

Introduction to Petroleum Engineering



Introduction

Contact:

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Working Time: Sunday to Thursday

8:30 a.m. to 5:00 p.m. every day

Room 225, Main Building / Tishk International University

Introduction to Petroleum Engineering



Course Objectives

- To provide the students with a background in the field of Petroleum Engineering
- To introduce and familiarize students with subjects which will be discussed in future courses, such as Drilling Engineering, Reservoir Engineering and Production Engineering, required for obtaining their Bachelor Degree.

COURSE CONTENT

Week	Hour	Date	Topic
1	3	3-7/2/2019	Introduction
2	3	10-14/2/2019	What is Petroleum Engineering? Terminology?
3	3	17-21/2/2019	Life cycle of Oil/Gas projects
4	3	24-28/2/2019	Drilling Rig types, main components
5	3	3-7/3/2019	Drill String, main components
6	3	26-28/3/2019	The Drilling Process
7	3	31/3-4/4/2019	Properties of reservoir fluids and rocks
8	3	7-11/4/2019	Reservoir rock and Fluid interaction
9	3	14-18/4/2019	Midterm Exam
10	3	21-25/4/2019	Relative Permeability, Mobility
11	3	28/4-2/5/2019	Types of reservoir and driving mechanism
12	3	5-9/5/2019	Well Completions
13	3	12-16/5/2019	Perforating, Acidizing, Hydraulic Fracturing
14	3	19-23/5/2019	Midstream and Downstream Operations
15	3	26-30/5/2019	Review
16	3	9-13/6/2019	Final Exam
17	3	16-20/6/2019	Final Exam



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Course Format/Evaluation

Course language: English

2 lectures / week

3 hours / week

Sunday: 13:30 to 14:30 / Main Building, Classroom 214

Monday: 09:00 to 11:00 / Main Building, Classroom 325



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Course Format/Evaluation

❑ Learning outcomes:

- Fundamentals of Drilling Engineering
- Basics of Reservoir Engineering
- Overview about Production Engineering

❑ Course book/textbook

- John R. Fanchi and Richard L. Christiansen: Introduction to Petroleum Engineering. Published by John Wiley and Sons, Inc., Hoboken, New Jersey, USA, 2017. ISBN 9781119193449. It is available in the library.

❑ Other course materials/References:

- Frank Jahn, Mark Cook and Mark Graham: DEVELOPMENTS IN PETROLEUM SCIENCE HYDROCARBON EXPLORATION AND PRODUCTION. Elsevier, 2ND EDITION, TRACS International Consultancy Ltd., Aberdeen, UK, 2008. ISBN: 978-0-444-53236-7, ISSN: 0376-7361
- Internet
- SPE: <https://www.spe.org/en/>



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Course Format/Evaluation

❑ Teaching methods

- Lectures
- Presentation
- Seminar
- Demonstration

❑ Assessments methods

- Attendance (10%)
- Participation (5%)
- Quiz (15%)
- Midterm Exam (30%)
- Final Exam (40%)

❑ Examinations

- Essay Questions
- Multiple choice
- Short answer

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What is Petroleum Engineering? Terminology?

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What is Petroleum

Petroleum is a mixture of hydrocarbon molecules and inorganic impurities that can exist in the solid, liquid (oil), or gas phase.

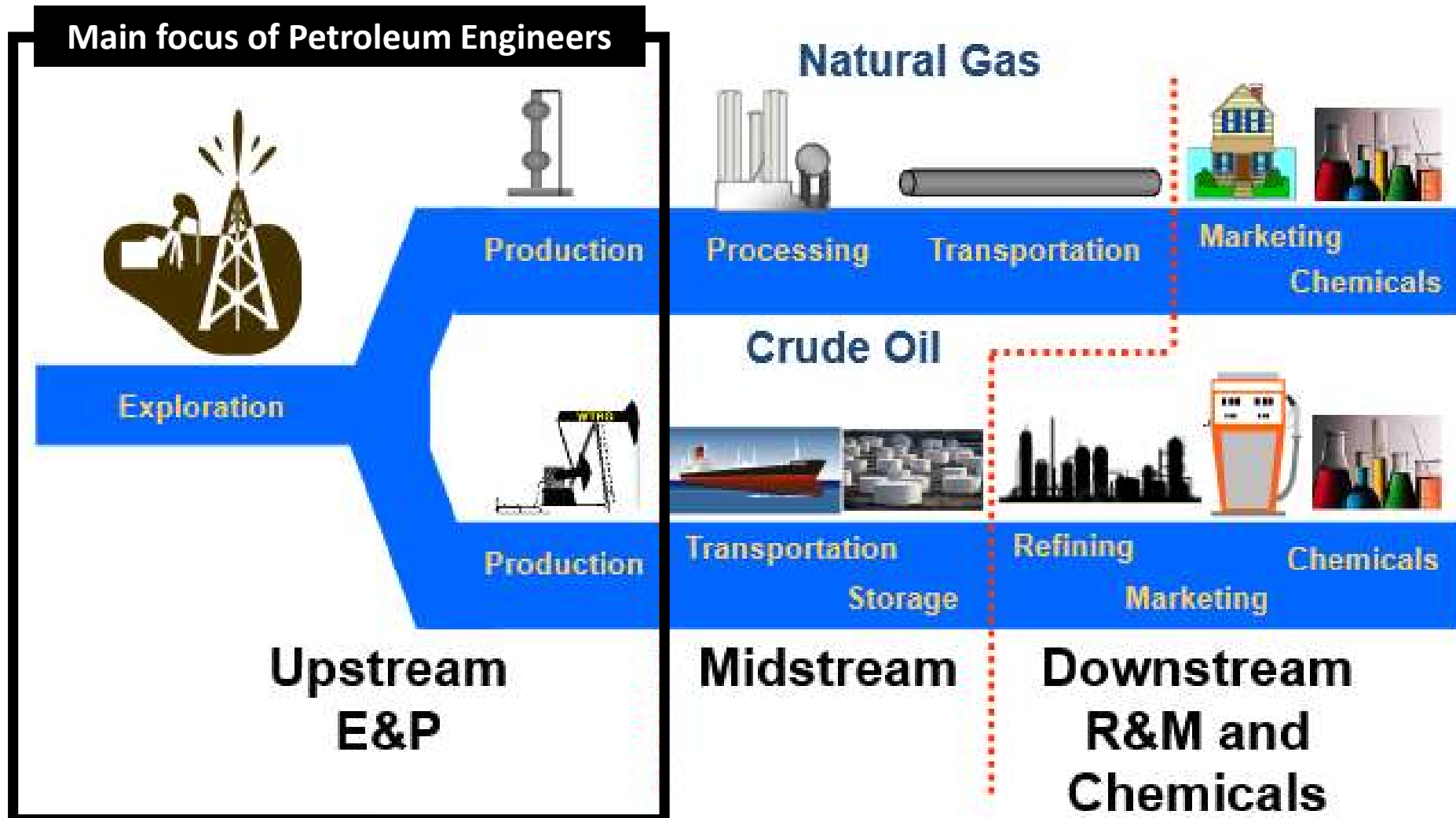
The word petroleum comes from Medieval Latin petroleum (literally "rock oil"), which comes from Latin **petra**, "rock" and **oleum**, "oil".

Petroleum engineering is concerned with the production of petroleum from subsurface reservoirs.

Petroleum engineers are expected to work in environments ranging from desert climates in the Middle East, stormy offshore environments in the North Sea, and arctic climates in Alaska and Siberia to deepwater environments in the Gulf of Mexico and off the coast of West Africa.

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What is Petroleum / Oil & Gas Supply Chain



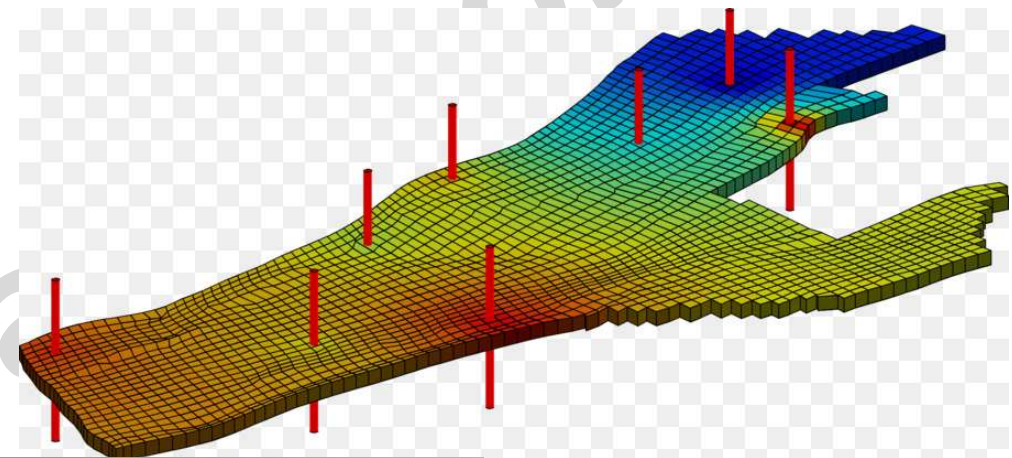
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What is Petroleum

- ❑ **Petroleum engineers:** They tend to specialize in one of three subdisciplines:



Drilling Engineering



Reservoir Engineering



Production Engineering



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What is Petroleum

Petroleum engineers: They tend to specialize in one of three subdisciplines:

- ❑ **Drilling engineers:**
are responsible for drilling and completing wells.

- ❑ **Production engineers:**
manage fluid flow between the reservoir and the well.

- ❑ **Reservoir engineers:**
seek to optimize hydrocarbon production using an understanding of fluid flow in the reservoir, well placement, well rates, and recovery techniques.

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Petroleum Engineers can have the following careers

- National Oil Companies / government employee
- International Oil Companies
- Academic sectors
- Private sectors
- Mineral exploration and production companies
- Refineries
- ..



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Oil and Gas Units

TABLE 1.1 Examples of Common Unit Systems

Property	Oil Field	SI (Metric)
Length	ft	m
Time	hr	sec
Pressure	psia	Pa
Volumetric flow rate	bbl/day	m ³ /s
Viscosity	cp	Pa·s



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Classification of Oil and Gas

There are a variety of terms for describing hydrocarbon fluids at surface conditions.

Let q_o , q_g , ρ_o , ρ_w be oil, and gas production rates, oil, and freshwater density respectively.

Gas–oil ratio (GOR):
$$GOR = \frac{q_g}{q_o} \quad \text{API} = \left(\frac{141.5}{\gamma_o} \right) - 131.5 \quad \gamma_o = \frac{\rho_o}{\rho_w}$$

Table: Rules of Thumb for Classifying Fluid Types

Fluid Type	Separator GOR (MSCF/STB)	Gravity (°API)	Behavior in Reservoir due to Pressure Decrease
Dry gas	No surface liquids		Remains gas
Wet gas	>50	40–60	Remains gas
Condensate	3.3–50	40–60	Gas with liquid dropout
Volatile oil	2.0–3.3	>40	Liquid with significant gas
Black oil	<2.0	<45	Liquid with some gas
Heavy oil	≈0		Negligible gas formation

Data from Raymond and Leffler (2006).



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Alternative Energy Opportunities

Petroleum engineering principles can be applied to subsurface resources other than oil and gas. Examples include:

- Geothermal energy
- Compressed air energy storage (CAES)

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Life cycle of Oil/Gas projects (Reservoir)

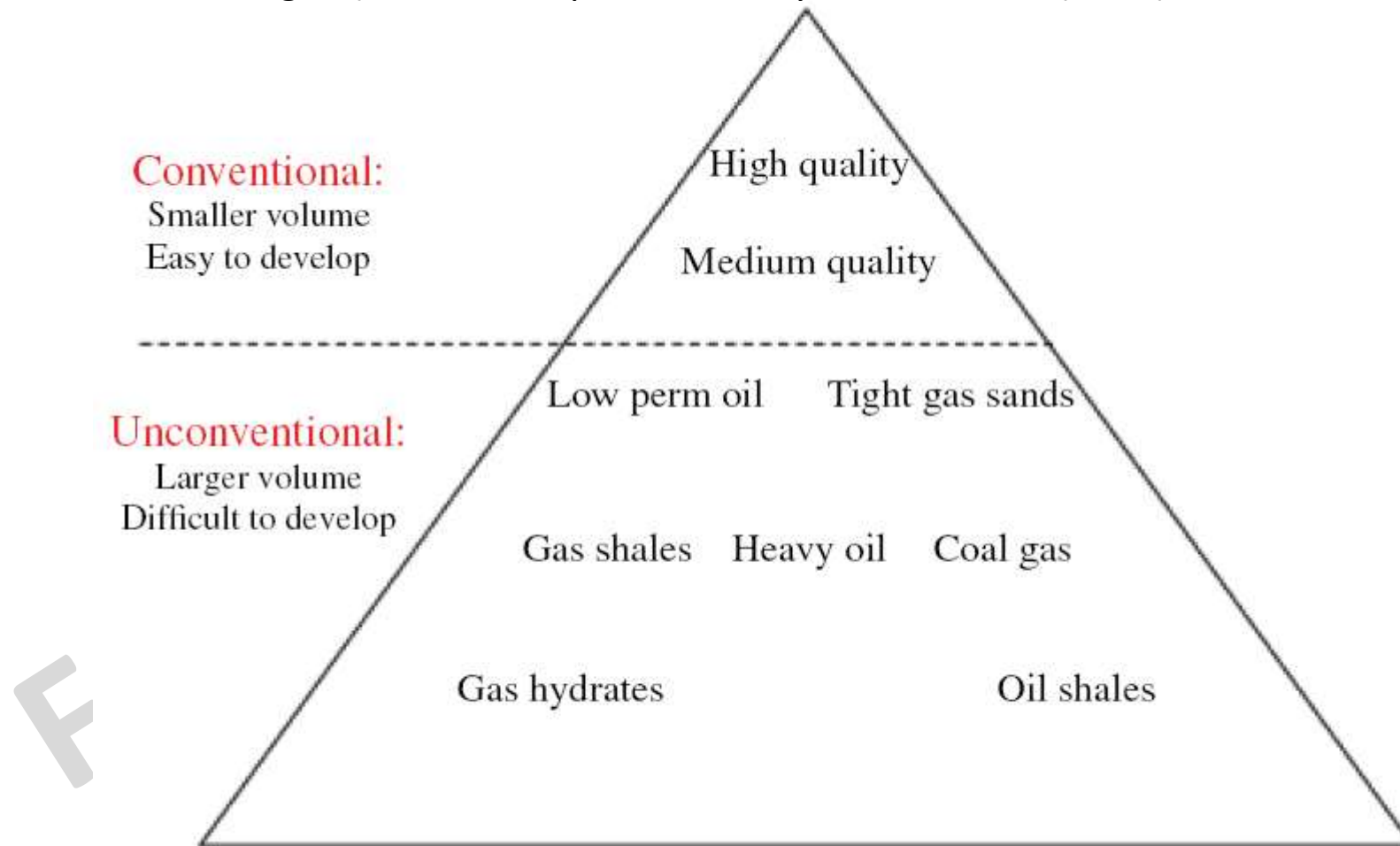
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RESOURCES AND RESERVES

Resource triangle. (Source: Adapted from Snyder and Seale (2011) and Holditch, 2007)





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RESOURCES AND RESERVES

Oil and gas resources may be characterized as **conventional** and **unconventional** resources.

- ❑ **Conventional** oil and gas resources refer to formations that can be produced at economic flow rates or that produce economic volumes of oil and gas without stimulation treatments or special recovery processes and technologies.

- ❑ **Unconventional** oil and gas resources refer to formations that cannot be produced at economic flow rates or do not produce economic volumes of oil and gas without stimulation treatments or special recovery processes and technologies.



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RESOURCES AND RESERVES

The amount of the resource that can be extracted is discussed in terms of **reserves**.

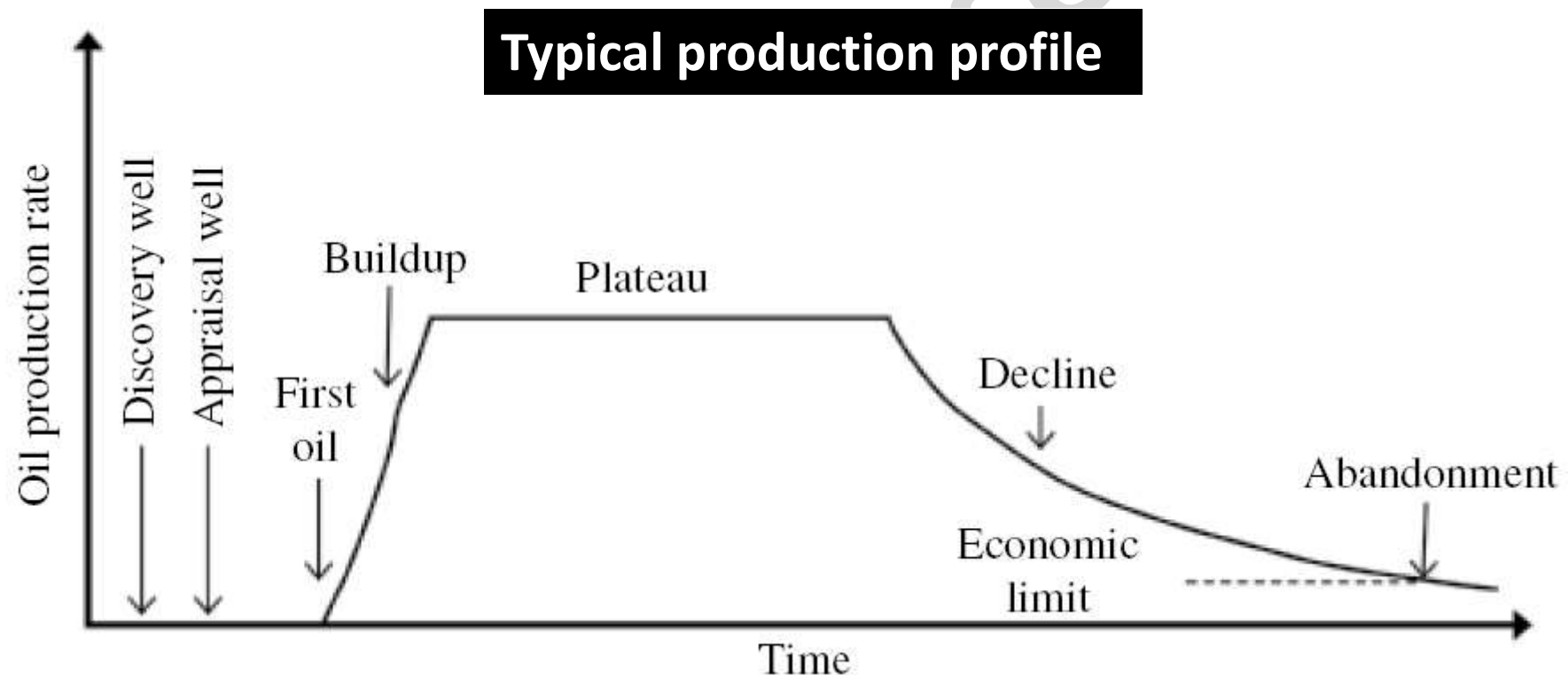
Reserves classifications are:

- ❑ **Proved reserves:** Those quantities of petroleum, which by analysis of geoscience and engineering data, can be estimated with reasonable certainty to be commercially recoverable, from a given date forward, from known reservoirs, and under defined economic conditions, operating methods, and government regulations.
- ❑ **Probable reserves:** Those additional reserves which analysis of geoscience and engineering data indicate are less likely to be recovered than proved reserves but more certain to be recovered than possible reserves.
- ❑ **Possible reserves:** Those additional reserves which analysis of geoscience and engineering data suggests are less likely to be recoverable than probable reserves.

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Life cycle of Oil/Gas projects (Reservoir)

The life cycle of a reservoir begins when the field becomes an exploration prospect and does not end until the field is properly abandoned. An exploration prospect is a geological structure that may contain hydrocarbons.





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Life cycle of Oil/Gas projects (Reservoir)

- Exploratory wells** can be used to test a trap that has never produced, test a new reservoir in a known field, and extend the known limits of a producing reservoir.

- Discovery** occurs when an exploration well is drilled and hydrocarbons are encountered.

- Appraisal wells** are used to provide more information about reservoir properties and fluid flow.

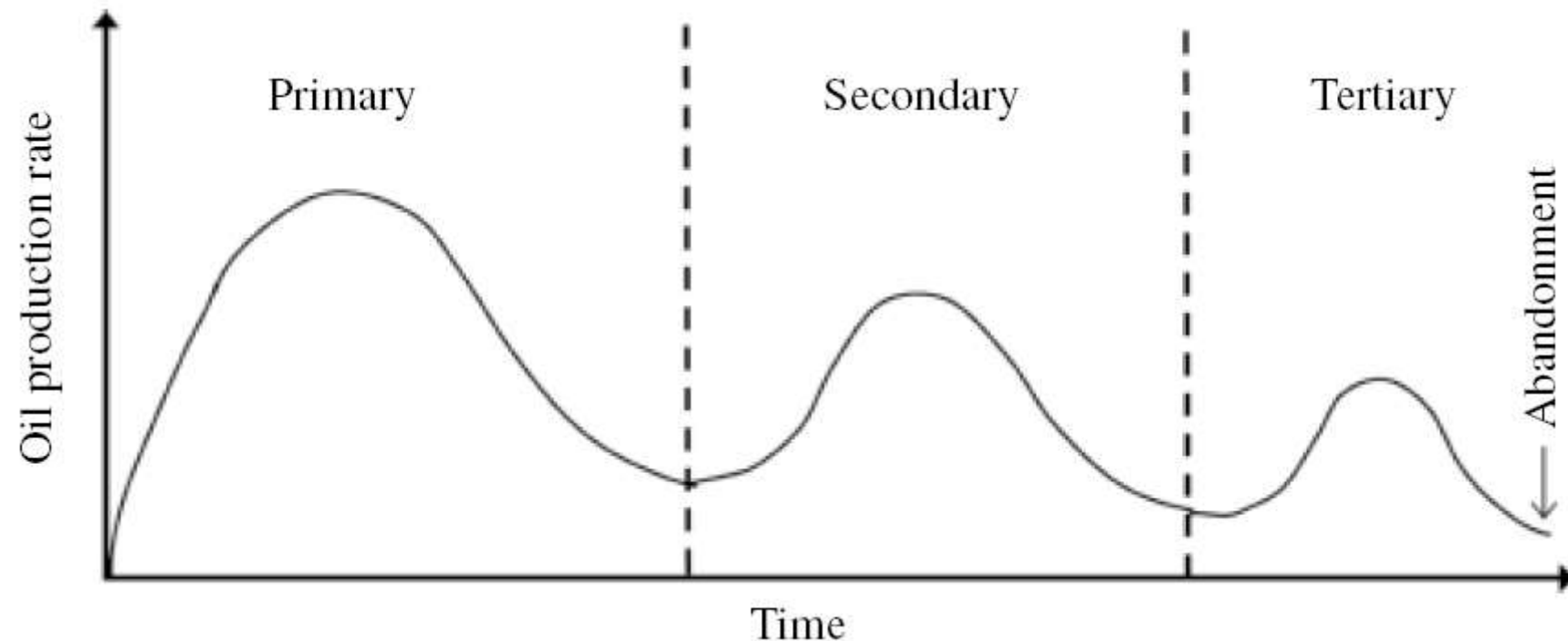
- Development wells** are drilled in the known extent of the field and are used to optimize resource recovery.

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Life cycle of Oil/Gas projects (Reservoir)

Traditionally, production stages are identified as:

primary, secondary, and tertiary production.





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Life cycle of Oil/Gas projects (Reservoir)

Primary production is the first stage of production and relies entirely on natural energy sources to drive reservoir fluids to the production well. The reduction of pressure during primary production is often referred to as primary depletion.

Oil recovery can be increased in many cases by slowing the decline in pressure. This can be achieved **by supplementing natural reservoir energy**.

The injection of water or natural gas may be referred to as **pressure maintenance or secondary production**.

EOR (enhanced oil recovery) processes include chemical, thermal, and microbial processes. EOR processes are originally implemented **as a third, or tertiary production stage** that followed secondary production.

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Petroleum by country

□ Consumption

According to the US Energy Information Administration (EIA) estimate for 2011, the world consumes **87.421** million barrels of oil each day.

This table orders the amount of petroleum consumed in 2011 in thousand barrels (1000 bbl) per day and in thousand cubic metres (1000 m³) per day

Consuming nation 2011 ↕	(1000 bbl/ day) ↕	(1000 m ³ / day) ↕
United States ¹	18,835.5	2,994.6
China	9,790.0	1,556.5
Japan ²	4,464.1	709.7
India ²	3,292.2	523.4
Russia ¹	3,145.1	500.0
Saudi Arabia (OPEC)	2,817.5	447.9
Brazil	2,594.2	412.4
Germany ²	2,400.1	381.6
Canada	2,259.1	359.2
South Korea ²	2,230.2	354.6
Mexico ¹	2,132.7	339.1
France ²	1,791.5	284.8
Iran (OPEC)	1,694.4	269.4
United Kingdom ¹	1,607.9	255.6
Italy ²	1,453.6	231.1

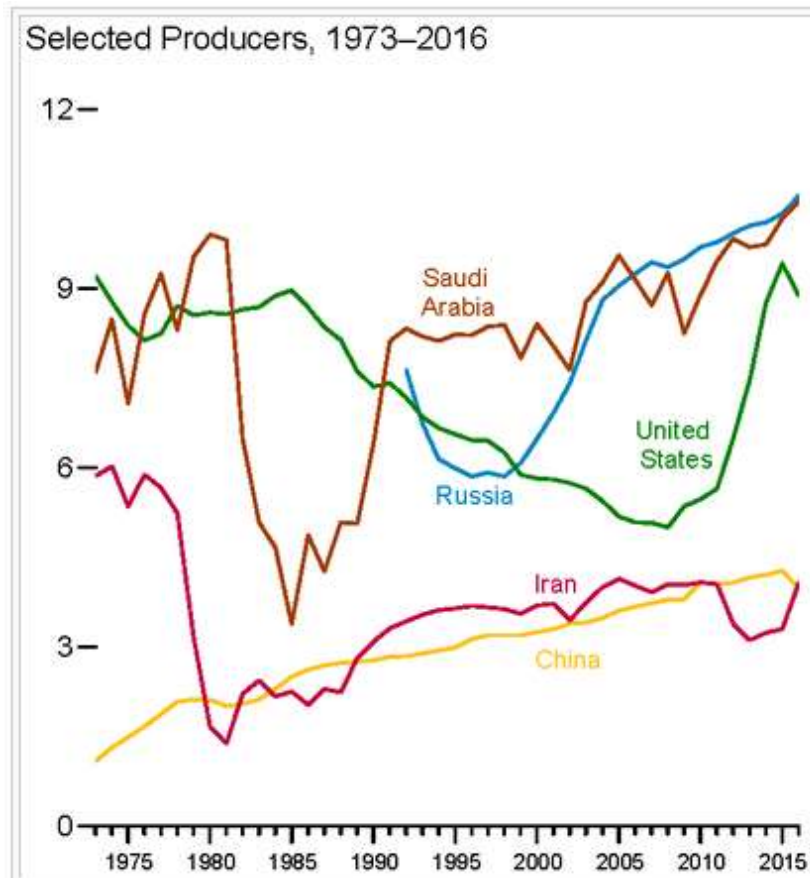
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Petroleum by country

□ Production

Top oil-producing countries
(million barrels per day)



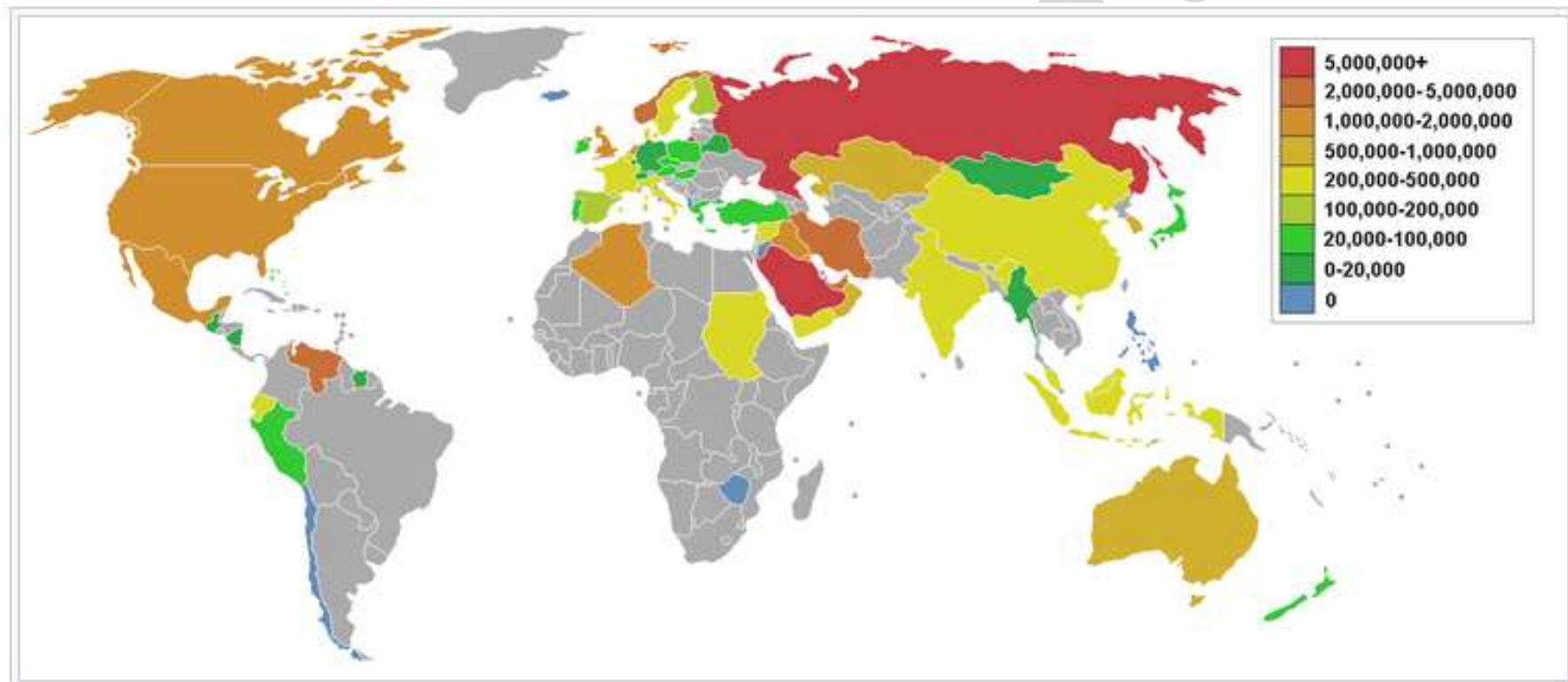
#	Country	Oil Production (bbl/day, 2016) ^[10]
1	Russia	10,551,497
2	Saudi Arabia (OPEC)	10,460,710
3	United States	8,875,817
4	Iraq (OPEC)	4,451,516
5	Iran (OPEC)	3,990,958
6	China, People's Republic of	3,980,650
7	Canada	3,862,694
8	United Arab Emirates (OPEC)	3,106,077
9	Kuwait (OPEC)	2,923,825
10	Brazil	2,515,459
11	Venezuela (OPEC)	2,276,967
12	Mexico	2,186,877
13	Nigeria (OPEC)	1,999,885
14	Angola (OPEC)	1,769,615
15	Norway	1,647,975
16	Kazakhstan	1,595,199
17	Qatar (OPEC)	1,522,902
18	Algeria (OPEC)	1,348,361
19	Oman	1,006,841
20	United Kingdom	939,760

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Petroleum by country

□ Export

Oil exports by country (barrels per day, 2006)



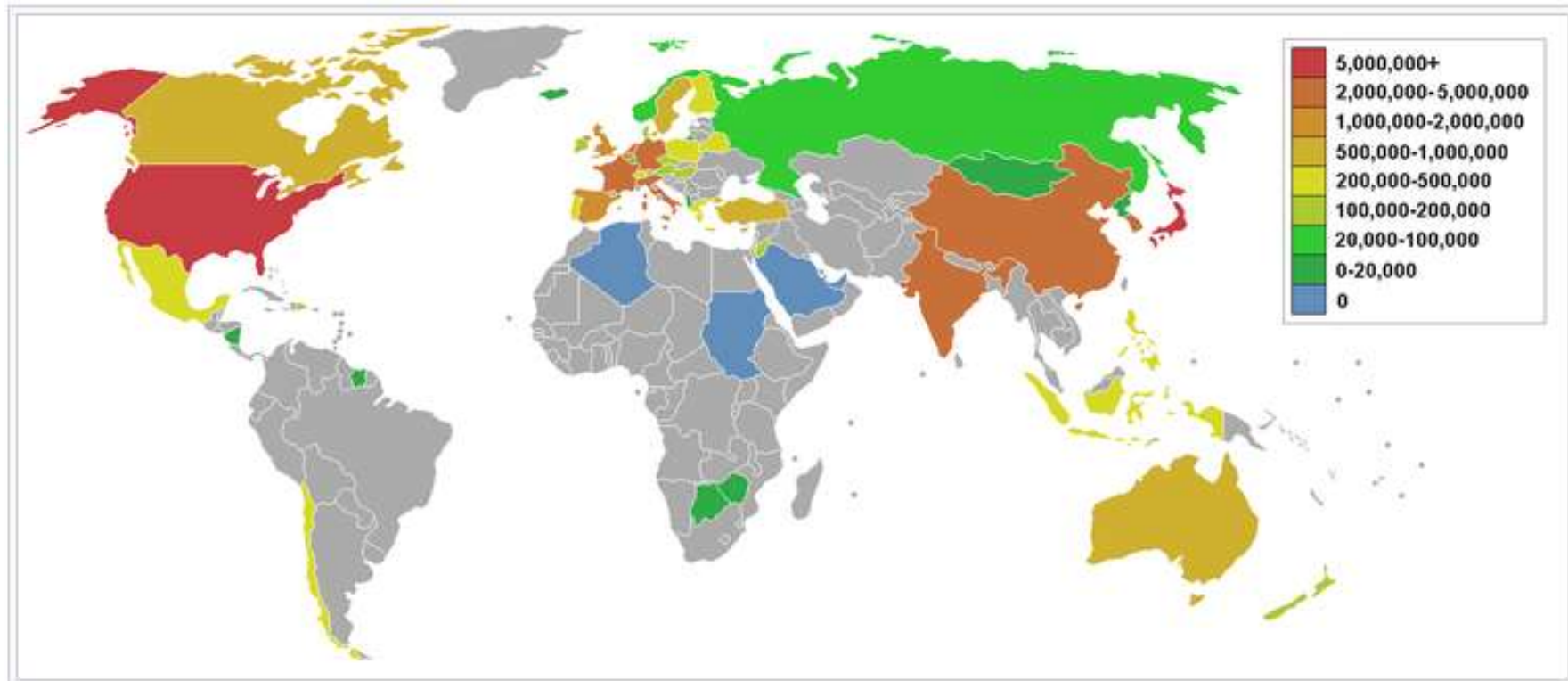
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Petroleum by country

Import

Oil imports by country (barrels per day, 2006)



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Petroleum by country

❑ OPEC

The **Organization of the Petroleum Exporting Countries (OPEC)** is an intergovernmental organisation of 14 nations, founded in **1960 in Baghdad** by the first five members (**Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela**), and headquartered in **Vienna, Austria since 1965**.



Flag

Country	Region	Membership Years ^{[2][3]}	Population (2016 est.) ^[11]	Area (km ²) ^[12]	Oil Production (bbl/day, 2016) ^{[13][14]}	Proven Reserves (bbl, 2016) ^{[15][16]}
 Algeria	North Africa	1969–	40,606,052	2,381,740	1,348,361	12,200,000,000
 Angola	Southern Africa	2007–	28,813,463	1,246,700	1,769,615	8,423,000,000
 Ecuador	South America	1973–1992, 2007–	16,385,068	283,560	548,421	8,273,000,000
 Equatorial Guinea	Central Africa	2017–	1,221,490	28,051	227,000	1,100,000,000
 Gabon	Central Africa	1975–1995, 2016–	1,979,786	267,667	210,820	2,000,000,000
 Iran	Middle East	1960 ^[8] –	80,277,428	1,648,000	3,990,956	157,530,000,000
 Iraq	Middle East	1960 ^[8] –	37,202,572	437,072	4,451,516	143,069,000,000
 Kuwait	Middle East	1960 ^[8] –	4,052,584	17,820	2,923,825	101,500,000,000
 Libya	North Africa	1962–	6,293,253	1,759,540	384,686	48,363,000,000
 Nigeria	West Africa	1971–	185,989,640	923,768	1,999,885	37,070,000,000
 Republic of the Congo	Central Africa	2018– ^[14]	5,125,821	342,000	260,000	1,600,000,000
 Saudi Arabia	Middle East	1960 ^[8] –	32,275,687	2,149,690	10,460,710	266,578,000,000
 United Arab Emirates	Middle East	1967 ^[9] –	9,269,612	83,600	3,106,077	97,800,000,000
 Venezuela	South America	1960 ^[8] –	31,568,179	912,050	2,276,967	299,953,000,000
OPEC Total			483,630,000	12,492,695	35,481,740	1,210,703,000,000
World Total			7,685,421,000	510,072,000	80,622,287	1,650,585,000,000
OPEC Percent			6.3%	2.4%	44%	73%

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Petroleum by country

□ Iraq

Iraq's total Petroleum and other liquids production and consumption

