

BOOK 6

Unconventional Hydrocarbons Shale Oil & Shale Gas A Game Changer

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TPA

Sharing Experience

Building bridges between the oil industry and academic circles by delivering technical or business-related presentations by professors or experts.



OIL & GAS and ENERGY GLOBAL ISSUES

A Toolbox to understand the World of Energy in the Global Economy

The Toolbox is updated twice a year and benefits from the contributions of TPA Professors:

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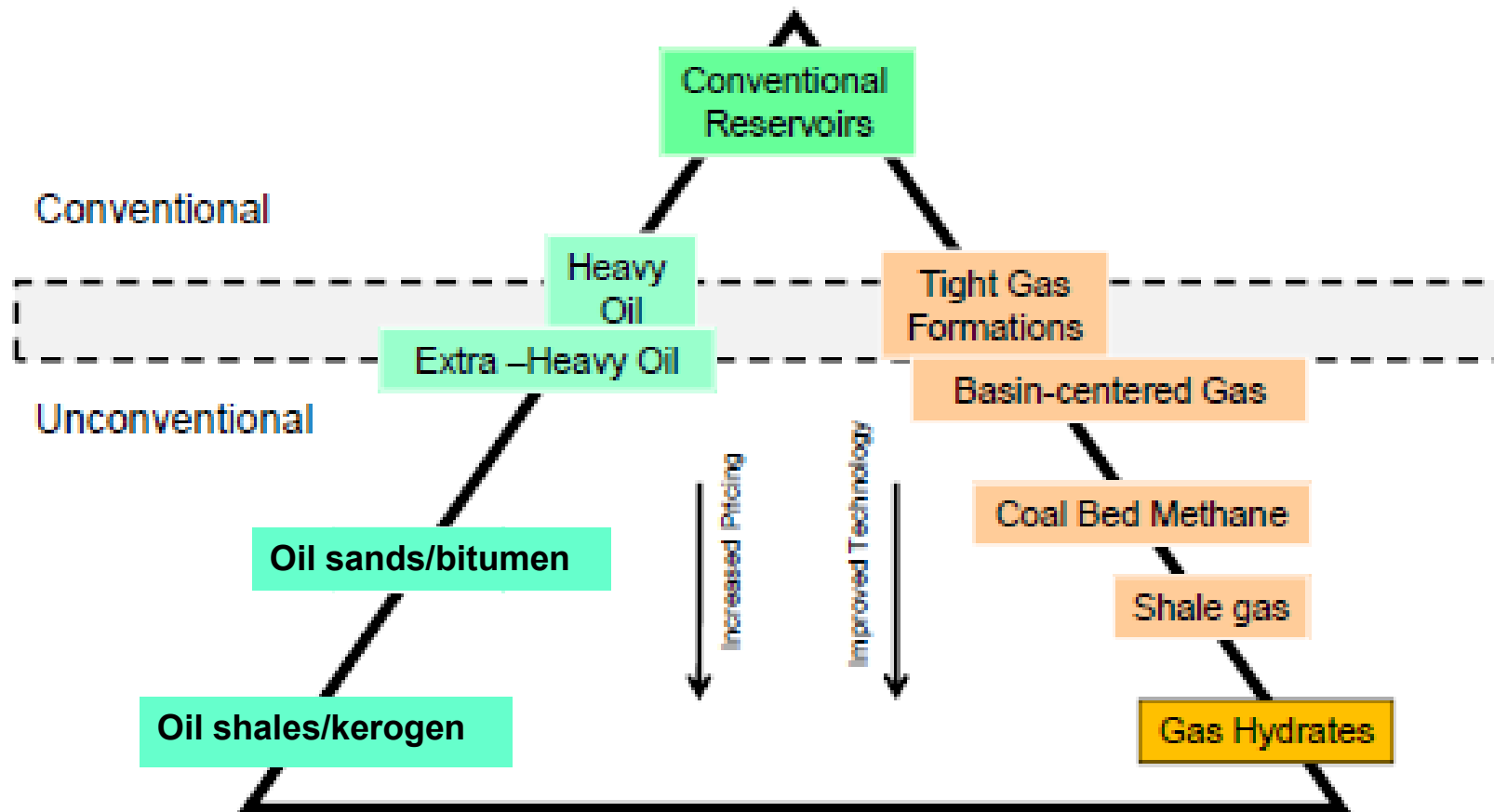
BOOK 9 Coal Industry Fundamentals

BOOK 10 Nuclear Industry Fundamentals



Some definitions

Conventional and unconventional Resources (SPE)



Source: SPE 2011

(modified from Holditch, JPT Nov. 2002)

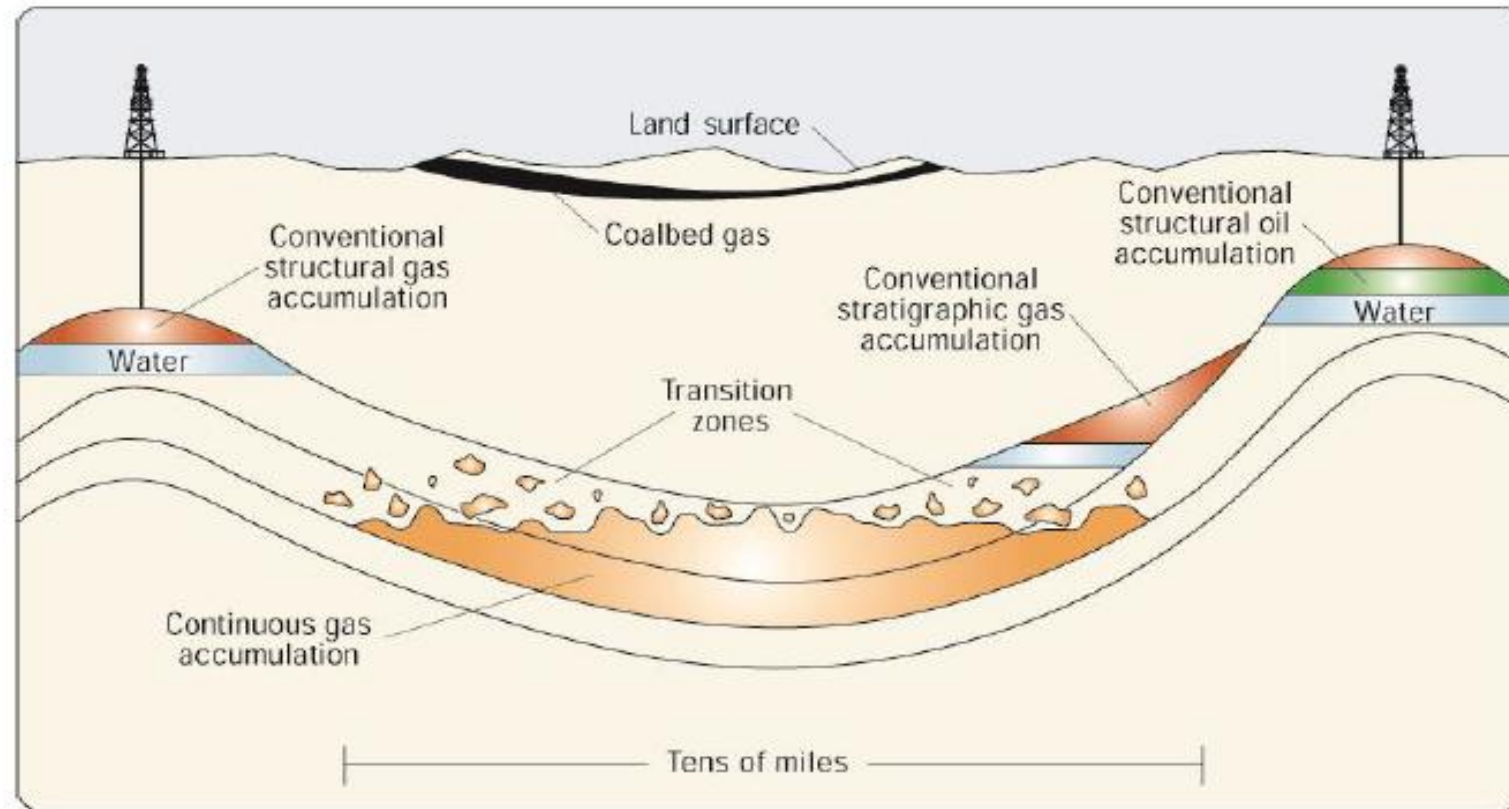


Different categories of unconventional Hydrocarbons

- **Xtra-Heavy Oil**
- **Oil Sands**
- **Shale Oil and Light Tight Oil (LTO):** Petroleum that consists of light crude oil contained in petroleum-bearing formation with low permeability, like shale or tight sandstone, which have migrated from the source-rock (LTO) or not (Shale Oil)
- **Oil-Shale Oil or Kerogen Oil:** Oil produced from Oil Shale by pyrolysis, hydrogenation or thermal dissolution
- **Tight Gas:** Natural gas trapped in low permeability reservoirs after migration
- **Shale Gas:** Natural gas trapped in very low permeability source rock



Conventional vs continuous source rock resources



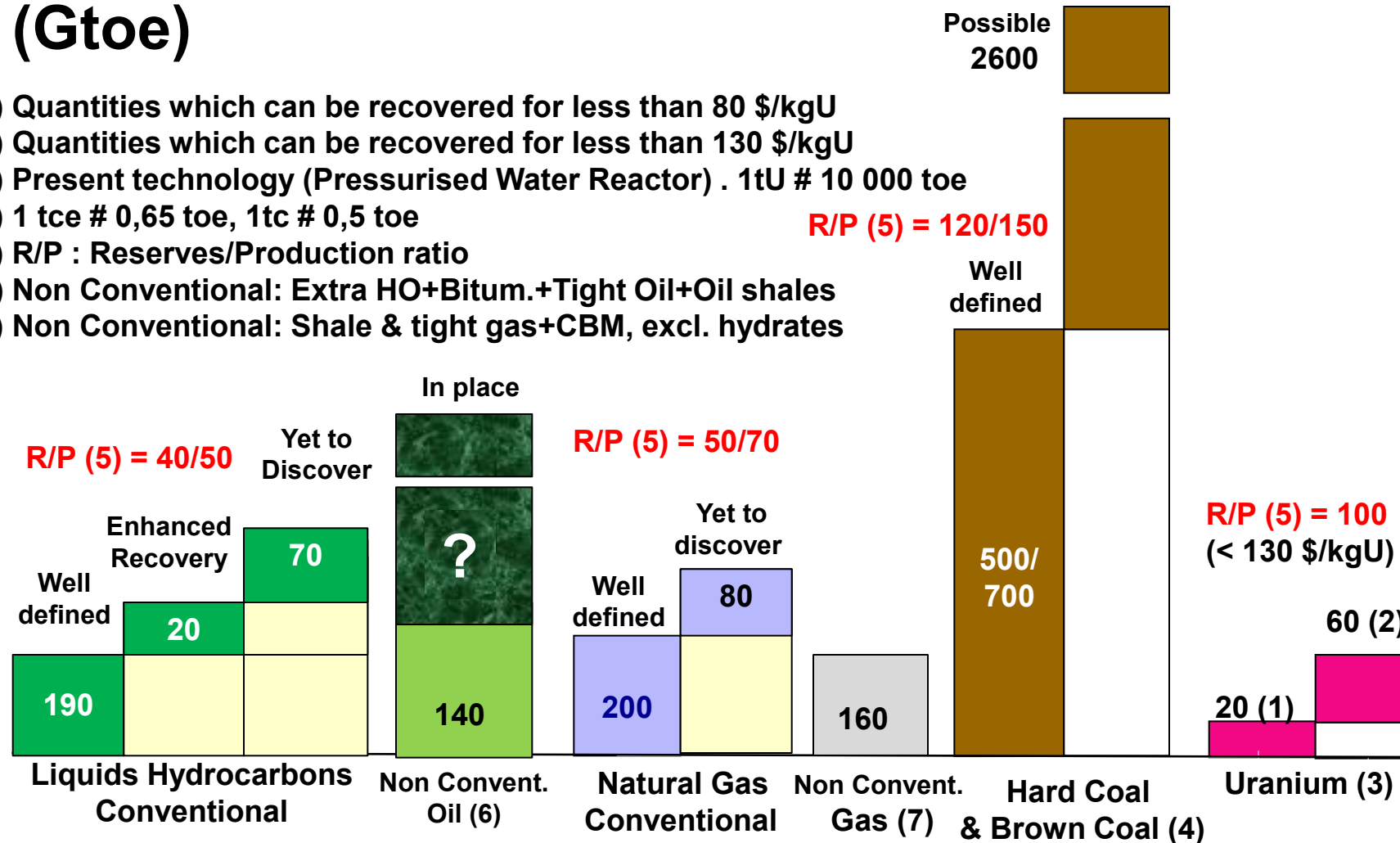
Source: USGS



Reminder - World Resources (Gtoe) – Vision 01/01/2019

(Gtoe)

- (1) Quantities which can be recovered for less than 80 \$/kgU
- (2) Quantities which can be recovered for less than 130 \$/kgU
- (3) Present technology (Pressurised Water Reactor) . 1tU # 10 000 toe
- (4) 1 tce # 0,65 toe, 1tc # 0,5 toe
- (5) R/P : Reserves/Production ratio
- (6) Non Conventional: Extra HO+Bitum.+Tight Oil+Oil shales
- (7) Non Conventional: Shale & tight gas+CBM, excl. hydrates



Source: Total, WCA, CEA, BP

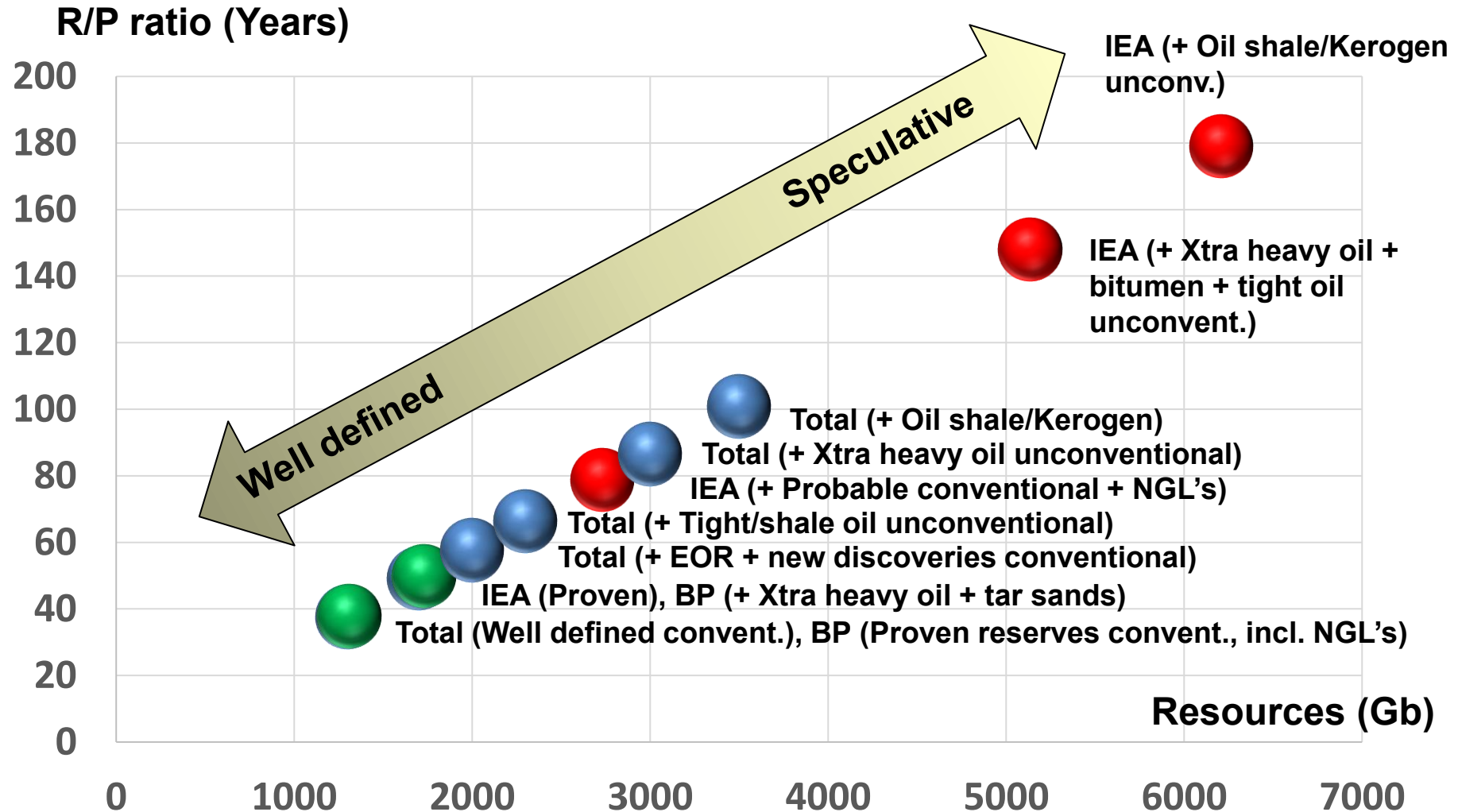
Nota: Oil Proven Reserves BP end 2018= 1730 Gb # 240 Gt, R/P # 50

R/P varies vs sources. Not at scale

TPA Toolbox Energy Book 6
Unconventional Hydrocarbons



Reconciliation of Oil Resources Estimates at end 2019 – Gb & Number of Years



Oil Reserves and Resources end 2024 IEA (Gb)

(Consensus on proven reserves, different opinions on additional resources)

Oil (billion barrels)	Proven reserves	Resources	Conventional crude oil	Tight oil	NGLs	EHOB	Kerogen oil
North America	222	2 410	231	233	150	795	1 000
Central and South America	296	848	247	57	49	492	3
Europe	14	109	54	19	28	3	6
Africa	124	445	306	54	82	2	-
Middle East	902	1 139	861	29	206	14	30
Eurasia	146	940	227	85	57	552	18
Asia Pacific	51	270	115	72	64	3	16
World	1 756	6 161	2 042	549	636	1 862	1 073

Notes: NGLs = natural gas liquids; EHOB = extra-heavy oil and bitumen. The breakdown of coal resources by type is an IEA estimate. Coal world resources exclude Antarctica.

Sources: BGR (2023); CEDIGAZ (2024); Energy Institute (2024); OGJ (2023); US EIA (2023); USGS (2012a and 2012b); IEA databases and analysis.

Source: IEA WEO 2025

Note: EHOB: Extra Heavy Oil & Bitumen



Conventional and Unconventional Oil Resources End 2024 (Gb)

IEA WEO 2025:

Proven Reserves end 2024: 1756 Gb

Remaining Resources at end 2024:

Conventional : 2042 Gb

Tight Oil : 549 Gb

NGL : 636 Gb

EHOB : 1862 Gb

Kerogen Oil : 1073 Gb

Total # 6161 Gb

Source: IEA WEO 2024
EHOB: Extra Heavy Oil and Bitumen



Conventional and Unconventional Gas Resources End 2024 (T.m3)

Natural gas (trillion cubic metres)	Proven reserves	Resources	Conventional gas	Tight gas	Shale gas	Coalbed methane
North America	19	143	49	9	78	7
Central and South America	9	84	28	15	41	-
Europe	5	45	18	5	18	5
Africa	19	100	50	10	40	0
Middle East	84	119	99	9	11	-
Eurasia	69	165	127	11	10	17
Asia Pacific	19	136	42	21	53	20
World	224	792	413	80	250	49

Notes: NGLs = natural gas liquids; EHOB = extra-heavy oil and bitumen. The breakdown of coal resources by type is an IEA estimate. Coal world resources exclude Antarctica.

Sources: BGR (2024); CEDIGAZ (2025); Energy Institute (2024); OGI (2024); US EIA (2025); USGS (2012a and 2012b); IEA databases and analysis.



Conventional and Unconventional Gas Resources End 2024 (T.m³)

IEA WEO 2025:

Remaining Recoverable Resources end 2023:

Conventional : 413 T.m³ # 14 600 Tcf

Tight Gas : 80 T.m³

Shale Gas : 250 T.m³

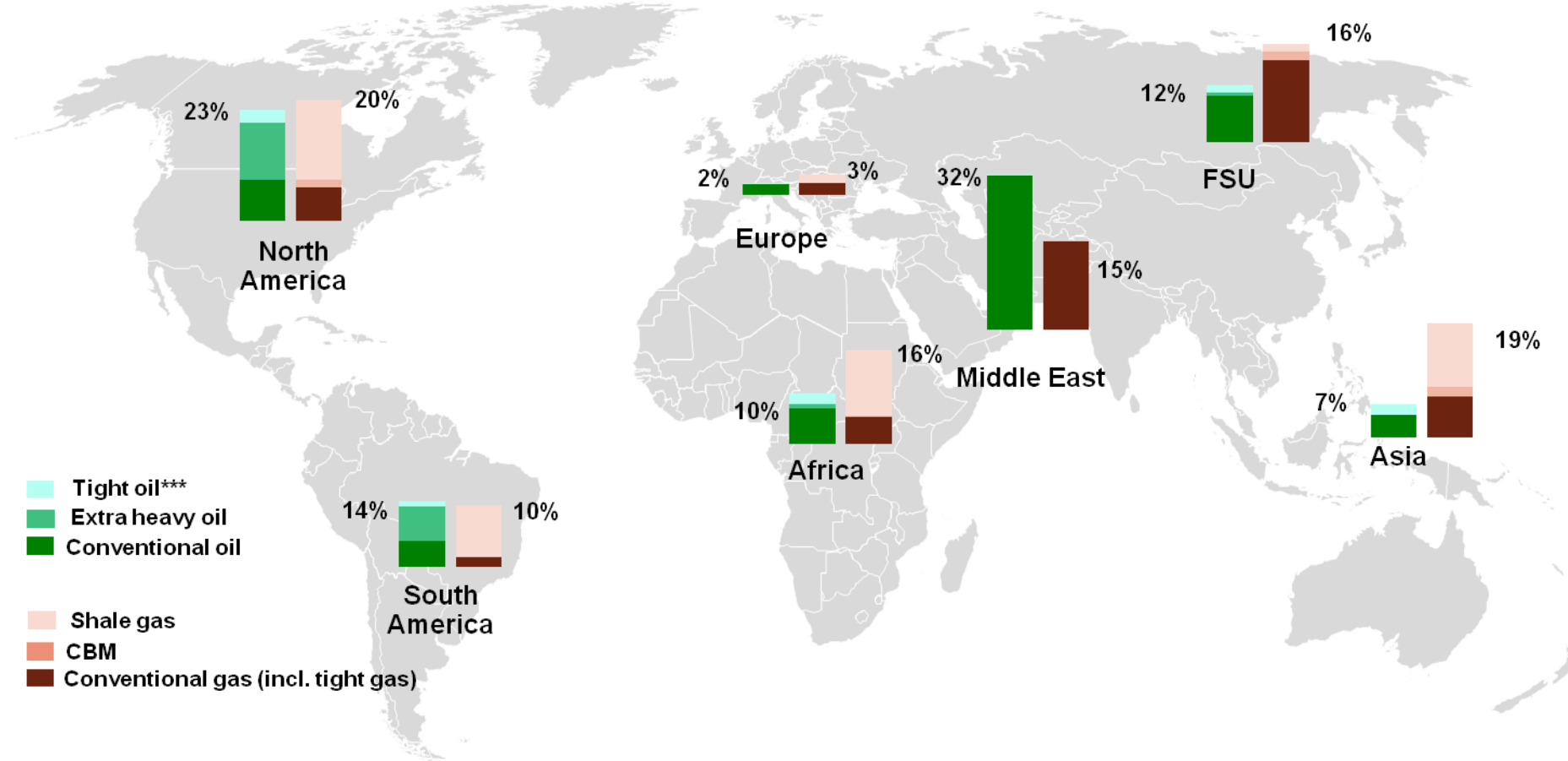
CBM : 49 T.m³

Unconventional : 379 T.m³ # 13 400 Tcf

Total # 792 T.m³ # 28 000 Tcf



Unconventional brings a new distribution of hydrocarbons Reserves



*** Incl. NGL from Shale gas



Unconventional Hydrocarbons : Major challenges



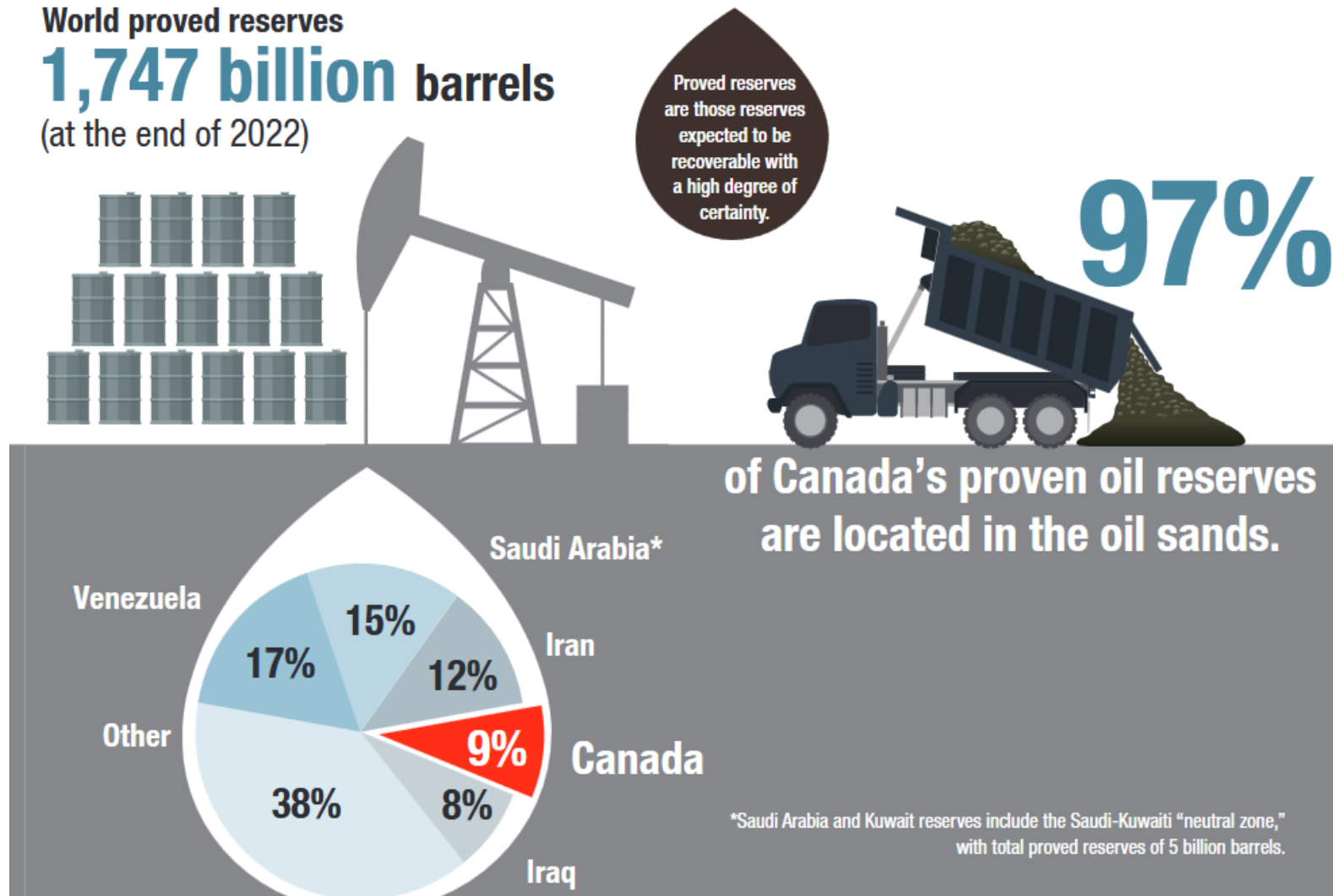
Example 1 : Oil sands (Canada)



Oil sands Exploitation



Canada Oil Sands



Source: Energy Factbook 2024 - 2025

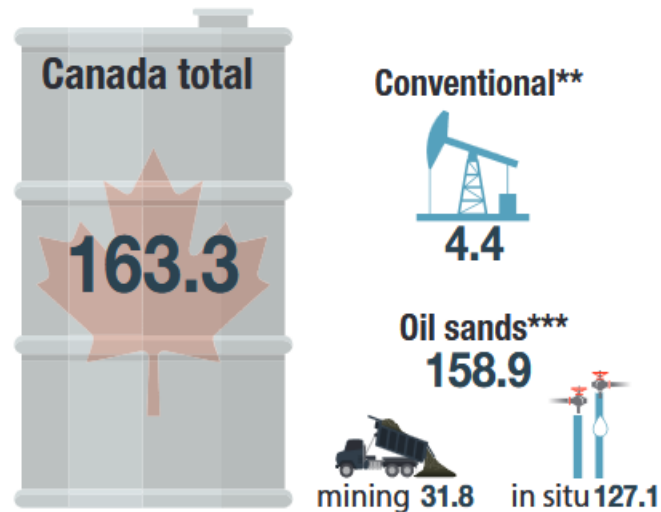


Canada Oil Sands

CANADIAN RESOURCES

REMAINING ESTABLISHED RESERVES*

(billion barrels, as of December 2022)

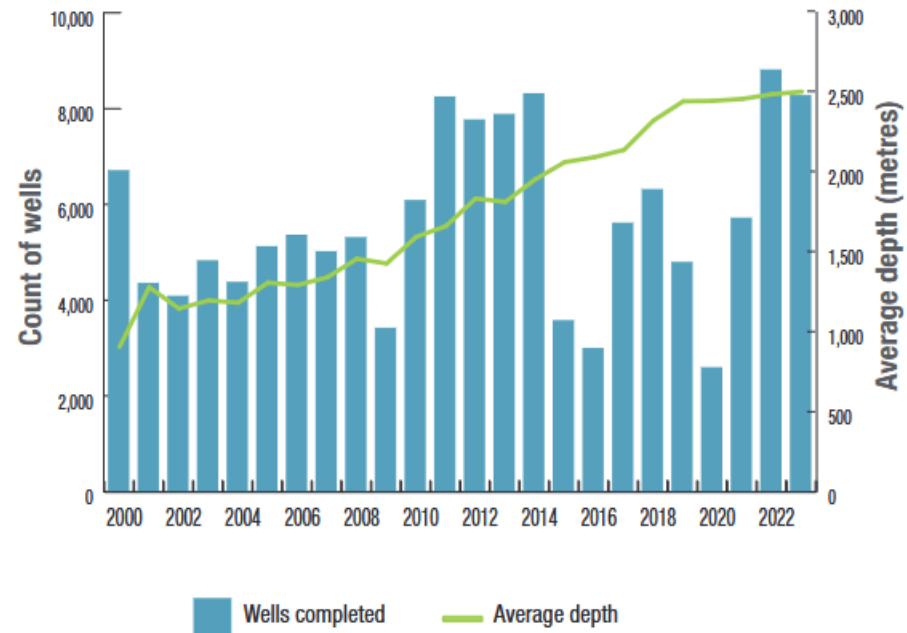


* Reserves known to exist and recoverable under current technological and economic conditions. Totals may not sum due to rounding.

** Reserves also include proved reserves of pentanes plus (a crude-oil equivalent that is associated with oil production).

***With improved technology, it is estimated that 315 billion barrels are ultimately recoverable from the oil sands. Totals may not sum due to rounding.

COUNT AND AVERAGE DEPTH OF OIL WELLS COMPLETED IN WESTERN CANADA



Source: Energy Factbook 2024 - 2025

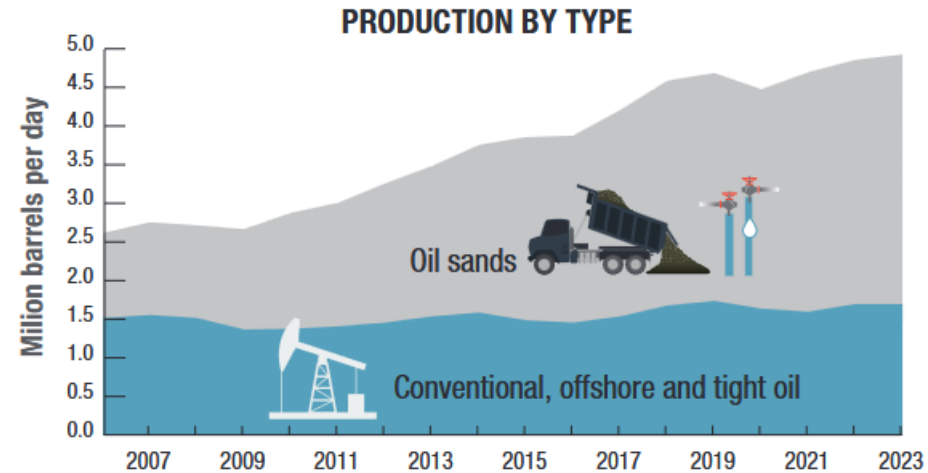


Canada Oil Sands

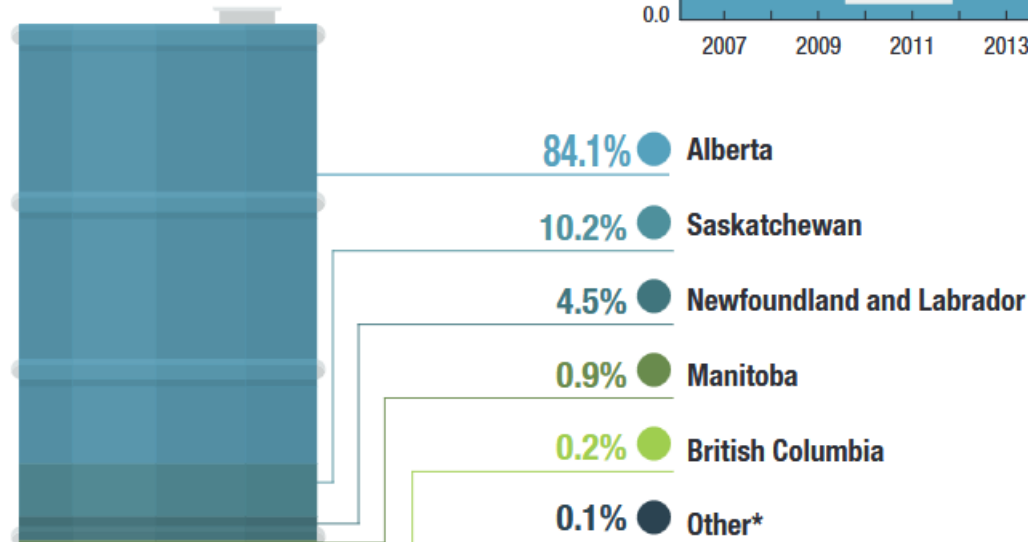
CANADIAN PRODUCTION

Oil sands production has exceeded conventional production since 2010.

In 2023, oil sands production was **3.2 MMb/d** compared with **1.7 MMb/d** of other oil production.



PRODUCTION BY PROVINCE, 2023



*Other: Nova Scotia, Ontario and the Northwest Territories.

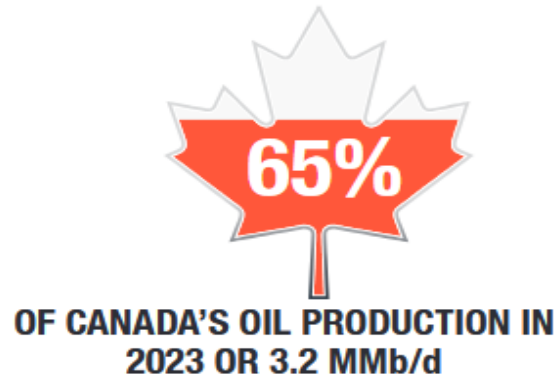
Source: Energy Factbook 2024 - 2025



Canada Oil Sands

OIL SANDS

An estimated **\$366 billion** of capital investment to date, including **\$12.4 billion** in 2023



BITUMEN UPGRADING

- Crude bitumen from oil sands may be transported to upgraders for processing to make it lighter – “synthetic crude oil.”
- In 2023, **41%** of the raw bitumen produced was sent for upgrading in Alberta.
- Major companies with upgrading capacity include Syncrude, Suncor, Shell, Canadian Natural Resources, Husky and Nexen-CNOOC.
- The total upgrading capacity in Canada is **1.5 MMb/d**
- Bitumen may also be blended with diluent (e.g. condensates) and sold directly to refineries capable of processing heavier oils.

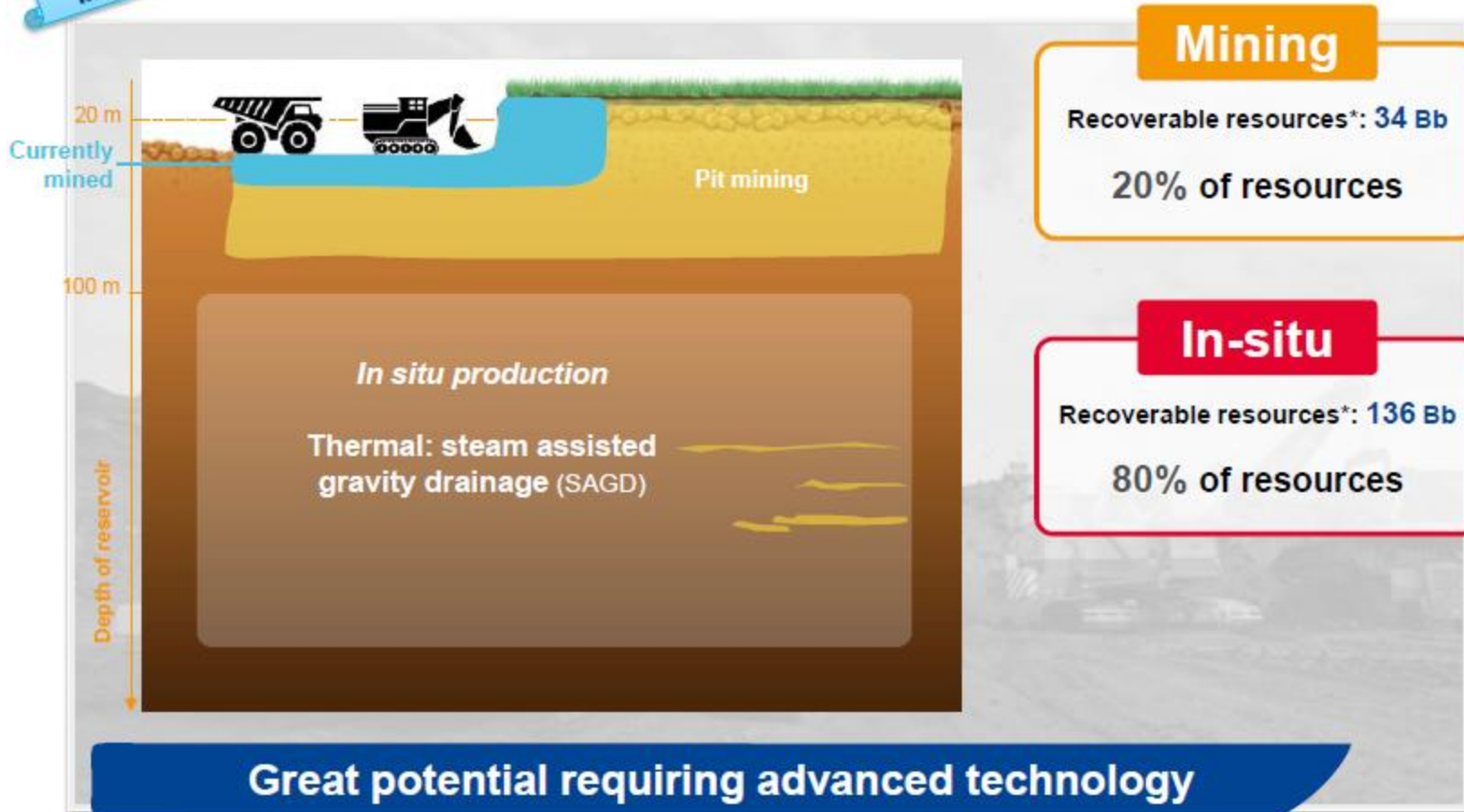
Source: Energy Factbook 2024 - 2025



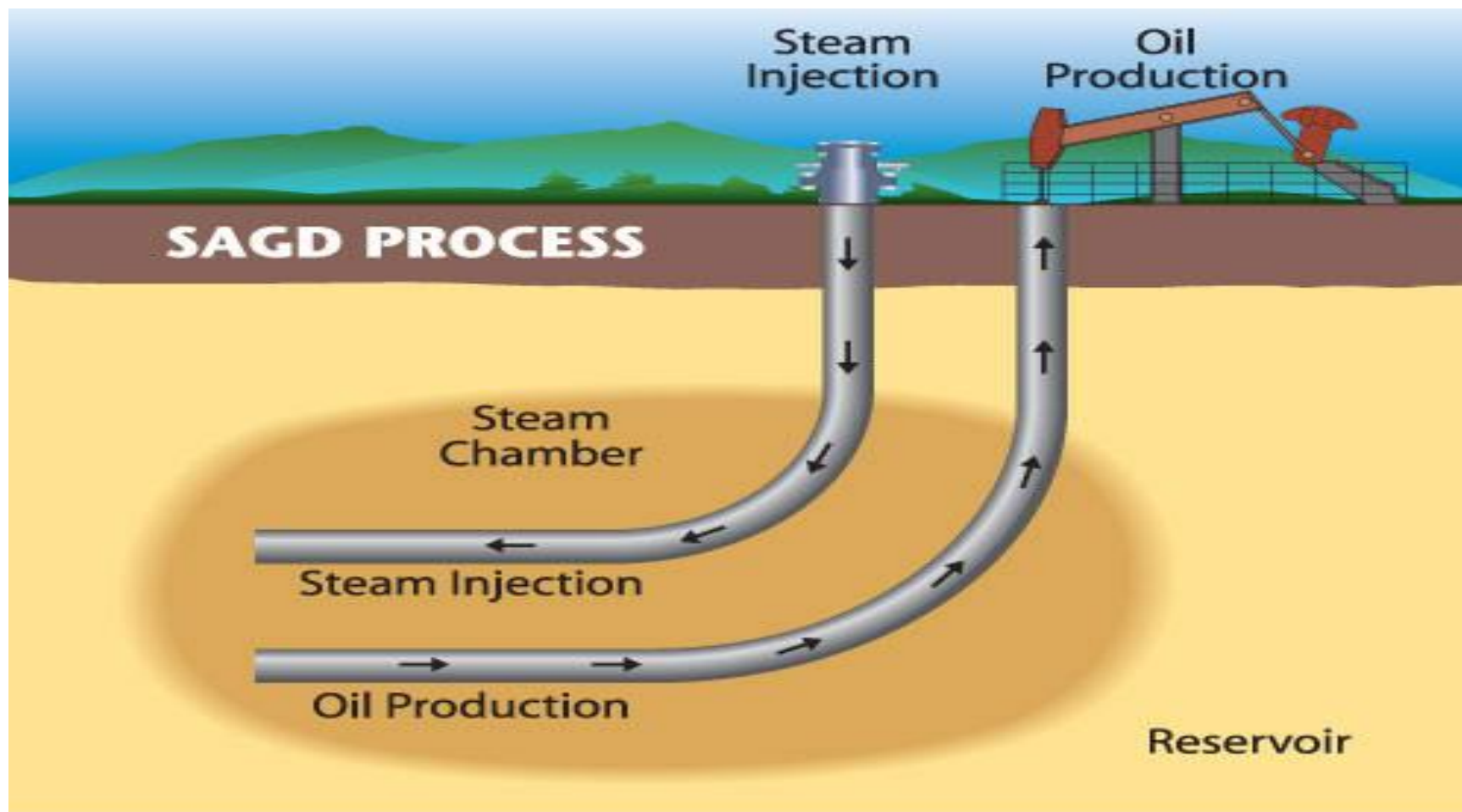
Alberta Oil sands

HOW TO BUILD-UP
TOGETHER TOTAL'S
KNOW-HOW IN
MINING ACTIVITIES

MINING AND IN-SITU EXTRACTION METHODS FOR OIL SANDS



SAGD PROCESS



Source: Canadian Centre for Energy Information

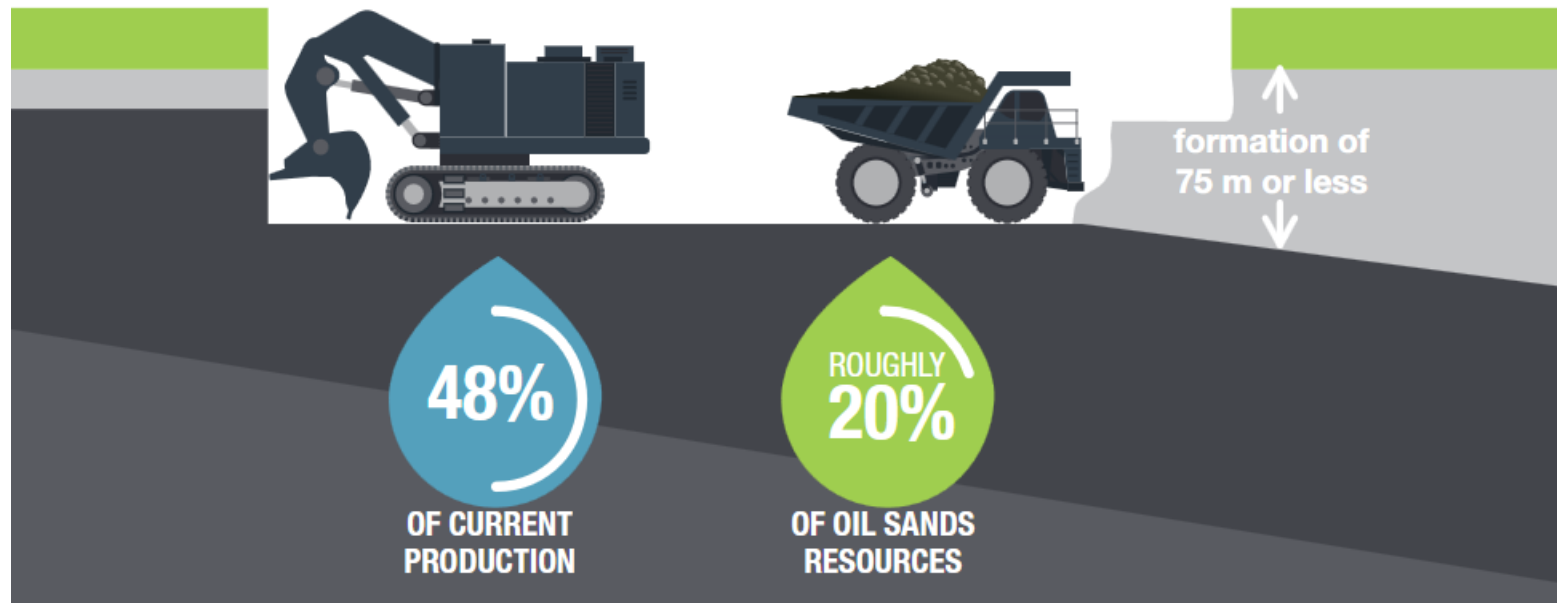


Canada Oil Sands

MINING METHOD

Process: Companies use trucks and shovels to scoop oil sands from the ground. The oil sands are then transported to extraction plants where bitumen is separated from the sand by using steam. Tailings are then pumped into settling basins.

In 2023, **seven projects in Alberta** produced **1,647 Mb/d**: Syncrude Mining Project (**366 Mb/d**), Suncor Base Mine (**249 Mb/d**), CNRL Horizon Mine (**266 Mb/d**), Athabasca Oil Sands Project – Muskeg River (**195 Mb/d**), Jackpine Mine (**129 Mb/d**), Imperial's Kearl Mine (**288 Mb/d**) and Fort Hills (**154 Mb/d**).



Source: Energy Factbook 2024 - 2025

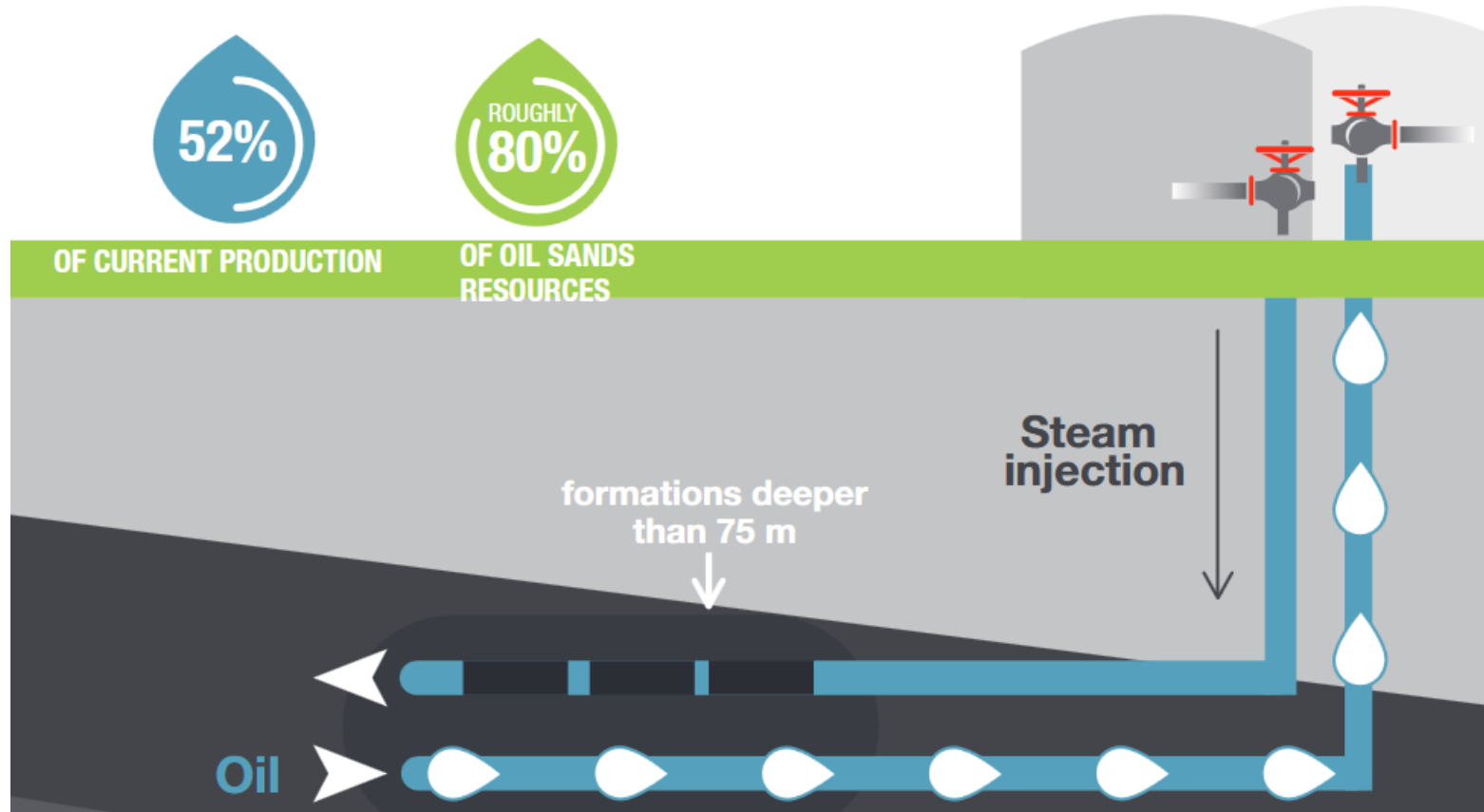


Canada Oil Sands

IN SITU METHOD

Process: Companies drill vertical and/or horizontal wells to inject steam to facilitate the flow of oil.

More than 20 projects in Alberta – The largest projects in 2023 were Firebag and MacKay River (Suncor) at **251 Mb/d**, Christina Lake (Cenovus) at **237 Mb/d**, Foster Creek (Cenovus) at **183 Mb/d** and Cold Lake (Imperial Oil) at **137 Mb/d**.



Source: Energy Factbook 2024 - 2025



Environmental considerations

HOW TO BUILD-UP
TOGETHER TOTAL'S
KNOW-HOW IN
MINING ACTIVITIES

THREE MAIN ENVIRONMENTAL ISSUES IN THE OIL SANDS



Air



Water



Land

IMPACTS

Emissions from site machinery and boilers in connection with mechanical and hot extraction processes

Consumption for extraction purposes and tailings ponds for separation

Land disturbance and impact on the biodiversity of the ecosystems in the boreal forest and humid zones

HOW TO CONTROL THEM

- SO₂/NO_x treatment
- Energy efficiency
- Carbon Capture & Storage (CCS)

- Reduction of water usage and make-up
- Treatment and recycling
- Offstream water storage

- Reduction of footprint
- Reclamation
- Compensation (fish habitat and species at risk)



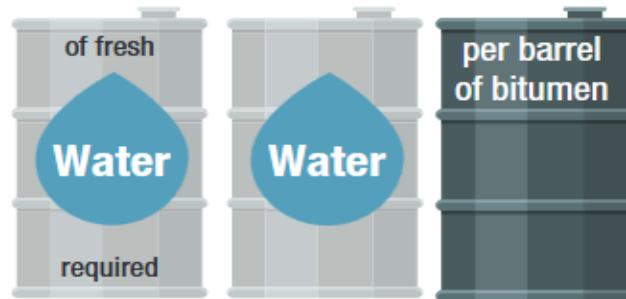
Environmental considerations

OIL SANDS: ENVIRONMENTAL CONSIDERATIONS

WATER

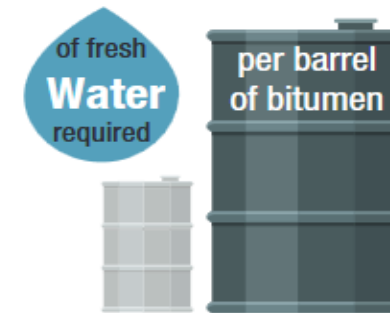
Mining method:

2.0 barrels

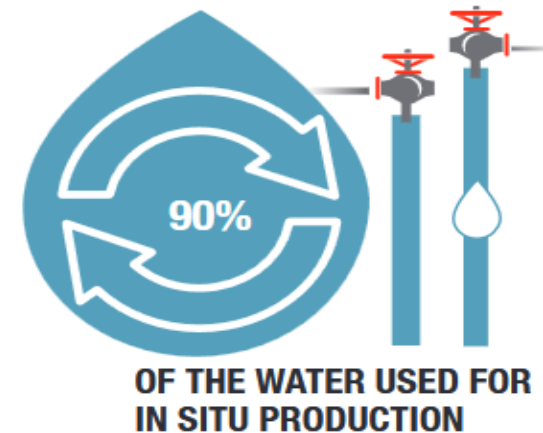


In situ method: an average of

0.16 barrels



Oil sands producers recycle about



Source: Energy Factbook 2024 - 2025



Oil Sands Exploitation & Economics

Challenging Projects in term of Technology, Environment and Costs.

High Capex and High Break-even Oil Price to secure profitability. Environmental aspects challenges.

Following the decrease of Crude Oil Price in 2014, Joslyn (Total & partners), Corner Field (Statoil & partners) have been put on hold.

In August 2018, Total sold its participation in Joslyn to Canadian Natural Resources Ltd (CNRL) for an amount of 225 Mcan\$.

Huge financial assets depreciation impacted Companies 2019 and 2020 accounts following the Oil Price decrease

In October and November 2023, TotalEnergies finalized the cession of all its Oil Sands canadian assets (Fort Hills and Surmont) to respectively Suncor and Conoco Phillips for 4 GUS\$ eq.

The Energy Transition and Climate Change threats combined with the environmental constraints challenge the pursuit of those exploitations.



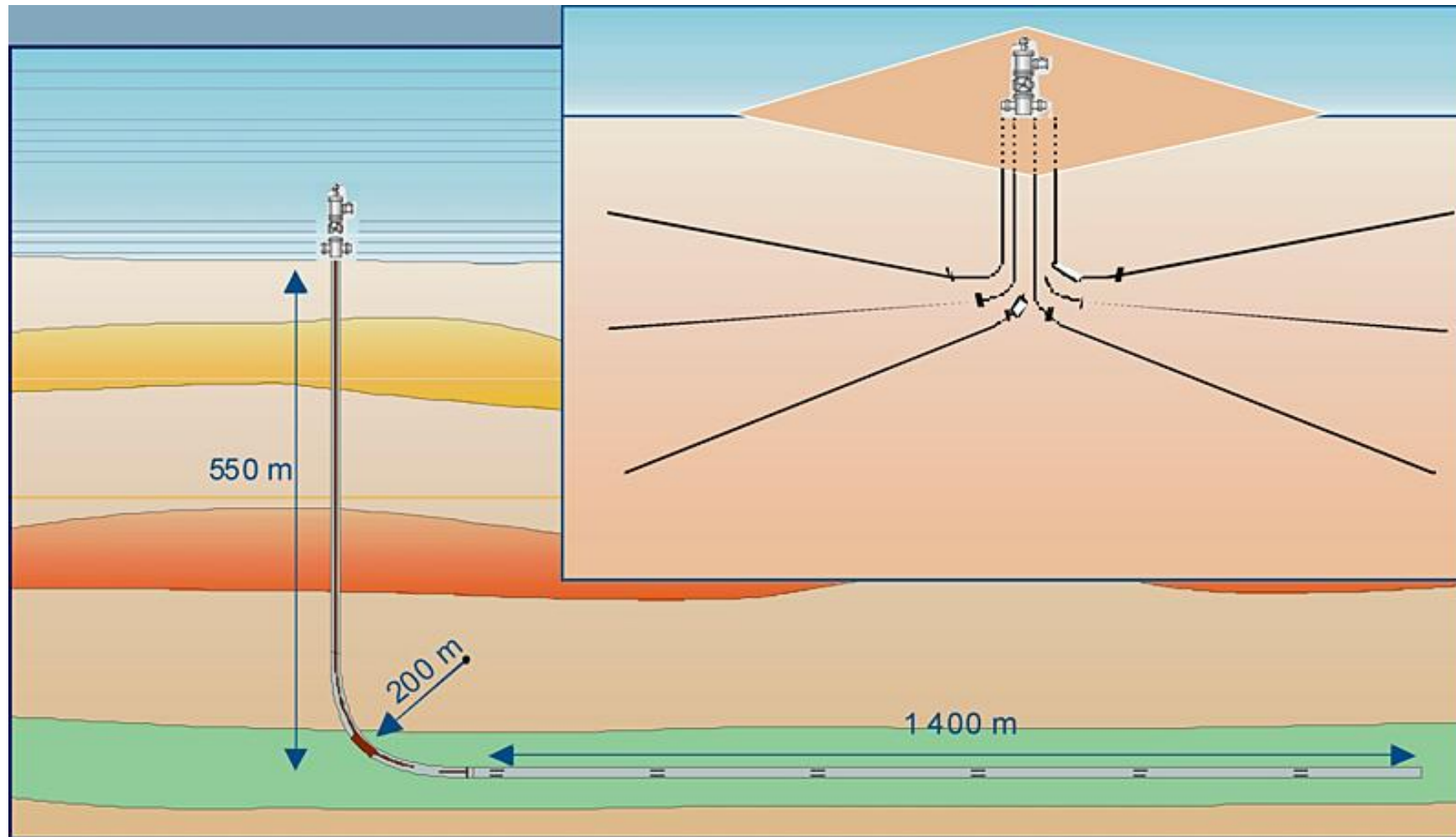
Example 2 : Xtra Heavy Oil



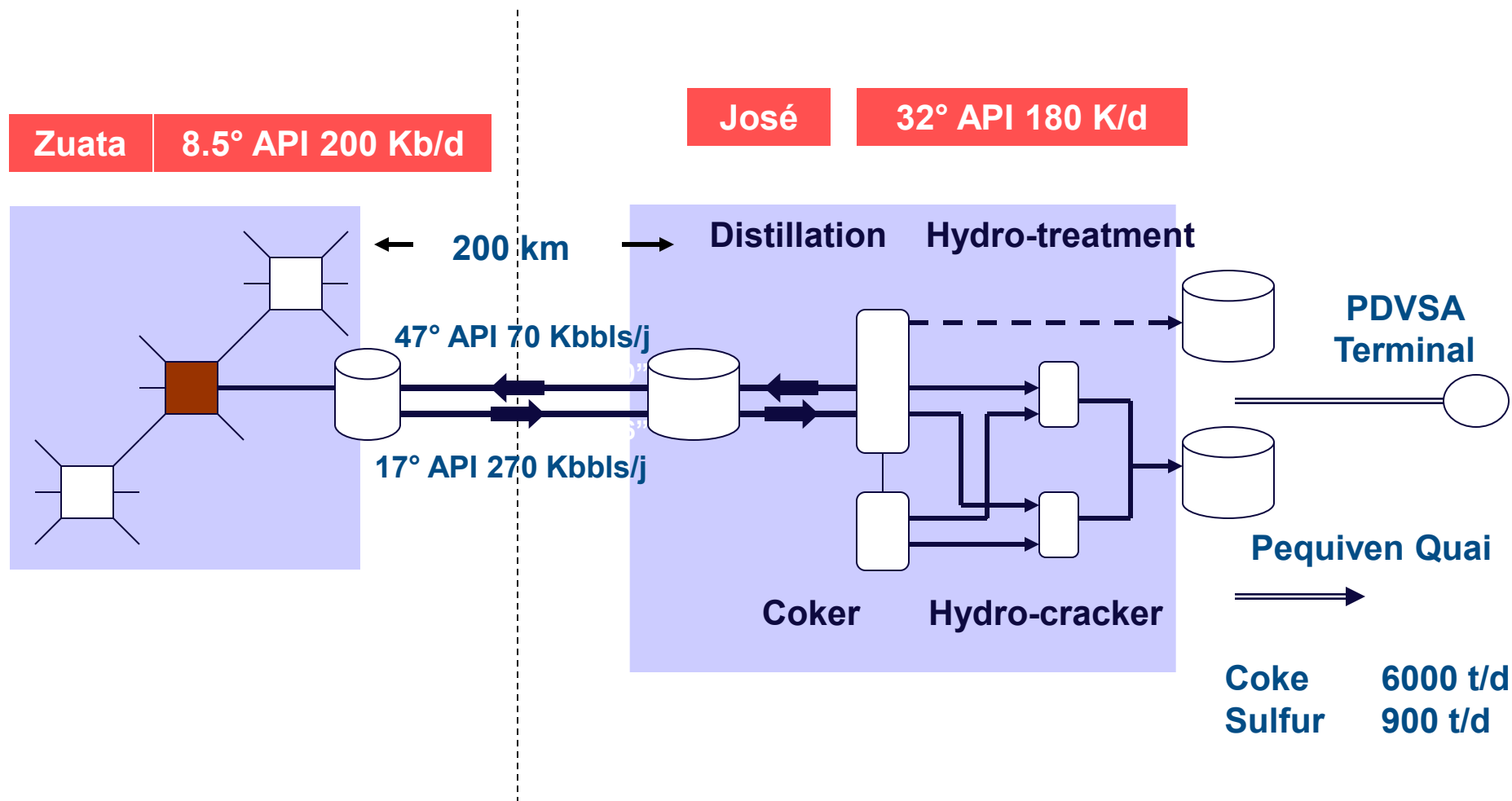
SINCOR Project



SINCOR: “Cold Production” Scheme



SINCOR Development Scheme



Source : TOTAL



Current Difficulties on the PETROCENEDO Project (Formerly SINCOR) now 100% PDVSA – The History

- ☐ **Operator: Petroleos de Venezuela SA (PDVSA)**
- ☐ **Historic minority partners: Total, Equinor, Rosneft, Chevron.**
- ☐ **Difficult Management Environment**
- ☐ **Sanctions against Venezuela put at risk production and additional financing**
- ☐ **Oil price decreases and fluctuations put at risk the economics of the project.**
- ☐ **In July 2021, TotalEnergies transferred its participation to Corporation Venezolana de Petroleos (CVP), a PDVSA affiliate.**
- ☐ **Recurrent technical and economical difficulties for this project, also in connection with the country political and economic situation.**

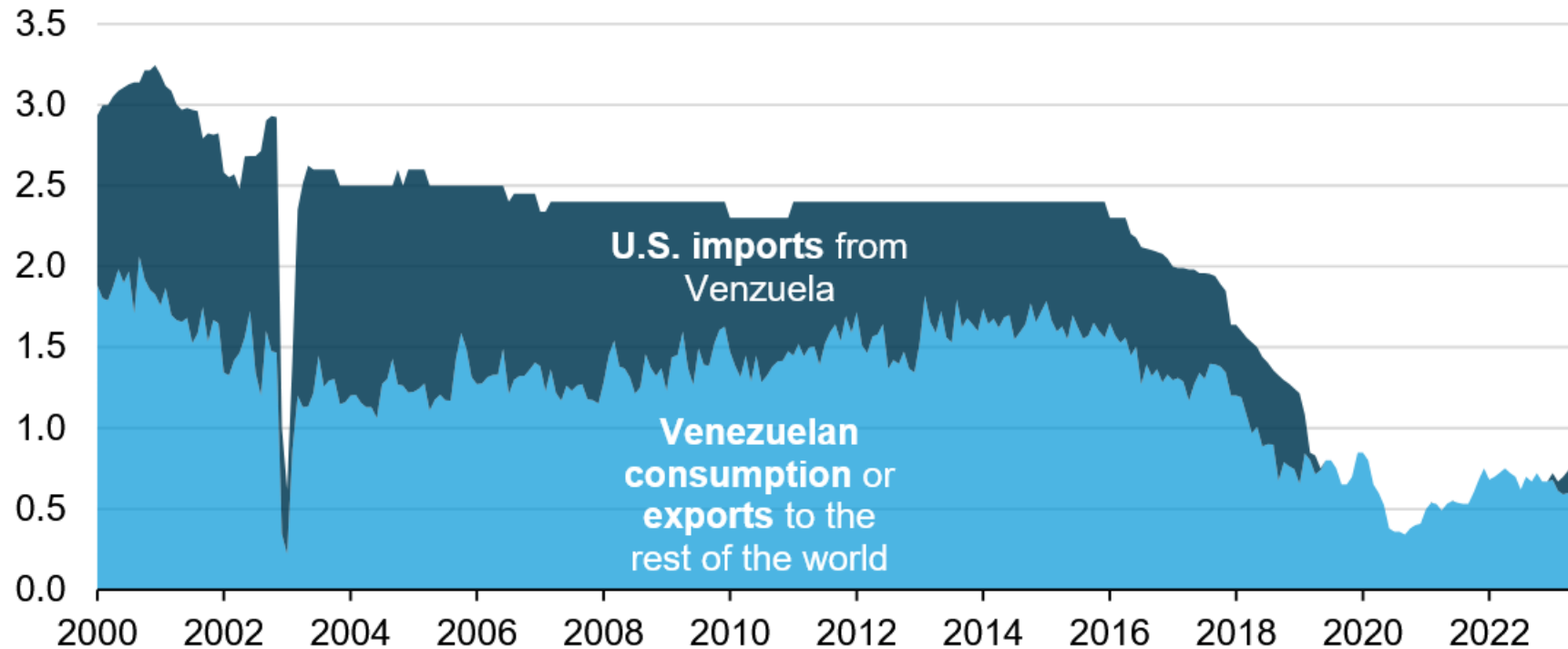


Drastic decrease of venezuelian Oil Production since 2016

Venezuela's heavy crude oil output increases are limited following U.S. sanctions relief

Monthly Venezuela crude oil production (Jan 2000–Jul 2023)

million barrels per day

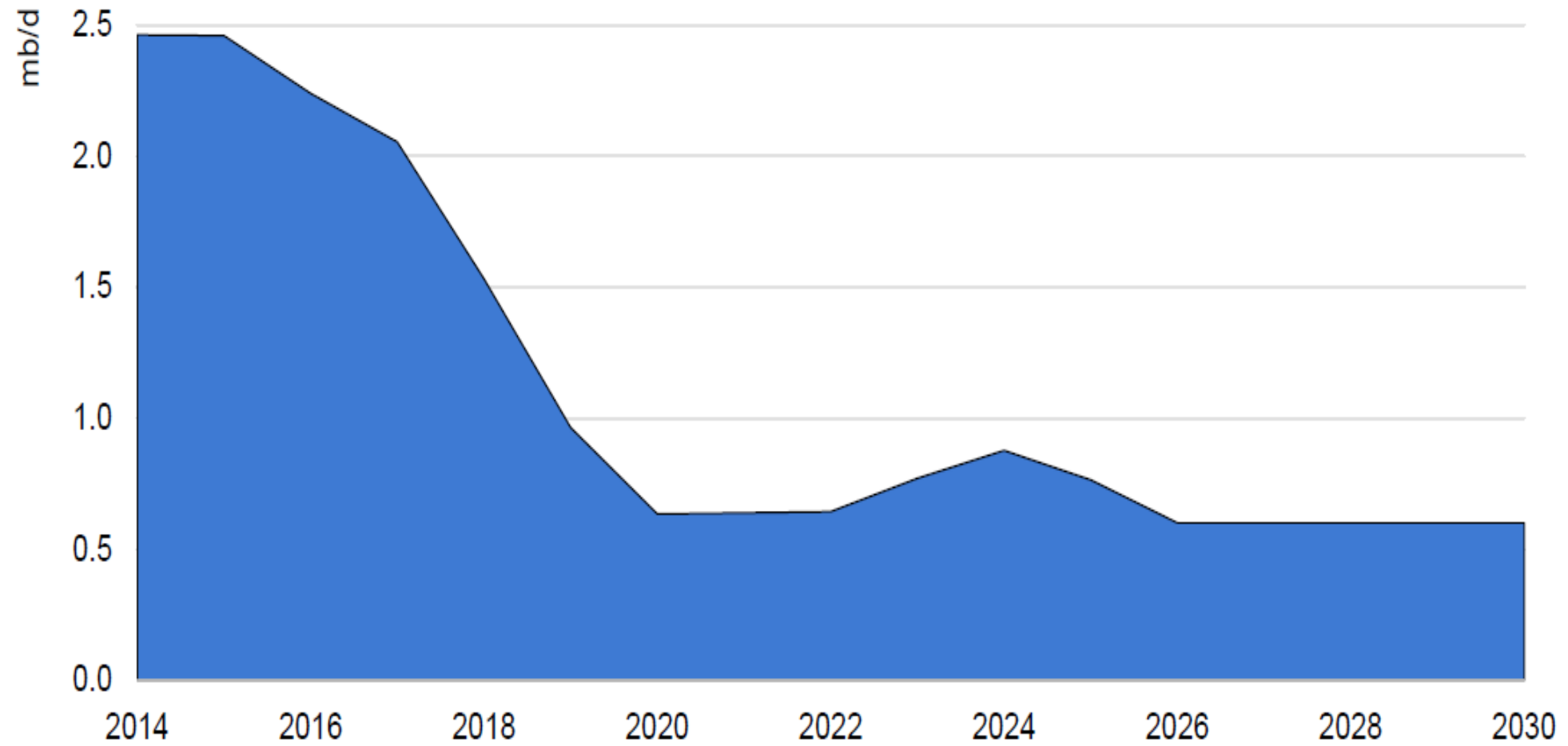


Data source: U.S. Energy Information Administration, *Short-Term Energy Outlook* (STEO)



Drastic decrease of venezuelian Oil Production since 2016

Venezuela crude oil production, 2014-2030



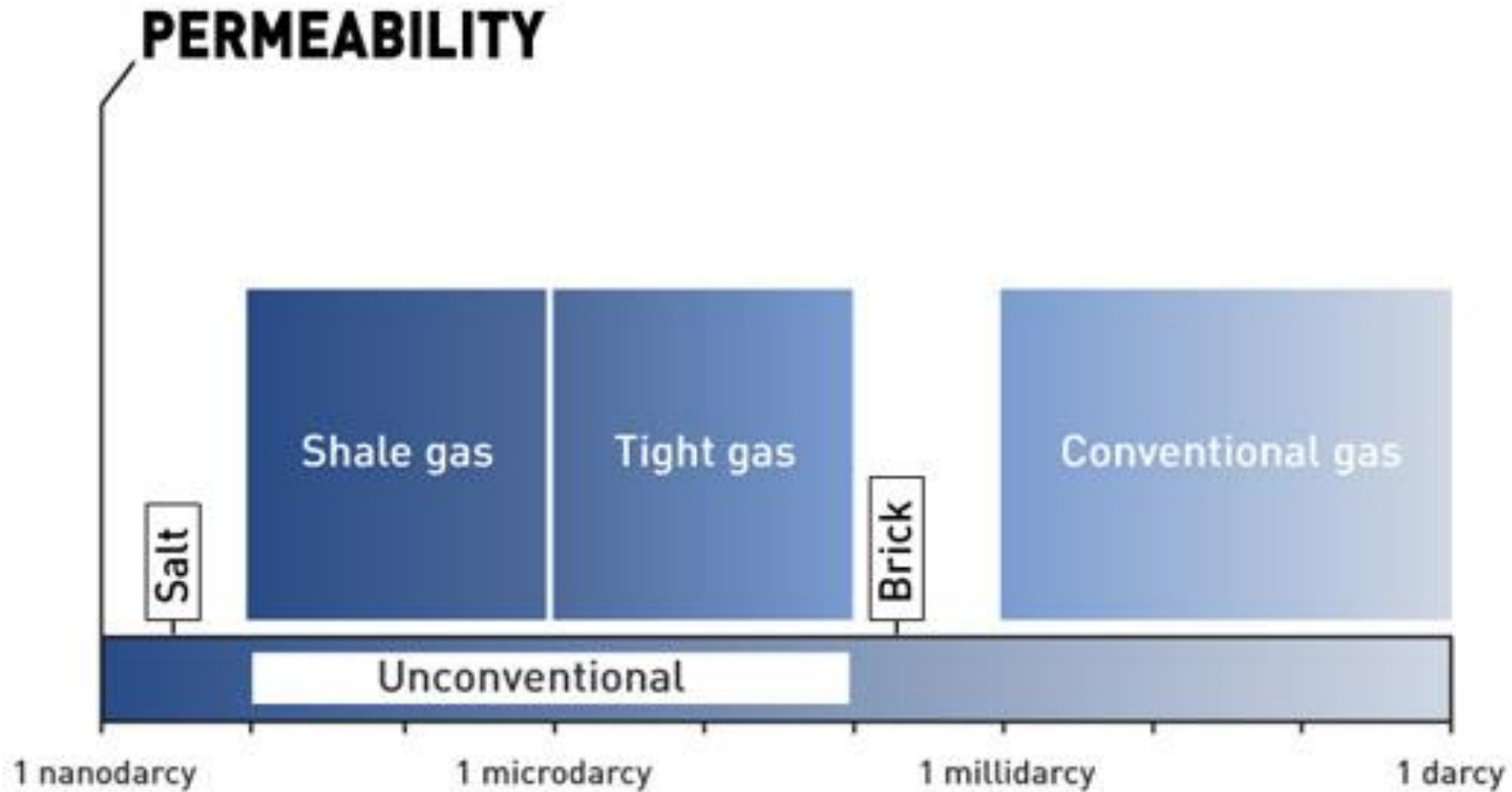
Source: IEA Oil 2025



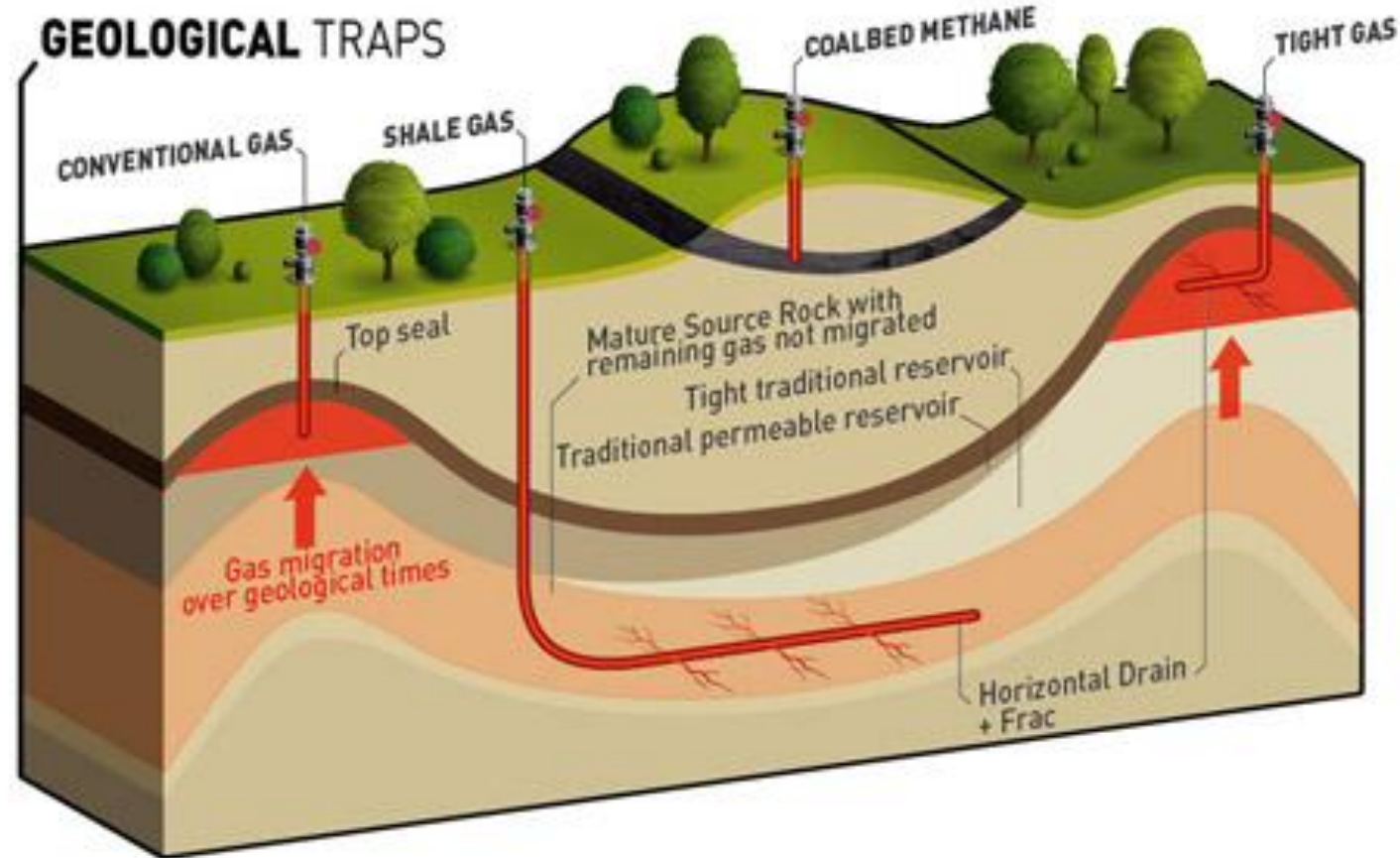
Example 3 : Shale Gas and Oil



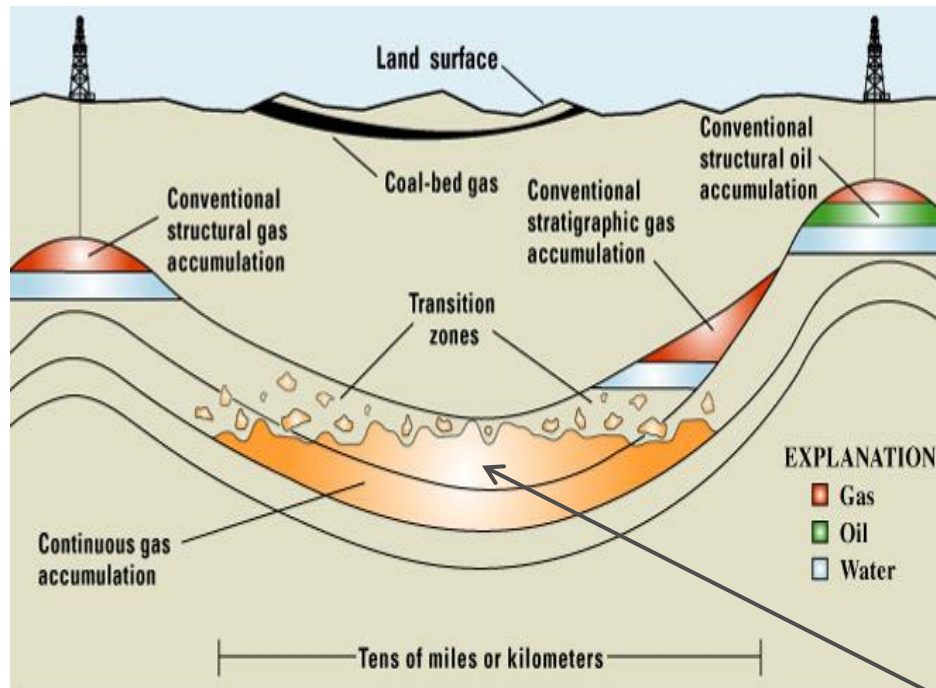
Conventional & Non-conventional Gas



Conventional & Non-conventional Gas



What is Gas Shale?



- ▶ **A very simple petroleum system:**
A continuous gas accumulation across a basin that is at the same time:

- A source rock
- A reservoir with “conventional” porosity
- A trap

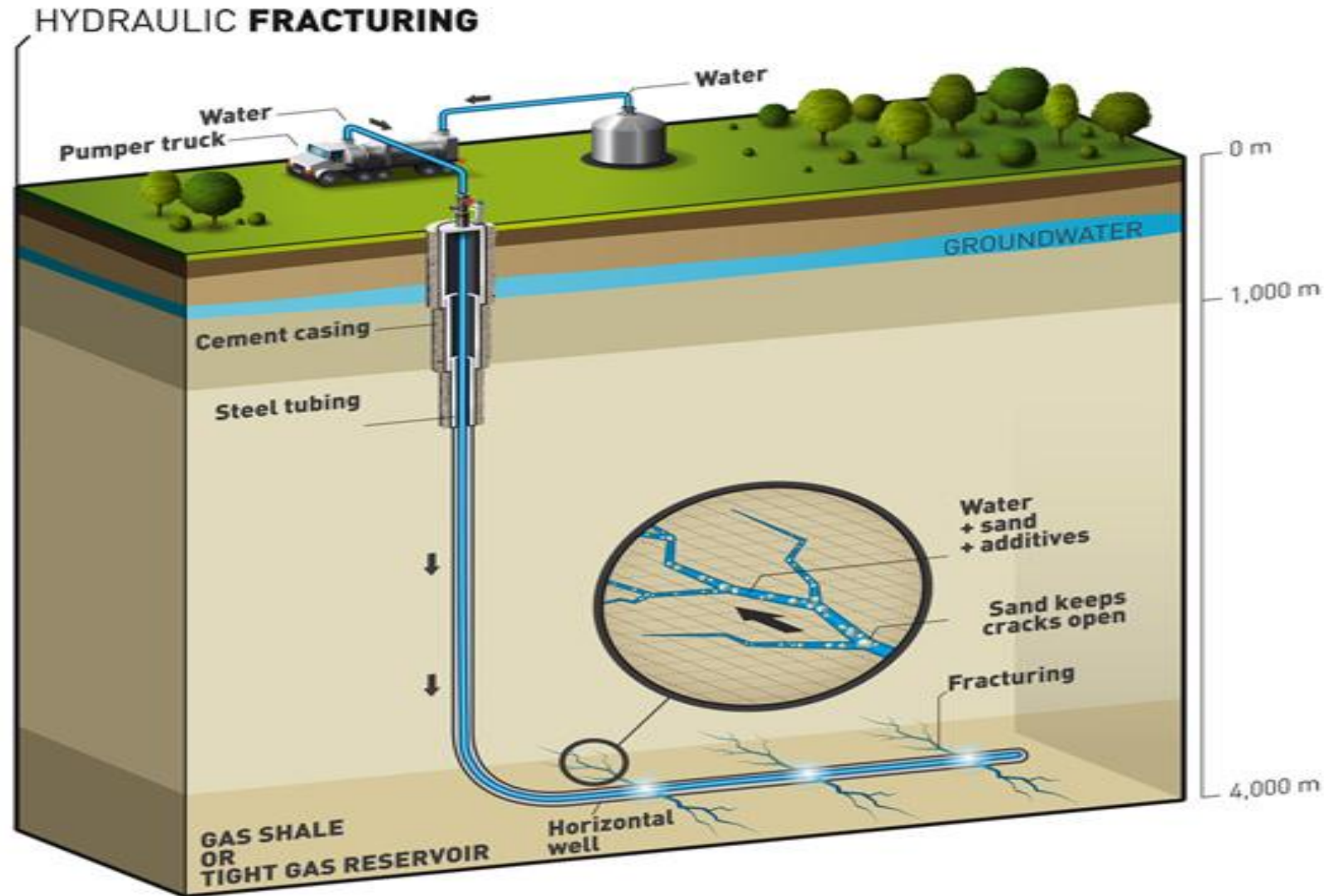
GAS SHALE



Shale Gas

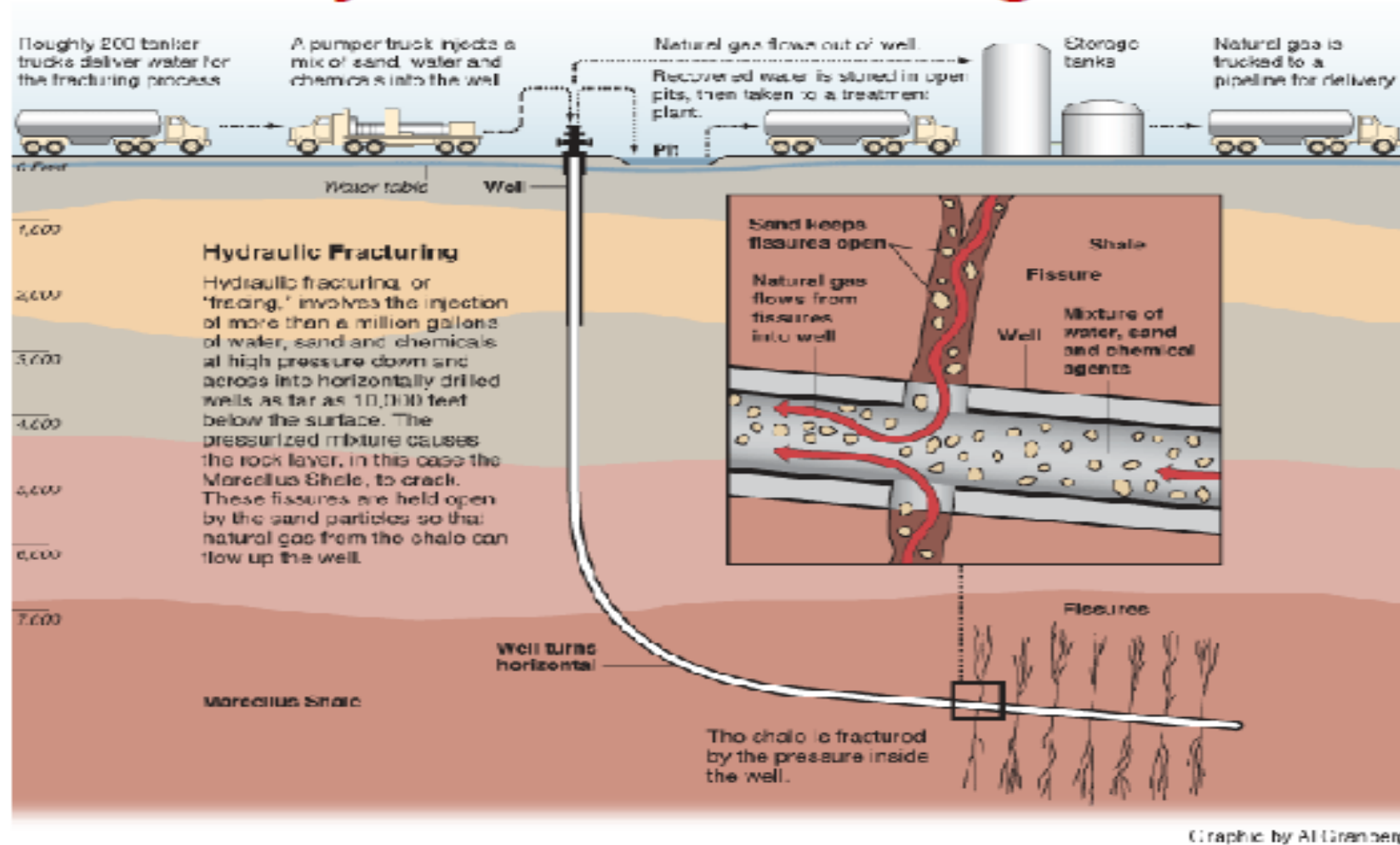


Hydraulic Fracturing



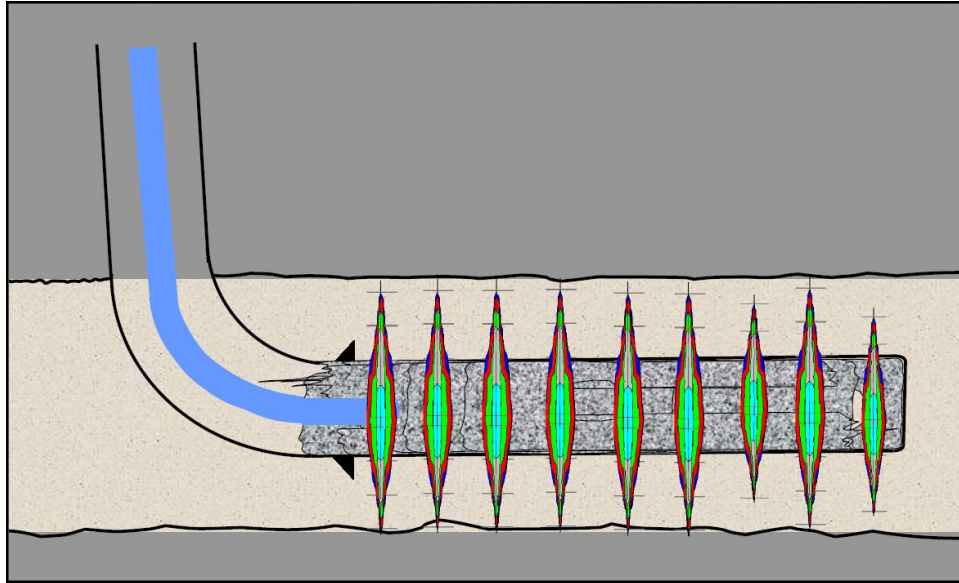
Hydraulic Fracturing

Hydraulic Fracturing



Well technology

Horizontal drains and multiple hydrofracs

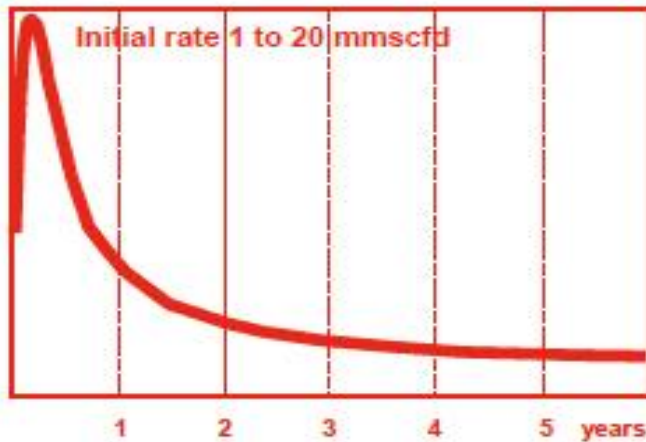


- > 1,000 meters horizontal or more
- > Water fracs with low sand concentration
- > 5 to 10 fracs per well, up to 20
- > High pumping rate:
10 to 25 cubic meters/minute
- > 1,000 to 2,000 tons sand per well
- > 10,000 to 20,000 cubic meters water per well

Cost of a well: 8 M\$ in 2012, 5/6 M\$ in 2015, 17 M\$ in US Marcellus basin 2026



Shale gas well: massive hydraulic fracturations



- 1500 m horizontal wells
- Up to 16 fracturation stages
- 2000 t of sand injected
- 100 000 bl of water injected
- Microseismic monitoring

KAZENERGY forum 2010, 5-6 Oct 2010, Almaty, Kazakhstan



Shale Oil and Shale Gas exploitation – Economic conditions evolve upon time

- Short profile of production, rapid decline, low productivity per well, low recovery rate (5%).
- Needs for drilling more wells than for conventional oil & gas exploitation. From 2011 to 2014, more than 100 000 wells were drilled in the US.
- Capex are the most important part of the costs. Opex are limited. Costs depend upon the location of the basins.
- Costs of the wells # 5 to 13 M\$. Costs are declining since 2012/2013 thanks to technical optimization. 2014 average cost of a shale well in the US = 7,1 M\$, 1/3 reduction in 2019.
- Many small, medium size oil companies involved. Need to finance through debt. High sensitivity to oil & gas price.
- Impact of an oil price collapse from 90 to 40 \$/b can represent 1 Mb/d of production.
- Shale Oil and shale Gas development activity is very dependant upon the Oil & Gas prices.
- In the period 2022 – 2023, important rebound of the unconventional production thanks to Oil Price increase.
- In 2023, US is by far the first Oil producer in the World. Today, US are the first Oil & Natural Gas producer, and one of the first LNG exporter in the World.
- Following the result of the presidential election in US, it is expected that the Shale Oil & Gas production in the country will be more promoted. But economics depend upon the Oil price.



Water Use

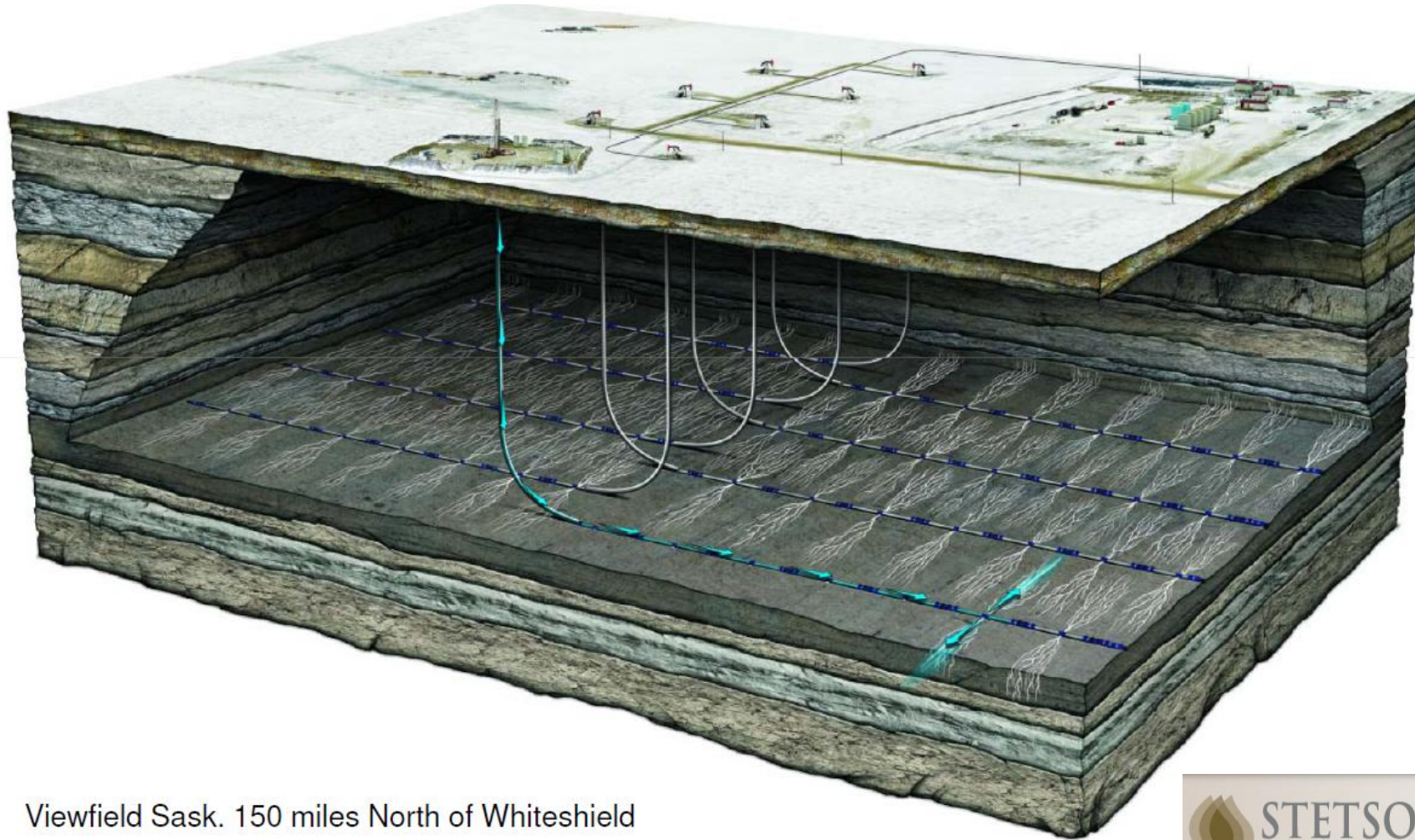
- ◆ Shale gas is one of the most water-efficient sources of energy
 - Coal: 2-4 times more water per unit of energy
- ◆ Water produced with oil production is often used to minimize impact on local supply
- ◆ A typical well requires 10,000-20,000 cubic meters of water (Equivalent to 3-6 Olympic-sized swimming pools)
- ◆ Water is only required for a short time during the drilling and completion process and does not represent a long-term water commitment
- ◆ Part of the injected water will be re-produced: proper management & disposal is critical, and is a standard practice in the O&G industry (for 1 b of oil produced in the world, 4 b of water are produced & treated)



Damme-2 well, Germany



Shale Gas & Oil typical development (USA)

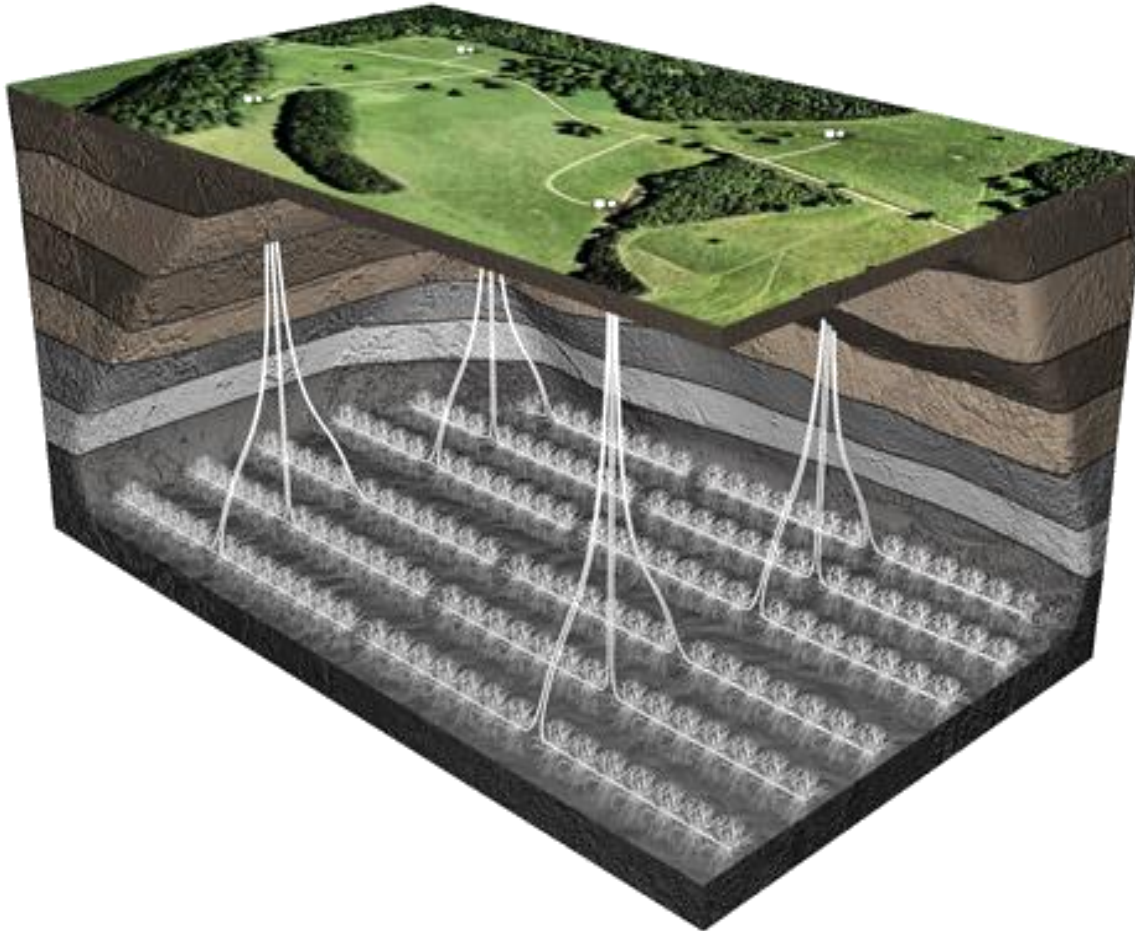


Viewfield Sask. 150 miles North of Whiteshield

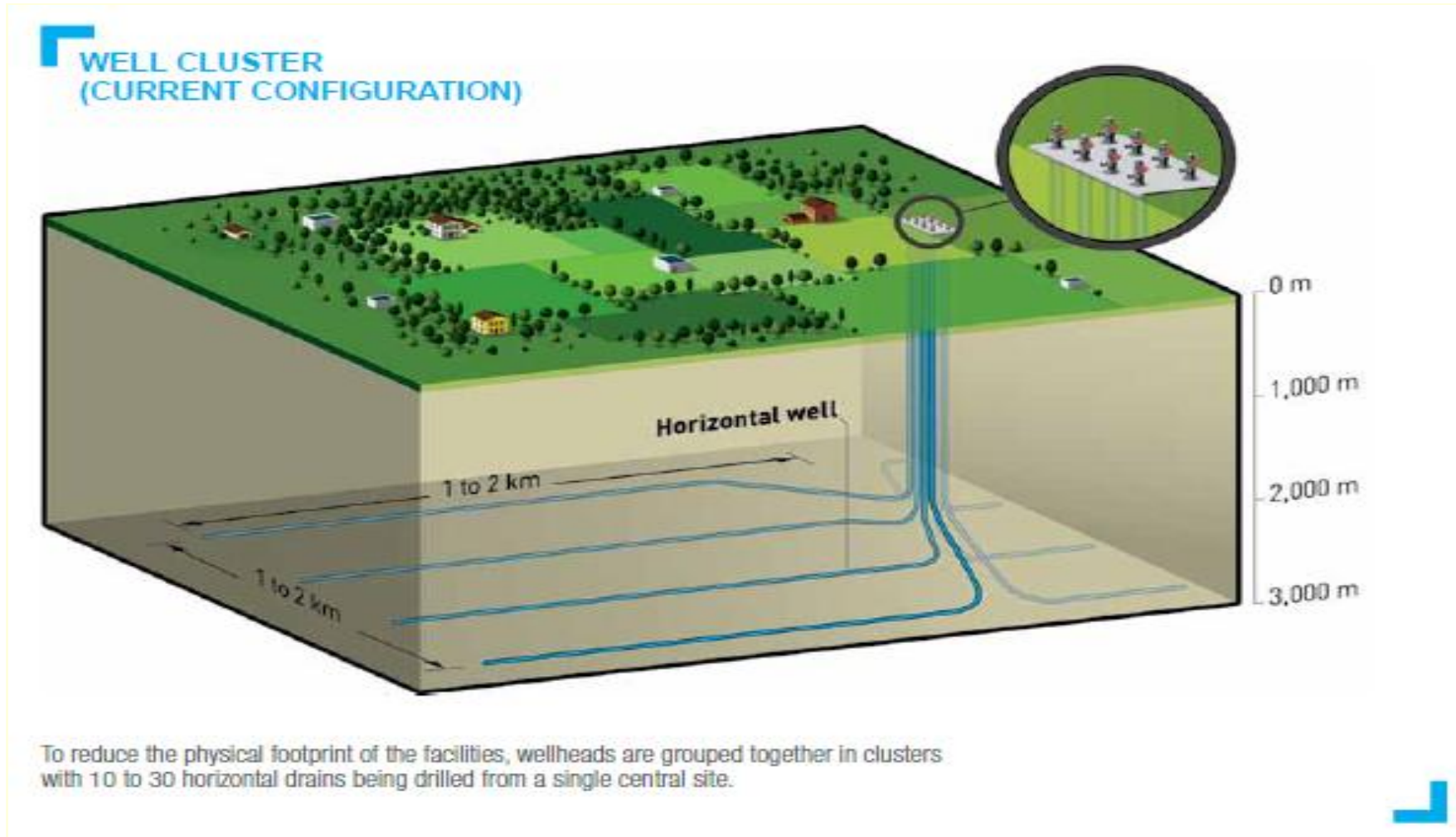


Shale Gas Development scheme

Reducing well drilling sites by increasing horizontal drains length & number of wells per cluster



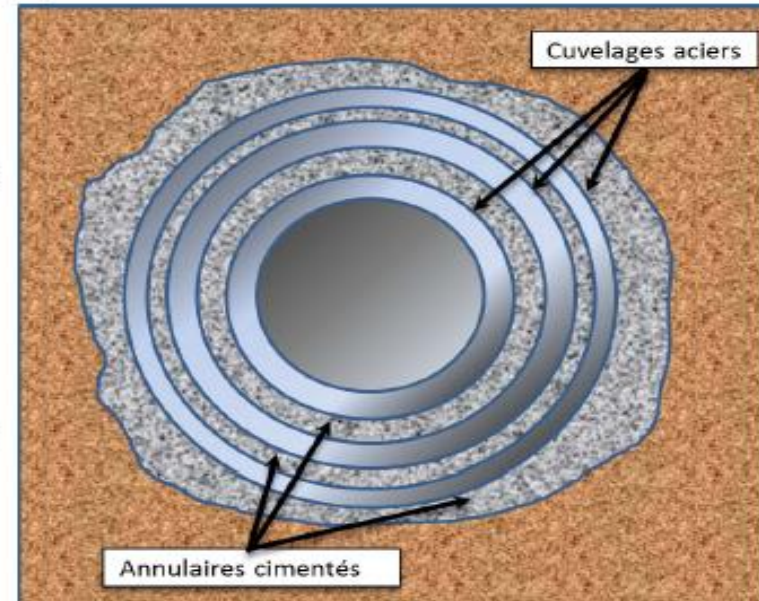
Gas Shale Exploitation Well cluster



Gas Shales technology – Well integrity

Préservation du sous-sol Intégrité des puits

- La pose de cuvelages en acier concentriques et la cimentation des espaces annulaires permettent de créer plusieurs barrières étanches et assurent la protection des eaux souterraines
- Ce processus est hautement **réglementé en Europe** et les opérateurs se doivent d'adhérer aux normes les plus strictes sur la conception des puits.



Coupe typique d'un puits cimenté

Moyens de contrôle

- Contrôles des cimentations de surface par une société mandatée par l'état
- Contrôle des cimentations de surfaces par mesure acoustiques
- Contrôles périodiques de la corrosion des tubages



Gas Shales technology - Impact of fracturation fluids

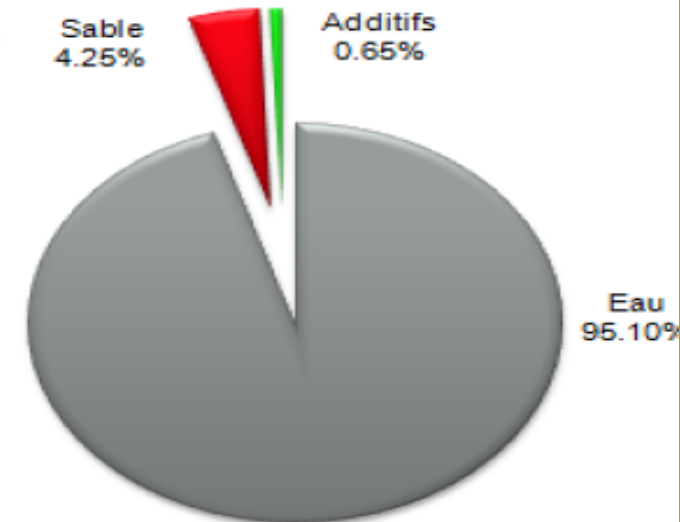
Risque de pollution par les fluides de fracturation

Bonnes Pratiques

- Les nouvelles technologies visent à utiliser des produits moins polluants ou provenant de l'industrie alimentaire
- Les concentrations en additifs sont réduites au minimum
- Les interventions sont réalisées par des sociétés disposant des accréditations en termes de sécurité, qualité et environnement (ISO 9001/2; MASE; ISO 14000)

Transparence:

- Les compositions des fluides utilisés sont accessibles au public aux USA.
- C'est une obligation en Europe, avec la réglementation REACH
- Les fiches de type FDS sont disponibles sur site pour chaque produit utilisé



Environmental aspects



Source: AFTP



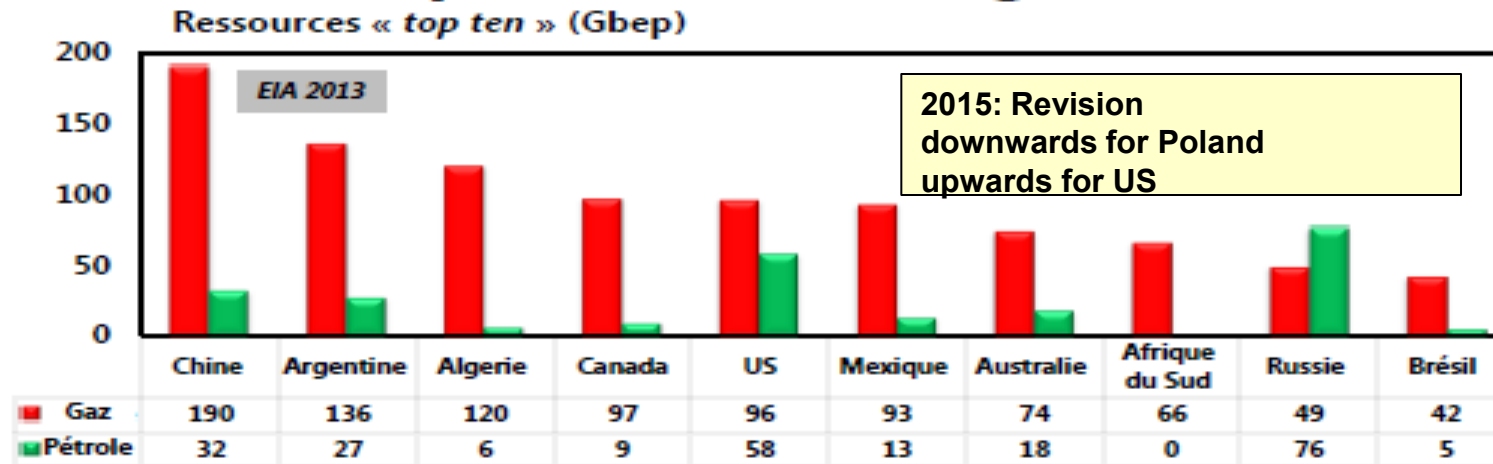
Unconventional HC in the world



Oil & Gas Shales

Additional Resources worldwide – A 2015 Vision

World and Europeans shale oil & gas stakes



Notional additional resources

	Gas Gboe	Oil Gbbl
Conventional	1100	1650
Unconventional	1200	350
Additional (%)	110	20

**Notional data to be taken
very cautionnally !**

Notional European resources

Country	Shale gas		Shale oil	Total Gboe
	Tcf	Gboe	Gbbl	
Poland	148	25	3,3	28
France	137	23	4,7	28
Romania	51	9	0,3	9
Denmark	32	5	0	5
UK	26	4	0,7	5
Netherlands	26	4	2,9	7
Others	50	9	1	10
Total	470	80	12,9	93



Reminder - Unconventional HC in the world

Shale oil and shale gas resources are globally abundant

Basins with assessed shale oil and shale gas formations



Source: U.S. basins from U.S. Energy Information Administration and United States Geological Survey; other basins from Advanced Resources International (ARI) based on data from various published studies.



Reminder - Unconventional HC in the world

Table 1. Technically recoverable shale oil and shale gas resources in the context of total world resources

	Crude oil (billion barrels)	Wet natural gas (trillion cubic feet)
Outside the United States		
Shale oil and shale gas ¹	287	6,634
Non-shale ²	2,847	13,817
Total	3,134	20,451
Increase in total resources due to inclusion of shale oil and shale gas	10%	48%
Shale as a percent of total	9%	32%
United States³		
Shale / tight oil and shale gas	58	665
Non-shale	164	1,766
Total	223	2,431
Increase in total resources due to inclusion of shale oil and shale gas	35%	38%
Shale as a percent of total	26%	27%
Total World		
Shale / tight oil and shale gas	345	7,299
Non-shale	3,012	15,583
Total	3,357	22,882
Increase in total resources due to inclusion of shale oil and shale gas	11%	47%
Shale as a percent of total	10%	32%

¹ Advanced Resources International, Inc. (ARI) 2013.

² *Oil & Gas Journal*, Worldwide Report, December 3, 2012; U.S. Geological Survey, An Estimate of Undiscovered Conventional Oil and Gas Resources of the World, 2012, Fact Sheet 2012-3028, March 2012; U.S. Geological Survey, Assessment of Potential Additions to Conventional Oil and Gas Resources of the World (Outside the United States) from Reserve Growth, 2012, Fact Sheet 2012-3052, April 2012.

³ U.S. Energy Information Administration, various reports.



Reminder - Unconventional HC in the world

Table 2. Top 10 countries with technically recoverable shale oil resources

Rank	Country	Shale oil (billion barrels)	
1	Russia	75	
2	U.S. ¹	58	(48)
3	China	32	
4	Argentina	27	
5	Libya	26	
6	Australia	18	
7	Venezuela	13	
8	Mexico	13	
9	Pakistan	9	
10	Canada	9	
World Total		345	(335)

¹ EIA estimates used for ranking order. ARI estimates in parentheses.

Table 3. Top 10 countries with technically recoverable shale gas resources

Rank	Country	Shale gas (trillion cubic feet)	
1	China	1,115	
2	Argentina	802	
3	Algeria	707	
4	U.S. ¹	665	(1,161)
5	Canada	573	
6	Mexico	545	
7	Australia	437	
8	South Africa	390	
9	Russia	285	
10	Brazil	245	
World Total		7,299	(7,795)

¹ EIA estimates used for ranking order. ARI estimates in parentheses.



Conventional and Unconventional Oil Resources End 2024 (Gb)

IEA WEO 2025:

Proven Reserves end 2024: 1756 Gb

Remaining Resources at end 2024:

Conventional : 2042 Gb

Tight Oil : 549 Gb

NGL : 636 Gb

EHOB : 1862 Gb

Kerogen Oil : 1073 Gb

Total # 6161 Gb

Source: IEA WEO 2024
EHOB: Extra Heavy Oil and Bitumen



Conventional and Unconventional Gas Resources End 2024 (T.m³)

IEA WEO 2025:

Remaining Recoverable Resources end 2023:

Conventional : 413 T.m³ # 14 600 Tcf

Tight Gas : 80 T.m³

Shale Gas : 250 T.m³

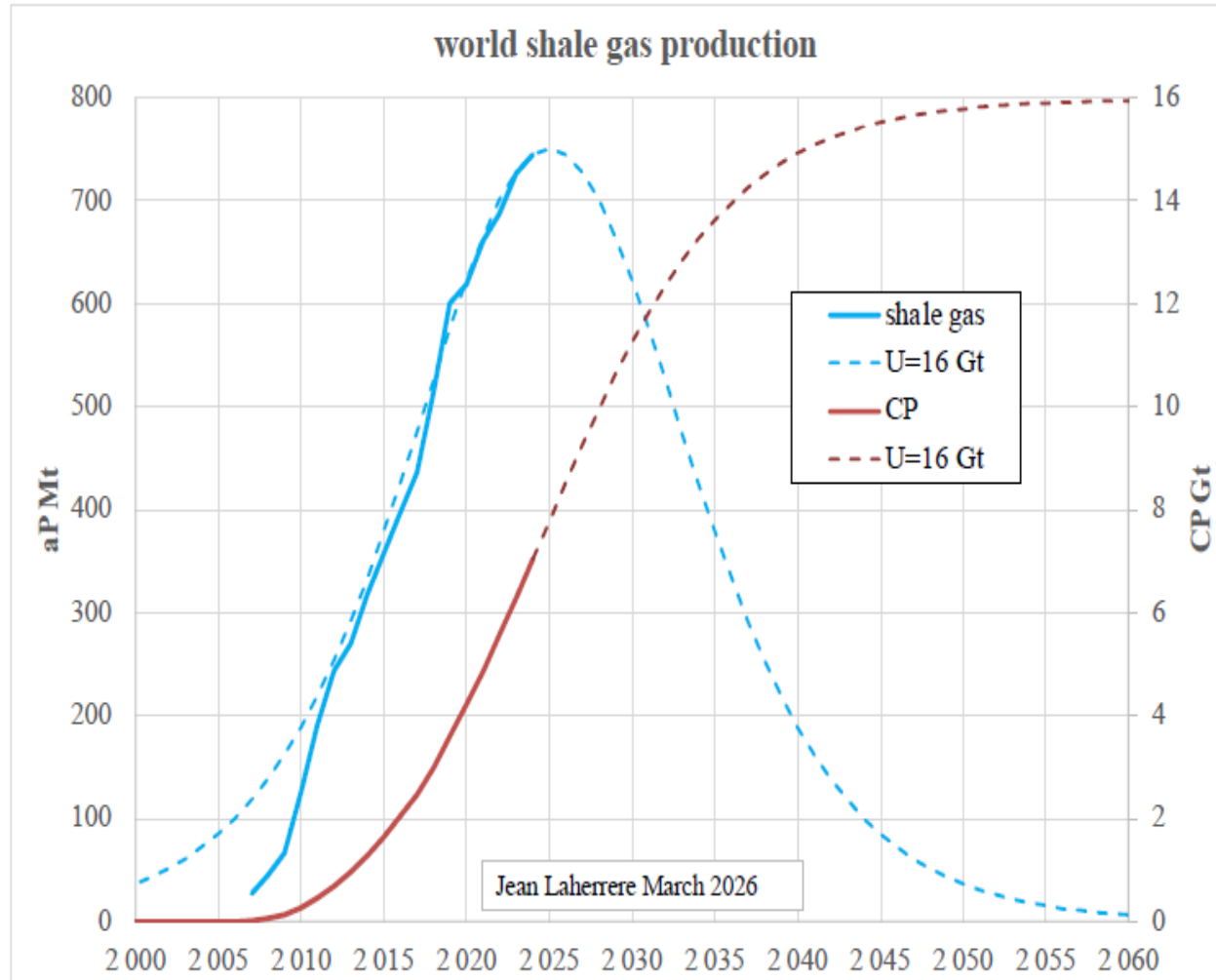
CBM : 49 T.m³

Unconventional : 379 T.m³ # 13 400 Tcf

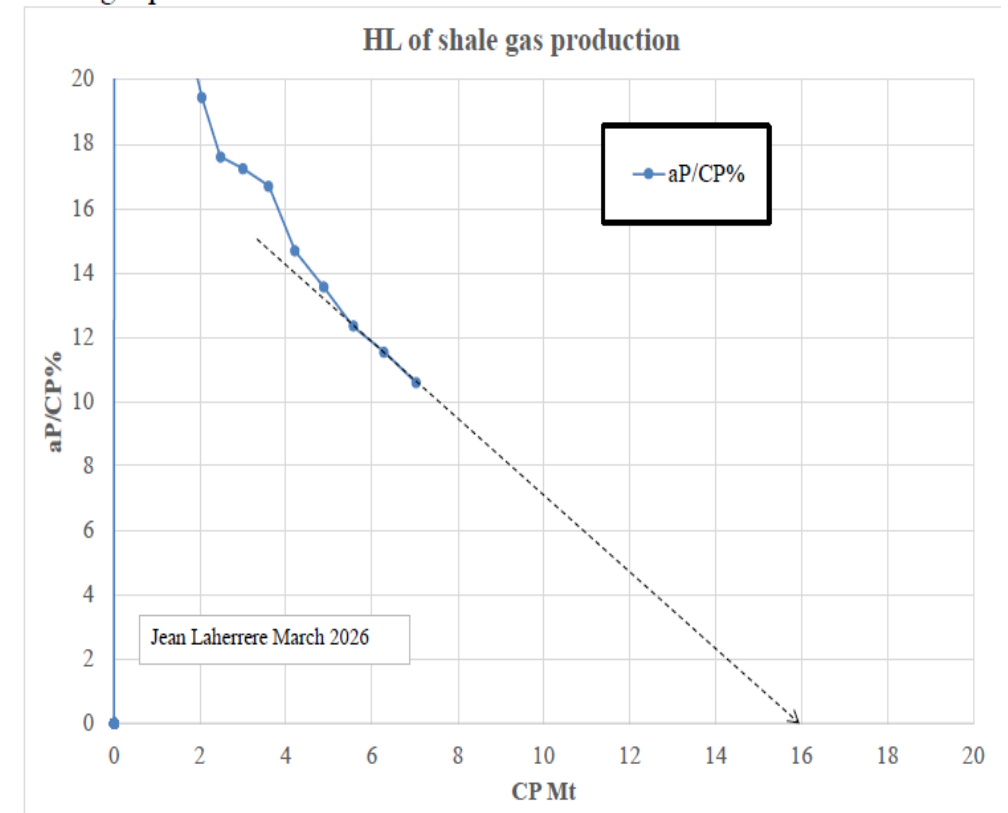
Total # 792 T.m³ # 28 000 Tcf



World Shale Gas Production



-Shale gas
HL of shale gas production trends towards 16 GT



For a 16 Gt ultimate, shale gas production is about peaking!

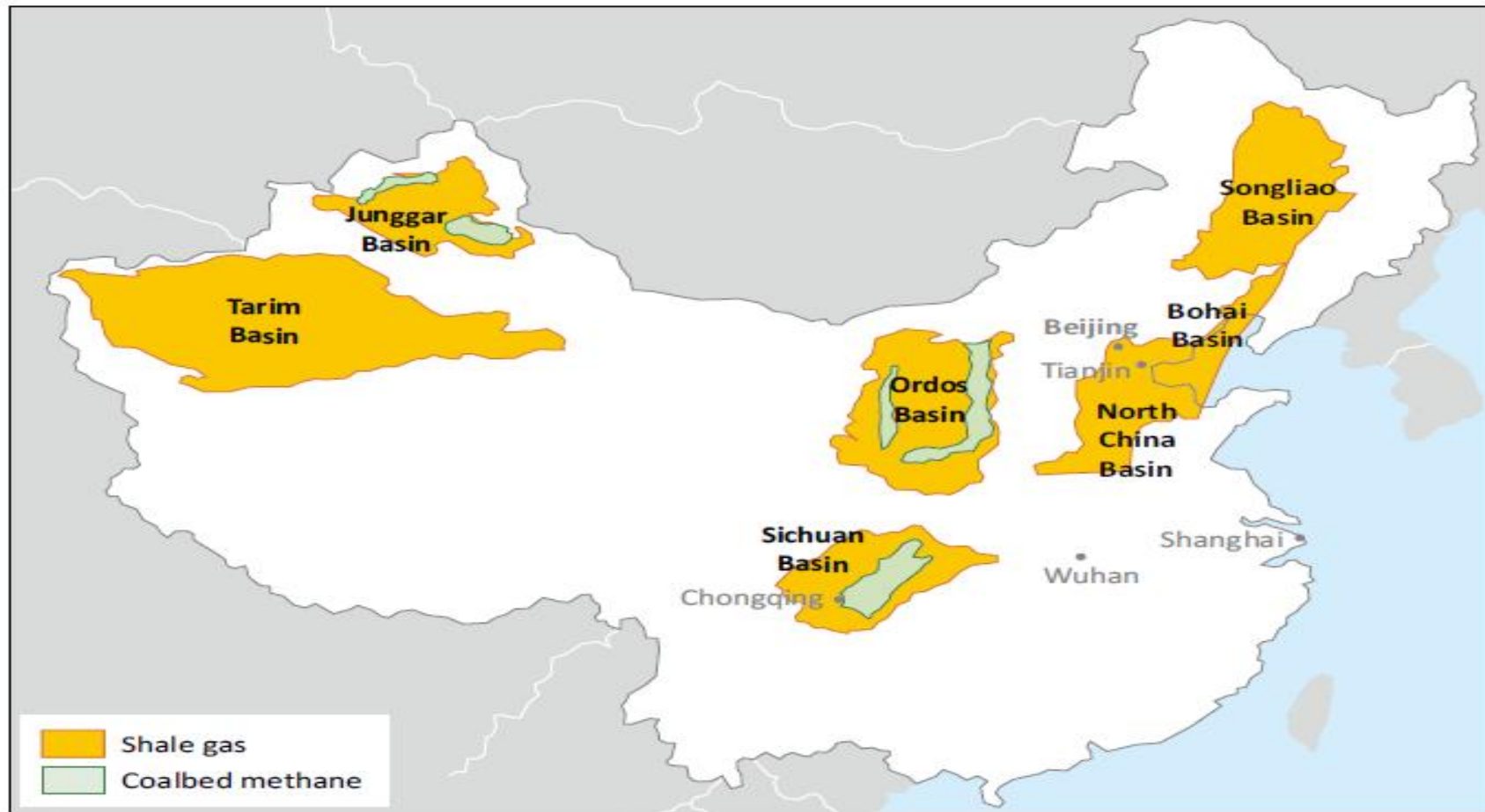
Source: ASPO Jean Laherrère March 2026



Unconventional Resources – A zoom on China



Main Unconventional Gas Resources in China

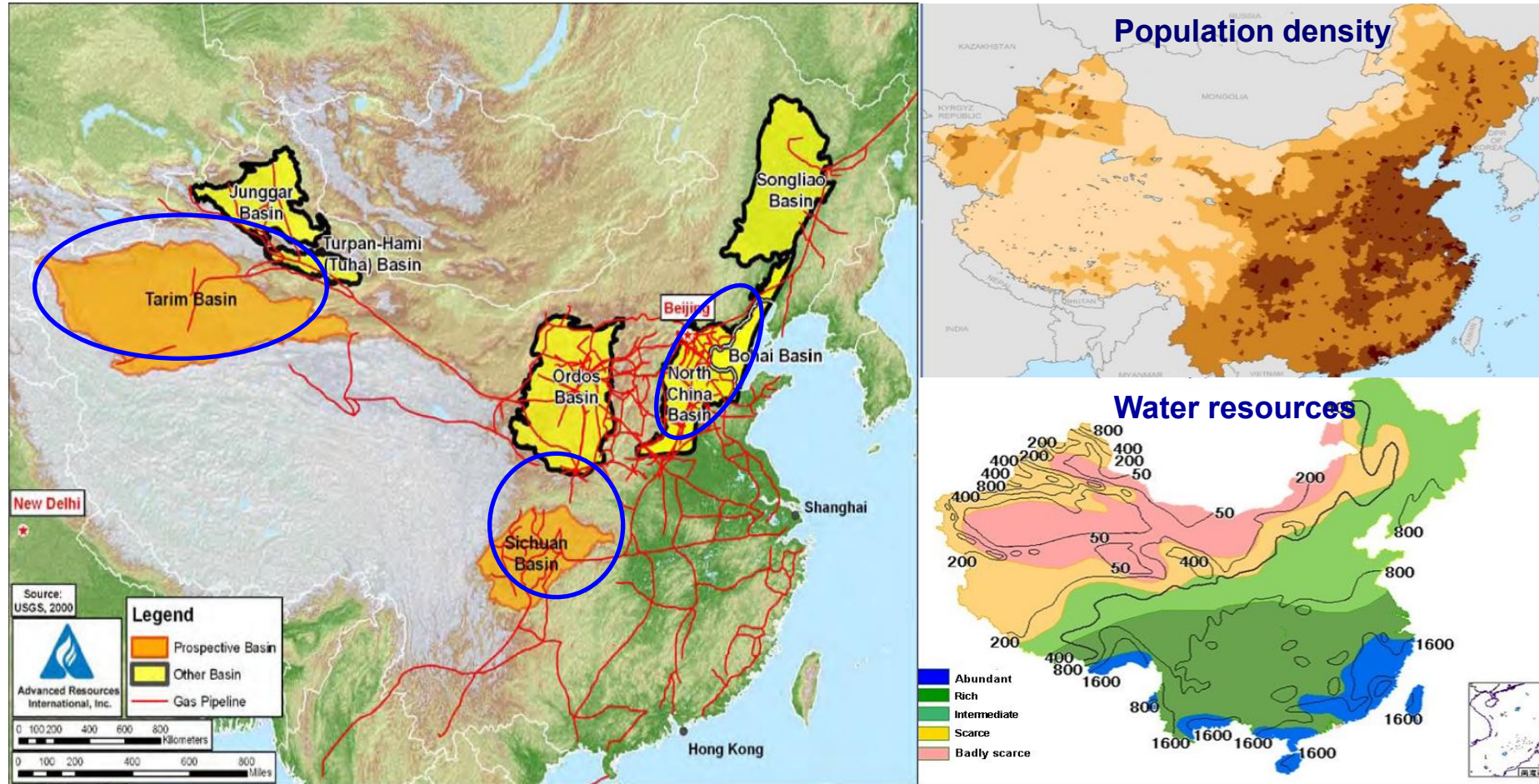


This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.



Major Shale Gas Basins and Pipeline System of China

70% of In-Place resources (CNPC)

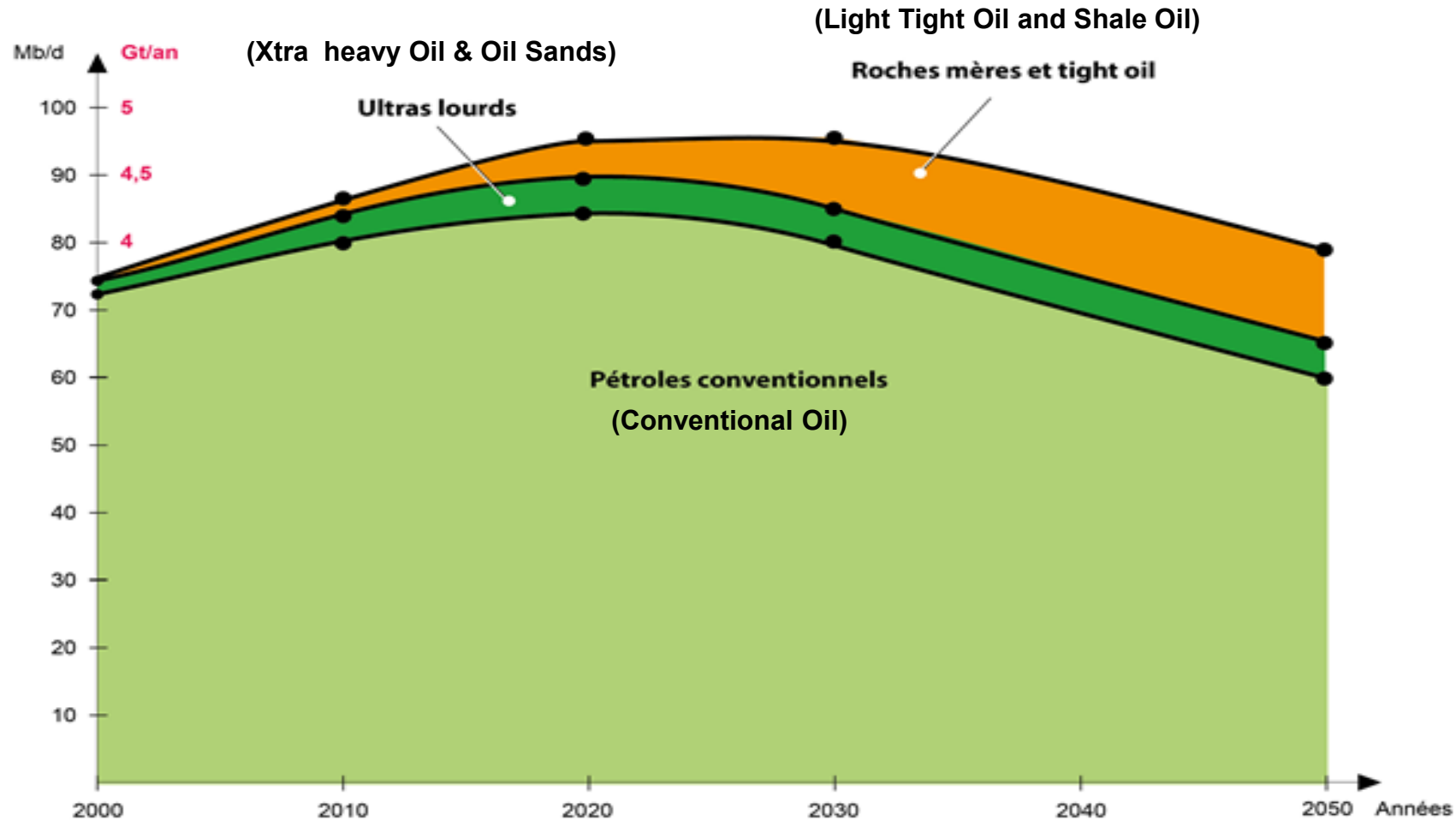


World Conventional & Unconventional Oil Production Profiles



One Oil Production Perspective 2000 – 2050

Impact of Unconventional Oil (including NGLs)

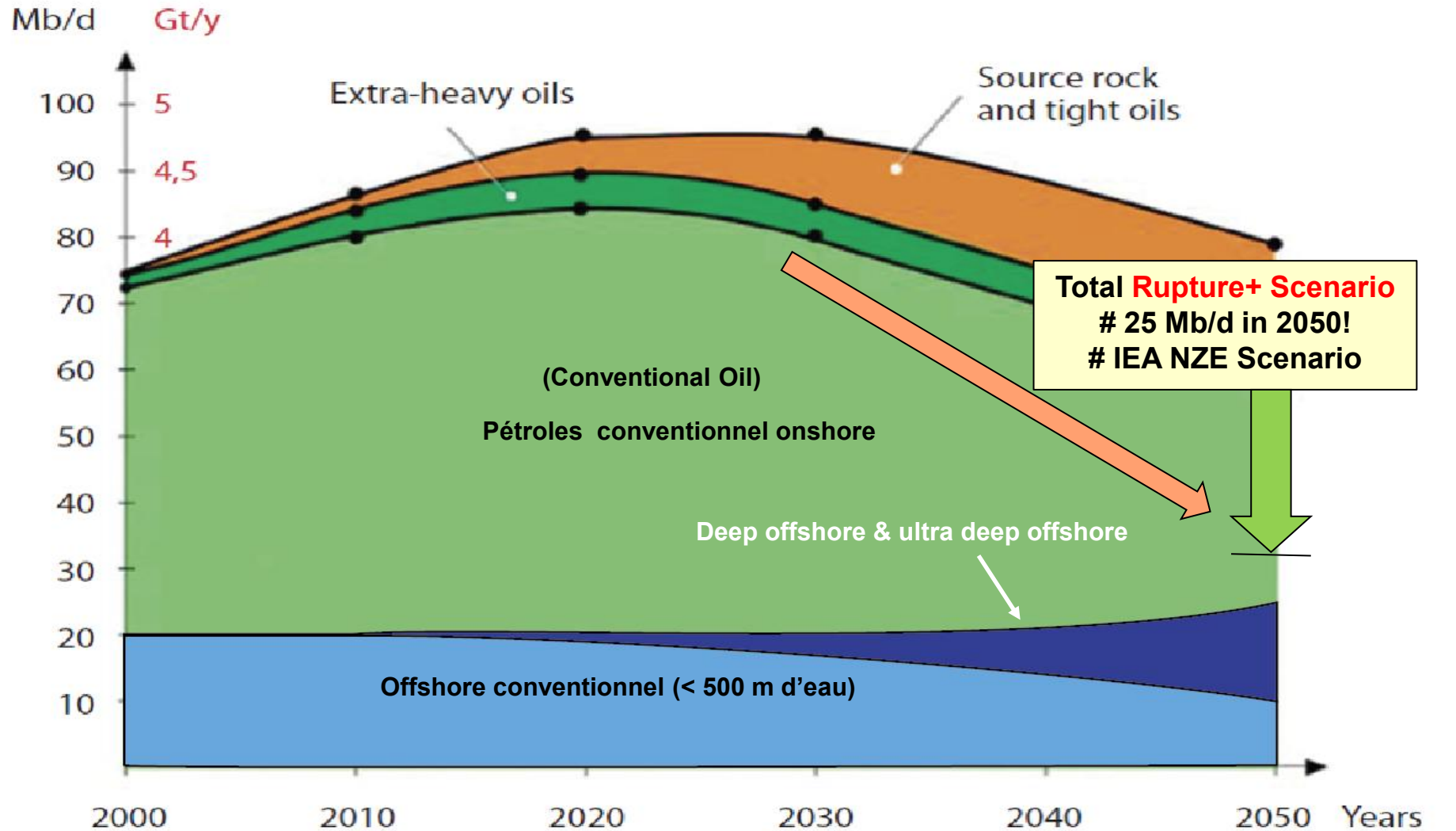


Source: Alain Perrodon et Pierre Bauquis, 20 novembre 2015

Assumptions for Crude Oil Price: 100\$/b in 2012, 70\$/b in 2020, 120\$/b in 2030, 150 \$/b in 2050 (cst 2015)



One Scenario for Oil Production Perspectives 2000 – 2050. A 2015 – 2018 Vision Impact of Unconventional Oil (including NGLs) & split onshore, conventionnal offshore, deep & ultra-deep offshore. Impact of future scenarios!



Source: P.R. Bauquis et A. Perrodon 2015/18

66



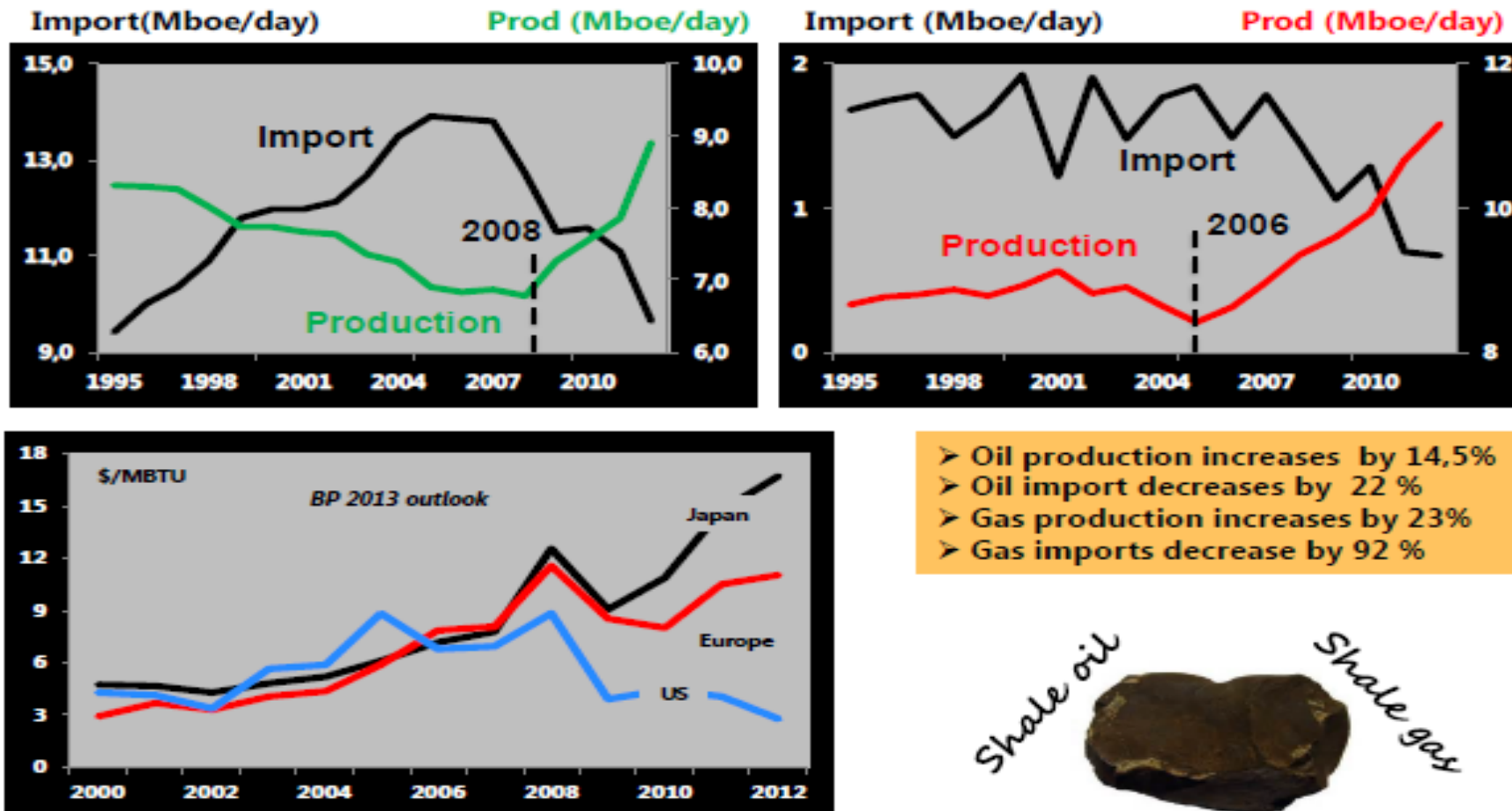
A zoom on Unconventional HC in US - The History
In the following, Global Energy & Oil & Gas business
in the US are presented including both conventional
and unconventional Hydrocarbons



Global impact of Shale Oil & Gas in the US

2006 – 2008: The Start - Period 2000 - 2013

2006 & 2008 : the start of an oil & gas revolution



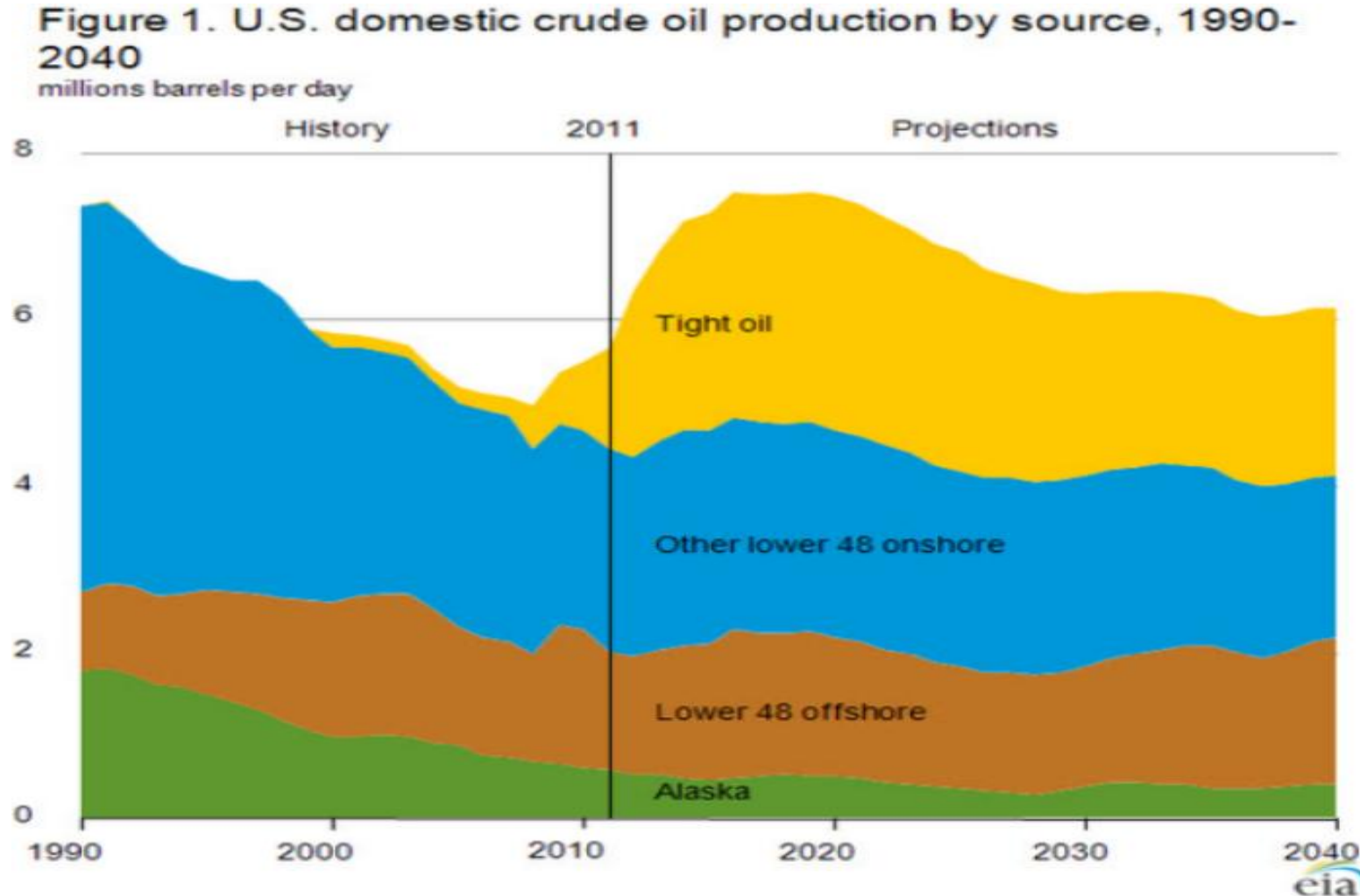
- Oil production increases by 14,5%
- Oil import decreases by 22 %
- Gas production increases by 23%
- Gas imports decrease by 92 %



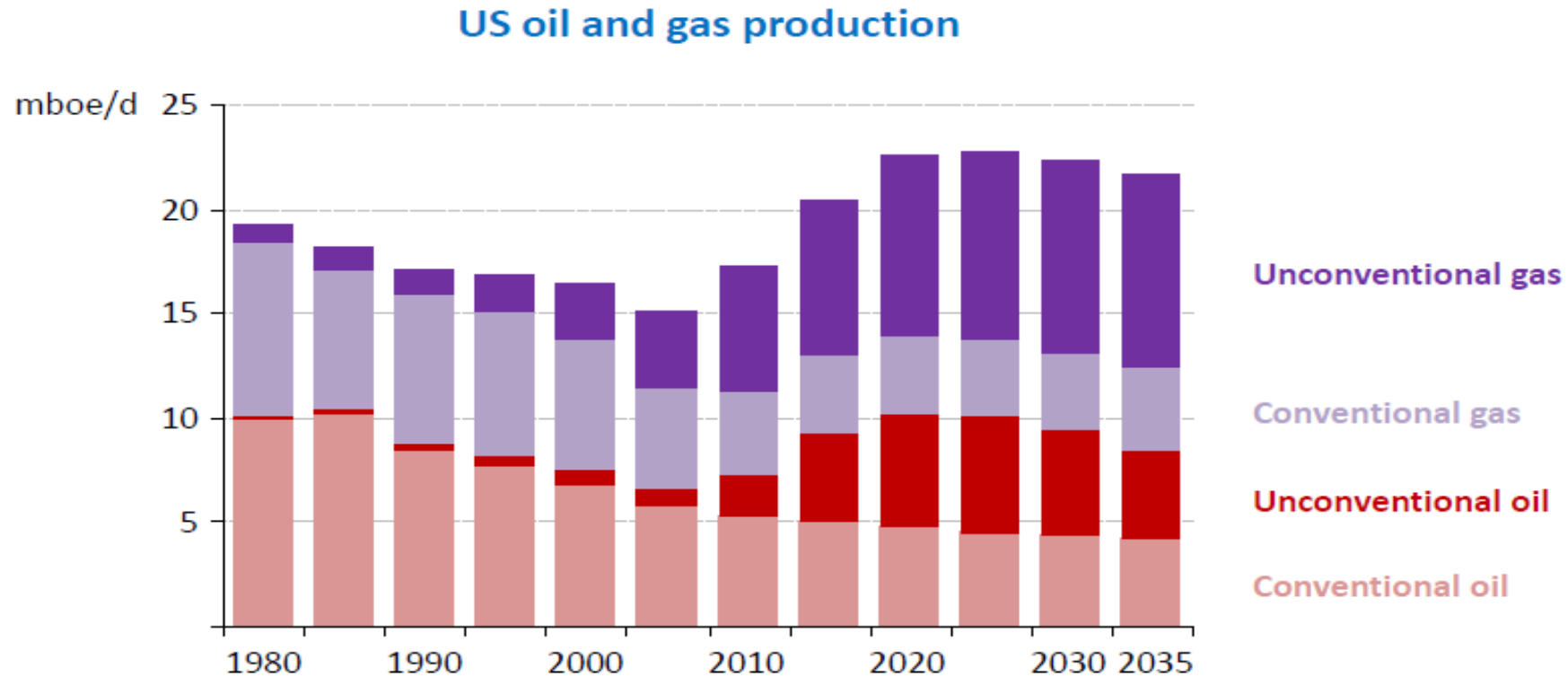
Oil, Natural Gas and NGLs Production in the US Past, present and perspectives



Reminder - The emergence of unconventional HC increases significantly US Oil & Gas Production.
A 2011 EIA view which was a bit pessimistic.....



Reminder - The emergence of unconventional HC increases significantly US Oil & Gas Production.
A 2012 IEA view which was a bit pessimistic.....

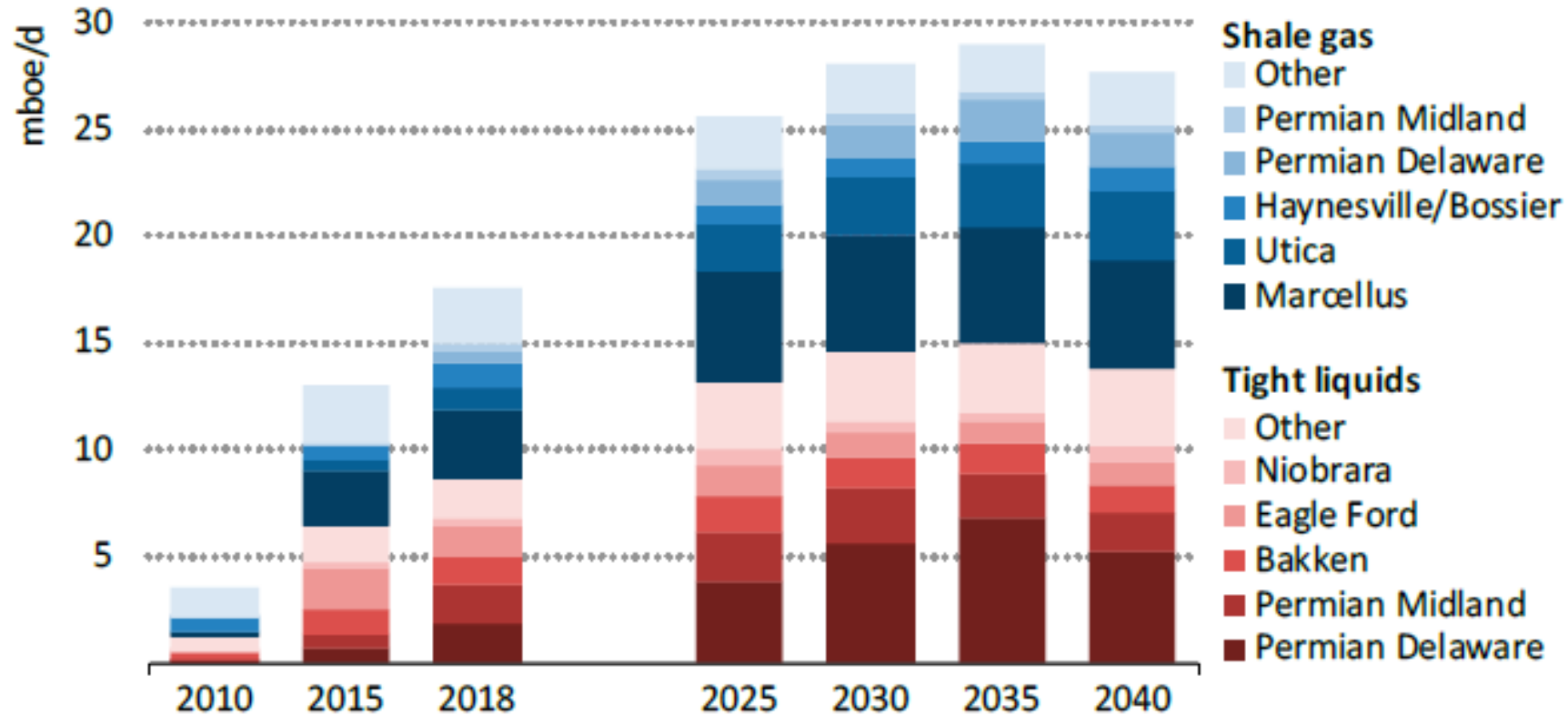


The surge in unconventional oil & gas production has implications well beyond the United States

Source: IEA WEO 2012, oil include NGLs



Reminder – The emergence of unconventional HC increases significantly US Oil & Gas Production. A IEA view 2019
The 2012 IEA view was much more pessimistic.....

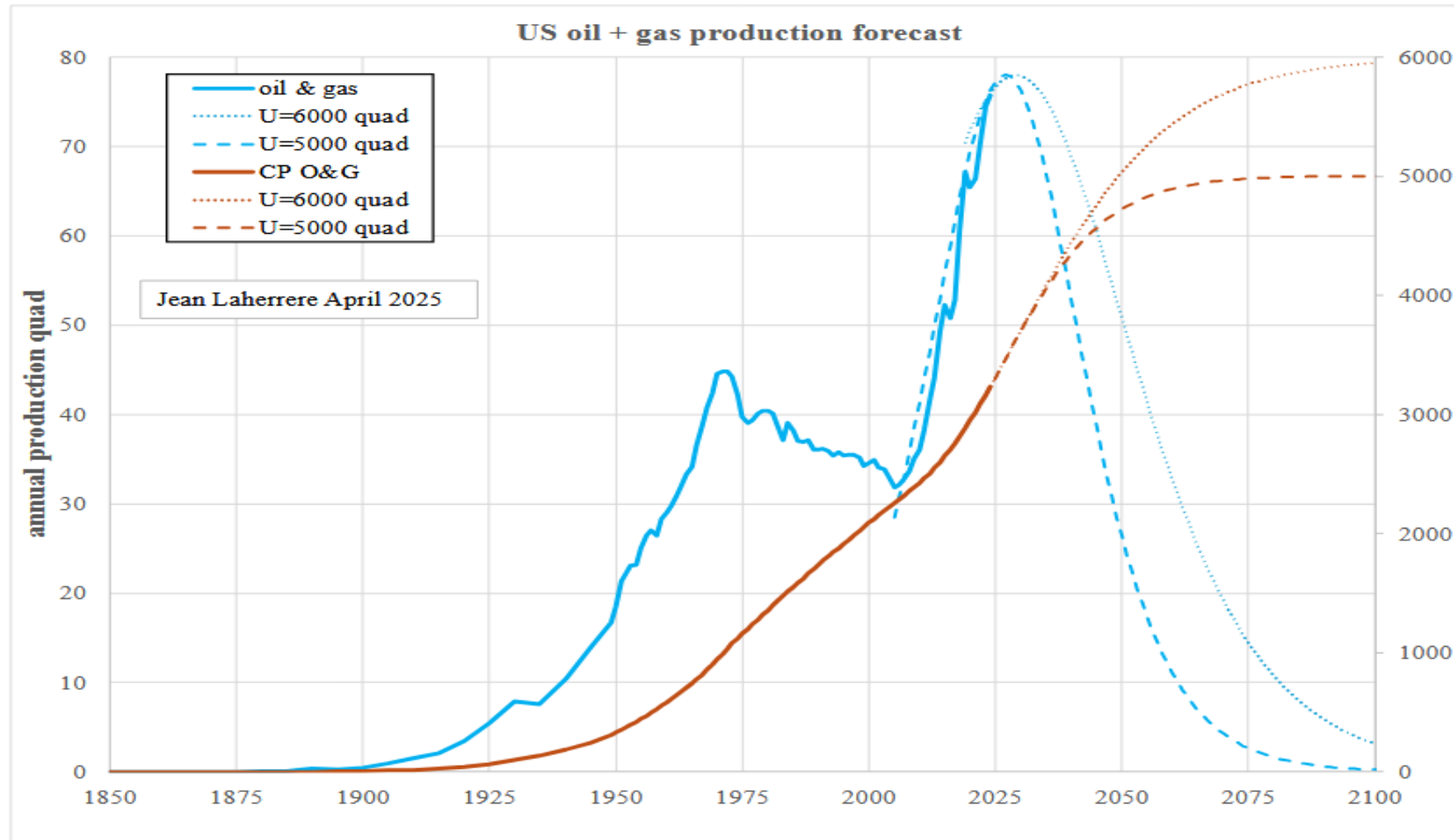


United States shale production alone (oil and gas) is projected to exceed the entire oil and gas output of Russia before 2025



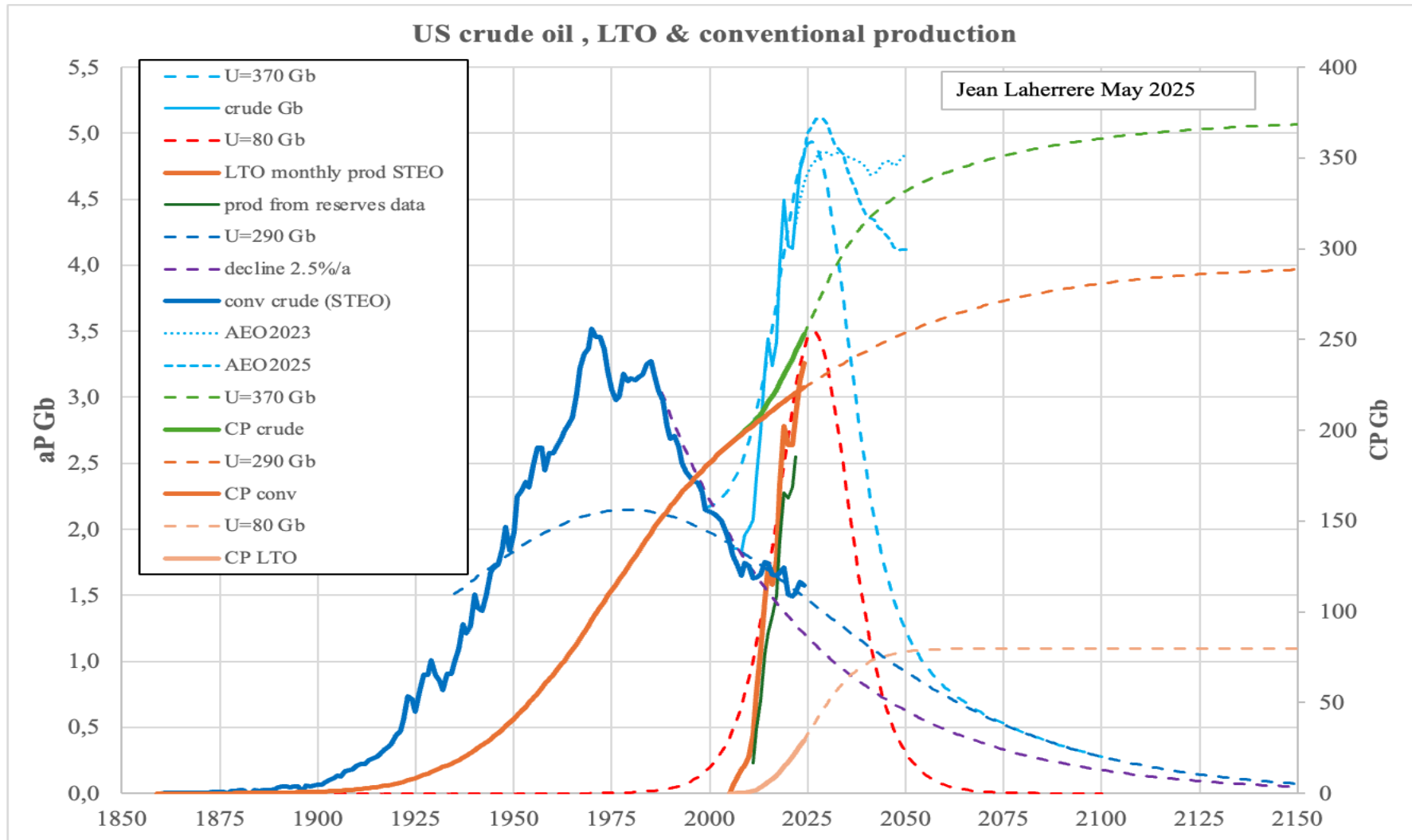
US Oil & Gas Production forecast

The impact of unconventional HC is great!



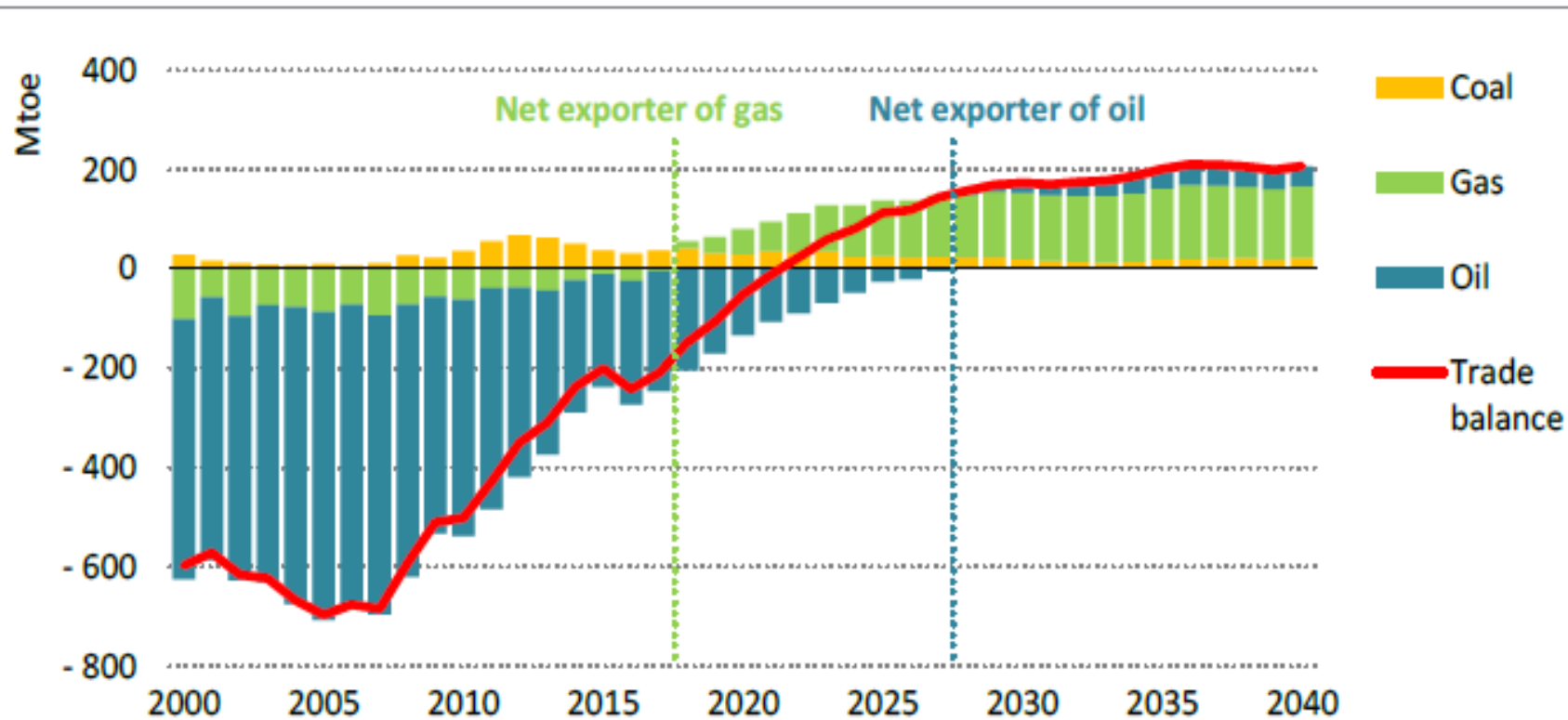
US Oil & Gas Production forecast

The impact of unconventional HC is great!



Reminder - A vision 2017

US are going to become Net Exporter of HC



The United States is switching already to become a net gas exporter, and is projected to become a net oil exporter in the late 2020s

Source: IEA WEO 2017



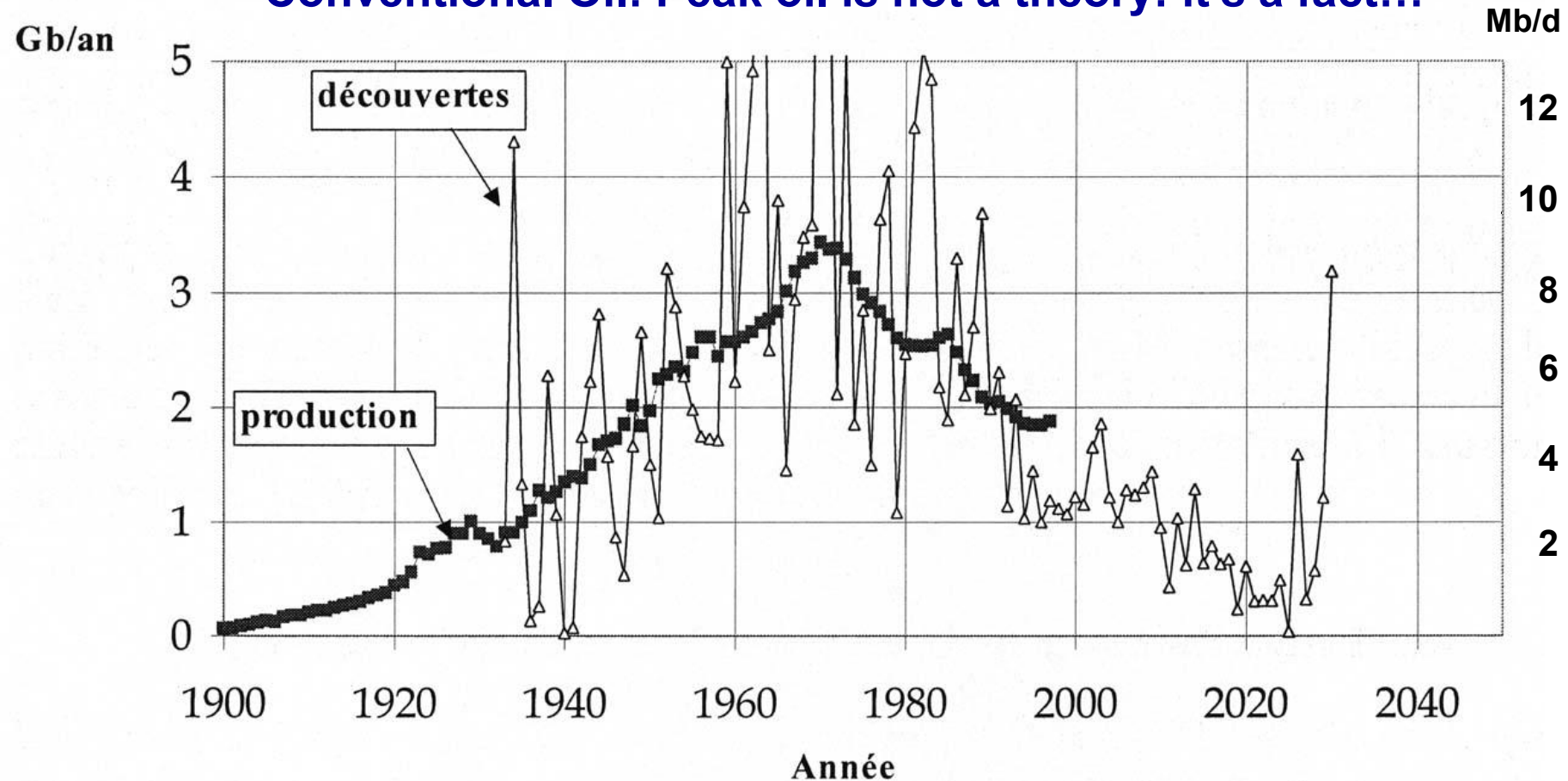
Oil Production in the US

Past, present and perspectives



The irreversible (?) decline of Crude Oil Production in the USA But as from 2006/2008, « Shale Oil » reversed the trend

Conventional Oil: Peak oil is not a theory: it's a fact...



(*) Discoveries are registered as per their initially declared sizes and their timing is « forwarded » by 33 years

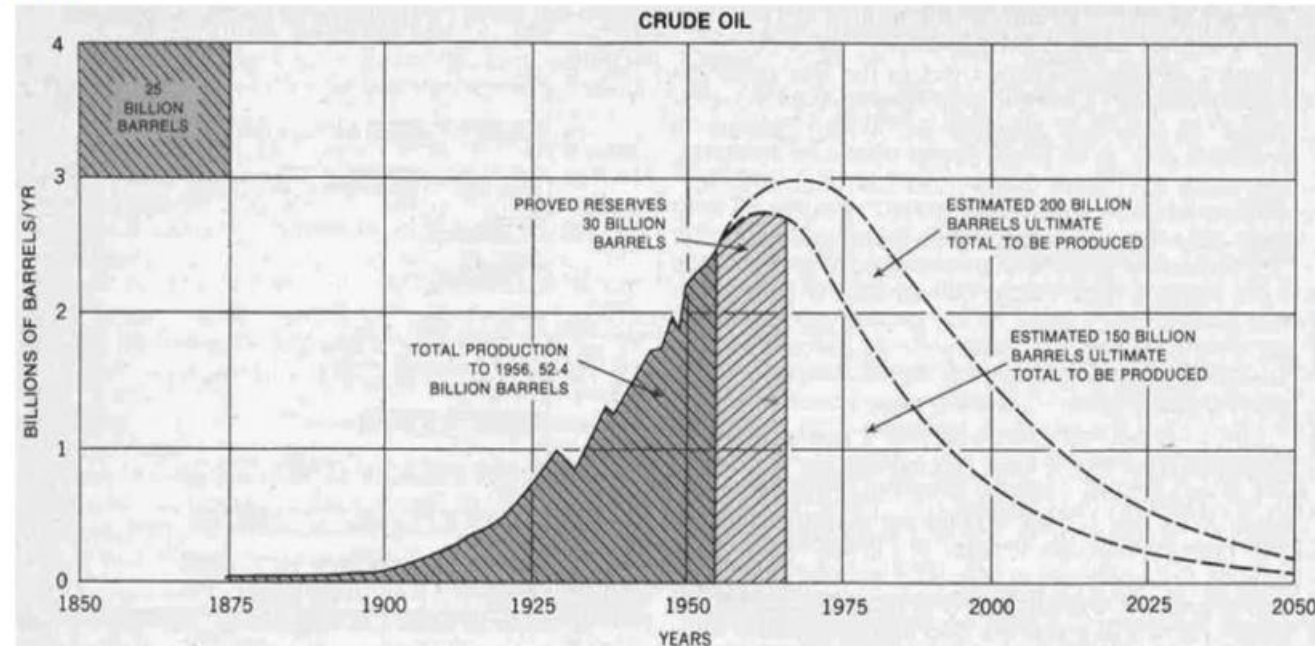
Source : King Hubbert 1956 - Updated by Jean Laherrere



The irreversible (?) decline of Crude Oil Production in the USA

Peak oil is not a theory: it's a fact...

Hubbert in his 1956 paper forecasted US crude oil production peak in 1970 using an ultimate of 200 Gb

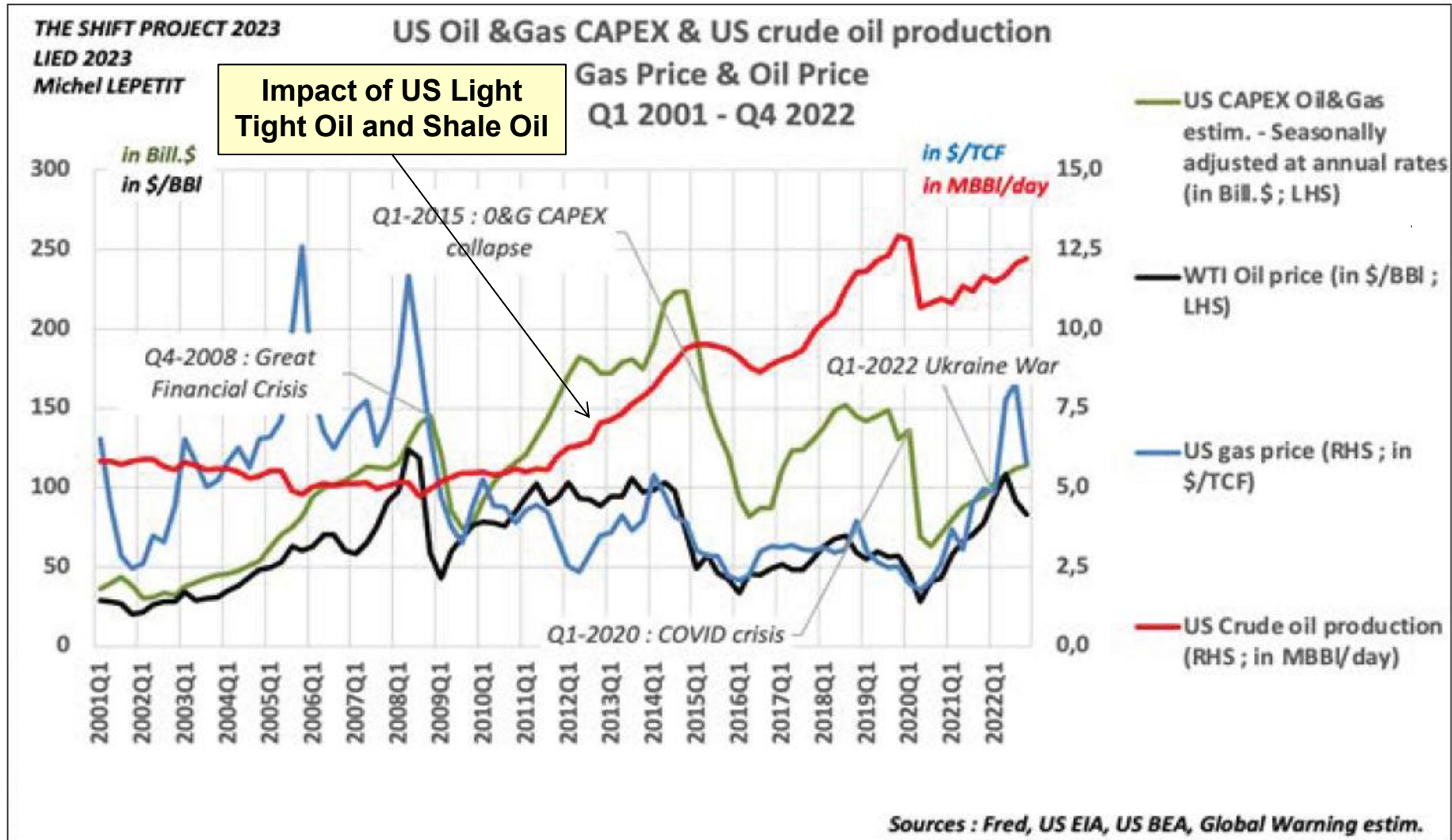


Hubbert's 1956 peak oil graph. Source: M. King Hubbert, "Nuclear Energy and Fossil Fuels," Shell Development Company, Publication No. 95, reprinted from Drilling and Production Practice (1956).

Hubbert mentions that the forecast is for oil produced with 1956 techniques, meaning that he excludes Alaska, future deepwater and LTO production!



The irreversible (?) decline of Crude Oil Production & Investments in the US - Period 2001 - 2022



Source: Michel Lepetit (ASPO) 2023

79

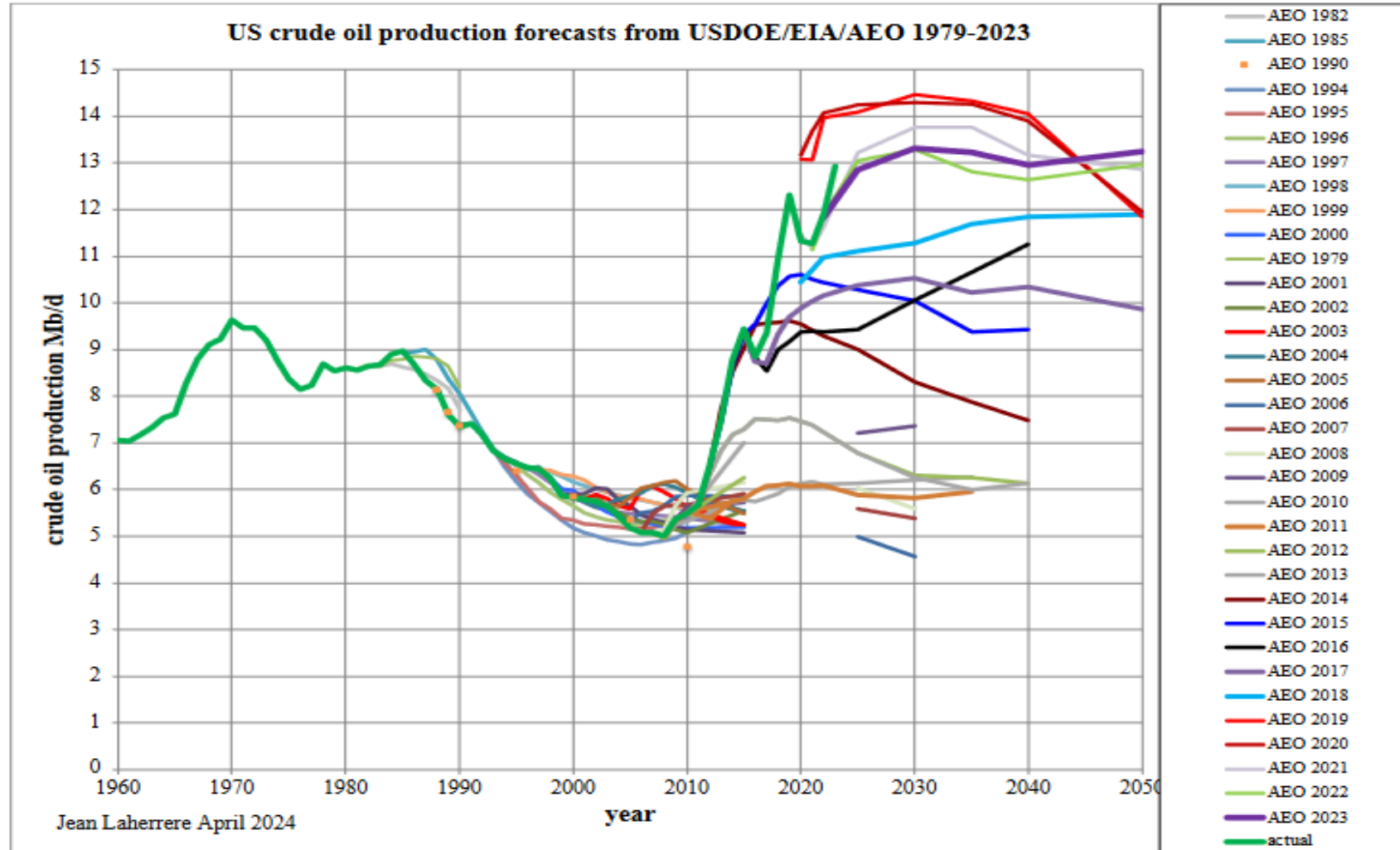
Energy Book 6
Unconventional Hydrocarbons



US Oil Production Evolution and Forecasts

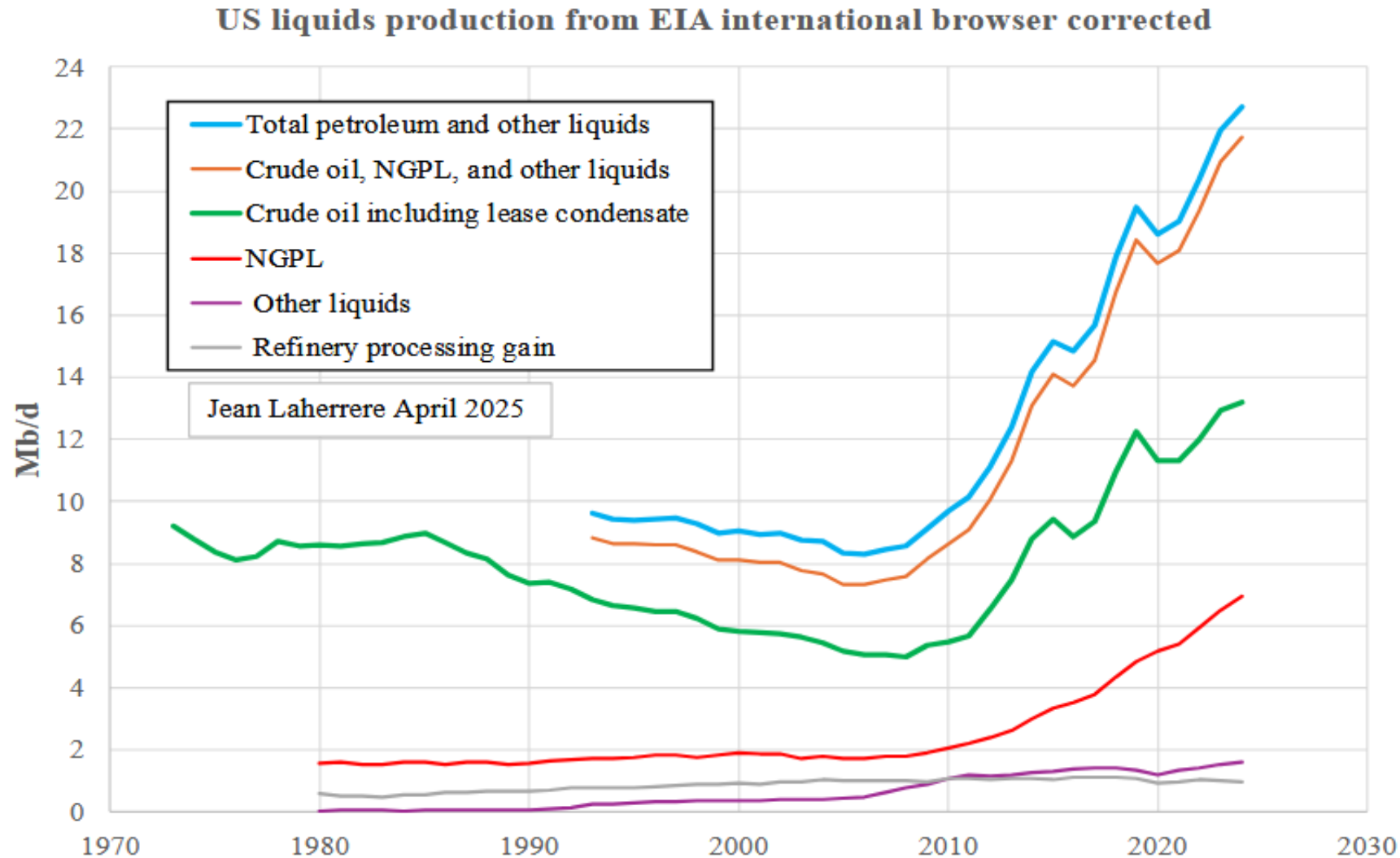
Sharp impact of Light Tight Oil Production

Making forecasts is a difficult exercise!



US Liquids Production

Sharp impact of Light Tight Oil Production

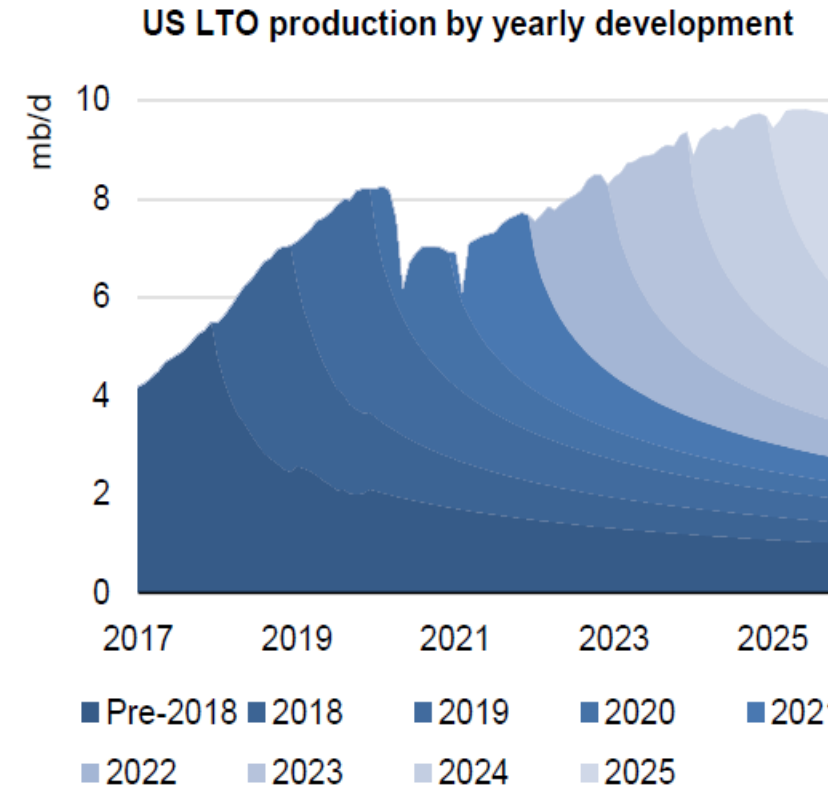
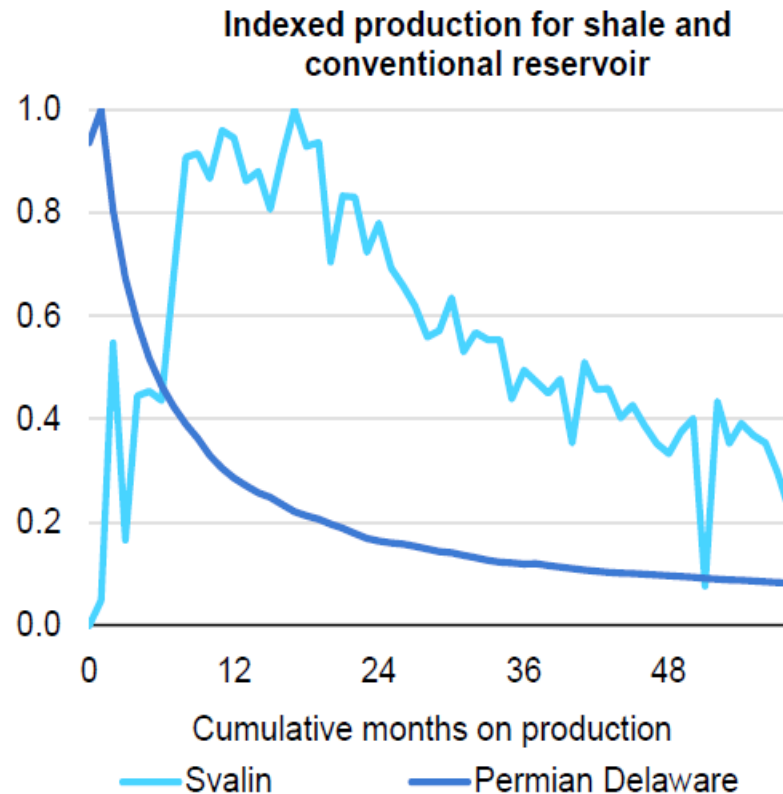


Source: Jean Laherrère ASPO - April 2025



For US LTO fields, Production is declining rapidly

Indicative field declines and US LTO by development year



IEA. CC BY 4.0.

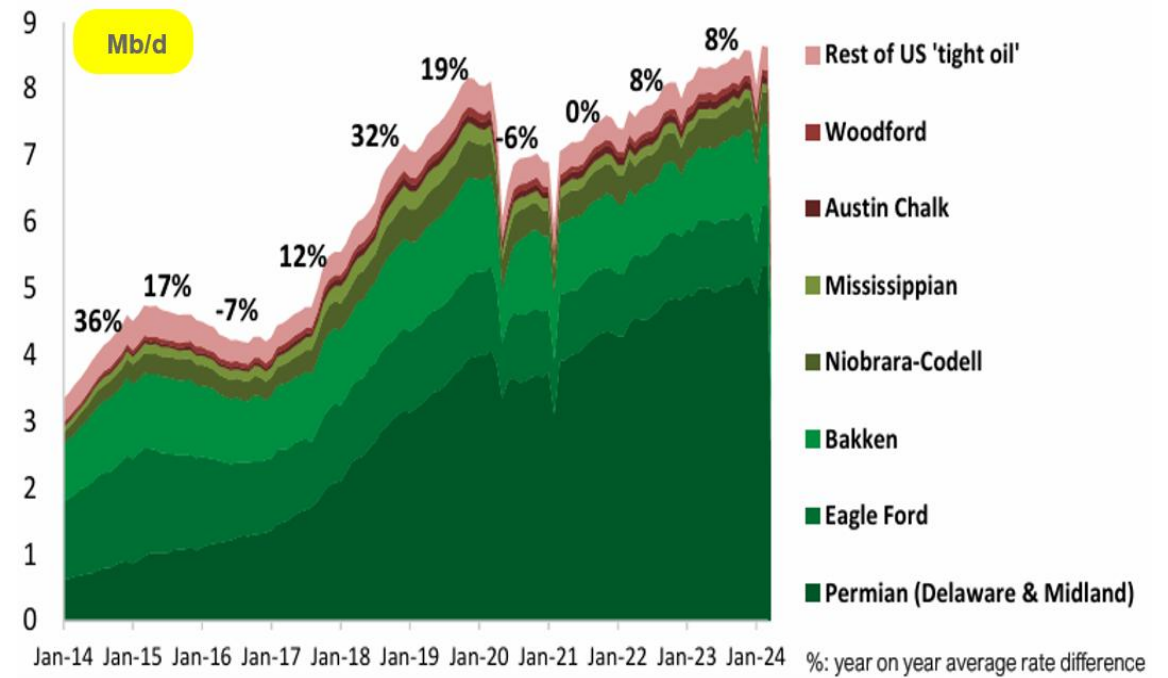
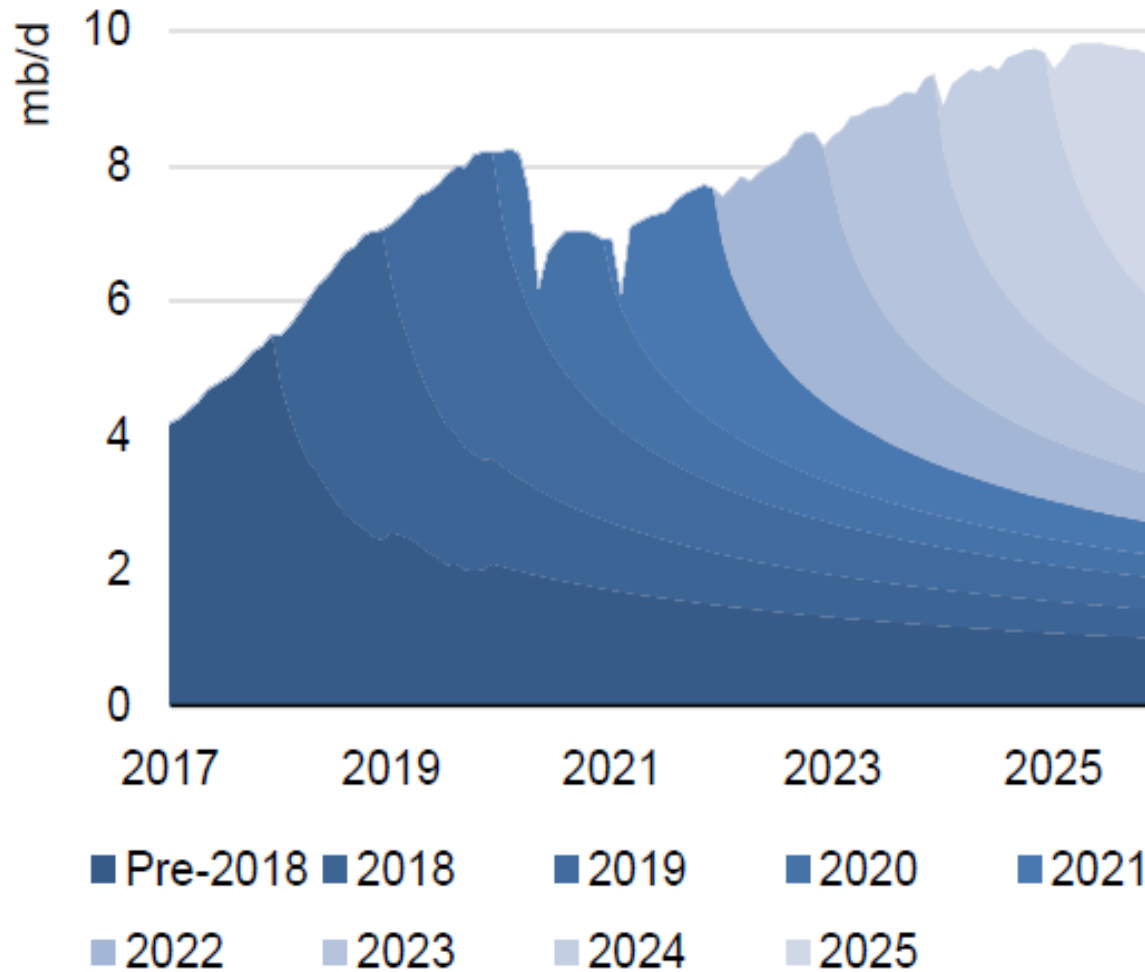
Notes: Permian Delaware median well type-curve. Svalin is a Norwegian Paleocene sandstone reservoir developed in a single stage with no additional development during the period shown. Production is indexed with peak output equal to 1.

Source: IEA analysis based on historical data from Rystad Energy ShaleWellCube and [Norskpetroleum](#).



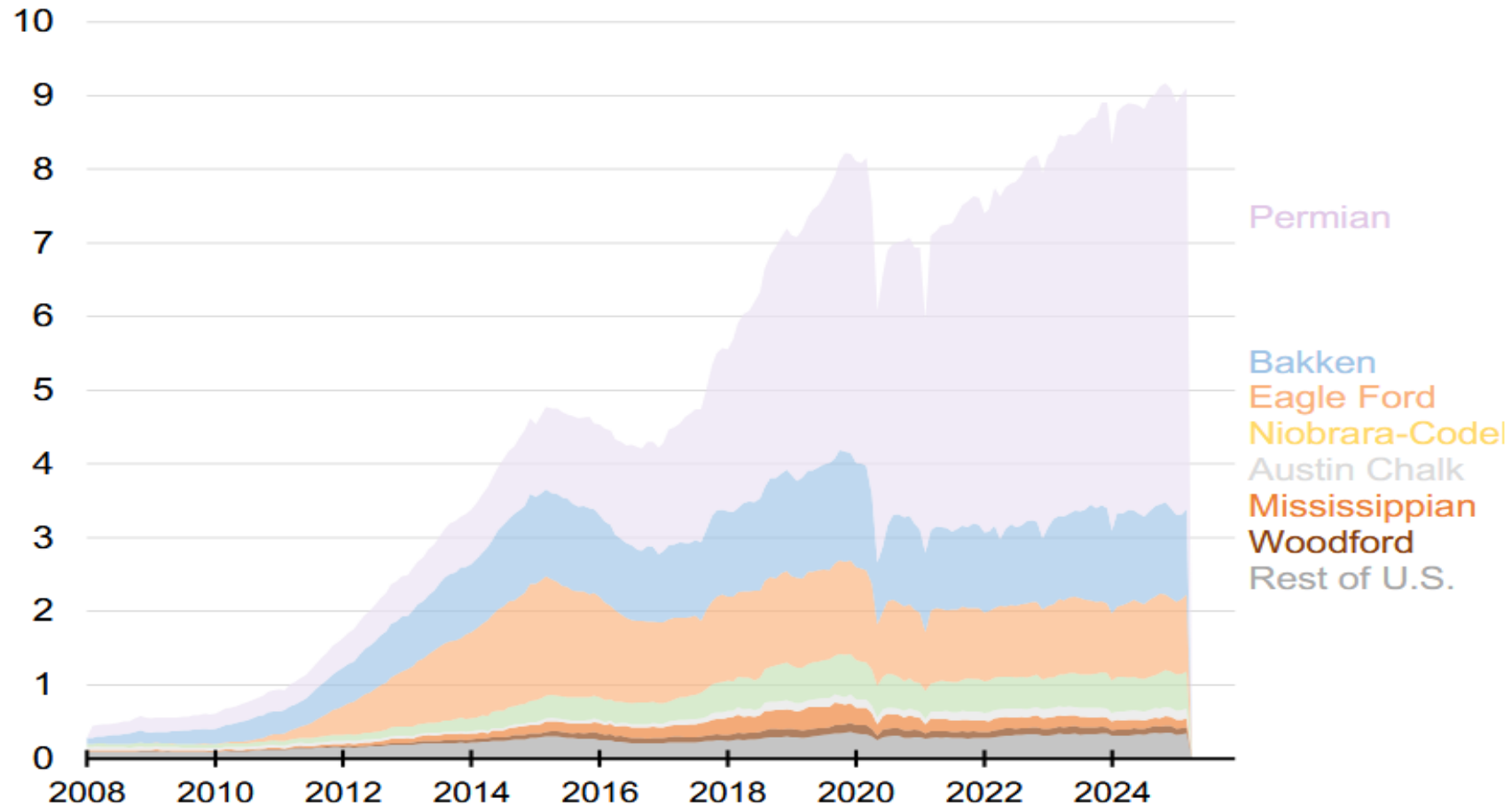
US Shale/Tight Oil Production per Plays/Basins 2014 – 2025

US LTO production by yearly development



Tight Oil Production by formation

Monthly U.S. tight oil production by formation

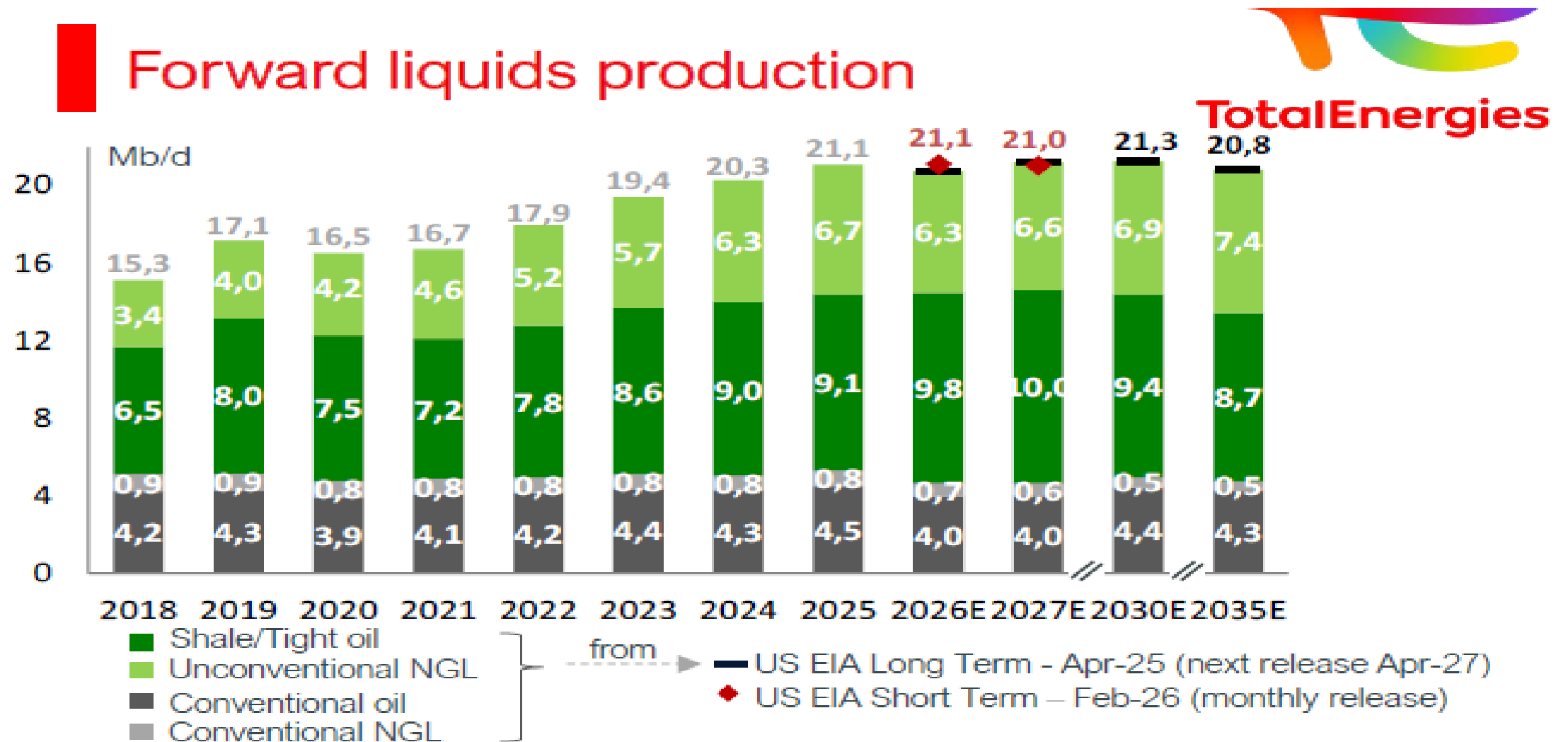


Data source: U.S. Energy Information Administration, Short-Term Energy Outlook, April 2025



Evolution of US Liquids Production (in Mb/d)

Stagnation of Conventional Oil & NGL, boost of Unconventional



Natural Gas Production in the US Past, present and perspectives

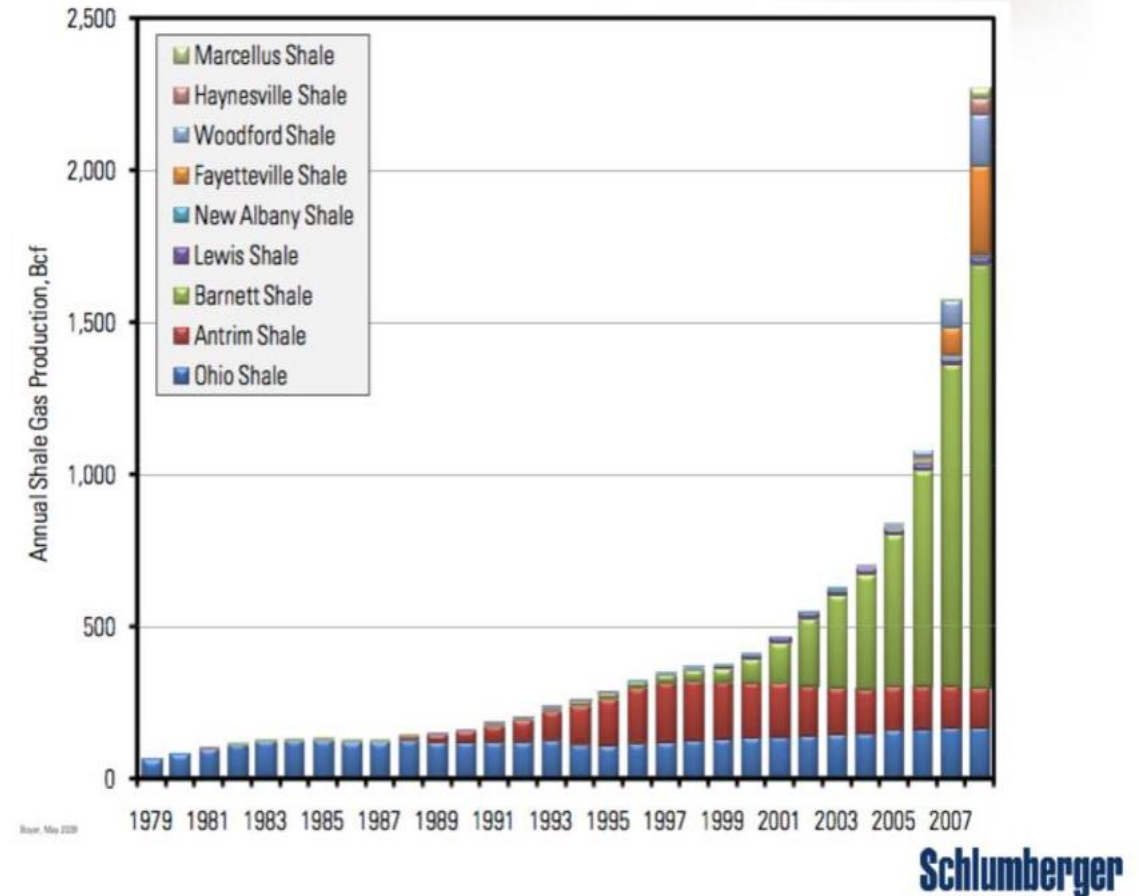


US Shale Gas – The History

Shale Gas History

- First Commercial Gas well – Fredonia, NY (1821)
 - New York's "Dunkirk Shale" at a depth of less than 30 feet
- Ohio Shale – Big Sandy Field (1880)
- Hydraulic Fracturing used in the Oil & Gas Industry (1950-60s)
- Barnett Shale – Ft. Worth Basin Development (1982)
- Horizontal wells in Ohio Shales (1980s)
- Successful Horizontal Drilling in Barnett Shale (2003)
- Horizontal Drilling Technology Applied in Appalachian Basin, Ohio and Marcellus Shales (2006)
- Horizontal Drilling and Hydraulic Fracturing are key technologies in the economic success of modern Shale Gas Development

Shale gas production in the US

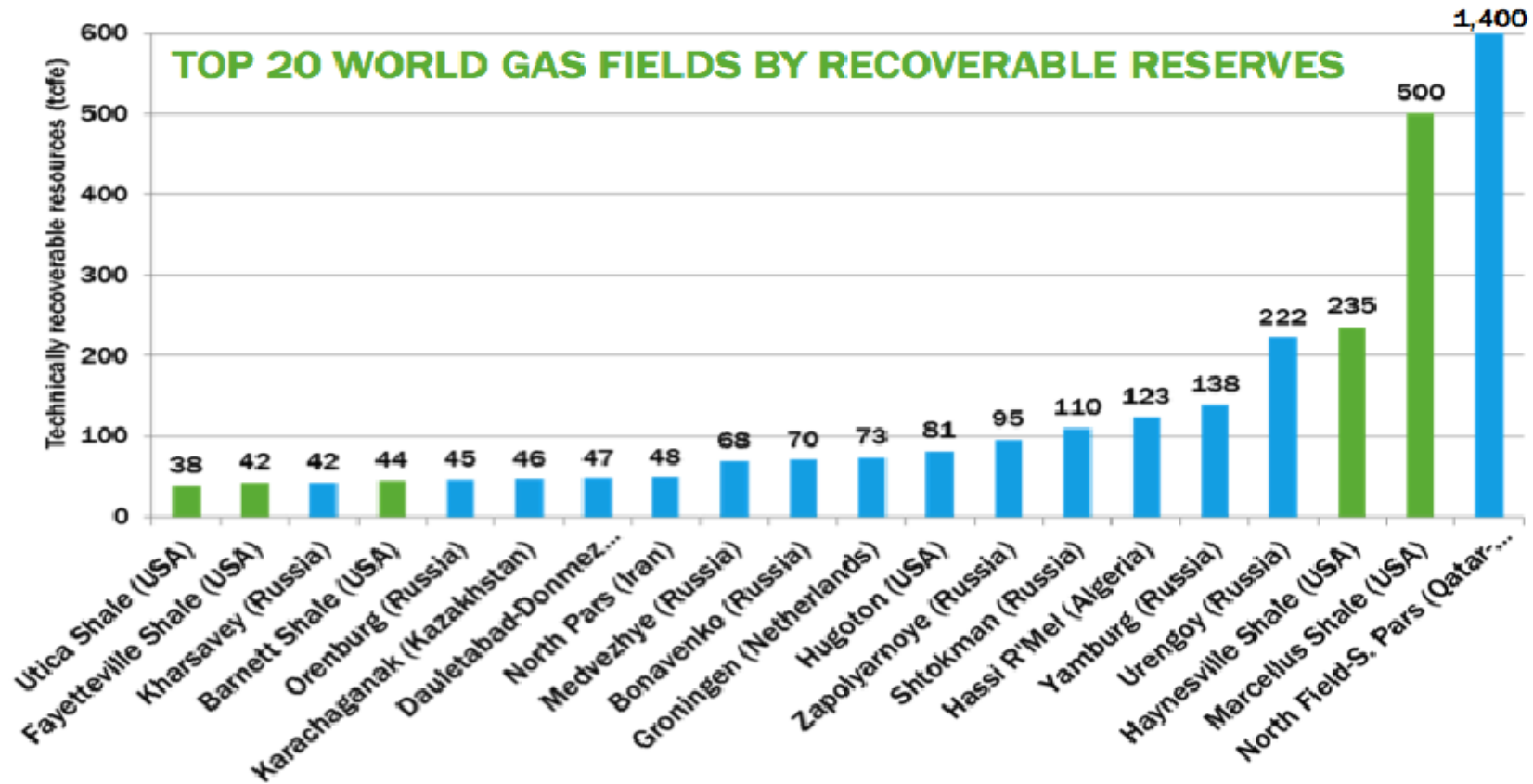


Source: Jean Laherrère – December 2022



US Shale Gas – The History

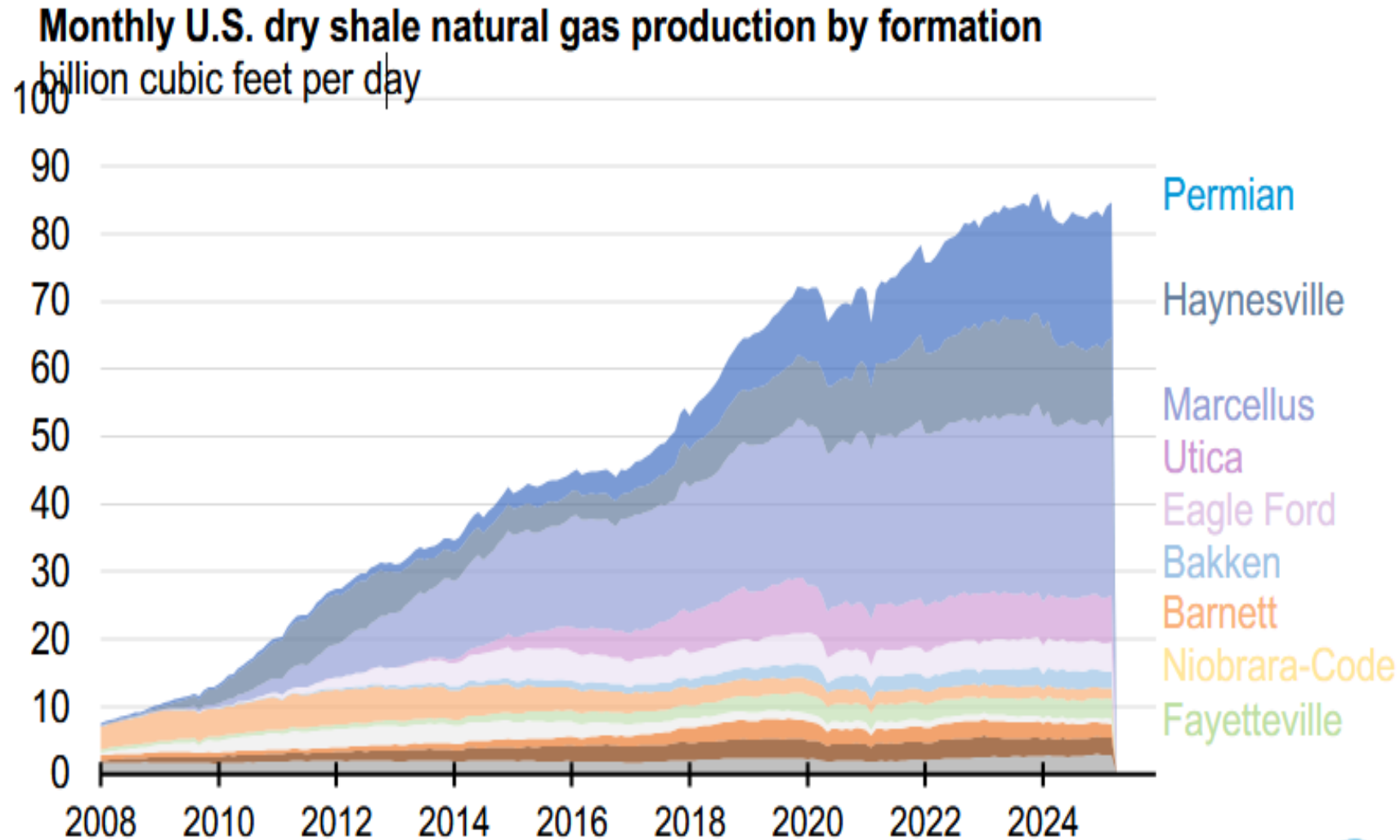
BIG 5 NEW U.S. NATURAL GAS SHALE PLAYS ARE WORLD-CLASS DISCOVERIES



Source: Jean Laherrère – December 2022



US Shale Gas Production by formation

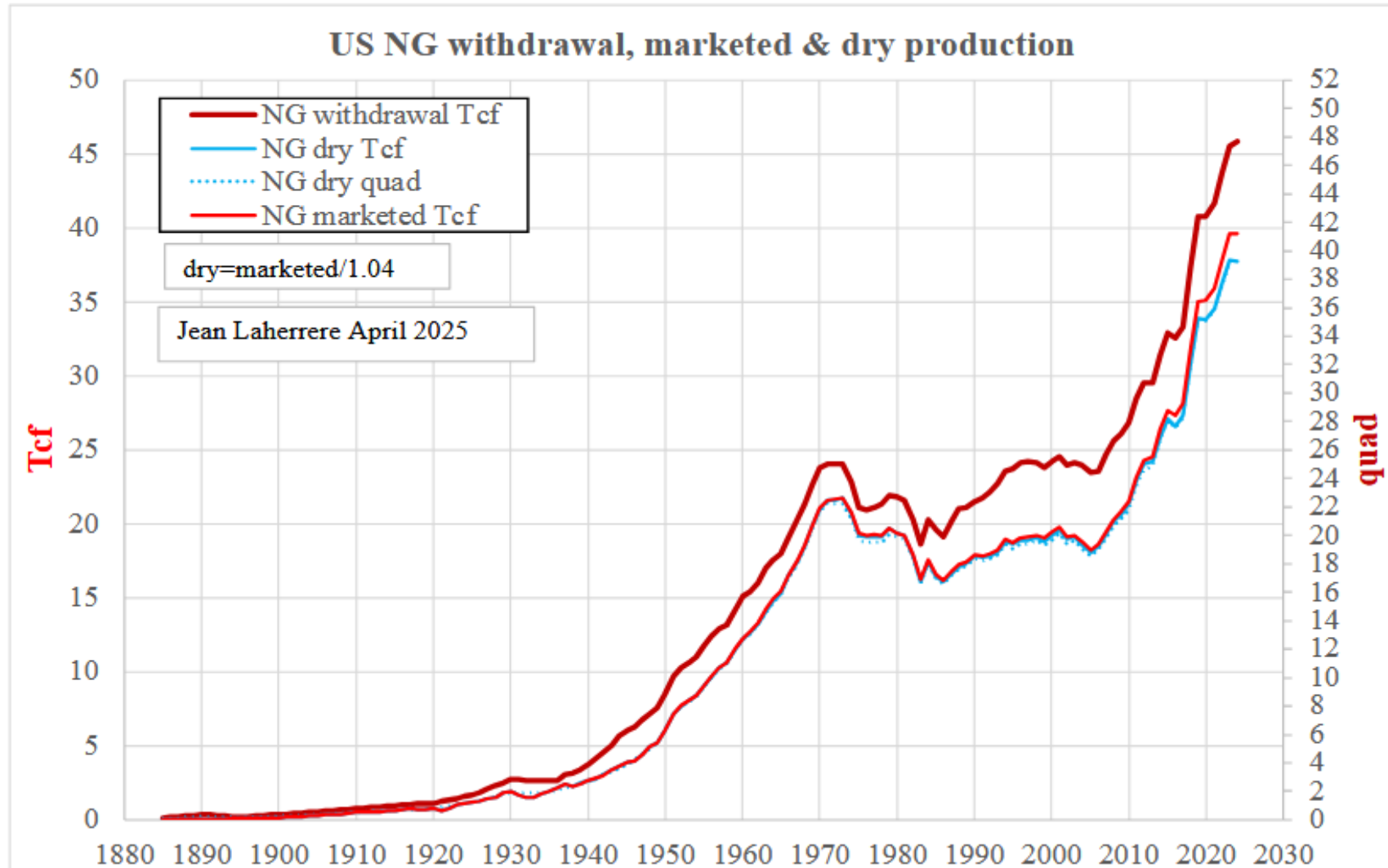


Data source: U.S. Energy Information Administration, Short-Term Energy Outlook, April 2025



US Natural Gas Production Evolution and Forecasts

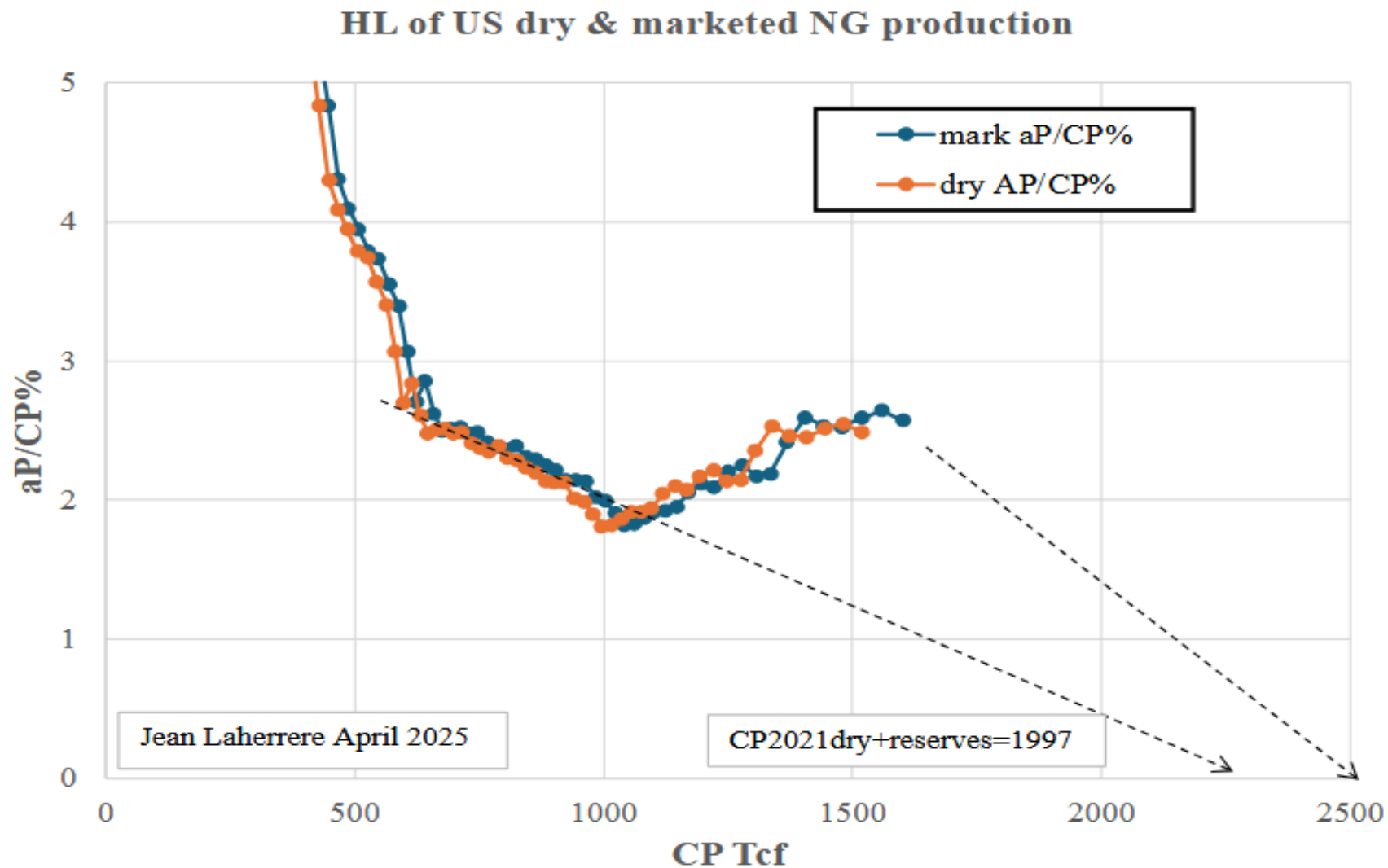
Sharp impact of Shale Gas Production



Source: Jean Laherrère ASPO April 2025

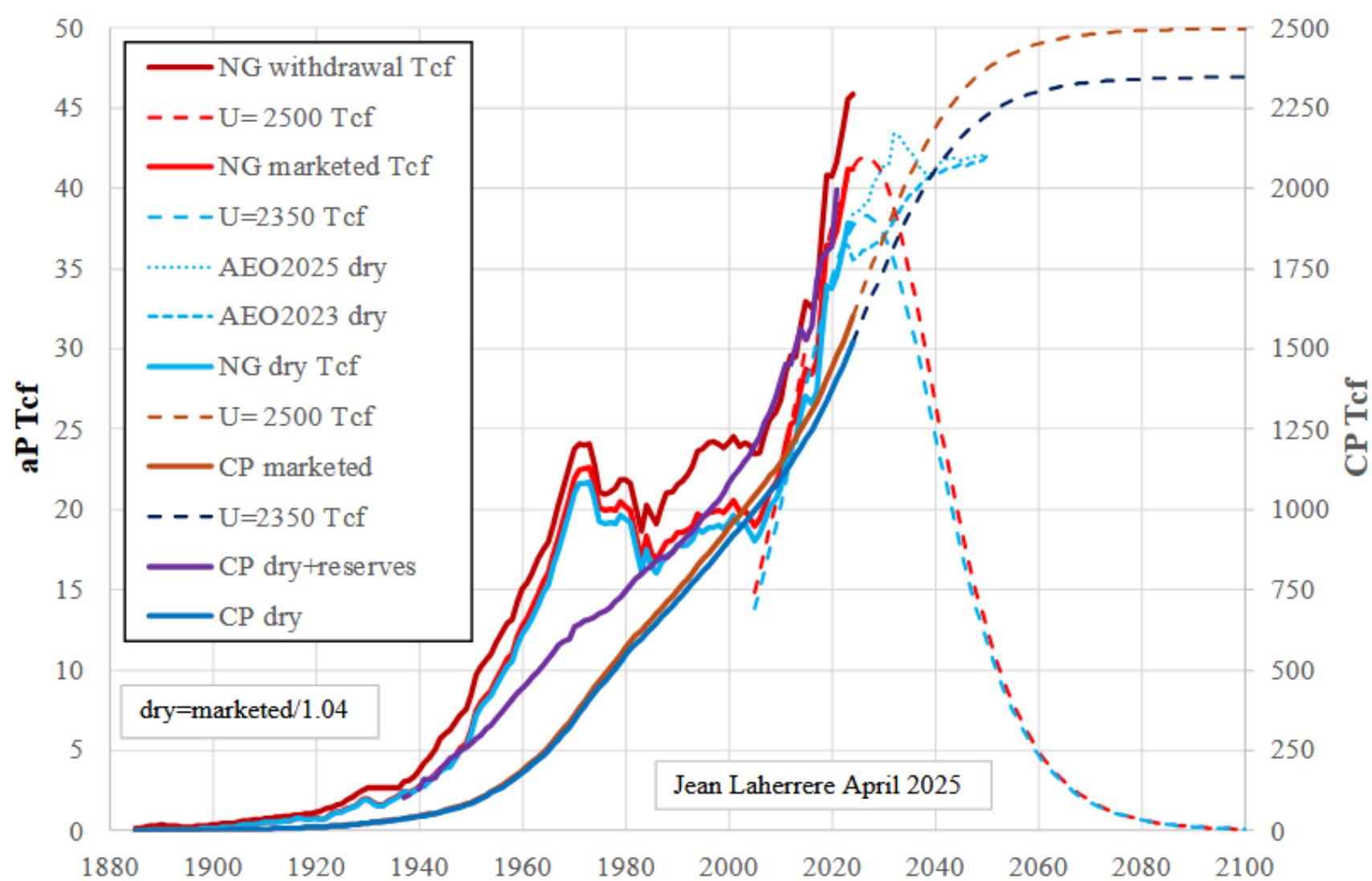


HL of US Natural Gas Marketed Production Sharp impact of Shale Gas Production



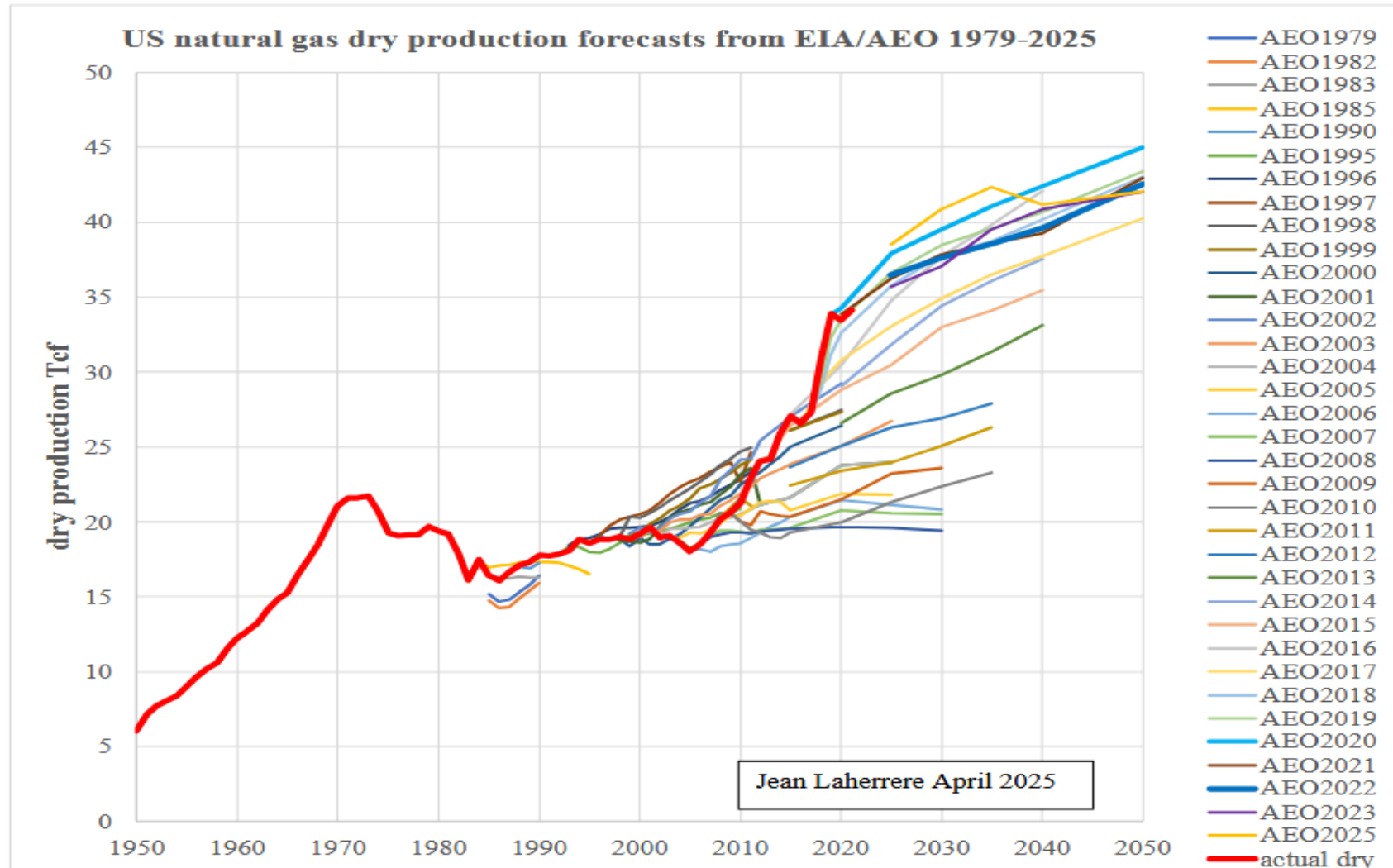
US Natural Gas Production Evolution and Forecasts

Sharp impact of Shale Gas Production



US Natural Gas Production Forecasts

Making forecasts is a difficult exercise!

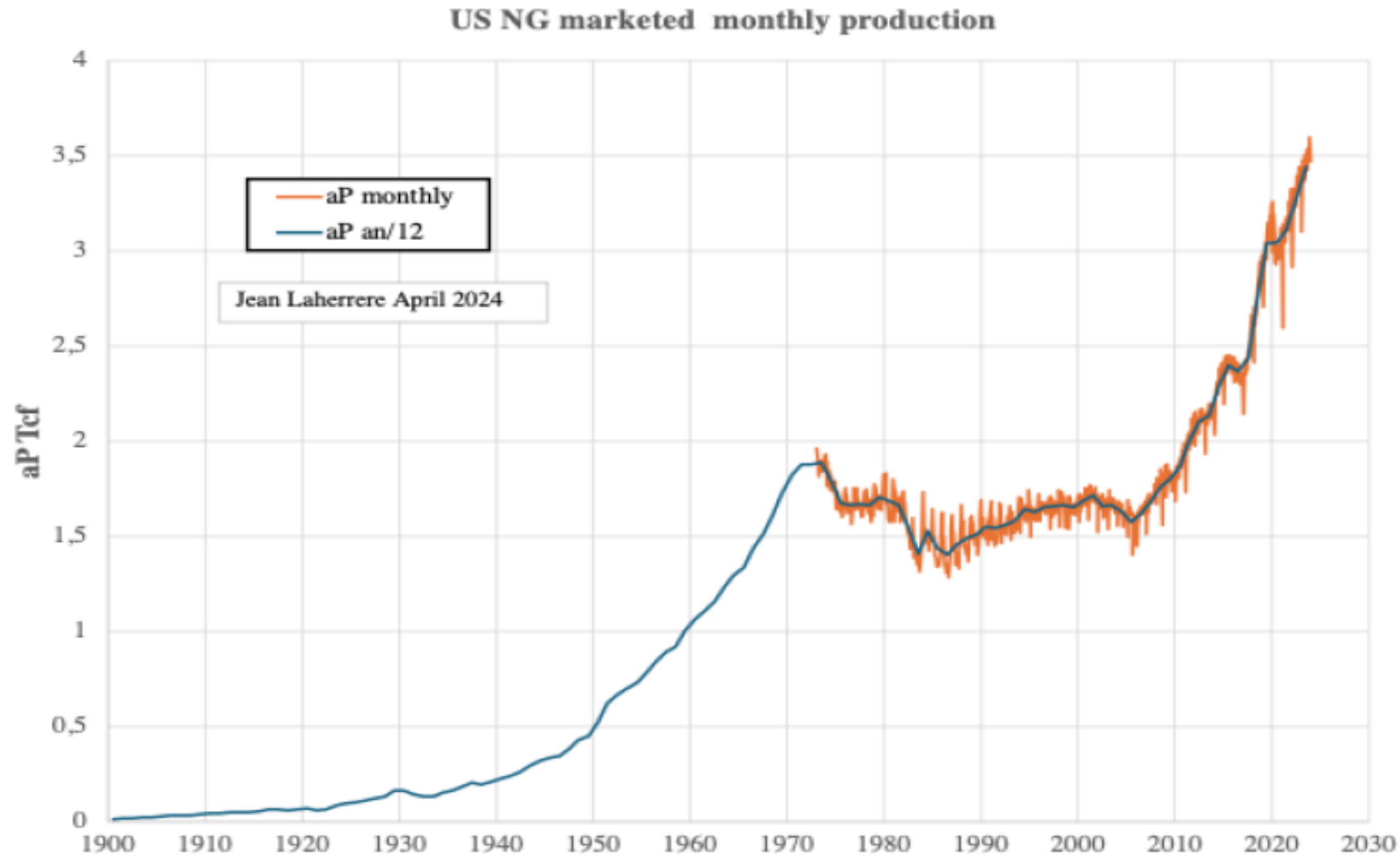


Source: Jean Laherrère ASPO April 2025



US Natural Gas monthly Production Evolution and Forecasts

Sharp impact of Shale Gas Production



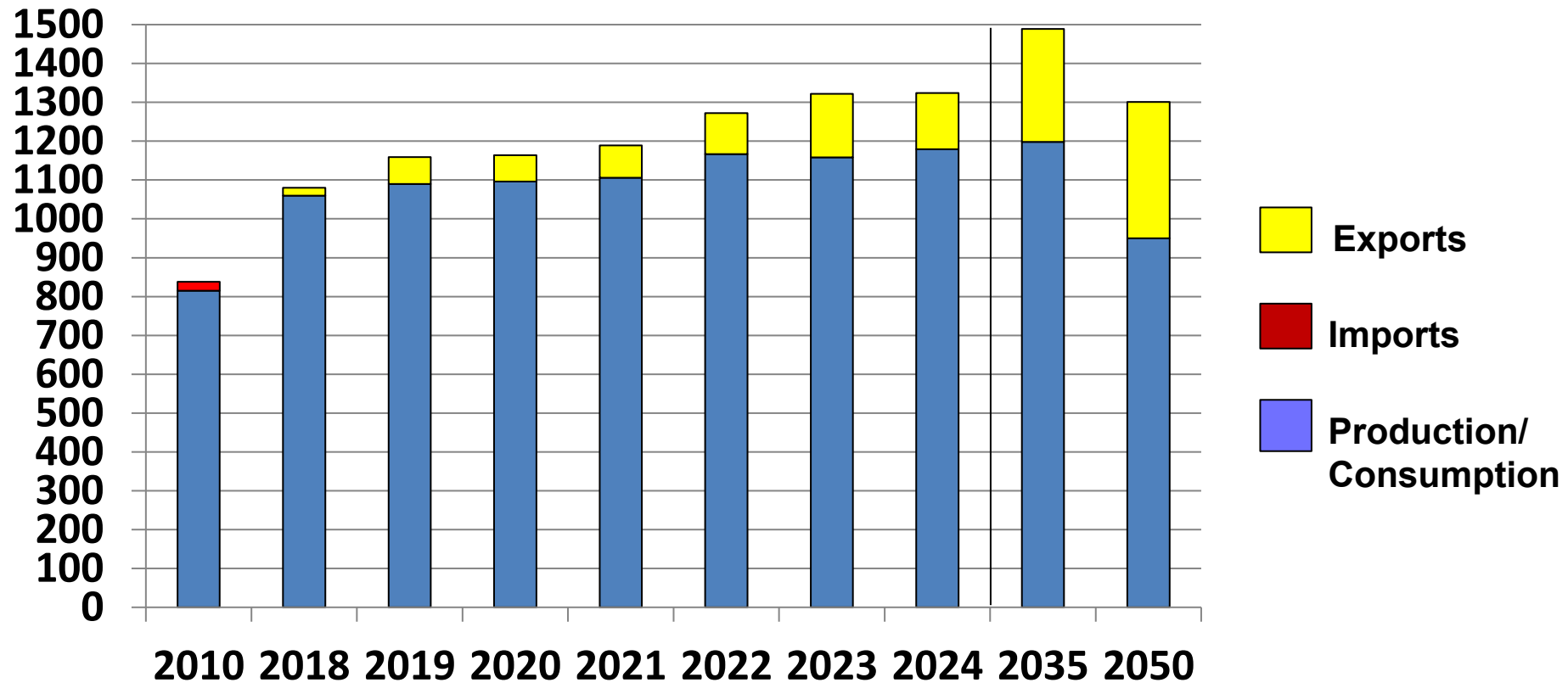
Source: Jean Laherrère ASPO April 2024



Gas Supply and Demand North Americas*

IEA 2025 STEPS Scenario

(G.m³)



Shale Gas production changes the picture: US has become a gas exporter

* US, Canada, Mexico

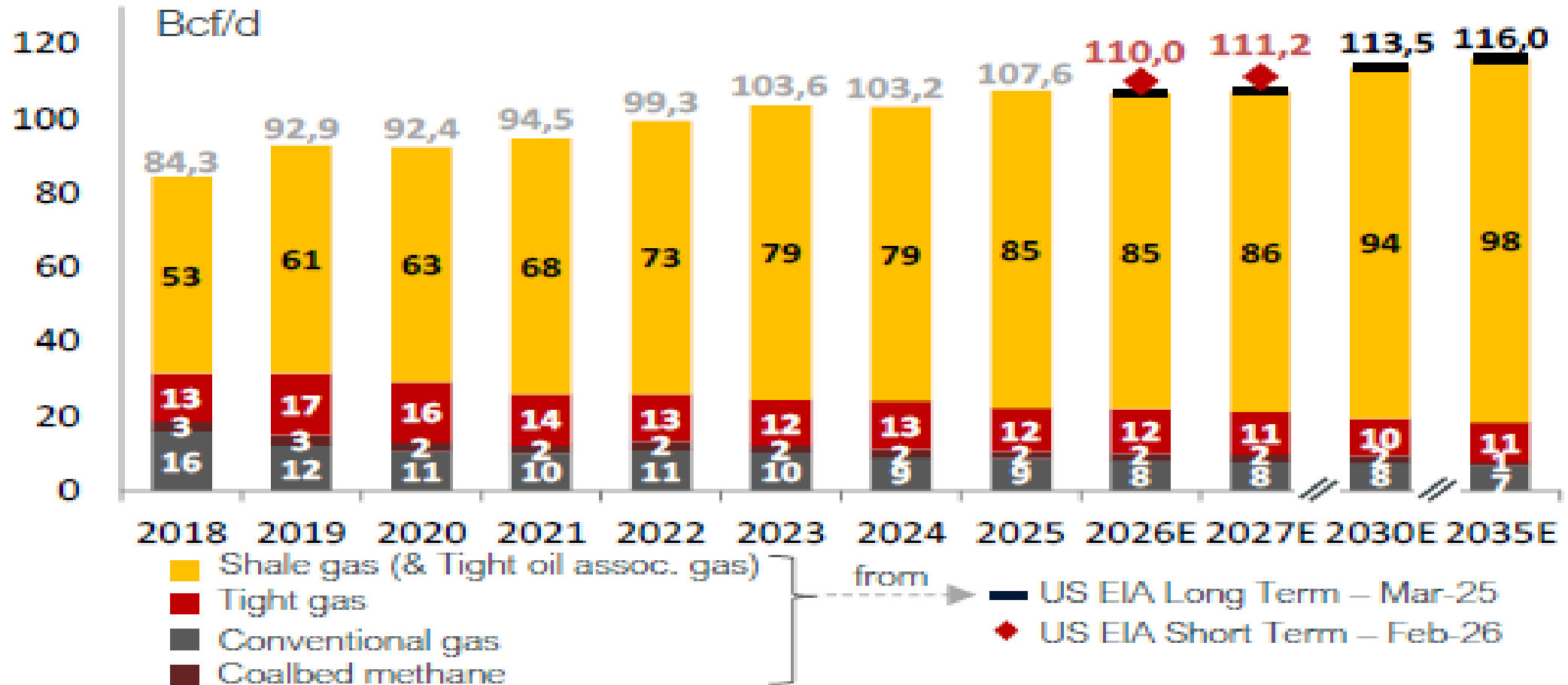
Data from IEA WEO 2025



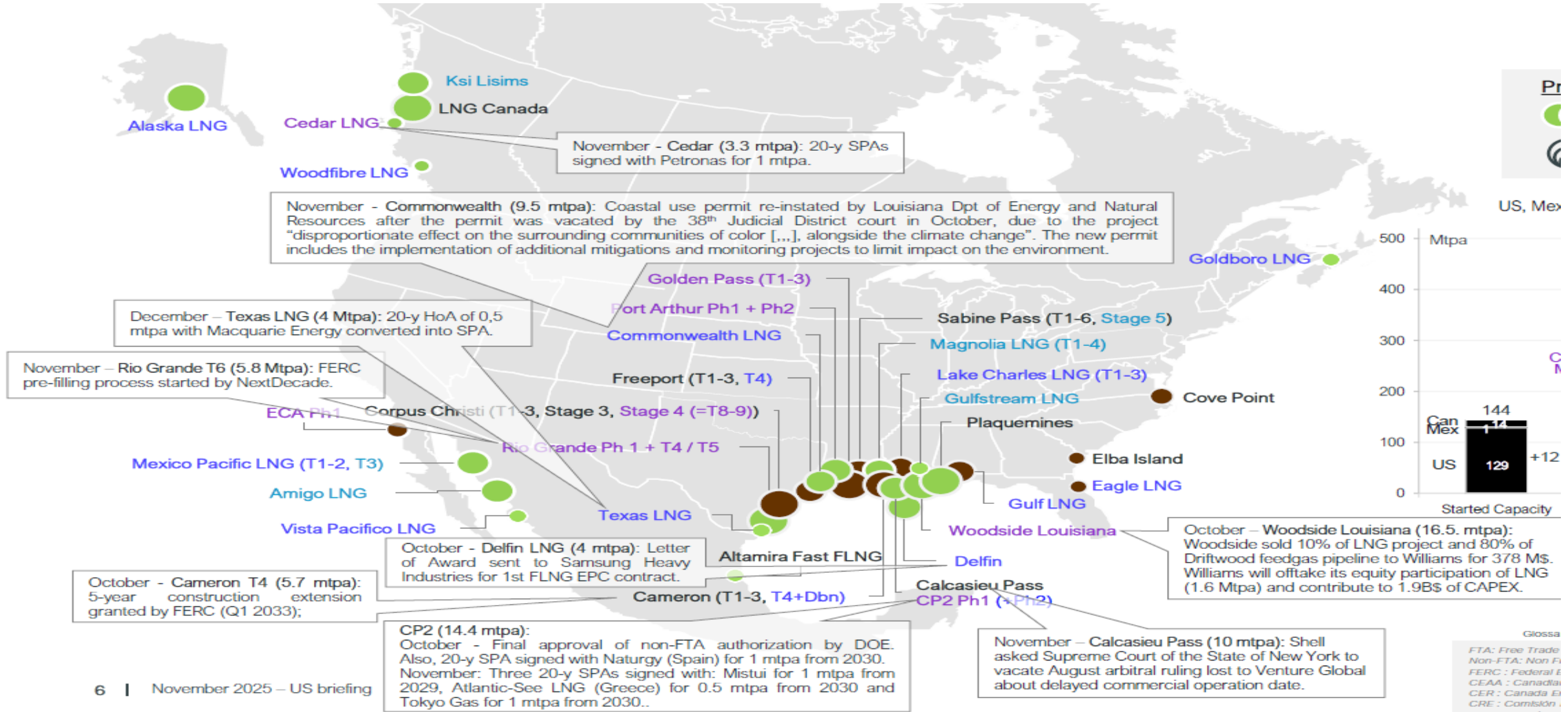
Evolution of Gas Production (in Bcf/d)

Stagnation of Conventional Gas, boost of Unconventional

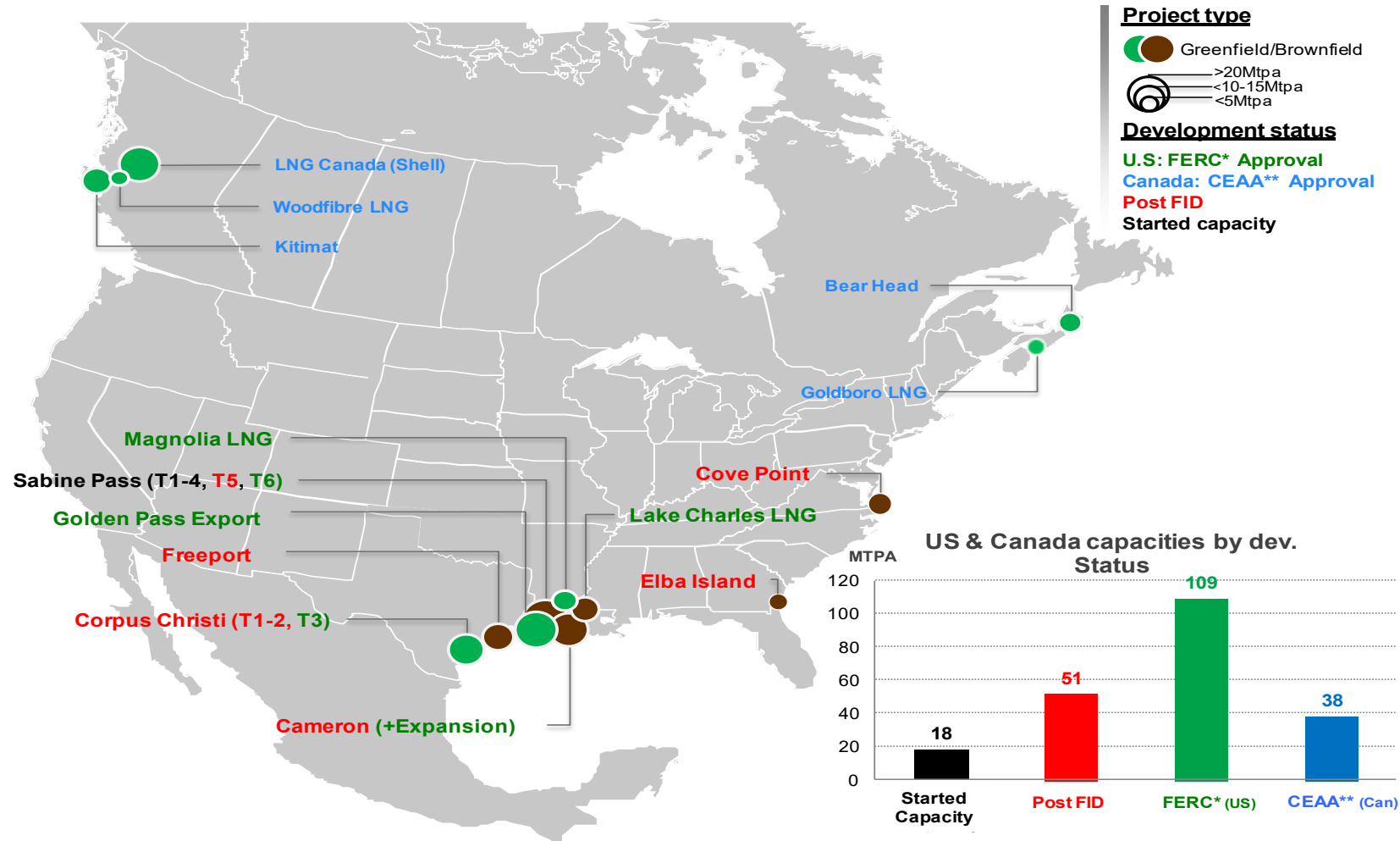
Forward dry gas production (2)



North America LNG Projects - 2026



Reminder - North America LNG Capacities & Exports - Vision 2017

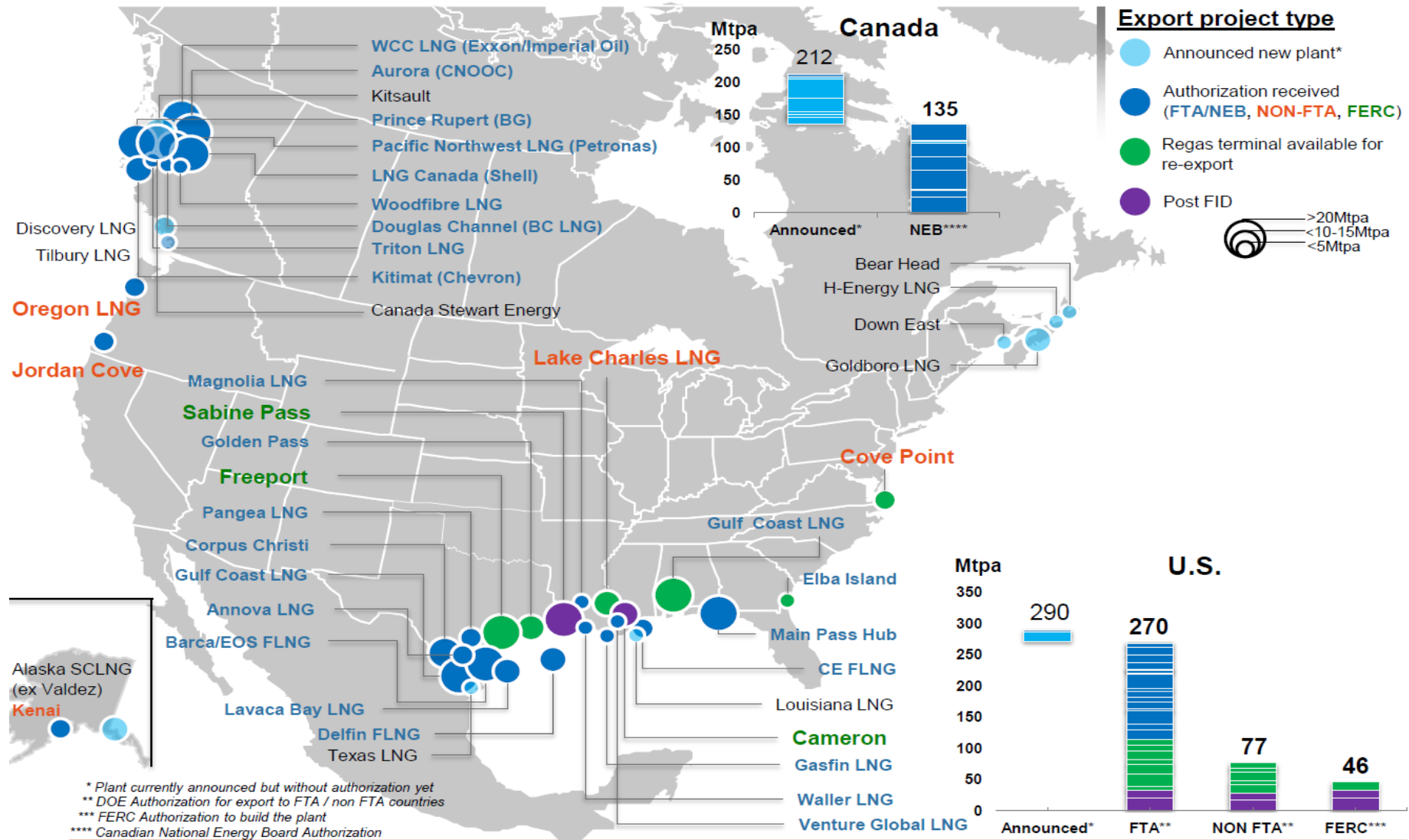


*FERC : Federal Energy Regulatory Commission - US Authorization to build the plant

** CEAA : Canadian Environmental Assessment Agency - Can. Authorization to build the plant

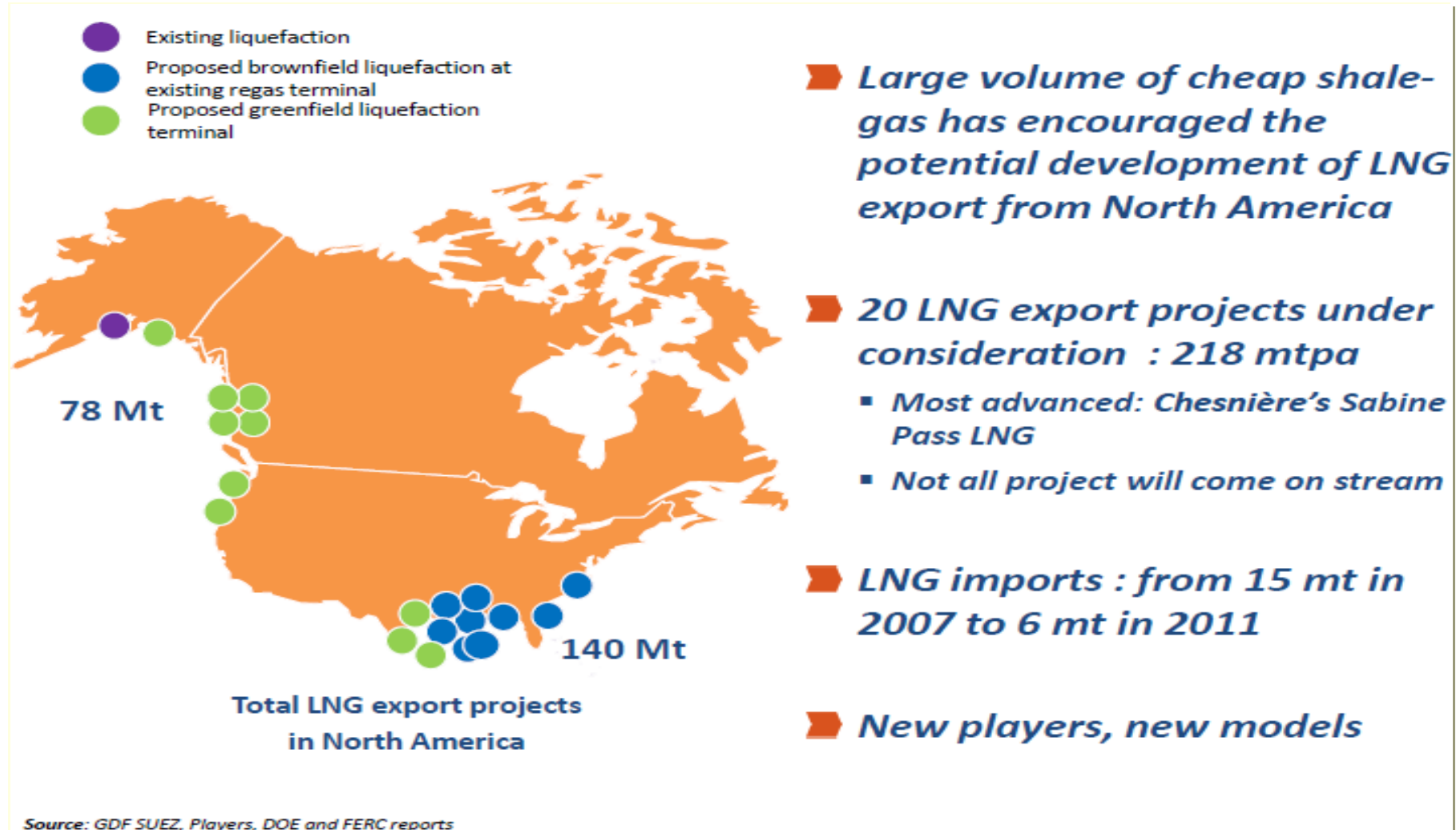


Reminder - US LNG Future Exports – Vision 2015



Reminder - USA: Future Natural Gas Exporter....Vision 2012

Regas terminals to be transformed into LNG export plants



US Energy Information Administration (EIA) History of Annual Energy Outlook (AEO) Reports



US Annual Energy Outlook 2026

Analysis by Scenarios



Annual Energy Outlook 2026

April 2026



The *Annual Energy Outlook 2026* (AEO2026) explores medium- and long-term alternative futures in the United States. AEO2026 is published in accordance with statutory provisions requiring the Administrator of the U.S. Energy Information Administration (EIA) to prepare an annual report on energy consumption and supply.¹ These projections are used by federal, state, and local governments; industry; trade associations; and other planners and decisionmakers in the public and private sectors.

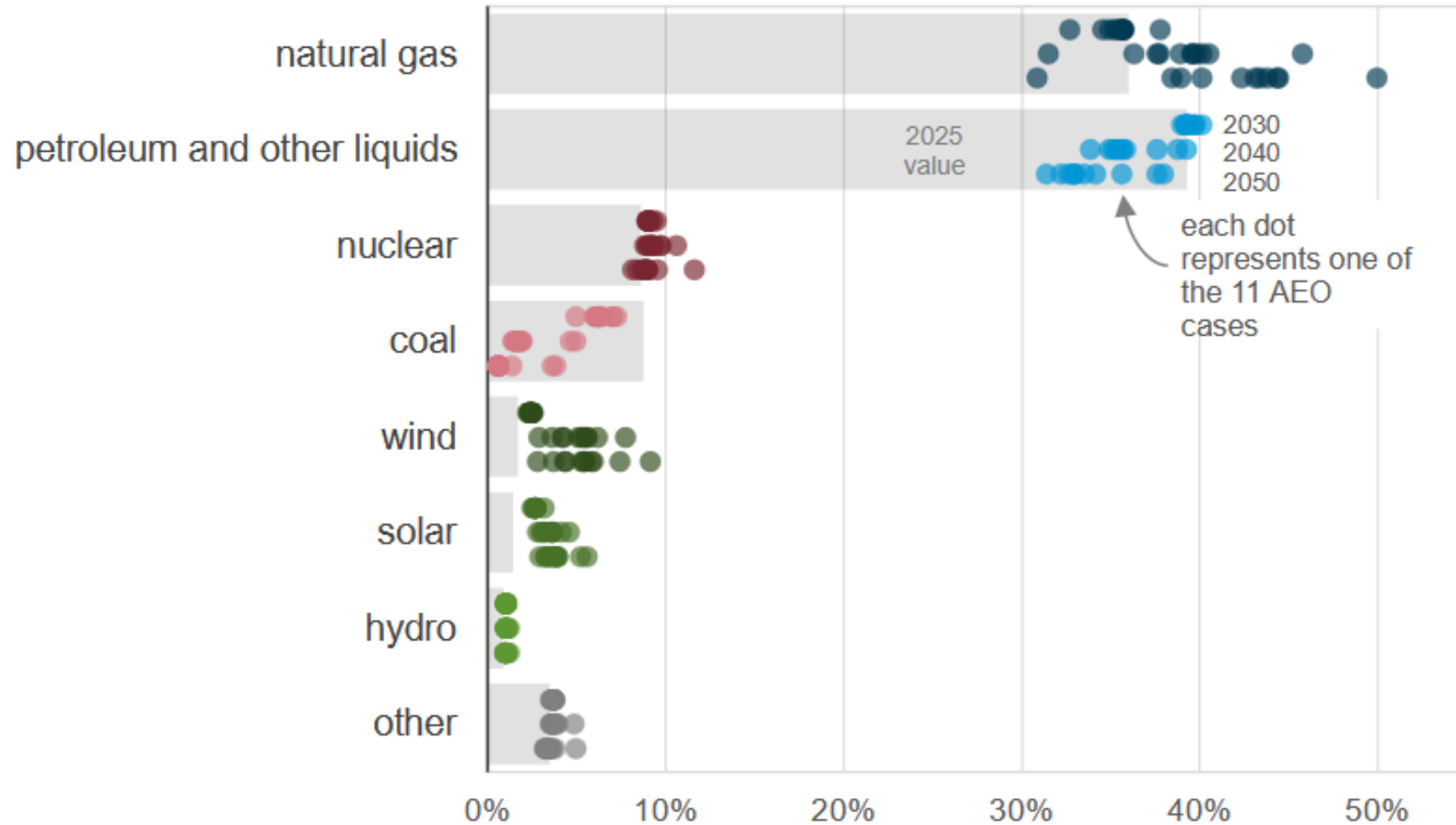
We prepared the AEO using the National Energy Modeling System (NEMS), an integrated model that captures interactions of economic changes and energy supply, demand, and prices. Given the complex nature of the energy markets, we produced a series of projections, or cases, with varying assumptions, which represent a range of outcomes for the U.S. energy system. These outcomes are not predictions of what will happen, rather the results represent modeled projections of what could happen given certain assumptions and methodologies. In most cases we model, we only consider current events, laws, and regulations implemented as of December 2025. These assumptions are documented and are available on the [AEO website](#). In addition to these documents, we created a separate [report](#) that explains how we implemented the One Big Beautiful Bill Act (OBBBA) in our AEO2026 cases.



US Consumption by Fuel

U.S. consumption by fuel in 2030, 2040, and 2050

share of annual total



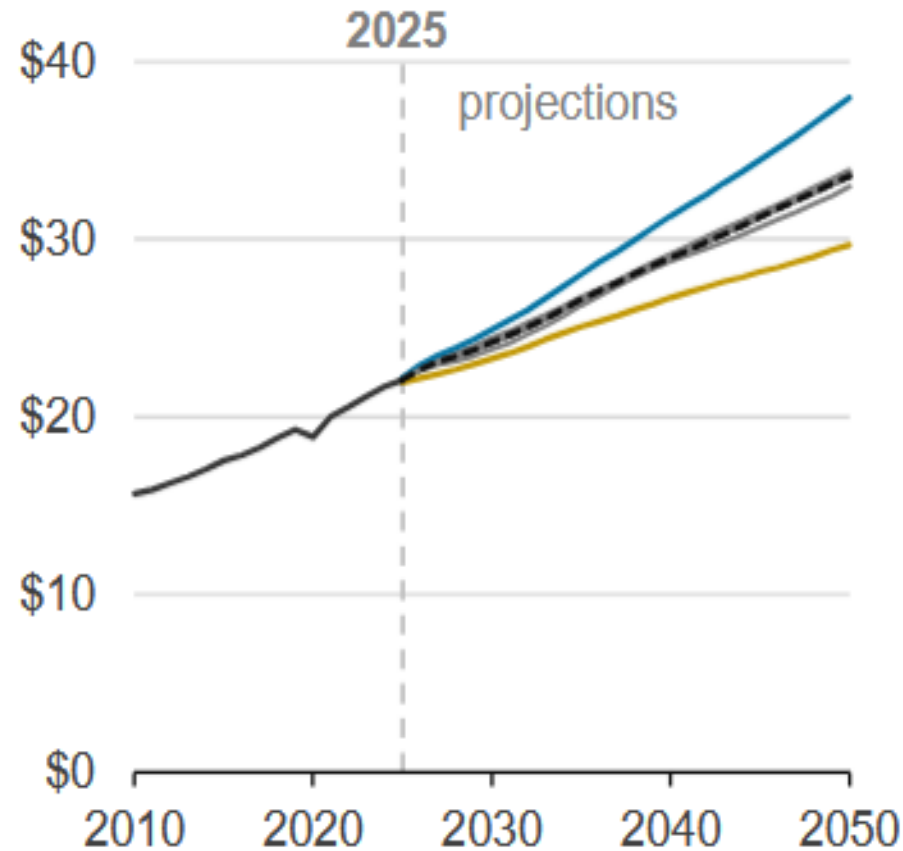
Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2026*, April 2026

Source: US IEA AEO 2026

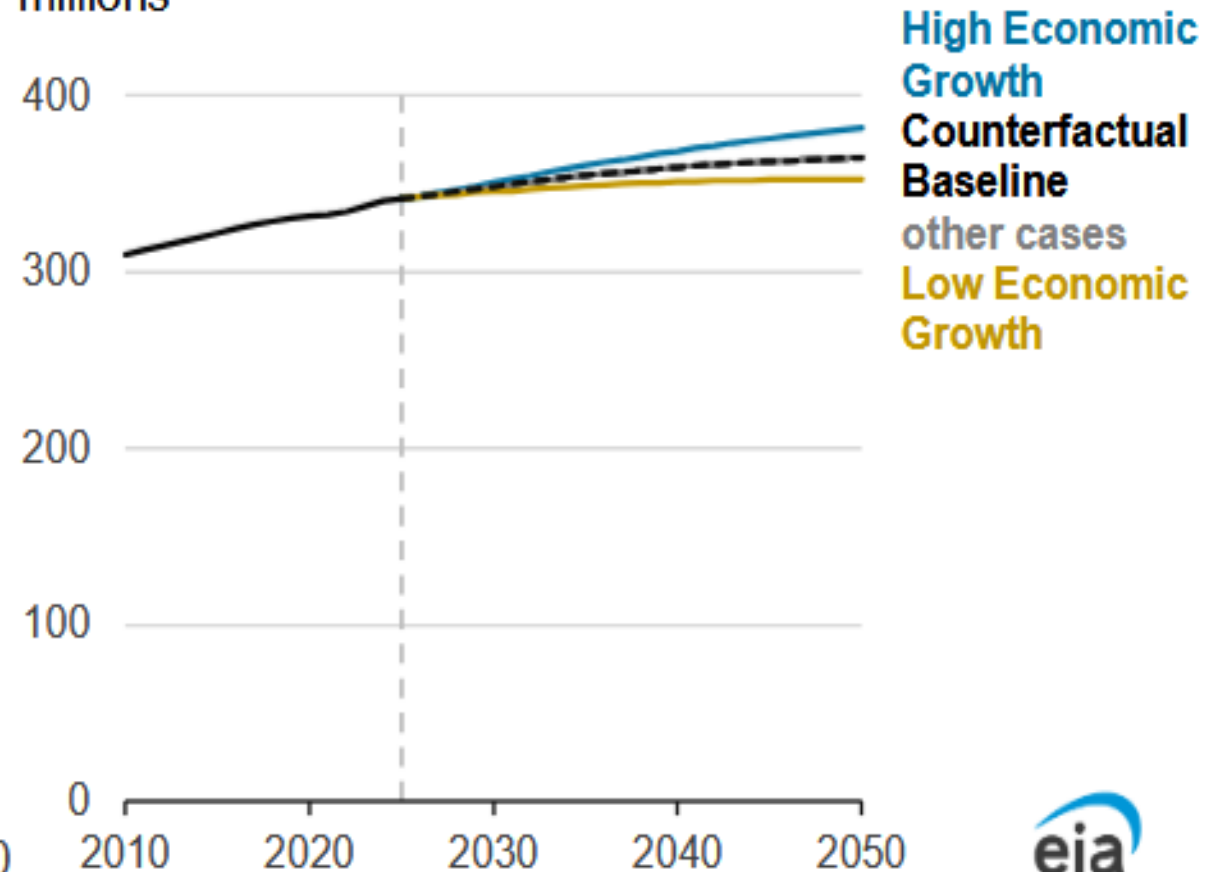


US GDP & Population

U.S. gross domestic product
trillion 2012 dollars



U.S. population
millions



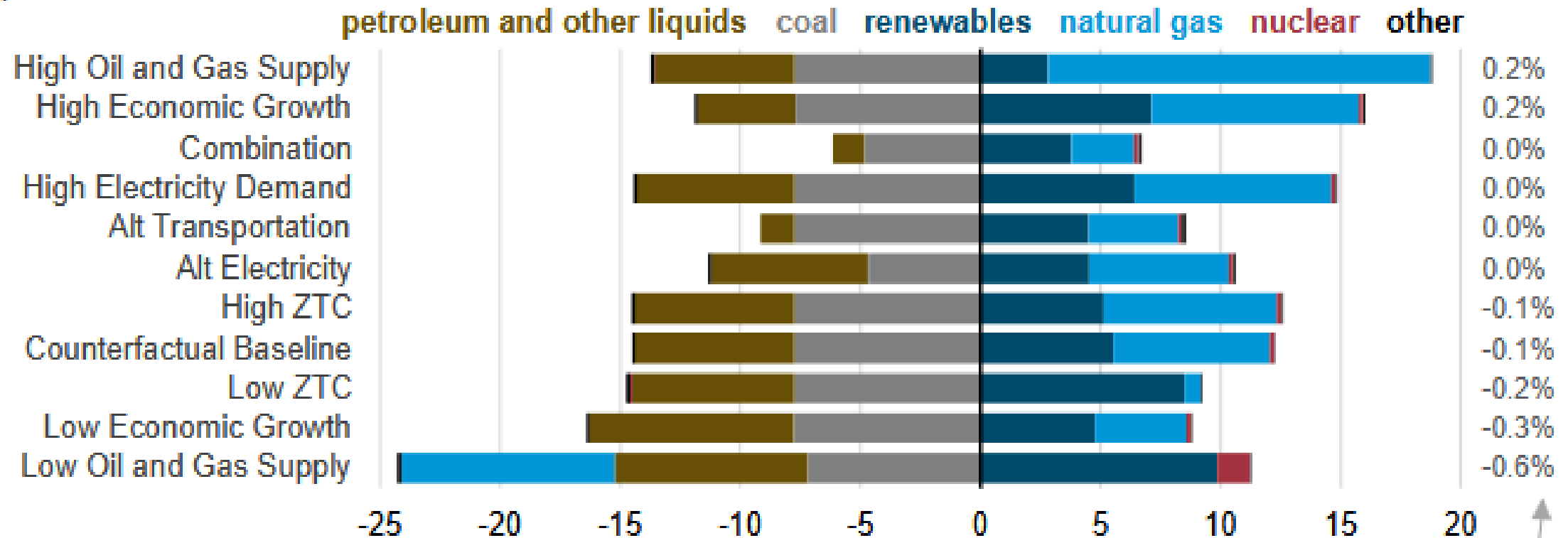
Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2026*, April 2026

Source: US IEA AEO 2026



US Consumption by Fuel

U.S. consumption by fuel, 2050 difference from 2025
quadrillion British thermal units



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2026*, April 2026
Note: Alt=Alternative; Combination=Alternative Transportation-Alternative Electricity; ZTC=Zero-carbon Technology Cost

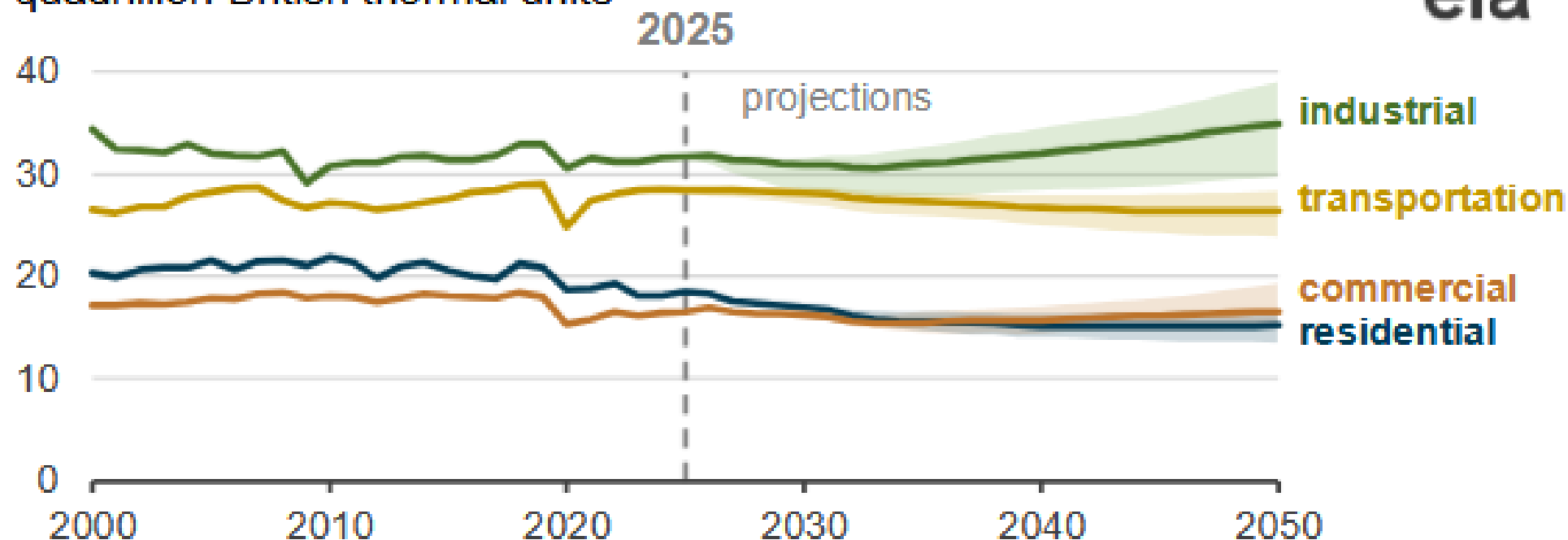
compound annual
growth rate
(2025-2050)

Source: US IEA AEO 2026



US Energy Consumption by end-use sector

Total energy consumption by end-use sector quadrillion British thermal units



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2026*, April 2026

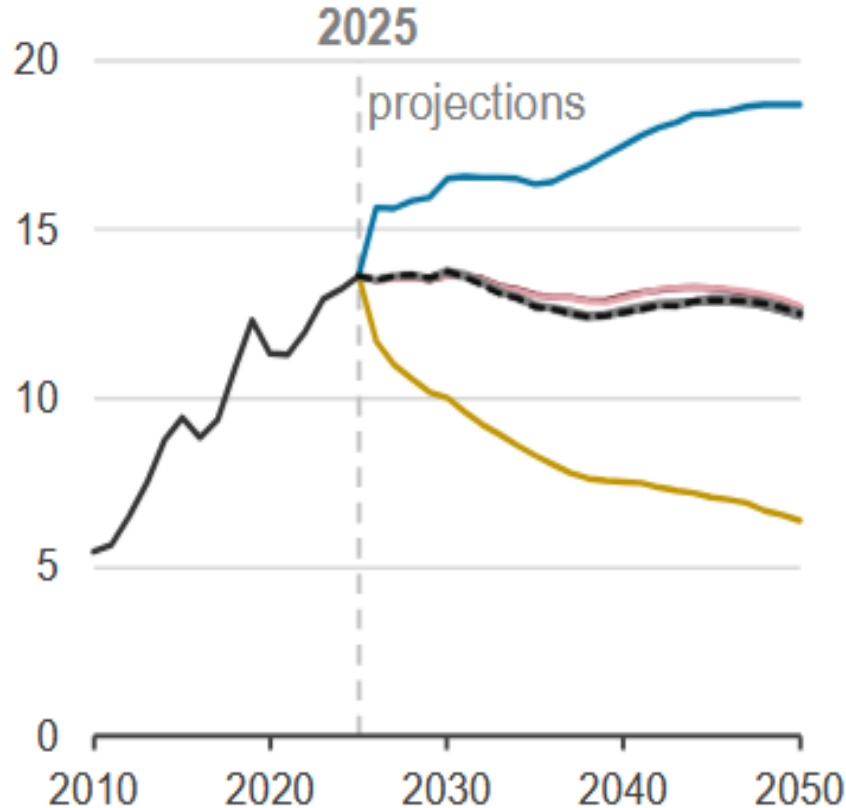
Note: Total consumption in end-use sectors includes purchased electricity, electricity-related losses, and hydrogen-related losses. Transportation sector includes pipeline and liquefaction consumption.

Each line represents AEO Counterfactual Baseline case projections.

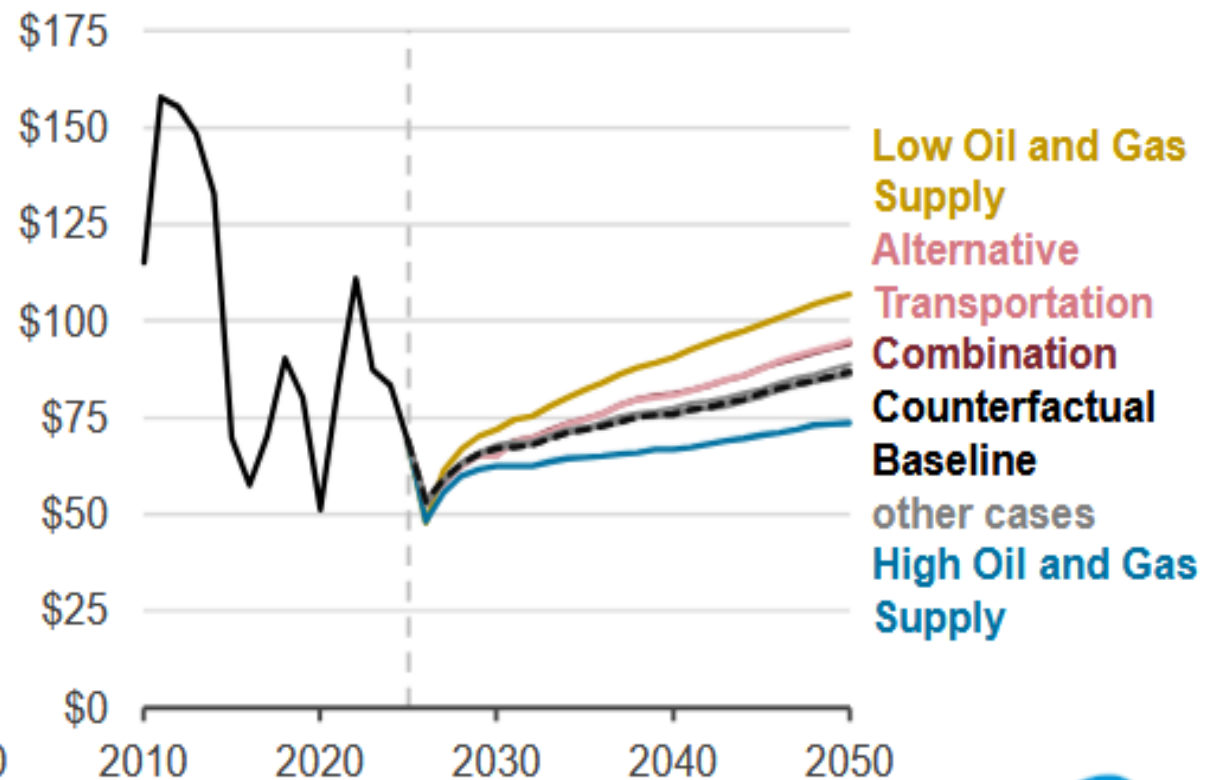


US Oil Production & Price

Crude oil production
million barrels per day



Brent crude oil price
2025 U.S. dollars per barrel



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2026*, April 2026

Note: Alternative Transportation and Combination cases closely align.



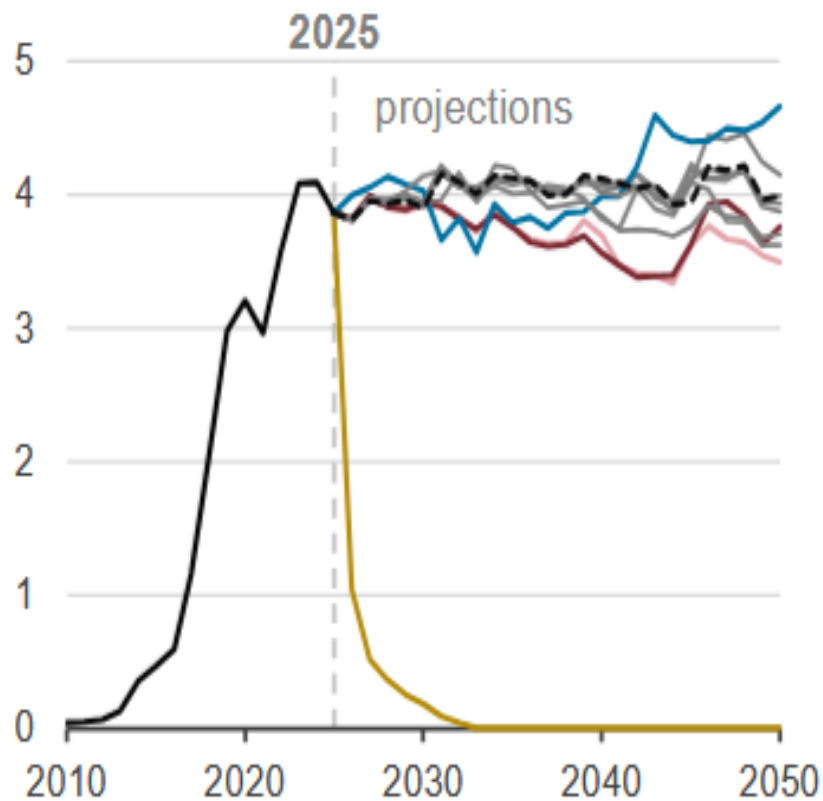
Source: US IEA AEO 2026



US Oil & Petroleum Liquids Exports

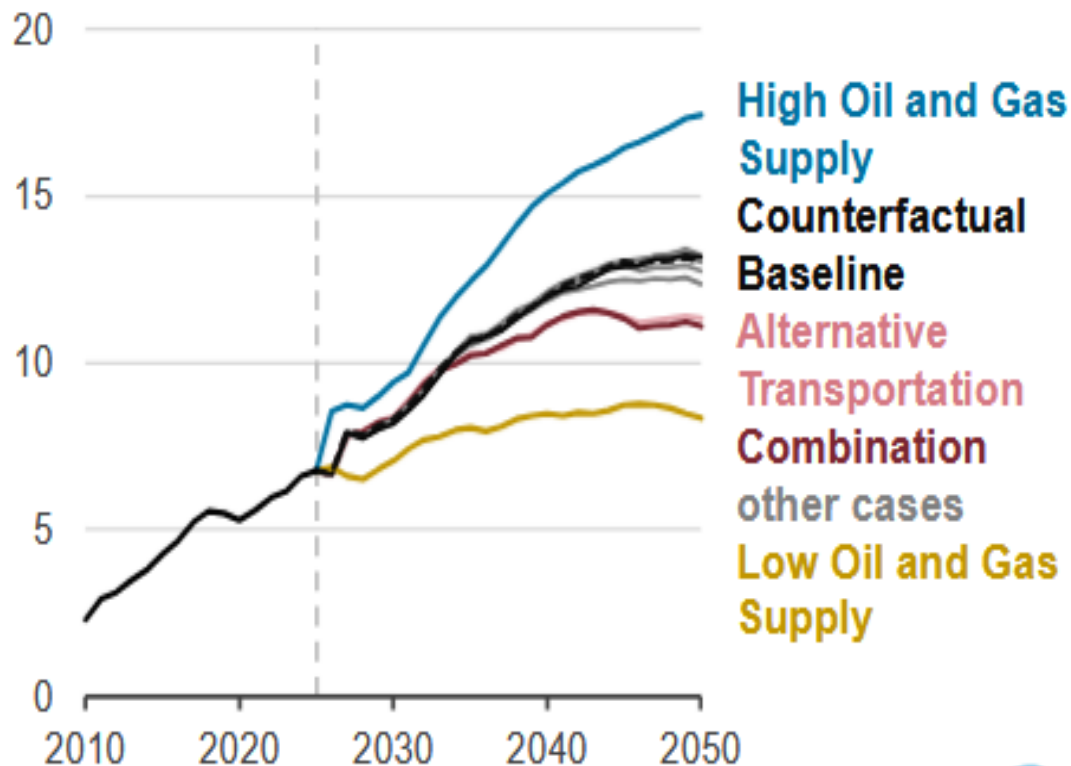
Gross crude oil exports

million barrels per day



Gross petroleum liquids exports

million barrels per day



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2026*, April 2026

Note: Alternative Transportation and Combination cases closely align in some instances.

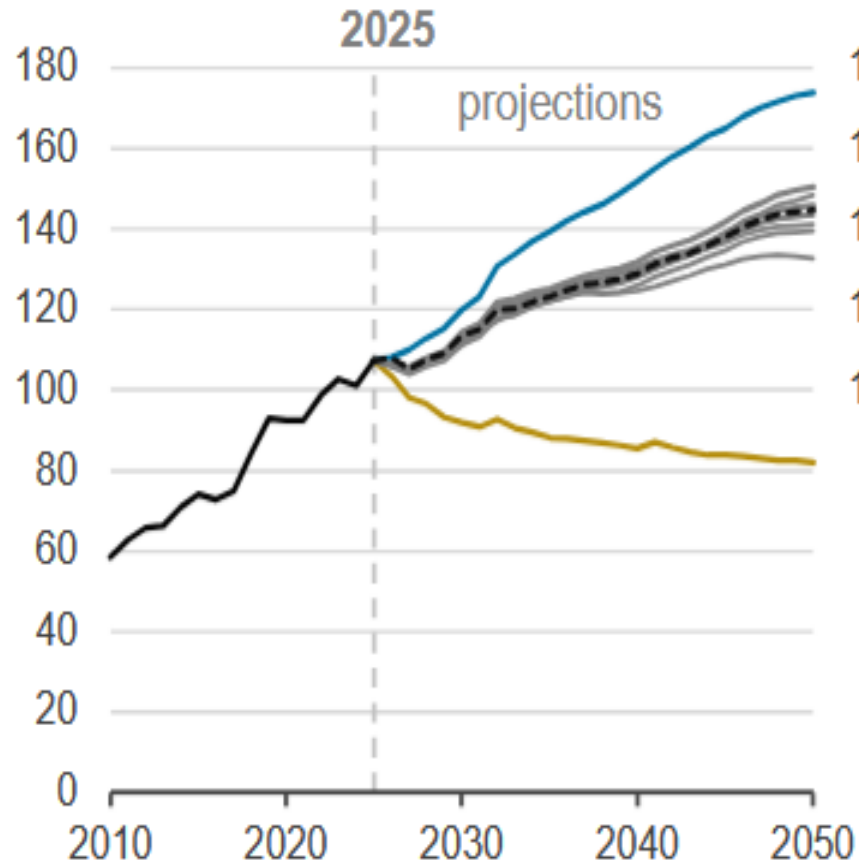


Source: US IEA AEO 2026

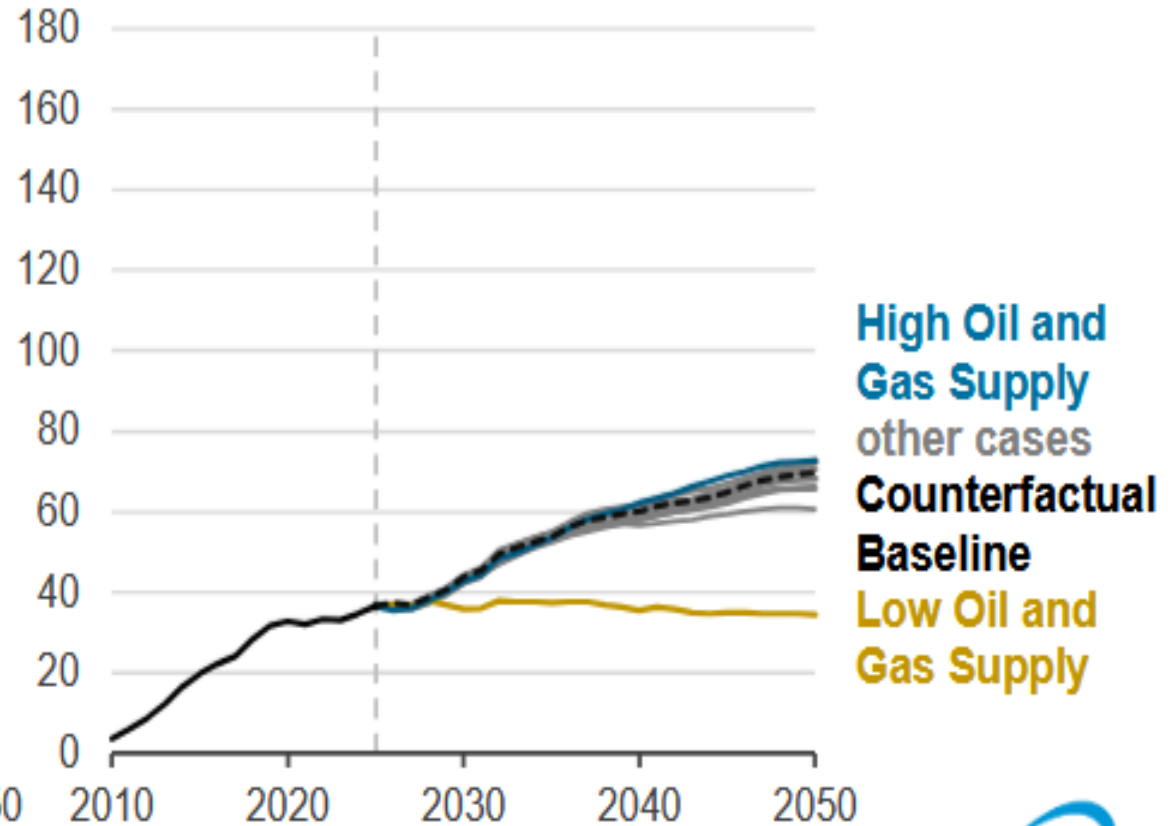


US Gas Production

U.S. dry natural gas production
billion cubic feet per day



U.S. onshore natural gas production: East
billion cubic feet per day

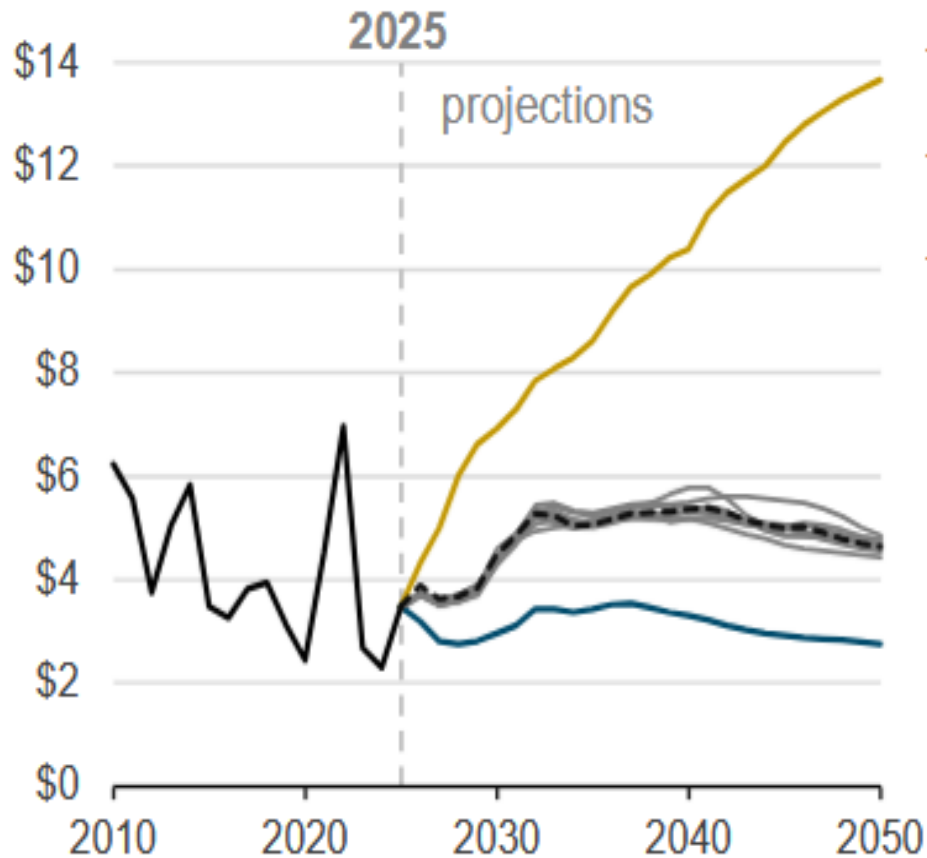


Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2026*, April 2026

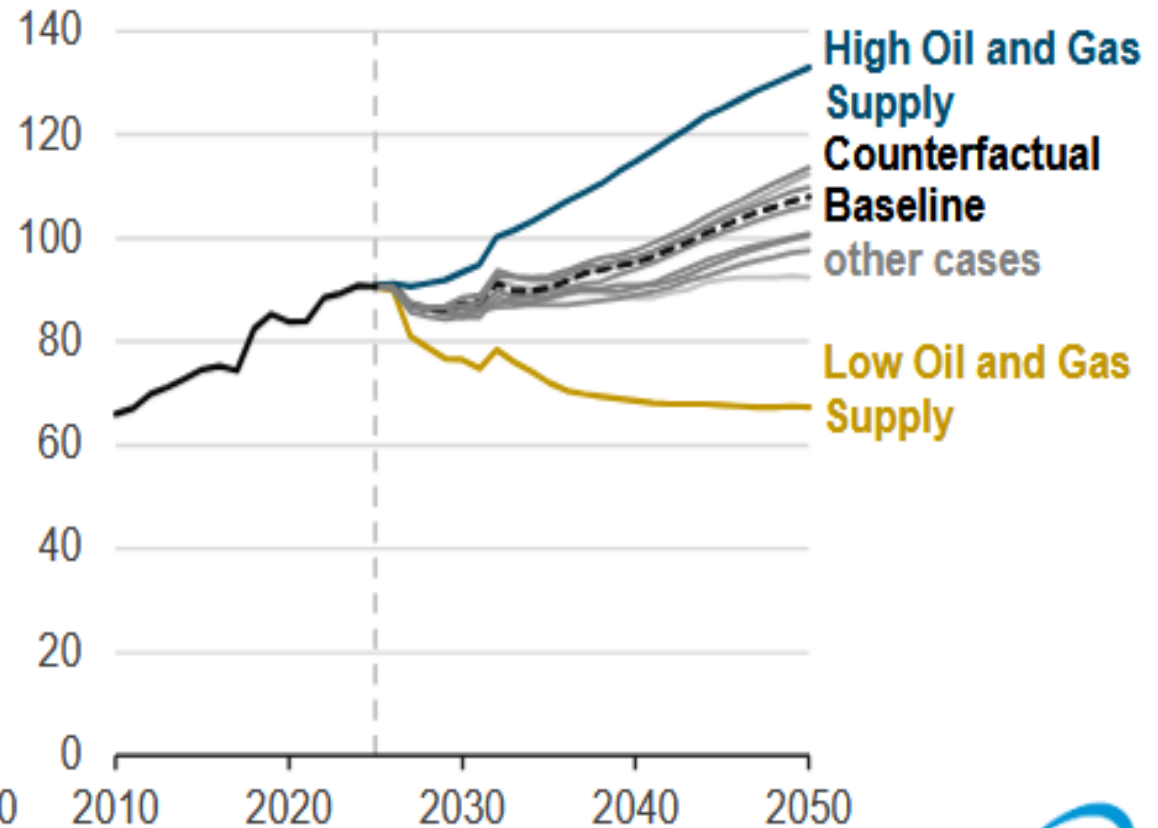


US Gas Price & Consumption

Henry Hub natural gas spot price
U.S. dollars per million British thermal units



U.S. natural gas consumption
billion cubic feet per day



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2026*, April 2026



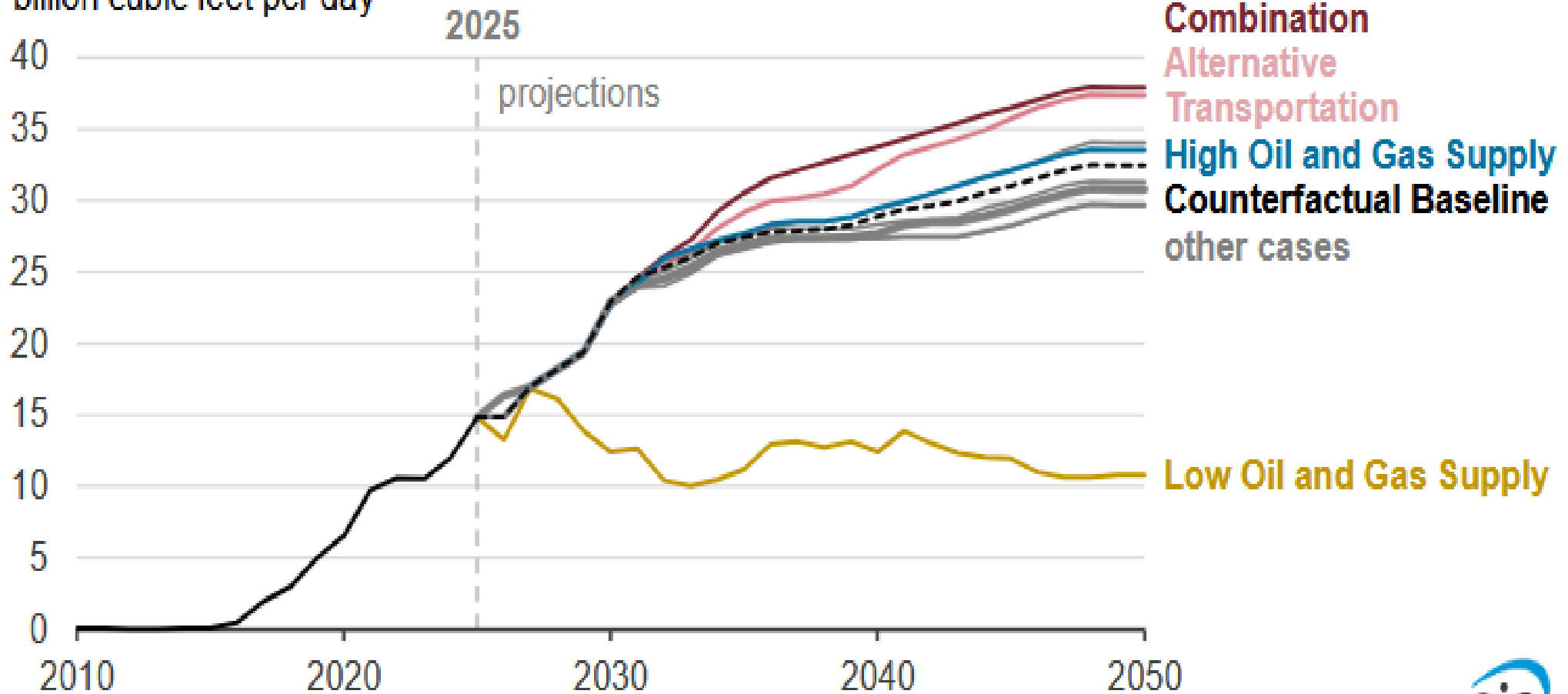
Source: US IEA AEO 2026



US LNG Exports – An important Growth

U.S. liquefied natural gas exports

billion cubic feet per day



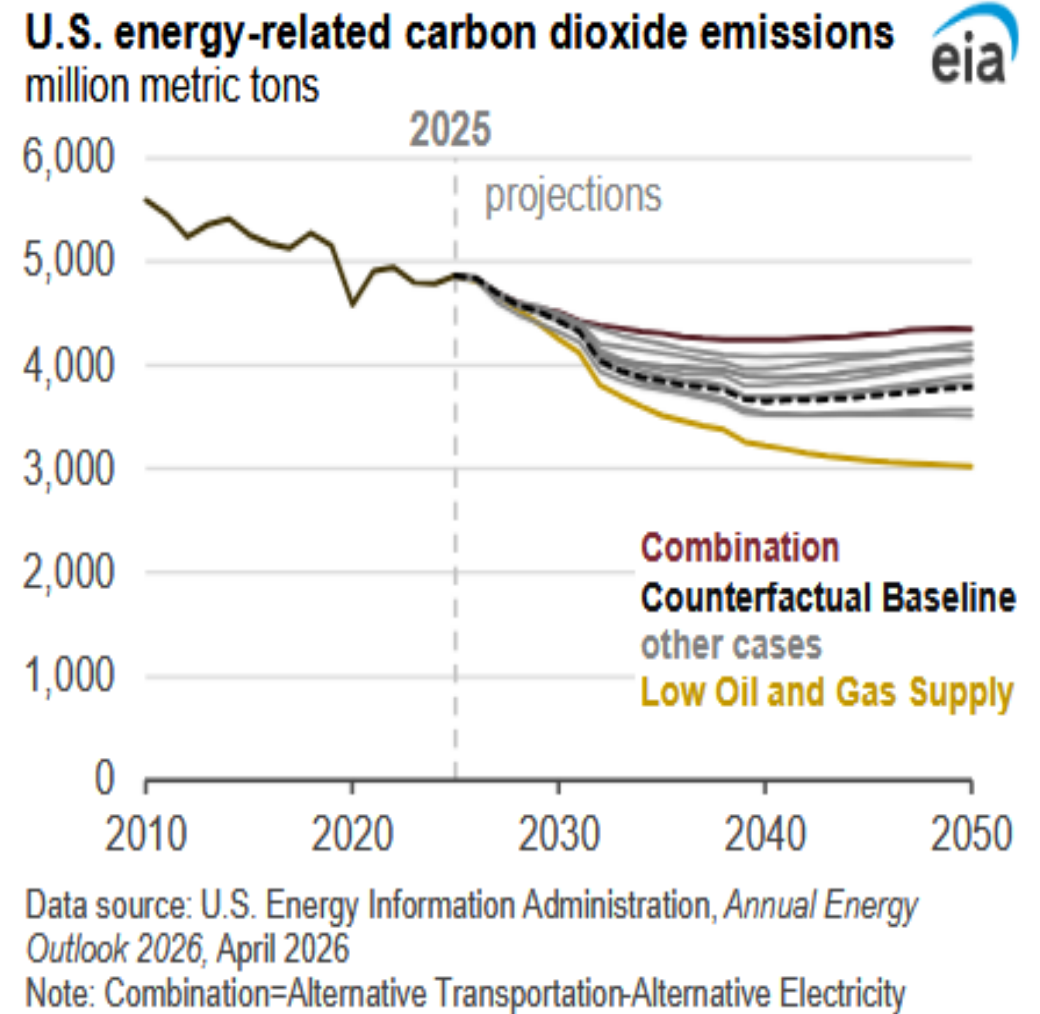
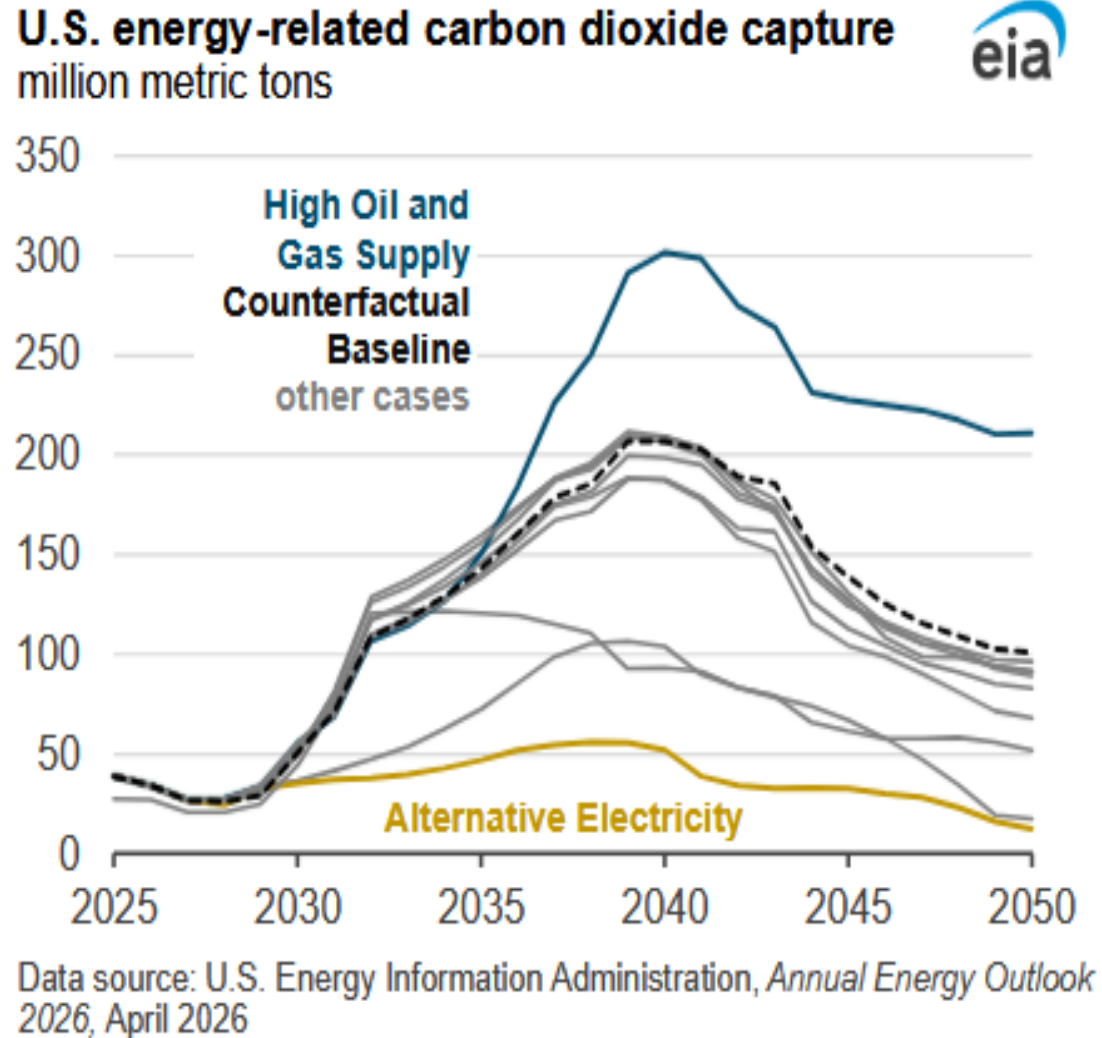
Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2026*, April 2026



Source: US IEA AEO 2026



US Energy Carbon Capture & Emissions

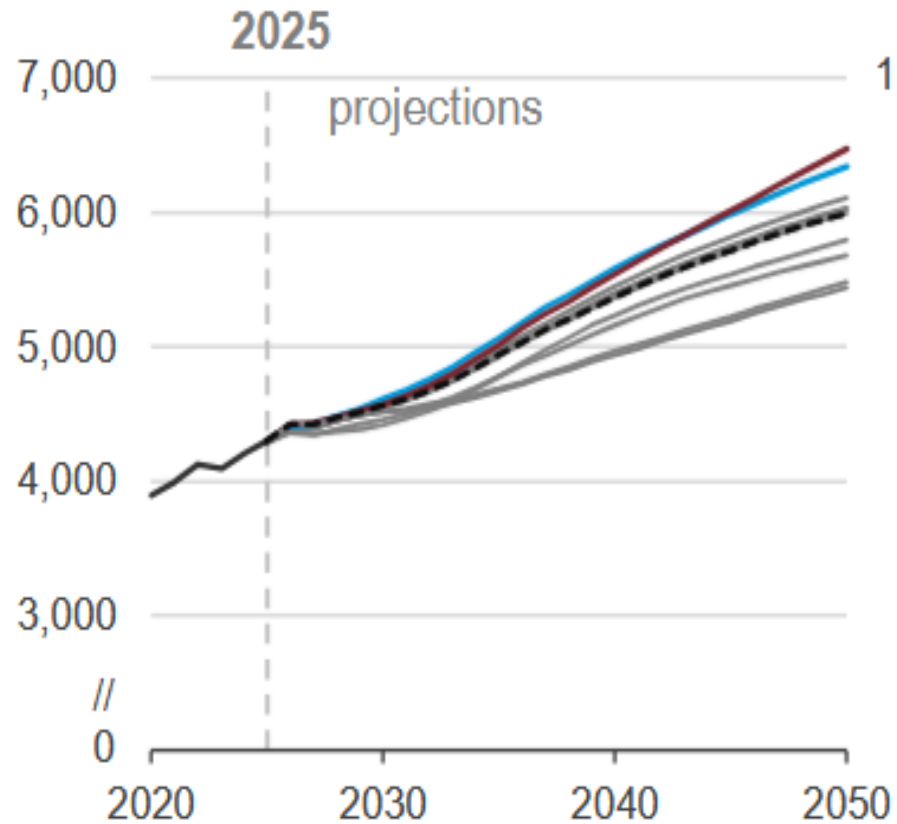


Source: US IEA AEO 2026

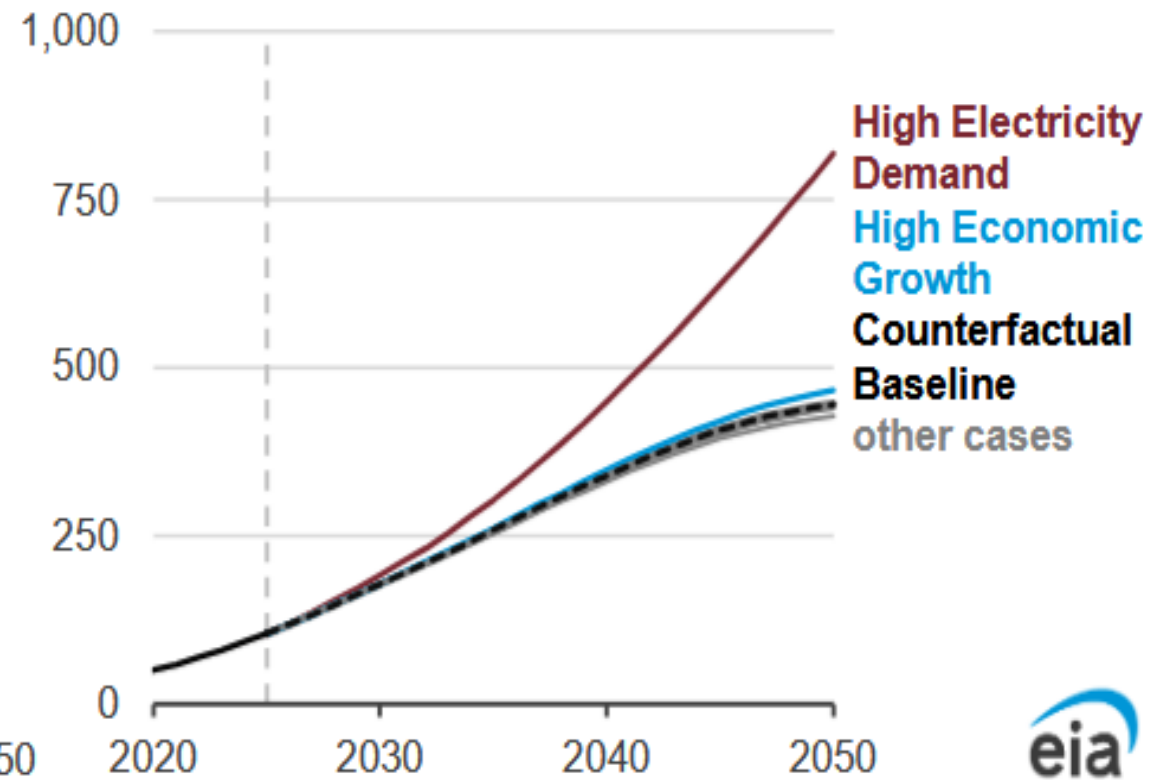


US Electricity Consumption (focus on Data centers)

**Total electricity consumption,
all sectors**
billion kilowatthours



**Commercial data center server
electricity consumption**
billion kilowatthours



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2026*, April 2026



Source: US IEA AEO 2026



Warning: US EIA has not published an AEO in 2024. Next AEO in 2025

Statement on the *Annual Energy Outlook* and EIA's plan to enhance long-term modeling capabilities

At the U.S. Energy Information Administration (EIA), a core aspect of our mission is to develop long-term projections of the U.S. energy system that inform decision makers at all levels. This work requires keeping pace with rapidly evolving energy markets, policies and regulations, macroeconomic trends, technology innovation, and resource availability.

EIA's National Energy Modeling System (NEMS), which we use to produce our *Annual Energy Outlook* (AEO), requires substantial updates to better model hydrogen, carbon capture, and other emerging technologies.

Our usual AEO publication schedule does not accommodate these necessary model enhancements, which require significant time and resources. As a result, EIA will not publish an AEO in 2024. This decision does not affect publications relying on our near-term modeling, such as the *Short-Term Energy Outlook*.

By retooling NEMS in 2024, the next AEO in 2025 will more comprehensively address existing laws and regulations in the Reference case, including up-to-date provisions in the Inflation Reduction Act and regulatory actions that could be finalized in the coming months.

We have also embarked on a longer-term effort to develop a flexible, next generation modeling framework that is better suited to address the ongoing changes in the U.S. energy sector.

We will continue to communicate with our stakeholders on these critical modeling issues and provide regular progress reports [on our website](#).

Our plan ensures that the AEO will continue to provide a sound and independent long-term perspective on the U.S. energy sector for lawmakers, energy modelers, and other stakeholders.

EIA: Energy Information Administration

AEO: Annual Energy Outlook

Source: EIA AEO July 2023



Introduction to the US EIA AEO 2025

Introduction

The *Annual Energy Outlook 2025* (AEO2025) explores potential long-term energy trends in the United States. AEO2025 is published in accordance with Section 205c of the Department of Energy Organization Act of 1977 (Public Law 95-91), which requires the Administrator of the U.S. Energy Information Administration (EIA) to prepare an annual report that contains trends and projections of energy consumption and supply. These projections are used by federal, state, and local governments; industry; trade associations; and other planners and decisionmakers in the public and private sectors.

We prepared the AEO by using the National Energy Modeling System (NEMS) to project a set of scenarios that, taken together, represent a range of outcomes for the U.S. energy system. AEO2025 represents the culmination of a year-long effort that enabled major upgrades to NEMS.

Our policy assumptions are central to understanding our AEO2025 projections. In most of the cases we model, we only consider laws and regulations implemented as of December 2024. As is the case every time we prepare an AEO, a cutoff date is necessary to enable us to conclude our modeling and integrate the final results for publication. Therefore, legislation, regulations, executive actions, and court rulings after that date are not included. We are releasing the model results without a lengthy market analysis this year.

The U.S. energy system underwent major changes in the first quarter of the 21st century as oil and natural gas production surged, renewables were deployed more widely, and energy consumption patterns changed. AEO2025 can help stakeholders examine the ways in which the system could further change through 2050.

EIA: Energy Information Administration
AEO: Annual Energy Outlook
Source: EIA AEO April 2025



US EIA AEO 2025 : One Reference case plus 6 scenarios

AEO2025 Reference case

Our Reference case assesses how the U.S. energy markets could operate under laws and regulations current as of December 2024 and under historically observed technological growth assumptions.

Alternative Electricity case

Our Alternative Electricity case assumes the Clean Air Act (CAA) Section 111 rule implemented by the Environmental Protection Agency (EPA) in April 2024 to regulate carbon dioxide emissions from new gas-fired combustion turbines and existing coal, oil, and gas-fired steam generating units is not in place, and the affected generators are able to operate under rules existing prior to April 2024. In this case, existing coal-fired plants continue operating without requiring modifications to reduce emissions, and generation from new natural gas-fired combined cycle units isn't constrained based on whether the plant has installed carbon capture equipment.

Alternative Transportation case

Our Alternative Transportation case assumes the National Highway Traffic Safety Administration's Corporate Average Fuel Economy standards and EPA's vehicle tailpipe emission standards for model years 2027–2032 are not in place. The case also assumes the California Air Resources Board's zero-emission vehicle sale mandates for trucks issued since our last published AEO are not in place. Rules affecting fuel economy and tailpipe emissions that were issued for model years 2026 and earlier remain in place. In this case, introduction of new electric vehicle (EV) models and building of EV charging infrastructure are based on growth in EV sales and registrations rather than on announced public and private sector plans. In addition, manufacturer reshoring of EV and battery supply chains, including growth in eligibility for credits under the Inflation Reduction Act, is slower than in the Reference case.

High and Low Oil Price cases

In the High Oil Price case, the price of Brent crude oil increases to \$157 per barrel (b) in 2050, compared with \$91/b in the Reference case and \$48/b in the Low Oil Price case.



US EIA AEO 2025 : One Reference case plus 6 scenarios

High and Low Oil and Gas Supply cases

The High Oil and Gas Supply case assumes ultimate recovery for new tight oil, tight gas, or shale gas wells are 50% higher than in the Reference case. The case also assumes 50% higher undiscovered resources in Alaska and offshore fields. Technological improvement is assumed to be 50% faster. The Low Oil and Gas Supply case assumes the converse.

High and Low Zero-Carbon Technology Cost cases

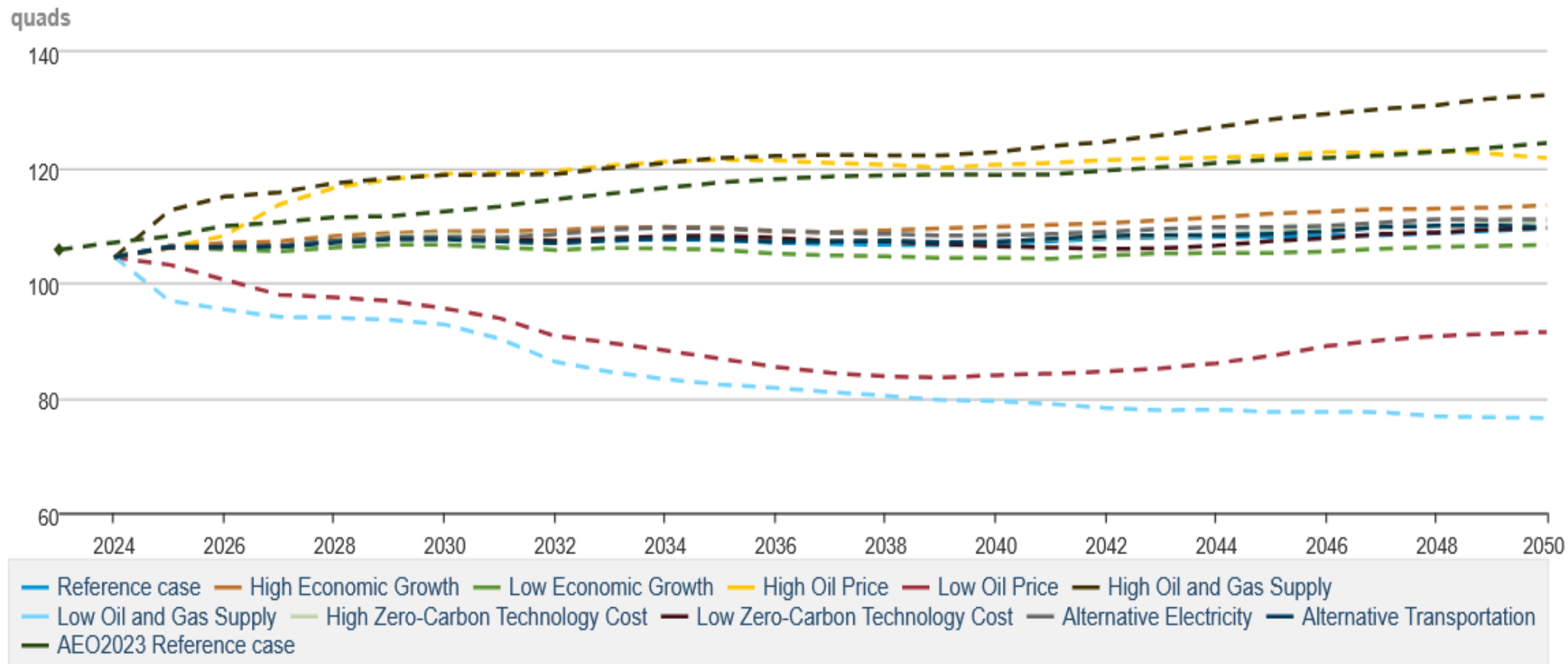
The Low Zero-Carbon Technology Cost case assumes faster cost declines for electricity-generating technologies that produce zero emissions as construction and manufacturing experience grows, resulting in 40% lower costs than in the Reference case in 2050. The High Zero-Carbon Technology Cost case, conversely, assumes no additional cost reductions from learning with additional deployment of these electricity generating technologies.

High and Low Economic Growth cases

The High Economic Growth case assumes the compound annual growth rate for U.S. GDP is 2.1% through 2050, and the Low Economic Growth case assumes a 1.2% rate. By contrast, the Reference case assumes the U.S. GDP annual growth rate is 1.8% over the projection period.



US EIA AEO 2025 – Total Energy: Production: Total



Data source: U.S. Energy Information Administration

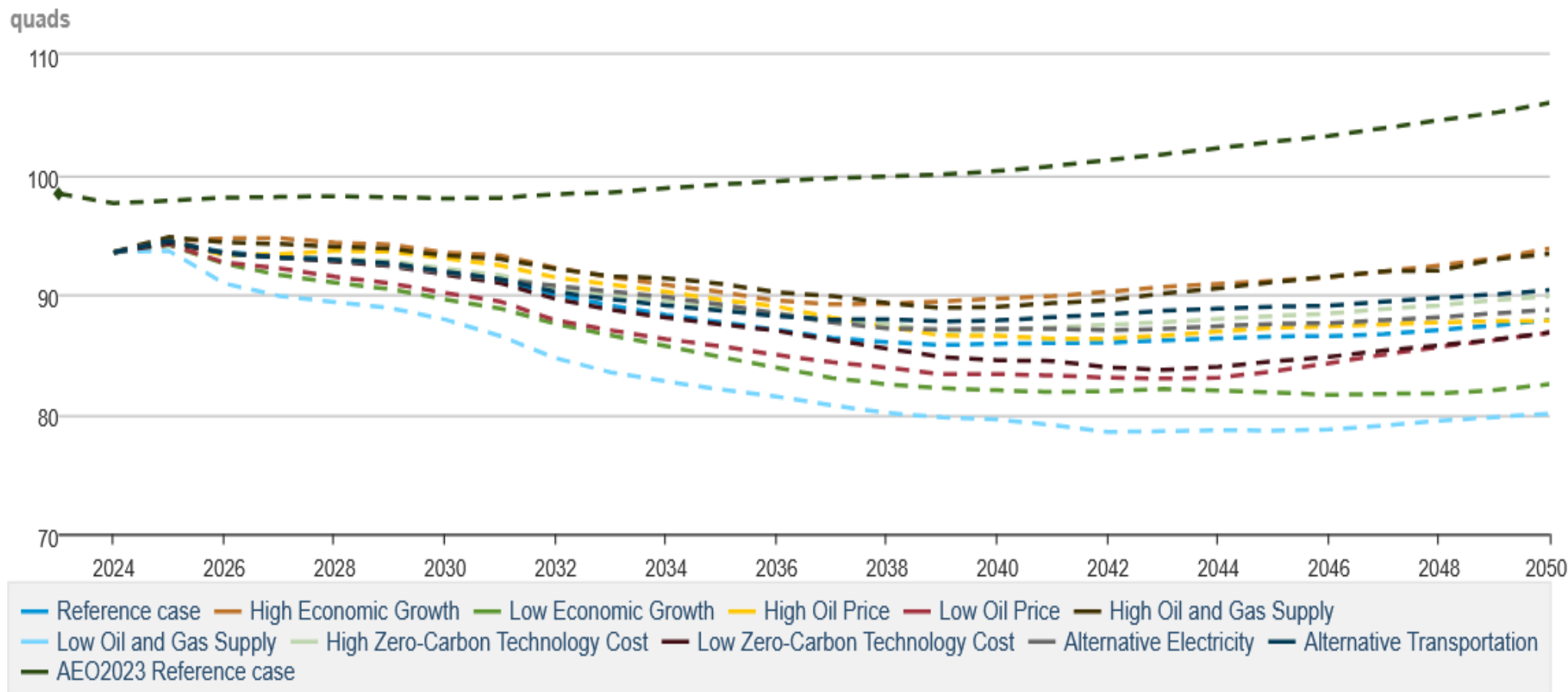
EIA: Energy Information Administration

AEO: Annual Energy Outlook

Source: EIA AEO April 2025 - 1 quad = 1 quadrillion Btu # 25 Mtoe



US EIA AEO 2025 – Total Energy: Consumption: Total



Data source: U.S. Energy Information Administration

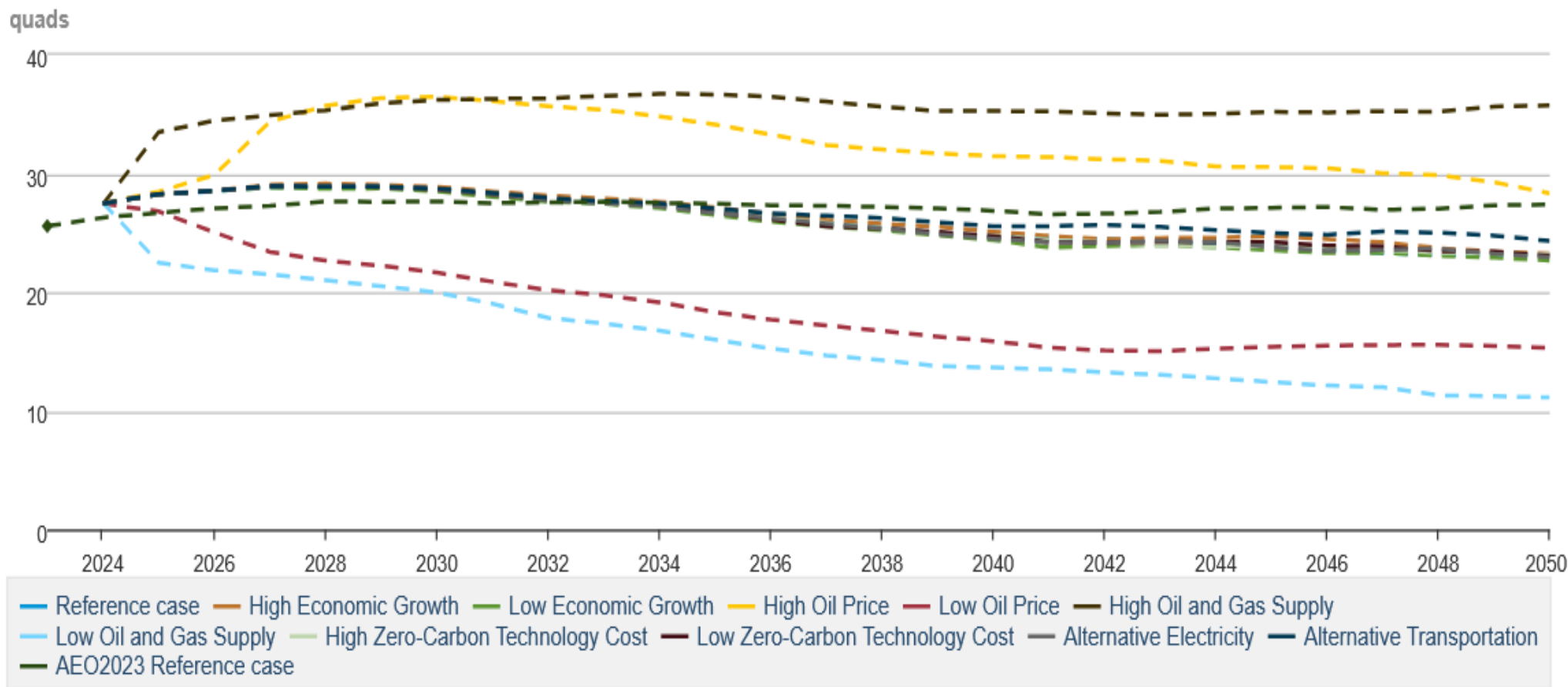
EIA: Energy Information Administration

AEO: Annual Energy Outlook

Source: EIA AEO April 2025 - 1 quad = 1 quadrillion Btu # 25 Mtoe



US EIA AEO 2025 – Total Energy: Production: Crude Oil and Lease Condensate



Data source: U.S. Energy Information Administration

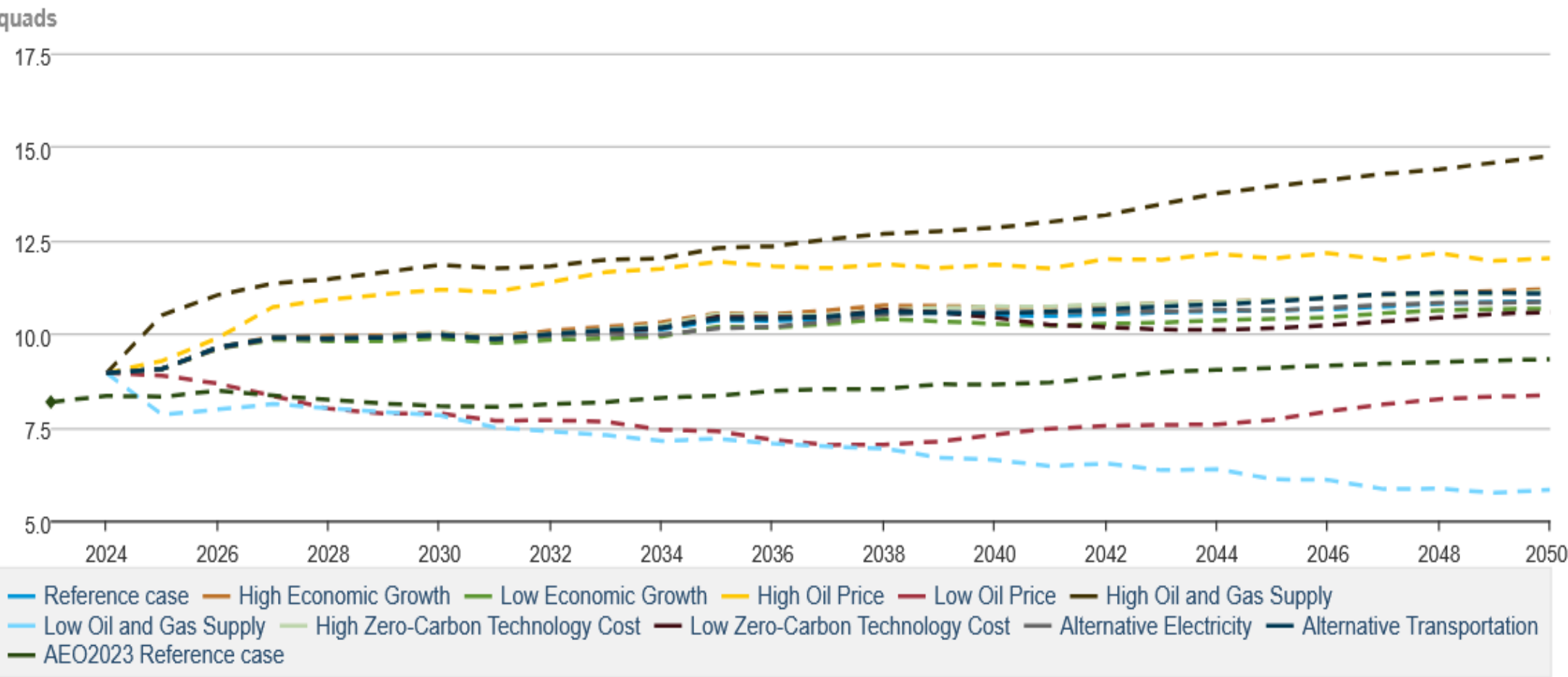
EIA: Energy Information Administration

AEO: Annual Energy Outlook

Source: EIA AEO April 2025 - 1 quad = 1 quadrillion Btu # 25 Mtoe



US EIA AEO 2025 – Total Energy: Production: Natural Gas Plants Liquids

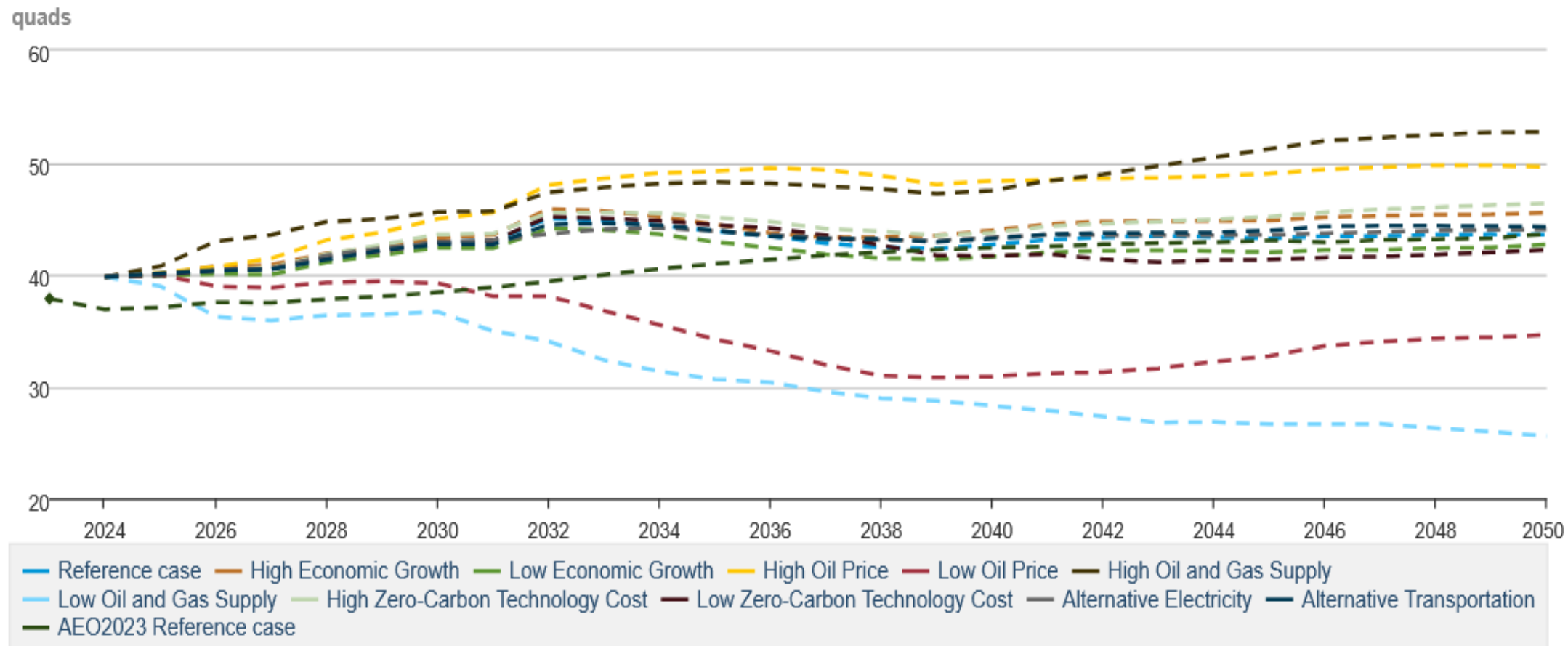


eia Data source: U.S. Energy Information Administration

EIA: Energy Information Administration
AEO: Annual Energy Outlook
Source: EIA AEO April 2025 - 1 quad = 1 quadrillion Btu # 25 Mtoe



US EIA AEO 2025 – Total Energy: Production: Dry Natural Gas



Data source: U.S. Energy Information Administration

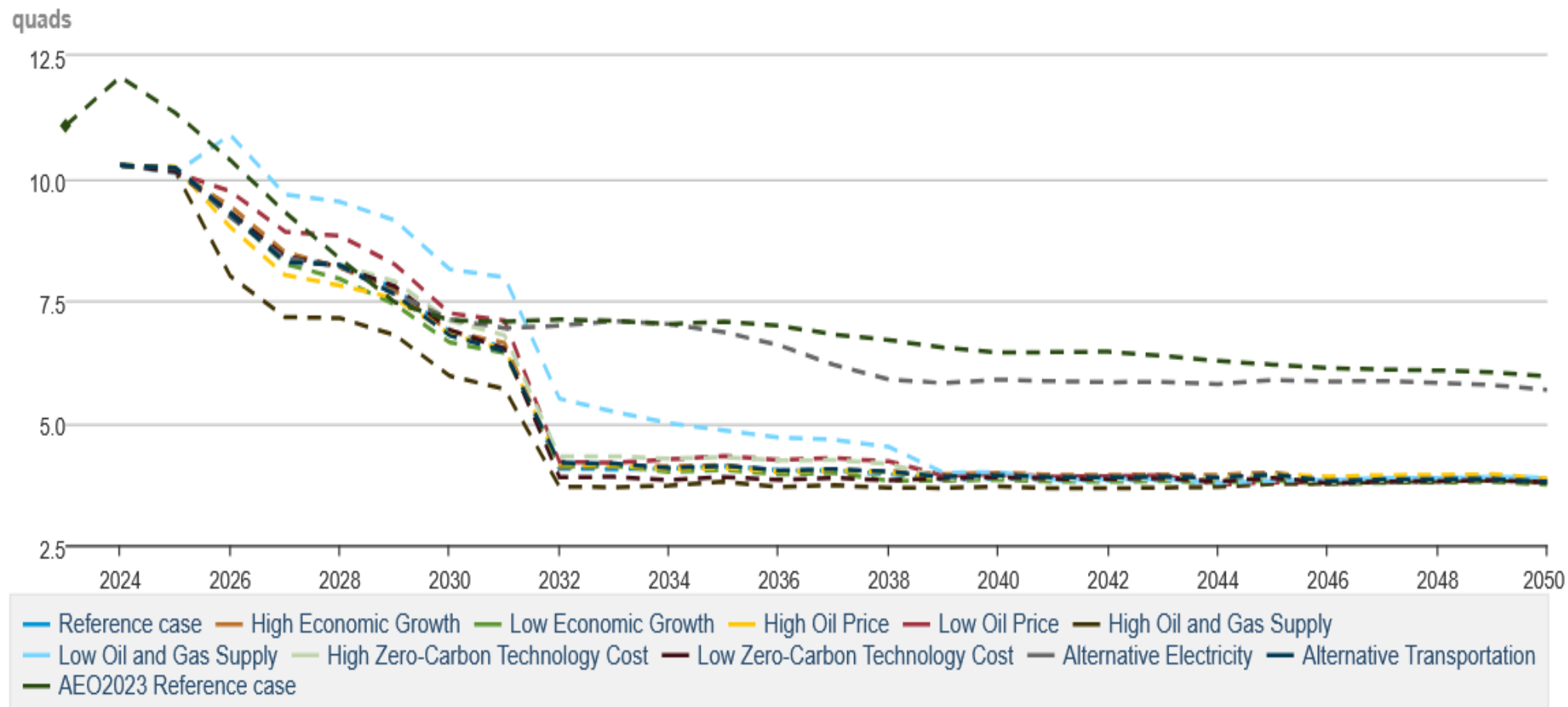
EIA: Energy Information Administration

AEO: Annual Energy Outlook

Source: EIA AEO April 2025 - 1 quad = 1 quadrillion Btu # 25 Mtoe



US EIA AEO 2025 – Total Energy: Production: Coal



 Data source: U.S. Energy Information Administration

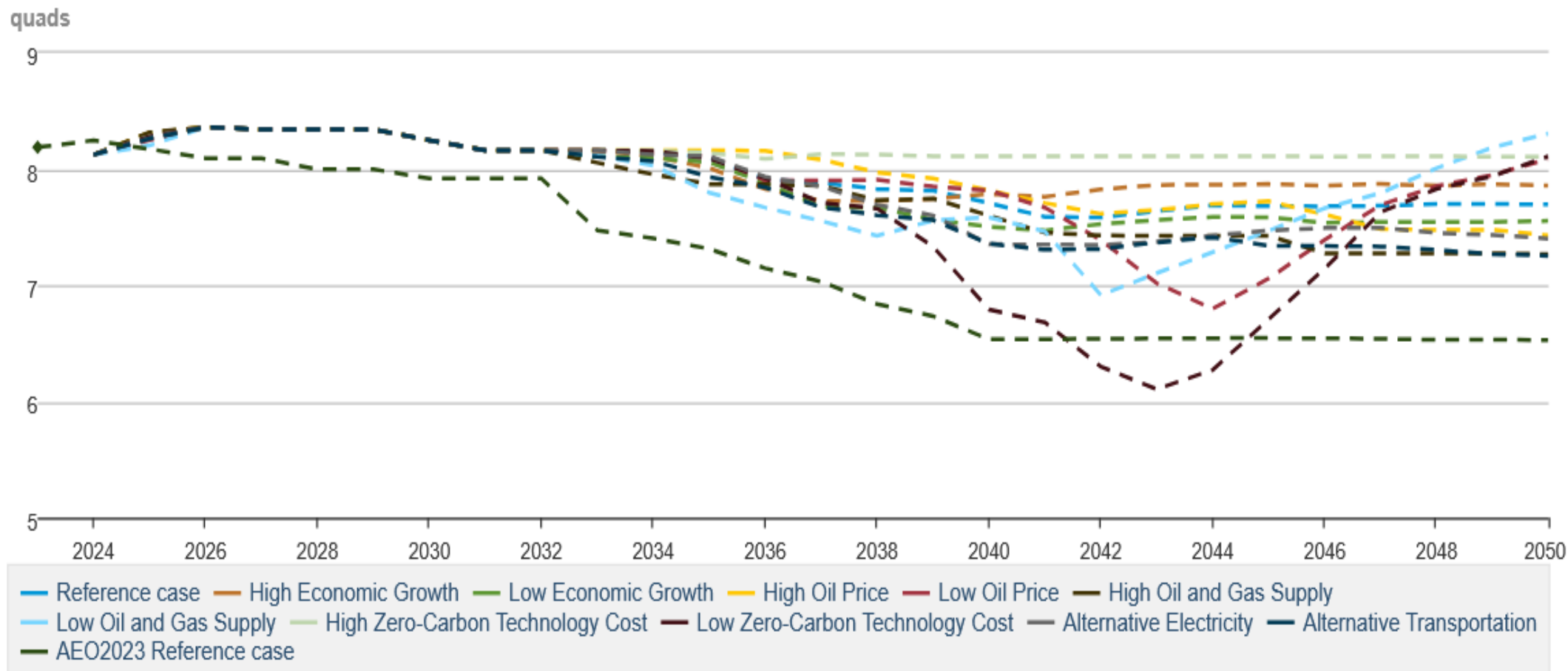
EIA: Energy Information Administration

AEO: Annual Energy Outlook

Source: EIA AEO April 2025 - 1 quad = 1 quadrillion Btu # 25 Mtoe



US EIA AEO 2025 – Total Energy: Production: Nuclear



Data source: U.S. Energy Information Administration

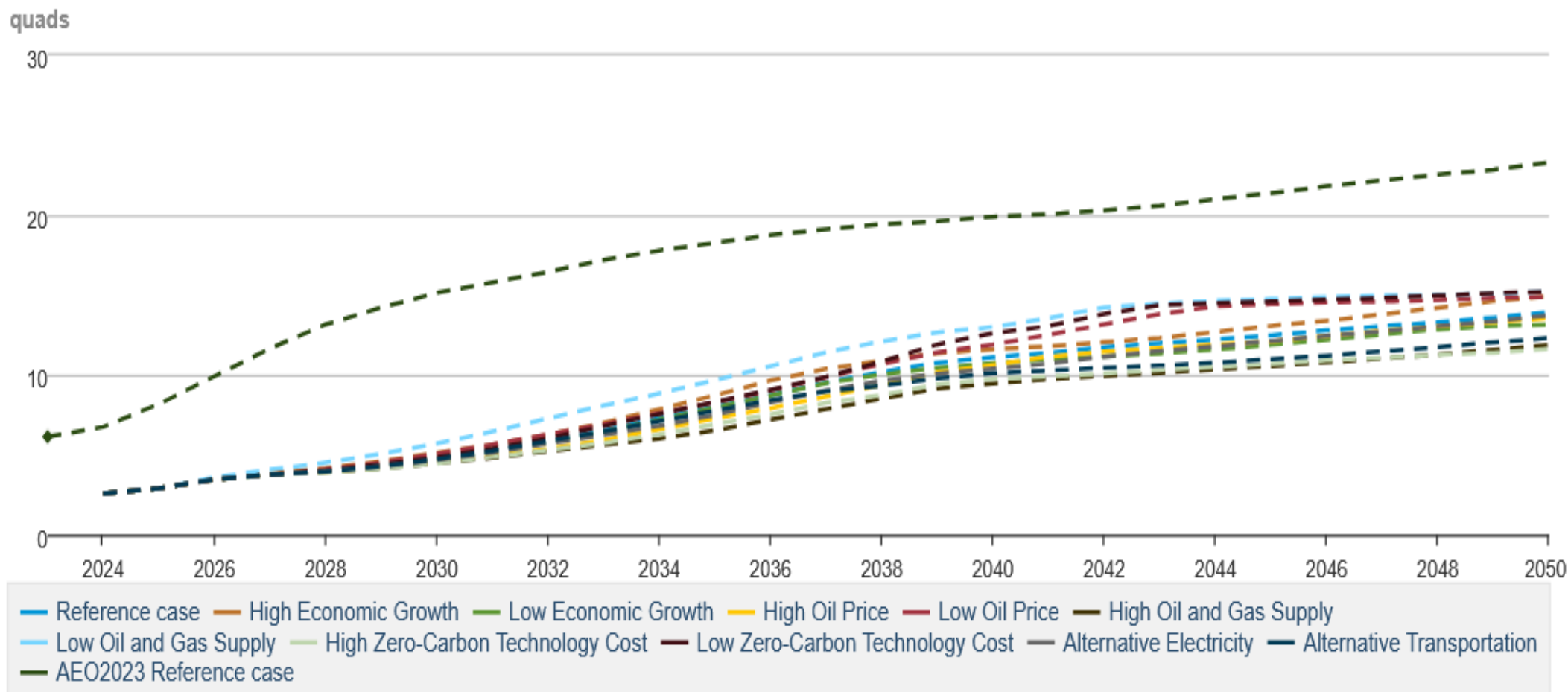
EIA: Energy Information Administration

AEO: Annual Energy Outlook

Source: EIA AEO April 2025 - 1 quad = 1 quadrillion Btu # 25 Mtoe



US EIA AEO 2025 – Total Energy: Production: Renewables excl. Hydro



Data source: U.S. Energy Information Administration

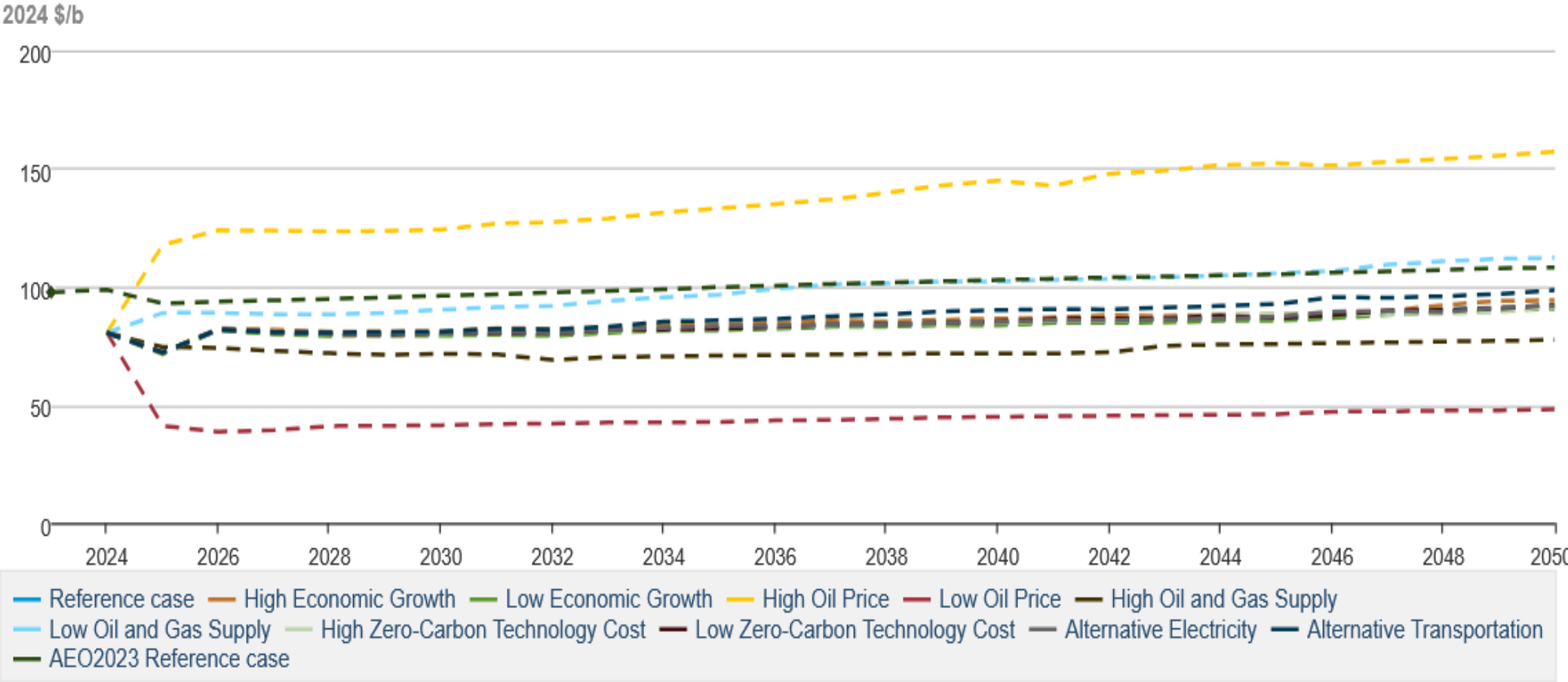
EIA: Energy Information Administration

AEO: Annual Energy Outlook

Source: EIA AEO April 2025 - 1 quad = 1 quadrillion Btu # 25 Mtoe



US EIA AEO 2025 – Total Energy: Brent Price

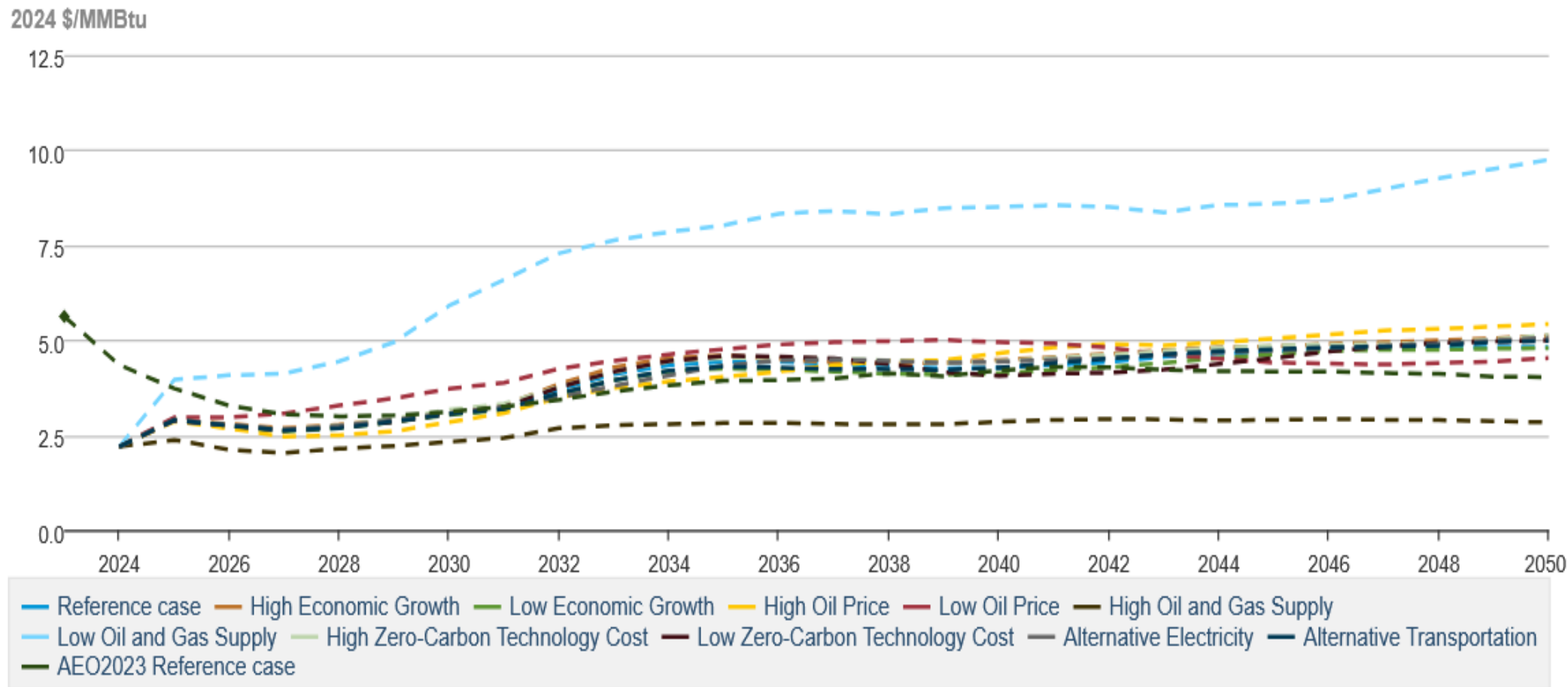


 Data source: U.S. Energy Information Administration

EIA: Energy Information Administration
AEO: Annual Energy Outlook
Source: EIA AEO April 2025



US EIA AEO 2025 – Total Energy: Henry Hub Gas Price



Data source: U.S. Energy Information Administration

EIA: Energy Information Administration

AEO: Annual Energy Outlook

Source: EIA AEO April 2025



Reminder - AEO 2023 Highlights

AEO2023 Highlights

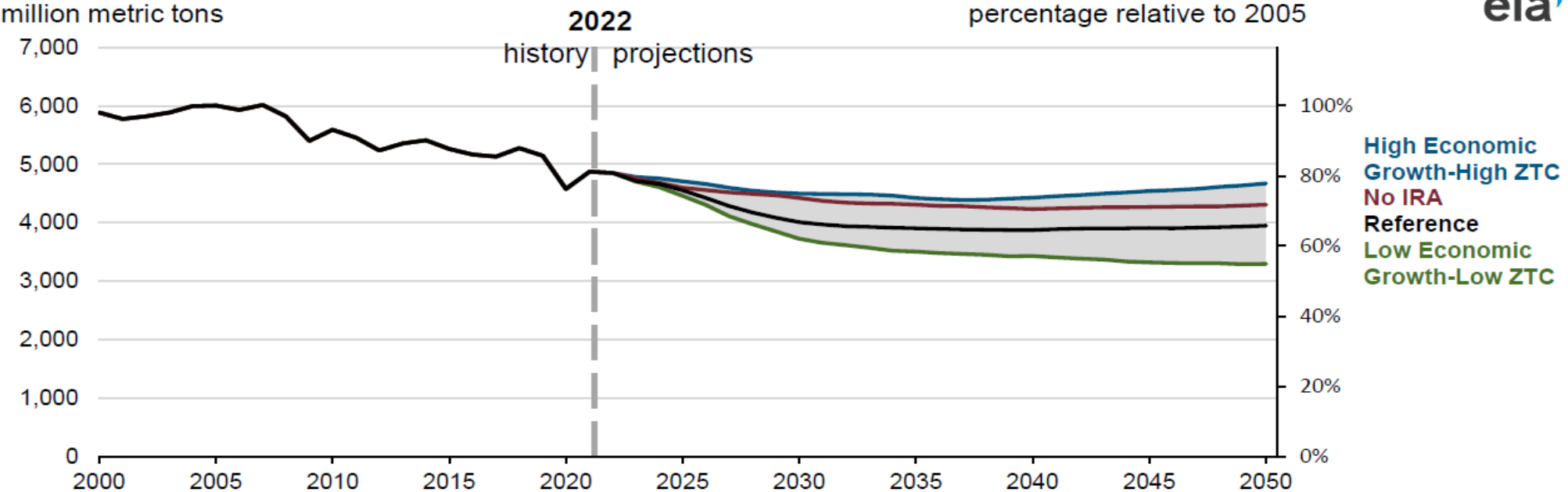
- Energy-related CO₂ emissions fall across all AEO2023 cases because of increased electrification, higher equipment efficiencies, and more zero-carbon electricity generation.
- Renewable generating capacity grows in all regions of the United States in all AEO2023 cases, supported by growth in installed battery capacity.
- Technological advancements and electrification drive projected decreases in demand-side energy intensity.
- The United States remains a net exporter of petroleum products and of natural gas through 2050 in all AEO2023 cases.



Reminder - AEO 2023 Highlights

By 2030, energy-related CO₂ emissions fall 25% to 38% below 2005 levels

Total energy-related carbon dioxide emissions
million metric tons



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. ZTC=Zero-Carbon Technology Cost; IRA=Inflation Reduction Act.

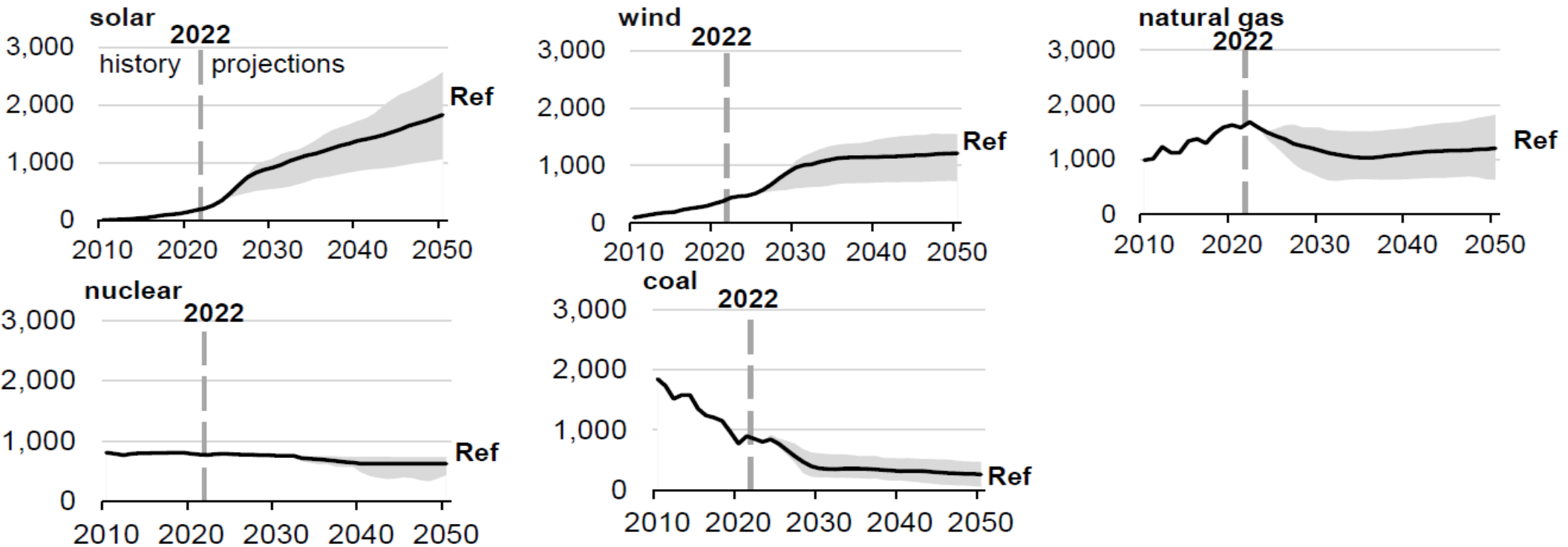


Reminder - AEO 2023 Highlights

Power demand is increasingly met by renewables

U.S. electricity generation by select technologies for all cases

billion kilowatthours



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.

Ref=Reference case

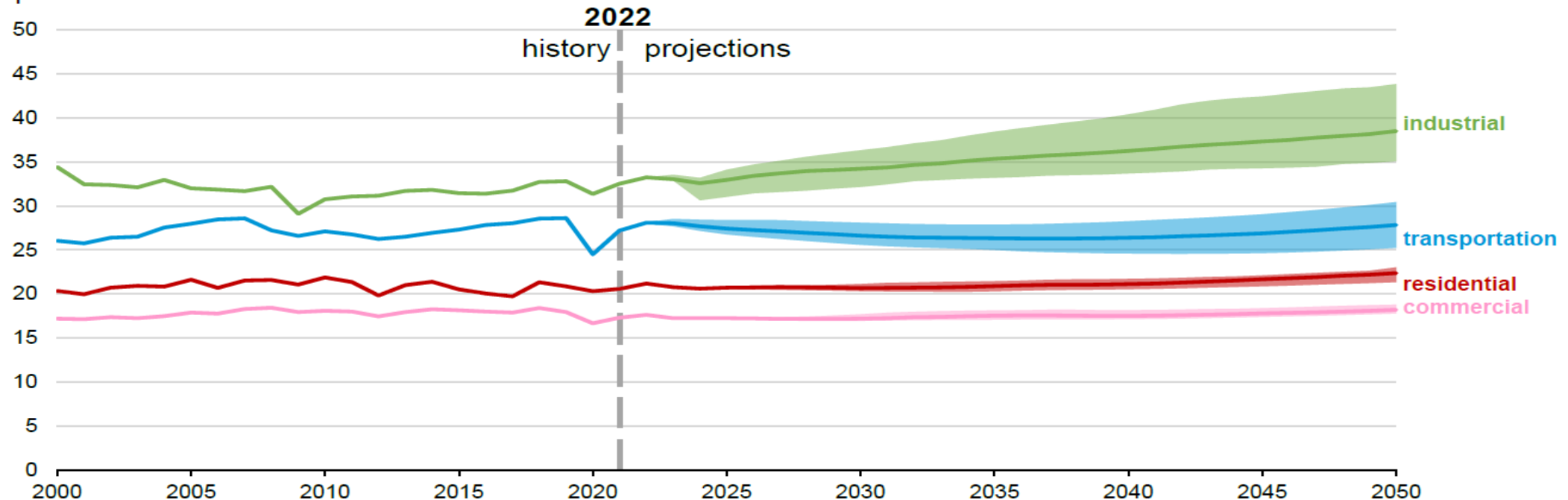
Source: EIA AEO 2023 – March 2023
1 quad = 1 quadrillion Btu # 25 Mtoe



Reminder - AEO 2023 Highlights

U.S. energy consumption increases to 2050, and electricity plays an increasingly larger role

Total energy consumption by end-use sector
quadrillion British thermal units



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

Note: Total consumption in end-use sectors includes purchased electricity and electricity-related losses. Each line represents AEO2023 Reference case projections. Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases.

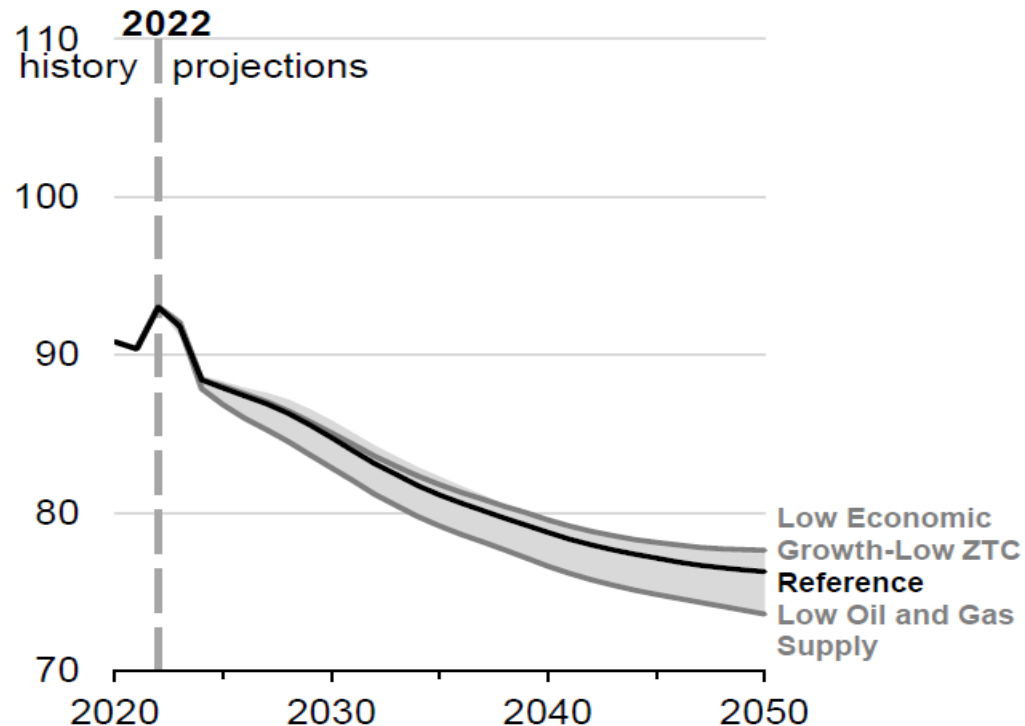
Source: EIA AEO 2023 – March 2023
1 quad = 1 quadrillion Btu # 25 Mtoe



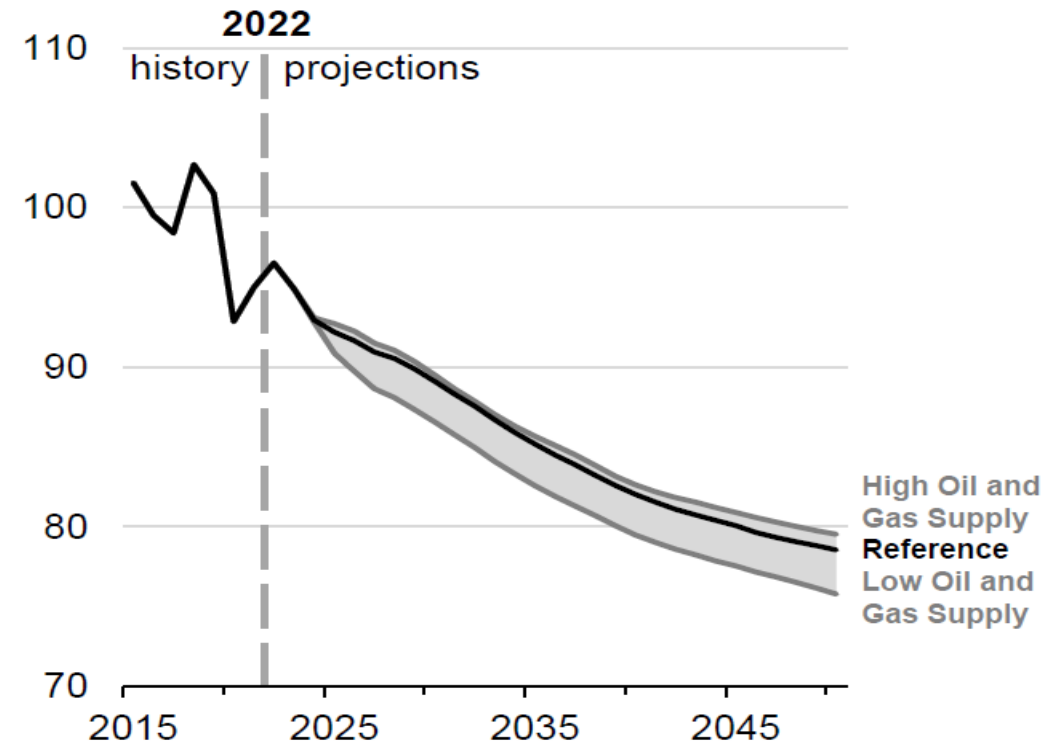
Reminder - AEO 2023 Highlights

Average energy intensity declines through 2050 across all cases

Residential delivered energy intensity
million British thermal units per household



Commercial delivered energy intensity
thousand British thermal units per square foot



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.

ZTC=Zero-Carbon Technology Cost

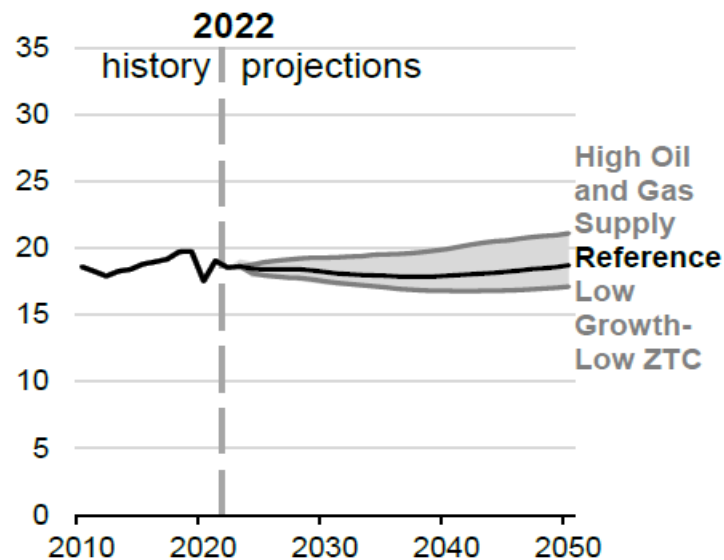
Source: EIA AEO 2023 – March 2023
1 quad = 1 quadrillion Btu # 25 Mtoe



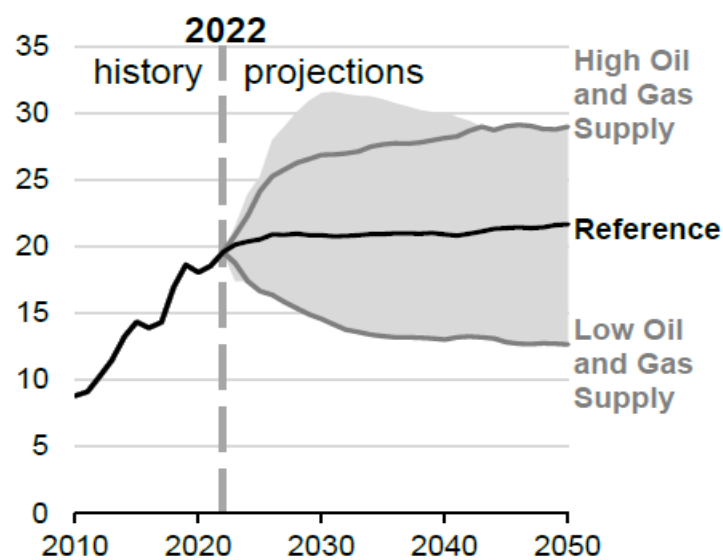
Reminder - AEO 2023 Highlights

In all cases, we project that the United States will remain a net exporter of petroleum products through 2050

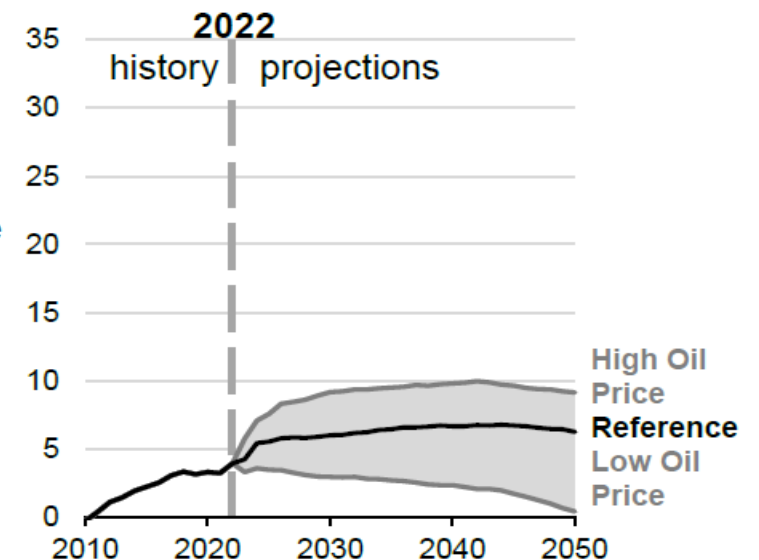
Petroleum and other liquids consumption
million barrels per day



Petroleum and other liquids production
million barrels per day



Petroleum products net exports
million barrels per day



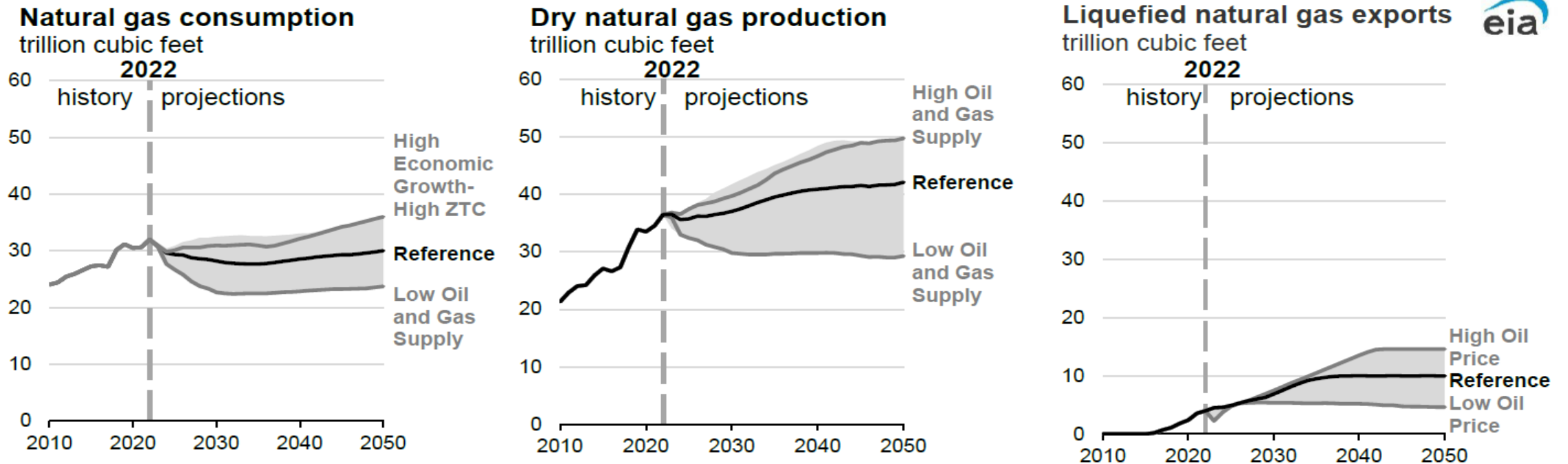
Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)

Note: Biofuels are not included in *petroleum and other liquids* production or consumption. Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases. ZTC=Zero-Carbon Technology Cost



Reminder - AEO 2023 Highlights

Liquefied natural gas exports drive production; domestic consumption remains stable



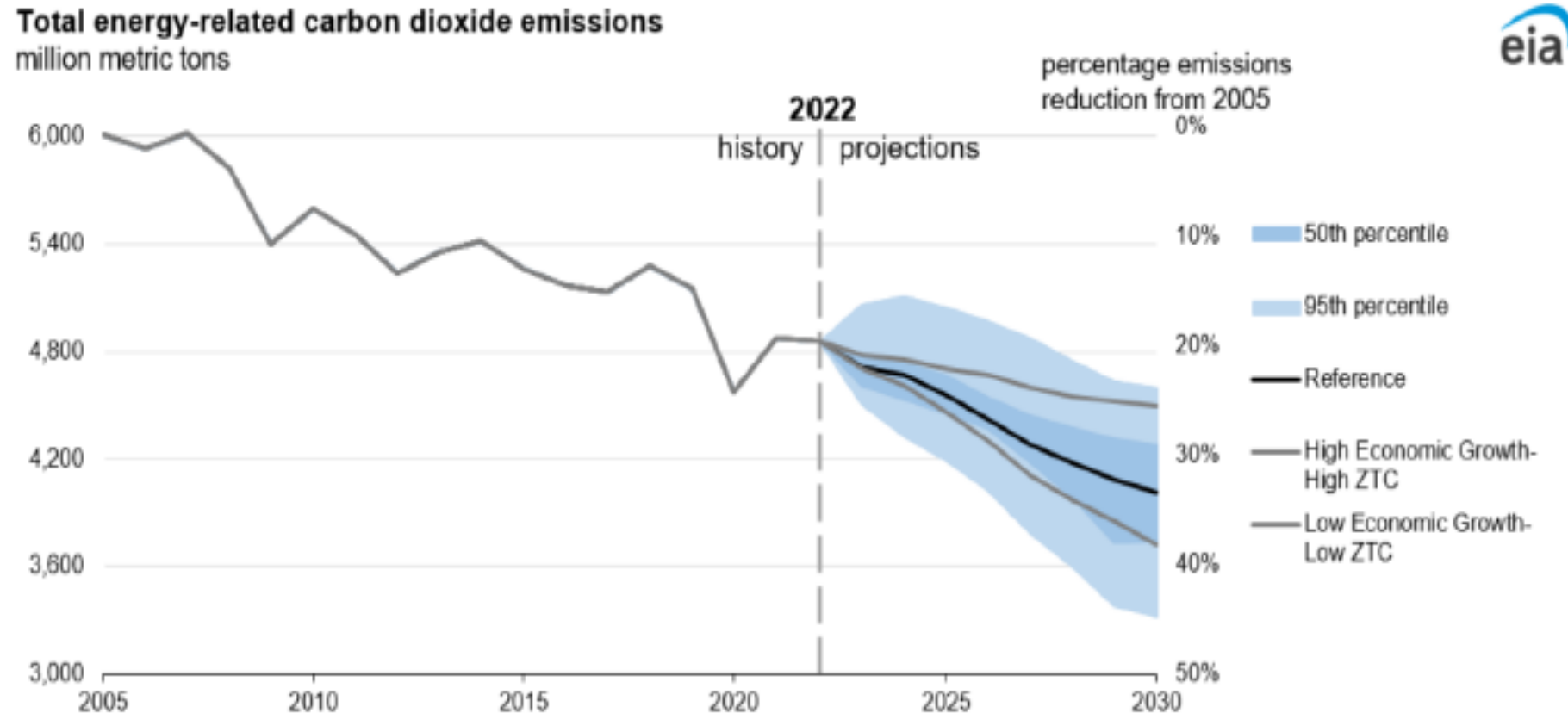
Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)

Note: Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases. ZTC=Zero-Carbon Technology Cost

Source: EIA AEO 2023 – March 2023
1 quad = 1 quadrillion Btu # 25 Mtoe



Reminder - AEO 2023 Highlights



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

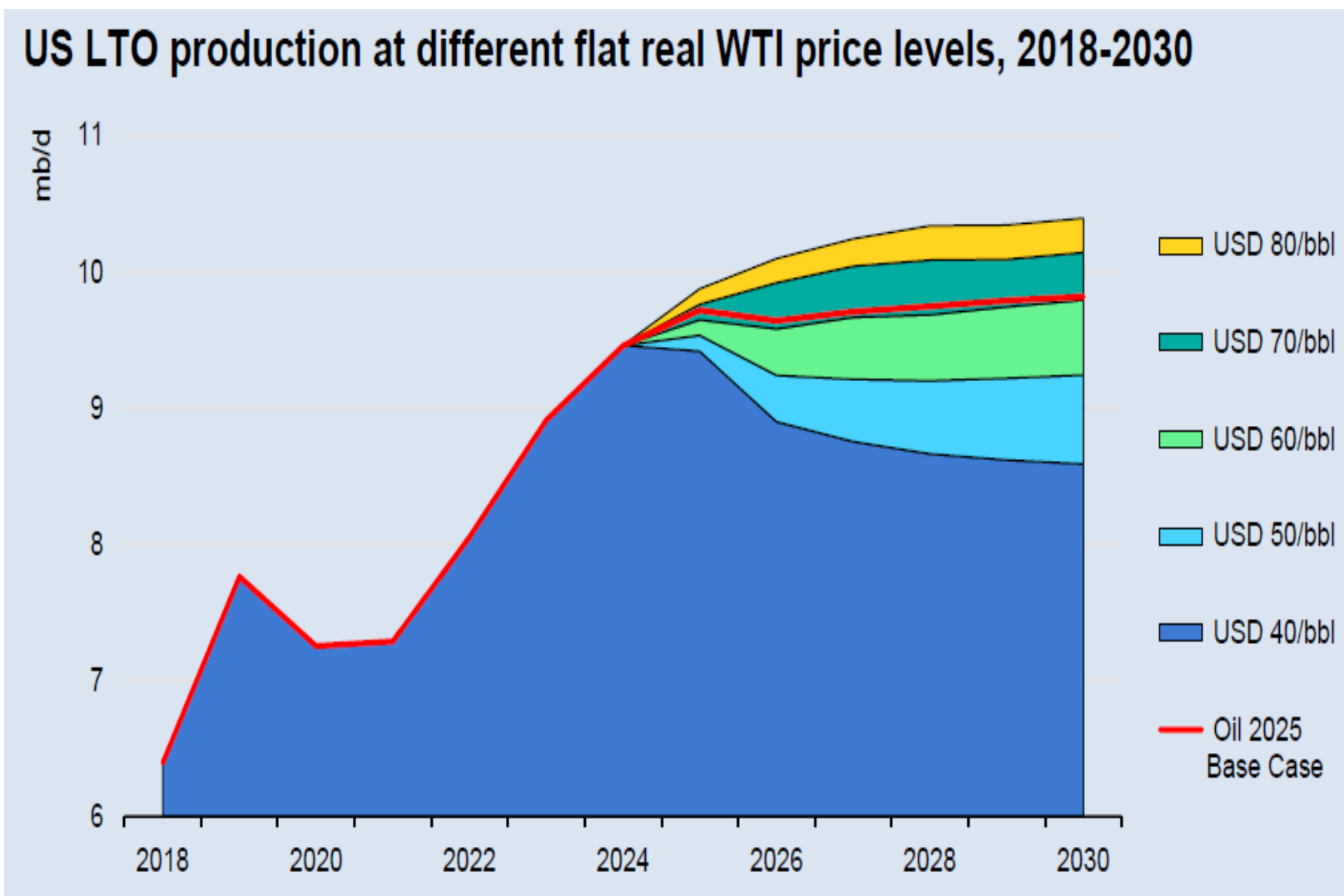
Note: Cone of uncertainty associated with total energy-related CO₂ emissions using empirical projection intervals. Historical values and AEO2023 Reference case are displayed as solid black line. The projection error density forecast by blue shaded areas. The different shades correspond to the 50th and 95th percentiles. AEO2023 envelope side cases are in solid grey lines. ZTC=Zero-Carbon Technology Cost.



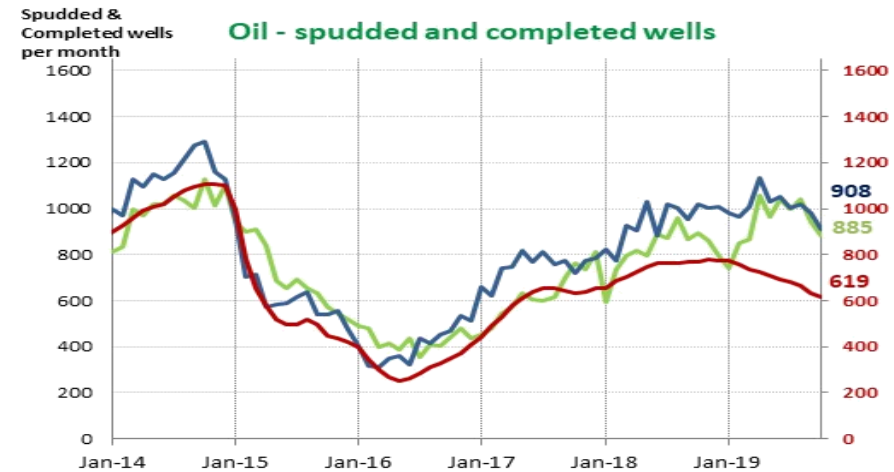
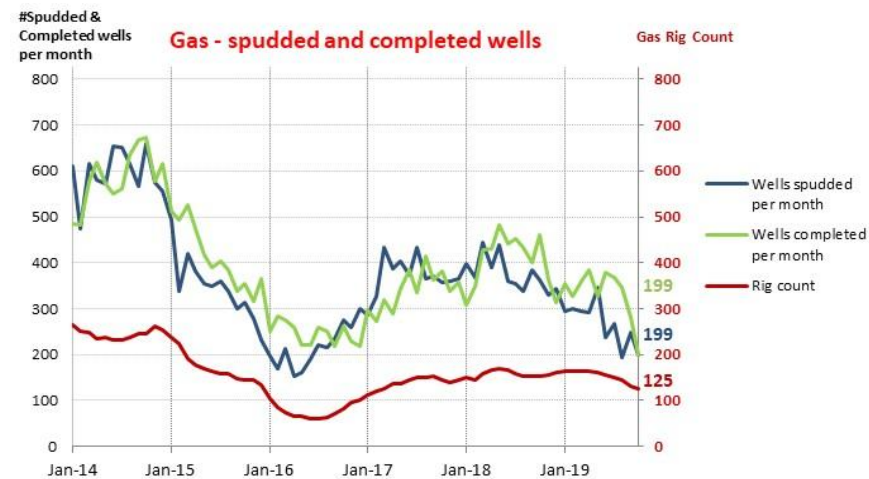
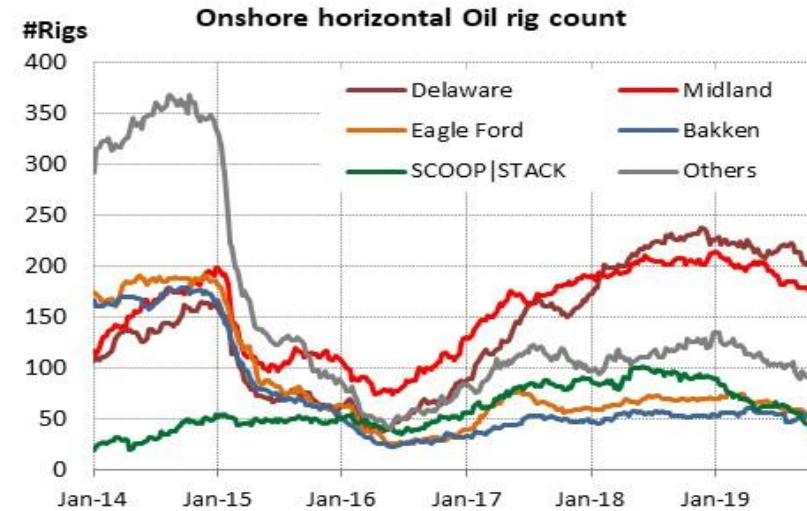
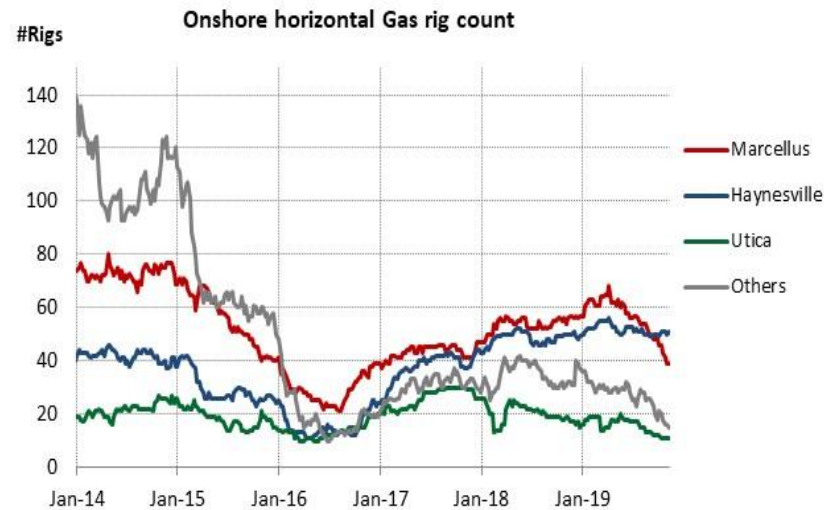
Logistical Aspects
Activity Level depends upon Oil & Gas Price
and Technical Environment



US LTO future Production depends upon the Crude Oil Price



Reminder: US Drilling and Completion Activity 2014 - 2019

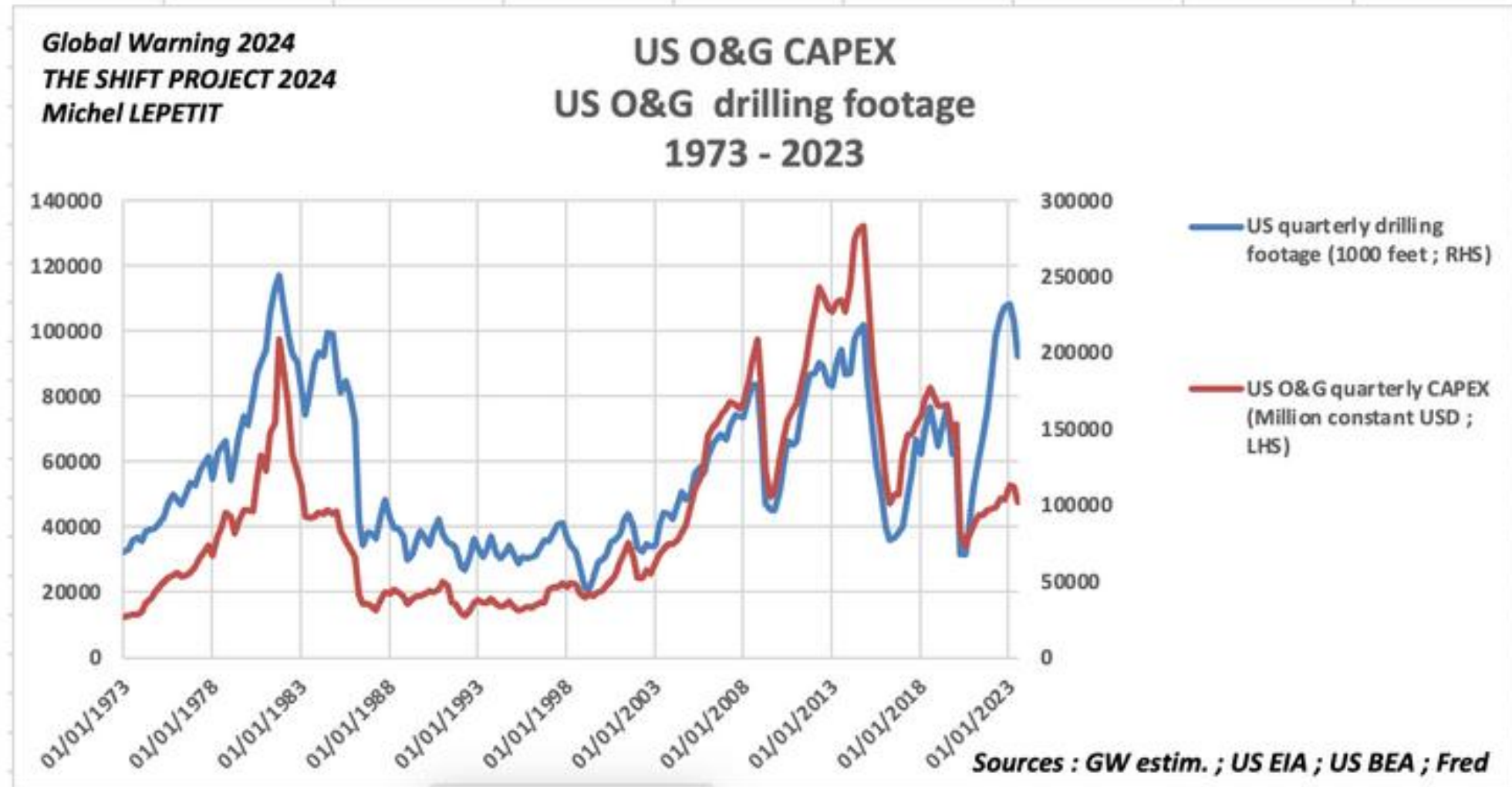


Source: Rystad, Baker Hughes, Total

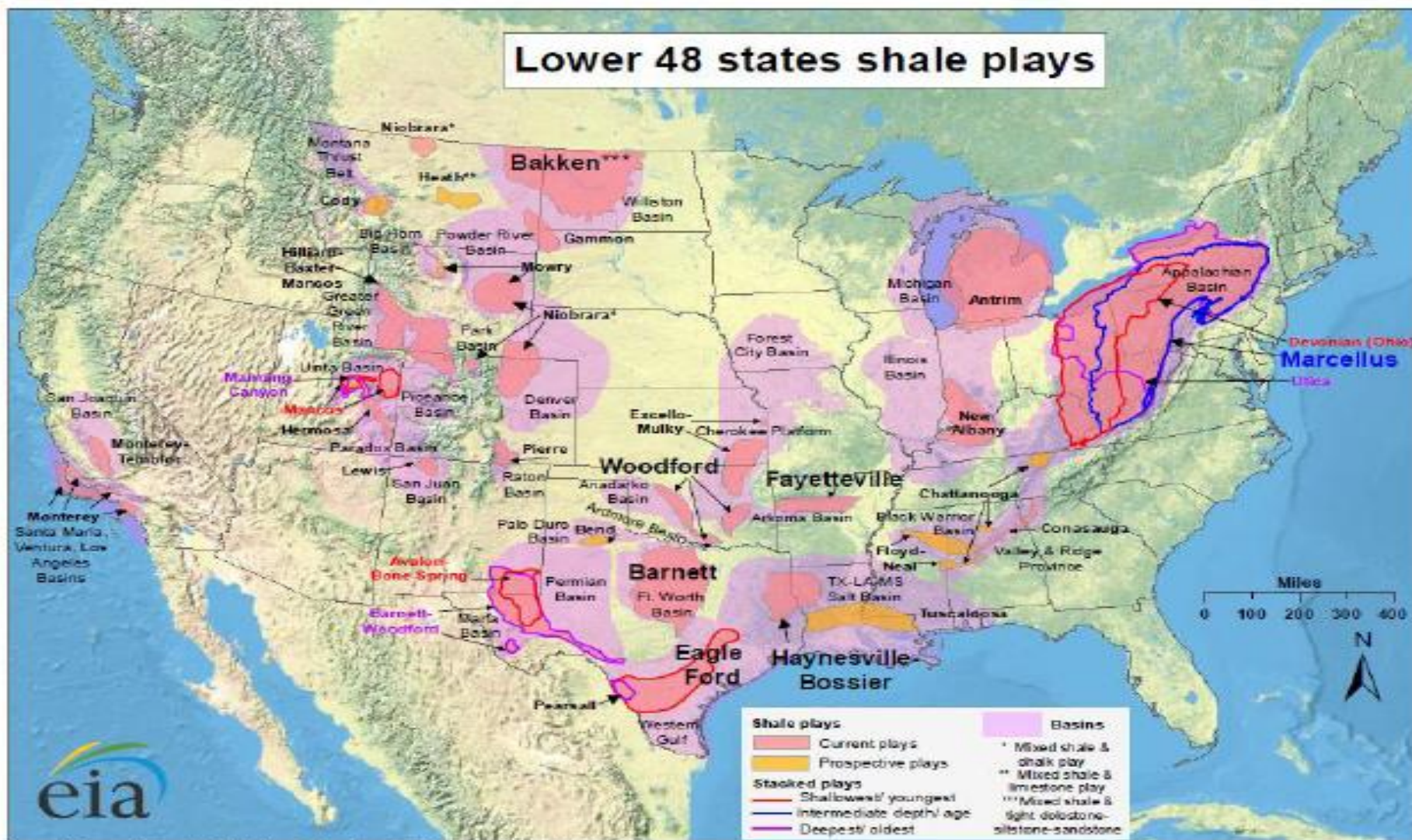


US O&G Capex vs Drilling Footage

Increased activity as from 2000 but large fluctuations



New plays to potentially impact supply-demand balance



Gas Shale exploitation

Dallas-Forth Worth airport

- **55 pads**
- **8 wells per pad**
- **300-325 wells**



Some comments on Gas prices
See Book 5



US Shale Gas: a game changer, but sharp decrease of gas price challenges profitability

- Depending upon zones, production costs vary from 2 to 8 \$/Mbtu.
- With a current gas price of 2/3 \$/Mbtu, profitability is questioned.
- Barnett basin: less profitable, dry gas.
- Marcellus, Utica basins: low costs, good profitability.
- Production of associated liquids in shale gas improves the profitability.
- Shale oil business combined with associated gas production is more profitable.
- And profitability and break-even costs improve thanks to the technical progress.
- Activity are very dependant upon the gas price and oil price fluctuations.
- The Trump Administration is promoting a dynamic development of Oil & Gas activity in the US



Specific cases

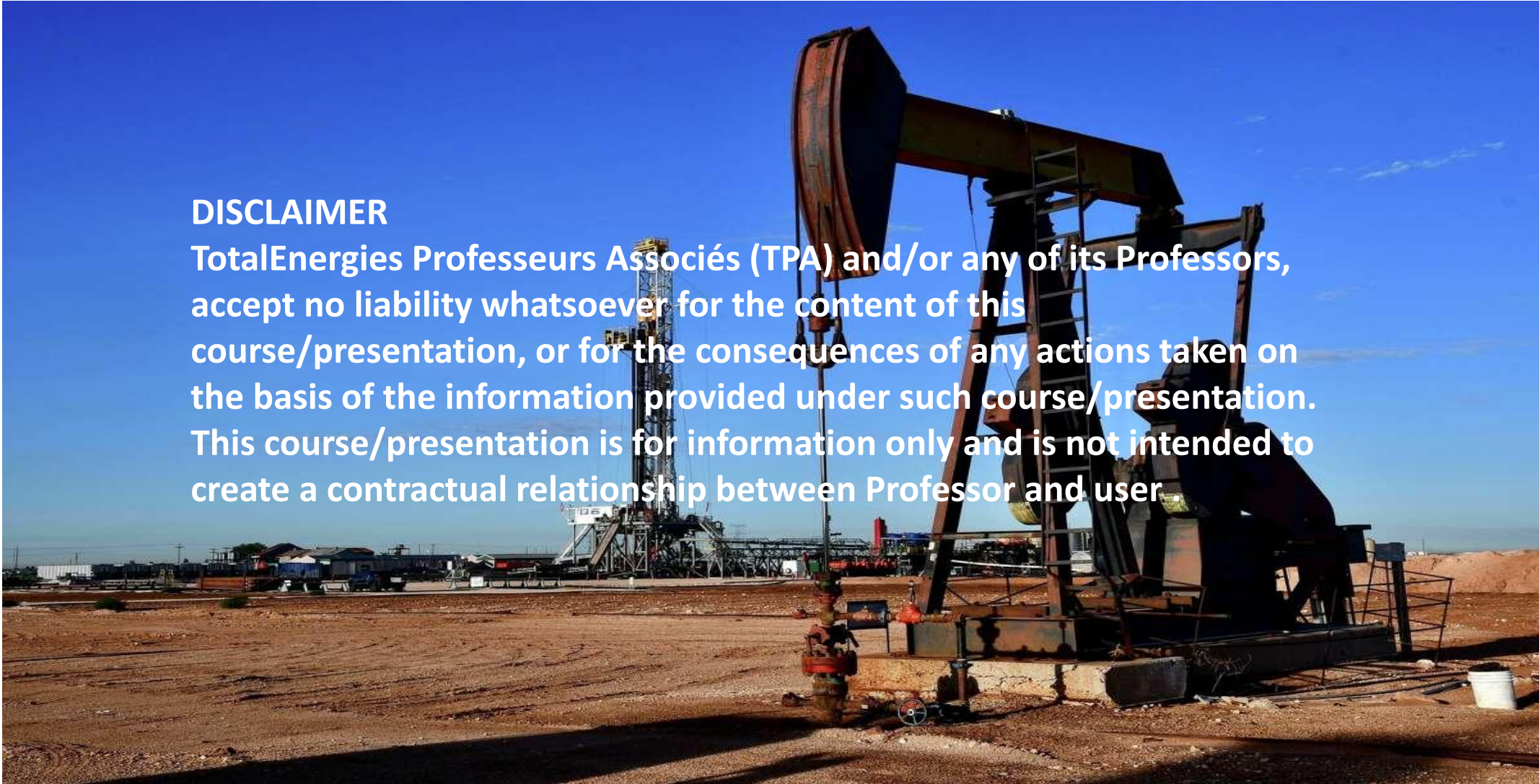
- **In France, a number of licences for gas shales exploration and exploitation have been cancelled.**
- **Hydraulic fracturation technic is forbidden (Law 13 july 2011)**
- **Gas shales exploration is forbidden.**
- **Under the initiative of UFIP (Union Française des Industries Pétrolières), establishment of « Centre des Hydrocarbures Non Conventionnels ».**



Unconventional Oil & Gas – History & current situation

- In Europe, the context is different from US. Lower density of population in the US in the prospective areas, more flexible legislation,.....compared to those in Europe.
- Drilling operations started in UK, Germany, Poland.
- Poland consumes 15 Gm3 Natural Gas per year. 2/3 are imported from Russia. Poland is deemed to have important shale gas resources (Evaluation from 800 to 2000 Gm3). The first wells have been disappointing. Chevron, ExxonMobil, ENI and Total stopped their prospection. With the objective to reactivate the Petroleum Companies' interest to explore and exploit shale gas, the government created a « Zone franche » sector of activity, which can benefit a reduced income tax rate.
- Despite fluctuations, the drastic decrease of crude price in 2015/ 2017 and 2020 has currently limited the prospection activity. But activity of Unconventional Hydrocarbons production is linked with the prices of these commodities.
- The russian invasion of Ukraine has upset the european gas market and has reinforced the role of US in supplying Europe.
- In the US, as from 2025, the Trump Administration clearly announced the promotion of developing intensively Oil & Gas (« Drill, baby, drill »)





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