



# EIA's International Energy Outlook 2023 and Perspectives on U.S. Liquefied Natural Gas (LNG)

*Enerclub*

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**U.S. Energy Information Administration**

*Independent Statistics and Analysis*

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# *International Energy Outlook 2023 (IEO2023)*

# What's new in the *International Energy Outlook 2023*?

- Narrative improvements carried from the *Annual Energy Outlook 2023* (AEO2023), including technical notes and an emphasis on the range of results
- New cases examining capital costs of zero-carbon technologies
- Modeling improvements:
  - New analysis regions
  - New oil and natural gas model
  - Higher temporal resolution in the electricity model
  - Assumptions about the impacts of Russia's full-scale invasion of Ukraine

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Increasing population and income offset declining energy intensity on energy demand

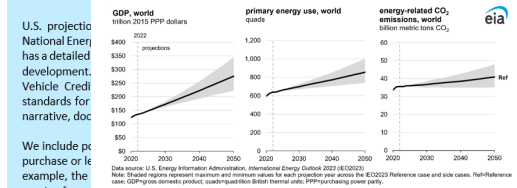
The future trajectory of energy demand will be determined by the interrelated set of dynamics in population, income, and energy intensity. The model represents both the future pathways. Total global energy demand increases 34% from 666 quadrillion Btu in 2022 to 895 quadrillion Btu in 2050 in the Reference case and varies 1,034 quadrillion Btu by 2050 in the range of cases. Total global energy-related CO<sub>2</sub> emissions increase 34% from 36.6 billion metric tons in 2022 to 49.1 billion metric tons in 2050 in the Reference case, and vary 1.0 billion metric tons in the range of cases.



October 2023

## Technical Note 1: EV penetration

We determine the non-U.S. share of electric vehicle (EV) sales in our projection using a multinomial logit function that includes comparative vehicle purchase price, cost to drive, model availability, and access to EV charging infrastructure, which both support further increases in EV sales. In our projection, the purchase price and cost to drive factors are affected by enacted and enforceable regional purchase incentives and fuel economy standards, declining battery costs, and electricity and gasoline prices. We do not include stated aspirations for EV sales in our projection.



## GDP growth and population trends are major drivers of energy market projections

IEO2023 assumes that, as incomes and population rise over time, energy consumption increases as more people can afford to drive, use commercial services, demand goods, and control building temperatures. Macroeconomic projections, specifically population and GDP trends, are key drivers of the energy consumption and production results in WEPS.

Global population increases from 7.9 billion in 2022 to 9.6 billion in 2050, an average growth rate of 0.7%, and does not vary across cases. The regions with the largest population increases by 2050 are Africa (1 billion), the Other Asia-Pacific region (306 million), and India (249 million) across all cases. Falling populations in China, Japan, Russia, and South Korea will weigh on GDP growth as the labor force shrinks.

## The IEO2023 includes cases that vary technical and economic assumptions

- All cases reflect current laws and regulations as of March 2023, and the U.S. results come directly from the AEO2023, which assumes U.S. laws and regulations as of November 2022 remain unchanged.

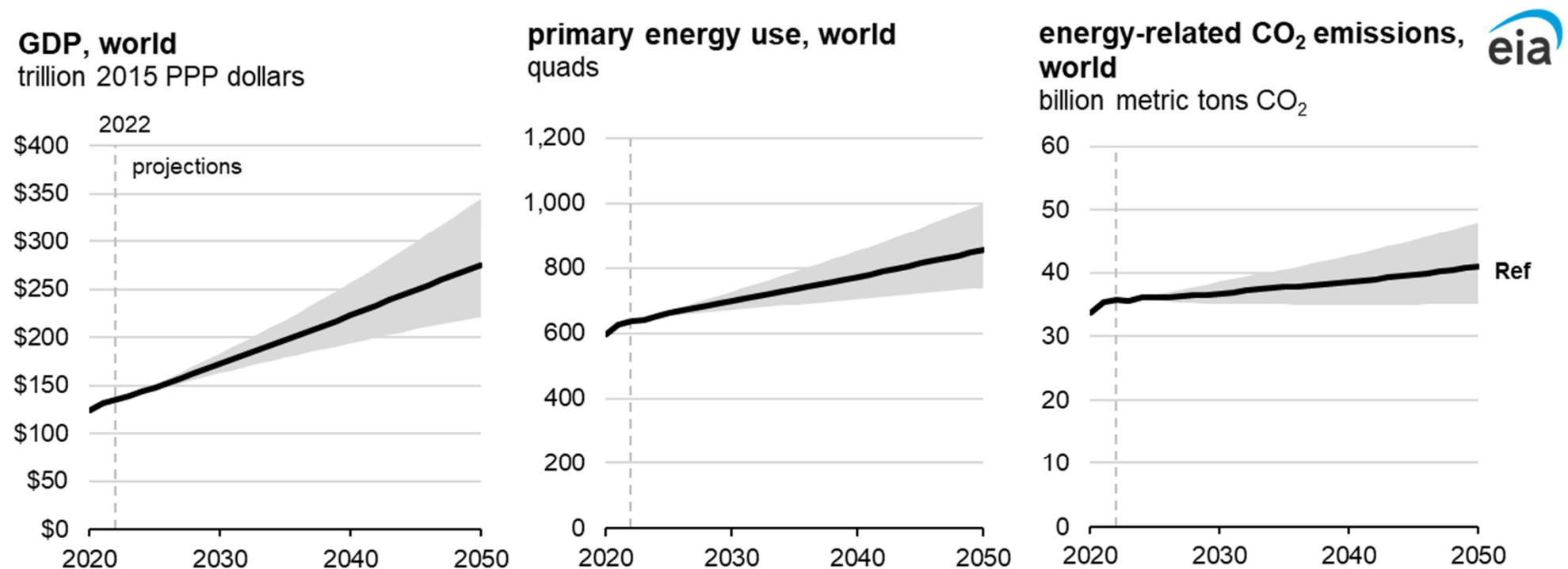
IEO2023 Case	Assumptions
Reference	Global average annual GDP (purchasing power parity) percentage change (2022–2050): 2.6% Brent: \$102 per barrel (2022\$) in 2050 Zero-carbon technologies' 2022–2050 cost reductions: up to 20%
Economic Growth	Low: 1.8% average annual GDP percentage change (2022–2050) High: 3.4% average annual GDP percentage change (2022–2050)
Oil Price	Low: \$48 per barrel (2022\$) in 2050 High: \$187 per barrel (2022\$) in 2050
Zero-Carbon Technology Cost (electric power sector)	Low: 40% reduction in capital costs below Reference case by 2050 High: No reduction in costs

*Note: Zero-carbon technologies include solar, wind, battery storage, and nuclear.*

## IEO2023 Highlights

- **Increasing population and income offset the effects of declining energy and carbon intensity on emissions.**
- The shift to renewables to meet growing electricity demand is driven by regional resources, technology costs, and policy.
- Energy security concerns hasten a transition from fossil fuels in some countries, although they drive increased fossil fuel consumption in others.

# Across most cases, energy-related CO<sub>2</sub> emissions continue to rise through 2050 under current laws

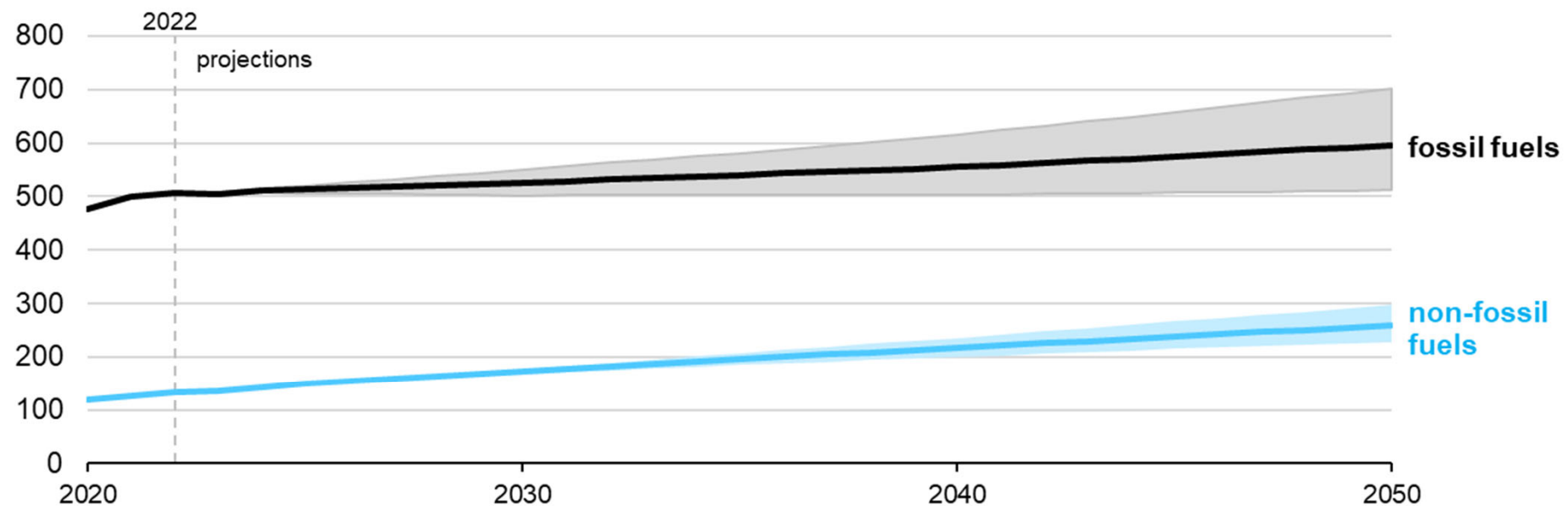


Data source: U.S. Energy Information Administration, *International Energy Outlook 2023* (IEO2023)

Note: Shaded regions represent maximum and minimum values for each projection year across the IEO2023 Reference case and side cases. Ref=Reference case; GDP=gross domestic product; quads=quadrillion British thermal units; PPP=purchasing power parity.

# Increasing demand and current policies drive steady growth in fossil fuel energy—and faster growth in non-fossil fuel sources

Primary energy use, world  
quads



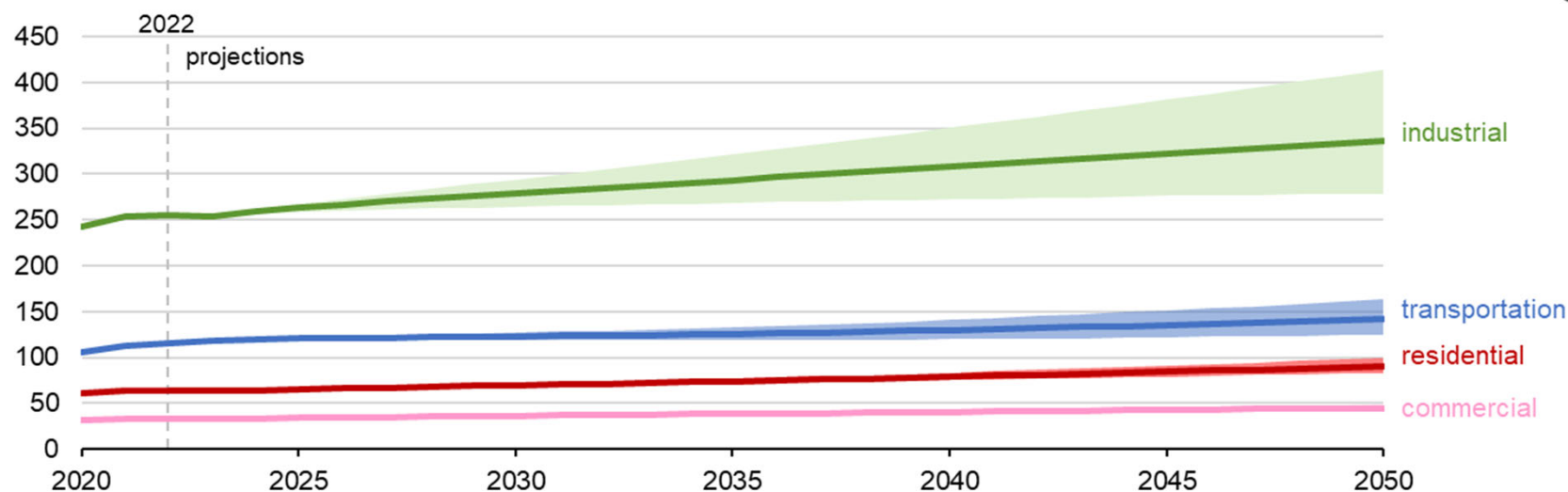
Data source: U.S. Energy Information Administration, *International Energy Outlook 2023* (IEO2023)

Note: Each line represents IEO2023 Reference case projections. Shaded regions represent maximum and minimum values for each projection year across the IEO2023 Reference case and side cases. Quads=quadrillion British thermal units.



## Across all IEO2023 cases, energy consumption increases, with strong global demand growth in the industrial sector

Total energy consumption by sector, world  
quads

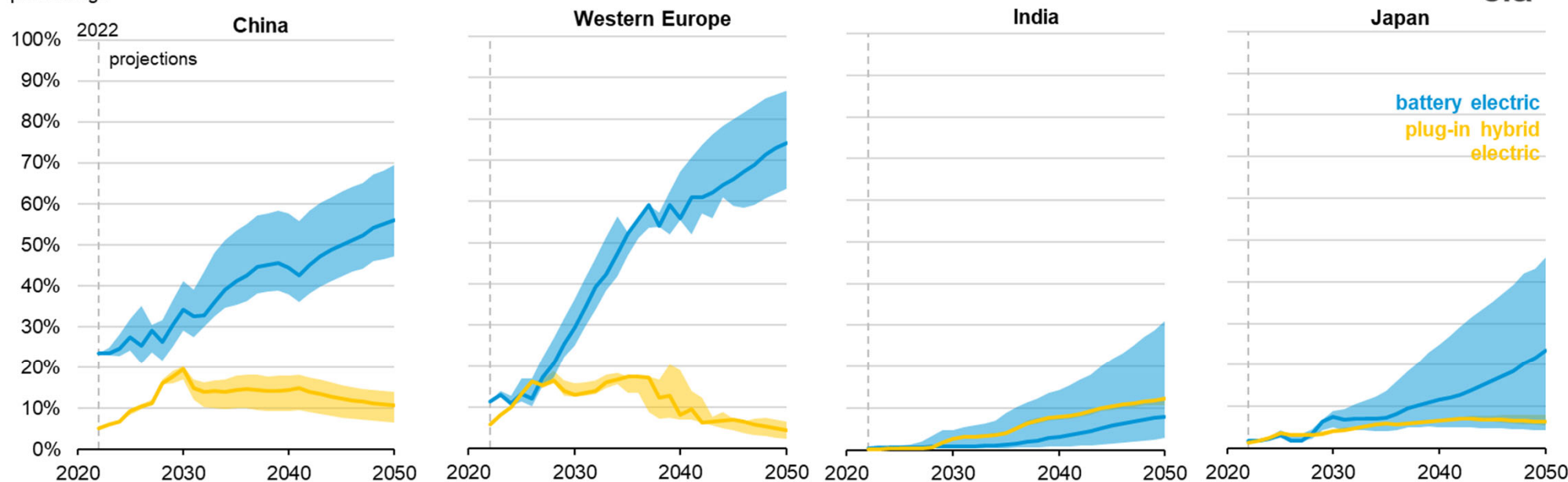


Data source: U.S. Energy Information Administration, *International Energy Outlook 2023* (IEO2023)

Note: Quads=quadrillion British thermal units. Each line represents IEO2023 Reference case projections. Shaded regions represent maximum and minimum values for each projection year across the IEO2023 Reference case and side cases.

# Electric vehicle sales grow due to policy incentives, efficiency standards, electricity prices, and battery costs

Electric share of light-duty vehicle sales  
percentage



Data source: U.S. Energy Information Administration, *International Energy Outlook 2023* (IEO2023)

Note: Each line represents IEO2023 Reference case projections. Shaded regions represent maximum and minimum values for each projection year across the IEO2023 Reference case and side cases.

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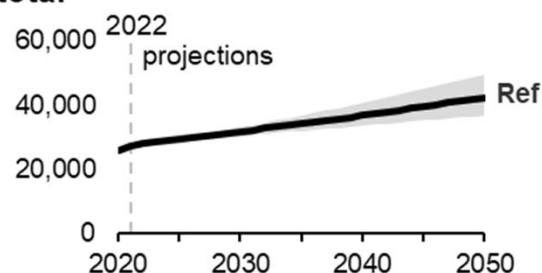
Total electricity generation worldwide increases 30% to 76% relative to 2022 across cases, and renewables and nuclear supply 54% to 67% of the total demand across cases in 2050

### Electricity generation by fuel, world

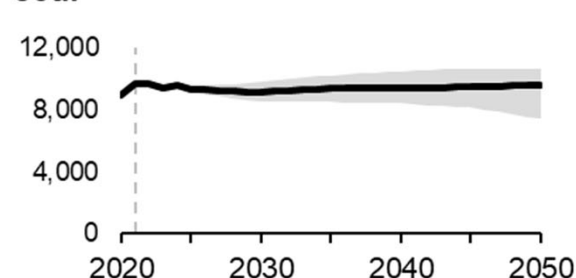
billion kilowatthours



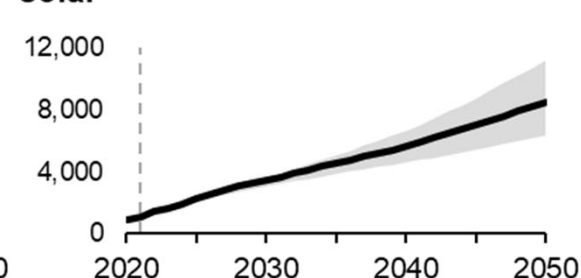
#### total



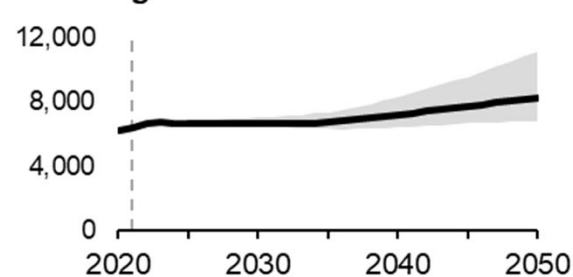
#### coal



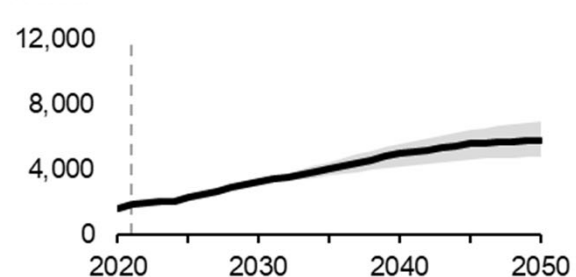
#### solar



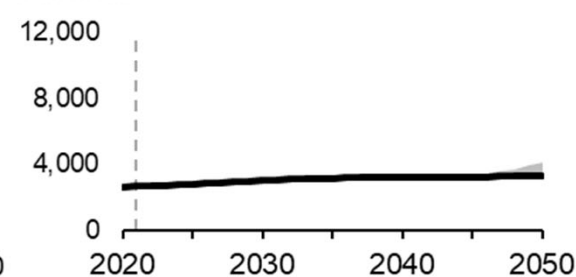
#### natural gas



#### wind



#### nuclear



Data source: U.S. Energy Information Administration, *International Energy Outlook 2023* (IEO2023)

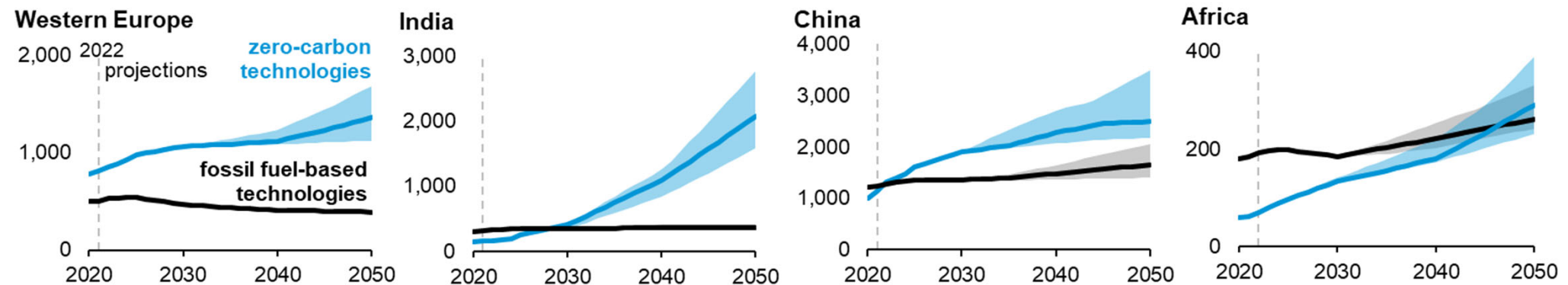
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Ref=Reference case.

## IEO2023 Highlights

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# Energy security considerations that favor locally available resources contribute to zero-carbon technology growth, which varies by region

**Electricity-generating capacity, zero-carbon and fossil fuel-based technologies, select regions**  
gigawatts

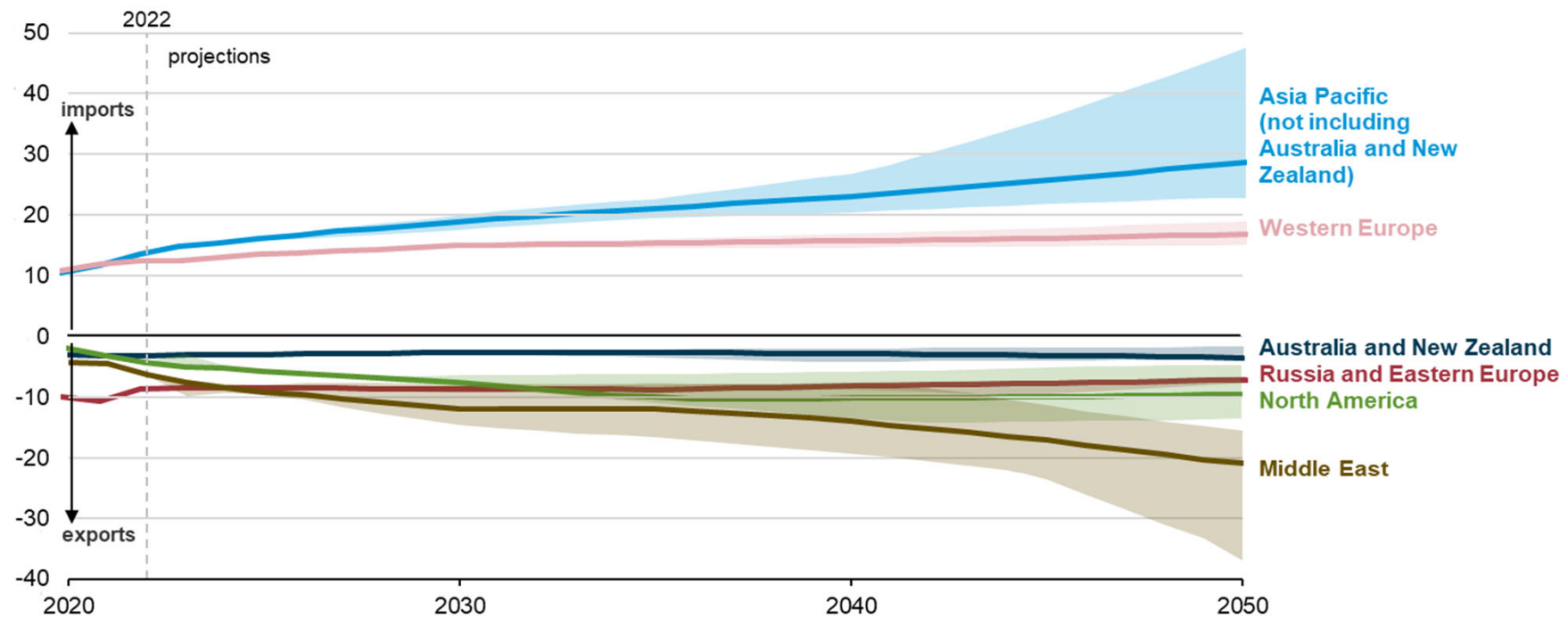


Data source: U.S. Energy Information Administration, *International Energy Outlook 2023* (IEO2023)

Note: Each line represents IEO2023 Reference case projections. Shaded regions represent maximum and minimum values for each projection year across the IEO2023 Reference case and side cases.

# Asia and Europe import more natural gas to meet growing demand, mostly supplied by growing production from the Middle East

**Net natural gas trade**  
trillion cubic feet



Data source: U.S. Energy Information Administration, *International Energy Outlook 2023* (IEO2023)

Note: Each line represents IEO2023 Reference case projections. Shaded regions represent maximum and minimum values for each projection year across the IEO2023 Reference case and side cases.

The background is a solid blue color. There are two large, concentric white arcs that sweep across the upper half of the image, creating a stylized horizon or wave effect.

# Perspectives on U.S. LNG



## *Annual Energy Outlook 2023* Background

- The *Annual Energy Outlook 2023* (AEO2023) explores long-term energy trends in the United States
- AEO2023 was released on March 16, 2023, with most of the LNG assumptions finalized by summer of 2022
- AEO2023 reflects many changes from the passage of the Inflation Reduction Act (IRA) in early 2022, which altered the U.S. policy we use to develop our projections
- AEO2023 does not include the recent pause on pending LNG export approvals. We have not yet analyzed the effects of the pause, which according to the announcement, is temporary and therefore, it is unclear what the long-term impact of the pause will be

## AEO2023 LNG planned capacity assumptions

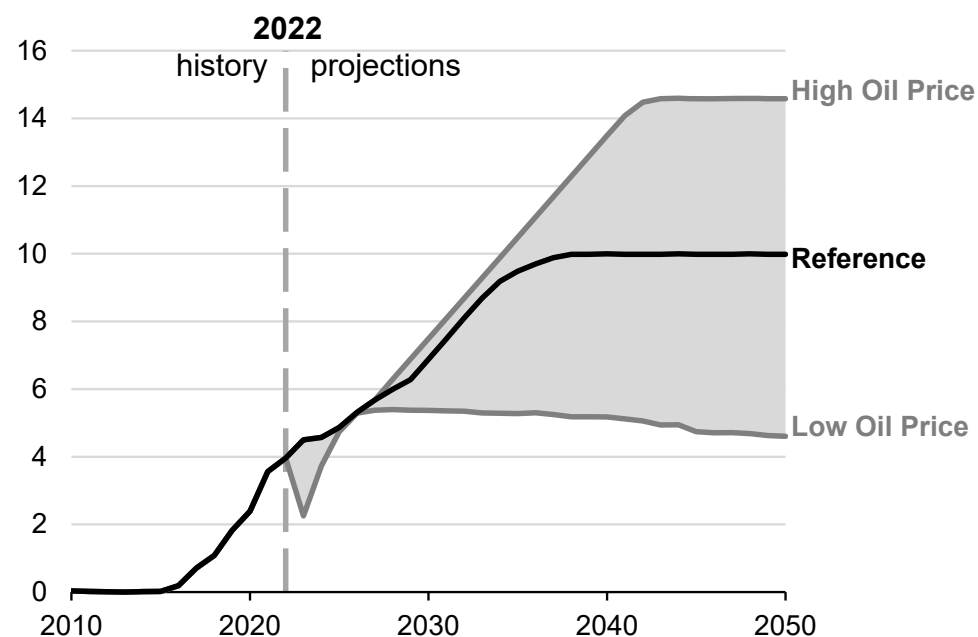
- LNG projects that were under construction as of summer 2022 enter AEO2023 projections exogenously according to the expected in-service dates from EIA's [Liquefaction Capacity Tracker](#).

LNG Project	Baseload capacity (Bcf/d)	Estimated in-service date
Golden Pass Train 1 (TX)	0.68	December 2023
Golden Pass Train 2 (TX)	0.68	July 2024
Golden Pass Train 3 (TX)	0.68	December 2024
Plaquemines Phase 1 (LA)	1.58	December 2024
Corpus Christi Stage III (TX)	1.32	December 2025

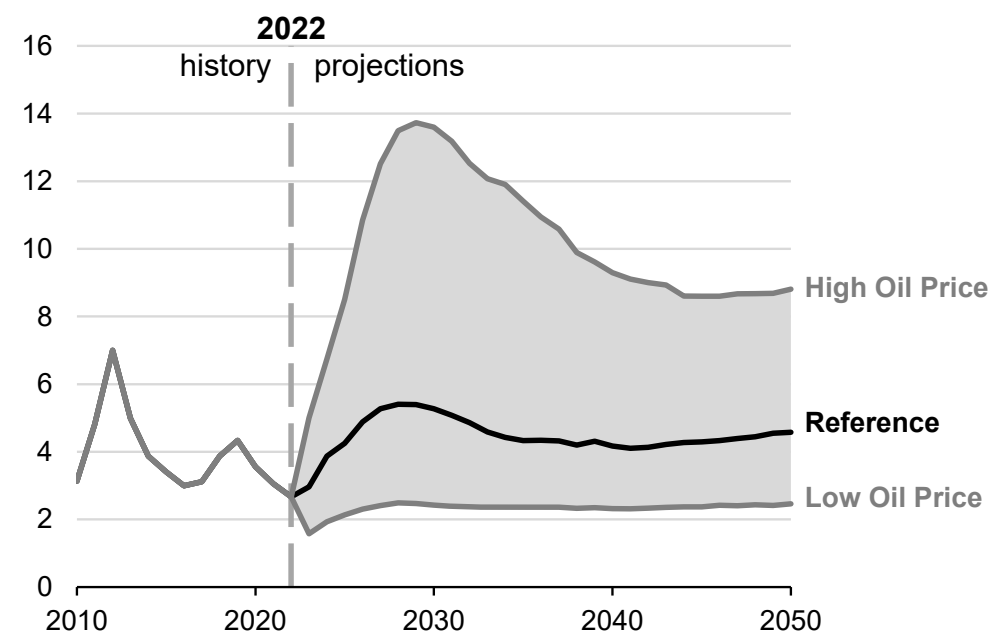
Source: [Assumptions to the Annual Energy Outlook 2023: Natural Gas Market Module](#)

## Liquefied natural gas exports grow through the late 2030s in the Reference case, but are sensitive to oil prices

**Liquefied natural gas exports**  
trillion cubic feet



**Ratio of Brent price to natural gas price at Henry Hub**  
Brent price/Henry Hub price (energy-equivalent terms)



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)

Note: Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases.

# AEO 2023 International LNG Price cases

**Table 2. Description of cases**

Case	Description
<b>Reference case</b>	We assume that up to three natural gas liquefaction trains, each with 200 billion cubic feet (Bcf) capacity, are built each year (a maximum of 600 Bcf of liquefied natural gas [LNG] capacity). This constraint on new capacity represents our assessment of the logistical challenges in building such large, complex facilities. We assume that world natural gas prices start at their recent historical ratio to the world oil price. Over time, the price of LNG becomes less tied to the world oil price as the ratio of flexibly priced LNG to the representative regional net natural gas demand increases relative to its base year level. The ratio reflects the tightness or looseness of the world LNG market pushing or pulling, respectively, world natural gas prices toward or away from the world oil price.
<b>High LNG Price case</b>	The High LNG Price case assumes that LNG prices in Europe and Asia are higher by an average of nearly 25% relative to the Reference case in 2050.
<b>Low LNG Price case</b>	The Low LNG Price case assumes that LNG prices in Europe and Asia are lower by an average of nearly 20% relative to the Reference case in 2050.
<b>Fast Builds Plus High LNG Price case</b>	In the Fast Builds plus High LNG Price case, we use the same higher price assumptions from the High LNG Price case, but we also assume four natural gas liquefaction trains, each with 200 Bcf capacity, can be built each year (a maximum of 800 Bcf of LNG capacity), a level that likely remains technically feasible.

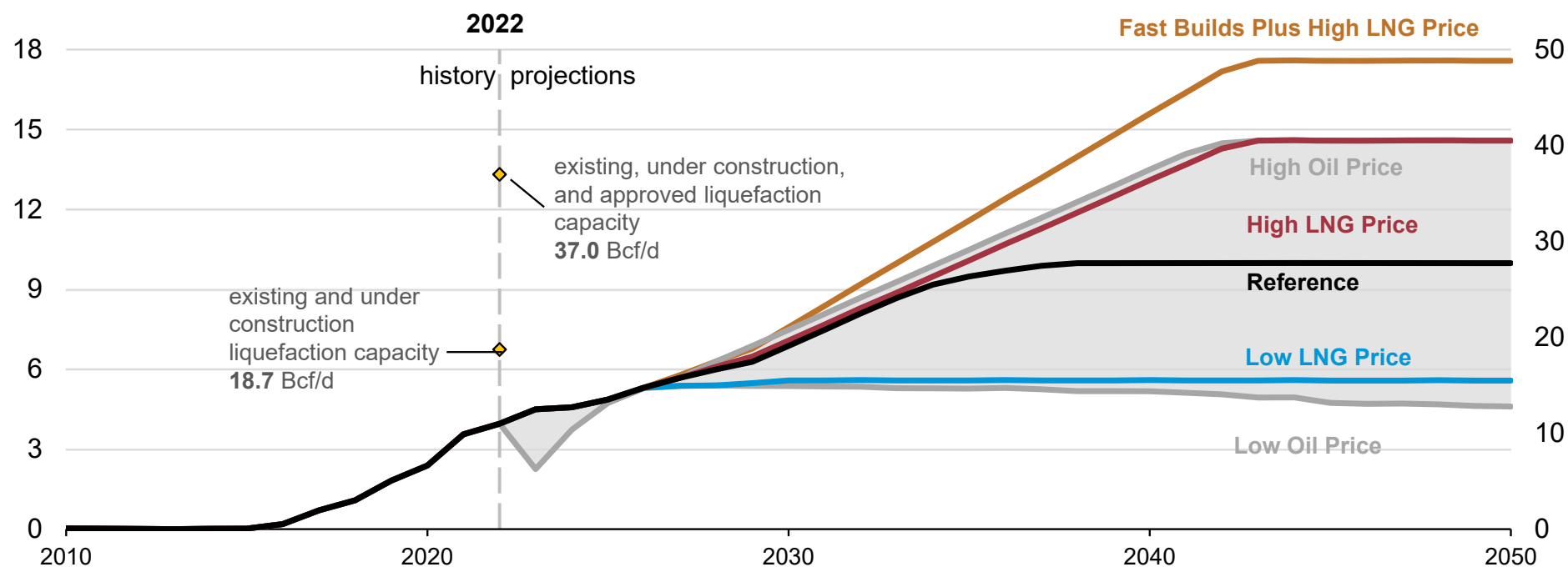
Source: [\*Issues in Focus: Effects of Liquefied Natural Gas Exports on the U.S. Natural Gas Market \(AEO2023\)\*](#)

# Lifting modeled capacity build constraints combined with higher world LNG prices increase U.S. LNG exports

## U.S. liquefied natural gas (LNG) exports, AEO2023

trillion cubic feet

billion cubic feet per day



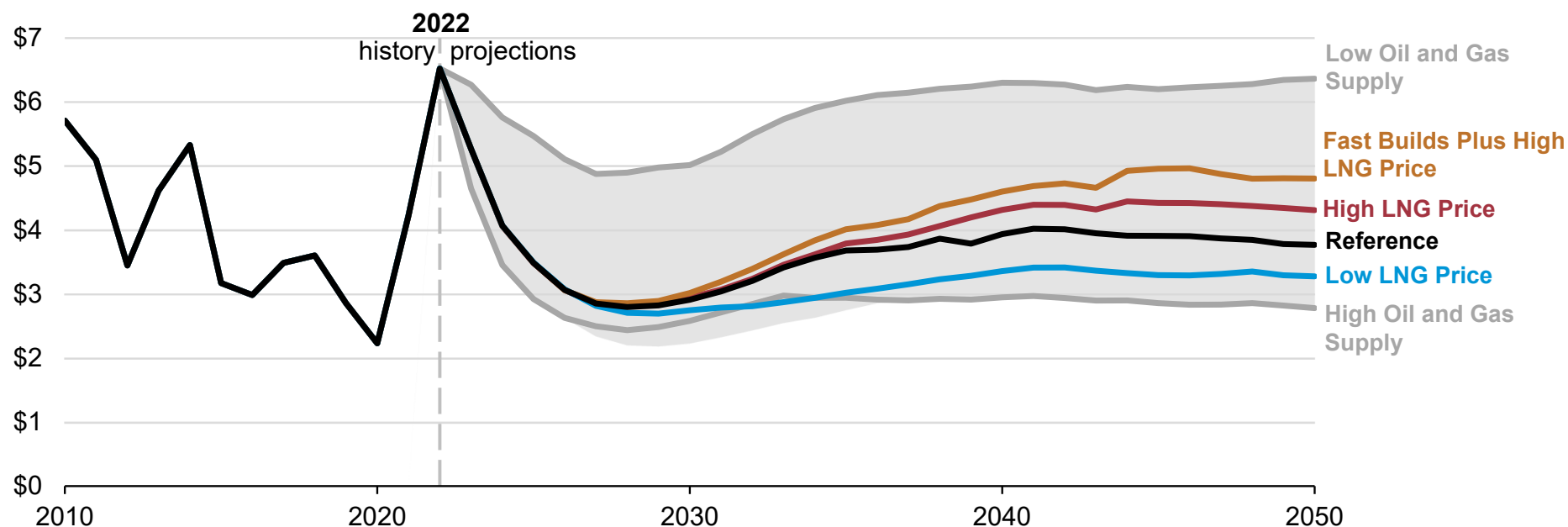
Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023) and [LNG Capacity Tracker](#).

Note: Existing, under construction, and approved LNG capacities are baseload capacities. Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases.

# The natural gas spot price is influenced by changing LNG export volumes

## Natural gas spot price at the Henry Hub, AEO2023

2022 dollars per million British thermal units



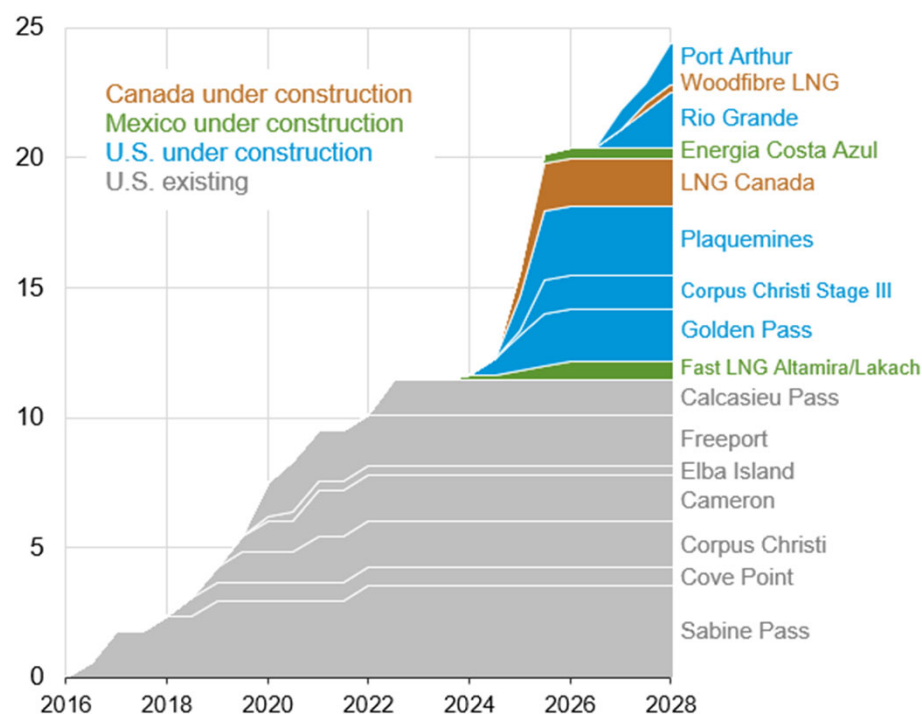
Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023).

Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases.

# Upcoming North American LNG projects and changes since AEO2023

North America liquefied natural gas export capacity by project—existing and under construction (2016–2027)

billion cubic feet per day



- By 2027, we now expect 24.3 Bcf/d of LNG capacity in North America, an increase from 11.4 Bcf/d today
  - 9.7 Bcf/d from the United States
  - 2.1 Bcf/d from Canada
  - 1.1 Bcf/d from Mexico
- LNG exports from Mexico will be supplied using natural gas from the United States
- LNG exports from Canada will be supplied using natural gas from Western Canada

Source: [Today in Energy: LNG export capacity from North America is likely to more than double through 2027](#) (11/13/2023)

## For more information

- International Energy Outlook 2023 (report and data): [eia.gov/ieo](https://www.eia.gov/ieo)
- Annual Energy Outlook 2023 (report and data): [eia.gov/aeo](https://www.eia.gov/aeo)
- AEO2023 Issues in Focus: Effects of Liquefied Natural Gas Exports on the U.S. Natural Gas Market: [eia.gov/outlooks/aeo/IIF\\_LNG/](https://www.eia.gov/outlooks/aeo/IIF_LNG/)



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