S&P Global
Commodity Insights

PRESENTATION

Energy security, geopolitics, climate

The future of North American oil supply

Daniel Yergin, Vice Chairman of S&P Global
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December 2024

Oil Sands Dialogue researches critical topics

Available for download on S&P Global's Canadian Oil Sands Dialogue webpage

- Canadian oil sands production and emissions history, February 2024
- The North American advantage: Secure oil and gas production, December 2023
- Greenhouse gas intensity of western Canadian condensate, May 2023
- Assessing the adequacy of western Canadian crude oil export capacity, September 2022
- Carbon capture and storage and the Alberta oil sands, July 2022
- The trajectory of oil sands GHG emissions: 2009–35, April 2022
- Canadian Crude Logistics, August 2021
- What is different about differentials? Understanding the price of oil in western Canada, December 2020
- The GHG intensity of Canadian oil sands production: A new analysis, July 2020
- Four years of change: Oil sands cost and competitiveness in 2018, April 2019
- Looking north: A US perspective on Canadian heavy oil, December 2018

Continental divide: How North America and the Middle East create oil price cycles — and why this matters

Jim Burkhard

Vice President, Global Head of Crude Oil Markets research

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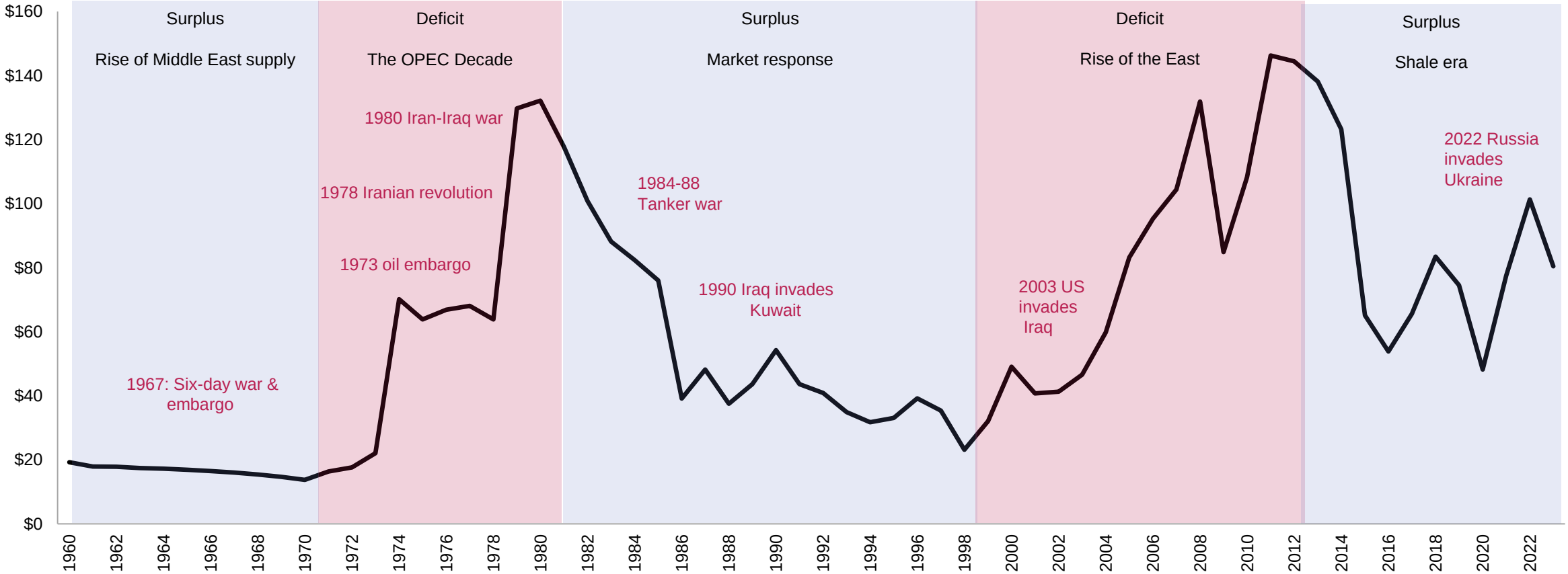
Oil prices move in cycles of surplus and deficit

Annual average crude oil prices (real 2023 $/b)

Oil prices cycles, 1960–2023, annual average real prices in 2022 $/b



Data compiled May 2024.
Sources: S&P Global Commodity Insights; Inflation adjustment factor from US Bureau of Labor Statistics.

North America and the Middle East shape price cycles from the supply side. They are the largest oil producing regions — and the most responsive to market conditions.

Surplus market

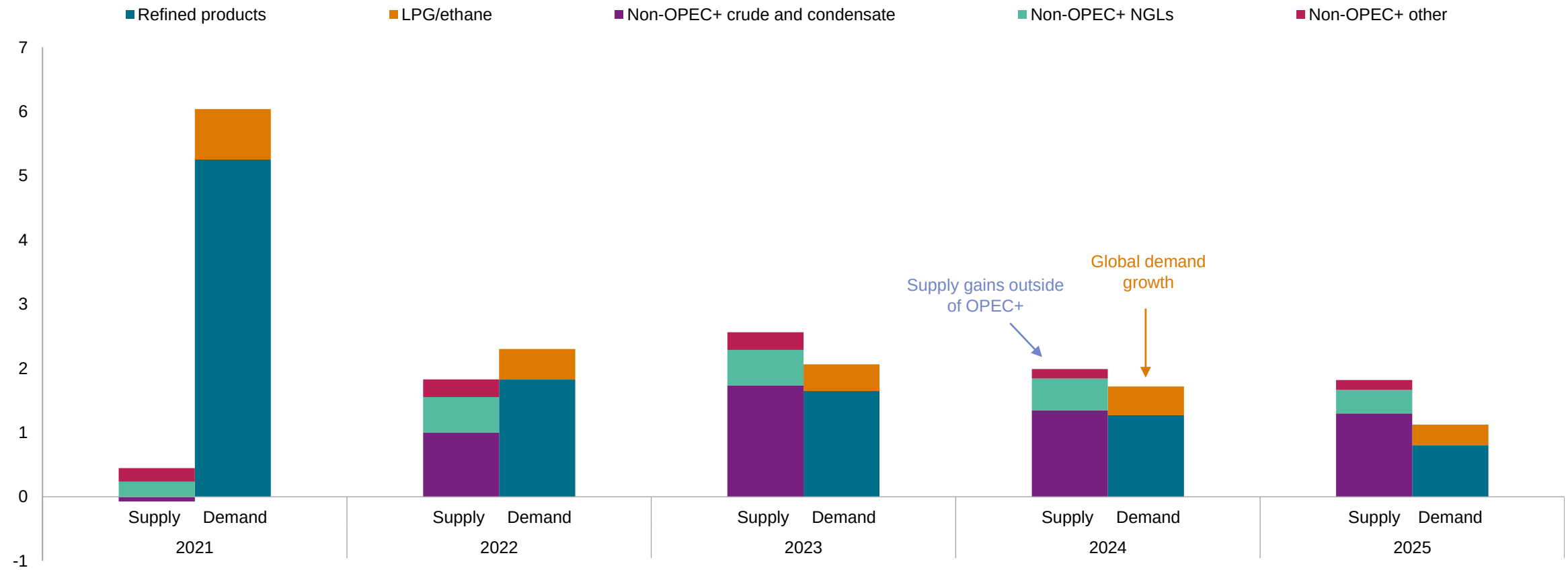
- North America: Strong production growth
- Middle East supply: Unadjusted

Deficit market

- North America: Weak production growth
- Middle East supply: Adjusted

Supply gains outside of OPEC+ — driven by the Americas — match or exceed world demand growth

Change from previous year in non-OPEC+ supply growth and global demand growth (million b/d)



Data compiled May 2024.
Source: S&P Global Commodity Insights.

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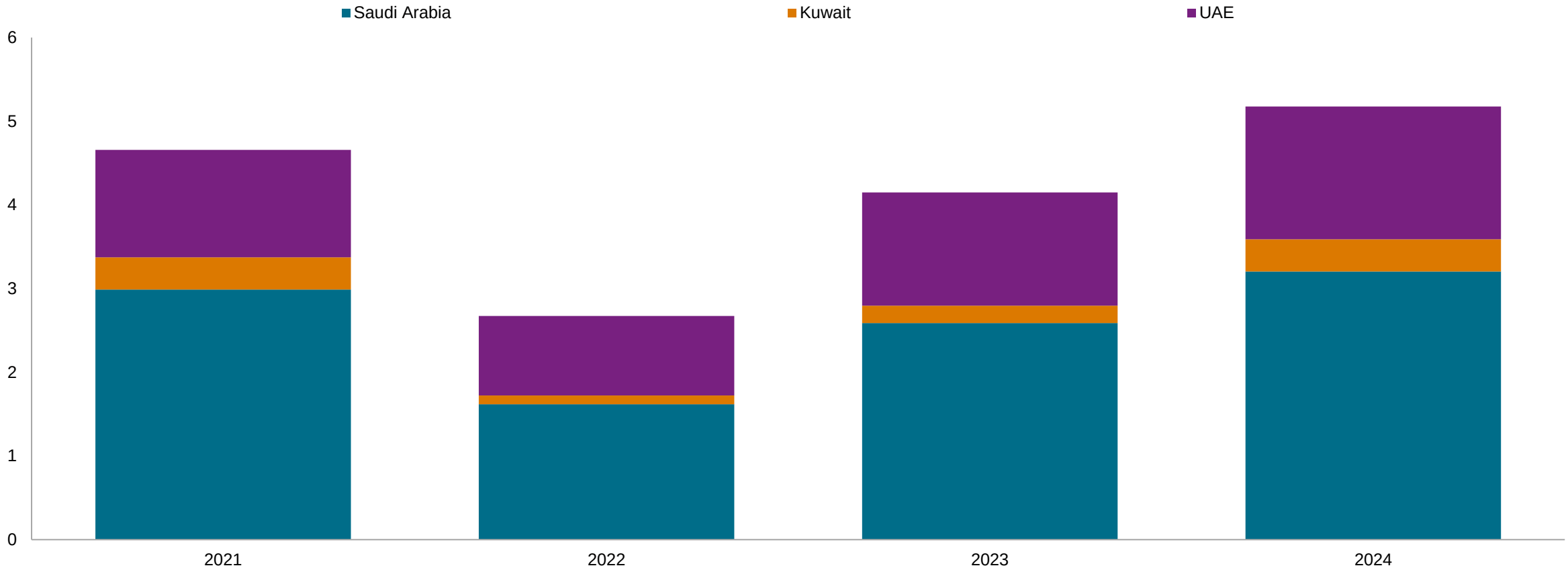
Gulf-3 unused (spare) crude oil production is ample at 5.2 million b/d in 2024 — and could rise further in 2025

Average annual spare capacity (million b/d)



Data compiled May 2024.
Gulf-3 = Saudi Arabia, the United Arab Emirates and Kuwait.
Source: S&P Global Commodity Insights.

What does this mean for the 2024–25 price environment?

1. The cycle of surplus will continue with strong North American growth and a high level of Middle East spare capacity (or more Middle East production).
2. Supply related geopolitical events have limited — and often fleeting — impact on price in a cycle of surplus.
3. OPEC+ supply restraint is key to supporting prices above $75/b. Higher OPEC+ production is bearish, unless demand growth stronger than expected or US supply growth is weaker.
4. Demand hits new record highs, but growth is decelerating.
5. If demand growth disappoints and prices fall, there is less scope for production cuts.

The shale era of surplus will come to an end — but when?

The earliest it could it happen is 2026.

Understanding the engines of world oil supply growth

The oil sands and the Permian Basin

Raoul LeBlanc / Global Upstream / Vice President

Celina Hwang / Commodity Insights / Director

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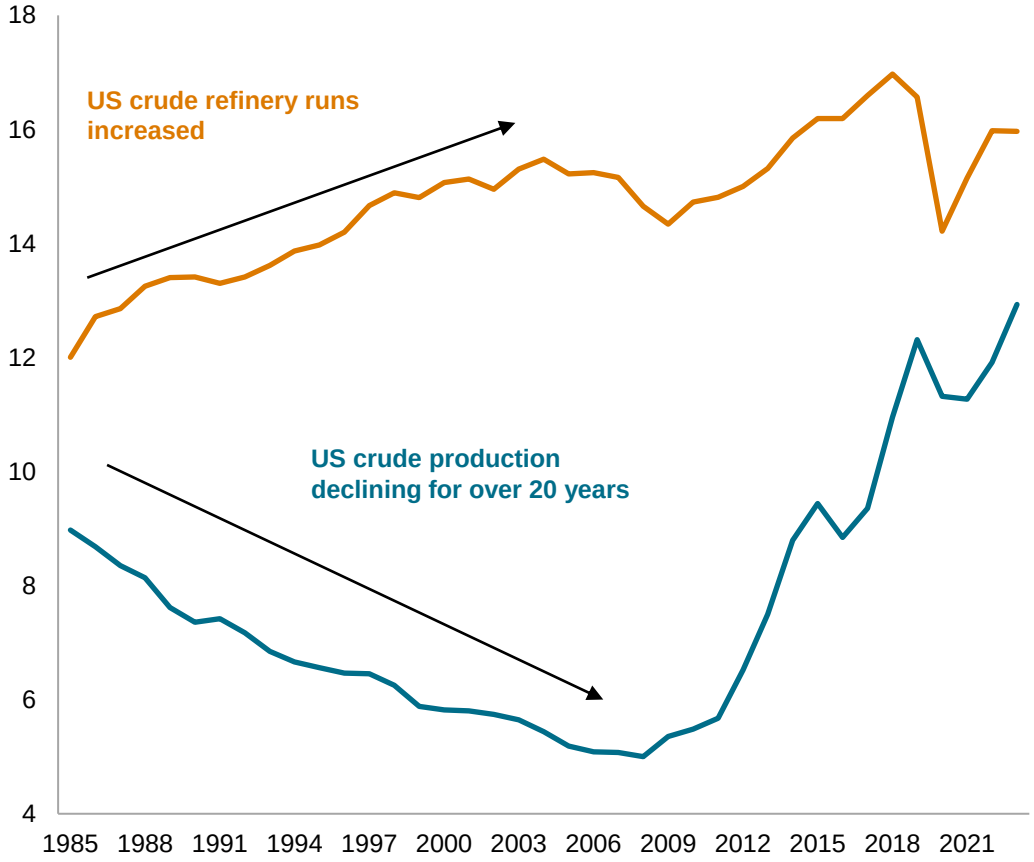
Key messages

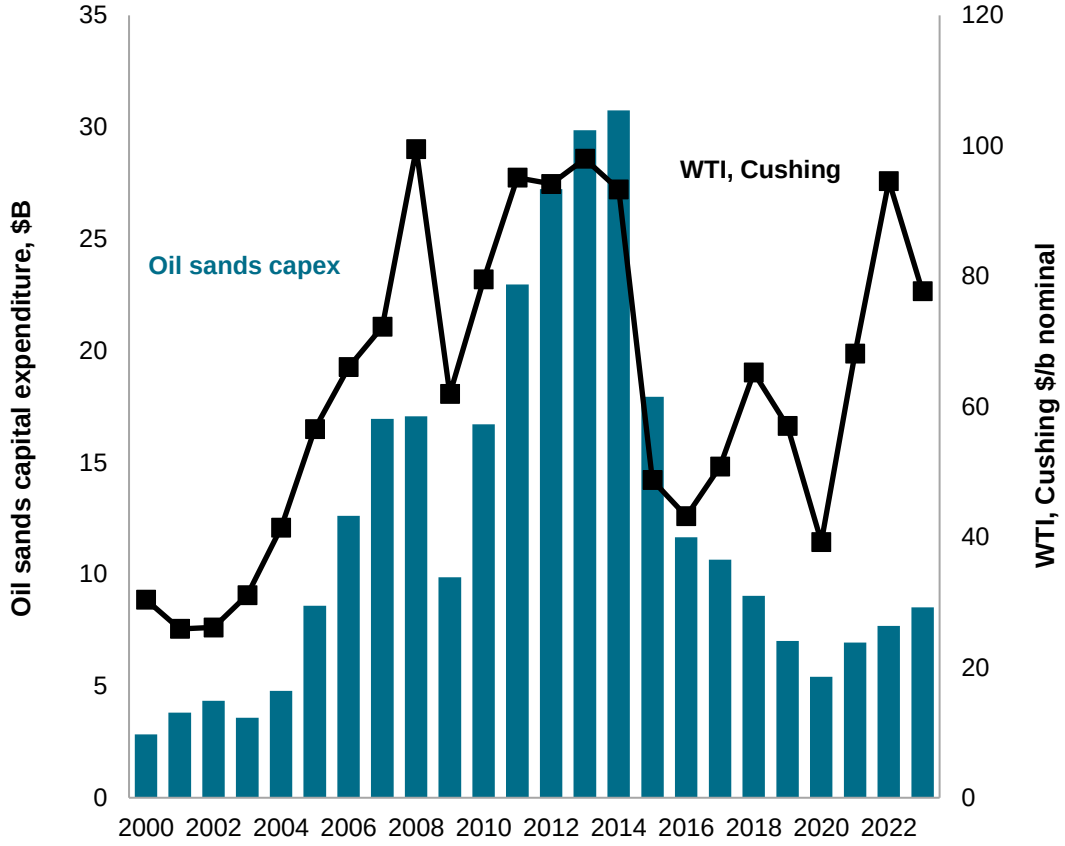
- **Oil sands and tight oil have for the most part been complementary sources of supply, together helping strengthen continental energy security and displacing offshore imports.** Oil sands supply, both light and heavy grades of crude oil has come from heavy bitumen blends that have targeted distinct refiners. Tight oil, primarily from the Permian, has met the needs of light sweet crude oil demand. The US is now the largest producer globally and Canada is the fourth largest. Both Canadian and US supply has displaced supply coming from outside North America.
- **Oil sands and tight oil growth largely came from the sense that the world was running out of oil.** In the late 1980s through to the early 2000s, demand for oil continued to grow while US production was falling, and Canadian oil production was growing only modestly. The sense that the world was running out of oil and North America was becoming less energy secure started to arise. Technological advancements — fracking in tight oil basins and steam-assisted gravity drainage (SAGD) in the oil sands — changed the course of oil production for both countries.

Increasing reliance on non-North American crude spurred investment in crude production in the mid to late 2000s

US crude production and refinery runs (million b/d)



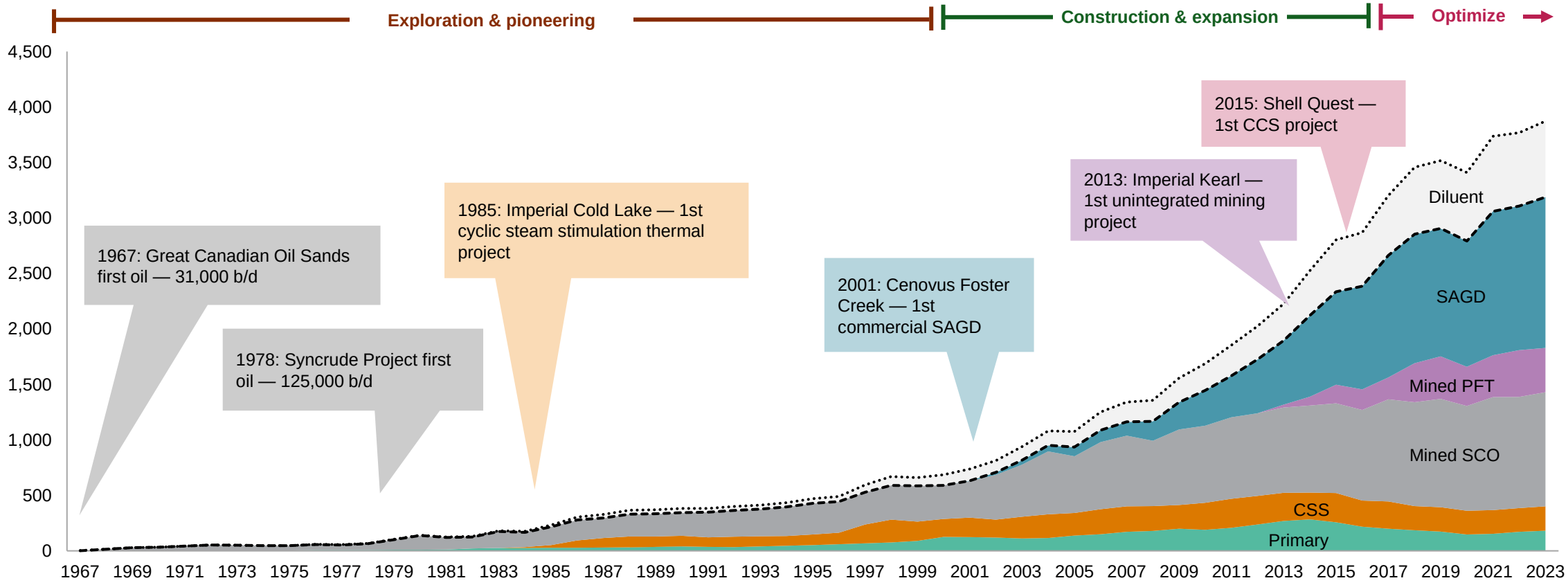
Oil sands capital expenditure and WTI, Cushing, 2000–23



Data compiled June 4, 2024.
Sources: S&P Global Commodity Insights; CAPP; AER; EIA.

Throughout its history oil sands have gone through various stages of life

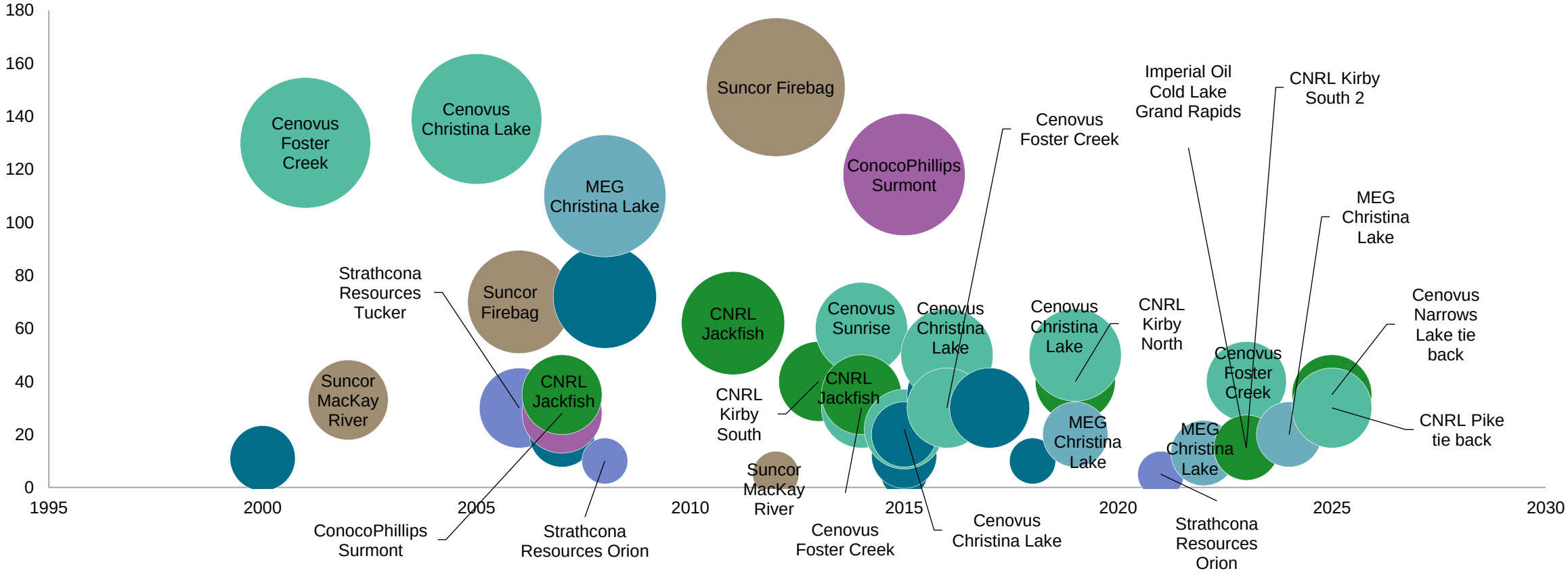
Historical oil sands production, 1967–2023 (thousand b/d)



Data complied May 10, 2023.
PFT = paraffinic froth treatment; SCO = synthetic crude oil; CSS = cyclic steam stimulation.
Sources: EUB; AER; S&P Global Commodity Insights.

A significant amount of SAGD capacity has been installed since the early 2000s

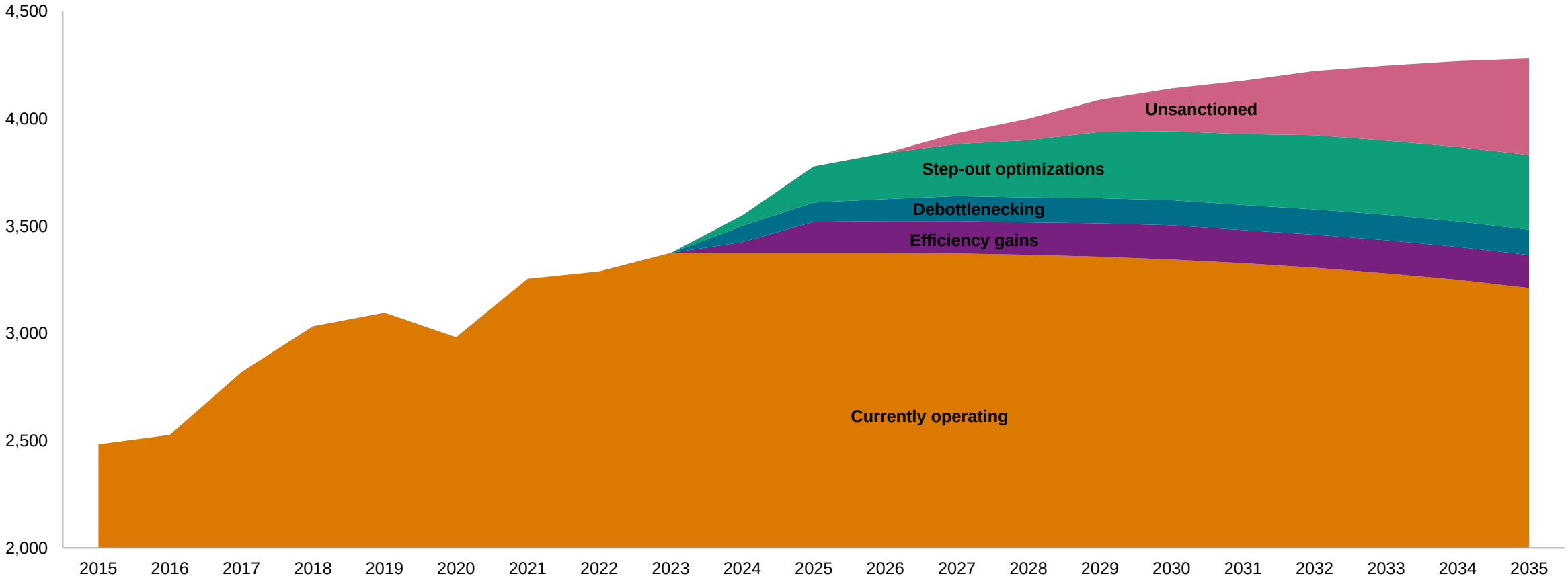
Oil sands installled SAGD capacity by vintage and scale of operation (thousand b/d)



Date compiled June 11, 2024.
Source: S&P Global Commodity Insights.

Oil sands' long slow base decline creates a solid level of production for years

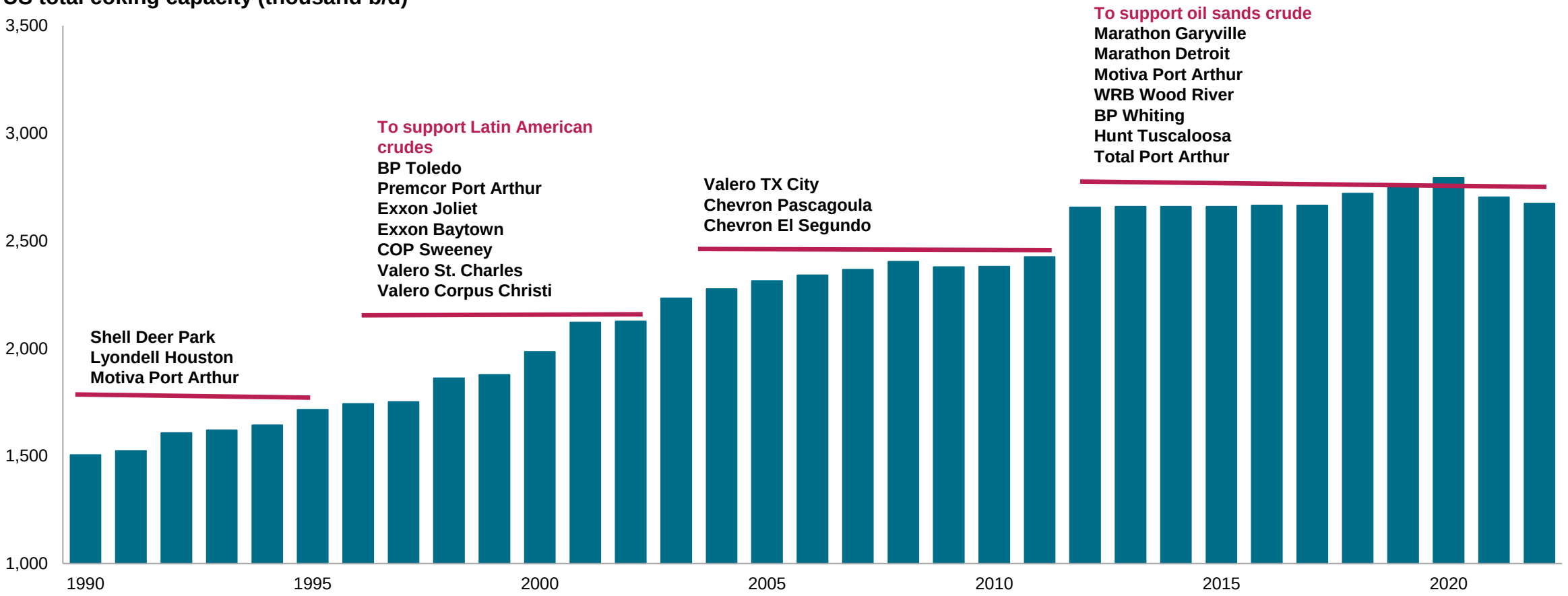
Oil sands expected and potential production (thousand b/d)



Date compiled June 5, 2024.
Unsanctioned volume is not in the current Commodity Insights outlook. Representative growth of 50,000 b/d each year from 2027 to 2035.
Source: S&P Global Commodity Insights.

Heavy oil conversion capacity has increased since 1990, providing a home for Canadian heavy crude

US total coking capacity (thousand b/d)

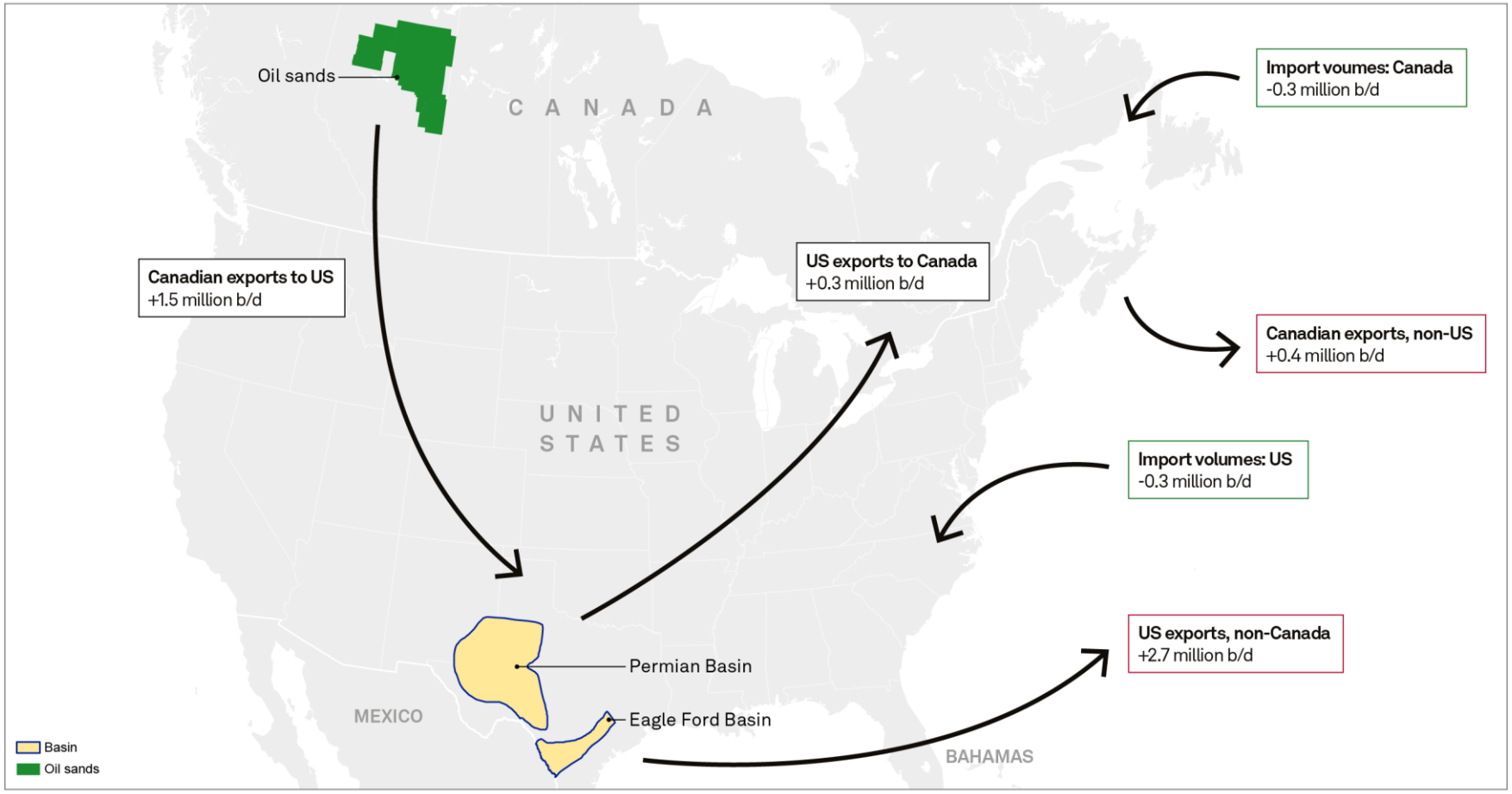


Data compiled June 1, 2023.
Sources: S&P Global Commodity Insights; EIA.

Oil supply growth helped to strengthen North American energy security

Cross-border oil trade helped displaced offshore imports

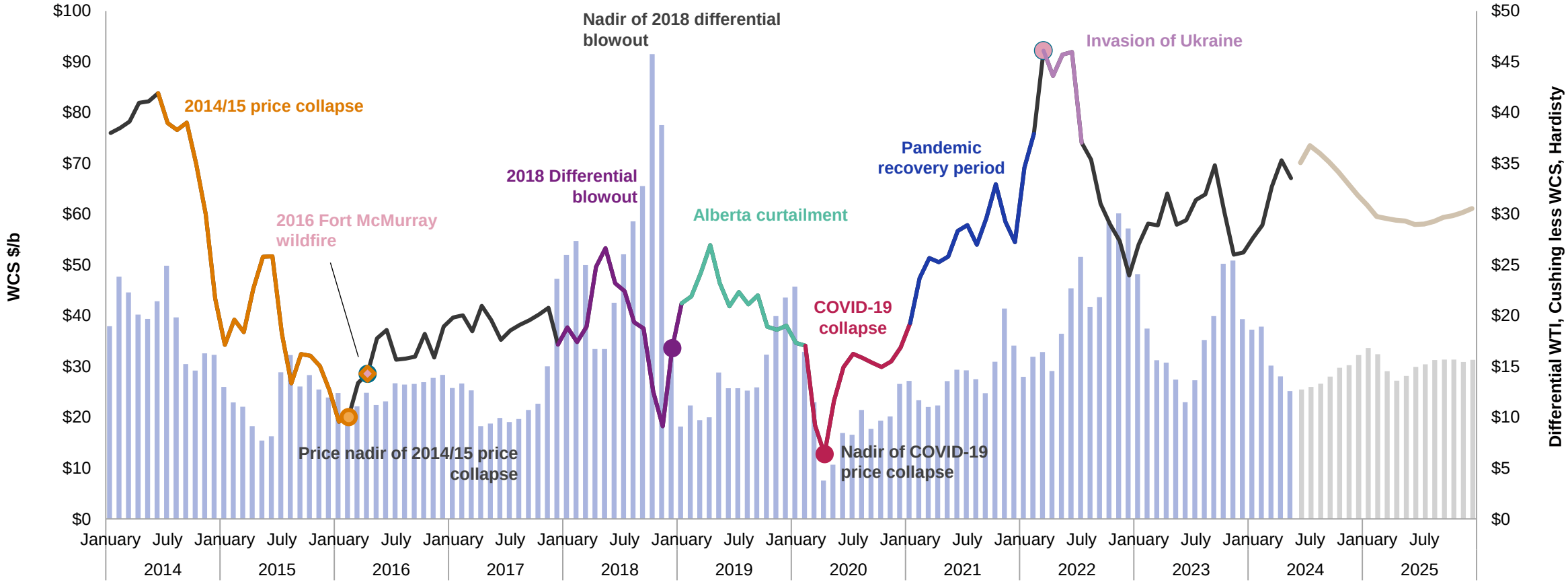
North American crude trade flows and displacement of offshore imports (2010–21)



Data compiled July 5, 2024.
Source: Data taken from S&P Global Commodity Insights upstream E&P content (Accumap): 2013653

Western Canada has grappled with price instability driven by global and local factors since 2014

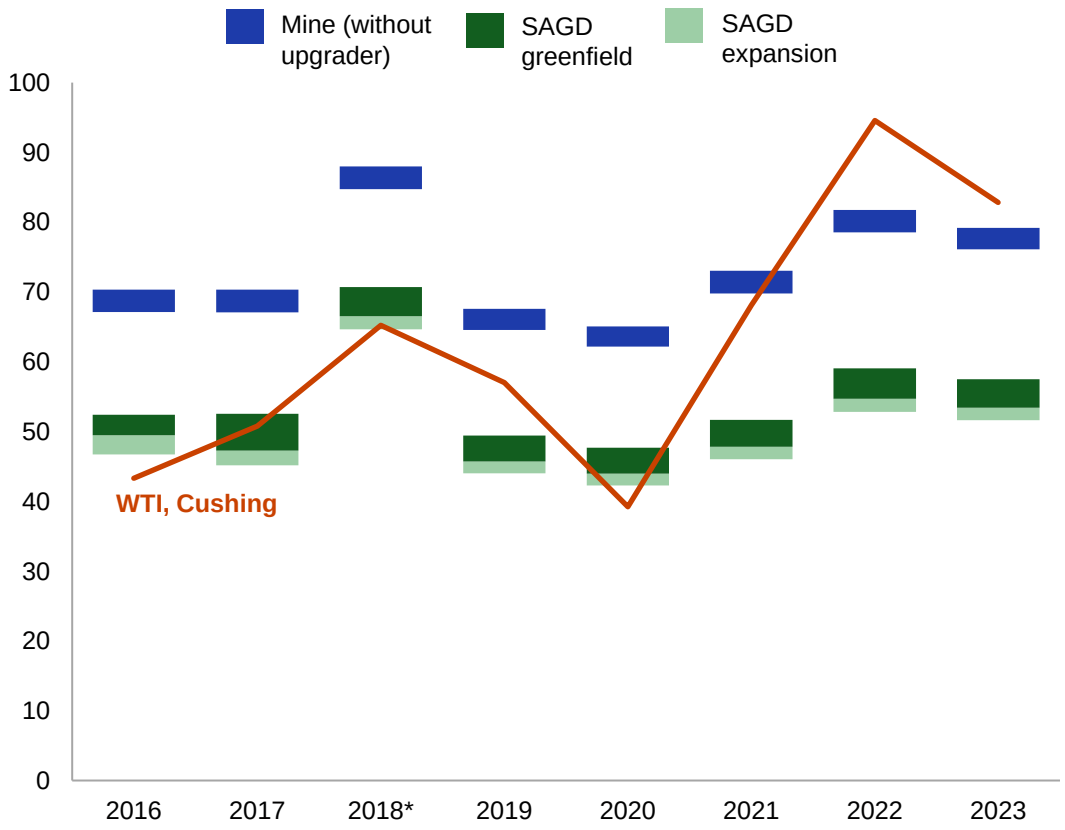
Western Canadian heavy sour price (WCS, Hardisty, 2014–25)



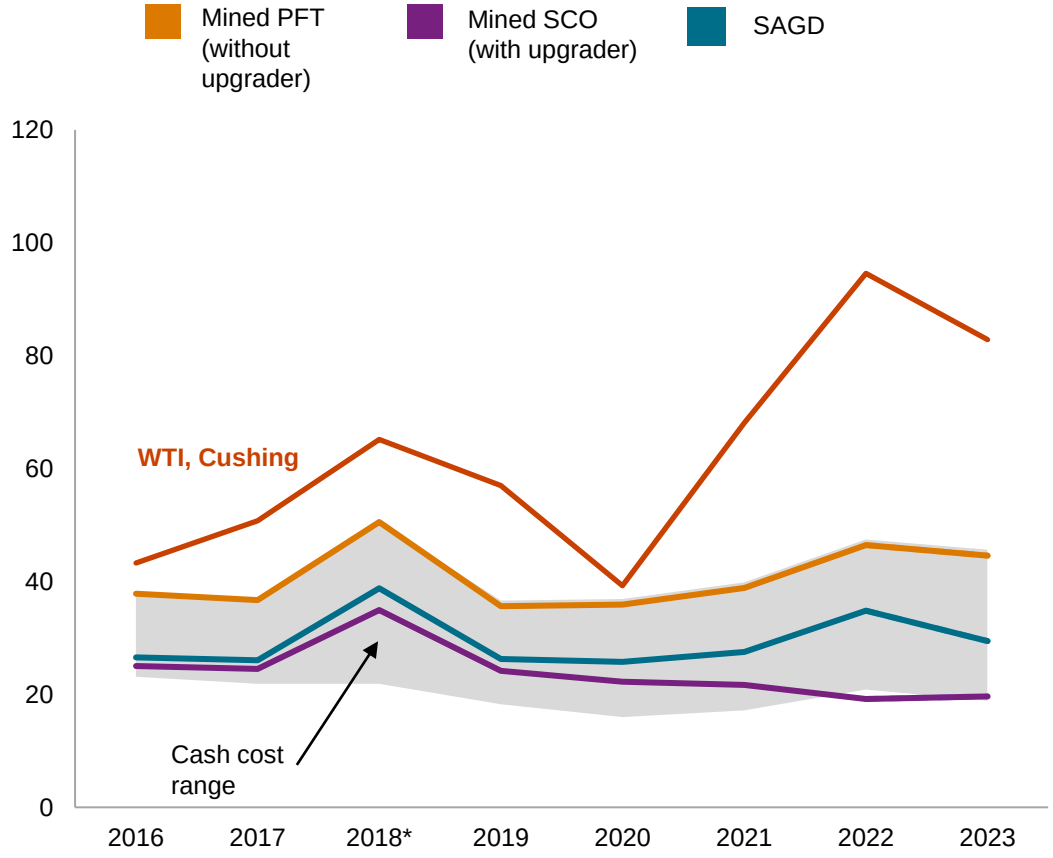
Data compiled June 4, 2024.
Source: S&P Global Commodity Insights.

New capacity addition costs have struggled compared to installed capacity operating costs

Canadian oil sands break-even analysis, 2020–23 ($/b, WTI basis)



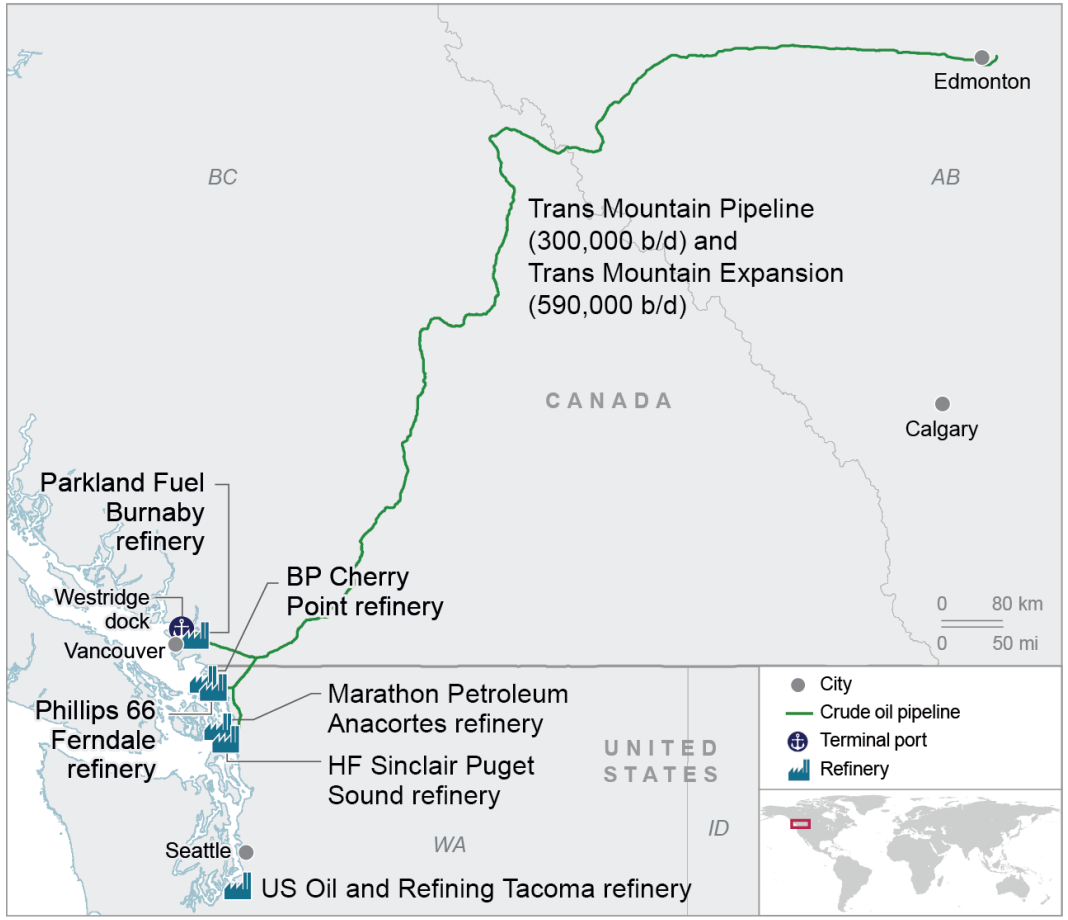
Canadian oil sands cash cost breakeven (WTI basis)



Data compiled April 12, 2024.
* Breakeven in 2018 suffered from regional price collapse due to transportation constraints. ** Breakeven in 2023 and 2024 is using an estimated operating cost based off the 2022 actuals.
Source: S&P Global Commodity Insights.

The TMX Project is anticipated to provide some price stability

Trans Mountain Pipeline System

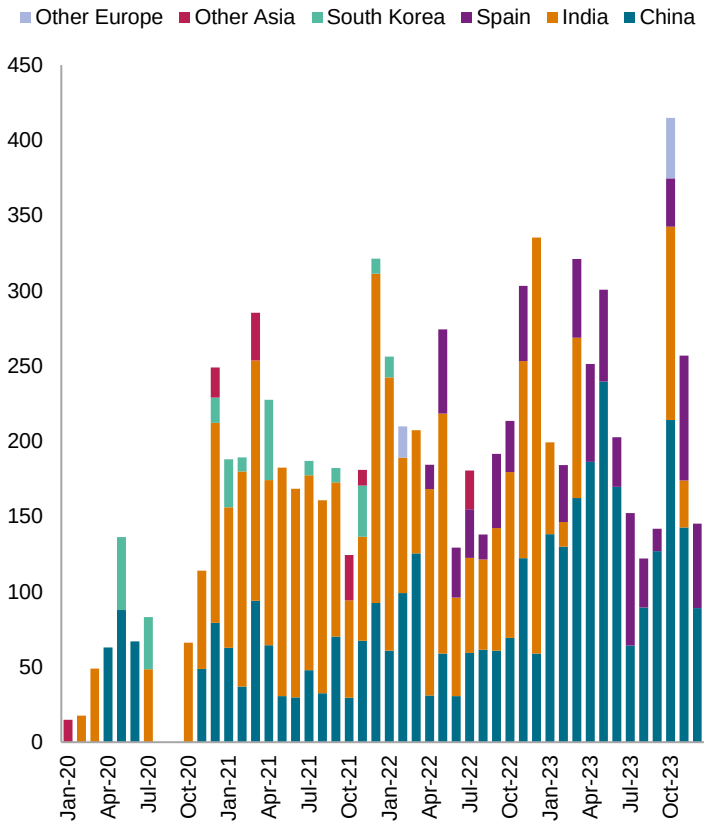


Data compiled Feb. 8, 2024.
Source: S&P Global Commodity Insights midstream content (EDIN): 2012270

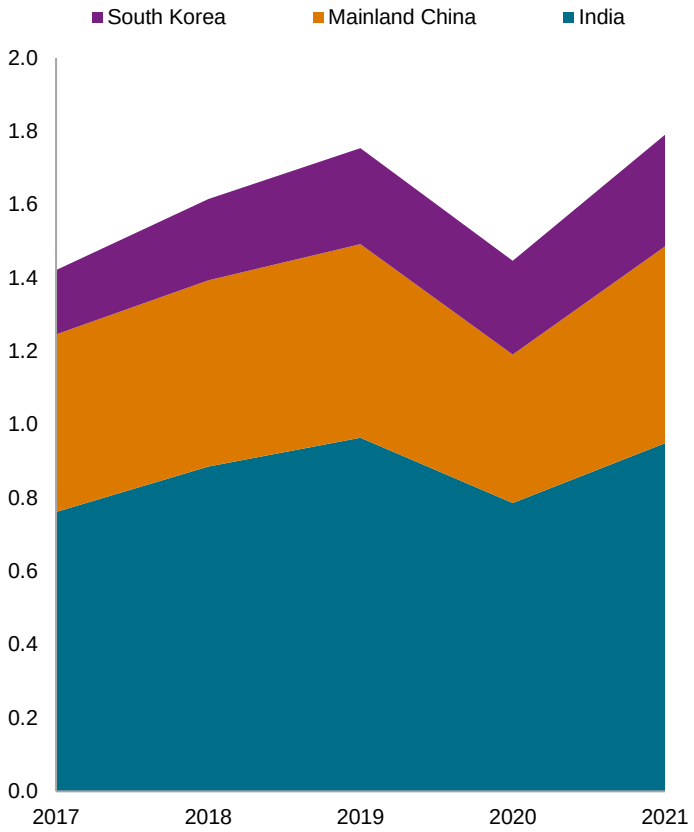
- We assume the Trans Mountain Pipeline Expansion Project (TMX) is online by the end of the second quarter of 2024.
- TMX adds 590,000 b/d of offshore export capacity via shipments from Edmonton, Alberta, to Burnaby, British Colombia. The existing Trans Mountain Pipeline has a capacity of about 350,000 b/d and delivers both light crude and refined products.
- Following the completion of TMX, the system is expected to operate with 540,000 b/d of heavy capacity and 350,000 of light and refined product capacity for a total system capacity of 890,000 b/d.
- By allowing Canadian crude oil to move directly offshore, TMX provides more efficient access to alternative markets in the Pacific Basin.
- The original cost estimate in 2013 for TMX was C$6.3 billion, which by March 2023 had risen to C$30.9 billion and as of Feb. 27, 2024, Trans Mountain is expecting costs to rise another 10%.

Asia and California are the likely destinations for Canadian heavy crude exported via TMX

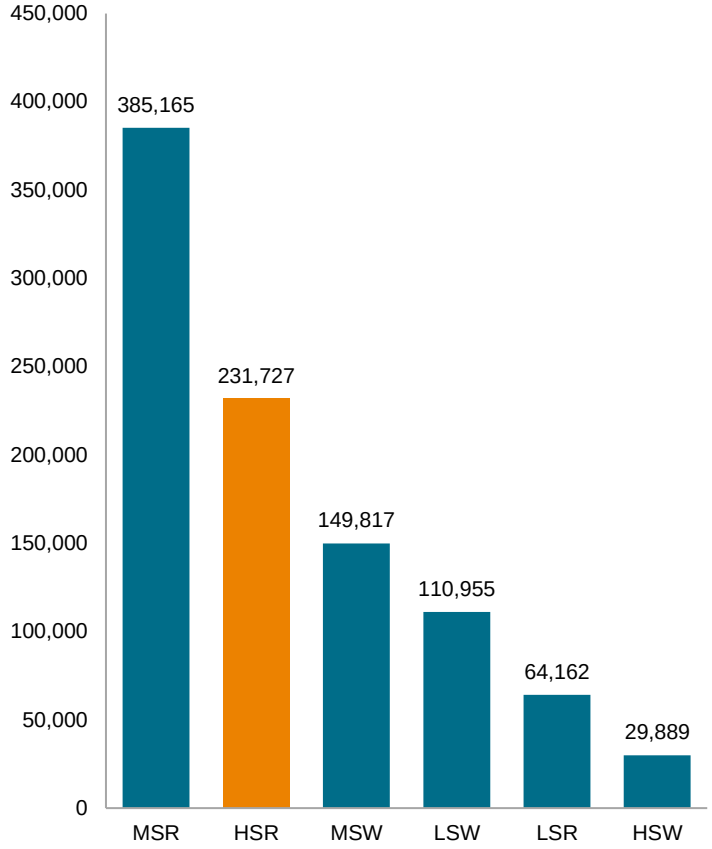
Western Canadian crude oil re-exports via USGC, by destination (thousand b/d)



Heavy, sour oil imports by key Asian refining center (million b/d)



California refinery crude imports, 2023 (thousand b/d)

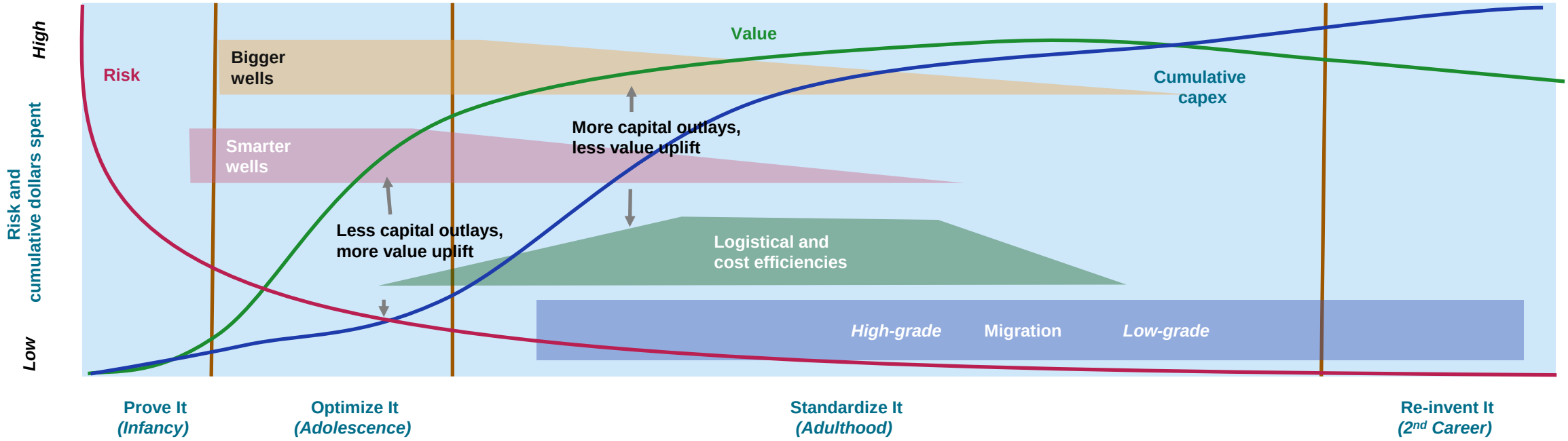


Data compiled Nov. 3, 2023.
Sources: S&P Global Commodity Insights; California Energy Commission; US Customs and Border Protection.

Value, risk and levers in upstream North America

Significant value-add-per-dollar spent comes in the initial stages, when risk is high. Most independents have sought to monetize after optimization, before major capital commitments.

How unconventional plays work: Value creation and improvement

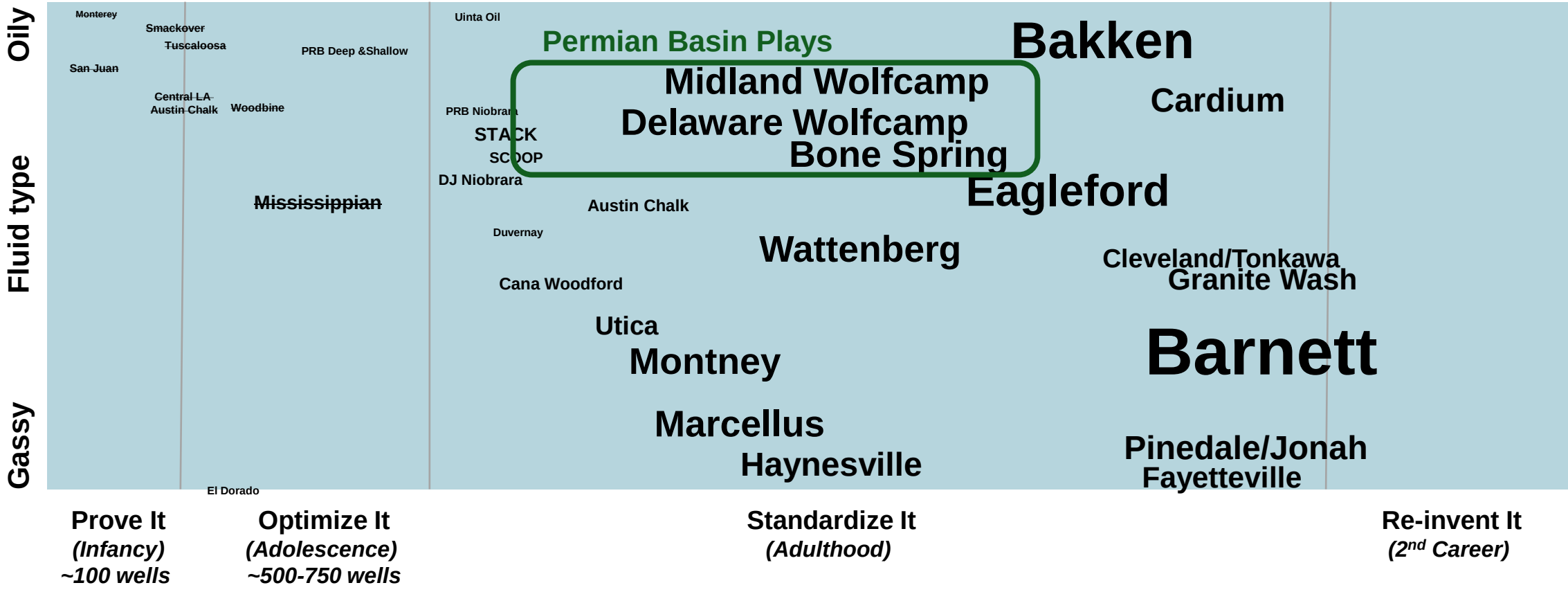


Source: S&P Global Commodity Insights.

The cupboard is full

A large resource base has already been de-risked and will feed the system for several years.

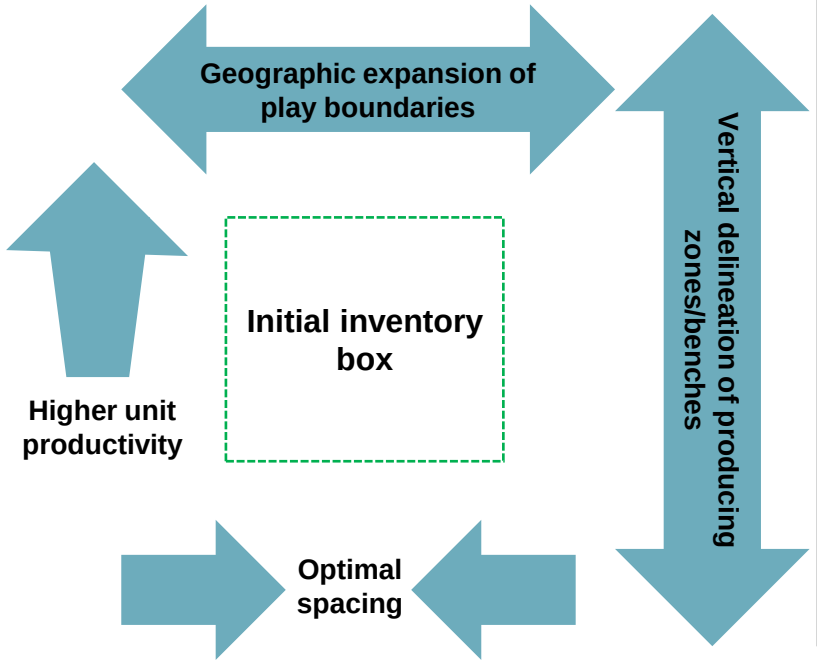
How unconventional plays work: Life stages



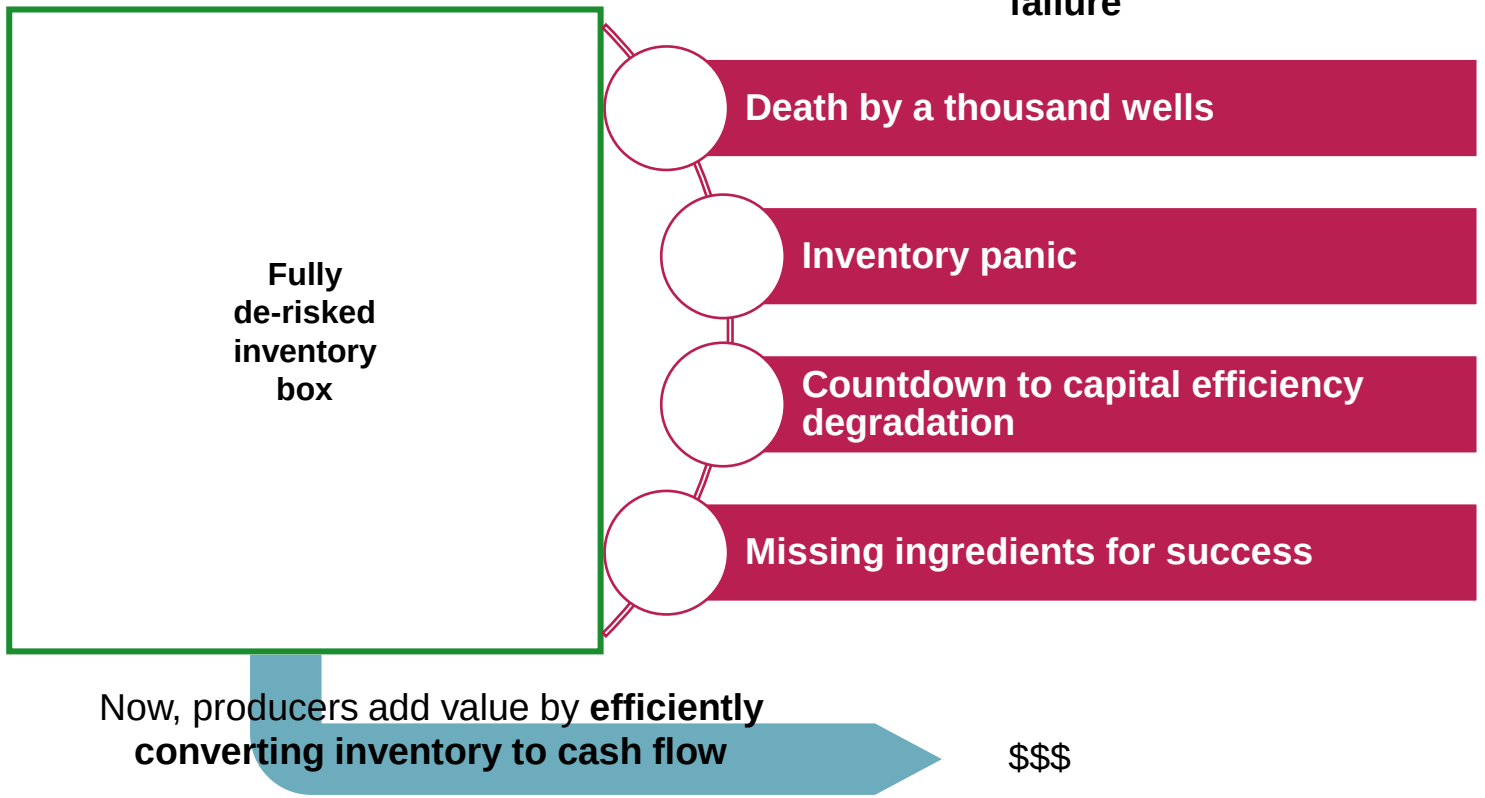
Source: S&P Global Commodity Insights.

Exploration and production's shrinking box problem

In initial stages of play development, producers **added value by expanding the inventory box** by investing in four upsides



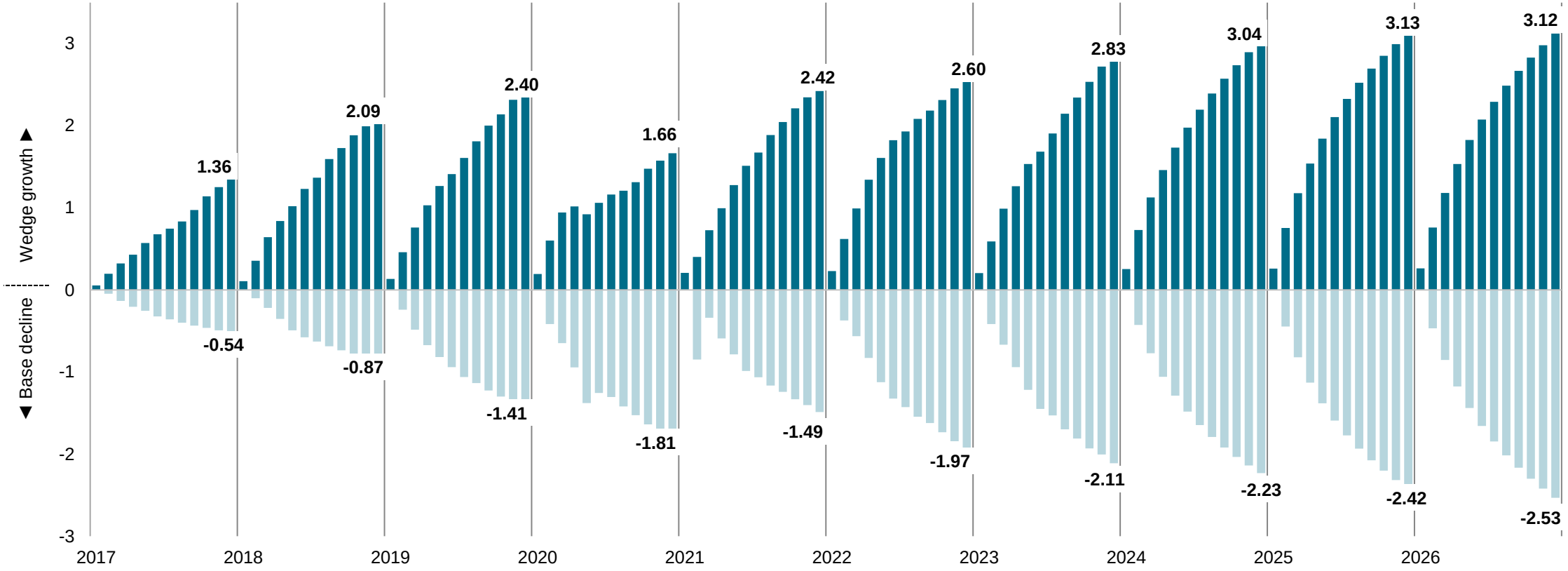
With the box no longer expanding, investors are exposed to **new risks and points of failure**



Source: S&P Global Commodity Insights.

The Permian treadmill

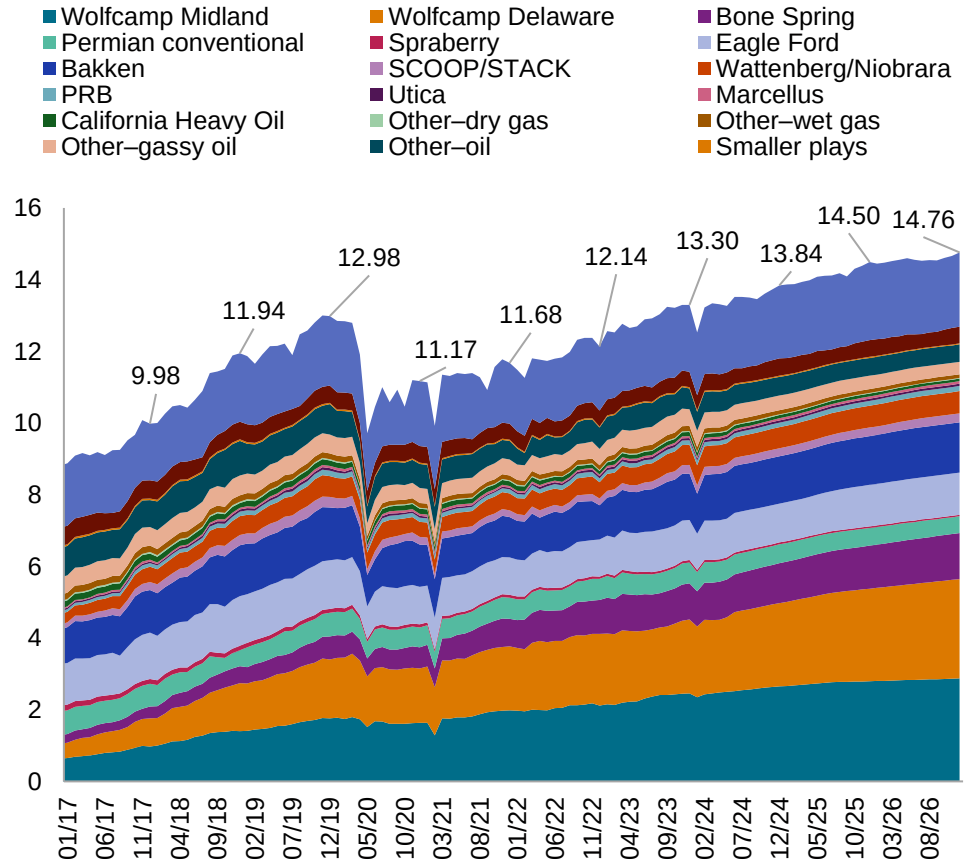
Permian unconventional base decline and wedge production (million b/d)



Data compiled April 29, 2024.
Base decline represents total production decline from existing wells over a given year. Wedge growth reflects incremental production from new wells completed each year.
Owing to unavoidable methodological reasons, base decline is underestimated, and sum of wedge and base overstates growth modestly.
Source: S&P Global Commodity Insights.

Slower rig additions push growth from 2024 to 2025

US oil production in million b/d (December volumes noted)



- After rig counts collapsed in 2023, both public and private operators have been reluctant to restart activity despite attractive oil prices. With an average realized price of $84/b WTI in 2024, operators will deploy $132 billion in Lower 48 onshore upstream capex as they balance 325,000 b/d of Lower 48 onshore production growth while generating $77 billion of free cash flow.
- Despite a slower-than-expected increase in oil-directed rig activity thus far in 2024, rigs should return to drilling, particularly in the Permian, through the remainder of the year. Rig additions will lead to accelerated production growth in 2025, with Lower 48 onshore volumes reaching 11.8 million b/d by December 2025.

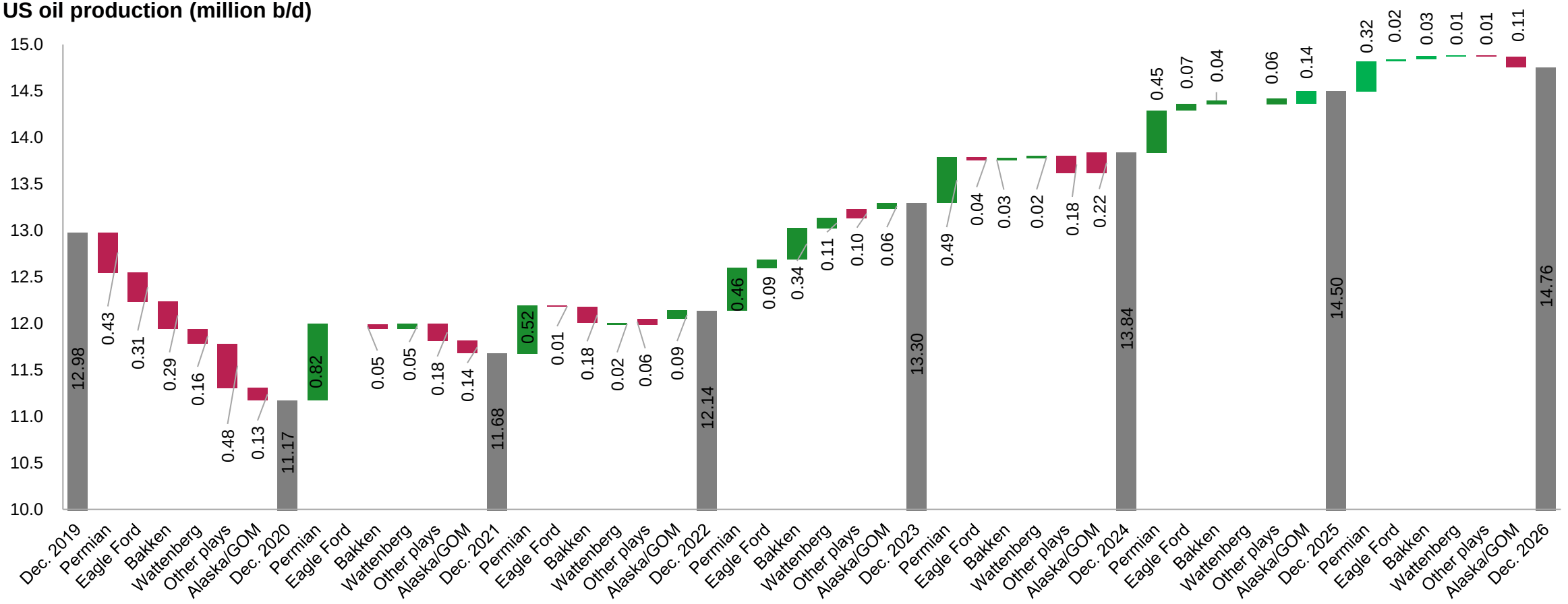
US upstream operational summary

	Annualized totals					Year-over-year change			
	2021	2022	2023	2024	2025	2021–22	2022–23	2023–24	2024–25
Annual average oil production (million b/d)	11.3	11.9	12.9	13.4	14.1	0.6	1.0	0.7	0.7
December oil production (million b/d)	11.7	12.1	13.3	13.8	14.5	0.5	1.2	0.5	0.7
Lower 48 onshore December oil production (million b/d)	9.5	9.9	11.0	11.3	11.8	0.4	1.1	0.5	0.4
Estimated onshore D&C capex ($ billion)	68.2	100.6	122.9	131.8	149.3	32.4	22.4	8.8	17.6
Onshore new wells onstream	13,518	15,595	16,162	15,986	16,405	2,077	567	-175	419
Average onshore rig count	515	763	706	637	721	248	-58	-68	84

Data compiled April 25, 2024.
PRB = Powder River Basin; SCOOP = South Central Oklahoma Oil Province; STACK = Sooner Trend (oil field), Anadarko (basin), Canadian and Kingfisher (counties); D&C = drilling and completion.
Source: S&P Global Commodity Insights.

Slow restart to drilling activity curbs 2024 growth, accelerates 2025 volumes

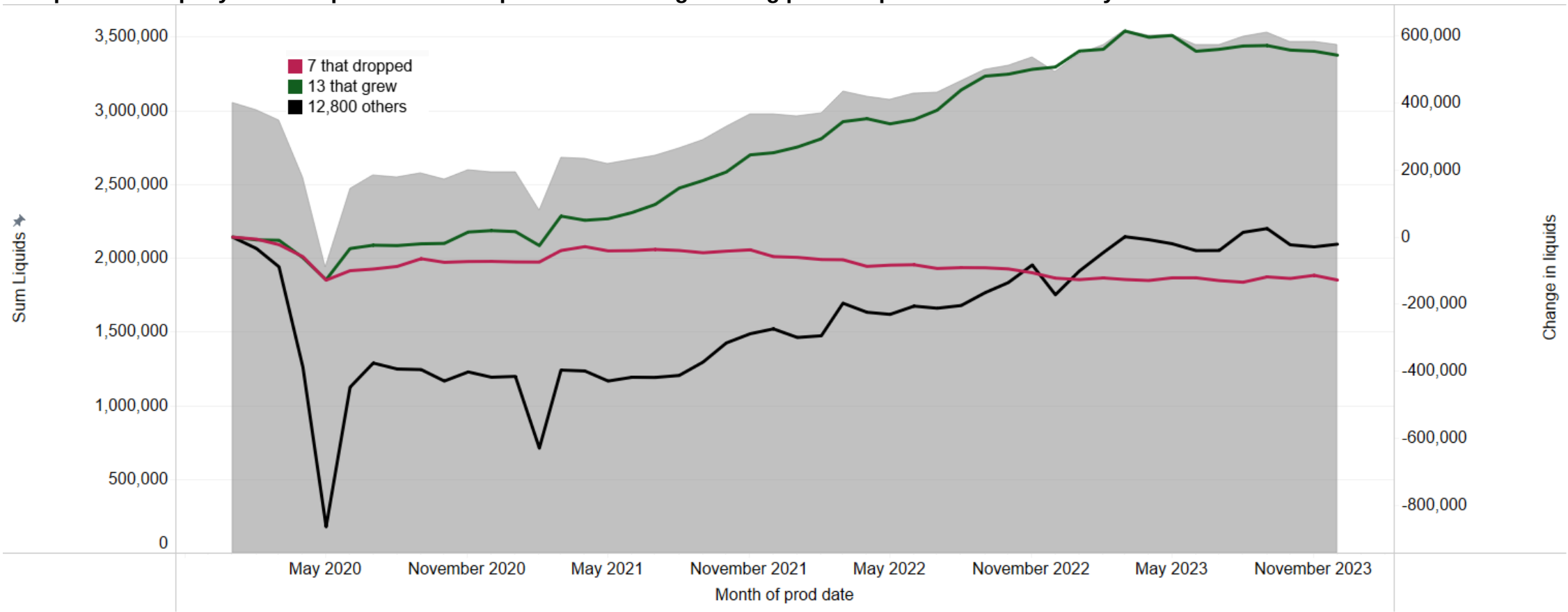
US oil production (million b/d)



Data compiled April 25, 2024.
GOM = Gulf of Mexico.
Source: S&P Global Commodity Insights.

Private operator production trajectory quickly flattened in early 2023 and has not recovered

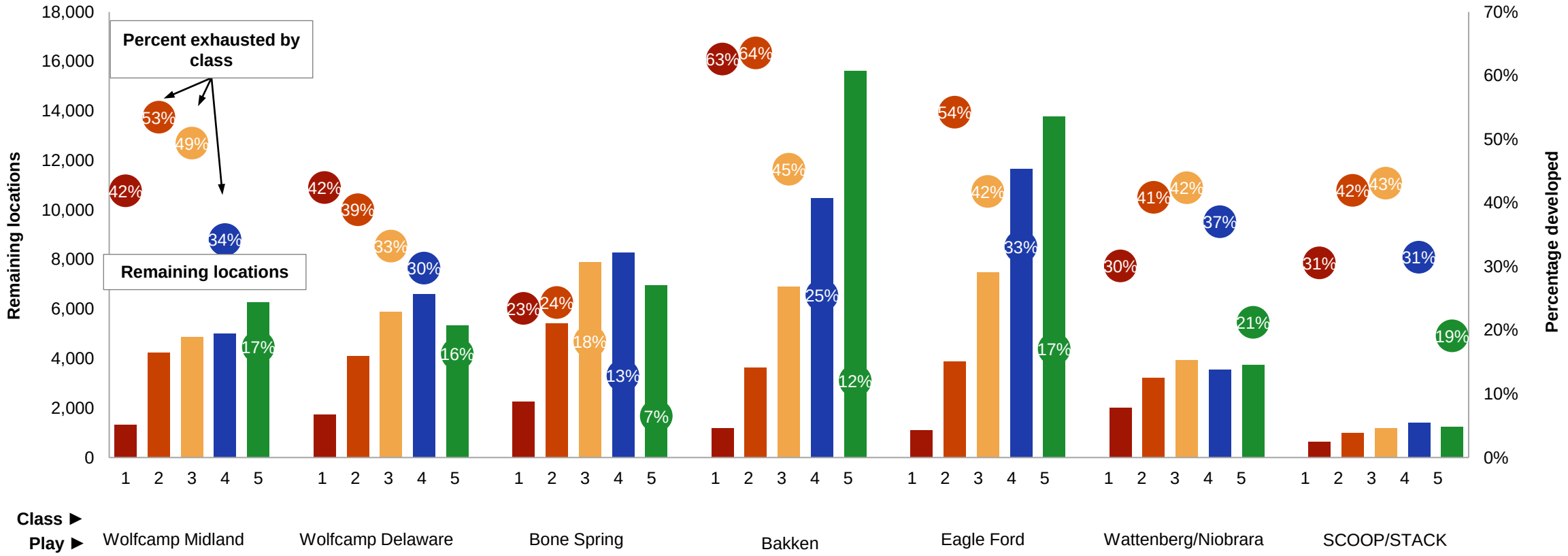
Total private company onshore production and production change among private operators from January 2020 to November 2023



Data compiled May 6, 2024.
Source: Data taken from S&P Global Commodity Insights upstream E&P content (Energy Studio: Impact).

Mature plays face exhaustion of core areas within the decade, but Permian can keep growing through late 2020s

Liquids plays: Remaining locations and percent developed by acreage class



Data compiled May 2024.
Bars in graph above indicate wells remaining; circles indicate percentage developed.
Remaining undeveloped locations indicate total undrilled location inventory locations; exhaustion rate indicates share of total locations that have been developed to date.
Source: S&P Global Commodity Insights

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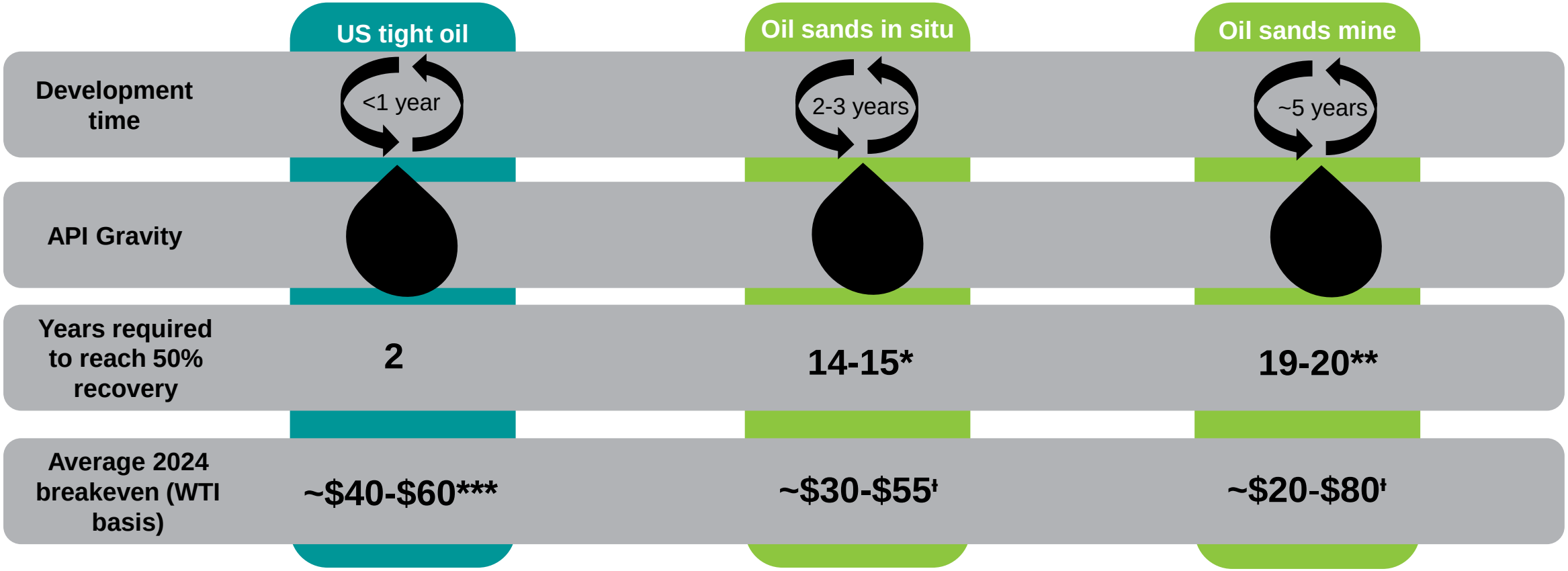
Tight oil and oil sands are distinct sources of supply

US tight oil and Canadian oil sands qualities and estimates



API = American Petroleum Institute.
* Based on 30-year productive life. ** Based on 40-year productive life. *** Breakeven required to maintain tight oil production flat.
ǂ Range of half-cycle (cash cost) to full-cycle breakeven.
Source: S&P Global Commodity Insights.

New oil sands projects take at least three times longer than tight oil to get to first oil





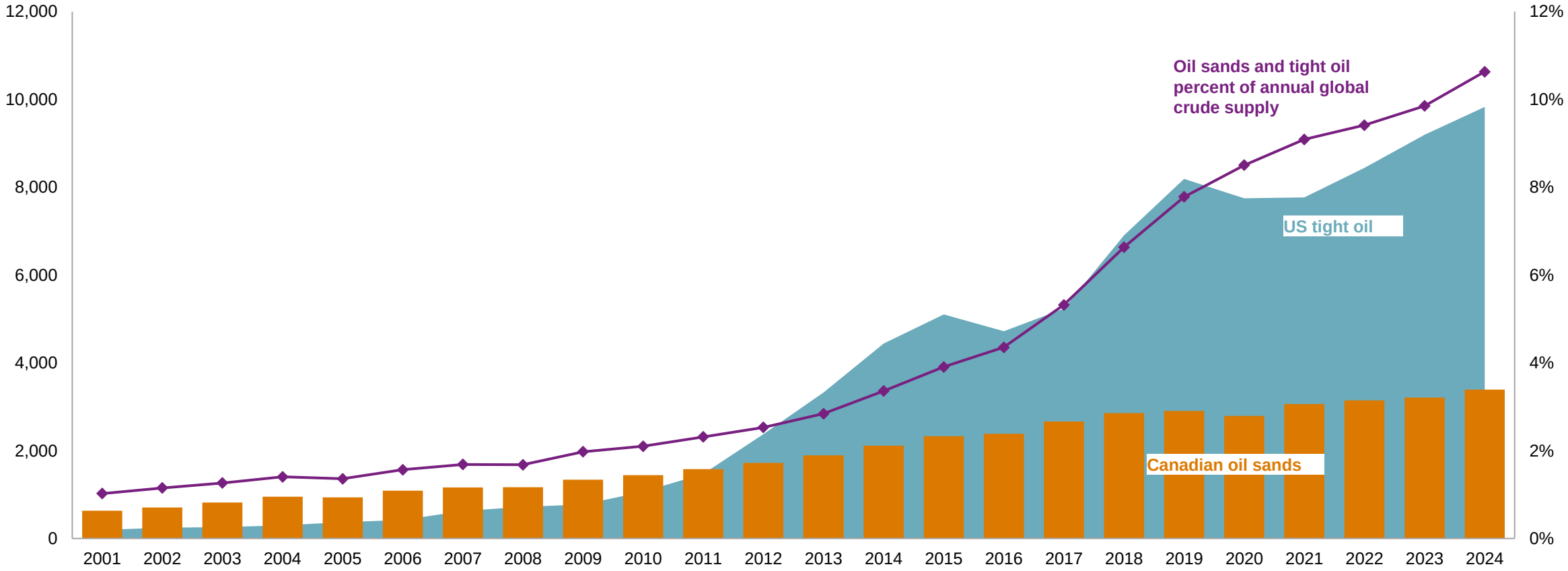

	Engineering and design	Regulatory review	Development	Ramp-up	Capital recovery	Productive life
SAGD	**3 to 4 years**	**2 to 3 years**	**2 to 3 years**	**1 to 2 years**	**5+ years**	**30 years**
Mine	**3 to 5 years**	**3 to 5 years***	**4 to 5 years**	**1 to 2 years**	**10+ years**	**40 years**
LTO	**Less than a month**	**1 to 3 months**	**4 to 5 months**	**1 to 2 years**	**~40 months**	**~30 years**

From sanction to fully ramped, an oil sands SAGD project takes about three times longer and an oil sands mine about three to five times longer than a tight oil program.
From concept to fully ramped, an oil sands SAGD takes about four to six times longer and an oil sand mine takes about six to eight times longer than a tight oil program.

LTO = light tight oil.
* Upper bound based on Shell Jackpine expansion applied for review in 2007 with a decision rendered in 2013.

Despite the differences between the oil sands and tight oil, significant growth has propelled North America to become the largest producer of crude globally

Oil sands and tight oil production (thousand b/d) and percent of global crude total



Data compiled May 31, 2024.
Source: S&P Global Commodity Insights.

The future of the two pillars of North American supply

Kevin Birn, Vice President, Center of Emissions Excellence

Raoul LeBlanc, Vice President, Upstream Solutions

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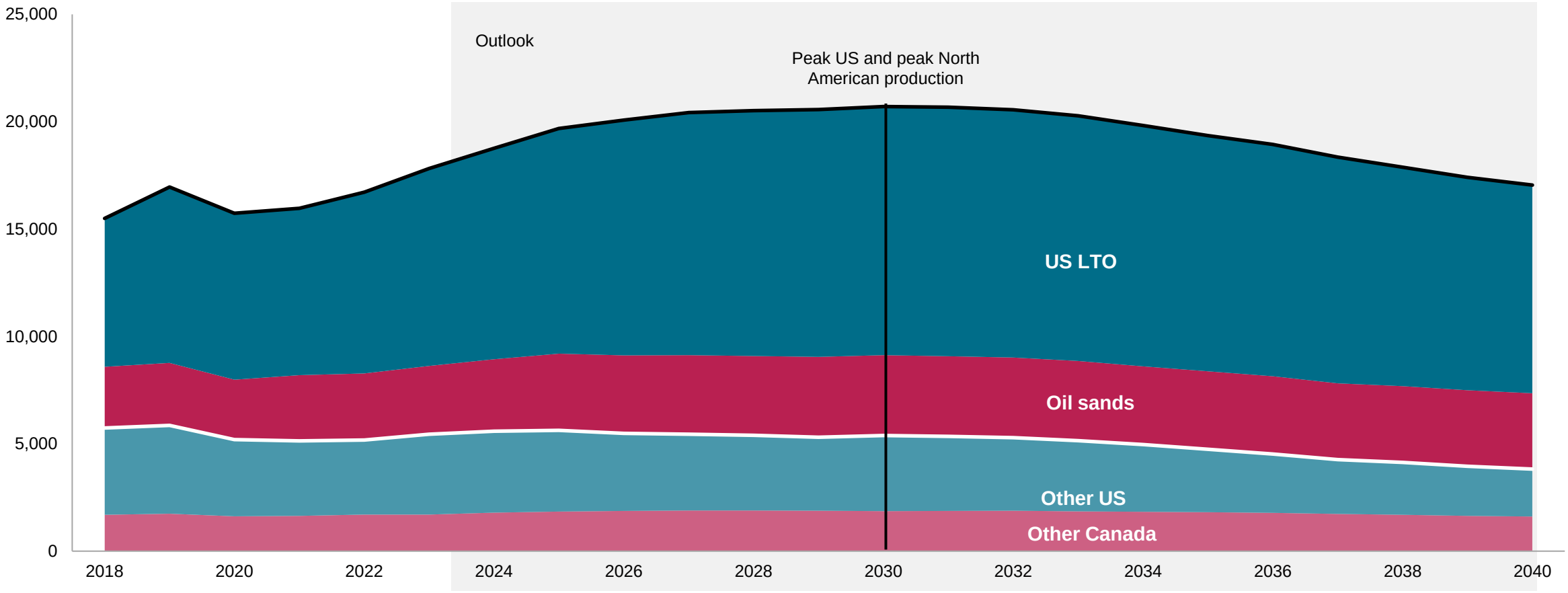
The world has changed: Three factors weigh on future of North American supply

- **Shareholder returns.** Years of poor returns have shifted the priorities of the North American upstream business. Wall Street has instilled capital discipline into upstream, increasing shareholder returns, raising expectations for higher oil prices in the long run and raising the bar for decarbonization investments.
- **Energy transition.** Amid concerns about the future of oil demand, the larger and longer upfront out-of-pocket investment required for new oil sands projects is seen as riskier than tight oil, which can return capital in months. However, the incredibly shallow decline rate of oil sands operations makes it particularly resilient.
- **Carbon competitiveness and decarbonization policy.** The US and Canadian governments are both regulating to lower emissions, but the approaches are distinct. US oil and gas emissions are not material to national emissions, and the US' approach has generally favored "carrots" and a focus on methane. In Canada, oil and gas emissions are material to national emissions, with the government favoring "sticks," and pushing for action on CO_2.
- Oil sands and tight oil have grown to become two pillars of North American and global energy supply and security. Both are expected to grow, but at a slower pace than recent years and for different reasons.

Canada and the United States together will continue to be the largest producers of crude oil in the world

North American crude oil production, 2018–30 (thousand b/d)



Source: S&P Global Commodity Insights.

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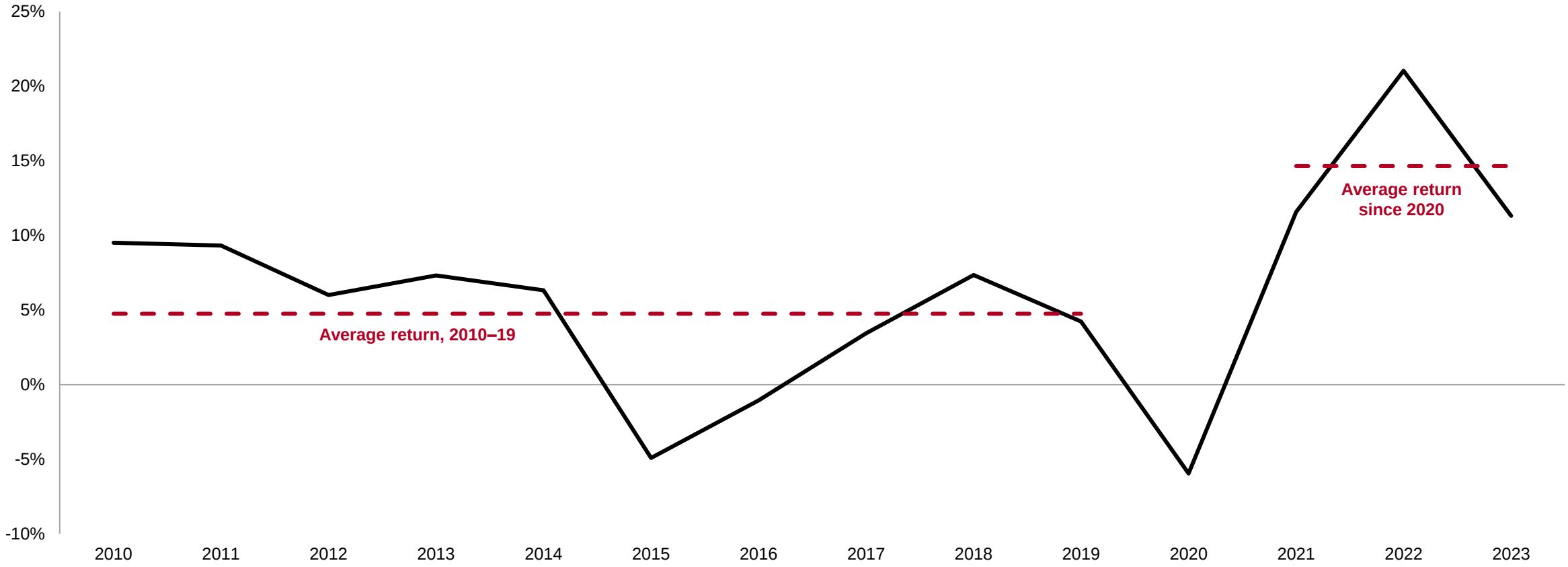
Shareholder returns

Perceptions of the energy transition

Policy

Years of poor returns have shifted the priorities of the North American upstream business from volume to value

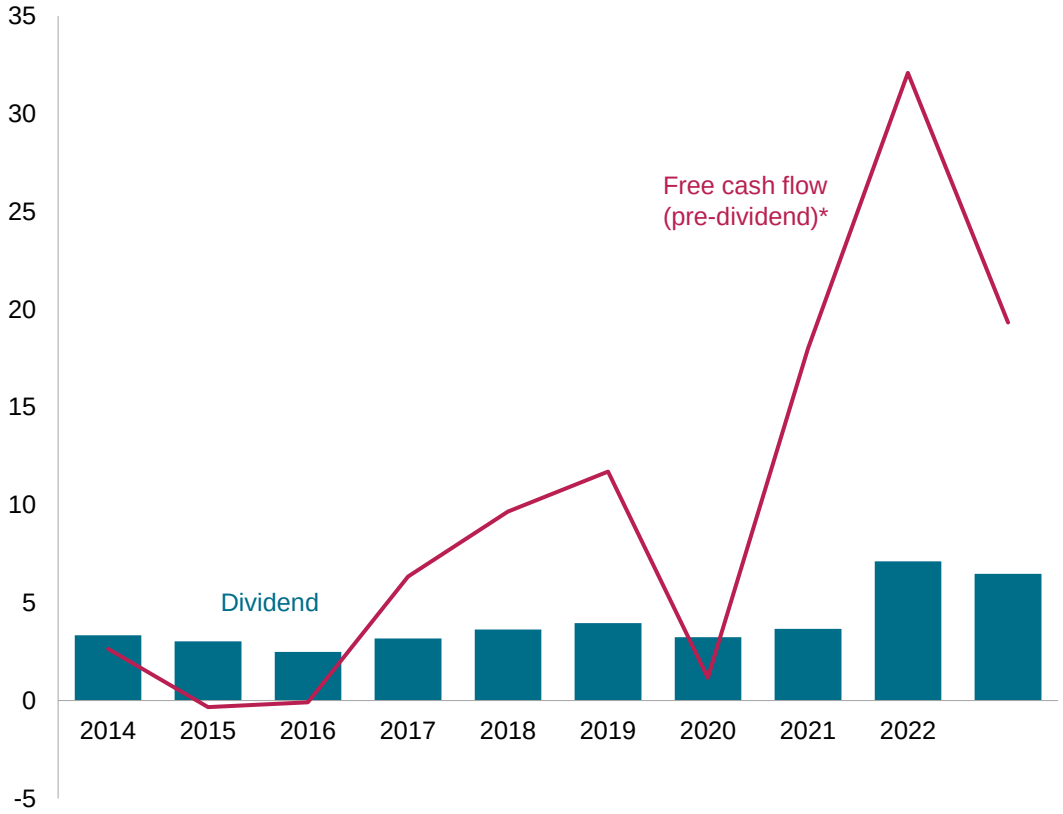
Upstream return on capital



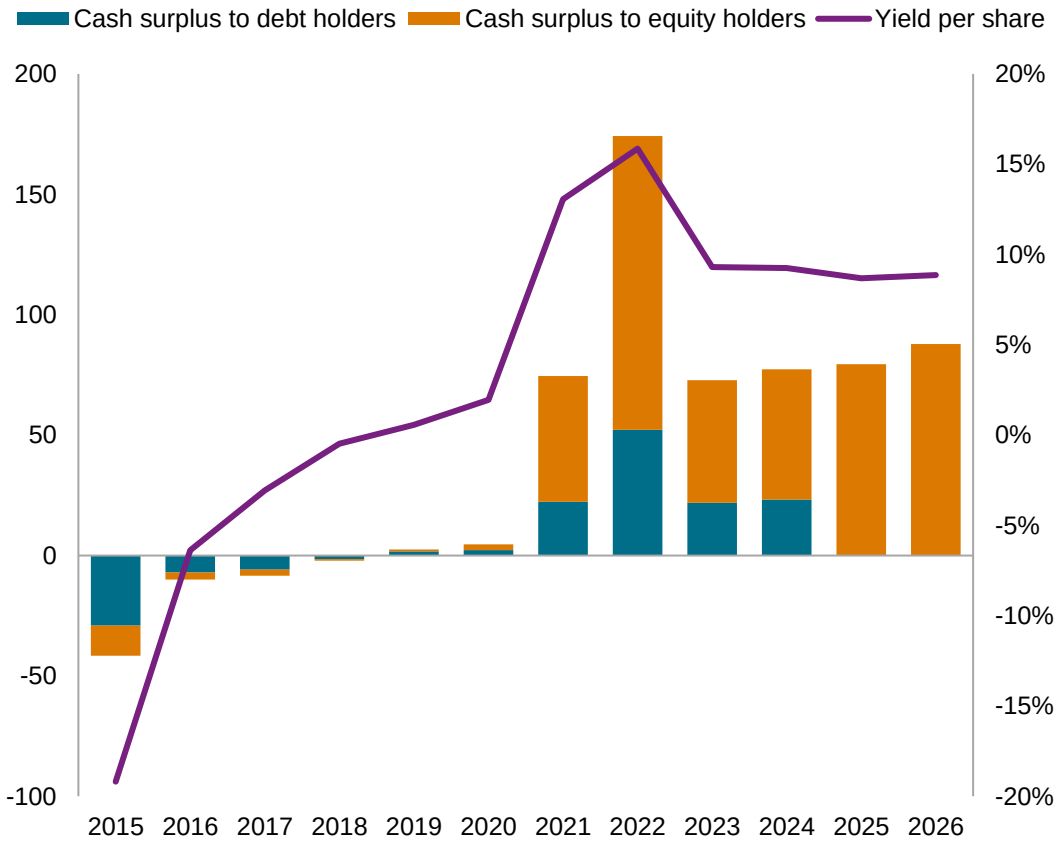
Data compiled June 7, 2024.
Source: S&P Global Commodity Insights.

Oil sands and shale are (finally) generating acceptable returns

Free cash flow of "Big 4" Canadian oil sands players by year (pre-dividend) ($B)



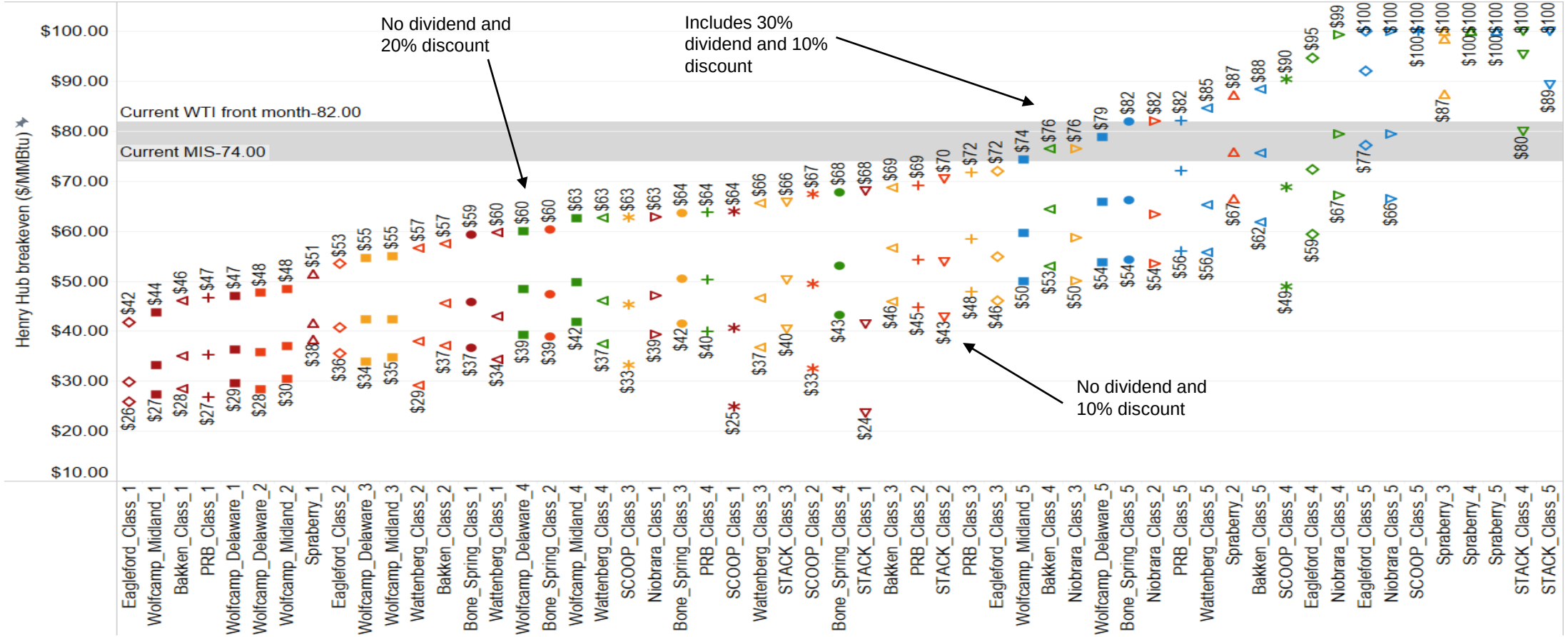
Onshore US cash surplus and proxy yield per share ($B)



Data compiled May 30, 2024.
*Note includes only largest four oil sands companies.
Source: S&P Global Commodity Insights.

Shareholder demand for cash raising break-even prices from $55 to about $70/b

Oil breakevens by play and acreage class (WTI breakeven, $/b)



Data compiled April 24, 2024.

Breakevens assume $3.50/Mcf Henry Hub and 26 cents per gallon ethane and are capped at $100/b. Shapes indicate play; solid shapes are notable Permian plays.

Source: S&P Global Commodity Insights.

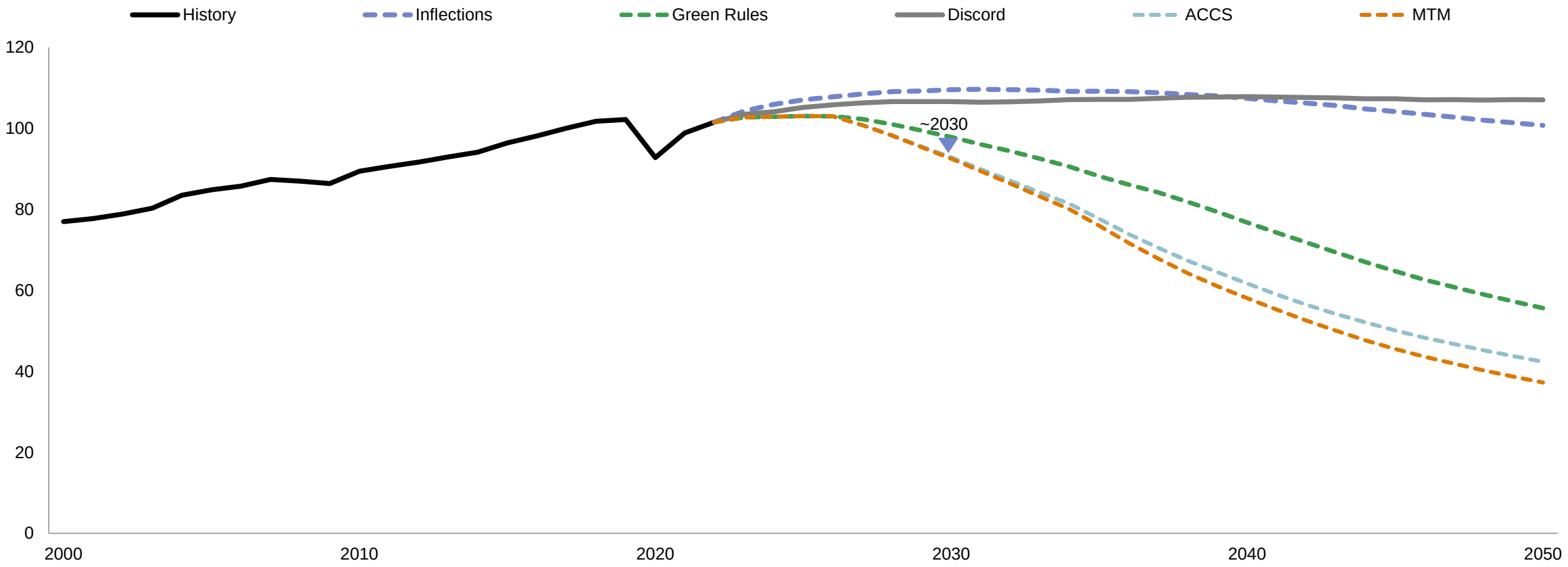
Shareholder returns

Perceptions of the energy transition

Policy

The energy transition has introduced a greater array of expectations on the future of oil demand

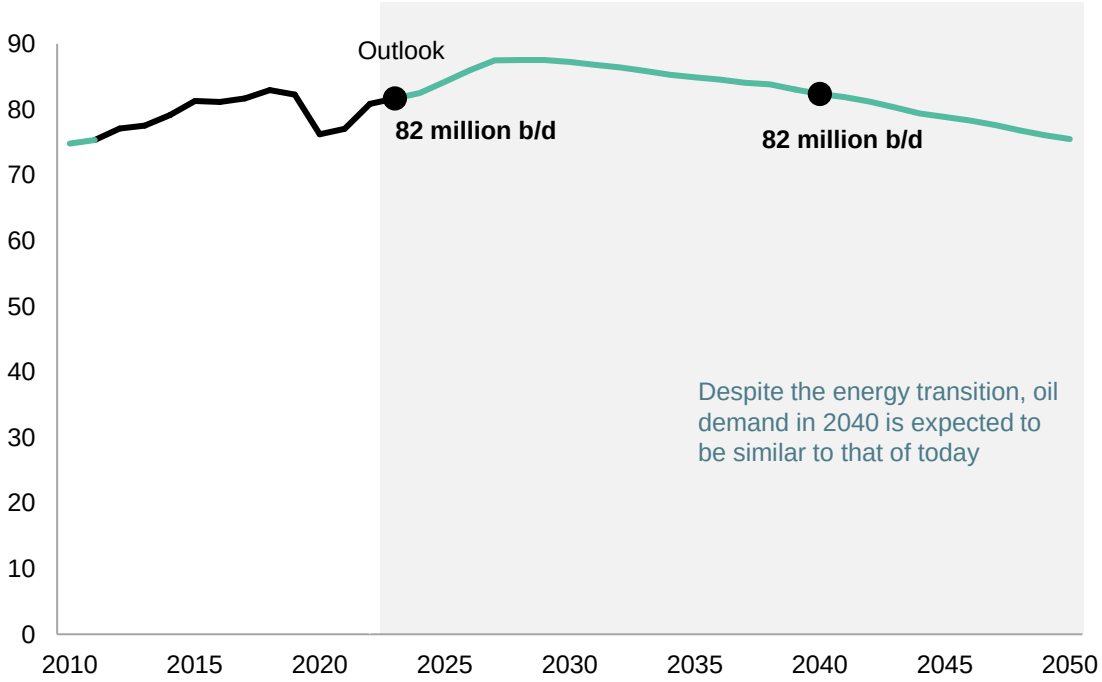
Global primary oil demand, 2000–50 (million b/d)



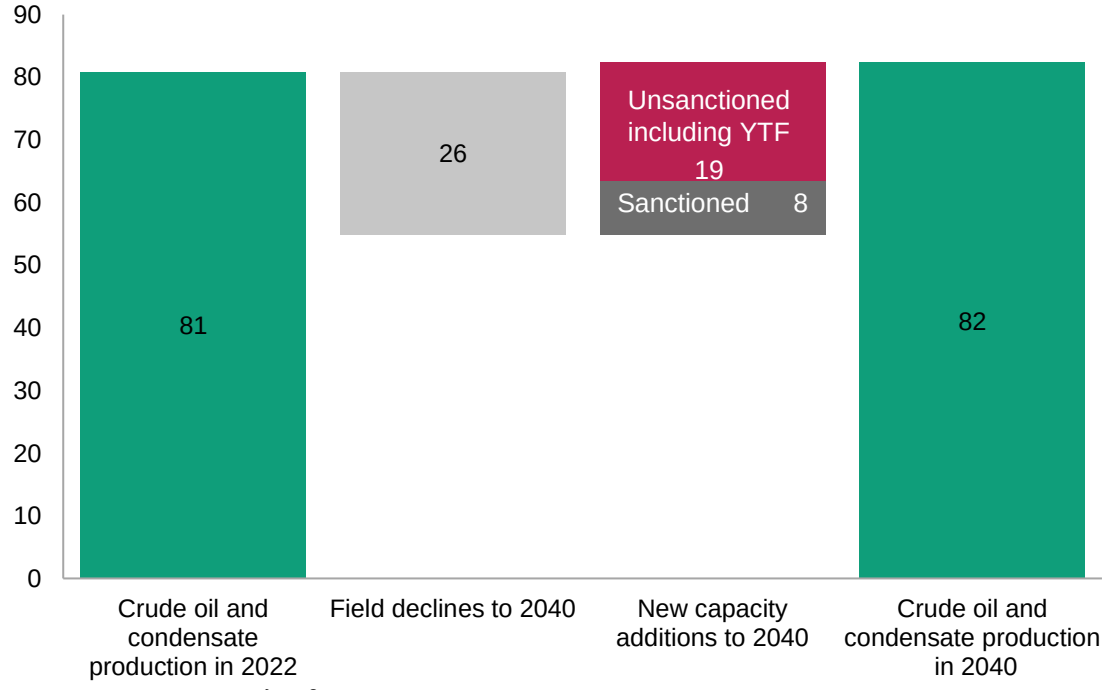
Data compiled May 2024.
ACCS = accelerated CCS case; MTM = multitech mitigation case.
Source: S&P Global Commodity Insights.

In our base case oil demand peaks this decade, but more is needed; between now and 2040 nearly a third of current supply will need to be replaced

World crude and condensate supply (million b/d)



Global crude oil and condensate production outlook in 2040 (million b/d)

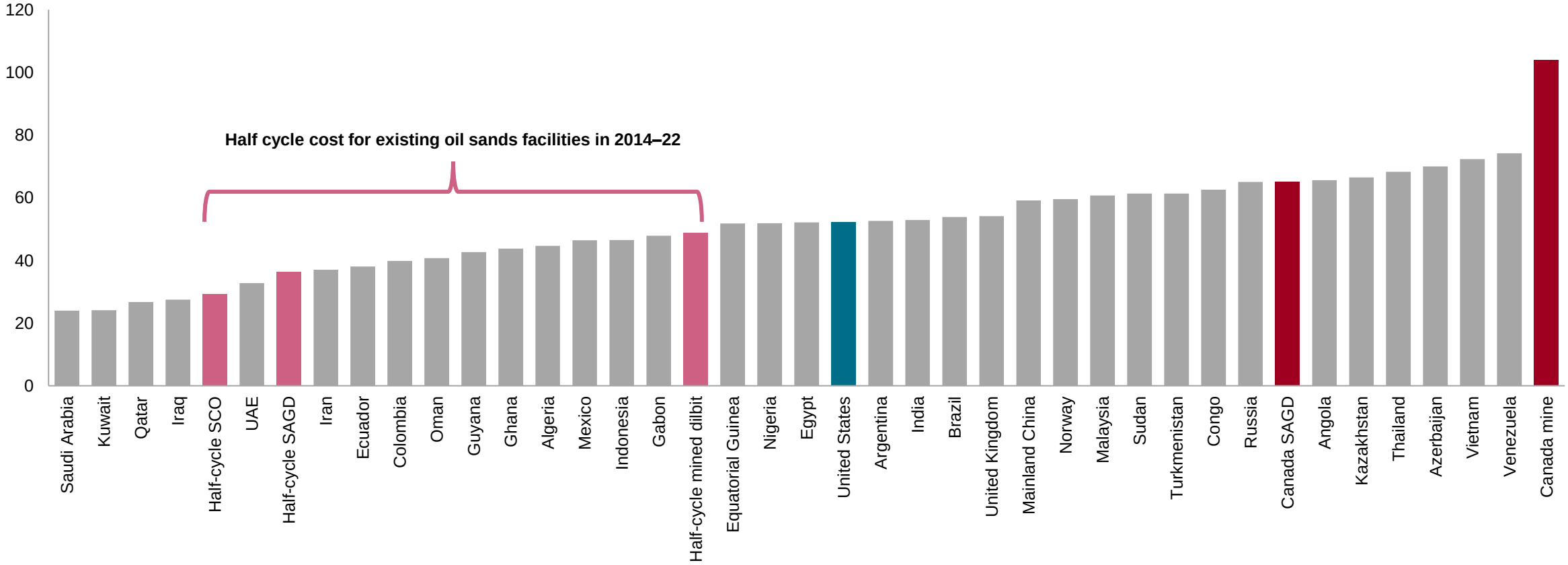


- World crude and condensate production averaged about 81 million b/d in 2022; by 2040, the conventional base production will have declined by 26 million b/d, or 32%. By 2040, the call on crude production is forecast to be 82 million b/d, almost the same as 2022. However, significant new oil output is still needed.

Data compiled April 26, 2024.
Source: S&P Global Commodity Insights.

Compared with other global crude production, existing oil sands assets have a lower cost of supply with a lower decline rate

Average full-cycle costs and oil sand half-cycle costs in terms of Dated Brent ($/b)



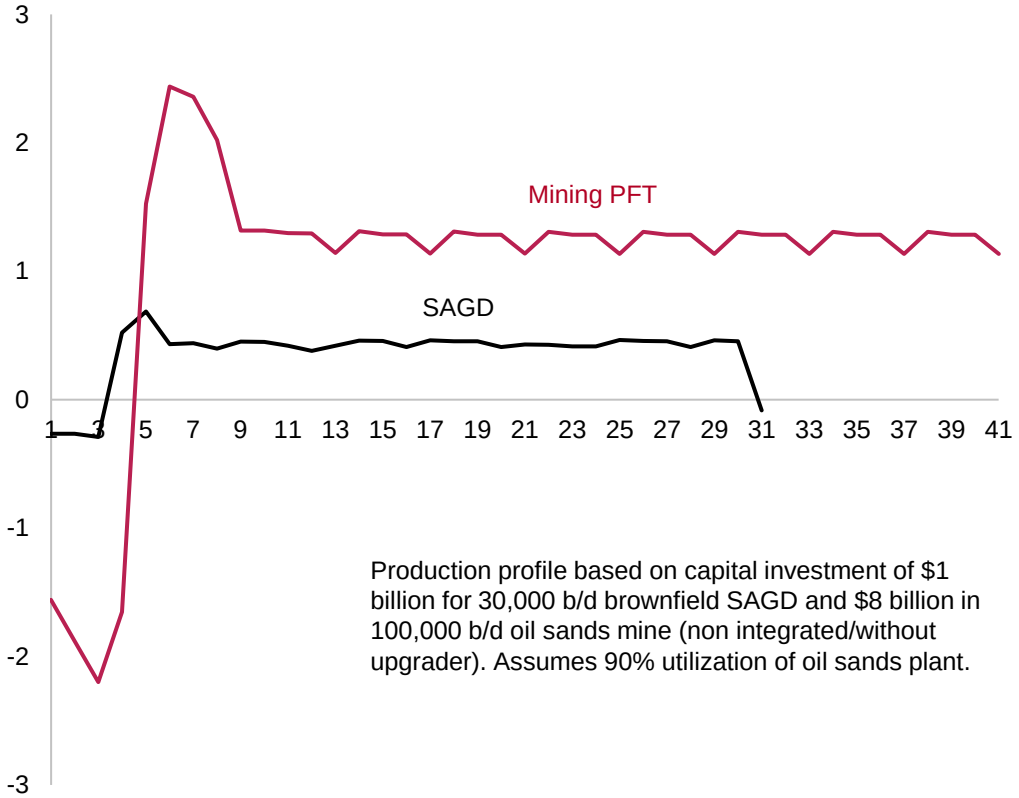
Data compiled April 2023.

Half-cycle costs for oil sands include diluent and transportation costs as well as a quality difference to light tight oil and is estimated on a WTI basis plus the 2023 estimated Dated Brent-WTI spread of $4.49/b. The half-cycle cost spread is the 2014–22 range.

Sources: S&P Global Commodity Insights; various producer financial reports.

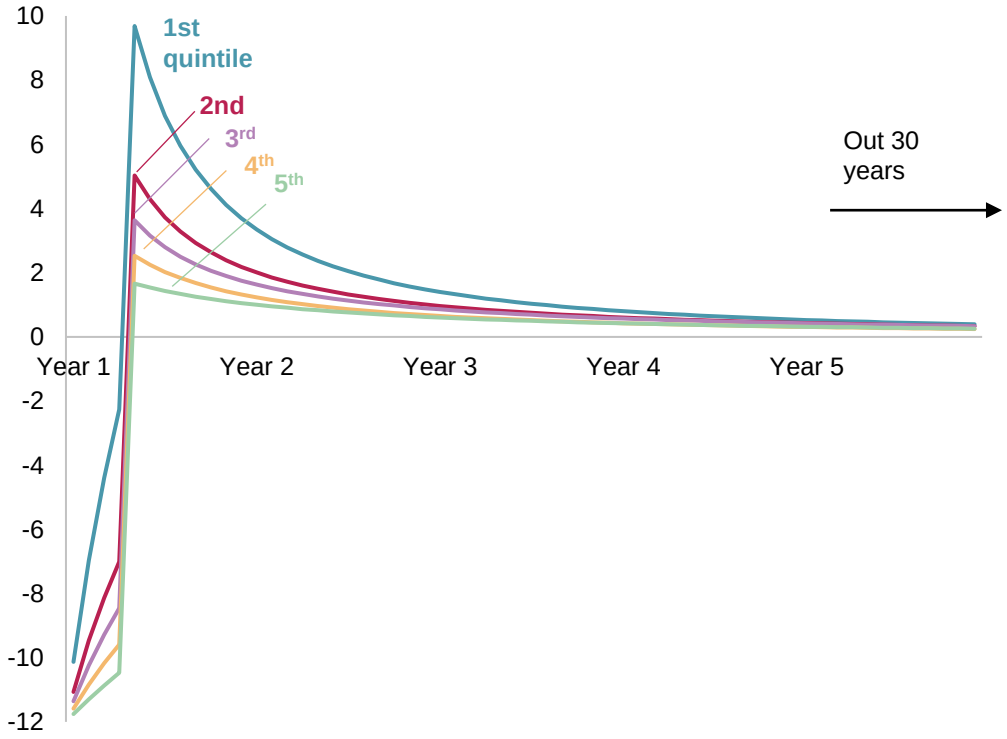
Time value of money may be the single greatest difference between oil sands and tight oil

Oil sands and tight oil profile of equivalent total barrels produced over 30 years ($M)



Production profile based on capital investment of $1 billion for 30,000 b/d brownfield SAGD and $8 billion in 100,000 b/d oil sands mine (non integrated/without upgrader). Assumes 90% utilization of oil sands plant.

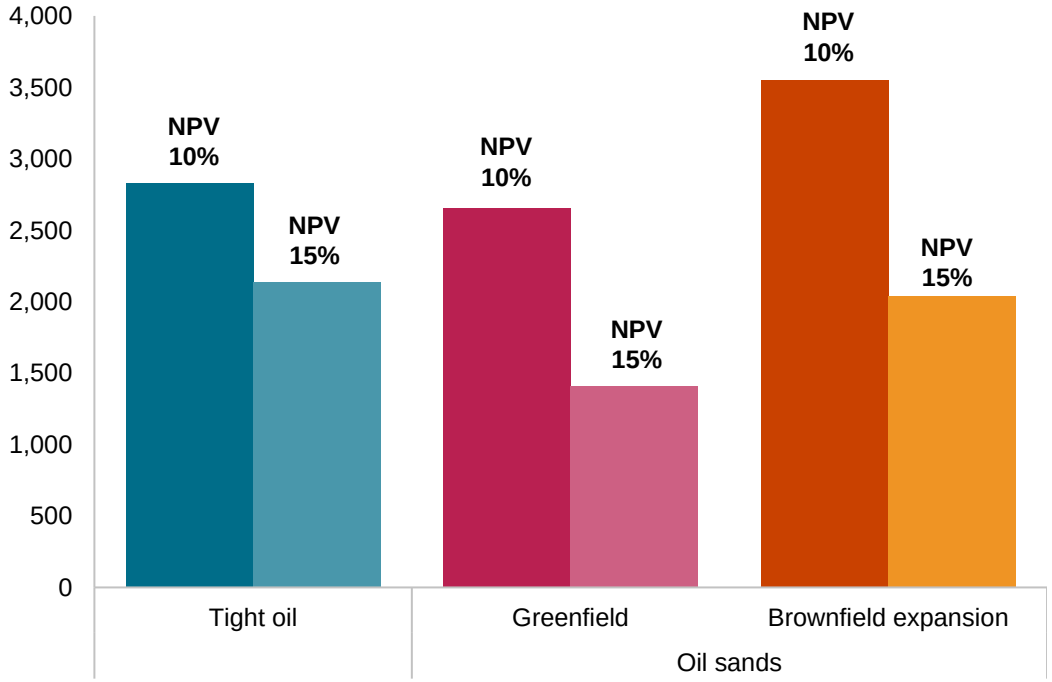
Representative tight oil cash flow profile by quintile (b/d annual average)



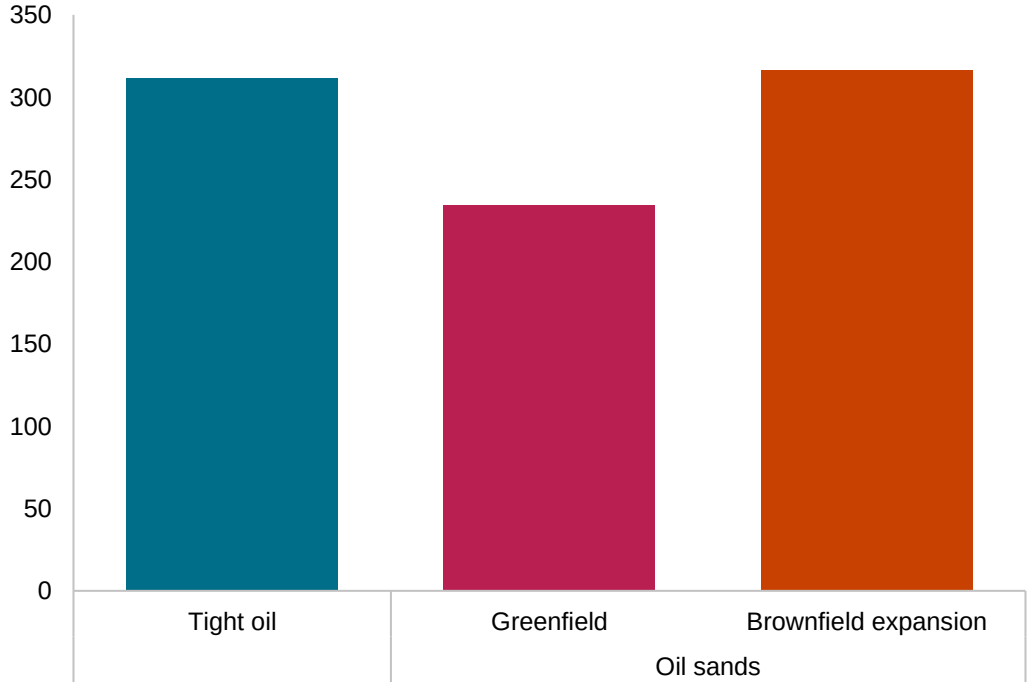
Data compiled June 7, 2024.
Source: S&P Global Commodity Insights.

Oil sands can generate higher NPV than tight oil at lower discount rates, but are more sensitive to time value of money than tight oil

NPV (at 10% and 15%) of equivalent "out-of-pocket" investment (at 60 WTI, $M)



Cumulative barrels produced over 30 years (million barrels, at $60/b WTI)



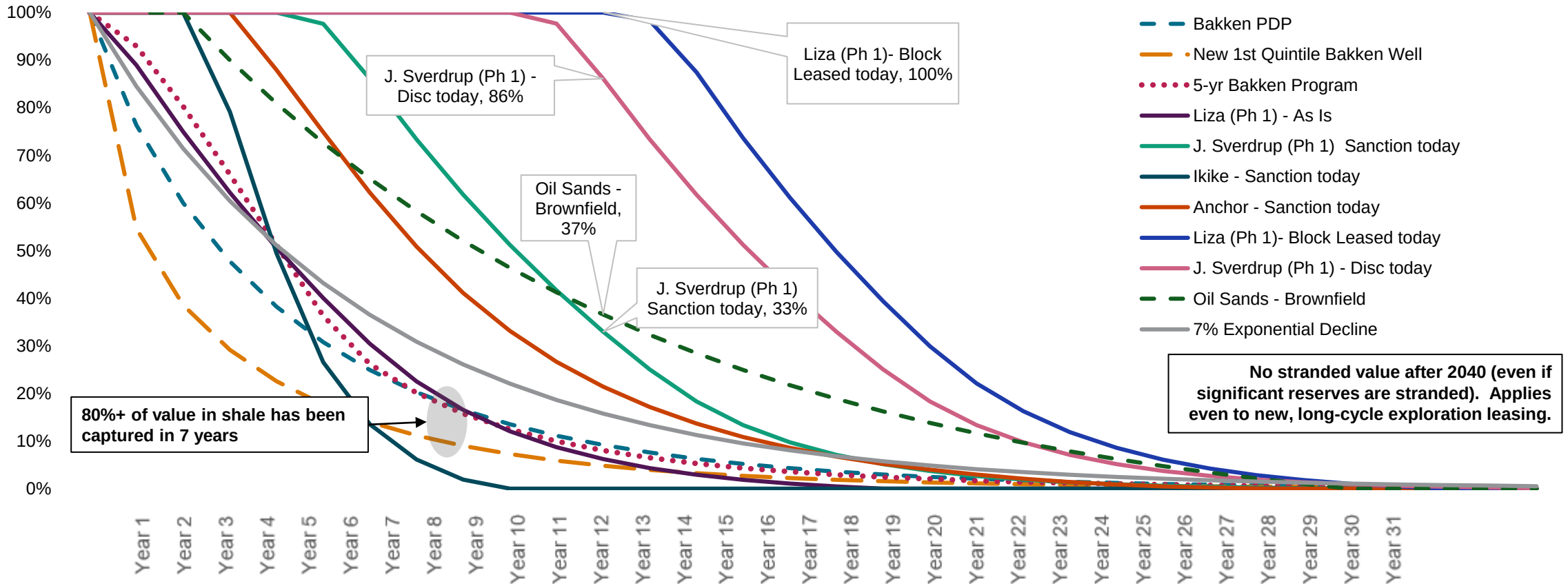
For tight oil investment of $4 billion, only $760 million is "out-of-pocket." This equates to about a 26,000 b/d greenfield oil sands SAGD project or a 31,000 b/d oil sands SAGD expansion.

Data compiled June 15, 2024.
NPV = net present value.
Source: S&P Global Commodity Insights.

Strand curves: Accelerated Energy Transition may, ironically, favor shale

Shale's high decline rates, modularity and short development cycle all become advantages if regulatory and market uncertainty increase

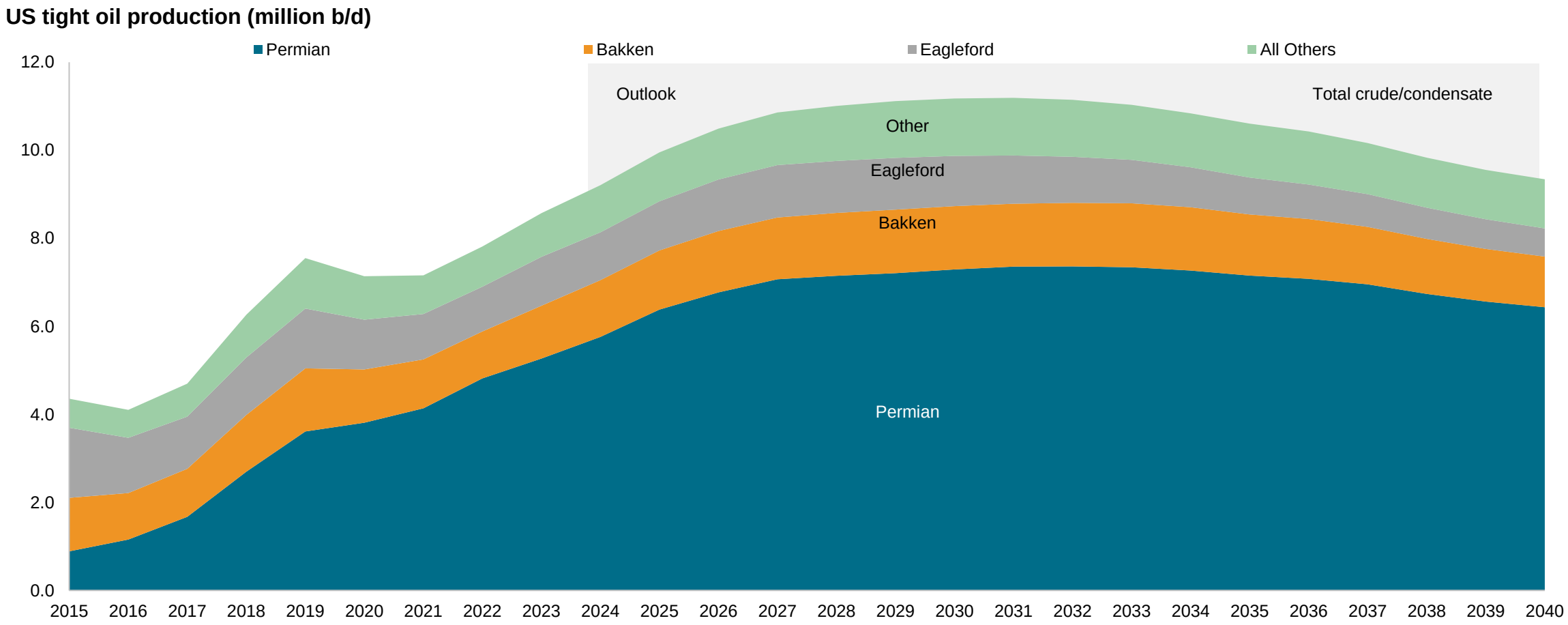
Strand risk curves, % of discounted boe stranded by year of abandonment



Data compiled June 2023.
boe = barrels of oil equivalent.
Assumed discount rate: 10%.
Source: Upstream Solutions, a product of S&P Global Commodity Insights.

S&P Global
Commodity Insights

Not done yet: Permian to drive continued expansion

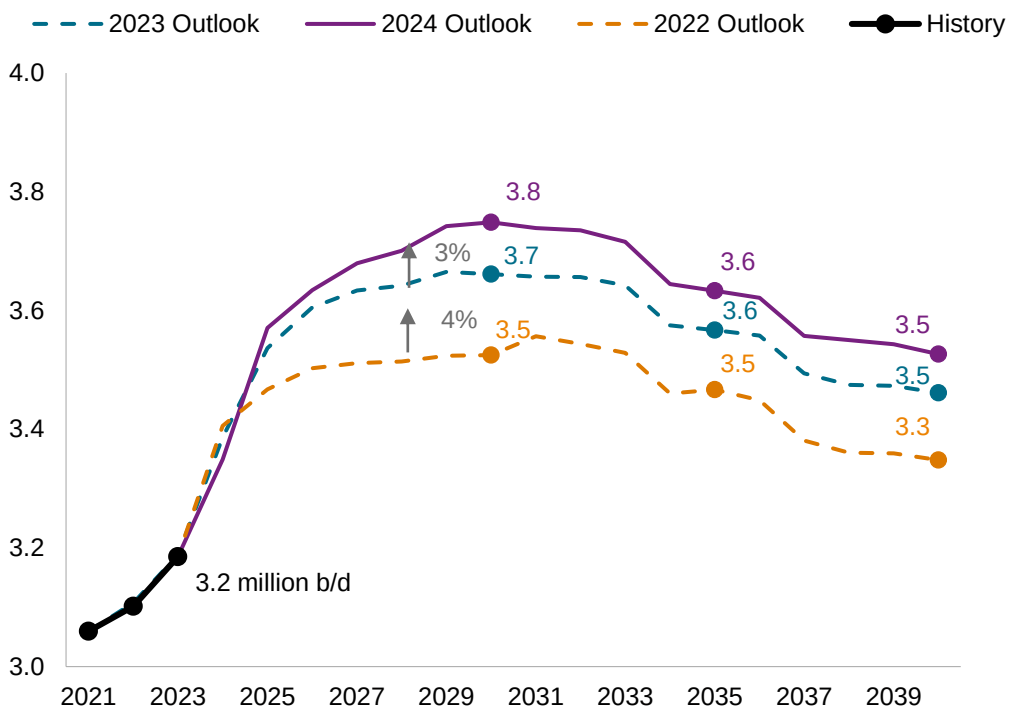


Data compiled June 7, 2024.
Source: S&P Global Commodity Insights.

S&P Global
Commodity Insights

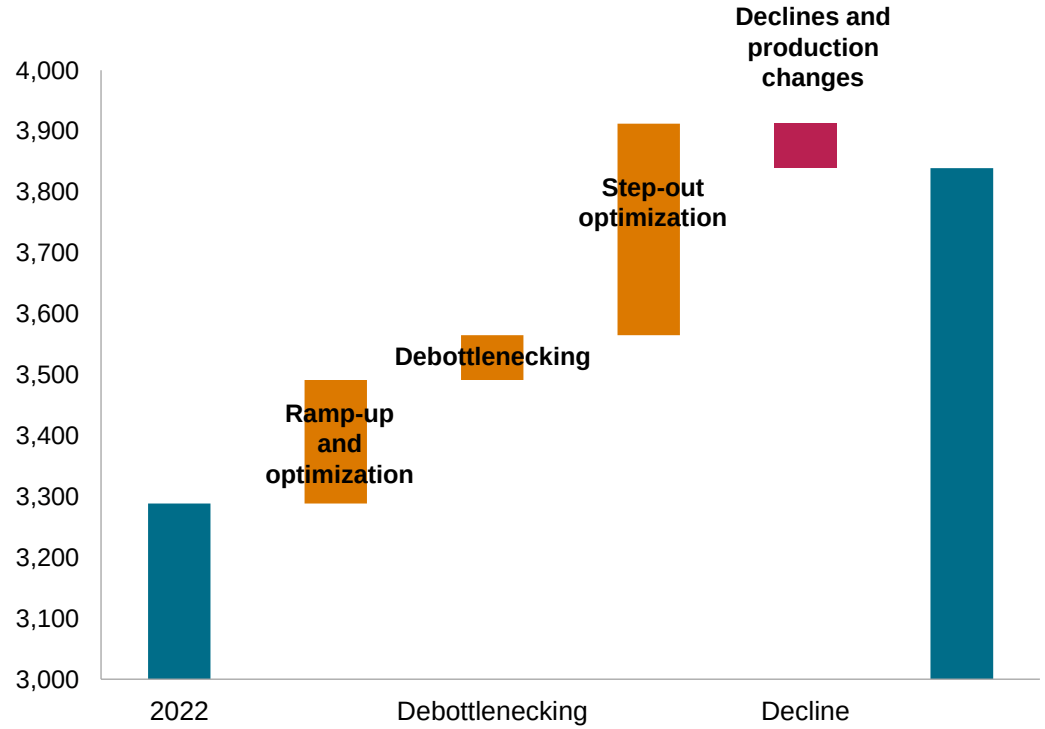
The oil sands have entered an age of optimization, where growth principally comes from existing operations

S&P Global Commodity Insights oil sands 10-year production outlook (million b/d)



Data compiled May 10, 2024.

Composition of oil sands growth, 2022–35 (thousand b/d)



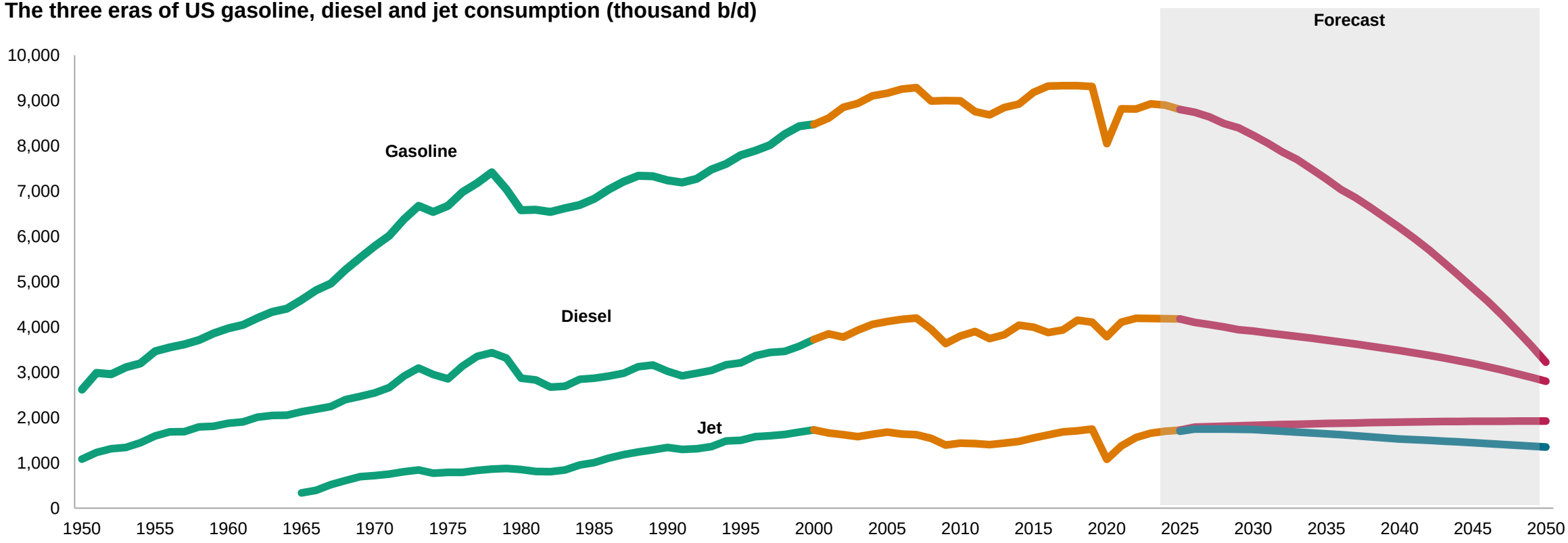
Data compiled April 6, 2024.

Source: S&P Global Commodity Insights.

The integrated nature of North American infrastructure makes US demand a critical influence on the future of oil sands

Oil sands heavy crude may be advantaged, due to its higher diesel yield.

The three eras of US gasoline, diesel and jet consumption (thousand b/d)



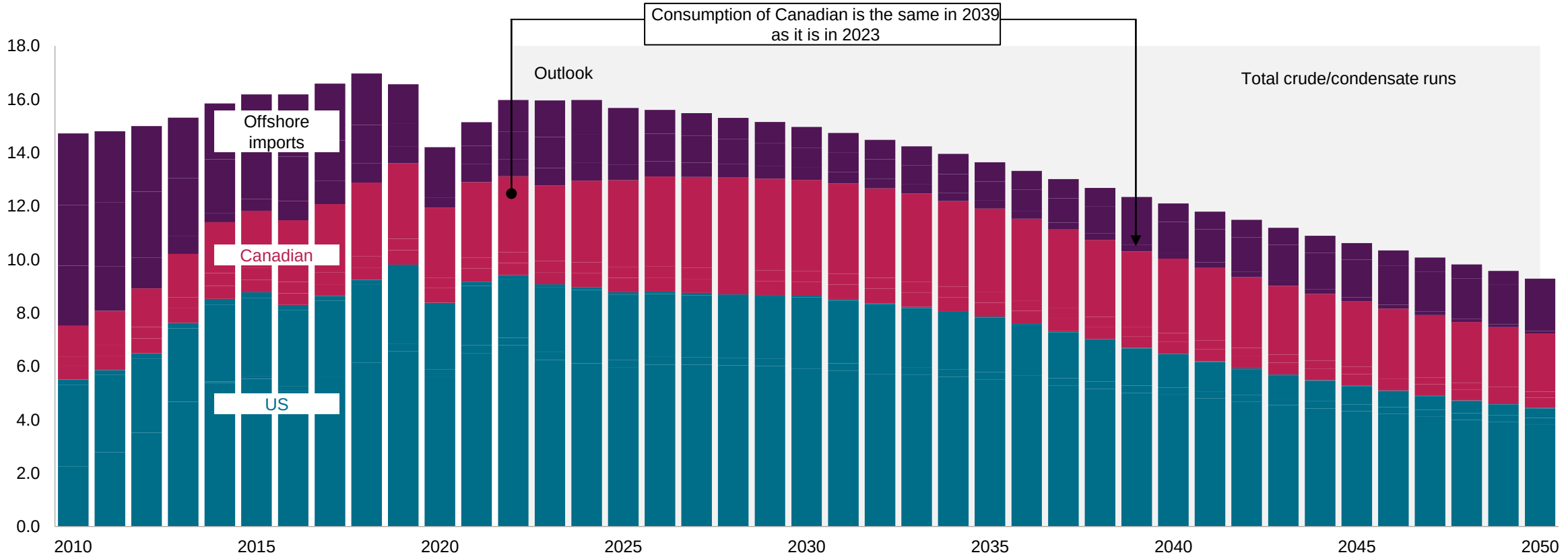
Data compiled June 7, 2024.
Source: S&P Global Commodity Insights.

S&P Global
Commodity Insights

US tight oil and Canadian oil sands will remain a critical source of supply for the US refinery complex, as oil sands may be particularly resilient

Domestic sweet/sour inputs expected to fall as coastal and eventually inland refineries rationalize

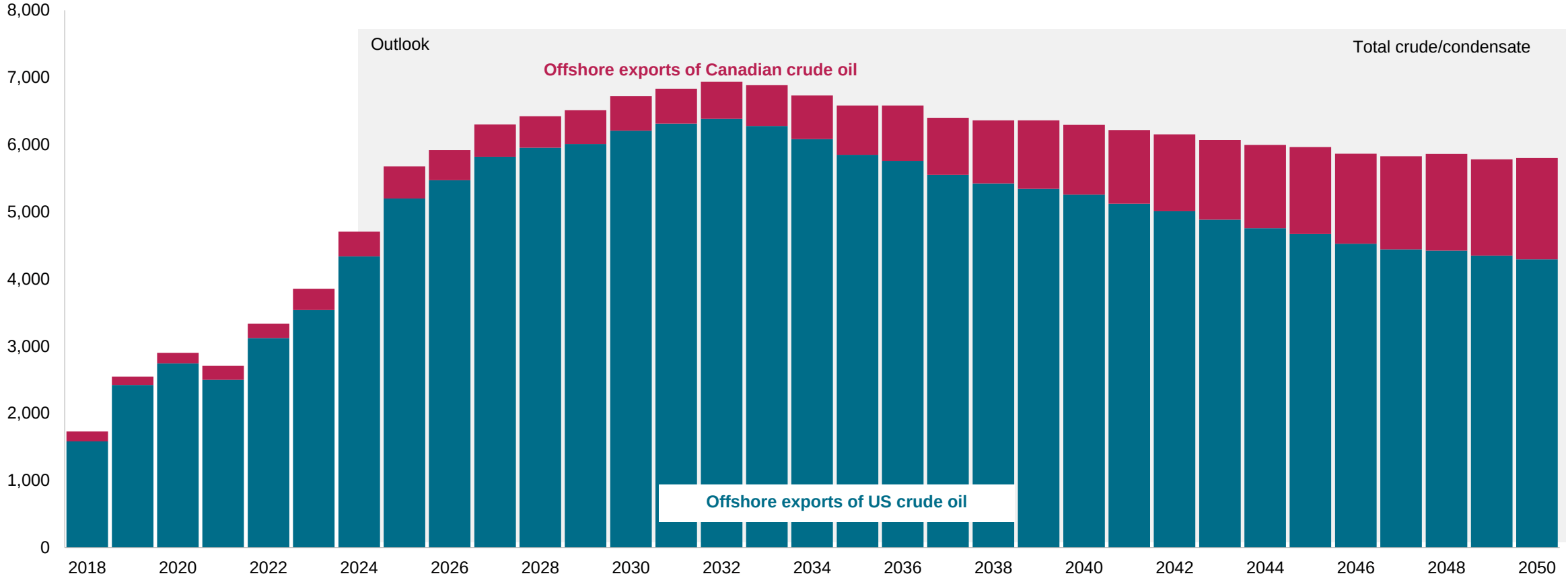
US crude oil balance (thousand b/d)



Data compiled May 18, 2024.
Source: S&P Global Commodity Insights.

Supply growth will push more North American supply offshore, but as onshore demand weakens over the longer term more oil sands will need to move offshore

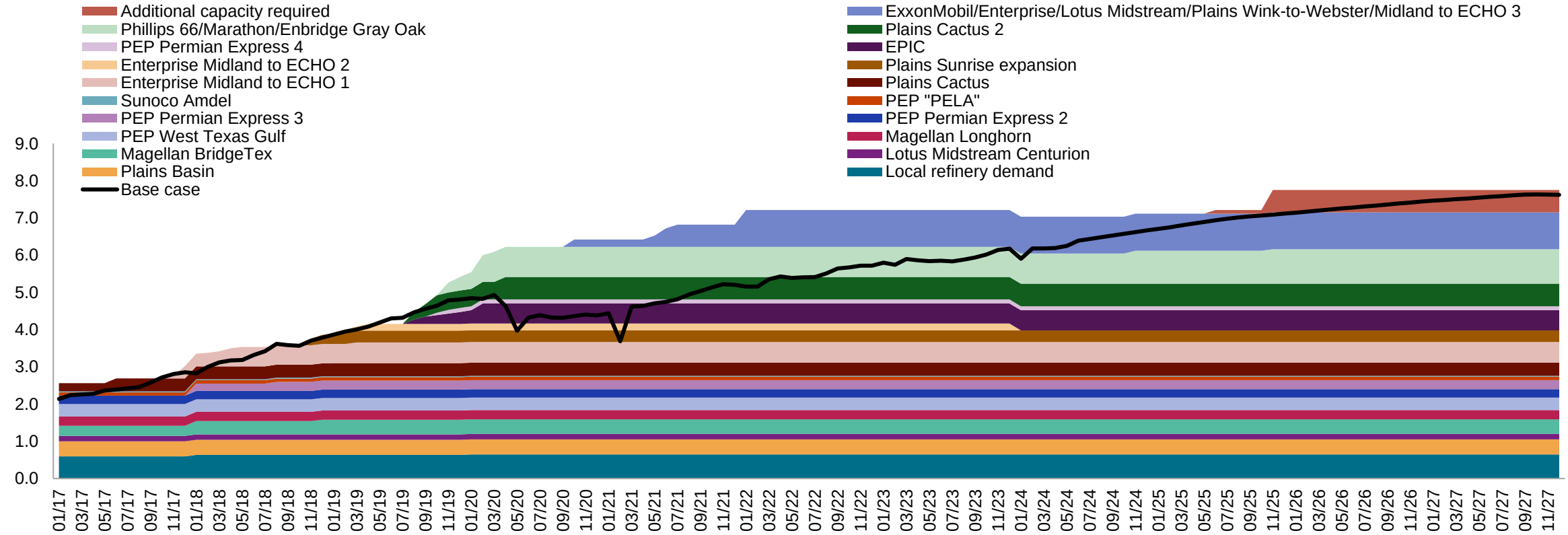
North American exports to non-North American destinations, 2018–50 (thousand b/d)



Data compiled June 7, 2024.
Source: S&P Global Commodity Insights.

With growth comes pipeline demand: Permian oil production could face headwinds around 7.1 million b/d in 2025 without additional pipeline capacity, although rail is an option

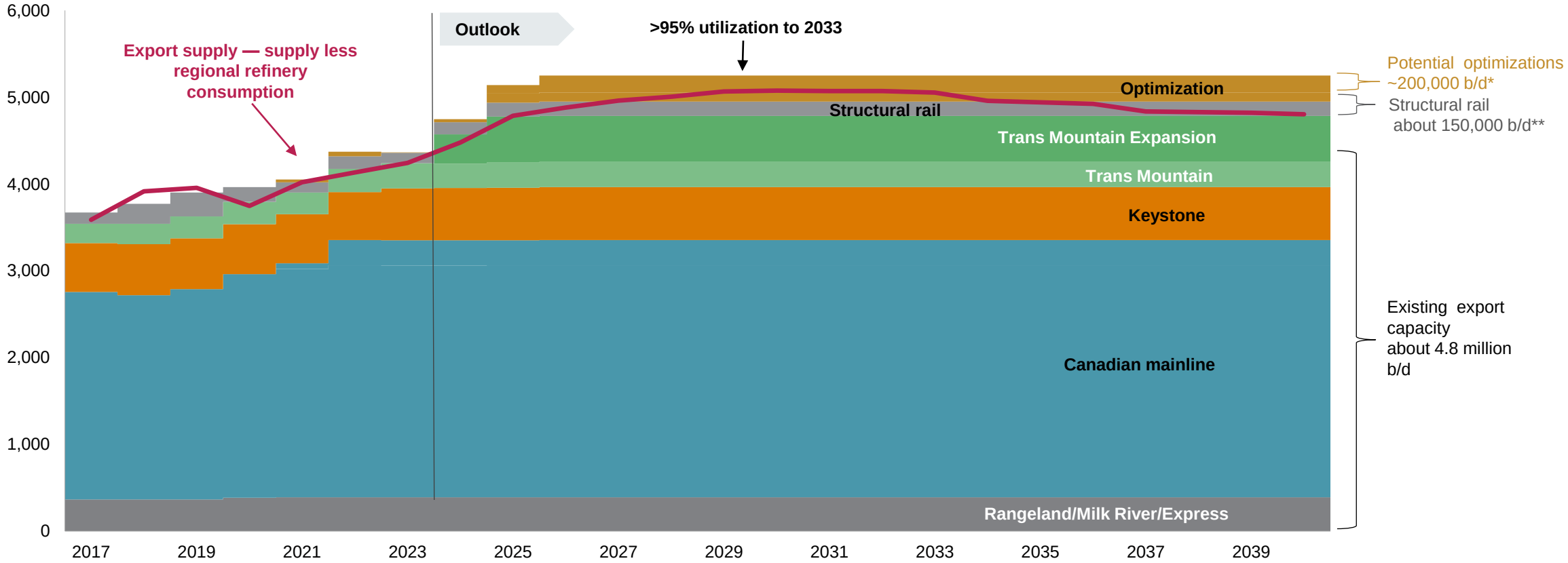
Permian crude oil production and capacity ceiling (production and takeaway capacity b/d)



Data compiled June 7, 2024.
Source: S&P Global Commodity Insights.

Even with the completion of the Trans Mountain pipeline, additional export capacity (pipelines and/or rail) may be needed late in 2026

Western Canada crude oil takeaway capacity (thousand b/d)



Data compiled June 10, 2024.

* Potential optimization projects include Enbridge Mainline optimization and South Bow's Keystone optimization. ** TMX volume based on Trans Mountain toll application presentation.

Estimated effective pipeline capacity. Presentation is of total capacity and not sorted for anticipated utilization, which will be influenced by firm versus spot takeaway capacity commitments. Western Canadian export supply does not account for the use of storage throughout the year, which could help to minimize impacts to pricing due to high levels of pipeline utilization.

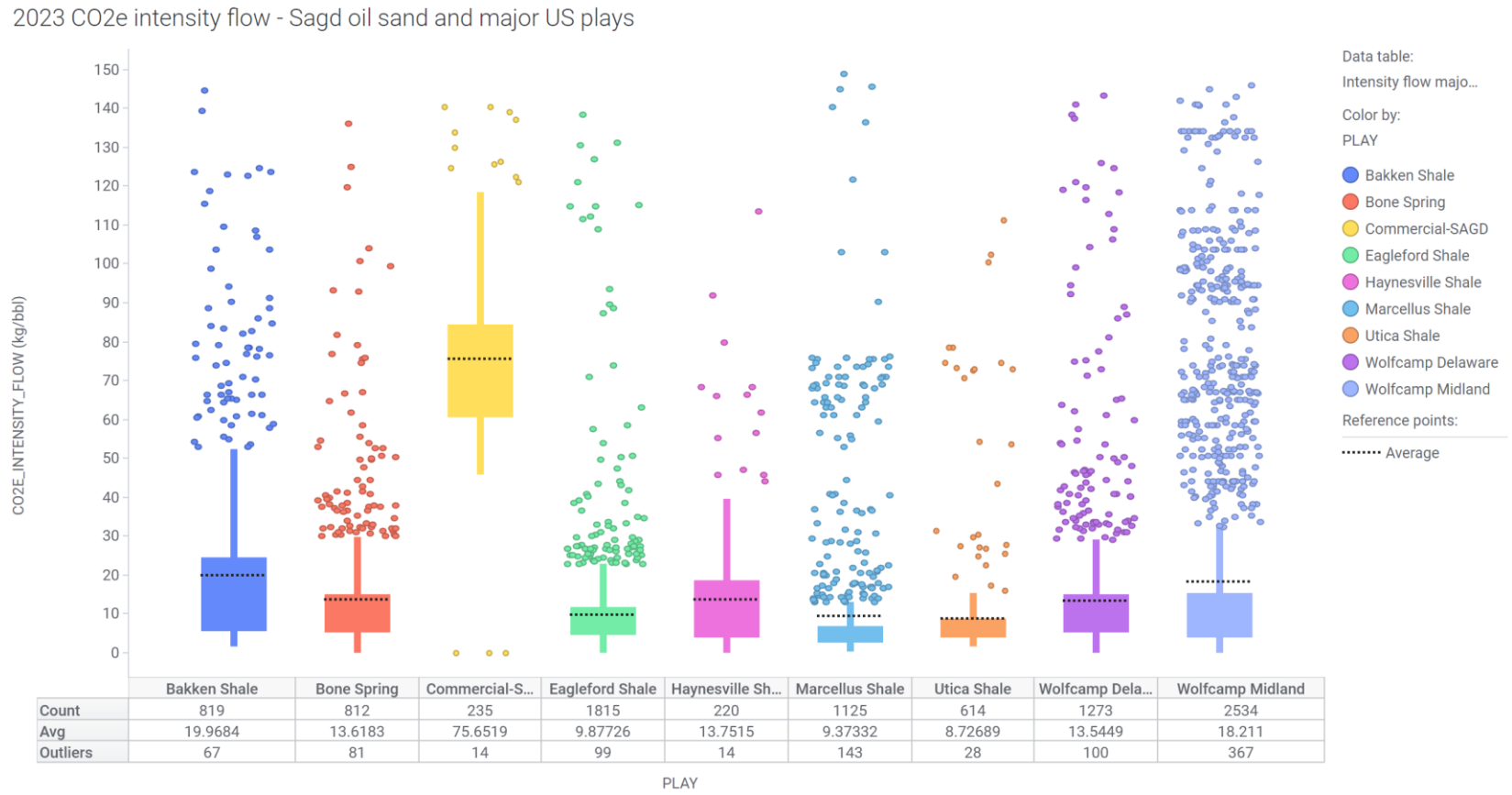
Source: S&P Global Commodity Insights.

Shareholder returns

Perceptions of the energy transition

Policy

Beware the flaw of averages: Distributions matter and the heterogeneity of upstream emissions in extreme

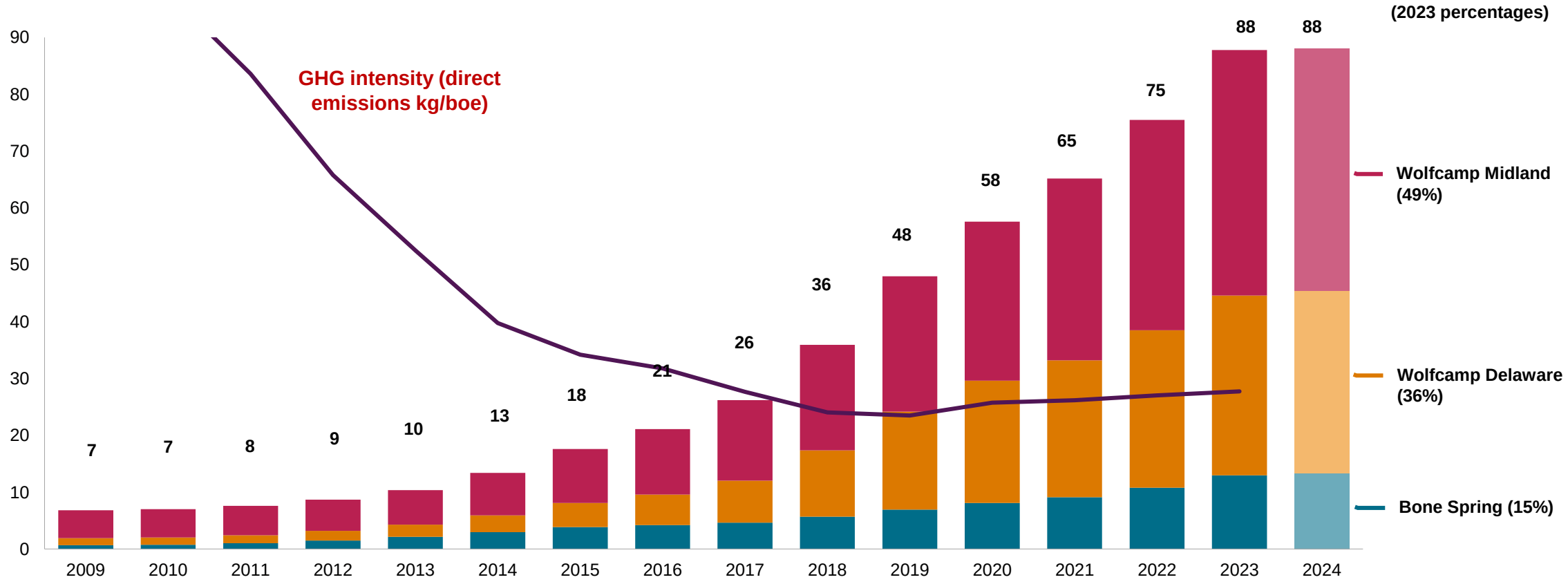


	Bakken Shale	Bone Spring	Commercial-S...	Eagleford Shale	Haynesville Sh...	Marcellus Shale	Utica Shale	Wolfcamp Dela...	Wolfcamp Midland
Count	819	812	235	1815	220	1125	614	1273	2534
Avg	19.9684	13.6183	75.6519	9.87726	13.7515	9.37332	8.72689	13.5449	18.211
Outliers	67	81	14	99	14	143	28	100	367

Data compiled June 2024.
Source: Upstream Solutions, a product of S&P Global Commodity Insights.

GHG intensity has collapsed with standardization, but growth has pushed absolute emissions up

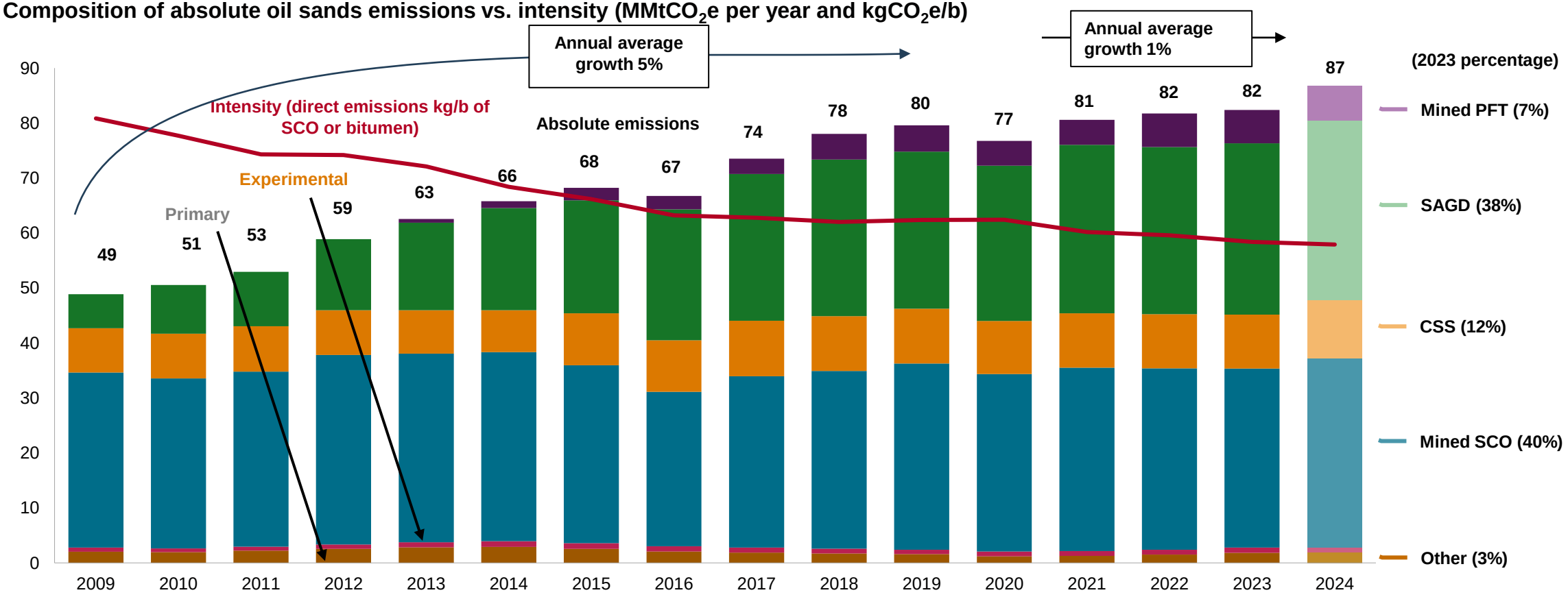
Composition of absolute Permian (Bone Spring, Wolfcamp Delaware and Midland) emissions vs. intensity ($MMtCO_2e$ per year and $kgCO_2e/boe$)



Data compiled June 7, 2024.
Source: S&P Global Commodity Insights.

Since 2020 the pace of oil sands emissions growth has slowed

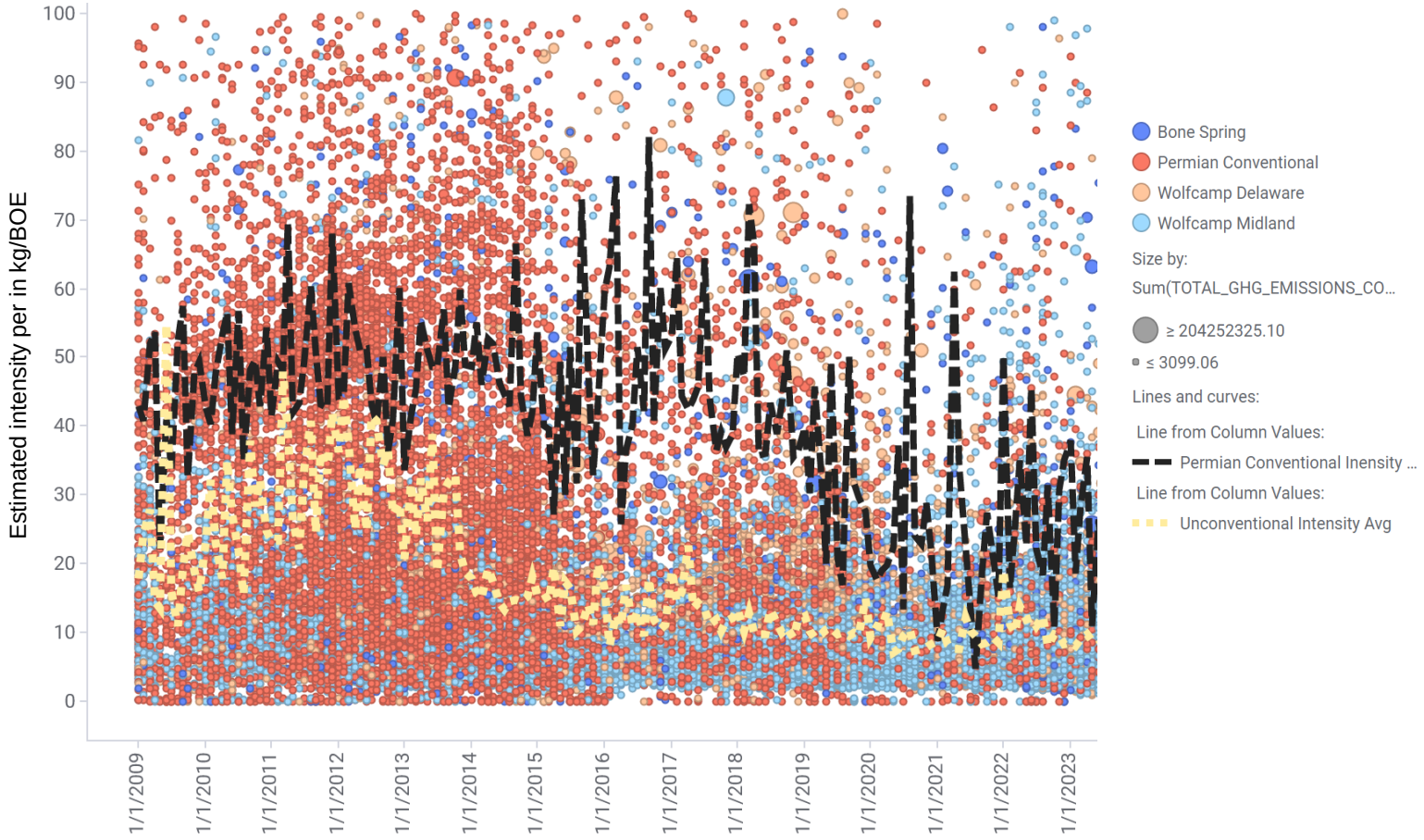
Composition of absolute oil sands emissions vs. intensity ($MMtCO_2e$ per year and $kgCO_2e/b$)



Data compiled: May 12, 2023.
Source: S&P Global Commodity Insights.

Huge spread in Permian intensity — both between and within plays

Lifetime GHG intensity of Permian wells by date of first production



Even with the “factory” approach of unconventional development, lifetime intensities vary significantly.

Unconventional well emissions reflect the path of productivity and operational efficiency gains.

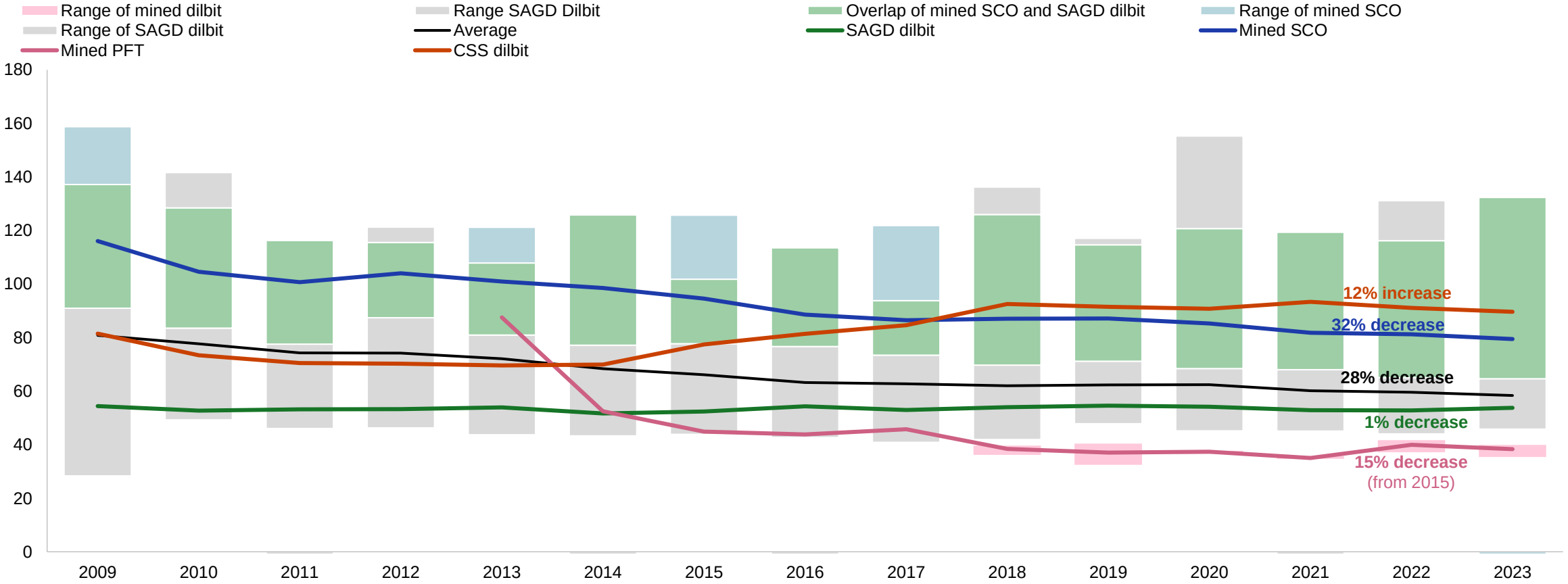
The emissions footprint of conventional production has been improving, but still lags shale significantly.

Data compiled June 2024.
Source: S&P Global Commodity Insights.

S&P Global
Commodity Insights

On average, the GHG intensity of Canadian oil sands has fallen 28% since 2009, but the experience of individual segments and/or technologies varies

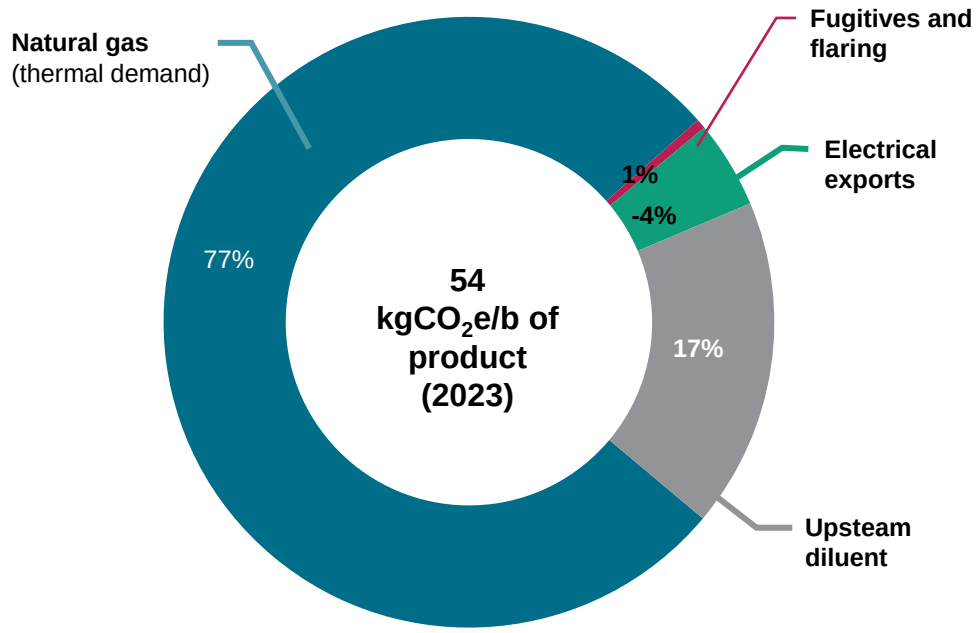
Range and average of GHG intensity of oil sands extraction by year and by technology (2009 to 2023 in $kgCO_2e/b$ of marketed product)



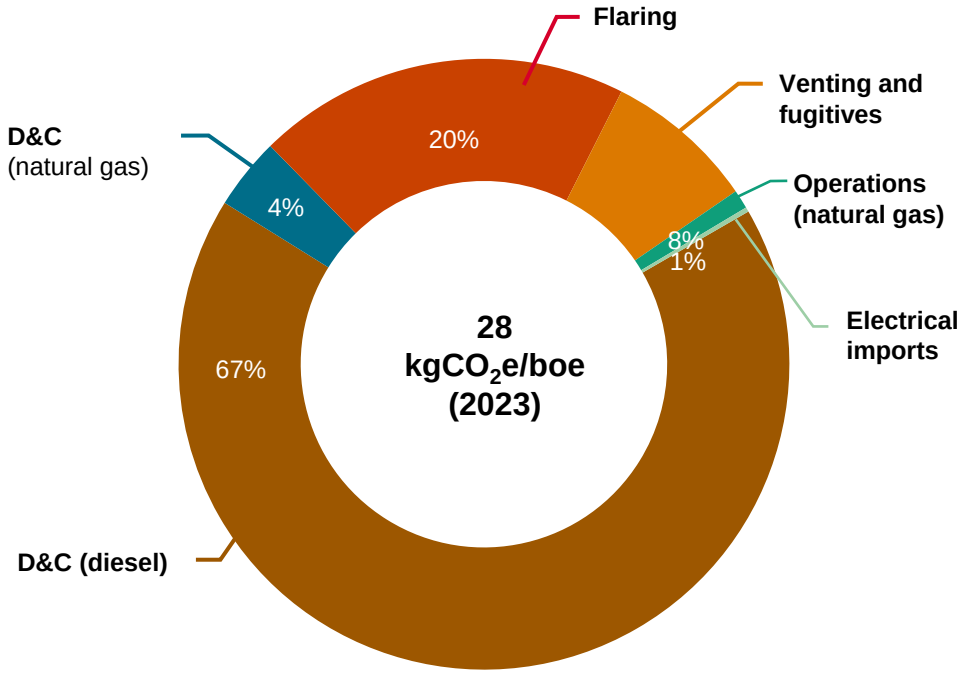
Data compiled June 4, 2024.
Bars in the graph represent the range of the GHG intensity for each oil sands extraction type.
Source: S&P Global Commodity Insights.

There is no one-size-fits-all solution for emission abatement, with opportunities linked to the current purpose and source of emissions

Composition of marketable SAGD dilbit in 2023 ($kgCO_2e/b$ of product)



Composition of average Permian GHG intensity in 2023 (annual activity $kgCO_2e/boe$)



Data compiled June 2024.
System boundaries do not include upstream natural gas production.
Source: S&P Global Commodity Insights.

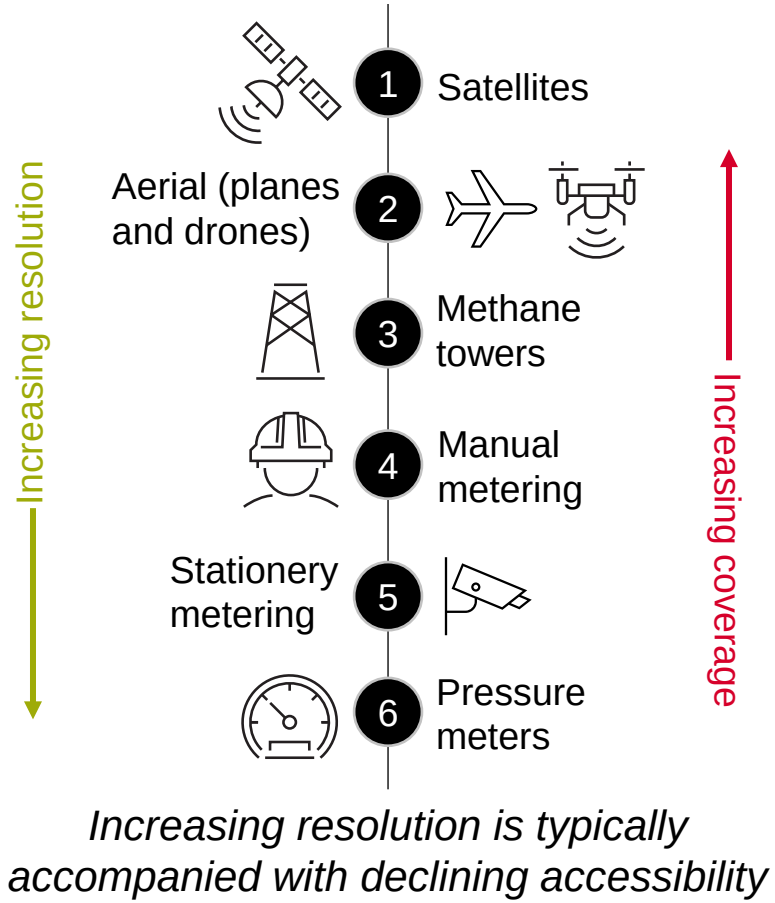
There are trade-offs that impact the quality and reliability of methane observation, and a layered approach is needed

Resolution impacts the ability to attribute releases to a source.

Threshold impacts the methane concentration that can be detected.

Coverage effects the area that can be seen or monitored.

Frequency is the rate that observations can be revisited.



Increasing resolution is typically accompanied with declining accessibility

Source: S&P Global Commodity Insights.

Describing the elephant: Multiple interpretations create confusion

155 billion cubic feet

2.01 % of natural gas produced

0.92 % of energy produced

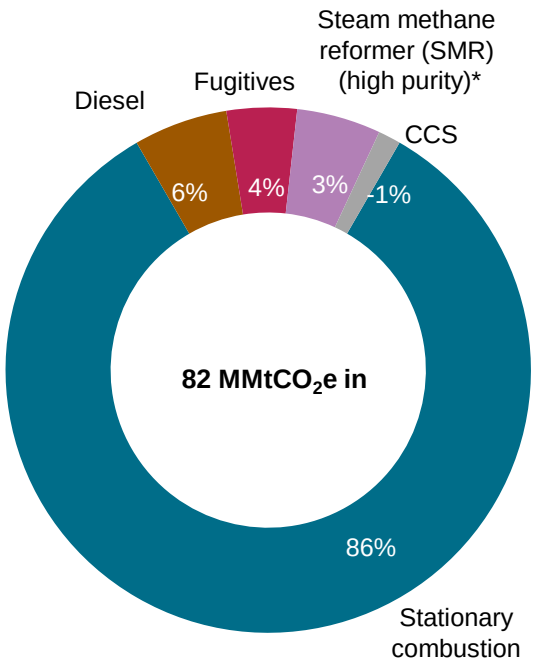
0.43 % of value produced

Pros	Cons
• Simple • Consistent with climate impact	• Offers no context/cost-benefit • Does not allow meaningful comparison between areas of varying size
• Logical elegance in comparing gas with gas • Provides gas loss rate	• Oil production carries zero methane emissions • Penalizes oilier operations with little gas production • Most methane emissions come from oil-processing equipment
• Compares environmental cost with benefit (energy) for society • Reflects reality of full integration of oil and gas operations	• Energy equivalency of 6 mcf of gas per 1 barrel of oil does not reflect value equivalency of about 20 to 1 • Actual uses of fuel may be irrelevant to energy content
• Exposes economic considerations, which drive real-world decisions • Reflects location factors influencing gas prices	• Depends heavily on uncontrollable factors (prices) • High volatility makes it unusable as an index to show improvement over time

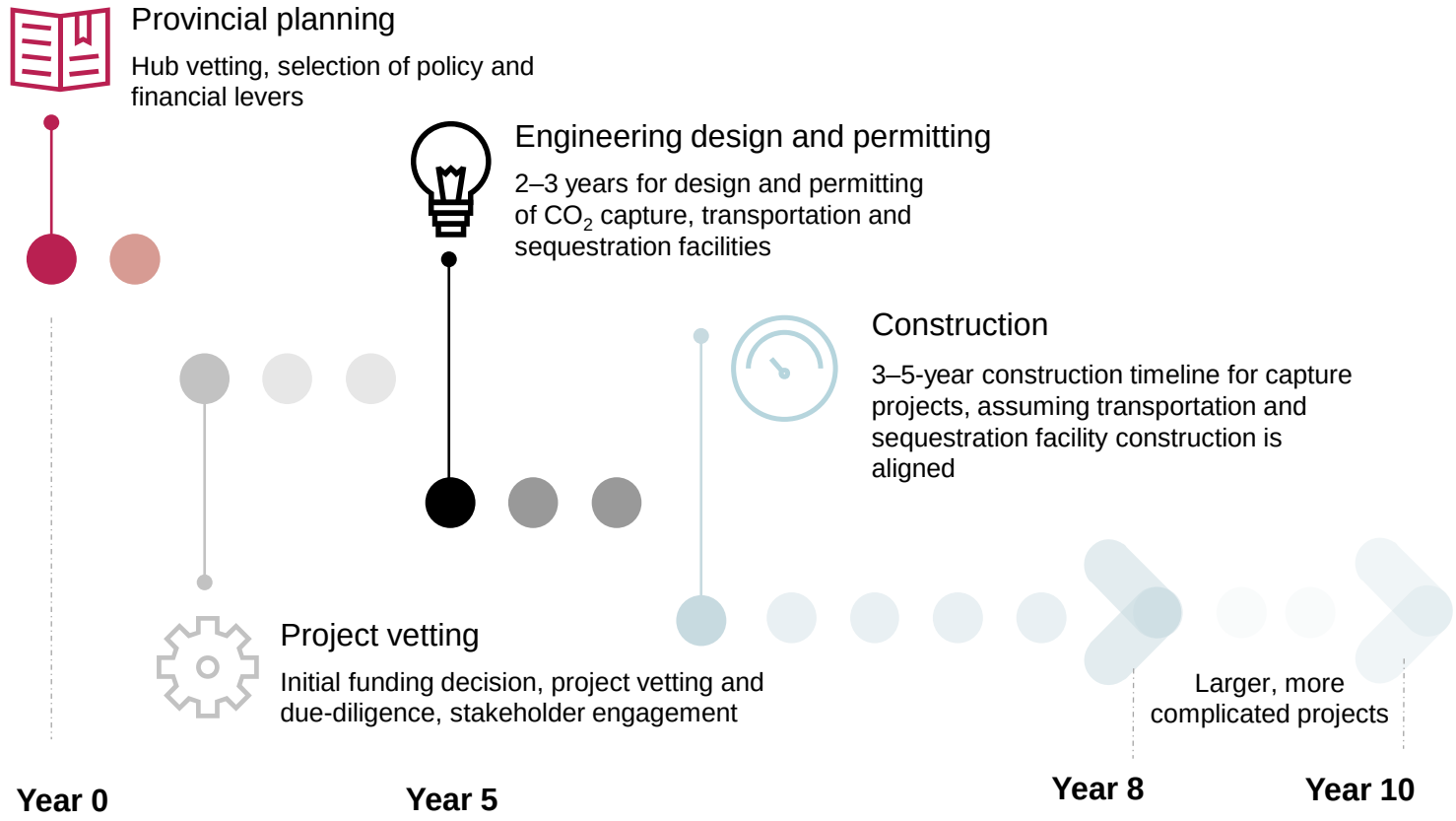
CH_4 = methane.
2022 estimates.
Source: Kairos Aerospace.

Oil sands are large industrial processes well suited to CCS, but still costly; there are significant savings from coordinated approach

Oil sands GHG emissions by source



High-level development timeline — CCS project example



Data compiled April 2023.
Source: S&P Global Commodity Insights.

Pressure to decarbonize has increased in North America; the US is more focused on methane, while Canada is moving on methane and CO_2 and layering policies

Canadian policy focused on price signals

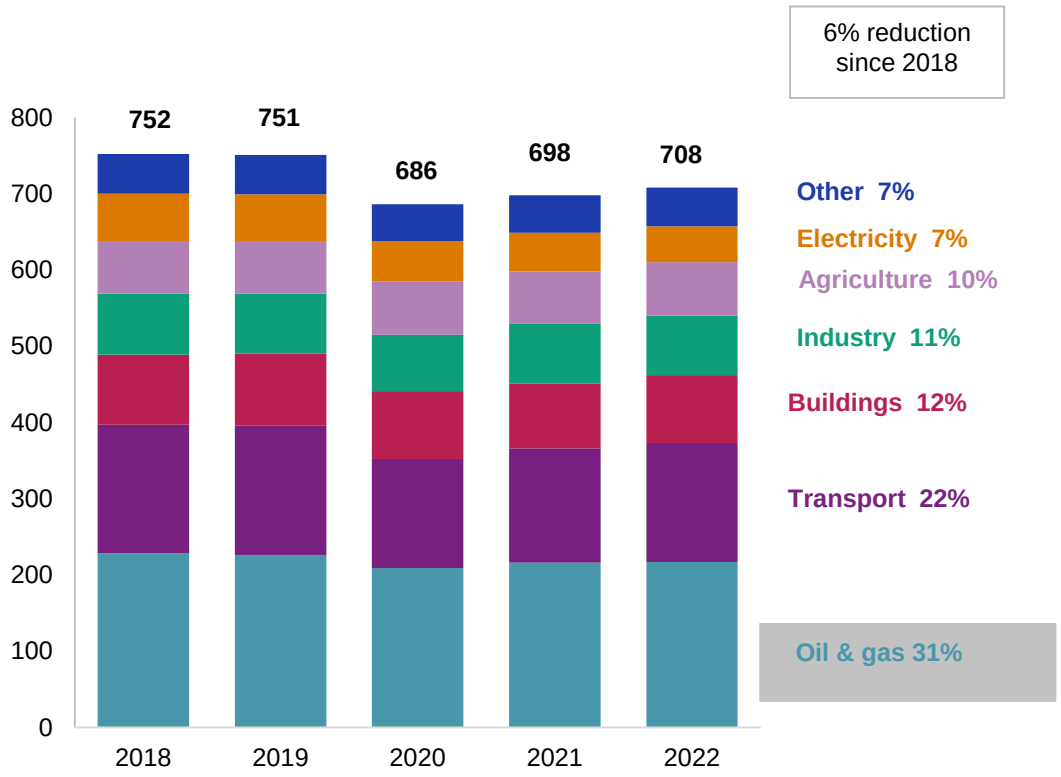
- Industrial carbon price: There has been a price on oil sands emissions since 2007. In recent years the price of carbon has been increasing, as is the stringency of policy. The price level remains a subject of political debate.
- Oil and gas emissions limit: The Canadian government has proposed an incremental cap-and-trade policy on the oil and gas sector, including the oil sands. The initial target would start in 2030 and decline over time. The price implications are not well understood.

US regulation focused on methane

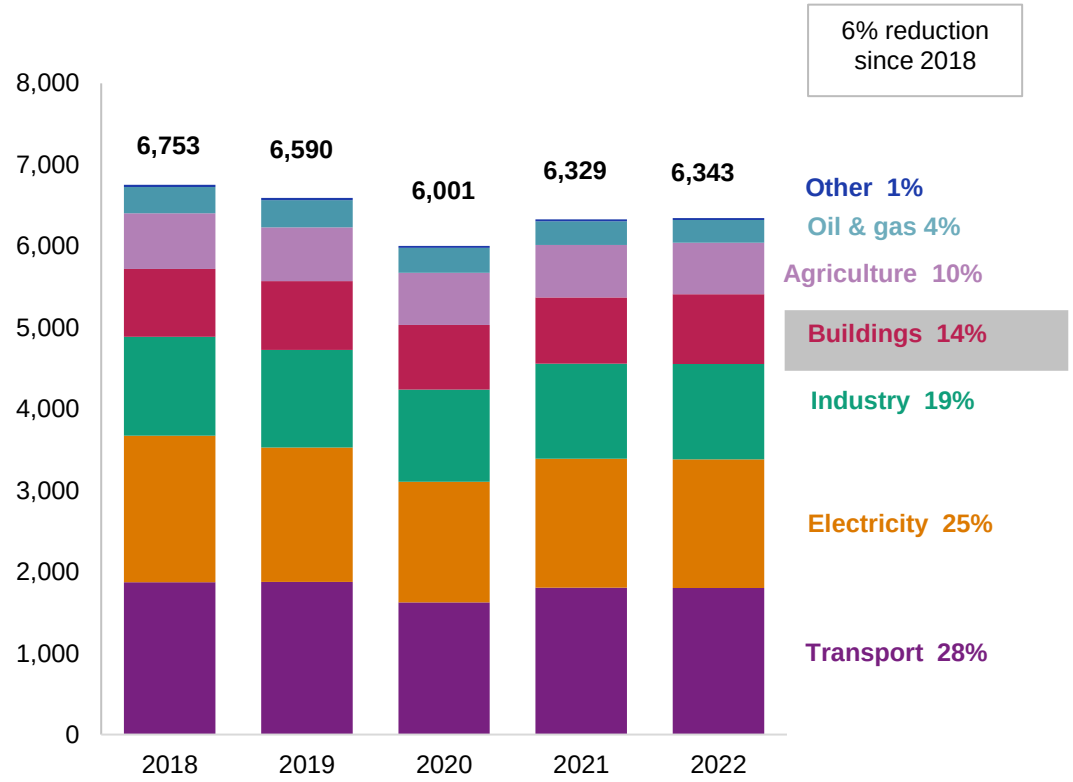
- Methane surcharge (Waste Emissions Charge)
- New Environmental Protection Agency regulations
  - Specific equipment requirements
  - Measurement integration
  - Allowing use of new technologies
  - Super-emitter program
- Tightening state regulations
- Price on carbon is not expected

The share of oil and gas emissions in Canada underscores why it is a larger focus compared to the United States

Composition of Canada's national emissions ($MMtCO_2e$ 2022)



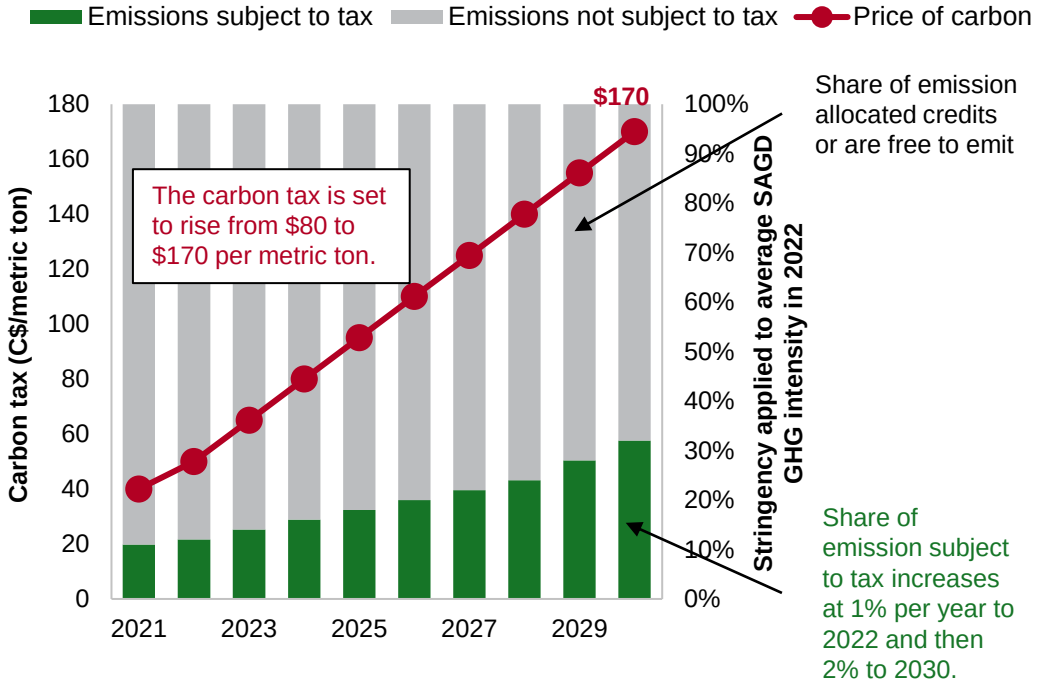
Composition of United States emissions ($MMtCO_2e$ 2022)



Data compiled June 2024.
Source: Canada's National Inventory Report.

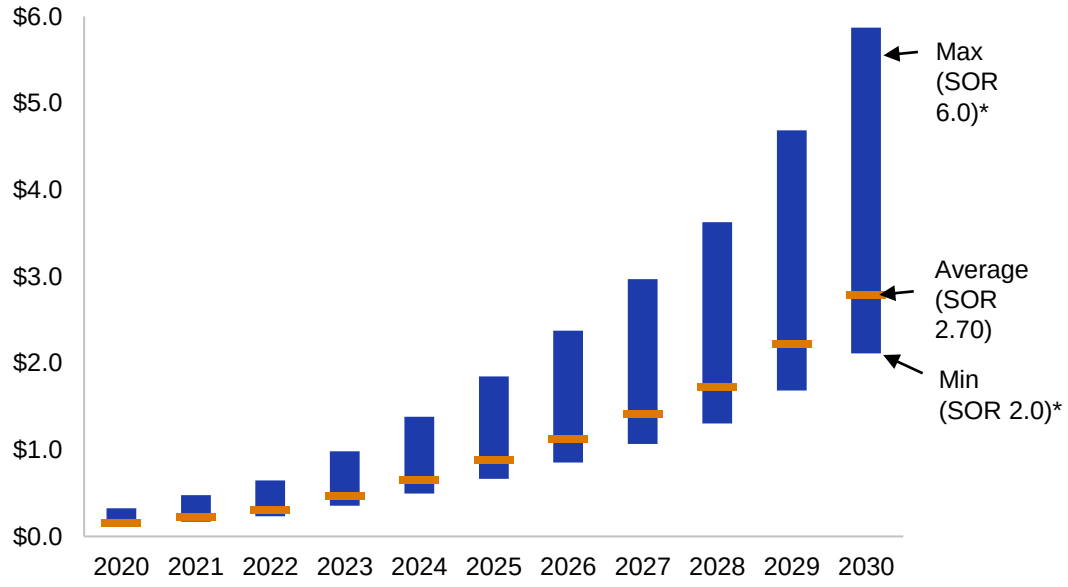
Oil sands emissions are subject to carbon pricing, which has been administered through an output-based intensity pricing mechanism

Visual depiction of relative carbon price and share of emission subject to compliance under TIER



Assuming all compliance is met by paying the price, that cost would be total output times emission intensity subject to tax

Estimated potential cost per barrel of Alberta TIER without intensity improvements (US$/b)



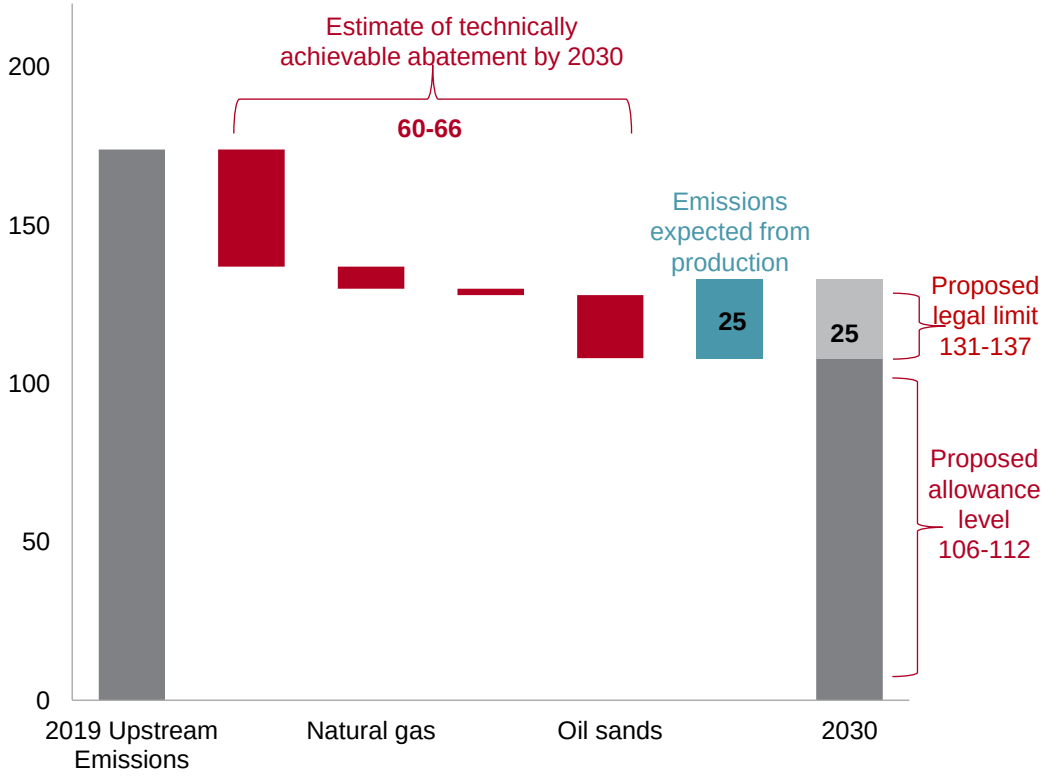
Carbon price (C$)	$80	$110	$140	$170

*Facilities that are within the top decline of output would be assessed against the weighted average of the intensity of the top decline of production. In thermal operations the least GHG intensity facility production is roughly 15% of total supply.

Data compiled Dec. 12, 2023.
SOR = steam-to-oil ratio; TIER = Technology Innovation and Emissions Reduction regulation.
Sources: S&P Global Commodity Insights; Government of Alberta.

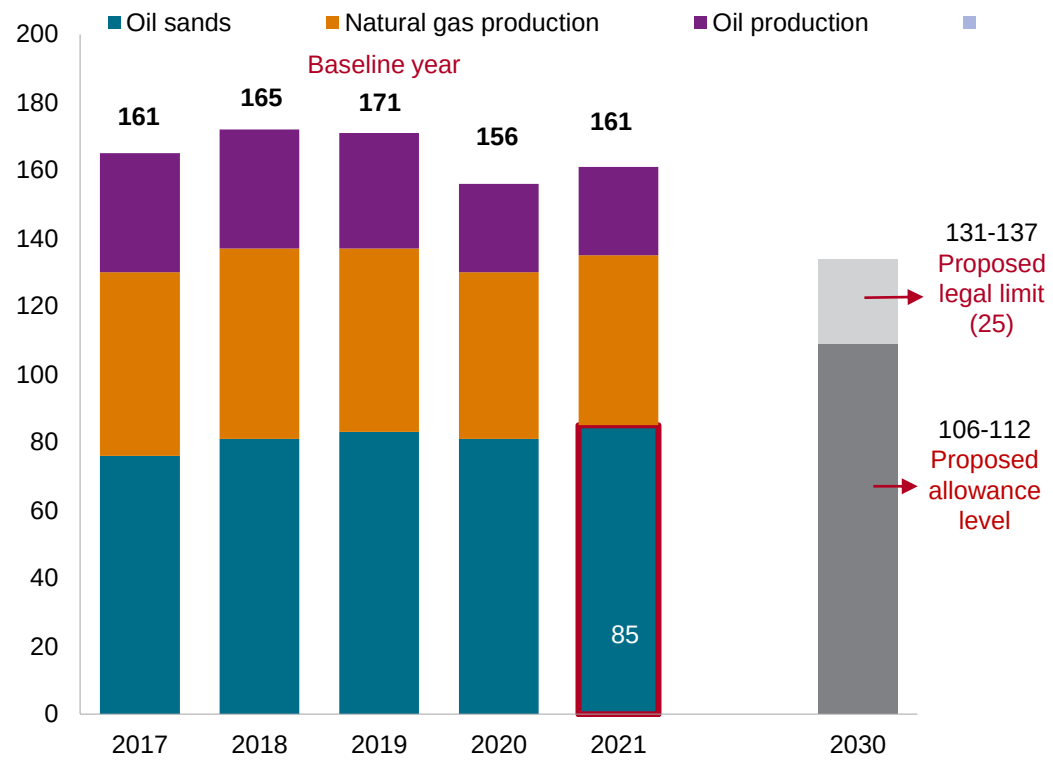
The Canadian government is proposing to cap oil and gas emissions starting in 2030, and setting limits to ensure emissions decline in line with national ambitions

Canada's estimated level of 2030 emissions cap and legal upper bound ($MMtCO_2e$)



Source: Environment and Climate Change Canada, National inventory report 1990–2021: greenhouse gas sources and sinks in Canada 2023.

Oil and gas emissions subject to cap compared to 2030 cap levels ($MMtCO_2e$)

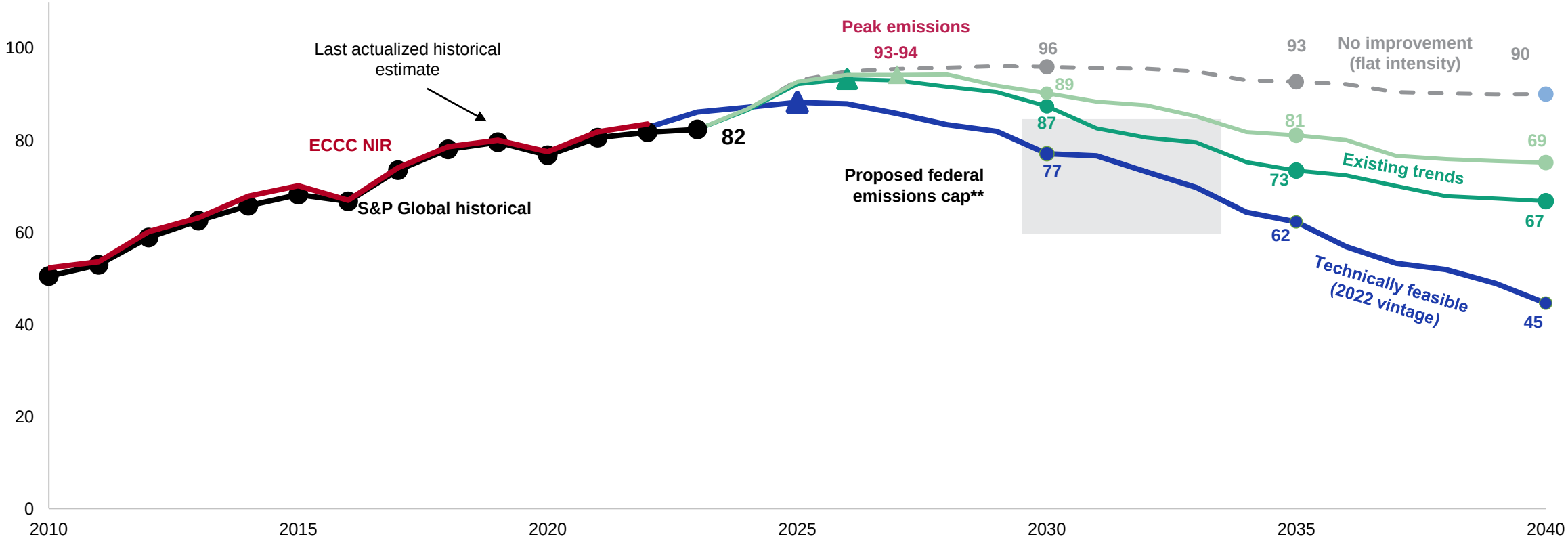


Sources: S&P Global Commodity Insights; Environment and Climate Change Canada, National inventory report 1990–2021: greenhouse gas sources and sinks in Canada 2023.

Data compiled Dec. 12, 2023.

The flexibility of the oil and gas emissions limit appears technically achievable but introduces uncertainty and cost

S&P Global Commodity Insights absolute oil sands GHG emissions projections compared with other announcements and outlooks ($MMtCO_2e$ per year)



* Environmental and Climate Change Canada (ECCC) National Inventory Report (NIR) and projections have been adjusted to align to same facilities as S&P Global Commodity Insights outlook.
** S&P Global has interpreted the proposed federal emissions cap as 20 $MMTCO_2e$ per year reduction by 2030, including an assumption of a three-year multiyear compliance period, and a 25 $MMTCO_2e$ flexible range.
Sources: S&P Global Commodity Insights; Government of Canada: A Regulatory Framework publication.

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