U.S. & Global Refining Capacity

The Energy Council
December 8, 2023

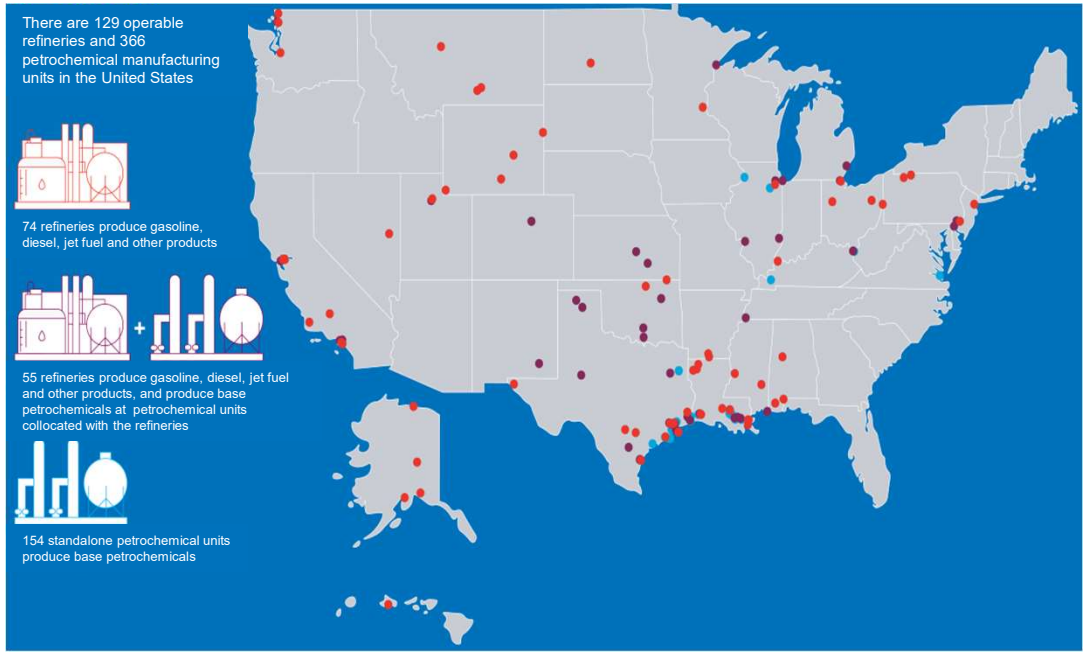
John Eick,
American Fuel &
Petrochemical Manufacturers

AFPM
American
Fuel & Petrochemical
Manufacturers

American Fuel & Petrochemical Manufacturers (AFPM)

- Founded in 1902.
- Represents U.S. refining and petrochemical manufacturing industries and midstream.
- 403 refiners and petrochemical units owned by member companies.

U.S. Refineries and Petrochemical Manufacturing



Petroleum Industry Overview

Upstream

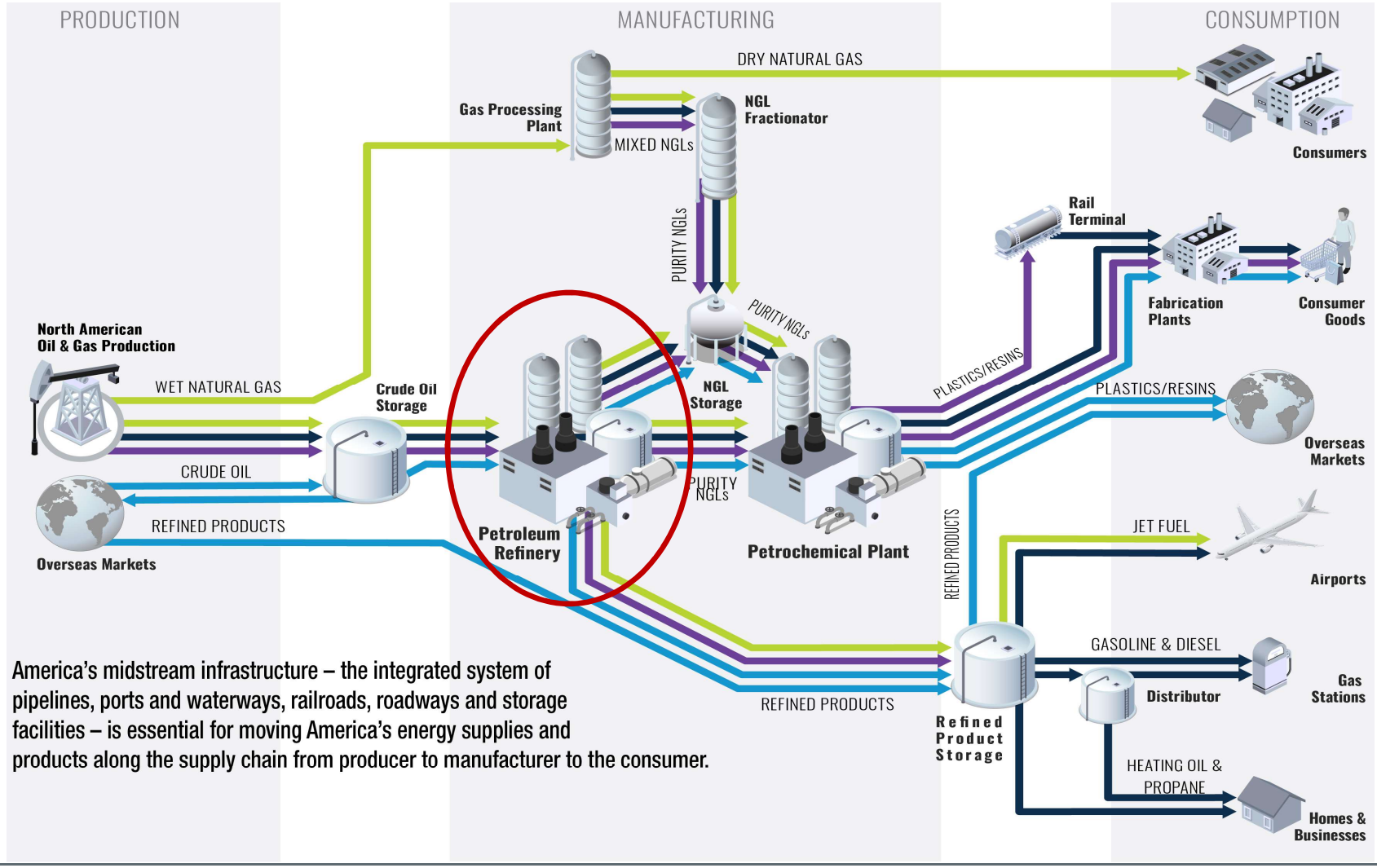
Crude oil exploration, development, and production.

Downstream

Refining crude oil into gasoline, diesel, jet fuel, and other products and marketing refined products to consumers.

Midstream

Pipelines, storage terminals, marine vessels, rail, and trucks that connect upstream with refining and refining with consumers.



America's midstream infrastructure – the integrated system of pipelines, ports and waterways, railroads, roadways and storage facilities – is essential for moving America's energy supplies and products along the supply chain from producer to manufacturer to the consumer.

U.S. Refining Industry's Economic Impact

1 **$521 billion to the national GDP.**

2 **$42 billion in federal taxes.**

3 **$80 billion in state/local taxes.**

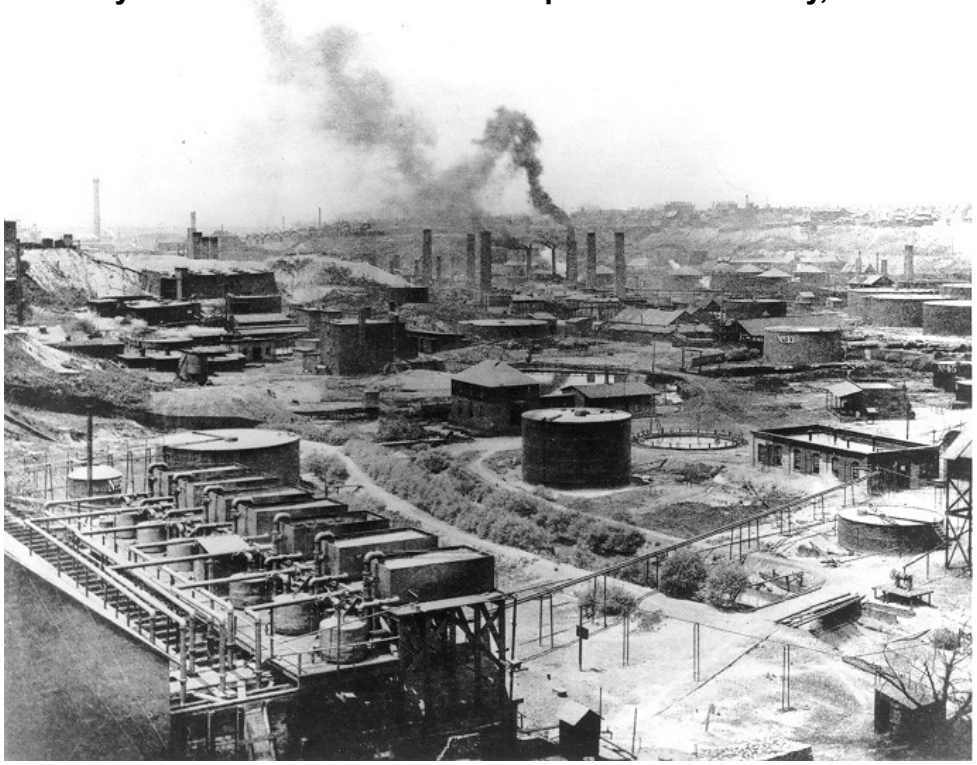
4 **Supports 2.6 million jobs, with an average compensation of ~$260,000 per year.**

Source: Oxford Analytics analysis of IMPLAN 2021 data

A Brief History of U.S. Refining

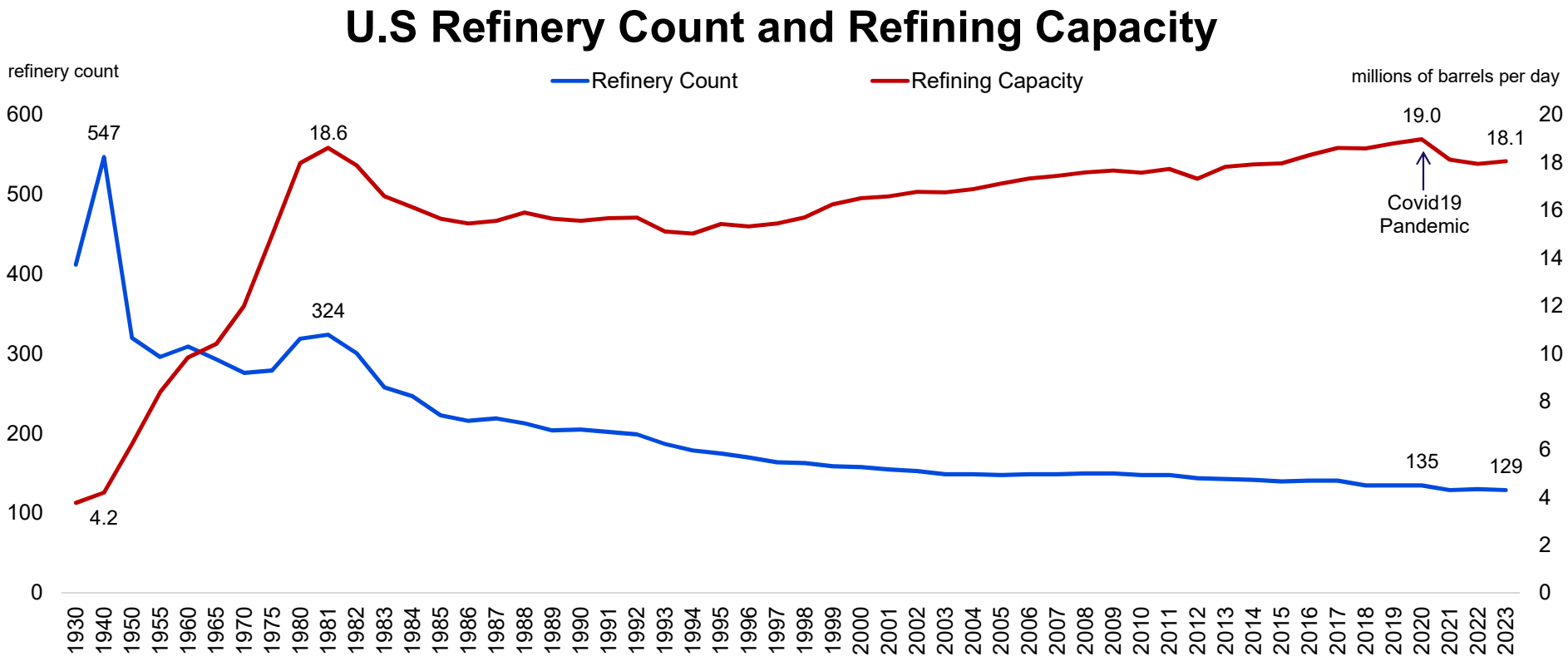
- First U.S. refinery was built by Samuel Kier in Pittsburgh in 1853 with a capacity of 1 bpd.
- Kerosene was the primary refined product and was used as lamp oil, replacing whale oil.
- U.S. oil production “began” in 1859 when the first well was drilled in northwestern Pennsylvania.
- First commercial refinery was built in Titusville, Pennsylvania in 1860.
- Crude oil was first transported in wooden barrels by wagon and later by rail.
- Cleveland was the nation’s first refining center, followed by Pittsburgh.
- Last large refinery built in the U.S. was Marathon’s Garyville refinery which came online in 1977.

Standard Oil Co.'s No. 1 Refinery in Cleveland when the city was the center of the world petroleum industry, 1889



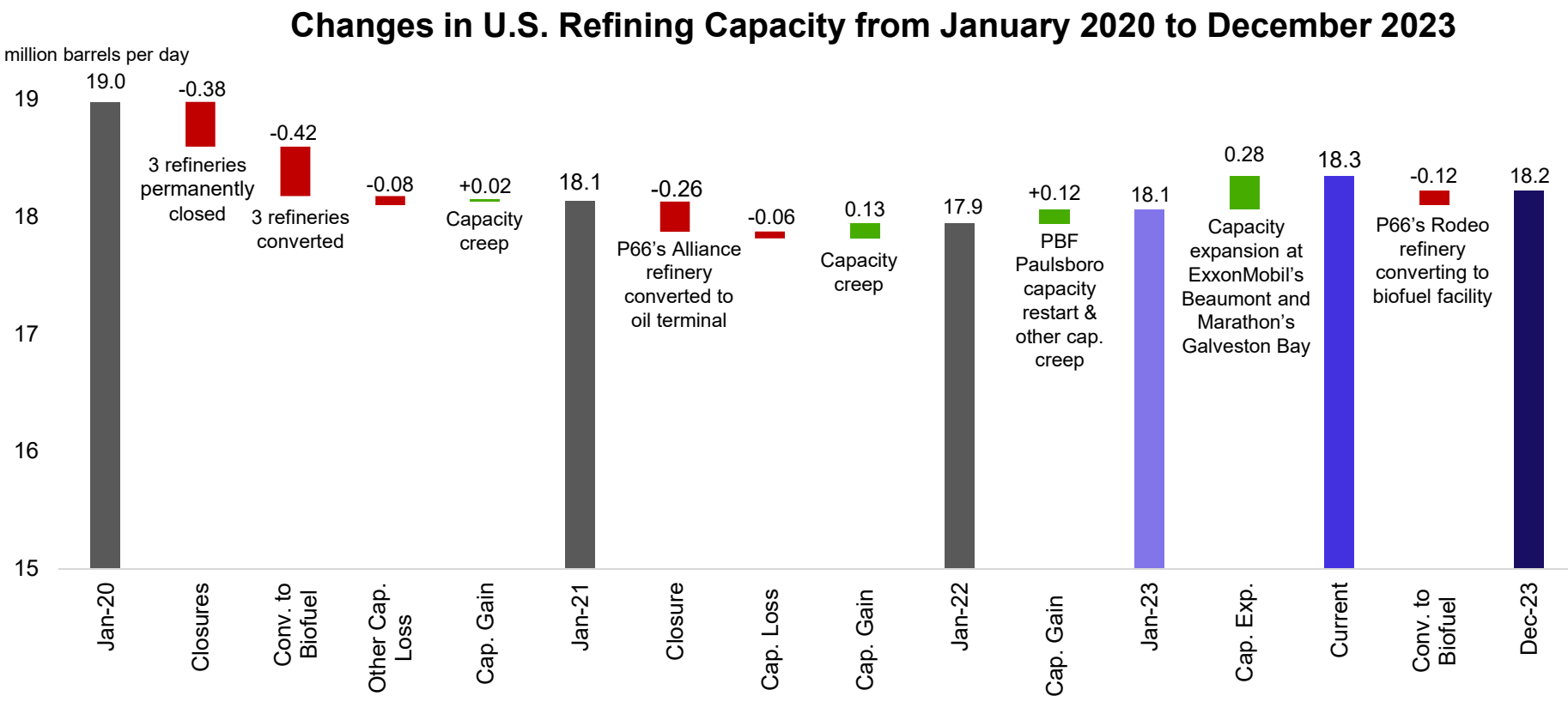
Source: Case Western Reserve University, Encyclopedia of Cleveland History

Evolution of U.S. Refining Industry



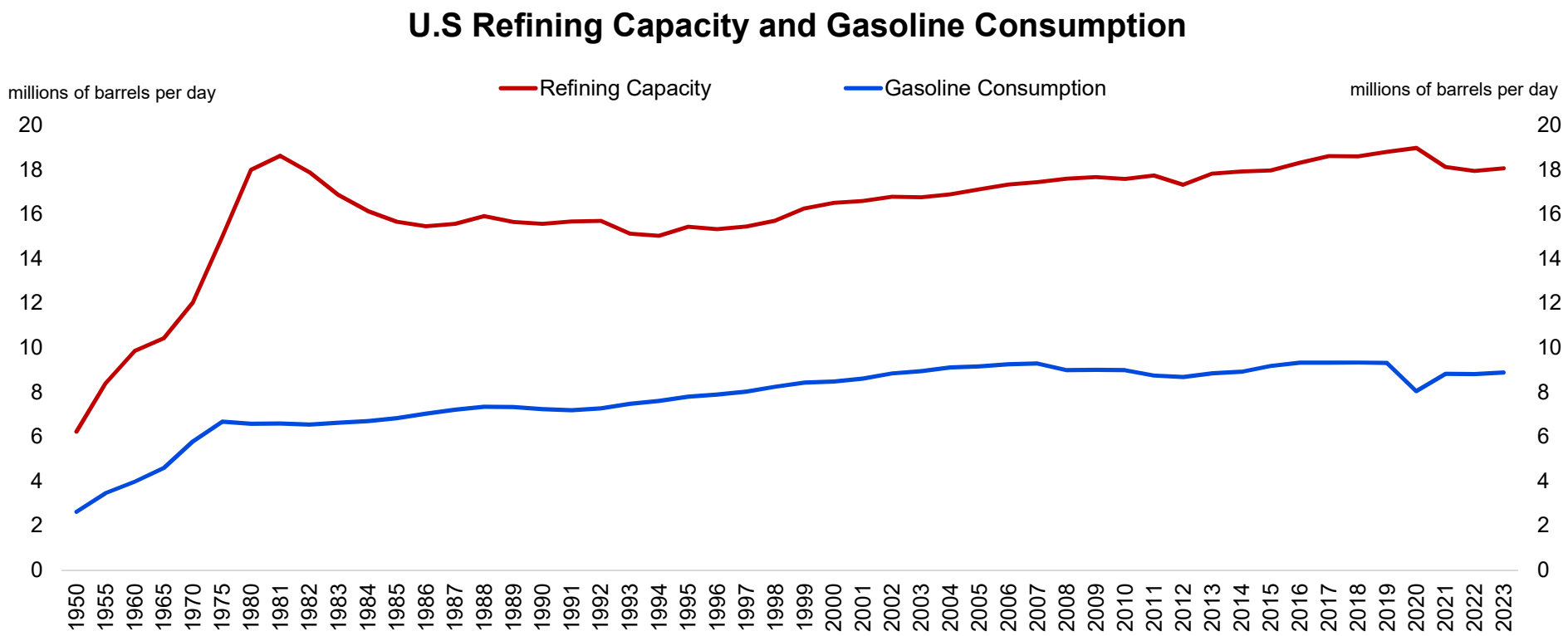
Source: U.S. Energy Information Administration (EIA)

U.S. Refining Capacity Expands in 2023



Source: U.S. Energy Information Administration (EIA) and AFPM analysis

Refining Capacity vs. Gasoline Consumption

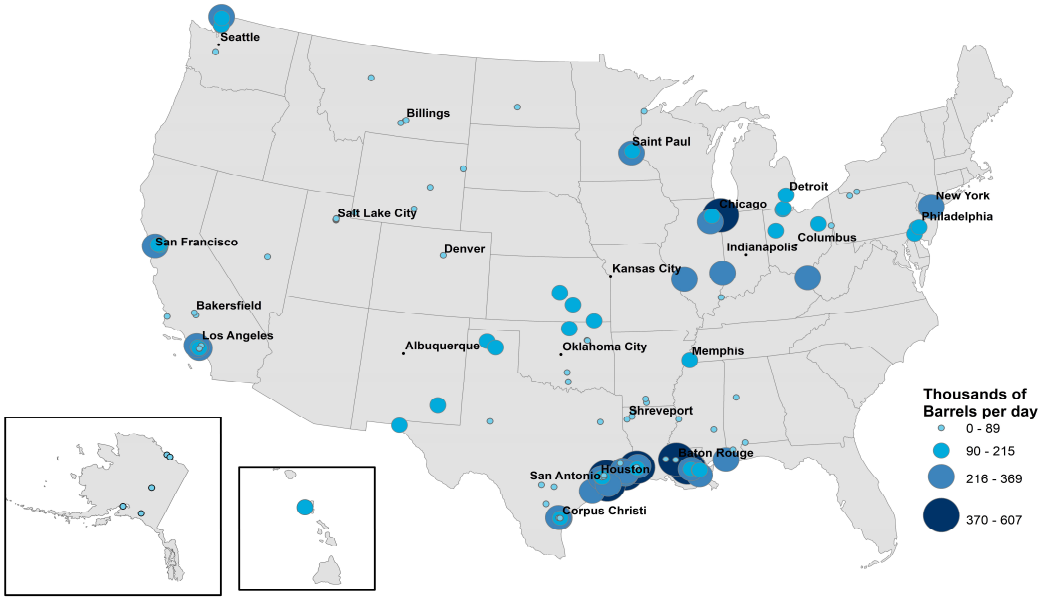


Notes: 2023 refining capacity is as of Jan 1, 2023. 2023 gasoline consumption data comes from the U.S. Energy Information Administration's Short-Term Energy Outlook November 2023
Source: U.S. Energy Information Administration (EIA)

U.S. Refining Footprint

- 129 refineries in the U.S. with current capacity of 18.3 million barrels per day (bpd).
  - Traditional petroleum refineries produce transportation fuels and other products.
  - Specialty refineries produce primarily asphalt, lubricants and other non-fuel products.
- More than 50% of U.S. refining capacity is located along the Gulf Coast.
- Four largest U.S. refineries:
  - *Marathon Galveston Bay, TX, 633,000 bpd.*
  - *Motiva Port Arthur, TX, 630,000 bpd.*
  - *ExxonMobil Beaumont, TX, 609,000 bpd.*
  - *Marathon Garyville, LA, 596,000 bpd.*
- Smallest U.S. refinery:
  - *Talley Asphalt Products, Kern, CA, 1,700 bpd.*

Map of U.S. Refineries and Refining Capacity



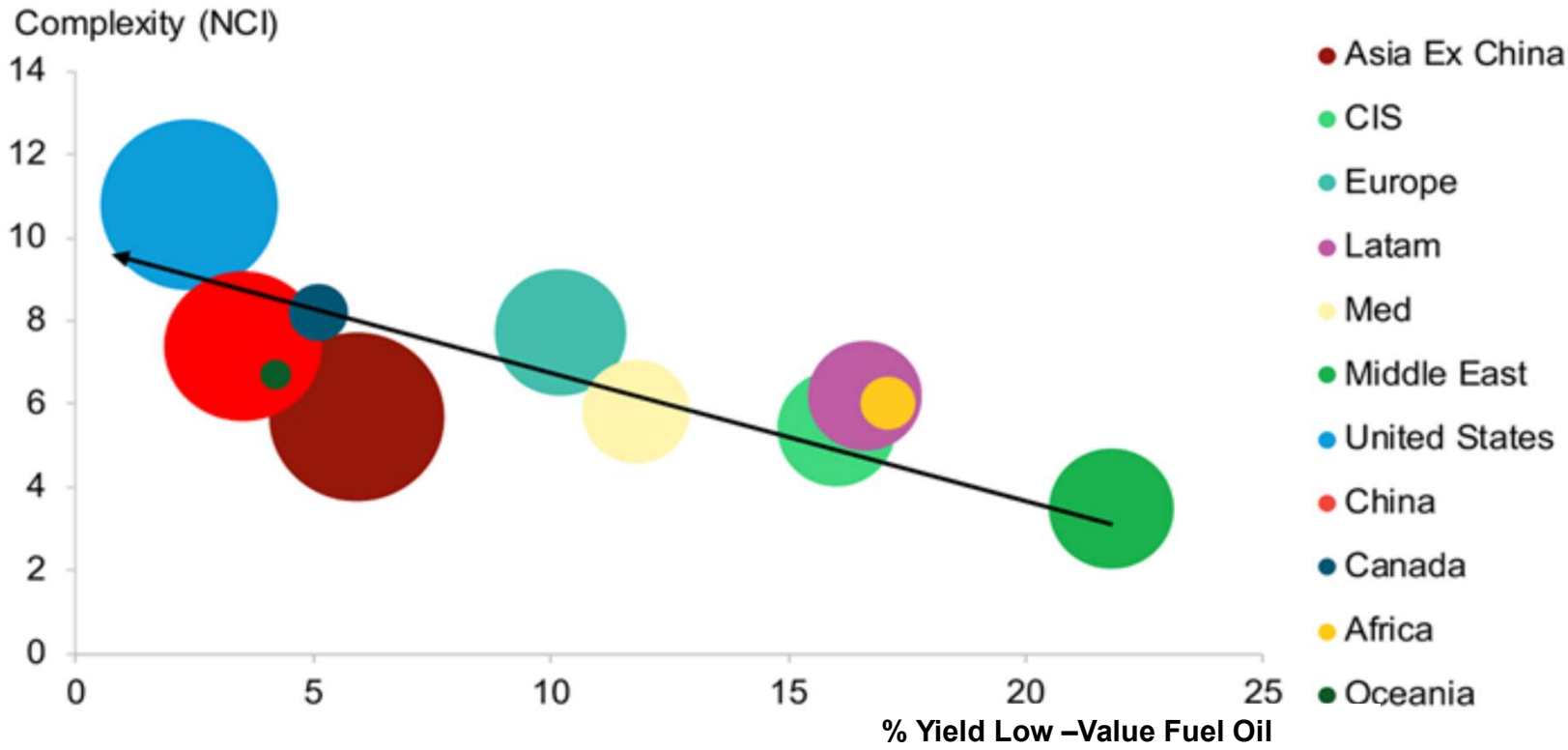
Notes:
- Post Jan 1, 2023, Motiva reported its refining capacity to be 630,000 bpd
- Capacities of Marathon's Galveston Bay and ExxonMobil Beaumont refineries include expansions that were completed in Q1 2023

Source: Oxford Economics for AFPM

Not All Refineries are the Same!

- **Refineries vary in complexity and are configured to process specific qualities of crude oil to produce specific yields of products to meet demand.**
  - *Low complexity refineries run light, sweet crudes and produce more low-value products.*
  - *High complexity refineries run heavy, sour crudes and produce more high-value products.*

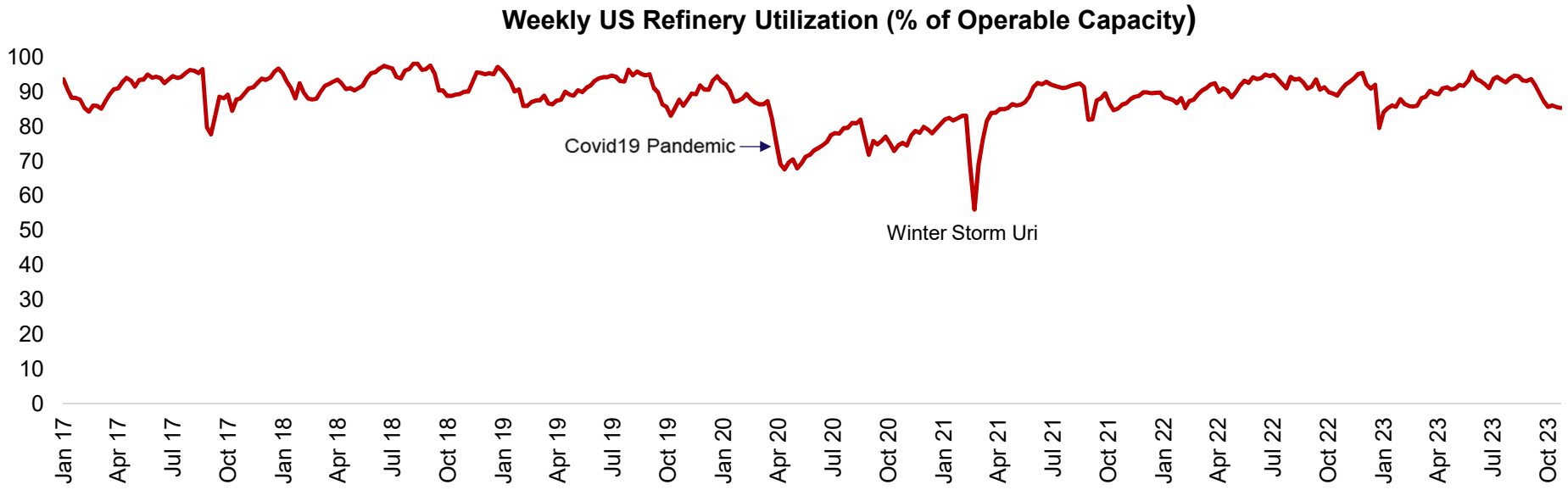
U.S. Fleet is the Most Complex in the World



Notes: NCI = Nelson Complexity Index. Bubble size indicates total CDU capacity
Source: Bloomberg New Energy Finance (BNEF), Oil & Gas Journal, JODI

U.S. Refinery Utilization

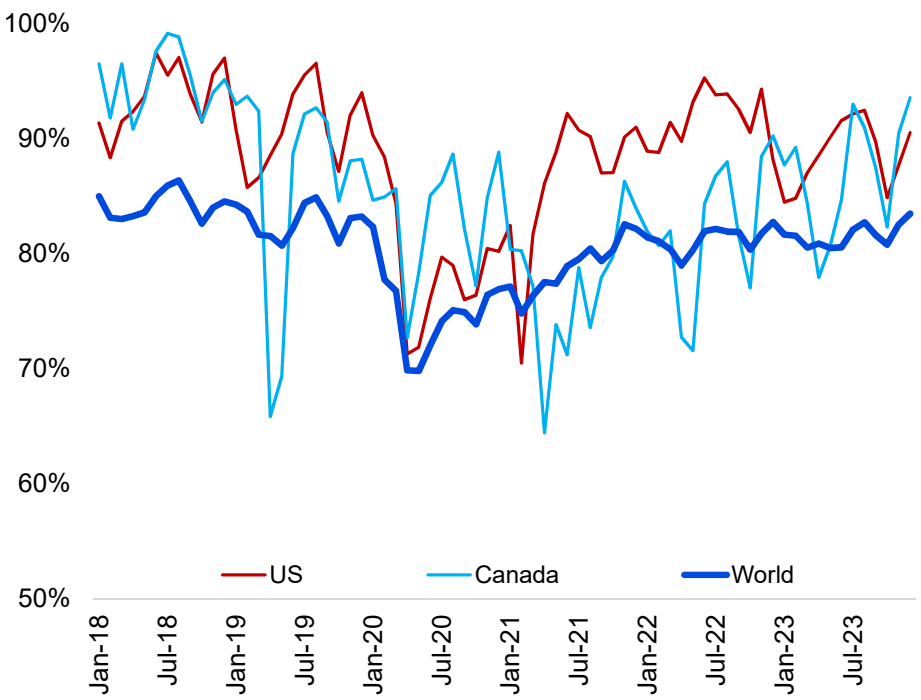
Refineries around the world do not operate at the same rate. U.S. refineries tend to operate at or above a 90% utilization rate. In 2022, U.S. refinery utilization averaged 92%. Prior to start of the seasonal maintenance in the fall of 2023, U.S. refineries were running at 93% of operable capacity.



Source: U.S. Energy Information Administration Weekly Petroleum Status Report (WPSR) for the week ending October 27, 2023

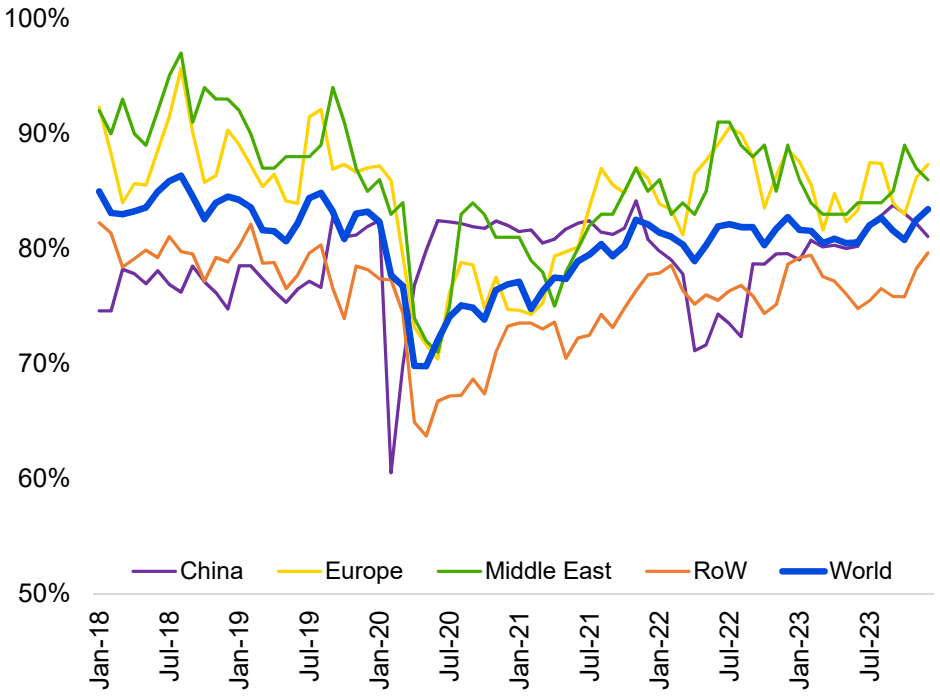
U.S. & Canada Lead the World in Utilization

Refinery Utilization Rates by Region/Country



Source: S&P Global Commodity Insights

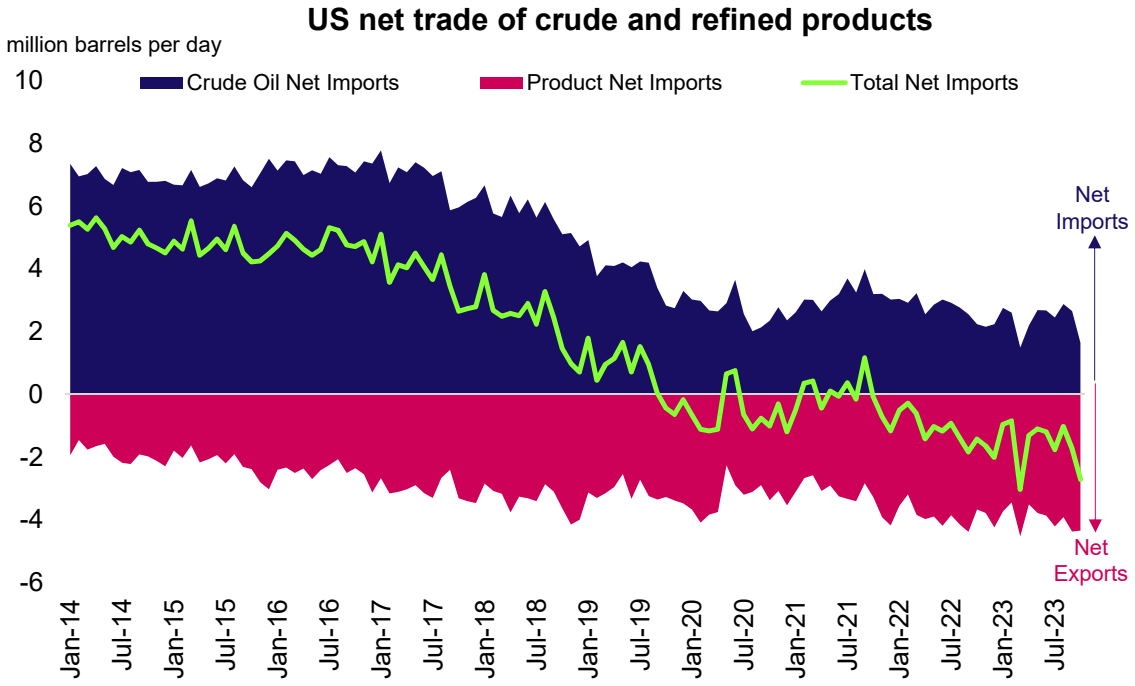
Refinery Utilization Rates by Region/Country



Source: S&P Global Commodity Insights

The U.S. is the largest exporter of refined products in the world

- The U.S. is a key supplier of diesel, gasoline, and other refined products to a global market that has been upended by Russia's invasion of Ukraine.
- In 2022, U.S. exported 5.9 million bpd (90 billion gallons) of refined products to more than 100 countries.
- Key markets are:
  - Mexico.
  - Central and South America.
  - Europe (diesel).
  - Asia (NGLs).
- The U.S. exports approximately 20% of its refined products.

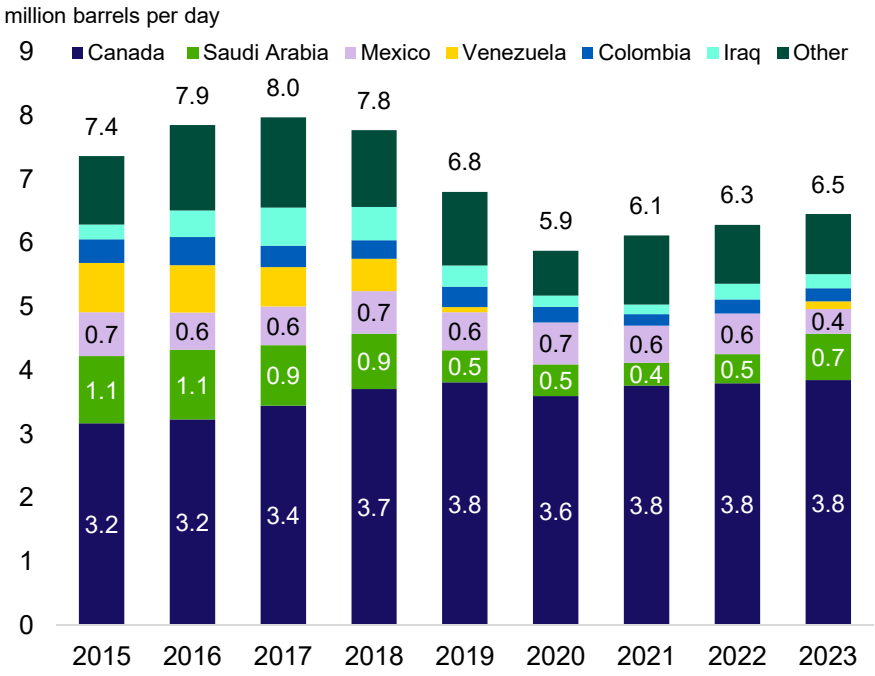


Source: U.S. Energy Information Administration Short-Term Energy Outlook October 2023

Canada is a Vital U.S. Energy Partner

- U.S. refineries process 84% of the crude oil produced in North America (U.S., Canada, and Mexico).
- Canada supplied 3.8 million bpd or 60% of U.S. crude imports for 2022.
  - The Canadian share of U.S. crude imports has grown from 43% in 2015 to 60% in 2022.
  - Most of the crude supplied is heavy sour and is transported by pipelines and rail.
- Canada imports crude and refined products from the U.S.
  - Crude imports (2022): 333,000 bpd.
  - Refined product imports (2022): 512,000 bpd.
- NGLs account for approximately 50% of U.S. refined product exports and include propane, ethane, and natural gasoline.
  - NGL exports to Canada are primarily natural gasoline which is used as a diluent for bitumen.

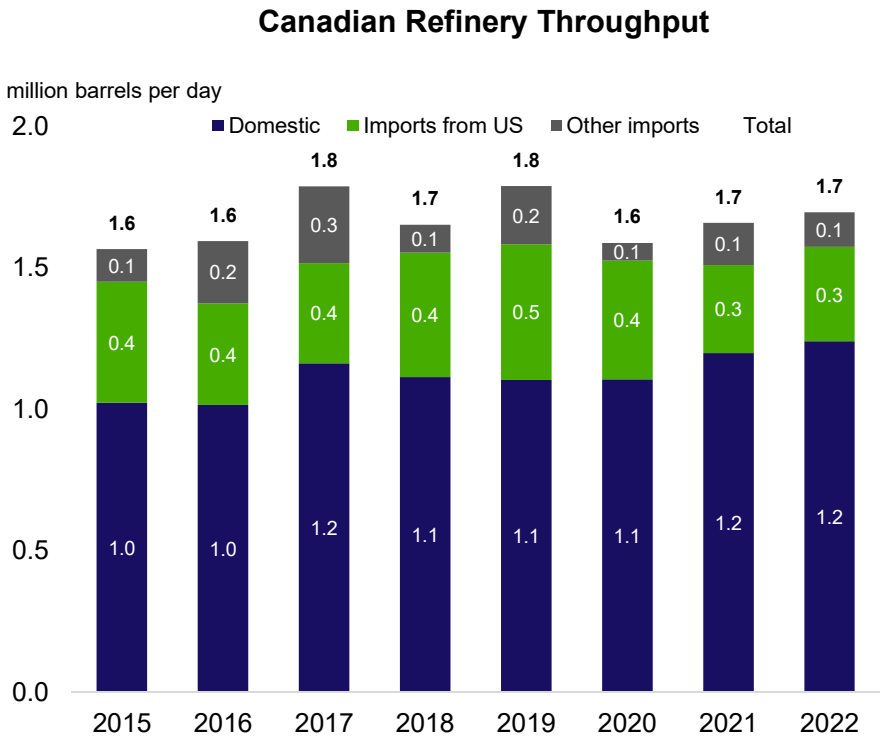
U.S. Crude Imports by Country



Notes: 2023 U.S. crude import data is through August 2023
Source: U.S. Energy Information Administration data and AFPM analysis

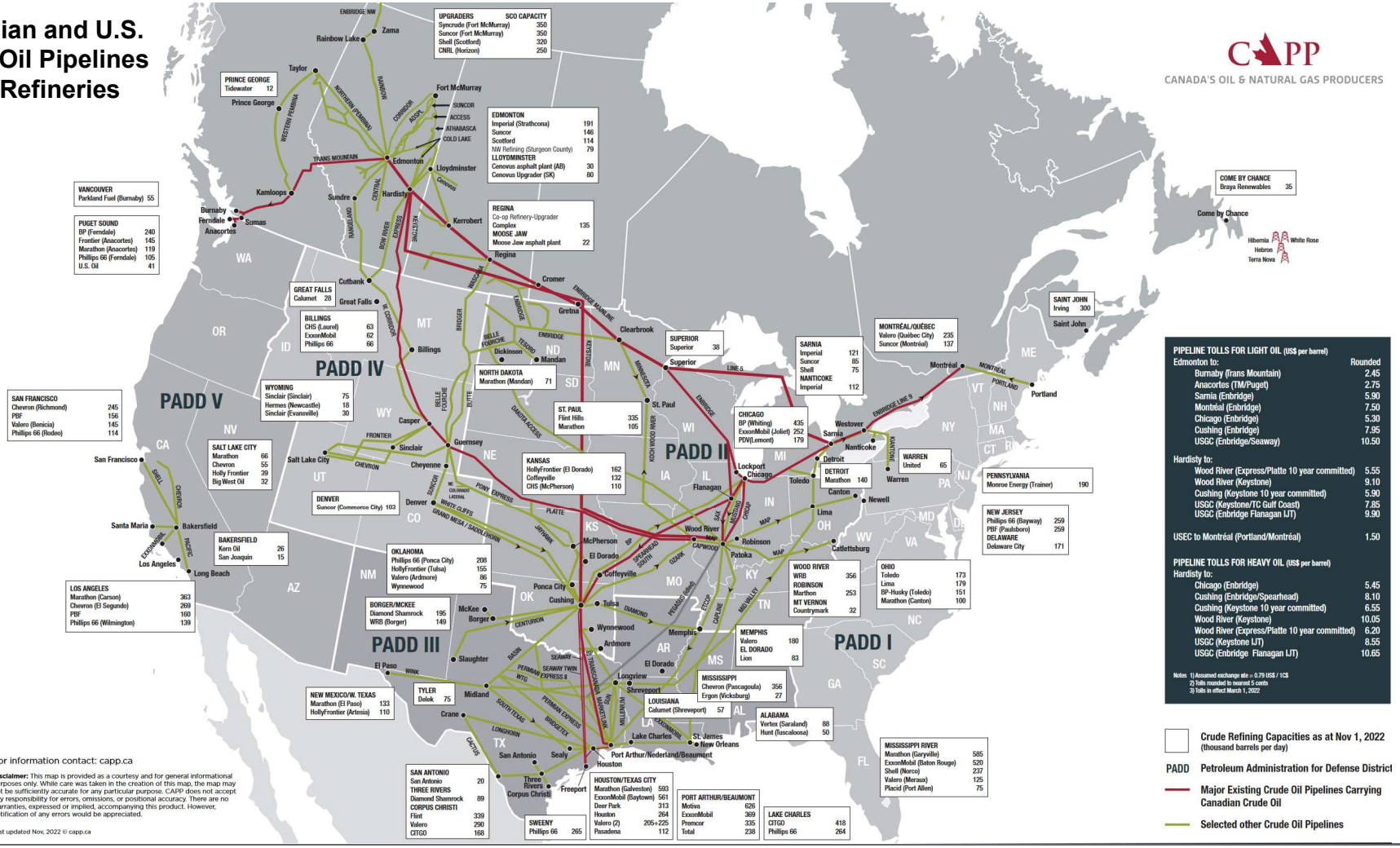
Canadian Refineries

- Canada has 14 total refineries with combined crude distillation capacity of 1.8 million bpd.
  - 12 petroleum refineries produce transport fuels and other products.
  - 2 specialty refineries produce asphalt.
- Canada has 5 upgraders that process bitumen into synthetic crude.
- Irving's Saint John refinery is the largest refinery with capacity of 300,000 bpd.
  - St. John refinery is a major supplier of refined products to the New England region.
- Canadian refineries operated at 92% utilization in 2022.
- Canadian refineries process domestic (73%) and imported crude oil. U.S. crude oil imports accounted for 73% of total imports in 2022.



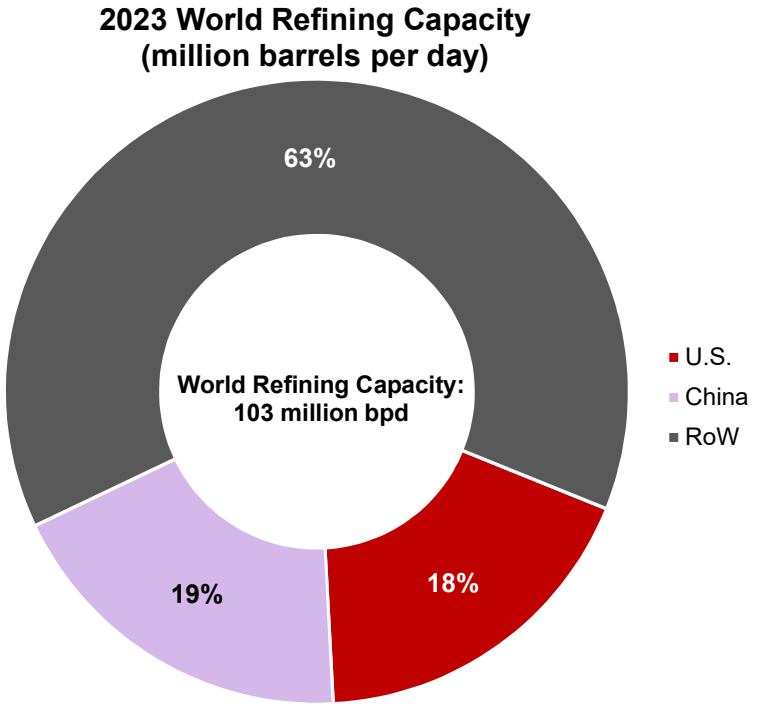
Source: Oil Sands Magazine's and AFPM's analysis

Canadian and U.S. Crude Oil Pipelines and Refineries



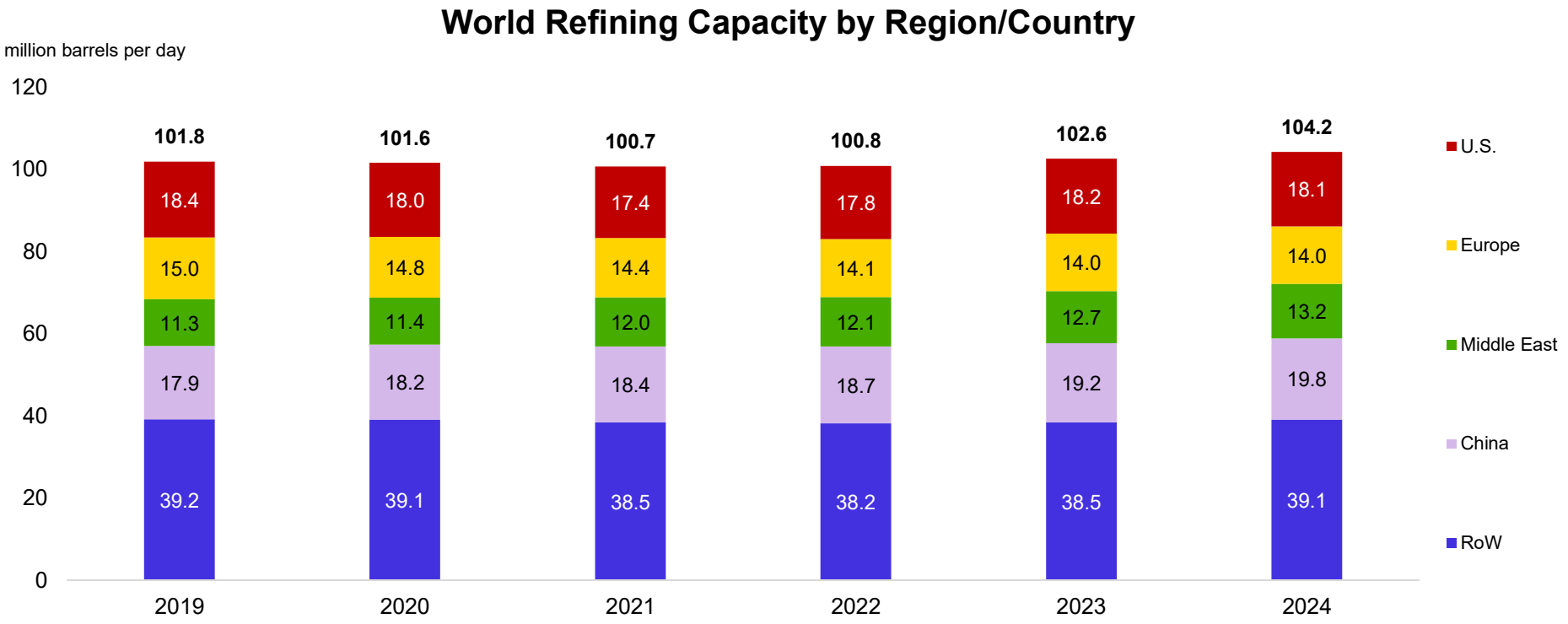
U.S. Refining Capacity is 18% of the World's Capacity

- U.S. has more refining capacity than any other country except China, however the U.S. is the world's leader in the amount of utilized refining capacity.
- The U.S. share of global refining capacity was 18% in 2023.
  - In 2024, the U.S. share is projected to slip to 17% as capacity outside the U.S. increases and U.S capacity declines.
- There are approximately 700 refineries in the world.
  - Largest refinery is Reliance, Jamnagar, India, 1.2 million bpd.
  - New large refineries in Kuwait, Nigeria, and China in 2023 and 2024.
  - In the U.S, ExxonMobil's Beaumont refinery added 250,000 bpd of refinery capacity in 2023.



Source: S&P Global Commodity Insights, U.S. Energy Information Administration Refinery Capacity Report 2023 and AFPM's analysis

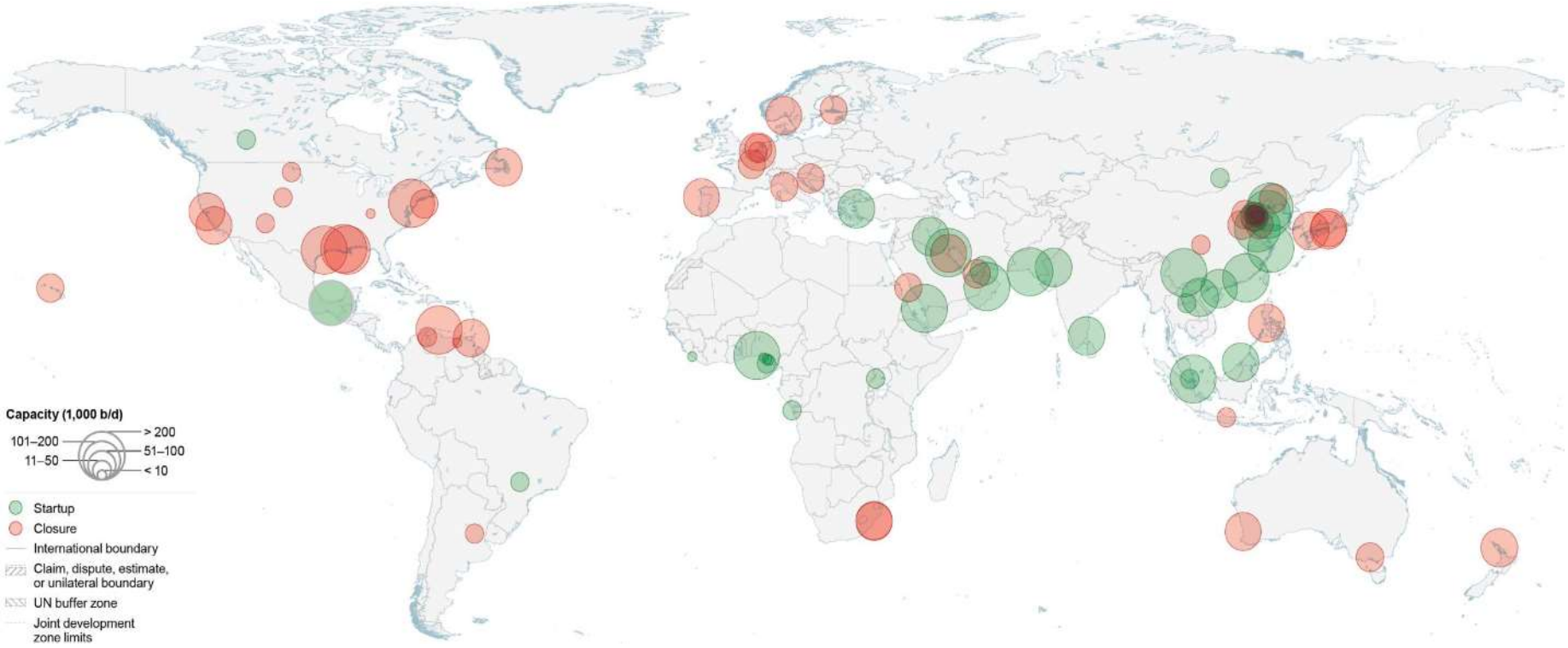
World Refining Capacity Growth Driven by China and the Middle East



Source: S&P Global Commodity Insights, U.S. Energy Information Administration Refinery Capacity Report 2023 and AFPM's analysis

Capacity Expansion and Contraction

Refinery startups and closures between 2017 to 2026



Source: S&P Global Commodity Insights

Concluding Thoughts

- The U.S. refining system is the most complex and efficient in the world.
- While China may now have a larger nameplate capacity, U.S. refineries operate at a substantially higher utilization rate, making the U.S. the largest producer (and exporter) of refined products in the world.
- Canada remains a vital U.S. energy partner and is responsible for producing 60% of the crude oil imported into the U.S. to be refined.

Thank you.

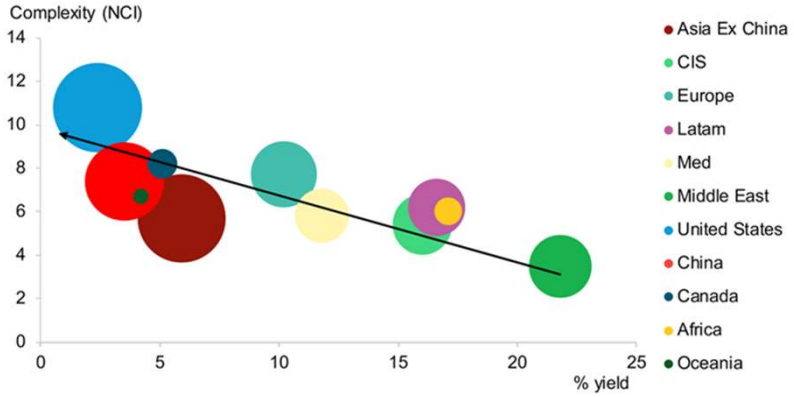
John Eick
jeick@afpm.org
(919) 760-5783

Frequently Asked Questions

Frequently Asked Questions

What types of refineries does the U.S. have?
Can a heavy crude refinery run light crude?
What type of crude does the U.S. produce?
How much crude does the U.S. import and from where?
What types of crude does the U.S. import?
Where do crude imports go?
What drives U.S. gasoline prices?
Who owns retail gas outlets?
Does the U.S. export gasoline?
Why is a product export ban bad policy?
Why are refining margins so high right now?
Why did U.S. refineries close?
Why can't closed refineries be restarted?
Why can't U.S. refineries produce more gasoline and diesel fuel?

Answer: AFPM estimates approximately 70% of U.S. refining capacity is capable of handling heavy crude. There are 60 refineries with cokers (a unit to help refine the "bottom of the barrel" heavy crudes into valuable products). Those facilities account for 13.2 million bpd of capacity. More than half of this capacity is located along the Gulf Coast.



Source: BloombergNEF, Oil & Gas Journal, JODI (JODI<GO> on Bloomberg Terminal)
Note: NCI = Nelson Complexity Index. Bubble size indicates total CDU capacity

Frequently Asked Questions

What types of refineries does the U.S. have?
Can a heavy crude refinery run light crude?
What type of crude does the U.S. produce?
How much crude does the U.S. import and from where?
What types of crude does the U.S. import?
Where do crude imports go?
What drives U.S. gasoline prices?
Who owns retail gas outlets?
Does the U.S. export gasoline?
Why is a product export ban bad policy?
Why are refining margins so high right now?
Why did U.S. refineries close?
Why can't closed refineries be restarted?
Why can't U.S. refineries produce more gasoline and diesel fuel?

Answer: Heavy crude refineries can run some light crude but are optimized to run heavy/sour crude oil that typically trades at a discount to higher-quality crude.

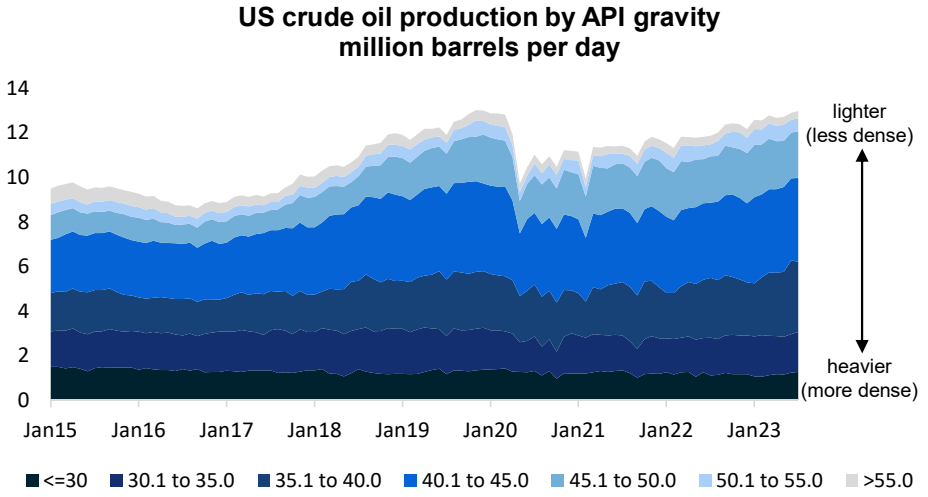
These refineries must also have economic access to "fit for purpose" crude. In other words, refineries process the most economic crudes that fit their specific refinery specifications. Most of the time that means sourcing U.S. crude.

However, a mismatch between crude supply and refinery hardware will cause U.S. refineries to run less efficiently, ultimately hurting their ability to compete in a global market.

Frequently Asked Questions

What types of refineries does the U.S. have?
Can a heavy crude refinery run light crude?
What type of crude does the U.S. produce?
How much crude does the U.S. import and from where?
What types of crude does the U.S. import?
Where do crude imports go?
What drives U.S. gasoline prices?
Who owns retail gas outlets?
Does the U.S. export gasoline?
Why is a product export ban bad policy?
Why are refining margins so high right now?
Why did U.S. refineries close?
Why can't closed refineries be restarted?
Why can't U.S. refineries produce more gasoline and diesel fuel?

Answer: In 2022, U.S. produced 11.9 million bd of crude oil, 75% of which was light crude. U.S. light crude oil output has increased by 44% since 2015, while heavier crude oil has decreased by 7%. Most heavier U.S. crude is produced in the Gulf of Mexico.



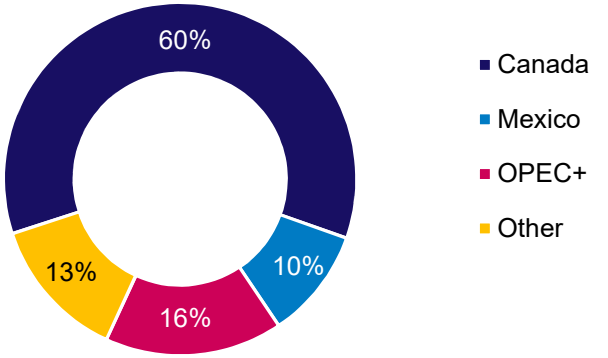
Frequently Asked Questions

What types of refineries does the U.S. have?
Can a heavy crude refinery run light crude?
What type of crude does the U.S. produce?
How much crude does the U.S. import and from where?
What types of crude does the U.S. import?
Where do crude imports go?
What drives U.S. gasoline prices?
Who owns retail gas outlets?
Does the U.S. export gasoline?
Why is a product export ban bad policy?
Why are refining margins so high right now?
Why did U.S. refineries close?
Why can't closed refineries be restarted?
Why can't U.S. refineries produce more gasoline and diesel fuel?

Answer: U.S. refiners imported 6.3 million bpd of crude oil in 2022. Of those imports, 71% were from Canada and Mexico. OPEC+ excluding Mexico accounted for 16%, with the remaining 13% coming from about 20 or so countries.

In 2022, North American crude oil accounted for 84% of U.S. refinery inputs.

Crude Imports by Origin

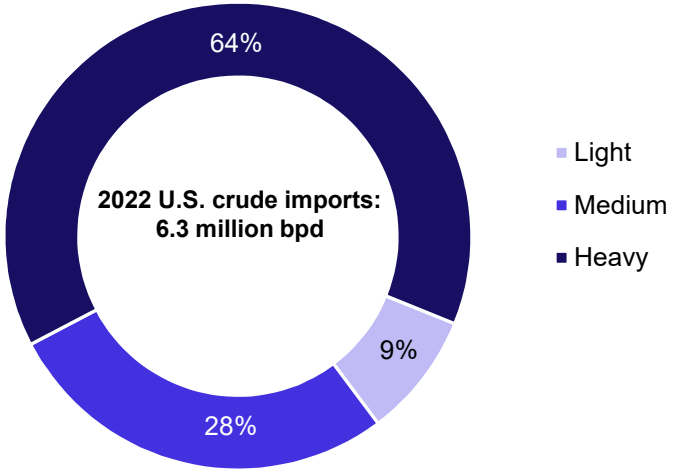


Frequently Asked Questions

What types of refineries does the U.S. have?
Can a heavy crude refinery run light crude?
What type of crude does the U.S. produce?
How much crude does the U.S. import and from where?
What types of crude does the U.S. import?
Where do crude imports go?
What drives U.S. gasoline prices?
Who owns retail gas outlets?
Does the U.S. export gasoline?
Why is a product export ban bad policy?
Why are refining margins so high right now?
Why did U.S. refineries close?
Why can't closed refineries be restarted?
Why can't U.S. refineries produce more gasoline and diesel fuel?

Answer: Of U.S. crude imports in 2022, 91% were heavy and medium grades and 9% were light.

U.S. 2022 crude imports by grade



Frequently Asked Questions

What types of refineries does the U.S. have?
Can a heavy crude refinery run light crude?
What type of crude does the U.S. produce?
How much crude does the U.S. import and from where?
What types of crude does the U.S. import?
Where do crude imports go?
What drives U.S. gasoline prices?
Who owns retail gas outlets?
Does the U.S. export gasoline?
Why is a product export ban bad policy?
Why are refining margins so high right now?
Why did U.S. refineries close?
Why can't closed refineries be restarted?
Why can't U.S. refineries produce more gasoline and diesel fuel?

Answer: All PADDS import crude oil.

- The U.S. Gulf coast imports nearly all heavy/medium crude and has all but displaced light imports with U.S.-produced crude oil.
- The U.S. East and West Coasts import all grades because they do not have economic access to U.S.-produced crude (infrastructure constraints).
- The Midwest and Mountain West import Canadian crude of all grades.

Frequently Asked Questions

What types of refineries does the U.S. have?
Can a heavy crude refinery run light crude?
What type of crude does the U.S. produce?
How much crude does the U.S. import and from where?
What types of crude does the U.S. import?
Where do crude imports go?

What drives U.S. gasoline prices?

Who owns retail gas outlets?
Does the U.S. export gasoline?
Why is a product export ban bad policy?
Why are refining margins so high right now?
Why did U.S. refineries close?
Why can't closed refineries be restarted?
Why can't U.S. refineries produce more gasoline and diesel fuel?

Answer: Gasoline prices are primarily a function of the price of crude oil, which accounts for more than 50% of the pump price of regular gasoline. Costs for distribution and marketing, federal and state taxes, as well as refining costs and refining profits make up the balance. Components of September national average pump price of $3.84/gallon were as follows:

Crude Oil	55.1%	$2.11
Refining Costs	19.4%	$0.75
Distribution and Marketing	12.3%	$0.47
Taxes	13.2%	$0.51
Total		**$3.84**

Frequently Asked Questions

What types of refineries does the U.S. have?
Can a heavy crude refinery run light crude?
What type of crude does the U.S. produce?
How much crude does the U.S. import and from where?
What types of crude does the U.S. import?
Where do crude imports go?
What drives U.S. gasoline prices?
Who owns retail gas outlets?
Does the U.S. export gasoline?
Why is a product export ban bad policy?
Why are refining margins so high right now?
Why did U.S. refineries close?
Why can't closed refineries be restarted?
Why can't U.S. refineries produce more gasoline and diesel fuel?

Answer: 94% of gas stations are independently owned and operated businesses that purchase gasoline from refiners and marketers for resale to the public.

More than 50% of stations are single store owners. Although many retail outlets have licensed the brands of major oil companies, those companies do not own or operate the vast majority of outlets.

Oil companies have largely exited the retail end of the chain.

Frequently Asked Questions

What types of refineries does the U.S. have?
Can a heavy crude refinery run light crude?
What type of crude does the U.S. produce?
How much crude does the U.S. import and from where?
What types of crude does the U.S. import?
Where do crude imports go?
What drives U.S. gasoline prices?
Who owns retail gas outlets?
Does the U.S. export gasoline?
Why is a product export ban bad policy?
Why are refining margins so high right now?
Why did U.S. refineries close?
Why can't closed refineries be restarted?
Why can't U.S. refineries produce more gasoline and diesel fuel?

Answer: Yes, the US exports gasoline - US refineries, are among the most competitive, efficient and sophisticated in the world and are major suppliers of fuels to the global market.

The US exports gasoline because it is not economic for US refineries to supply gasoline to all parts of the country because of infrastructure challenges, including Jones Act shipping and insufficient pipeline capacity to move products from refining centers along the USGC and in the Midwest to markets in the East which lacks sufficient refining capacity to meet in region demand.

As a result, to minimize the cost of gasoline to consumers, the US imports gasoline into the East Coast and exports it from the Gulf and West Coasts to supply growing global markets, primarily Latin America.

Frequently Asked Questions

What types of refineries does the U.S. have?
Can a heavy crude refinery run light crude?
What type of crude does the U.S. produce?
How much crude does the U.S. import and from where?
What types of crude does the U.S. import?
Where do crude imports go?
What drives U.S. gasoline prices?
Who owns retail gas outlets?
Does the U.S. export gasoline?
Why is a product export ban bad policy?
Why are refining margins so high right now?
Why did U.S. refineries close?
Why can't closed refineries be restarted?
Why can't U.S. refineries produce more gasoline and diesel fuel?

Answer: An export ban would increase crude oil and refined products prices and cede critical markets to hostile foreign powers, threatening domestic energy security and that of our allies while contributing to global instability and harming U.S. consumers.

U.S. is a major supplier of gasoline and diesel to Mexico, other Latin American nations, and Europe.

Loss of U.S. exports means global higher crude and product prices because customers would be forced to pay more to replace lost energy supplies and have to reply on Chinese and Russian exports - both of which are looking for opportunities to expand their energy presence in the Americas.

Frequently Asked Questions

What types of refineries does the U.S. have?
Can a heavy crude refinery run light crude?
What type of crude does the U.S. produce?
How much crude does the U.S. import and from where?
What types of crude does the U.S. import?
Where do crude imports go?
What drives U.S. gasoline prices?
Who owns retail gas outlets?
Does the U.S. export gasoline?
Why is a product export ban bad policy?
Why are refining margins so high right now?
Why did U.S. refineries close?
Why can't closed refineries be restarted?
Why can't U.S. refineries produce more gasoline and diesel fuel?

Answer: While 2022 refinery earnings were atypically high, margins have normalized.

- 2022 margins reflected a return to pre-pandemic fuel demand with a slower rebound in crude oil and fuel production.
- The world lost 3.3 MMBD refining capacity across 2020 to 2022 due to Covid-related demand losses.
- Product inventories around the world were low.
- Tight supplies and concerns about fuel adequacy combined to increase fuel prices higher, pushing refining margins higher.
- Global refining capacity now higher than pre-Covid and global refinery utilization rates have returned to pre-Covid levels, taking pressure off fuel supplies.

Frequently Asked Questions

What types of refineries does the U.S. have?
Can a heavy crude refinery run light crude?
What type of crude does the U.S. produce?
How much crude does the U.S. import and from where?
What types of crude does the U.S. import?
Where do crude imports go?
What drives U.S. gasoline prices?
Who owns retail gas outlets?
Does the U.S. export gasoline?
Why is a product export ban bad policy?
Why are refining margins so high right now?
Why did U.S. refineries close?
Why can't closed refineries be restarted?
Why can't U.S. refineries produce more gasoline and diesel fuel?

Answer: Decisions to shutter or convert a refinery away from petroleum processing are meticulously reasoned and based on far more than short-term market conditions. Factors that inform the decision include:

- Current and projected petroleum fuel demand
- Facility locations and the markets they serve
- The political and policy environment, including pressures to move away from liquid fuels
- Federal and state regulatory compliance costs
- Individual facility economics.

Demand destruction during the pandemic certainly sped up the timeframe for refinery closures and transitions to renewable fuel production, but many of these moves were already planned or underway.

Frequently Asked Questions

What types of refineries does the U.S. have?
Can a heavy crude refinery run light crude?
What type of crude does the U.S. produce?
How much crude does the U.S. import and from where?
What types of crude does the U.S. import?
Where do crude imports go?
What drives U.S. gasoline prices?
Who owns retail gas outlets?
Does the U.S. export gasoline?
Why is a product export ban bad policy?
Why are refining margins so high right now?
Why did U.S. refineries close?
Why can't closed refineries be restarted?
Why can't U.S. refineries produce more gasoline and diesel fuel?

Answer: Shuttered refineries cannot be returned to operation with the flip of a switch.

More than half of the 1.1 million bpd of refining capacity lost in the United States since 2020 is already in the process of being transitioned to full-time renewable fuel production or being dismantled.

Restarting a refinery that has been idled would require significant time to inspect machinery, piping, storage tanks, electrical and other systems, and to secure required operating permits. Staff would need to be recruited, rehired, and trained. And facilities would need to reintegrate with supply chains. A restart is not a quick-turn project, and the investment cannot be based on short-term market conditions.

Frequently Asked Questions

What types of refineries does the U.S. have?
Can a heavy crude refinery run light crude?
What type of crude does the U.S. produce?
How much crude does the U.S. import and from where?
What types of crude does the U.S. import?
Where do crude imports go?
What drives U.S. gasoline prices?
Who owns retail gas outlets?
Does the U.S. export gasoline?
Why is a product export ban bad policy?
Why are refining margins so high right now?
Why did U.S. refineries close?
Why can't closed refineries be restarted?
Why can't U.S. refineries produce more gasoline and diesel fuel?

Answer: U.S. refineries maximize gasoline and diesel production on an ongoing basis. In fact, we are the world's top producers of gasoline, diesel, jet fuel and other refined products.

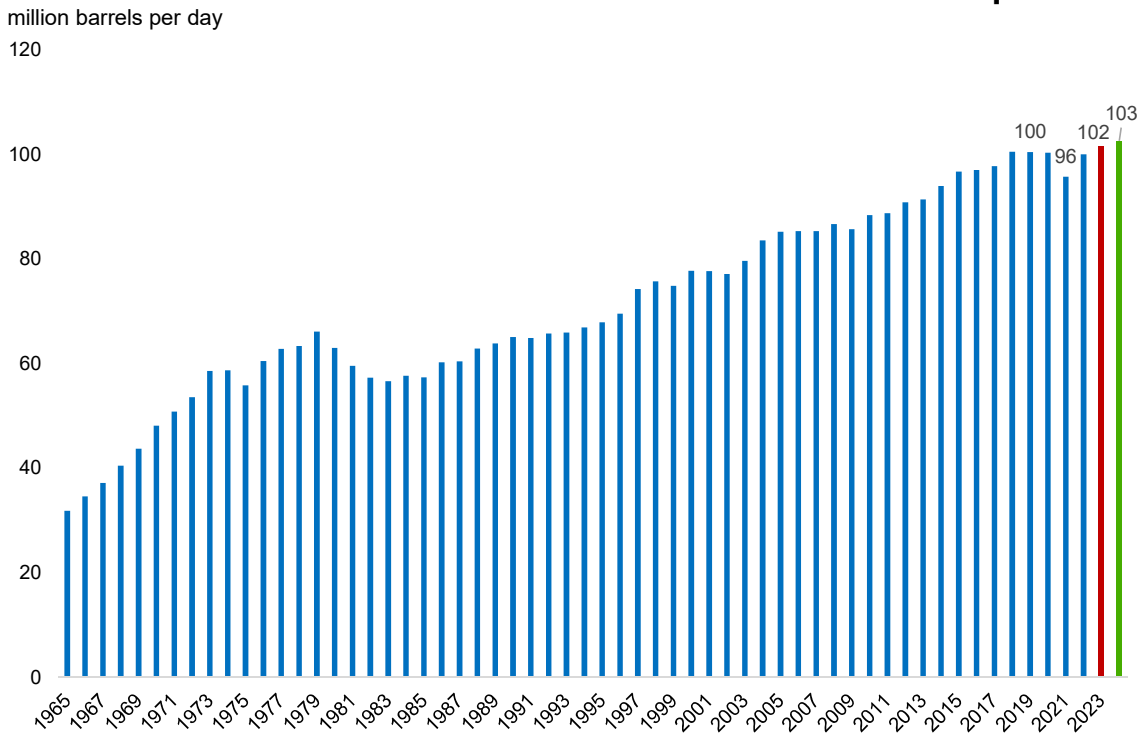
A barrel of crude oil produces a range of products – not just gasoline and diesel - so there's always some kerosene, jet fuel, heating oil, asphalt and/or residual fuel produced alongside gasoline and diesel at U.S. refineries.

U.S. refineries are currently operating at 85% of capacity because it is maintenance season. Many U.S. refineries perform major maintenance in the fall after the summer driving season has ended and before the winter heating season ramps up.

Global Crude Oil Production

- The world is expected to produce about 77 million bpd of crude oil plus another 25 million bpd of other liquids like oil sands in 2023.
- U.S. is world's largest crude oil producer followed by Saudi Arabia and Russia.
  - U.S. output of crude oil is approximately 16% of total world crude supply.
- Growth in the world's crude supply comes from non-OPEC countries like the U.S., Canada, Brazil, Guyana, and Norway.
- Crude output from OPEC+ is constrained because of production cuts and other disruptions.
  - OPEC+ is made up of 13 OPEC countries and 10 non-OPEC countries.

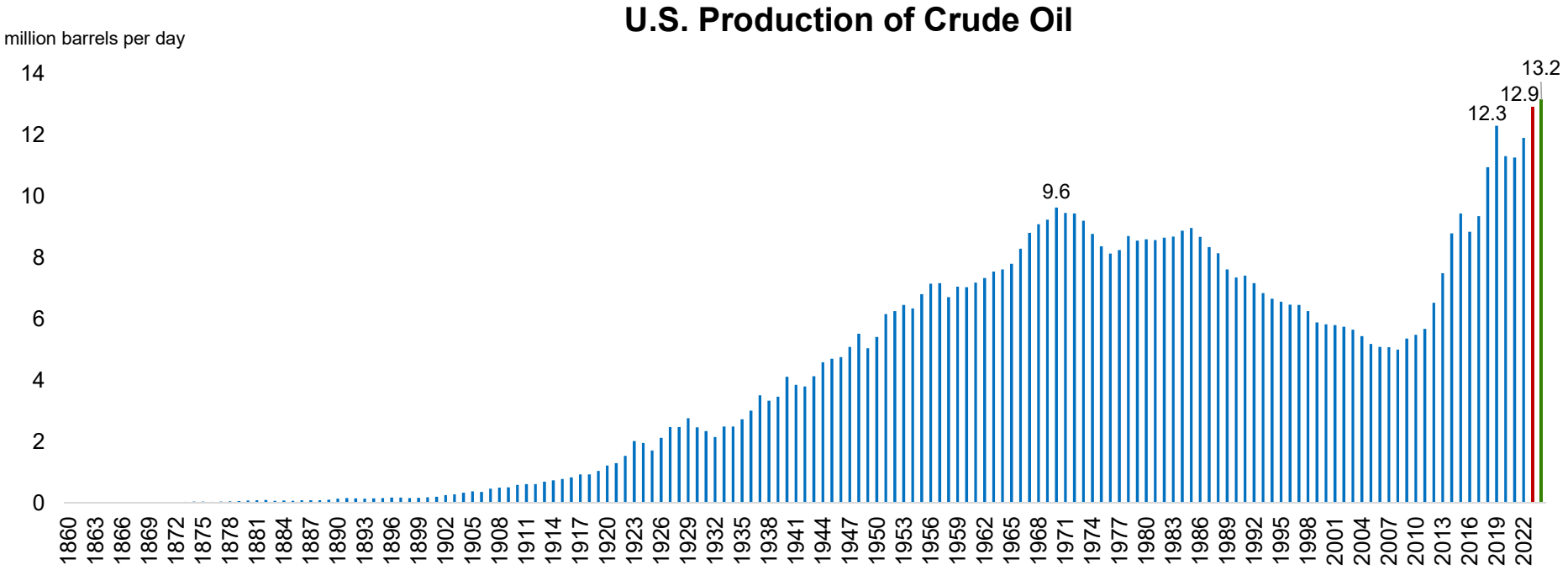
Global Production of Crude Oil and Other Liquids



Source: World Energy Institute's Statistical Review of World Energy 2023 and U.S. Energy Information Administration Short-term Energy Outlook November 2023

U.S. Crude Oil Production

U.S. production of crude oil averaged 12.9 million bpd in 2022 and is projected to reach 12.9 million in 2023 and 13.2 million bpd in 2024.



Note: 2023 and 2024 U.S. crude production are projections from the U.S. Energy Information Administration

Source: U.S. Energy Information Administration Short-term Energy Outlook November 2023