

# The OUTLOOK FOR U.S. NATURAL GAS SUPPLY

EPRINC LNG WORKSHOP

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MICHAEL C. LYNCH

[LYNCH@ENERGYSEER.COM](mailto:LYNCH@ENERGYSEER.COM)

# *Natural Gas Supply to 2100*

**M. A. Adelman**

*Professor Emeritus, Economics Department and Center for Energy and Environmental Policy  
Research, Massachusetts Institute of Technology*

and

**Michael C. Lynch**

*Research Affiliate, Center for International Studies, Massachusetts Institute of Technology*

PREPARED FOR 2003  
WORLD GAS CONFERENCE  
TOKYO



DRI • WEFA, A Global Insight, Inc. Company



International Gas Union

Union Internationale de L'Industrie du Gaz

# SOME BASICS

## ▶ ENERGY

- ▶ MOST EXPERT OPINION ISN'T REALLY
  - ▶ CLICHES, BIAS

## ▶ SUPPLY

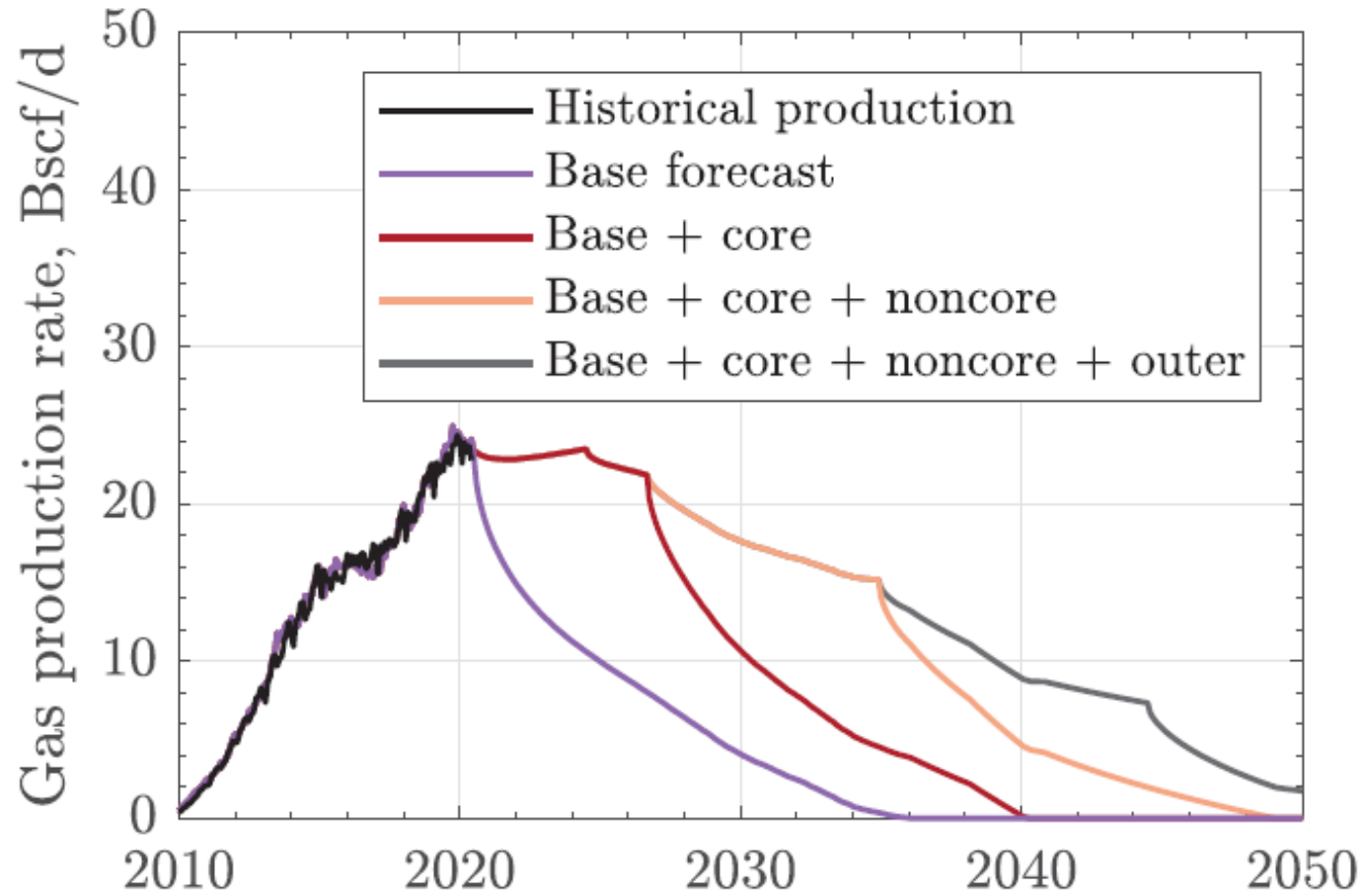
- ▶ BAD MODELING
  - ▶ HUBBERT CURVES, RTD
- ▶ MALTHUSIAN BIAS
  - ▶ CAN'T PREDICT DISCOVERIES, ASSUME NONE
- ▶ OMITTED VARIABLES
  - ▶ TECHNOLOGICAL PROGRESS
  - ▶ IN-FILL DRILLING
  - ▶ PRICE: REALLY?

# MANY CONCERNS

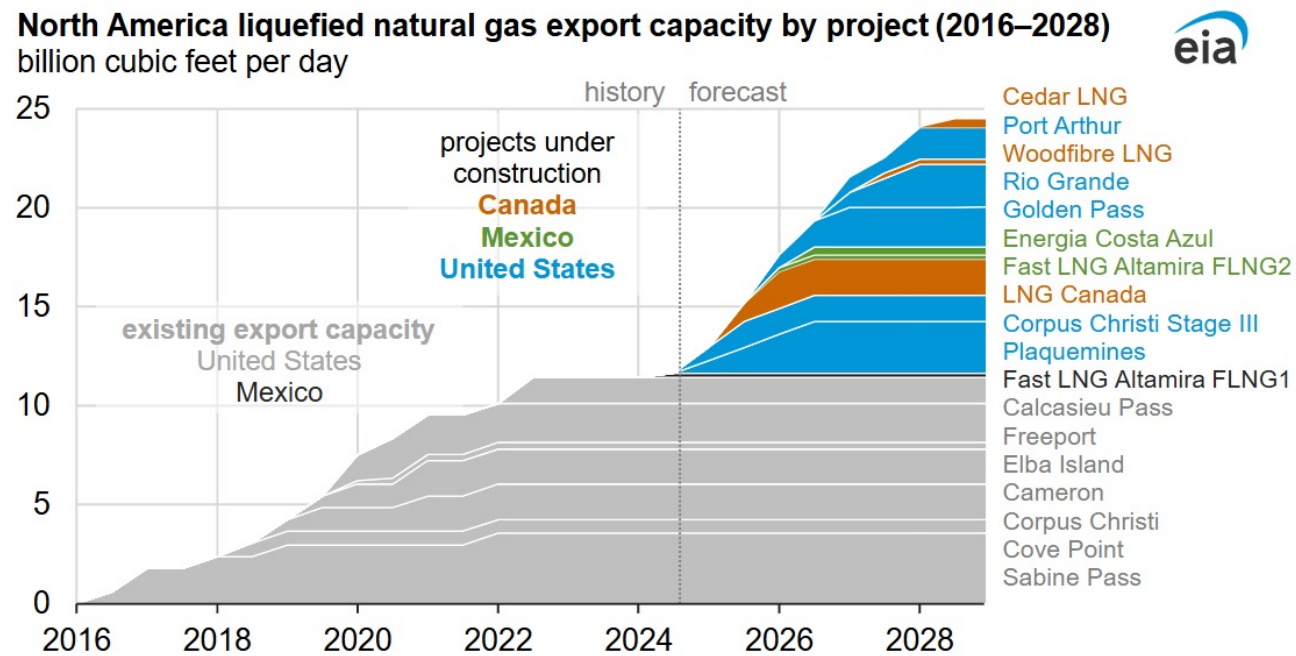
- ▶ GENERALIZED FEARS
  - ▶ “GIANT SLURPING SOUND”
  - ▶ “RETIREMENT PARTY NOT A BOOM”
  - ▶ “BUBBLE”
- ▶ SPECIFIC ISSUES
  - ▶ SWEET SPOT DEPLETION
  - ▶ FLATTENING SUPPLY
  - ▶ SOARING LNG EXPORTS
  - ▶ POLITICS
    - ▶ FRACKING BANS
    - ▶ LNG EXPORT PAUSE
    - ▶ GAS APPLIANCE BANS

# IS MARCELLUS NEAR A PEAK?

(SAPUTRA ET AL 2024)



# WILL THIS PUT PRESSURE ON DOMESTIC PRICES?



**Data source:** U.S. Energy Information Administration, [Liquefaction Capacity File](#), and trade press

**Note:** Export capacity shown is project's baseload capacity. Online dates of LNG export projects under construction are estimates based on trade press. LNG=liquefied natural gas; FLNG=floating liquefied natural gas

# THE LOOMING CRISIS

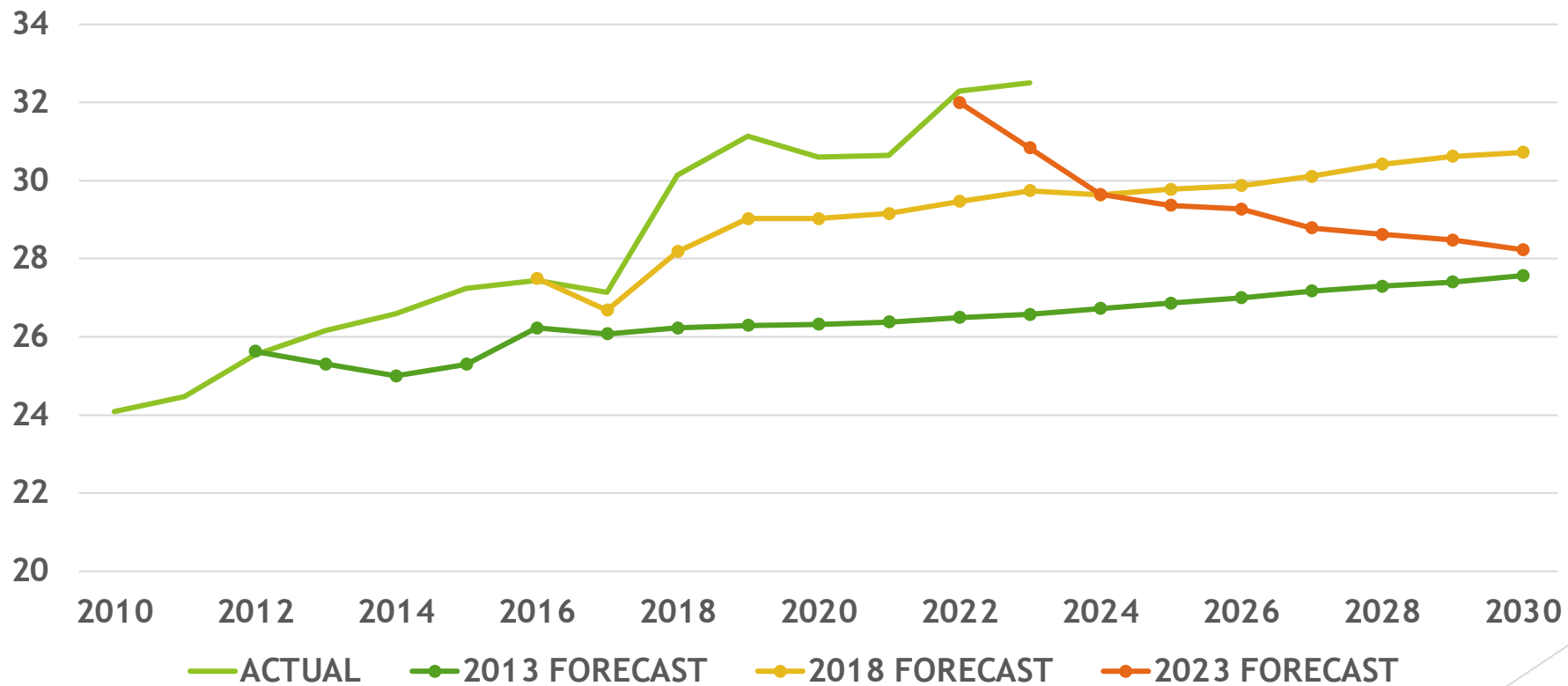
- ▶ **“Like all bubbles, this one will pop sooner than expected and when it does, the aftermath will be very unpleasant.”**
- ▶ **“However, high well- and field-decline rates, coupled with a finite number of drilling locations, suggest that production will drop off sharply when sweet spots are depleted.”**
- ▶ **“we've already drilled through all of the known sweet spots in these plays.”**
- ▶ **“Shale is not a revolution—it's a retirement party.”**
- ▶ **“...the shale gas boom is rapidly maturing and we are quickly approaching a point where shale gas production heads into decline. In fact, the majority of shale gas basins in America are already exhibiting declining production.”**
- ▶ *(All of these pre-date 2015; shale gas production has since doubled, adding 40+ bcf/d to supply)*

# MARKET BALANCE (EIA FORECAST; TCF/YR)

	<b>Changes:</b>	
	<b>2023-2018</b>	<b>2028-2023</b>
<b>Dry Gas Production</b>	<b>5.716</b>	<b>-0.05</b>
<b>Net Pipeline Exports</b>	<b>0.609</b>	<b>1.281</b>
<b>Net LNG Exports</b>	<b>3.321</b>	<b>1.612</b>
<b>Consumption</b>	<b>1.743</b>	<b>-0.691</b>

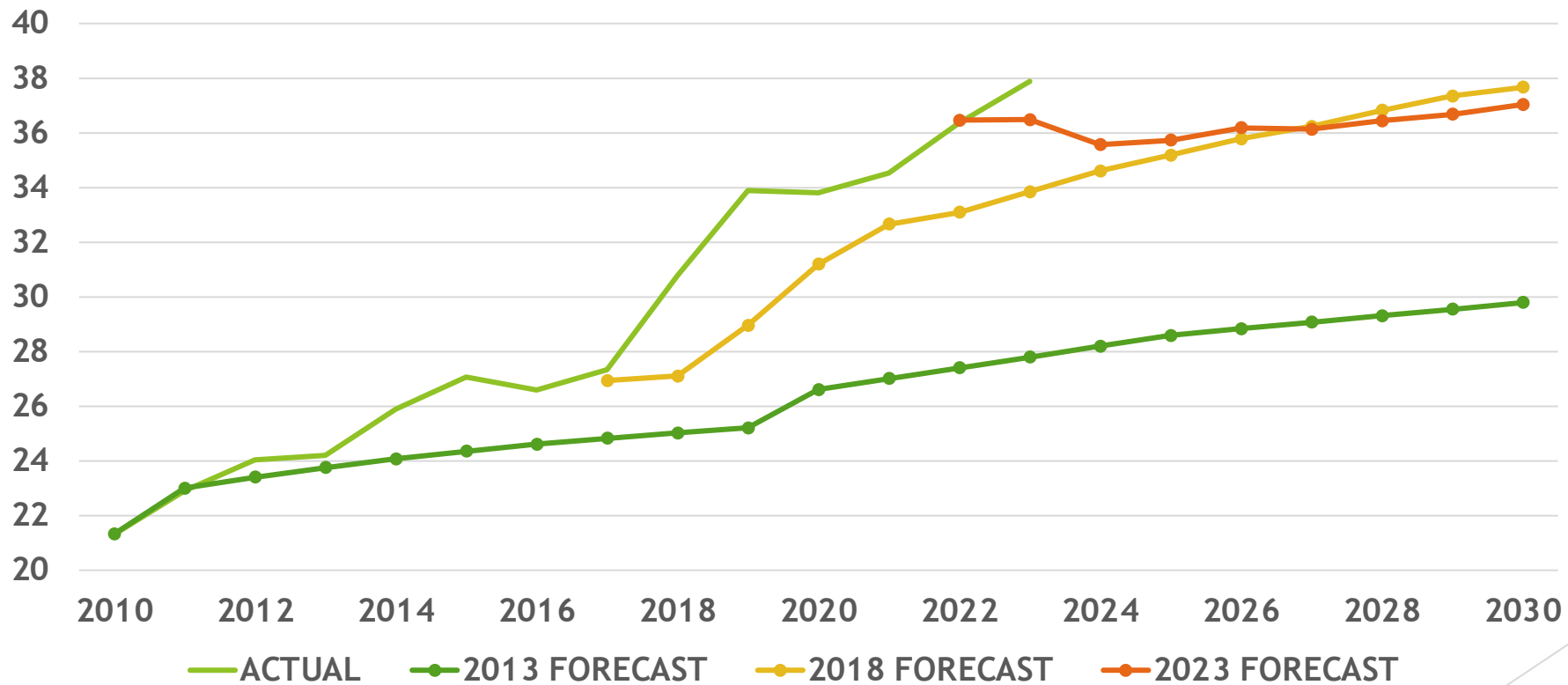


# CONSUMPTION KEEPS GROWING (EIA FORECASTS)



THE EIA'S PAST CONSUMPTION FORECASTS WERE REPEATEDLY TOO PESSIMISTIC.

# ...AND PRODUCTION

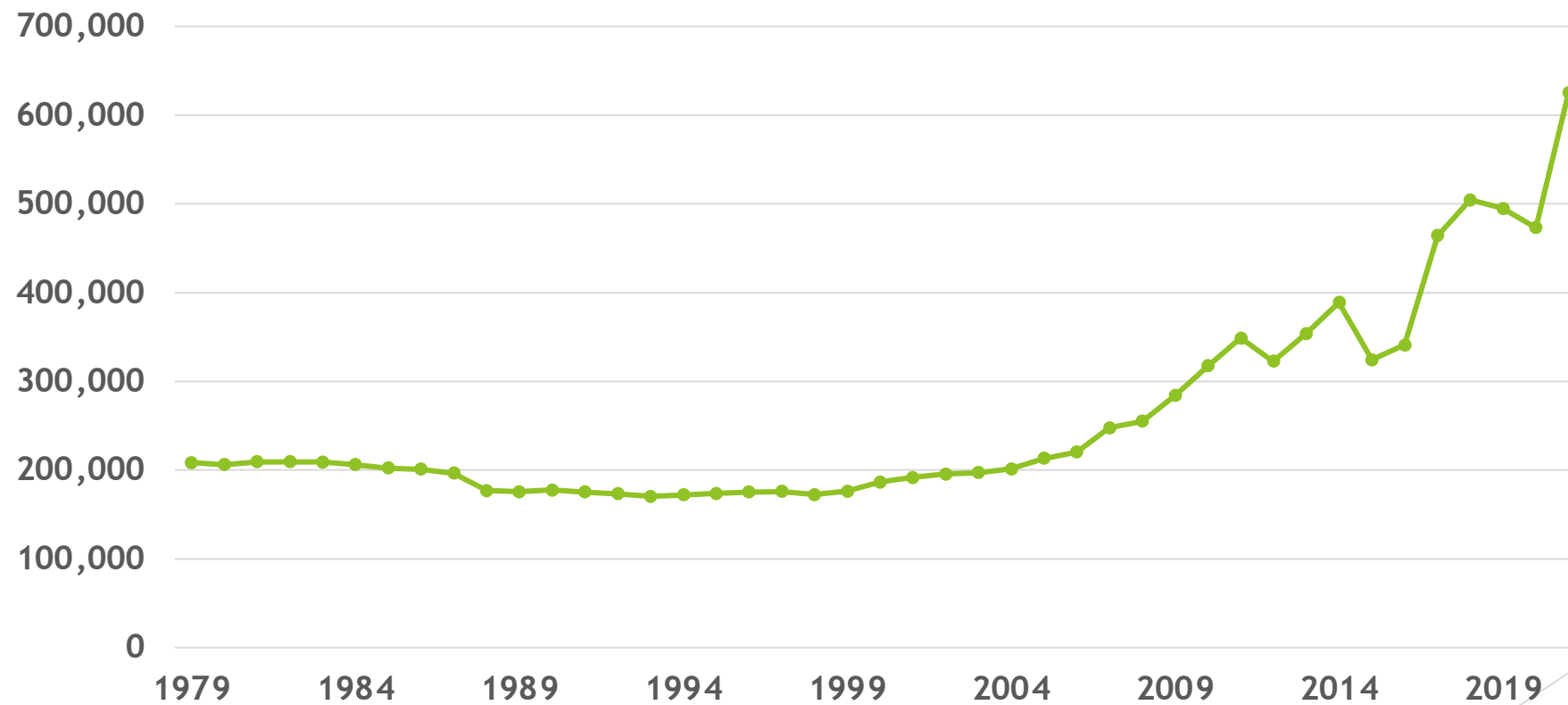


PRODUCTION FORECASTS HAVE ALSO BEEN TOO PESSIMISTIC. SKEPTICISM SHOULD BE USED WHEN CONSIDERING THEIR PROJECTIONS.

# THE PROBLEM OF RESOURCES

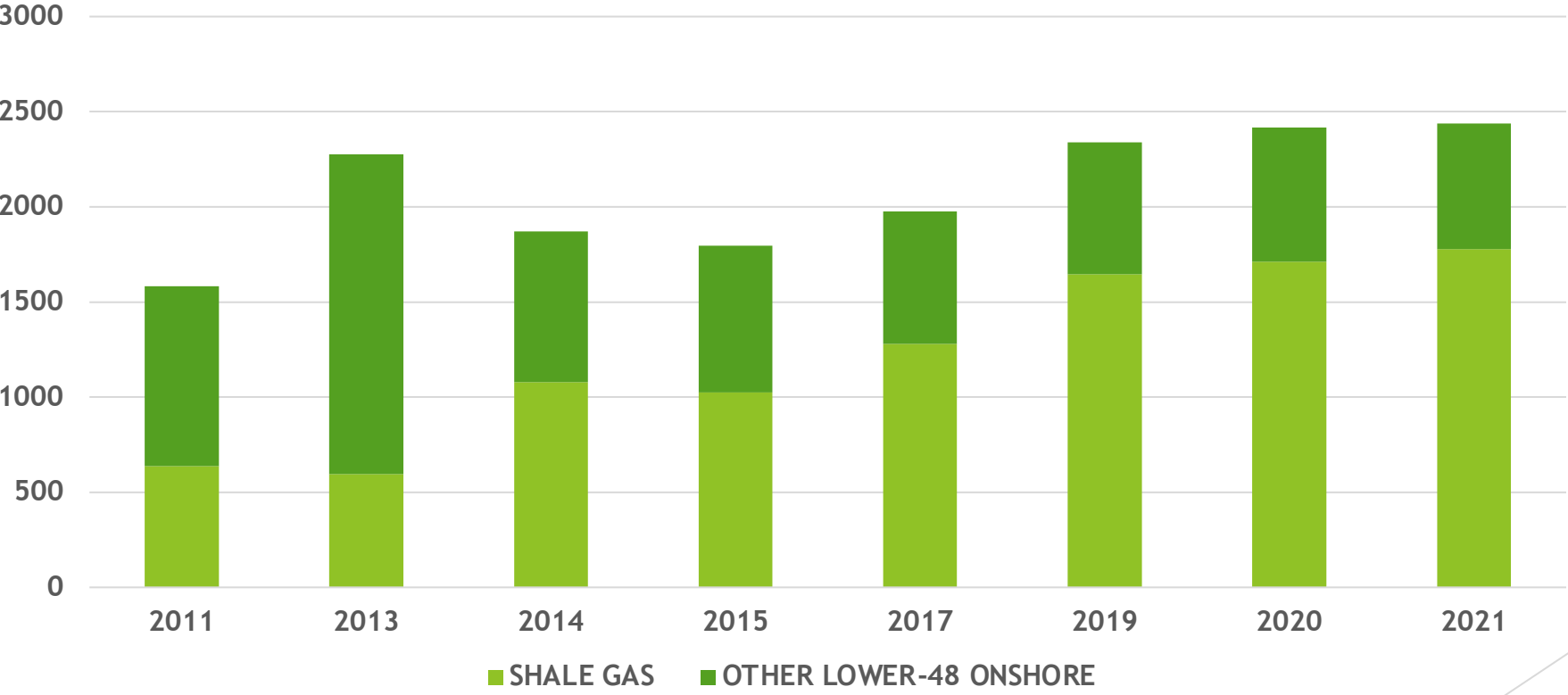
- ▶ FINITE BUT NOT REALLY
  - ▶ AND NOT RELEVANT
- ▶ LONG-TERM INCREASES
  - ▶ BETTER KNOWLEDGE
  - ▶ BETTER METHODS
    - ▶ UNLEASHING NEW SOURCES
      - ▶ COAL BED METHANE, THEN SHALE, NEXT HYDRATES?
- ▶ 90% OF ESTIMATES TOO PESSIMISTIC (EVEN USGS)
  - ▶ OIL URR GOES FROM 500 BB IN 1950 TO 2000 IN 1970 TO 3500 NO

# WET GAS RESERVES (BCF)

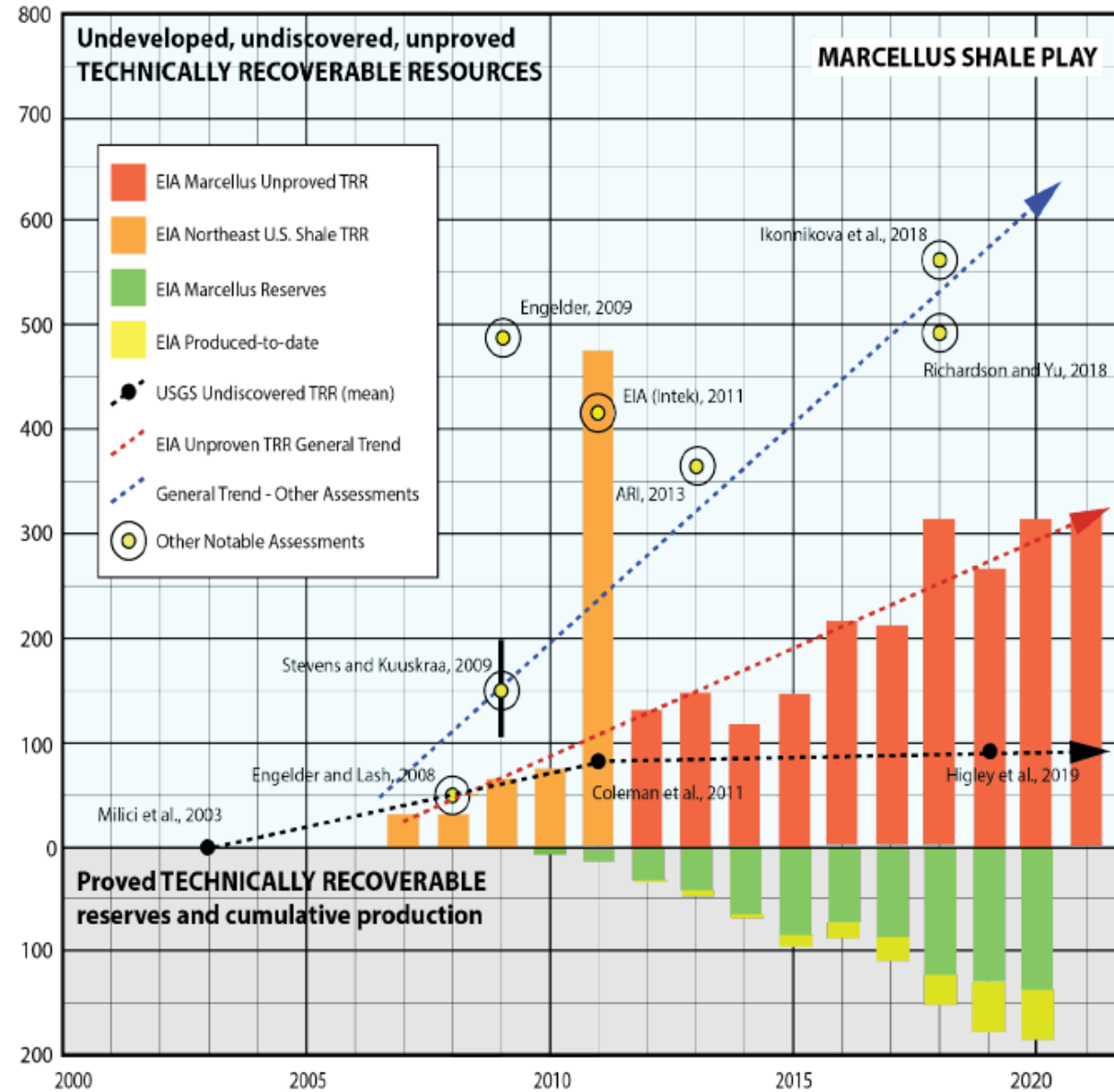


# RESOURCES GROW

## EIA ESTIMATES OF ONSHORE TRR IN TCF



Tcfg



**RESOURCE ESTIMATES ARE GROWING NOT SHRINKING**

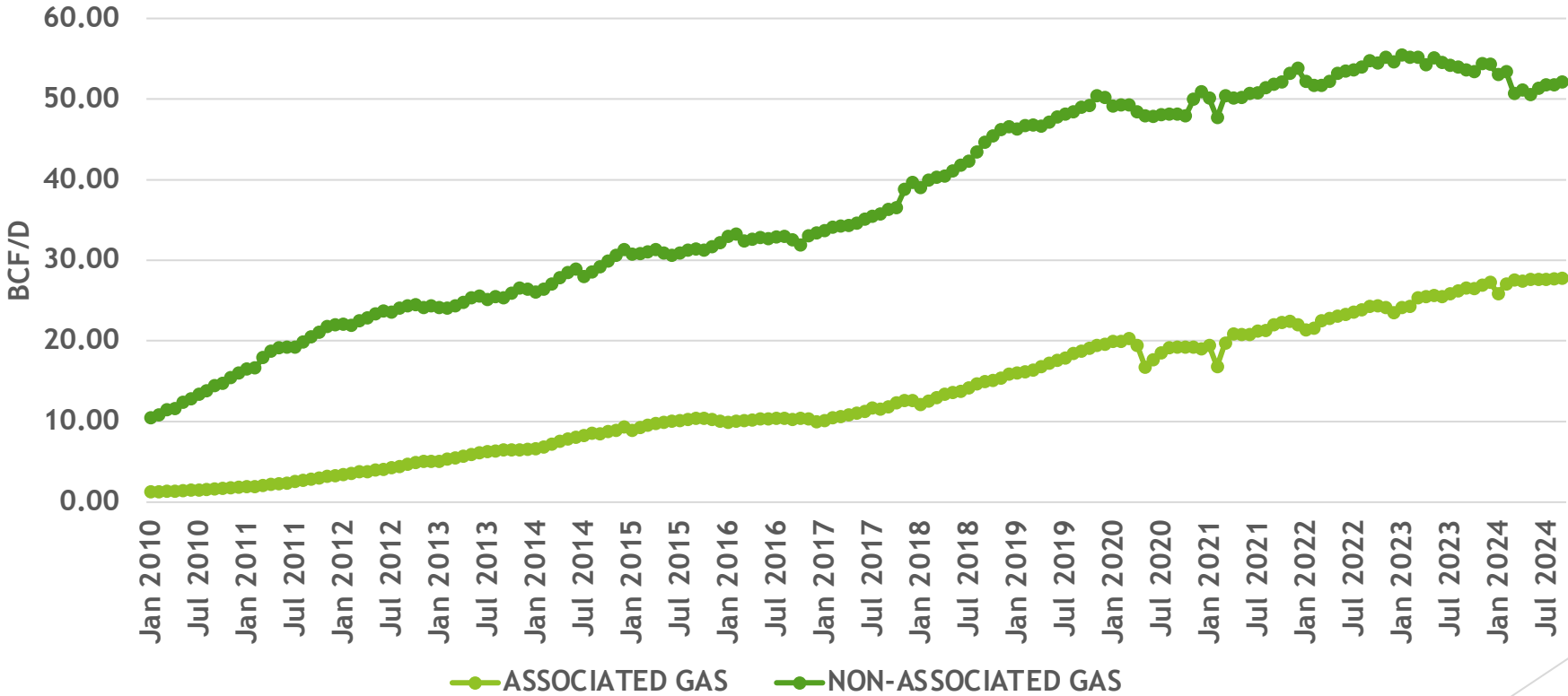
**SOURCE: NETL, BOSWELL (2021)**

# ASSOCIATED GAS

- ▶ GAS PRICE A SMALL SHARE OF REVENUE
- ▶ RESOURCE BASE IS LARGE
  - ▶ PERMIAN: 81 TCF RESERVES
    - ▶ USGS ESTIMATE OF 'UNDISCOVERED' IS 270 TCF
    - ▶ PRODUCTION 7% OF RESERVES, 1.8% OF TOTAL
  - ▶ EAGLE FORD: 40 TCF PROVED RESERVES
    - ▶ USGS ESTIMATE OF 66 TCF UNDISCOVERED
    - ▶ PRODUCTION IS 4% OF RESERVES, 1.5% OF TOTAL

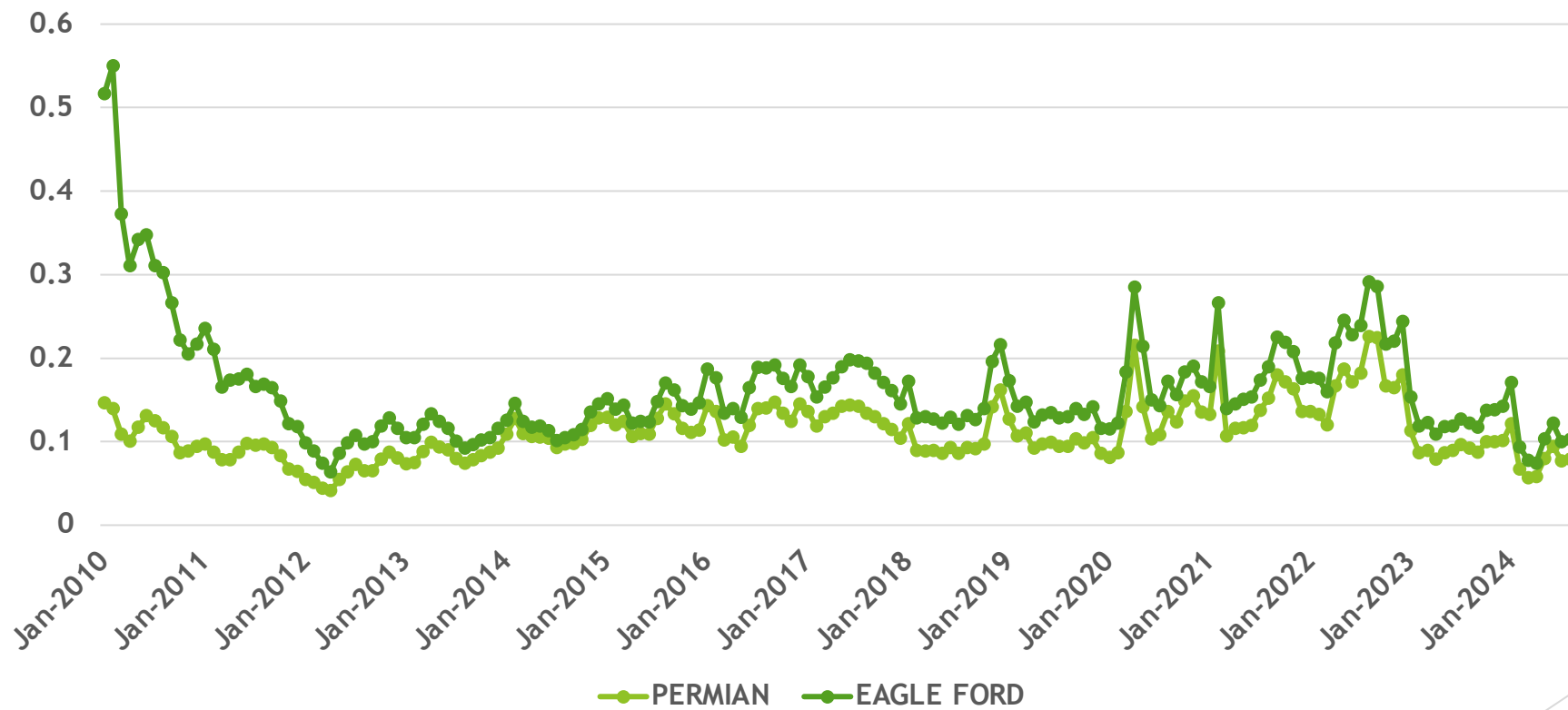
# RELATIVE PRODUCTION

(ASSOCIATED VS NON-ASSOCIATED GAS)





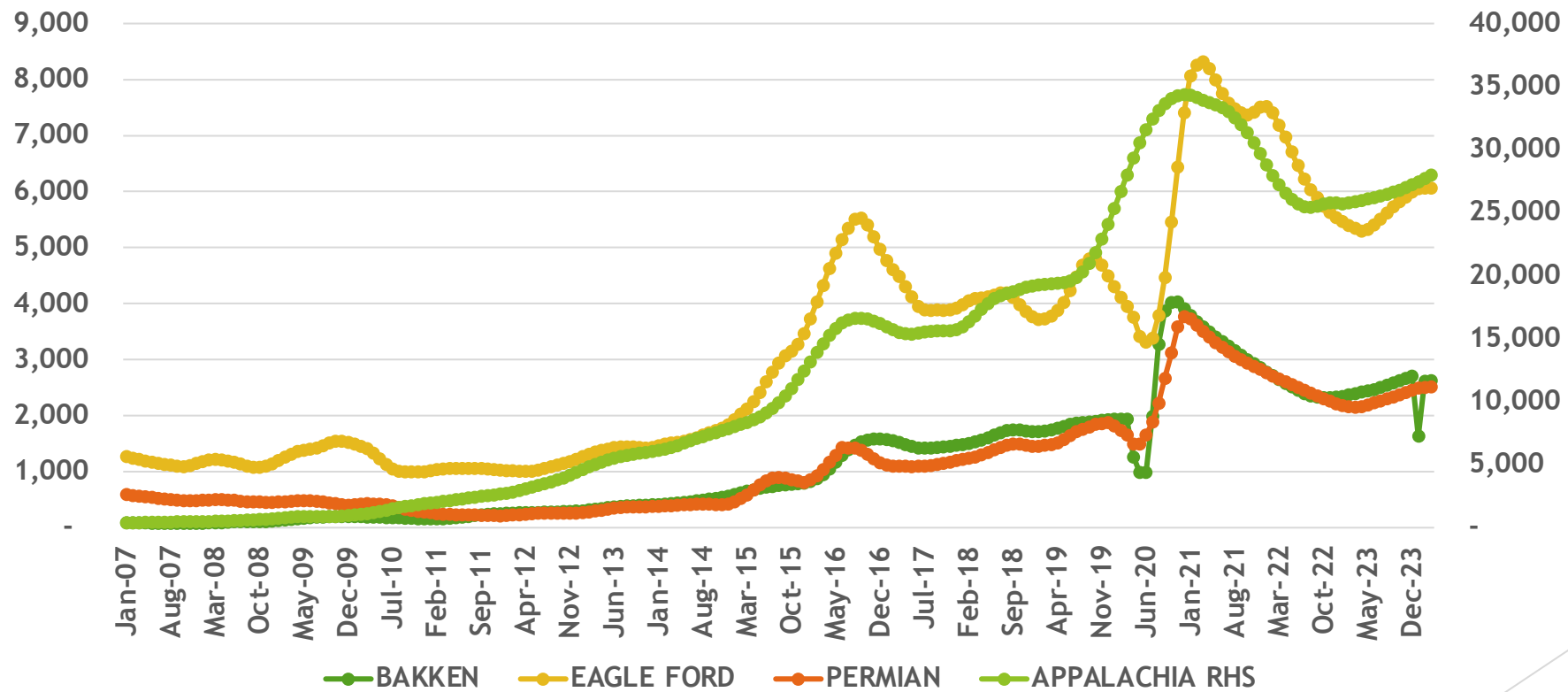
# SHARE OF REVENUE FROM GAS



# DEPLETION VERSUS PRODUCTIVITY

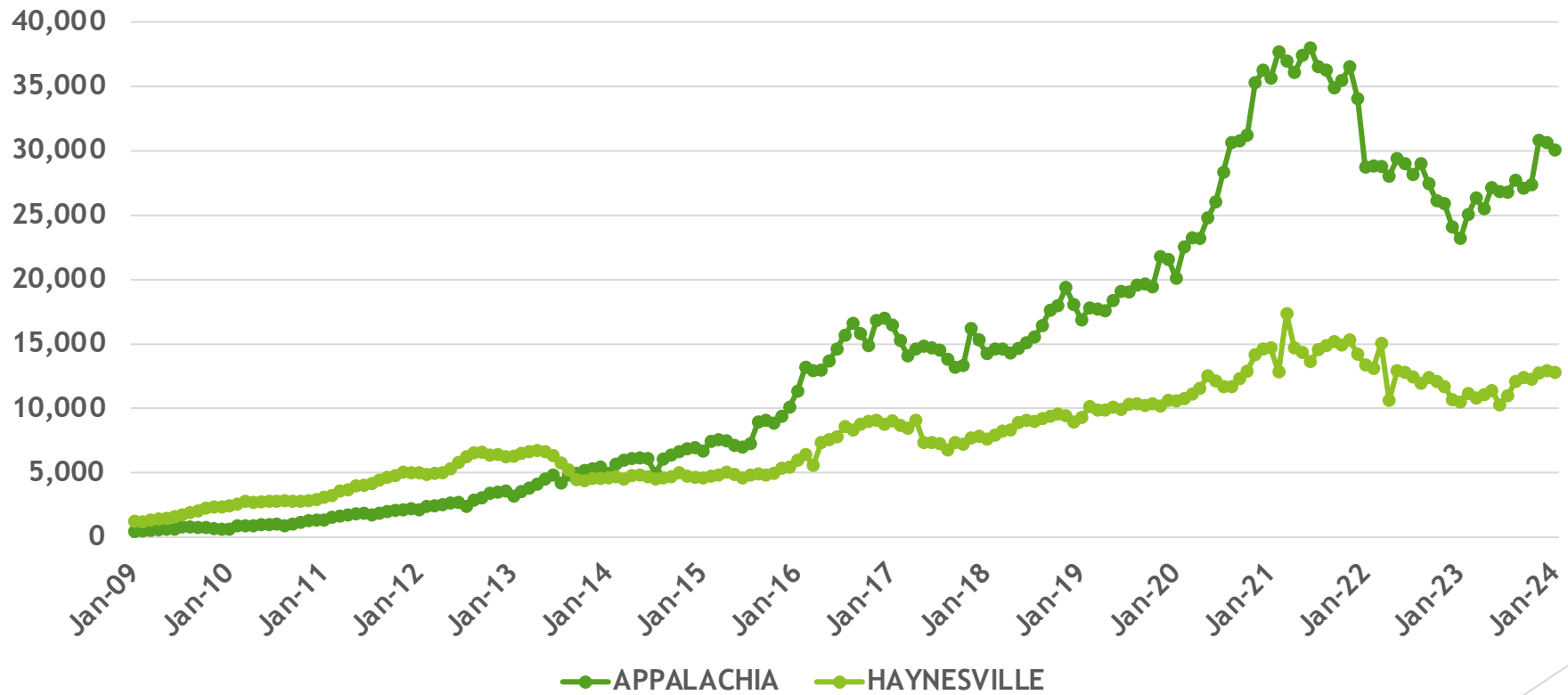
- ▶ AN AGE OLD STORY
- ▶ CARTER IN 1977: WE NEED A NEW SAUDI ARABIA EVERY THREE YEARS
- ▶ PEAK OIL SCARE AND THE RED QUEEN
  - ▶ TECHNOLOGY ACCELERATES PRODUCTION, DOESN'T INCREASE RECOVERY
- ▶ EVERY HIGH SHALE DECLINE RATES
  - ▶ 60-80% IN ONE TO TWO YEARS
- ▶ BUT OMITTED VARIABLES:
  - ▶ BETTER RECOVERY
  - ▶ MORE DRILLING

# RIG PRODUCTIVITY (MCF/D/RIG; EIA DATA)

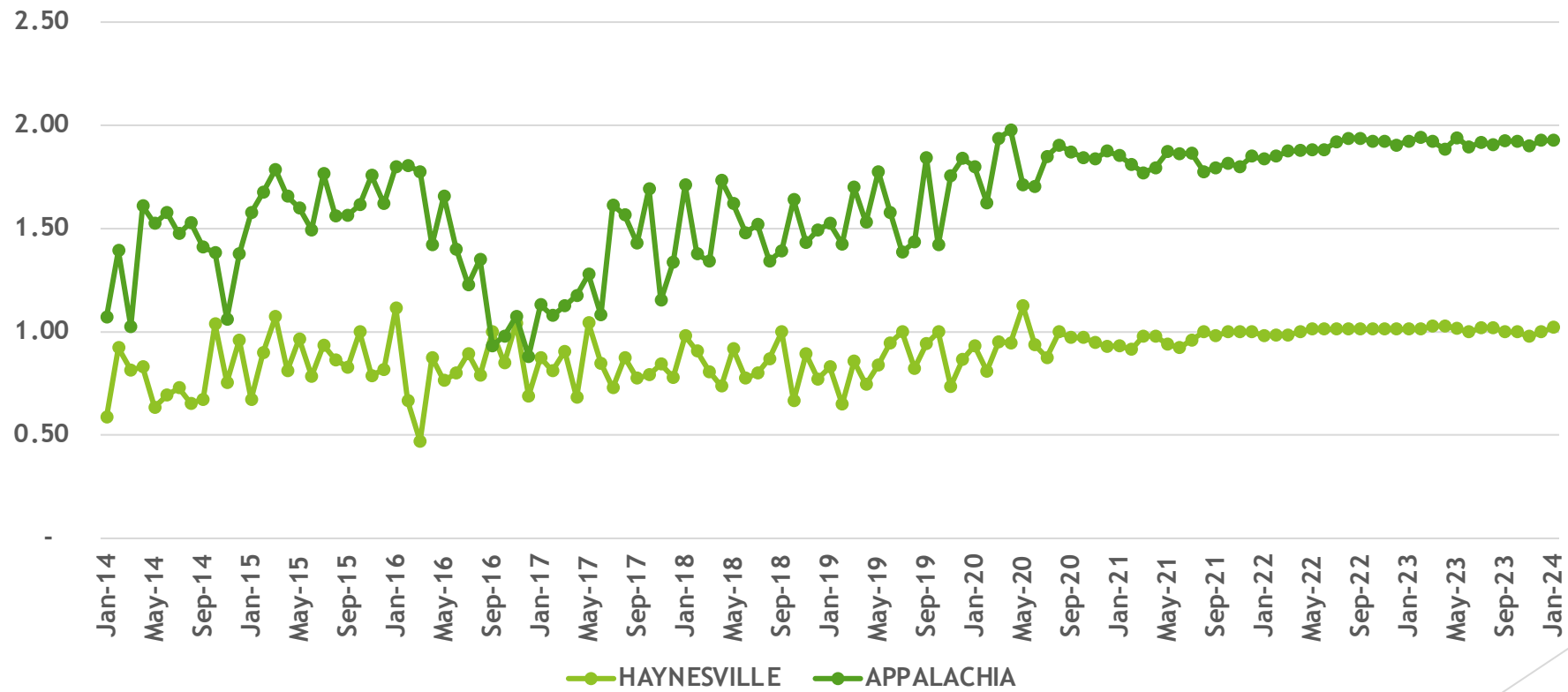


# CAPACITY ADDITIONS/RIG

(SMOOTHED; MCF/D/RIG)

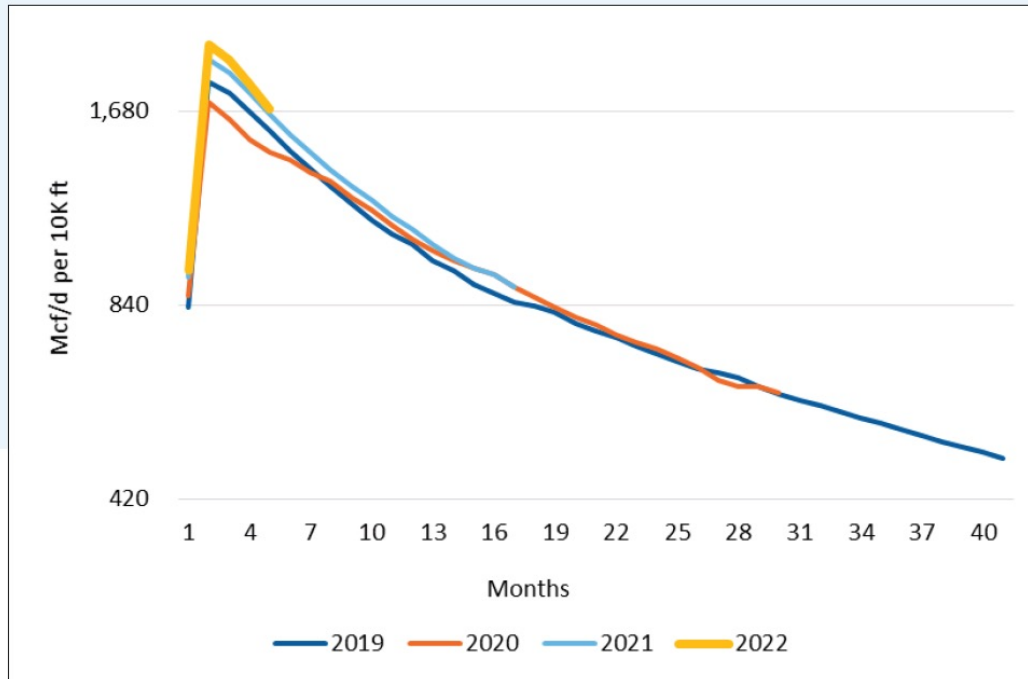


# WELLS/RIG



# NO SIGN OF SHARP DECLINE

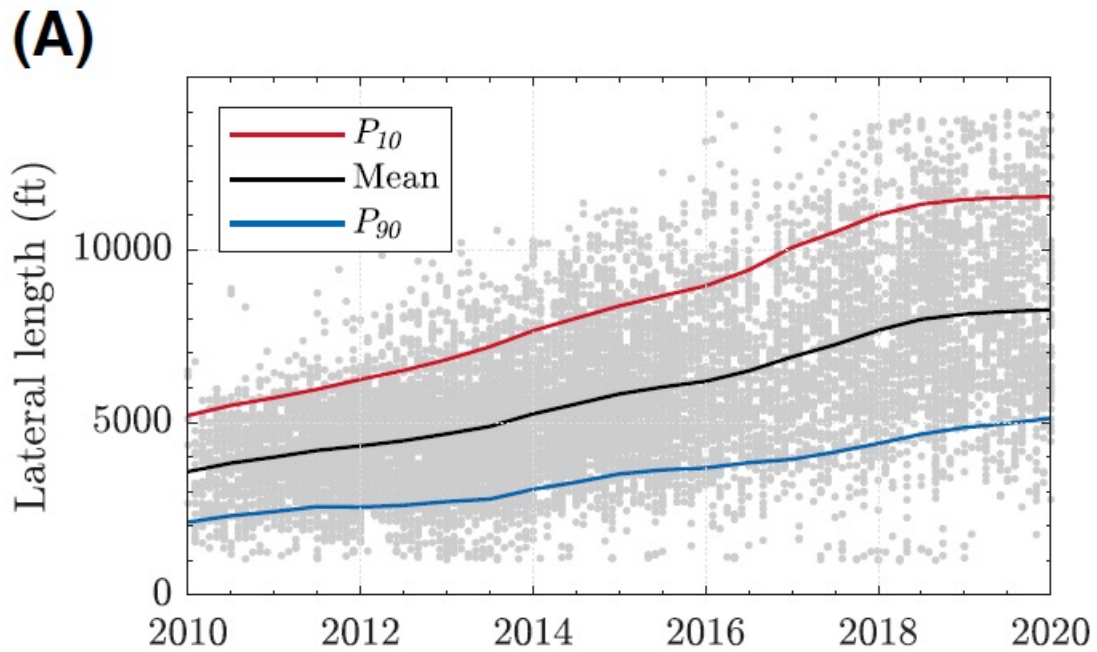
Figure 13: Gas Productivity of Major US Shale Plays (Combined Permian, Rockies, Anadarko, and Gulf Basins) – Normalized 10,000 Foot Decline Curve Basins



Source: PetroNerds, Enverus raw data

Source: Curtis “Unconventional  
And underestimated) (2023) EPRINC

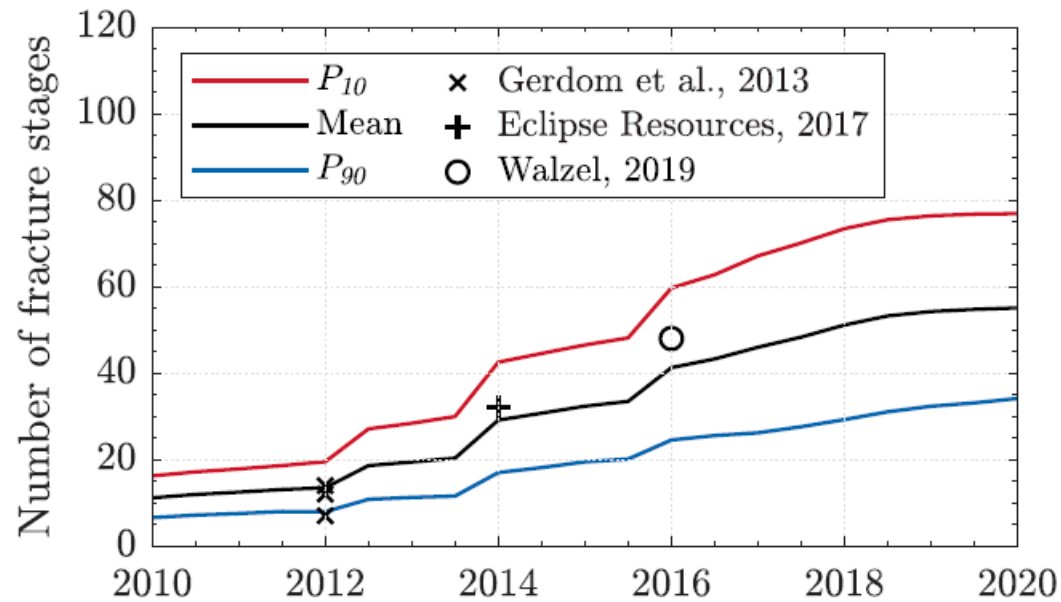
# MARCELLUS CASE: LATERAL LENGTHS INCREASING 7% P.A.



Source: Saputra et. al.

# MARCELLUS CASE: (FRACTURE STAGES INCREASE 10% P.A.)

(D)



Source: Saputra et. al.



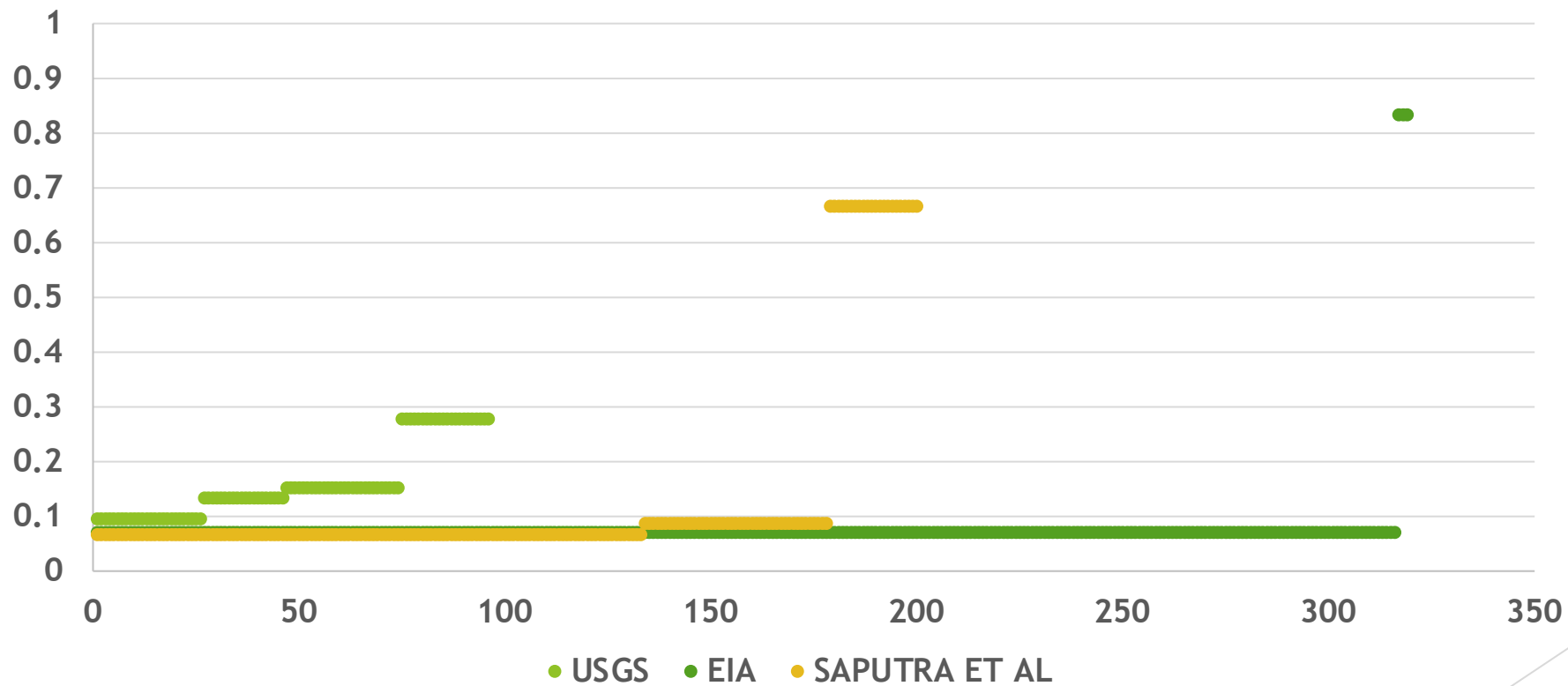
# MARCELLUS RESOURCE

	EIA RESERVES	EIA TRR	USGS TRR	UT-BEG TRR	Saputra et al TRR
	153.3	319	96.5	560	178-200
""Depletion' Rate	0.06	0.03	0.09	0.02	0.05

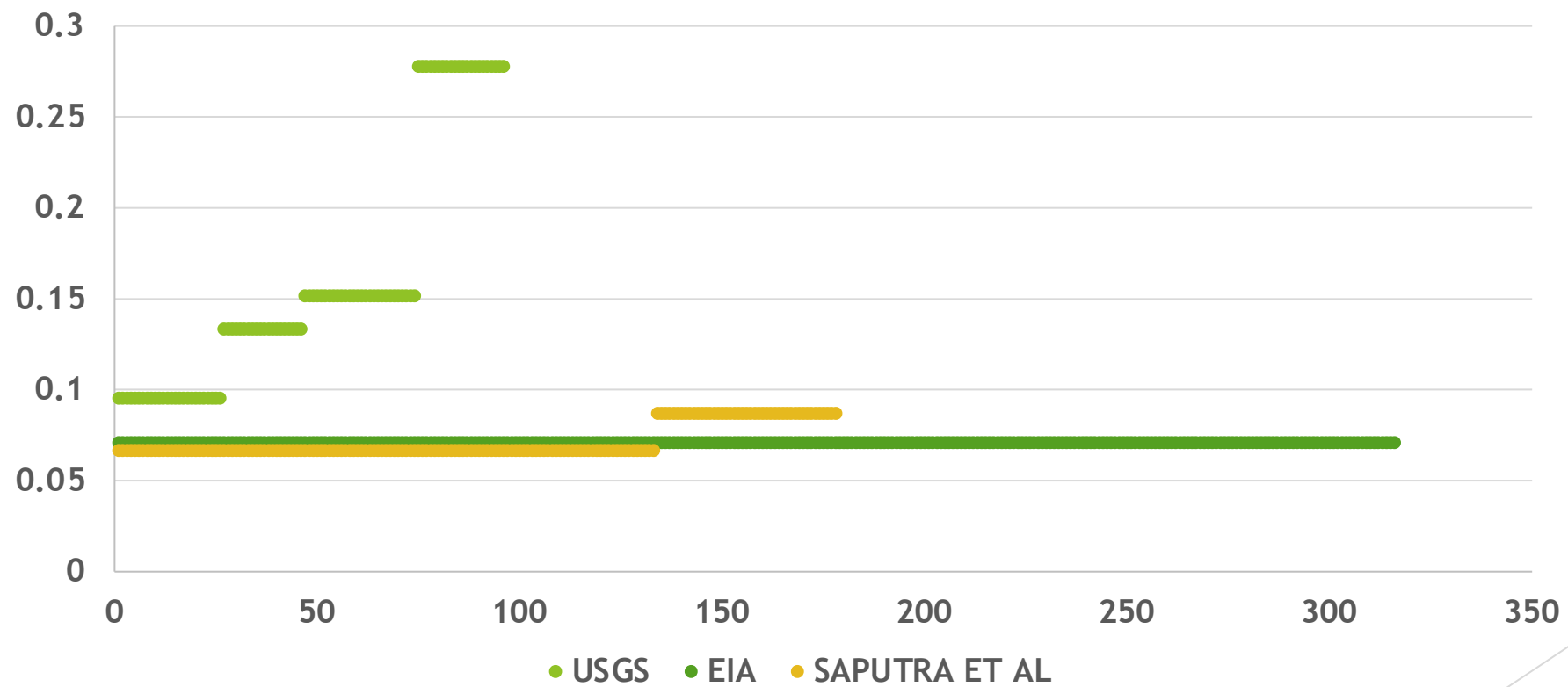
# MARCELLUS BREAKDOWN

	USGS	EIA	Suputra et al.
<b>Interior</b>			
TRR	91.8	315.8	133.05
Density	7.2	14.1	15
<b>Western/Noncore</b>			
TRR	4	2.9	45.2
Density	0.2	1.2	11.5
<b>Outer/Foldbelt</b>			
TRR	0.7	0.2	21.52
Density	0.1	0.2	1.5
<b>Density is bcf per square mile except for Suputra et al which is bcf/well.</b>			

# SUPPLY CURVES FOR MARCELLUS (TCF: PRODUCTION IS 10 TCF/YR)



# CLOSE UP VIEW



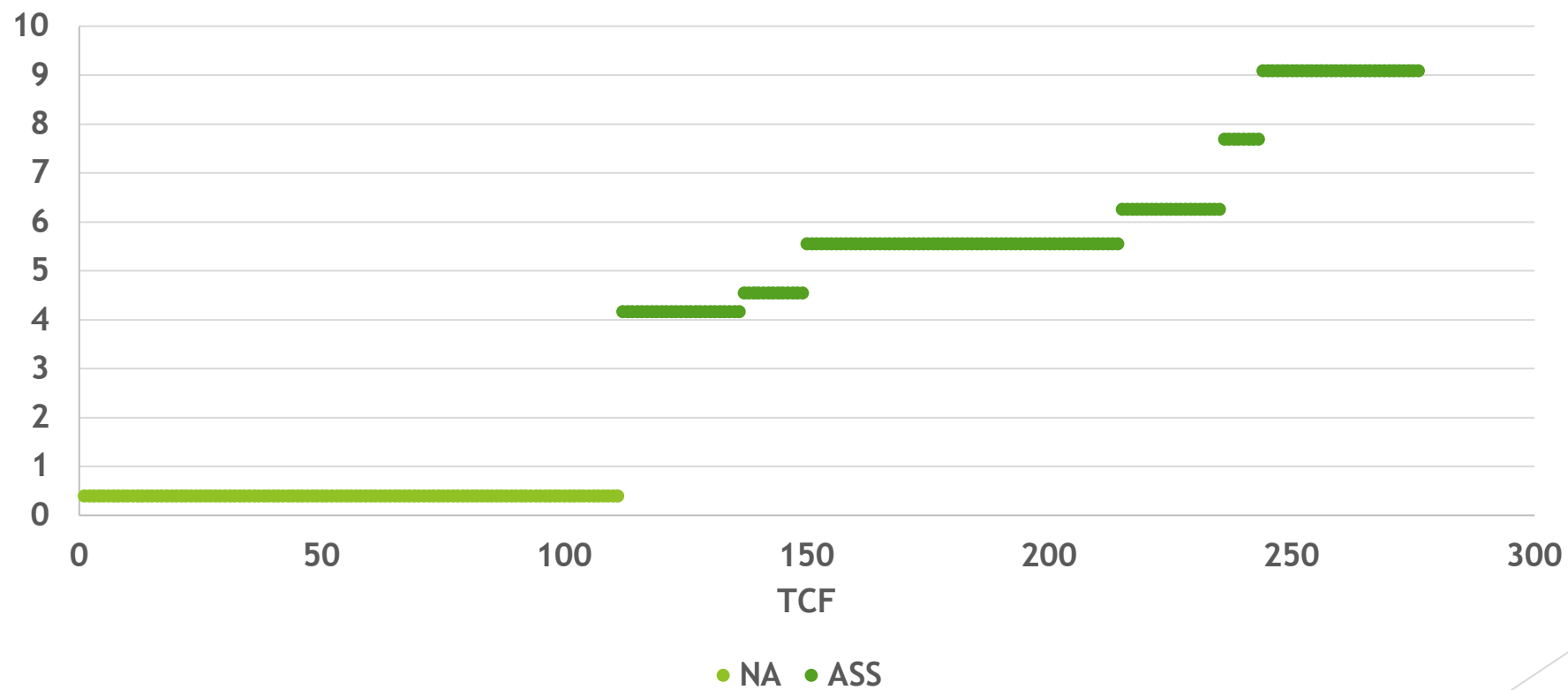
# MARCELLUS EVOLUTION

	WELLS/SQ MILE			AREA IN SQ MILES		
	2014	2018	2023			
Macellus Foldbelt	4.3	4.3	4.3	869	867	867
Mercellus Interior	4.3	4.3	4.3	16688	21266	23486
Marcellus Western	5.5	5.5	5.5	2684	2510	2485
	BCF/WELL			TCF		
Macellus Foldbelt	0.315	0.168	0.061	1.2	0.6	0.2
Mercellus Interior	1.589	3.383	3.883	113.9	309	392.5
Marcellus Western	0.257	0.264	0.223	3.8	3.7	3.1

# THE PERMIAN

- ▶ TRR IN 2013: 48 TCF
  - ▶ 2023: 340 TCF
- ▶ NEW BASINS: 140 TCF
- ▶ AREA: DOUBLED FROM 41 TO 85 000 SQ MILES
- ▶ WOLFCAMP: 11 TCF IN 2013, 181 IN 2023
  - ▶ AREA 13K TO 34K SQ MILES
  - ▶ BCF/WELL FROM 0.217 TO 0.835 IN 2023

# ...AND THE PERMIAN (PRODUCTION 9 TCF/YR)



# SUMMARY

- ▶ SHALE RESOURCE IS ENORMOUS: 1,777.9 TCF (60 YEARS)
  - ▶ INCLUDING CONVENTIONAL, 2,793 TCF (NEARLY 100 YEARS)
  - ▶ AND GROWING: RECOVERY FACTOR IS 20-25% (60-80 FOR CONVENTIONAL)
- ▶ PRODUCTION COSTS VERY LOW
  - ▶ DEPLETION IS MINOR: 1-3% PER YEAR AND STABLE (OF TRR)
  - ▶ ASSOCIATED GAS COSTS ARE NEGLIGIBLE
- ▶ IMPROVEMENTS:
  - ▶ DPR DATA: APPALACHIA IMPROVEMENT ABOUT 9% PER YEAR, HAYNESVILLE 7% P.A. DECLINE IN COSTS
  - ▶ LATERAL LENGTHS, FRACTURES: 7-10% PER YEAR



# CONCLUSIONS

- ▶ RESOURCE BASE IS HUGE
  - ▶ BEING DEPLETED SLOWLY IN MOST ESTIMATS
  - ▶ PRODUCTIVITY IMPROVING NOT DECLINING: SO FAR
    - ▶ MOSTLY LONGER LATERALS, MORE FRACTURES
  - ▶ NEW OPPORTUNITIES?
    - ▶ IMPROVING RECOVERY FACTOR
    - ▶ REVISITING OLDER BASINS (BARNETT)
- ▶ ASSOCIATED GAS MARCHES ON
  - ▶ W/O OIL PRICE COLLAPSE