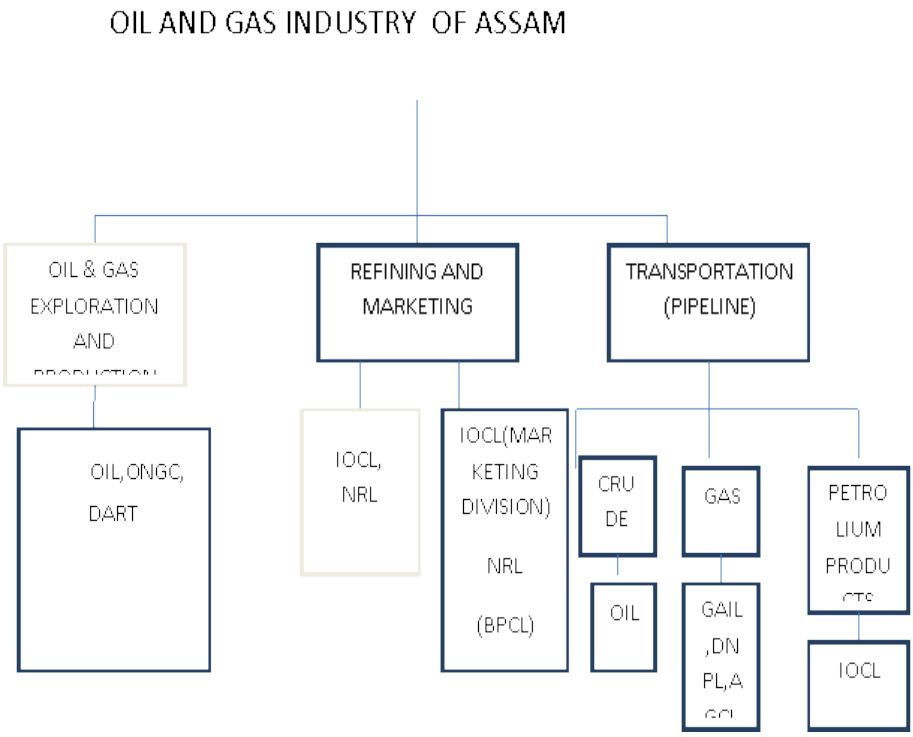
Guwahati Refinery: The present capacity of the Refinery is 1.00 MMTPA .The crude refining capacity utilisation of the refinery was 90.4 in 2015-16. It was first refinery to install “Indmax Unit” a novel technology developed by IOCL R & D Centre for upgrading heavy ends to LPG, motor spirit and diesel oil in 2003.

Bongaigaon Refinery: Bongaigaon Refinery and Petrochemical Ltd (BRPL) became a subsidiary of Indian Oil Corporation Ltd in March 2001. BRPL was amalgamated with the holding company, Indian Oil Corporation Ltd effective from 25th March, 2009.The present capacity of the refining is 2.350 MMTPA. The crude refining capacity utilisation of the refinery was 103.9% in 2015-16. BRPL which was originally processing Assam crudes in now capable of processing imported crudes. It also has a Petrochemical Complex consisting of Xylene Di Methyl Terepthalate (DMT) and PolysterStepleFibre units.

Numaligarh Refinery:Current shareholding pattern of NRL is Bharat Petroleum Corporation Limited (61.65%), Oil India Limited (26%) and Government of Assam(12.35%). The present capacity of the Refinery in 3000 MMTPA. The crude refining capacity utilisation of the refinery was 84.0% in 2015-16.It is equipped with modern units Hydrocraker and Delayed Coker for maximising distillate yield.(GOI, 2016-2017)

The present state of Oil and Gas industry in Assam as set out in Figure 1.

Figure 1: The present state of Oil and Gas Industry in Assam



Source: Author

Future of Oil and Gas Industry in Assam: The Government has notified National Policy on Biofuels-2018 on 8th June, 2018 which envisages a target of 20% blending of ethanol in petrol by 2030. The policy has widened the scope of raw material for ethanol procurement and thereby is expected to give boost to the Biofuel programme of the country. One of the major feature of the policy is expandingthe scope of raw material for ethanol production by allowing use of sugarcane juice, sugar containing materials like sugar beet, sweet sorghum, starch containing materials like corn, cassava, damaged food grains like wheat, broken rice, rotten potatoes, unfit for human consumption for ethanol production. The policy allows use of surplus food grains for production of ethanol for blending with petrol with the approval of National Biofuel Coordination Committee.

Sustainable Alternative Towards Affordable Transportation(SATAT) initiative was launched on 1.10.2018 to promote Compressed Bio Gas (CBG) as an alternative, green transport fuel for efficient management of biomass and organic waste. SATAT has envisaged developing 5000 CBG plants with total CBG production capacity of 15 Million Metric Tonne Per Annum(MMTPA) i.e. equivalent to 54 MMSCMD of gas by 2023. CBG plants will also produce a by product i.e. bio-manure and the same can be utilized in farming sector.

The North-East Vision 2030 document is a focused and consultative exercise to develop a common and shared aspiration for benefiting people of the North-Eastern region. With involvement and inputs of various stakeholders, industry players and state governments, the vision document not only includes the ambition for the region but also an actionable roadmap. The objectives of the plan are to leverage the region's hydrocarbon potential, enhance access to clean fuels, improve availability of petroleum products, facilitate economic development and to link common people to the economic activities in this sector. The states covered include Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. The Ministry also undertook series of consultations with the state governments while draftingthe vision document. 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.

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