

Energy In Transition

September 2021

Mark A. Buntz, Senior Vice President
Director, Alternative Investments



Energy In Transition

Agenda

- Background on Fossil Fuel
- US Climate Goals
- EIA Annual Energy Outlook 2021
- IRENA Energy Transition Outlook
- Financing the Energy Transition
- Barriers to An Energy Transition
- Summary

Background – Fossil Fuels Dominance

Fossil fuels – Building the Dependency

- Density of energy was a siren song.
- The world began its dependency with coal in the 1700s.
- Oil became the dominant source with the 1859 discovery in Pennsylvania.
- For the next 160 years, demand for cheap, dense energy grew.
- The pandemic created a unique decline in carbon due to declining fossil fuel emissions.
- Fossil fuel demand is expected to fully recover by 2024-2025.

Background – Climate is the Focus

Addressing the Global Climate Crisis

- Governments have been making the case for alternatives since the 1970s.
- Since 1975, fossil fuels for electricity generation has fallen from 95% of production to 85% in 2020.
- Changes are slow and the amount of financial resources needed is high.
- The IEA expects fossil fuel reliance to decline more rapidly than it has in the past 45 years.
- Renewables have a cost of capital advantage.

In spite of the new technologies, the IEA is still projecting that 70-75% of the primary global energy consumption may be met through fossil fuels in the year 2040.

Background – Alternative Energy

Wind and Solar

- Wind and solar have become cost competitive.
- Wind and solar need storage to scale in electricity generation.
- Transmission capacity remains a barrier to broader adoption.

Battery electric vehicles(BEV)

- BEVs are gaining market share from traditional vehicles, particularly in China.
- Norway has banned the sale of new internal combustion engine (ICE) vehicles by 2025.
- China and California have both banned the sale of ICE vehicles by 2035.
- Barriers to adoption include cost, range anxiety and the age of the ICE vehicles in existence today.

U.S. Climate Goals

- The US has established aggressive goals, targeting cutting greenhouse gas emissions by 2030 compared to 2005.
- This goal represents a 50% reduction over the next 9 years, four times faster than what has occurred over the previous 15 years.
- The most ambitious goals are to reduce carbon emissions to zero by 2050.

Needless to say, there is a substantial amount of uncertainty regarding the achievability of these goals.

EIA 2021 Energy Outlook – Base Case Assumptions

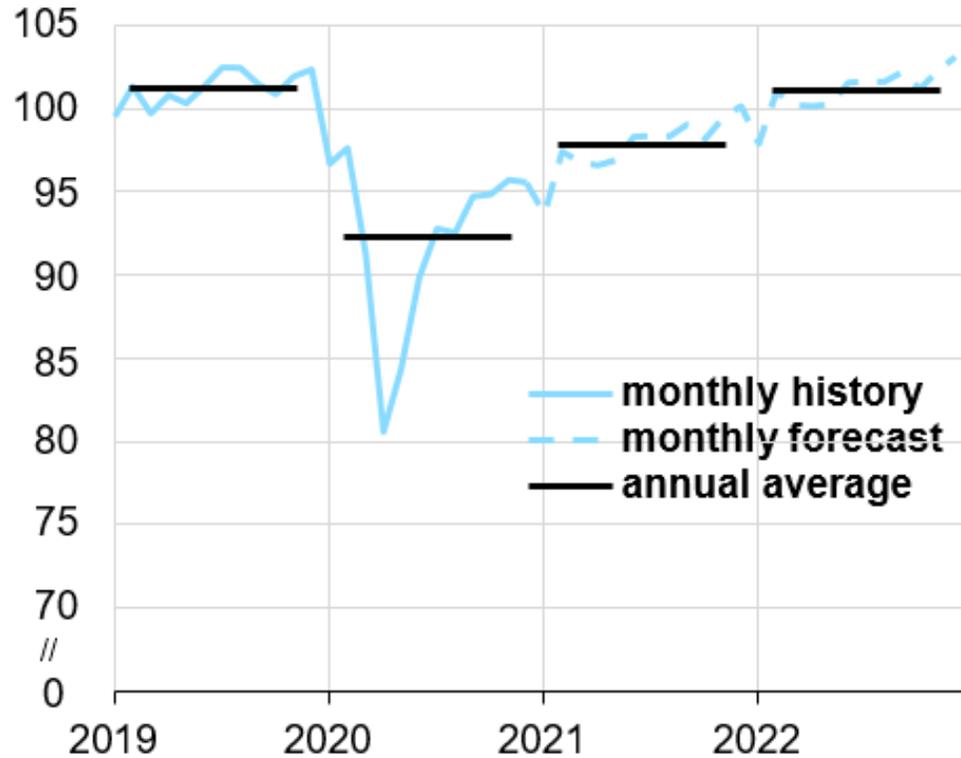
Fossil energy use does not fall despite the growth of alternative energy sources.

- Energy consumption in aviation grows through 2030.
- Industrial output is expected to grow faster than GDP.
- Energy efficiencies related to ground transportation level off in 2026 – 2027.
- Renewable power generation will largely displace coal.
- The industrial sector increases consumption of natural gas.
- Emissions decrease from 2023 to 2035 as the transition occurs away from coal.
- After 2035, emissions rise from 2035 levels due to increasing population and economic growth.

EIA Forecast – Oil Markets

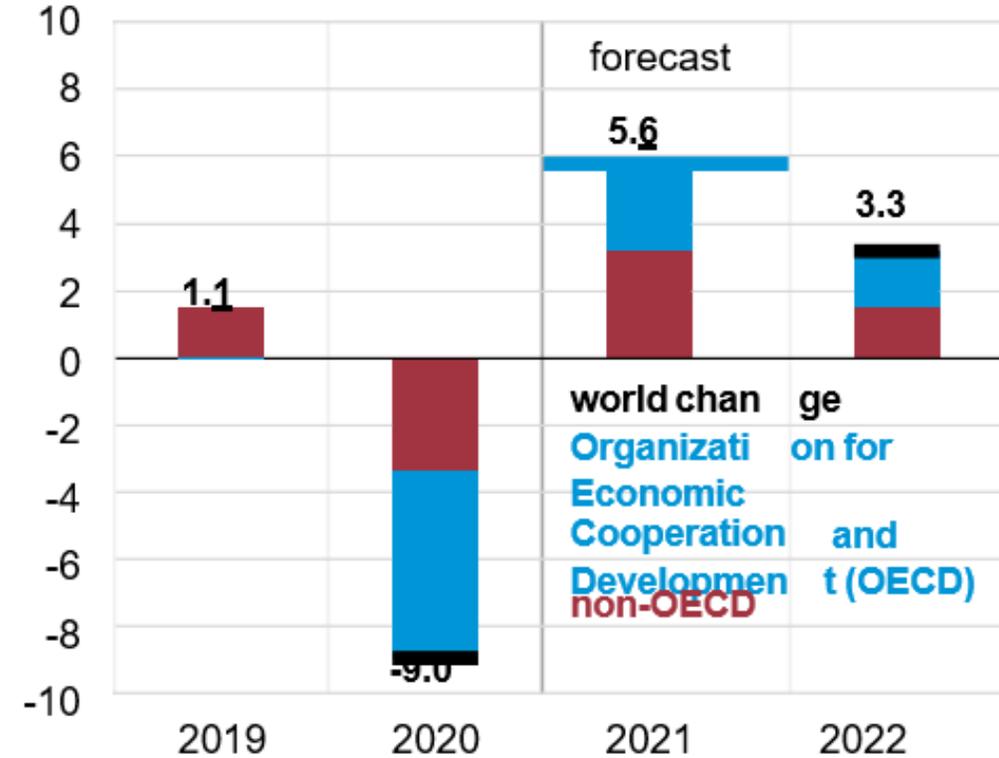
World liquid fuels consumption

million barrels per day



Components of annual change

million barrels per day



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

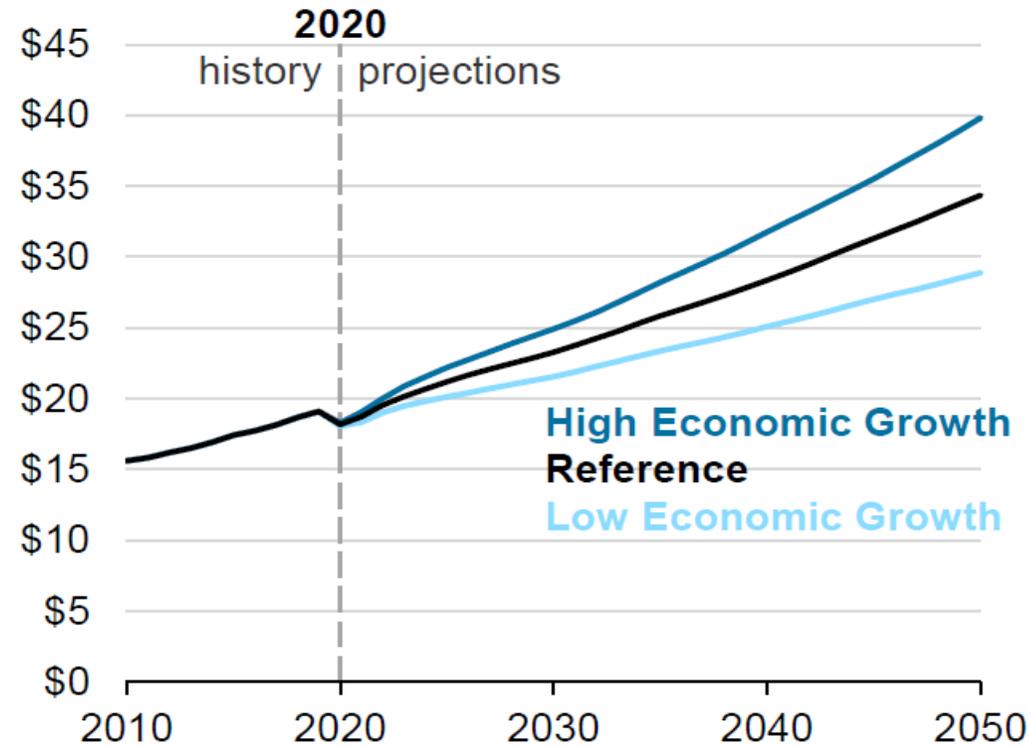
After the COVID shock, world oil demand returns to new highs by 2024.

EIA Forecast – GDP Growth and Energy Demand

U.S. gross domestic product assumptions

AEO2021 economic growth cases

trillion 2012 dollars

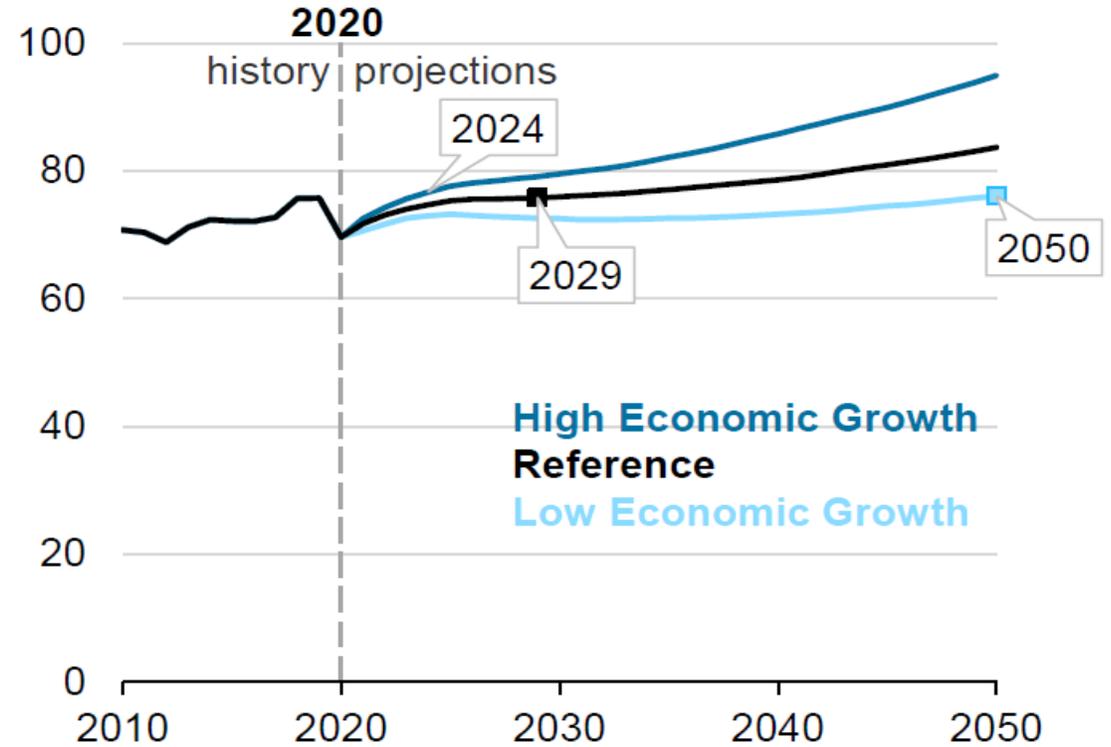


Source: Energy Information Agency 2021

U.S. delivered energy across end-use sectors

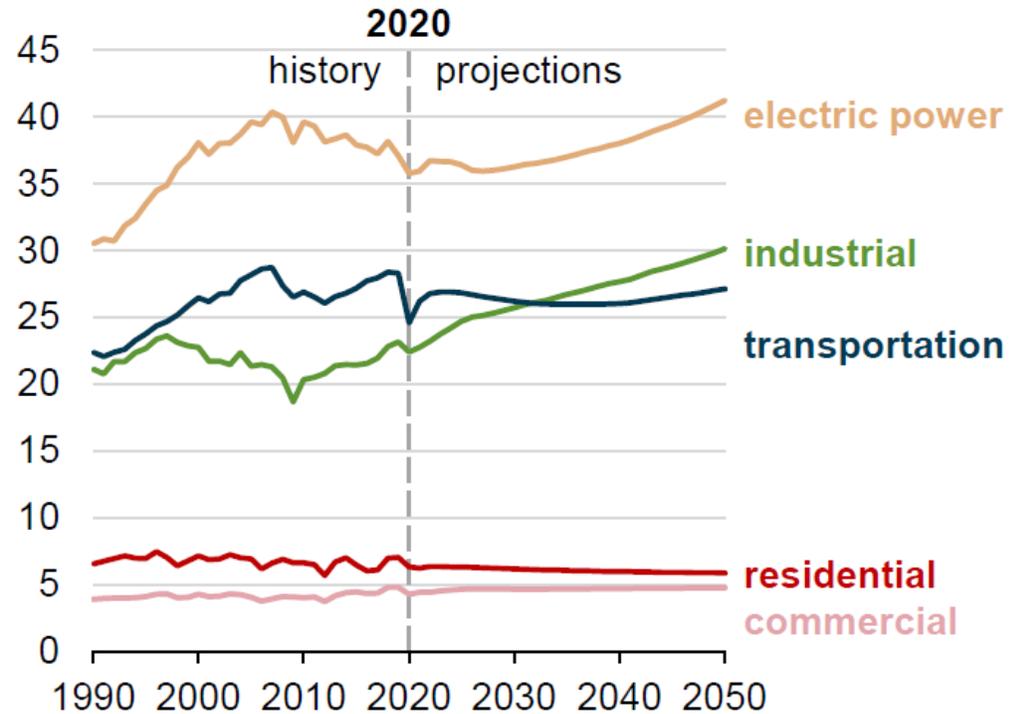
AEO2021 economic growth cases

quadrillion British thermal units



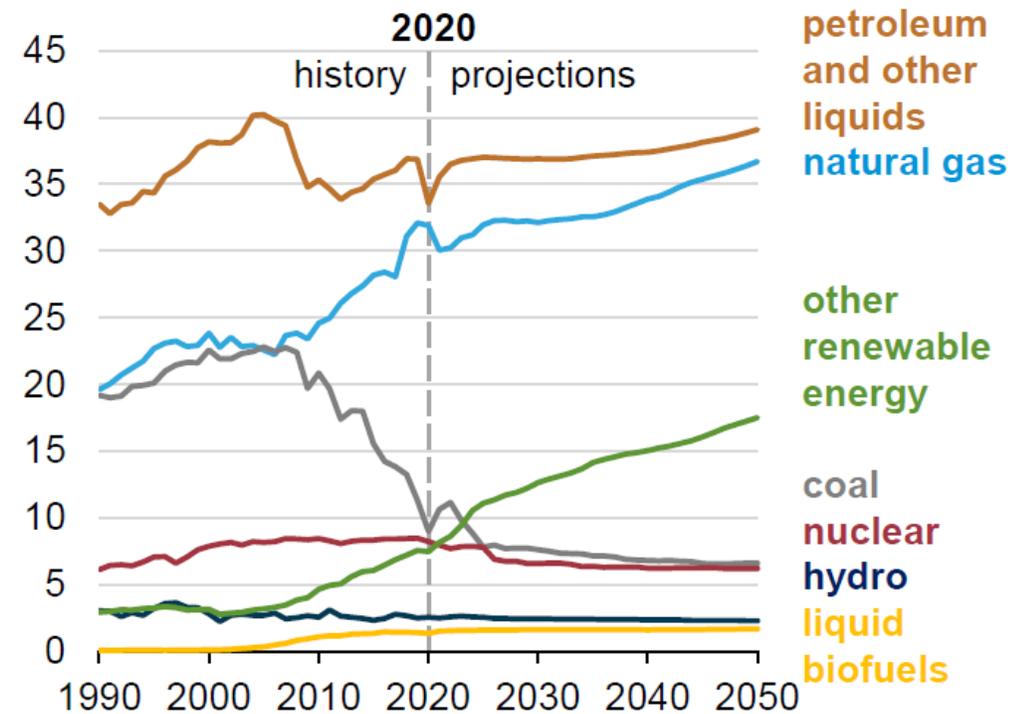
EIA Forecast - Energy Consumption By Fuel

U.S. energy consumption by sector
AEO2021 Reference case
quadrillion British thermal units



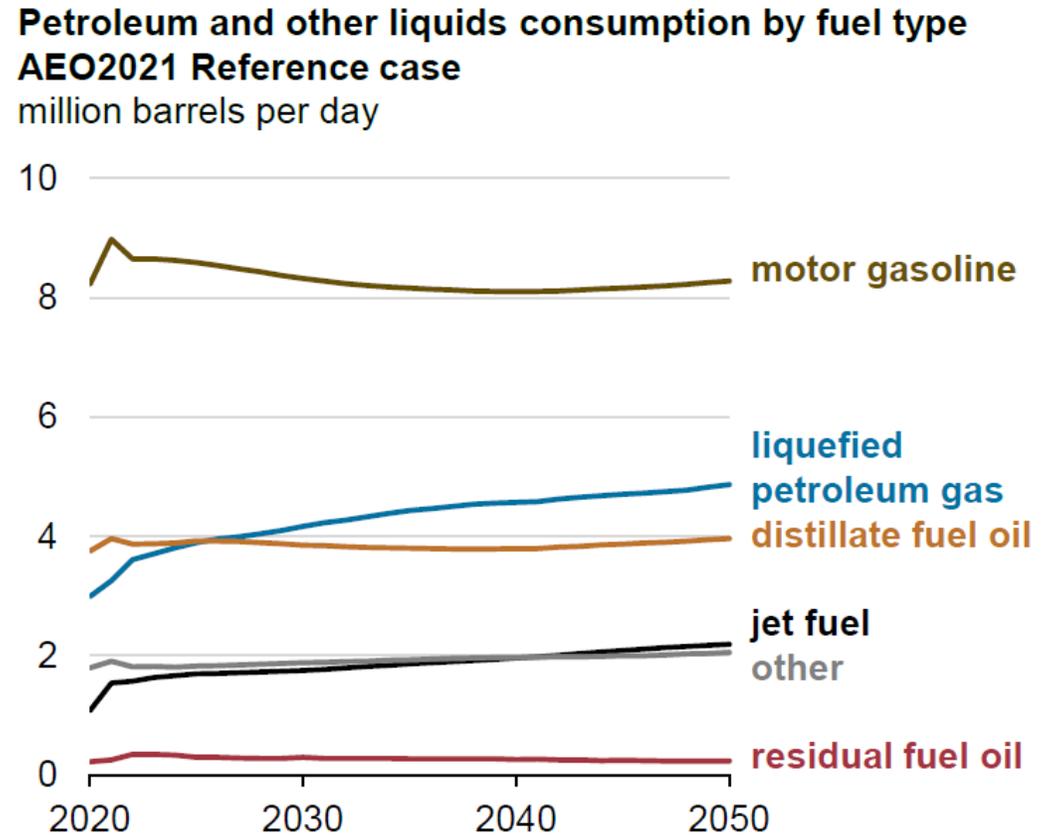
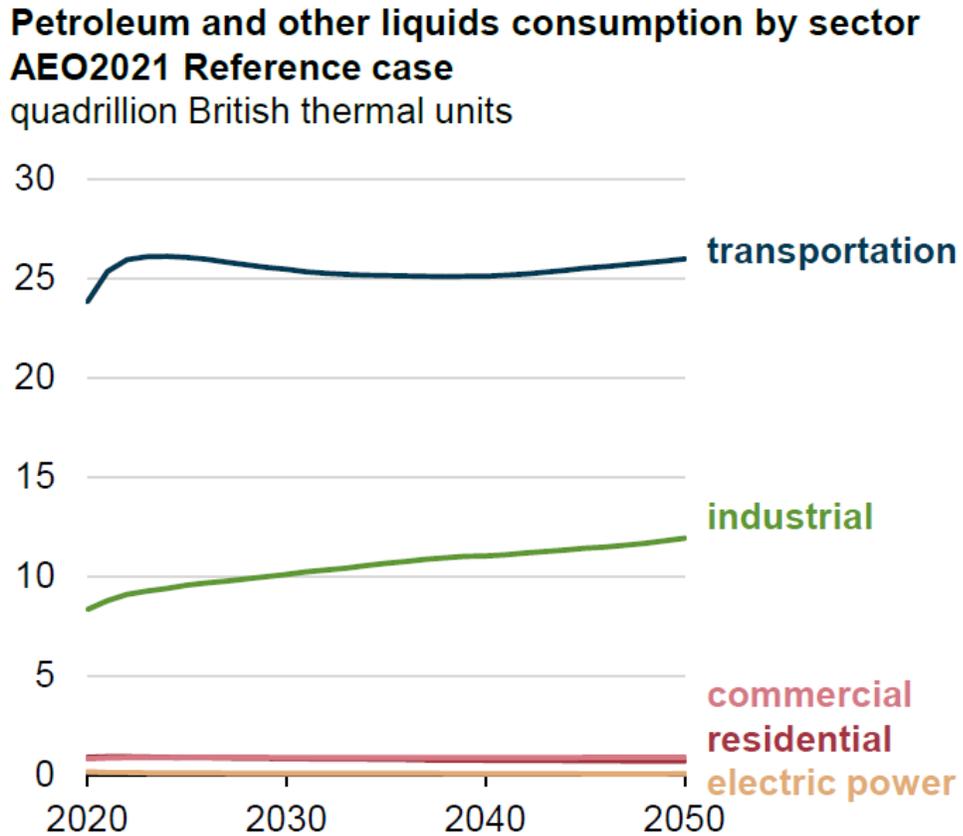
Source: Energy Information Agency 2021

U.S. energy consumption by fuel
AEO2021 Reference case
quadrillion British thermal units



- In spite of growth in renewables, this sector is still only ~18% of total energy consumption by 2050

EIA Forecast – Oil Demand



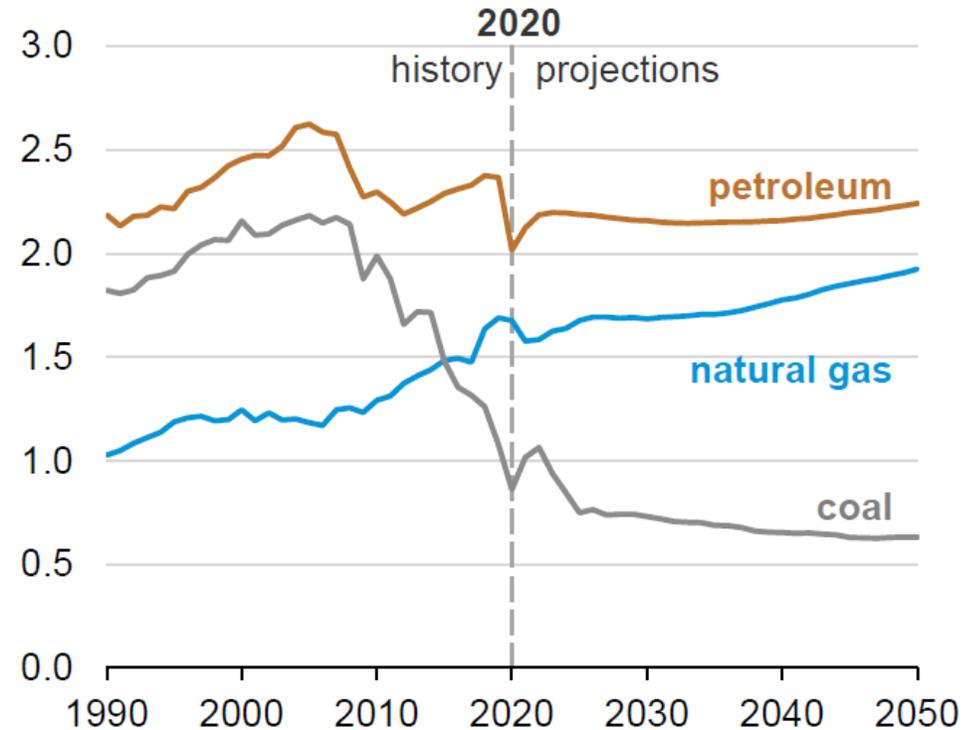
Source: Energy Information Agency 2021

Petroleum consumption growth occurs in the industrial sector use of liquefied petroleum gas

EIA Forecast – Emissions from Fossil Fuels

U.S. energy-related carbon dioxide emissions by fuel
AEO2021 Reference case

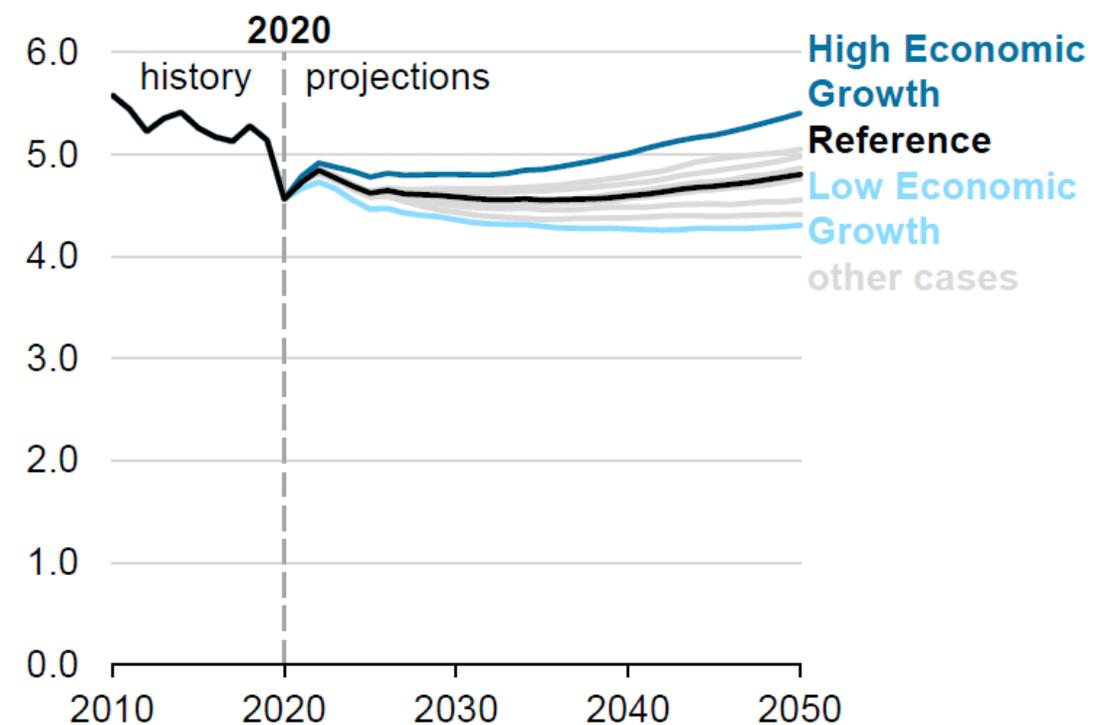
billion metric tons



Source: Energy Information Agency 2021

U.S. energy-related carbon dioxide emissions
AEO2021 economic growth cases

billion metric tons



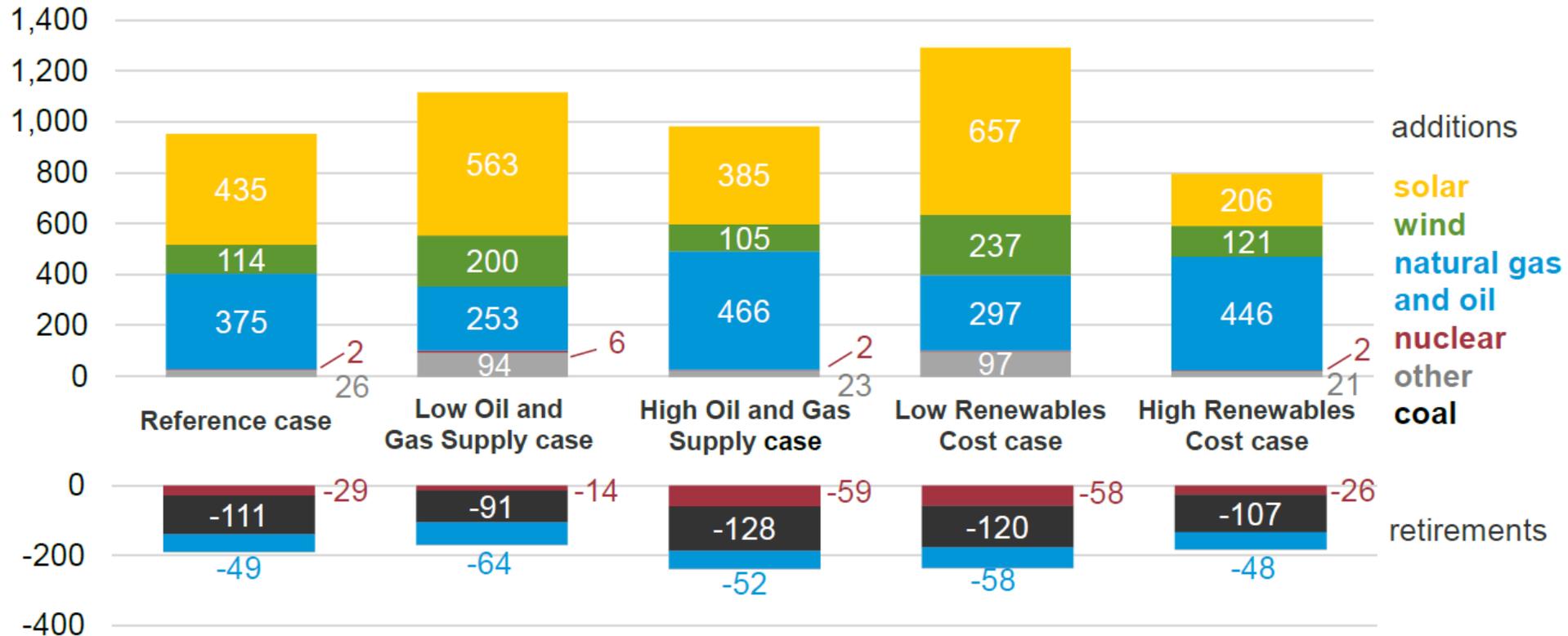
U.S. energy-related CO₂ emissions continue to decrease near term, but they start rising after 2035

EIA Forecast – Electricity Generation New Additions

Cumulative electricity generating capacity additions and retirements (2021–2050)

AEO2021 selected cases

gigawatts

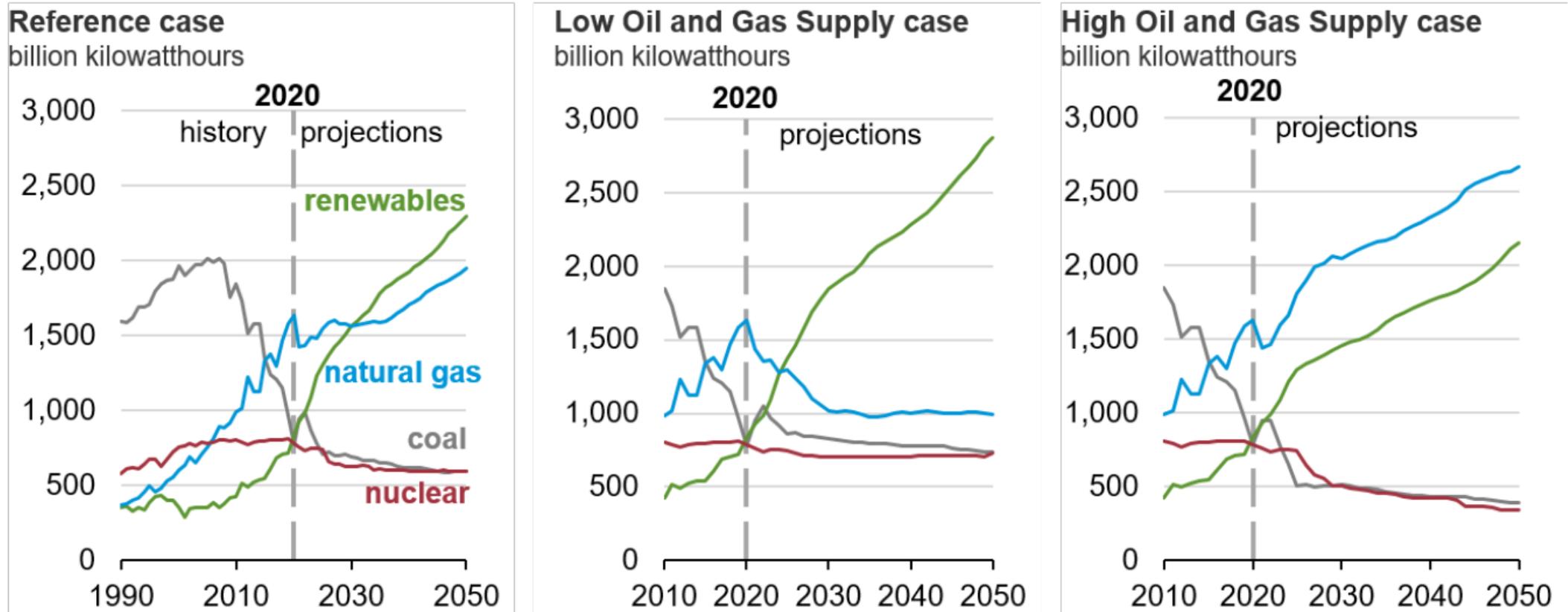


Source: Energy Information Agency 2021

Additions come primarily from solar, wind, and natural gas

EIA Forecast – Electricity Generation by Source

U.S. electricity generation, AEO2021 oil and gas supply cases



Source: Energy Information Agency 2021

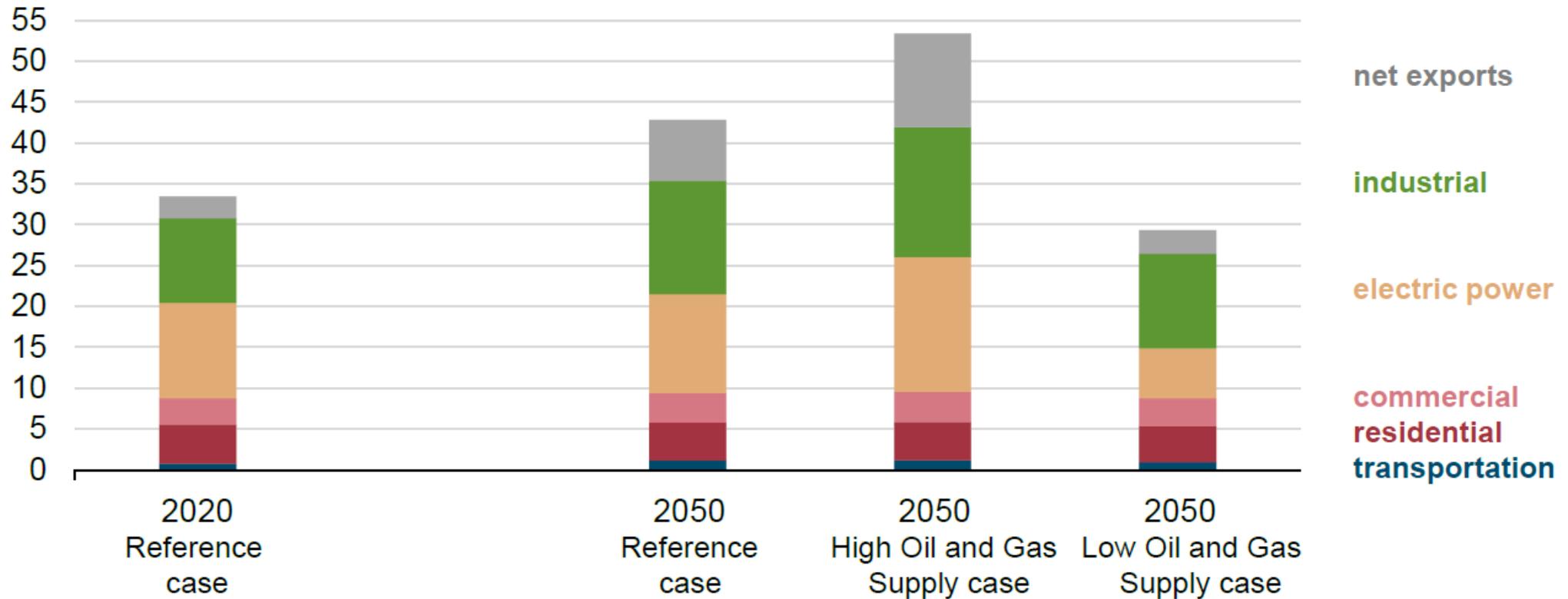
Natural gas prices influence competition with renewables

EIA Forecast – Natural Gas Demand

U.S. natural gas consumption by sector and net exports, 2020 and 2050

AEO2021 selected cases

trillion cubic feet

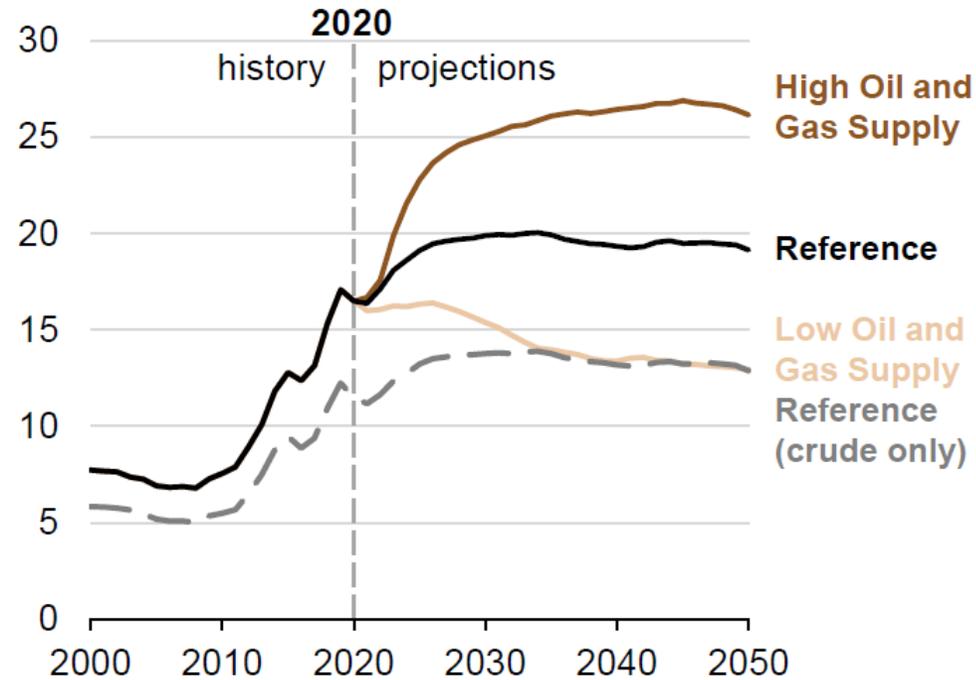


Source: Energy Information Agency 2021

Under most scenarios, natural gas production grows through 2050

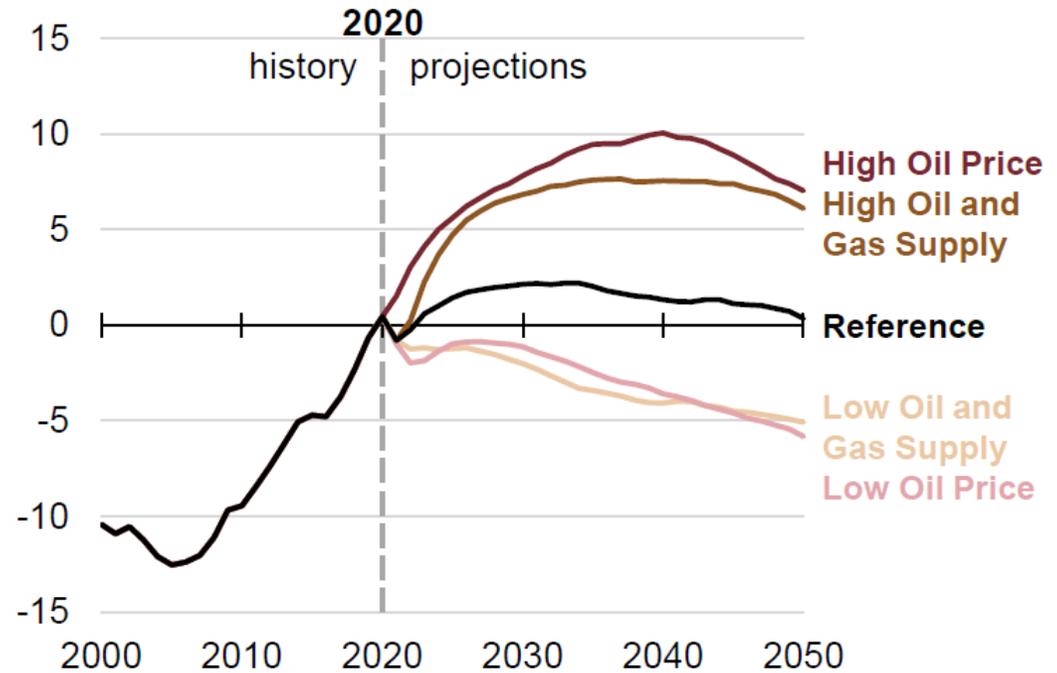
EIA Forecast - Expected U.S. Oil and Gas Production

U.S. crude oil and natural gas plant liquids production
AEO2021 oil and gas supply cases
 million barrels per day



Source: Energy Information Agency 2021

U.S. petroleum and other liquids net exports
AEO2021 oil and gas supply and price side cases
 million barrels per day



- In all cases, the United States continues to be a globally significant producer of crude oil and refined liquids
- U.S. is expected to be global exporter of oil and gas

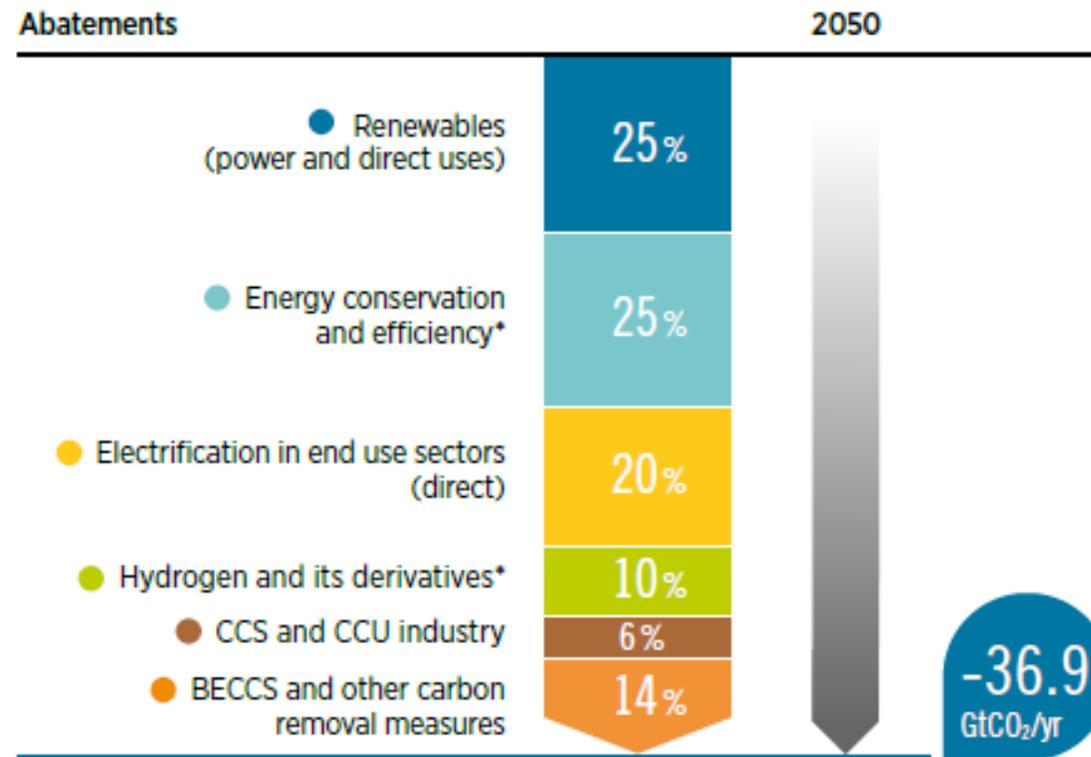
International Renewable Energy Agency Outlook - 1.5°C Pathway

- The International Renewable Energy Agency (IRENA) in cooperation with IEA has developed a framework to avoid a worldwide increase in temperature of 1.5°C by 2050.
- IRENA maintains global greenhouse gas emissions must be reduced by 45% from the 2010 levels by 2030.
- IRENA believes that recent trends show that the achievement gap is widening.
- IRENA's World Energy Transitions Outlook outlines the avenues to take to avoid the impact of a 1.5°C increase in temperature.
 - Included in the following pages are some of the slides from this recent study.

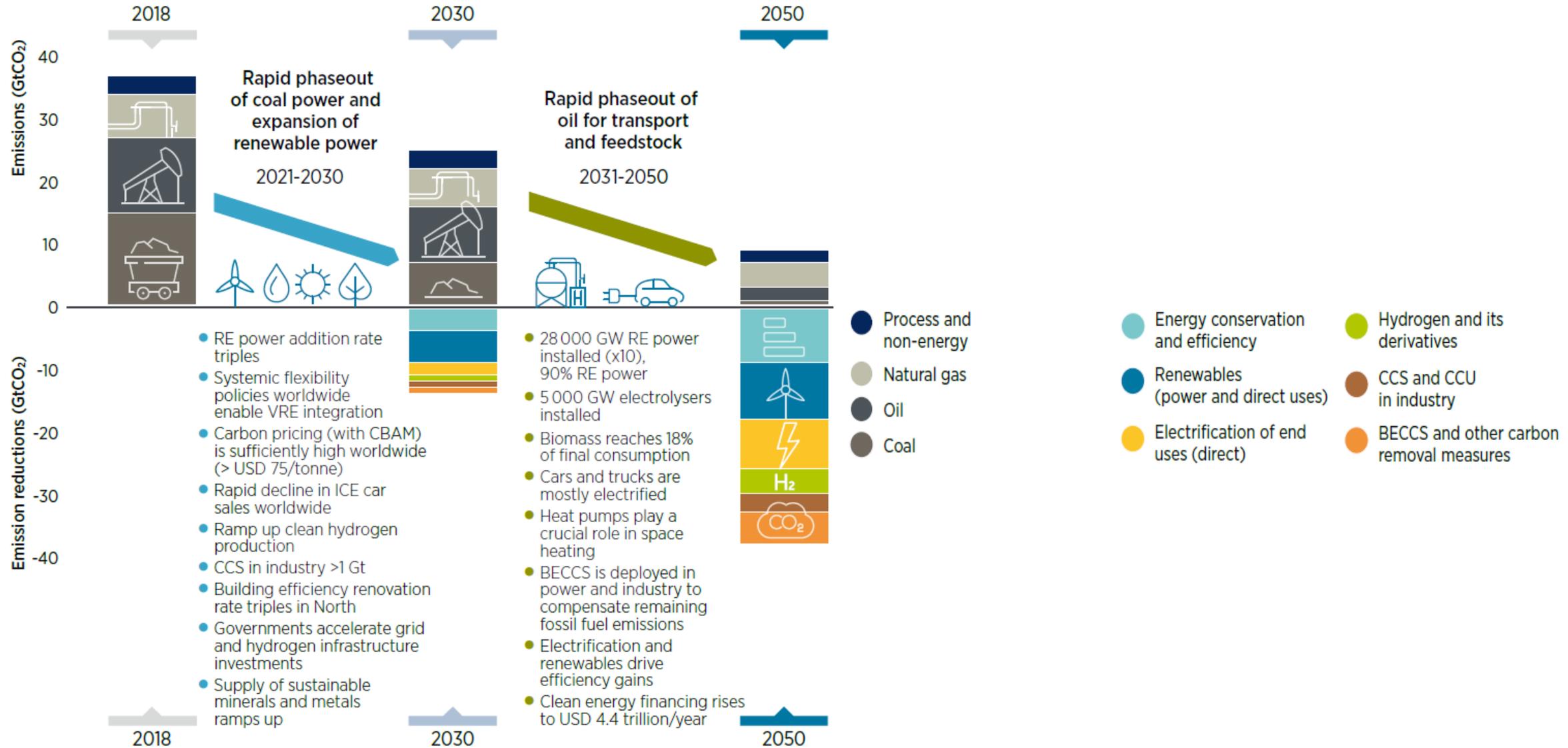
IRENA - Technological Avenues to Climate Targets

IRENA's analysis shows that over 90% of the solutions for 2050 targets involve renewable energy through direct supply, electrification, energy efficiency, hydrogen and bioenergy combined with carbon capture.

Targeted policies are required to make the transition swiftly enough to meet the 1.5°C goal.



IRENA - Evolution of Emissions with Phase Outs of Coal and Oil



IRENA - Key Assumptions for the 1.5°C Pathway

Scenarios are as follows:

- By 2050, electricity will be the main energy carrier, increasing from a 21% to 50% share.
- Renewable technologies will see an eight-fold increase
- The annual energy intensity improvement rate needs to rise to 2.9% from sub-1.5%.
- Hydrogen and derivatives will account for 12% of final energy use by 2050.
- Bioenergy will represent 18% of total final energy consumption in 2050.
- For fossil fuels, decarbonization efforts will require CCS and Co2 removal technologies.
- The above goals will require substantial financial resources worldwide to be achieved.

Barriers to Energy Transition - Costs

- The IRENA report is a roadmap to preventing an increase in global temperatures of 1.5°C by 2050.
- The financing costs of the global energy transition are set forth below:
 - \$131 trillion USD needed globally by 2050 to avoid 1.5°C increase.
 - Current government strategies already anticipate significant investment in energy amounting to \$98 trillion USD by 2050.
 - However, \$24 trillion USD will have to be redirected from fossil fuel to new technologies between now and 2050.
- Public funding will need to grow two-fold to energize private finance and ensure implementation of the energy transition

Barriers To An Energy Transition – National Self-Interest

According to the United Nations Intergovernmental Panel of Climate Change, the world must cut carbon dioxide emissions to net zero by 2050 in order to prevent global warming of 1.5°C or likely more.

So why is more not being done (per a recent Brookings Institute op-ed)

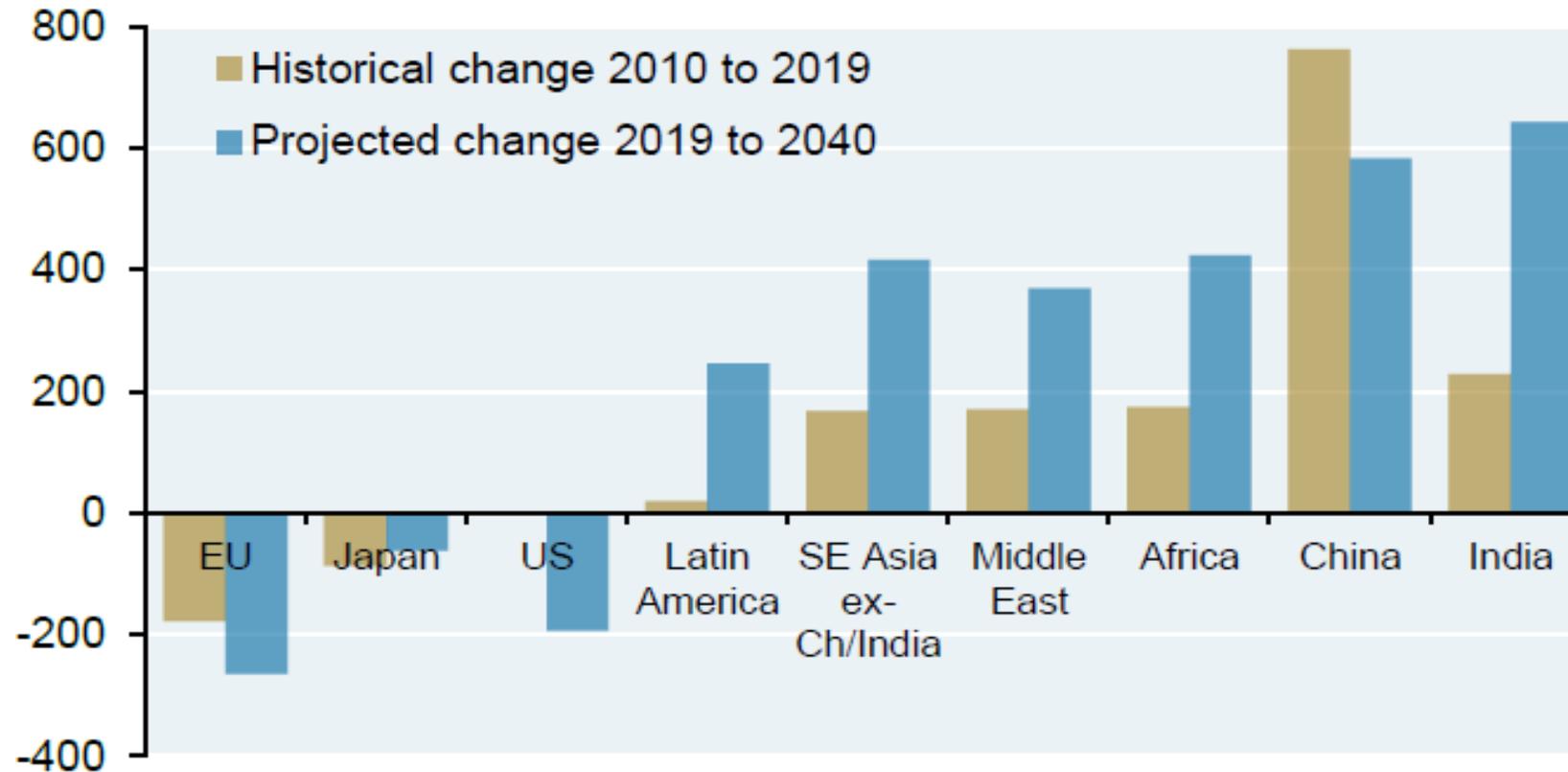
- When advocating policies that result in aggregate welfare gains, economists often fail to give enough consideration to their likely distributional impact.
- Instead, they often implicitly assume that the winners will compensate the losers.
- But if such compensation does not actually occur, the losers are left worse off and can often block change.
- This imbalance of consequences makes coordination around the world difficult.
- Another issue is that there are many who believe that global warming may not be occurring at all.

The following slides are some examples that demonstrate the points made above.

Barriers to Energy Transition – Emerging Markets Need Cheap Energy

Change in primary energy use, past and future

Million tonnes of oil equivalent



Source: International Energy Agency Stated Policies Scenario. 2020.

Barriers to Energy Transition - U.S. Personal Vehicle Fleet

Average age of US light vehicles in operation

Years



Source: US Bureau of Transportation Statistics, IHS Markit. 2020.

It takes a LONG time to replace the vehicle fleet.

Barriers to Energy Transition – China

China finances more than 70% of all coal plants built today, according to a Quartz analysis of data from Refinitiv Eikon. South Korea and Japan have backed away from the projects.



Chart: The Conversation/CC-BY-2.0 • Source: [Quartz](#) • [Get the data](#)

Barriers to Energy Transition – China drive Emissions

In 2019, the world's six largest carbon dioxide emitters together accounted for 51% of the global population and 67% of total CO2 emissions from fossil fuels.

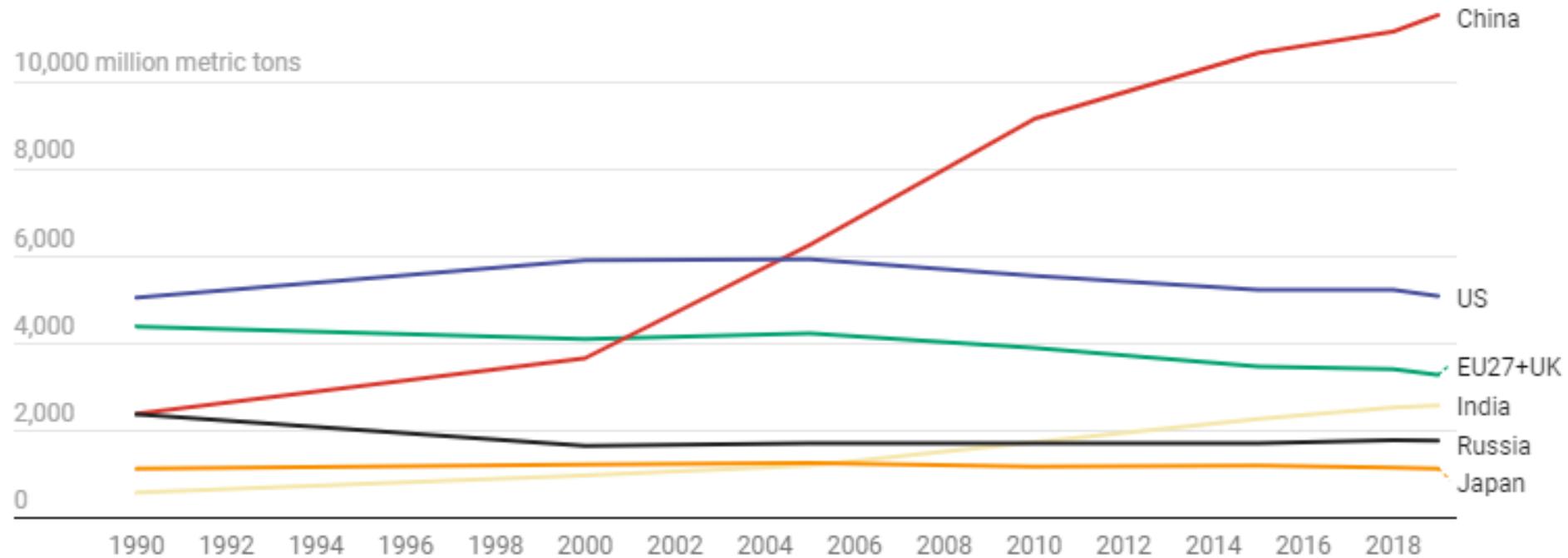


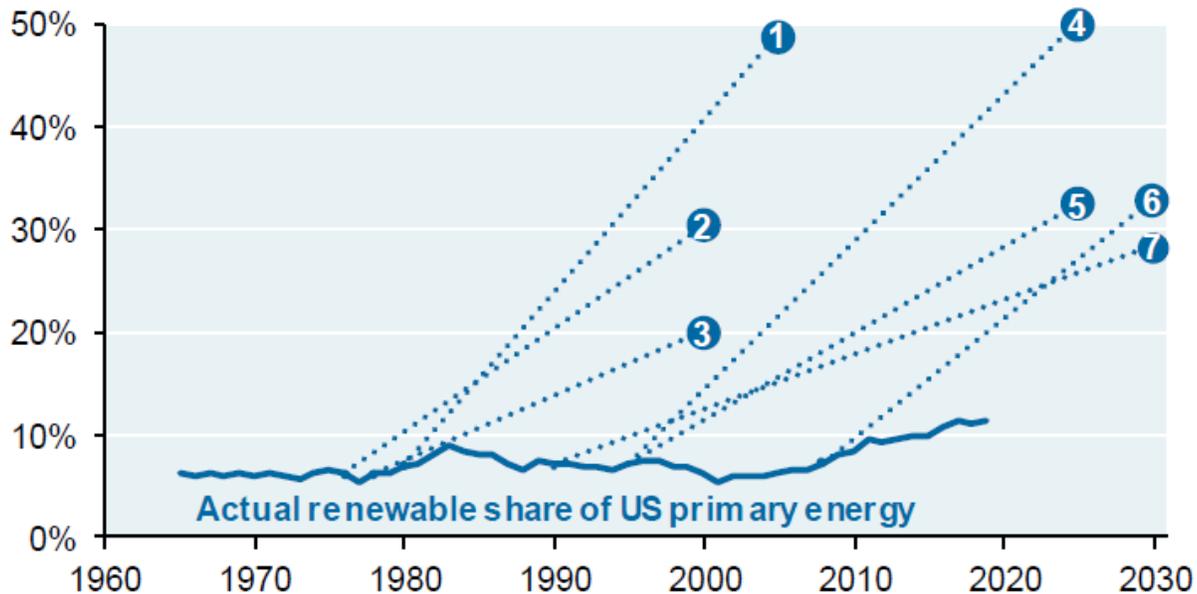
Chart: The Conversation/CC-BY-ND • Source: [European Commission](#) • [Get the data](#)

Barriers to Energy Transition – Prior Energy Transition Failures

Overly ambitious forecasts of the 4th great energy transition

Renewable share of US primary energy consumption

Lines start when forecasts were made and end in year of forecast



Source: EIA, listed authors, Vaclav Smil, JPMAM. 2019. Renewables include wind, solar, hydropower, geothermal, biomass, wood and waste.

- ① Physicist Bent Sorensen
- ② Amory Lovins, Rocky Mountain Institute
- ③ Carter Administration (solar only)
- ④ Clinton Presidential Advisory Panel
- ⑤ Intergovernmental Panel on Climate Change
- ⑥ Google 2030 Clean Energy Plan
- ⑦ National Renewable Energy Laboratory

In 2020, Mark Jacobson (Stanford) forecast 80% by 2030

- Energy transitions which have occurred over the last 50 years or so have fallen well short of the original expectations

Summary

- Dramatic divergence between EIA and IRENA assumptions.
- The recent IRENA study shows the world is woefully short of a 1.5°C goal.
- In spite of the Paris Agreement, CO2 emissions increased by 1.3% annually between 2014 and 2019.
- Without broad global cooperation, changes to energy production will be incremental.
- A binding international agreement may be required to achieve IRENA goals.
- The costs to implement a global energy transition are enormous.
- The history of energy transitions as well as recent assessments indicate this current transition may take longer than expected.

DISCLOSURES

BOK Financial Corporation (BOKF) offers wealth management and trust services through various affiliate companies and non-bank subsidiaries including advisory services offered by BOKF, NA and its subsidiaries BOK Financial Asset Management, Inc. and Cavanal Hill Investment Management, Inc. each an SEC registered investment advisor. BOKF offers additional investment services and products through its subsidiary, BOK Financial Securities, a broker/dealer, member FINRA/SIPC, and an SEC registered investment adviser and BOK Private Wealth, Inc., also a SEC registered investment adviser. **Investments are not insured by FDIC and are not guaranteed by BOKF, NA or any of its affiliates. Investment are subject to risks, including the possible loss of principal amount invested.** Alternative investments carry significant risk and require investors to meet certain eligibility requirements. Clients should discuss their tolerance for risks associated with these types of strategies with their advisor before committing to any investment. Clients should also carefully review offering documents associated with their investments in order to fully understand the risks associated with each individual product.

© 2021 BOK Financial Corporation. Services provided by BOKF, NA. Member FDIC. BOKF, NA is the banking subsidiary of BOK Financial Corporation.