Energy Economics and Policy
AUEB

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Lecture 5:
Oil and Gas

Objectives

- Oil
  - Formation, exploration and extraction methods
  - Oil reserves / αποθέματα, peak oil / μέγιστη ποσότητα εξόρυξης
  - Crude oil and by-products / πετρέλαιο και παράγωγα
  - Future contracts and negative oil prices
  - OPEC cartel: two models to study it

- Natural gas
  - Gas trends, major players
  - Gas networks
  - The Greek gas network
  - The role of gas in the transition to a carbon-free era
  - Geopolitics of gas

- Biofuels
  - Pros and cons
  - The tortilla crisis: competition between food and energy

Fossil fuels formation

- Oil and natural gas are formed from organic matter (οργανική ύλη) from dead plants and animals. These *hydrocarbons (υδρογονάνθρακες)* take millions of years to form under specific pressure and temperature conditions

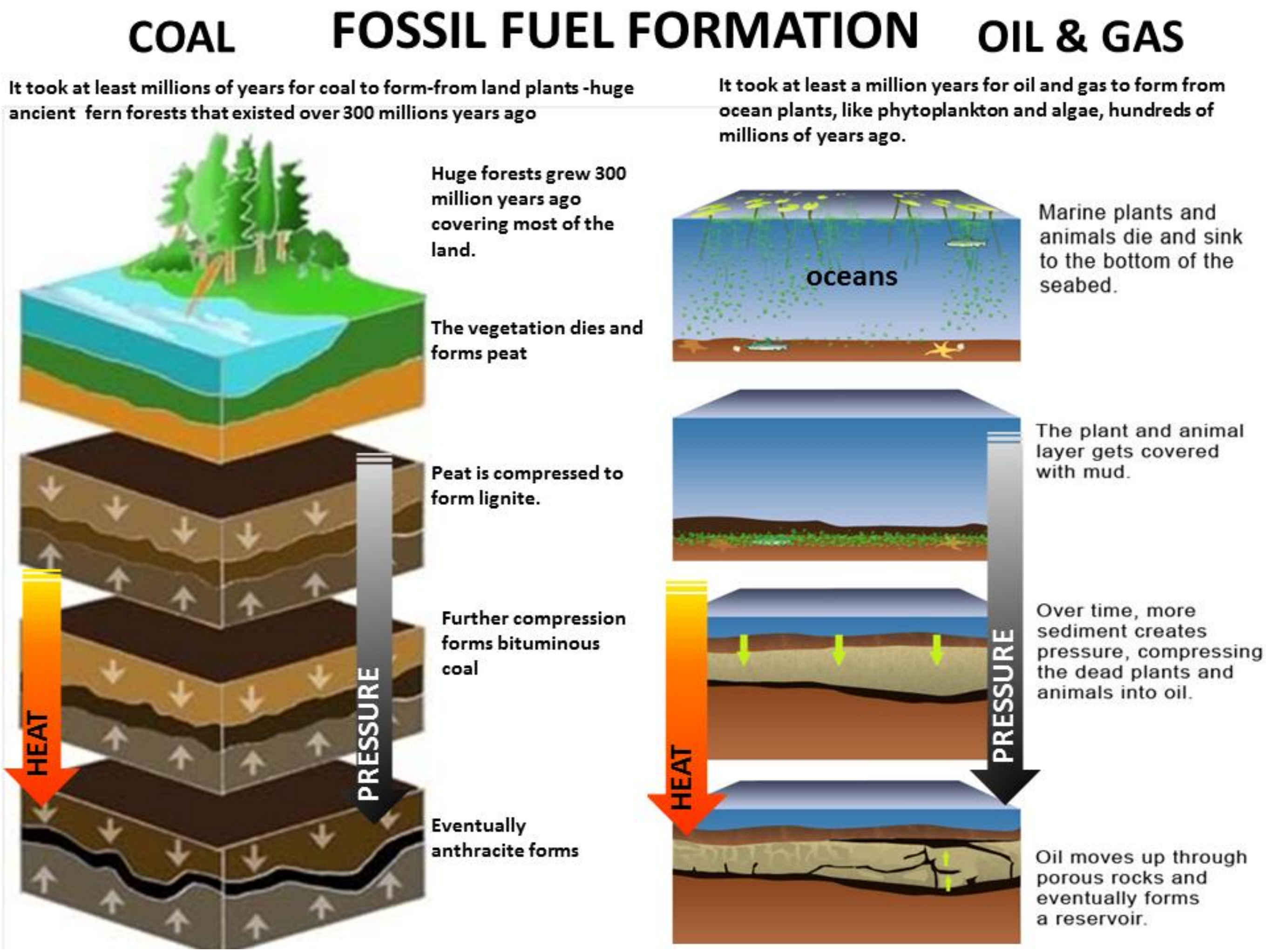
- About 60 million years to form = non renewable for our time horizons

- When a living organism dies is either:
    - eaten by predators, scavengers (σαπροφάγα) or bacteria
    - oxidizes – its molecules are combined with oxygen in the air to create natural fertilizer for plants

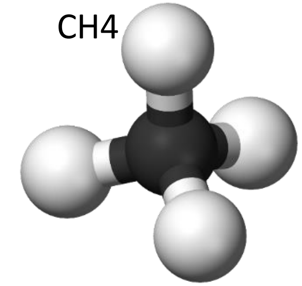
- Only **0.1% escapes this fate and is transported by water, sinking to the bottom of the sea or continental lakes**. In poor oxygen environments as further sediments (ιζήματα) accumulate on top pressure and temperature increases helping the transformation of this 0.1% by anaerobic bacteria to fossil fuels

https://www.youtube.com/watch?v=pvH-h7TzSsE

Fossil fuels formation



Methane
CH4

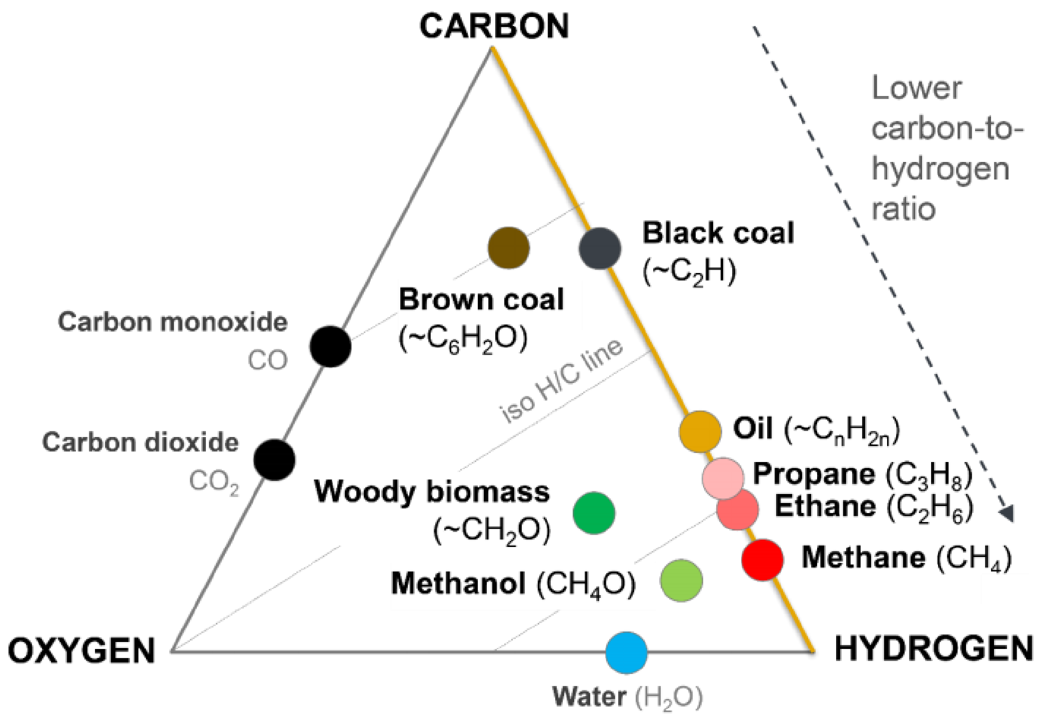


What is oil and gas?

- Oil and gas are mixes of molecules of different liquid hydrocarbons
- Hydrocarbons: molecules composed of carbon (C) and hydrogen (H)
  - The simplest is CH4 (picture) – methane / natural gas
    (Example: Greek natural gas is 85% methane)
  - We can have more complex molecules with two, three,.. atoms of C or higher ratio of C to H
  - As the number of carbon atoms increase molecules start becoming denser, liquid, more sticky, oily.
  - At high concentrations molecules turn to solid (e.g. asphalt, bitumen)
- The fact that oil can be transported as liquid is one the major advantages
- In contrast natural gas needs to be pressurized
- Popularity over coal due to much higher energy content (energy density)

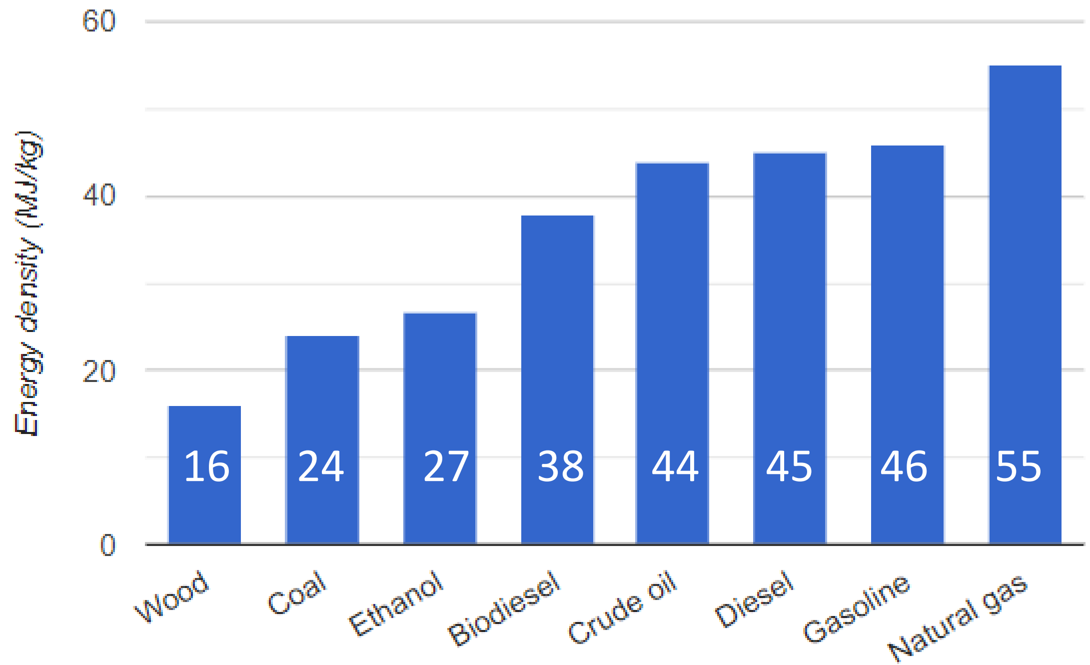
Oil & Gas Chemistry

C/H ratio of carbon-based fuels



- The lower the C/H ratio the lower the CO_2 emissions upon burning. Therefore natural gas is a particularly attractive fossil fuel
- Its main drawback is its low volumetric energy density/ενεργειακή πυκνότητα κατ΄όγκο

Energy density of carbon-based fuels



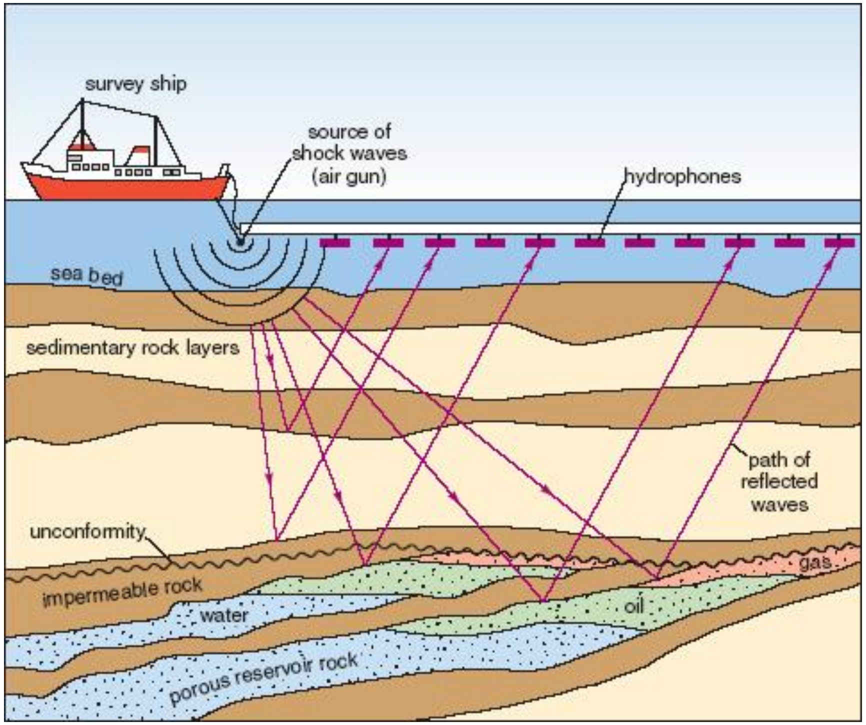
- Compare the above to:
  - Hydrogen (H2) – 120 MJ/kg
  - Uranium (U235) – 3,900,000 MJ/kg

- Densities: nat. gas 0.68 kg/m3, gasoline 748.9 kg/m3 → gas needs to be pressurized which is an expensive and energy-intensive procedure

How do we look for oil/gas?

Seismic exploration

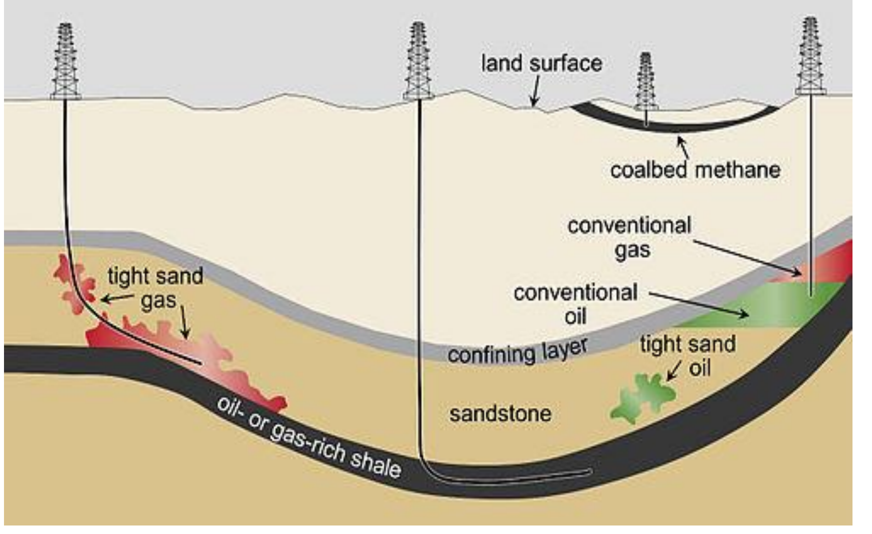
- Create small explosions – small sound shocks
- The sound penetrates the earth and creates an echo
- The echo creates an image of the sub-surface formation
- But it is when we actually drill that we know for sure what is there



Conventional and unconventional oil/gas

Conventional reservoirs:
Συμβατικά αποθέματα

- Buoyancy (άνωση) keeps hydrocarbons in place under a confining rock layer
- Usually hydrocarbons form well-defined accumulations/συσσωρεύσεις of crude oil and natural gas

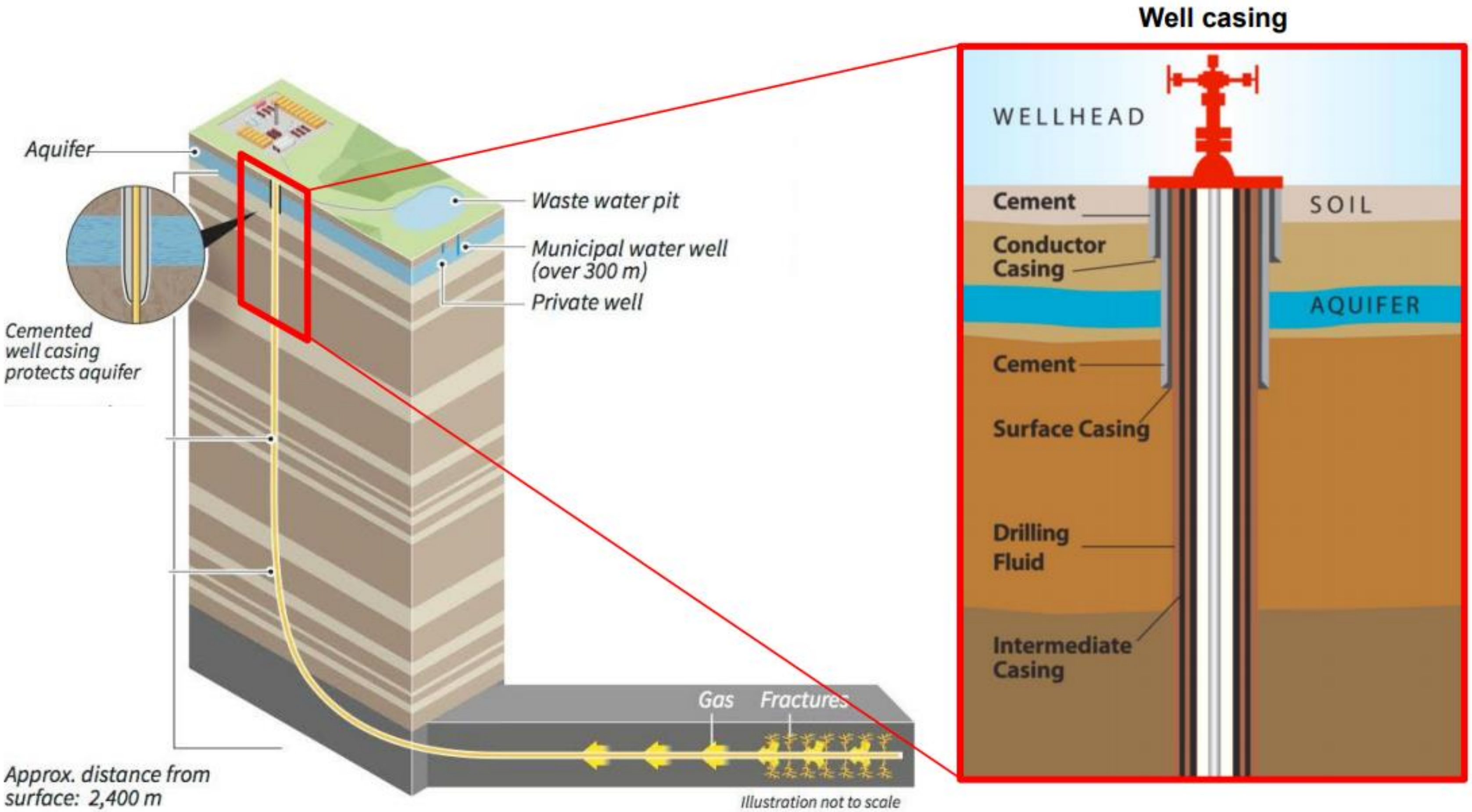


- Reservoir and fluid characteristics (high rock permeability/διαπερατότητα and low fluid viscosity/ιξώδες) allow the resource to flow into a wellbore

Unconventional reservoirs:

- Hydrocarbons in poorly-connected pores or hydrocarbons that are too viscous/heavy (e.g. oil shales in the US and tar sands / oil sands in Canada)
- Need for more advanced extraction technology = increased marginal cost → Makes sense only when oil prices are high

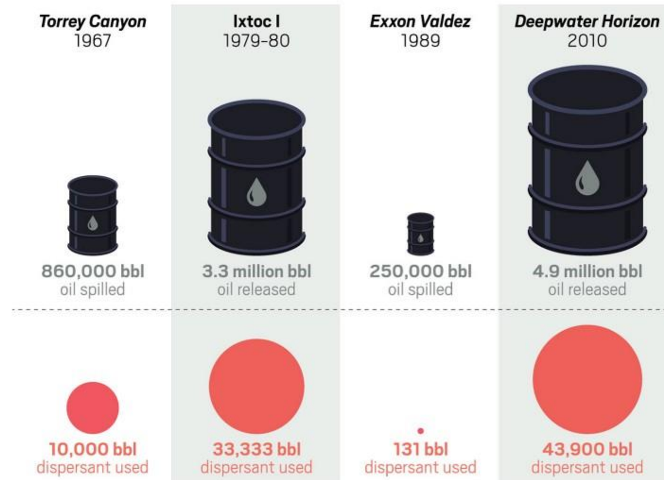
Fracking /υδραυλική ρωγμάτωση

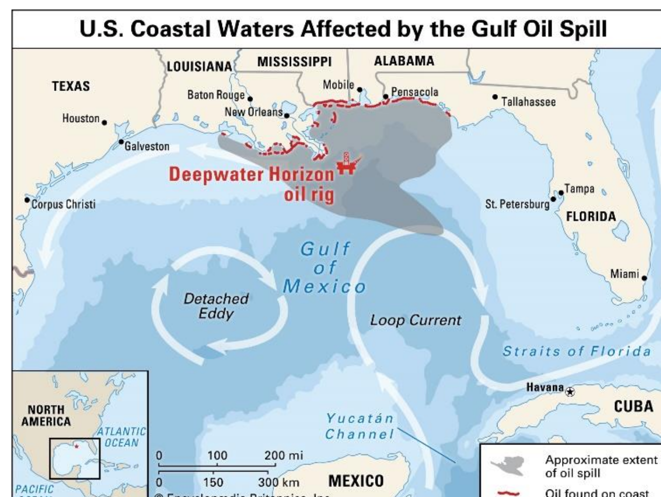


Sources: National Geographic, Chesapeake Energy, EIA., USGS

Fracking: https://www.youtube.com/watch?v=VY34PQUiwOQ&feature=youtu.be
Deep sea drilling: https://www.youtube.com/watch?v=YQtDiX2Dbr0

Drilling going wrong
BP's Deepwater horizon oil spill





BP's Deepwater Horizon bill tops $65bn

Firm's financial pain offset by rising oil prices as it winds down payouts from 2010 disaster

Global oil reserves / αποθέματα πετρελαίου

Nobody knows precisely how much oil exists under the earth's surface and how much it will be possible to produce in the future.

Reserves/αποθέματα

- Proved: 90/95% probability that commercially recoverable oil exists
- Probable: 50-89% probability …
- Possible: 10-49% probability…

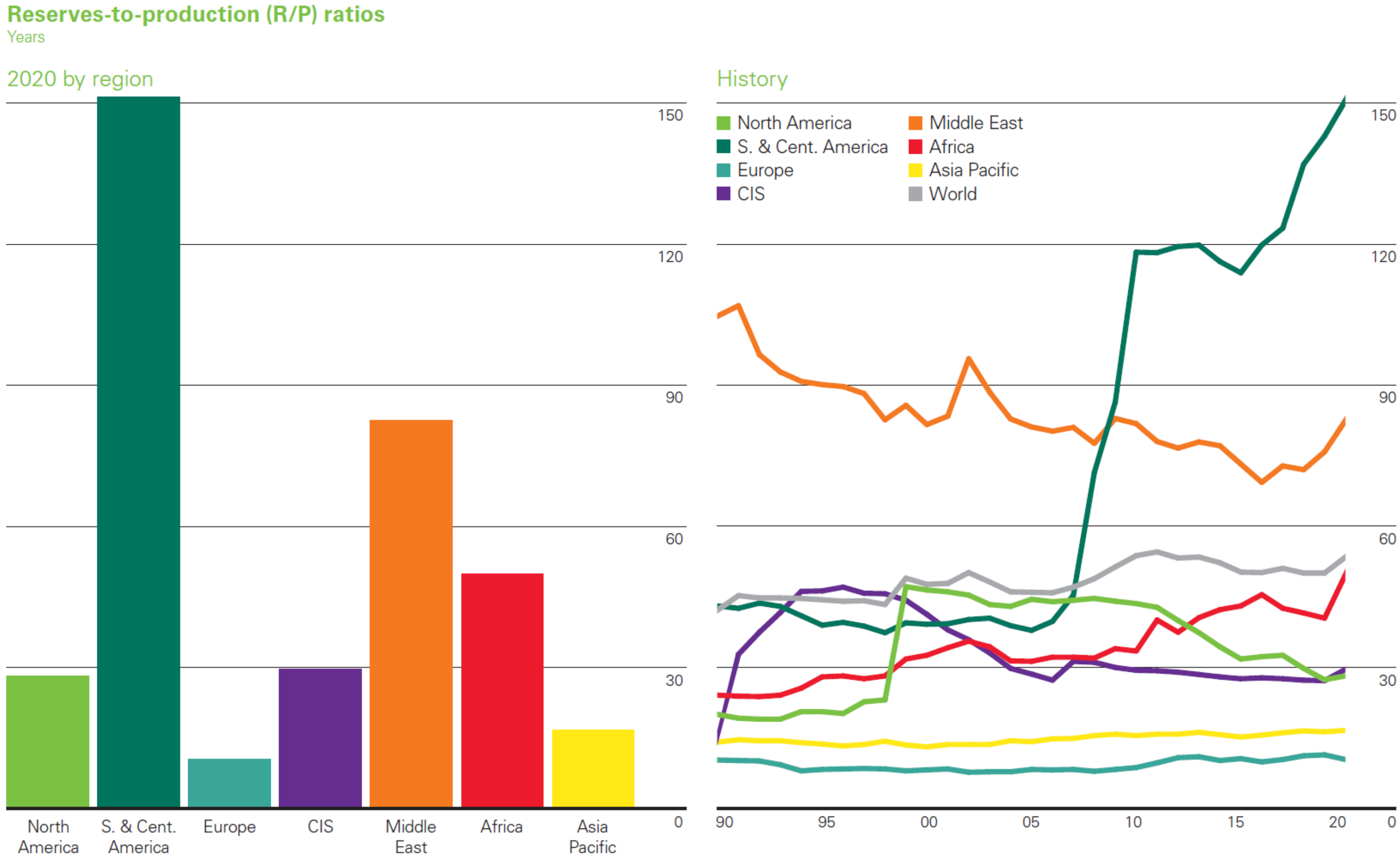
Recovery factor RF/συντελεστής ανάκτησης

- Percentage of oil that can be extracted in a given accumulation
- E.g. for UK the expected RF of the "Continental Shelf" site is 43%
- Recovery factors tend to rise over time due to technological progress

See BP's 2021 statistical review for different statistics here

Global oil reserves

R/P ratio = εναπομένουσα εξόρυξη σε χρόνια εάν συνεχίσουν με τον ίδιο ρυθμό παραγωγής



Global proved oil reserves were 1732 billion barrels at the end of 2020, down 2 billion barrels versus 2019. The global R/P ratio shows that oil reserves in 2020 accounted for over 50 years of current production. OPEC holds 70.2% of global reserves. The top countries in terms of reserves are Venezuela (17.5% of global reserves), closely followed by Saudi Arabia (17.2%) and Canada (9.7%).

BP, Statistical Review of World Energy 2021

Peak oil / μεγιστοποίηση παραγωγής πετρελαίου

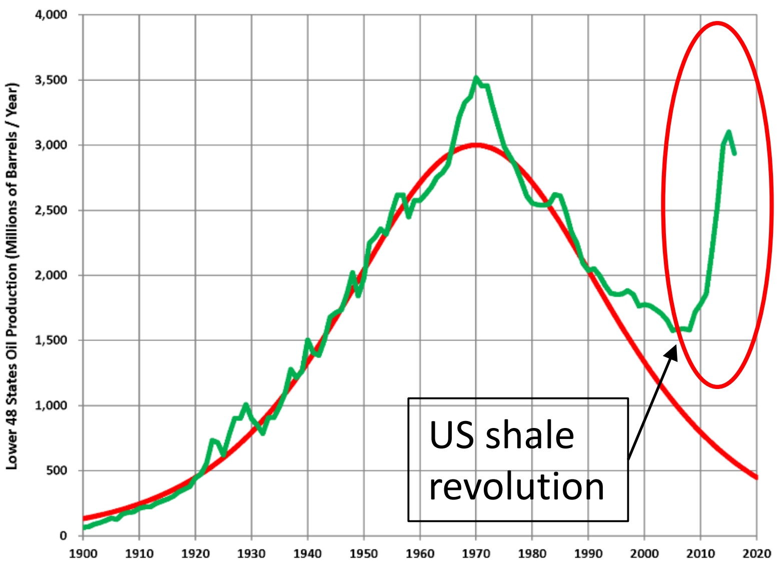
Is peak oil in sight?

Oil as a fossil fuel was generated over millions of years, and the accumulation of oil that exists in the ground in the earth, is being drawn down very quickly. So sooner or later, we are going to run out of it. But are we running out of it?

Peak oil: point in history when half of the global *recoverable* oil has been extracted. At this point the rate of oil production is at its maximum

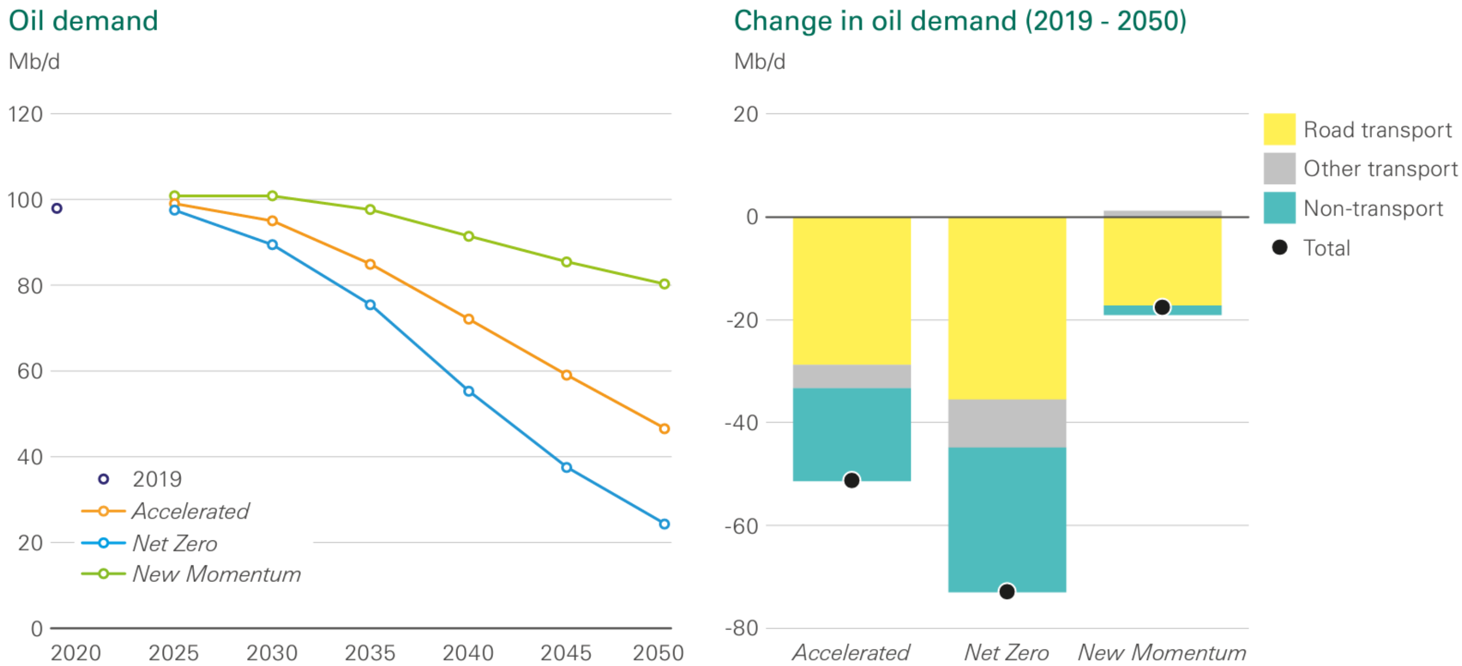
Hubbert curve

Hubbert's prediction for US crude oil production (1956) in red, and actual US production through to 2014 in green



Peak oil

From peak supply to peak demand



Left: BP Energy outlook 2022 (link here)

BP estimates that **peak oil has been reached in 2019**:

- Accelerated: significant tightening of climate policies
- Net Zero: climate policies + technology improvement + behavioural changes
- New Momentum: current trajectory (SDGs, technologies, current consuming behaviour)

Peak oil

From peak supply to peak demand

Reasons behind peak oil demand

- Technological progress – energy demand turns electric (e.g. mobility)
- Policy becomes more stringentto meet environmental targets agreed by countries (Paris agreement – 1.5 deg C warming in 2100 relative to pre-industrial times)
- People environmental awareness
- Covid-19 to have a long-lasting operational changes – e.g. less business travelling, more home office

Oil + Add to myFT

Opec dismisses concerns that peak oil demand is close

Cartel forecasts swift recovery and two decades of growth, in contrast to many in sector

Opec said in its annual outlook that its base case was for demand to grow from 90.7m barrels a day this year to 109.3m b/d in 2040 © REUTERS

Anjli Raval, Senior Energy Correspondent OCTOBER 8 2020

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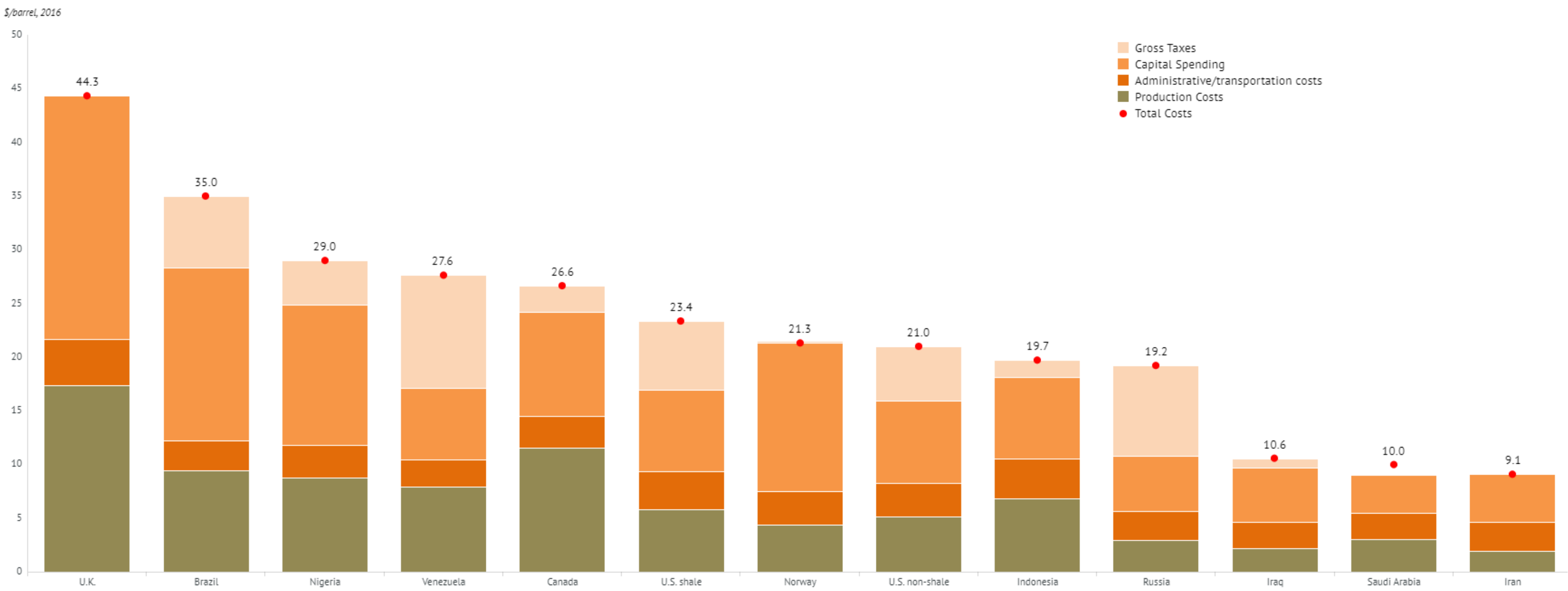
Reasons against peak oil demand

- Developing countries need more energy on their path to development
  - Why not a clean path??
- Renewables as a new technology entail a risk that investors are not willing to take
  - Fossil technologies are mature and risks are known
  - But what about environmental policy risk??

Cost of end products / κόστος τελικών προιόντων

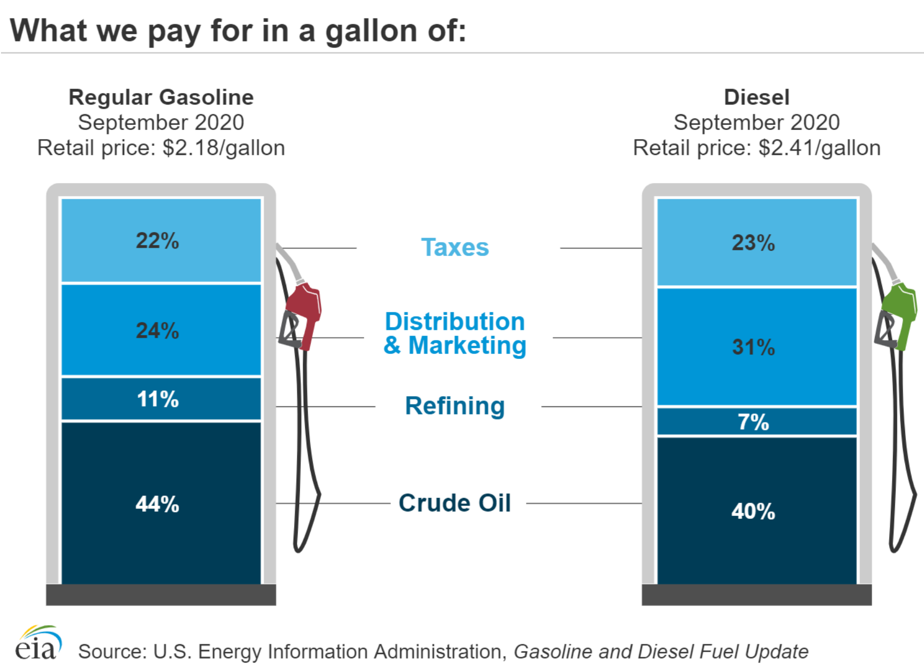
- Most of the cost is at the level of exploration and production
- OPEC has lowest production costs, UK has the highest
- That's why OPEC can exercise monopoly pricing power



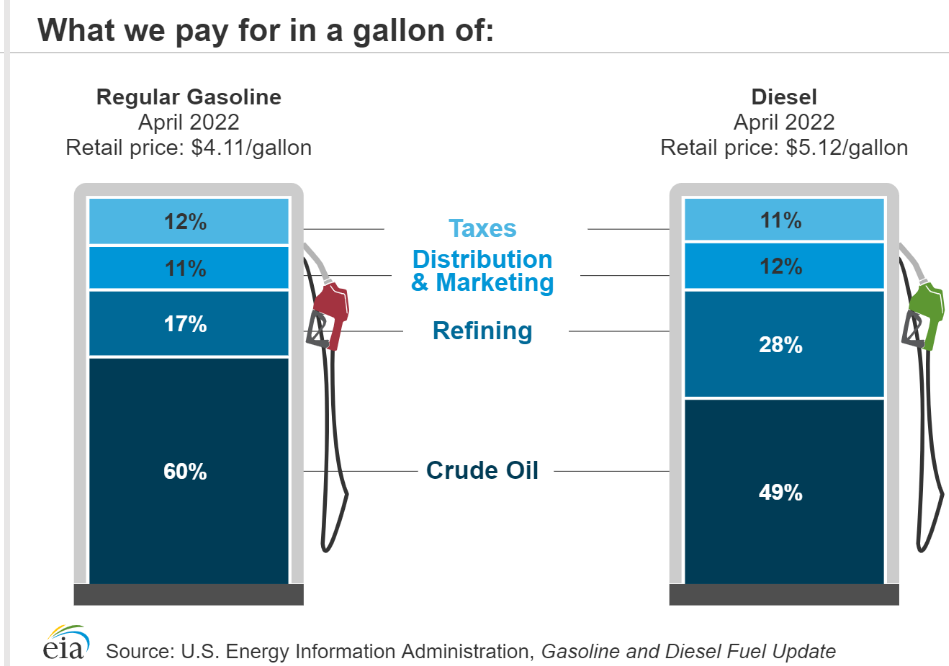
https://knoema.com/nolsgce/cost-of-crude-oil-production-by-country-and-crude-oil-prices

Cost of end products

2020



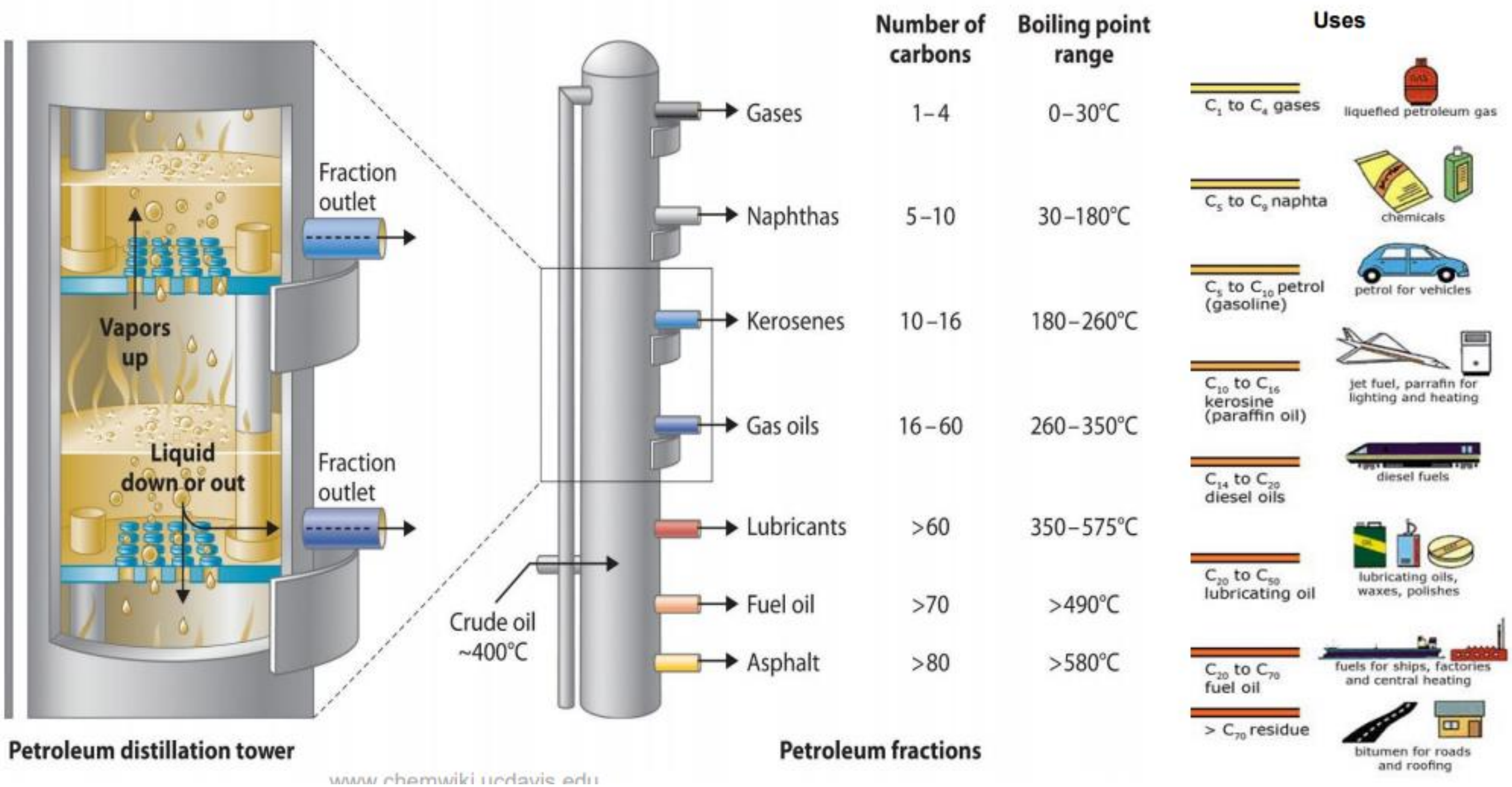
2022

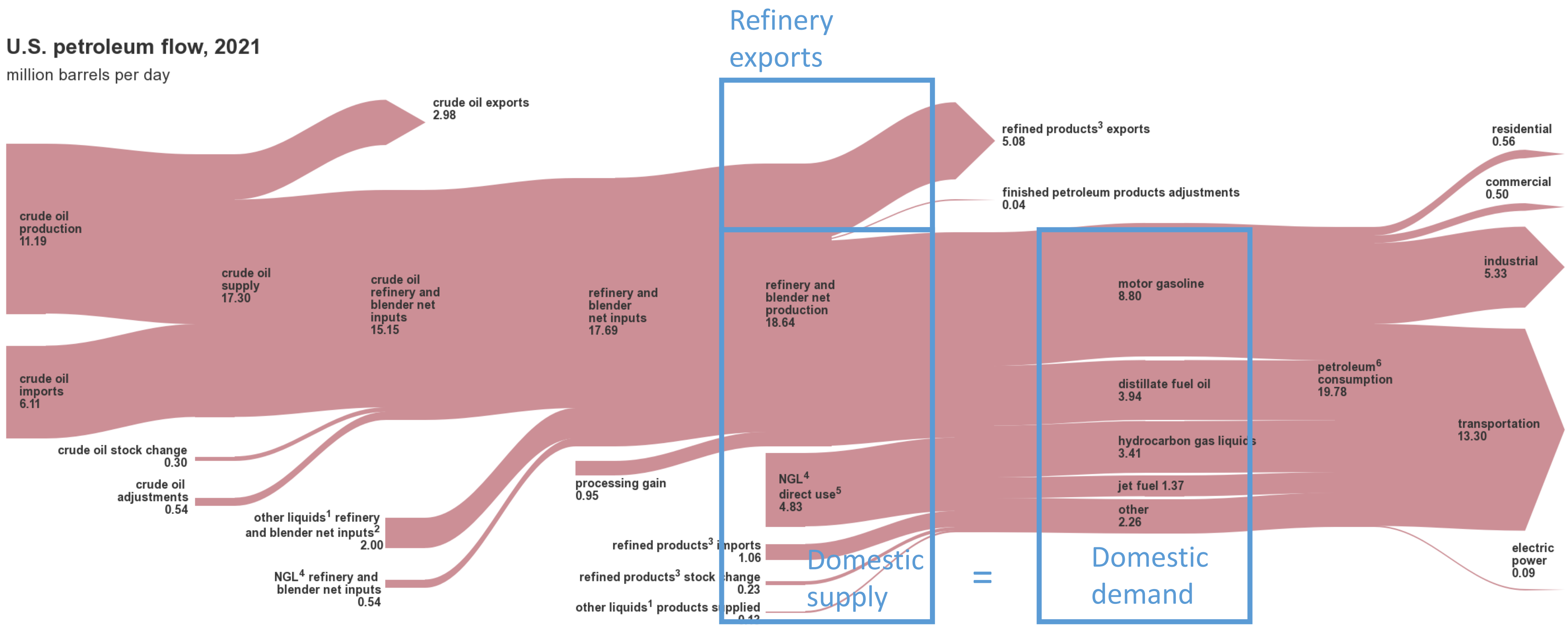


1 barrel = 42 gallons

Refining – distillation tower

- **Refinery**: converts crude oil into a mix of different finished (end) petroleum products
- Important: all of end products add to the profit of the refinery – if there is less demand for one product, profit margins get reduced
- Refineries in Europe were designed to create mostly gasoline → dieselization of fleet problematic



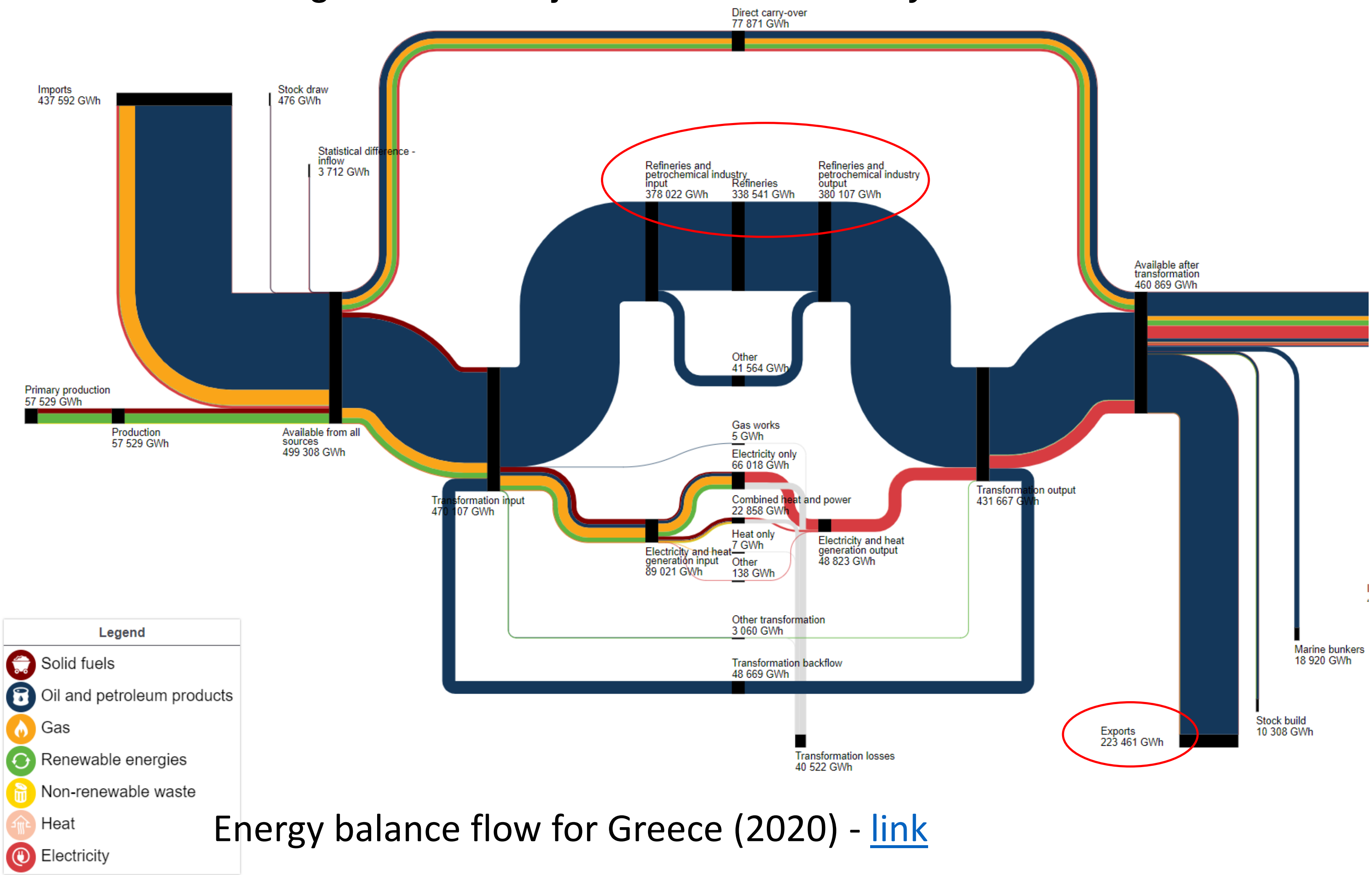


[1] Unfinished oils, hydrogen/biofuels/other hydrocarbons, and motor gasoline and aviation gasoline blending components. | [2] Biofuels plant net production (1.145), net imports (0.725) and adjustments (0.249) minus stock change (-0.007) and product supplied (0.130). | [3] Finished petroleum products and hydrocarbon gas liquids. | [4] Natural gas liquids. | [5] Field production (5.397) and biofuels plant net production (-0.022) minus refinery and blender net inputs (0.544). | [6] Petroleum products supplied. | Notes: • Data are preliminary. • Values are derived from source data prior to rounding for publication. • Totals may not equal sum of components due to independent rounding.

Sources: U.S. Energy Information Administration (EIA), *Monthly Energy Review* (April 2022), Tables 3.1, 3.2, 3.3b, 3.3e, 3.4, 3.5, 3.7a-3.7c; and EIA, *Petroleum Supply Monthly* (March 2022).

Refining in Greece

- Refining is a big industry in Greece: more exports than domestic use
- Low margins are a major hit for the industry



Energy balance flow for Greece (2020) - link

Spot market and futures / Αγορά άμεσης παράδοσης και συμβόλαια μελλοντικής εκπλήρωσης

Commodity spot prices and future prices are prices for a contract, but the agreement between the buyer and the seller differs:

- Spot price is the current price for immediate purchase and delivery
- Futures price reflects a financial transaction that will occur on a later date

In the spot market, buyers and sellers are exposed to the price fluctuation; this can be minimized (hedged) by using futures

Spot market and futures / Αγορά άμεσης παράδοσης και συμβόλαια μελλοντικής εκπλήρωσης

- A future contract is a legal agreement to buy or sell a particular commodity or security at a predetermined price, at a specific time in the future

- Futures are usually standardized and can be traded on Exchanges
  - Example: one oil contract on the Chicago Mercantile Exchange (CME) is for 1,000 barrels of oil

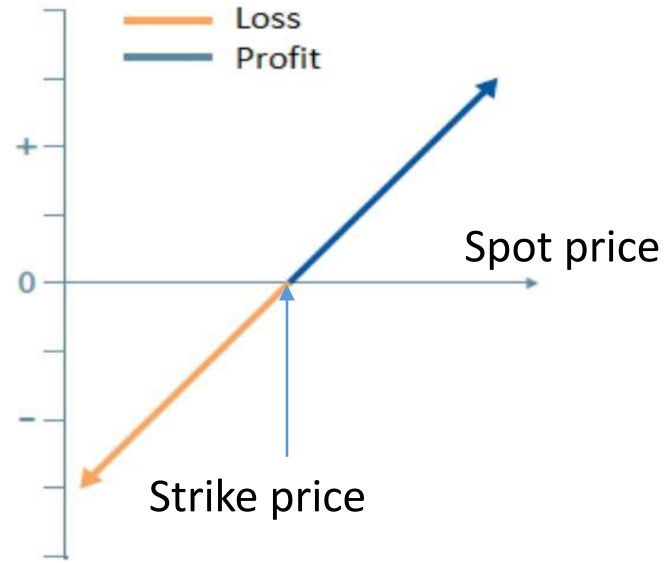
- Future contracts are used by two categories of market participants:

  - Producers or buyers hedge = guarantee a given price in the future and thus protect themselves from possible prices fluctuations
  - Traders may speculate = bet on price changes of the underlying asset

Long vs. Short position

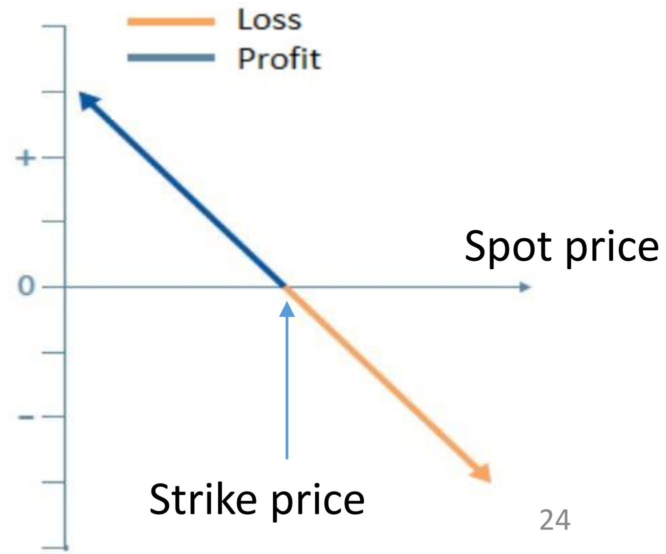
Long

- A buyer of a future contract has the "long" position
- In this position, the buyer expects prices to rise and hedges against that risk
- Rising prices increase the value of the future contract, while increasing the procurement costs
- The two offset each other; at the delivery day the two should be the same



Short

- A seller of a future contract is going "short"
- In this position, the seller expects prices to fall in the spot market and hedges against that risk
- Falling prices increase the value of the position, but result in lower profits in the spot market
- Once again, the two offset each other



Oil futures

- Imagine an oil producer that plans to produce 1m barrels of oil next year

- Assume current price spot price of $100/barrel

- Due to market volatility price can be higher or lower in a year
  - If (s)he expects prices to be higher he may not lock in a price now
  - If (s)he expects prices to be lower he can use futures to lock-in $100/b

- The price of the contract is determined by:
  - The spot price
  - The economic outlook (interest rates, economic cycle, …)
  - Time to maturity (closer to expiration, price of contract = spot price)
  - Producer's outlook (accounting infos like leverage, profit etc ...)
  - **Storage costs**

- Different to electricity, oil has i) big storage costs and ii) bulky physical delivery → <u>when the contract expires, oils has to be delivered!</u>

20th April 2020: Oil futures turning negative

BBC | Sign in | Home | News | Sport | Reel | Worklife | Travel | Future

NEWS

US oil prices turn negative as demand dries up

20 April

Coronavirus pandemic

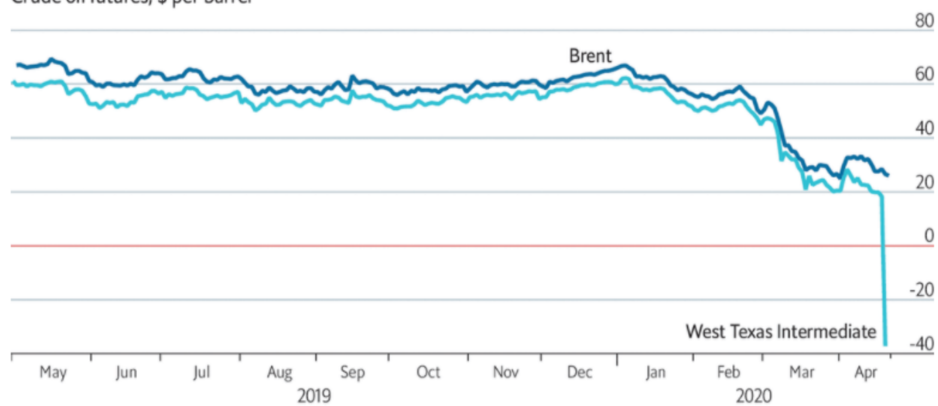
The price of US oil has turned negative for the first time in history.

The Economist

American crude oil has fallen to less than nothing

Excess supply and a storage shortage push prices through the floor

West Texas Precipitate
Crude oil futures, $ per barrel



20th April 2020: Oil futures turning negative

FORECASTING COMMODITY prices is a mug's game. *The Economist* has been much mocked for our suggestion in 1999 that, in a world "drowning in oil", a barrel of the stuff might cost as little as $5. That was just before the oil price shot up from $10 to a peak of nearly $150 over the next decade. This month, however, the world is again awash and the oil price has plunged to unheard-of depths. On April 20th a barrel of West Texas Intermediate oil for delivery in May had a negative price-tag, meaning sellers had to pay buyers. On April 27th prices for June also slumped by more than a quarter, though remained positive, at just over $12 a barrel. A row between Russia and Saudi Arabia, and lower demand for oil because of the covid-19 lockdowns, have left markets flooded. Analysts are asking again, as in 1999, if the world will have to get used to permanently low prices not just for oil but for other commodities too.

Why negative oil prices?

- The price went negative on 20 April, a day before the May WTI future expired

- Coronavirus caused reduction in oil demand while OPEC cuts were scheduled for 1st of May (i.e. after the expiration of May 2020 futures)
  - So there was an oversupply in the market
  - At the same time storage space was getting limited

- Anyone who still held a May 2020 future contract would have to take physical delivery in May

- Usually traders can roll this contracts over to the next month. But with demand falling due to corona virus and storage approaching maximum capacity no one wanted the contract

- Bottom line: producers were willing to pay purchasers to take oil off their hands due to fears that most storage will run out of space by end of May

https://www.eia.gov/todayinenergy/detail.php?id=43495

OPEC

- Organization of the Petroleum Exporting Countries (OPEC) was established in Iraq in 1960 by five leading producers: Iran, Iraq, Kuwait, Saudi Ar., Venezuela
- Later joined by Qatar (1961), Indonesia (1962), Libya (1962), the United Arab Emirates (1967), Algeria (1969), Nigeria (1971), Ecuador (1973), Gabon (1975), Angola (2007), Equatorial Guinea (2017) and Congo (2018)
- Currently, the Organization has a total of 13 Member Countries
- Goal: coordinate petroleum policies of member states to secure a fair and stable return on their investment in the petroleum industry
- OPEC accounts for: 40% of world oil production, 50% of oil trade, 80% of proven oil reserves, very low production costs (see slide 23)

→ OPEC can influence the world oil price

OPEC

Bloomberg

Oil Gains Most in a Month as OPEC+ Hints at Delay to Output Hike

By Andres Guerra Luz
November 3, 2020, 12:09 AM GMT+1 *Updated on November 3, 2020, 4:46 PM GMT+1*

- Falling dollar boosts appeal of commodities priced in currency
- Algeria Says Russia, Saudi Pressing for OPEC Cuts Extension

Cartel: collusion (αθέμητη σύμπραξη) among members to reduce output and increase prices at a level higher than competition (why see lecture)

In general most of OPEC members don't have the power to influence the market (maybe Saudi Arabia does)

Market sharing strategy: production of each member is a fixed fraction of OPEC's total production, which is decided on cartel's meetings

OPEC

Two models to study the world price of oil

1. The dominant firm model
   → understand oil pricing

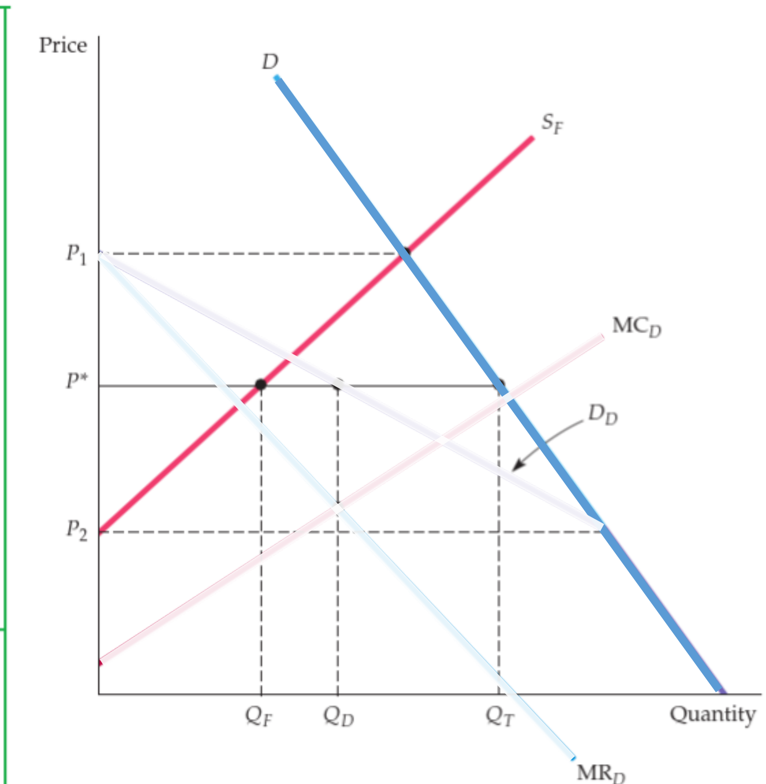
2. Competitive market model with OPEC
   → study supply/demand shocks

The dominant firm model

- The supply curve of the competitive part of the market (followers) S_F is their MC curve
- In perfect competition equilibrium would be at the intersection of D with S_F
- In the dominant firm model the dominant firm sets price first according to monopoly rules and the rest of countries/firms take this price as given.

FIGURE 12.9
PRICE SETTING BY A DOMINANT FIRM

The dominant firm sets price, and the other firms sell all they want at that price. The dominant firm's demand curve, D_D, is the difference between market demand D and the supply of fringe firms S_F. The dominant firm produces a quantity Q_D at the point where its marginal revenue MR_D is equal to its marginal cost MC_D. The corresponding price is P^*. At this price, fringe firms sell Q_F, so that total sales equal Q_T.



The dominant firm model

- At P1, the followers can supply the whole market; the dominant firm supplies zero
- At P2, the dominant firm supplies the whole market (price too low for production to be profitable for followers)
- The leader's demand is therefore $D_D = AR_D = D - S_F$ and produces according to MR=MC
- The rest respond to this price by producing according to MC=P

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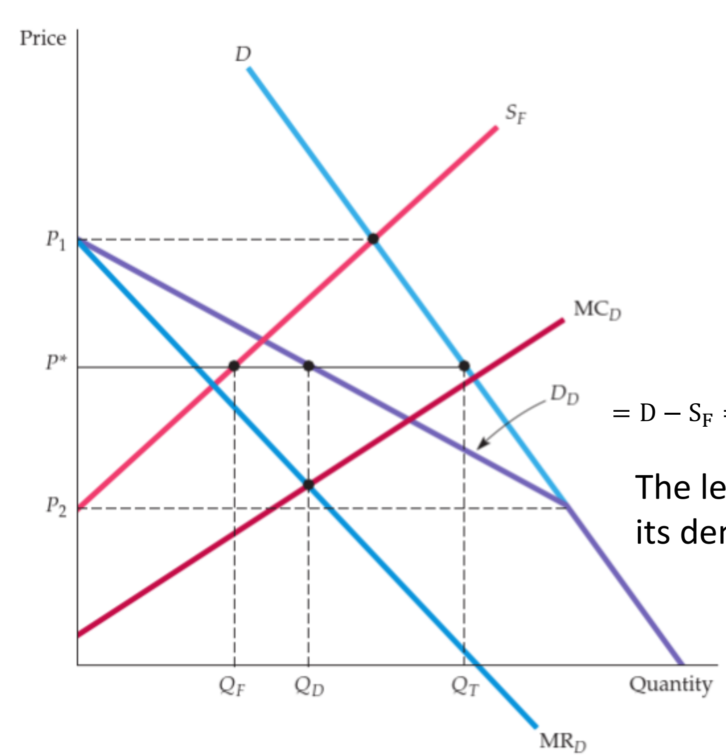


$= D - S_F = AR_D$

The leader "derives" its demand curve

The dominant firm model for OPEC

- OPEC produces Q_{OPEC} according to the rule $MC_{OPEC}=MR_{OPEC}$ and sets price according to $p^*=AR_{OPEC}$ for this quantity (remember lecture 2 sl. 44)
- The competitive part of the market takes this price as given and produces according to $S_c=MC_c=p^*$ (lecture 2)
- The sum of $Q_c + Q_{OPEC}$ covers total demand
- Note that without OPEC prices would have been competitive and much lower ($p_c < p^*$)

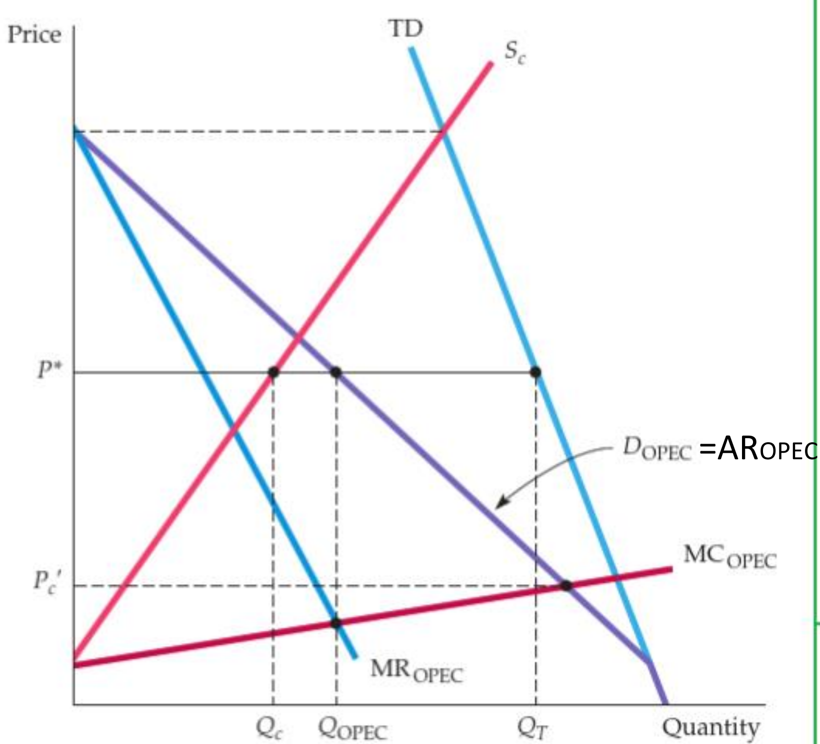


FIGURE 12.10
THE OPEC OIL CARTEL

TD is the total world demand curve for oil, and S_c is the competitive (non-OPEC) supply curve. OPEC's demand D_{OPEC} is the difference between the two. Because both total demand and competitive supply are inelastic, OPEC's demand is inelastic. OPEC's profit-maximizing quantity Q_{OPEC} is found at the intersection of its marginal revenue and marginal cost curves; at this quantity, OPEC charges price P^*. If OPEC producers had not cartelized, price would be P_c, where OPEC's demand and marginal cost curves intersect.

Competitive market with OPEC

- Similar to the COVID example we saw in lecture 1

- Knowing elasticities of demand ϵ_D and supply ϵ_S we can calculate competitive demand (D) and supply (S) curves (lecture 1 or note after lecture 1) according to:

$$D = q^* + \epsilon_D \frac{q^*}{p^*}(p - p^*)$$

Here (p*,q*) are the observed "equilibrium" market price and total quantity demanded(=supplied), i.e. $q^* = q^{OPEC} + q^C$, with q^{OPEC} quantity supplied by OPEC and q^C by competitors. The competitive supply curve reads:

$$S^C = q^C + \epsilon_S \frac{q^C}{p^*}(p - p^*),$$

Total supply is $S^C + q^{OPEC}$ such that:

$$S = q^* + \epsilon_S \frac{q^C}{p^*}(p - p^*).$$

In the competitive model the equilibrium is calculated as always by

$$D = S$$

Example: Saudi production cuts

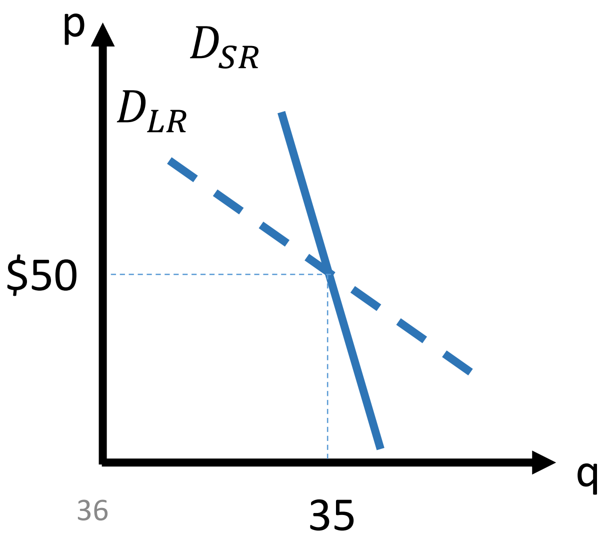
Pindyck and Rubinfeld 8th or 9th ch. 2

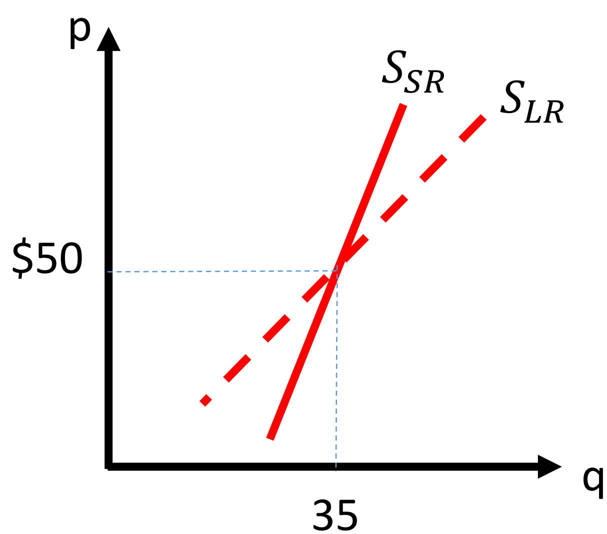
How would Saudi production cuts impact the price of oil in the short and in the long run?

- 2015-2016 price approx. $50 / barrel
- World demand = world supply = 35 bb/y
- OPEC supply = 12 bb/y
- Competitive (non-OPEC) supply = 23 bb/y
- Saudi production = 3.6 bb/y (part of OPEC)

(bb = billion barrels)

Elasticities:	SR	LR
World demand (ϵ_D)	-0.05	-0.30
Competit. Supply (ϵ_S)	0.05	0.30





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Example: Saudi production cuts

Pindyck and Rubinfeld 8th or 9th ch. 2

Before production cuts:

Short-Run demand: $D_{SR} = 36.75 - 0.035\,p$

Short-Run competitive supply: $S_{SR}^{C} = 21.85 + 0.023\,p$

Short-Run total supply: $S_{SR} = \underbrace{33.85}_{21.85+12\,(OPEC)} + 0.023\,p$

Long-Run demand: $D_{LR} = 45.5 - 0.21\,p$

Long-Run competitive supply: $S_{LR}^{C} = 16.1 + 0.138\,p$

Long-Run total supply: $S_{LR} = \underbrace{28.1}_{16.1+12\,(OPEC)} + 0.138\,p$

(You may verify that D=S in both short-run and long-run gives p=$50/b and q=35bb/y)

Example: Saudi production cuts

Pindyck and Rubinfeld 8th or 9th ch. 2

What if Saudis stopped production? → total production lower by 3.6 bb/y

Short-Run demand: same as before

Short-Run competitive supply: same as before

Short-Run total supply: $S_{SR}^{T} = \underbrace{30.25}_{33.85-3.6} + 0.023\,p$

New SR equil. price p=112.07

Long-Run demand: same as before

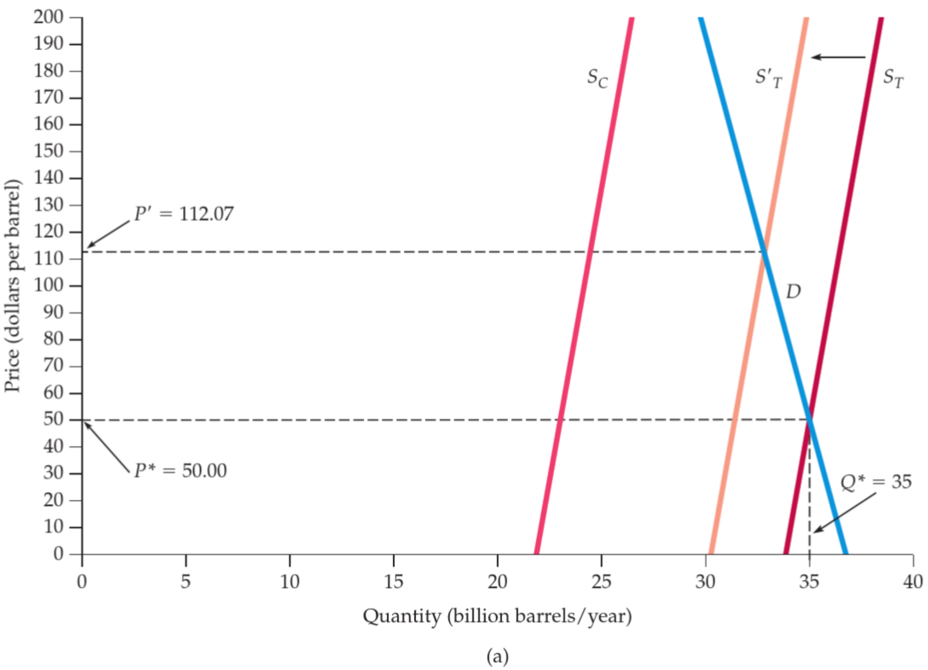
Long-Run competitive supply: same as before

Long-Run total supply: $S_{LR}^{T} = \underbrace{24.5}_{28.1-3.6} + 0.138\,p$

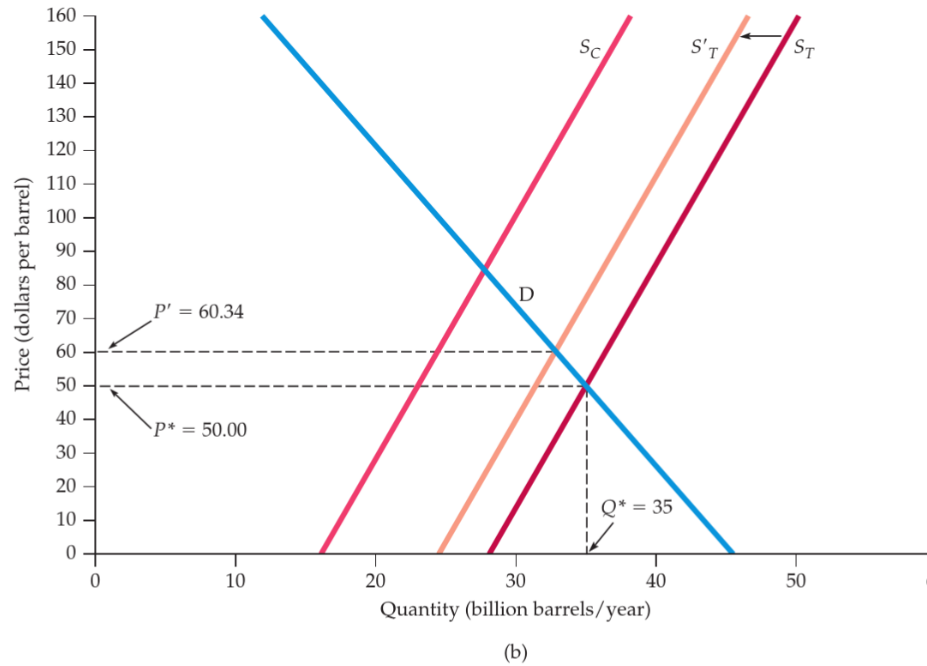
New LR equil. price p=60.34

Example: Saudi production cuts

Pindyck and Rubinfeld 8th or 9th ch. 2



Short-run



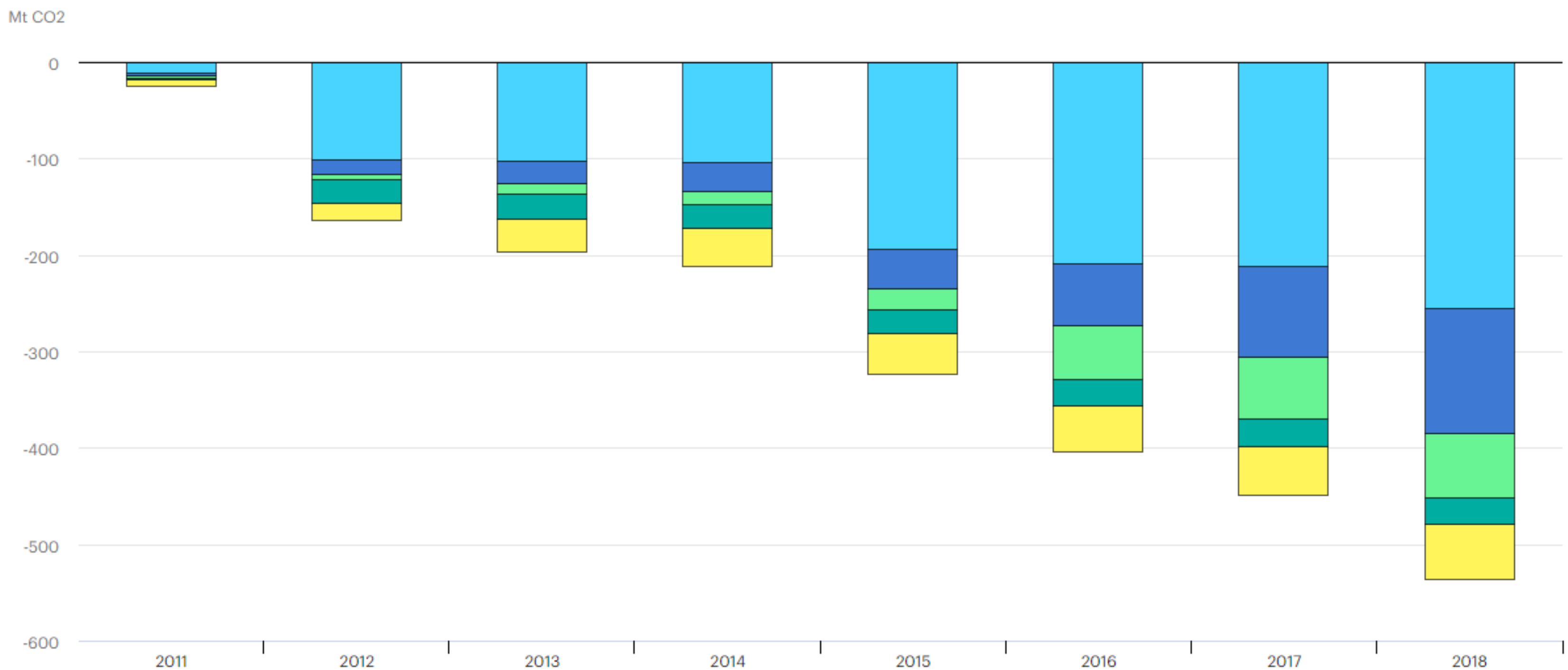
Long-run

Gas rising in importance

Natural gas is very important for global energy. Where it replaces more polluting fuels, it improves air quality and limits emissions of carbon dioxide.

CO2 savings from coal-to-gas switching in selected regions compared with 2010, 2018

Open

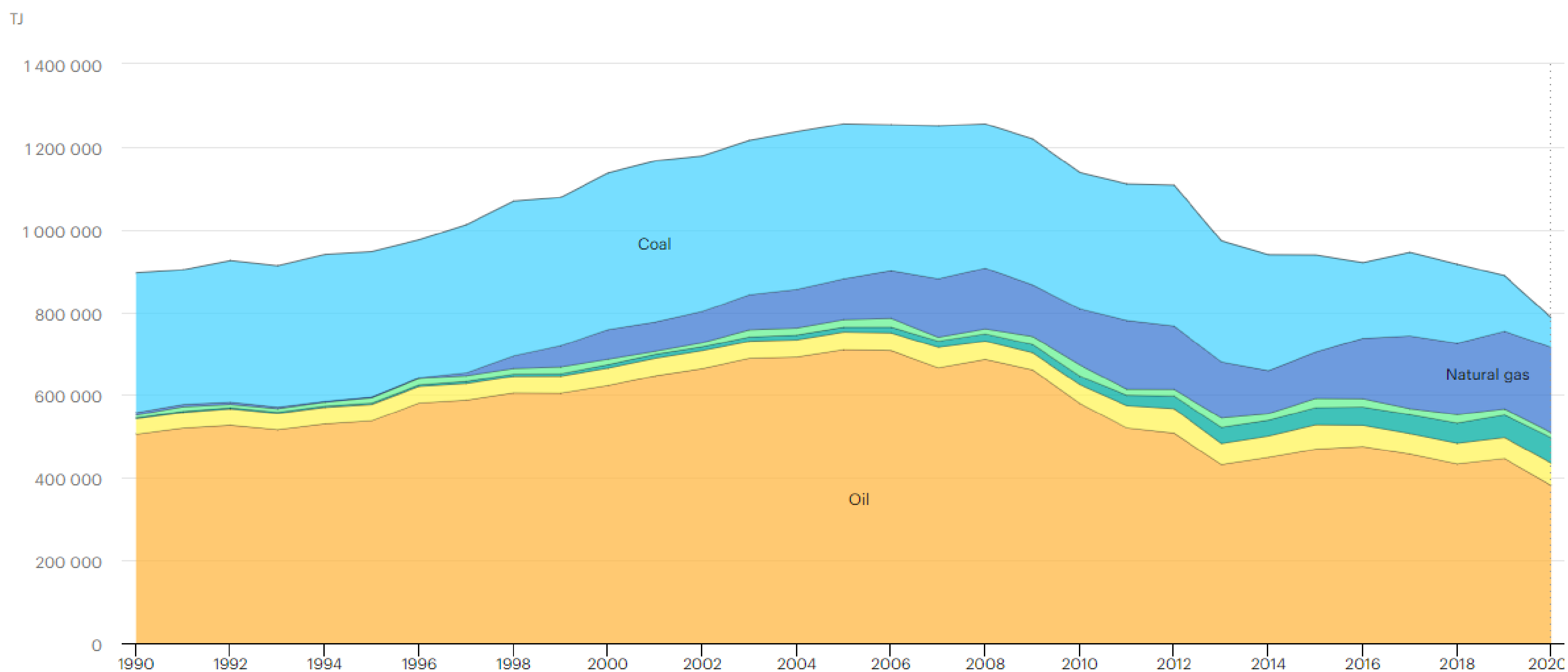


IEA. All Rights Reserved

United States China Europe India Rest of world

Gas consumption in Greece is steadily rising

Total energy supply (TES) by source, Greece 1990-2020



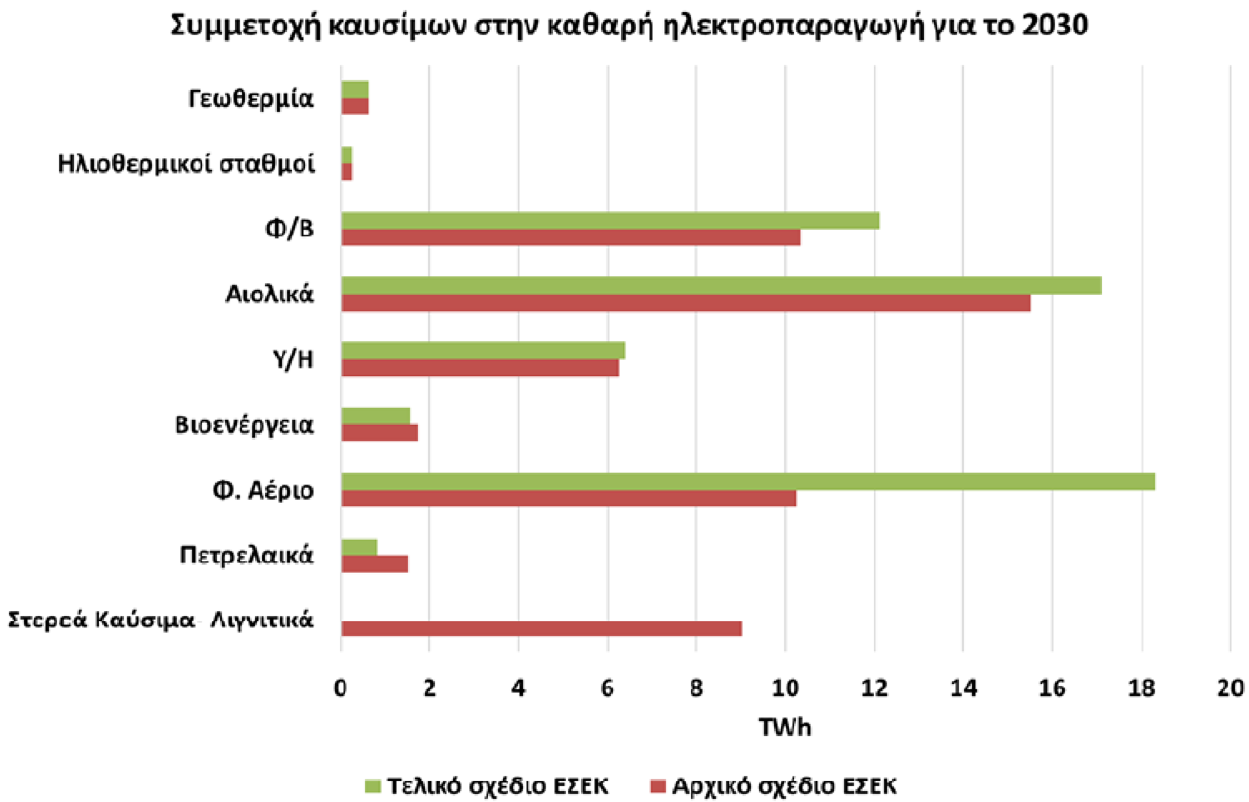
IEA. A

Coal · Natural gas · Hydro · Wind, solar, etc. · Biofuels and waste · Oil

Why natural gas for Greece?

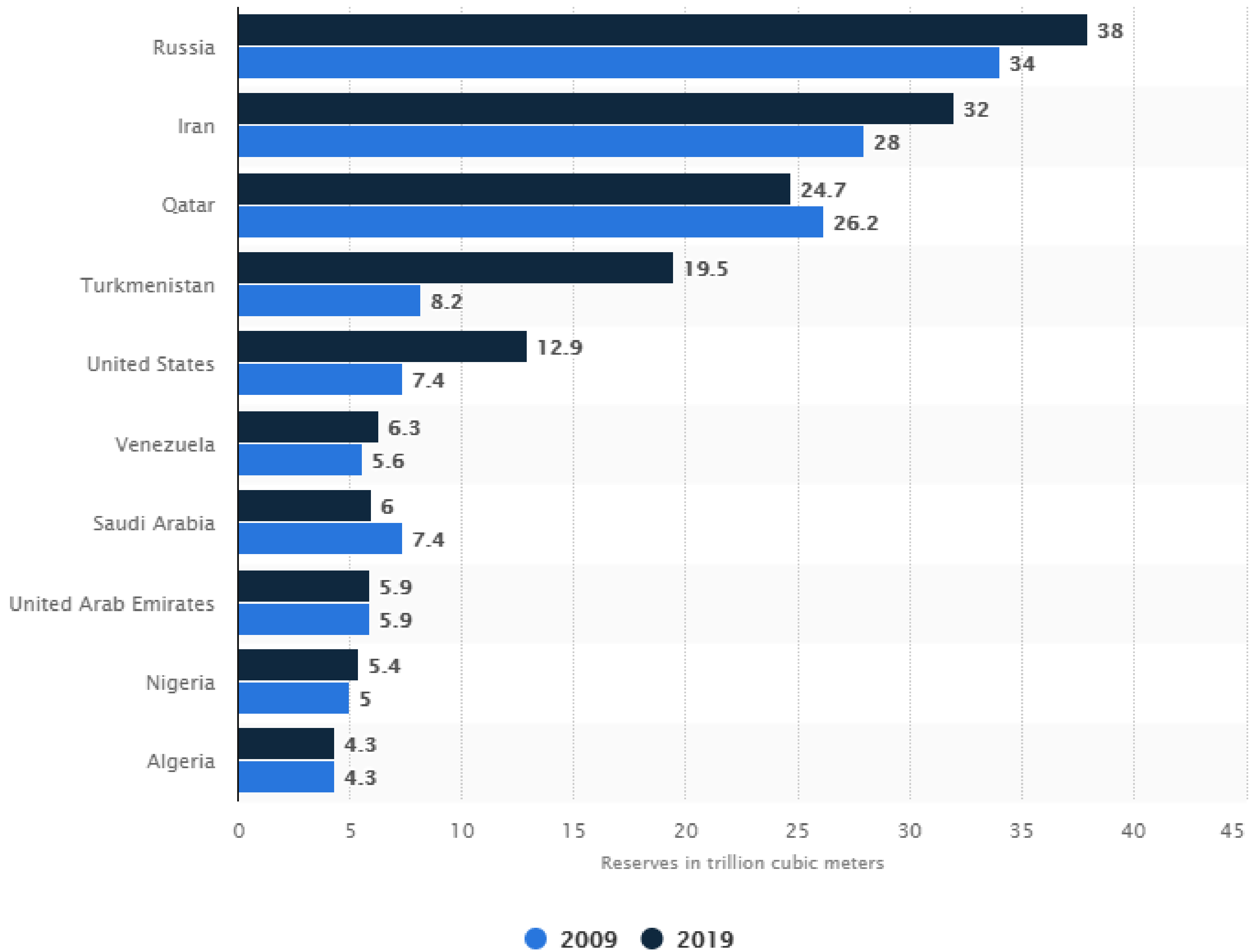
- Higher energy efficiency / lower emissions than coal and oil
- Higher flexibility for domestic, commercial and manufacturing use
- Higher flexibility as backup capacity for Renewable electricity (remember characteristics of renewables)
- Part of the European Energy Transition policy
- Geopolitical importance: increases collaboration between countries and strengthens the position of Greece as a hub for natural gas

Gas as part of Greek national targets



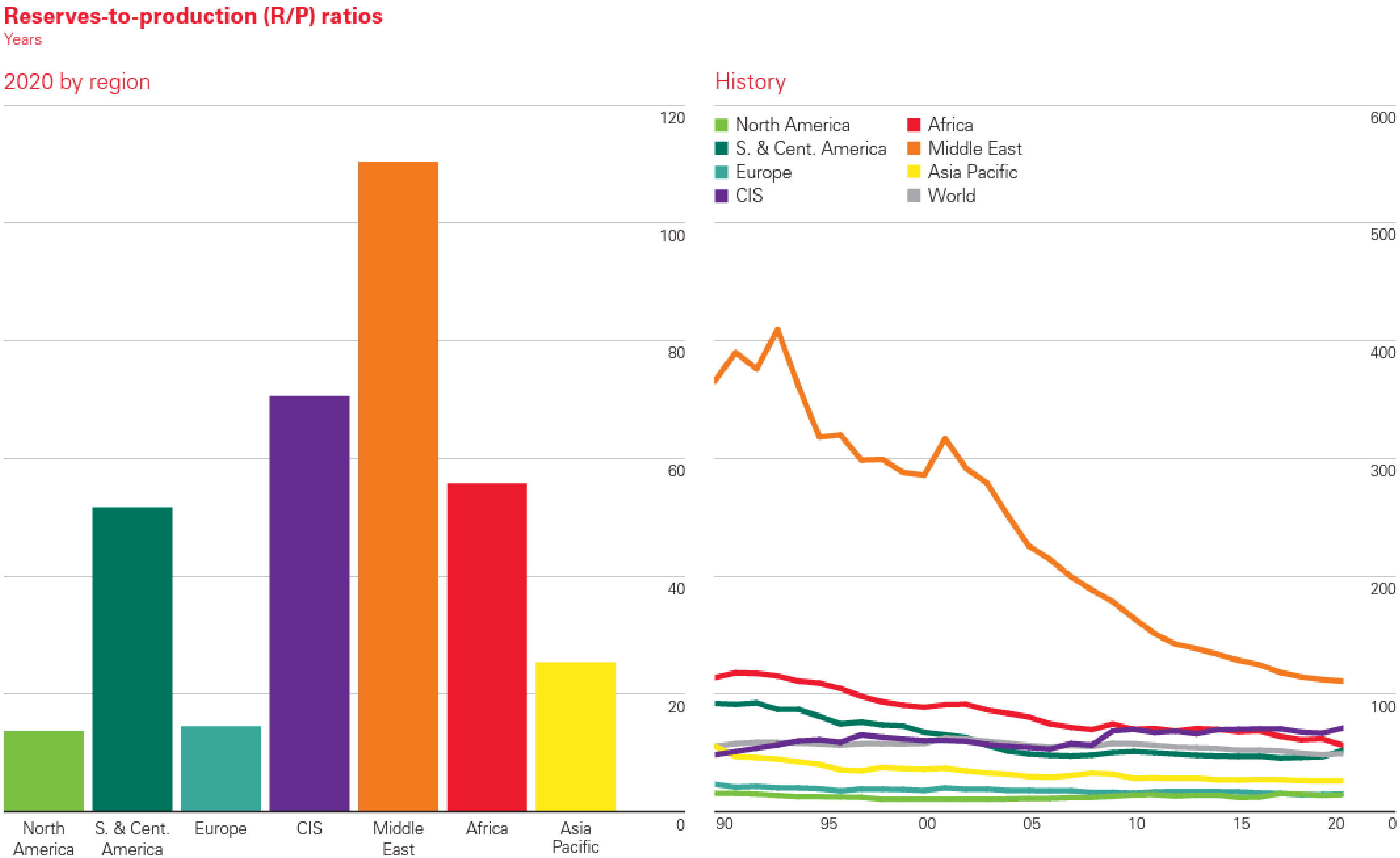
Who are the major players?

Proved gas reserves



Who are the major players?

Gas reserves-to-production (R/P) ratios



World proved gas reserves decreased by 2.2 Tcm to 188.1 Tcm in 2020. A revision to Algeria (-2.1 Tcm) provided the largest decrease, partially offset by a 0.4 Tcm increase in Canadian reserves. Russia (37 Tcm), Iran (32 Tcm) and Qatar (25 Tcm) are the countries with the largest reserves. The current global R/P ratio shows that gas reserves in 2020 accounted for 48.8 years of current production. The Middle East (110.4 years) and CIS (70.5 years) are the regions with the highest R/P ratio.

BP, Statistical Review of World Energy 2021

Geopolitics of gas

- Oil market is effectively global:
  - Oil is easy to store and transport
  - Impossible to segment the market → same oil prices around the world

- Gas requires a network / Import-Export facility / Compression etc..

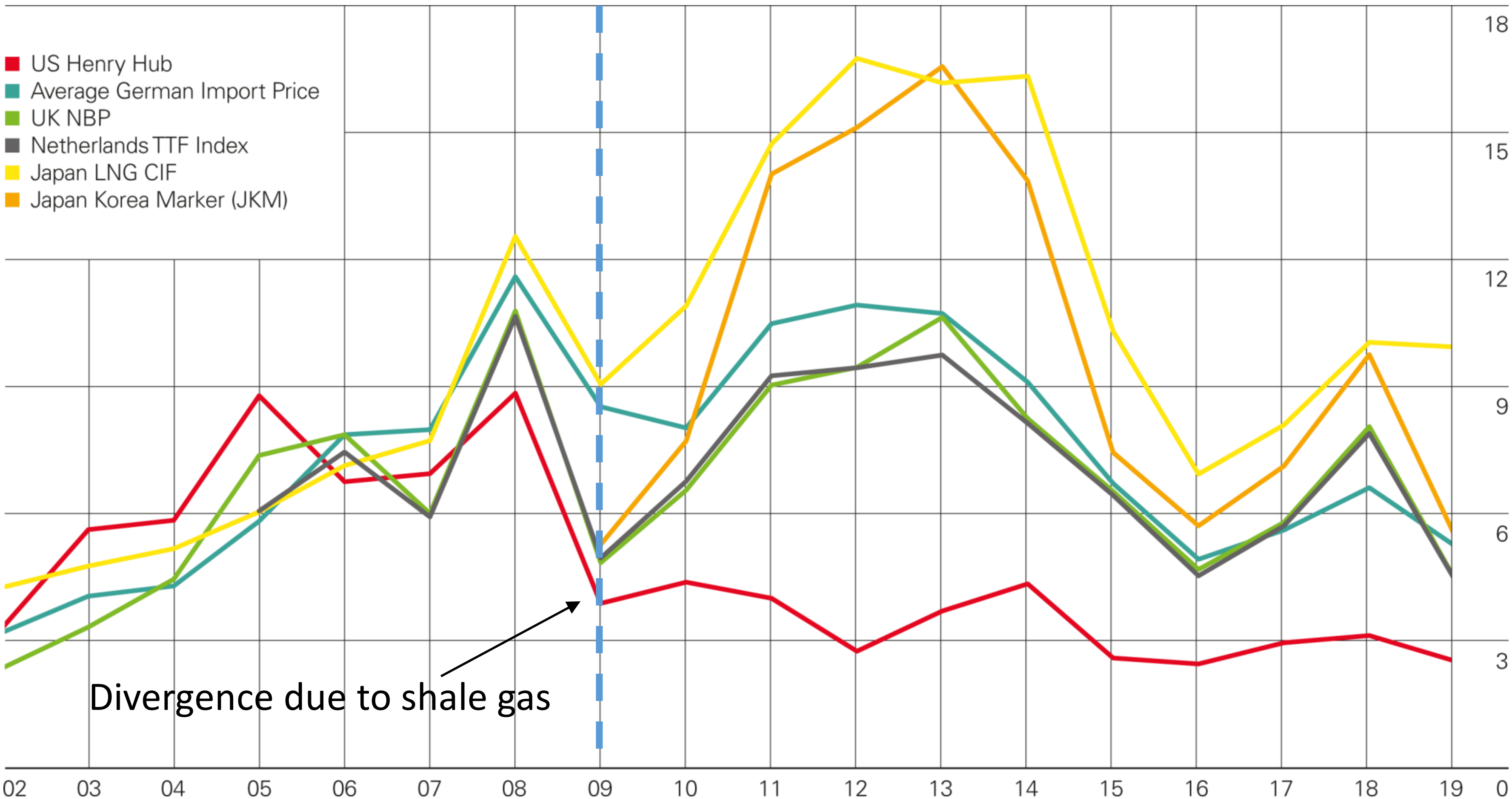
- Gas relies on a system of logistics which is much more demanding

- There are mainly three gas markets around the world:
  - North American → covers US & Canada needs not so much trade
  - East Asian → transportation mainly LNG ships
  - European → mainly imports from Russia and north Africa, transportation with pipelines

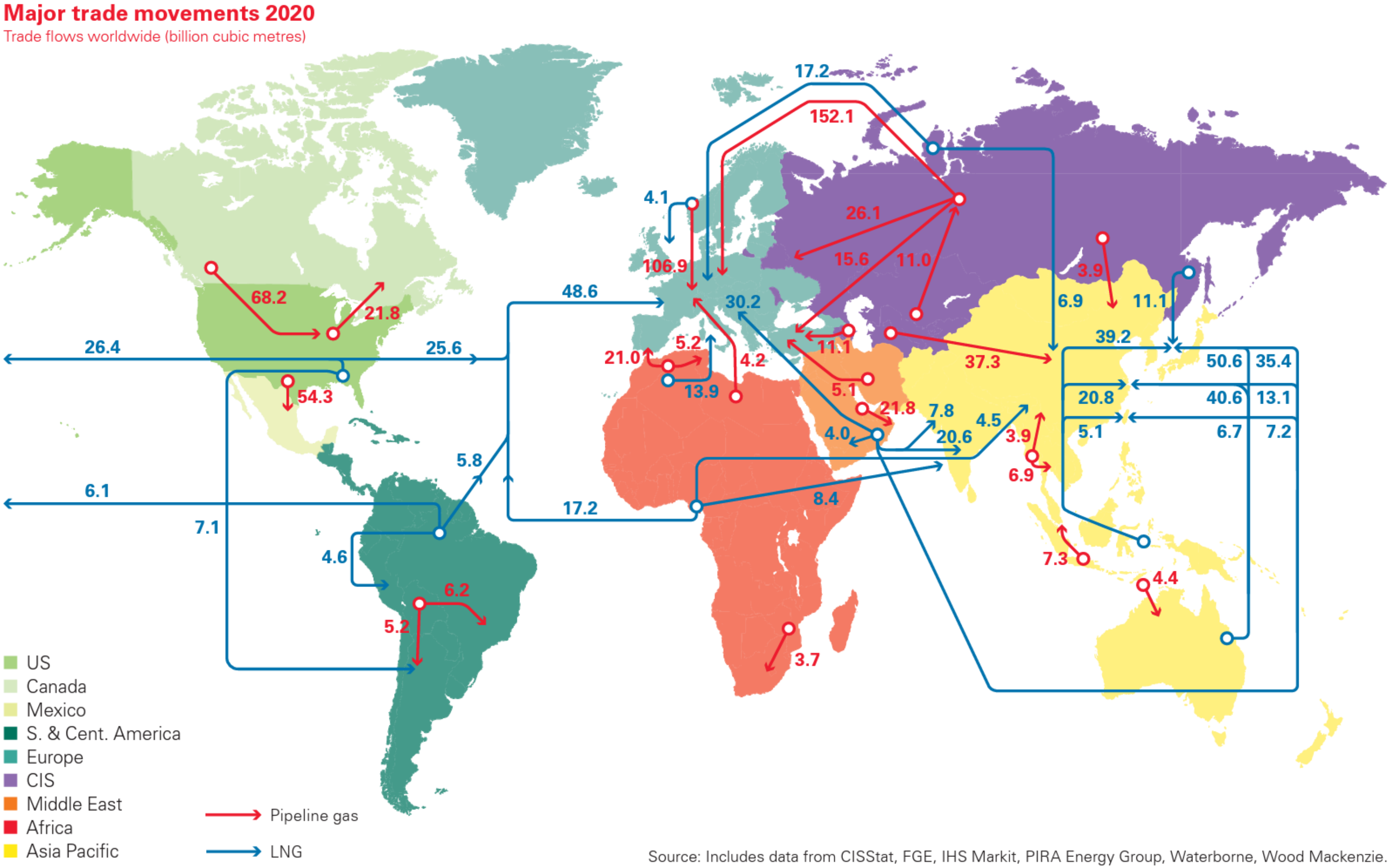
- With the East Med Pipeline Greece opens the door to East Asian gas which is of great importance for European and Greek energy security

Different markets = different prices

Gas prices $/mmBtu



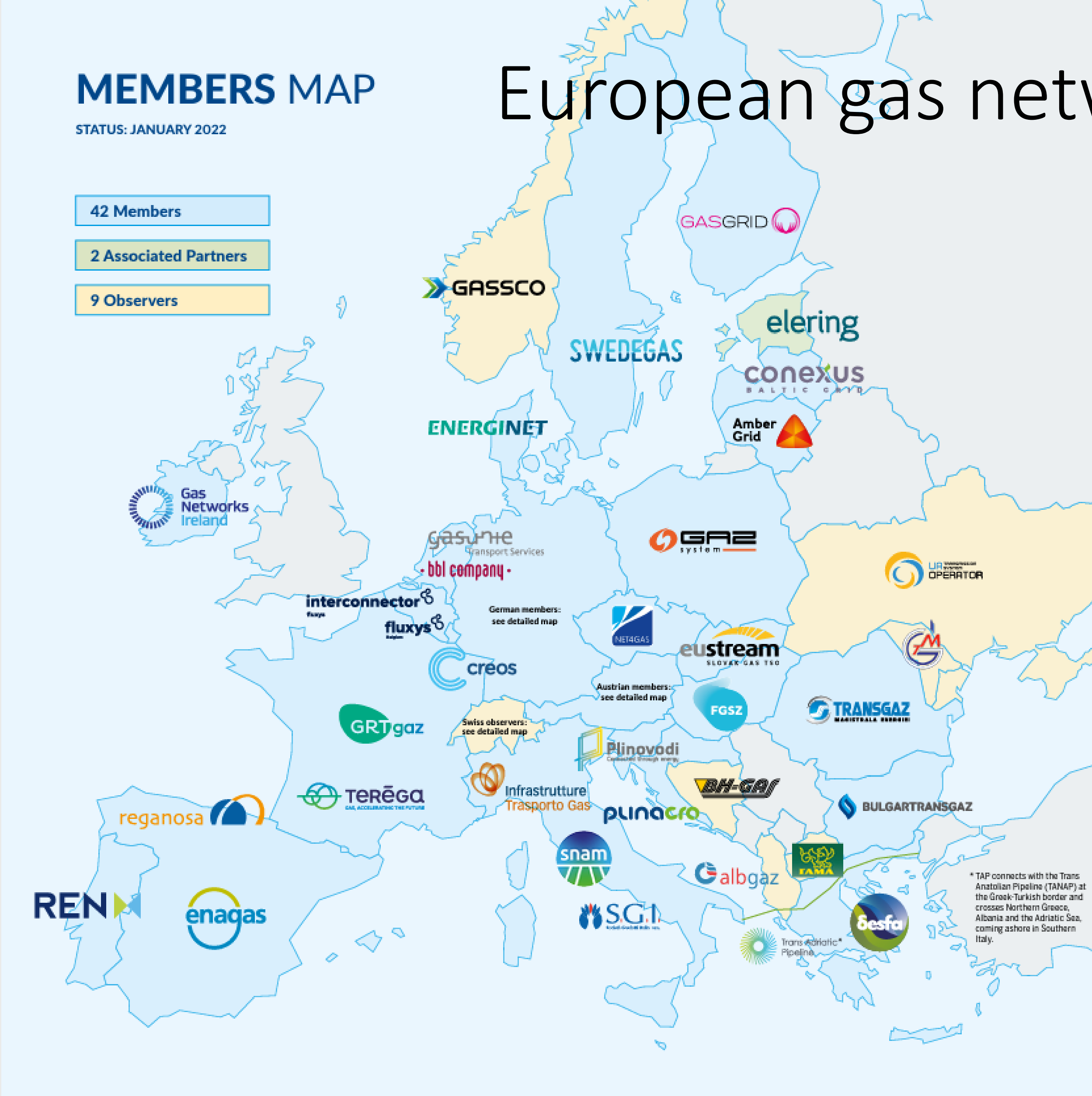
Major gas trade movements 2020



Source: Includes data from CISStat, FGE, IHS Markit, PIRA Energy Group, Waterborne, Wood Mackenzie.

BP, Statistical Review of World Energy 2021

European gas network



entsog
european network of transmission system operators for gas

Since its foundation, ENTSOG Member TSOs have provided wide coverage of the European gas market. In addition, ENTSOG's Articles of Association were modified in December 2010 to admit TSOs from EU countries currently derogated from the Third Energy Package, such as the Baltic States, as Associated Partners. This allowed for participation in ENTSOG activities.

In February 2011, TSOs from Third Party countries (candidates for EU accession, members of the Energy Community or EFTA) interested in following development of the network codes were also admitted to the Association as Observers.

AUSTRIA, GERMANY AND SWITZERLAND

The role of the European Network of Transmission System Operators for Gas (ENTSOG) is to facilitate and enhance cooperation between national gas transmission system operators (TSOs) across Europe, to ensure the development of a pan-European transmission system in line with European Union energy goals.

Gas is on European Energy Exchange

Greece is not yet connected

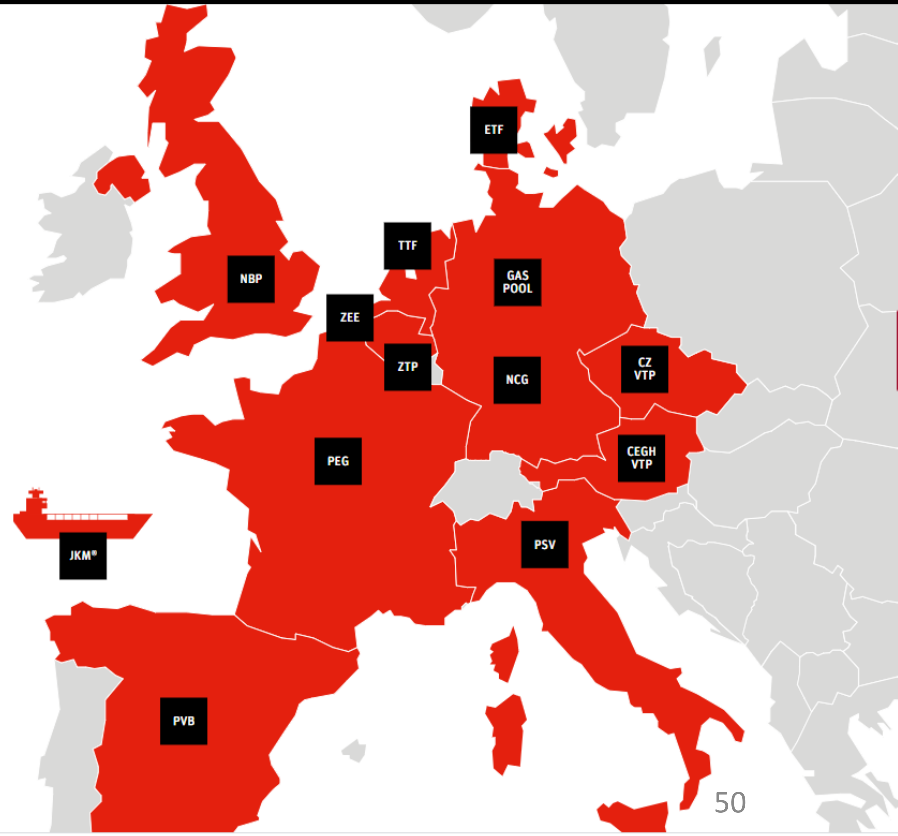
eex

NATURAL GAS MARKETS REGISTRY SERVICES ABOUT US SEARCH

Trading | Spot market data | Futures market data | List of members | Become a member | Technical access

Natural gas portfolio

EEX offers power derivatives and gas markets under one Exchange license and allows its members to trade natural gas contracts in the Austrian, Belgian, Czech, Danish, Dutch, French, German, Italian, Spanish and UK market areas. The natural gas product range covers spot, futures and options contracts for the major European gas hubs as well as trading in location spread products between these market areas. EEX also offers JKM® LNG Futures settled against the S&P Platts JKM® assessment, today's most reliable price estimation for the Asian region.



Greek gas system

(1) Import/Export – EU

Αγωγός IGB

(2) Import – non-EU

Αγωγός TAP

Αγωγός Poseidon

Import - LNG terminal Revythousa

Διαχειριστής δικτύου μεταφοράς:

ΔΕΣΦΑ

ΔΙΑΧΕΙΡΙΣΤΗΣ ΕΘΝΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ ΦΥΣΙΚΟΥ ΑΕΡΙΟΥ Α.Ε.

Ιδιοκτησία:

- 34% Ελληνικό Δημόσιο
- 56% Senfluga Energy Holding
- 10% Damco Energy

Το ΕΣΦΑ αποτελείται από:

- Κεντρικό αγωγό και κλάδους
- Μετρητικούς σταθμούς 1&2
- Σταθμό LNG Ρεβυθούσας
- Σταθμός συμπίεσης Θεσσαλονίκης
- Μετρητικούς/Ρυθμιστικούς σταθμούς
- Κέντρα ελέγχου κ’ κατανομής φορτίου
- Κέντρα λειτουργίας κ’ συντήρησης
- Σύστημα τηλελέγχου

Αγωγός East Med

Ελλάδα-Κύπρος-Ισραήλ-Ιταλία

https://www.politico.eu/article/eastmed-a-pipeline-project-that-ran-afoul-of-geopolitics-and-green-policies/

Greek gas market

- Μεταφορά: δίκτυο υψηλής πίεσης από τα σημεία εισαγωγής/εξαγωγής στα δίκτυα διανομής
- Διανομή: τοπικά δίκτυα χαμηλής πίεσης για χρήση από τους τελικούς καταναλωτές
- Προμηθευτές: εταιρίες που προσφέρουν φυσικό αέριο στους τελικούς καταναλωτές

Μεταφορά

ΔΕΣΦΑ

ΔΙΑΧΕΙΡΙΣΤΗΣ ΕΘΝΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ ΦΥΣΙΚΟΥ ΑΕΡΙΟΥ Α.Ε.

υπεύθυνος για τη λειτουργία, τη διαχείριση, την εκμετάλλευση και την ανάπτυξη του Εθνικού Συστήματος Φυσικού Αερίου

Ρυθμίζει την πίεση στο δίκτυο μέσω δημοπρασιών στο βάθρο εξισορρόπησης

Διανομή

διανομή αερίου αττικής

ΕΤΑΙΡΕΙΑ ΔΙΑΝΟΜΗΣ ΑΕΡΙΟΥ ΑΤΤΙΚΗΣ

ΕΔΑΘΕΣΣ

ΕΤΑΙΡΕΙΑ ΔΙΑΝΟΜΗΣ ΑΕΡΙΟΥ

ΔΕΔΑ

ΔΗΜΟΣΙΑ ΕΠΙΧΕΙΡΗΣΗ ΔΙΚΤΥΩΝ ΔΙΑΝΟΜΗΣ ΑΕΡΙΟΥ

υπεύθυνοι για τη λειτουργία, συντήρηση, και ανάπτυξη του δικτύου διανομής και σύνδεση τελικων καταναλωτων

Προμηθευτές

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ΕΤΑΙΡΕΙΑ ΠΡΟΜΗΘΕΙΑΣ ΑΕΡΙΟΥ ΘΕΣΣΑΛΟΝΙΚΗΣ ΘΕΣΣΑΛΙΑΣ Α.Ε. (ΖΕΝΙΘ)
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VOLTERRA A.E.
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ΔΕΗ Α.Ε.

Russia invasion to Ukraine and energy security

European Commission

English EN

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Available languages: English

Statement | 25 March 2022 | Brussels

Joint Statement between the European Commission and the United States on European Energy Security

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Preamble

The United States and the European Commission are committed to reducing Europe's dependency on Russian energy. We reaffirm our joint commitment to Europe's energy security and sustainability and to accelerating the global transition to clean energy. In condemning in the strongest terms Russia's further invasion of Ukraine, we express our solidarity and support for Ukraine. We share the objective of addressing the energy security emergency – to ensure energy supply for the EU and Ukraine. We welcome the continued progress toward the physical integration of Ukraine with the EU energy markets. The energy security and sustainability of the EU and Ukraine are essential for peace, freedom and democracy in Europe.

Case study: Optimal tariff to Russian gas

CEPS

OPTIMAL TARIFF VERSUS OPTIMAL SANCTION

The case of European gas imports from Russia

Daniel Gros

CEPS Policy Insights
No 2022-12 / March 2022

Abstract

Europe has set itself the aim of reducing its dependency on Russian gas imports. This paper provides an economic analysis of a tariff on imports of natural gas into the EU which would help achieve this goal. The starting point is Gazprom's monopoly on exports of gas from Russia and pricing power on the European market. Standard trade theory implies that a tariff on Russian gas imports would be beneficial for Europe even on purely economic grounds because it would lower the demand curve Gazprom faces and induce it to lower prices.

The standard linear model used here takes into account the availability of Liquified natural gas (LNG) supplies and confirms the general rule that it pays to levy a tariff on imports from a foreign monopoly. It yields the following numerical results:

- Only one half of the tariff would result in higher prices for European consumers and the tariff revenue would be more than sufficient to compensate them for this loss.
- The tariff, which maximises Europe's welfare, would be close to one third of the price at which Europe would stop importing from Russia. This would cut Gazprom's net revenues by approximately half.
- If the tariff is used as a sanctions weapon to reduce revenues for Russia, the tariff should be higher (around 60 %) and would cut Gazprom's revenues to one fourth of the free trade level.

The overall conclusion is thus that an EU import tariff on Russian gas would have a major impact on Russia's earning from gas exports and would certainly improve the European terms of trade.

Case study: Optimal tariff to Russian gas

- Calls for the EU or individual member states to ban imports of Russian gas
- The economic consequences would be very severe in the <u>short run</u>
- An <u>import tariff</u> to Russian gas would have strong impact on Russia's revenues

Political advantage of a tax on imports vs ban on imports:
1. Higher prices to trigger investments to alternative supplies
2. Revenue from tariff could be provided as aid to Ukraine (with ban prices will be higher but no revenue will be generated)

Russia cannot really avoid such a tax:
- EU accounts for 70% of overall Russian pipeline gas exports
- China takes substantial amounts but would not risk its energy security in the long-run

<u>Main outcome</u>:
- On strictly economic grounds a tariff on Russian gas would increase EU welfare
- The optimal tariff (1/3 of current spot price) would reduce Gazprom's profits by more than 50%
- A tariff should be preferred over a ban as it leads to higher welfare

Case study: Optimal tariff to Russian gas

Assumptions:

1. Constant marginal cost of supplying gas (without any taxes)

$$MC_{Russia} = c \quad (1)$$

2. Linear demand curve EU

$$Demand_{EU} = D - d_e p \quad (2)$$

- The higher is d_e, the more price-elastic is demand (see sl. 35), i.e. lower monopoly power for Gazprom (lecture 2, monopoly)

3. One gas price *p* for all → impact of changes in prices or tariff depends on <u>total import</u> of gas from all sources, i.e., piped Russian gas but also LNG

Case study: Optimal tariff to Russian gas

4. LNG gas a good substitute for piped gas

Asia can be a net supplier or net consumer, the gas from which (or to which) is transported via LNG at an increasing marginal cost. When there is no LNG demand, there is more LNG gas available to Europe. The Asian supply curve reads:

$$Supply_{Asia} = -S_a + s_a p \qquad (3)$$

- Because of $-S_a$ if *p* is small $Supply_{Asia} < 0$, i.e., gas would flow from Europe to Asia
- S_a can be considered as the overall strength of Asian demand
- s_a indicates the strength of the reaction of Asian demand to higher prices (elasticity)

Case study: Optimal tariff to Russian gas

Demand for Russian gas

$Demand_{Russian\ gas} = q = Demand_{EU} - Supply_{Asia}$, i.e.,

$$q = D + S_a - (d_e + s_a)p \ \rightarrow$$

(Solve for p) $$p = p(q) = \frac{D+S_a}{d_e+s_a} - \frac{q}{d_e+s_a} = R - r\,q \qquad (4)$$

- This is the price EU customers are willing to pay (willingness-to-pay)
- $R \equiv \frac{D+S_a}{d_e+s_a}$ is low if consumers are more elastic (d_e for EU and s_a for Asia)
- R is an indicator for the pricing power of Gazprom on the EU market. When $D + S_a$ is high (higher overall demand) or/and $d_e + s_a$ is low (consumers less elastic), Gazprom can charge higher prices

Case study: Optimal tariff to Russian gas

Monopoly pricing

- Gazprom is the single Russian gas supplier, i.e. a monopolist for Europe
- Economic theory: pricing according to the *MC = MR* rule

Total revenue $TR = p(q)q = \underbrace{(R - rq)}_{\substack{demand\ curve \\ slope\ -r}} q = Rq - rq^2 \rightarrow MR = R - \underbrace{2r}_{\substack{slope \\ -2r}} q$

Remember:
in perfect competition MR=AR (which is the demand curve). In monopoly AR>MR

- Total *MC* is *c+t,* i.e., the *MC* of supplying gas plus the tax (per unit of nat. gas)
- *MR=MC* → $R - 2rq = c + t \rightarrow$ $q = \frac{R-c-t}{2\,r}$ (5)
- Substitute (5) in (4) to get the price charged:

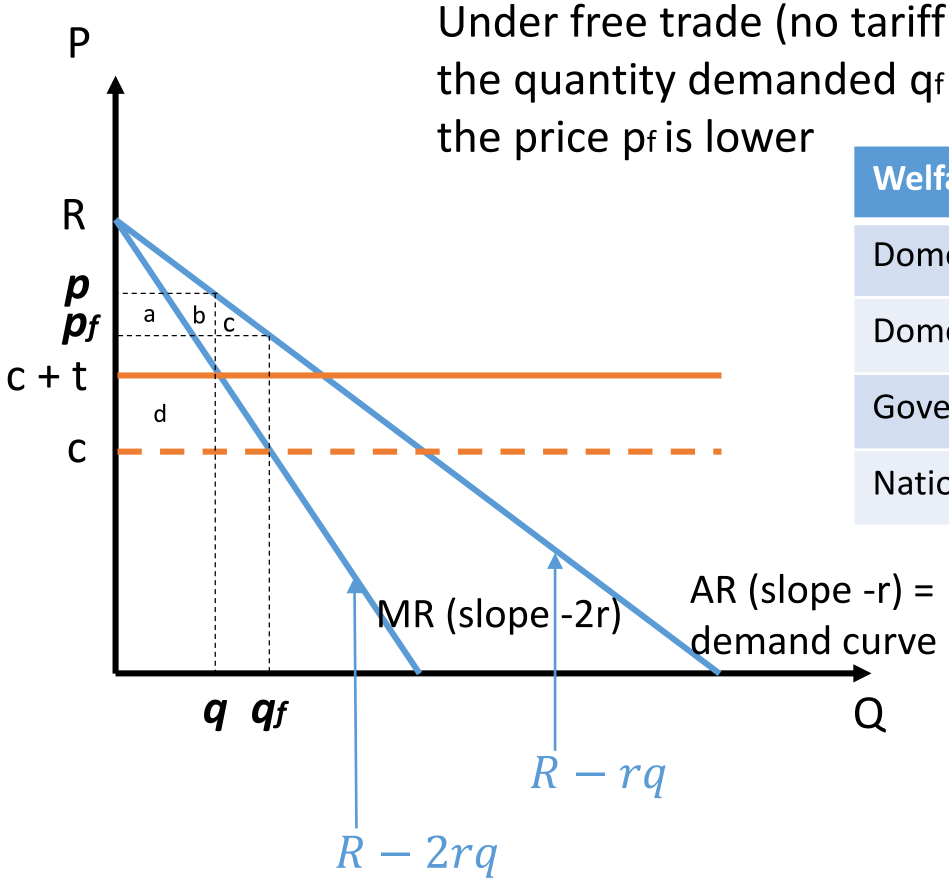
$$p = c + \frac{1}{2}(R - c + t) > c \qquad (6)$$

- Gazprom will charge higher prices than its marginal cost
- Price depends on *R* which incorporates: i) the availability from Asian supplies, ii) the response of consumers to higher gas prices (elasticities)

Case study: Optimal tariff to Russian gas

Monopoly pricing

Under free trade (no tariff t)
the quantity demanded q_f is higher and
the price p_f is lower



Welfare effect on importing country	
Domestic consumer surplus	-(a+b+c)
Domestic producer surplus	0
Government revenue	+d
National welfare	d - (a+b+c)

The importing country gains if d>a+b+c, which will always be the case for small t

Case study: Optimal tariff to Russian gas

Gazprom profits

Net profits: $\Pi_{Gazprom} = TR - TC = (Rq - rq^2) - (t + c)q$

And if we substitute q from (5) $$\Pi_{Gazprom} = \frac{(\mathrm{R-c-t})^2}{2} \qquad (7)$$

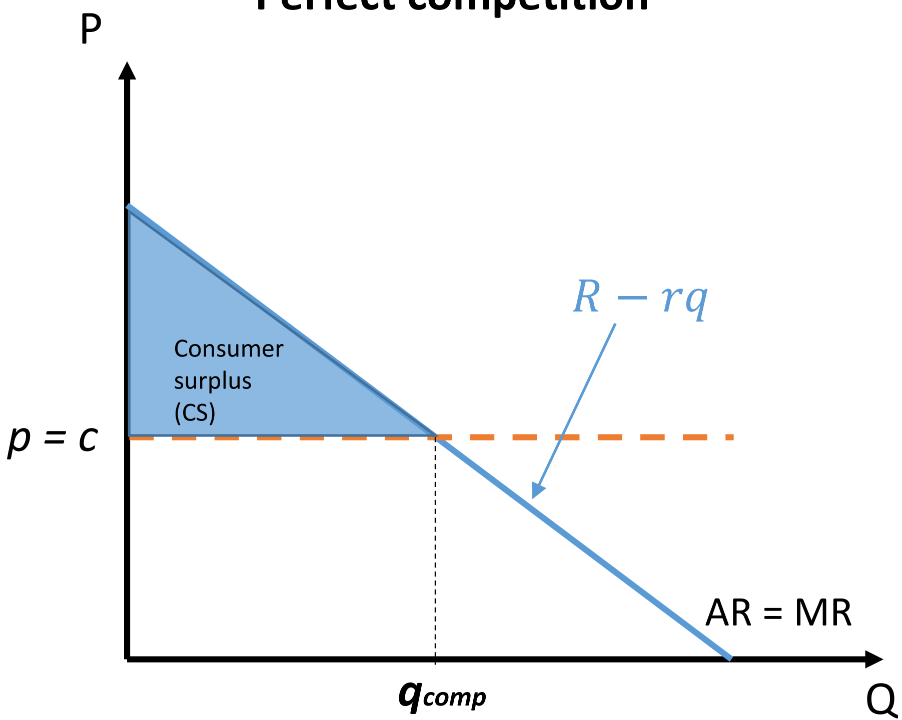
- Net profit of Gazprom declines as the tariff increases
- Net profit of Gazprom increases as R increases: higher demand from Europe & Asia, or/and consumers less elasticity

Question: How high should the tariff be?
Answer: the optimum tariff maximizes European welfare

Case study: Optimal tariff to Russian gas

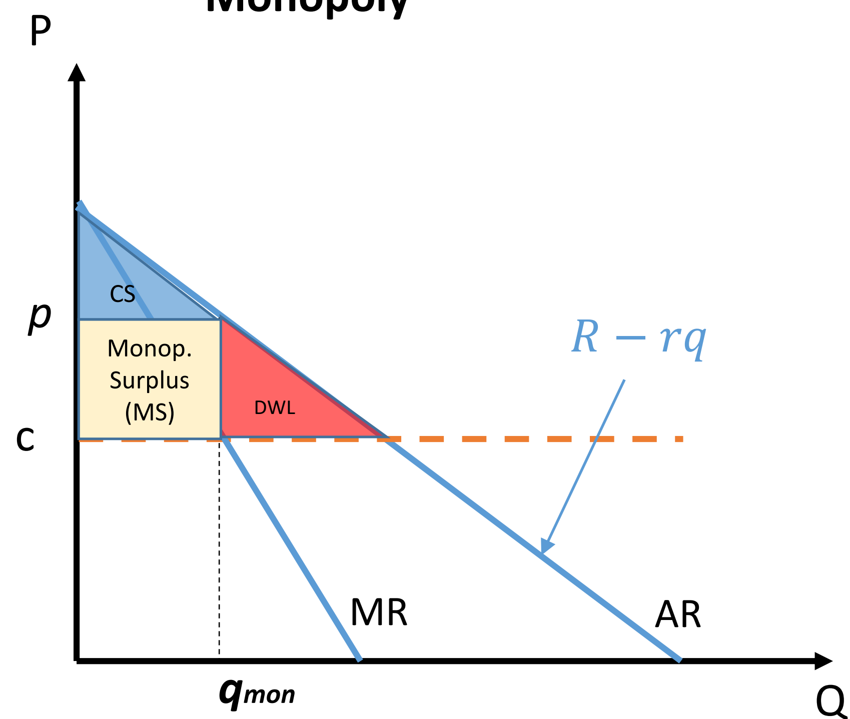
Welfare analysis

Perfect competition



Welfare = CS = $\int_0^{q_{comp}} (R - rq)dq - pq_{comp}$

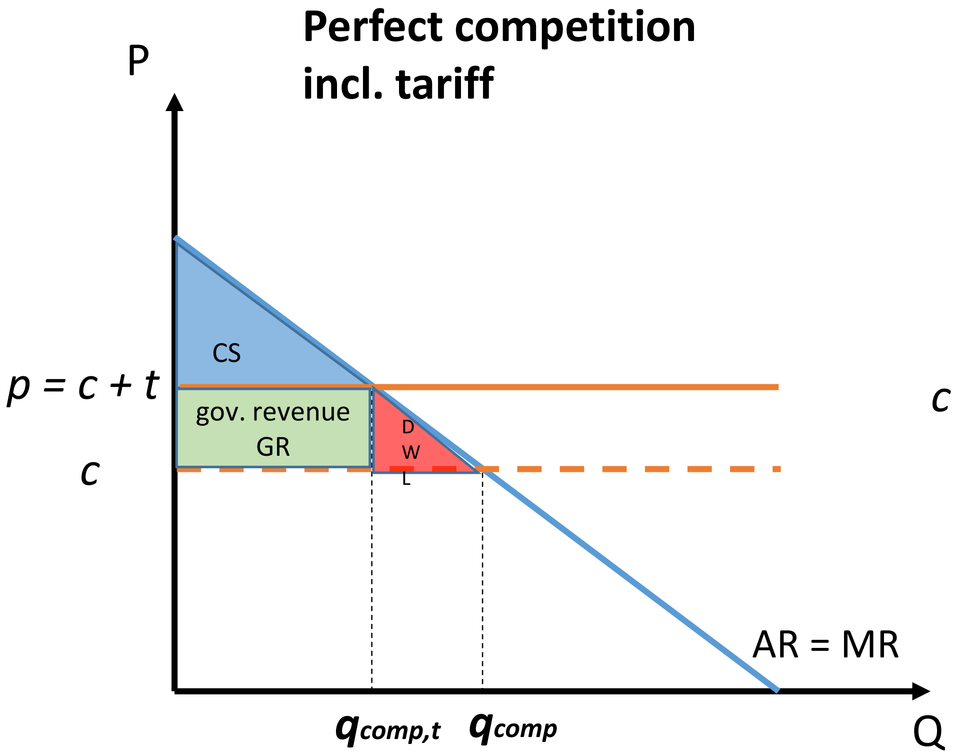
Monopoly



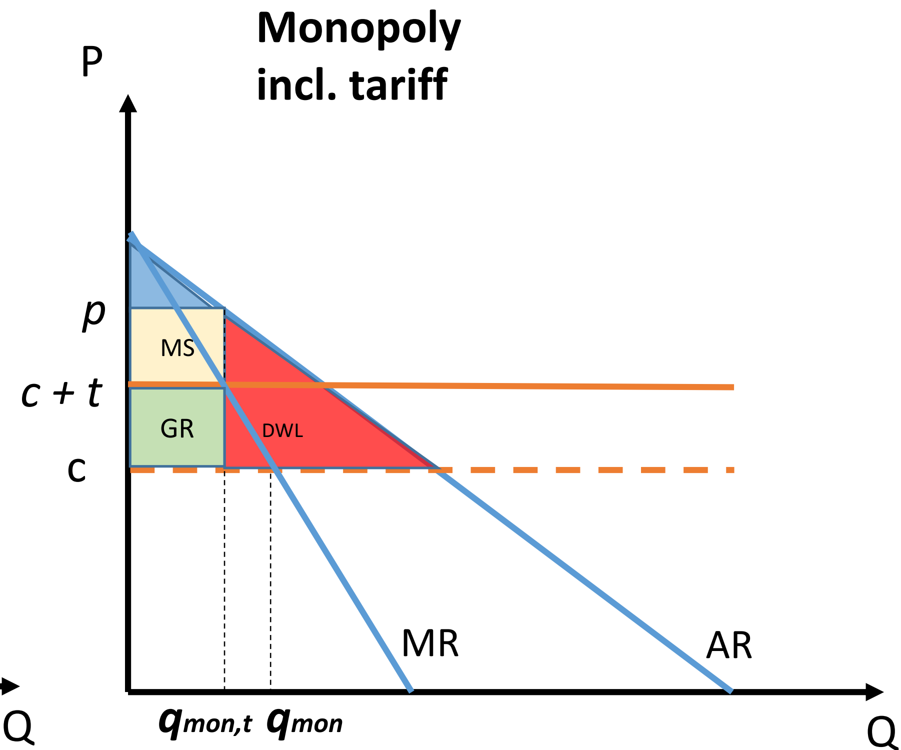
Welfare =CS= $\int_0^{q_{mon}} (R - rq)dq - p\, q_{mon}$

Case study: Optimal tariff to Russian gas

Welfare analysis



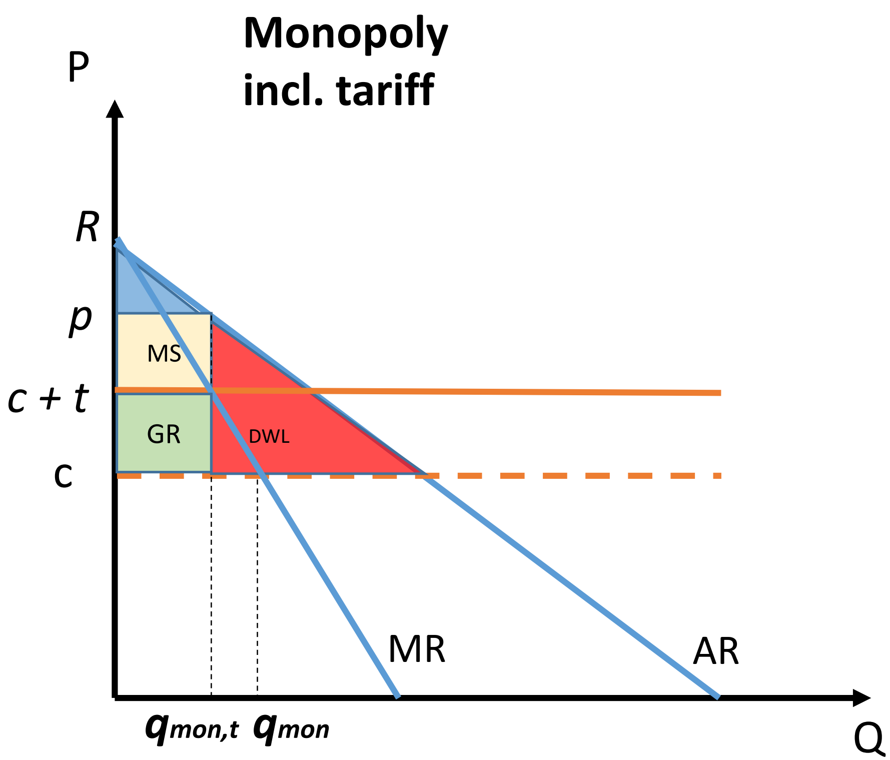
Welfare = CS+GR = $\int_0^{q_{comp,t}} (R - rq)dq - pq_{comp,t} + tq_{comp,t}$



Welfare = CS+GR = $\int_0^{q_{mon,t}} (R - rq)dq - pq_{mon,t} + tq_{mon,t}$

Case study: Optimal tariff to Russian gas

Welfare analysis



$W = \int_0^{q_{mon,t}} (R - rq)dq - (p - t)q_{mon,t} =$
$\frac{1}{2} q\ (R - p) - (p - t)q$

and substituting p from (6):

$$W = \frac{1}{2}(R - c + t)q - \frac{r}{2} q^2 \quad (8)$$

We maximize welfare by setting the derivative of (8) to zero, while remembering that $q = q(t)$ from 5:

$$\frac{dW}{dt} = 0 \rightarrow \boxed{t^* = \frac{R - c}{3}}$$

Case study: Optimal tariff to Russian gas

Optimal tariff: $$t^* = \frac{R-c}{3}$$

<u>Intuition</u>

- From (4), *R* can be thought as the price of gas if imports from Russia were banned
- Given that the current spot market reflects such a fear and that the marginal cost is much lower (an order of magnitude) than *R* the optimal tariff is approximately $t^* \approx \frac{spot\ price}{3}$
- t^* is decreasing the more reactive/elastic consumers are (through R); strong demand from Asia justifies higher tariff (see eq. (4))

$$\frac{\Pi^*_{Gaz}}{\Pi_{Gaz,no\ t}} = \frac{(\mathrm{R-c-t^*})^2}{(\mathrm{R-c-0})^2} = \frac{4}{9}$$

The optimum tariff (approx. 1/3 of current spot price) would deprive Gazprom of more than half of its current profits

What about biofuels/biocarbon?

Biofuels	
Pros	**Cons**
Renewable and "sustainable" energy source	Production can be quite inefficient
Low green house gas emissions	Not so low in the whole production chain
"cheaper" per unit of energy	Use of chemical pesticides
Large amounts of biomass "available"	Biodiversity loss
Increases energy security	High water demand
Reduces transportation distance	**Competition between food and energy**
Local job creation	

Tortilla crisis

The New York Times

Cost of Corn Soars, Forcing Mexico to Set Price Limits

By James C. McKinley Jr.

Jan. 19, 2007

MEXICO CITY, Jan. 18 — Facing public outrage over the soaring price of tortillas, President Felipe Calderón abandoned his free-trade principles on Thursday and forced producers to sign an agreement fixing prices for corn products.

The Mexican tortilla crisis came after a rise in the cost of corn, itself induced by growing ethanol consumption and booming demand in emerging countries

Tortilla crisis

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The fossil episode

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A B S T R A C T

Agriculture sector output (biocarbon) is a good substitute for oil in energy production but oil cannot be used as food. This one-way substitutability is analyzed in a dynamic general equilibrium model. It features three endogenous phases: a pure fossil, a mixed fossil and biocarbon and an absorbing biocarbon fuel only phase. In the latter two, the demand for biocarbon as fuel leads to increasing food prices. Depending on how easily capital and labor can reallocate, food prices increase by between 40% and 240%. The model is also used to analyze climate consequences of biocarbon fuel polices and of the shale revolution.

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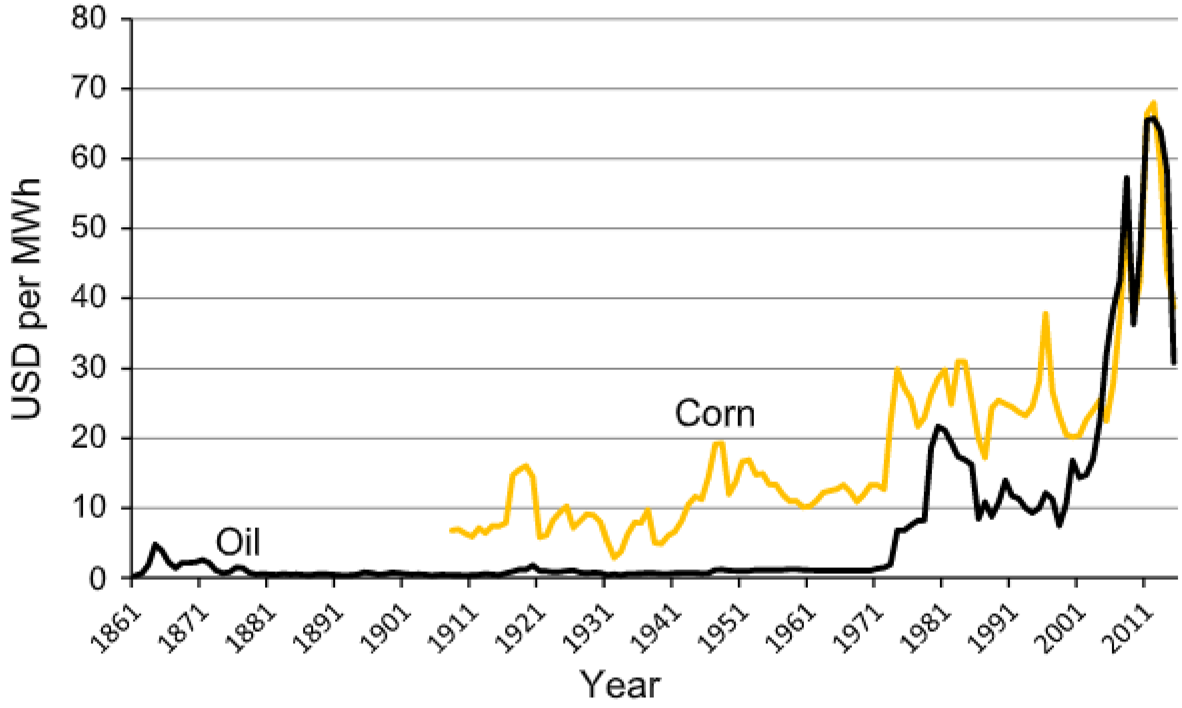
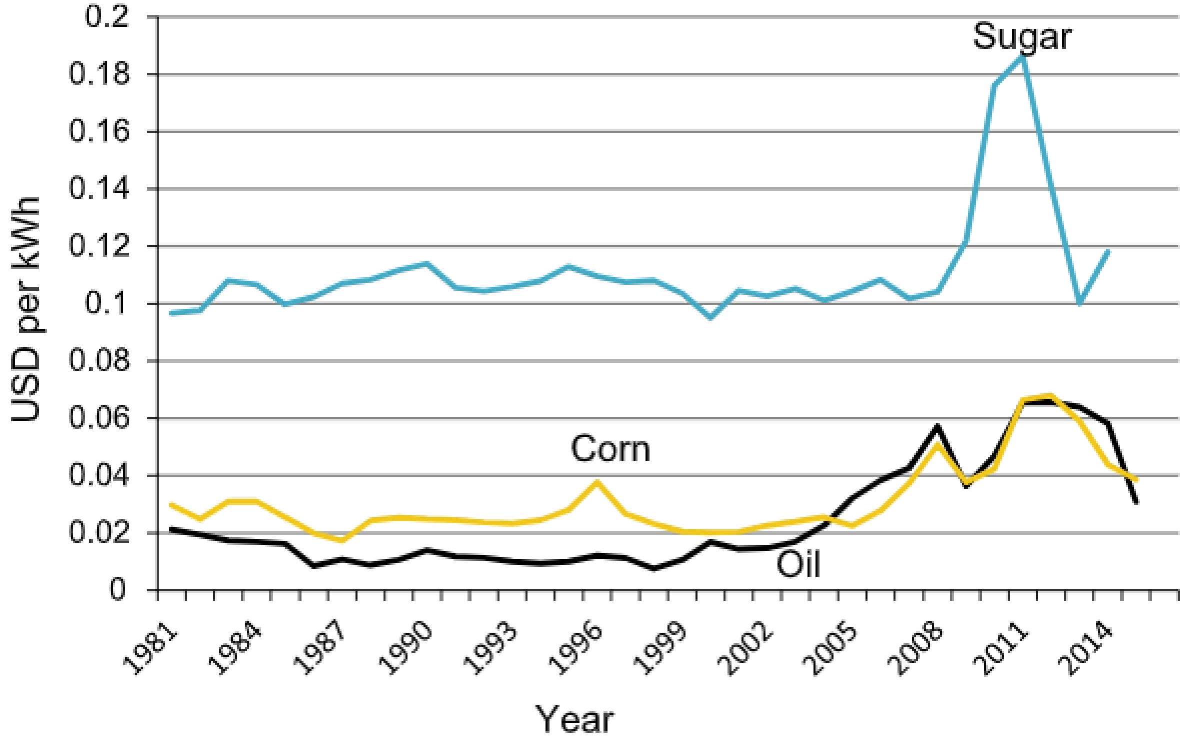
Tortilla crisis



- Oil prices have converged to the price of corn from below, coinciding with it since 2005
- With a higher degree of substitutability/υποκατάσταση, any factor affecting the price of one good is more likely to also drive the prices of good substitutes in the same direction

Tortilla crisis



- <u>Unidirectional</u> substitutability/ υποκατάσταση μονής κατεύθυνσης: corn can become fuel but oil cannot be eaten

- Unidirectional substitutability becomes operational when price of fossil carbon has reached the price of the biocarbon (both measured per unit of energy)