



QECA Desk 2018

Oil & Gas Industry Primer





The Queen's Energy & Commodities Association (QECA) is an undergraduate club focused on energy and commodities. As a joint-venture Engineering-Commerce club, QECA aims to showcase the relevance of these sectors from both a technical and financial perspective. As Canada is uniquely poised as a major producer of energy and raw materials, we explore the technology and business environment to develop these resources while highlighting the opportunities and careers available. QECA's primary objective is to raise the profile of these industries at Queen's through hosting presentations, socials and industry speakers as well as developing partnerships with conferences and clubs on-campus.

ABBREVIATIONS

bbbl/d	Barrels of oil per day	mmbtu	Million British thermal units
bcf	Billion cubic feet	mcf	Thousand cubic feet
bcfe	Billion cubic feet equivalent	mcf/d	Thousand cubic feet per day
boe	Barrels of oil equivalent	mmcf	Million cubic feet
boe/d	BOE per day	mmcfe	Million cubic feet equivalent
mmbbl/d	Million barrels per day	mmcf/d	Million cubic feet per day
mdbl	Thousand barrels	tcf	Trillion cubic feet
mboe	Thousand BOE		

Natural Gas converted into equivalence on the basis of 6 mcf = 1 boe



TECHNICAL GLOSSARY

Heavy Crude	Crude oil that has a density of over -900kg/m ³ and API gravity of 10-22.3
Light -Medium Crude	Light-Medium crude has a density of less than -900kg/3. Medium crude has an API gravity between 22.3-31.1, Light crude has an API gravity of over 31.1.
Barrel	Standard unit of measurement in petroleum industry. 1 barrel = 1.5891 m ³ .
Upstream	Focus on exploration and production. Finding resources and extracting them from the ground.
Midstream	Focus on transportation of resources to companies that will sell them. Mostly done via pipelines.
Downstream	Focus on refining and transforming raw resource into marketable products (gas, jet fuel, etc.)
Oilfield Services	Provide service to the three other sectors. Maintain equipment, upgrade technology, provide security, design equipment etc.
Integrated Majors	Focus on all three sectors, in different proportions. Ex. BP, Shell, Exxon Mobil.
Conventional Reserves	Oil production from primary or secondary recovery methods excluding oil from coal and shale, bitumen and extra heavy oil, and liquids from gas plants.
Unconventional Resources	Petroleum accumulations that require specialized extraction technology. These include shale deposits, bitumen, liquids from gas plants and oil shale deposits.
Sweet crude	Crude oil with a low sulfur content.
Sour crude	Oil that contains a high amount of hydrogen sulphide, and therefore must be treated (hydrodesulfurization) to remove the sulphur before it can be used.
Steam Oil Ratios	The ratio of the volume of steam injected into the reservoir to the volume of oil produced from the reservoir, typically used in SAGD production.
Oil Play	A petroleum play is a group of oil fields or prospective oil fields in the same region that are governed by the same geological factors.
Pay	A portion of a reservoir that contains economically producible resources.



AECO Price	Canadian standard for natural gas pricing.
Future Production Profile:	The future production is the estimated daily production of hydrocarbon/gas from the reservoir for the foreseeable future/life of the plant.
Total (Daily) BOE	Shows the barrels of equivalent production for both daily and annual extraction. Showing the combined production of crude oil and natural gas.
Total Reserves	All of company's reserves to date.

FINANCIAL GLOSSARY

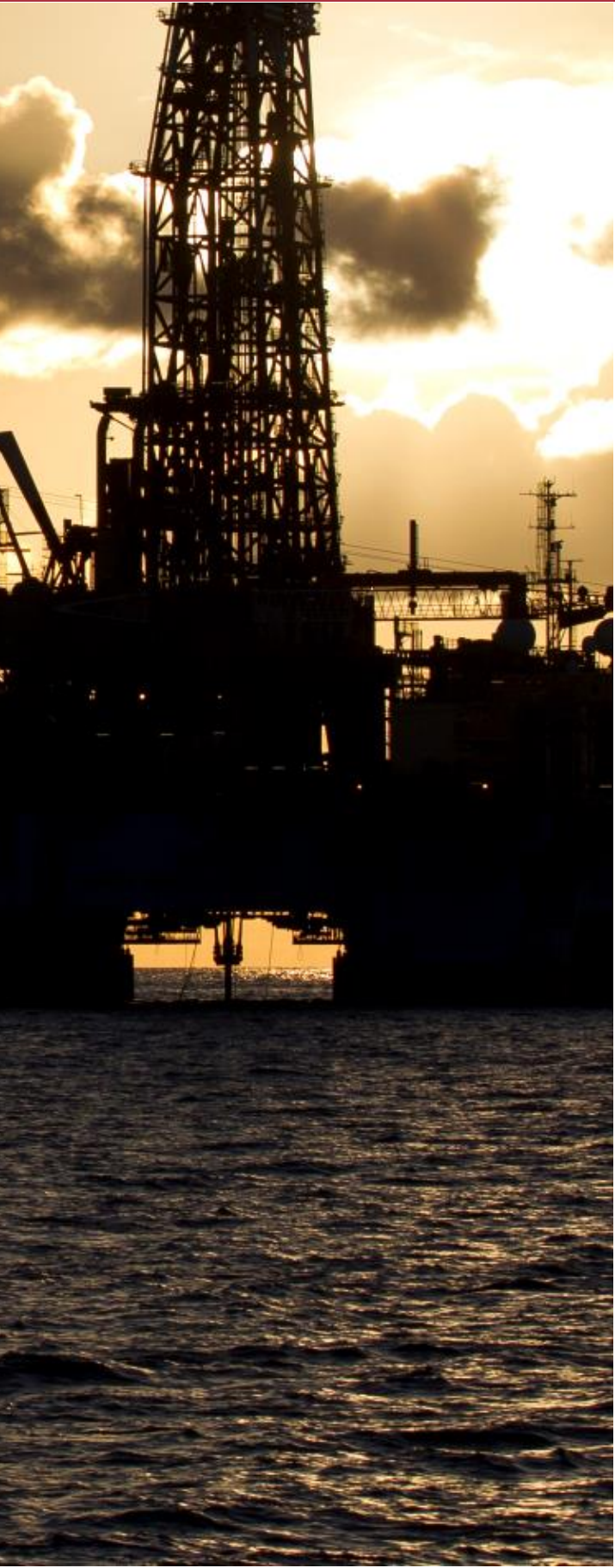
WTI	West Texas intermediate, considered the \$USD spot market price for crude oil. The benchmark is used for oil sales in Canada and the USA.
Brent	Brent benchmark is another widely used globally. Is composed of a blend of various crude oils produced in the North Sea region.
Proven	Reserves which on the available evidence are virtually certain to be technically and commercially producible, i.e. have a better than 90% chance of being produced.
Probable	Reserves which are not yet proven, but which are estimated to have a better than 50% chance of being technically and commercially producible.
Possible	Reserves which at present cannot be regarded as probable, but which are estimated to have a significant but less than 50% chance of being technically and commercially producible.
Reserves 1P	Proven
Reserves 2P	Proven + Probable
Reserves 3P	Proven + Probable + Possible
Reserve Life Index (RLI)	Reciprocal of the production to reserves ratio, shows how long reserves will last at current production rate with no additions to reserves.
Reserve Replacement Index	Measures the amount of proved reserves added to a company's reserve base during the year relative to the amount of oil and gas produced.



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Production to Reserves Ratio	Measures the total production against the total amount of reserves.
PV of Cash Flows	Present value of estimated future cash flows discounted by the risk-free rate of each project.
Implied Equity Value	Implied value of a company after P/NAV multiple is factored in.
Implied Share Price	Implied equity value by diluted shares outstanding. Represents the price that the company should be trading at.
Royalties	Payments due to the host government in return for the depletion of the Reservoirs and for allowing the producer access for the natural resources.
Revenue	Total sales of a company
Net Income	Bottom line profit.
EBITDA	Earnings before interest, taxes, depreciation & amortization.
Enterprise Value:	Calculated as the market capitalization plus debt, minority interest and preferred shares, minus total cash and cash equivalents.
OPEX	Operating expenditures. Expenses incurred as a running cost because of production and regular business activities.
CAPEX	Capital expenditures. Cost of developing or providing non-consumable parts for the product or system.



QUICK OVERVIEW

Crude Oil: A naturally occurring mixture of hydrogen and carbon atoms (hydrocarbons). These hydrocarbons are found in underground reservoirs within sedimentary rocks formed over millions of years, and are often mixed with natural gas, carbon dioxide, saltwater, sulphur and/or sand, which are separated from the liquid once extracted. Crude oil is extracted and refined into hundreds of end user products, including transportation fuels (gasoline, diesel), lubricants, heating fuels, plastics, clothing, cosmetics, and electricity.

Natural gas: Natural gas is a naturally occurring mixture comprised mainly of methane (CH₄), with longer hydrocarbon chains (more carbon atoms). This mixture often contains other non-hydrocarbon substances such as carbon dioxide, nitrogen, sulphur and/or helium.

Value Chain: The Oil & Gas industry is divided into three components of the value chain: Upstream, Midstream, and Downstream. Upstream deals with exploration, field developments, and production operations. Midstream pertains to transportation, storage, and distribution of product. Downstream is all about manufacturing and refining petrochemicals, wholesale, and marketing of product.

MARKET LANDSCAPE

Petroleum has become the world's most important source of energy due to its high-energy density, easy transportability, and relative abundance. Oil has held influence over the politics and economic strategies of nations more than any other commodity; frequently proving the source of instability, dispute, and war.

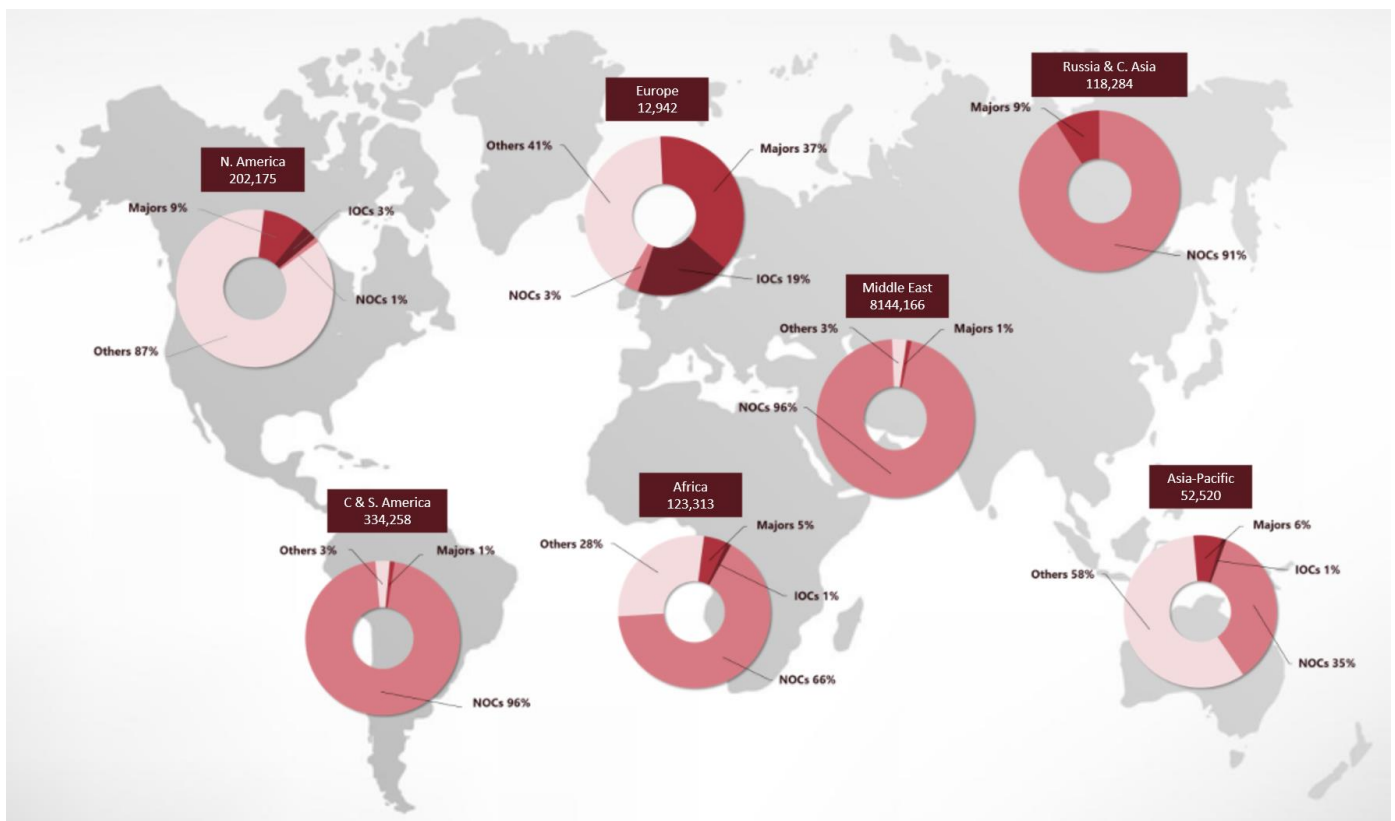
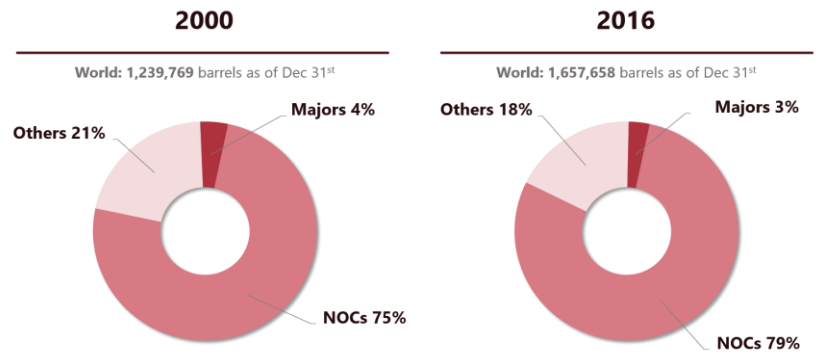
MAJOR PLAYERS

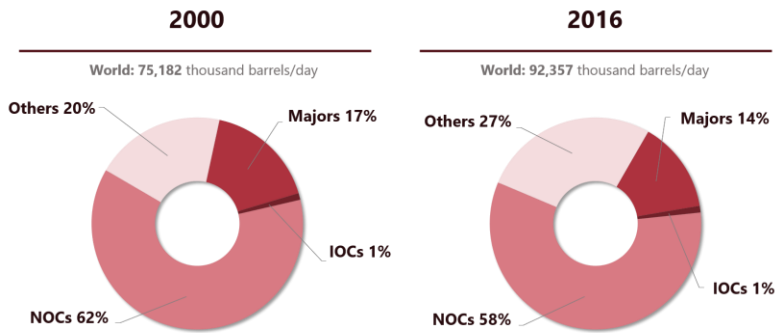
The O&G industry is made up of a framework of various types of companies. Four general types of companies exist in this ecosystem: IOC, NOC, Independent, and Oilfield service companies.

Type	Description	Examples
International Oil Companies (IOC) or Supermajors	Vertically integrated companies with global operations spanning the entire oil and gas value chain.	ExxonMobil, Chevron, BP, Royal-Dutch Shell, Total
National Oil Companies (NOC)	Majority state-owned companies that formed due to significant domestic reserves.	NIOC (Iran), PVDSA (Venezuela), Saudi Aramco (Saudi Arabia)
Independents	A term designated for companies that operate exclusively in a specific region or country, or companies that are not fully integrated. Generally, independents are not large enough to take on the entire value chain, and thus focus on one or two sectors of the industry.	Suncor Energy, Husky Energy, Encana, CNRL, Cenovus
Oilfield Service	They provide services such as operators or engineering to O&G projects. Oilfield service companies provide value by allowing companies to operate without having to purchase expensive equipment or hire staff outright.	Schlumberger, Haliburton, CGG

On a world basis, NOCs control majority of oil & gas reserves and production, while 'Majors' and 'Independents/Others' hold a greater percentage of the refining, liquefaction, and regasification operations. This spread, however, varies greatly region to region.

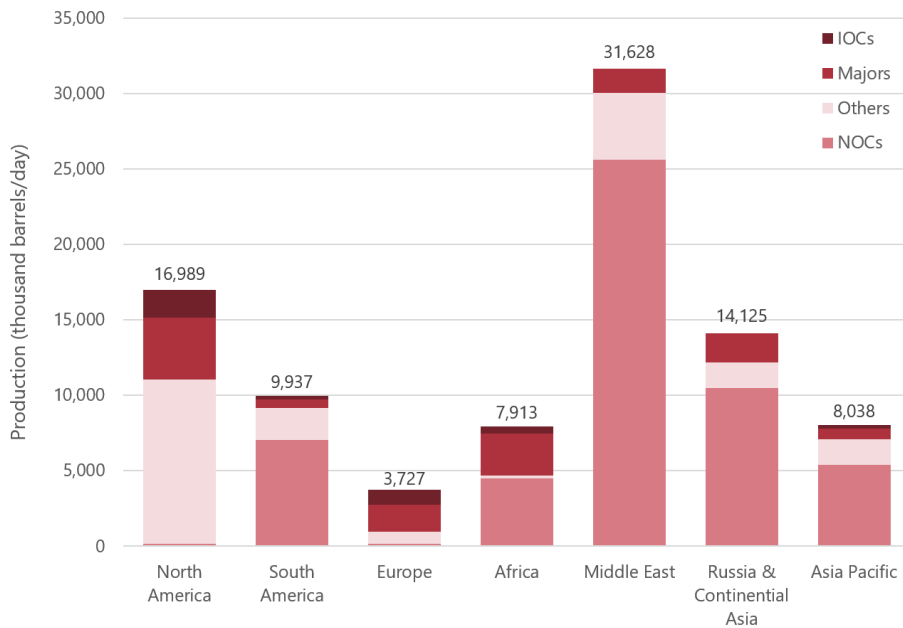
Since 2000, world reserves have increased 34%, this can be attributed to the development of better technology which allows for the recovery of oil at a lower cost. The regions with the highest reserves are the Middle East and Russia & Continental Asia, where IOC and Majors presence is almost non-existent compared to the NOCs.





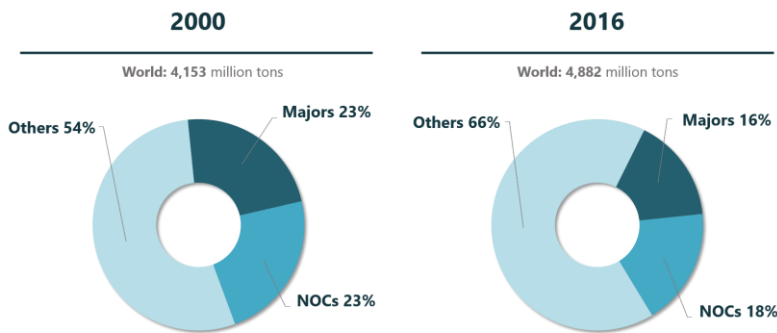
World oil production since 2000 has also increased substantially, at 23%. NOCs produce a majority of the world's oil, in all regions (above 50%) except in North America and Europe. IOCs, 'Others', and Majors, control the oil production in North America & Europe. Saudi Aramco, a Saudi Arabian NOC,

holds the largest amount of oil reserves at 260 billion barrels, and produces the most crude oil at 10.46 million bbl/day. Saudi Aramco also owns the world largest oil field, the Ghawar Field, which holds an estimated 71,000 million barrels, and produces an estimated 5,000,000 barrels of oil per day. In comparison, Canada's entire crude oil production at the end of 2016 was 4,460,000 bbl/day.



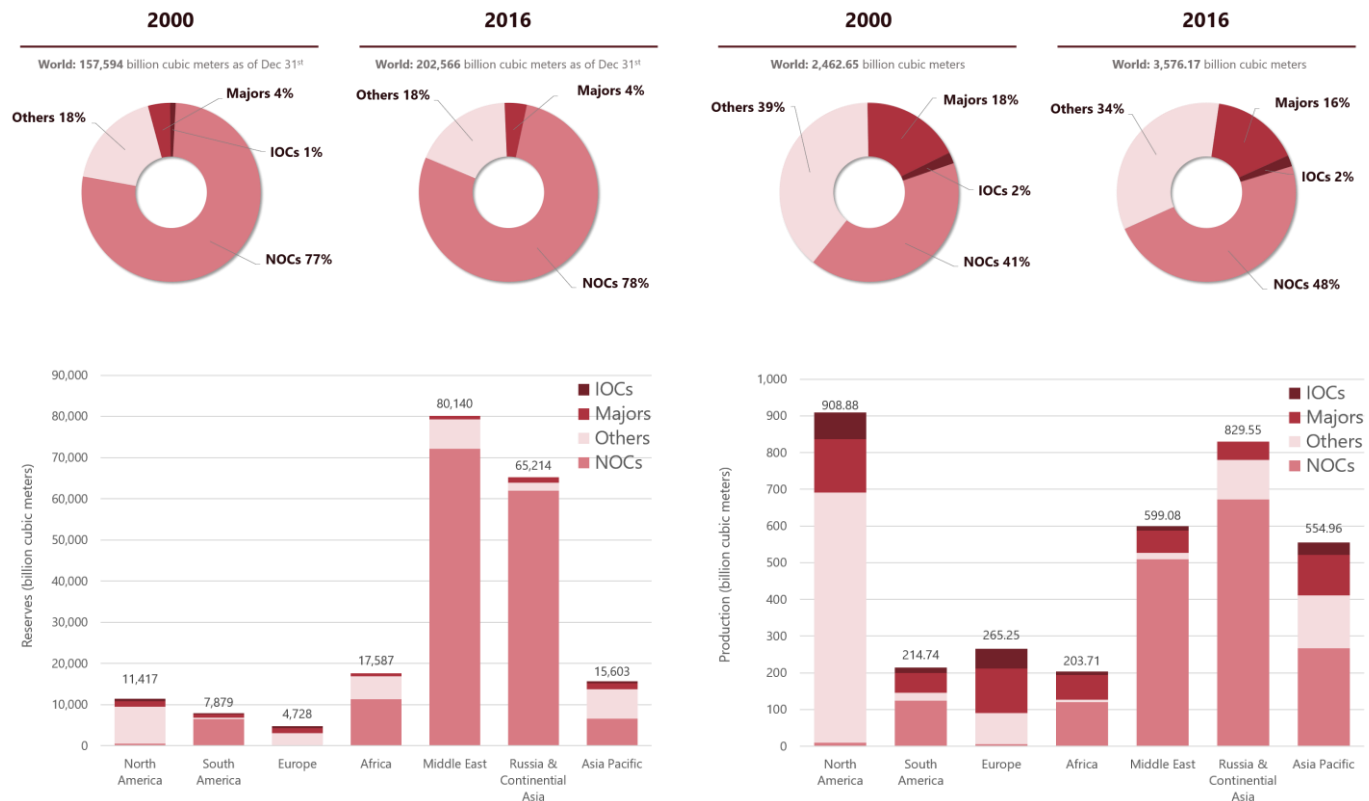
In contrast, the refining sector of the industry is more evenly distributed amongst NOCs, IOCs, Majors, and 'Others'. 'Others' make up most of companies running refining operations. Refining increased by 17.5% since 2000. In all regions, except South America and the Middle East, 'Others' have a majority stake in refining.

High amount of NOC refining in South America can be attributed to the Venezuelan NOC, PVDSA, and Brazilian NOC, Petrobras. Most refining occurs in Asia-Pacific, with 1,671 million tons of crude oil processed, although Asia-Pacific ranks 6th in total reserves, and 5th in total current production.



The world's largest oil refinery operation is in Jamnagar, operated by an Indian conglomerate holding company, Reliance Industries. It processes 1,240,000 bbl/day. In comparison, the Suncor Oil Sands, Fort McMurray, processes 450,000 bitumen bbl/d.

Natural gas reserves and production are also largely controlled by NOCs. The region-specific breakdown is different than crude oil reserves and production. North America is not a leader in gas reserves, but has the highest output of production. This can be attributed to the American shale gas boom. The development of new technologies that can access unconventional deposits has allowed North America to become the leading world producer of natural gas, with Russia & Continental Asia close behind.





UPSTREAM FUNDAMENTALS

Upstream is all activities associated with the exploration and production (E&P) of oil and natural gas. It encompasses activities related to searching for, recovering, and producing crude oil as well as natural gas. Upstream is all about wells: where to locate them, how deep and how far to drill them, and how to design, construct, operate and manage them to deliver the greatest possible ROI with the lightest, safest, and smallest operational footprint. Exploration deals with conducting geological and geophysical surveys to locate economical reserves of oil or gas. Drilling is physically creating the borehole in the ground that will become an oil & gas well. Drilling is typically done by rig contractors and service companies. Production is where reserves are 'converted to cash' by maximizing the recovery of hydrocarbons from subsurface reservoirs.

RESERVES

Oil and gas reserves and resources are volumes that are anticipated to be commercially recoverable at some point in the future. These reserves are in underground reservoirs and cannot be readily inspected or quantified with precision. Instead, reserve estimates are made based on the evaluation of data, which provides evidence of the quantity of hydrocarbons present in a given reservoir. Reserve estimates are a vital component in valuing the life of a drill site and its financial viability.

Discovered	Commercial	Proved Reserves (P1)	↑ Probability of Development
		Probable Reserves (P2)	
		Possible Reserves (P3)	
	Sub-Commercial	Contingent Resources	
		Unrecoverable	
Undiscovered	Prospective Resources		↑ Probability of Discovery
	Unrecoverable		

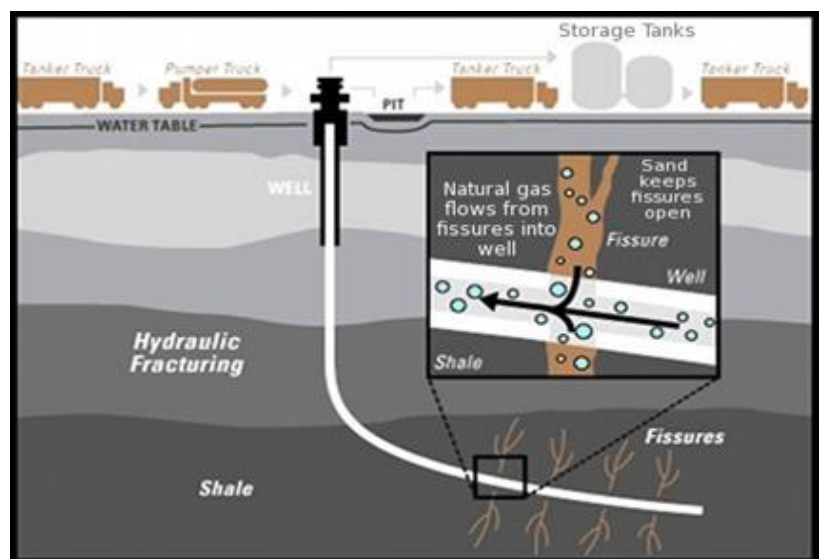
Conventional Reserves: Oil production which can be extracted just by the natural pressure of the wells and pumping or compression operations.

Unconventional Reserves: Petroleum accumulations that require specialized extraction technology. These include shale deposits, bitumen, liquids from gas plants

and oil shale. These reserves have largely been inaccessible in the past, but recent developments have made these deposits economical and has led to the rise of the so called "shale revolution". The most important technological advances have been the advent of horizontal drilling and multi-stage hydraulic fracturing.

Hydraulic fracturing involves the injection of high pressure water into the drilling well which causes rock layers to split and propped open with grains of sand, glass, or silica.

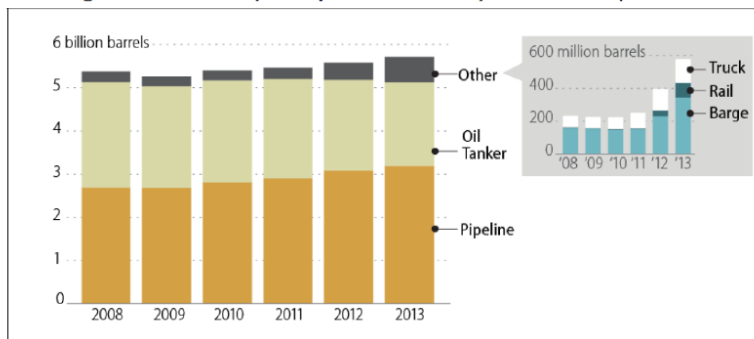
Horizontal drilling involves vertical drilling into the depth of the reservoir, followed by drilling sideways, parallel to the earth's surface once the depth is reached.



MIDSTREAM FUNDAMENTALS

The midstream segment involves the transportation of oil & gas from upstream to downstream refineries, as well as producing areas to population centers. Field gathering, processing plants, and transmission pipelines are the major assets in the midstream industry. Transportation assets include marine tankers, railroads, trucking fleets, and storage units. The midstream industry depends on both a healthy upstream supply and a strong consumer demand.

Figure 2. U.S. Refinery Receipts of Crude Oil by Mode of Transportation



Source: Prepared by CRS; data from EIA, *Refinery Capacity Report*, Table 9, June 2014.

Notes: Some shipments may involve multiple modes, such as rail to barge. This figure indicates only the mode used for the last leg of such shipments.

The first step in the midstream process is field gathering: the centralization of oil and gas from the thousands of wells through a network of small diameter pipelines. After field gathering, treated oil and natural gas is delivered via a complex transportation pipeline transmission and distribution infrastructure. Oil storage is straight forward with methods including fuel tank batteries, product bulk terminals,

refinery tanks, and holding tanks. Natural gas is different; due to large volumes and high pressures, it is generally stored underground until it is ready to be transported to market. Depleted gas reservoirs, salt caverns, and aquifers are common natural gas storage facilities.



OIL TRANSPORTATION

Method	Description	Advantages	Disadvantages
Pipeline	Large diameter pipelines are used to transport crude oil. Injected by a network of small diameter pipelines sourcing from wells, or at a central injection facility. Used primarily in long distance transportation.	<ul style="list-style-type: none"> - Most efficient means of transportation – operating 24/7 - Most cost effective - Lowest carbon footprint 	<ul style="list-style-type: none"> - Require continuous maintenance and inspection - Stringent standards and regulations - Controversial for its land disruption - Huge capital expenditure
Truck	Used in the first or last step of distribution from wells to refinery's. Not commonly used for long distance transport.	<ul style="list-style-type: none"> - Versatile; can travel to any destination - Minor environmental hazard 	<ul style="list-style-type: none"> - Small capacity (200 bbl) - Requires operator
Rail	Transportation of crude in tanker cars along existing rail infrastructure	<ul style="list-style-type: none"> - Can travel along existing rail networks - Spills are generally contained to land 	<ul style="list-style-type: none"> - Slow moving - Explosive hazard - Small Capacity - Existing rail networks were not designed to handle the mass of crude on the system
Tanker	Specially designed ships to transport large quantities of oil and gas.	<ul style="list-style-type: none"> - Flexibility in being able to transport large amounts of oil to global locations 	<ul style="list-style-type: none"> - Devastating aquatic environmental effects in the case of spills or leaks. - Tankers often run low quality oil (bunker fuel) which are highly polluting

NATURAL GAS TRANSPORTATION

Transportation of natural gas can be challenging due to natural gas being in the gaseous phase at atmospheric conditions. Natural gas transported through pipeline is the most common form of transportation. Due to its gaseous nature, it must be highly pressurized.

Liquefied Natural Gas (LNG)

An increasingly popular development has been the evolution of the LNG industry. Transforming natural gas into a cryogenic (ultracold) liquid increases its energy density dramatically, permitting movement by ship, barge, or tank truck instead of pipeline. There are three main steps in the LNG value chain, the liquefaction process, the shipment, and regasification. The natural gas is cooled at -163 °C, which reduces its volume by a factor of more than 600 and can be shipped and stored without pressurization. This is a much more cost-effective solution than using pipelines.

DOWNSTREAM FUNDAMENTALS

Downstream makes up the final step of the three major sectors of the oil & gas industry. The primary goal of the downstream sector is to process crude materials and form them into products that can be sold to consumers. Key downstream business sectors include refining, supply & trading, and both wholesale and retail product marketing. The downstream industry supplies thousands of products to end user costumers around the globe. Gasoline, jet fuel, asphalts, lubricants, plastics, and fertilizers are all example of common end user products. Fuel products for transportation account for 65% of global demand.

REFINING OVERVIEW

The range of products that are formed into usable products is conducted in a complex industrial facility called a refinery. Operators of a refinery commonly accept as feedstock a mix of crude oil types. A distillation column is used to separate the oil by its hydrocarbon chain length.

In the marketplace, these finished products are often classified as follows:

Light distillates: liquefied petroleum gas (LPG), gasoline, naphtha

Middle distillates: kerosene and related jet engine fuels

Heavy distillates and residuum: heavy fuel oil, lubricating oils, paraffin wax, asphalt/tar, petroleum coke



VALUATION

One method to value O&G companies is to derive ratios and compare to peers. This analysis provides insight into a company's relative performance and valuation. Common metrics for these ratios include cash flows, reserves, and production.

A NAV is used in place of a DCF for E&P companies. NAV's, like DCF's project out future cashflows and discount them to today. The differences between the DCF and NAV include the terminal value, the discount rate, and the assumptions. In a NAV model, the cashflows end after all the reserves have depleted. Typically, a 10% rate is used, rather than calculating the company's WACC. The assumptions used in a NAV include weighted oil/gas composition, forecasted oil/gas prices and production rates.

BENCHMARKS

Oil & gas is categorized according to benchmarks, which are essentially groupings with similar characteristics—mainly quality and location. These benchmark grades are used as a proxy for pricing across the global oil industry.

Benchmark	Description	Spot Price (January 2018)
Brent Crude	Global benchmark Sweet, light crude Accepted by a variety of buyers	\$68.72 USD/bbl
West Texas Intermediate (WTI)	US benchmark Sweet, light crude Heavily traded on financial markets Landlocked nature forces it to be traded at a discount versus Brent	\$63.40 USD/bbl
Western Canadian Select (WCS)	Canadian benchmark Heavy, sour crude	\$45.67 USD/bbl
Henry Hub	US benchmark Heavily traded on financial markets	\$3.12 USD/mcf
AECO-C	Alberta's consumers are based on gas prices established through the Natural Gas Exchange (NGX) electronic trading platform	\$2.71 USD/mcf

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