Economics of
Energy and Natural resources

Lesson 5. Market Design of hydrocarbons energy sources: building markets from vertical integrated industries

Prof. Roberto Fazioli

Let me start with …. European Strategies and policies regarding Energy Fields

Since its birth, the political institutions of the European Community had to deal with the various sectors of Energy, with pragmatism and strong planning. *Challenges facing the EU in the field of energy include issues such as increasing import dependency, limited diversification, high and volatile energy prices, growing global energy demand, security risks affecting producing and transit countries, the growing threats of climate change, slow progress in energy efficiency, challenges posed by the increasing share of renewables, and the need for increased transparency, further integration and interconnection in energy markets. A variety of measures aiming to achieve an integrated energy market, security of energy supply and a sustainable energy sector are at the core of the EU's energy policy.*

One of the agreed priorities of the May 2013 European Council was to intensify the diversification of the EU's energy supply and to develop local energy resources in order to ensure security of supply and reduce external energy dependency. With regard to renewable energy sources, Directive 2009/28/EC of 23 April 2009 introduced a 20% target to be reached by 2020, and the Commission proposed a target of at least 27% by 2030 in a revised Renewable Energy Directive (COM(2016)0382).
In the light of the crucial importance of gas and oil for the security of the EU's energy supply, the EU adopted *several measures to ensure that risk assessments are carried out and that adequate preventive action plans and emergency plans are developed*. Regulation (EU) No 994/2010 concerning measures to safeguard security of gas supply was adopted on 20 October 2010 with the aim of strengthening prevention and crisis response mechanisms. Directive 2009/119/EC requires Member States to maintain minimum oil stocks, corresponding to 90 days of average daily net imports or 61 days of average daily inland consumption, whichever of the two quantities is greater. The Commission has proposed extending the scope of application of Directive 2009/73/EC (the Gas Directive) to pipelines to and from third countries, including existing and future pipelines (COM(2017)0660).

According to the Energy Union (2015), some of the main aims of the EU's energy policy were (and are):

- *To Ensure the functioning of the internal energy market and the interconnection of (national) energy networks and industries;*
- *To Ensure **security of energy supply** in the EU;*
- *Promote energy efficiency and energy saving;*
- Promote research, innovation and competitiveness.

From the “beginning” of european policies and strategies, energy mix was (and is) based strongly on Conventional Energy Resources:

1. Coal
2. Petroleum
3. Natural Gas
4. Hydropower
5. Nuclear Power

Coal …. use:

Used in (*Thermal* -> almost 80%) power stations to produce high pressure steam, which then drives turbines **to generate electricity**.

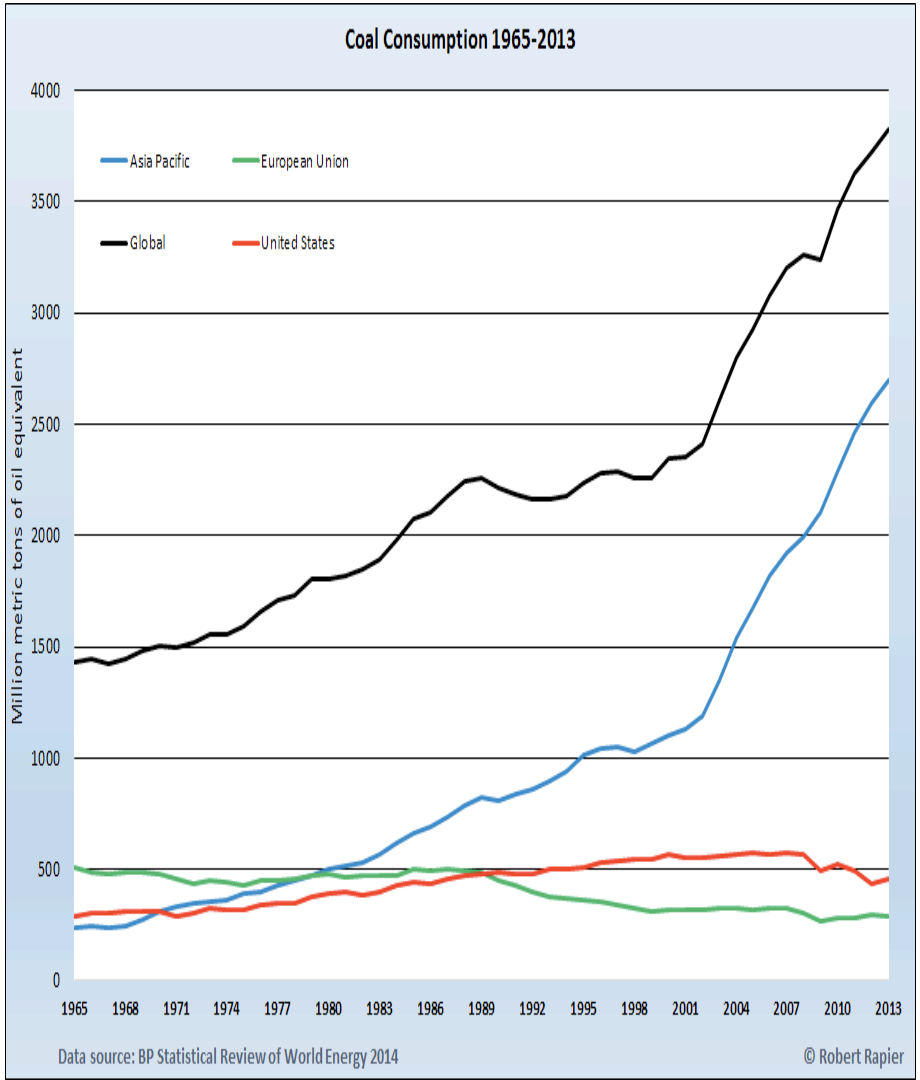
Used **to fire cement** and lime kilns.

Used in **steam engine** (… until the middle of the 20th Century)

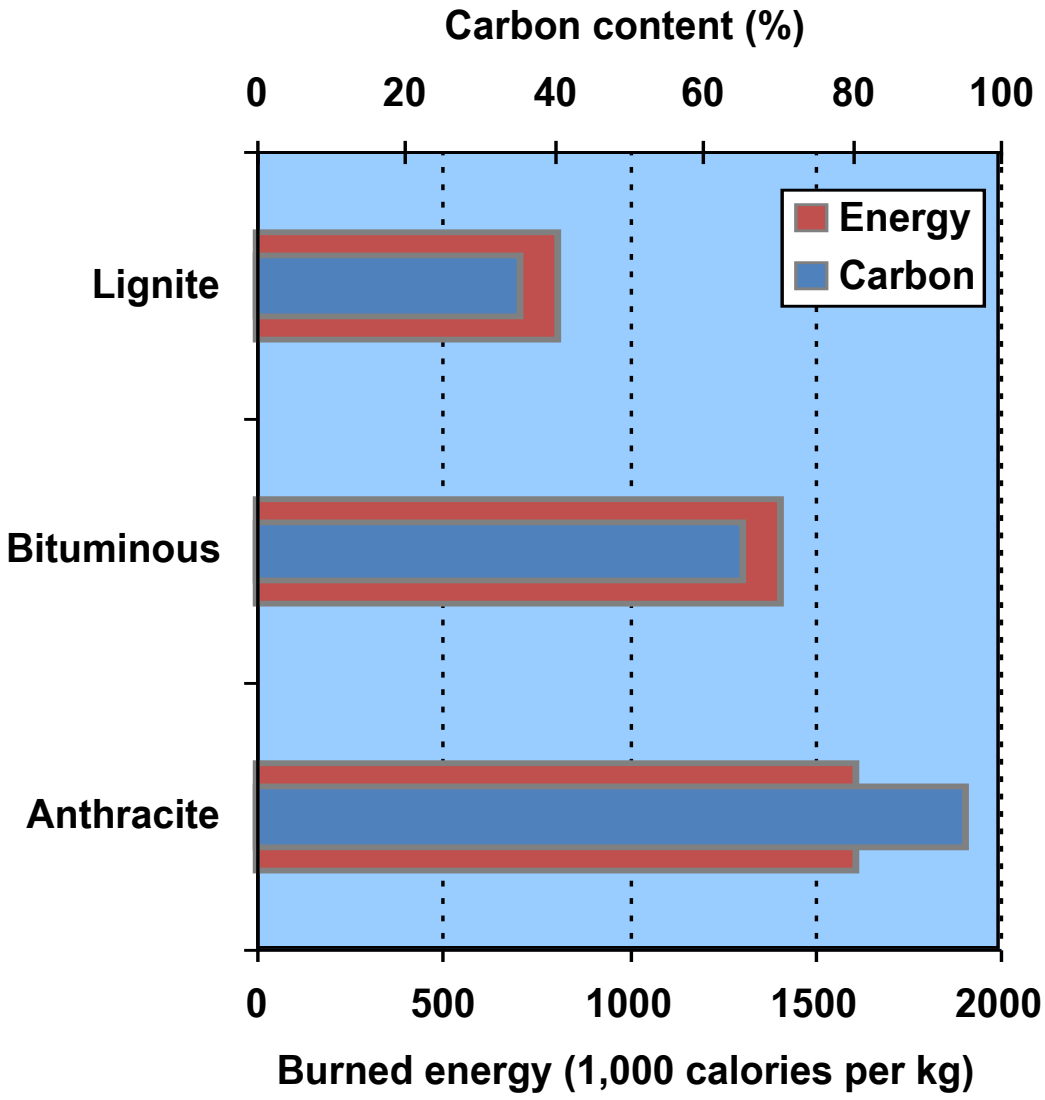
Used in **Metallurgical** factories.

Nature

- Formed from decayed swamp plant matter that cannot decompose in the low-oxygen underwater environment.
- Coal was the major fuel of the early Industrial Revolution.
- High correlation between the location of coal resources and early industrial centers:
  - The Midlands of Britain.
  - Parts of Wales.
  - Pennsylvania.
  - Silesia (Poland).
  - German Ruhr Valley.
- Three grades of coal.



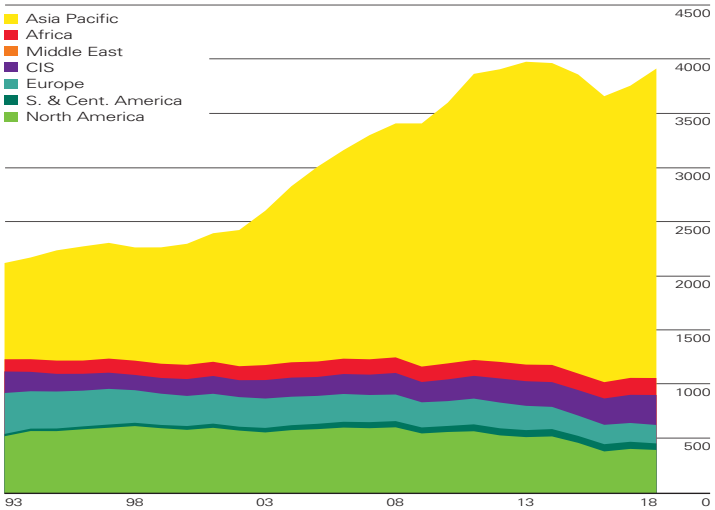
Coal



- Anthracite
  - Highest grade; over 85% carbon.
  - Most efficient to burn.
  - Lowest sulfur content; the least polluting.
  - The most exploited and most rapidly depleted.
- Bituminous
  - Medium grade coal, about 50-75% carbon content.
  - Higher sulfur content and is less fuel-efficient.
  - Most abundant coal in the USA.
- Lignite
  - Lowest grade of coal, with about 40% carbon content.
  - Low energy content.
  - Most sulfurous and most polluting.

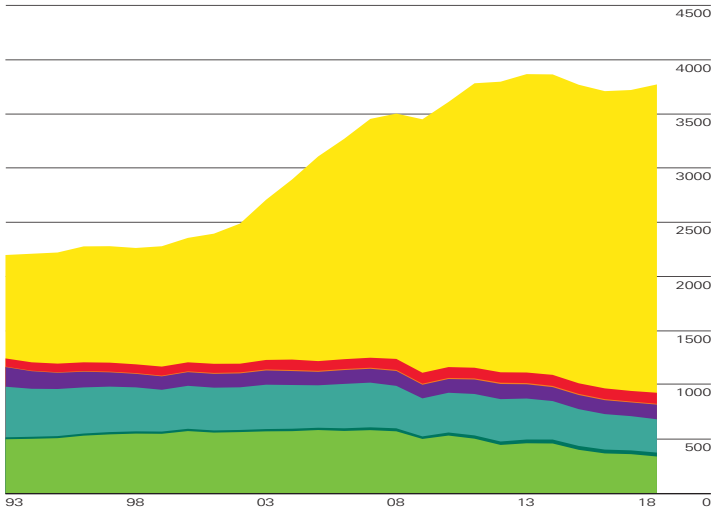
Coal: Production by region

Million tonnes oil equivalent



Coal: Consumption by region

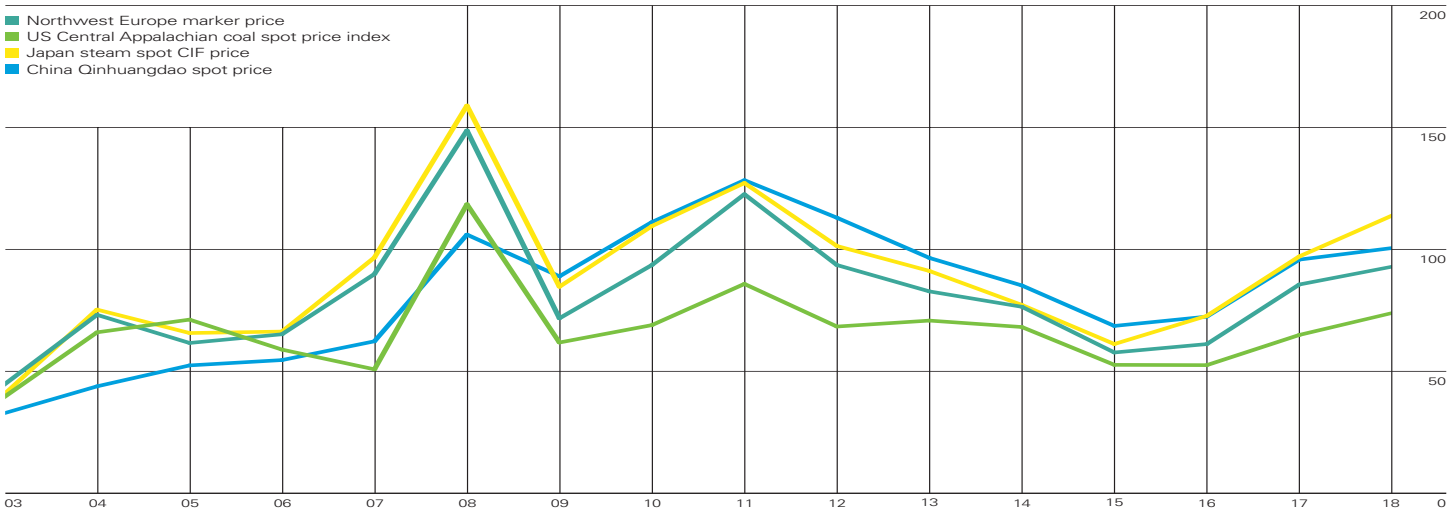
Million tonnes oil equivalent



Global coal production increased by 4.3% in 2018, significantly above the 10-year average of 1.3%. Production growth was concentrated in Asia Pacific (163 mtoe) with China accounting for half of global growth and Indonesian production up by 51 mtoe. Coal consumption increased by 1.4% in 2018, the fastest growth since 2013. Growth was again driven by Asia Pacific (71 Mtoe), and particularly by India (36 Mtoe). This region now accounts for over three quarters of global consumption, while 10 years ago it represented two thirds.

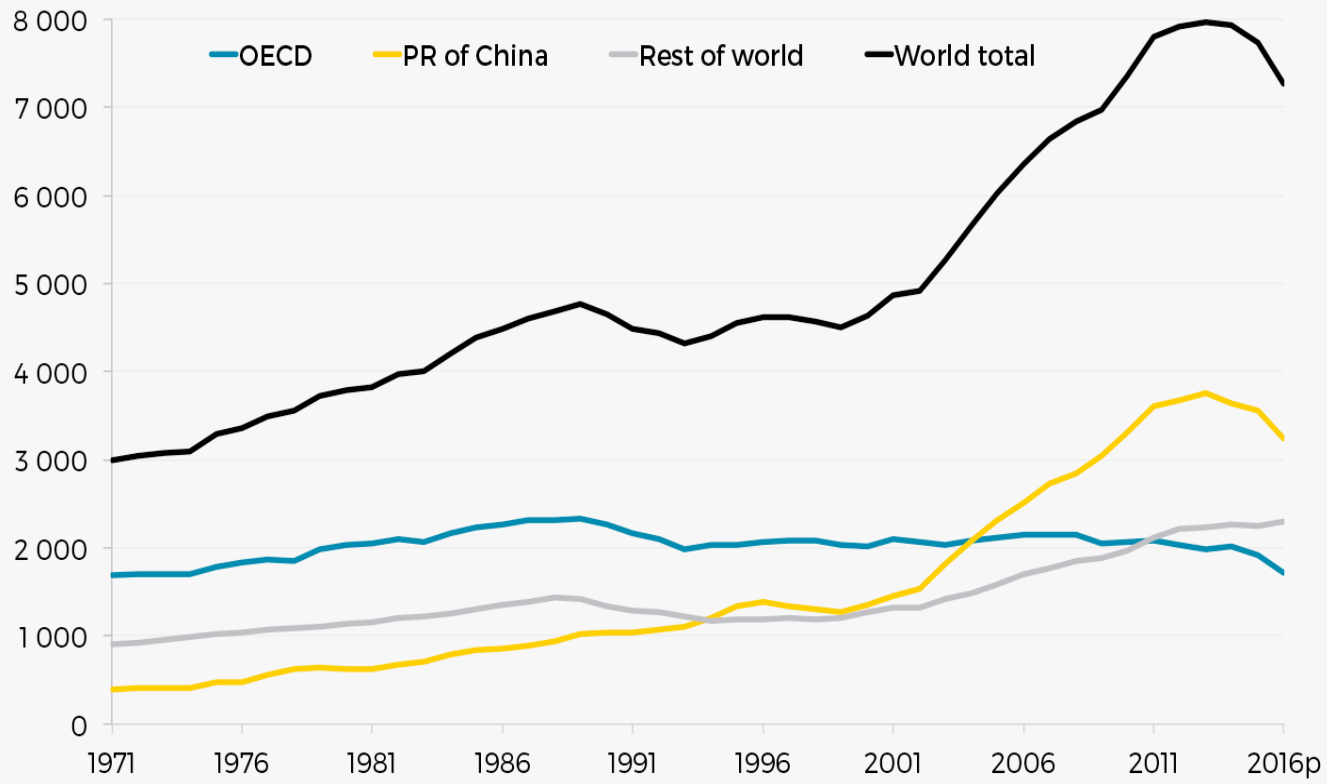
Coal prices

US dollars per tonne



World total coal production (Mt)

Coal Information 2017



Coal

Total proved reserves at end 2018

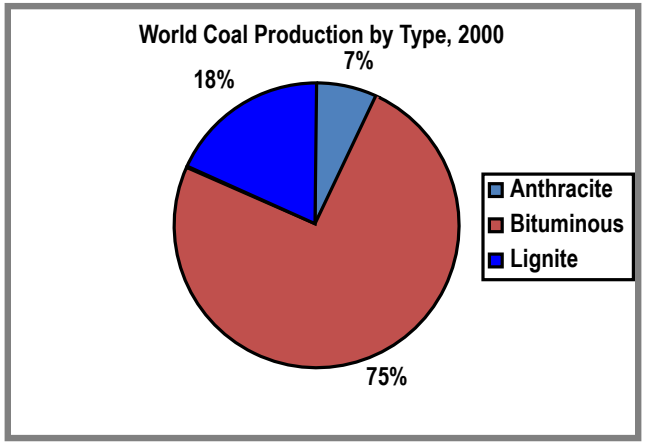
Million tonnes	Anthracite and bituminous	Sub-bituminous and lignite	Total	Share of total	R/P ratio
Canada	4346	2236	**6582**	0.6%	121
Mexico	1160	51	**1211**	0.1%	89
US	220167	30052	**250219**	23.7%	365
Total North America	225673	32339	**258012**	24.5%	342
Brazil	1547	5049	**6596**	0.6%	*
Colombia	4881	–	**4881**	0.5%	58
Venezuela	731	–	**731**	0.1%	*
Other S. & Cent. America	1784	24	**1808**	0.2%	*
Total S. & Cent. America	8943	5073	**14016**	1.3%	158
Bulgaria	192	2174	**2366**	0.2%	78
Czech Republic	110	2547	**2657**	0.3%	61
Germany	3	36100	**36103**	3.4%	214
Greece	–	2876	**2876**	0.3%	79
Hungary	276	2633	**2909**	0.3%	368
Poland	20542	5937	**26479**	2.5%	216
Romania	11	280	**291**	◆	12
Serbia	402	7112	**7514**	0.7%	199
Spain	868	319	**1187**	0.1%	433
Turkey	551	10975	**11526**	1.1%	139
Ukraine	32039	2336	**34375**	3.3%	*
United Kingdom	29	–	**29**	◆	11
Other Europe	1109	5172	**6281**	0.6%	189
Total Europe	56132	78461	**134593**	12.8%	215
Kazakhstan	25605	–	**25605**	2.4%	217
Russian Federation	69634	90730	**160364**	15.2%	364
Uzbekistan	1375	–	**1375**	0.1%	125
Other CIS	1509	–	**1509**	0.1%	358
Total CIS	98123	90730	**188853**	17.9%	329
South Africa	9893	–	**9893**	0.9%	39
Zimbabwe	502	–	**502**	◆	165
Other Africa	2756	66	**2822**	0.3%	164
Middle East	1203	–	**1203**	0.1%	*
Total Middle East & Africa	14354	66	**14420**	1.4%	53
Australia	70927	76508	**147435**	14.0%	304
China	130851	7968	**138819**	13.2%	38
India	96468	4895	**101363**	9.6%	132
Indonesia	26122	10878	**37000**	3.5%	67
Japan	340	10	**350**	◆	336
Mongolia	1170	1350	**2520**	0.2%	46
New Zealand	825	6750	**7575**	0.7%	*
Pakistan	207	2857	**3064**	0.3%	*
South Korea	326	–	**326**	◆	271
Thailand	–	1063	**1063**	0.1%	72
Vietnam	3116	244	**3360**	0.3%	81
Other Asia Pacific	1326	687	**2013**	0.2%	38
Total Asia Pacific	331678	113210	**444888**	42.2%	79
Total World	**734903**	**319879**	**1054782**	**100.0%**	**132**
of which: OECD	322234	177484	**499718**	47.4%	291
Non-OECD	412669	142395	**555064**	52.6%	89
European Union	22612	53356	**75968**	7.2%	171

*More than 500 years.
◆Less than 0.05%.

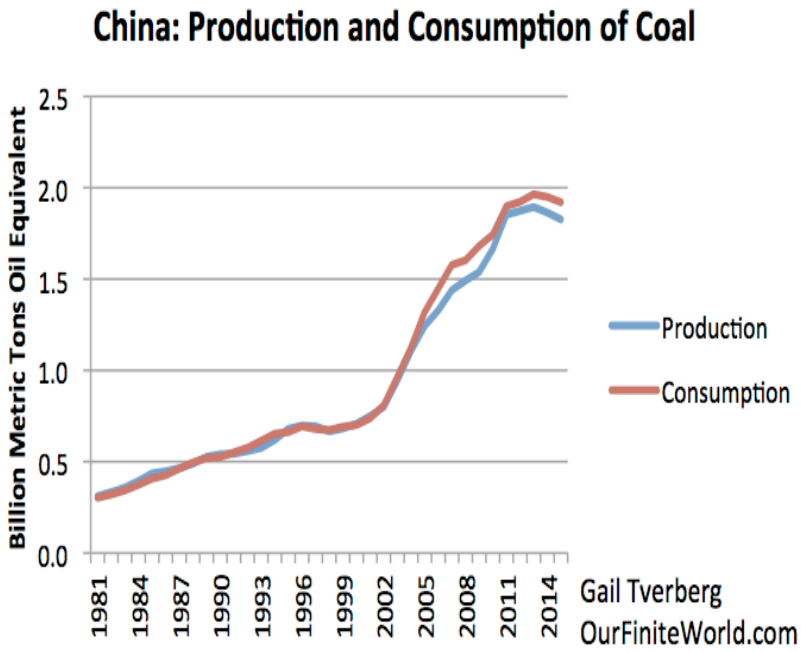
Source: Federal Institute for Geosciences and Natural Resources (BGR) Energy Study 2019.

Notes: Total proved reserves of coal – Generally taken to be those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions. The data series for total proved coal reserves does not necessarily meet the definitions, guidelines and practices used for determining proved reserves at company level, for instance as published by the US Securities and Exchange Commission, nor does it necessarily represent BP's view of proved reserves by country.
Reserves-to-production (R/P) ratio – If the reserves remaining at the end of any year are divided by the production in that year, the result is the length of time that those remaining reserves would last if production were to continue at that rate.
Reserves-to-production (R/P) ratios are calculated excluding other solid fuels in reserves and production.
Shares of total and R/P ratios are calculated using million tonnes figures.

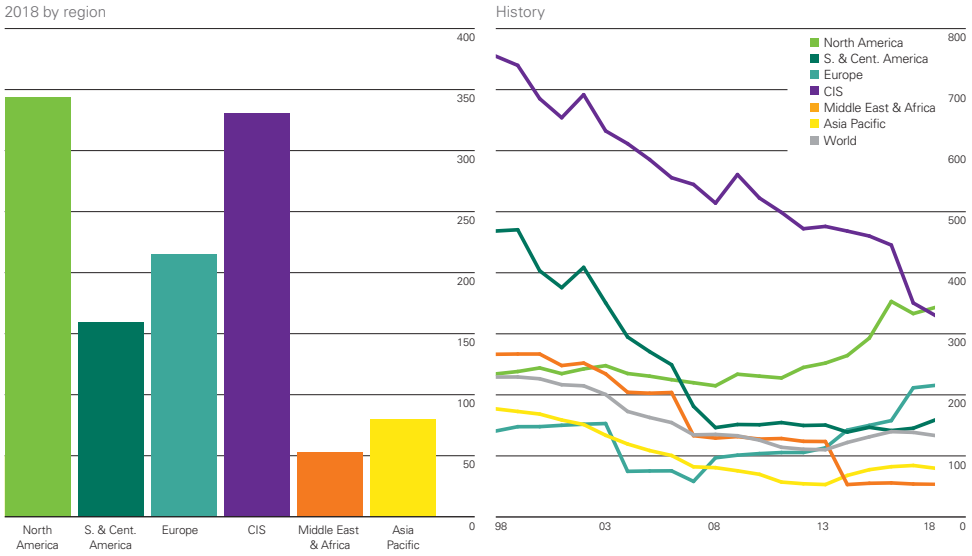
Global Coal Production and Reserves , (M short tons)



Industrial development of China is ALSO originated by a clear policy aimed to keep an efficient equilibrium between internal provision of essential natural resources (coal) and needs for that input in the cheapest way ….

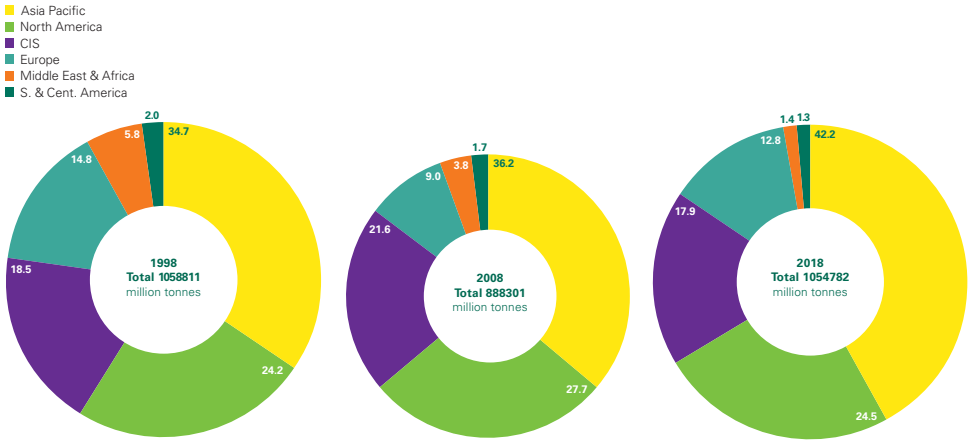


Reserves-to-production (R/P) ratios
Years



World coal reserves in 2018 stood at 1055 billion tonnes and are heavily concentrated in just a few countries: US (24%), Russia (15%), Australia (14%) and China (13%). Most of the reserves are anthracite and bituminous (70%). The current global R/P ratio shows that coal reserves in 2018 accounted for 132 years of current production with North America (342 years) and CIS (329 years) the regions with the highest ratio.

Distribution of proved reserves in 1998, 2008 and 2018
Percentage



Petroleum

Nature

Formation of oil deposits:

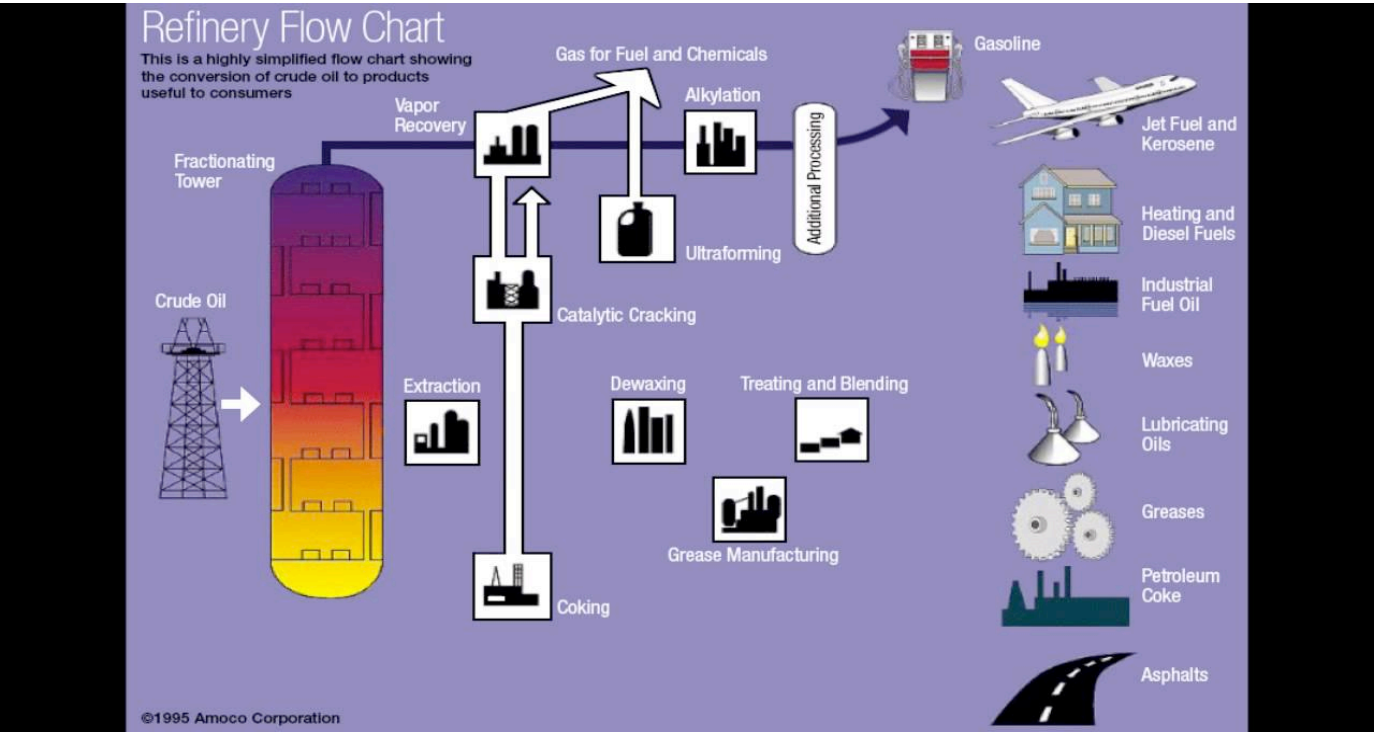
- Decay under pressure of billions of microscopic plants in sedimentary rocks.
- "Oil window"; 7,000 to 15,000 feet.
- Created over the last 600 million years.

Exploration of new sources of petroleum:

- Related to the geologic history of an area.
- Located in sedimentary basins.
- About 90% of all petroleum resources have been discovered.

Production vs. consumption:

- Geographical differences.
- Contributed to the political problems linked with oil supply.



Use

- Transportation:
  - The share of transportation has increased in the total oil consumption.
  - Accounts for more the 55% of the oil used.
  - In the US, this share is 70%.
  - Limited possibility at substitution.
- Other uses (30%):
  - Lubricant.
  - Plastics.
  - Fertilizers.
- Choice of an energy source:
  - Depend on a number of utility factors.
  - Favoring the usage of fossil fuels, notably petroleum.

Factors of Oil Dependency

Occurrence	Localized large deposits (decades)
Transportability	Liquid that can be easily transported. Economies of scale
Energy content	High mass / energy released ratio
Reliability	Continuous supply; geopolitically unstable
Storability	Easily stored
Flexibility	Many uses (petrochemical industry; plastics)
Safety	Relatively safe; some risks (transport)
Environment	Little wastes, CO_2 emissions
Price	Relatively low costs

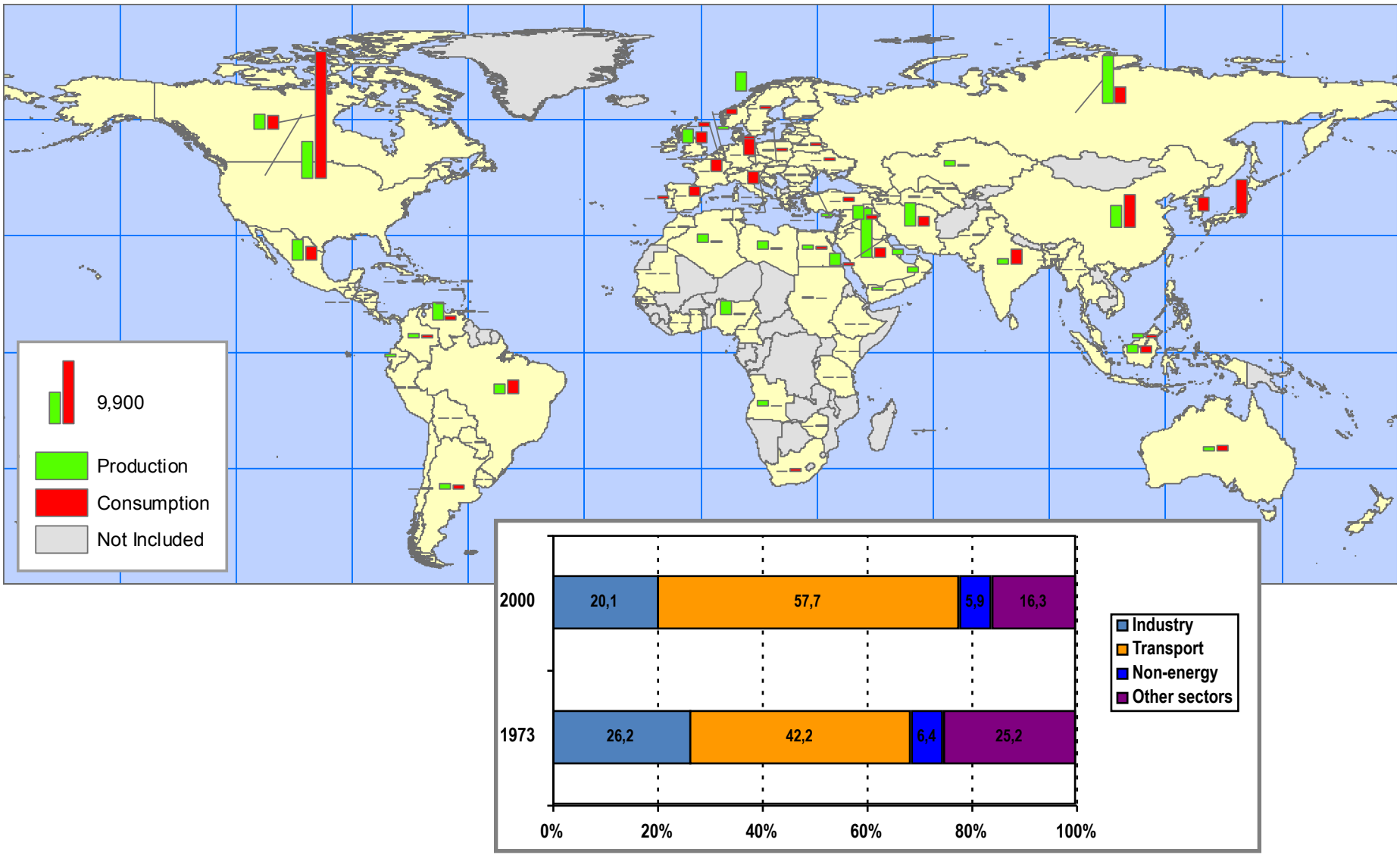
Why an oil dependency?

- Favor the usage of petroleum as the main source of energy for transport activities.
- The utility factors were so convenient that a dependency on petroleum was created.

Taxes

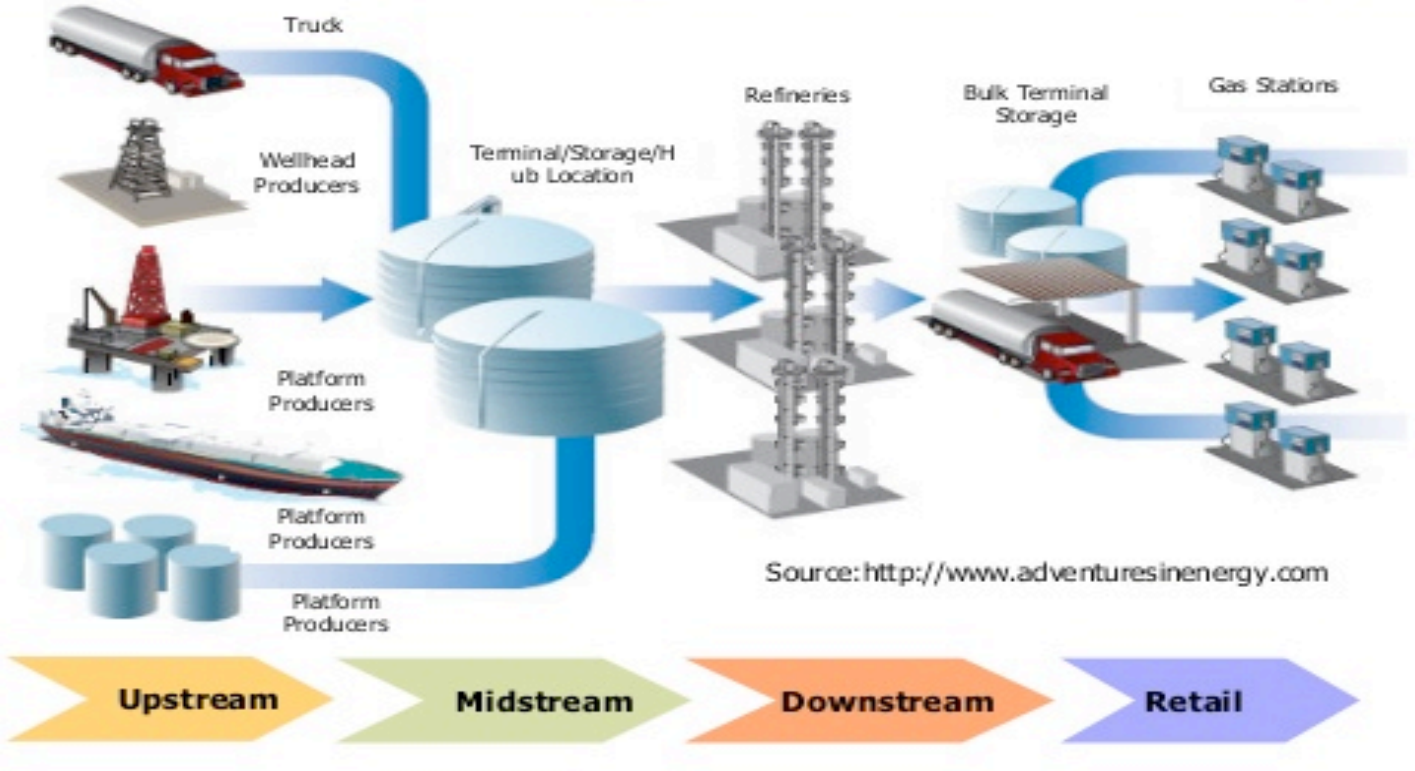
- Should oil be taxed?
- Should the development of alternative sources of energy be accelerated or enforced?

Petroleum Production and Consumption, *2002 (M barrels per day)*

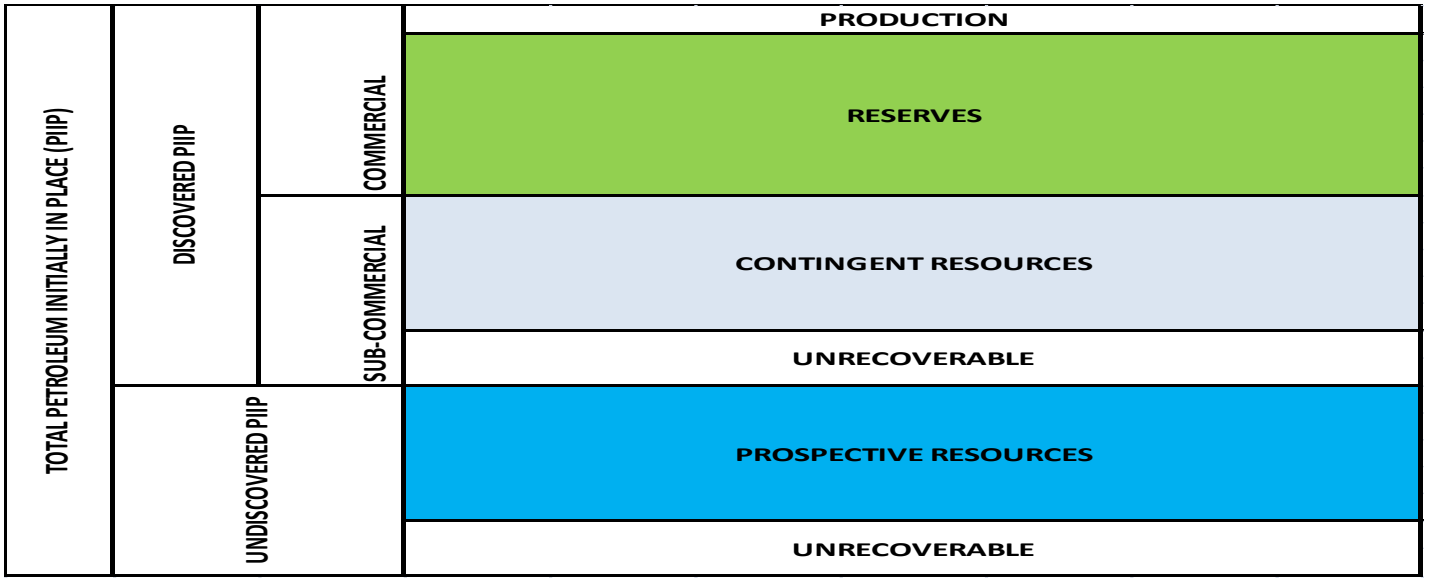


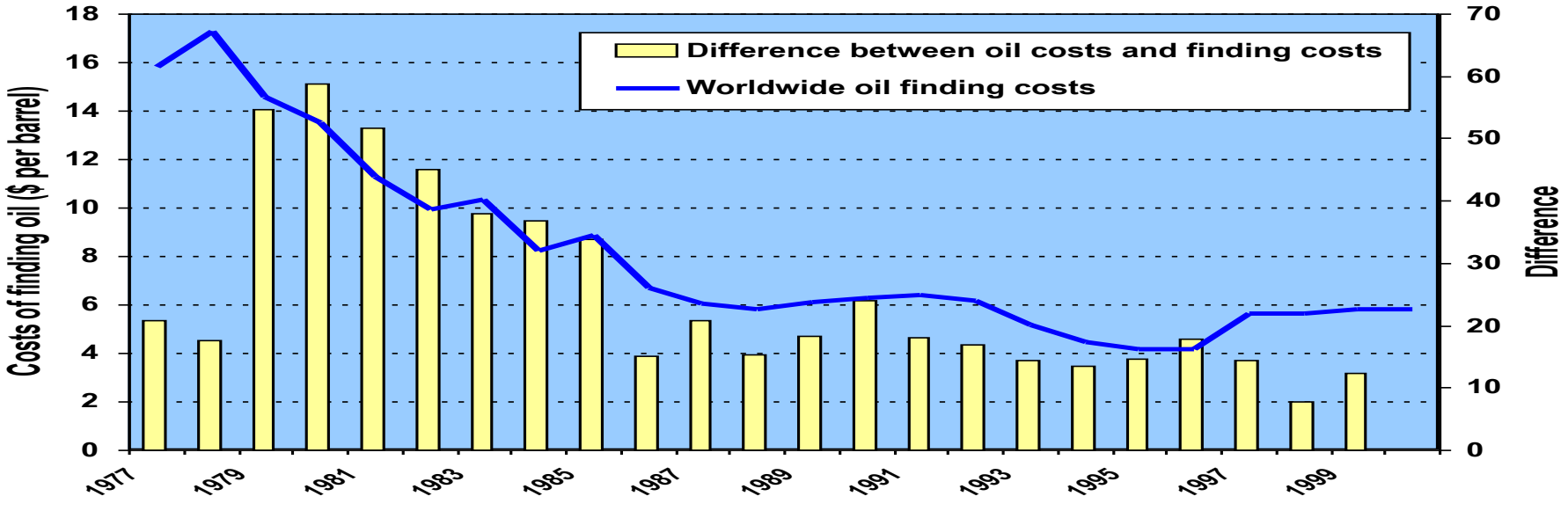
Petroleum Value Chain

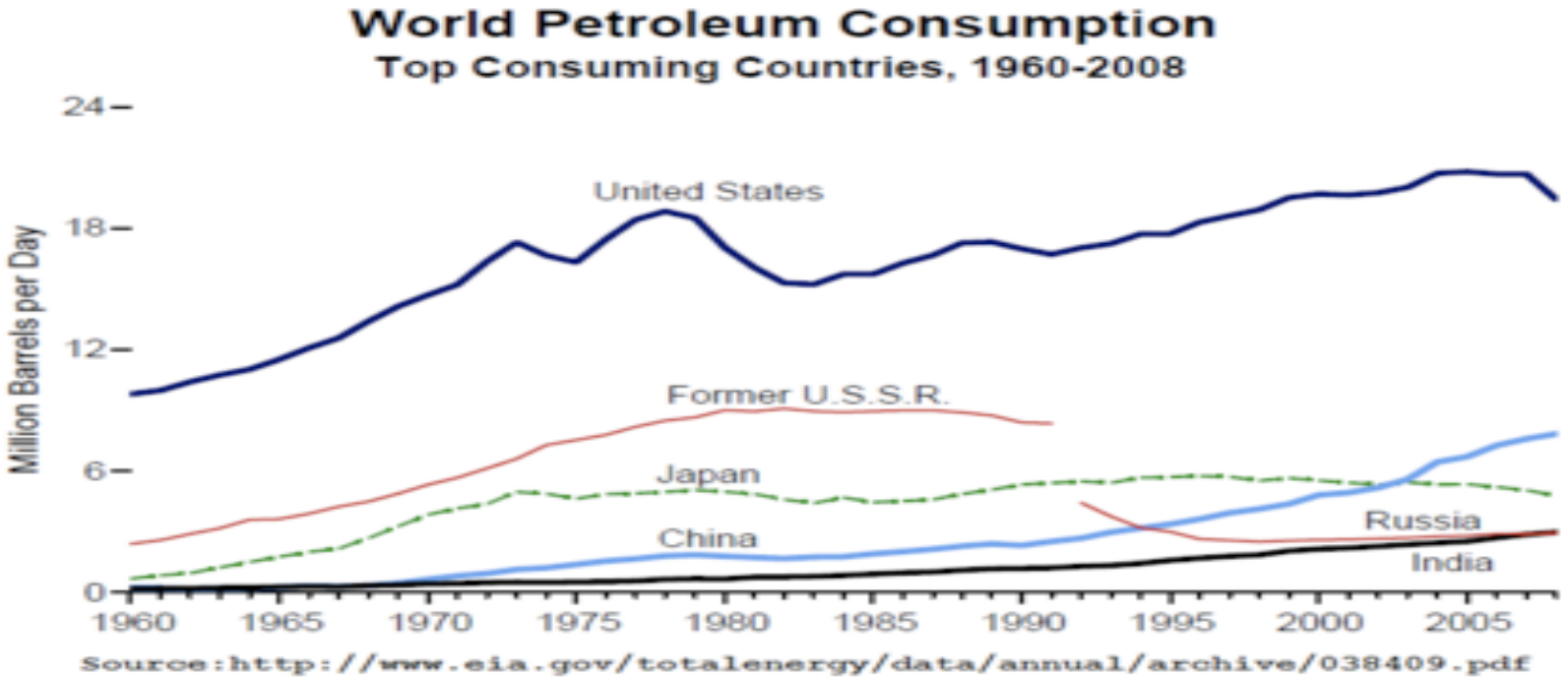
Picture below gives an overview of the supply chain of the oil and gas industry. Industry is organized into three broad categories based on the activities performed therein. They are mainly a) Upstream (Finding & producing hydrocarbons) b) Downstream (Refining hydrocarbons and producing saleable petroleum byproducts) c) Retail (Selling the byproducts to all the users who need them).Midstream, though is not a very popular term is used to describe the transport part.

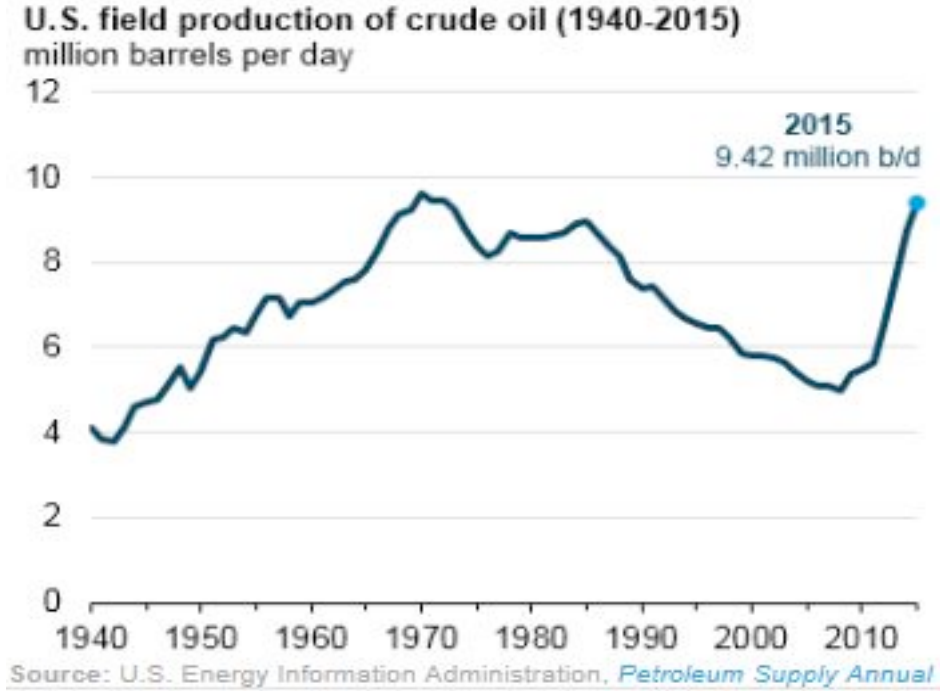


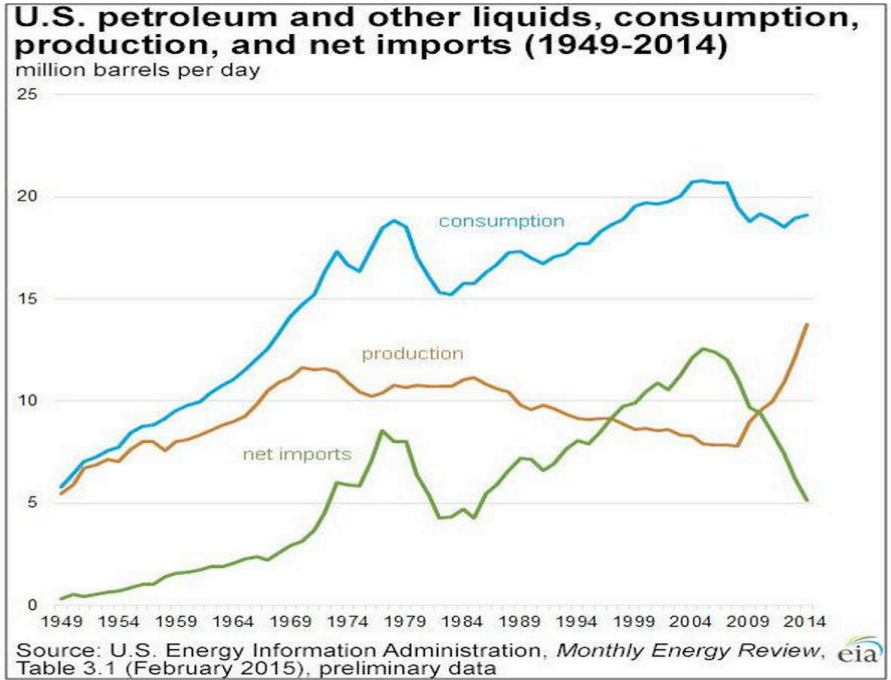
Riserve e risorse secondo la nomenclatura Society of Petroleum Engineers





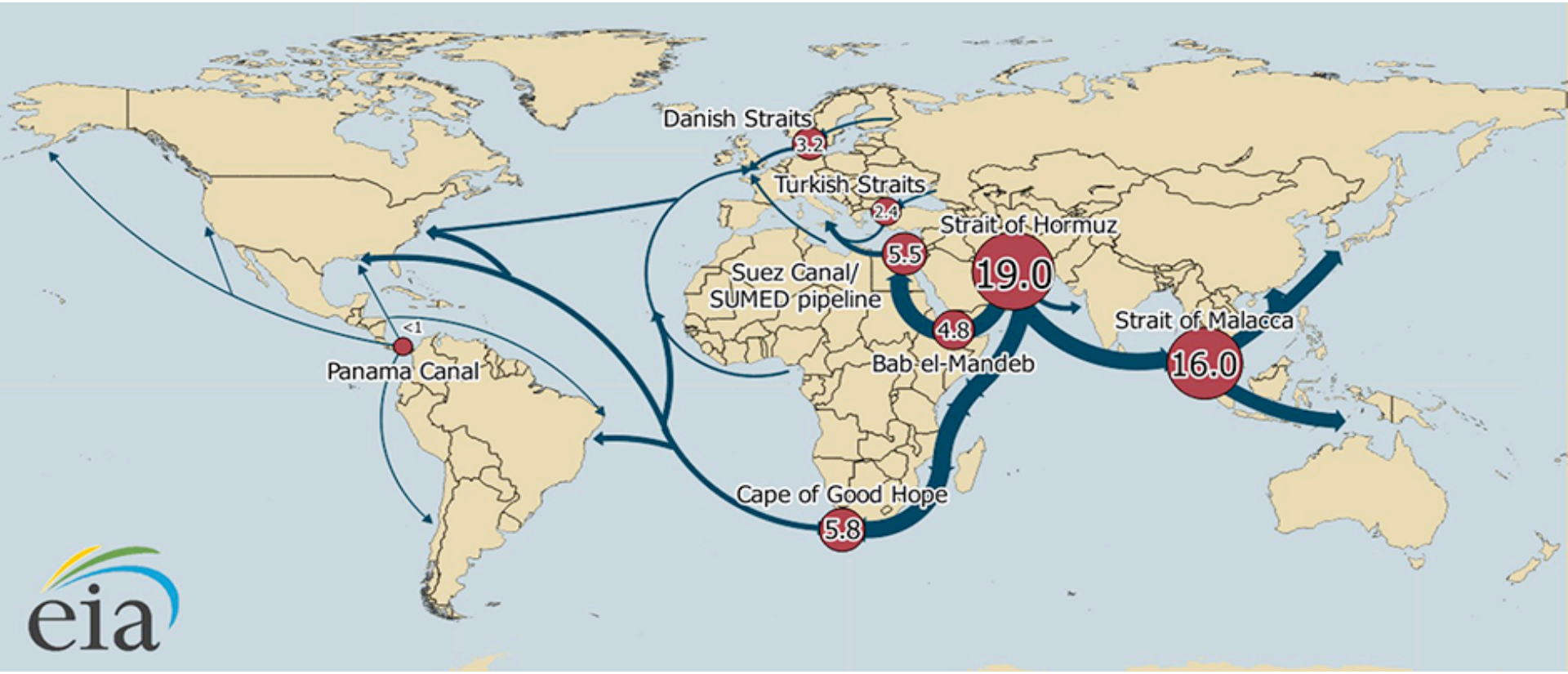

World Petroleum Consumption
Top Consuming Countries, 1960-2008
Million Barrels per Day
24
18
12
6
0
United States
Former U.S.S.R.
Japan
China
Russia
India
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Source:http://www.eia.gov/totalenergy/data/annual/archive/038409.pdf


U.S. field production of crude oil (1940-2015)
million barrels per day
12
10
8
6
4
2
0
2015
9.42 million b/d
1940
1950
1960
1970
1980
1990
2000
2010
Source: U.S. Energy Information Administration, Petroleum Supply Annual


U.S. petroleum and other liquids, consumption, production, and net imports (1949-2014)
million barrels per day
25
20
15
10
5
0
consumption
production
net imports
1949
1954
1959
1964
1969
1974
1979
1984
1989
1994
1999
2004
2009
2014
Source: U.S. Energy Information Administration, Monthly Energy Review, Table 3.1 (February 2015), preliminary data
eia

World chokepoints for maritime transit of oil are a critical part of global energy security.

About 61% of the world's petroleum and other liquids production moved on maritime routes. The Strait of Hormuz and the Strait of Malacca are the world's most important strategic chokepoints by volume of oil transit.

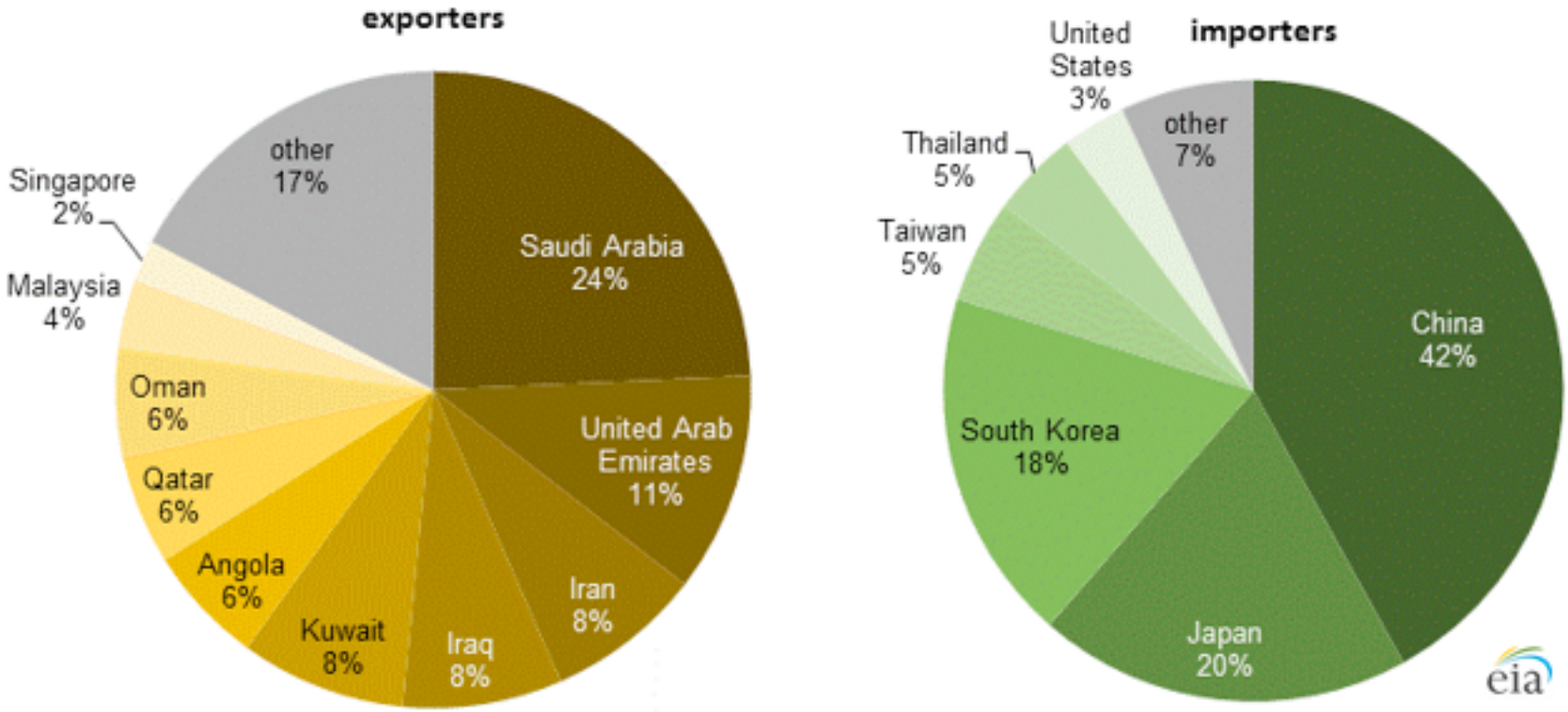


We defines world oil chokepoints as narrow channels along widely used global sea routes, some so narrow that restrictions are placed on the size of the vessel that can navigate through them. Chokepoints are a critical part of global energy security because of the high volume of petroleum and other liquids transported through their narrow straits. In 2015, total world petroleum and other liquids supply was about 96.7 million barrels per day (b/d). EIA estimates that about 61% that amount (58.9 million b/d) traveled via seaborne trade. Oil tankers accounted for almost 28% of the world's shipping by deadweight tonnage in 2016, according to data from the United Nations Conference on Trade and Development (UNCTAD), having fallen steadily from 50% in 1980. International energy markets depend on reliable transport routes. Blocking a chokepoint, even temporarily, can lead to substantial increases in total energy costs and world energy prices. Chokepoints also leave oil tankers vulnerable to theft from pirates, terrorist attacks, political unrest in the form of wars or hostilities, and shipping accidents that can lead to disastrous oil spills.

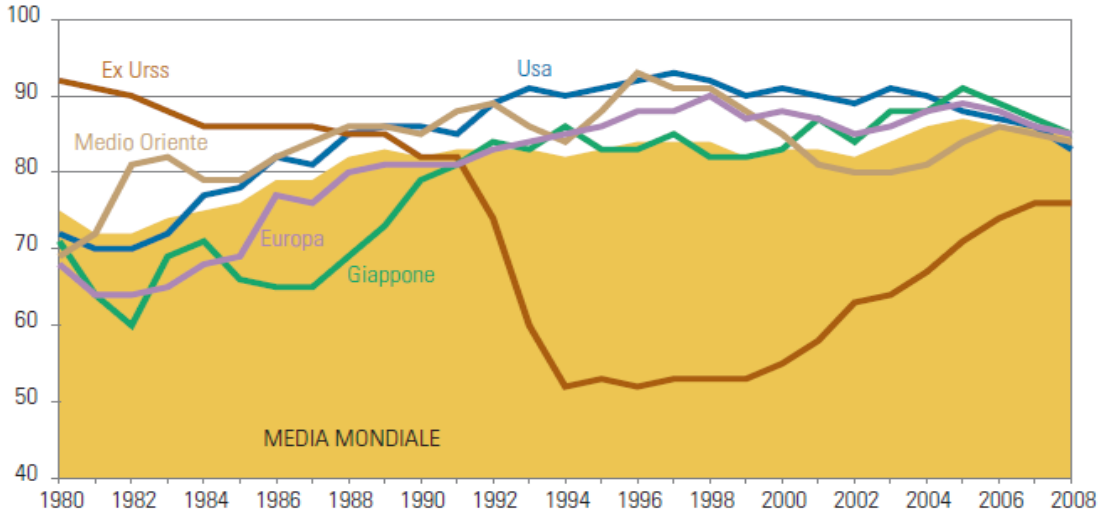
Seven chokepoints are part of major trade routes for global seaborne oil transportation. Disruptions to these routes could affect oil prices and add thousands of miles of transit in alternative routes. By volume of oil transit, the Strait of Hormuz, leading out of the Persian Gulf, and the Strait of Malacca (linking the Indian and Pacific Oceans) are the world's most important strategic chokepoints.

South China Sea crude oil trade flows (2016)

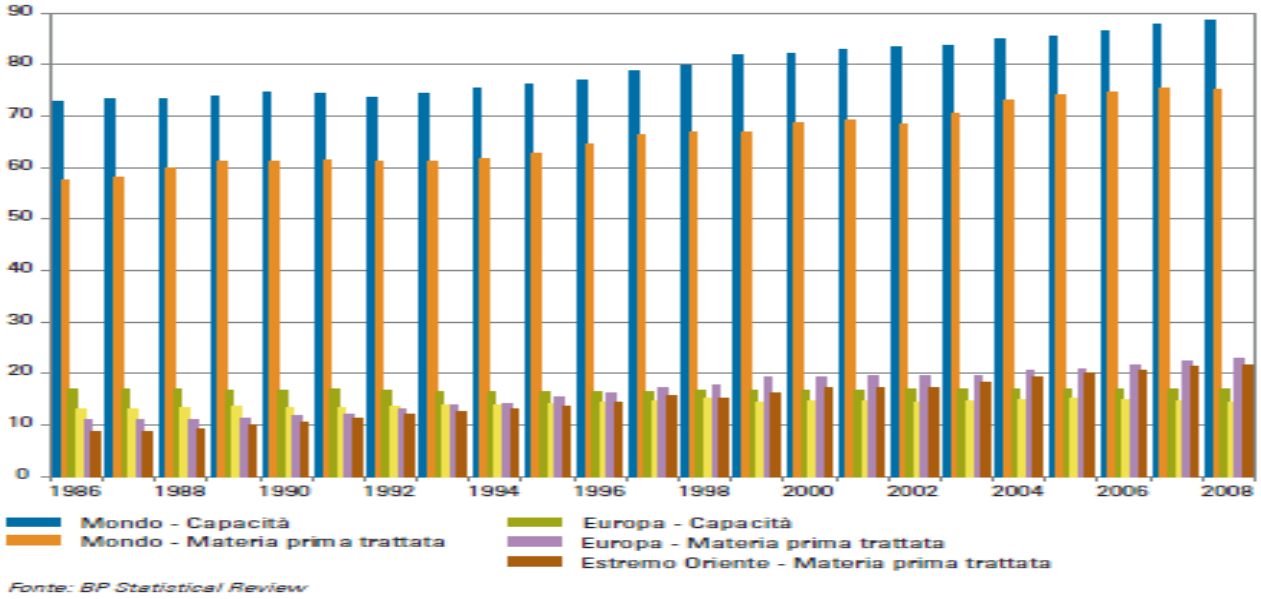
total trade: 15 million barrels per day



UTILIZZO DELLA CAPACITÀ DI RAFFINAZIONE

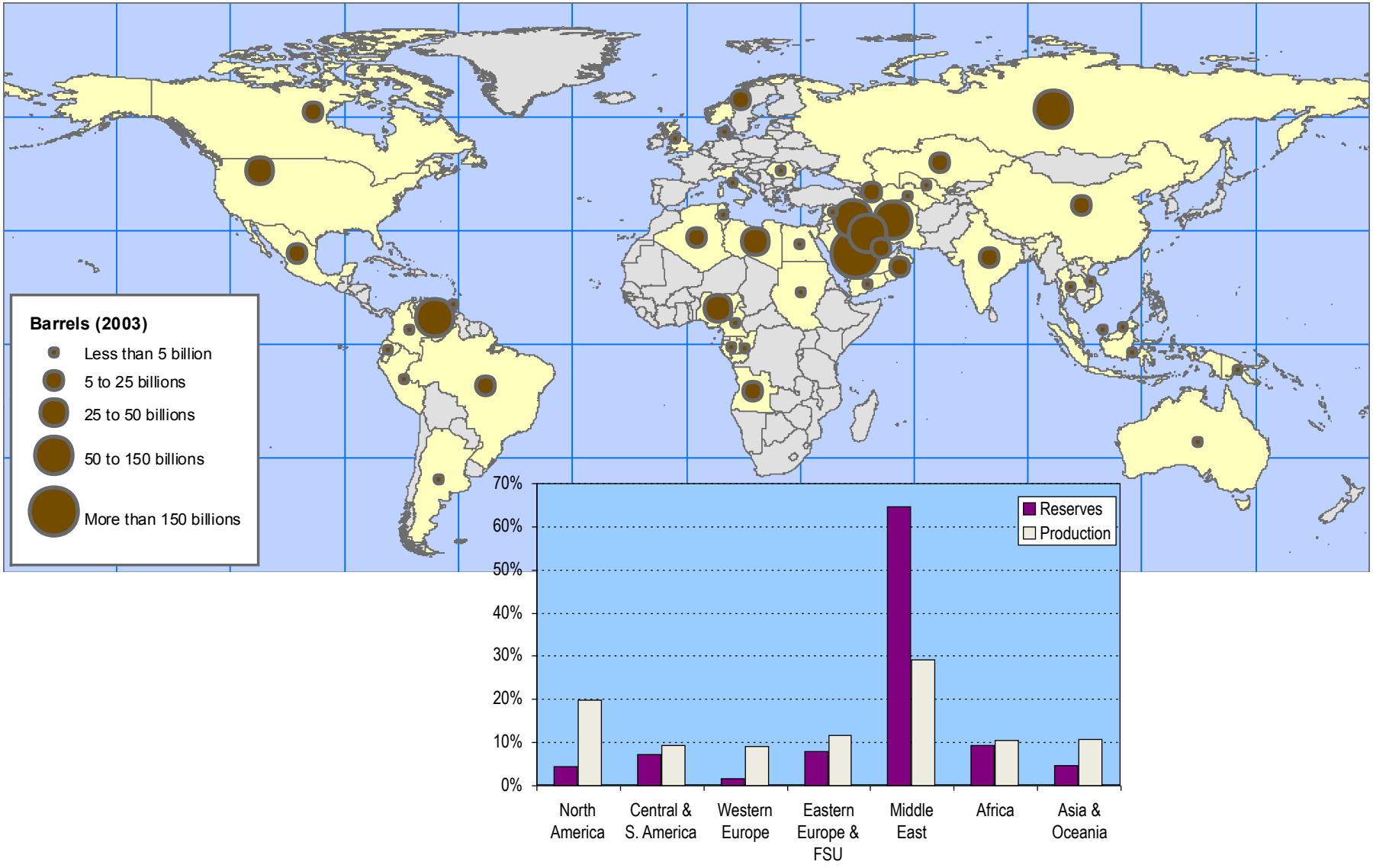


Fonte: BP Statistical Review

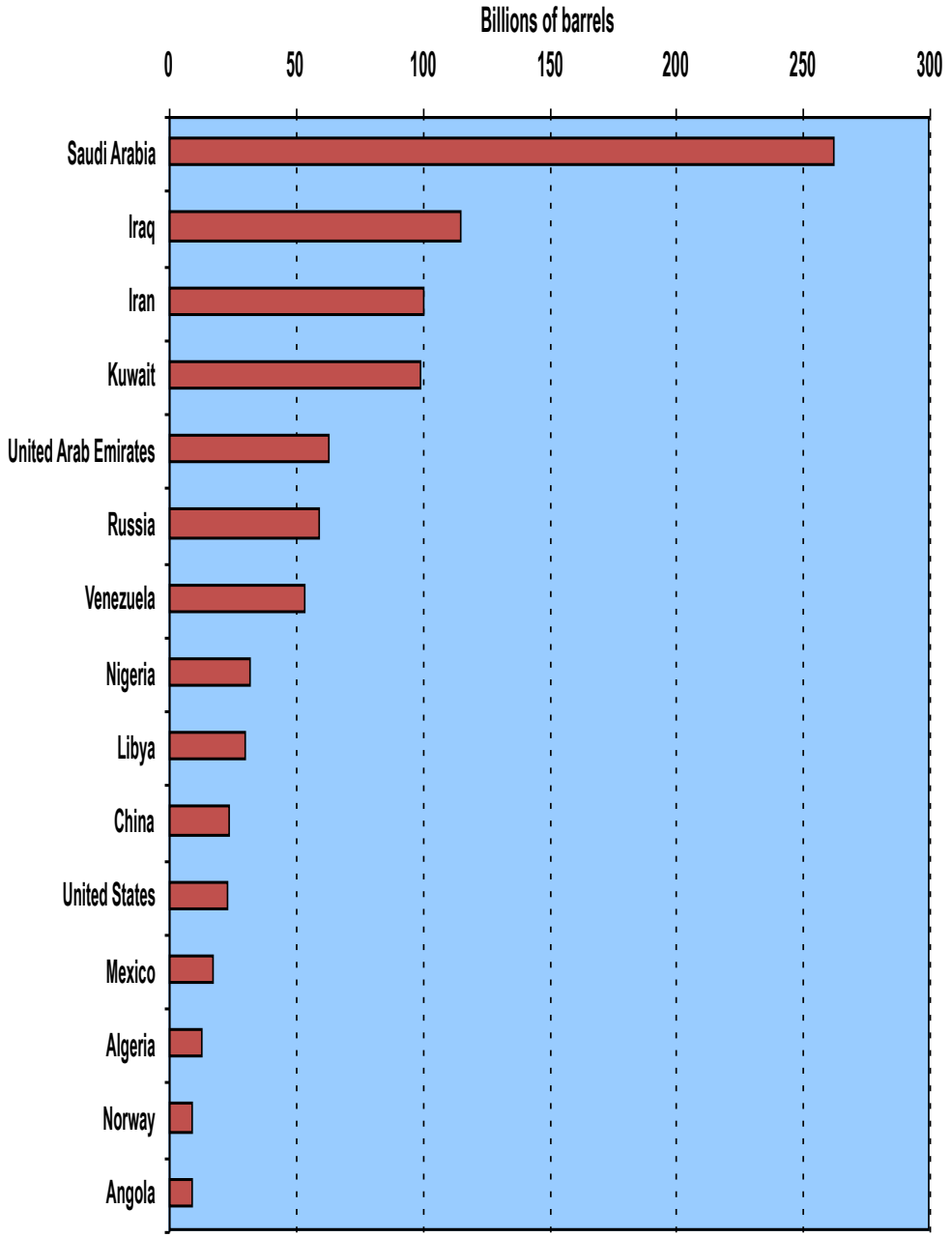


Fonte: BP Statistical Review

Global Oil Reserves



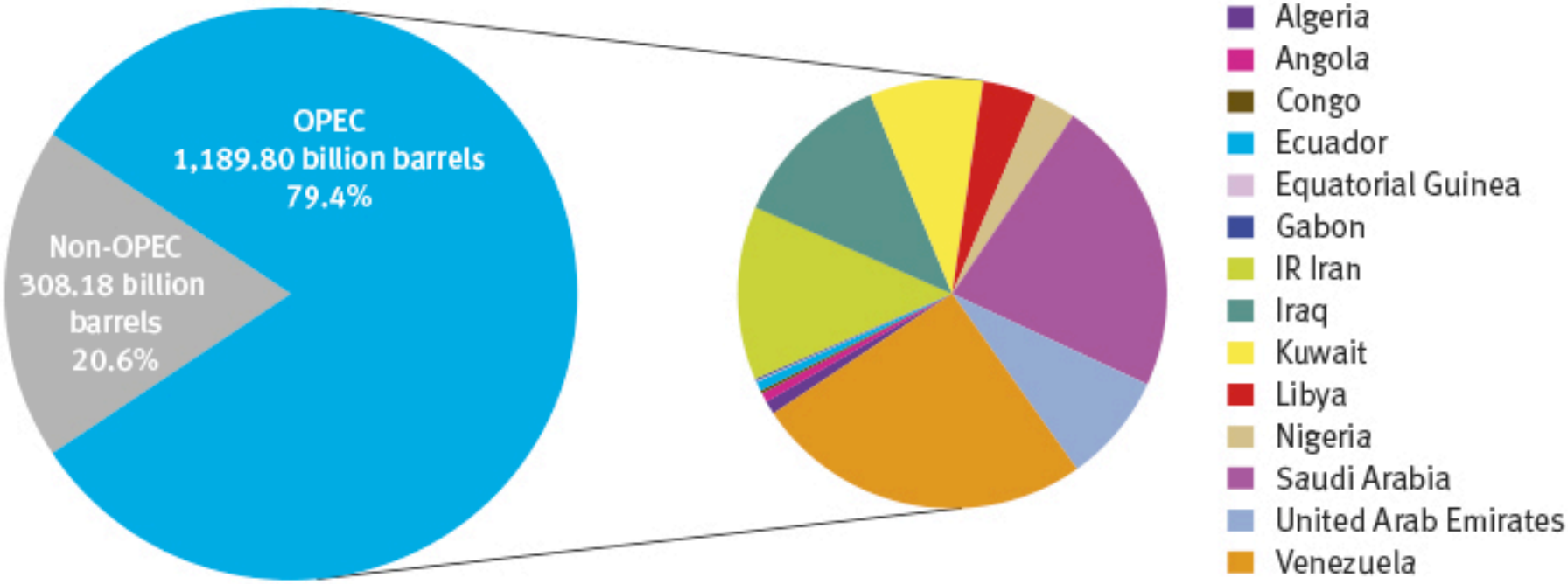
Major Crude Oil Reserves



Oil reserves

- The world oil production is currently running at capacity:
  - Limited opportunities to expand production.
  - 20% of the world's outcome comes from 14 fields.
- Ghawar:
  - The world's largest oil field; been on production since 1951.
  - Produces approximately 4.5 million barrels of oil per day.
  - 55 to 60% of Saudi Arabia's production.
  - Expected to decline sharply (use of water injection).
  - Could be 90% depleted.
- OPEC countries may have overstated its reserves:
  - Production quotas are based upon estimated reserves.
  - The larger the reserves, the more an OPEC country can export.
  - In the 1980s, most OPEC reserves doubled "on paper".
  - Extraction continues while reserves remain the same(?).

OPEC share of world crude oil reserves, 2018



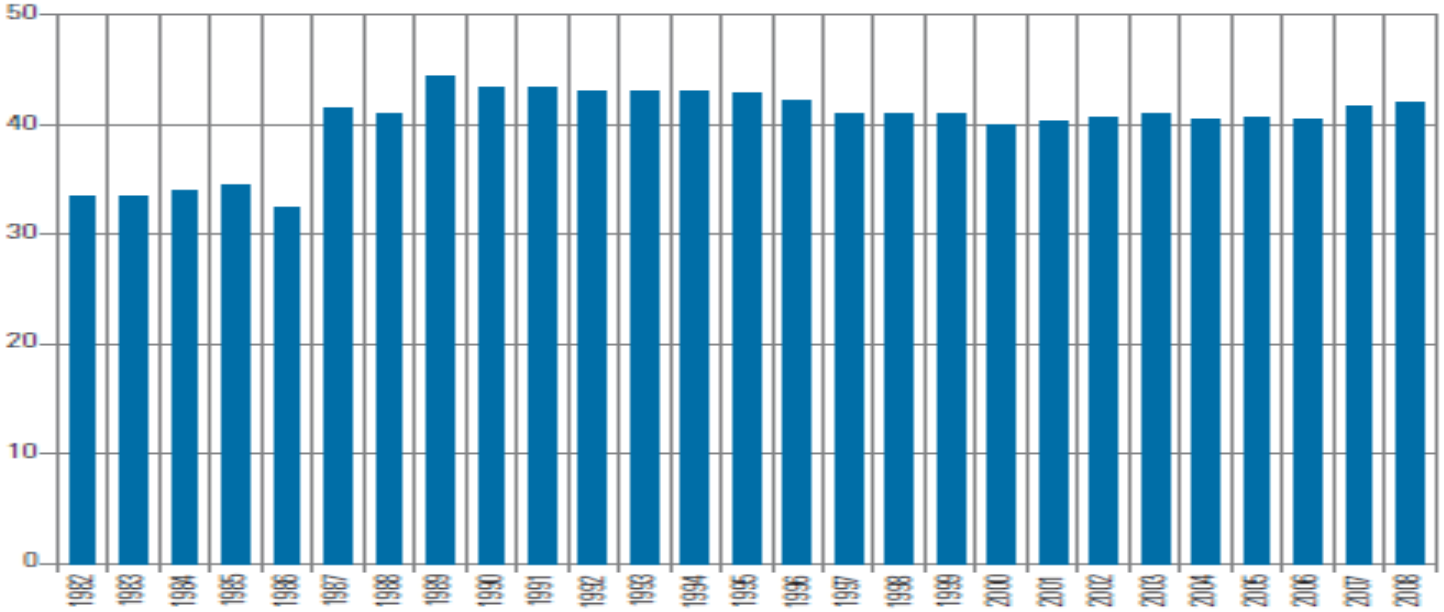
OPEC proven crude oil reserves, at end 2018 (billion barrels, OPEC share)

Venezuela	302.81	25.5%	Kuwait	101.50	8.5%	Algeria	12.20	1.0%	Gabon	2.00	0.2%
Saudi Arabia	267.03	22.4%	UAE	97.80	8.2%	Ecuador	8.27	0.7%	Equatorial Guinea	1.10	0.1%
IR Iran	155.60	13.1%	Libya	48.36	4.1%	Angola	8.16	0.7%			
Iraq	145.02	12.2%	Nigeria	36.97	3.1%	Congo	2.98	0.3%			

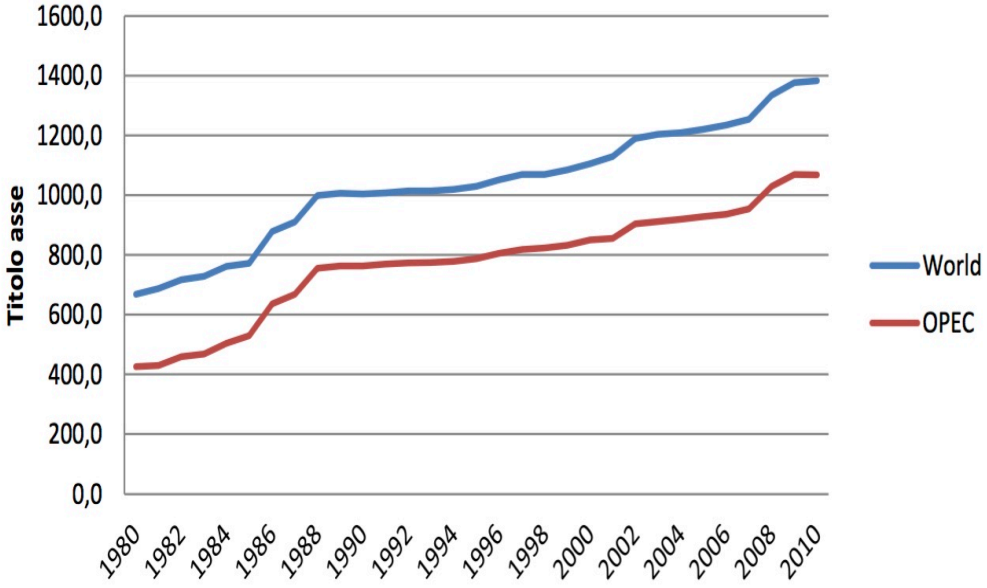
Source: OPEC Annual Statistical Bulletin 2019.

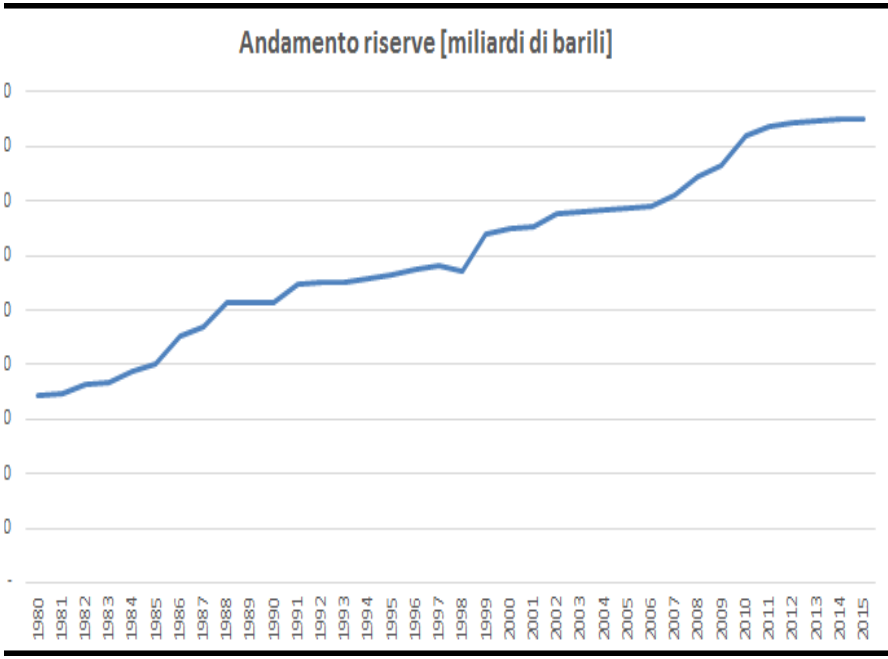
PETROLIO: RAPPORTO RISERVE ACCERTATE/CONSUMO (*)

(Risorse ancora disponibili in anni)



(*) I valori esprimono gli anni di residua disponibilità in base al rapporto tra le riserve accertate e il livello di consumo di ogni anno



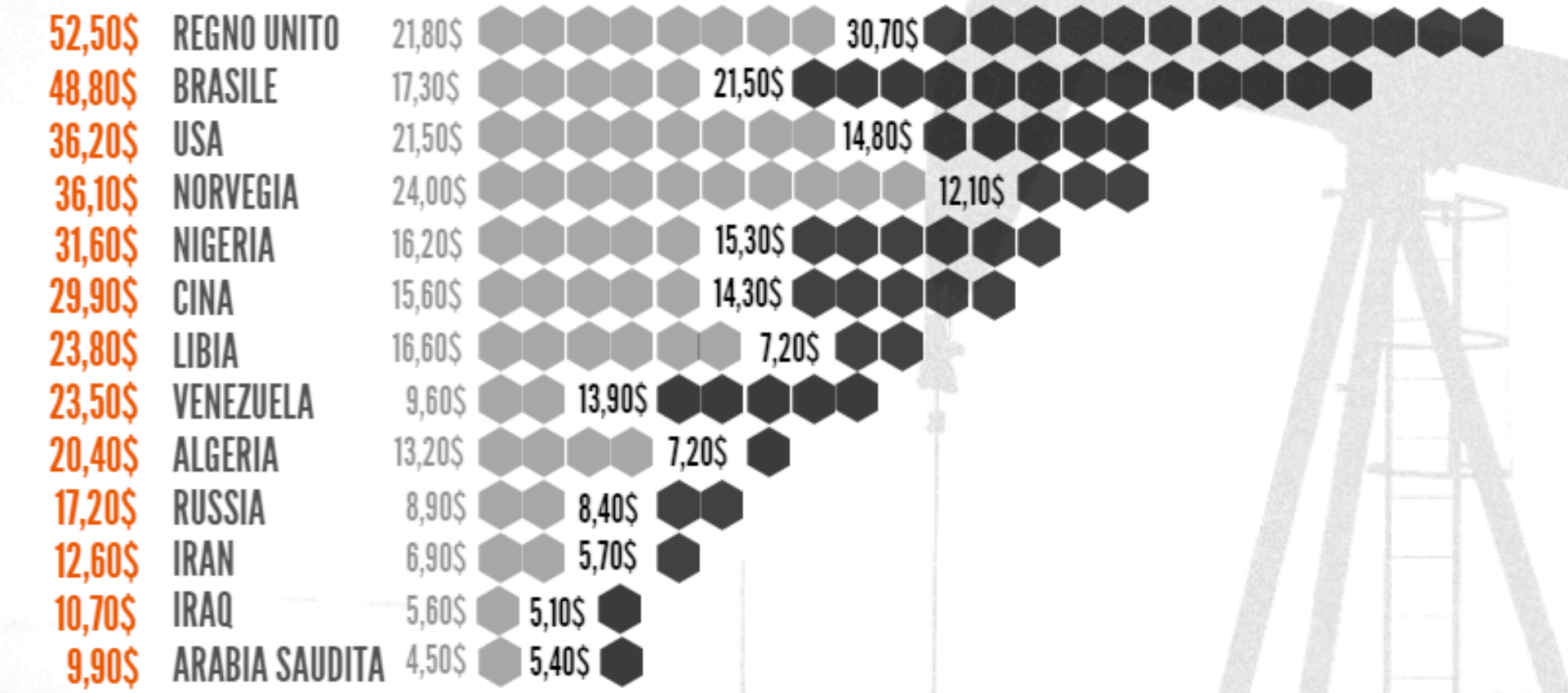


OIL: questions to keep in touch ….

- Prior oil spikes linked with short lived geopolitical events.
- The situation has changed at the beginning of the 21st century.
- A production issue:
  - Petroleum extraction appears to be running at capacity.
  - Demand, especially new consumers (China), is going up.
- A distribution issue:
  - Limited additional tanker and pipeline capacity.
- A refining issue:
  - Limited additional refining capacity.
  - No refineries were built in the US since 1974.

QUANTO COSTA RIEMPIRE UN BARILE?

IL COSTO COMPOSITO DI UN BARILE DI GREGGIO ALLA FINE DEL 2015 PER ALCUNI DEI PRINCIPALI PRODUTTORI



CAPEX, spesa di capitale

OPEX, costi di gestione

FONTE: RYSTAD ENERGY Novembre 2015

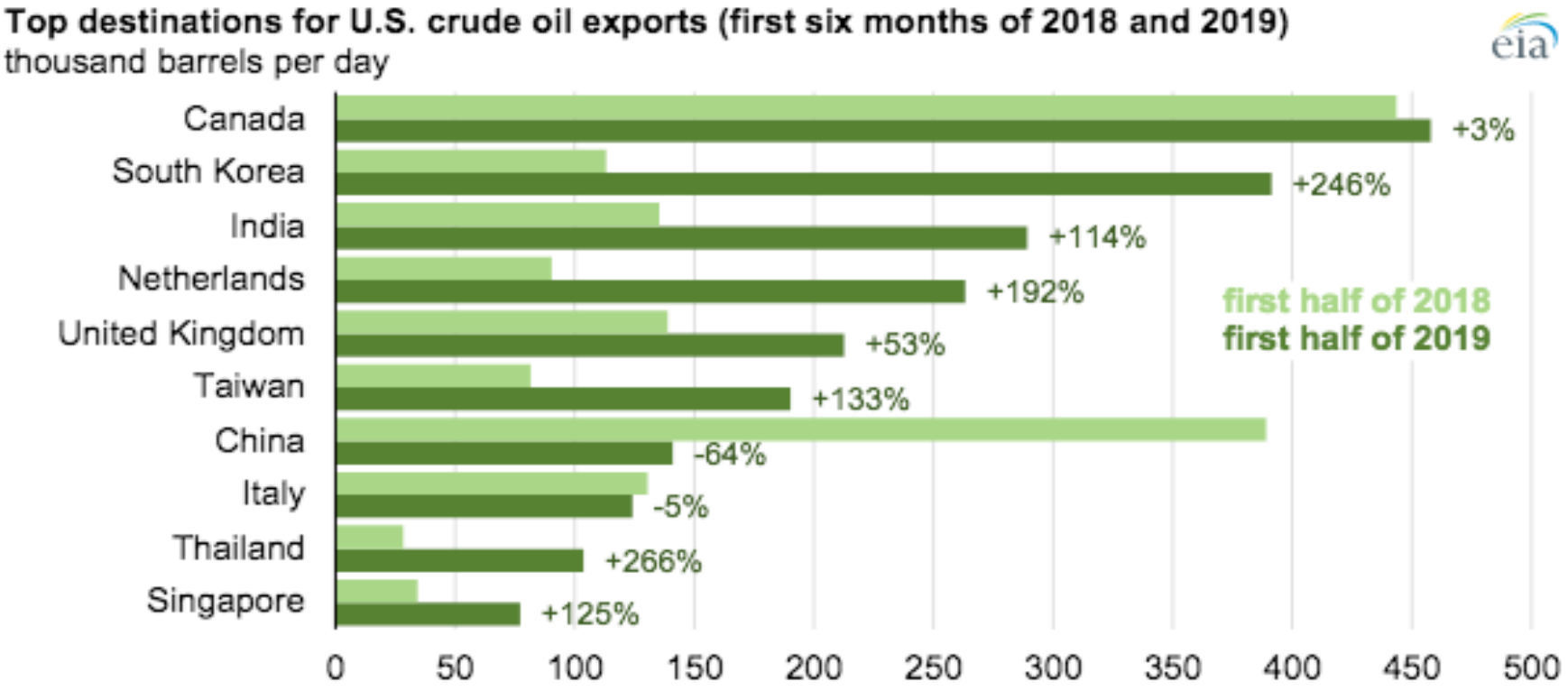
U.S. crude oil exports continued to grow in the first half of 2019

U.S. exports of crude oil rose to average 2.9 million barrels per day (b/d) in the first half of 2019, an increase of 966,000 b/d from the first half of 2018. U.S. crude oil exports also set a record-high monthly average in June 2019 at 3.2 million b/d.

The United States is still one of the world's largest importers of crude oil: in the first half of 2019, U.S. imports of crude oil less exports (net imports) averaged 4.2 million b/d compared with 6.1 million b/d in the first half of 2018. Increases in U.S. domestic crude oil production have resulted in reduced imports and increased exports.

Canada remained the top destination for U.S. crude oil exports, but volumes exported to Canada did not change much between the first halves of 2018 and 2019. By contrast, U.S. crude oil exports to most other major destinations have increased.

The top regional destination for U.S. crude oil exports was Asia and Oceania at 1.3 million b/d in the first half of 2019. U.S. crude oil exports to these countries collectively increased by 472,000 b/d (58%) compared with the same period in 2018, and exports to countries such as South Korea, India, and Taiwan more than doubled. China has been an exception to this regional trend: U.S. crude oil exports to China in the first half of 2019 averaged 248,000 b/d, or 64% less than the same period last year.

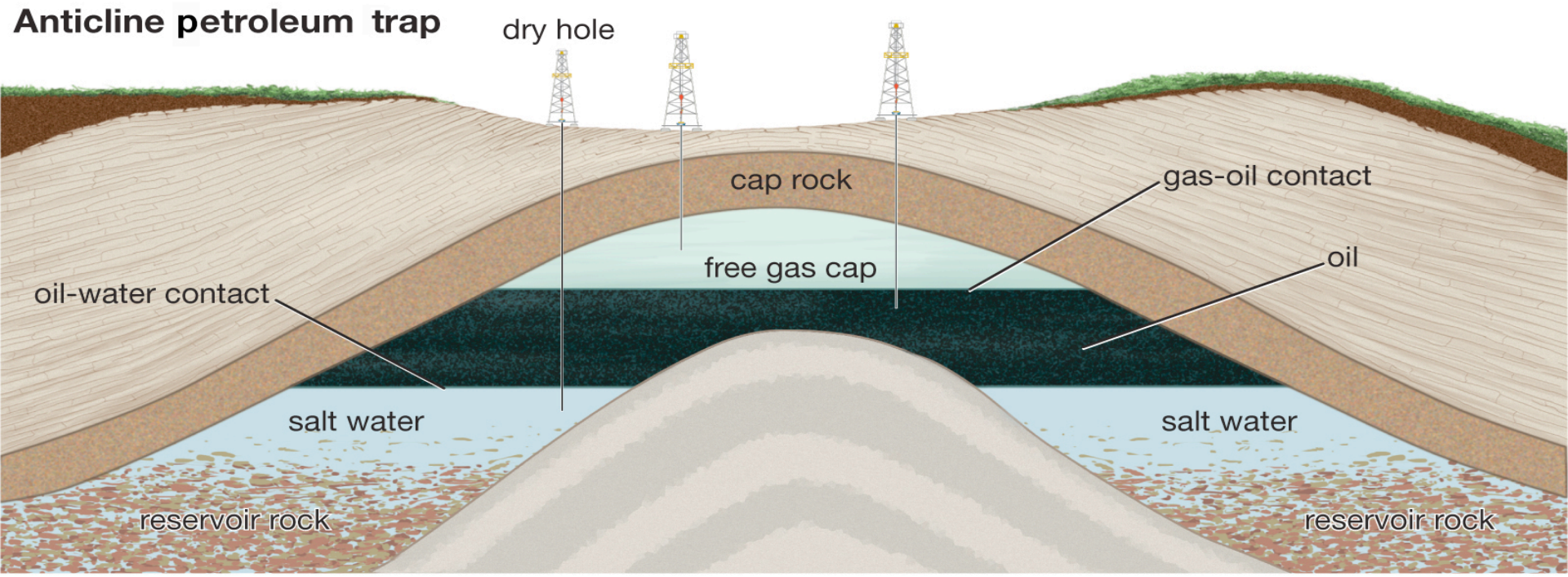


U.S. crude oil exports to Western European destinations averaged 824,000 b/d in the first half of 2019, or 66% more than in the first half of 2019. First-half 2019 exports to the Netherlands increased 173,000 b/d (192%) and exports to the United Kingdom increased 74,000 b/d (53%) compared with the first half of 2018.

Natural Gas

Nature

- Formation:
  - Thermogenic: converted organic material into natural gas due to high pressure.
  - Deeper window than oil.
  - Biogenic: transformation by microorganisms.
- Composition:
  - Composed primarily of methane and other light hydrocarbons.
  - Mixture of 50 to 90% by volume of methane, propane and butane.
  - “Dry” and “wet” (methane content); “sweet” and “sour” (sulfur content).
- Usually found in association with oil:
  - Formation of oil is likely to have natural gas as a by-product.
  - Often a layer over the petroleum.



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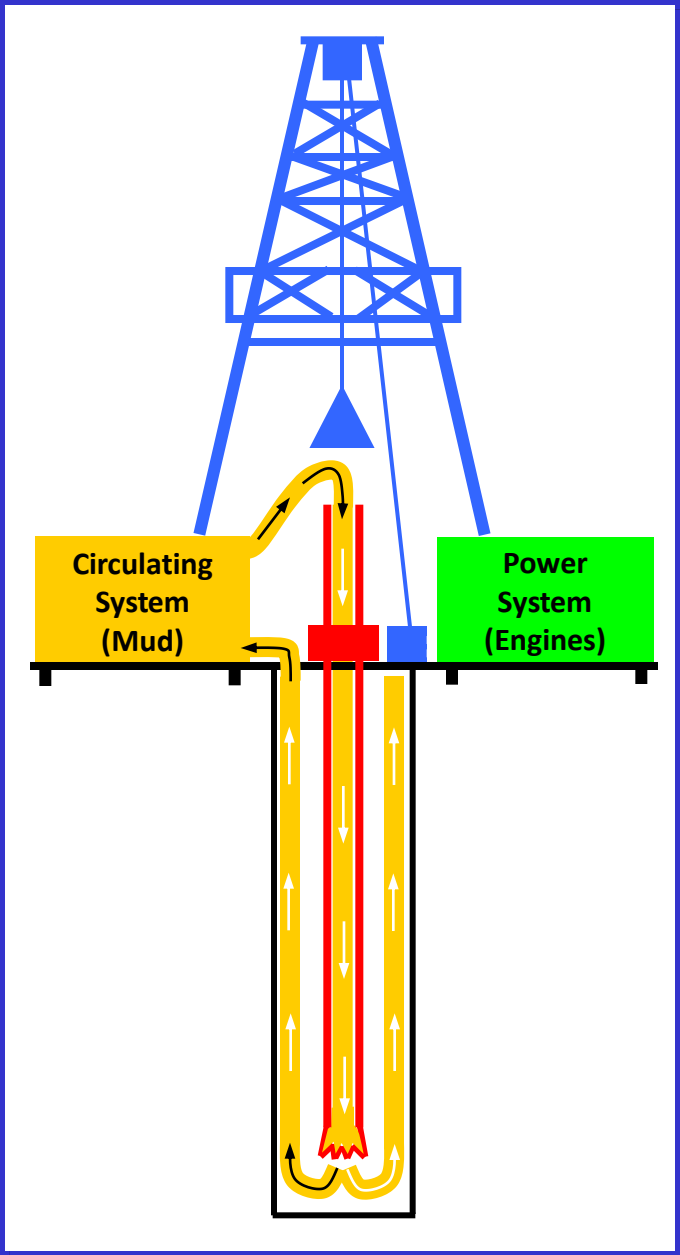
Drilling a well

Preliminary

1. Identify Prospect
   A. Seismic
   B. Log Correlation
2. Obtain Mineral Lease
3. Obtain Drilling Permit
4. Prepare Site



Major Rig Systems

1. Hoisting - Mast & Drawworks
2. Rotating - Turntable / Top Drive and Drill String
3. Circulating - Pumps and Mud
4. Power - Engines (Diesel / Electric)

Contract & Design Issues

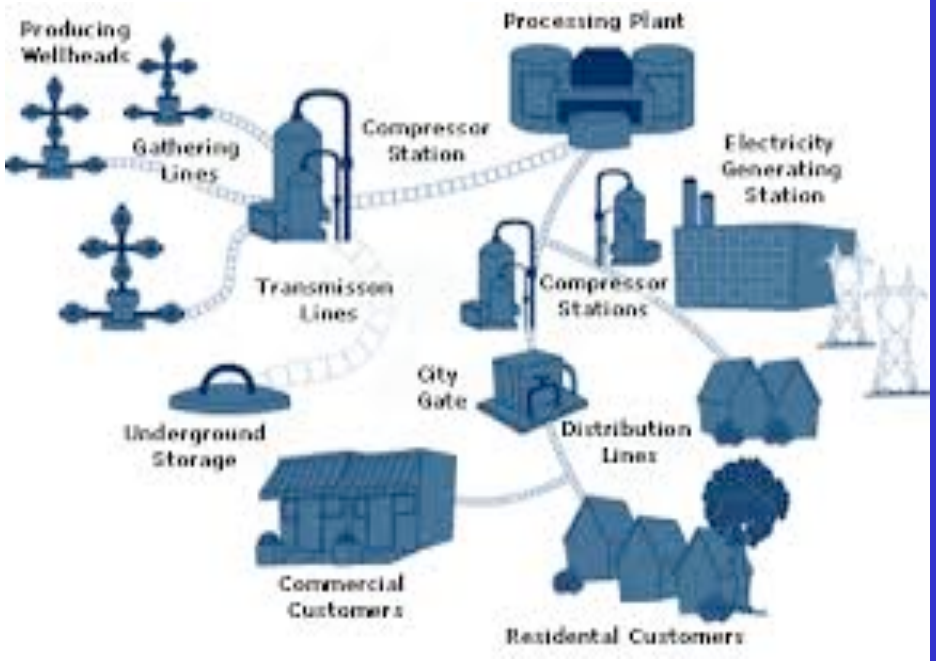
1. Drilling Contract
   A. Rate: Day, Footage, Turnkey
   B. Equipment & Start Date
2. Design Casing Program
3. Evaluate Surface Equipment Requirements

Activities While Drilling

1. Well Control - Blow Outs / Lost Holes
2. MWD - Directional Wells
3. Logging and Analysis
4. Decision to Complete
5. Tight Hole - Confidential

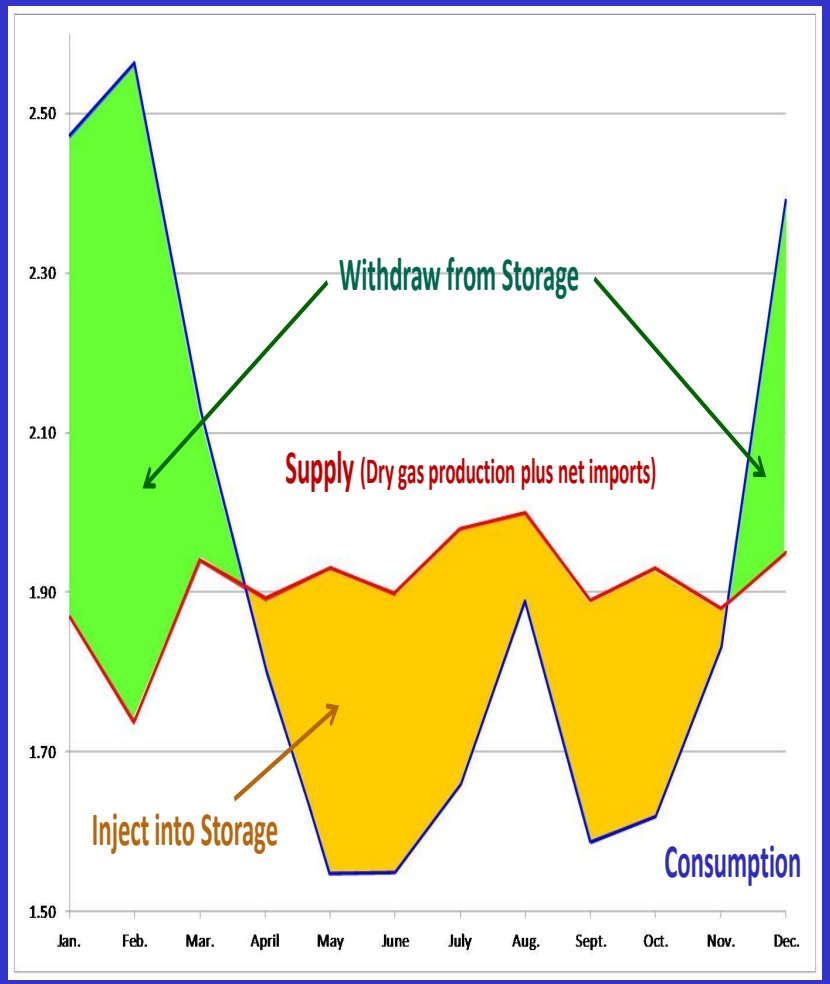
Use

- Mostly used for energy generation.
- Previously, it was often wasted - burned off.
- It is now more frequently conserved and used.
- Considered the cleanest fossil fuel to use.
- The major problem is transporting natural gas, which requires pipelines.
- Gas turbine technology enables to use natural gas to produce electricity more cheaply than using coal.

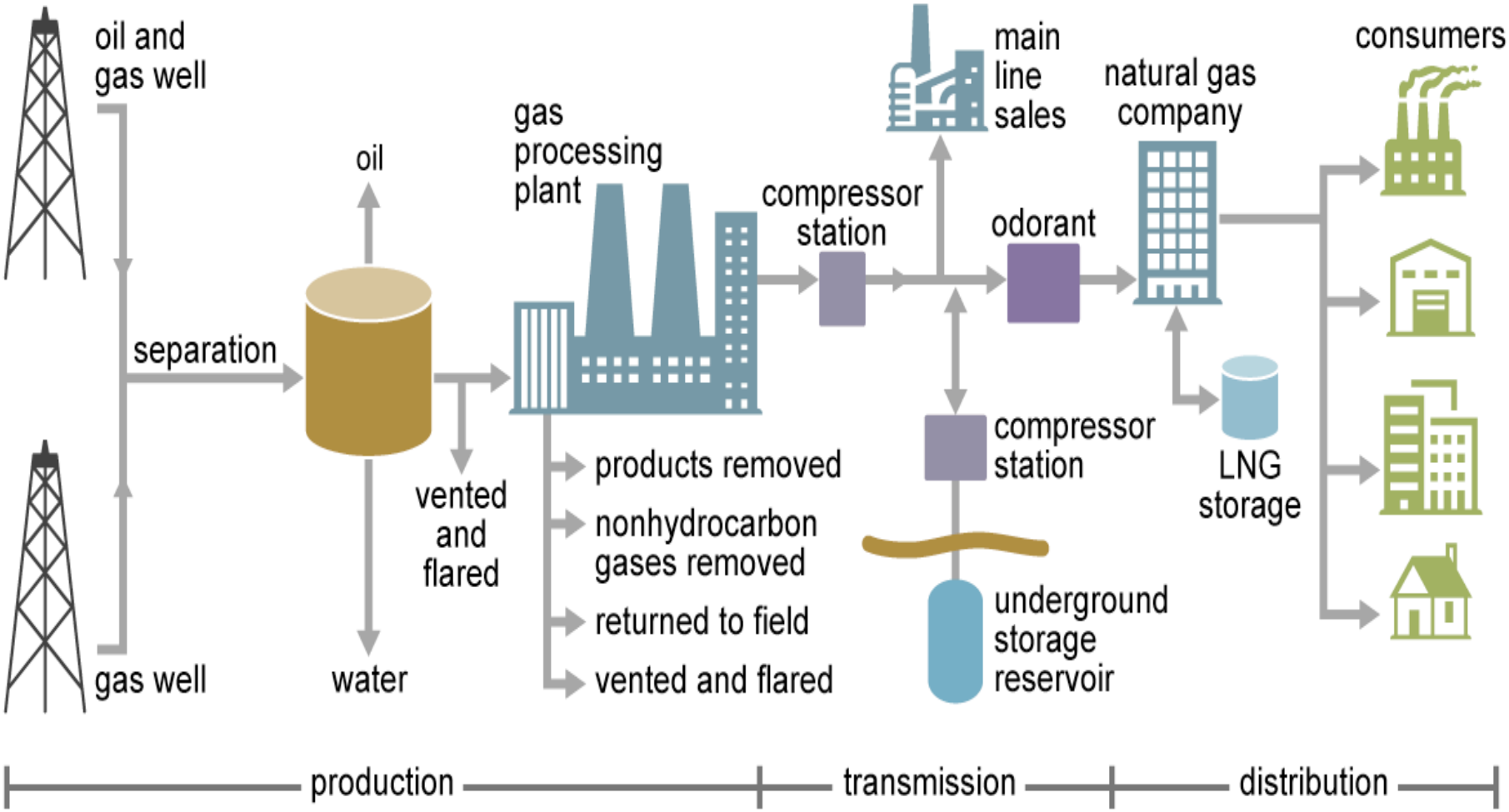


Seasonality of natural gas

Storage balances supply & consumption

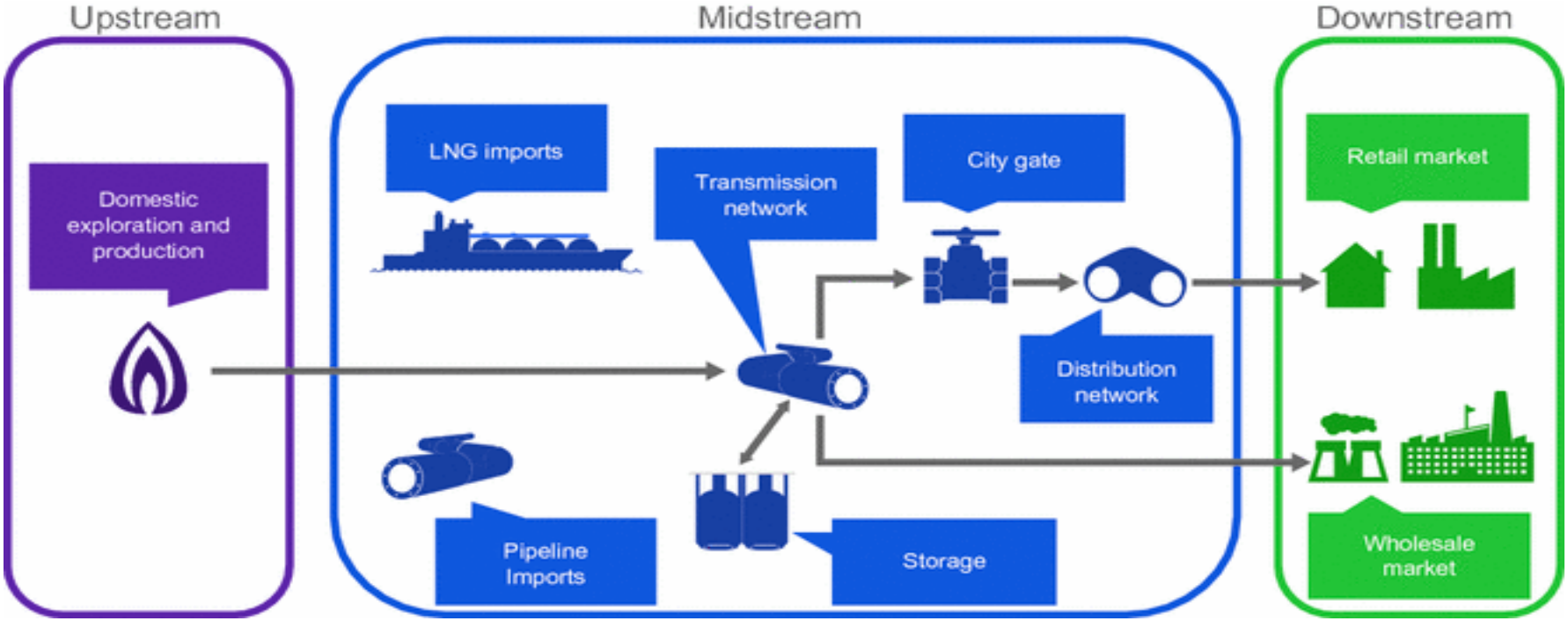


Natural gas production and delivery



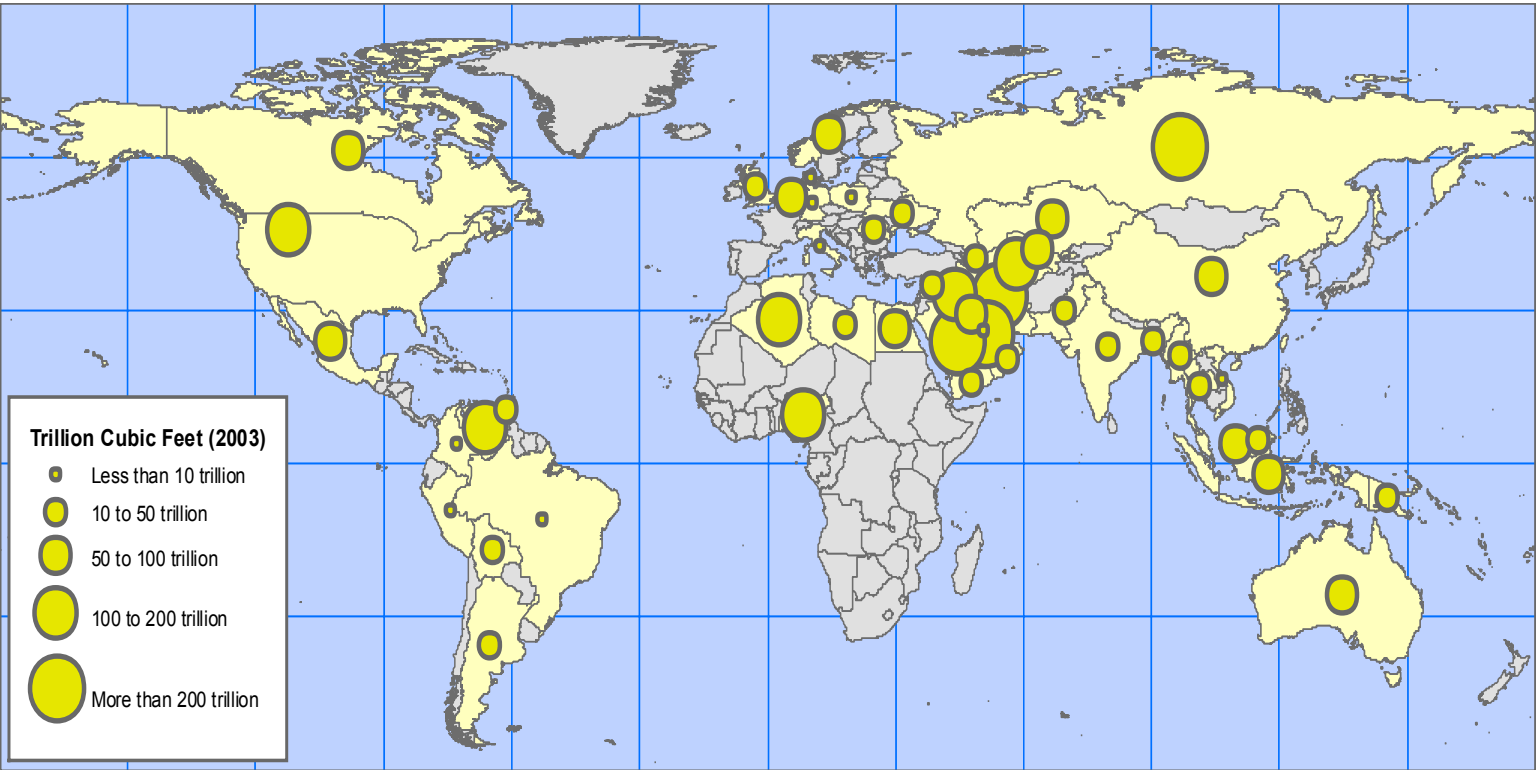
Source: U.S. Energy Information Administration

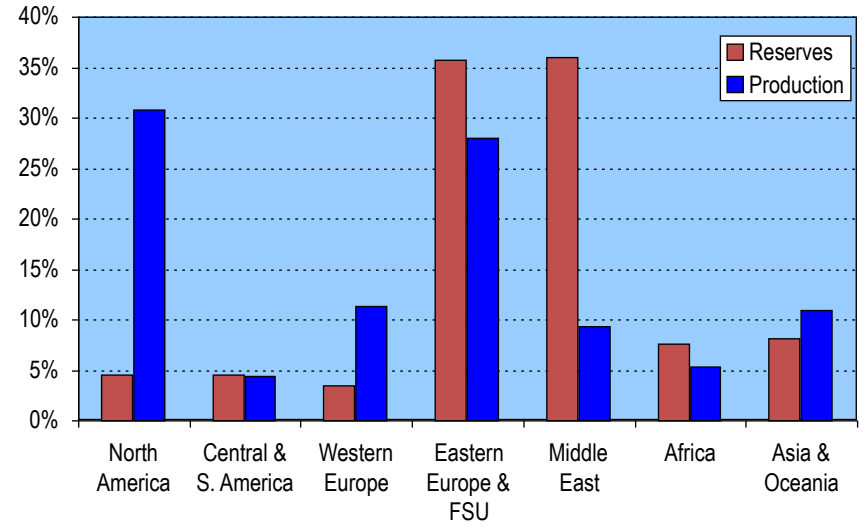
Natural Gas Industry: Upstream vs Midstream vs Downstream sector



When somebody wants to describe where a company or a service is in the Oil and Gas Supply chain, they usually use the generic business terms “Upstream” and “Downstream”. As companies or services get closer to servicing the end user, the more downstream they are located in the supply chain.
Each of these sectors have their own characteristics which will be elaborated in more details, further on in this article.
The upstream sector is also known as the E&P (Exploration and Production) sector. It is consisted of processes and operations that involve searching for potential underground or underwater crude oil and natural gas fields, drilling of exploratory wells, and subsequently drilling and operating the wells that recover and bring the crude oil and/or raw natural gas to the surface. In recent years, there is an evident shift towards the inclusion of unconventional gas as part of the Upstream sector. This also affects the developments in processing and transporting Liquefied Natural Gas (LNG).
The midstream sector is usually combined in the literature with the downstream sector. This segment in the supply chain, involves the transportation, storage and marketing of various oil and gas products. Transportation options can vary from small connector pipelines to massive cargo ships making trans-ocean crossings, depending on the commodity and distance covered.
When we are discussing the transportation of oil and natural gas, most oil can be transported in the current state, while the natural gas must be liquefied or compressed.
When it comes to the downstream sector, it encompasses the refining, processing, distillation and purification before turning it into usable, sell-able and consumable products e.g. fuels, raw chemicals and finished products etc. All the afore-mentioned services transform crude oil into usable products such as gasoline, fuel oils, and petroleum-based products. Retail marketing activities help move the finished products from energy companies to retailers or end users.

Global Natural **Gas Reserves**, 2003





- Substantial reserves likely to satisfy energy needs for the next 100 years.
- High level of concentration:
  - 45% of the world's reserves are in Russia and Iran.
- Regional concentration of gas resources is more diverse:
  - As opposed to oil.
  - Only 36% of the reserves are in the Middle East.

Availability of resources is a precondition of natural gas usage, so, looking at the natural gas industry as a whole, upstream production departments have virtual control over the operation of the whole industrial chain and the distribution of returns. As a result, opening up upstream exploration and development to new entrants is of major importance to the development of the natural gas market.

In developed European countries and in the United States, the natural gas exploration and development field is for the most part a **competitive market**, and this is closely related to the system of access to mineral rights. For instance, the privatisation of land ownership (and resources that lie beneath it) has been effective in encouraging exploration and development of natural gas, while also creating the conditions necessary for the shale natural gas revolution. The approach adopted in The Netherlands of "50-50 state-private ownership" has acted as a major stimulus in encouraging exploration for natural gas resources. The government generally implements a system of business licences, including mineral rights release mechanisms, for any companies that have been awarded mineral rights, thus avoiding hoarding of rights and delayed development. In the UK, for example, companies involved in bidding for mineral rights are expected to strictly abide by exploration and development requirements, otherwise they are likely to lose their licences. However, such a system requires strict supervision by the regulatory body.

However, natural gas resources differ from the average commodity in that not only do they have a value as a raw material, but access to such resources is also accompanied by massive profits and, in addition, they have a strategic value that derives from their relatively large influence on the national economy as a whole. It is due to such factors that in recent years, resource holders such as Russia and Middle Eastern and South American countries have been exerting ever-tighter control over their oil and gas resources. In light of this, the problem of how to increase activity in the upstream exploration and development field, while also ensuring that the majority of profits remain within the country, in addition to ensuring greater energy security for China, deserves greater consideration.

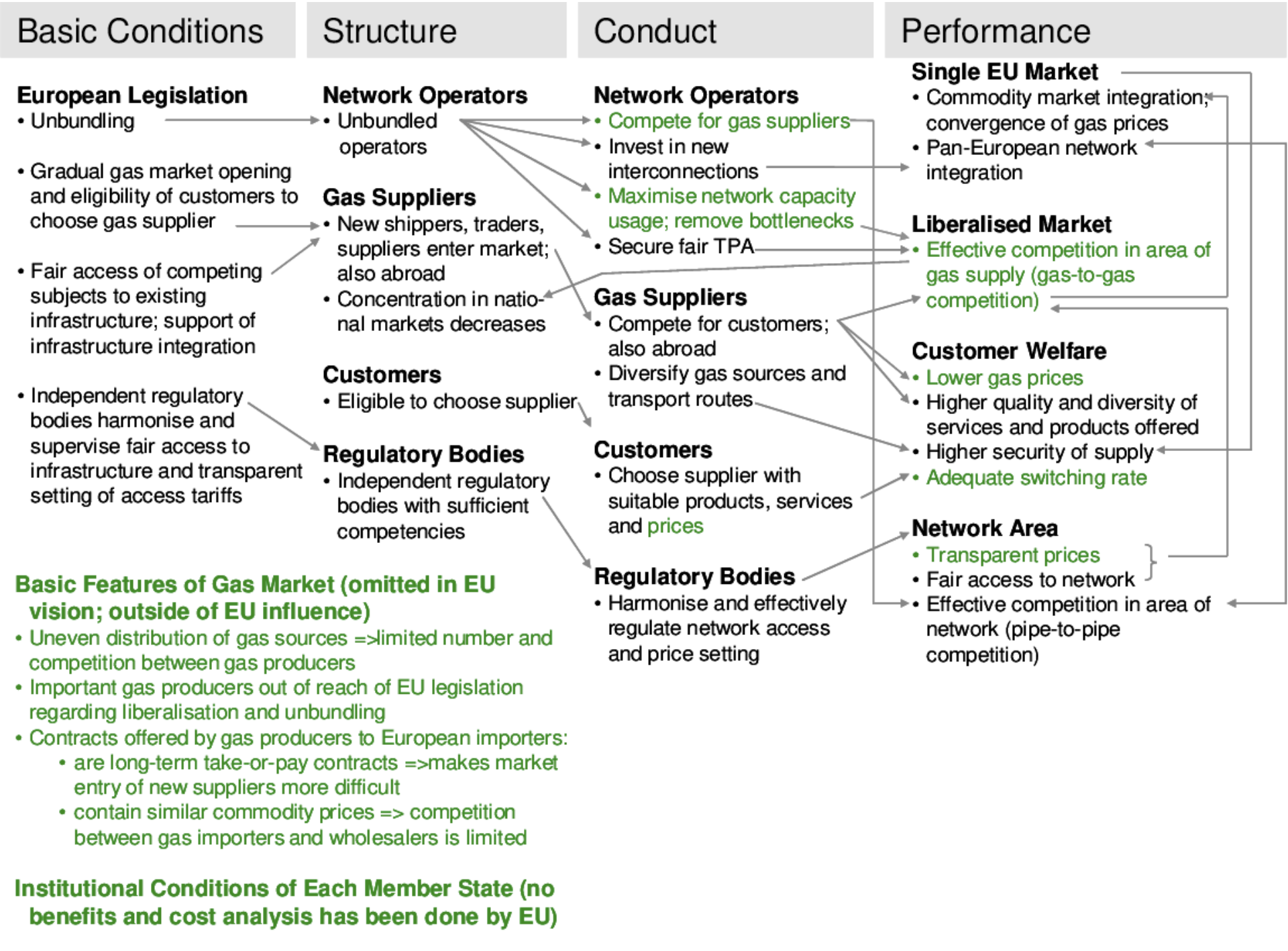
Natural gas is in the midst of a rapid growth phase. Since 2010, average global gas consumption has grown by 1.8% per year, making it the fastest growing energy source other than renewable power. In that time, the global gas industry has gone through a signi cant transformation, characterized by the North America shale boom, the rapid growth of LNG, and the development of new gas markets in Asia and the Middle East. This growth is as a result of the multiple bene ts o ered by gas as a clean, abundant, exible, and cost-e ective fuel.

Industry forecasts widely expect the rapid growth of gas to continue. The IEA and other leading forecasters project that gas consumption will grow by at least 1.6% per year over the coming decades. Among all fossil fuels, gas is the only energy source for which consumption is projected to grow in the long-run under all key scenarios, including the most aggressive low- carbon transition scenarios. As a result, gas is expected to overtake coal as the second leading source of energy by 2040.

Despite the positive recent developments and future outlook, gas has arguably not yet achieved the most optimistic growth projections. In particular, the share of gas in the global energy mix has remained virtually unchanged since 2010, with marginal growth only starting to be realized in 2017. This is due to challenges that gas faces in some markets based on its cost competitiveness relative to other fuel sources, accessibility of secure supply, and debates about the role that gas can play in promoting environmental sustainability.

To sustain rapid gas market growth and achieve the expectations of gas market share growth over the coming decades, three levers will be critical:

1. ***Cost Competitiveness***: Improving the relative cost of gas to other energy sources through a combination of LNG cost e ciencies, pricing environmental externalities, and promotion of local gas production in markets around the world.
2. ***Security of Supply***: Enabling gas supply security through the development of enhanced networks and infrastructure, more exible commercial models, and new modular access-enabling technologies (e.g. FSRUs).
3. ***Sustainability***: Promoting the environmental sustainability of gas as an instrument to reduce urban air pollution, by developing low carbon technologies for gas, integrating renewable gas sources into existing infrastructure, and limiting methane emissions.


Basic Conditions
Structure
Conduct
Performance
European Legislation
• Unbundling
• Gradual gas market opening and eligibility of customers to choose gas supplier
• Fair access of competing subjects to existing infrastructure; support of infrastructure integration
• Independent regulatory bodies harmonise and supervise fair access to infrastructure and transparent setting of access tariffs
Network Operators
• Unbundled operators
Gas Suppliers
• New shippers, traders, suppliers enter market; also abroad
• Concentration in national markets decreases
Customers
• Eligible to choose supplier
Regulatory Bodies
• Independent regulatory bodies with sufficient competencies
Network Operators
• Compete for gas suppliers
• Invest in new interconnections
• Maximise network capacity usage; remove bottlenecks
• Secure fair TPA
Gas Suppliers
• Compete for customers; also abroad
• Diversify gas sources and transport routes
Customers
• Choose supplier with suitable products, services and prices
Regulatory Bodies
• Harmonise and effectively regulate network access and price setting
Single EU Market
• Commodity market integration; convergence of gas prices
• Pan-European network integration
Liberalised Market
• Effective competition in area of gas supply (gas-to-gas competition)
Customer Welfare
• Lower gas prices
• Higher quality and diversity of services and products offered
• Higher security of supply
• Adequate switching rate
Network Area
• Transparent prices
• Fair access to network
• Effective competition in area of network (pipe-to-pipe competition)
Basic Features of Gas Market (omitted in EU vision; outside of EU influence)
• Uneven distribution of gas sources =>limited number and competition between gas producers
• Important gas producers out of reach of EU legislation regarding liberalisation and unbundling
• Contracts offered by gas producers to European importers:
• are long-term take-or-pay contracts =>makes market entry of new suppliers more difficult
• contain similar commodity prices => competition between gas importers and wholesalers is limited
Institutional Conditions of Each Member State (no benefits and cost analysis has been done by EU)

USA

1985 Order 436
Allowing users to sign contacts directly with manufacturers, encouraging the provision of pipeline services to third parties

1978
Natural gas policy encouraging pipelines to provide access to their transport services

1992 Order 636
Completely removed the "bundling" of natural gas sales with pipeline transport

2000 Order 637
Further removal of "bundling" between natural gas sales and pipeline transport

1998
The first Gas Directive required non-discriminatory access to 20% of the market in transport services, introducing the concept of "unbundling" without being obligatory

2003
The second Gas Directive made it obligatory to "unbundle", and launched the proposal that households should be free to choose their natural gas supplier

2009
The third Gas Directive was responsible for pipeline transport services becoming independent, giving customers the freedom to choose or change supplier

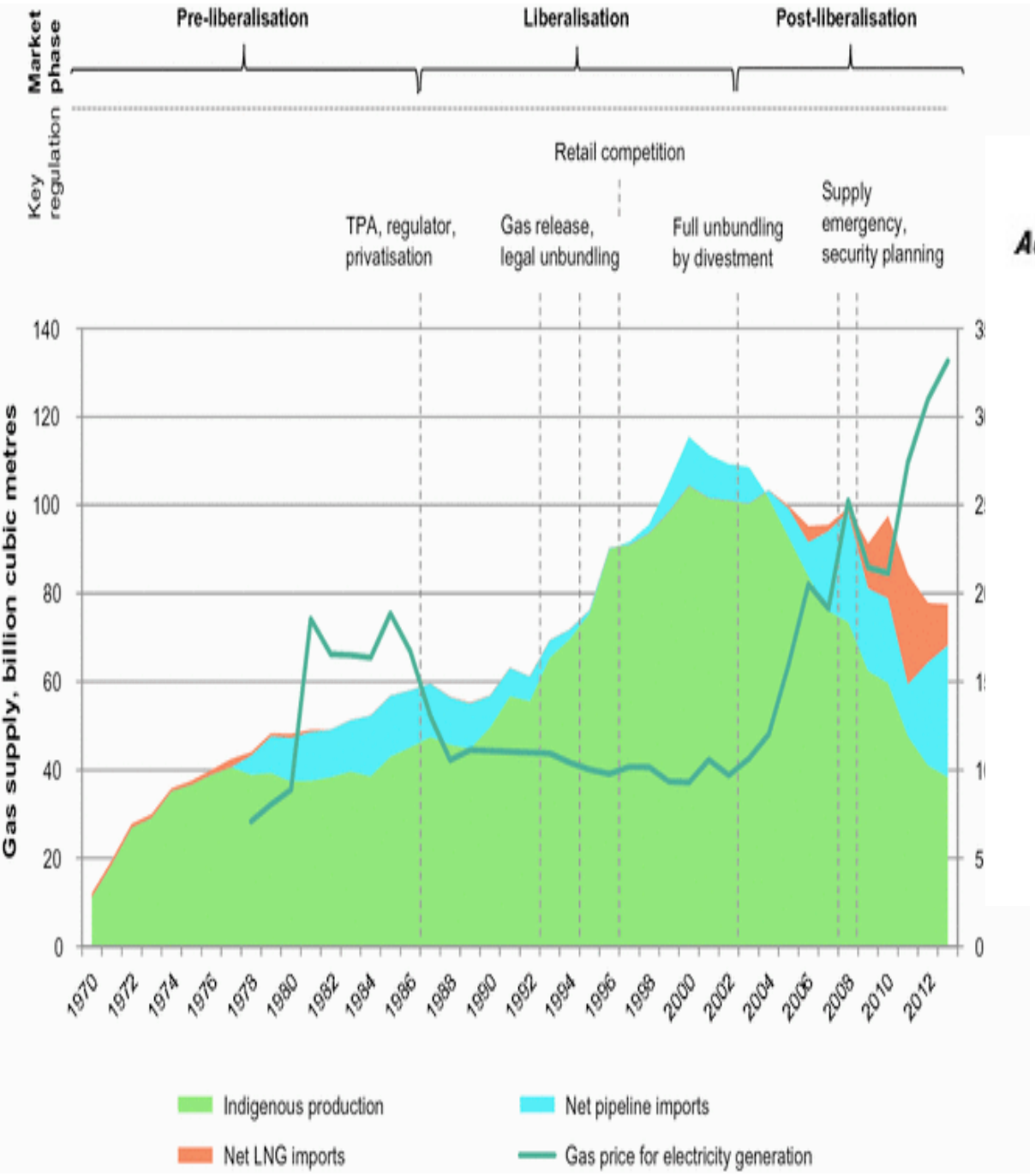
EUROPE

ofgem Making a positive difference for energy consumers

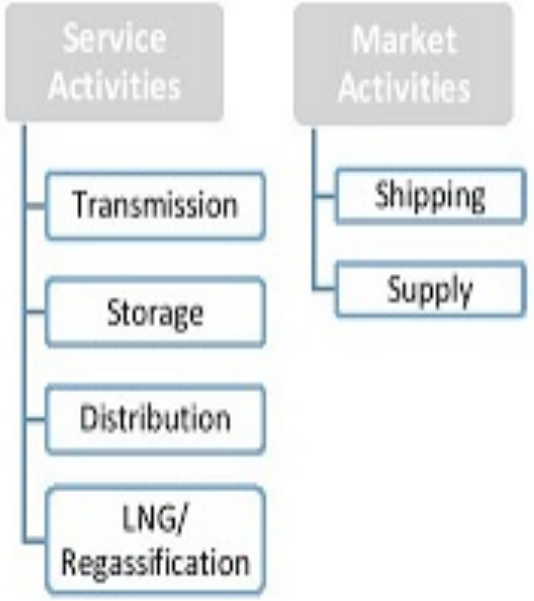
Privatisation and Liberalisation

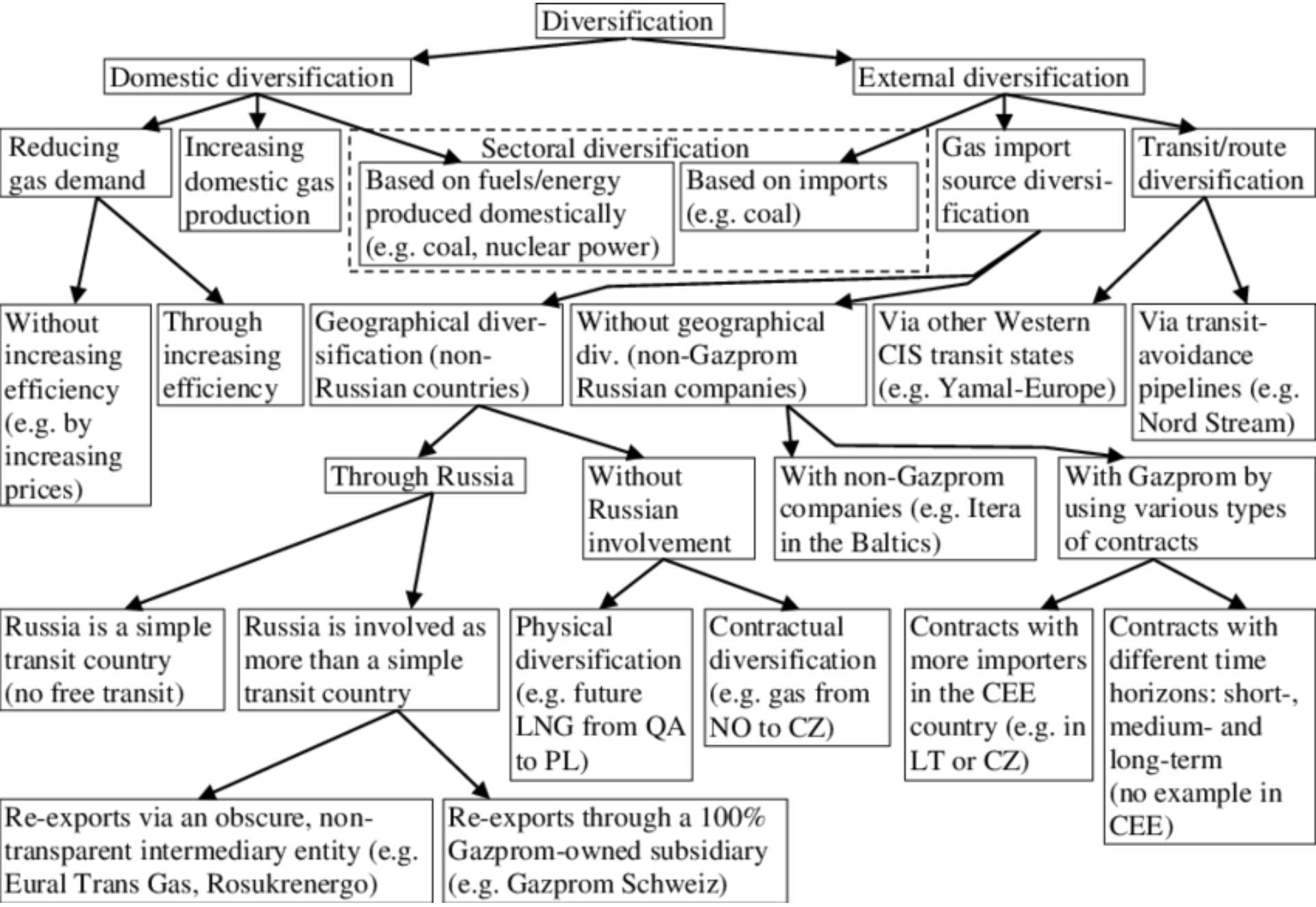
Gas Act 1986	Enabled privatisation of British Gas and created regulatory framework. No differentiation between supplier of gas and operator of transmission system. British Gas only authorised supplier for consumers < 25,000 therms (732 MWh) / year. Competition for consumption > 25,000 therms (732 MWh) / year ("large consumers")
1988 MMC report	Reference to MMC (Monopolies and Mergers Commission) for large consumer market. Concluded many large consumers had no realistic alternatives to British Gas, and evidence of price discrimination. As a result – British Gas required to price by reference to published schedules. Also undertook to contract for no more than 90% of any new supplies from UK continental shelf in the period June 1989 – May 1991.
1991 OFT review	Review for large consumer market. Found 1988 remedies had been ineffective in introducing self-sustaining competition in large consumer market. Particular obstacles – lack of available gas for competing suppliers, British Gas's monopoly of supply to smaller consumers and position in storage and distribution British Gas gave series of undertakings – creation of conditions so other suppliers should be able to supply at least 60 % of large consumers by 1995; and separation of transportation and storage activities, with published transparent charges. Gas release programmes to give competitors access to supplies. Combined with independent production from new fields supported development of competition.

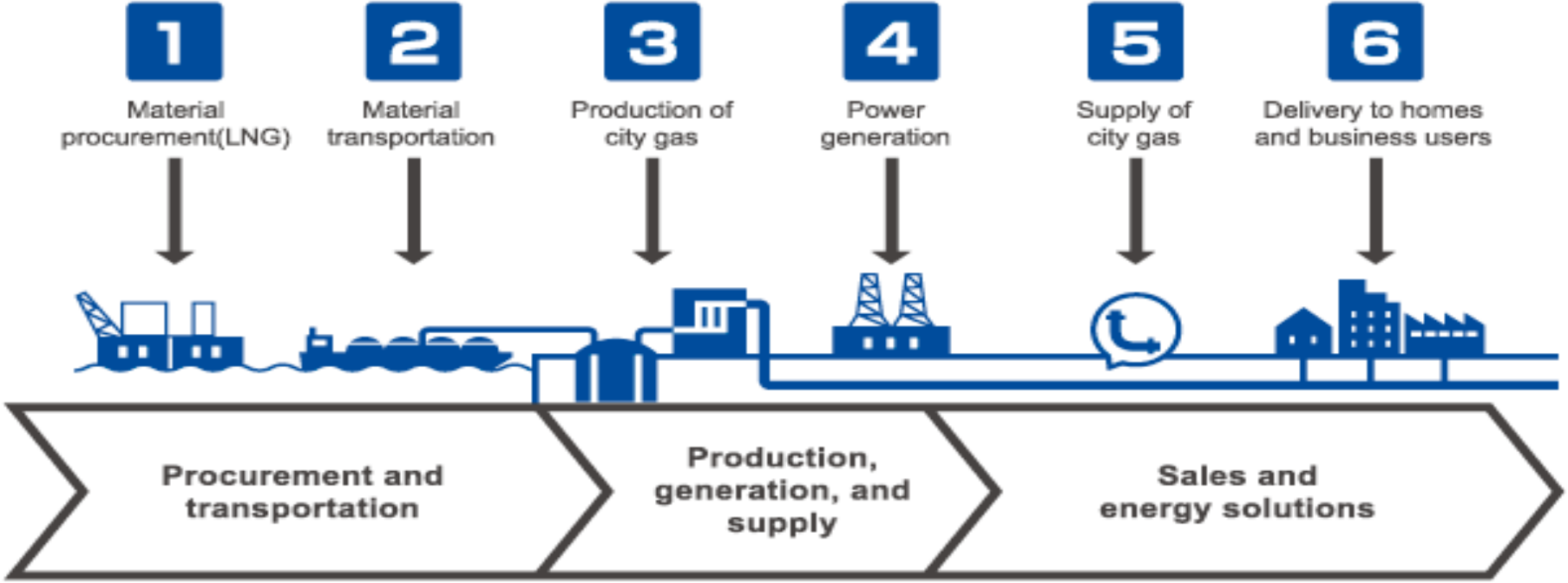
1986: Privatisation of British Gas
1996: Establishment of the Network Code
(TPA) and NBP 1998: Complete abolition of Centrica marketing monopoly
1998: Start up of the Interconnector
1998: Establishment of the Zeebrugge
1998: Directive concerning common rules for the internal market (following telecom deregulation)
2003: Directive concerning common rules for the internal market and repealing 1998 directive
2007: Third energy package
2009: Art 194 of the Lisbon Treaty, carefully crafted compromise between national sovereignty governing energy mix, exploitation of natural resources and energy taxation and a shared EU competence for other areas



Activities Regulated by the New Draft Gas Law

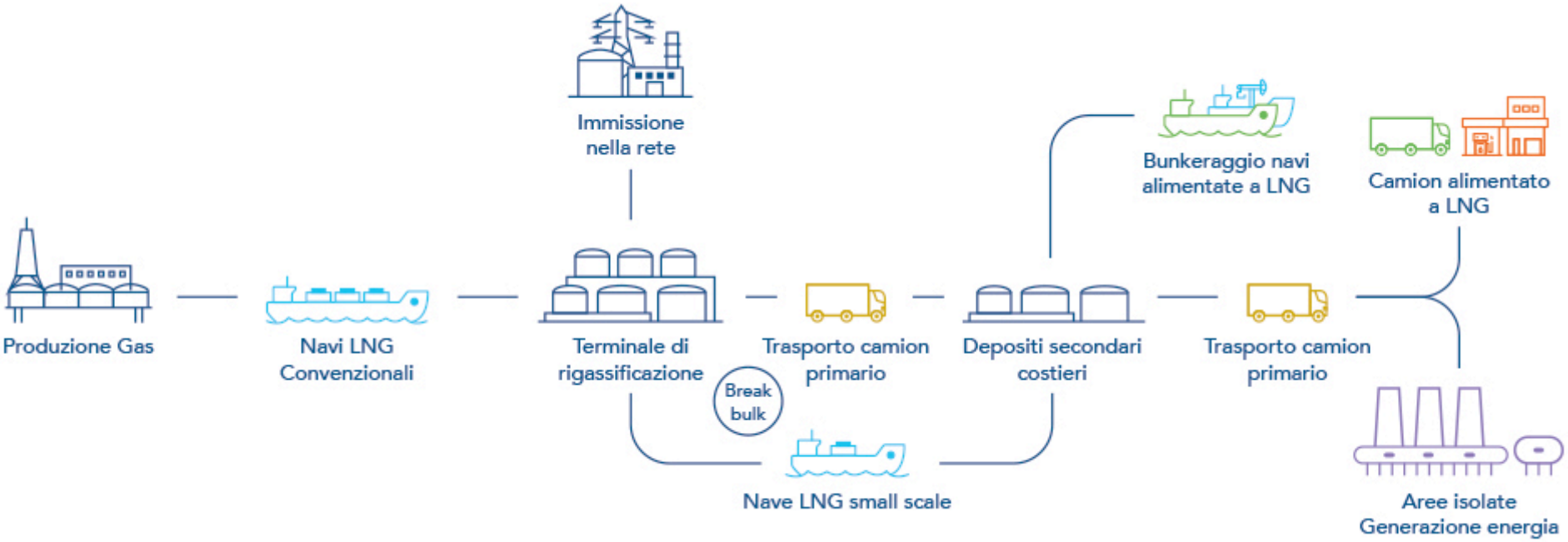


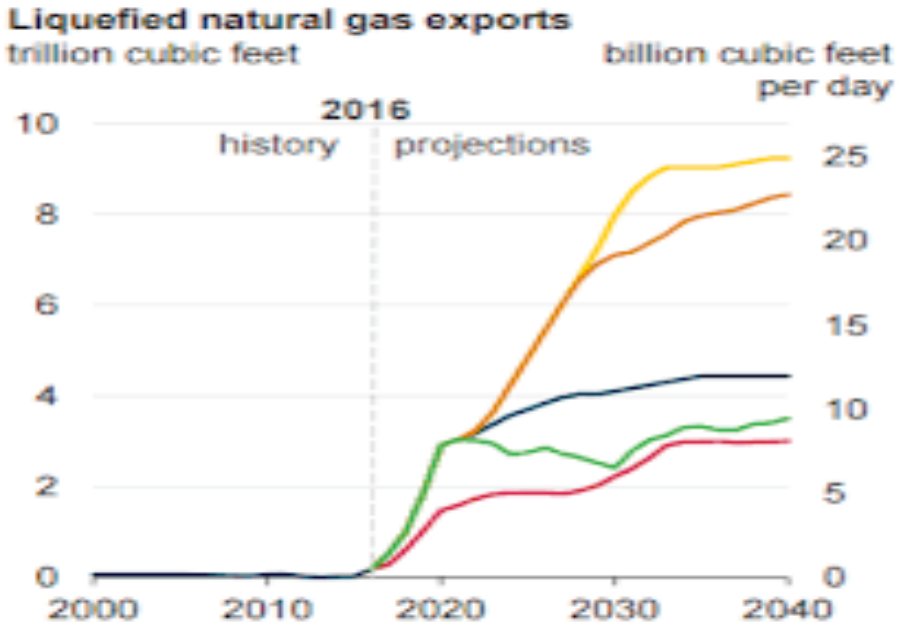

Diversification
Domestic diversification
External diversification
Reducing gas demand
Increasing domestic gas production
Sectoral diversification
Based on fuels/energy produced domestically (e.g. coal, nuclear power)
Based on imports (e.g. coal)
Gas import source diversi-fication
Transit/route diversification
Without increasing efficiency (e.g. by increasing prices)
Through increasing efficiency
Geographical diver-sification (non-Russian countries)
Without geographical div. (non-Gazprom Russian companies)
Via other Western CIS transit states (e.g. Yamal-Europe)
Via transit-avoidance pipelines (e.g. Nord Stream)
Through Russia
Without Russian involvement
With non-Gazprom companies (e.g. Itera in the Baltics)
With Gazprom by using various types of contracts
Russia is a simple transit country (no free transit)
Russia is involved as more than a simple transit country
Physical diversification (e.g. future LNG from QA to PL)
Contractual diversification (e.g. gas from NO to CZ)
Contracts with more importers in the CEE country (e.g. in LT or CZ)
Contracts with different time horizons: short-, medium- and long-term (no example in CEE)
Re-exports via an obscure, non-transparent intermediary entity (e.g. Eural Trans Gas, Rosukrenergo)
Re-exports through a 100% Gazprom-owned subsidiary (e.g. Gazprom Schweiz)



Liquefied natural gas (LNG)

- Liquid form of natural gas; easier to transport.
- Cryogenic process (-256oF): gas loses 610 times its volume.
- Value chain:
  - Extraction
  - Liquefaction
  - Shipping
  - Storage and re-gasification

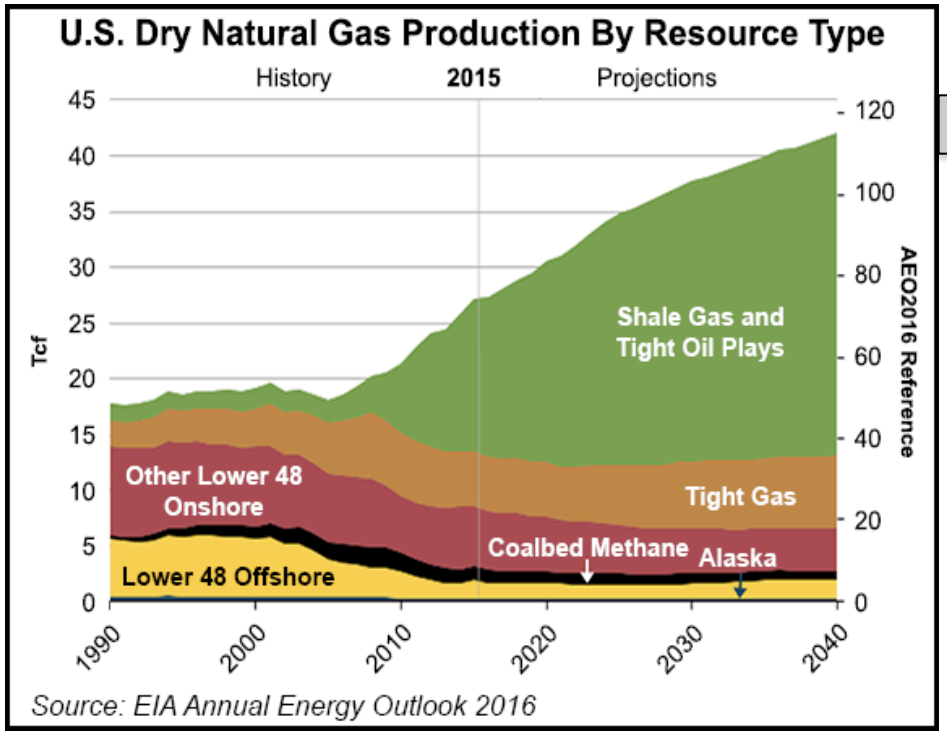


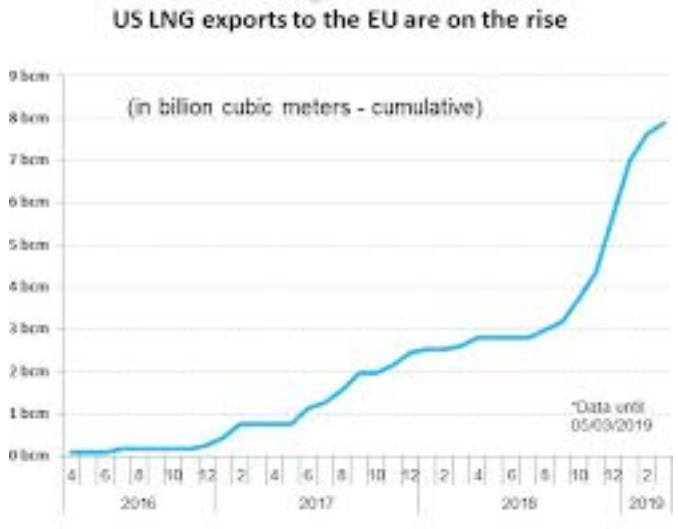


1. Natural Gas is the cleanest fossil fuel.
2. As LNG, has a Low carbon Footprint across its Value Chain.
3. Has a good position in tomorrow's energy mix.

Natural gas production from shales will account for 30% of global output by 2040 as shale resources are developed in more countries, particularly Mexico and Algeria, according to the U.S. Energy Information Administration (EIA).

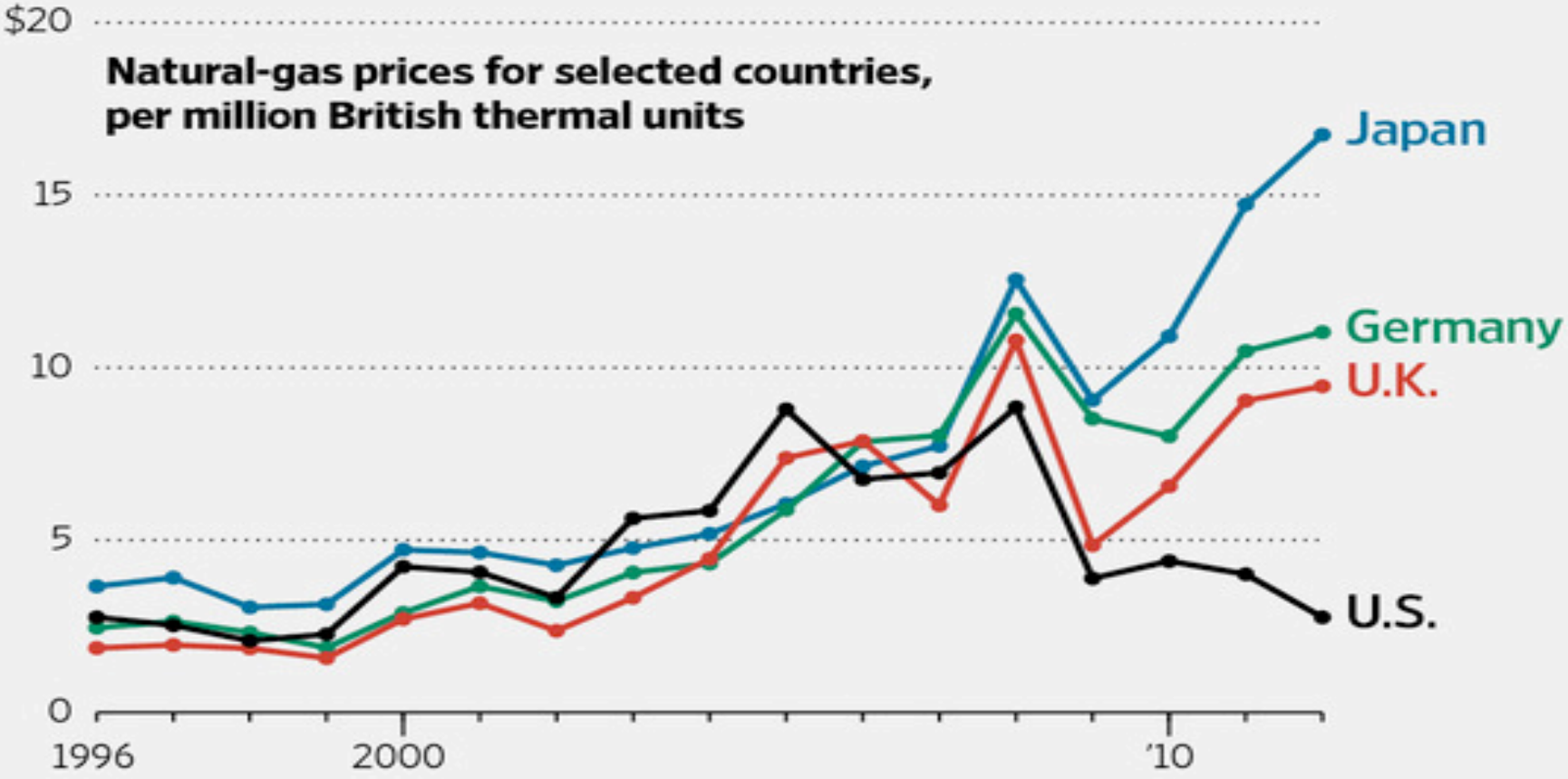
In fact, anticipated new entrants Mexico and Algeria, along with current shale producers -- the United States, Canada, China and Argentina -- will account for 70% of global shale production by 2040, EIA said. This is according to EIA's International Energy Outlook 2016 and Annual Energy Outlook 2016 (AEO2016) (see *Daily GPI*,May 17), which forecast that worldwide natural gas production overall will increase from 342 Bcf/d in 2015 to 554 Bcf/d by 2040. Shale accounts for the largest portion of the growth, rising from 42 Bcf/d in 2015 to 168 Bcf/d by 2040. In the United States, shales accounted for more than half of U.S. gas production last year. Shale production is projected to more than double from 37 Bcf/d in 2015 to 79 Bcf/d by 2040, which is 70% of total U.S. natural gas production in the AEO2016 reference case by 2040, EIA said. Shale production in 2040 is projected to be 50% higher under the "high oil and gas resources and technology" case, reaching 112 Bcf/d. However, in the "low oil and gas resources and technology" case, production is projected to be 50% lower than the reference case, reaching only 41 Bcf/d.





Carbon Backfire

More European electricity generators are switching from natural gas to cheaper but more carbon-intensive coal. The U.S. shale boom has lowered natural-gas prices in America and prompted coal producers there to export coal to Europe.



Note: Prices based on widely traded benchmarks in natural-gas market. For Japan, liquefied-natural-gas import price including cost, insurance and freight (CIF); for Germany, average import price including CIF; for U.K., national balancing point (NBP); for U.S., Henry Hub natural-gas spot price

Source: BP Review of World Energy 2013

The Wall Street Journal