Balancing Energy Security, Affordability and Decarbonization

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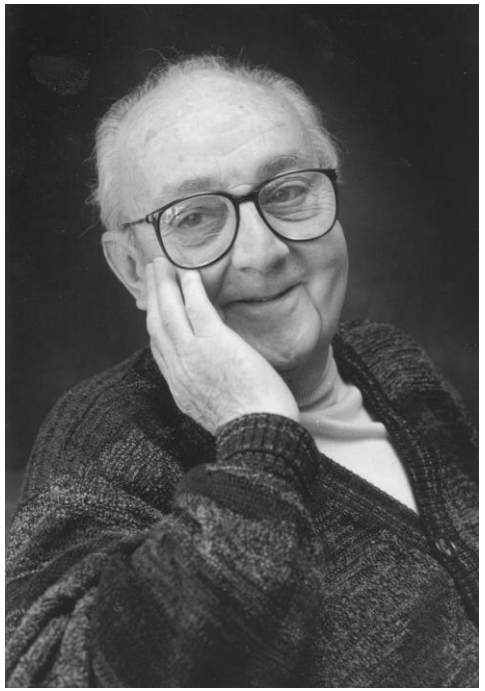
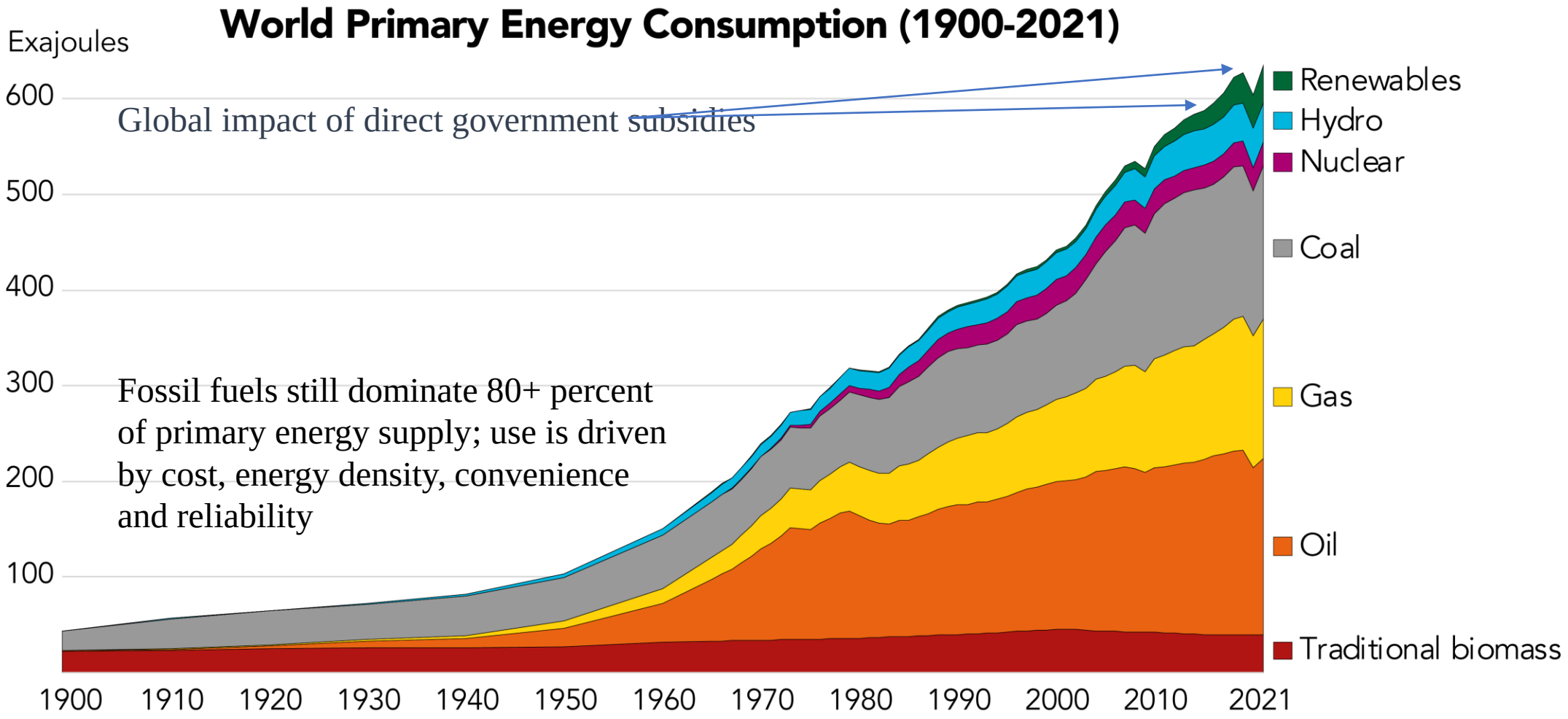
"All Models are Wrong, but Some are Useful"

George G.P. Box
British Statistician, 1919-2013



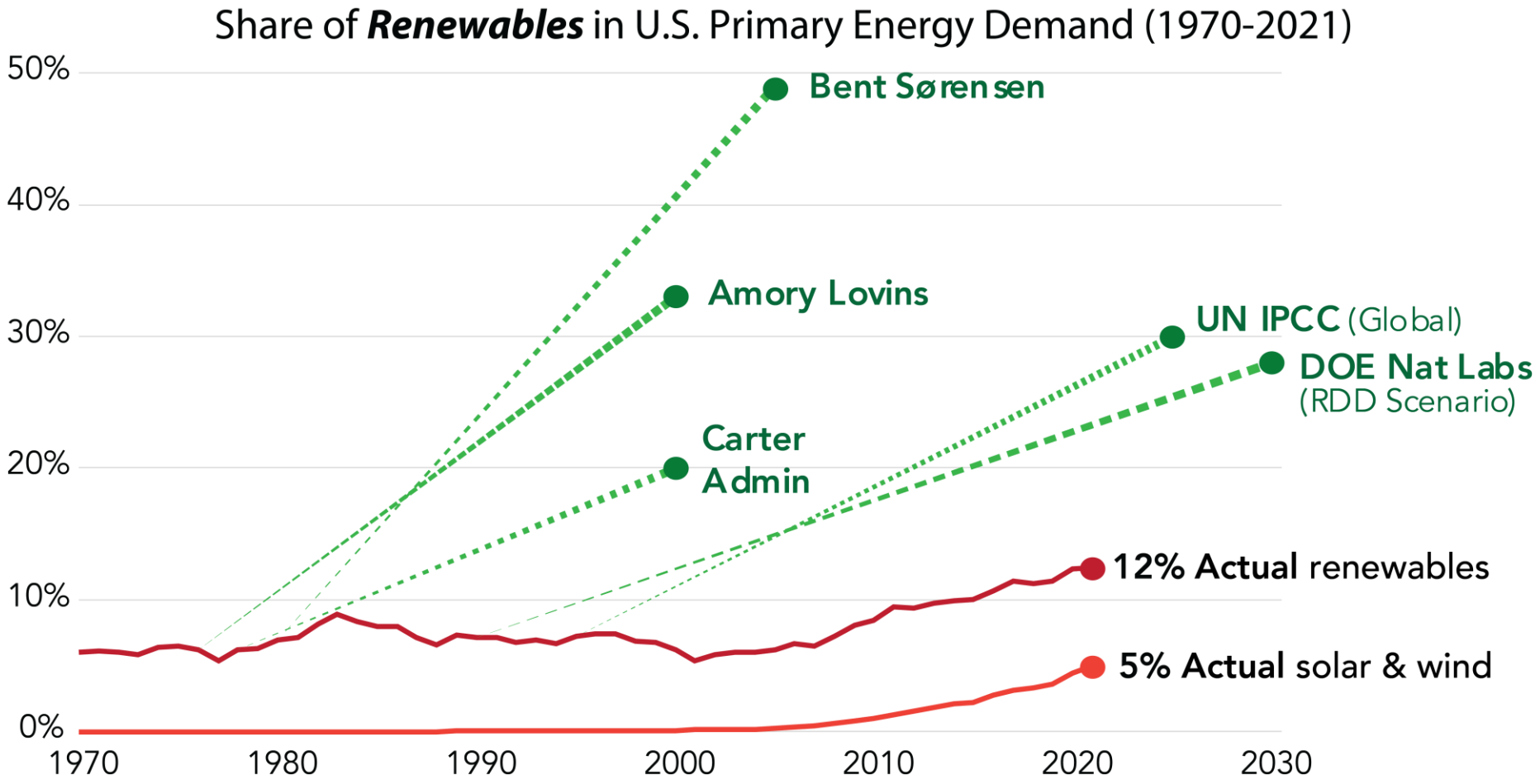
….Or Exactly How Hard is Net Zero When Balancing Energy Security, Affordability and Decarbonization?

Energy Transition is Hard & Rare



Source: Energy Policy Research, Vaclav Smil, BP

Ambition vs. Reality

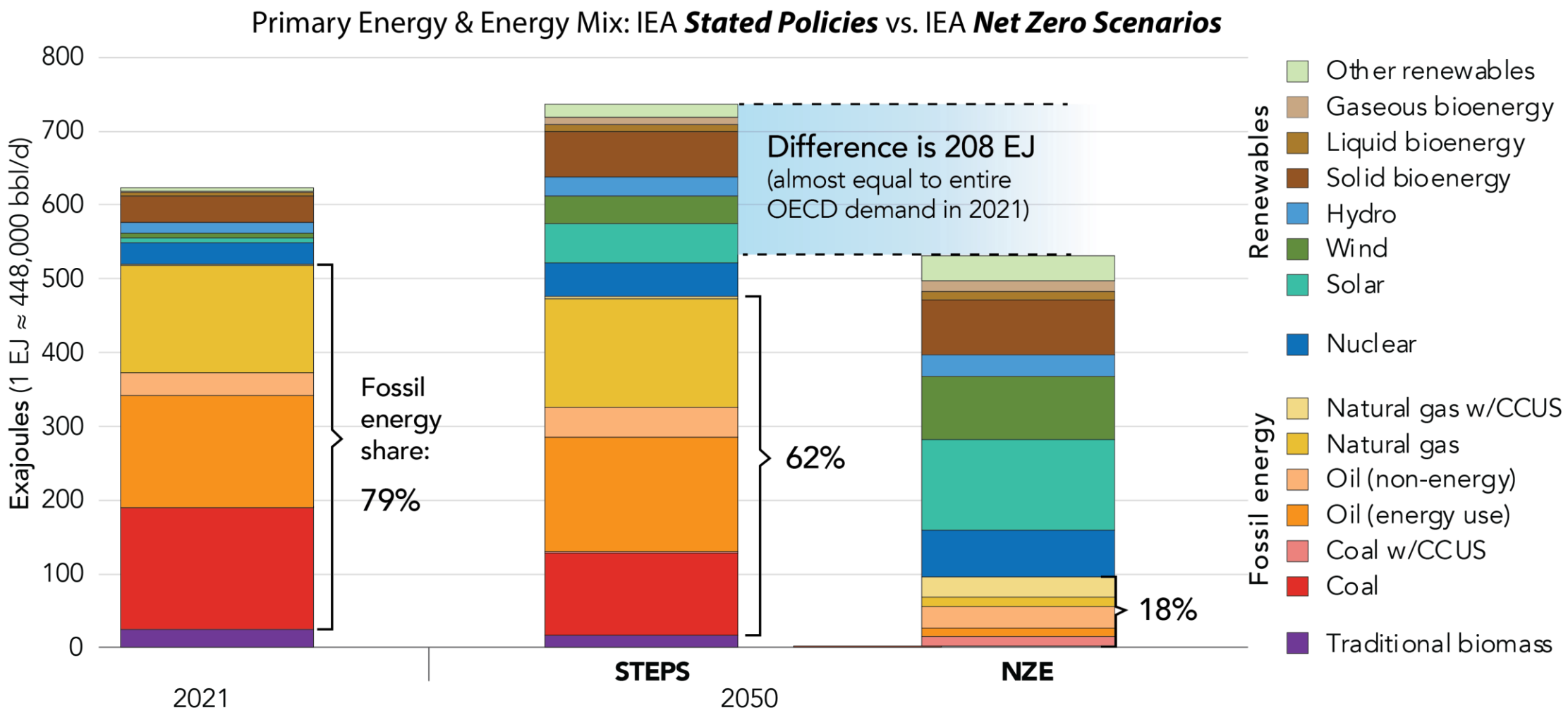


Sources: Vaclav Smil (original chart from *JPMorgan 2021 Annual Energy Paper)*; Amory Lovins, "Energy Strategy: The Road Not Taken?" (1976); "President Jimmy Carter's Remarks at White House Solar Panel Dedication Ceremony, 1979"; DOE, *The Potential of Renewable Energy: An Interlaboratory White Paper* (1990); *IPCC Second Assessment: Climate Change 1995.*
Note: Renewables include wind, solar, hydropower, geothermal, biomass.

Worldwide experience is similar:

According to Bloomberg NEF,
direct government subsidies and payments for wind, solar and other modern renewable fuels amounted to $5 trillion over the last 20 years. It has yielded a total contribution to worldwide primary energy demand of approximately 5%.

Net Zero Goals: Ambition or Delusion?



Source: EPRINC figures & calculations based on IEA World Energy Outlook 2022

Net Zero Requires Wide Range of Measures

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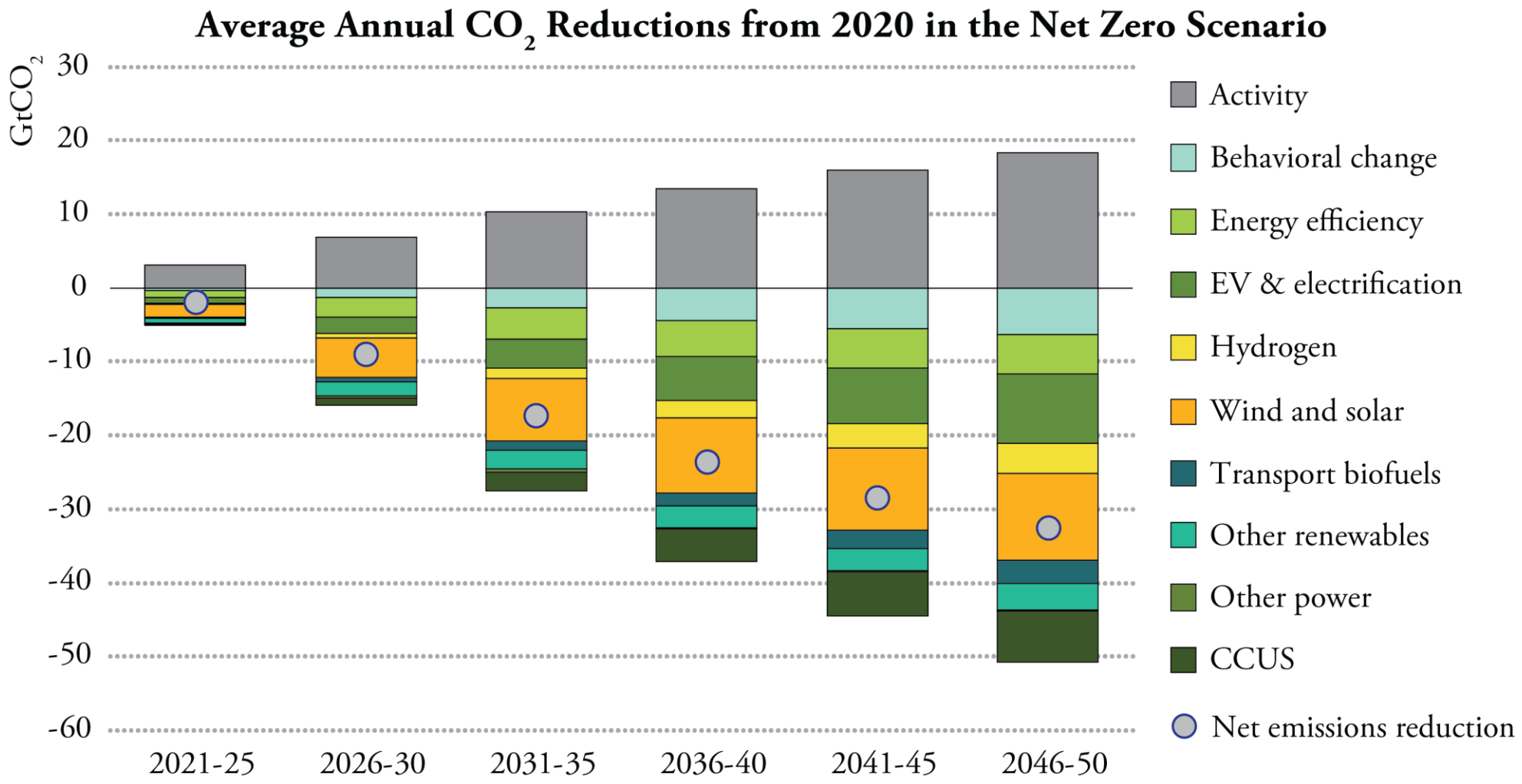
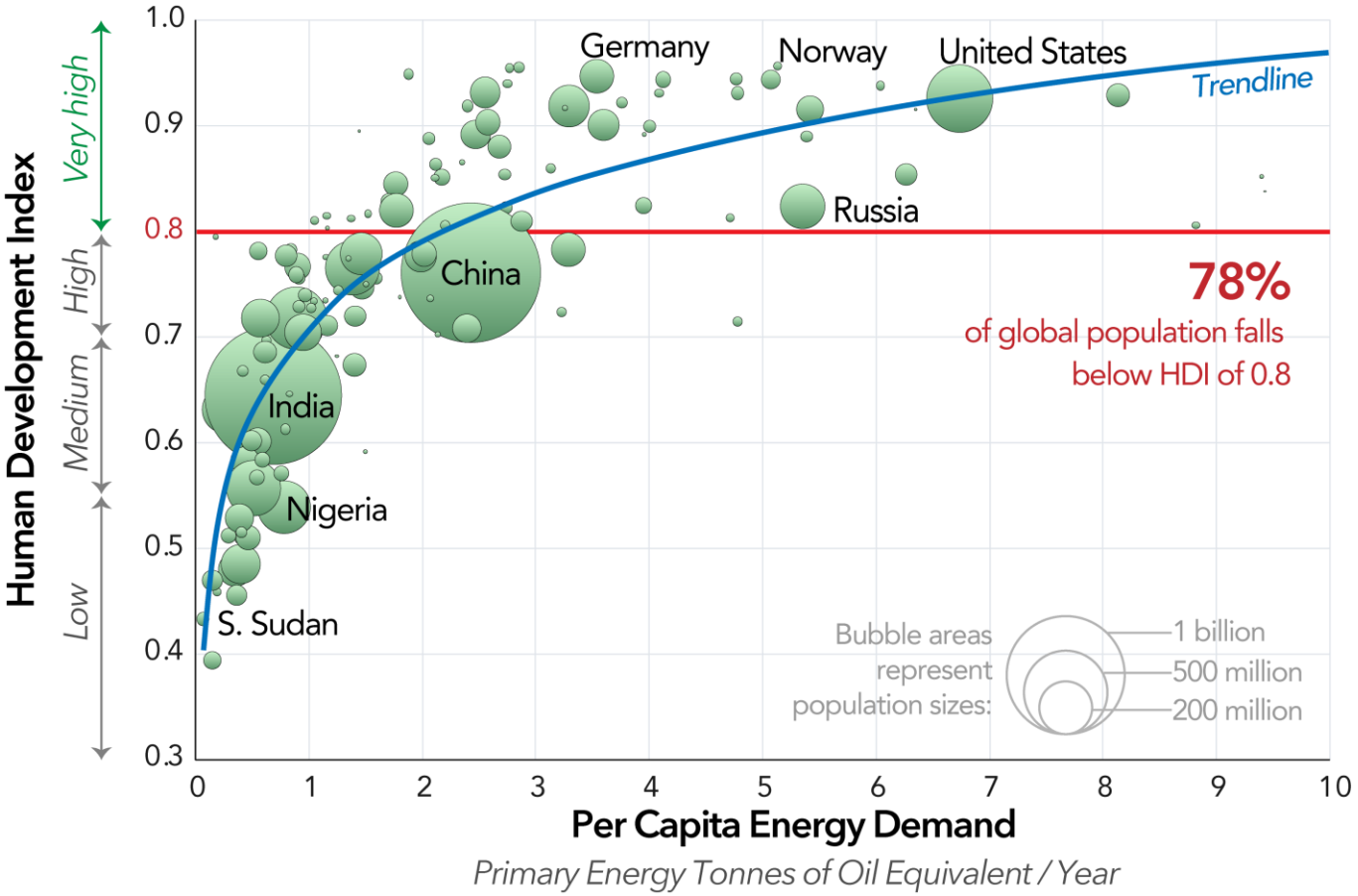


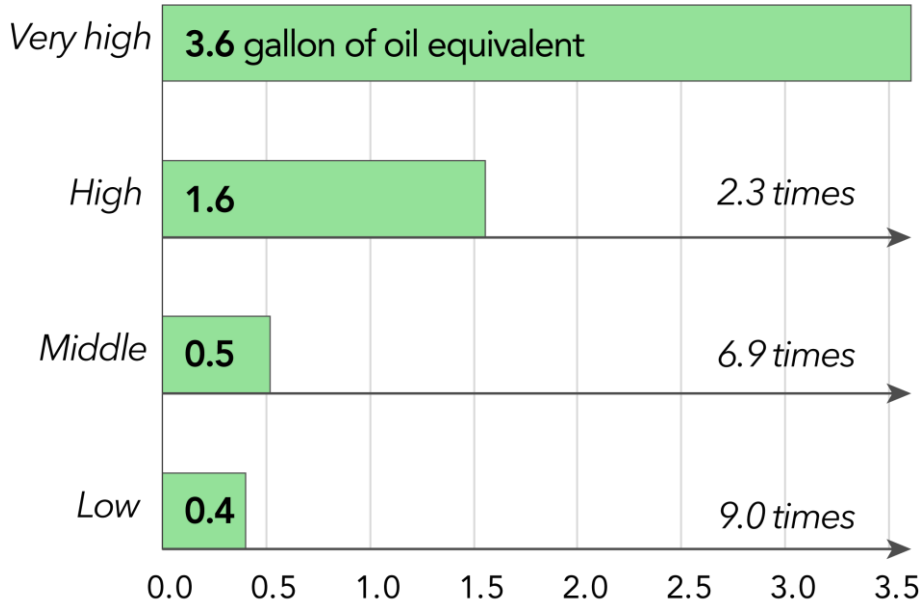
Source: IEA, *Net Zero by 2050 (2021)*.

Energy Supply and Human Development Index

Per Capita Energy Demand and Human Development Index (2019)



Daily per Capita Energy Demand by Human Development Index (2019)



Source: Energy Policy Research

Non-OECD: Energy Must Grow to Meet Economic Progress

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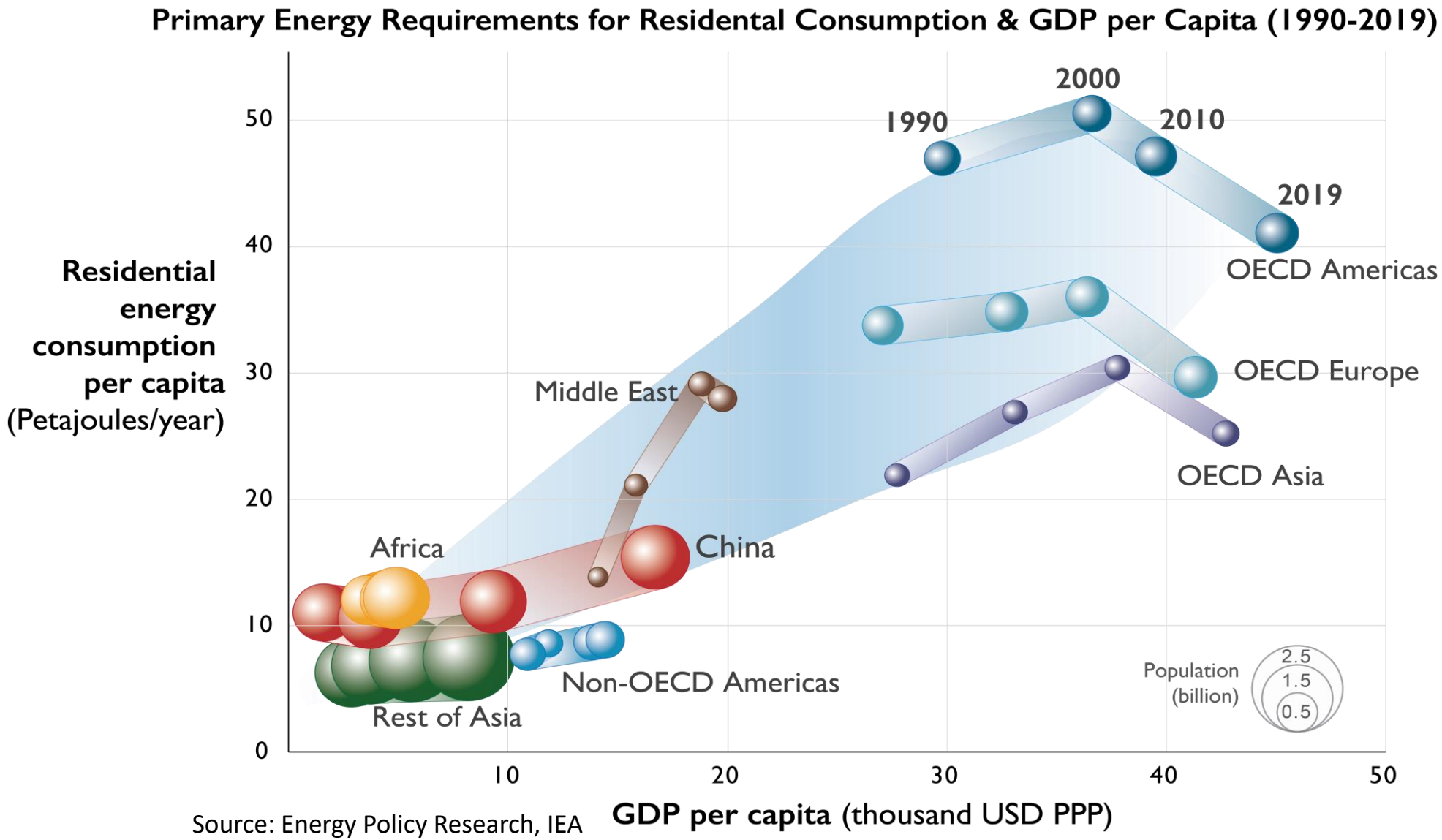


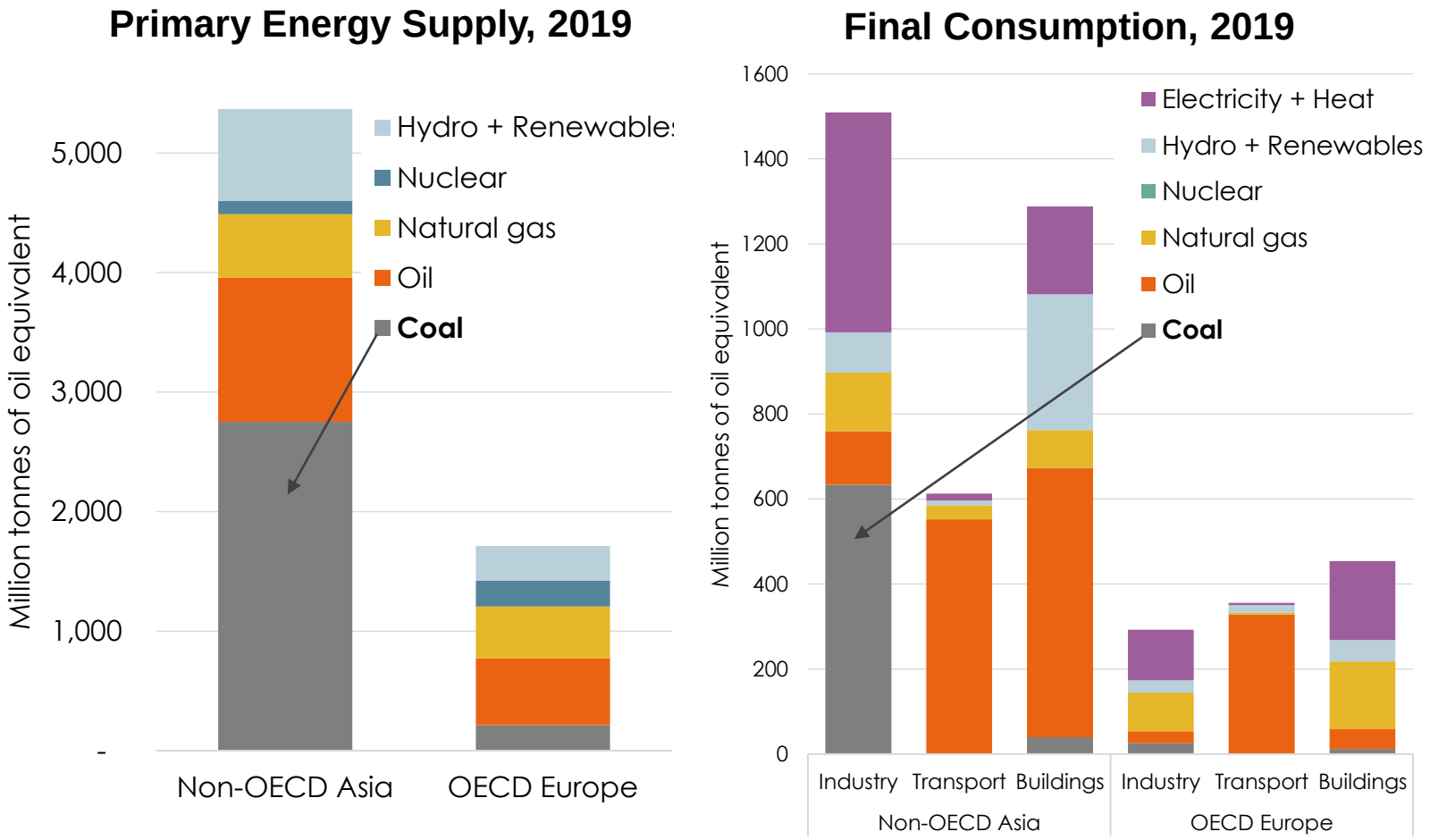
Source: Energy Policy Research, IEA

Different Pictures in Europe and Asia

Primary coal supply in non-OECD Asia (incl. China and India) was 2,751 Mtoe, 60% higher than the entire primary energy supply of OECD Europe.

In final consumption, 94% of non-OECD Asia coal use is consumed in industry, incl. “harder-to-abate” sectors like cement and steel.

Fuel Mix in Non-OECD Asia (incl. China) and OECD Europe



Source: EPRINC figures based on IEA data

It's Hard to Predict Non-OECD Demand: China Case

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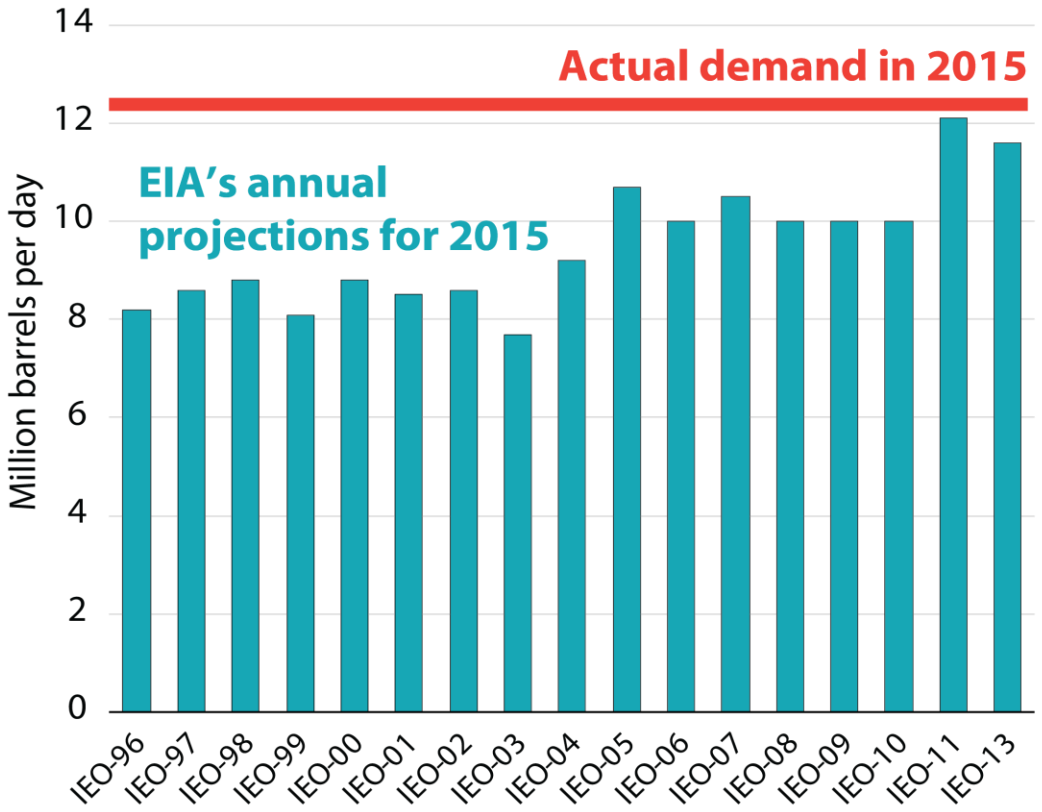
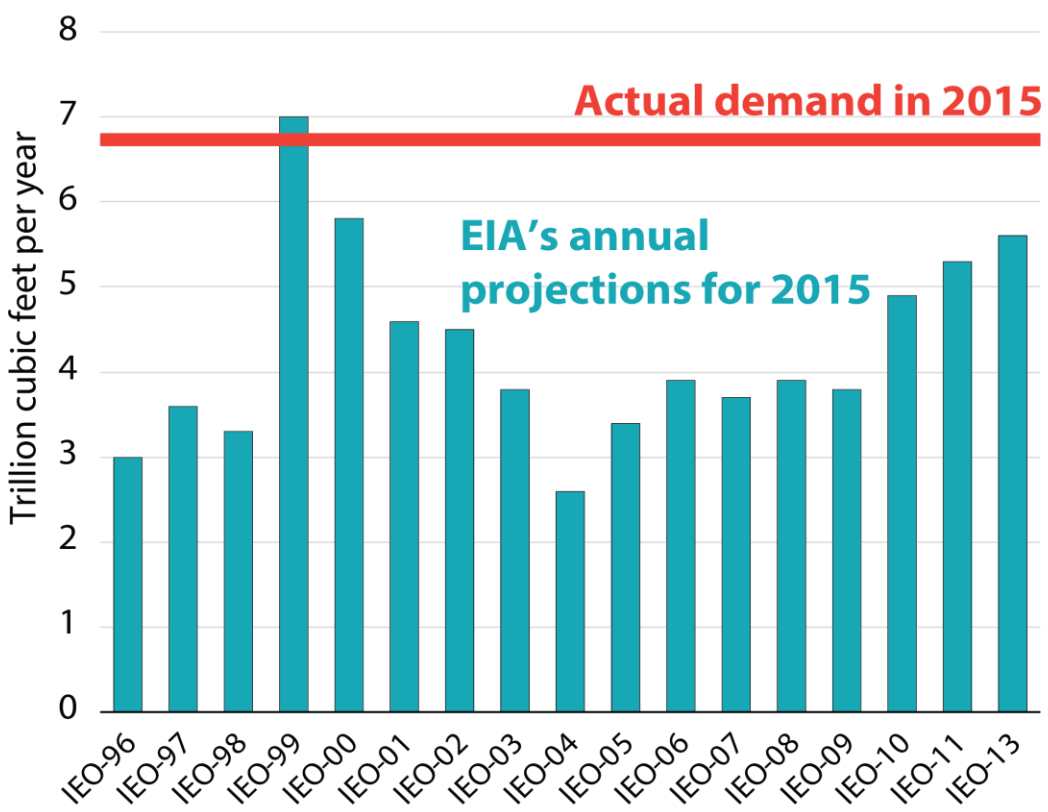
China's Liquids Demand in 2015: Projected vs. Actual



China's Gas Demand in 2015: Projected vs. Actual



Source: U.S. EIA's International Energy Outlooks (IEO) 1996-2013, 2016, EPRINC.

Note: On March 27, 2023, CNPC announced that 2023 petroleum demand would be 756 milion metric tons (mt) . Earlier forecasts for 2023 were 690mt (2018), 705mt (2019) and 740mt (2020). Bloomberg

Problem with OECD-Centered Worldview

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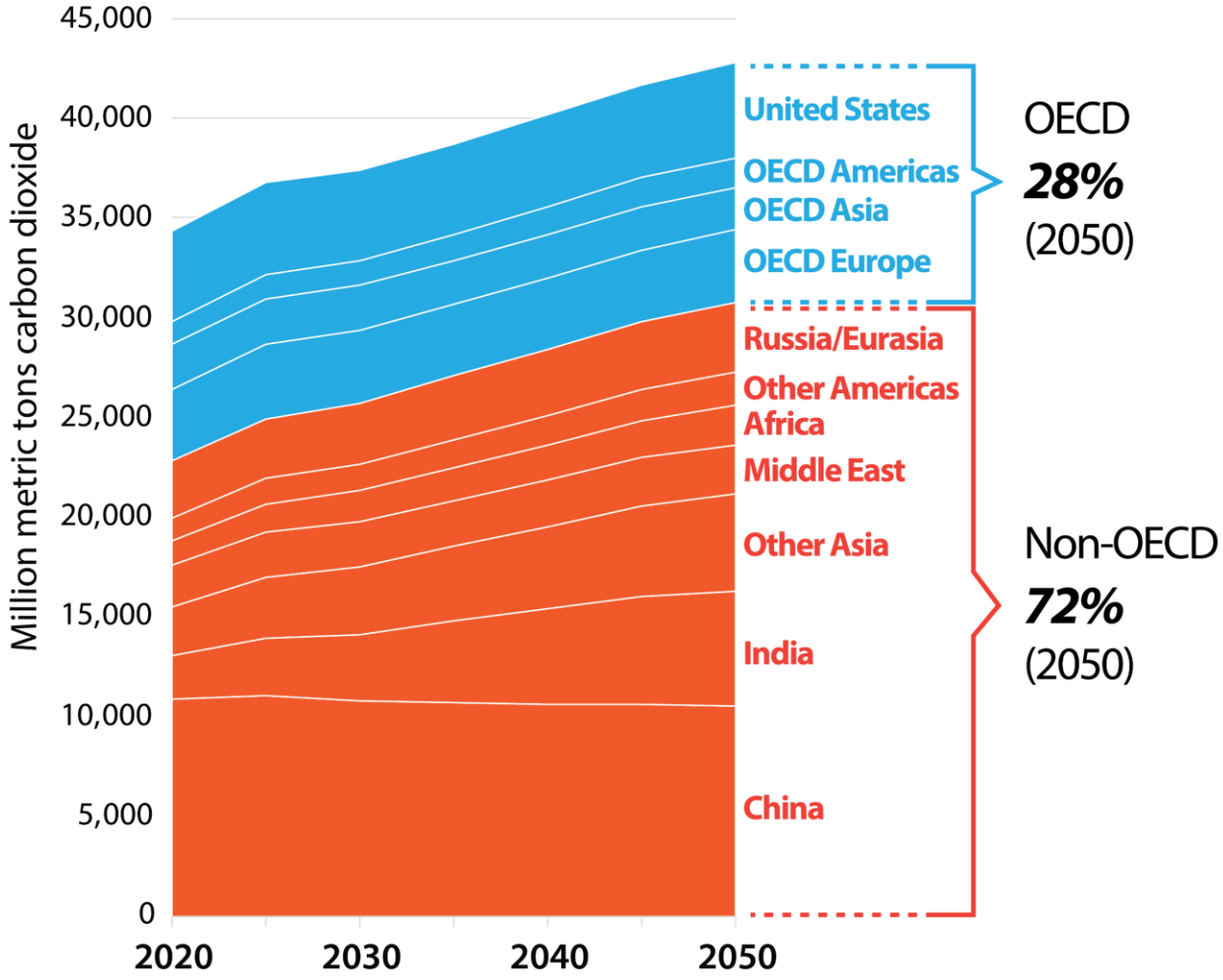
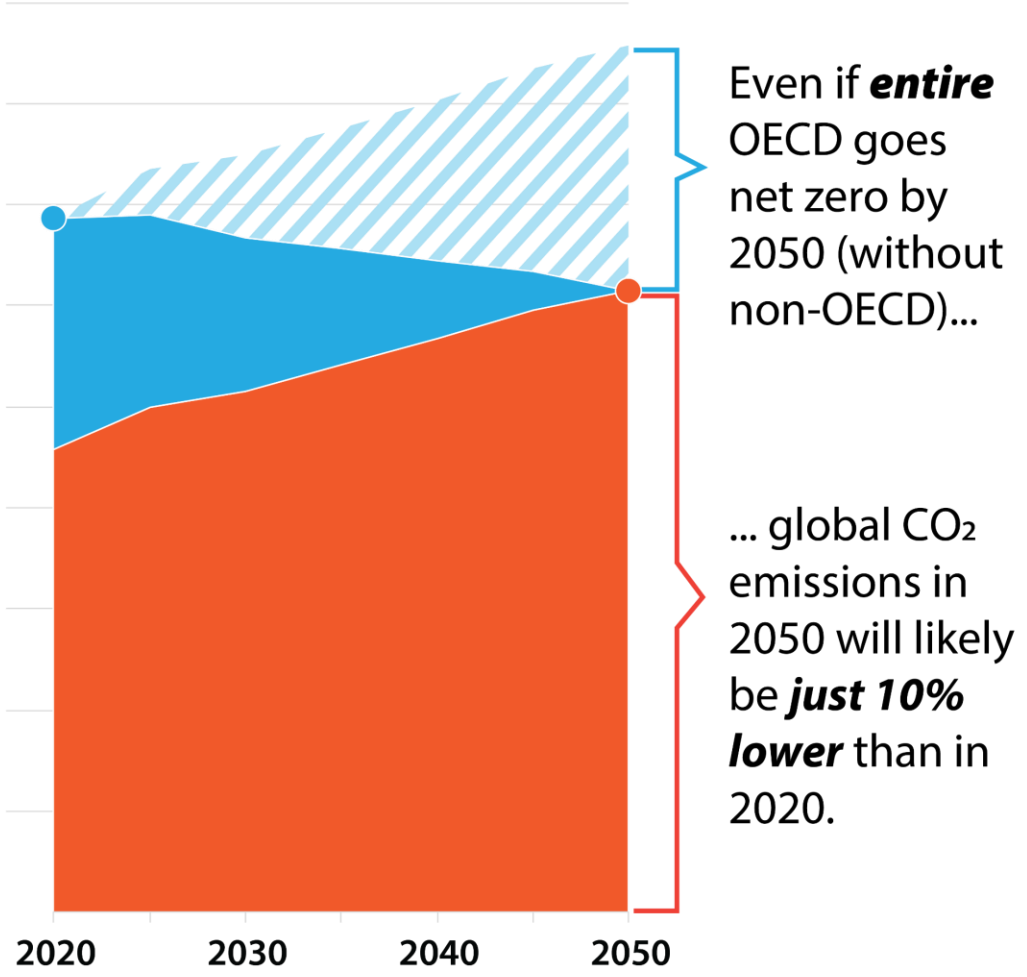
EIA Reference Case: ***Projected CO_2 Emissions***



Will ***OECD Net Zero*** Matter?



EPRINC analysis based on EIA's International Energy Outlook 2021 (most recent)

EIA Expects US Crude Oil Production to Hit All Time High in 2024

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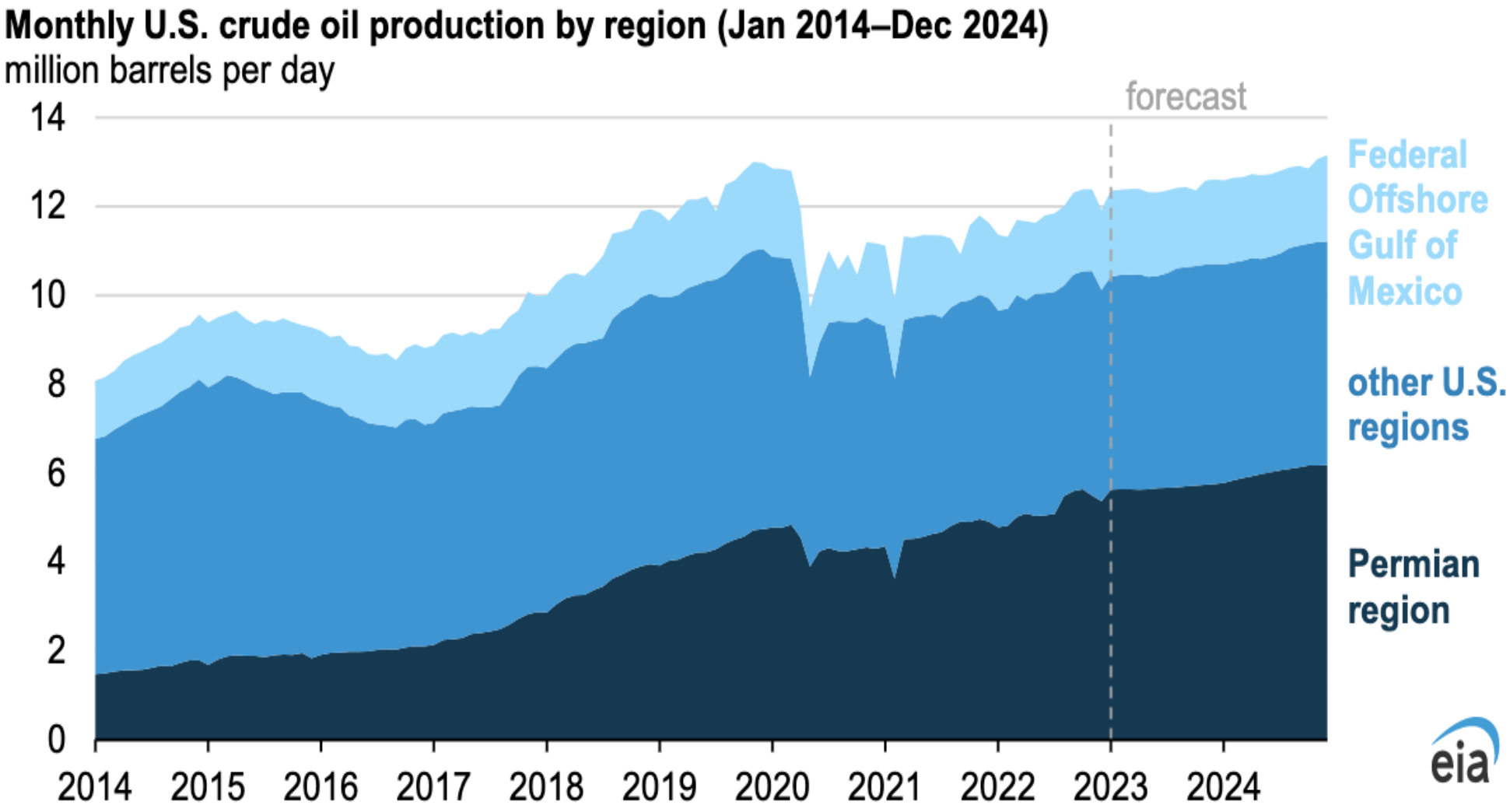
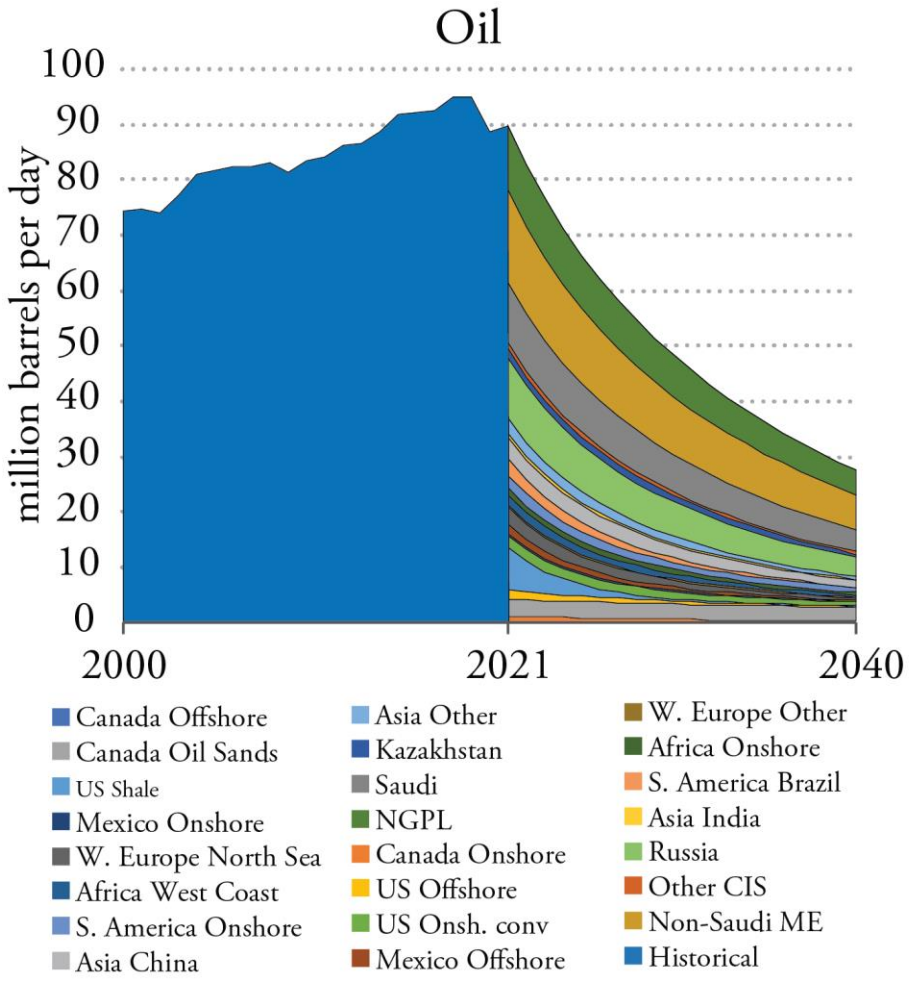
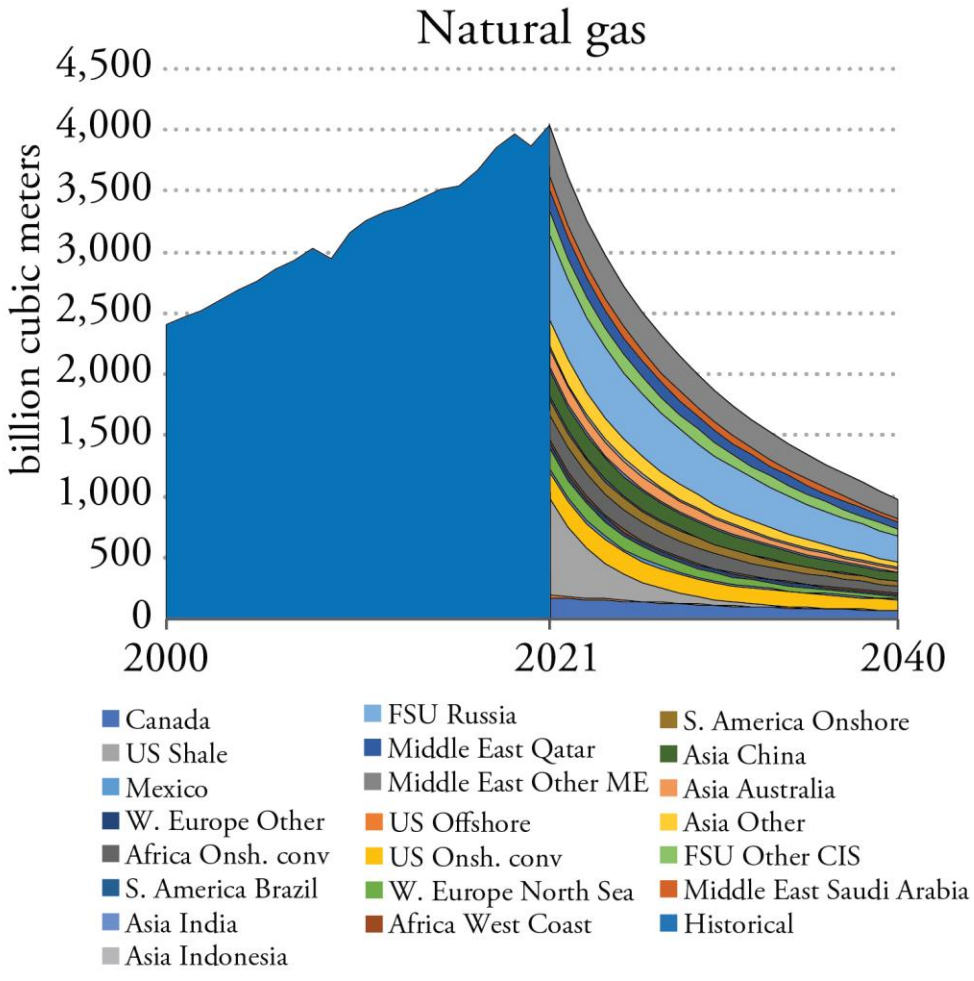


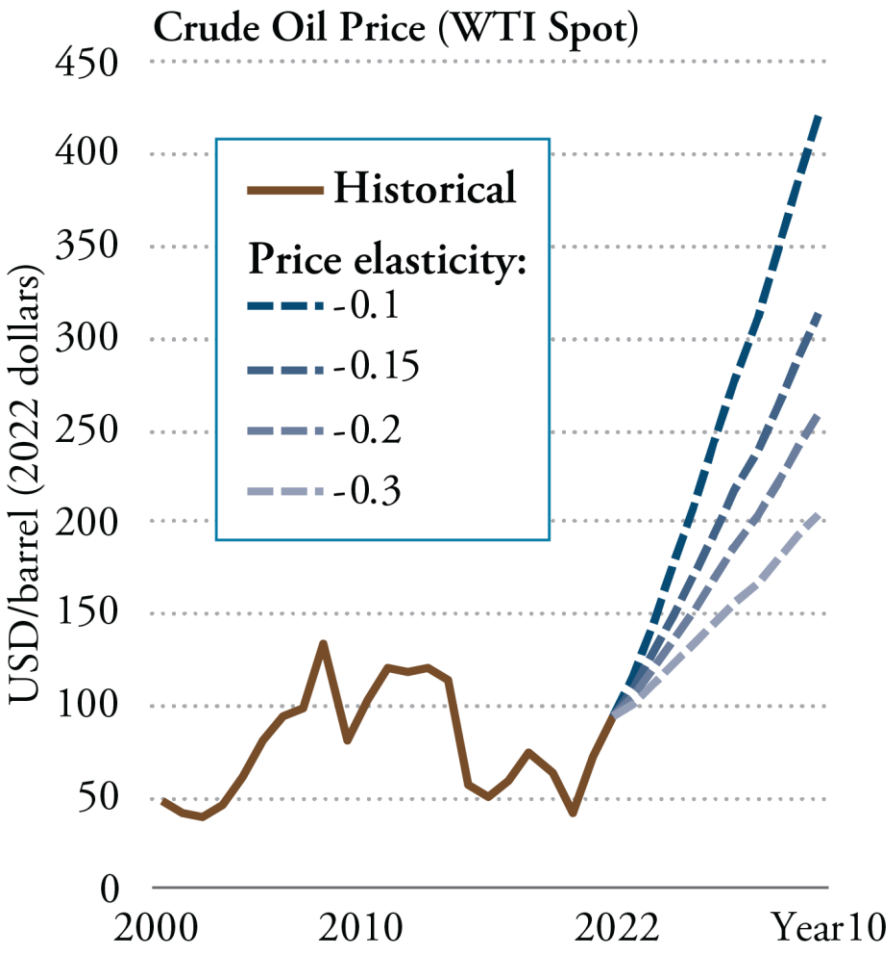
What Happens is Investment is Halted Worldwide for New Oil and Gas Development?

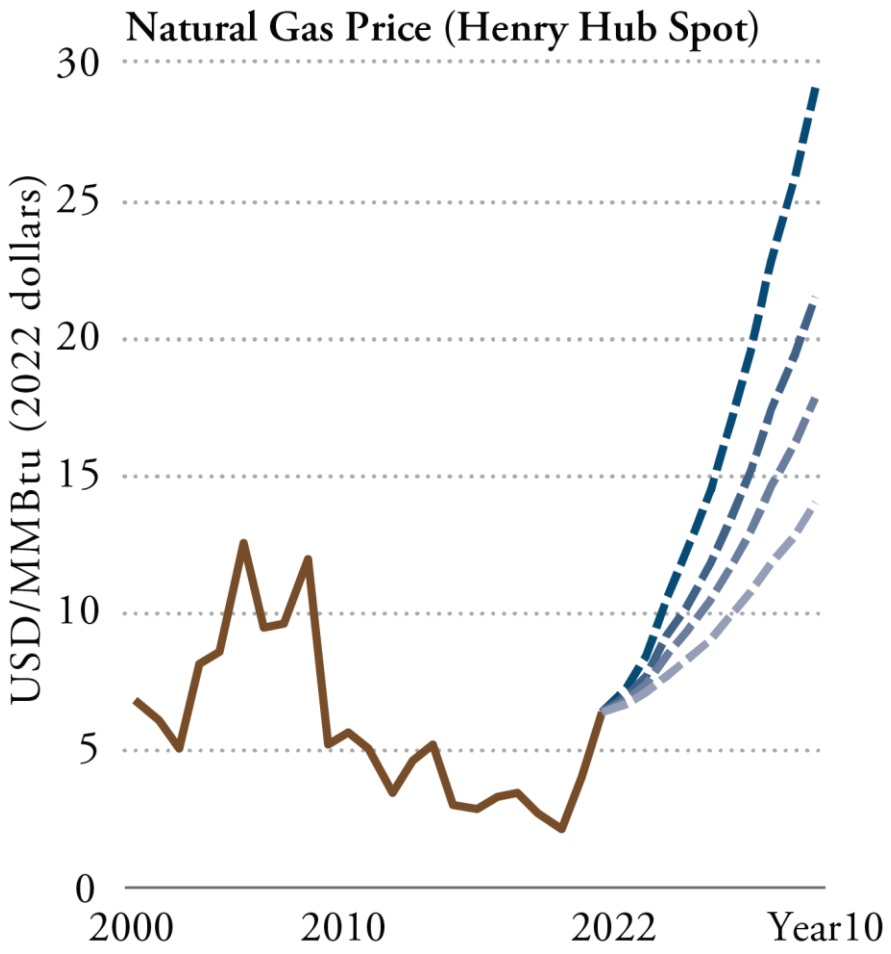




Source: Energy Policy Research, Michael Lynch

Oil and Gas Prices Under No New Investment Scenario (IEA-NZE) Based on Historic Price Elasticities of Demand





Source: Energy Policy Research

Implications of High Oil and Gas Prices Under No Investment Scenario

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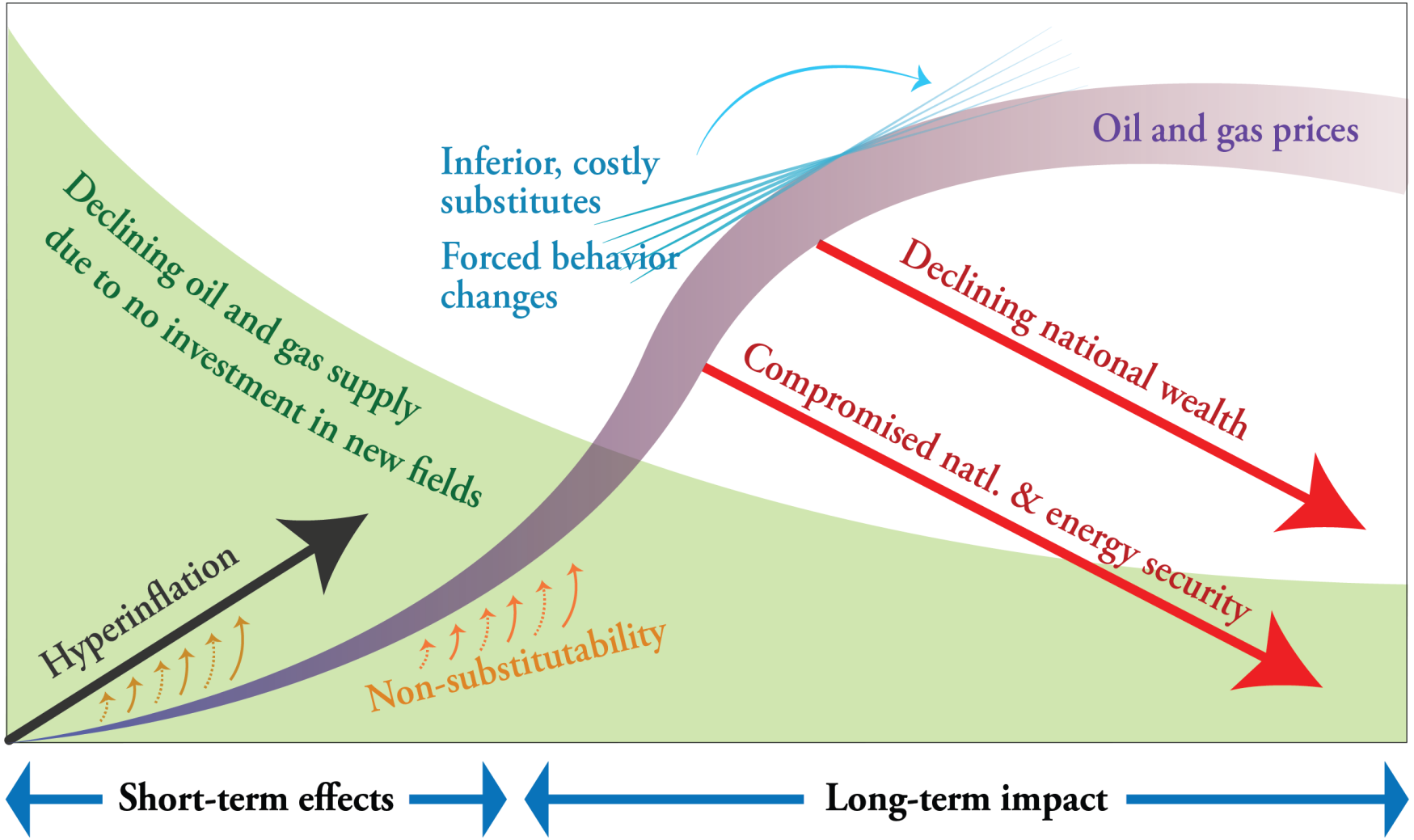

Oil Supply Concentration under Net Zero

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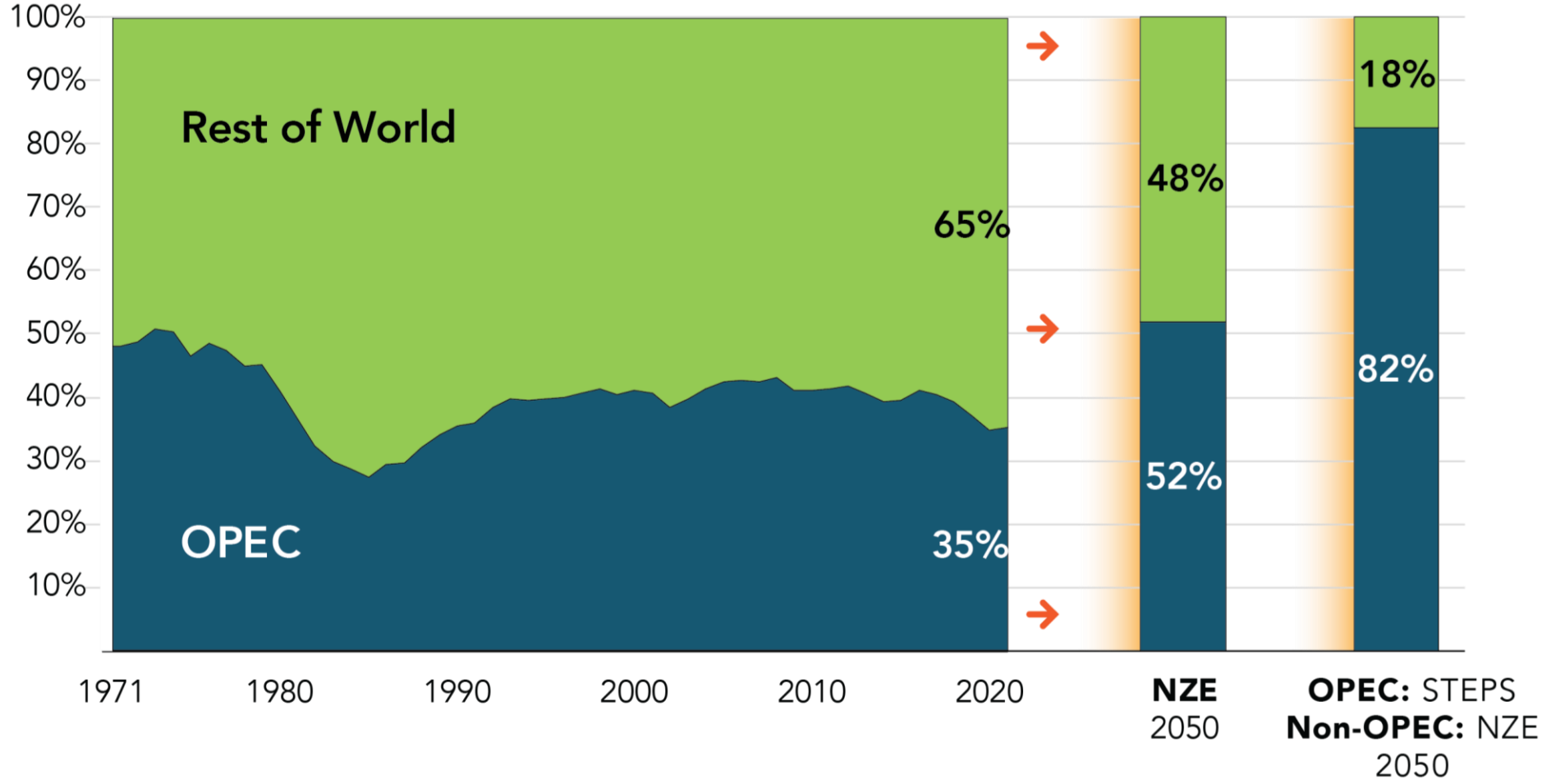
OPEC Share of Global Oil Production



Source: EPRINC figure based on IEA World Energy Outlook 2022, WEB data

Level of Commitment: Divide Between OECD and Non-OECD

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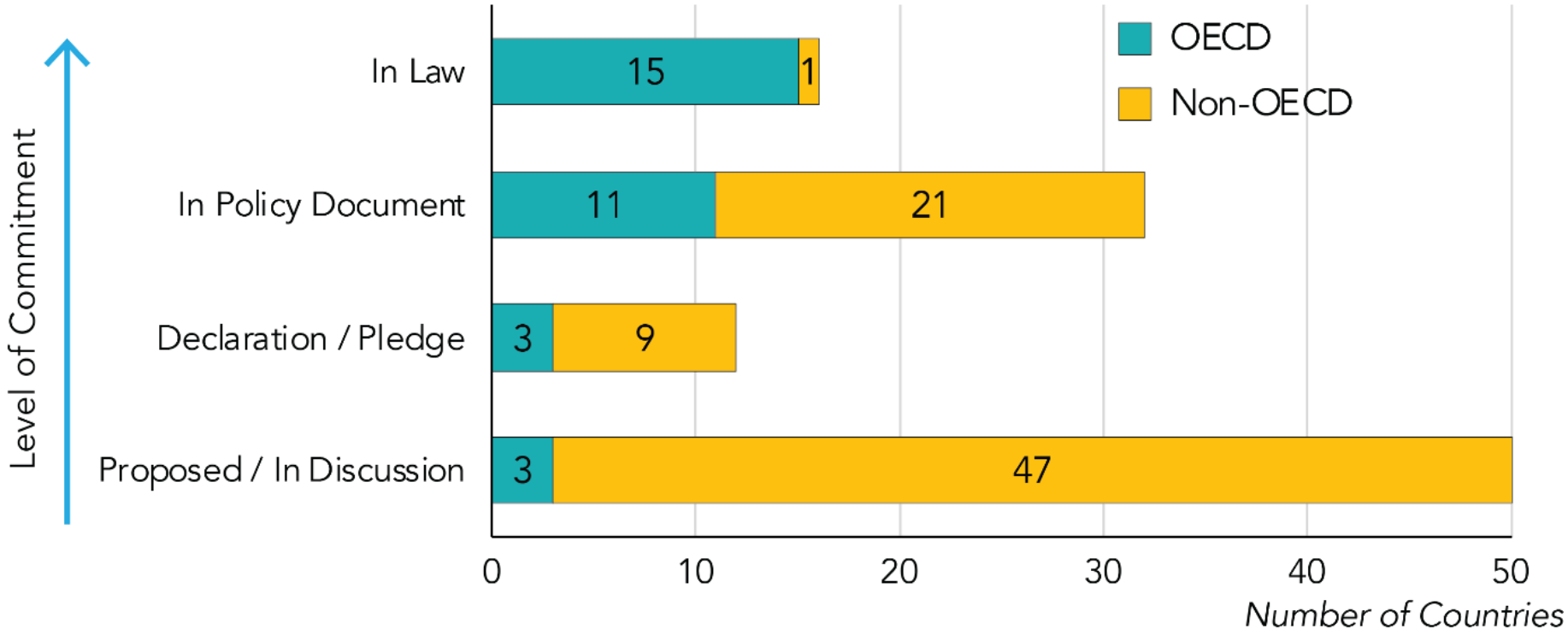
Two-Speed Transition: Net Zero by 2050 Level of Commitment



Sources: EPRINC figure based on data from Net Zero Tracker.

US Contributed 84% of Incremental Oil in 2010-2020

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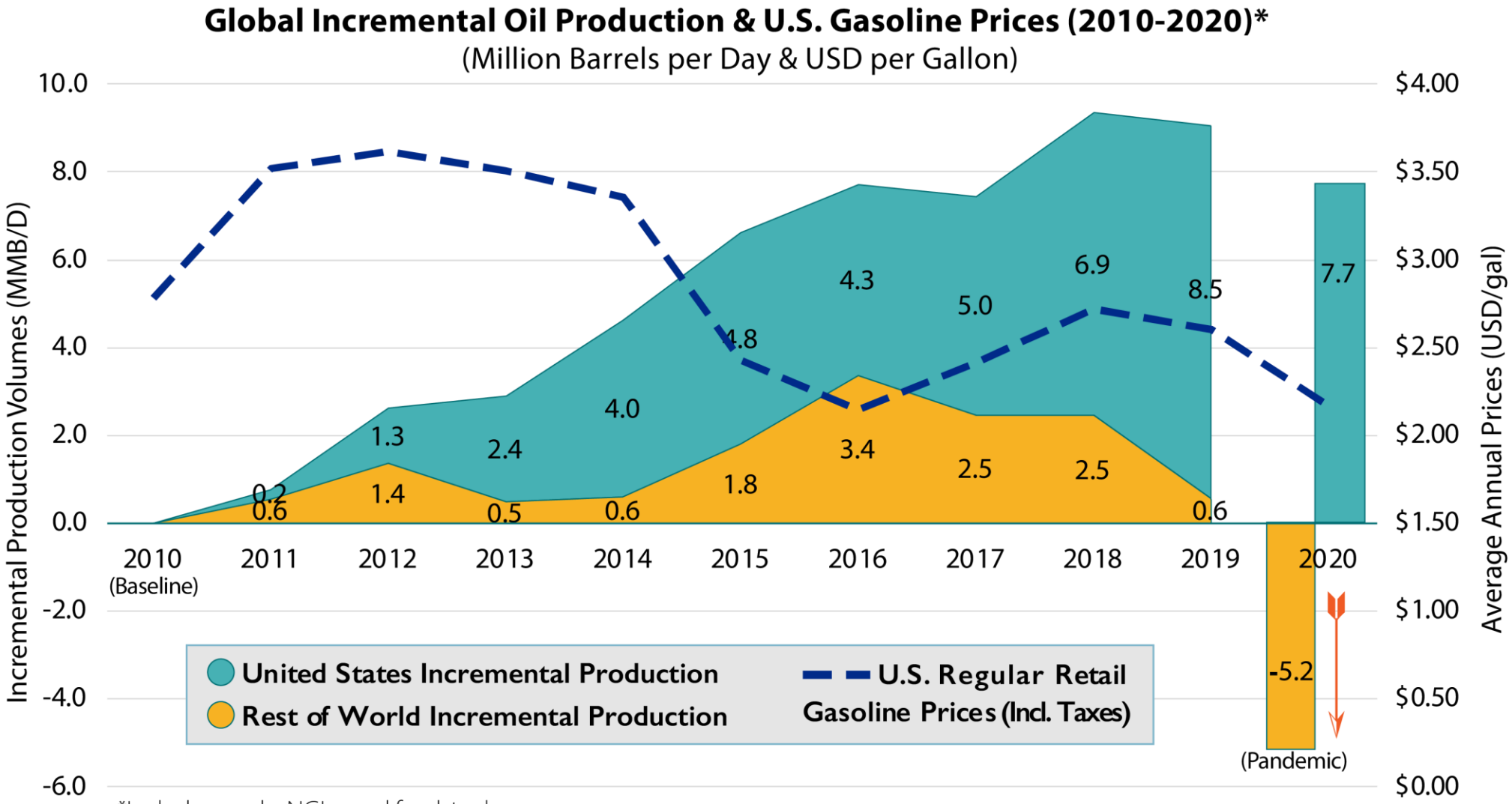
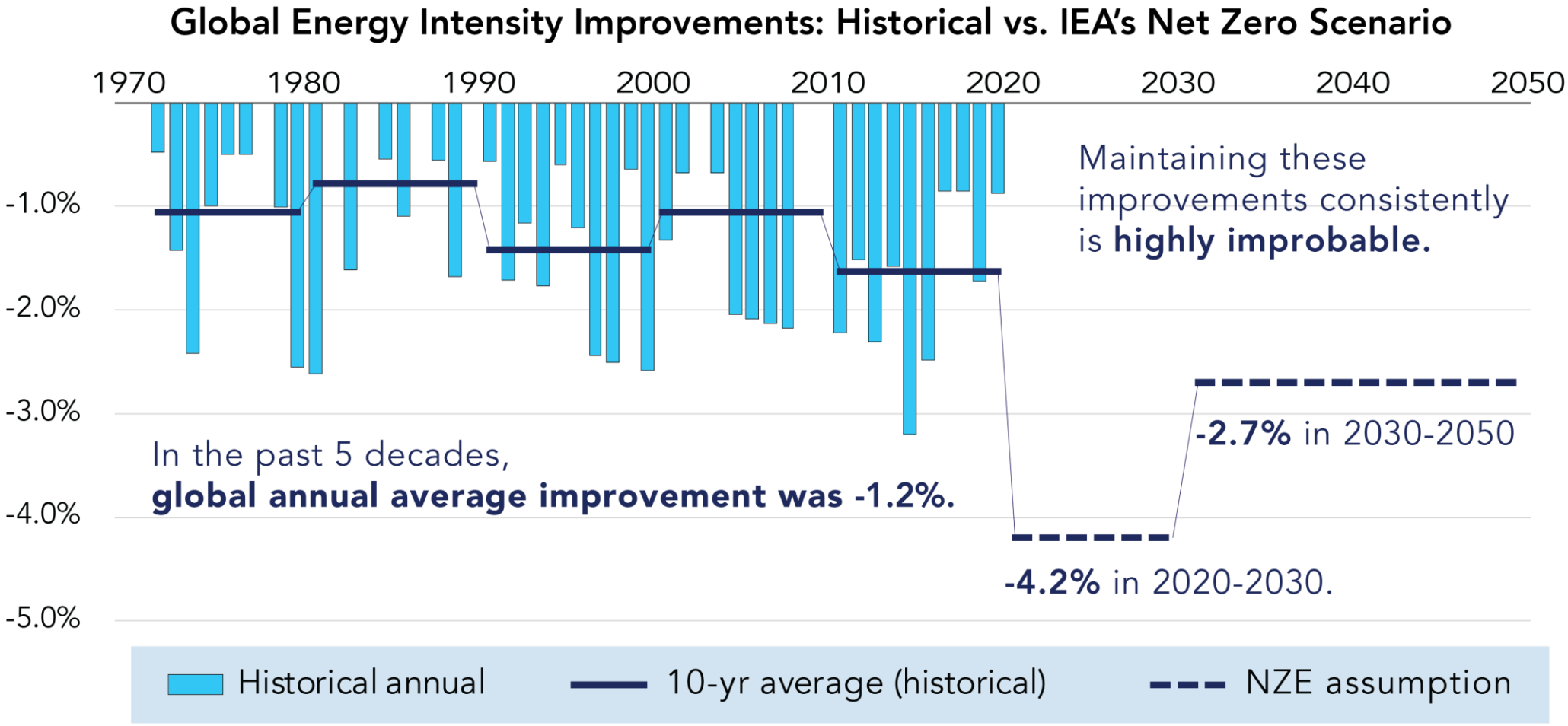


*Includes crude, NGLs, and feedstocks

EPRINC analysis based on data from IEA, EIA

Energy Intensity Improvements under Net Zero



Source: EPRINC figures & calculations based on IEA WEB
Note: Primary energy / GDP (2019 USD PPP) is used for the calculation.

Many Technologies Still in Early Stages of Readiness

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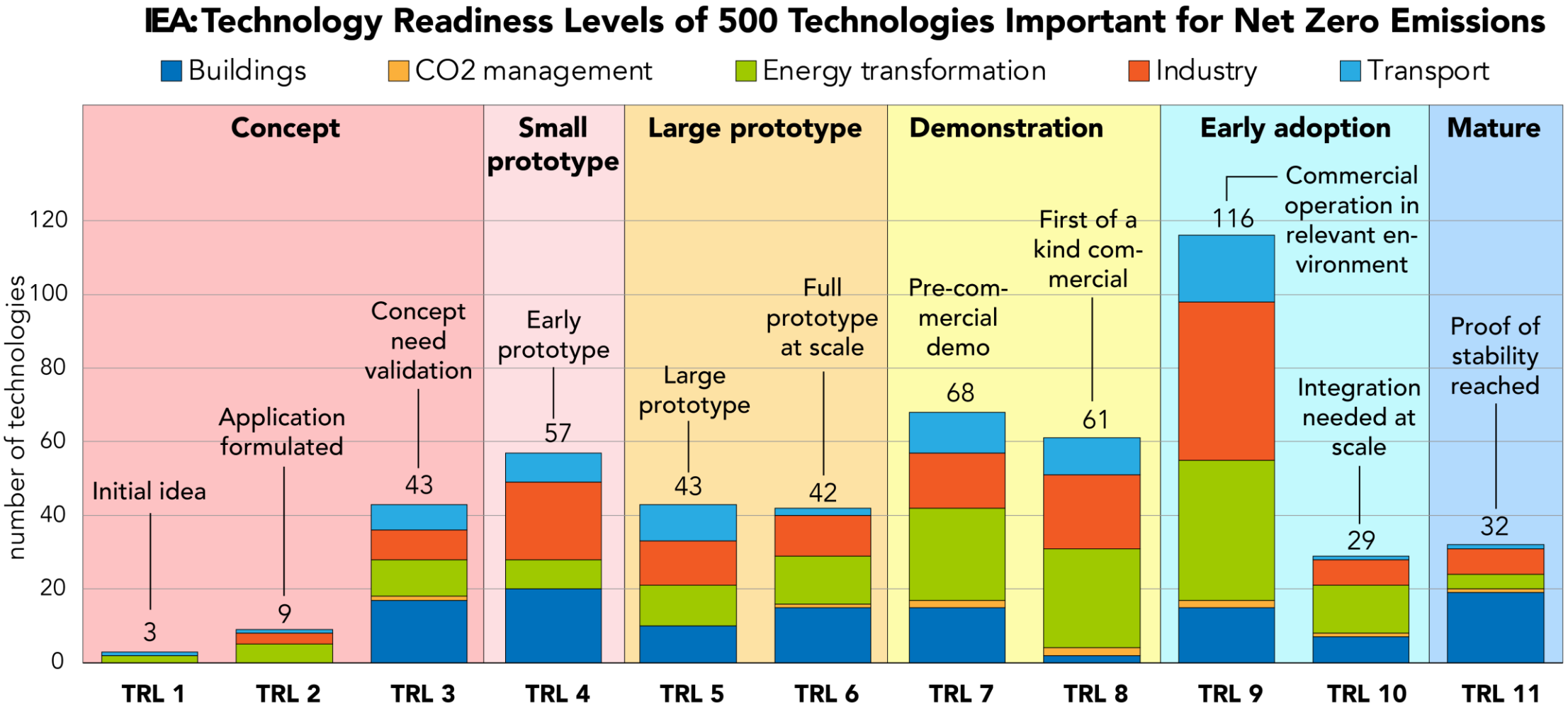

Source: EPRINC analysis based on IEA ETP

Massive Critical Minerals Required in a Low-Carbon Future

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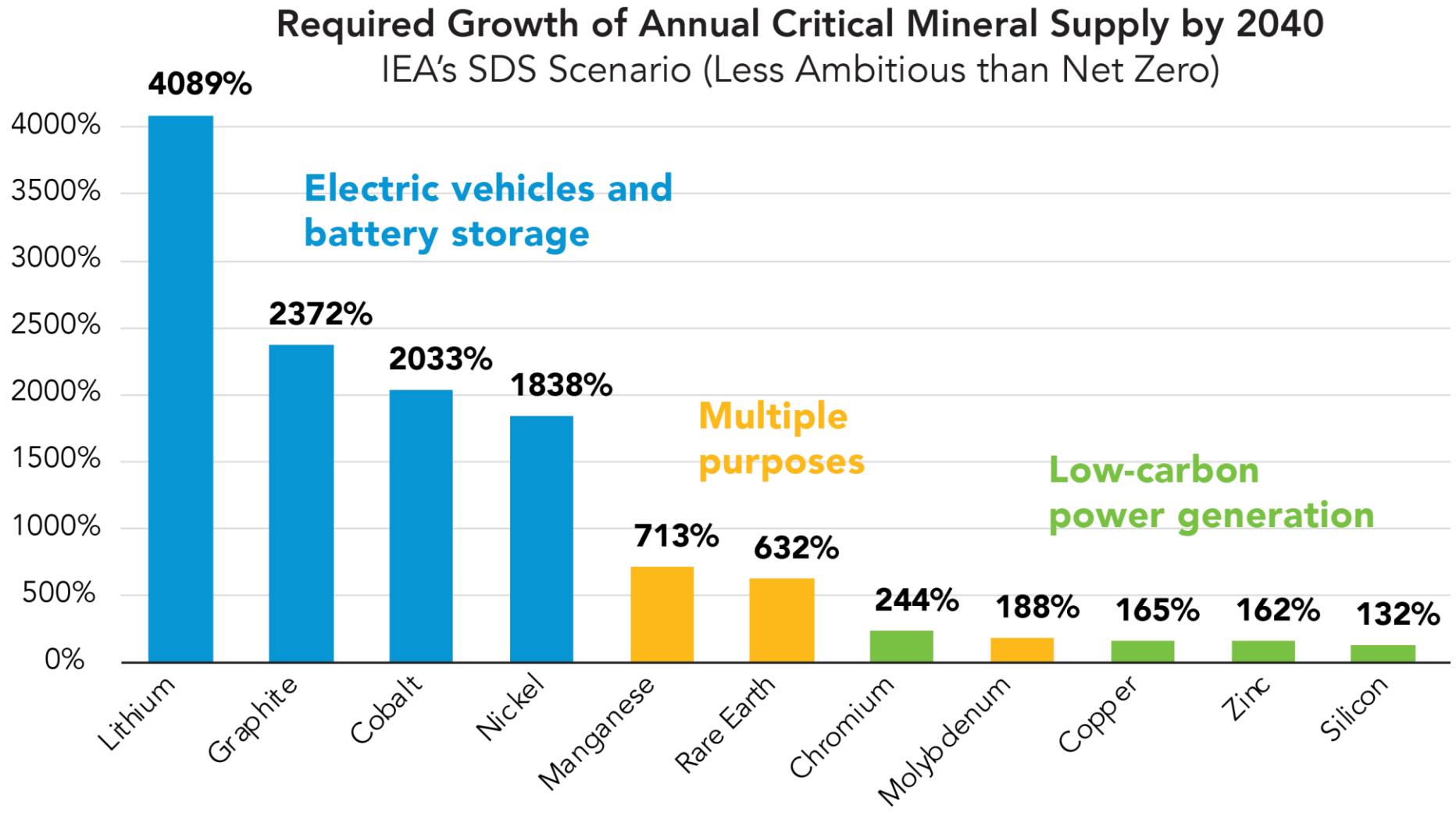
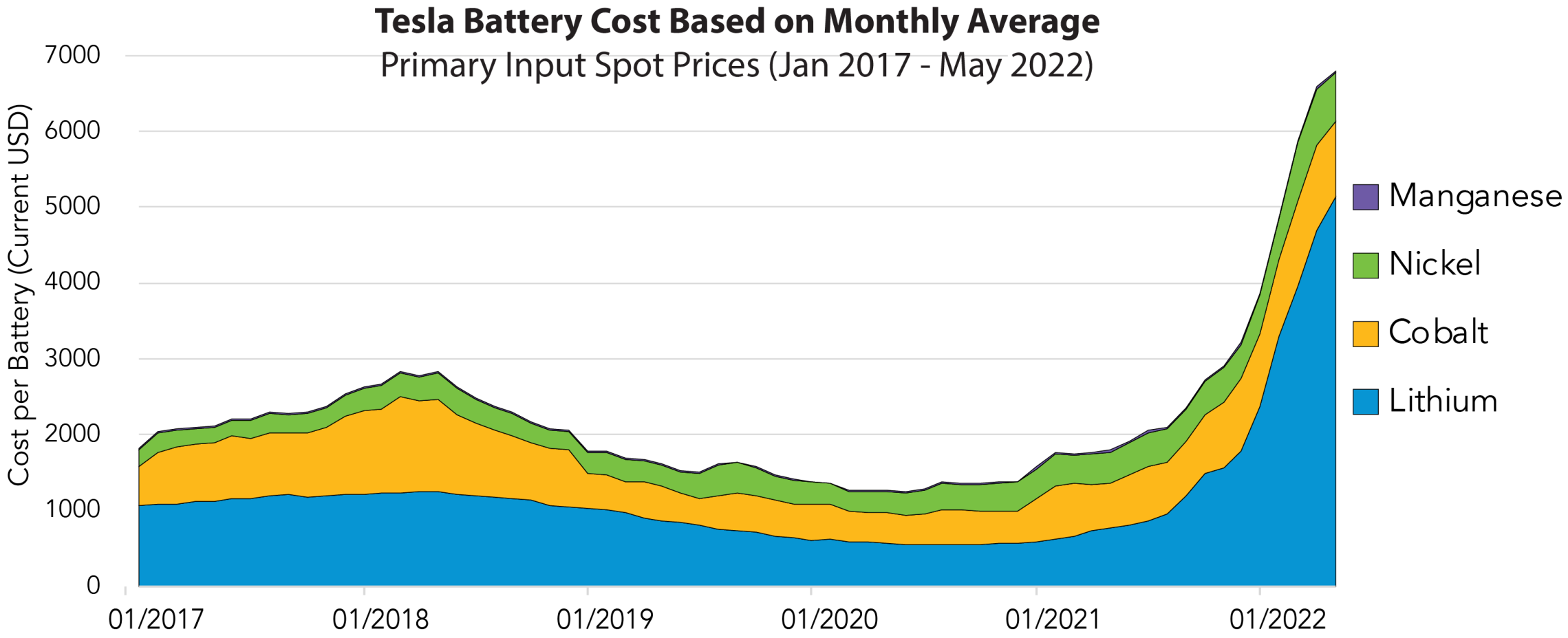


Source: EPRINC analysis based on IEA Critical Mineral Report 2021

Increased Vulnerability to Mineral and Metal Prices



Source: EPRINC analysis based on LME Monthly Data

Dependence on China to Increase with Energy Transition

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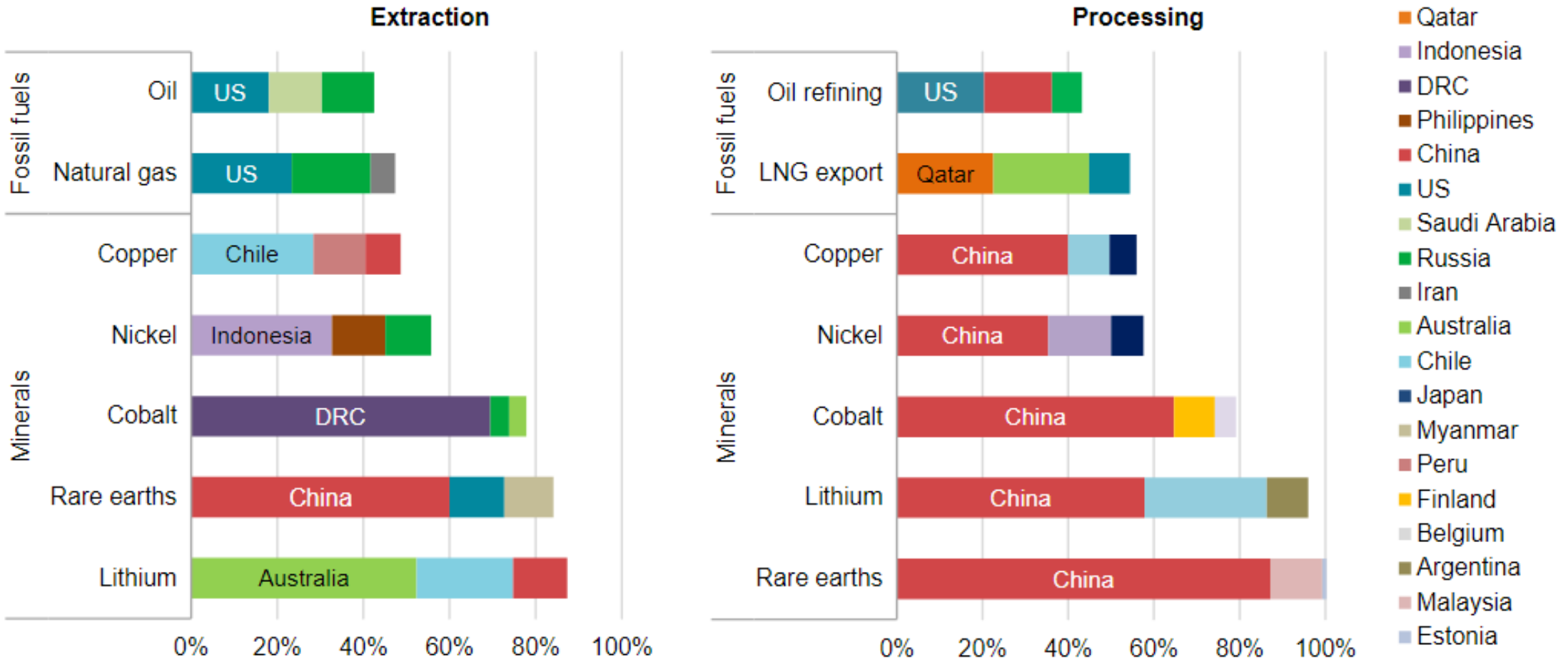
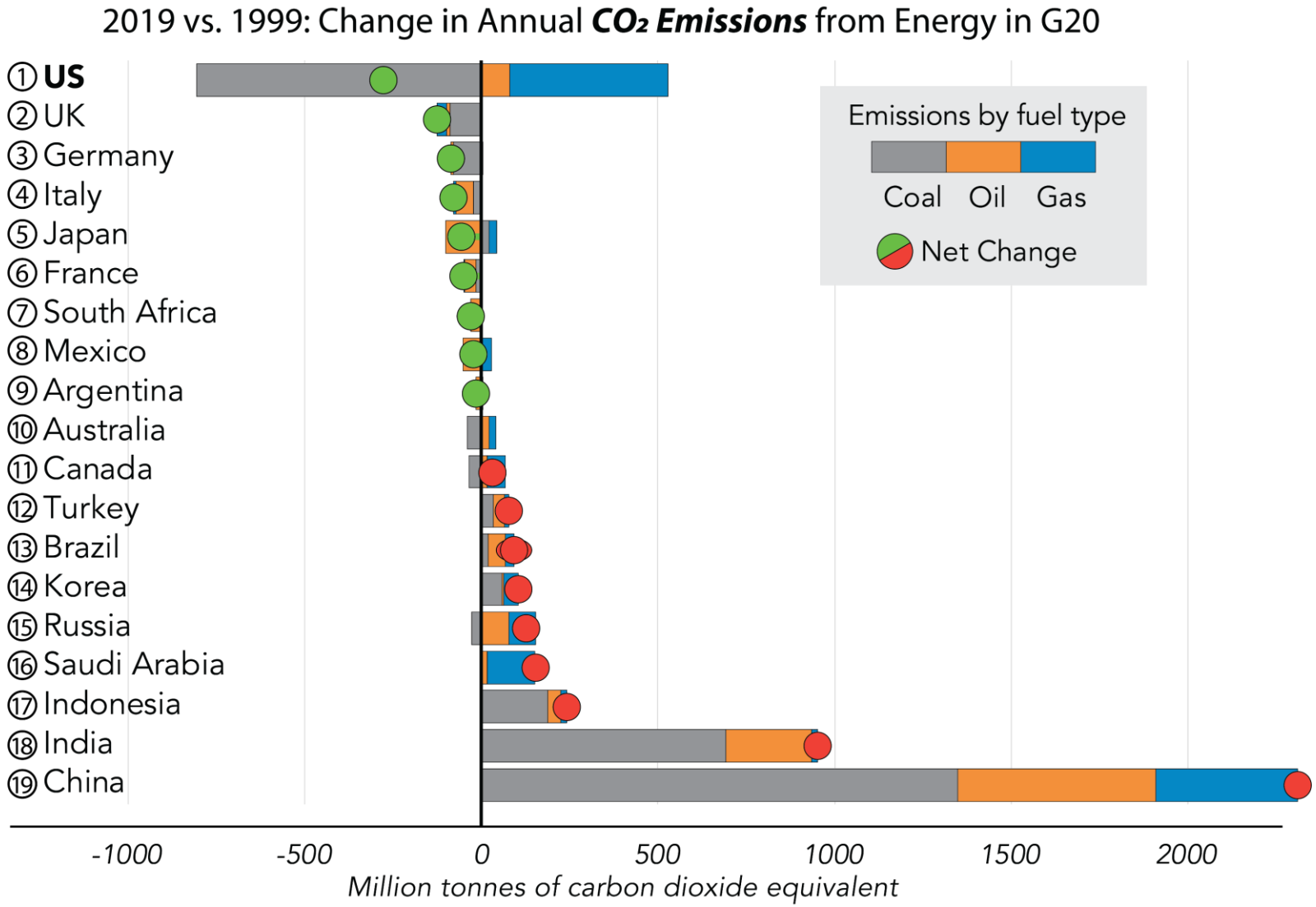
Share of top three producing/processing countries in ***selected minerals and fossil fuels***, 2019



Sources: IEA Report *The Role of Critical Minerals in Clean Energy Transition*; USGS (2021), World Bureau of Metal Statistics (2020); Adamas Intelligence (2020)

Gas Remains the Most Cost-Effective Pathway for Rapid Carbon Reductions



EPRINC analysis based on data from Global Carbon Atlas

As G7 heads of government get ready for their annual meeting in May, there remains no consensus on the role of natural gas as a pathway to a lower carbon future.

But there is no low-carbon future without gas.

The Myth of Stranded Oil & Gas Assets

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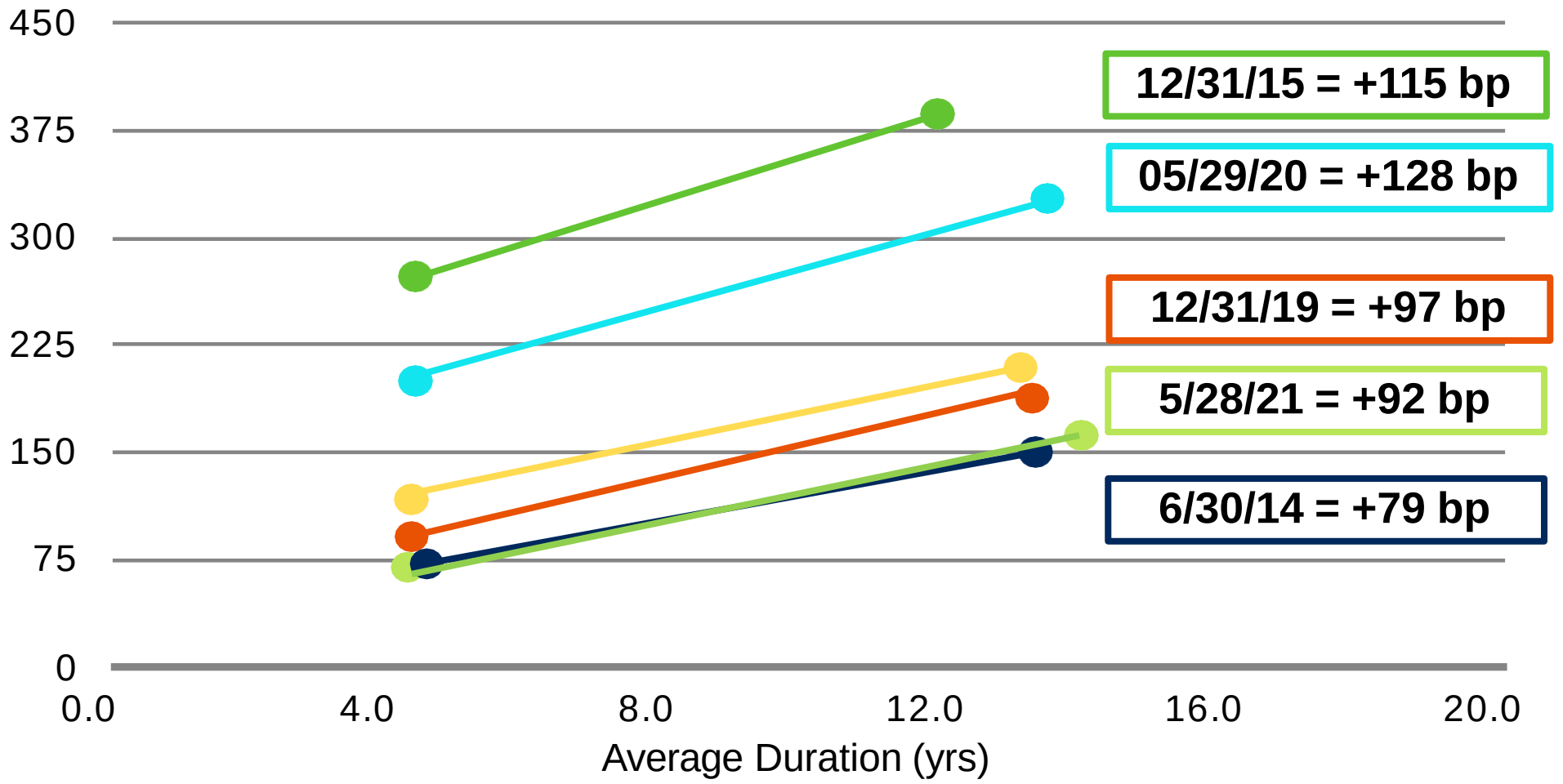
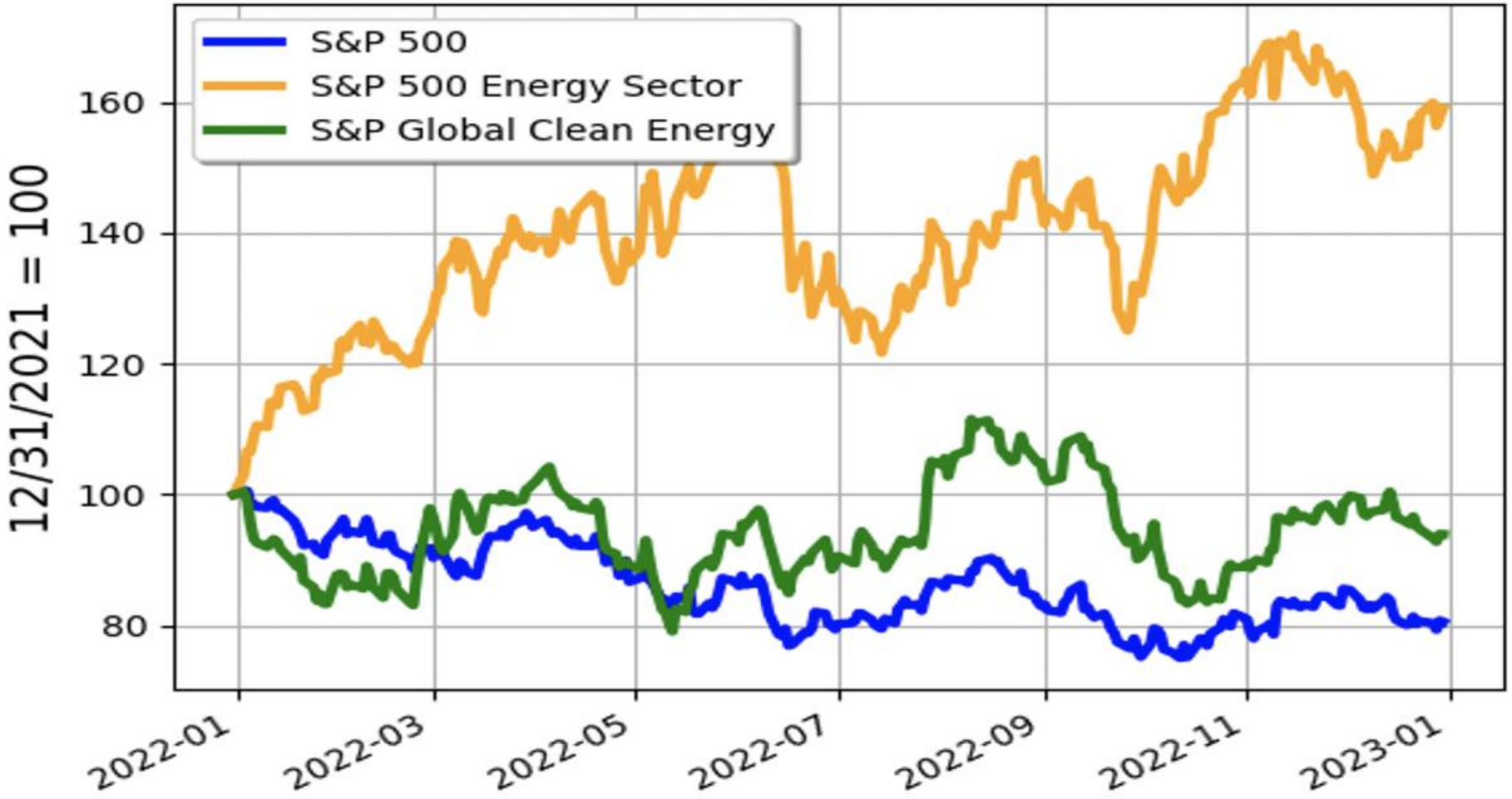
U.S. Investment Grade Energy Bond Credit Spread Curves



Source: Bloomberg Barclays

Performance of Index Funds: S&P 500, S&P 500 Energy Sector and S&P Global Clean Energy



Source: Energy Policy Research

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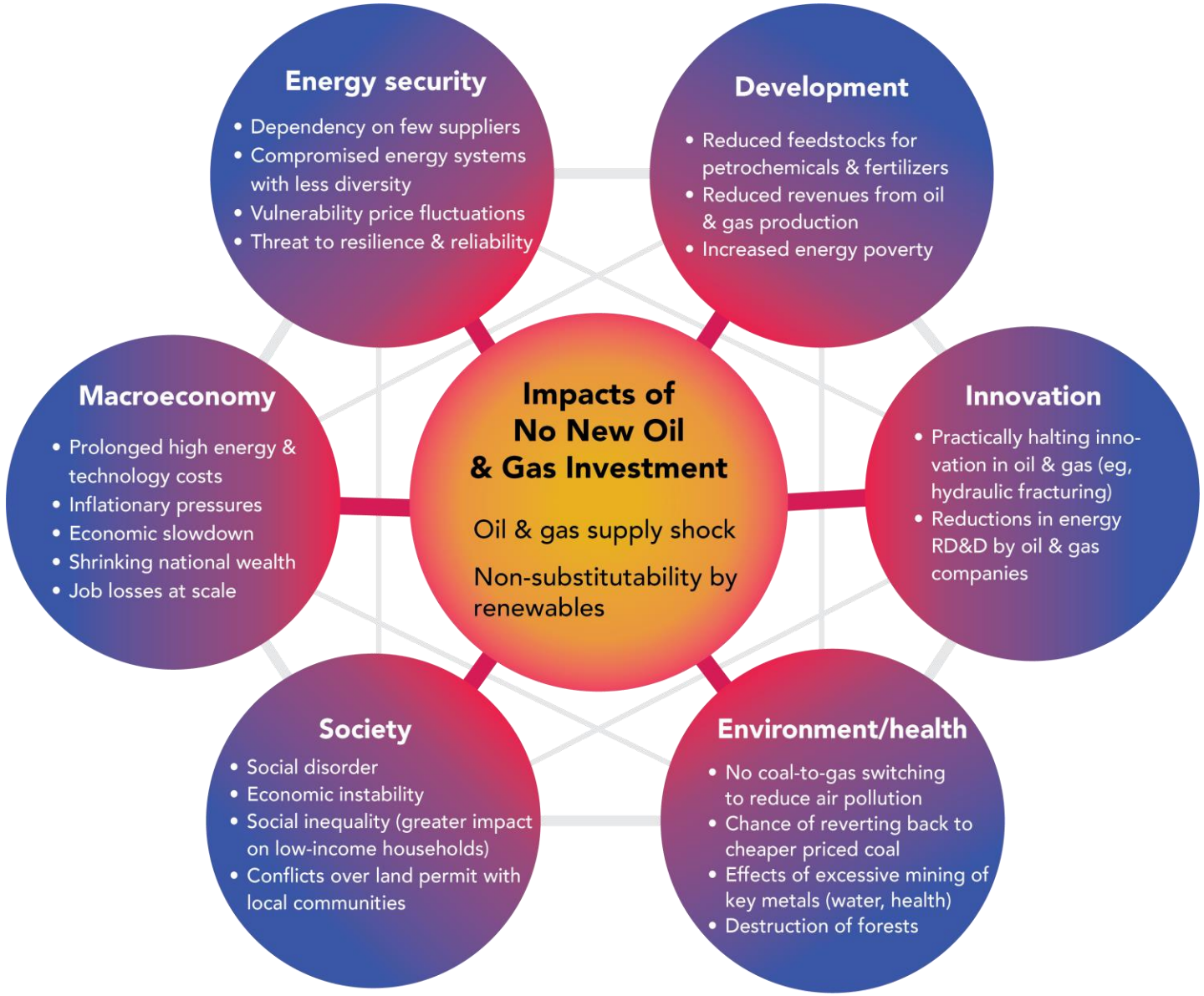
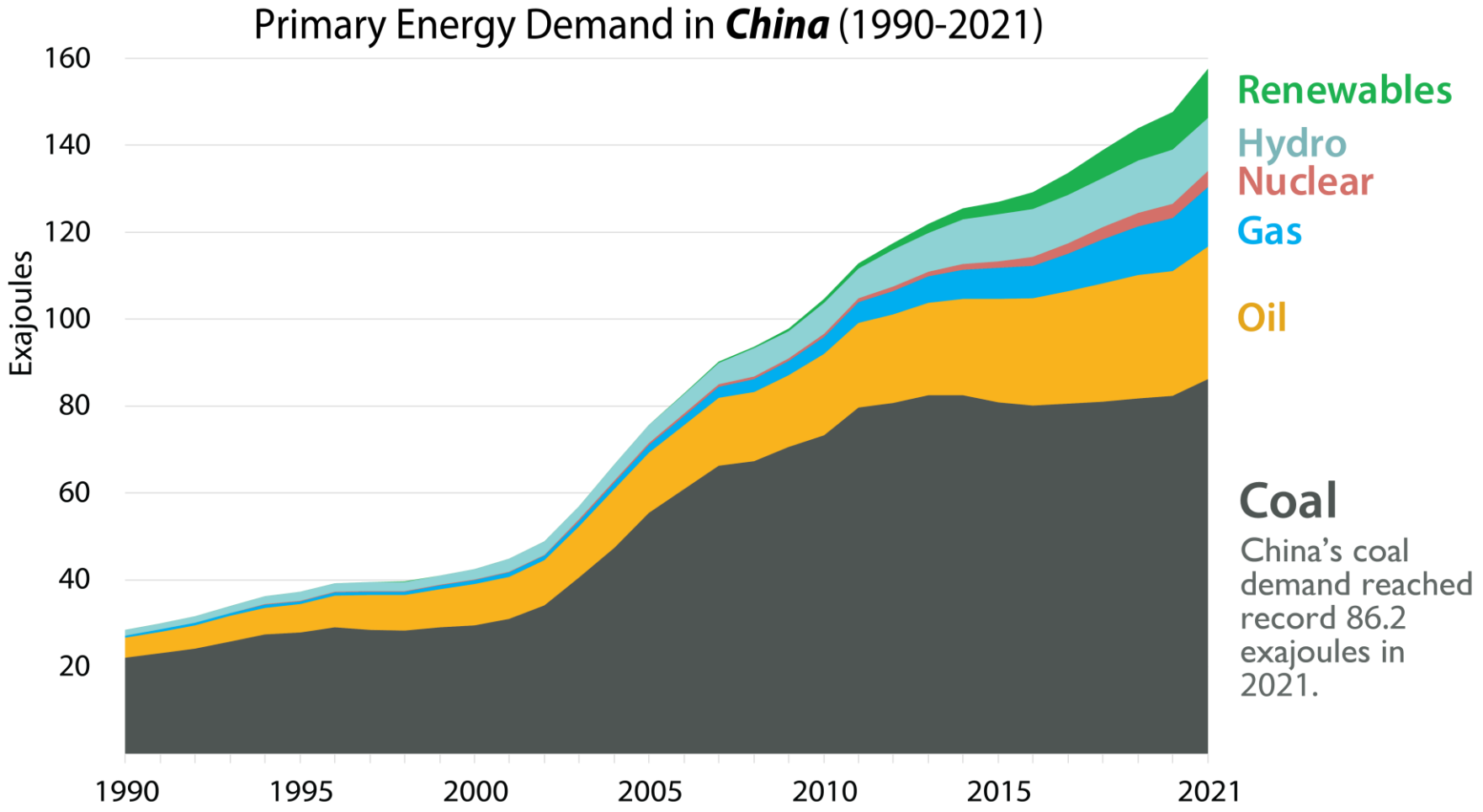


Source: EPRINC analysis

Do Policy Makers Understand the Consequences of No New Investment in Oil & Gas Development?

ADDITIONAL SLIDES

China Runs on Coal and Keeps Consuming Record Volumes

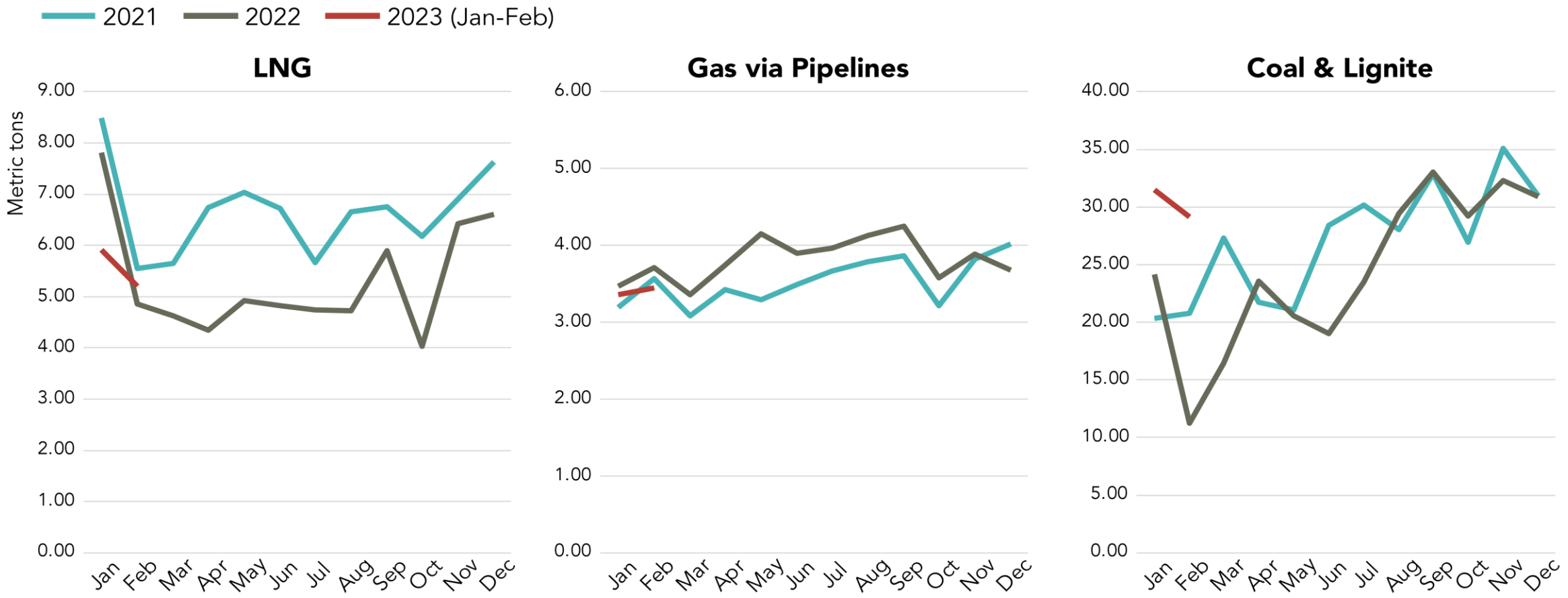


EPRINC chart based on BP Statistical Review of World Energy

Managing natural gas demand is not easy. Many think the primary risk is the energy transition, but the real risk is coal.

Despite its carbon neutrality goals, China's coal consumption reached 86.2 exajoules (EJ) in 2021, surpassing its previous record of 82.5 EJ in 2014.

China's Monthly Energy Imports: LNG Imports Below 2021 Levels, Short-term Outlook Remains Uncertain



Source: Energy Policy Research, China Customs, NDRC

2022: A Historically Bad Year for China's Natural Gas Demand and LNG Imports

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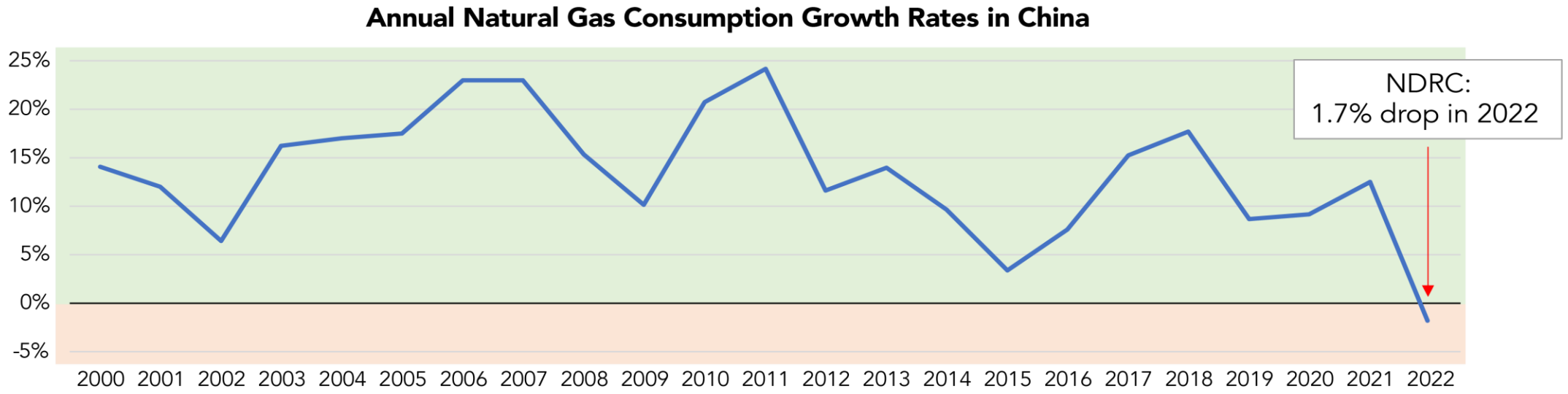
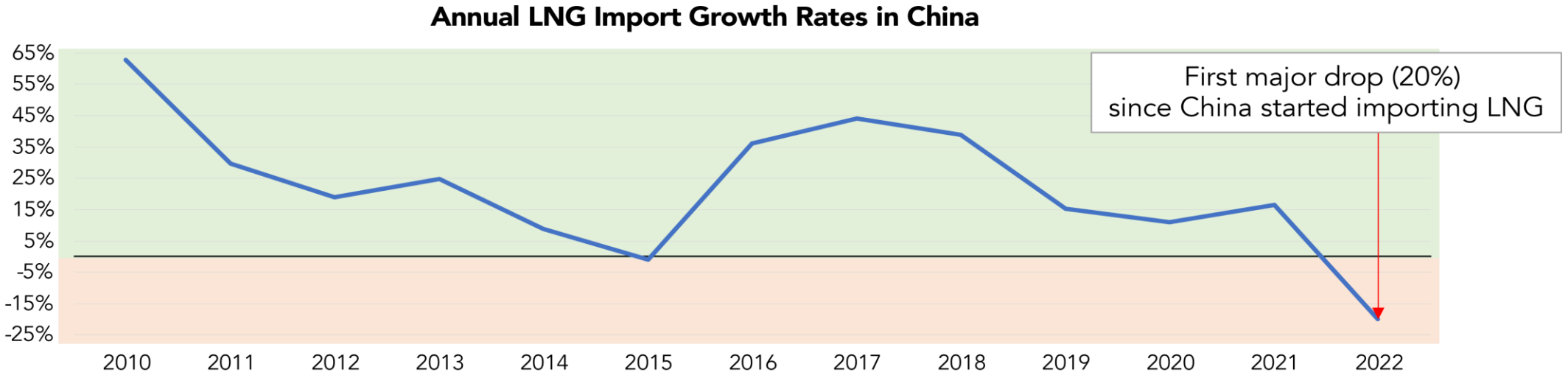
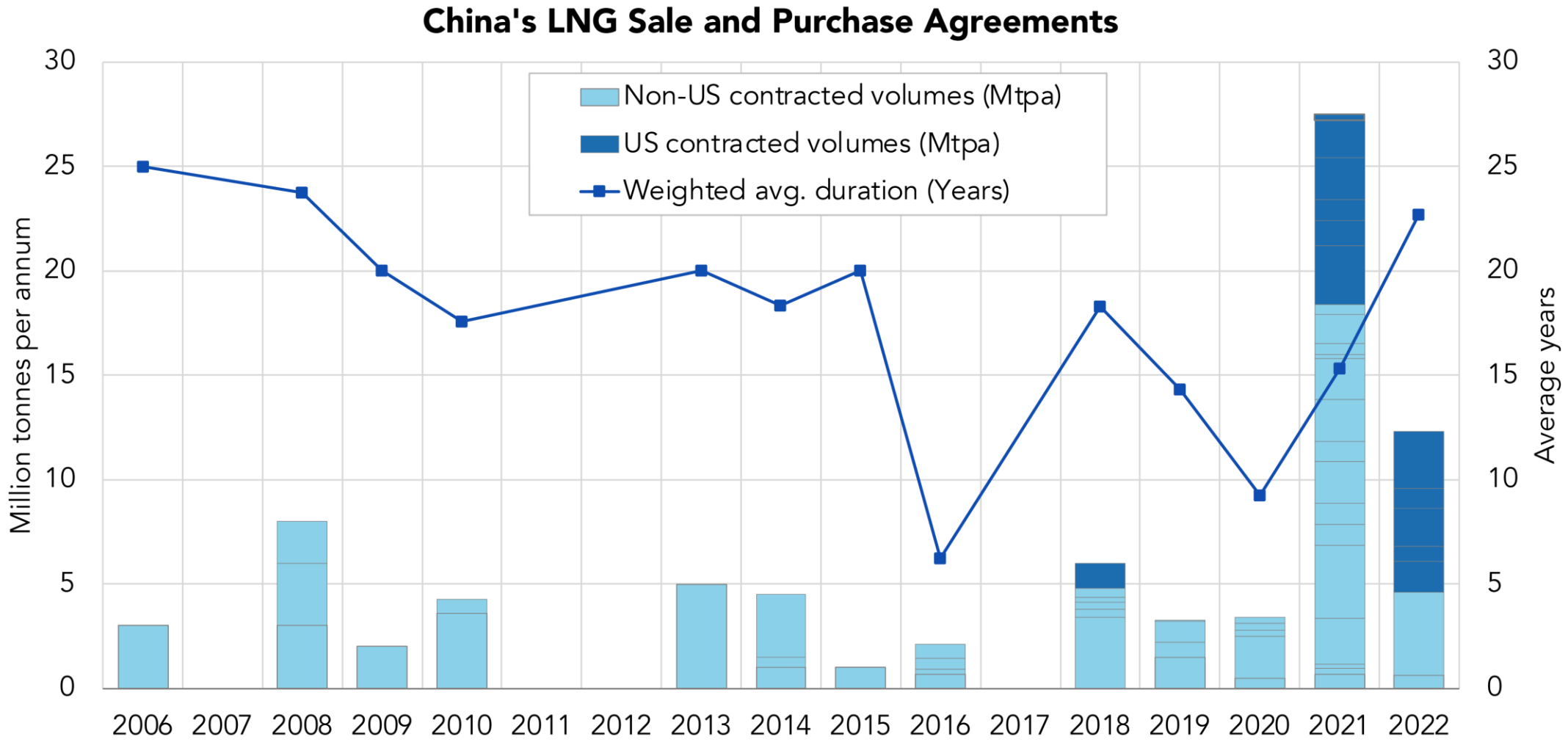




Source: EPRINC analysis based on data from BP, China Customs

China Signed Record Number of Long-term Contracts in 2021 & 2022



Each rectangle represents an SPA.
Source: 2006-2021 data from GIIGNL annual reports, 2022 data from various sources, press releases

Government Imposed Restrictions Will Yield Stranded Assets and Revenue Losses to States

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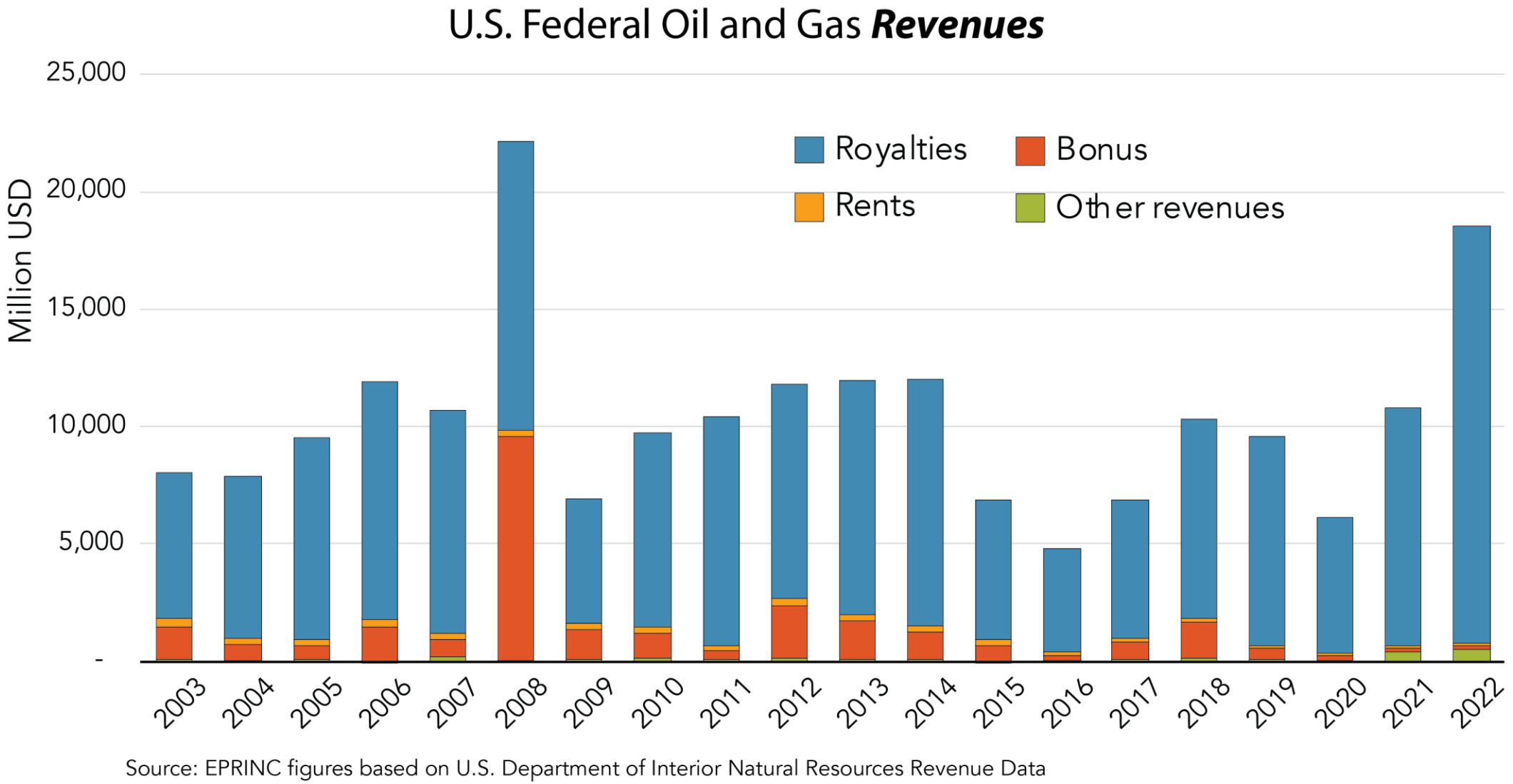
Federal Onshore Oil & Gas Lease Sale Yielded $468 Million for New Mexico in 2018

In December 2018, Federal onshore Oil & Gas Lease Sale yielded $972 million, of which $486 million was distributed to New Mexico under U.S. Law

These funds will no longer be available should a successful ban on federal oil & gas development proceeds.

These funds (sometimes as high as 30% of the New Mexico state budget) fund education and health programs

Oil and Gas Revenues Important for Local Development



Source: EPRINC figures based on U.S. Department of Interior Natural Resources Revenue Data

Electrification Trends: Non-OECD Long Way to Go

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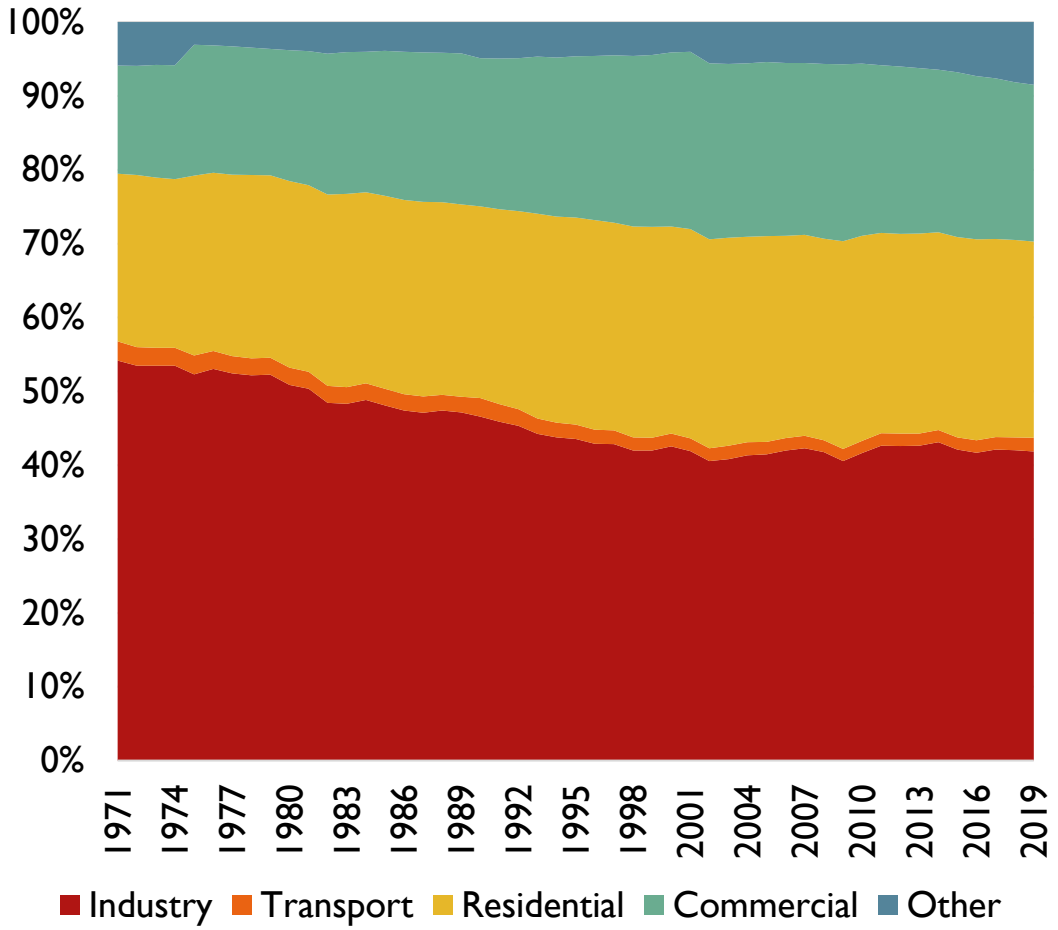
Global electricity consumption by end-use sector, 1971-2019



Source: Energy Policy Research, IEA WEB

Residential generation, kWh per capita