Decarbonization and National Security: US Fuel Production and Export Scenarios

National Clean Energy Week

September 26, 2023

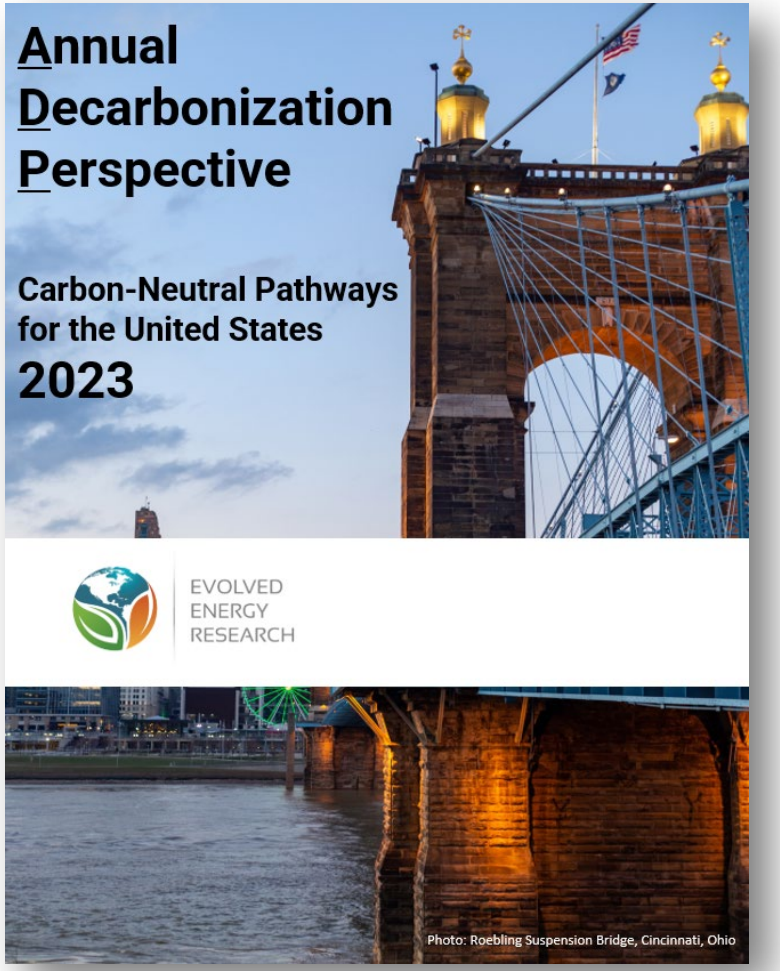
Prof. Jim Williams, University of San Francisco

Ryan Jones, Evolved Energy Research

2023 Annual Decarbonization Perspective October Release

EVOLVED ENERGY RESEARCH

- Funded by Breakthrough Energy to produce annual updates with new data, scenarios, and modeling capabilities
  - **Goal 1:** Produce the granular modeling necessary to create actionable emissions plans for the United States
  - **Goal 2:** Develop public datasets for other researchers exploring energy system questions
  - **Goal 3:** Reinforce modeling best practices
  - **Goal 4:** Encourage institutionalization of decarbonization pathways modeling by other institutions



ADP 2023 Scenarios

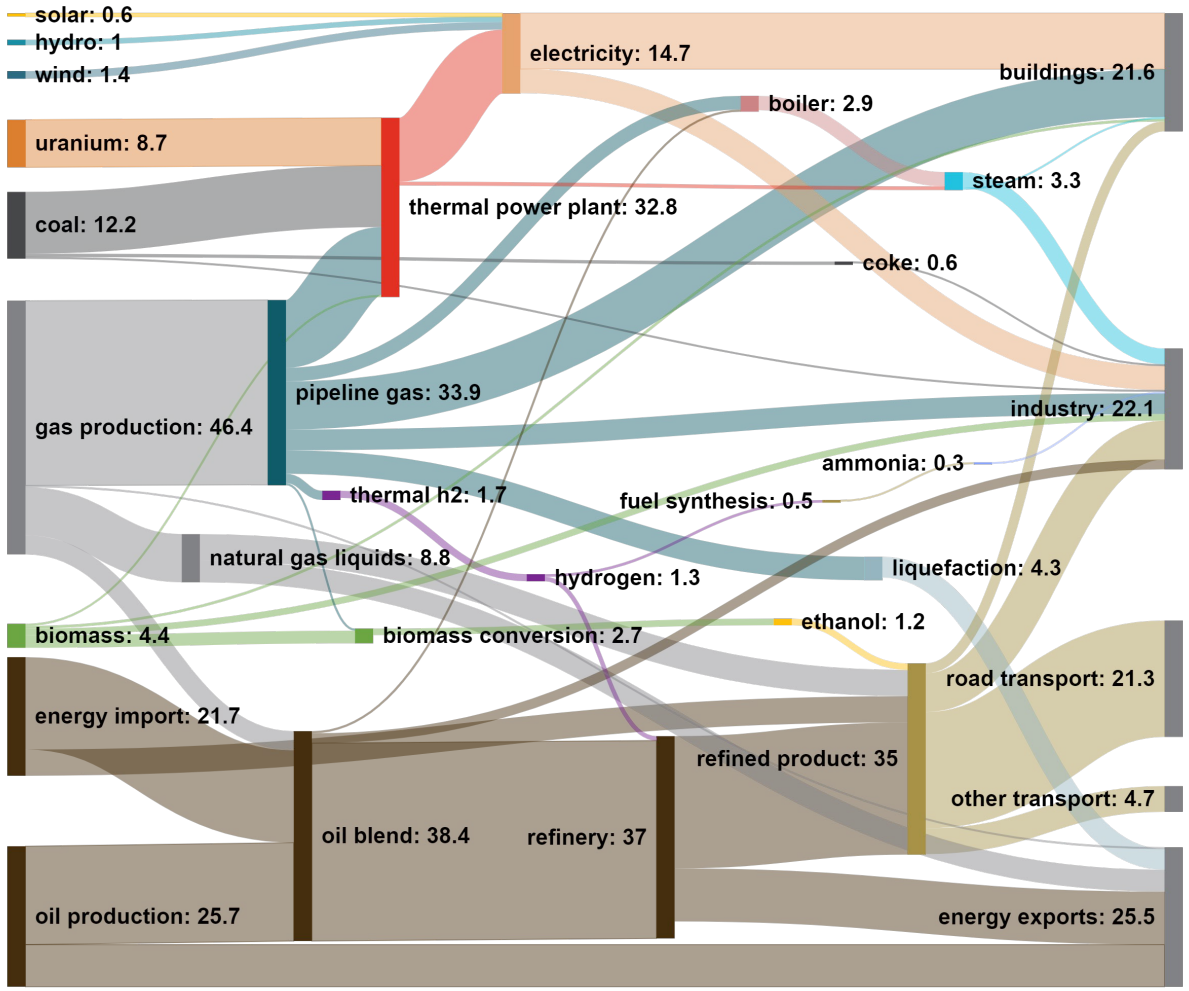
Scenario	Description
Baseline	Based on the DOE's Annual Energy Outlook 2023.
IRA	Based on Princeton's REPEAT mid scenario.
Central	Least-cost pathway for achieving net-zero greenhouse gas emissions by 2050.
Drop-In	Attempts to minimize capital, labor, and institutional disruption.
Low Demand	Reduces the demand for energy services from that used in the other net-zero scenarios.
Low Land	Limits the use of land-intensive mitigation solutions.
Slow Consumer Uptake	Delays by twenty years the uptake of fuel-switching technologies.
100% Renewables	Allows only wind, solar, biomass, and other forms of renewable energy by 2050.

U.S. Net-Zero Sankey Diagram

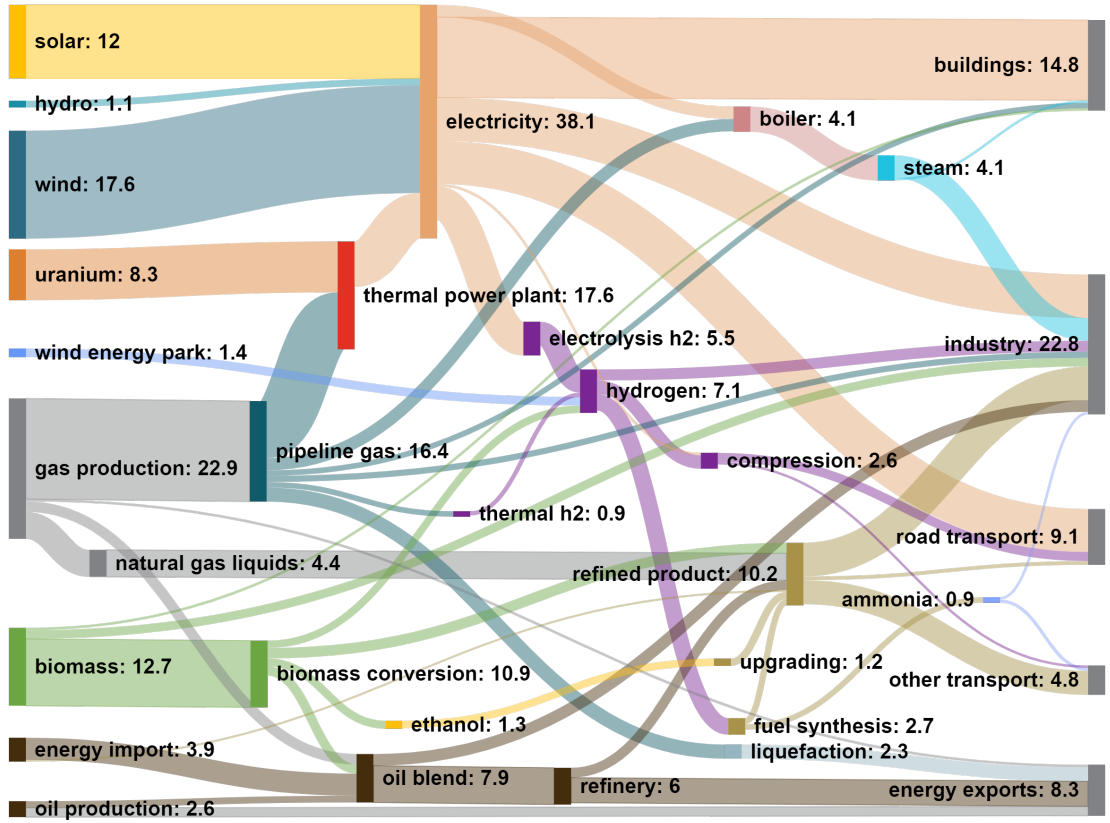
2023 Annual Decarbonization Perspective

EVOLVED ENERGY RESEARCH

2021



2050 Central Scenario



Decarbonization and National Security

EVOLVED ENERGY RESEARCH

What is the effect of a transition to a net-zero energy system by mid-century on US strengths and vulnerabilities?

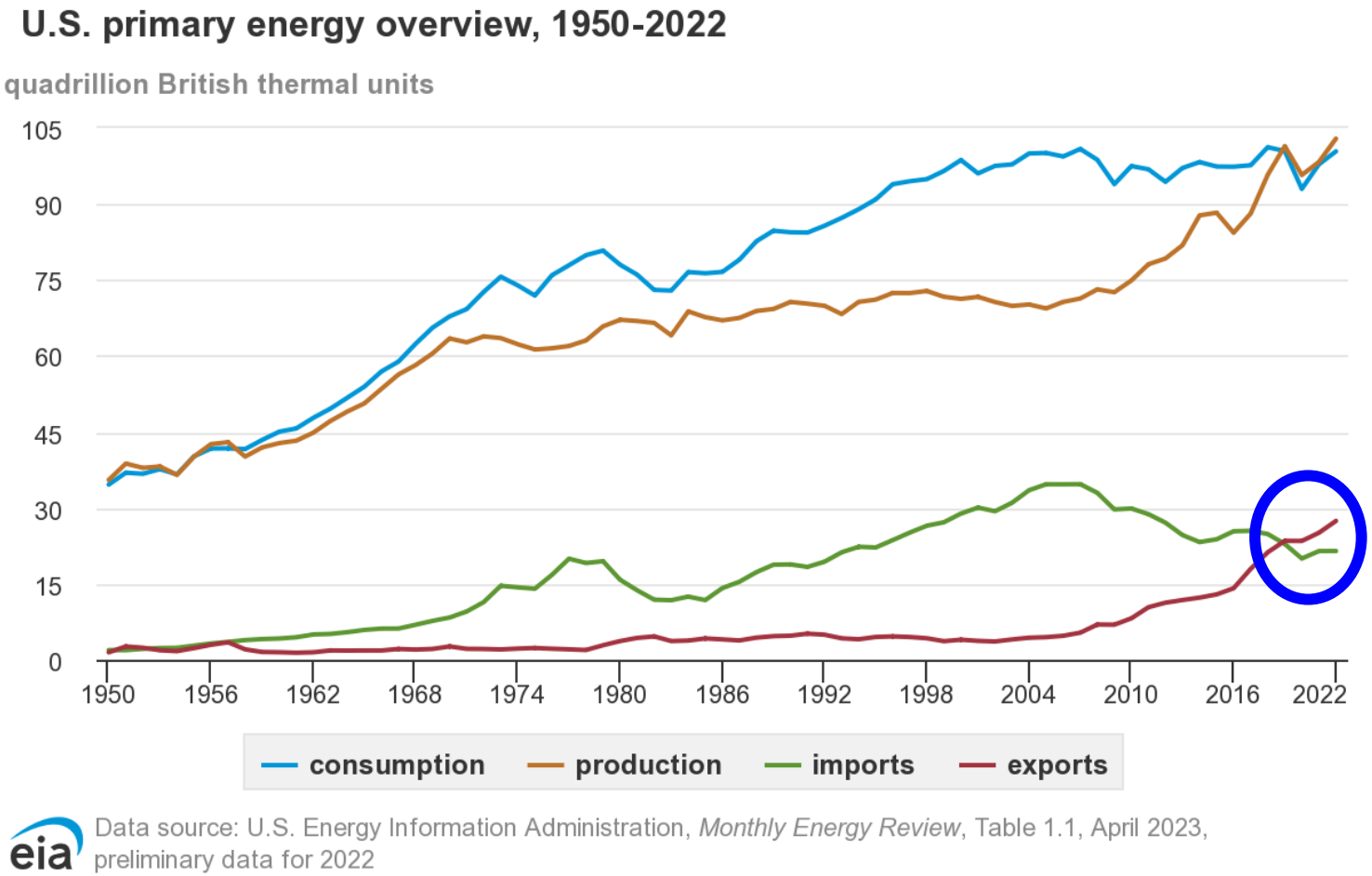
- **Energy supply diversity**
- **Electricity system reliability**
- **Strategic materials supply chains**
- **Industrial competitiveness**
- **Military mission readiness**
- **Global energy markets** ← Today's topic

Take-Home Messages

EVOLVED ENERGY RESEARCH

- Domestic decarbonization and domestic fossil fuel extraction are not necessarily at odds in the medium-term.
- Reduced domestic fossil fuel consumption (driven by electrification) can improve the U.S. geopolitical position by increasing export potential while also limiting U.S. exposure to oil price shocks.
- In the long-term, the volumes and composition of global energy trade will shift in a decarbonizing world.
- The U.S. is on a very competitive footing in emerging carbon neutral fuel markets and should work towards encouraging their development domestically and abroad.

The US is currently a net energy exporter



Data source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.1, April 2023, preliminary data for 2022

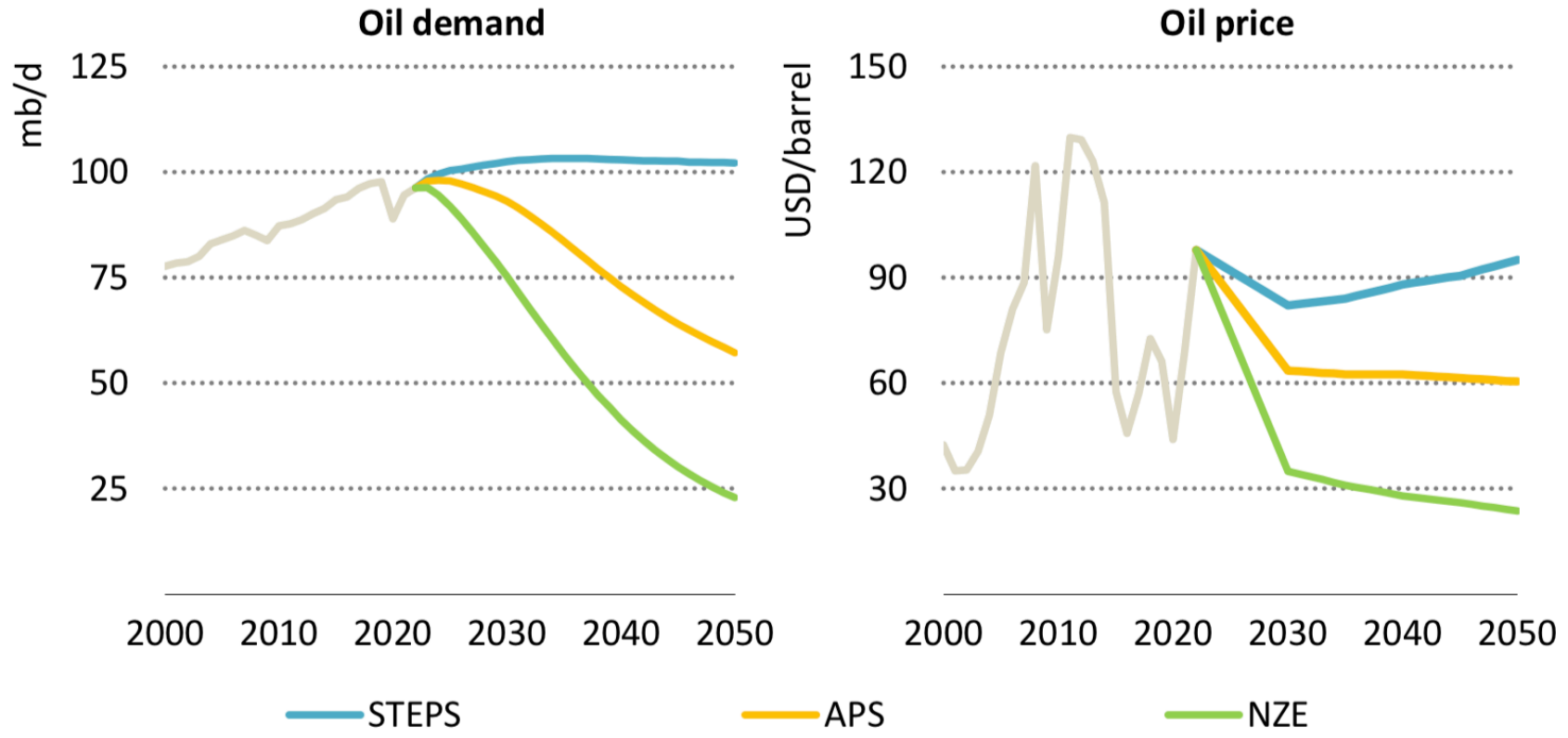
Net exporter since:

- 2017 for natural gas
- 2019 for total energy
- 2020 for petroleum

Future of US oil exports?

EVOLVED ENERGY RESEARCH

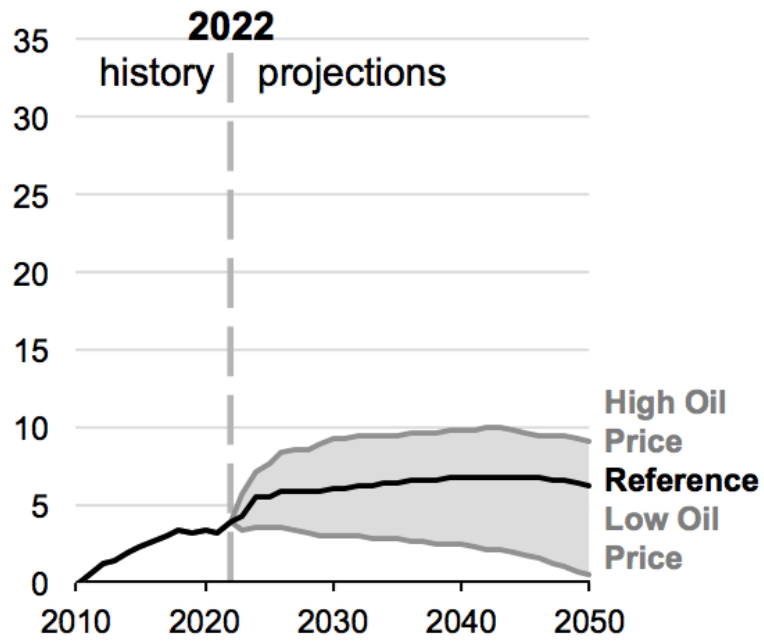
Figure 7.1 ▷ Global oil demand and crude oil price by scenario



IEA *World Energy Outlook 2022*

Petroleum products net exports

million barrels per day

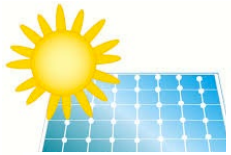


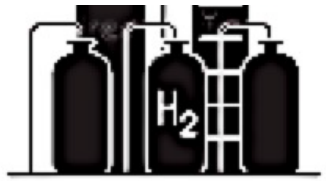
EIA *Annual Energy Outlook 2023*

Fuel production in a net-zero world

EVOLVED ENERGY RESEARCH

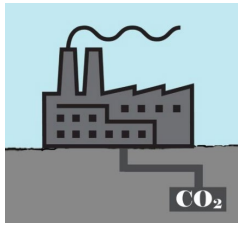
E-fuels



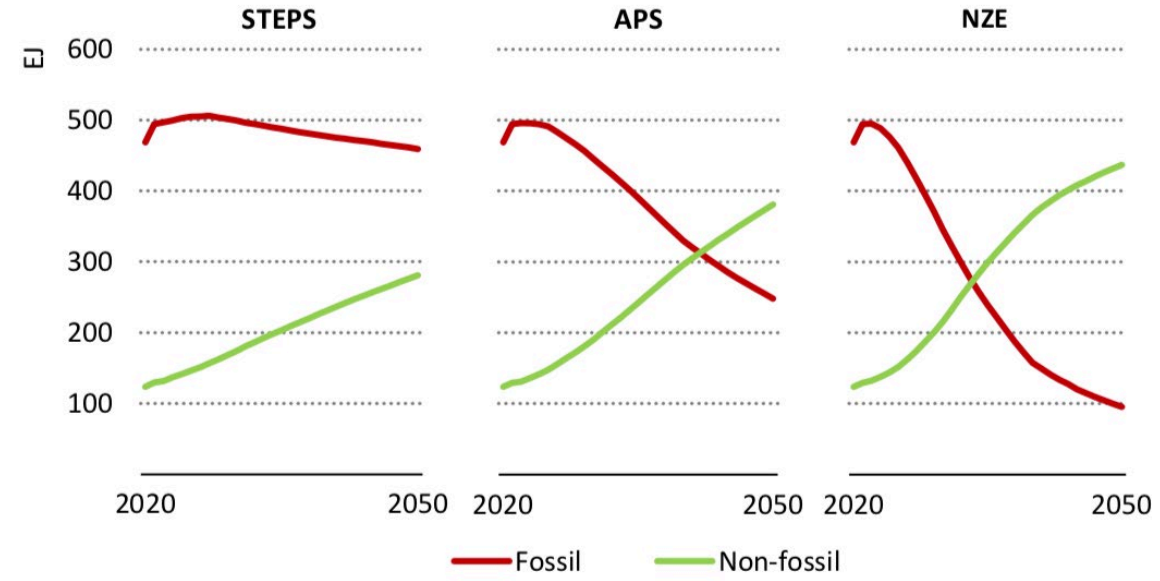


Biofuels

Fossil fuels with CCS



IEA Global Energy Scenarios



IEA. CC BY 4.0.

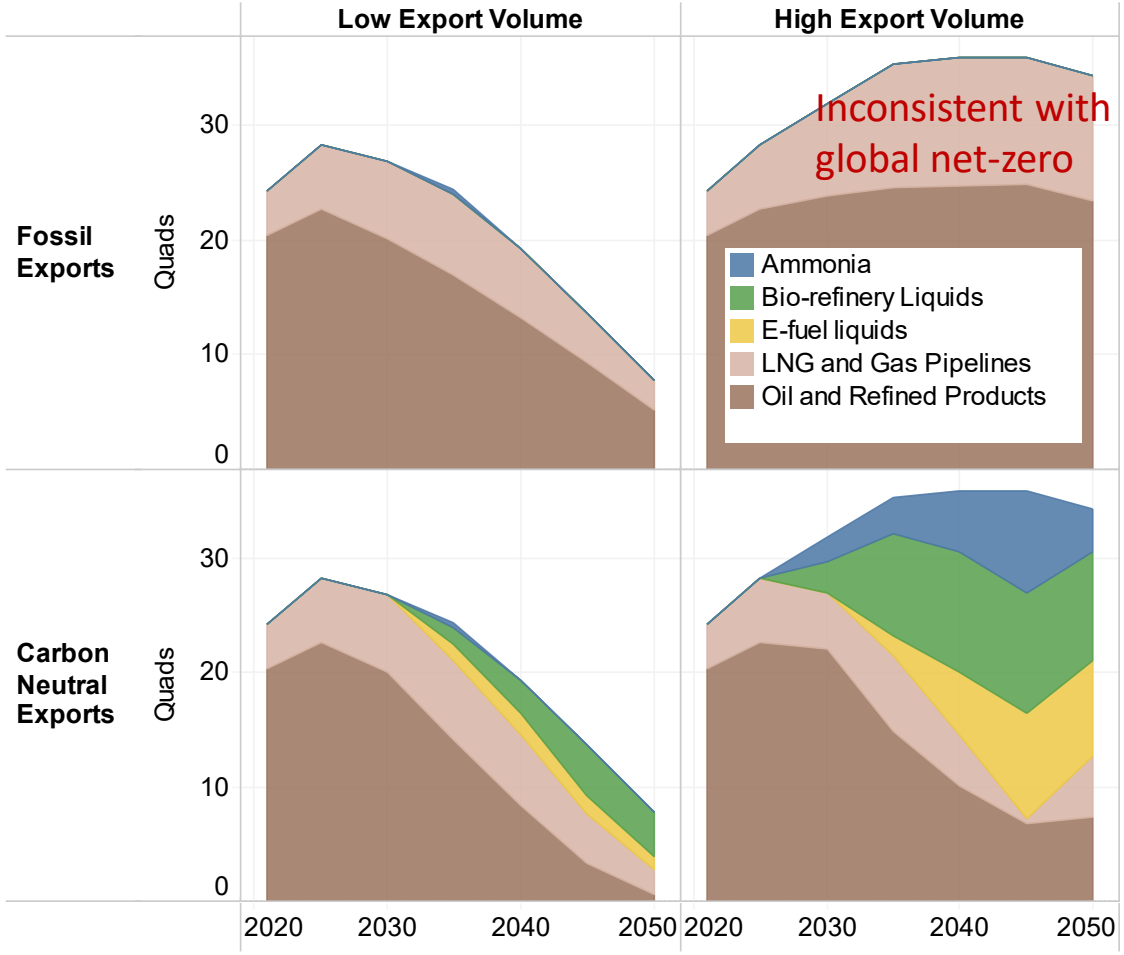
IEA *World Energy Outlook 2022*

Four US Export Scenarios

Low volume, high fossil	High volume, high fossil *
Low volume, carbon neutral	High volume, carbon neutral

*Inconsistent with global net-zero

Modeling Results: Composition of Fuel Exports



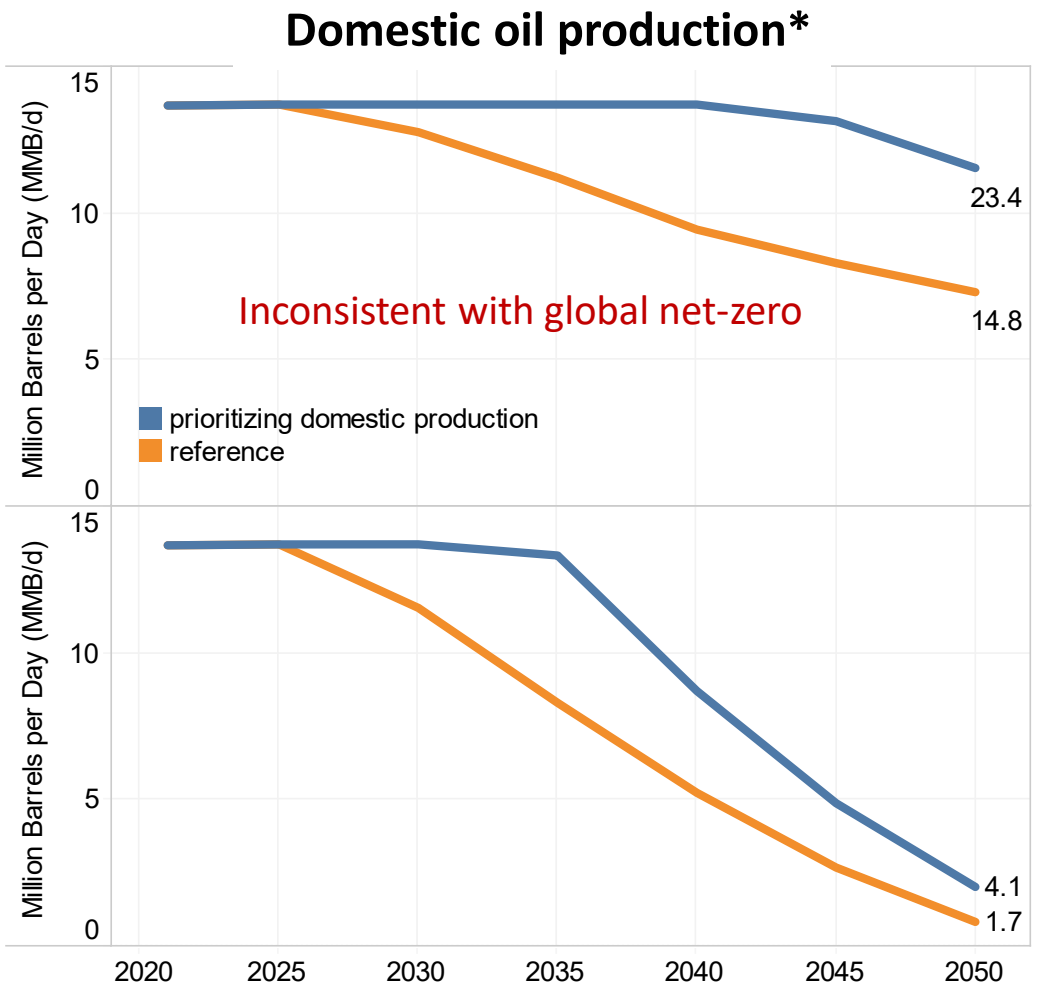
- All four cases are consistent with US reaching net-zero domestically by 2050
- Biofuels, hydrogen (in form of ammonia), and e-fuels displace fossil fuel exports in carbon neutral cases
- Remaining fossil fuel exports are offset by carbon capture in carbon neutral cases
- Higher market price of alternative fuels keep U.S. export revenues higher even in low volume carbon neutral export case

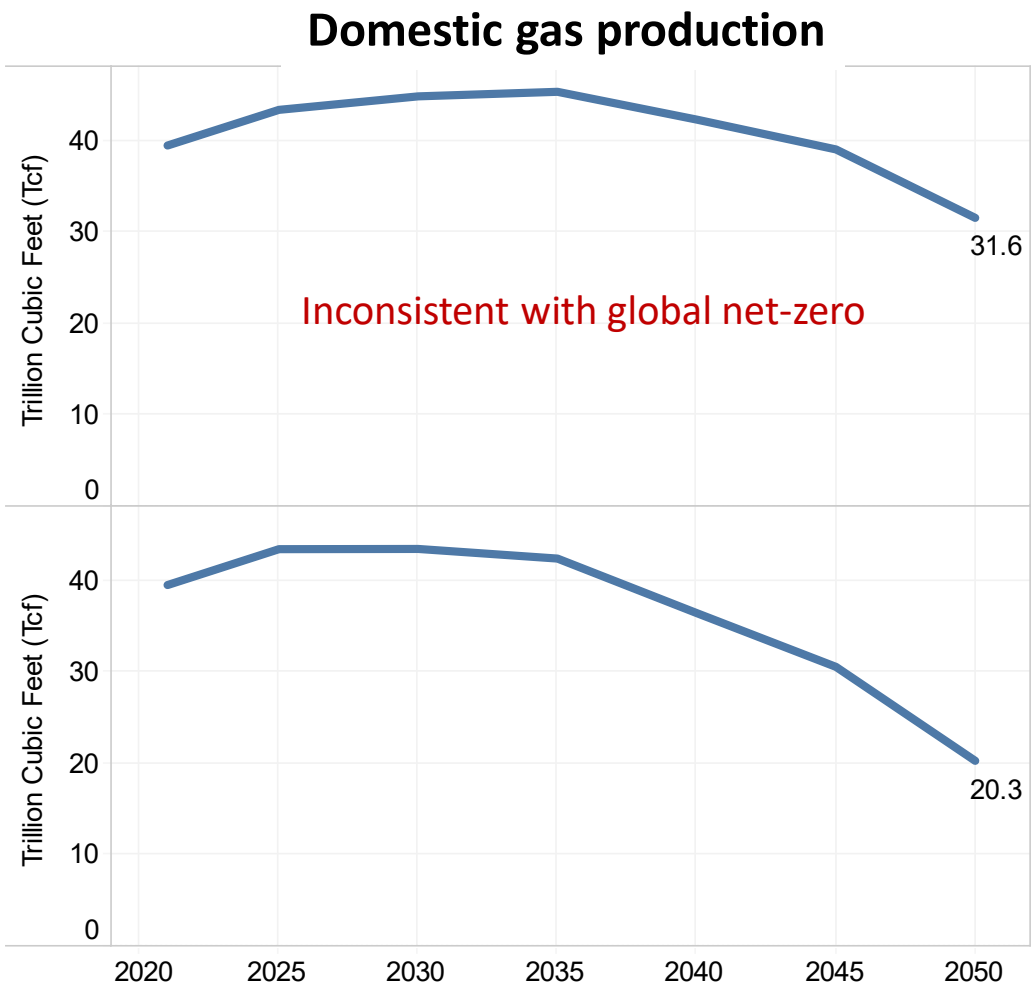
Modeling Results: Oil and Gas Production

EVOLVED ENERGY RESEARCH

High volume fossil export

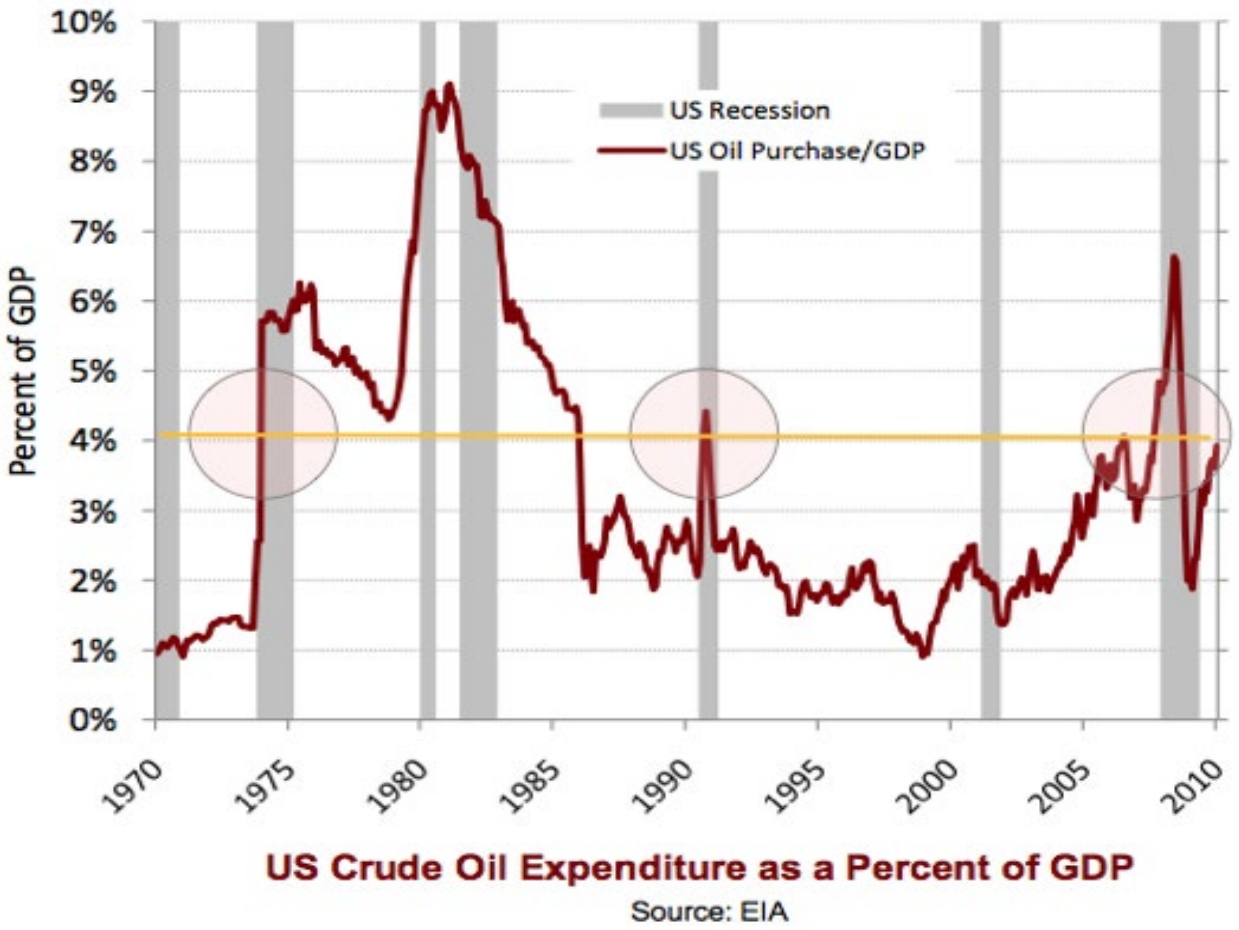
Low volume carbon neutral export

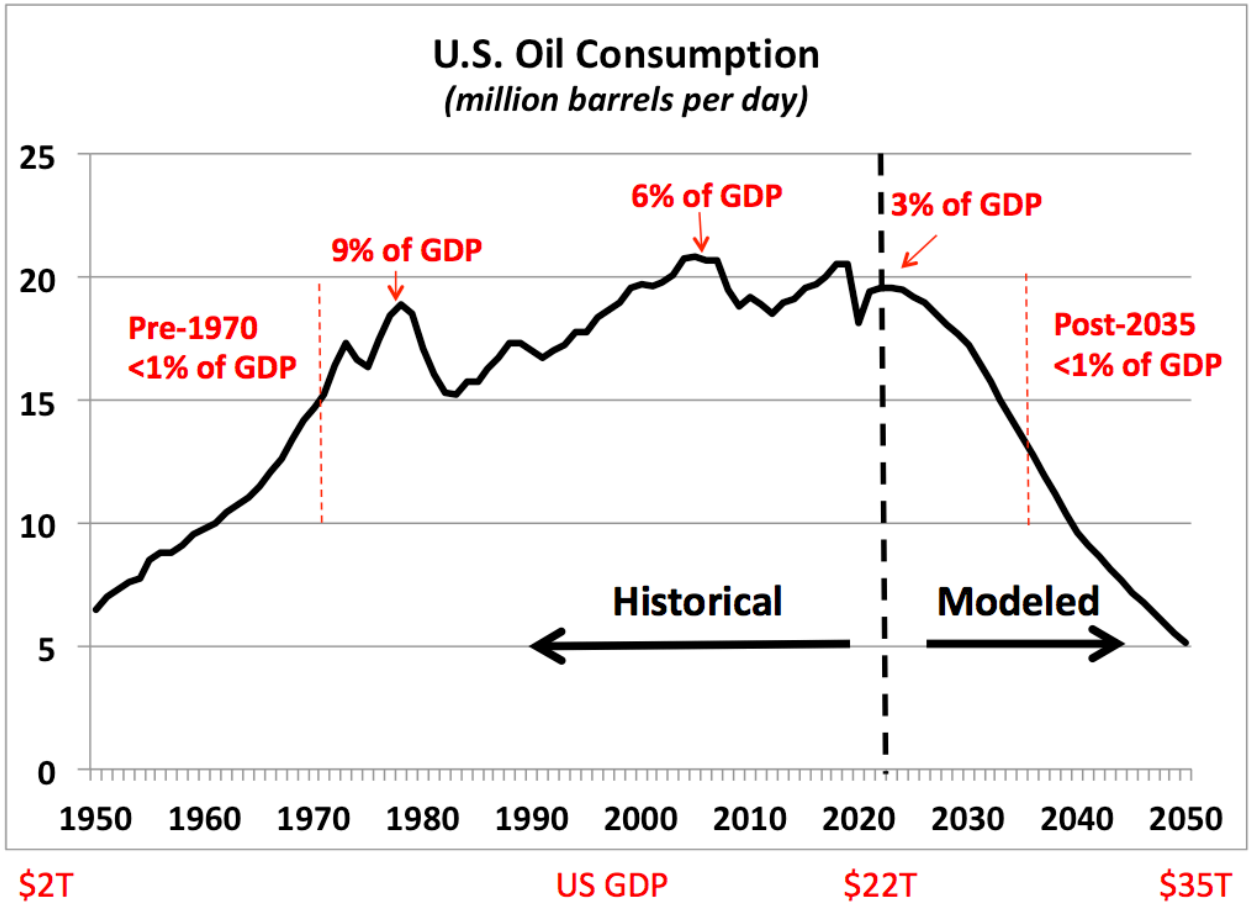




* Includes heavy condensate

Oil price shocks and US economy



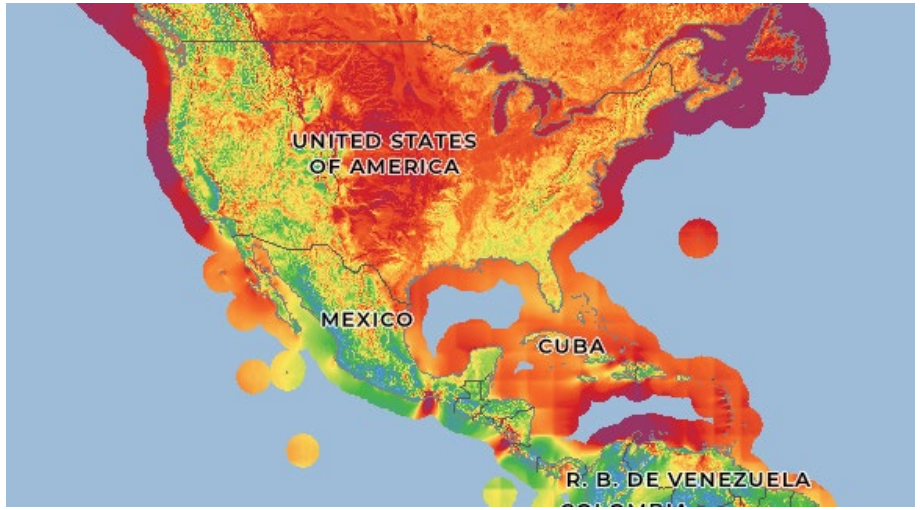


Sources: EIA, BEA, Evolved Energy ADP 2023

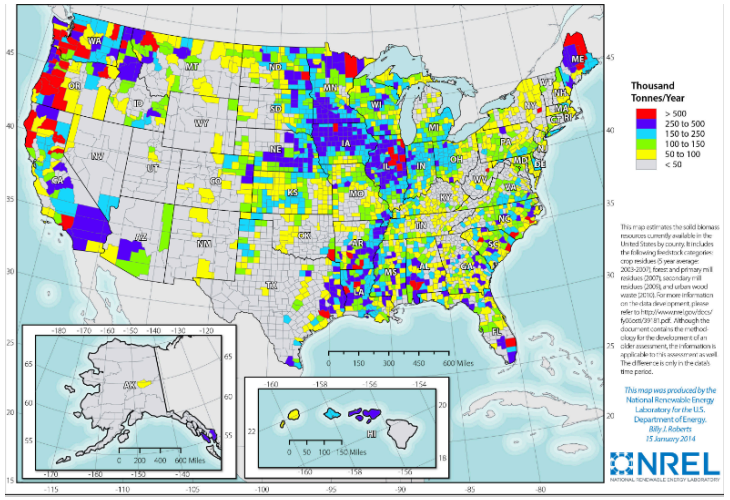
The U.S. has the resources to be globally competitive in all forms of primary energy

EVOLVED ENERGY RESEARCH

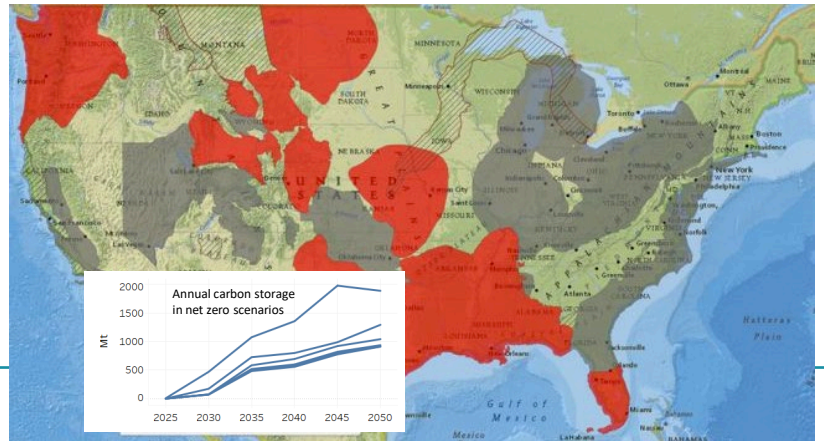
Solar and Wind



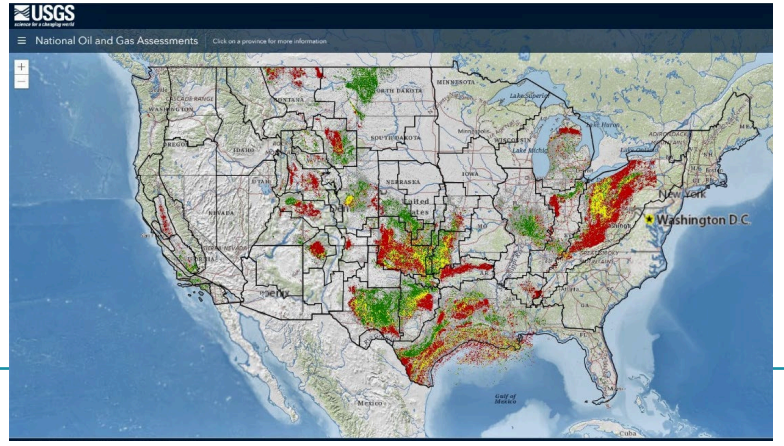
Biomass



Carbon Storage Potential



Fossil Fuels



Model Result: Export cost competitiveness

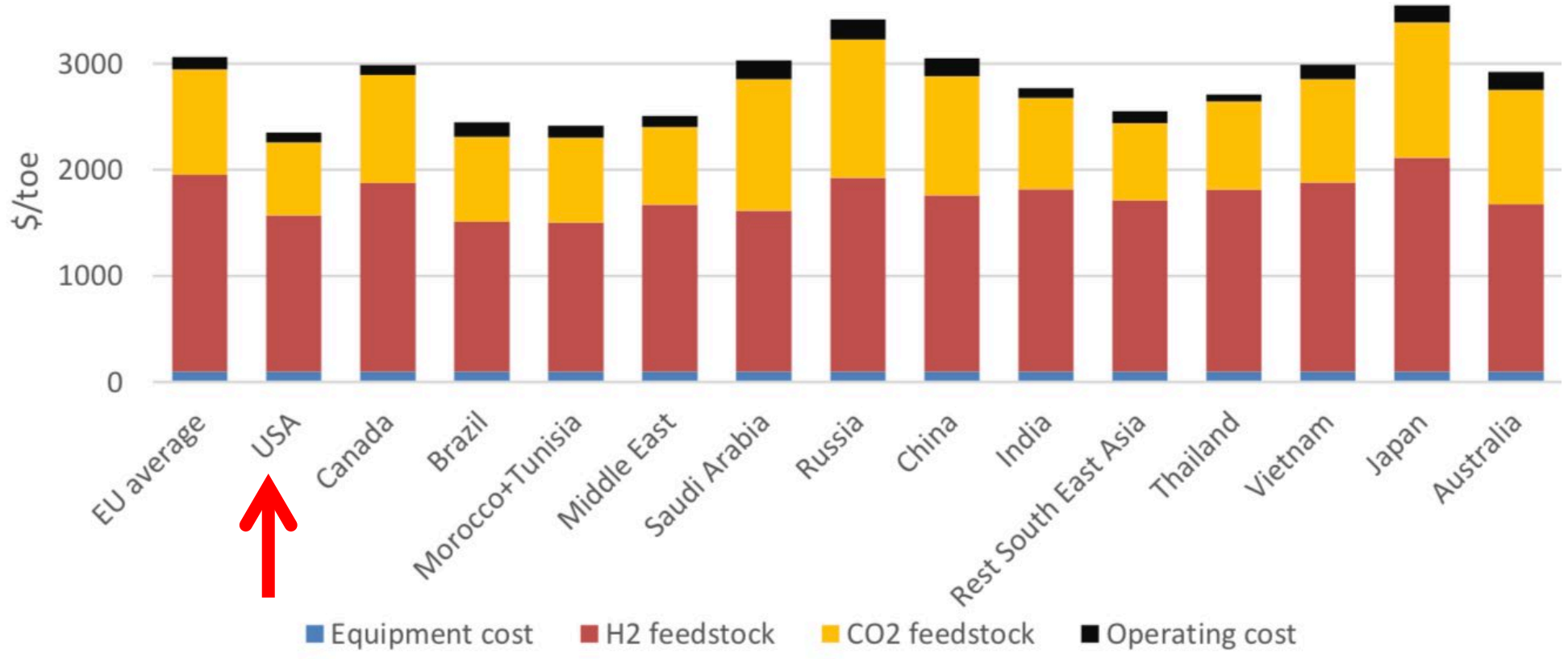
EVOLVED ENERGY RESEARCH

Long-Term Fuel Cost ($/MMBtu)	US Production	Int'l Production
Oil	$7 - $10	$5 - $10
Natural Gas	$2 - $3	$3 - $7
Decarbonized Liquid	$33 - $48	$50 - $80
Decarbonized Gas	$19 - $32	$20 - $35

Long-Term Forecast of E-Fuel Cost by Country

EVOLVED ENERGY RESEARCH

Figure 55. E-fuel production costs in selected countries/regions in 2050, 1.5°C Scenario



European Commission 2022, Energy Trade in a Decarbonized World

THANK YOU

EVOLVED
ENERGY
RESEARCH