THE OXFORD INSTITUTE FOR ENERGY STUDIES

A RECOGNIZED INDEPENDENT CENTRE OF THE UNIVERSITY OF OXFORD

UNIVERSITY OF OXFORD

Starting the Models – Assets and Revenues (3)

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Outline of the course

Overall objective – understand how senior management use economic models to make investment decisions

1. Introduction to key themes in the global energy market
2. Introduction to financial modelling as a management tool
    1. Understanding some key concepts
3. **Starting two models for an oil and a gas field – revenues and prices**
4. Inputting the costs – capital expenditure
5. Operating costs and paying the government
6. A power plant – a buyer and seller of energy
7. Calculating a discounted cashflow
    1. Why is it important
    2. How is it used to make decisions
8. Testing the investment decisions: running some numbers under different assumptions
9. Answering your questions

Starting to construct a real project cashflow model

- Revenues
  - Production of energy
  - Price received for energy supply
- Cost of Development (Capex)
  - How much will it cost to put the necessary infrastructure in place?
- Cost of Operations (Opex)
  - How much will it cost to run the infrastructure and produce energy
  - How much will it cost to transport it to market?

What will the government get out of it?

- Operating taxes
  - Royalty
  - Export tax
  - Other social taxes
- Profit Tax
  - Depreciation is a key assumption
- Alternative forms of taxation
  - Production Sharing Agreement

Time to talk about project parameters

- Investment costs
  - Cost of up-front investment
  - Timescale
- Production
  - How much energy is produced?
  - What is the output profile?
- Prices
  - Price of energy sales
  - Price of energy and other inputs
- Operating Costs
  - Cost to run the asset
  - Fuel input costs
  - Transport costs
  - Taxes

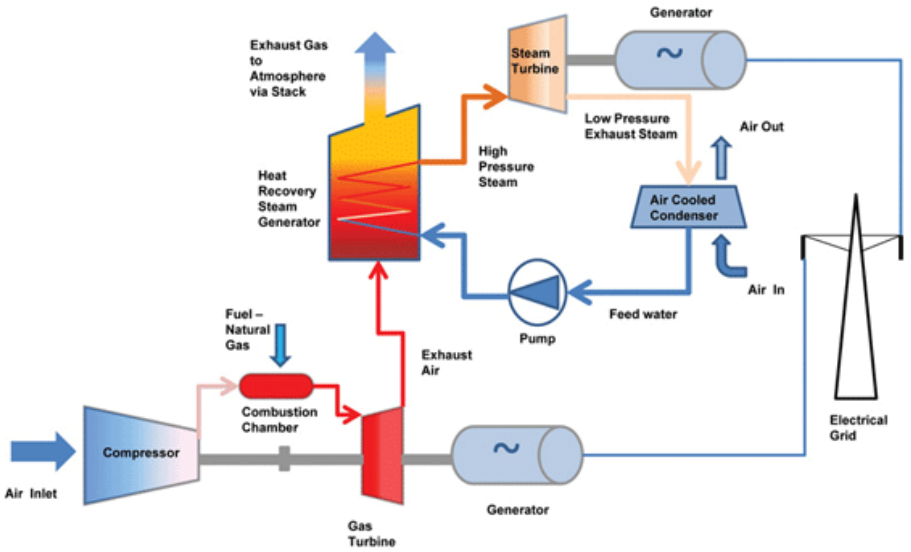
A major offshore oil production facility

- Multi-billion dollar projects offshore require huge up-front spending
- Onshore projects can be more incremental with production

Shale oil development in Texas

- Each well in a shale development is an individual investment with its own economics
- The numbers are smaller, but equally important to investors

A combined cycle gas plant



- 750MW CCGT power plant owned by EDF in France
- Cyclical process to maximise efficiency (around 54%)

Production Profile

A conventional oil or gas field production profile

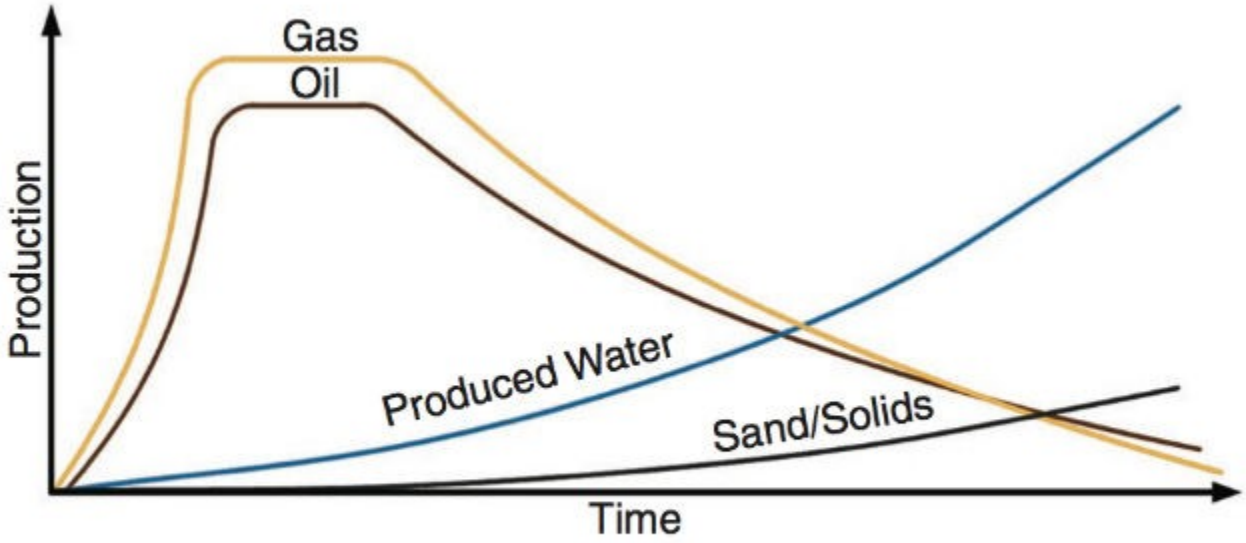


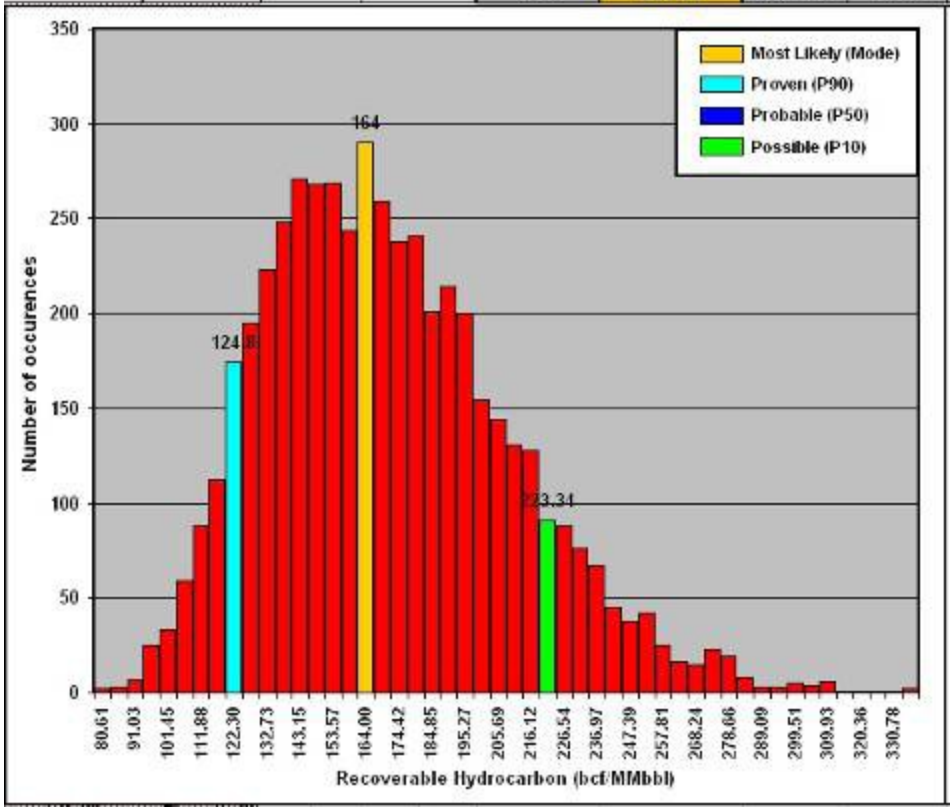
Fig. 1—A typical oilfield production profile.

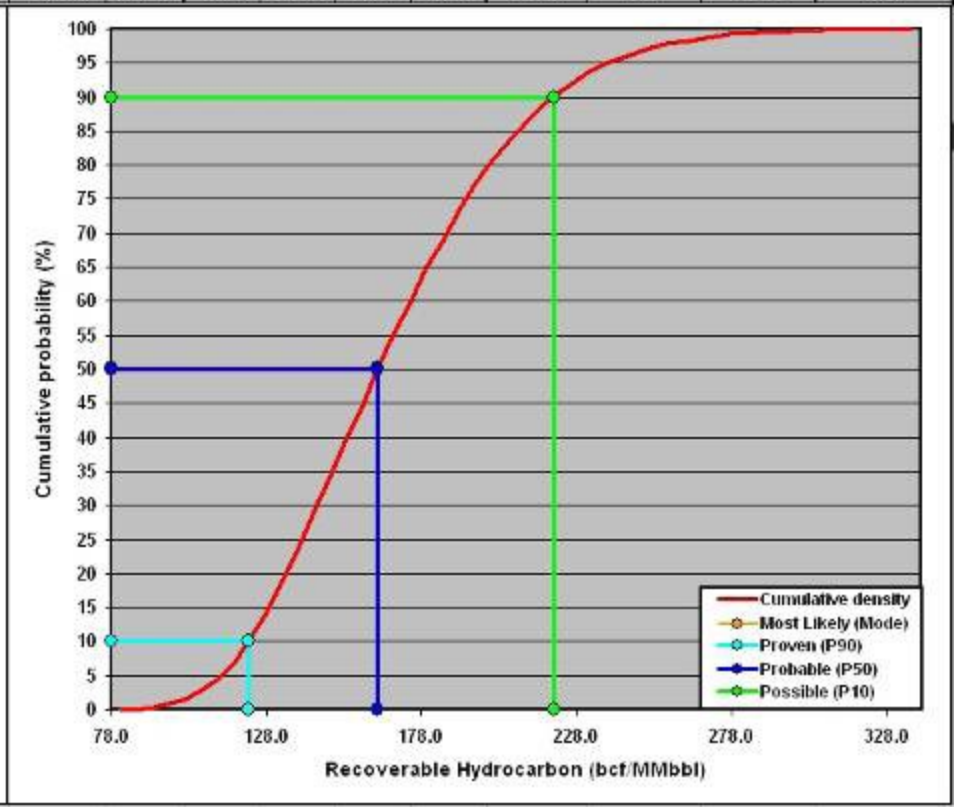
1. Initial surge to peak production
2. Plateau at peak for a number of years
3. Gradual decline towards abandonment
4. Water and solids production increases, undermining performance

Create a theoretical cashflow based on assumptions known to date

Monte Carlo reserve simulation: results and input parameter summary

Prospect Name	Modelling and structural parameters			Statistics	Recoverable hydrocarbon (bcf/MMbbl)	Volumetric parameters				Petrophysical parameters				PVT parameters			Field development parameters
	Number of Iterations	Reservoir Type	Trap Type			OWC/GWC depth (m)	Reservoir thickness (m)	Reservoir area (km^2)	GRV (10^8 m^3)	Φ (%)	Sw (%)	S_{hc} (%)	Area N/G	Reservoir Pressure (MPa)	Reservoir Temperature (°C)	Expansion Factor (Sm^3/Rm^3)	Recovery factor
M11-1 Preliminary results	5000	GAS	Simple Layer	Minimum	78.13	2800.01	18.25	8.002	148.12	9.52	20.15	60.30	1.00	46.08	97.00	322.00	0.604
				Most Likely	164.00	2803.41	25.29	8.070	224.85	12.23	30.15	69.85	1.00	46.08	97.00	322.00	0.704
				Maximum	338.45	2849.96	39.77	11.171	412.92	14.09	39.70	79.85	1.00	46.08	97.00	322.00	0.849
				P90	124.80	2804.86	21.79	8.158	193.22	10.66	24.55	64.52	1.00	46.08	97.00	322.00	0.650
				P50	166.48	2824.61	27.01	8.947	245.14	12.02	29.97	70.03	1.00	46.08	97.00	322.00	0.714
				P10	223.34	2844.68	34.13	10.192	315.06	13.19	35.48	75.45	1.00	46.08	97.00	322.00	0.790





Oil Production Forecast

Key Elements

- Time from first investment to first oil
- Ramp up period
- Peak production
- Peak production period
- Decline rate

Let’s model a conventional oil and gas field

- Reserves – 500mmbbls oil plus 1000bcf gas
- Start date –in 5th year after first investment
- Peak production – 6% of reserves
- Time to peak – 5 years
- Length of peak – 5 years
- Decline rates – 5% per annum

Revenues

Production x Price

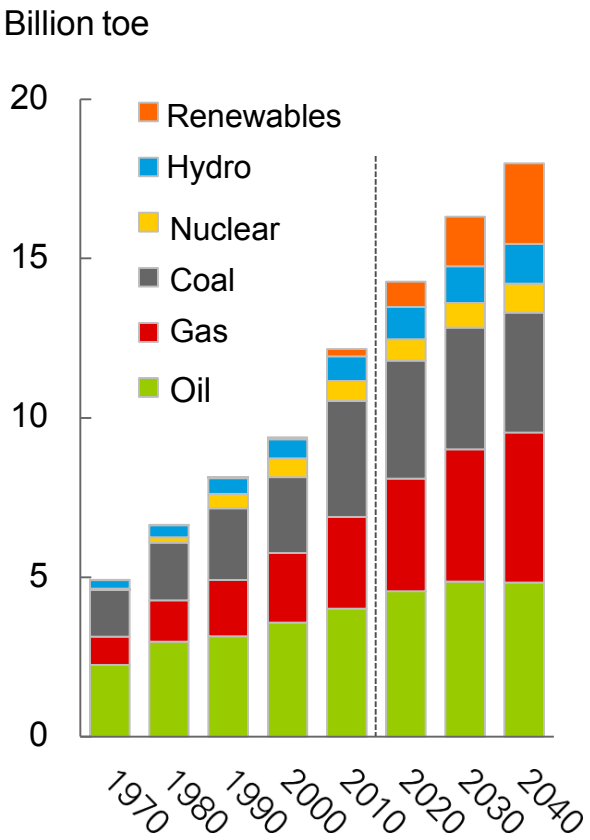
- Separate for oil and gas
- Oil price a good guide for overall outlook for energy market
- Gas price often linked to oil price in contracts, although in some countries is more market-based
- Key gas benchmark in US is Henry Hub, where gas is traded
- Electricity prices are often regulated, but in US it is traded in a free market environment

Some Scenario Planning

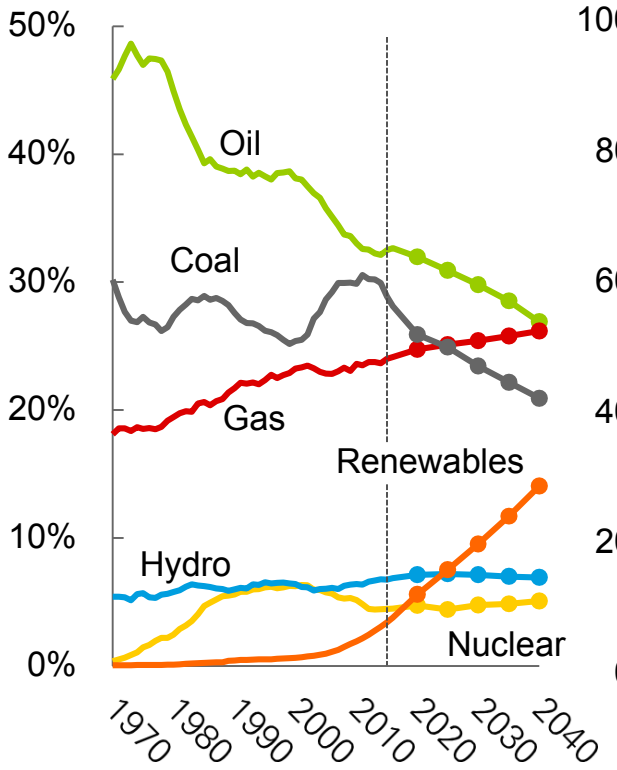
- We need to have some opinions of fuel prices for our cashflow model
- Future of oil gas and electricity prices is critical to revenues
- We also need to know how often our power plant will be operational (the load factor)
- Impact of changing energy economy is increasingly evident and needs to be discussed
- Strategic planning departments create a base case and various alternative outcomes around it
- The ultimate conclusion needs to be some price forecasts

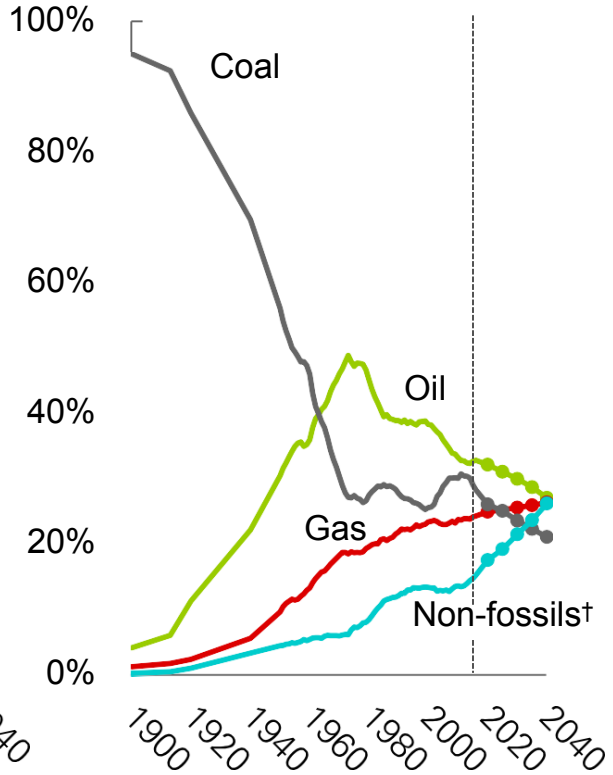
The transition to a lower carbon fuel mix continues…

Primary energy consumption by fuel



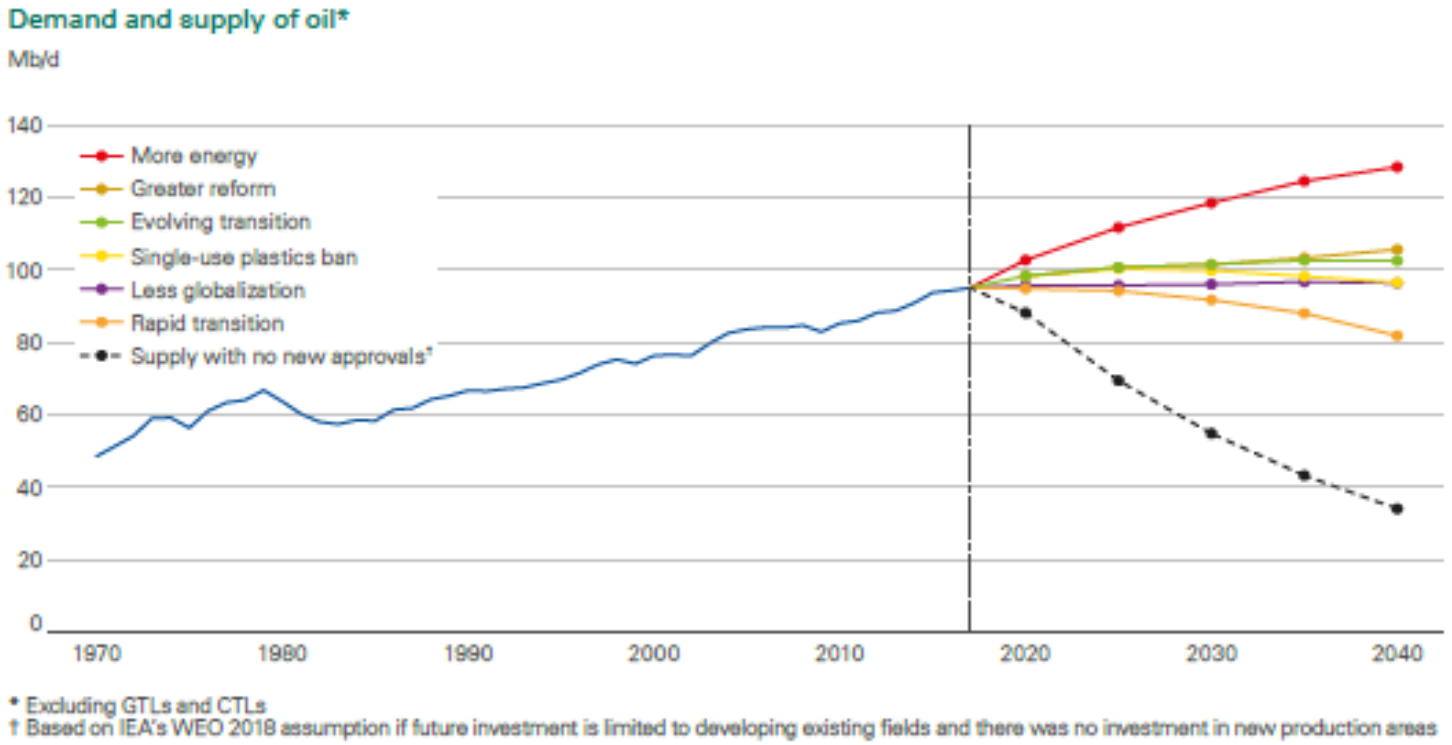
Shares of primary energy





† Non-fossils includes renewables, nuclear and hydro

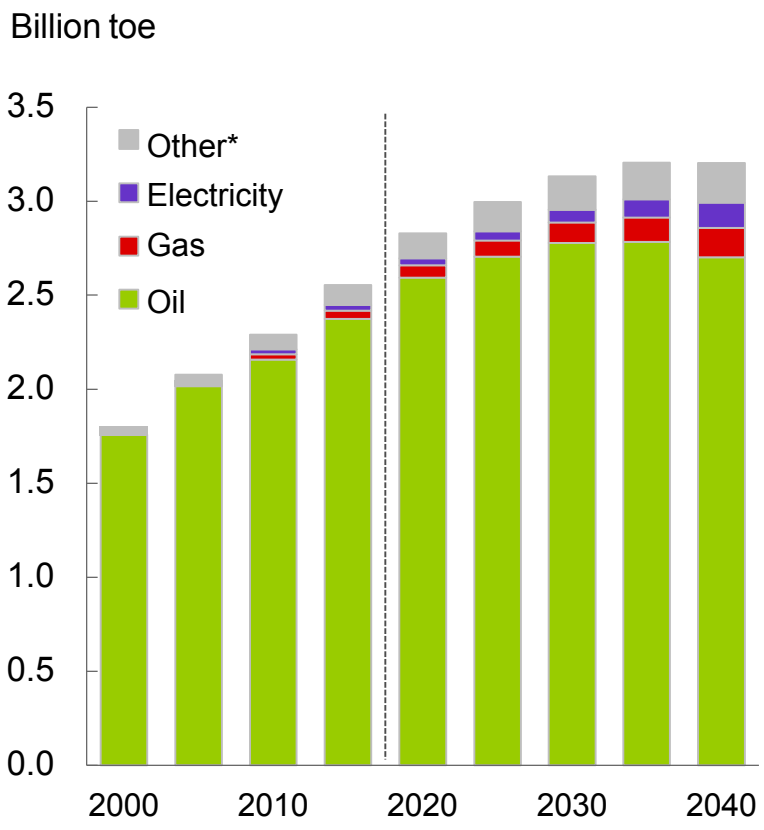
Alternative Scenarios for Oil Demand



- Broad range of scenarios based on development of energy economy
- Spread between high and low demand is over 40mmbpd
- New supply will be needed though; existing fields will inevitably decline

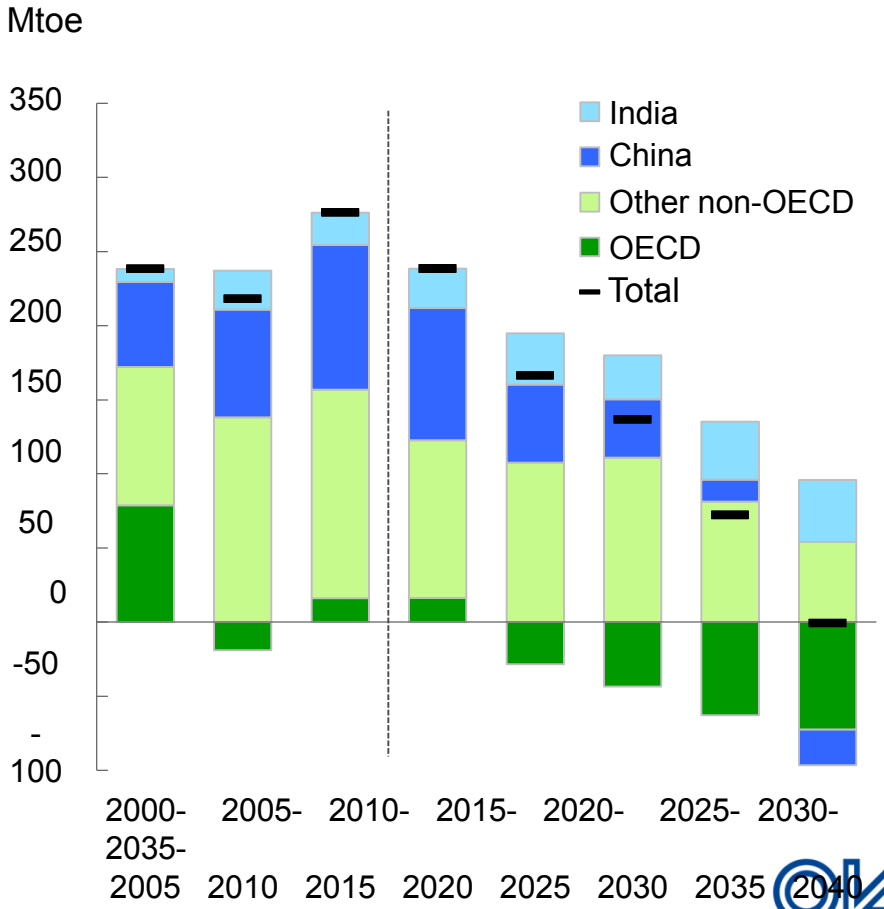
Transport demand continues to be dominated by oil…

Transport energy consumption by fuel type

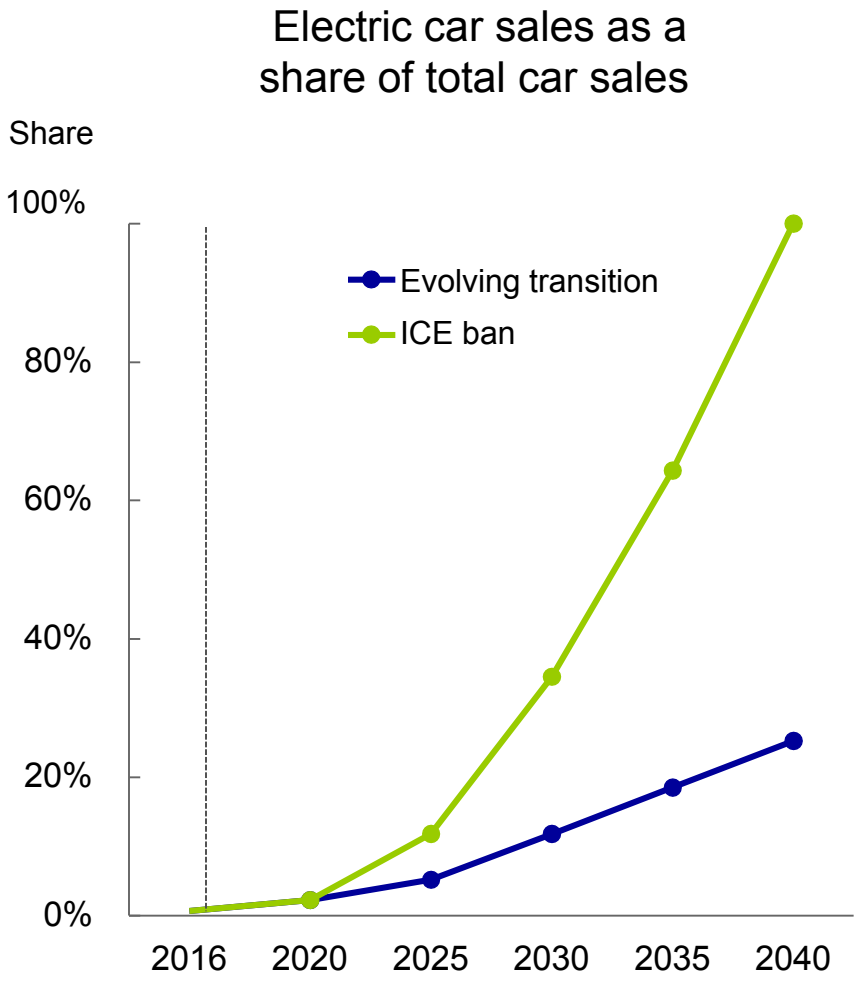


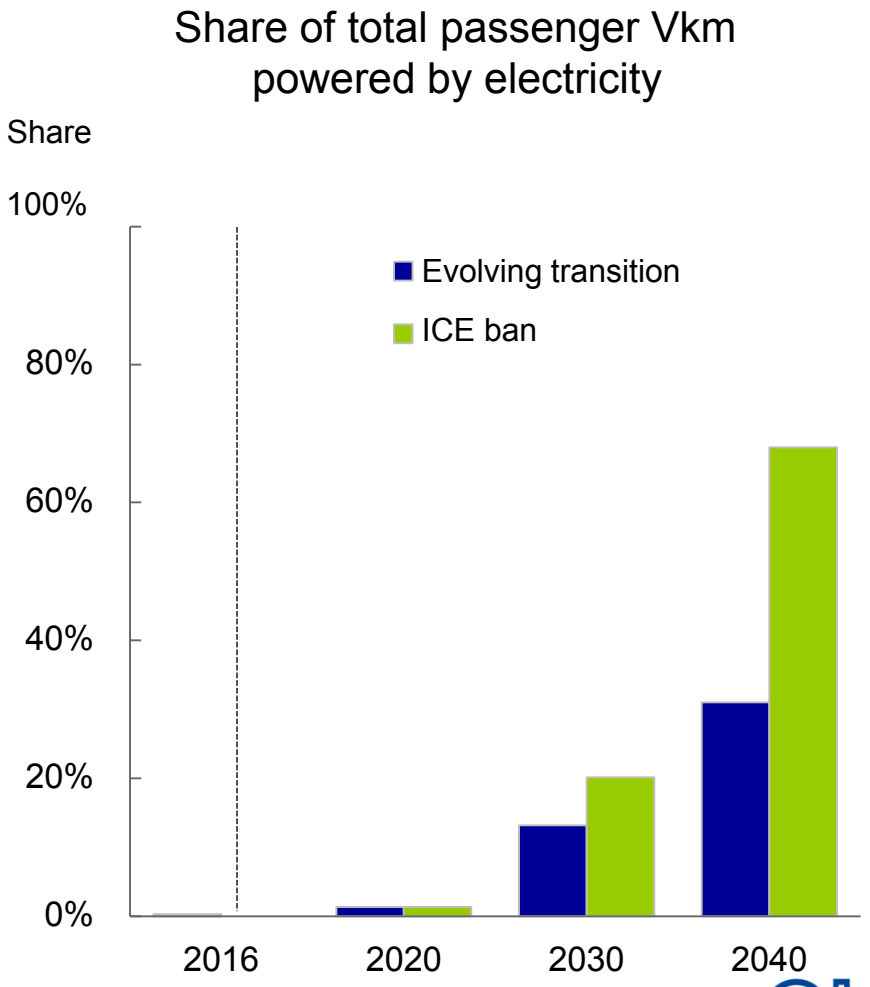
*Other includes biofuels, gas-to-liquids, coal-to-liquids, hydrogen

Transport energy consumption growth by region



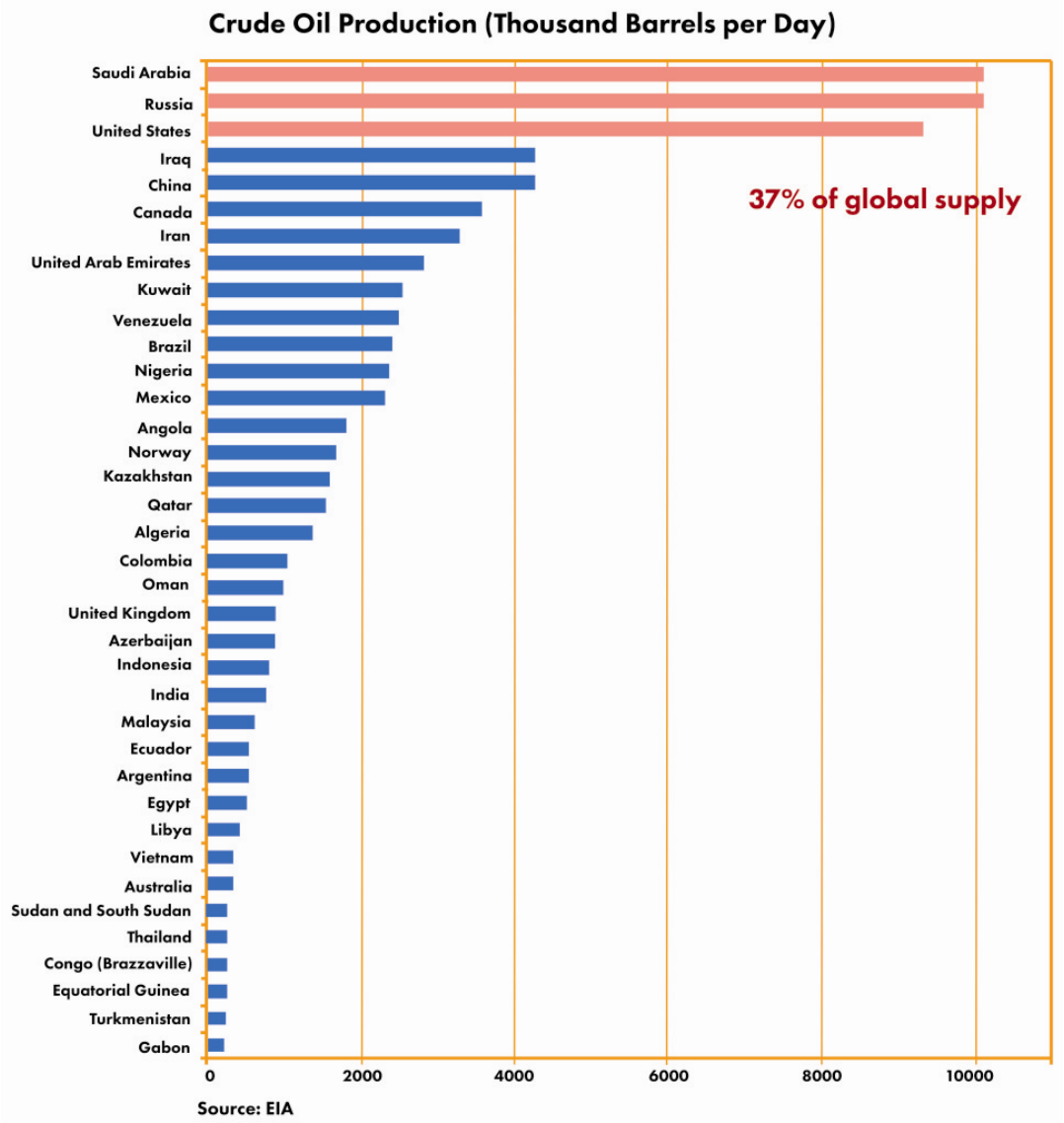
Alternative scenario: impact of faster growth in electric cars…



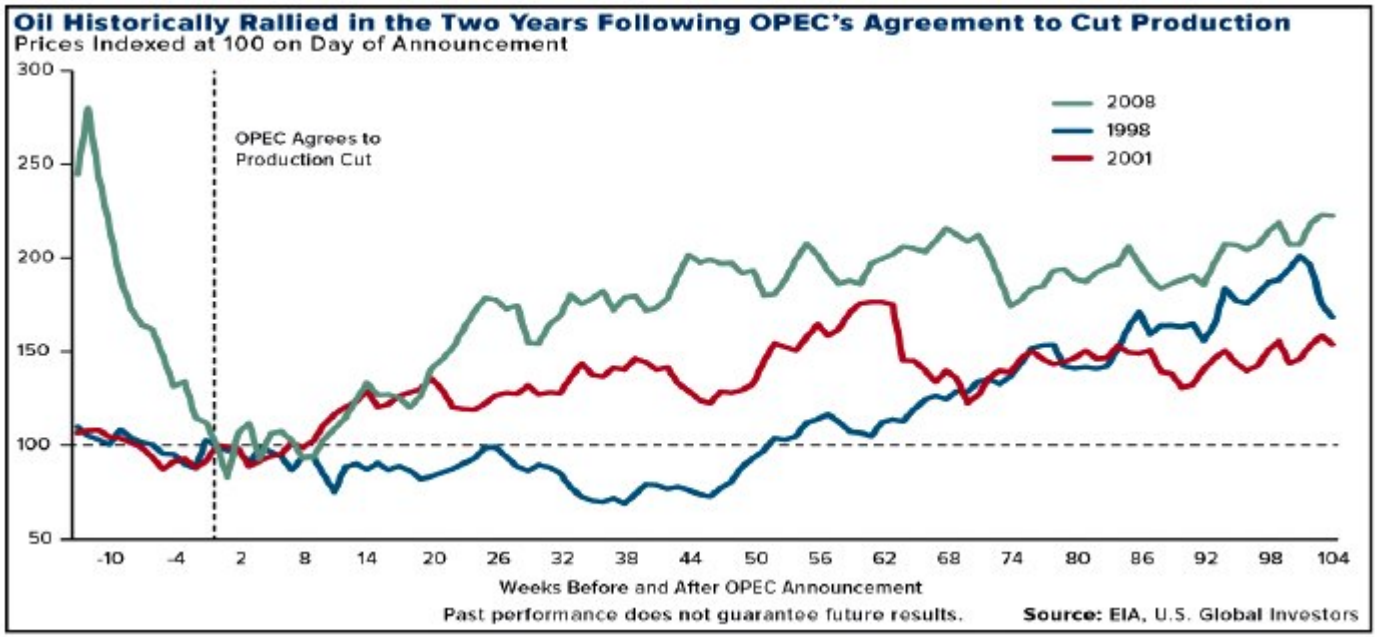


Oil production is dominated by three countries

- Saudi Arabia, Russia and the US account for more than one third of global oil output
- The Middle East is the dominant region, accounting for around 35% of output
- OPEC countries generate 42% of the world's oil, giving the cartel a strong lever over prices
- Many traditional non-OPEC countries are now in decline, other than the US



Impact of OPEC

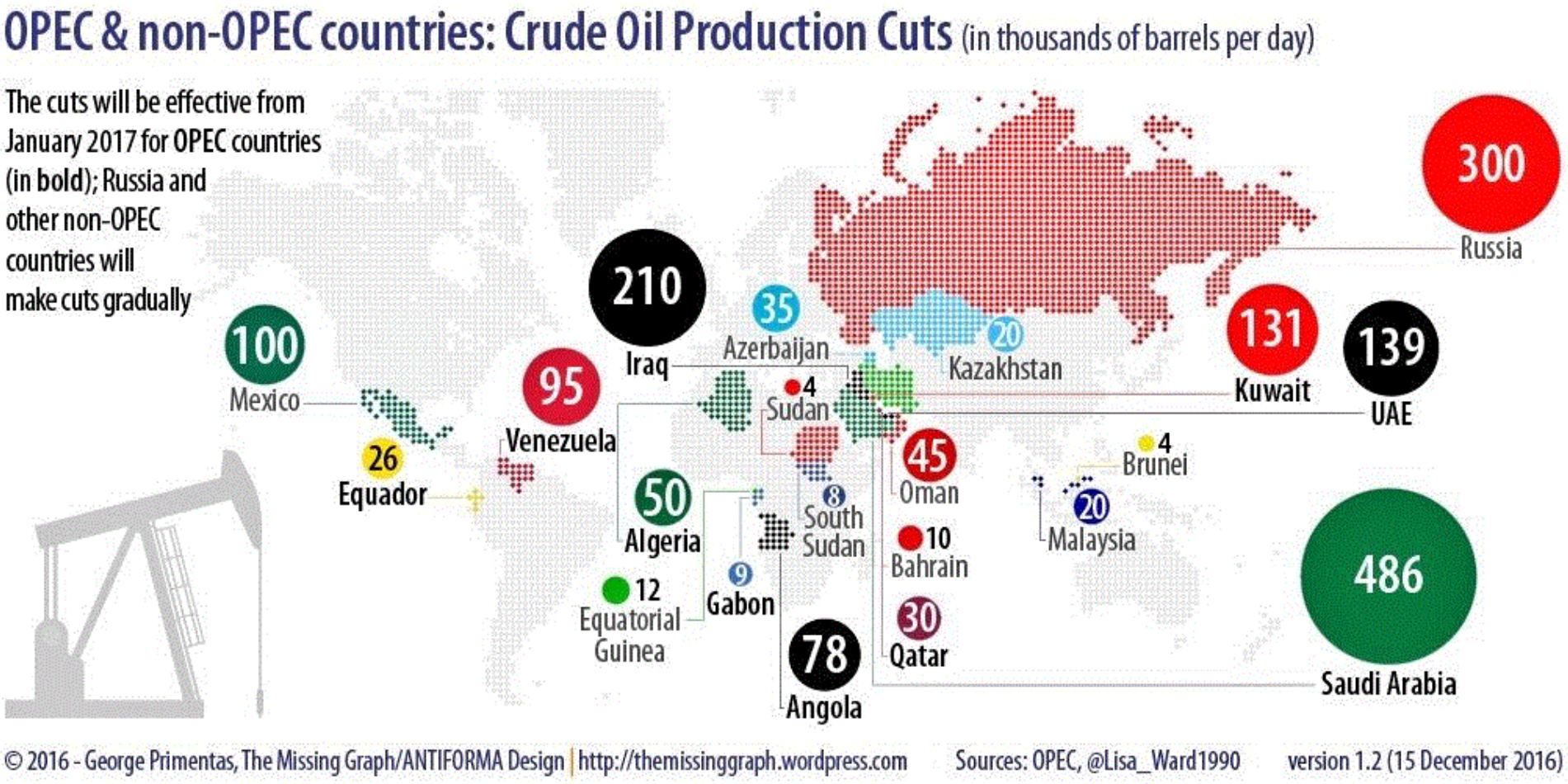


- OPEC accounts for around 40% of global oil production
- It tries to act as a cartel to control the oil price within an "acceptable" range
- Most recent cut was in November 2016 – price has risen from $45 per barrel to $70

OPEC decisions about future oil production and oil prices are critical for new projects

- Need to maximise oil revenues
- Historic strategy to preserve oil for future generations
- Now the question is whether there is a long-term future for oil?
- Largest reserve holders risk failing to monetise resources
- Low cost producers do not want to allow higher cost producers to take market share
- How to find the optimal balance?

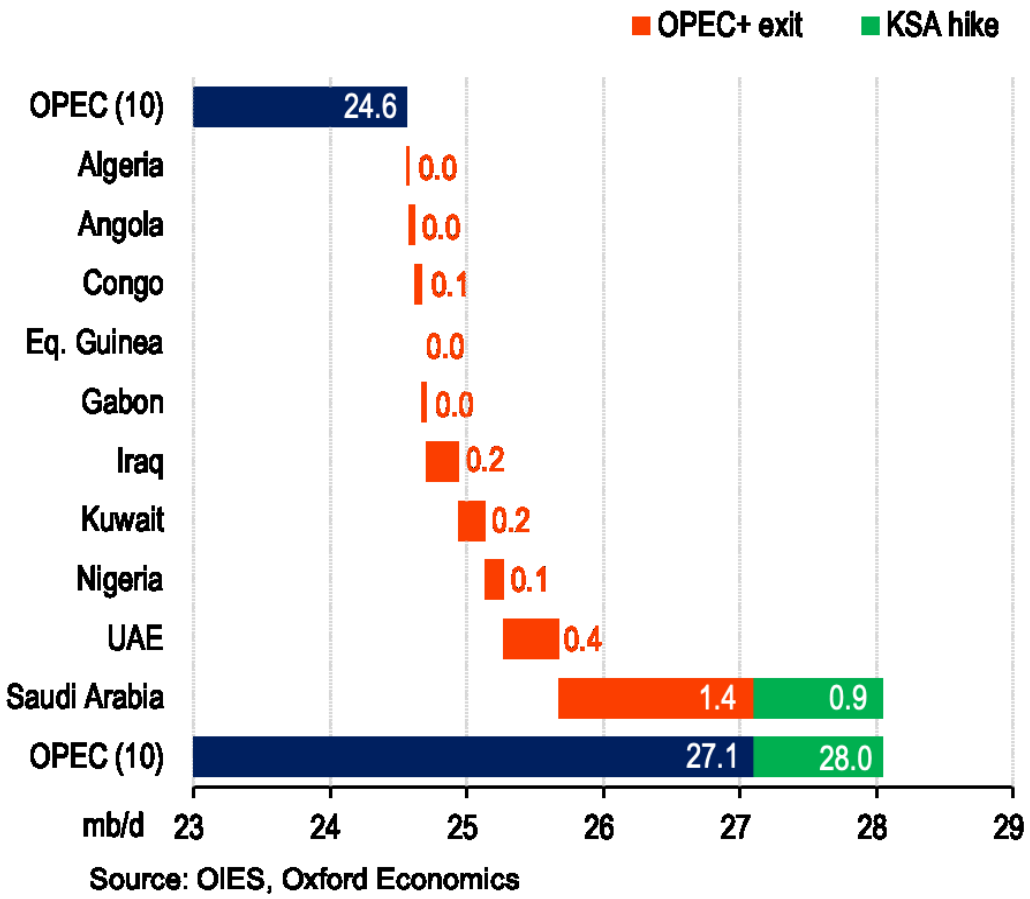
Strategy from Dec 2016 – avoid very low oil prices by cutting production



- What happens next? An oil glut from US shale or an oil shortage due to lack of investment and growing demand?

Saudi Arabia started a price war in March 2020 – bad timing!

OPEC+ agreement collapsed in March and supply surged



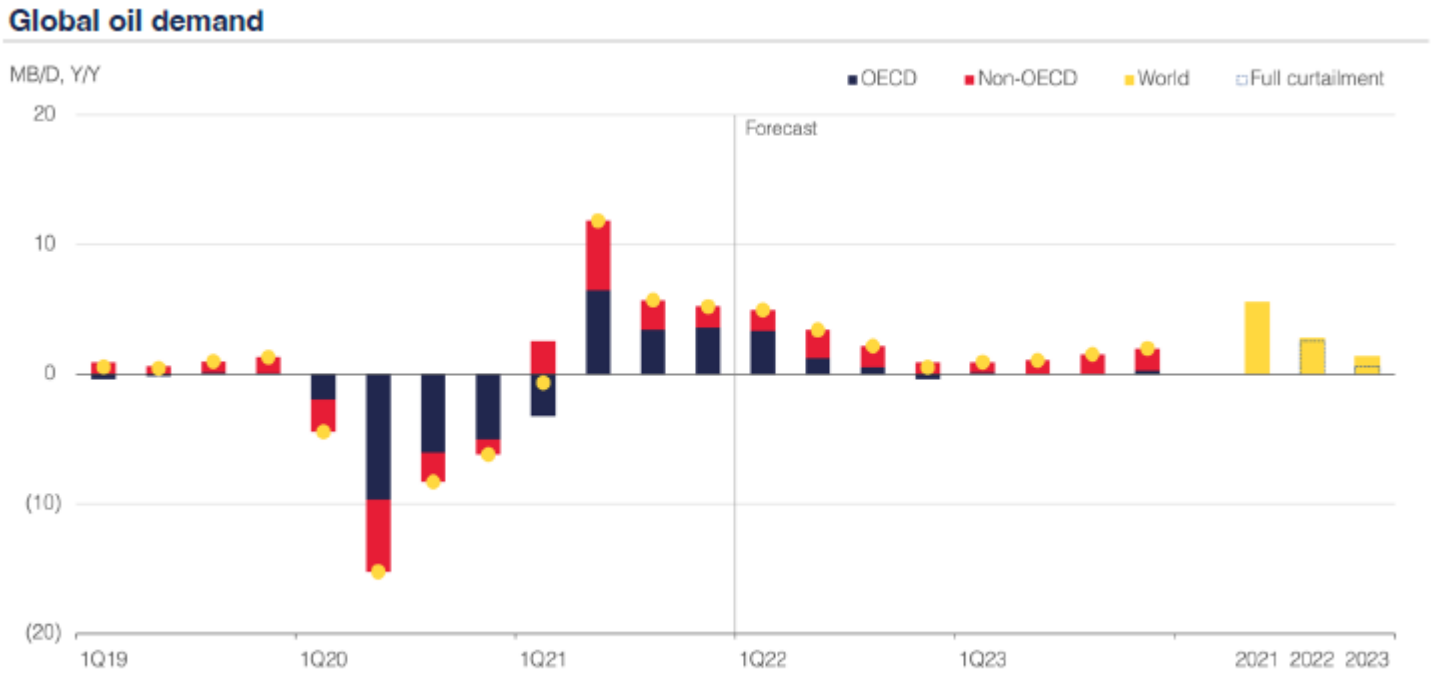
Source: OIES, Oxford Economics

Brent spot price

Source: OIES, EIA

Global oil demand has rebounded strongly but growth is flattening off due to high prices

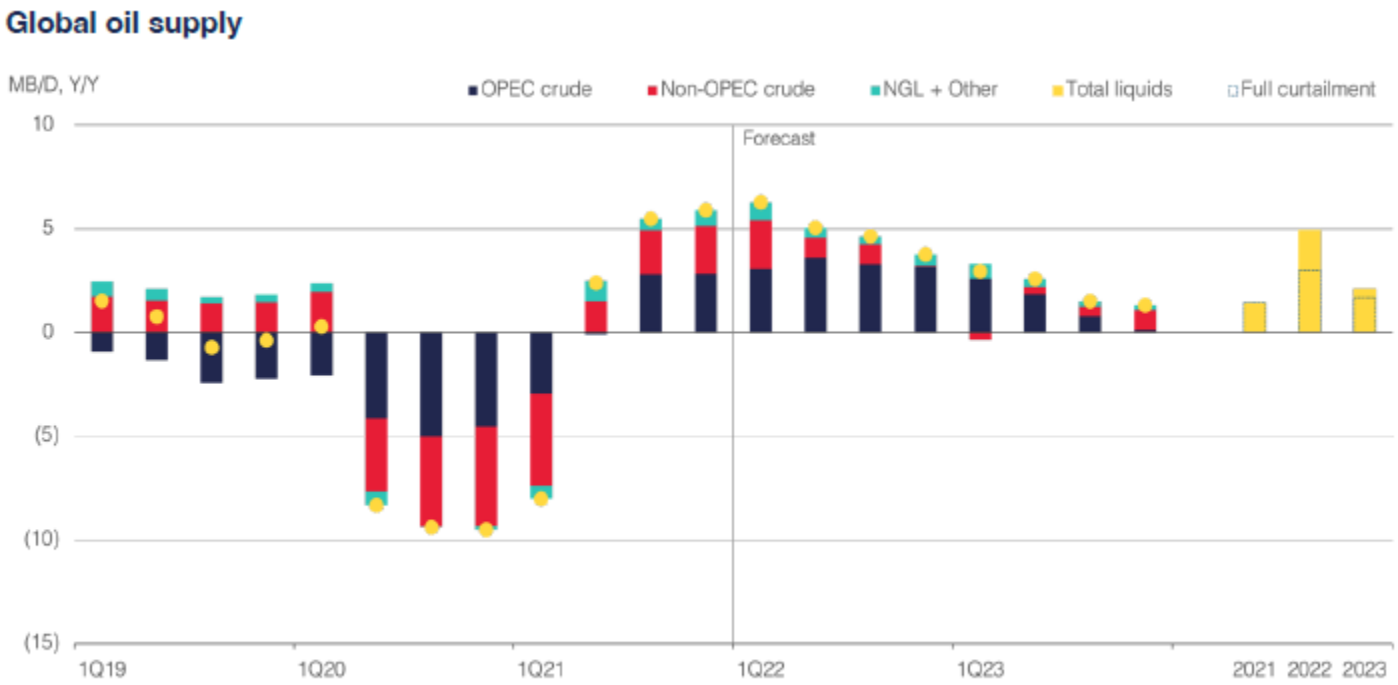
Global oil demand growth （annual）



Notes: The reference case assumes the loss of 1 mb/d of Russia's oil supplies in March 2022 and the full curtailment case assumes the loss of 4 mb/d of Russia's oil supplies between February and May 2022. Source: OIES

Global oil supply growth increasingly reliant on OPEC

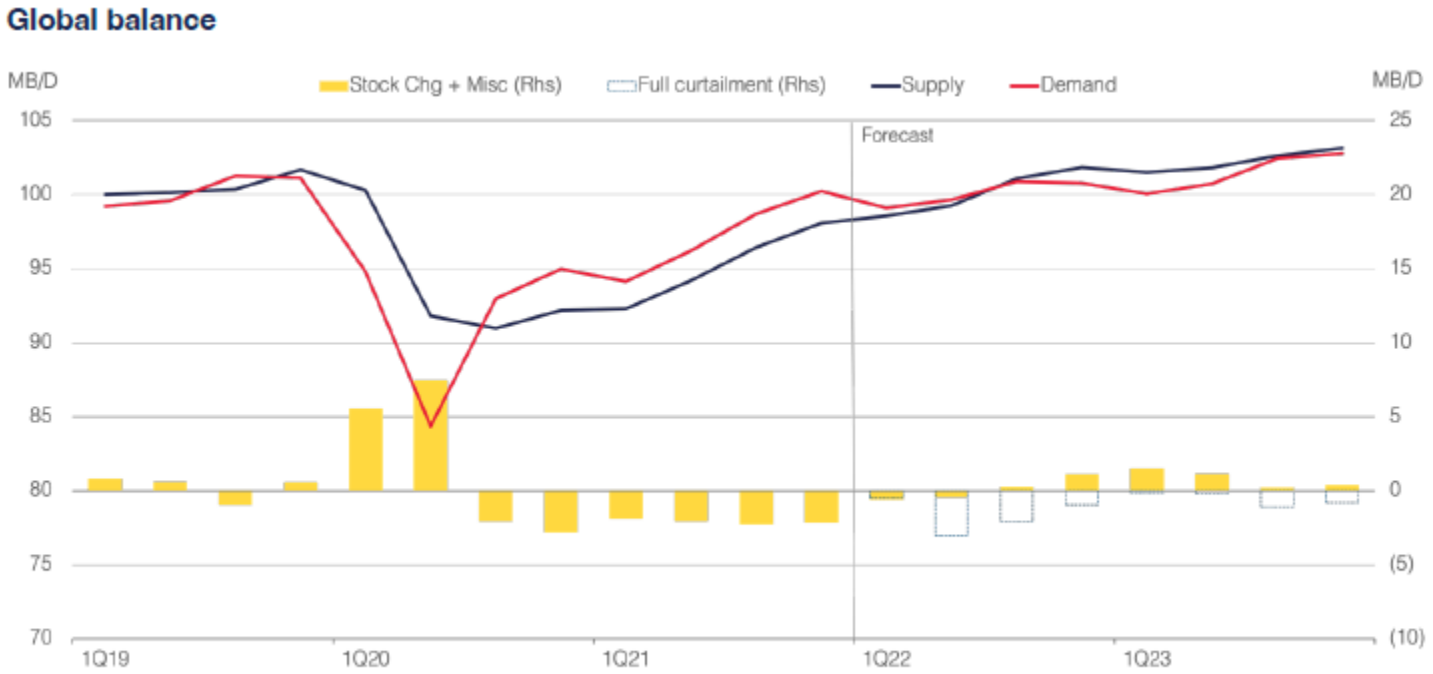
Global oil supply growth



Notes: The reference case assumes the loss of 1 mb/d of Russia's oil supplies in March 2022 and the full curtailment case assumes the loss of 4 mb/d of Russia's oil supplies between February and May 2022. Source: OIES

Global balance of supply and demand for oil before and after the start of the Russia–Ukraine war

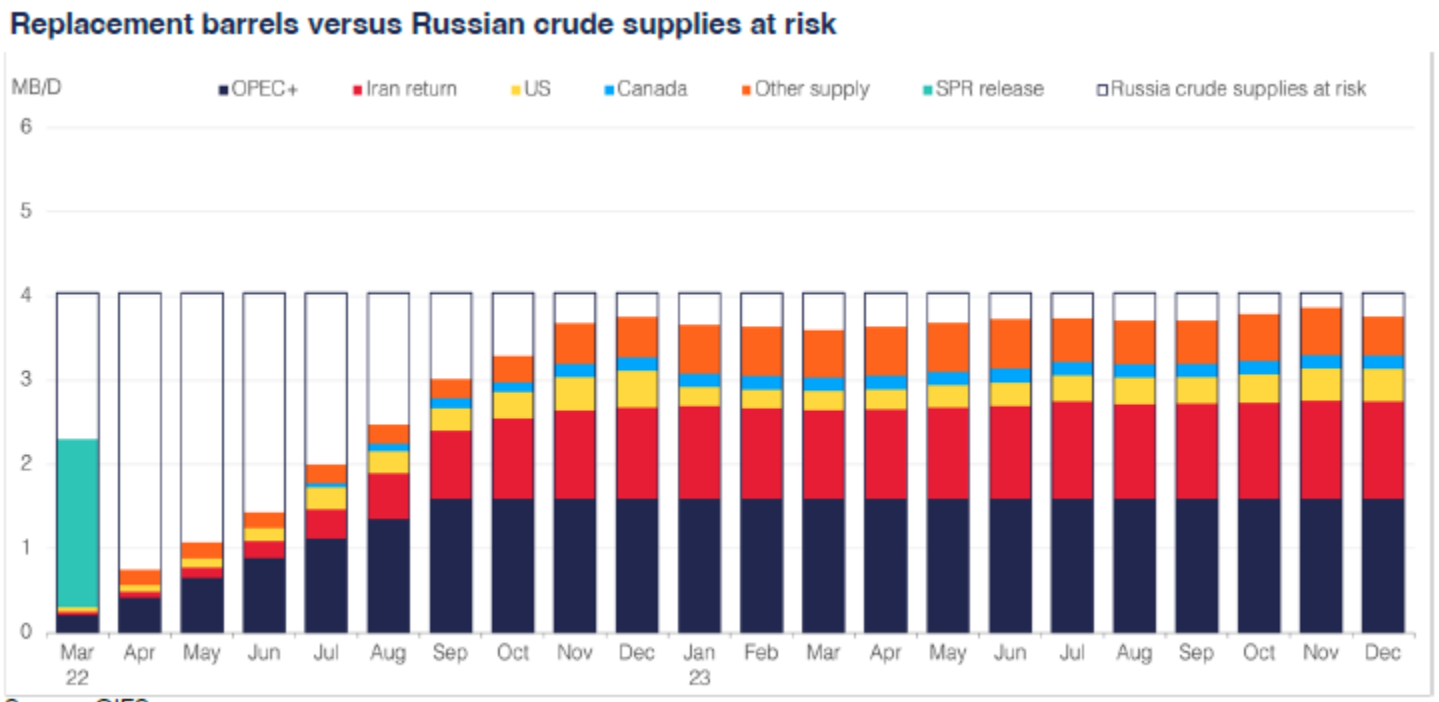
Global oil supply and demand balance



Notes: The reference case assumes the loss of 1 mb/d of Russia's oil supplies in March 2022 and the full curtailment case assumes the loss of 4 mb/d of Russia's oil supplies between February and May 2022. Source: OIES

What happens if Russian oil exports are banned globally?

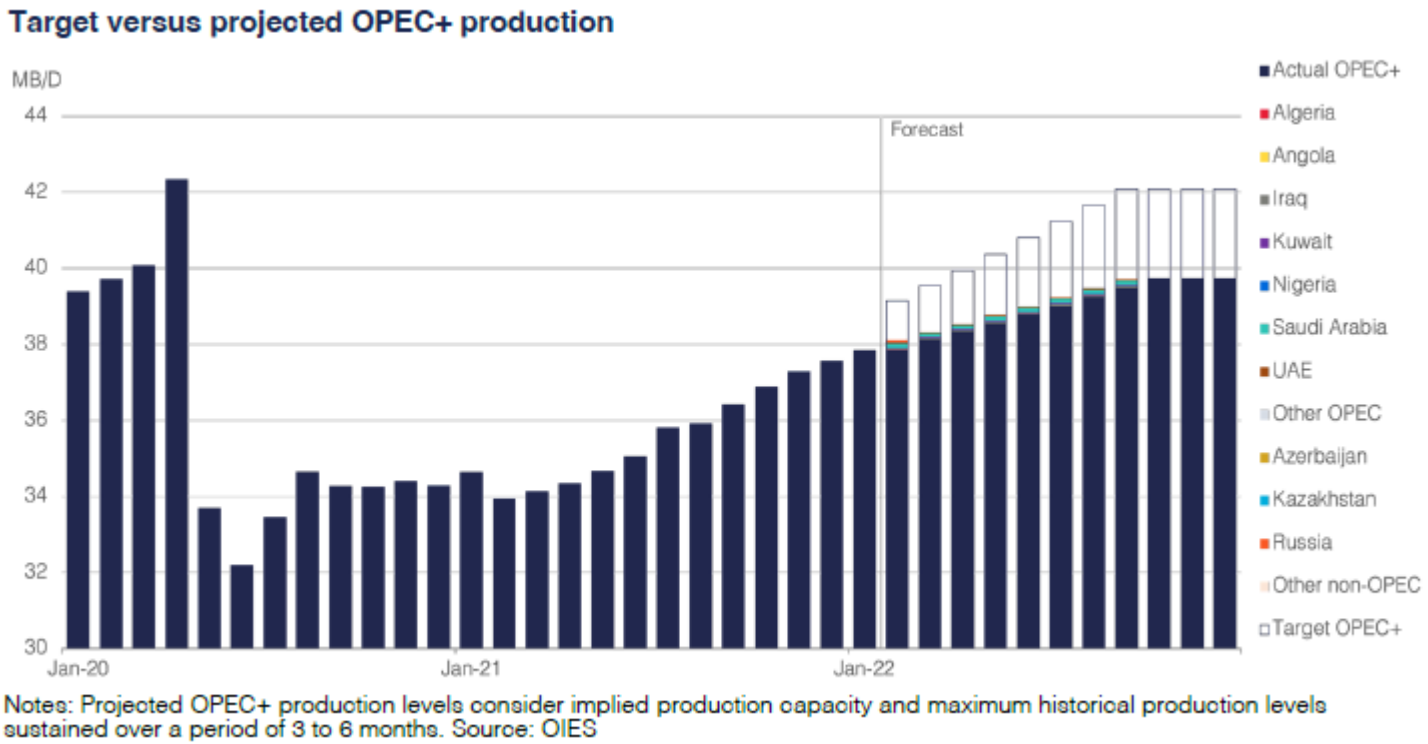
How to replace Russian export barrels



Source: OIES

OPEC cannot meet its own target to replace production lost in pandemic recession

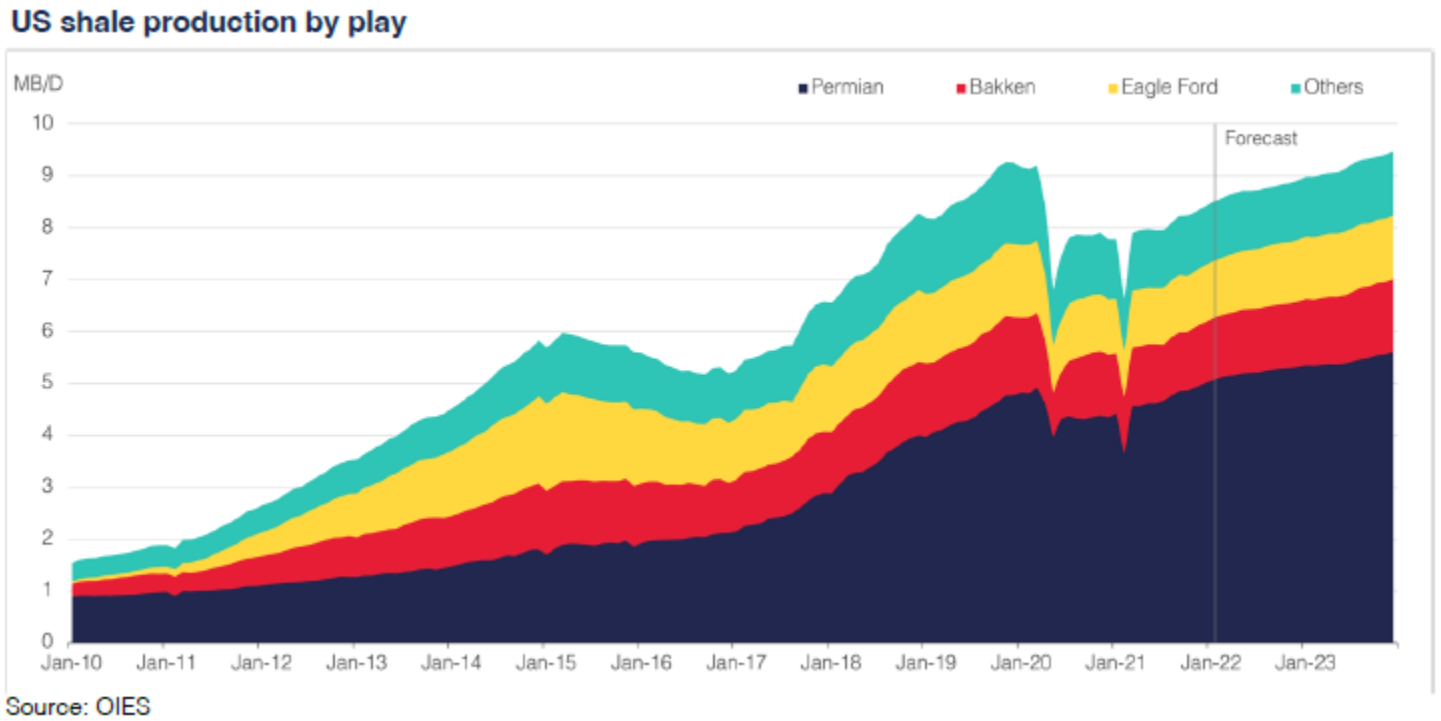
OPEC+ production and quota targets



Notes: Projected OPEC+ production levels consider implied production capacity and maximum historical production levels sustained over a period of 3 to 6 months. Source: OIES

US production is very reactive to price and is recovering after sharp drops

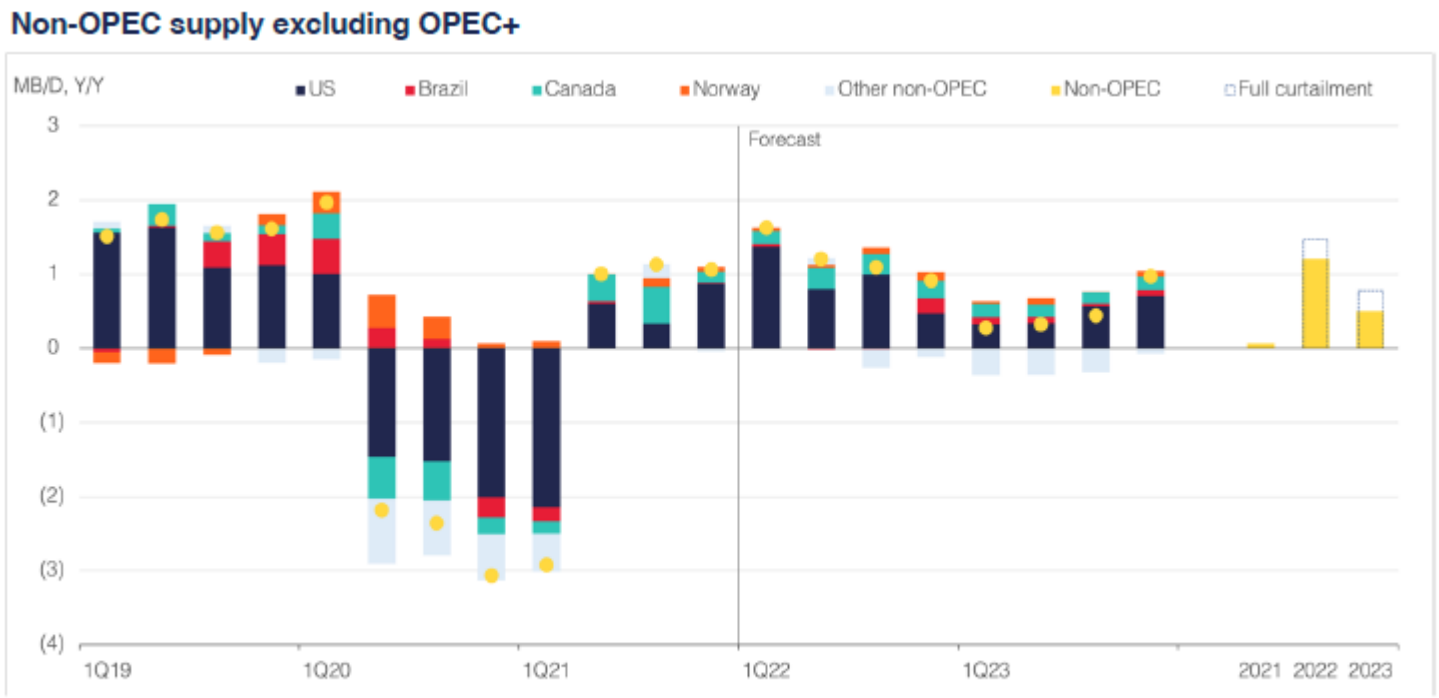
Oil production from US shale plays



Source: OIES

Other Non-OPEC supply upside is limited

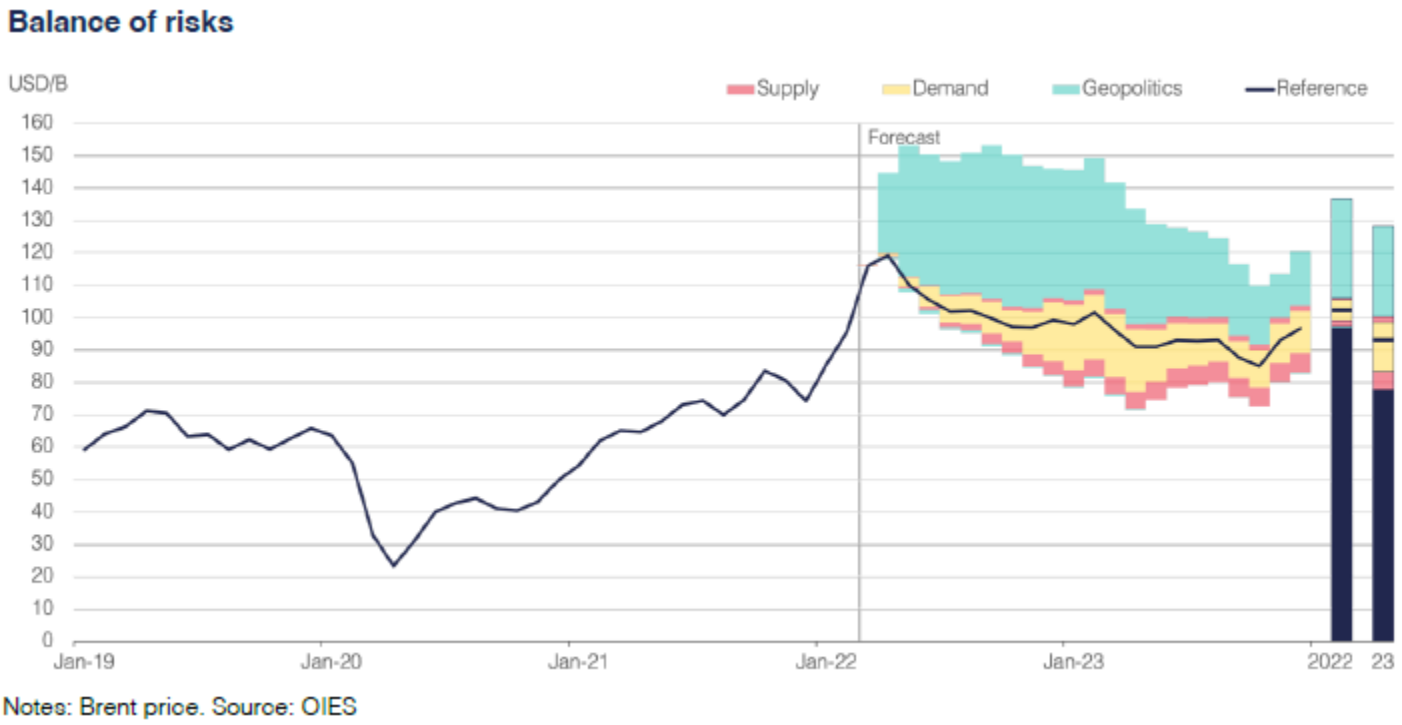
Production growth from Non-OPEC countries



Notes: Crude oil only. The reference case assumes the loss of 1 mb/d of Russia's oil supplies in March 2022 and the full curtailment case assumes the loss of 4 mb/d of Russia's oil supplies between February and May 2022. Source: OIES

Price outlook is uncertain given political as well as commercial risks

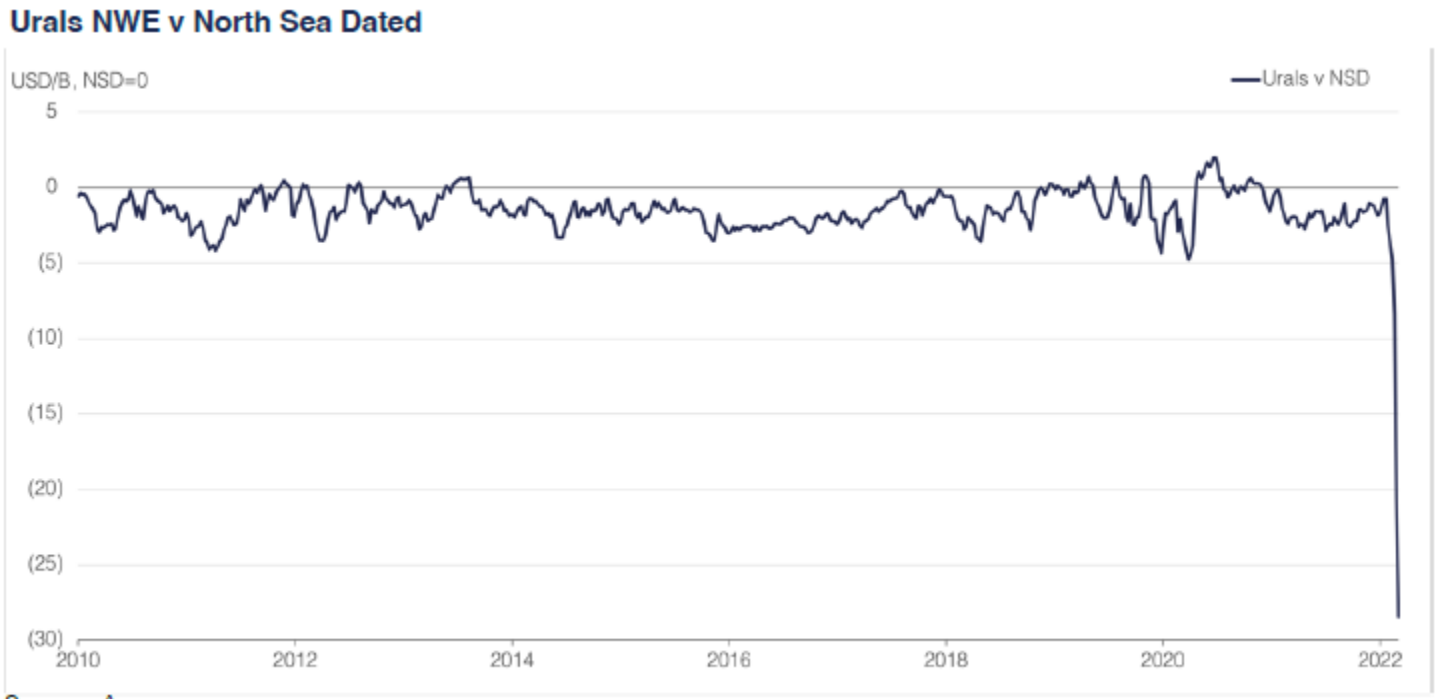
Forecast for Brent oil price



Notes: Brent price. Source: OIES

Russia oil is now trading at a huge discount as many countries and companies refuse to buy it

Differential between Urals Blend （Russian crude） and Brent （global benchmark）



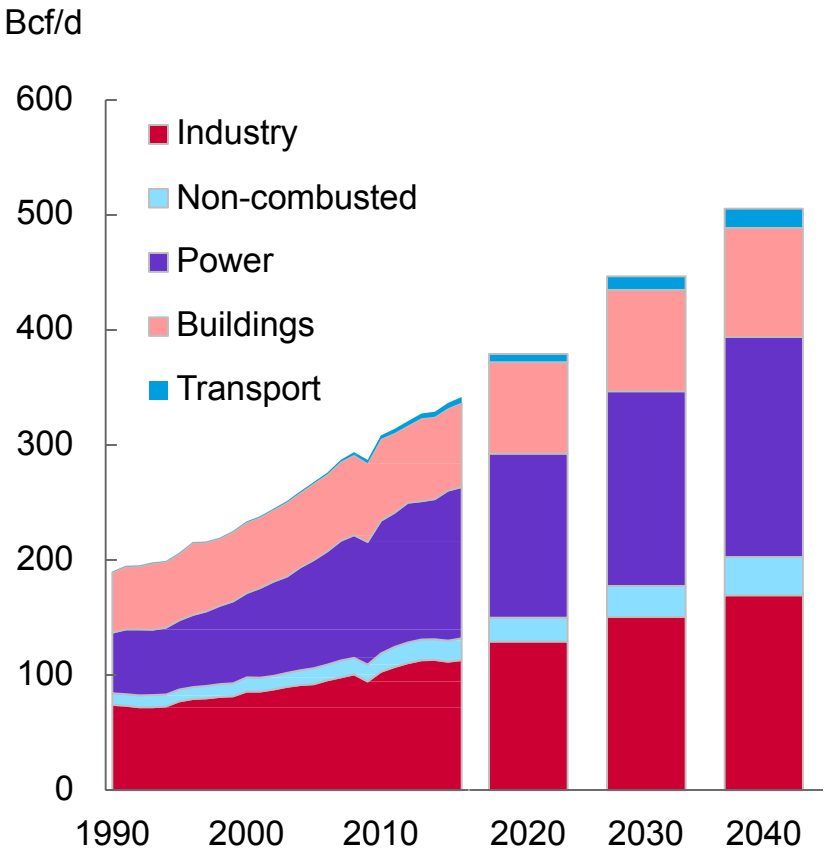
Source: Argus

Gas Price

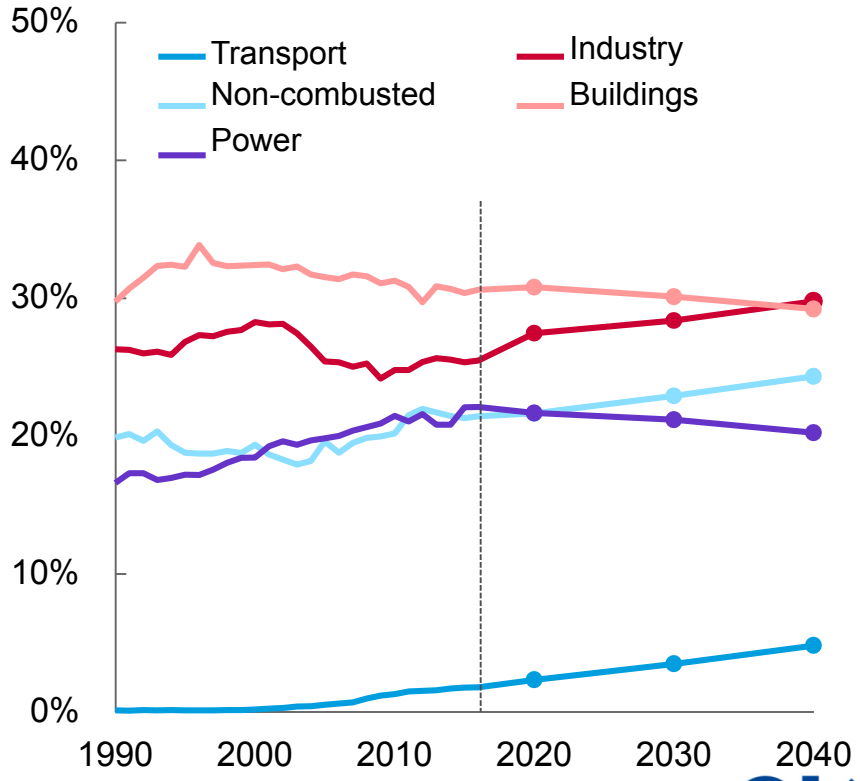
- Gas price has tended to be at a discount to oil on a heat equivalent basis
- 1 barrel of oil equals 6 million cubic feet (mcf) of gas
  - 1 million barrels = 1 billion cubic feet (Bcf)
- Oil price to gas price calculation:
  - » (Oil price / 6) x gas discount
  - » 60 / 6 x 90% = $9/mcf
- Gas industry analysts also talk about the relationship between gas and oil prices as a slope
- The slope is just the gas price divided by the oil price in percent
  - 9 / 60 = 15% slope
  - Slope on a heat equivalent basis is 16.67%
  - Normal slope is between 11% to 15% to allow for gas price discount

Growth in natural gas demand…

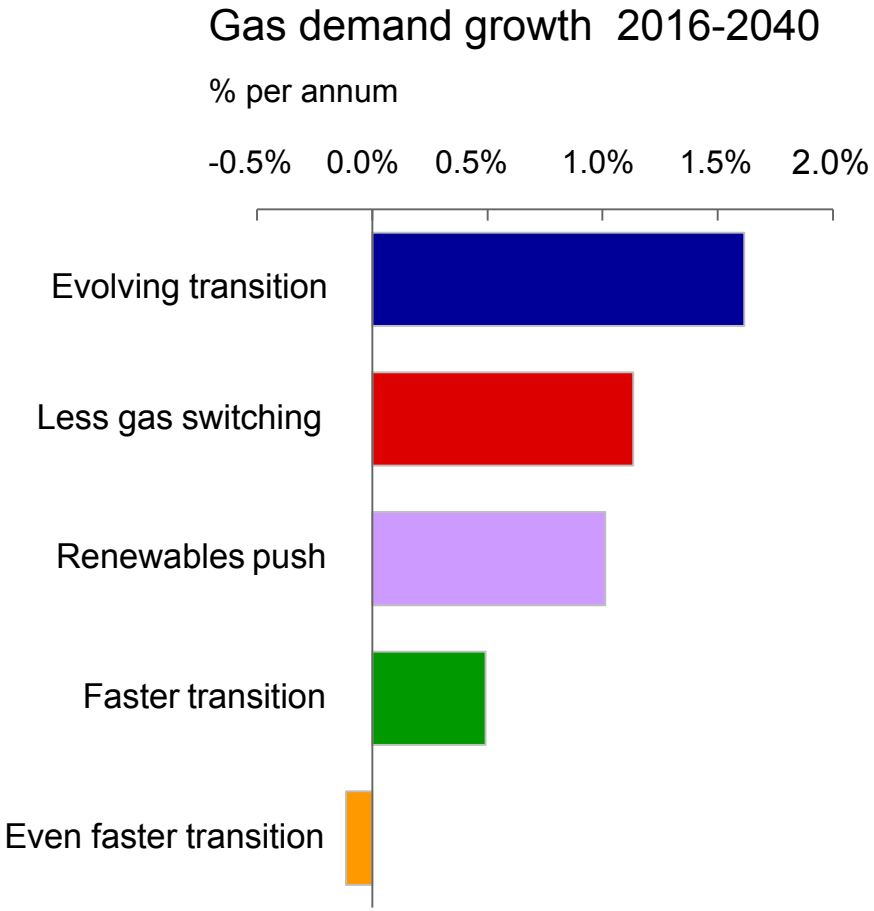
Gas consumption by sector

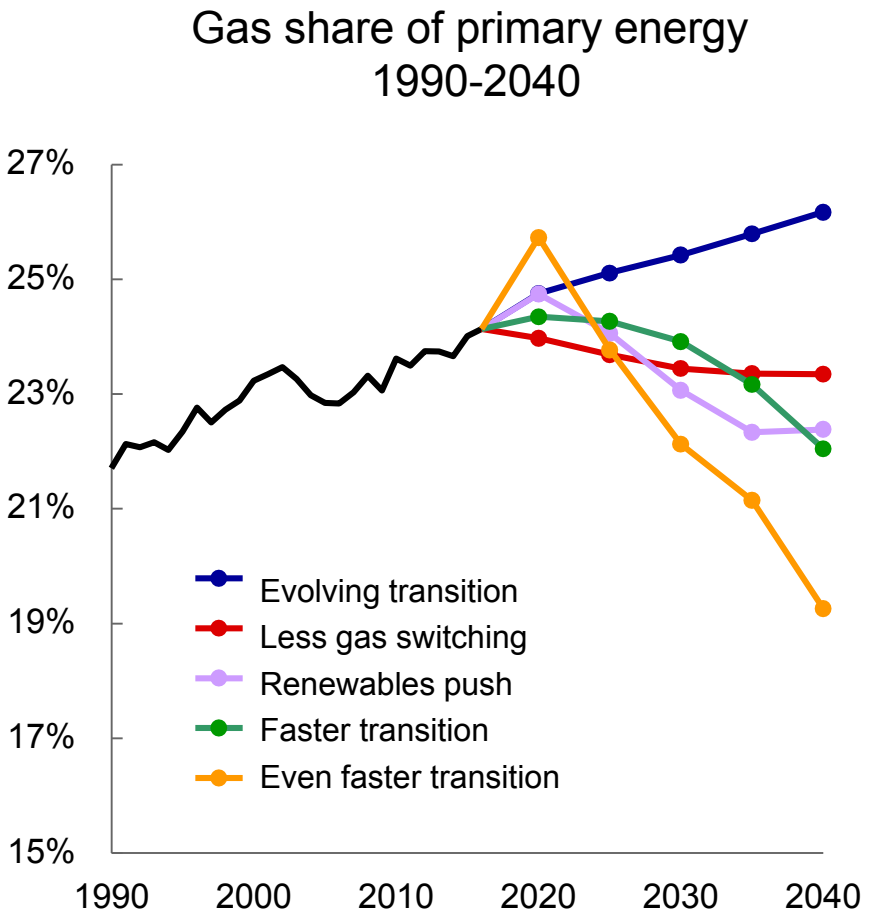


Gas share by sector

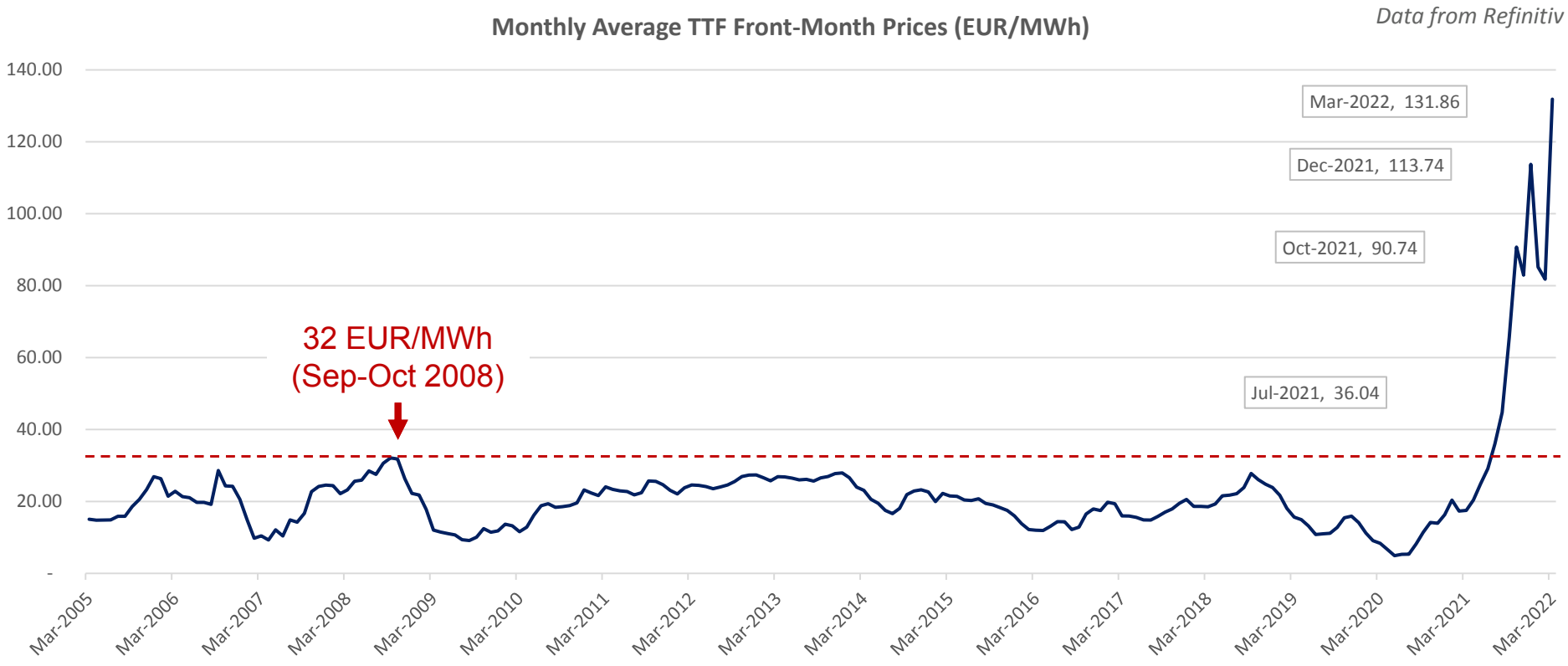


Prospects for gas demand could be dampened



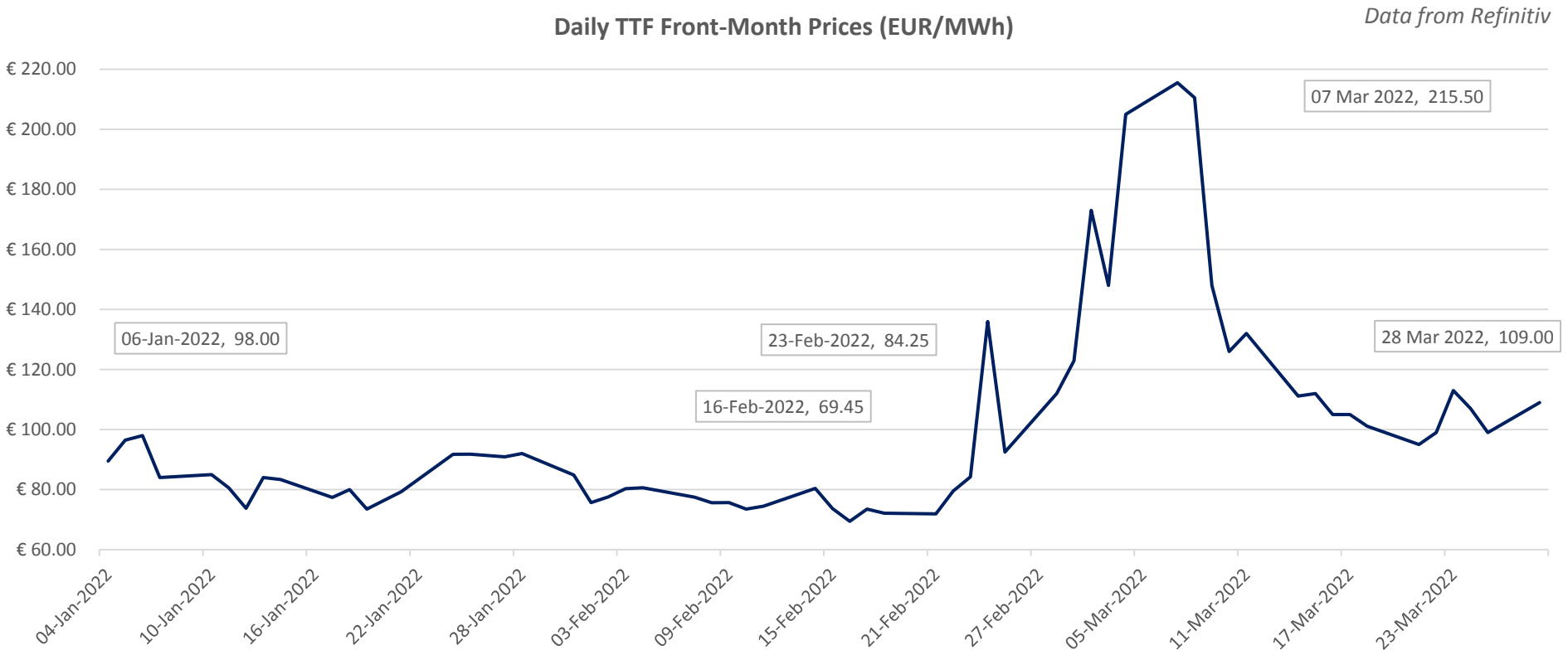


European gas prices – Monthly averages



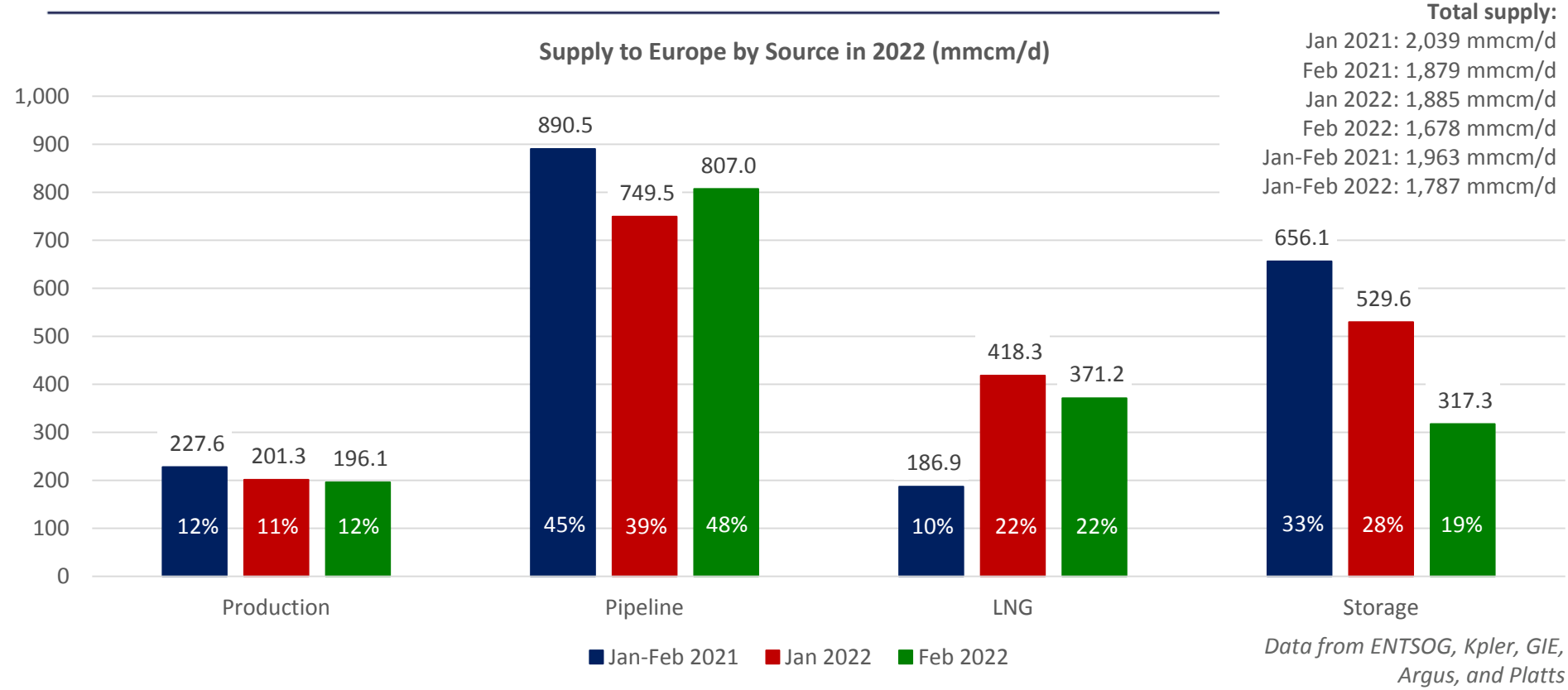
- European gas prices from 2005 to Q1-2021 were generally 15-25 EUR/MWh, with peak of 32 EUR/MWh
- Monthly average TTF Front-Month prices hit a new record in July 2021 and rose dramatically thereafter
- This was partly due to an already tight market, especially with lower imports from Russia
- It was also affected by fears of getting through winter with lower than usual storage stocks…
- … and concerns over Russian supply in the context of the build-up of Russian troops on Ukraine's borders

European gas prices – Daily TTF front-month prices



- Huge volatility in daily prices in Jan/Feb 2022, between 69 and 98 EUR/MWh – Spread of 29 EUR/MWh
- Immediate spike on Day 1 of Russian invasion of Ukraine – Further increase since then. On 7 Mar 2022, TTF Front-Month was 13 times higher than 7 Mar 2021 , and 3 times higher than on 16 Feb 2022
- Fears of physical interruption in supplies via Ukraine (pipeline damage) or complete cessation of supplies from Russia (sanctions or counter-sanctions)

European supply by source in Jan/Feb 2022

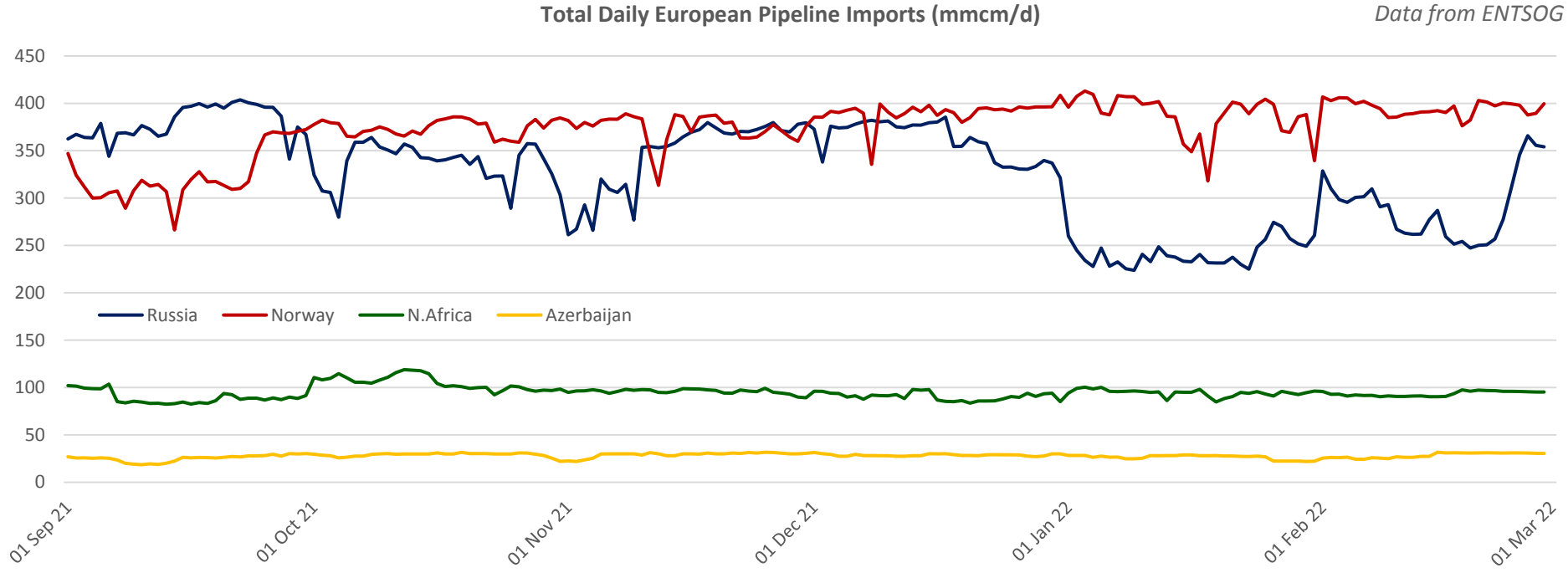


Total supply:
Jan 2021: 2,039 mmcm/d
Feb 2021: 1,879 mmcm/d
Jan 2022: 1,885 mmcm/d
Feb 2022: 1,678 mmcm/d
Jan-Feb 2021: 1,963 mmcm/d
Jan-Feb 2022: 1,787 mmcm/d

Data from ENTSOG, Kpler, GIE, Argus, and Platts

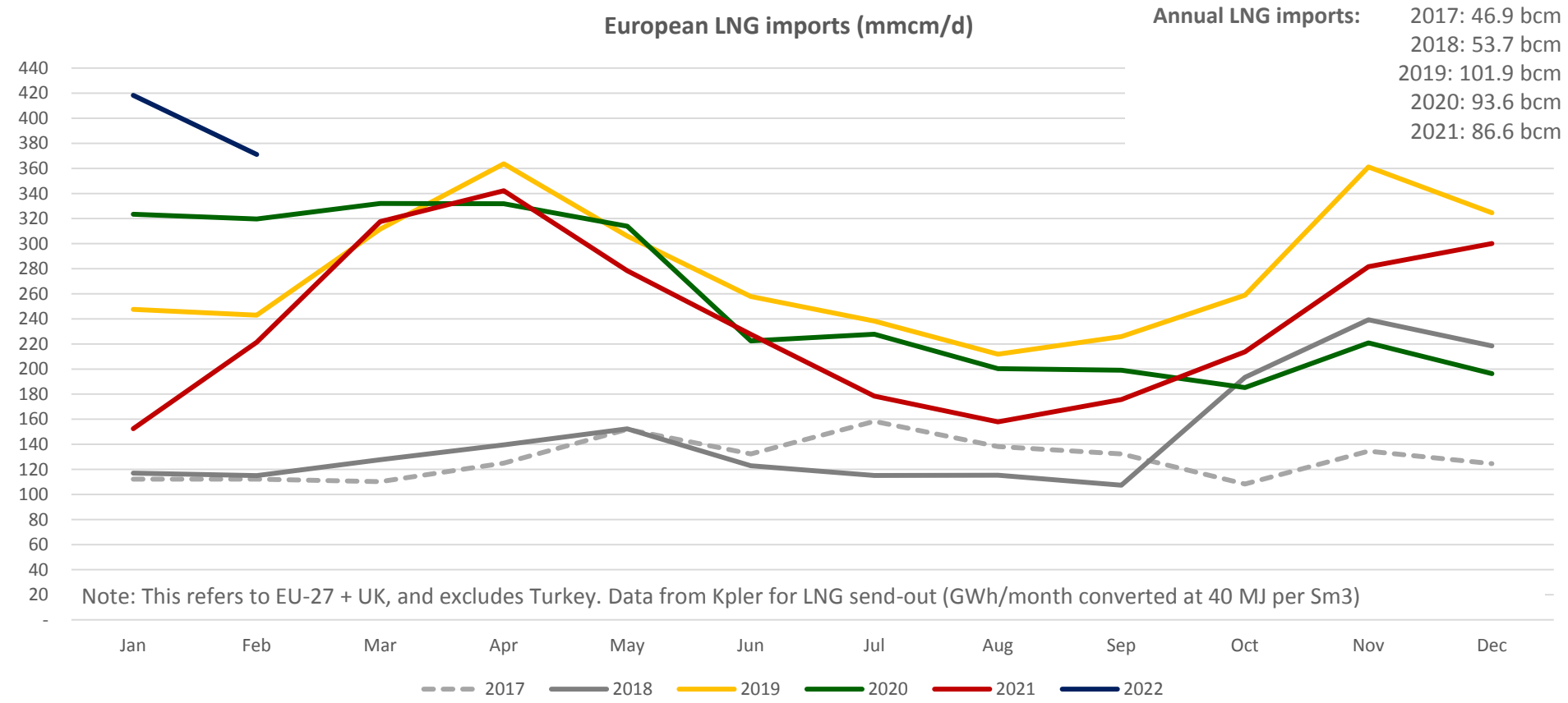
- In winter, storage withdrawals account for a significant share of supply
- In Jan/Feb 2022, LNG imports surged as higher prices attracted cargoes
- Pipeline supply remained by far the largest source of supply – Uptick in pipeline supply in Feb due to higher flows from Russia – However, this was still significantly lower than in Jan-Feb 2021
- Total supply down 8% y-o-y in Jan-2022 and down 11% in Feb-2022 (lower demand due to mild winter)

Pipeline imports by supplier (mmcm per day)



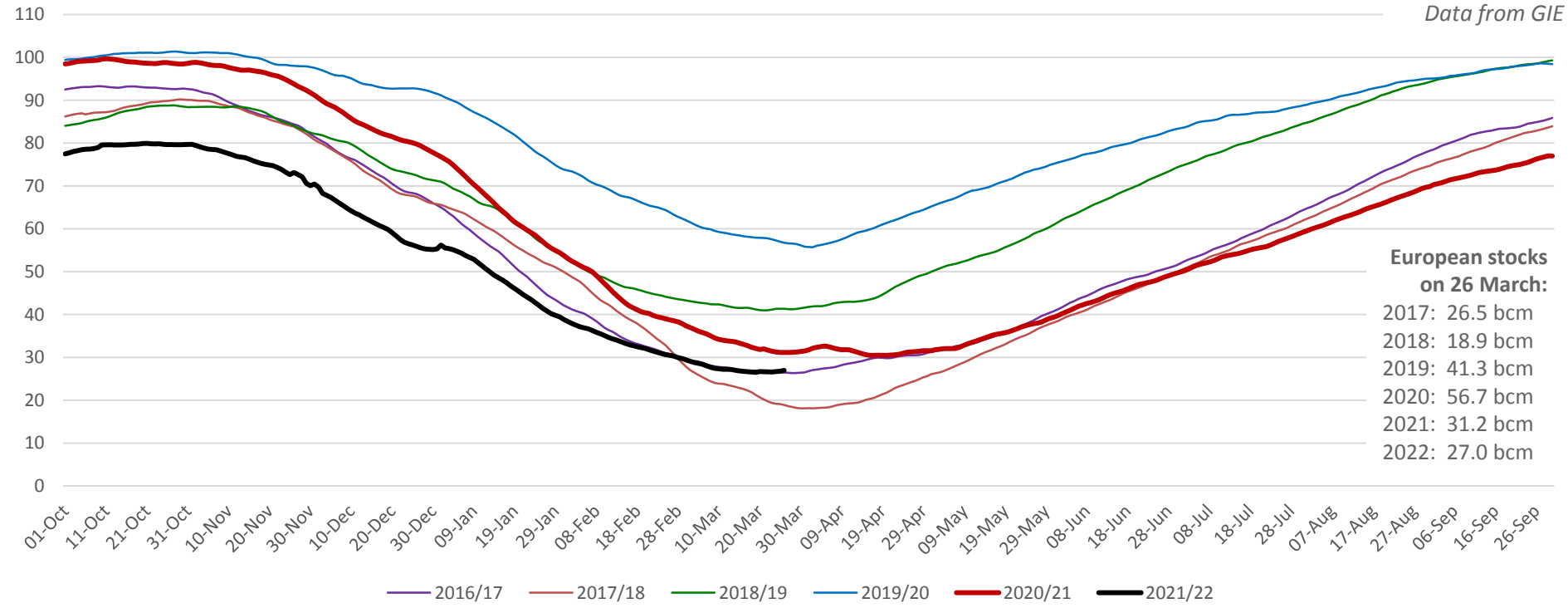
- Slump in flows from Russia between 27 Sep and 11 Nov 2021, and between 1 Jan and 23 Feb 2022
- Upsurge from 24 Feb, as day-ahead prices moved to significant premium over long-term contract prices
- Norwegian flows relatively high and stable since 25 Sep 2021
- Flows from North Africa also at maximum capacity, despite cessation of transit via Morocco to Spain
- Flows from Azerbaijan (on Turkey-Greece border) at 30 mmcm/d equivalent to 10.95 bcma
- Lack of significant upside potential for non-Russian pipeline imports beyond, for example, around 10 bcm

European LNG imports (mmcm/d)



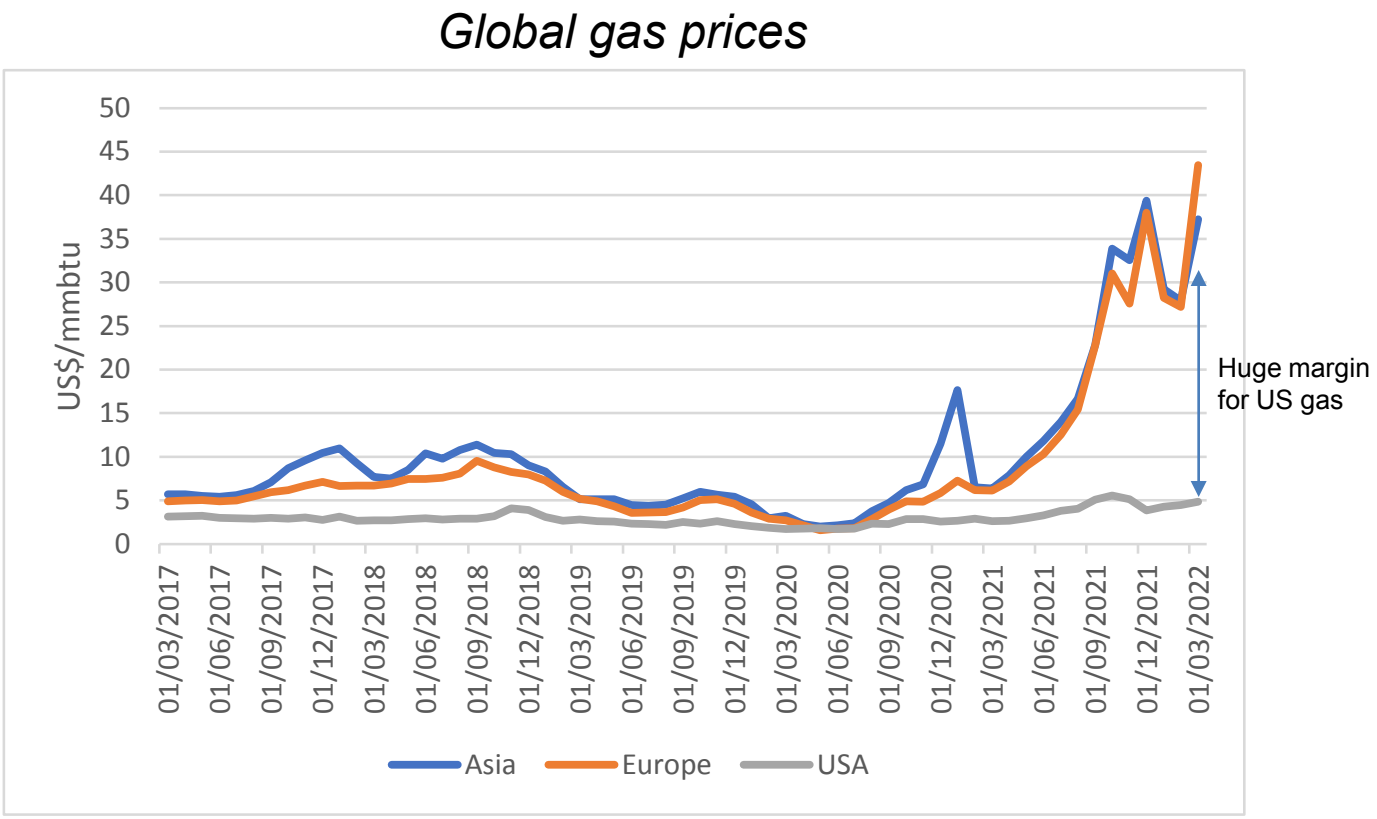
- Surge in European LNG imports since Q4-2018, with seasonal peak in March-May (2019-2021)
- High European prices attracting cargoes since Q4-2021, helped by increase in US LNG exports to Europe
- Jan-2022 record Euro LNG send-out (13.0 bcm) and Feb second-highest daily average (but fourth-highest monthly total [10.4 bcm], behind April & November 2019 [10.9 bcm], which had more days in the month)

European gas storage stocks



- In October 2019 and 2020, European stocks peaked at 100-101 bcm – These were supply-long years
- In October 2016, 2017, and 2018, this peak was 89-93 bcm – In 2021, this peak was 80 bcm
- European stocks c.10 bcm lower than 'usual' at the start of winter 2021/22
- European storage stocks on 26 Mar 2022 are close to 2017 level, but still down 4.2 bcm y-o-y
- Net injections since 24 March – stocks potentially 27.5 bcm on 1 April. Target of storage 80% full by 1 Nov 2022 means 52.5 bcm of injection in summer 2022 – 4.5 bcm more than in 1 Apr – 1 Nov 2021

The impact on gas prices has been global



Gas price becoming more global thanks to LNG

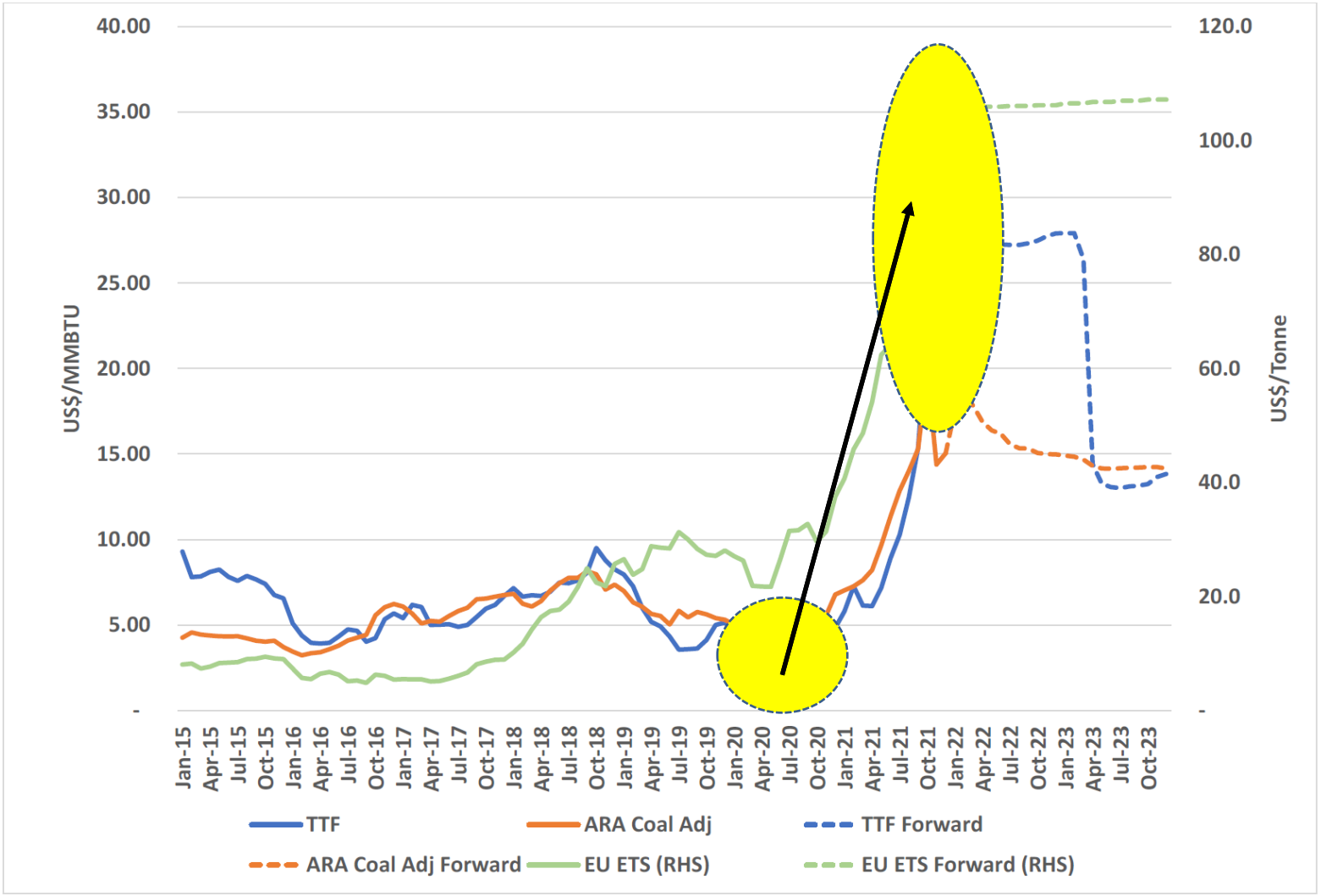
Rising supply and a recent fall in demand saw price falls 2018-2020

Winter 2020/21 was cold and started price rebound

Russia-Ukraine war has impacted global markets, not just EU

Competing fuels an issue at high prices

Coal is looking more attractive than gas even though the carbon price has risen



Source: Argus Media, ICE. Forward curve at 25 January 2022