



Energy Outlook 2023

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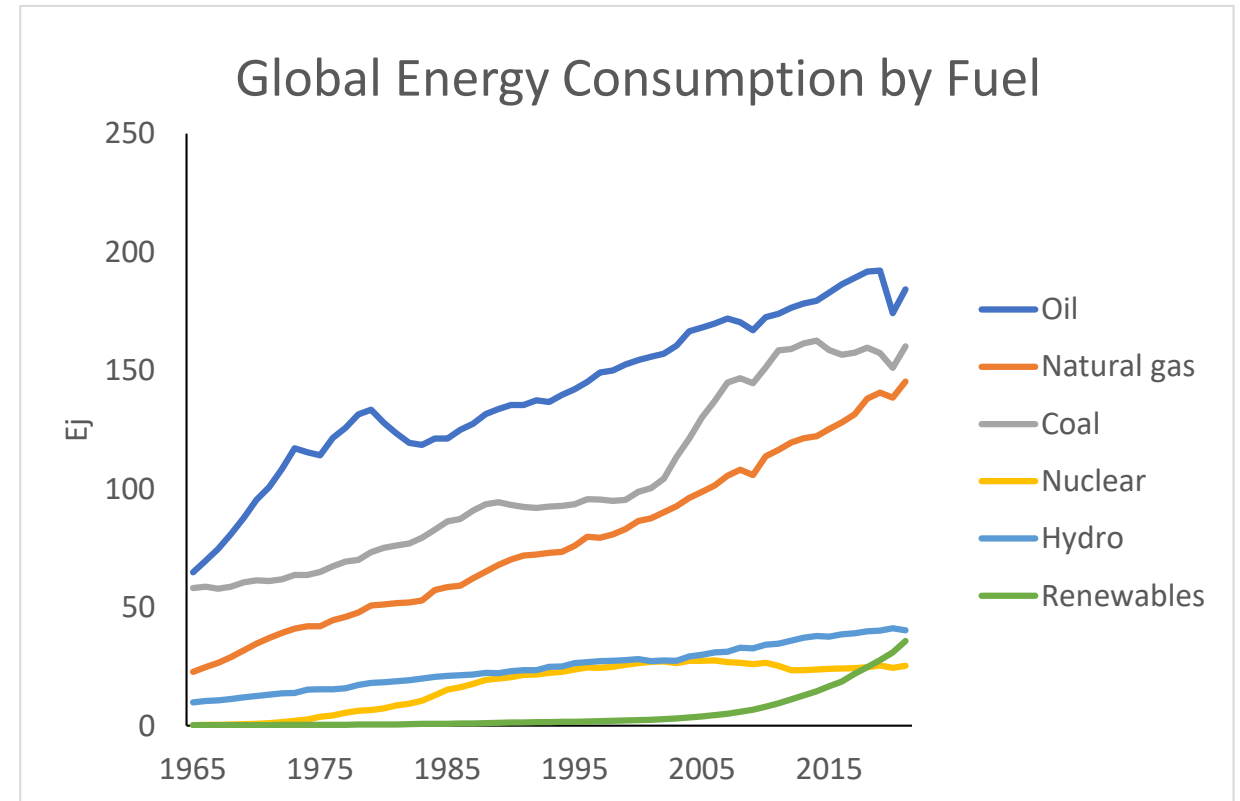
Ohio State University

Global Energy Trends

Total Energy Consumption is up 1.3% per year over last decade.

Largest gains in renewables, mainly wind and solar.

Global expansion in coal slowed earlier in 21st century, but it is picking up steam again?

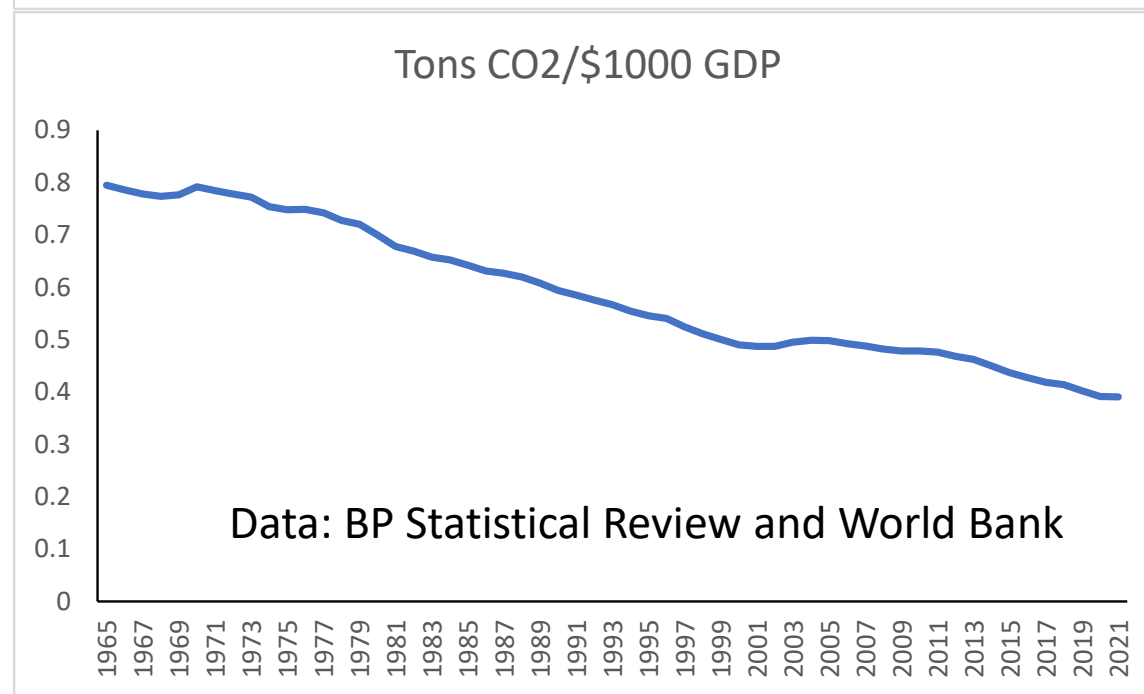
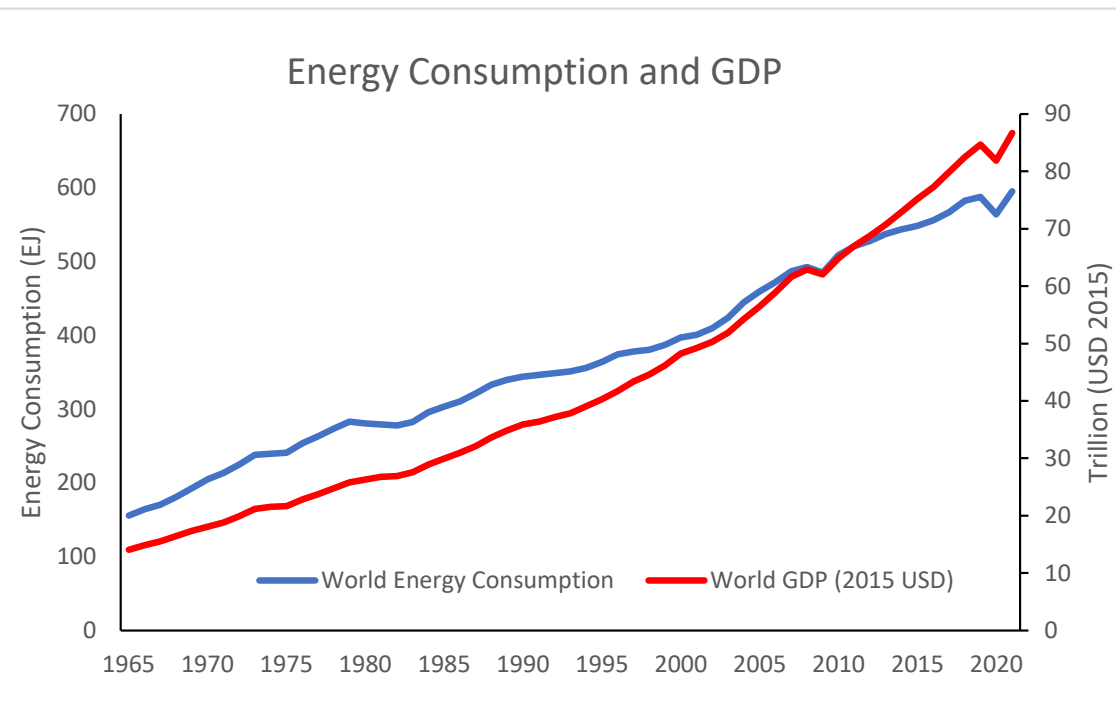


Data: BP Statistical Review

Global Energy Trends

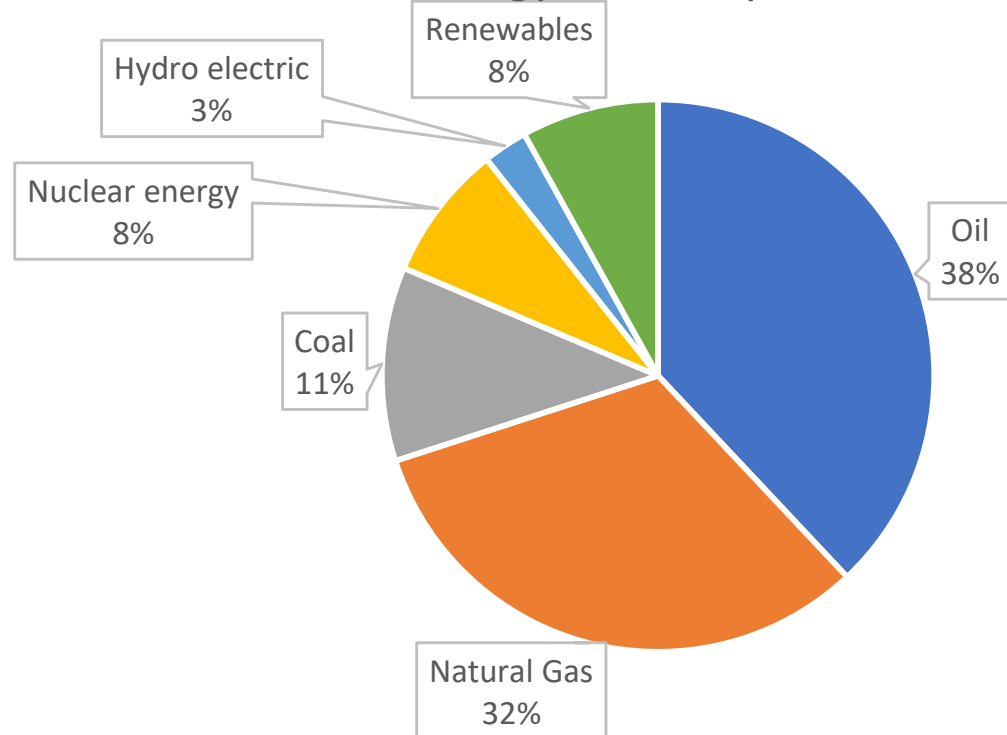
Income growth remains relatively strong, but efficiency gains are allowing society to economize on energy inputs (Decoupling)

Carbon emissions per \$ GDP have been falling relatively continuously, boosted by efficiency gains, fuel switching, and deployment of renewables.

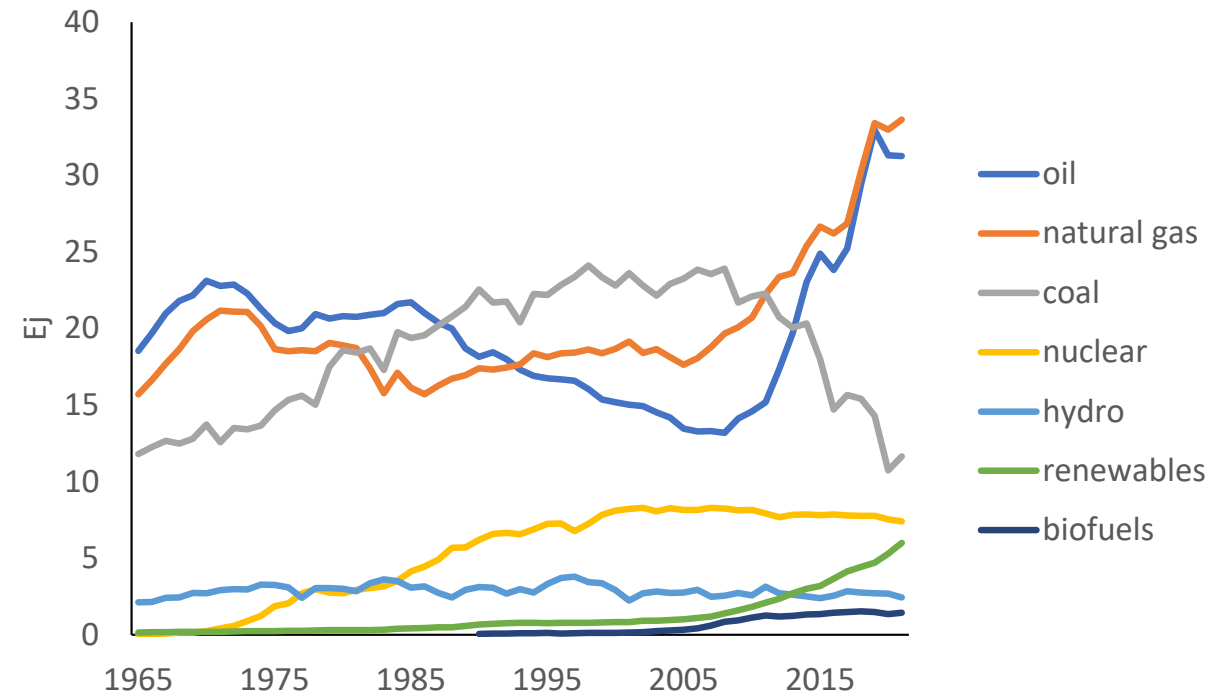


US Energy Consumption and Production

US Energy Consumption 2021



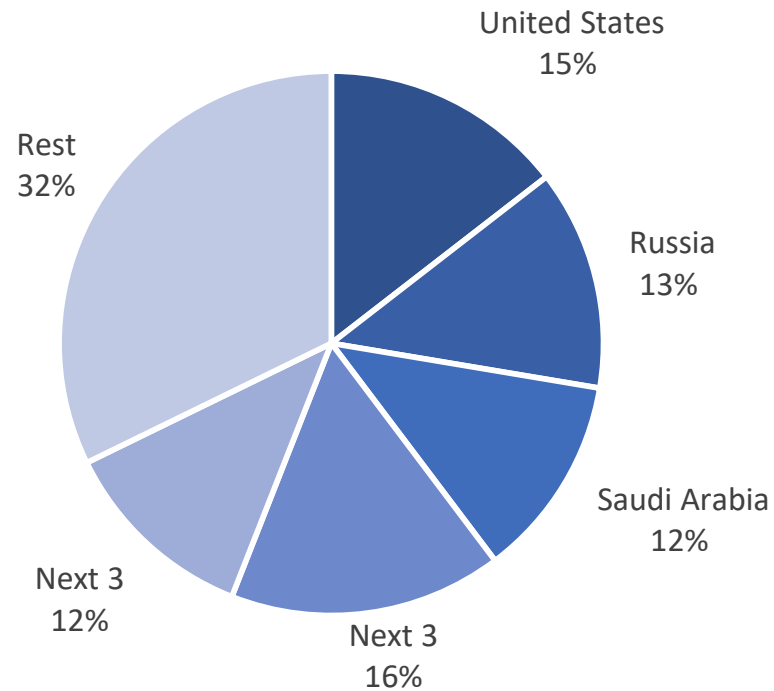
US Energy Production by Fuel



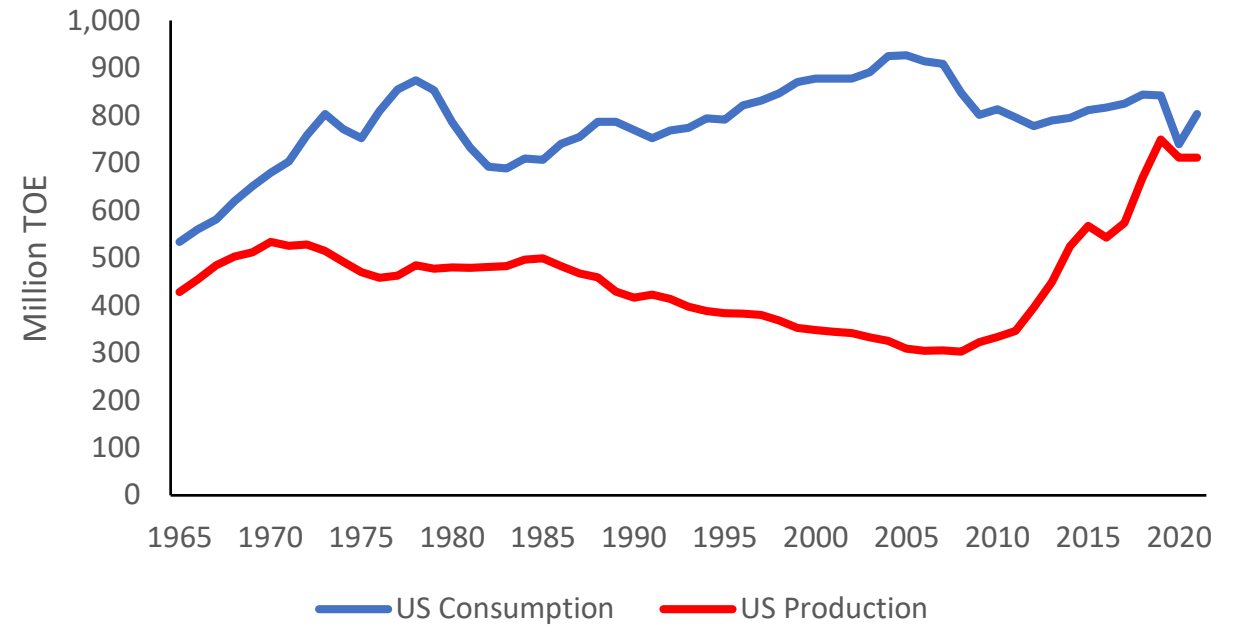
Data: BP Statistical Review

US Energy Independence?

Crude oil production 2022

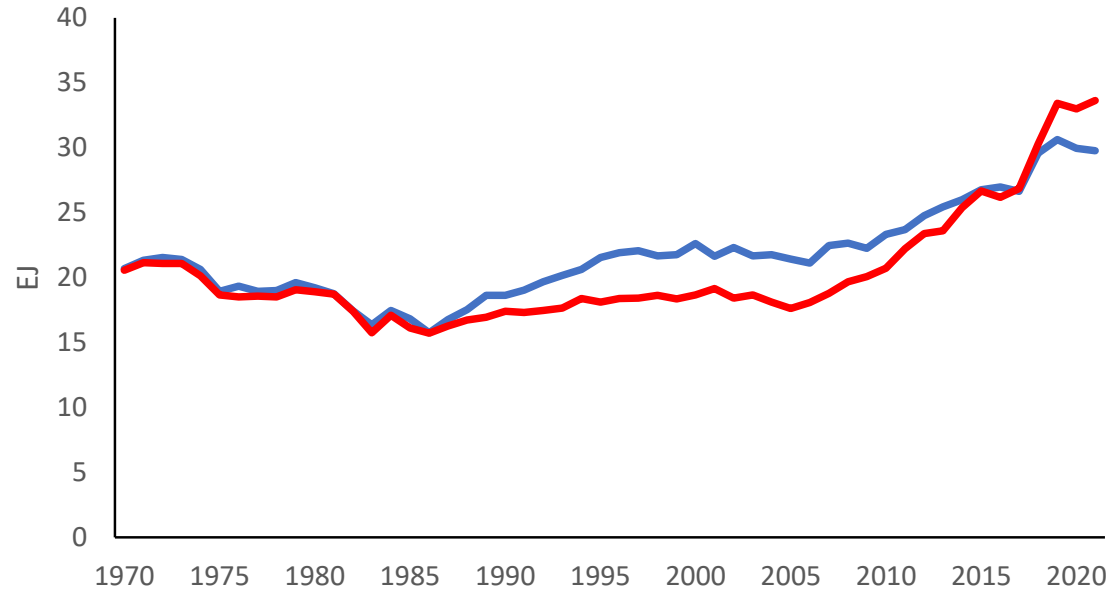


US Energy Independence - Oil

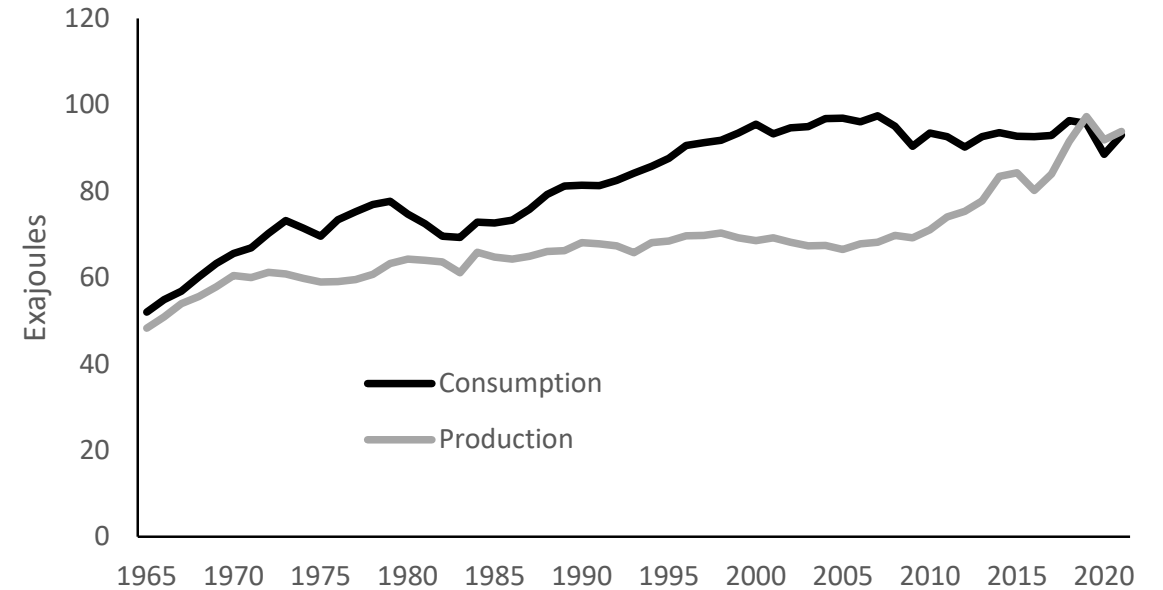


US Energy Independence?

US Energy Independence - Natural Gas



US Energy Independence - All Sources



However....

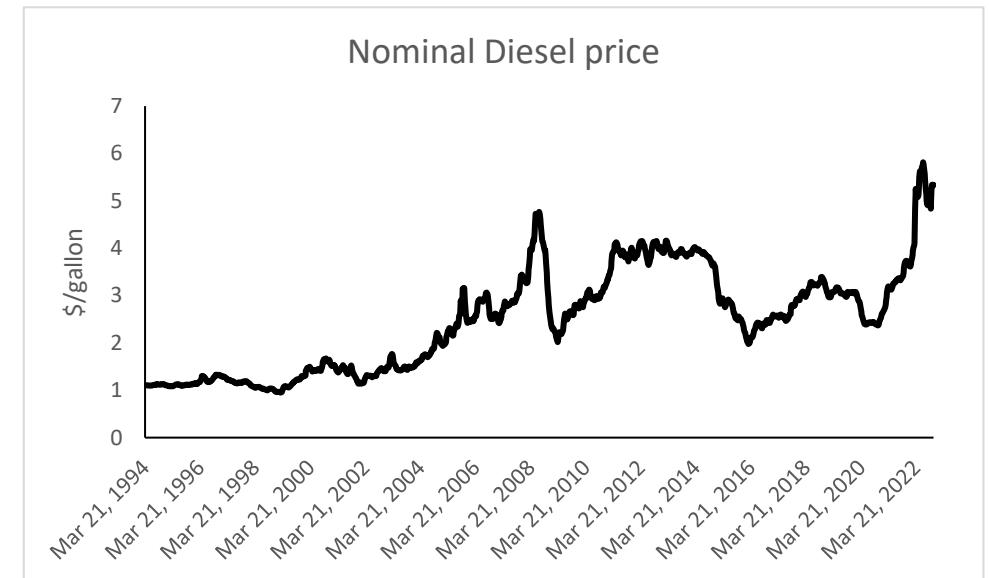
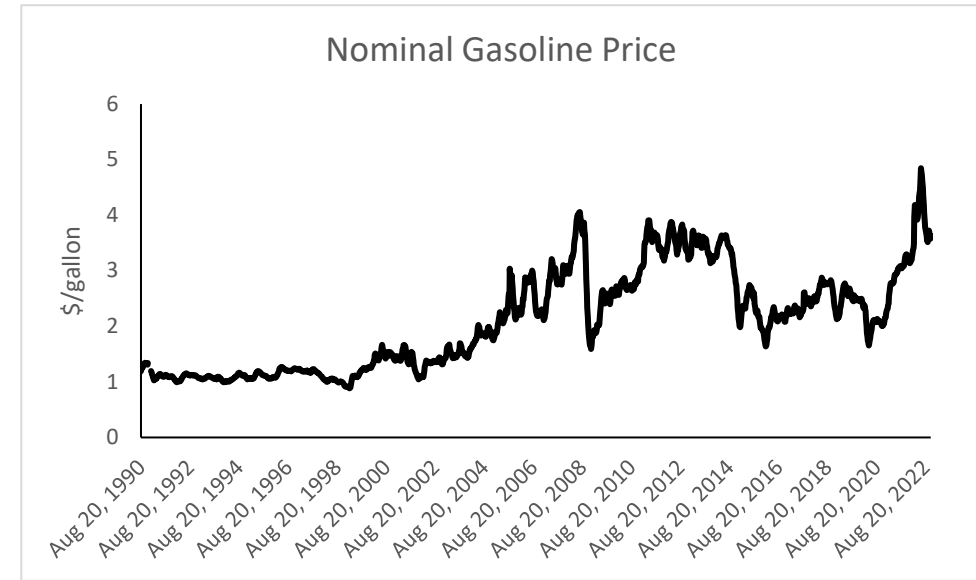
- Energy independence does not prevent us from experiencing supply shocks tied to the global energy market....
- Increased reliance on renewable energy could help, but Europe relies on renewables for 12% of their energy supply (50% more than than United States), and they are no less vulnerable to supply shocks than other regions.
- Events in the EU, Ukraine, Russia, China, Latin America, and Africa will affect our markets for the foreseeable future.

Gasoline and Diesel: Will prices remain elevated?

US gasoline and diesel prices have fallen modestly from their summer 2022 highs, but remain above the average from recent years.

The most recent increase is one of the fastest and strongest increases of the last 30 years.

Driven at first by strong demand response after the pandemic, coupled with slower than expected increase in output in OPEC and elsewhere, by supply contraction in Russian, and now OPEC.



Source: Energy Information Administration

Oil demand: Headwinds all around..

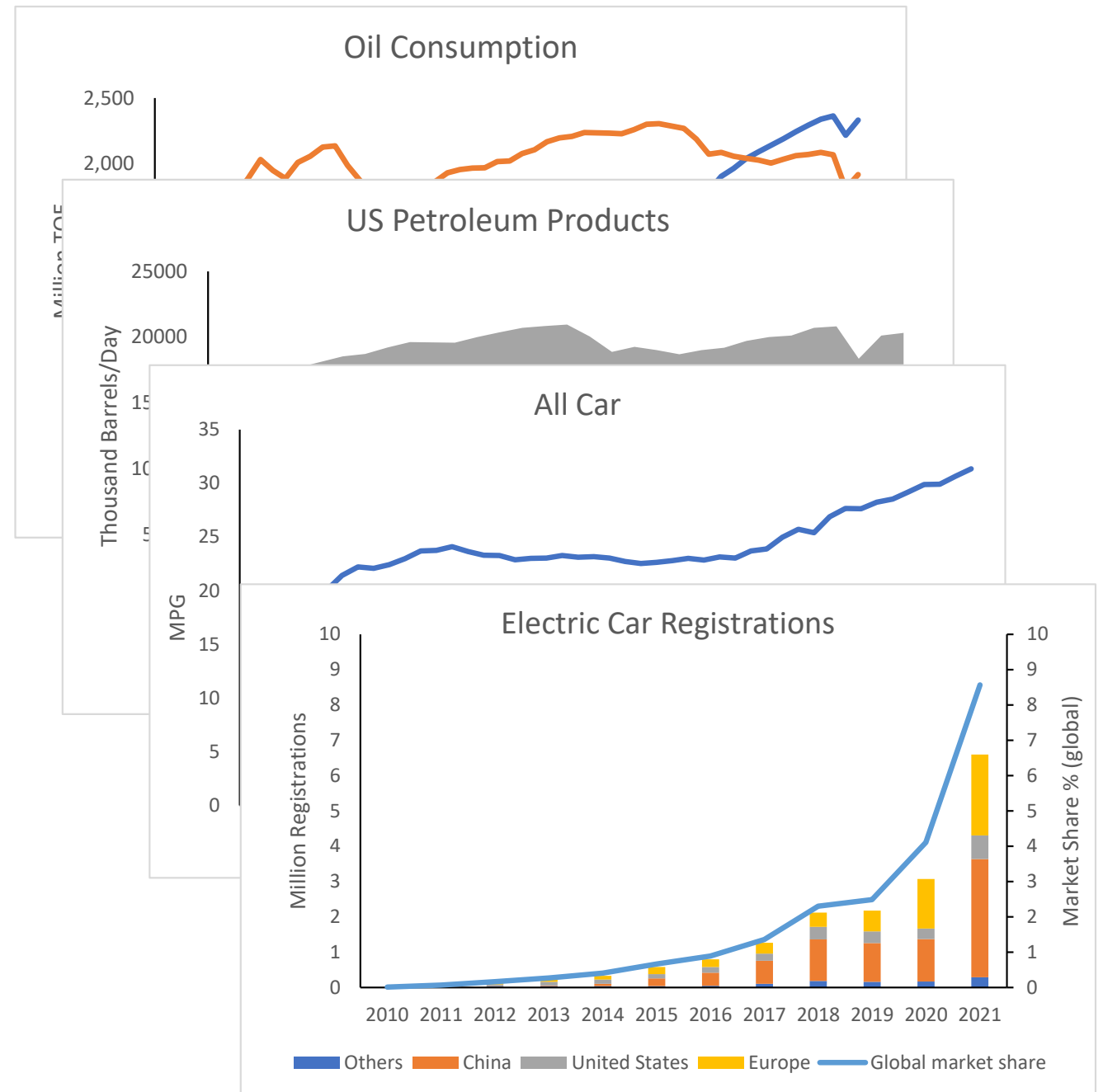
Short-term (1 – 2 years)

- IMF cut their global growth forecast for 2022 from 4.4%/yr to 3.2%/yr and to 2.7%/yr in 2023
 - Inflation at 8.8%/yr in 2022, but receding in 2023 to 6.5% and 4.1% in 2024.
 - US GDP growth revised down to 3.7%/yr
 - Strongest tightening of monetary policy globally in 15 years.
- The Federal Reserve revised US 2022 growth expectations down from 4.0%/yr in December 2021 to 0.2%/yr in November, 2022, and 2023 growth to 1.0%.
- Conference Board revised US 2022 growth expectations down from 3.0% to 1.8%/yr and 2023 growth at 0.0%/yr.

Oil demand:

Longer-term (>2 years)

- Are we approaching peak oil?
 - OECD peak oil happened in 2005.
 - US peak oil (so far) happened in 2007.
- Why?
 - Fuel efficiency rising.
 - Growth in electric car market.



Oil Supply:

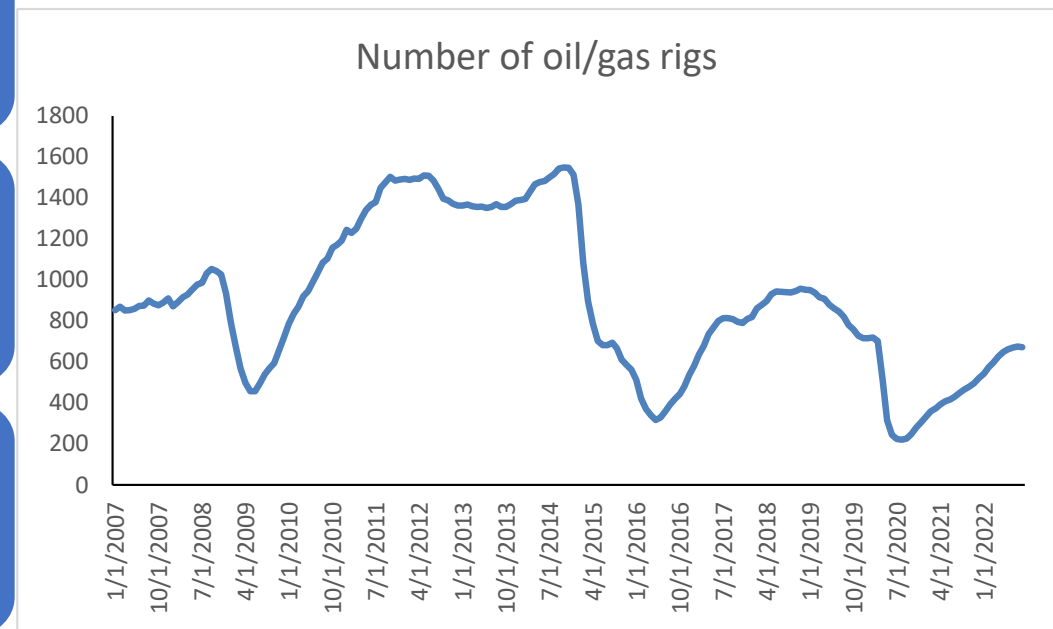
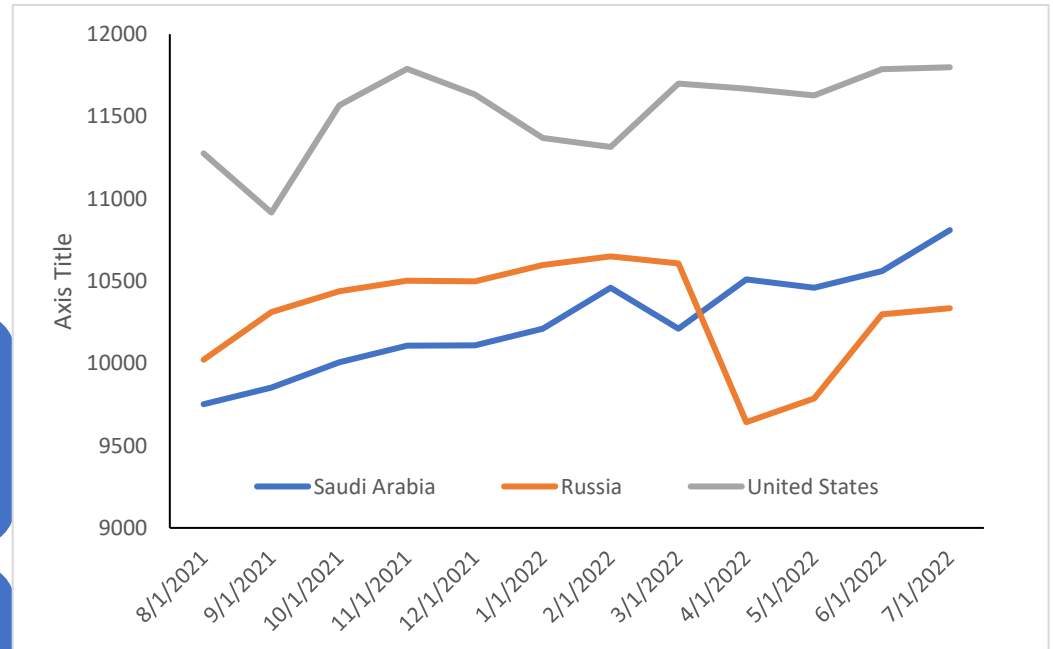
Short term – mixture of factors

Russian supply down 1 MMb/d in April (10%), but has recovered.

Urals oil trading at 25-30% discount compared to other oil benchmarks

Rig counts and activity are increasing in the United States, but slowly.

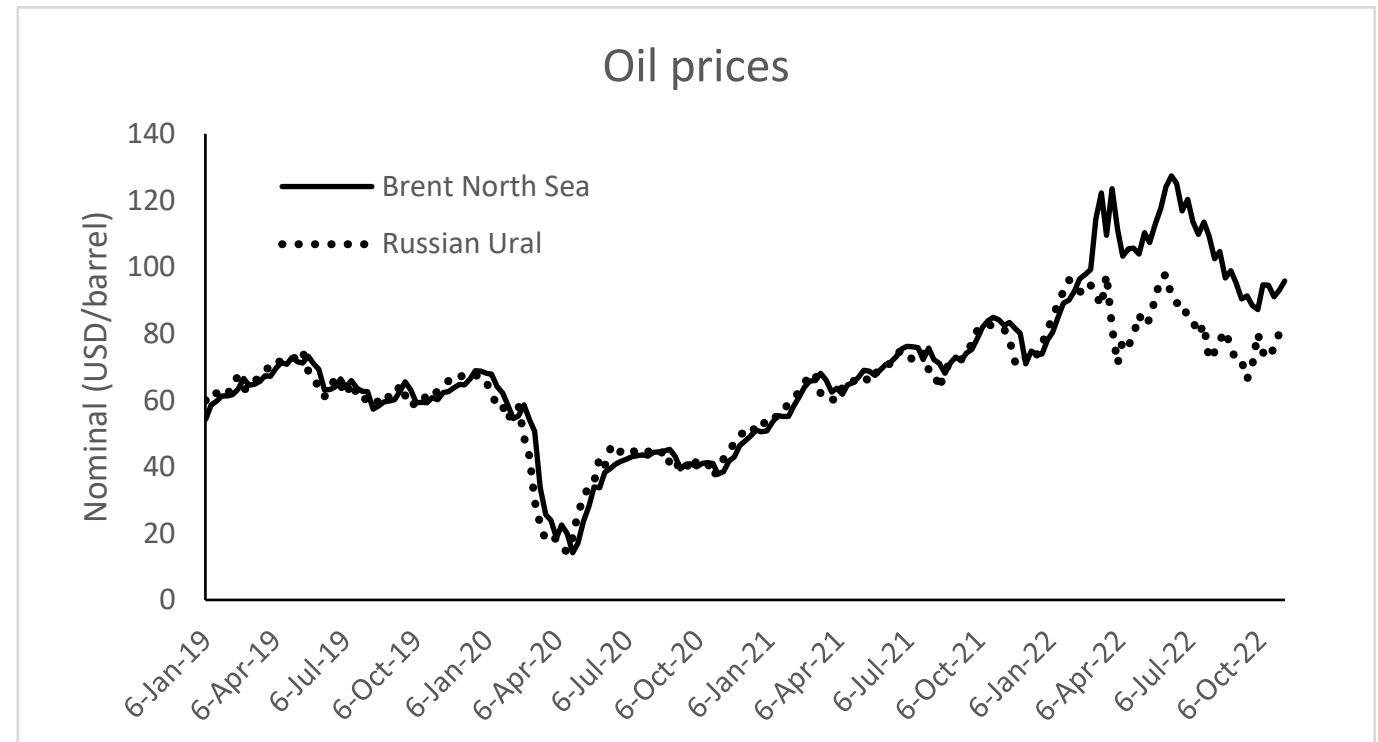
OPEC will reduce supply in December by up to 2 MMb/day.



Source: EIA

Oil price outlook

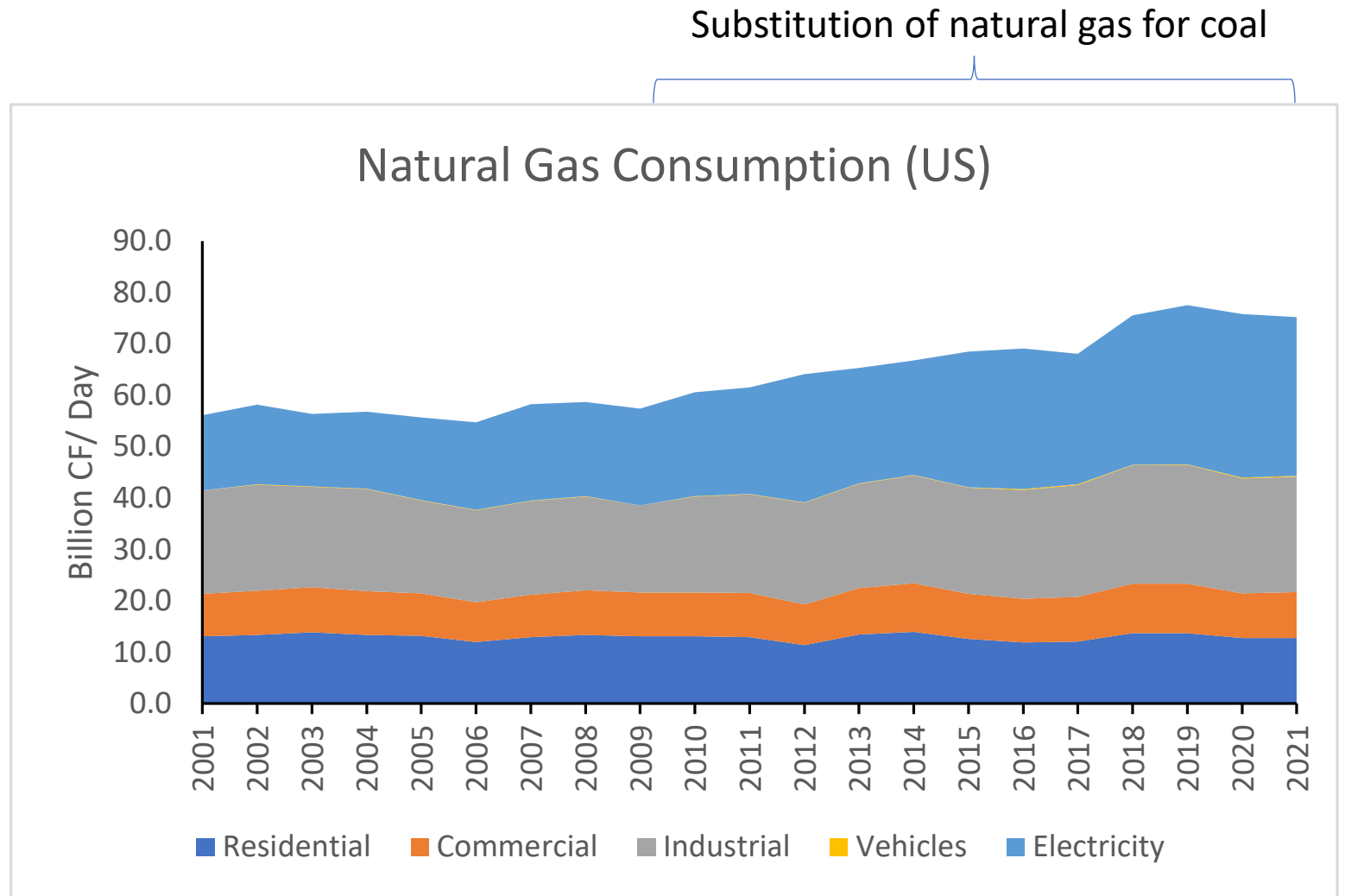
- Demand
 - Receding demand is already putting downward pressure on prices.
- Supply
 - Factors that initially reduced Russian output have dissipated.
 - Discount on Russian oil is giving them a market.
 - US output will continue to edge upward as labor market opens up, although US is not deploying assets as freely as 10-15 years ago.
- Prices will fall 5-10% in next few months, but Brent crude remains above \$85/b (WTI > \$76/b).
 - Gasoline prices \$3.50-\$3.70
 - Diesel \$4.90- \$5.20



Source: EIA and Investing.com (for Ural price)

Natural gas markets?

- All uses have grown.
- Since 2001
 - Electricity +72%
 - Industrial + 15%
 - Residential + 19%
 - Commercial +22%

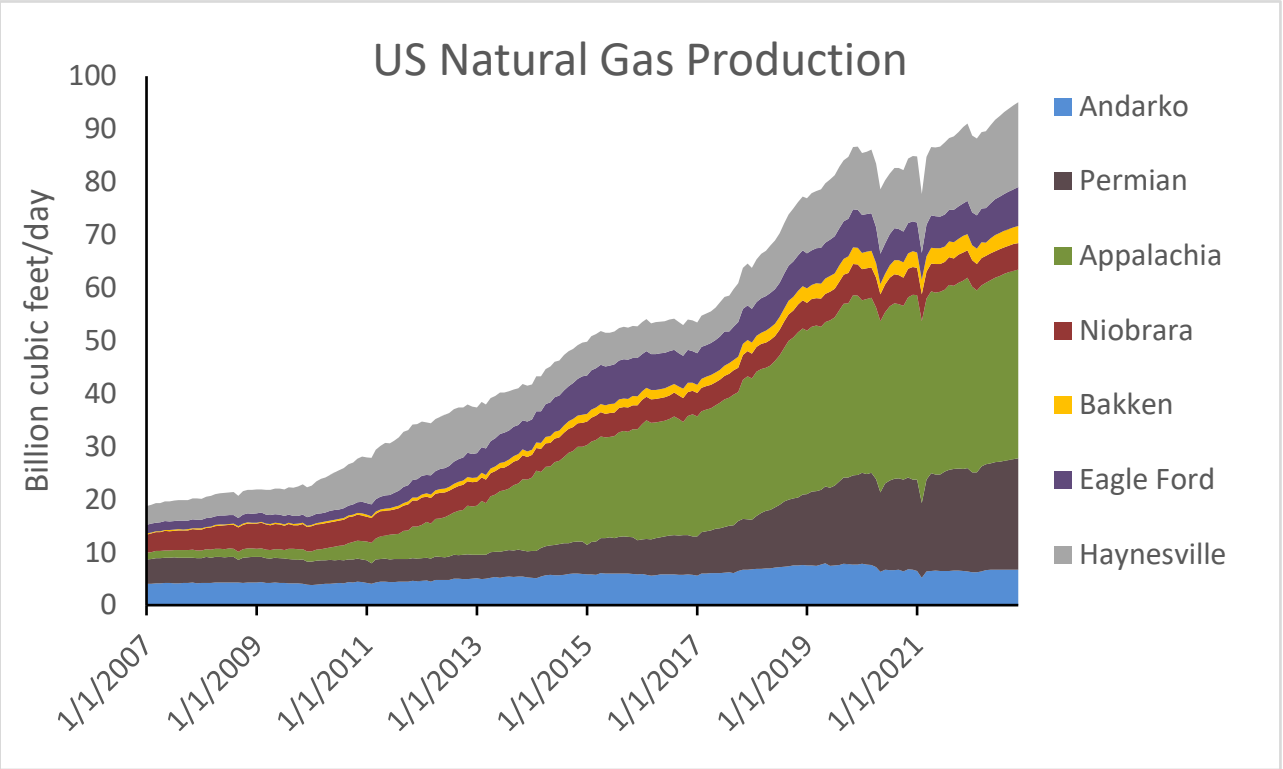


EIA's Drilling Productivity Report adds Anadarko region, aggregates Marcellus and Utica

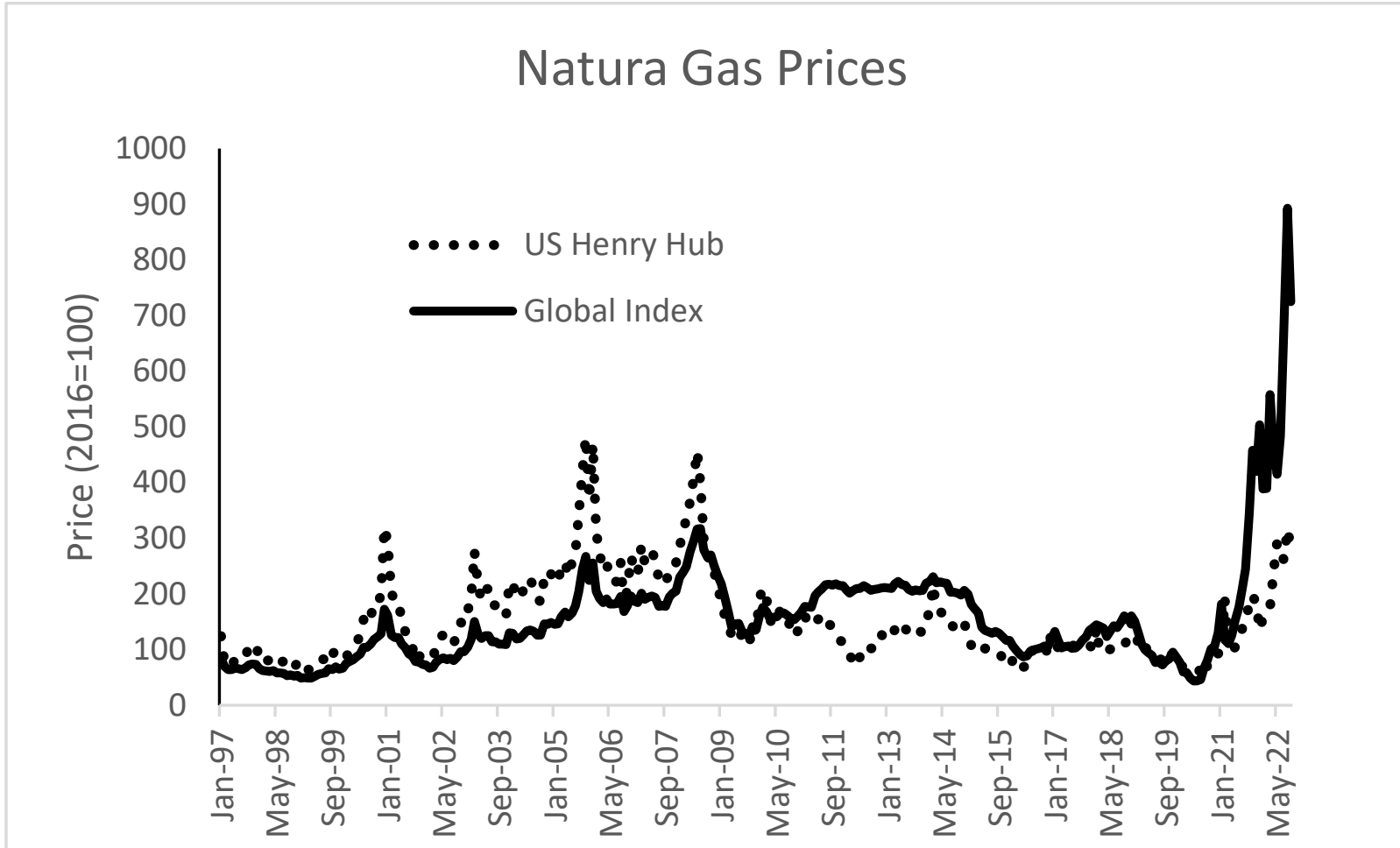
Regions in EIA's Drilling Productivity Report



Source: U.S. Energy Information Administration, [Drilling Productivity Report](#), August 2017



Natural gas: How much higher will price go?

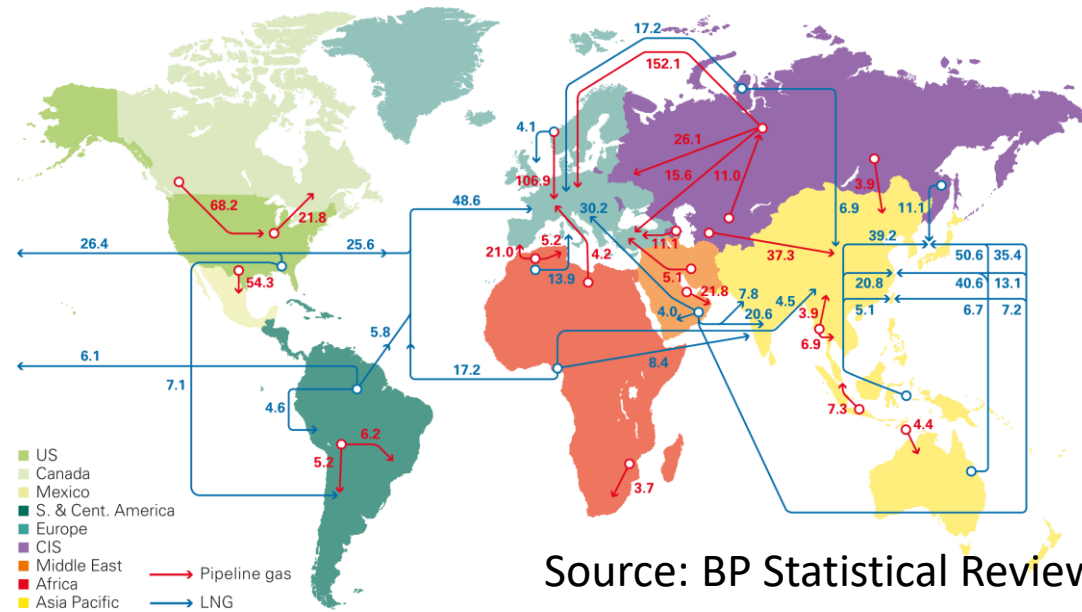


Source: EIA and IMF

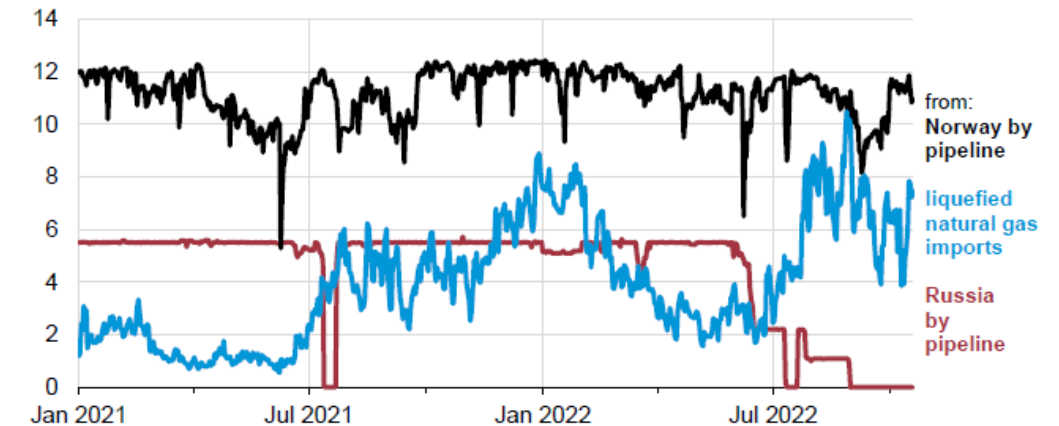
- Prices in Europe and Asia have risen far faster than North America.
- Natural gas is not as widely traded as oil (24% of total consumption v 52%)
- Most of the price increase globally due to allocation issues, not supply.

Natural Gas Trade Flows

- US exports ~15% of NG production, about half of which is now LNG (large increase in last 5 years)
- Europe imports 60-65% of their NG, with more than 50% from Russia and other CIS countries.



Daily natural gas flows into Northwest Europe (Jan 1, 2021–Oct 19, 2022)
billion cubic feet per day

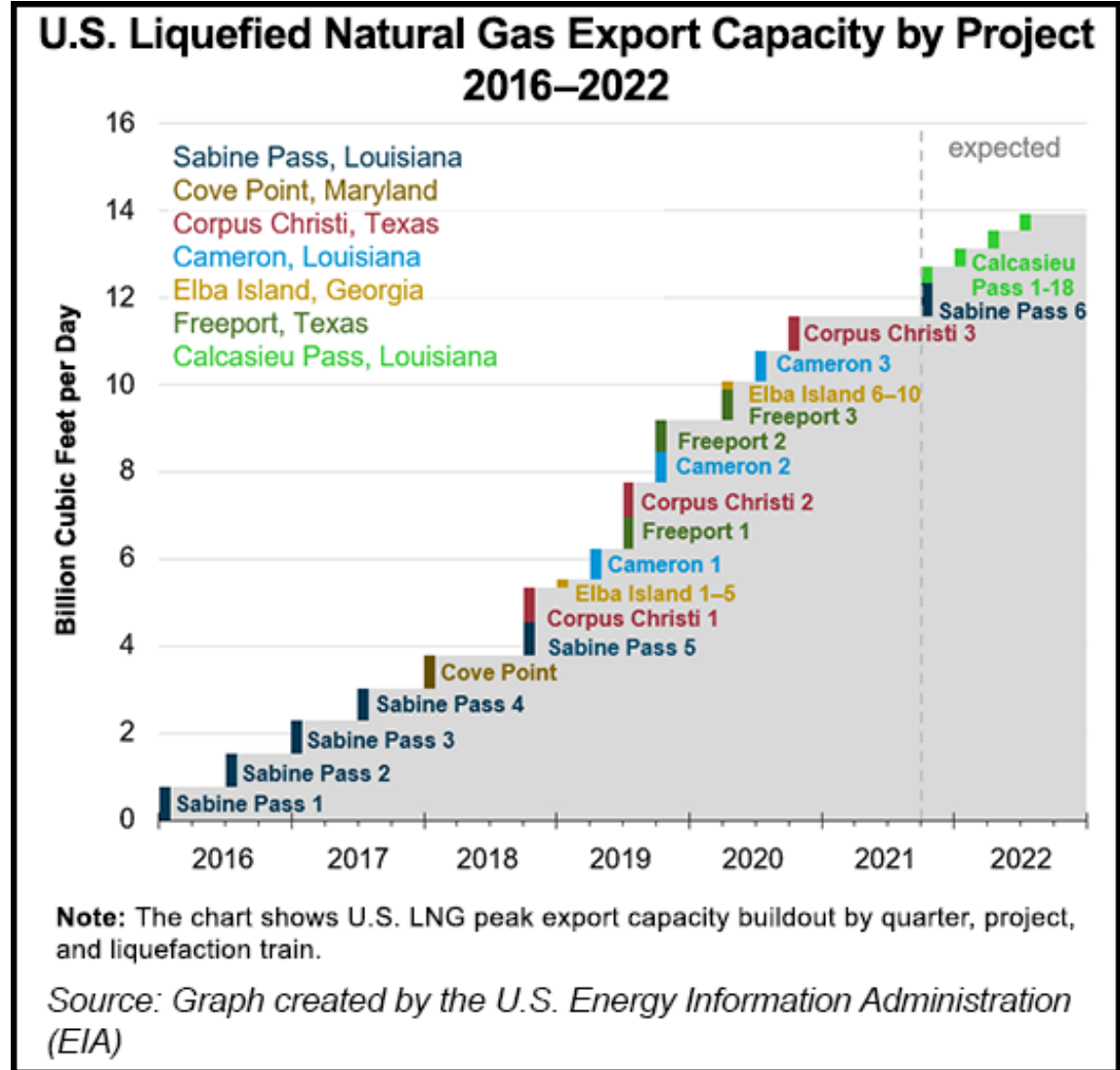


Data source: Bloomberg L.P.

Note: Russia by pipeline includes the Nord Stream and Yamal pipelines and pipelines entering Europe at Velke Kapusany. Natural gas flows from Norway represent daily exit nominations on pipeline infrastructure going from the Norwegian Continental Shelf to receipt terminals in Belgium, France, the United Kingdom, and Germany.

US LNG export capacity

- Growing and will pick up with higher global prices and continued new investments.
- Europe also needs to expand capacity to import.
- Floating regasification terminals have potential, but new ones also need to be built.



Nitrogen/Ammonia markets and prices

As with other energy intensive inputs, fertilizer prices have more than doubled in the past year.

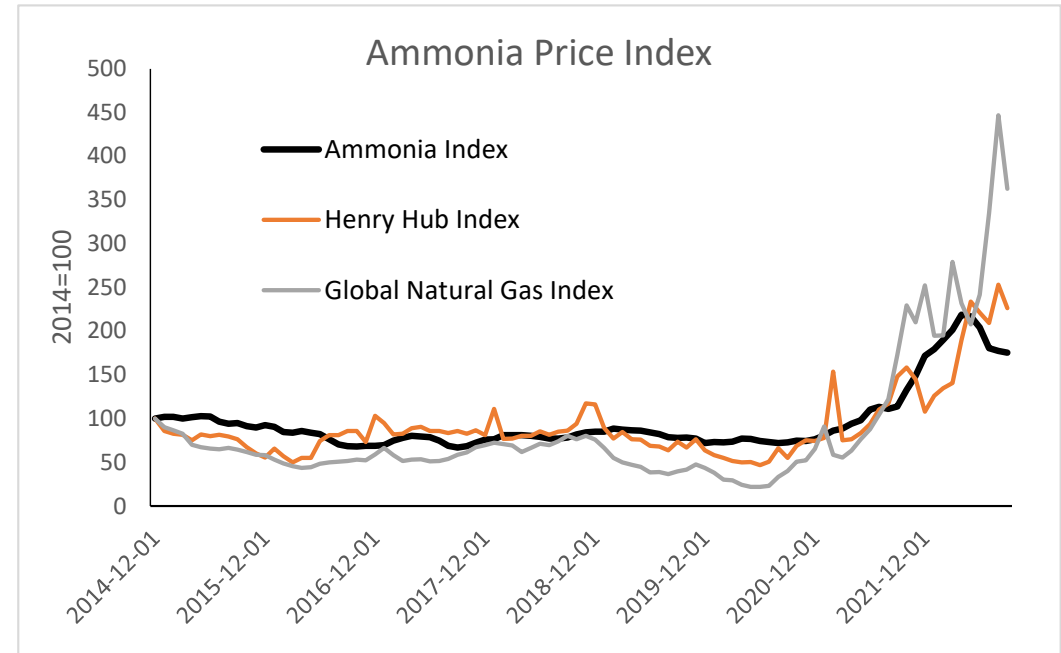
- A bit of relief on prices as farmers seem to have slowed their use.

US imports about 16% of its ammonia consumption, down from 35% a decade ago.

- US is the third largest producer, behind China and Russia, and just ahead of India.

Ammonia is easier to trade than LNG, so follows the international price.

- Prices are unlikely to fall as rapidly as natural gas prices.



Source: Saint Louis Federal Reserve Bank, EIA, and IMF

Longer-run competition for Ammonia....

- Hydrogen (H_2) can be used to create electricity/energy via a fuel cell, which can be used to power a car, or a powerplant...
- H_2 can be stored and transported fairly easily as ammonia
 - Blue ammonia = Ammonia that is produced via the traditional Haber-Bosch process, with carbon capture and storage (one location in the US)
 - Green ammonia = Ammonia that is produced via electrolysis of H_2O using renewable energy.
- Ammonia may be combusted directly to produce electricity.

Where are natural gas prices going?

- Short to medium term:
 - EIA predicts prices around \$6/MMBTU this winter, a 9-10% increase.
 - Natural gas storage levels are lower than in years past, putting upward pressure on prices.

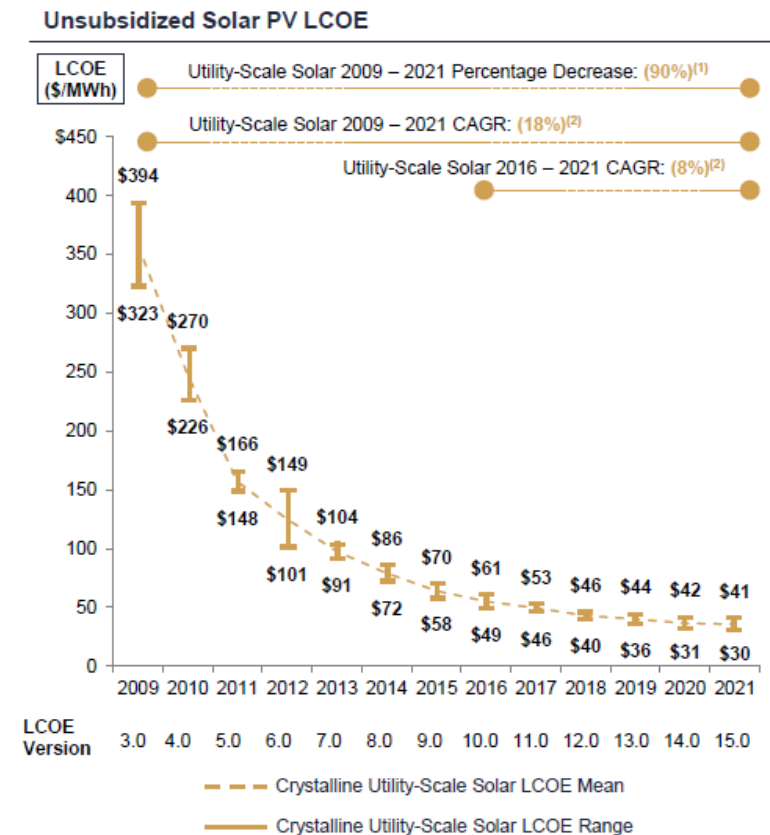
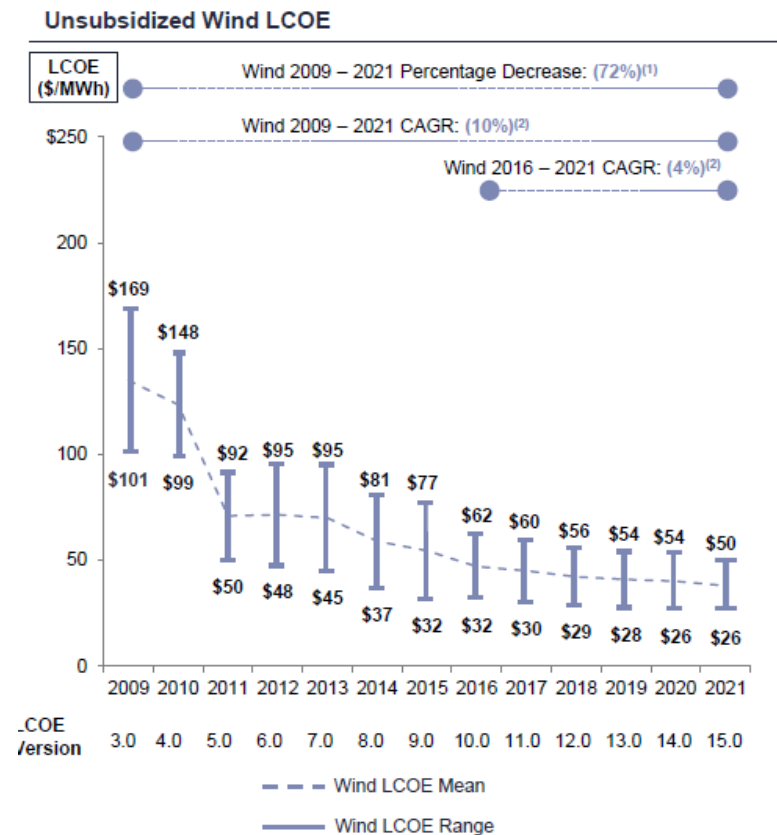


Natural gas prices in the longer-term?

- EIA predicts that prices start to moderate in 2023 in the US, as production expands by 10-15% over the next 5 years.
- Longer-term price growth is constrained by continued expansion of solar and wind.
 - Wind capacity expansions start to slow down
 - Solar capacity expansions continue to grow, both through industrial scale applications and smaller-scale (community solar, individual solar).
 - 14% of total generation in 2021, rising to 17% in the next 2 years.

Renewable and storage costs set a long-term upper bound for electricity and natural gas prices

- Longer run economics driven by falling costs of renewables...



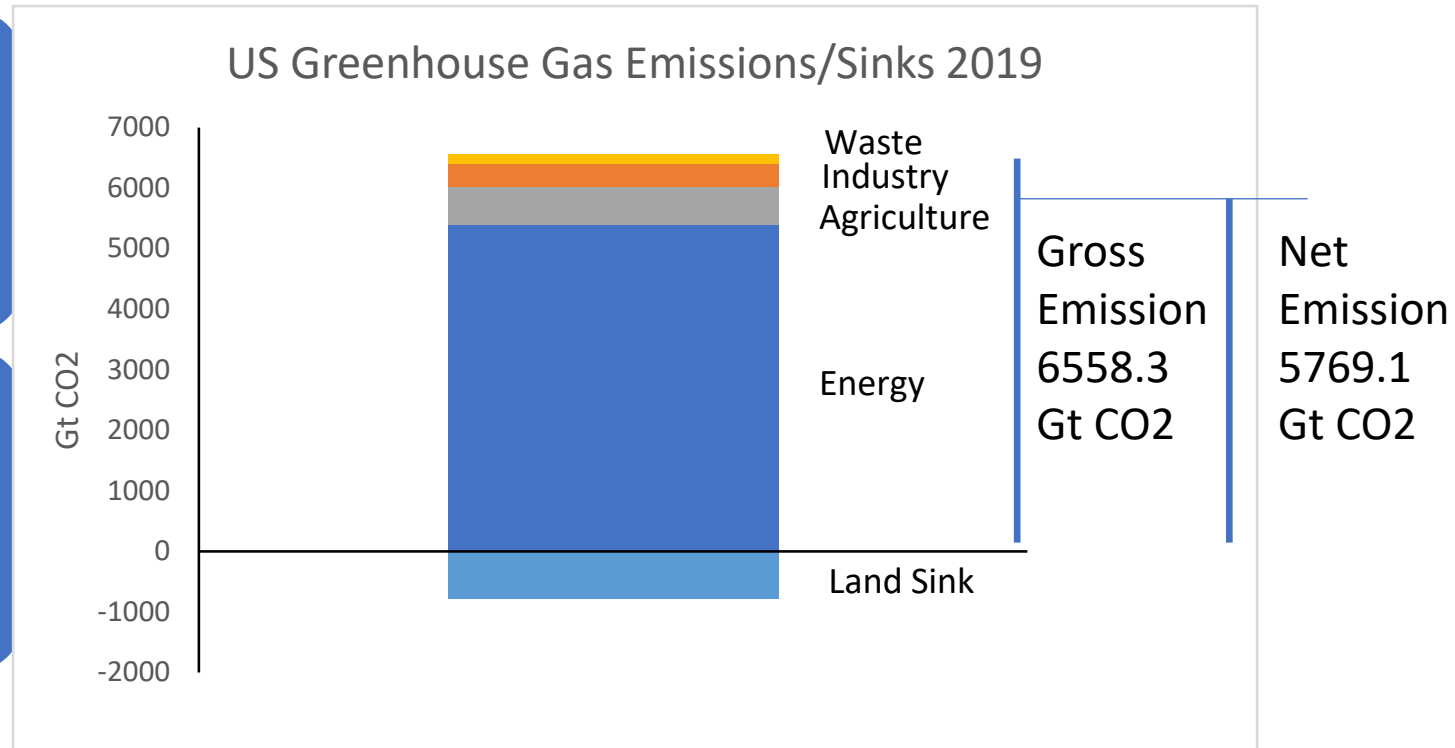
Source: Lazard's Levelized Cost of Electricity Analysis

Climate policy – carbon offsets

Carbon neutral/net zero = CO₂ emissions are balanced across space by CO₂ removals.

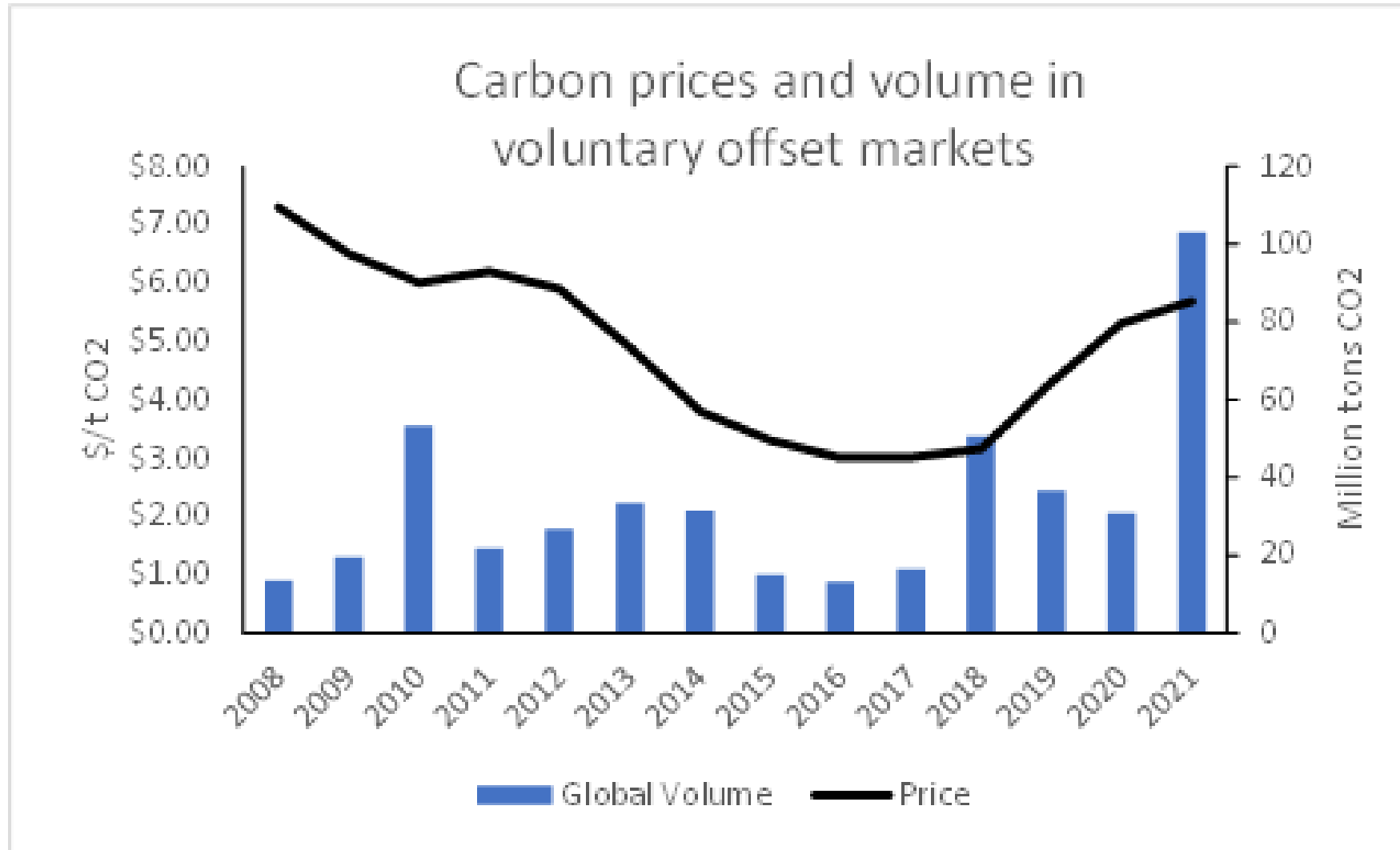
Carbon offsets are generated when carbon is removed from the atmosphere by photosynthesis, or by emission reductions from avoided losses.

- Forests, soils, methane, fertilizer, etc.



Source: US EPA

Carbon offset market has been around a long time



Data from annual "State of the Voluntary Carbon Markets Report", 2009-2021, published by Ecosystem Marketplace, a Forest Trends Initiative: www.Forest-trends.org

Current activity/prices

- California market: \$27-\$32/t CO₂ and \$18-\$20/t for offsets
- New Zealand market: \$50-\$55/t CO₂
- Voluntary market: \$10-\$15/t
 - Prices have risen as more companies have taken on net zero commitments and are testing the market.
- Aviation offsets ~ \$5/t
 - CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation) in pilot phase through 2023.
 - Relatively low prices probably dictated by the supply available.

Where are we going with carbon offsets?

- Recent reports by Bloomberg and others have suggested that offset markets could experience a large increase in prices, up to 3000%, if rules are set so stringently that land-based removal products are not included (e.g., avoided deforestation, afforestation, soil carbon).
- Concerns about *additionality*, *leakage*, and *permanence* in land-based options have been around for a long time, but the analysis suggest that these issues are easily handled.
- Globally, 4.9 billion tons CO₂/yr are available for <\$50 per ton in forest and agricultural offsets.
 - This more than doubles to 11.4 billion tons CO₂/yr at <\$100 per ton.
 - This amounts to 13%-29% of the total current emission from fossil fuels and 8.3%-20% of the total GHG emission.
 - A recent report on *Greenbiz* suggests that an increasing share of the world's CO₂ from fossil fuel consumption is covered by a net zero pledge (80%), although only some of this is regulatory.

Price expectations

- 1-5 year outlook: Modest price appreciation, with offsets rising to \$20 per ton.
 - Most net zero goals are 2030 and beyond.
 - One concern is that prices need to rise to invite new investments. At < \$20 per ton, the cheapest options are avoided deforestation, which is heavily driven by UN REDD+ programs.
- In the longer run, prices will rise 1-2% per year as more and more commitments are made and efforts undertaken.