

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



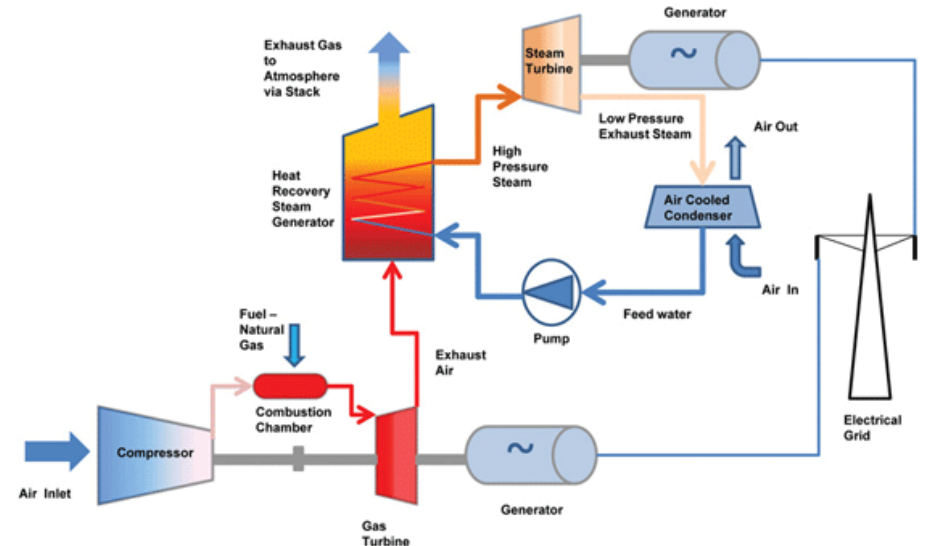
Shale oil development in Texas



- 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

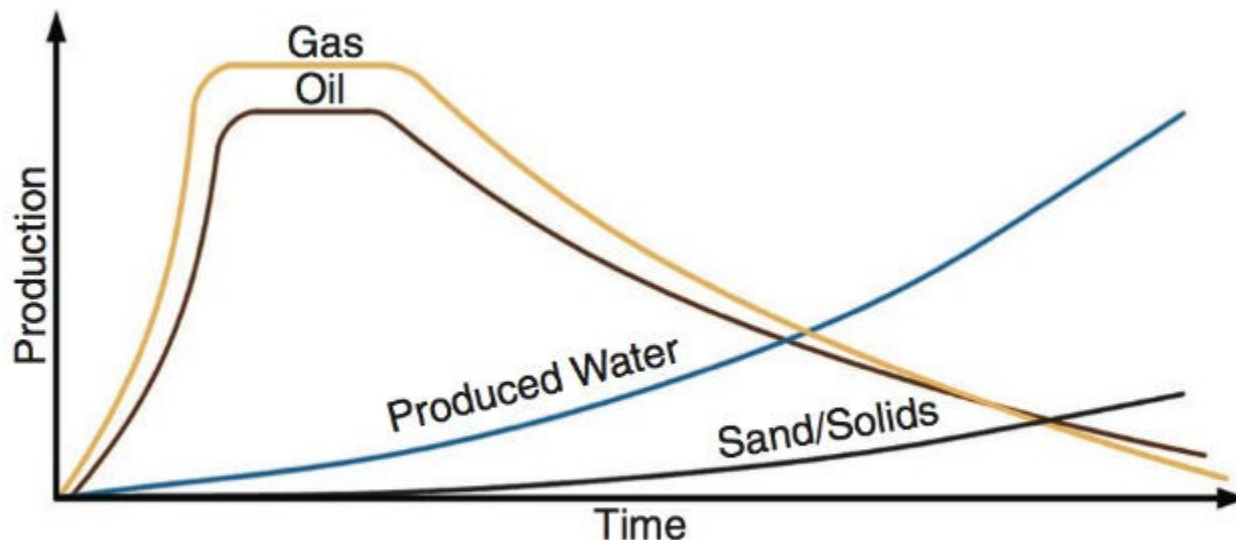


Fig. 1—A typical oilfield production profile.

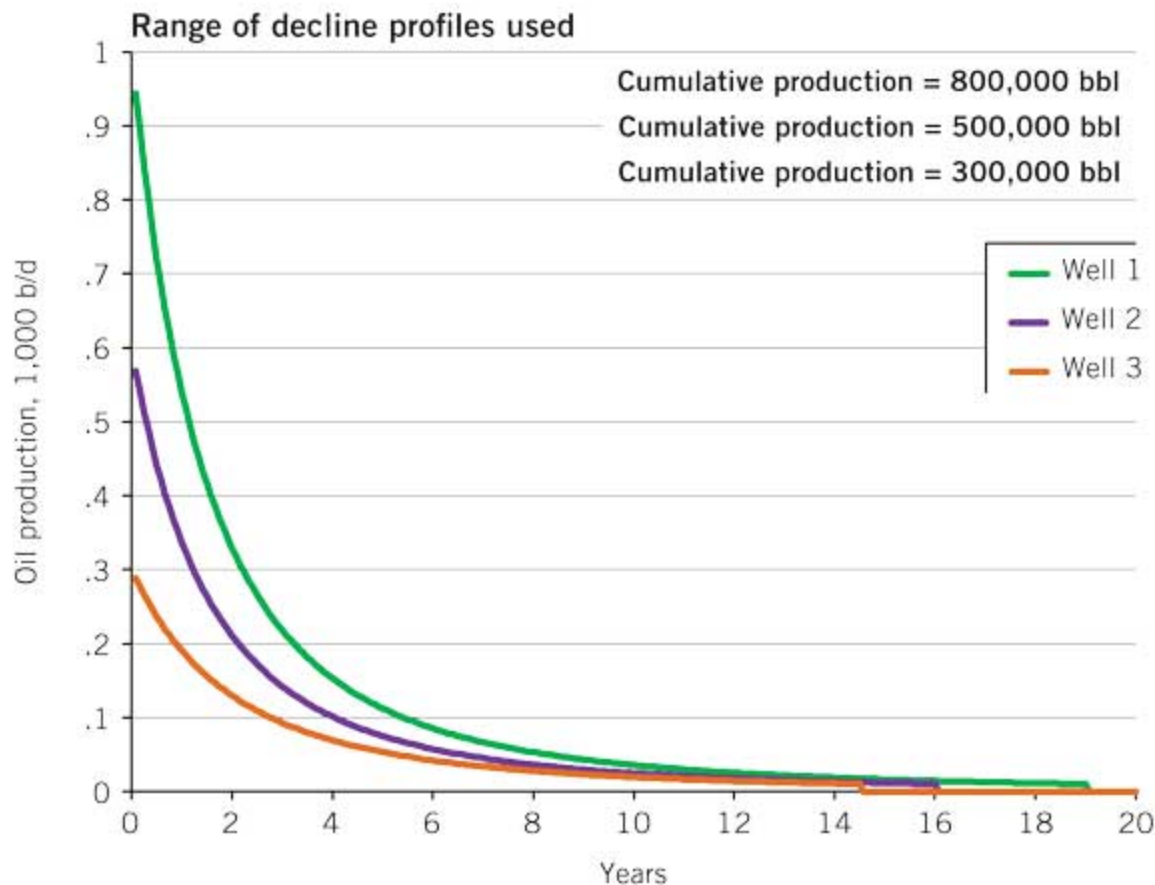
1. Initial surge to peak production
2. Plateau at peak for a number of years
3. Gradual decline towards abandonment
4. Water and solids production increases, undermining performance



Shale Oil Production Profile

TYPE PRODUCTION PROFILES AND PRODUCTION USED IN MODELING

FIG. 1

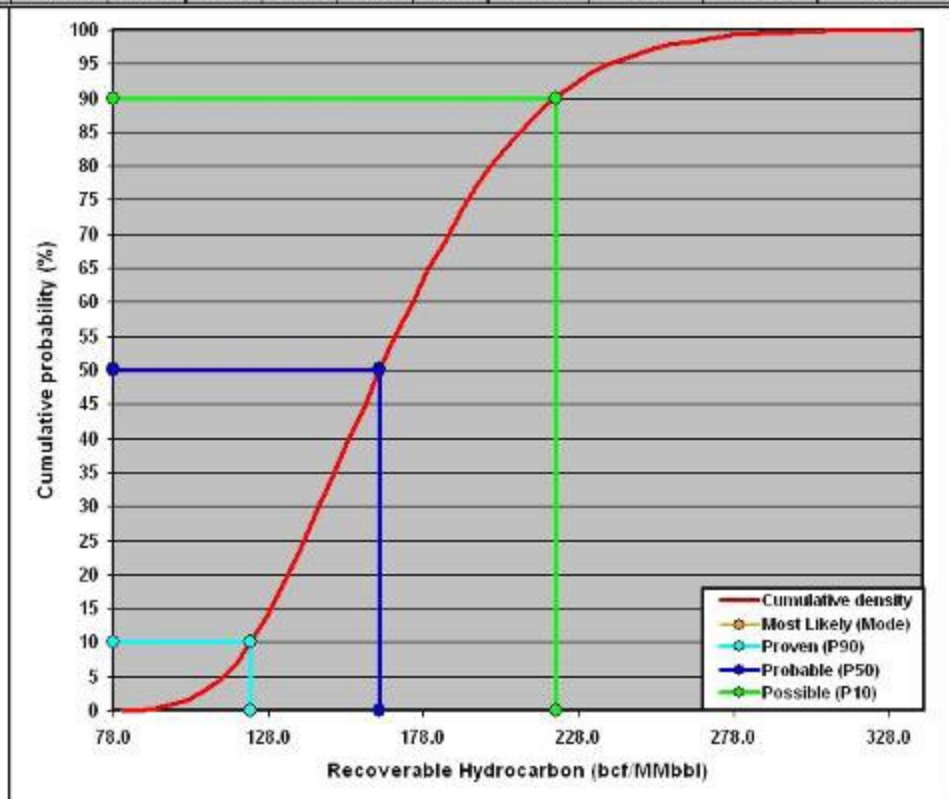
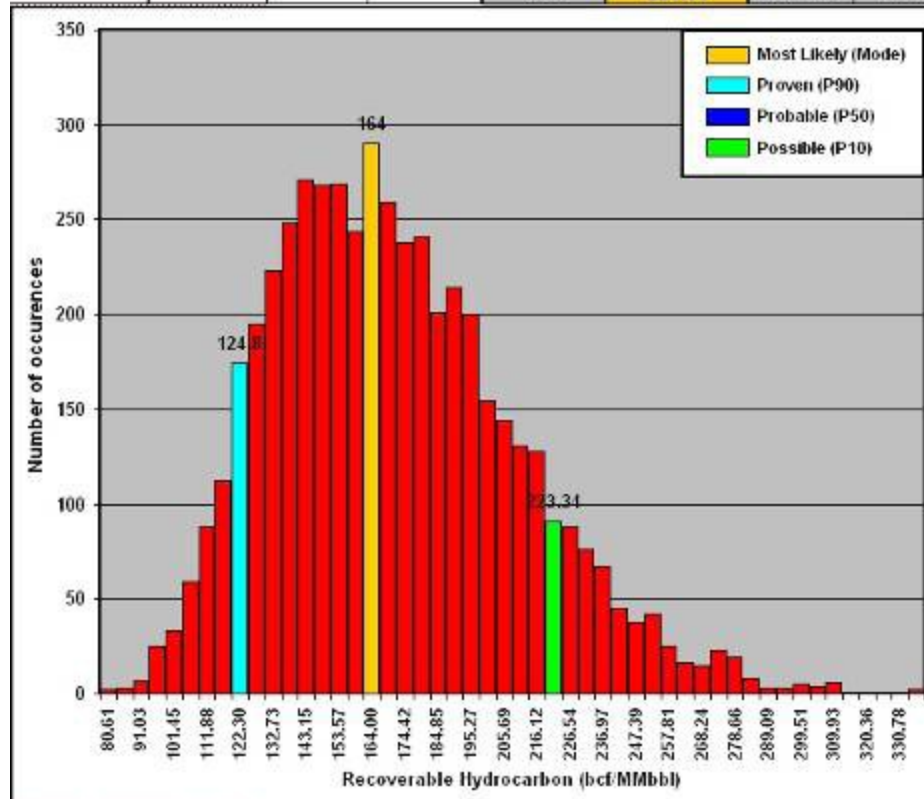


1. Immediate surge to peak production
2. Rapid decline over the first few years
3. Long plateau at low production rates

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 ⁹ 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 – 5 years after first investment
- Peak production – 7% 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

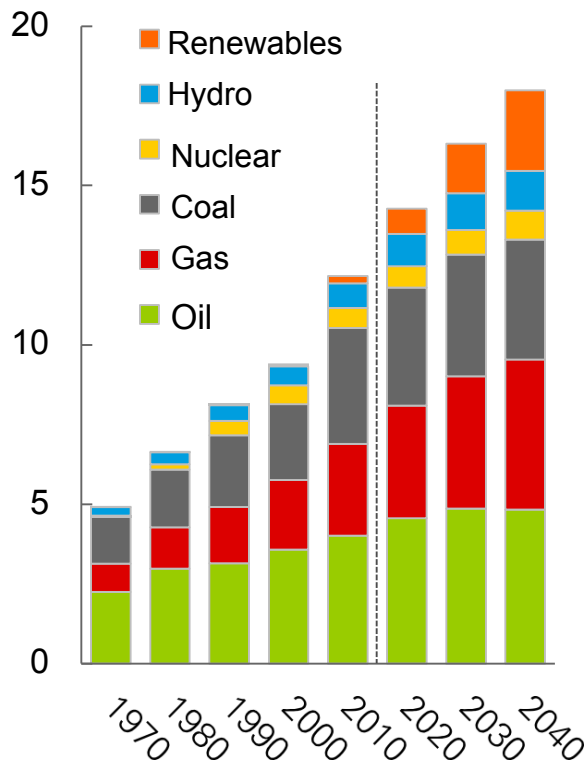
- We need to have some opinions of fuel prices for our cashflow model
- Future of oil gas and electricity prices is critical to revenues
- We also need to know how often our power plant will be operational (the load factor)
- Impact of changing energy economy is increasingly evident and needs to be discussed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



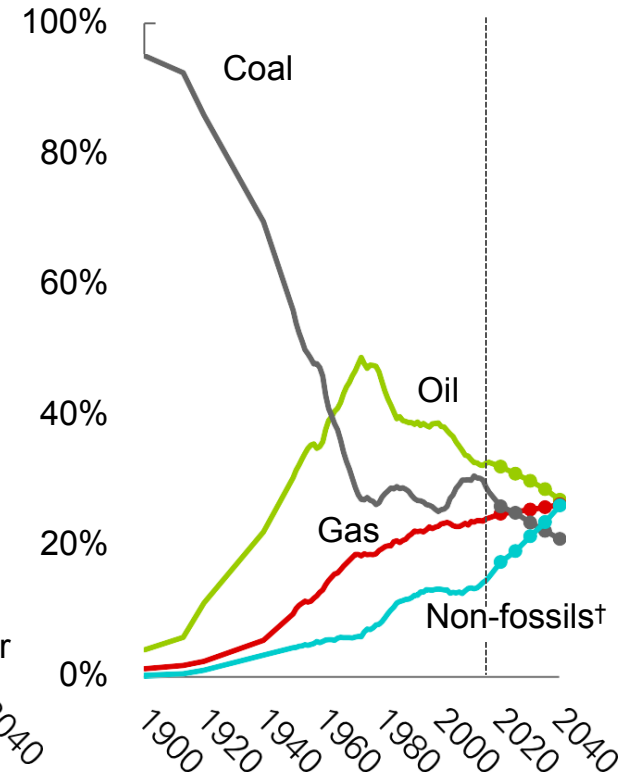
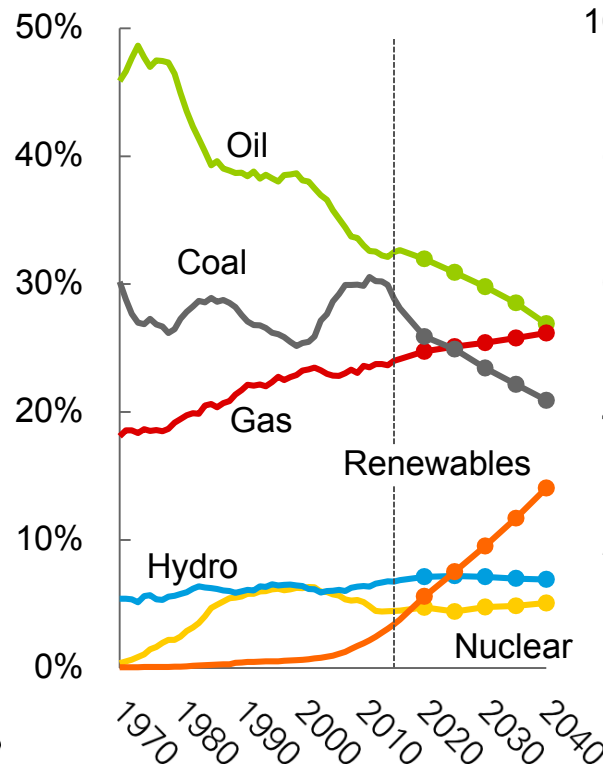
The transition to a lower carbon fuel mix continues...

Primary energy consumption by fuel

Billion toe



Shares of primary energy

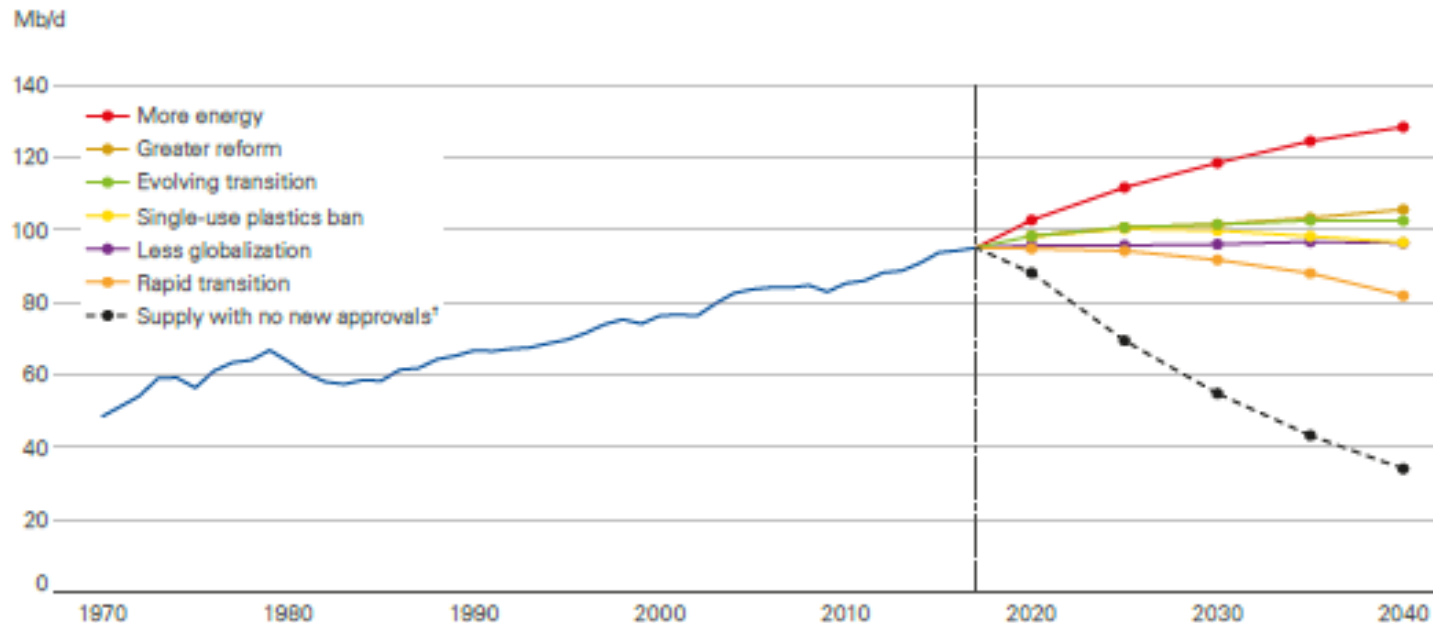


† Non-fossils includes renewables, nuclear and hydro



Alternative Scenarios for Oil Demand

Demand and supply of oil*



* Excluding GTLs and CTLs

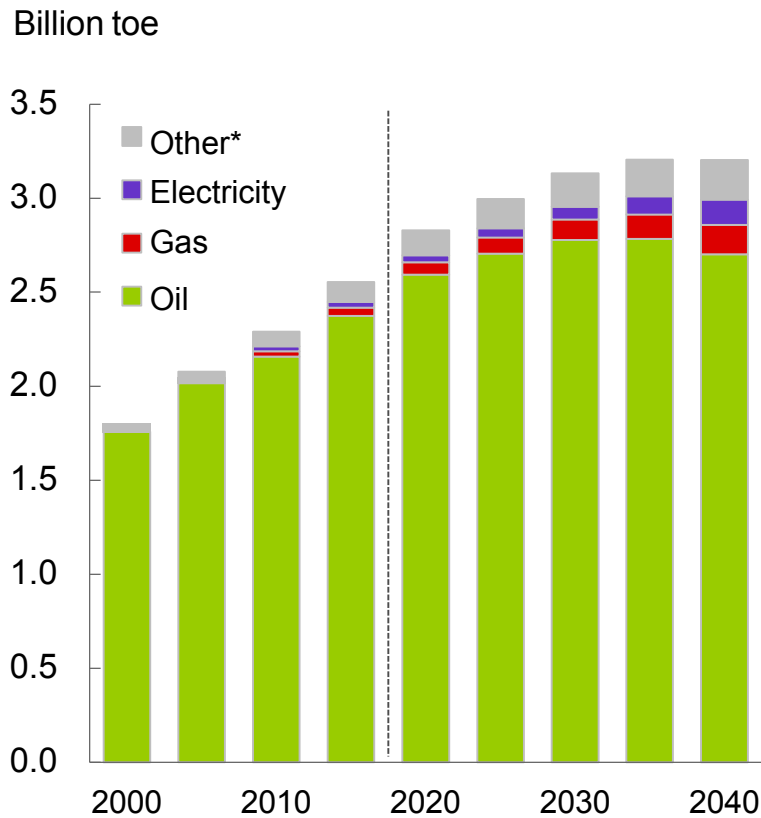
† Based on IEA's WEO 2018 assumption if future investment is limited to developing existing fields and there was no investment in new production areas

- 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



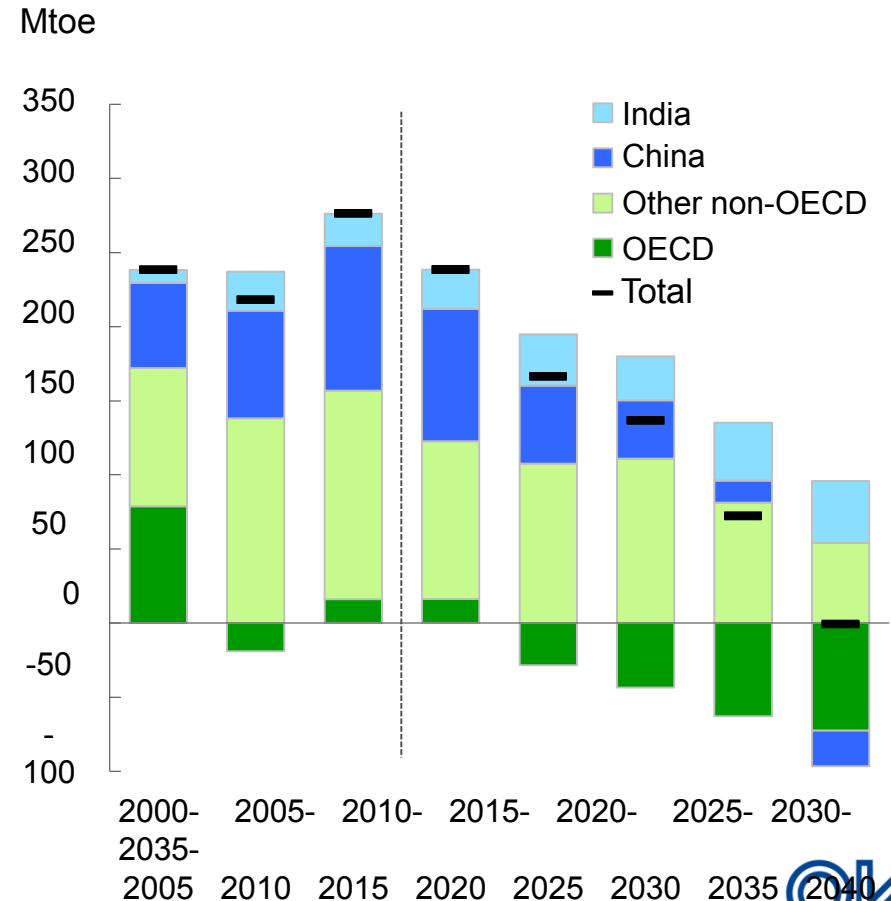
Transport demand continues to be dominated by oil...

Transport energy consumption by fuel type



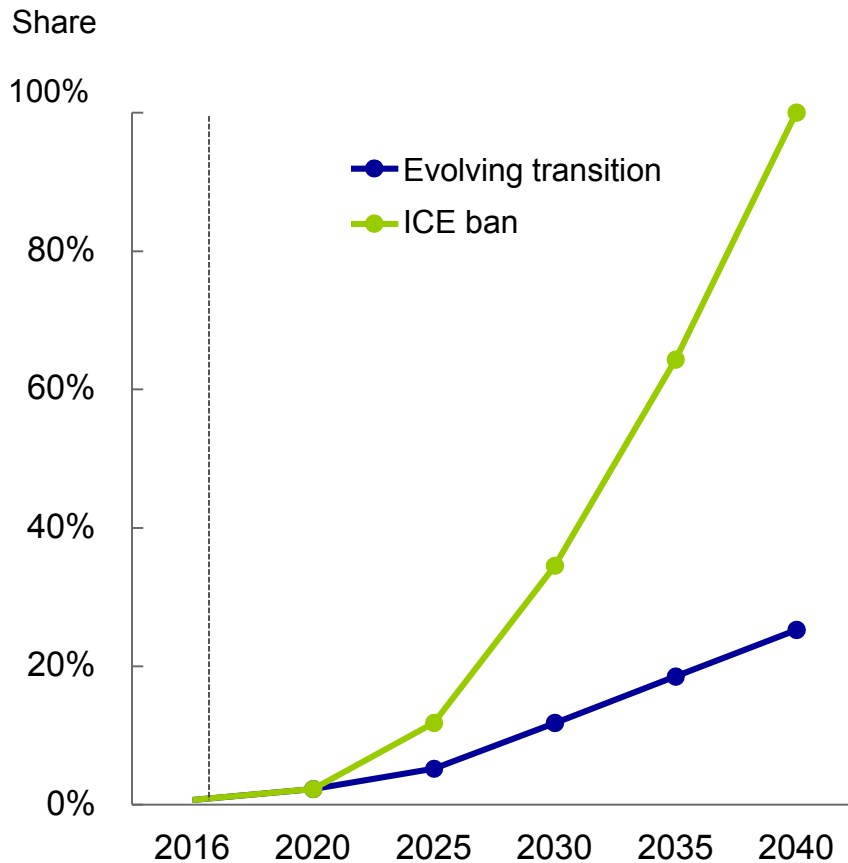
*Other includes biofuels, gas-to-liquids, coal-to-liquids, hydrogen

Transport energy consumption growth by region

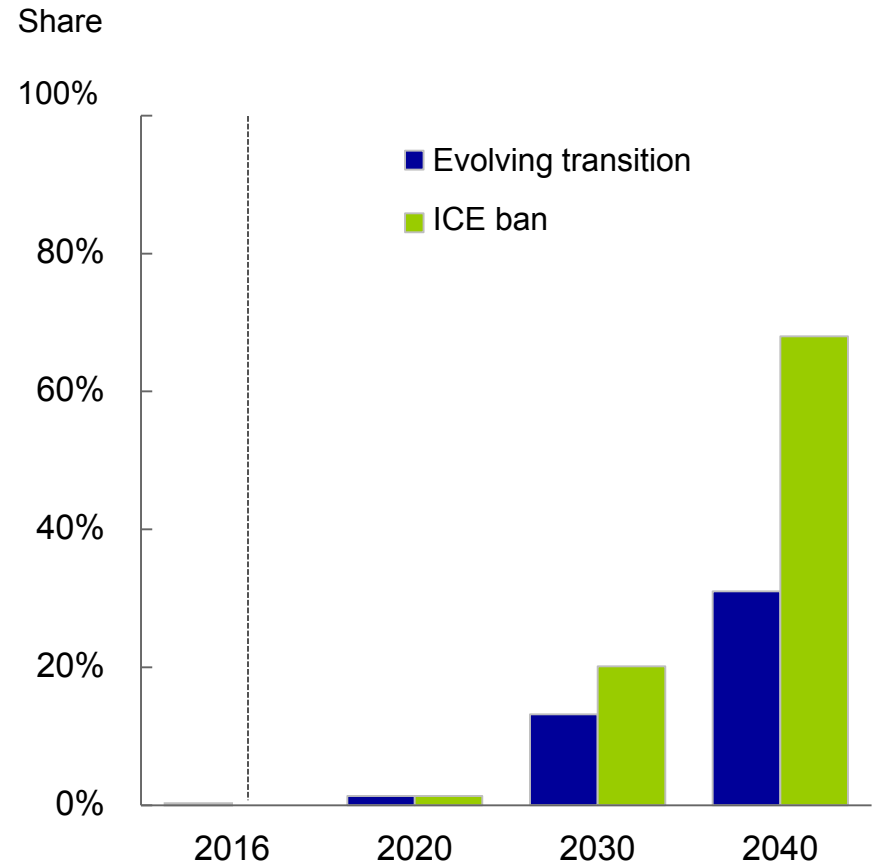


Alternative scenario: impact of faster growth in electric cars...

Electric car sales as a share of total car sales

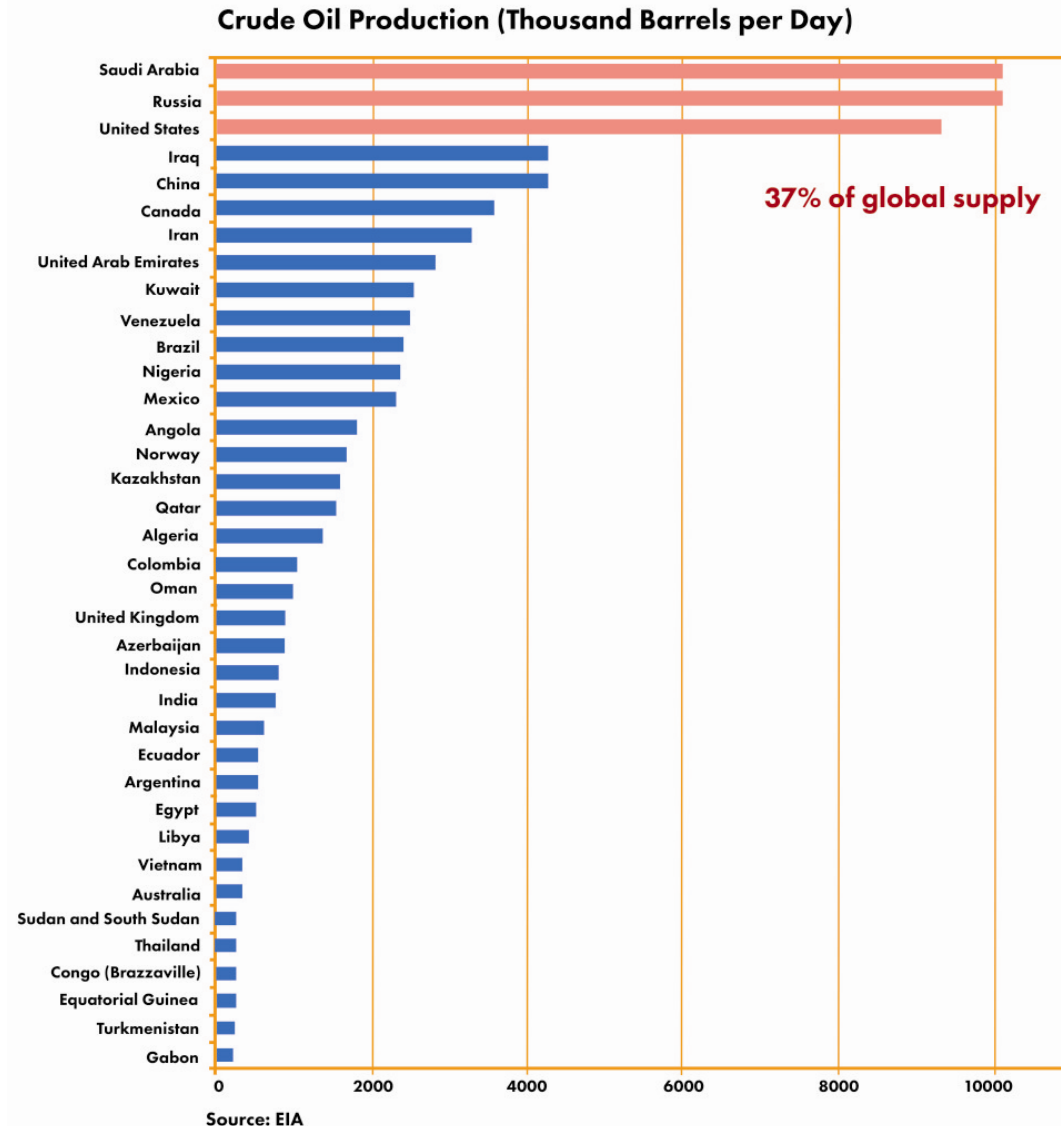


Share of total passenger Vkm powered by electricity

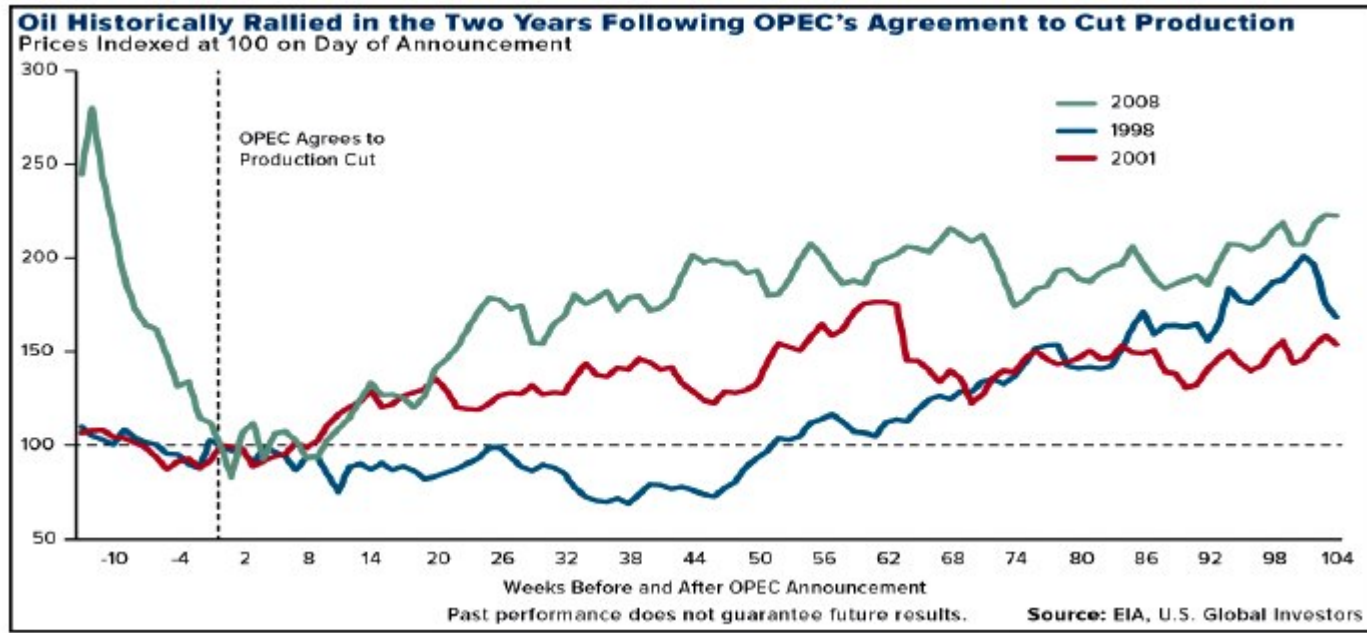


Oil production is dominated by three countries

- 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

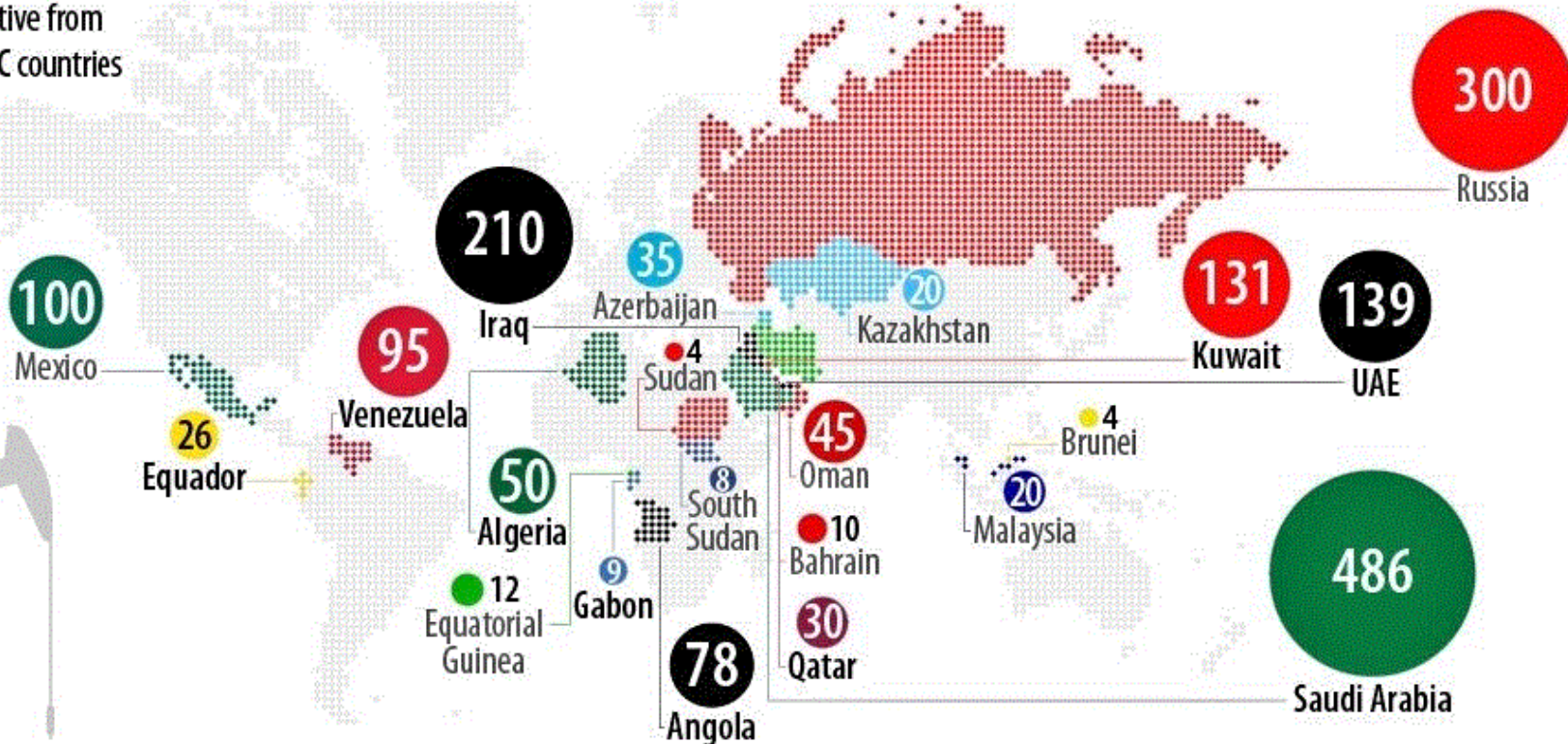
- Need to maximise oil revenues
- Historic strategy to preserve oil for future generations
- Now the question is whether there is a long-term future for oil?
- Largest reserve holders risk failing to monetise resources
- Low cost producers do not want to allow higher cost producers to take market share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



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

OPEC & non-OPEC countries: Crude Oil Production Cuts (in thousands of barrels per day)

The cuts will be effective from January 2017 for OPEC countries (in bold); Russia and other non-OPEC countries will make cuts gradually



© 2016 - George Primentas, The Missing Graph/ANTIFORMA Design | <http://themissinggraph.wordpress.com> Sources: OPEC, @Lisa_Ward1990 version 1.2 (15 December 2016)

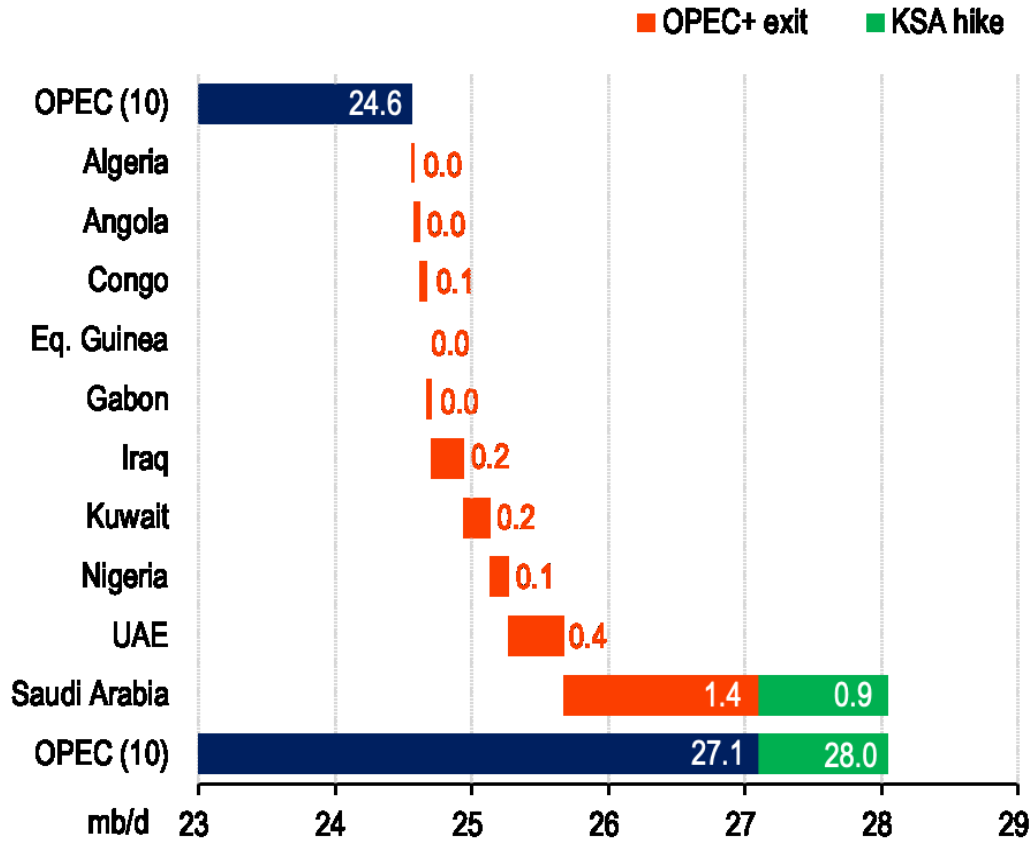
- What happens next? An oil glut from US shale or an oil shortage due to lack of investment and growing demand?





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



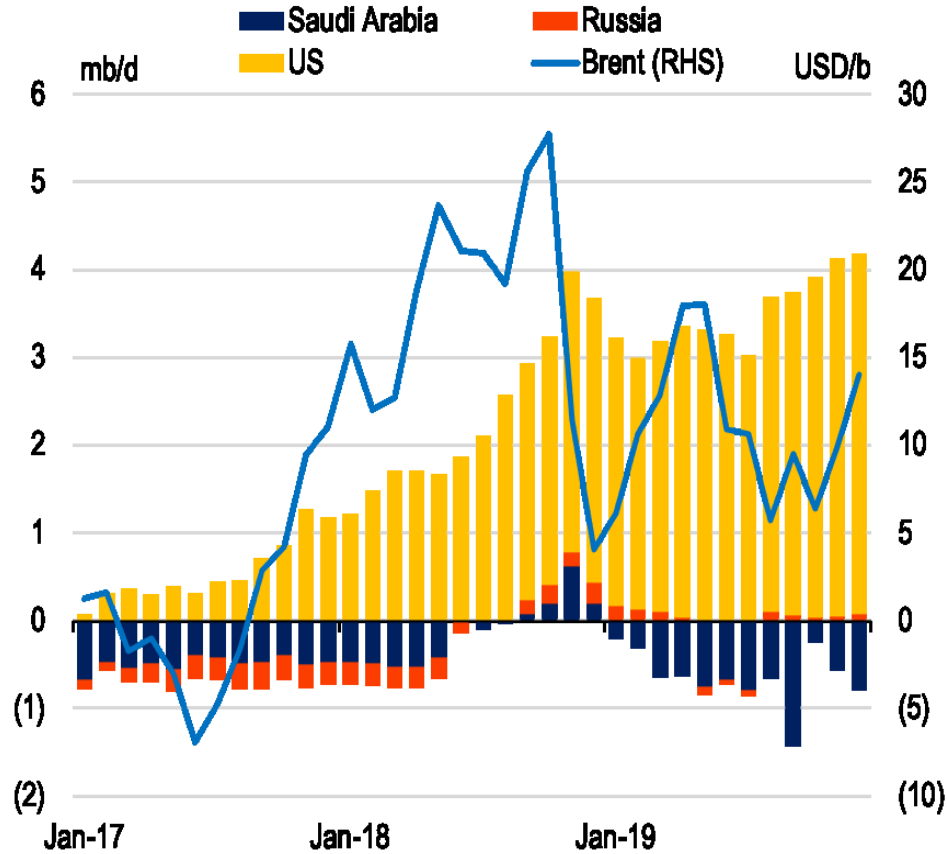
Source: OIES, EIA





Saudi decision in perspective: time to halt the rise of US shale (and other high cost) production

Big-3 production growth v Dec 16



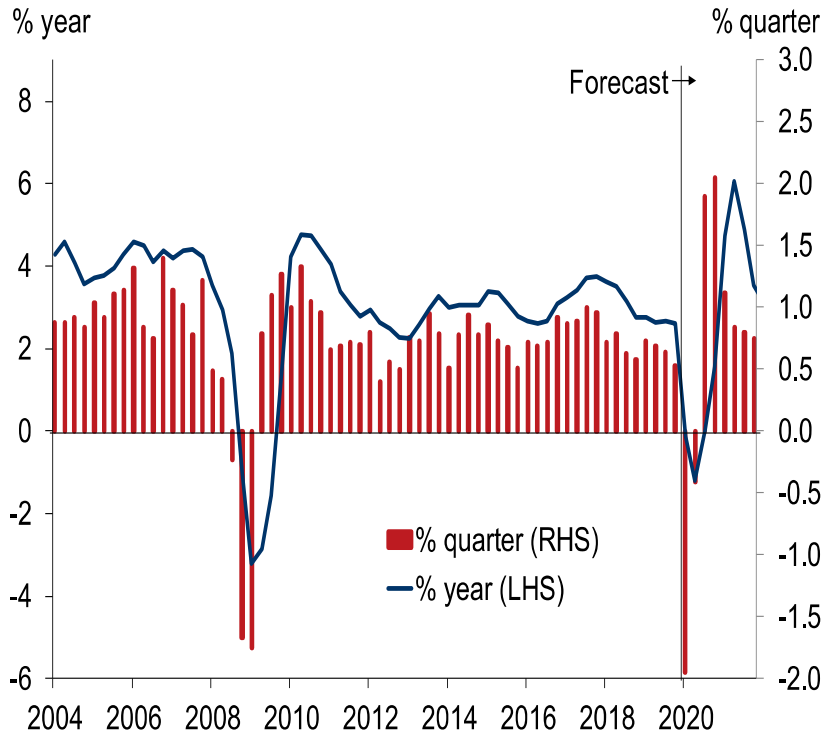
Source: OIES, IEA





Global economy recovering from a sharp recession

Global GDP growth



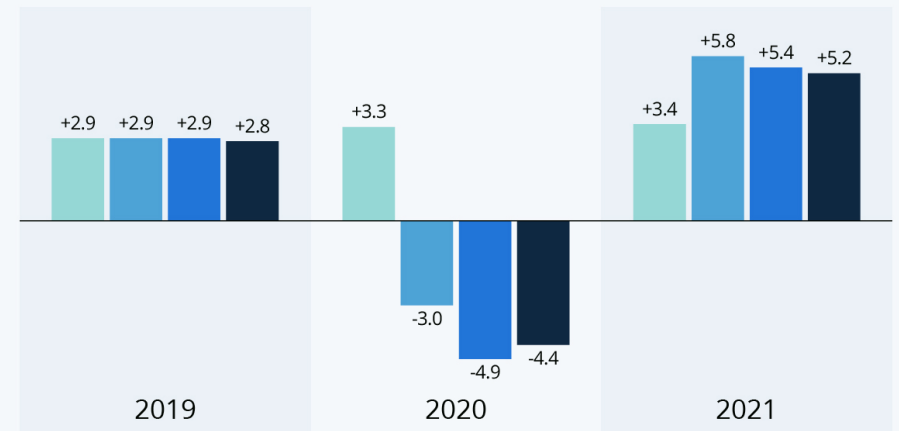
Source: Oxford Economics

GDP growth scenarios

IMF Forecast Shows Slight Improvement for 2020

Global GDP growth estimates published by the IMF before and during the COVID-19 pandemic (in %)

- January 2020 estimates
- April 2020 estimates
- June 2020 estimates
- October 2020 estimates



Source: International Monetary Fund



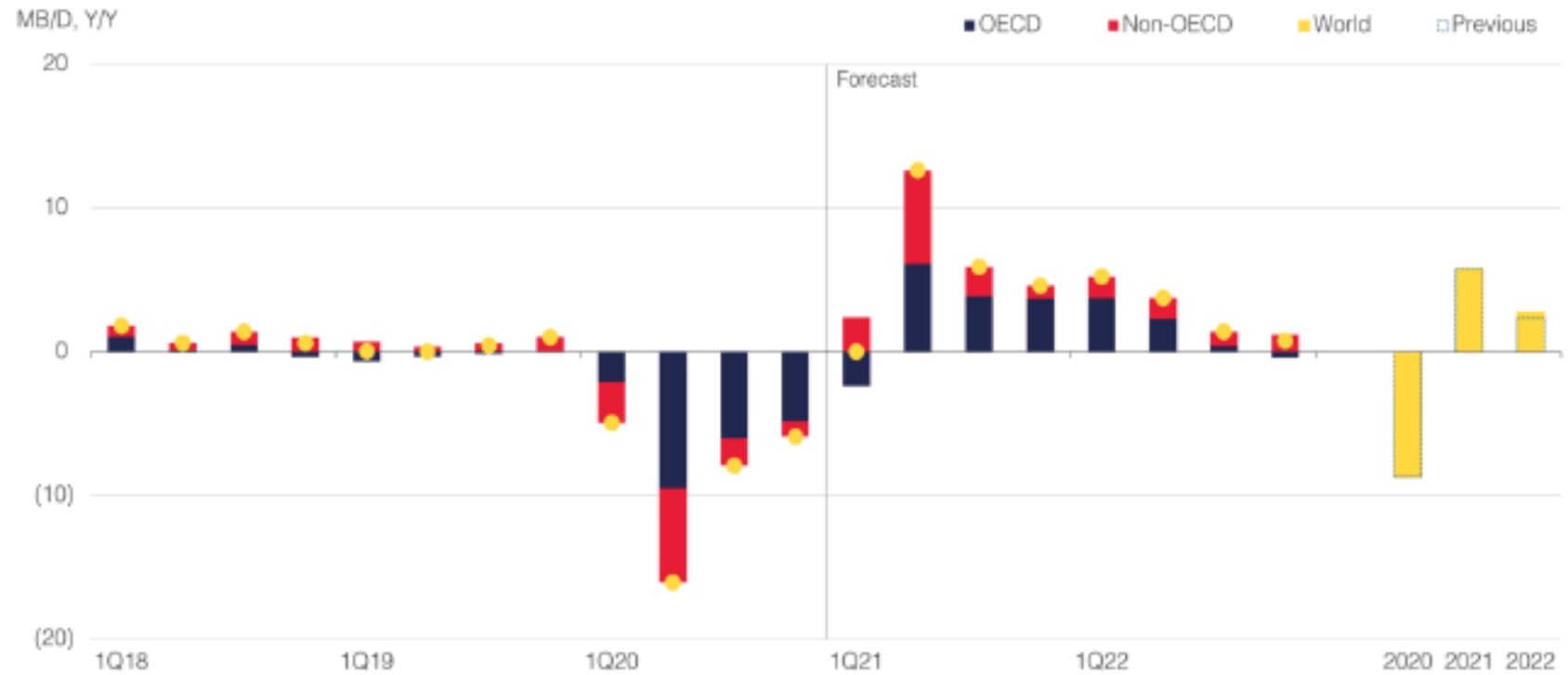
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Annual oil demand contracted in 2020, but strong rebound in 2021

Global oil demand



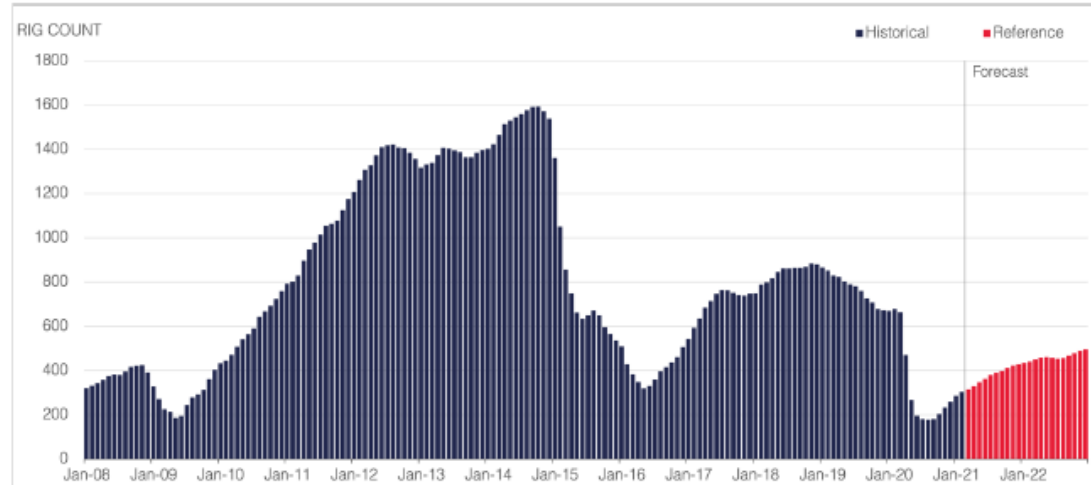
Source: OIES





US shale took a big hit in 2020 but is now recovering

US drilling activity



Source: OIES

US supply



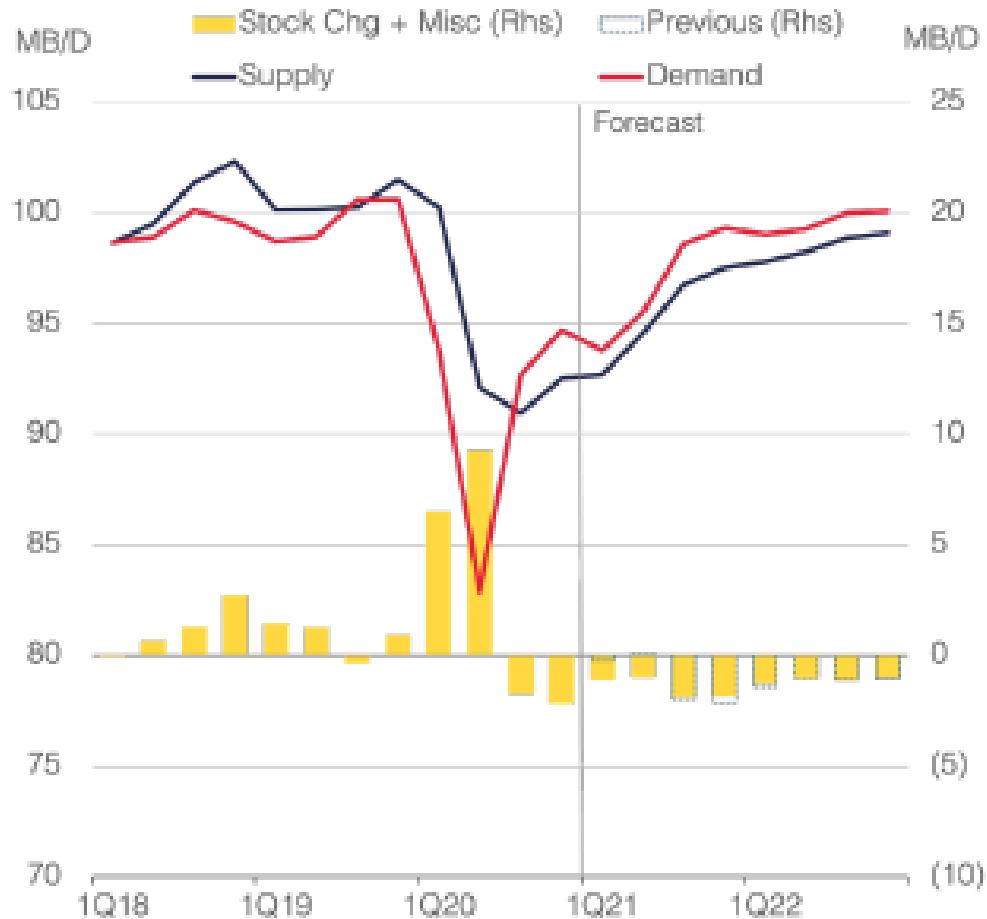
Notes: Crude oil only. Source: OIES





Market out of balance in 2020 with extreme surpluses that are now gradually unwinding

Global supply/demand balance



Source: OIES





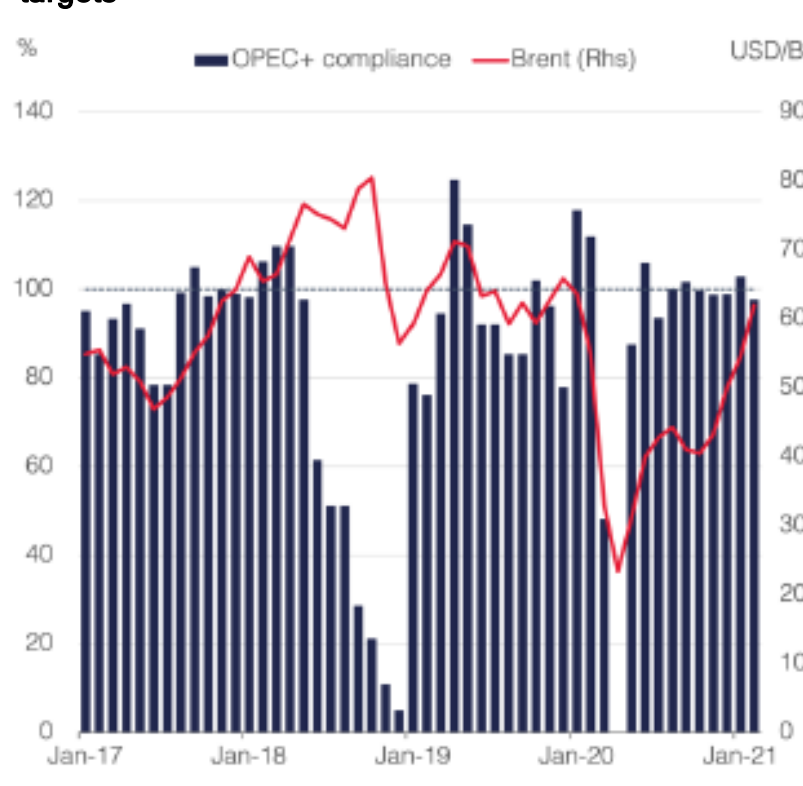
OPEC and Russia have helped to re-balance the oil market, led by Saudi Arabia

Saudi Arabi oil production



Source: IEA, OPEC, OIES

OPEC+Russia compliance with production targets



Notes: Excludes Venezuela and extra voluntary cuts.

Source: OIES





Brent fell sharply in 2020 but has recovered well thanks to OPEC production restraint

Brent price outlook



Source: OIES



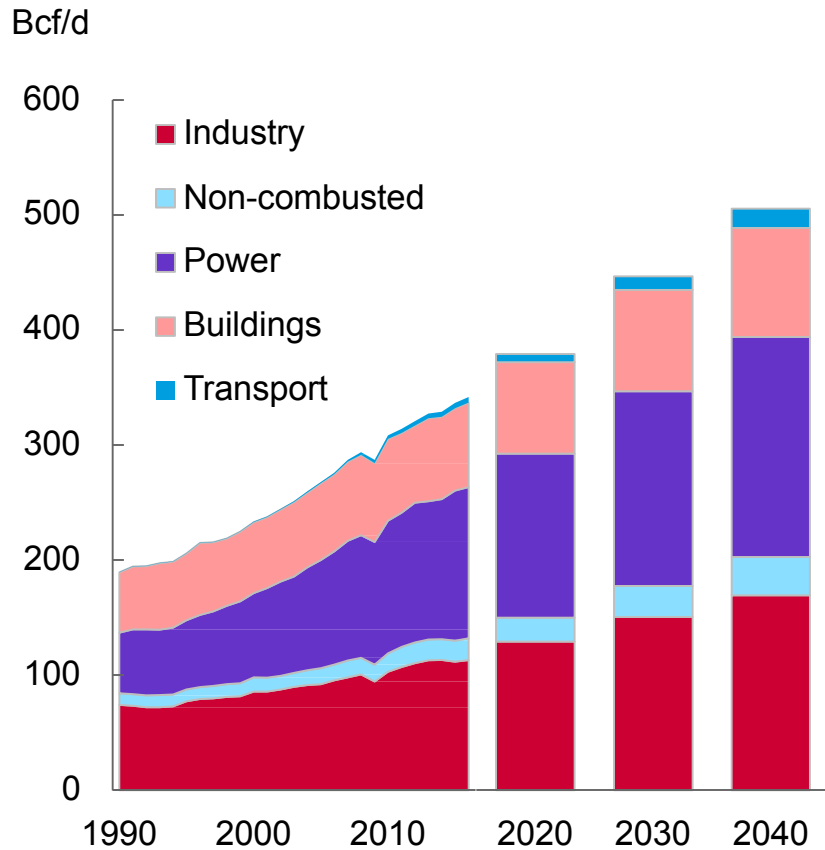
Gas Price

- 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
 - » $60 / 6 \times 90\% = \$9/\text{mcf}$
- 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

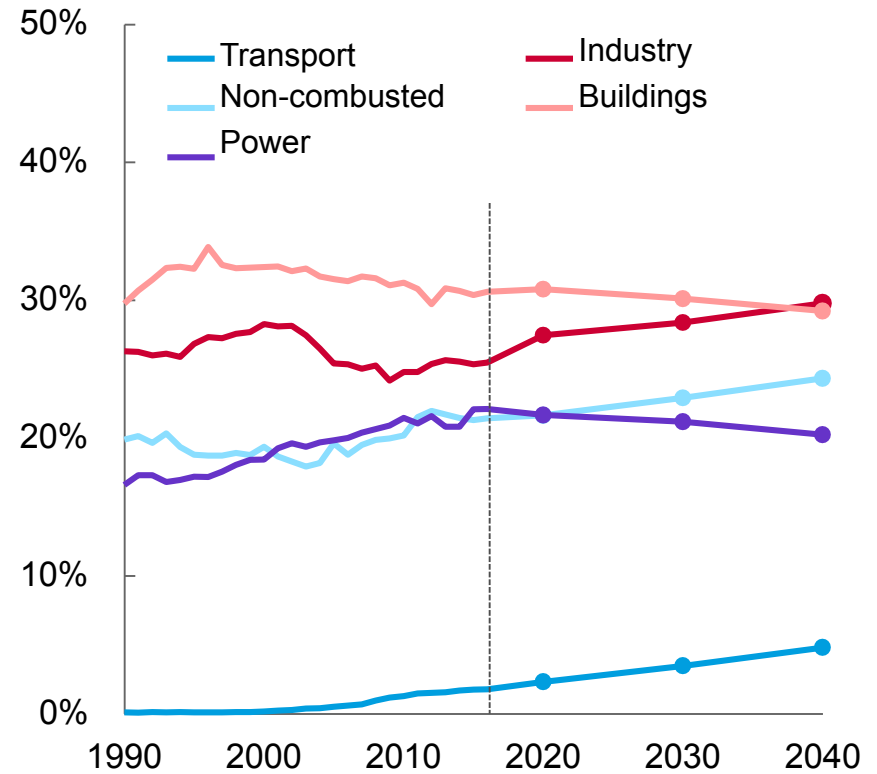


Growth in natural gas demand...

Gas consumption by sector



Gas share by sector

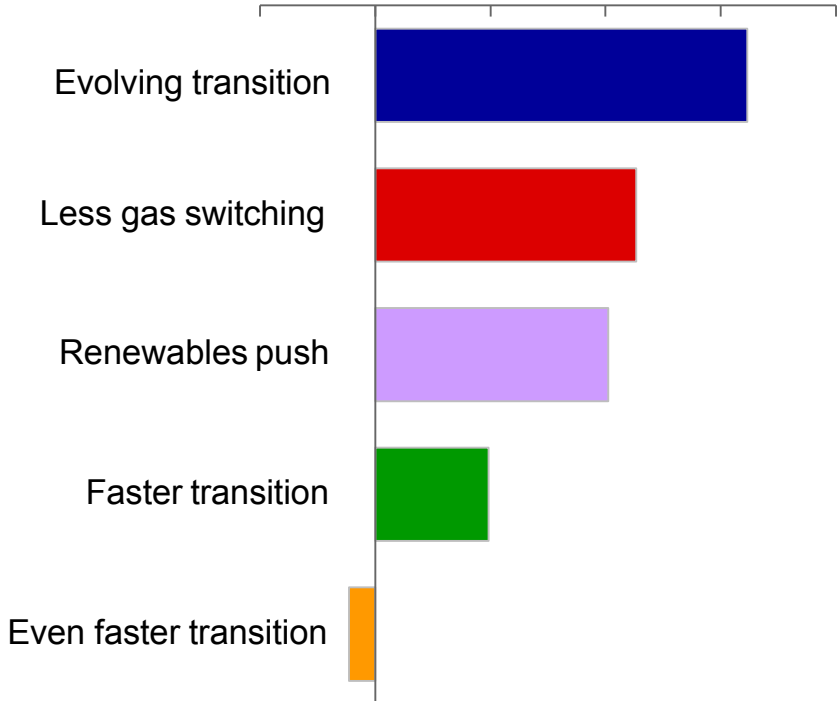


Prospects for gas demand could be dampened

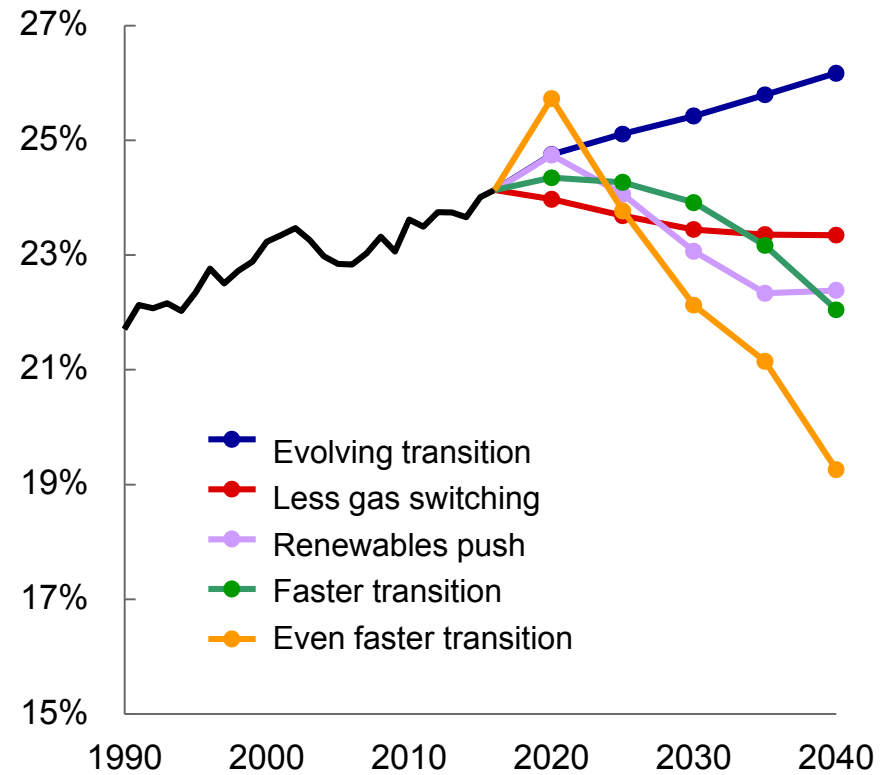
Gas demand growth 2016-2040

% per annum

-0.5% 0.0% 0.5% 1.0% 1.5% 2.0%

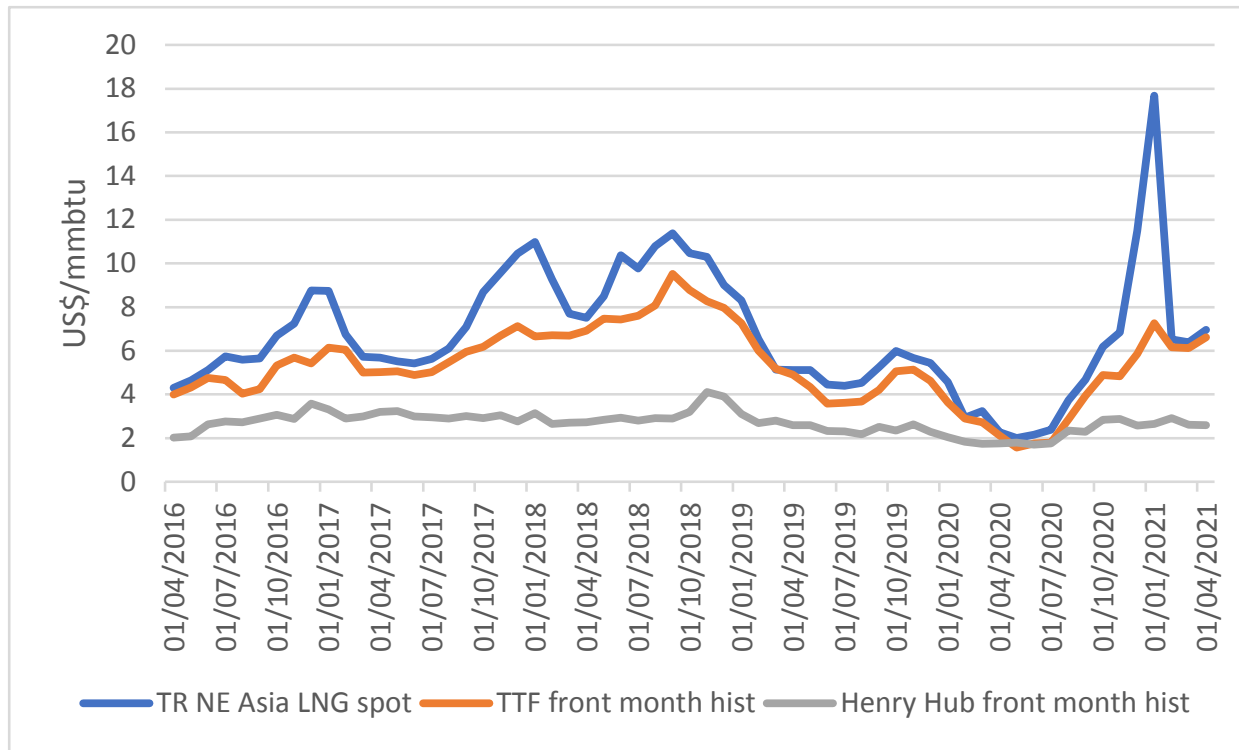


Gas share of primary energy 1990-2040



Gas prices have been falling and converging

Global gas prices



Gas increasingly priced relative to competing gas supply

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

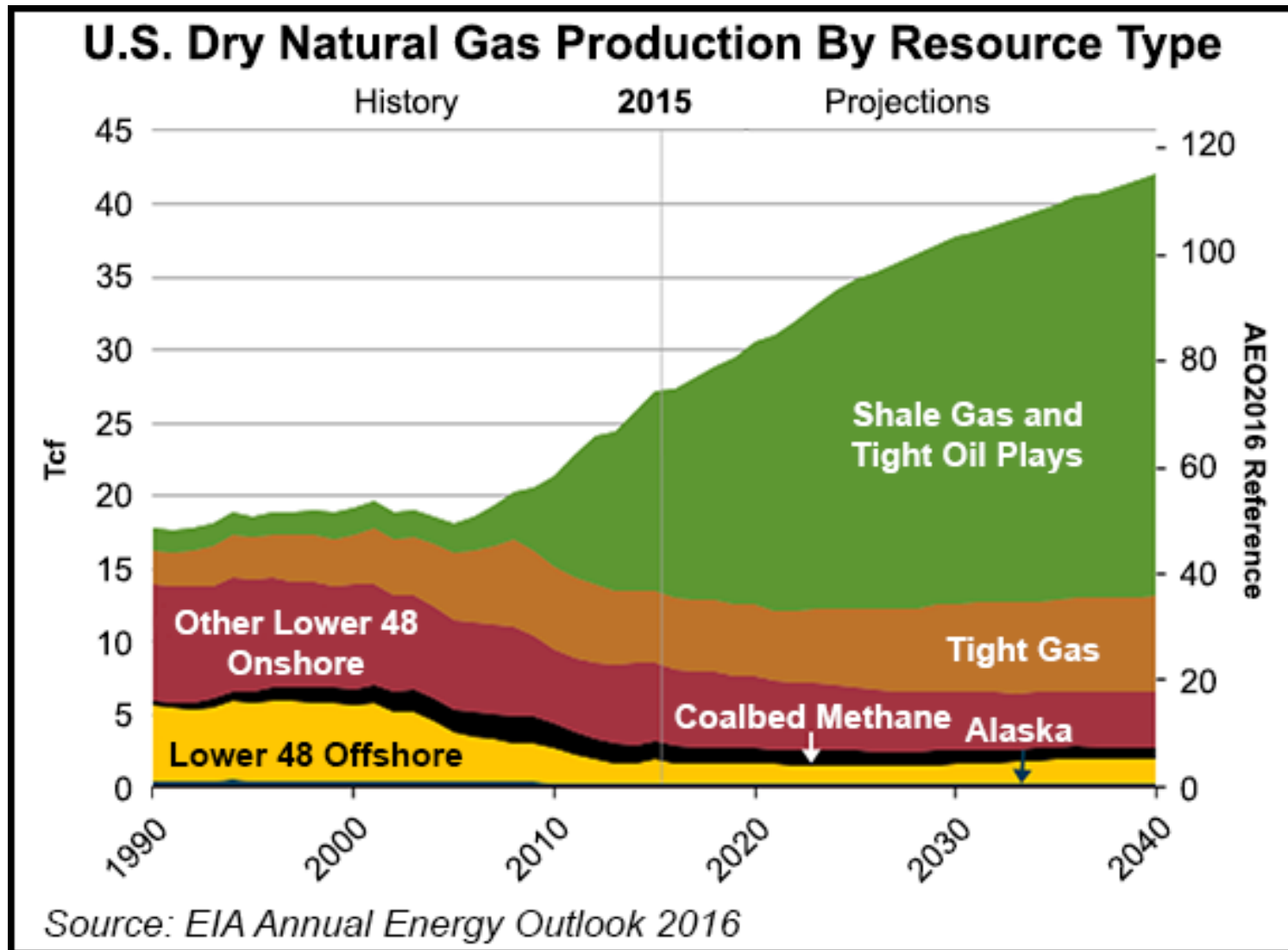
Winter 2020/21 underlined risks of short-term market dislocation, in this instance due to cold weather

Let's model a shale gas field

- Resources and reserves – 1000bcf with 10% recovery rate
- Start date – year after first investment
- Peak production – 25% of reserves
- Time to peak – 1st year
- Length of peak – 1 year
- Decline rates – 50% in year 2, 35% yr 3, 25% yr 4, 10% from then



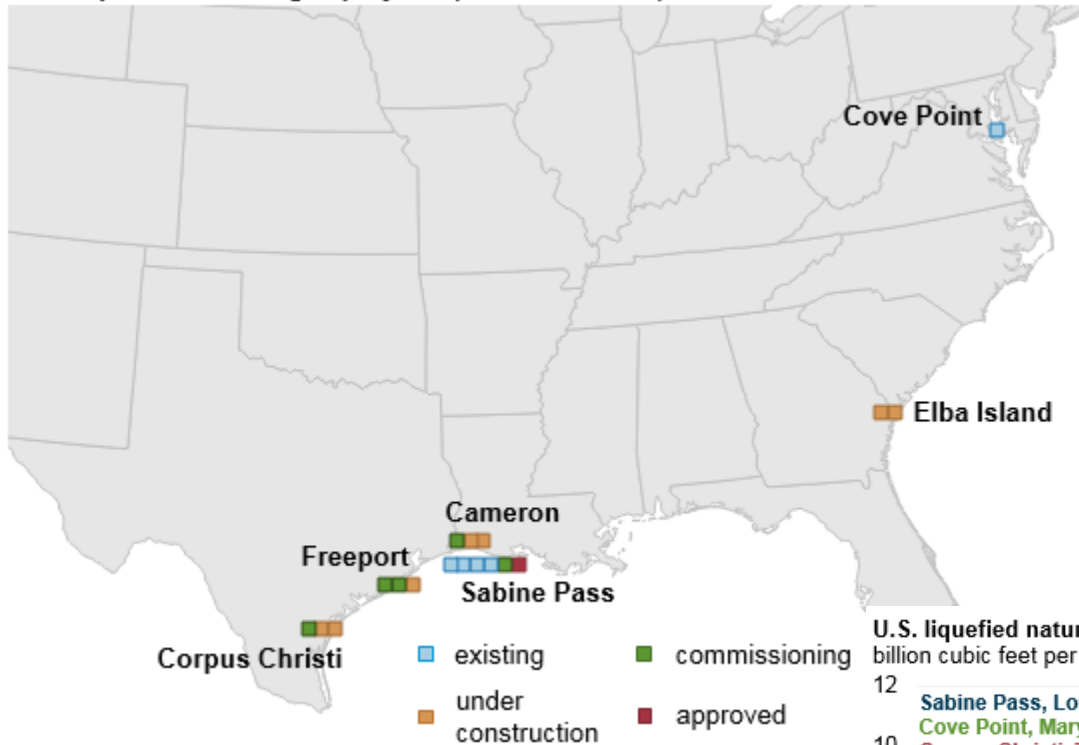
US shale gas production has risen sharply and looks set to continue



US gas is now being exported

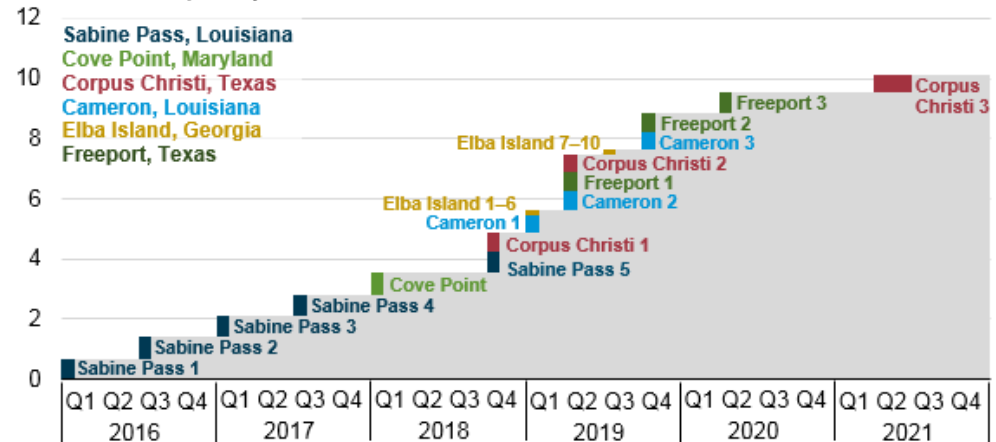
US LNG projects set to expand

U.S. liquefied natural gas projects (November 2018)



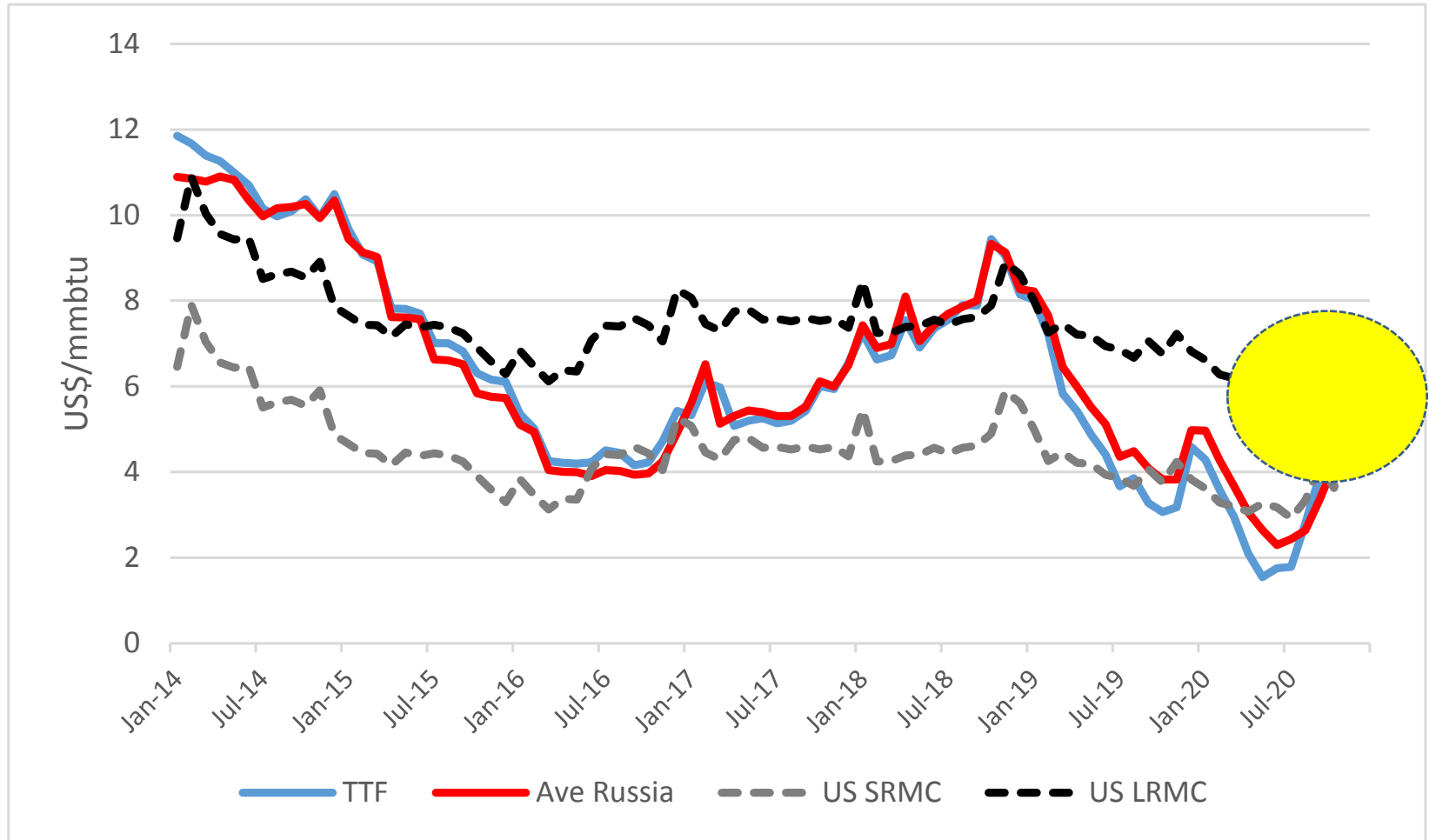
U.S. liquefied natural gas export capacity, 2016–2021

billion cubic feet per day



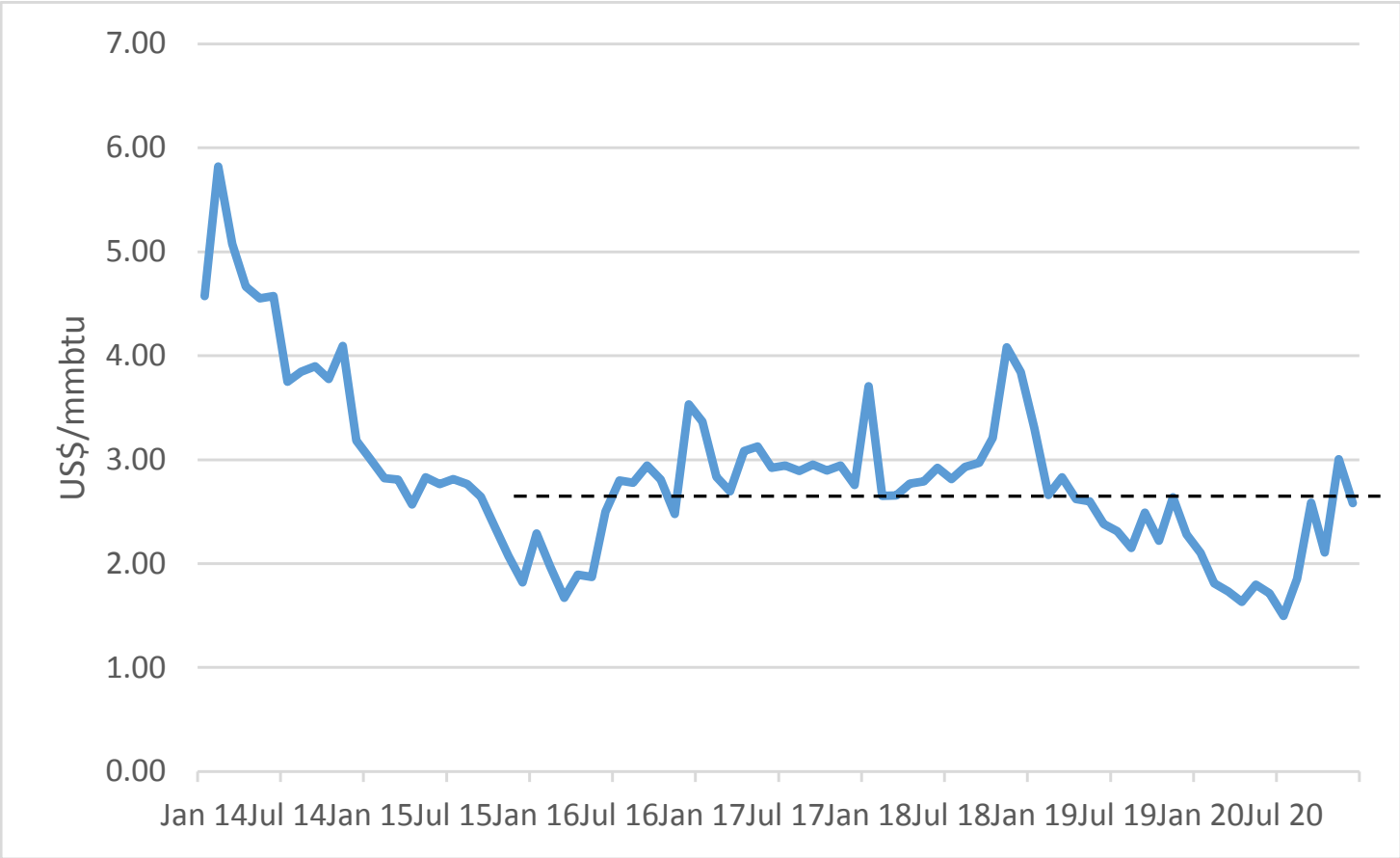
Is it worth exporting US gas?

European gas price versus US LNG at cost



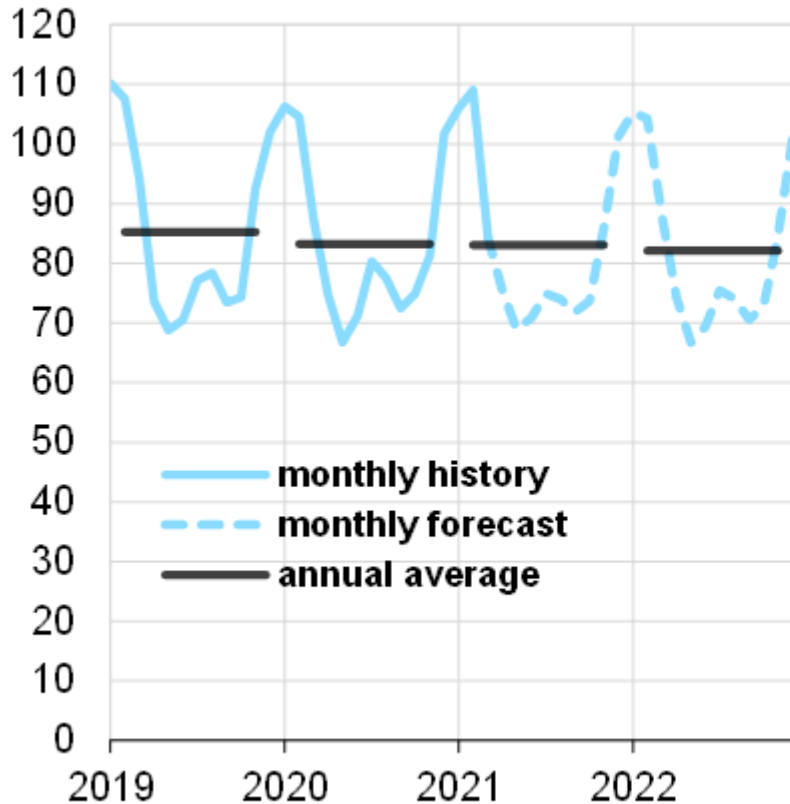
Decline in natural gas prices exaggerated by Covid-19

US (Henry Hub) Gas Price

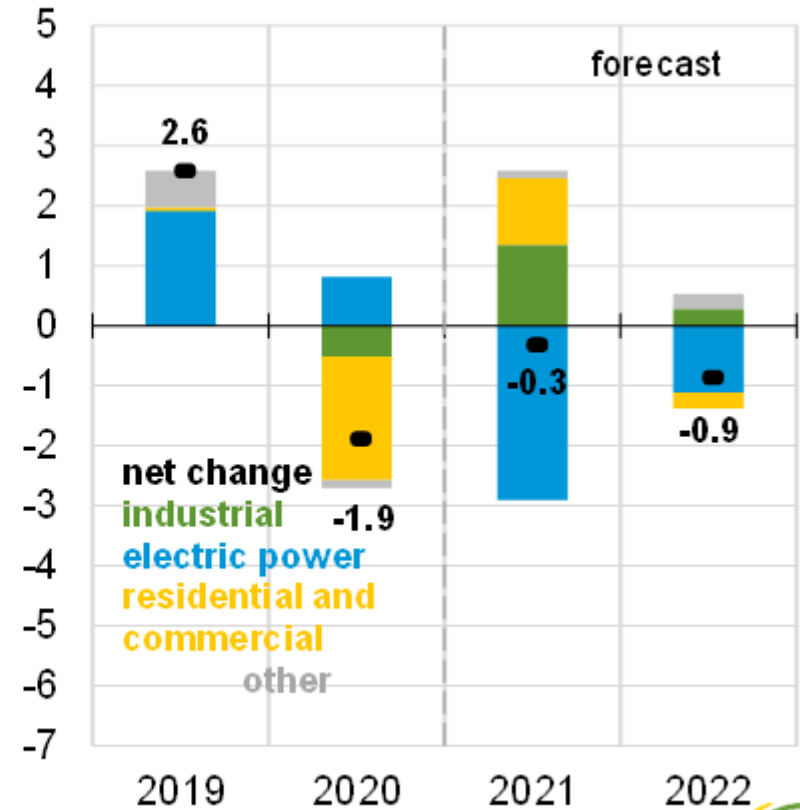


US Gas Market – demand remaining weak due to higher prices

U.S. natural gas consumption
billion cubic feet per day



Components of annual change
billion cubic feet per day



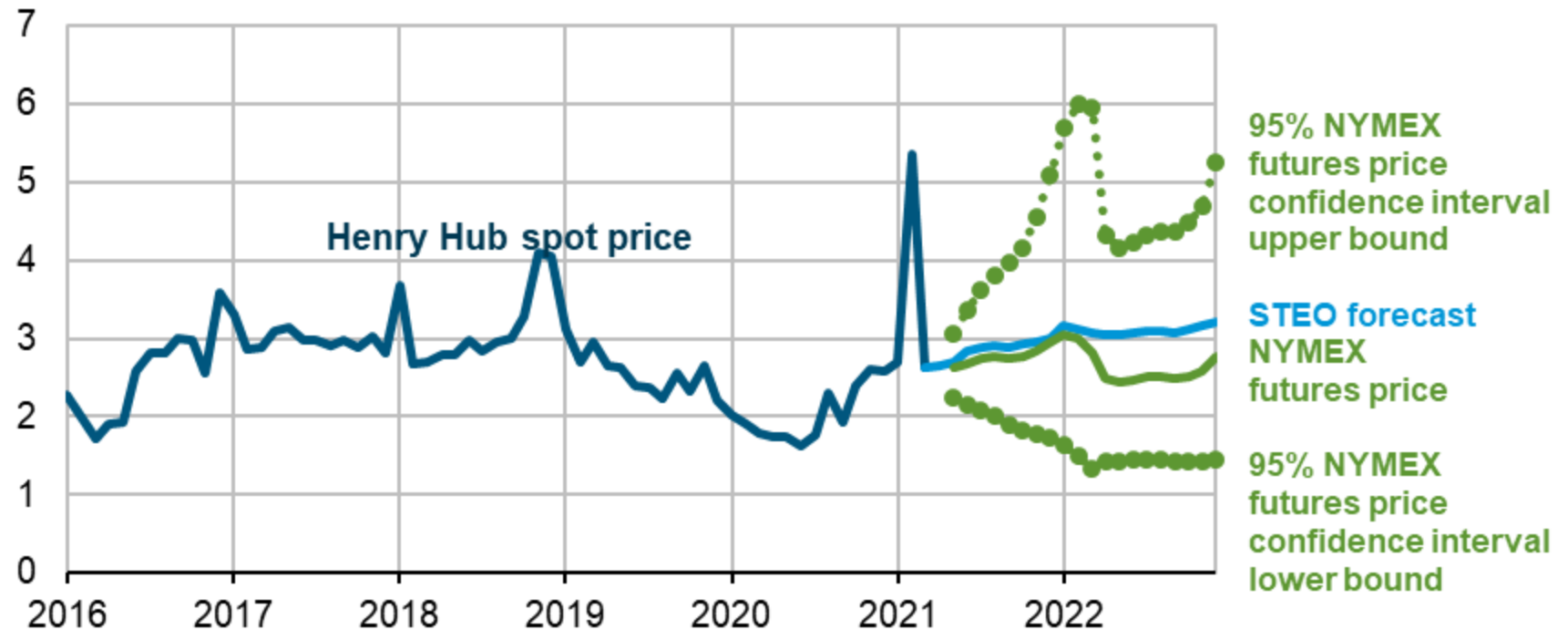
Source: U.S. Energy Information Administration, Short-Term Energy Outlook, April 2021



US Gas Market – price outlook

Henry Hub natural gas price and NYMEX confidence intervals

dollars per million Btu



Note: Confidence interval derived from options market information for the five trading days ending Apr 1, 2021. Intervals not calculated for months with sparse trading in near-the-money options contracts.

Sources: U.S. Energy Information Administration, Short-Term Energy Outlook, April 2021, and CME Group

