

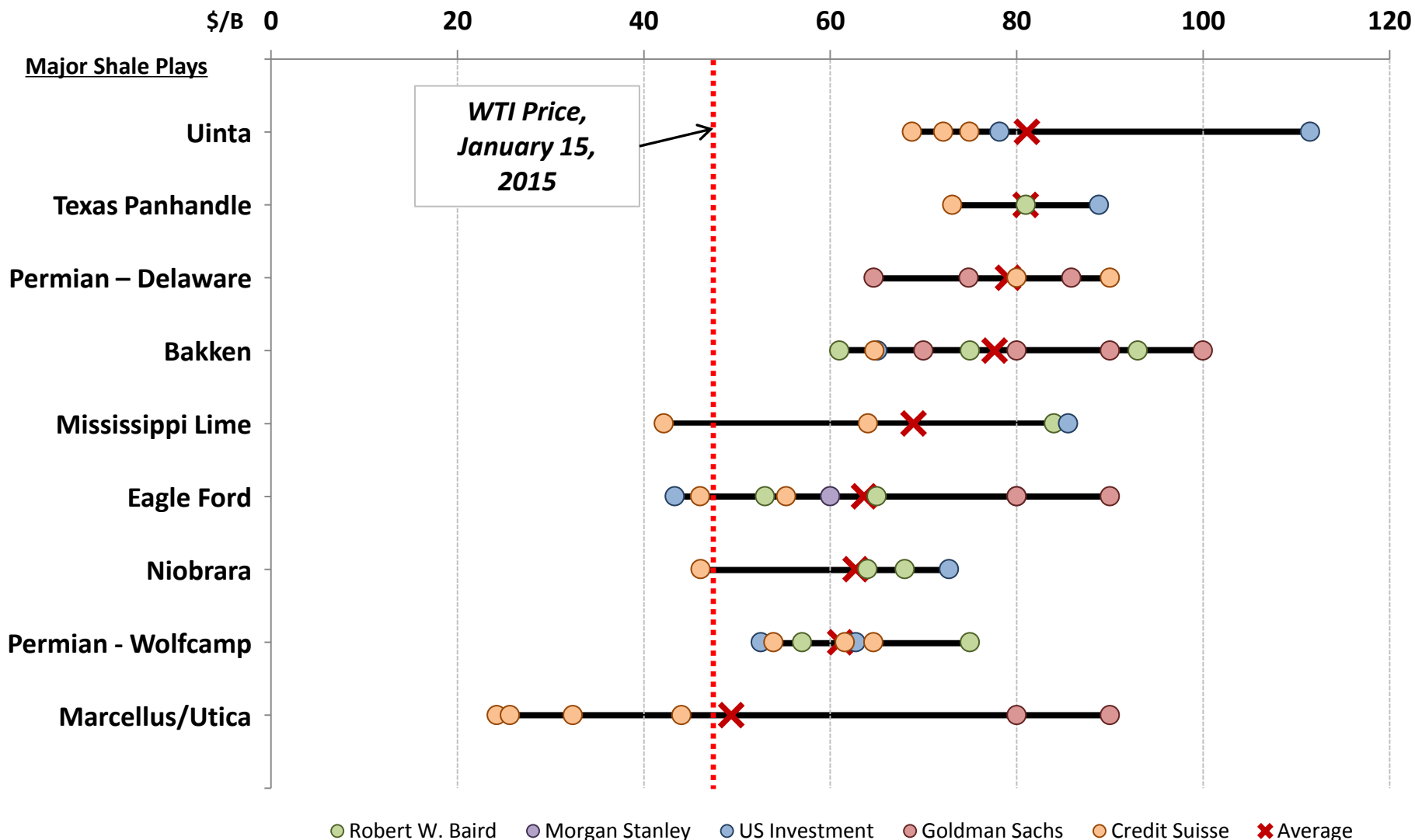
Refining America's Light Tight Oil (LTO) Production

**Argus Americas Crude Summit
January 28, 2015**

- **The Growth of U.S. LTO Production**
- **The Industry's Response to Date**
- **What Happens Next?**
- **Impact on Refined Products and Intermediates**
- **Other Considerations**

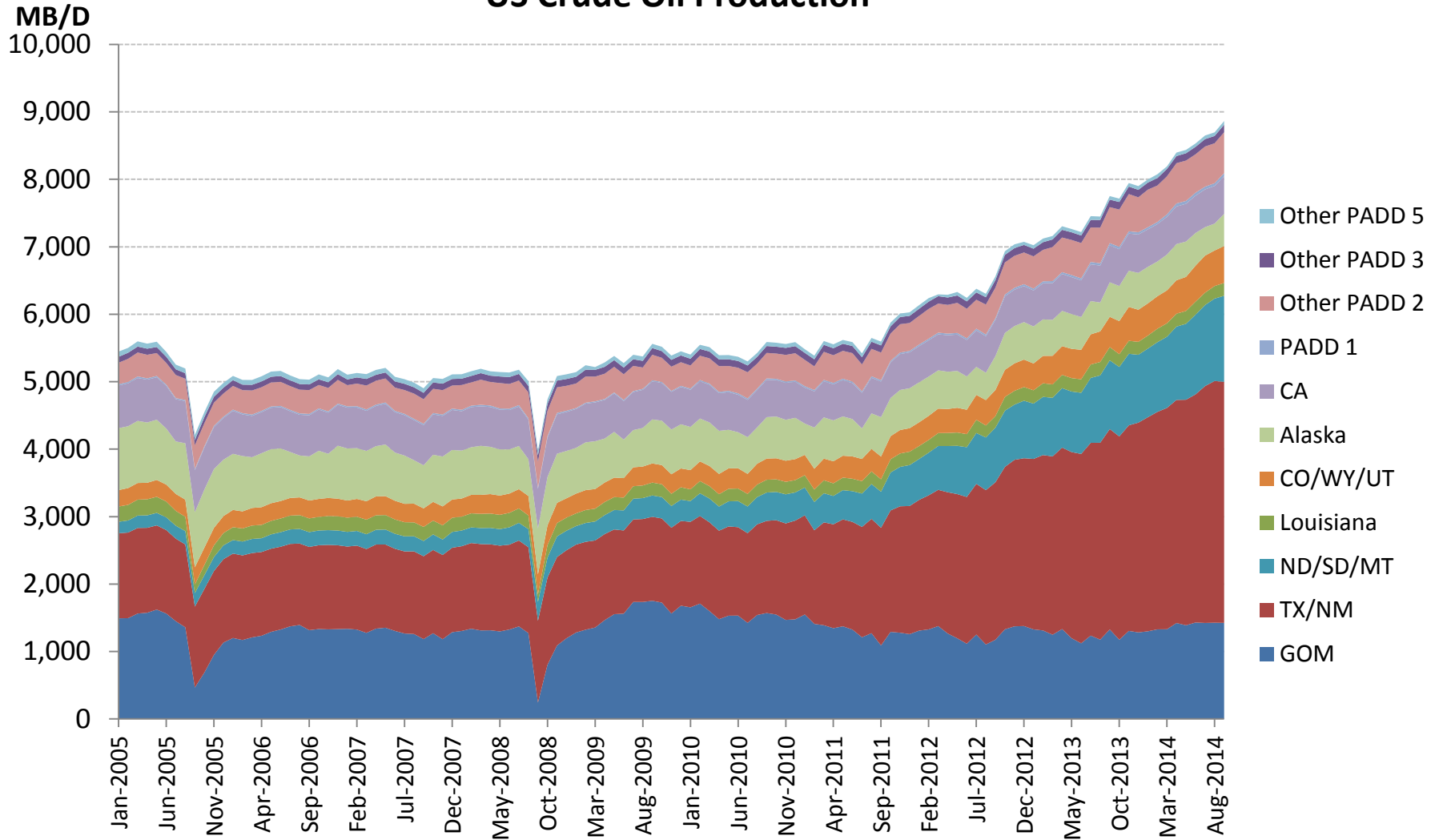
Note: This presentation assumes that current restrictions on crude oil exports will continue for at least the next several years, and does not address the pros/cons or impacts of lifting or keeping those restrictions.

Marginal Production Economics of Major U.S. Shale Plays

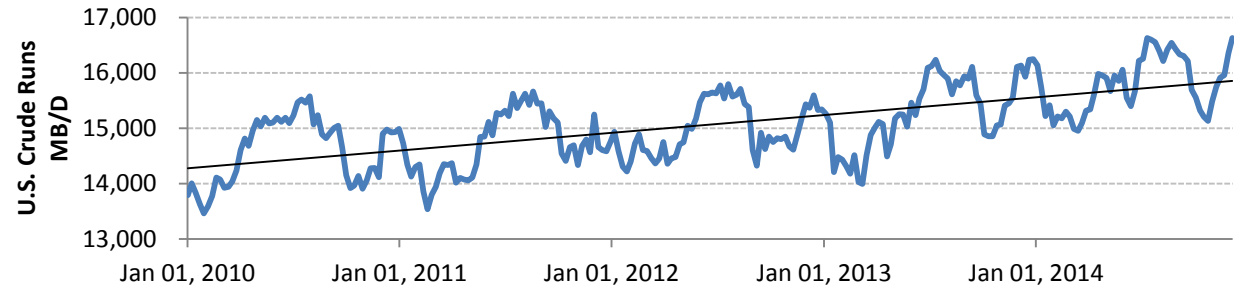


Note: Some companies report estimates for subplays such as "Uinta-Green River", "Uinta-Vertical", and "Uinta-Horizontal". For this analysis, those estimates have been grouped together in the major play.

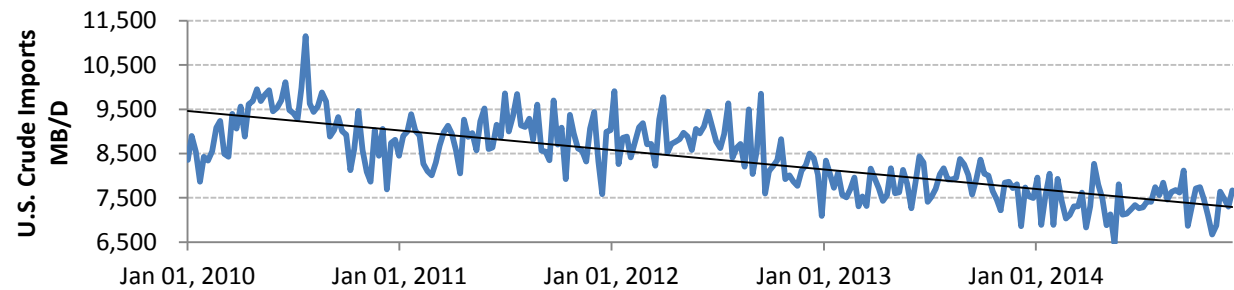
US Crude Oil Production



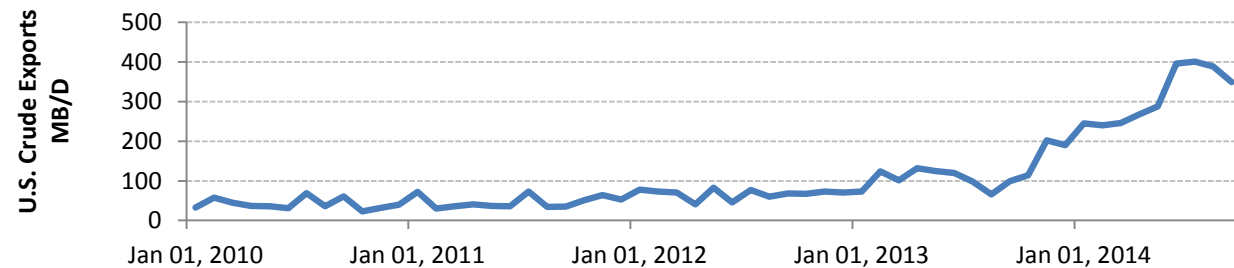
Increased Crude Runs



Displacement of Imports



Crude Oil Exports Begin Upward Climb



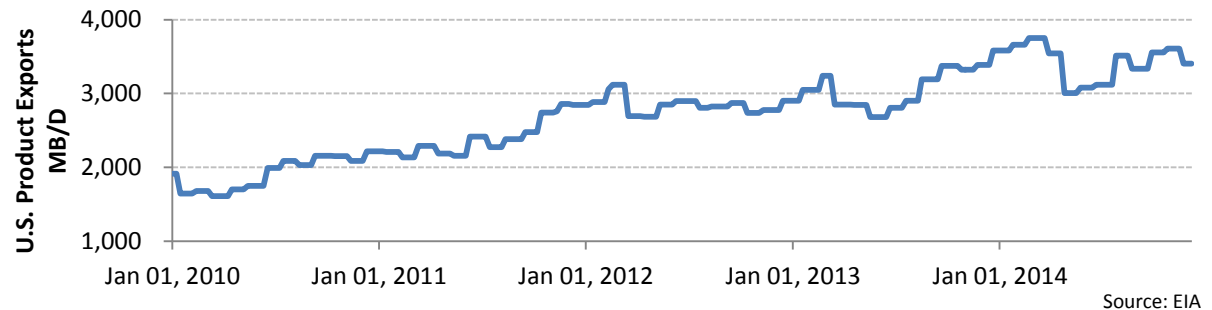
Source: EIA

The Industry's Response (continued)

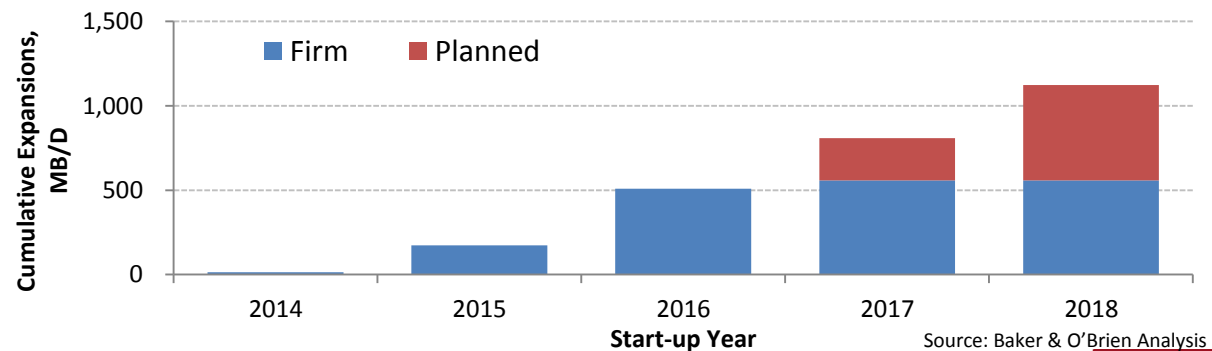
New Investments in Logistics Infrastructure



Expansion of Product Exports

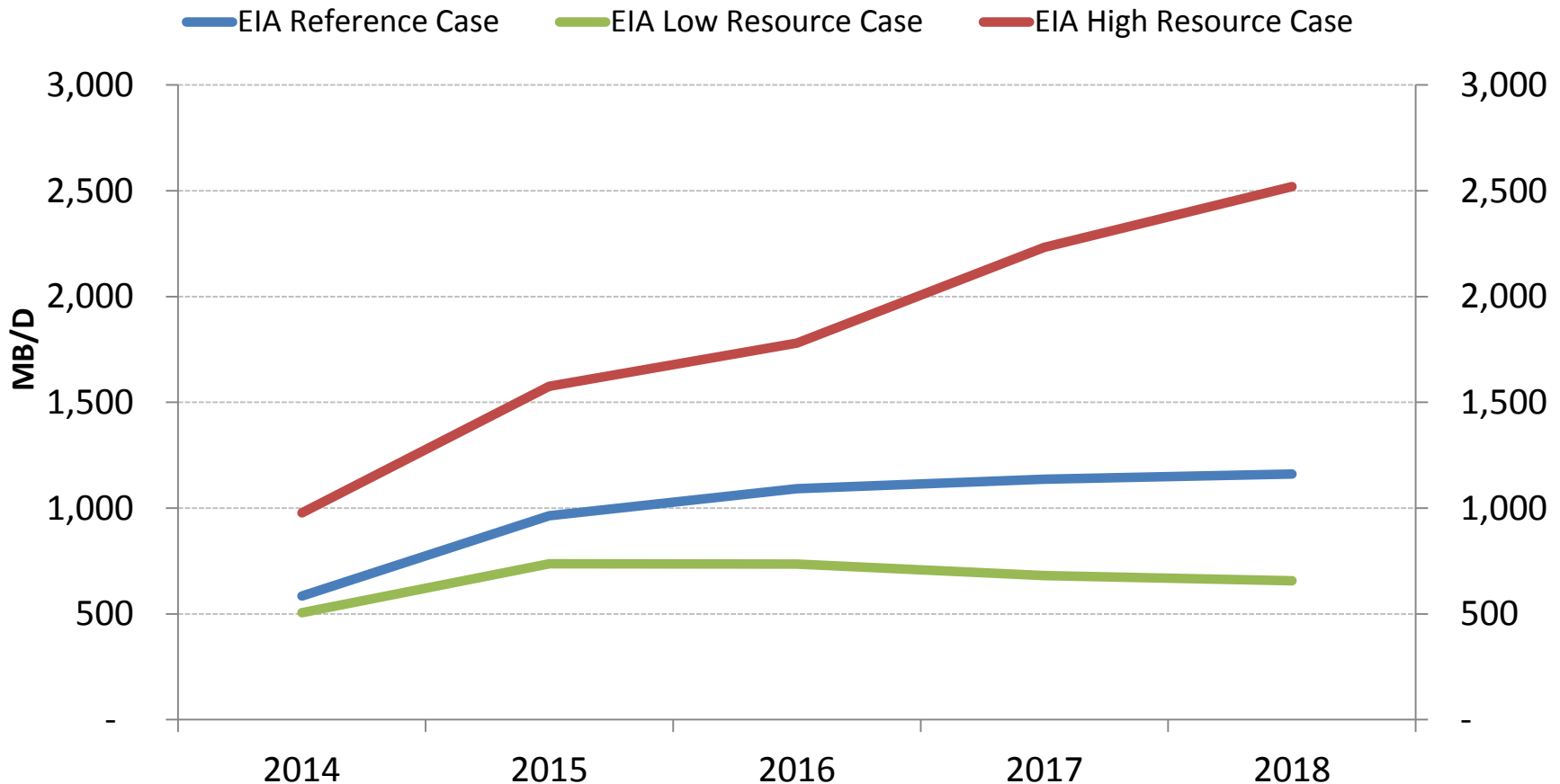


Expansions in Domestic Refining Capacity



How Much More LTO Was Expected?

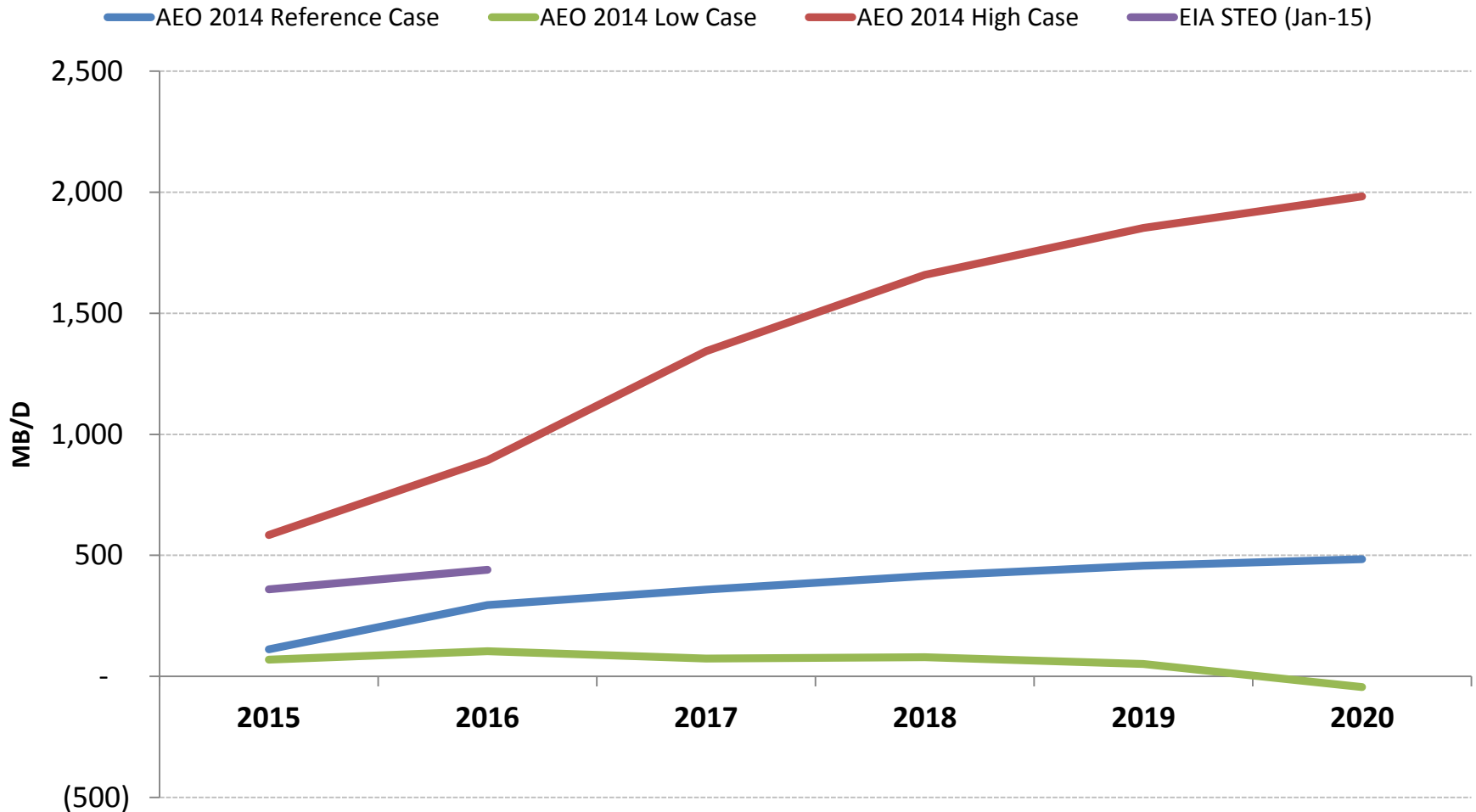
U.S. LTO Production Increase Since Q4 2013



Source: EIA. Incremental production is calculated using EIA's forecast for Lower 48 onshore crude oil production minus Q4 2013 actual production.

How Much More LTO Can We Now Expect?

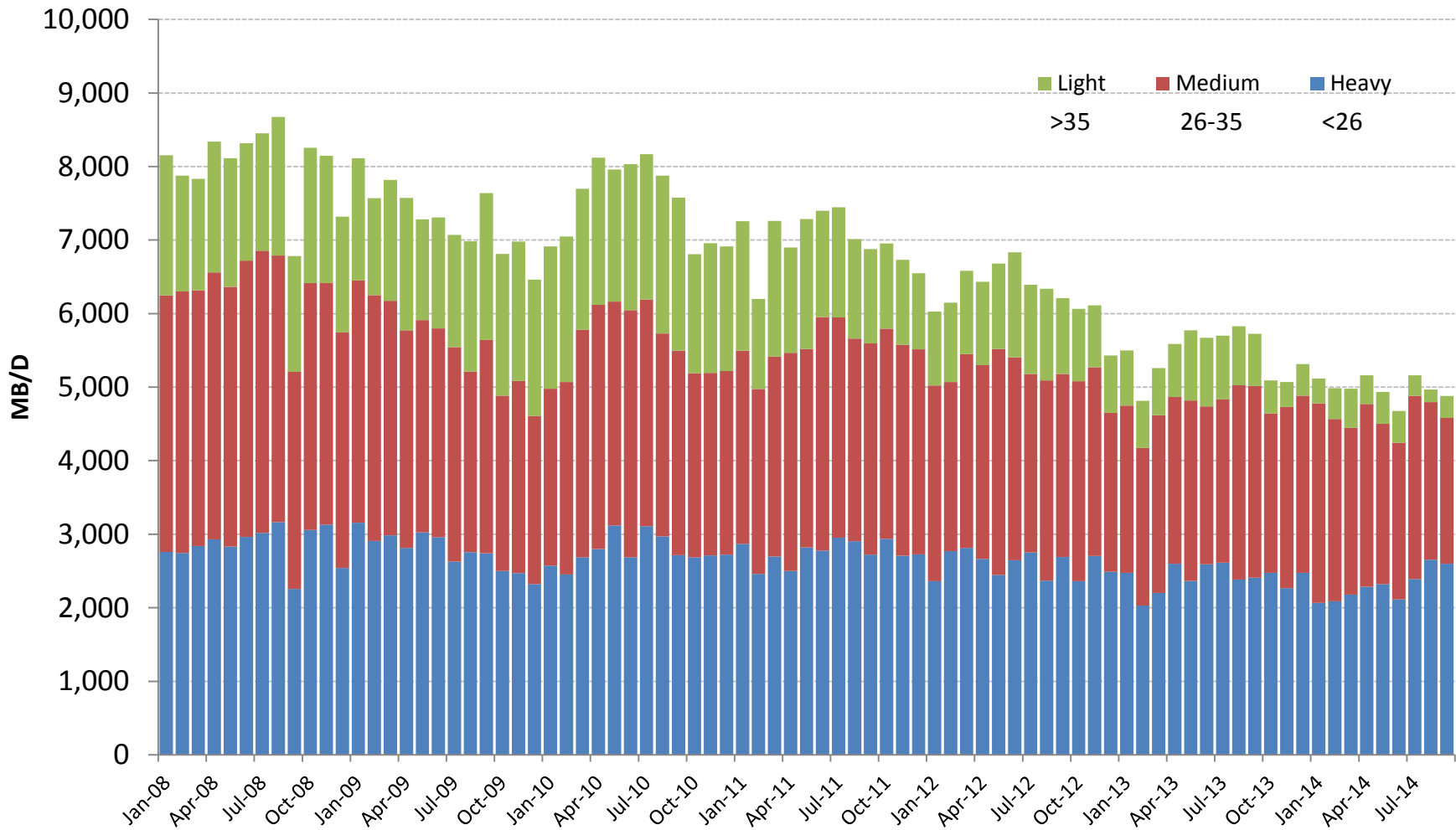
U.S. LTO Production Increase Since Q2 2014



Source: EIA. Incremental production is calculated using EIA's forecast for Lower 48 onshore crude oil production minus Q2 2014 actual production.

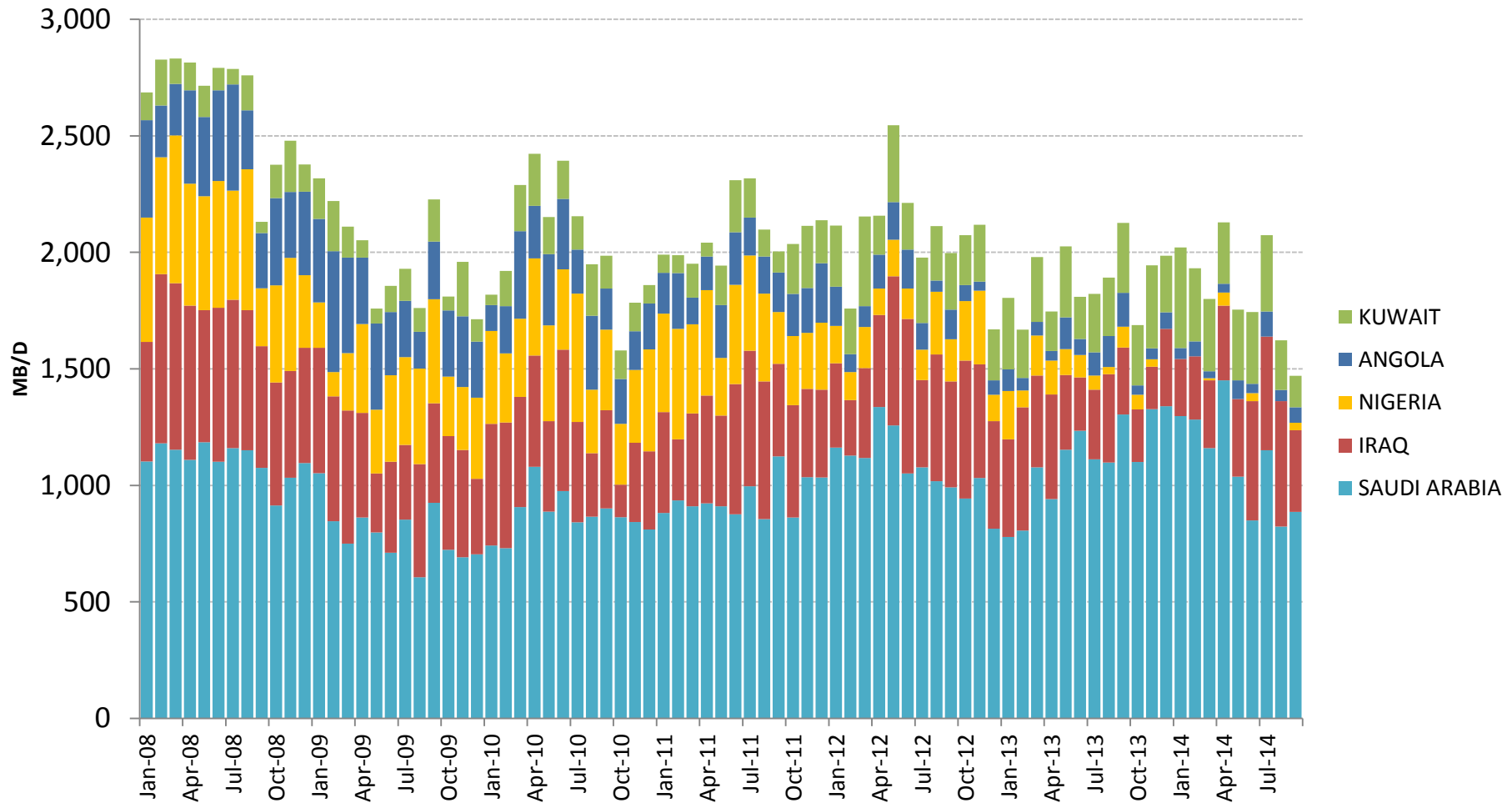
Displacement of U.S. Crude Oil Imports

**Lower 48 Waterborne Crude Oil Imports
(January 2008 - September 2014)**



Source: EIA

**U.S. Waterborne Medium Crude Oil Imports - Top 5 Sources
(January 2008 - September 2014)**

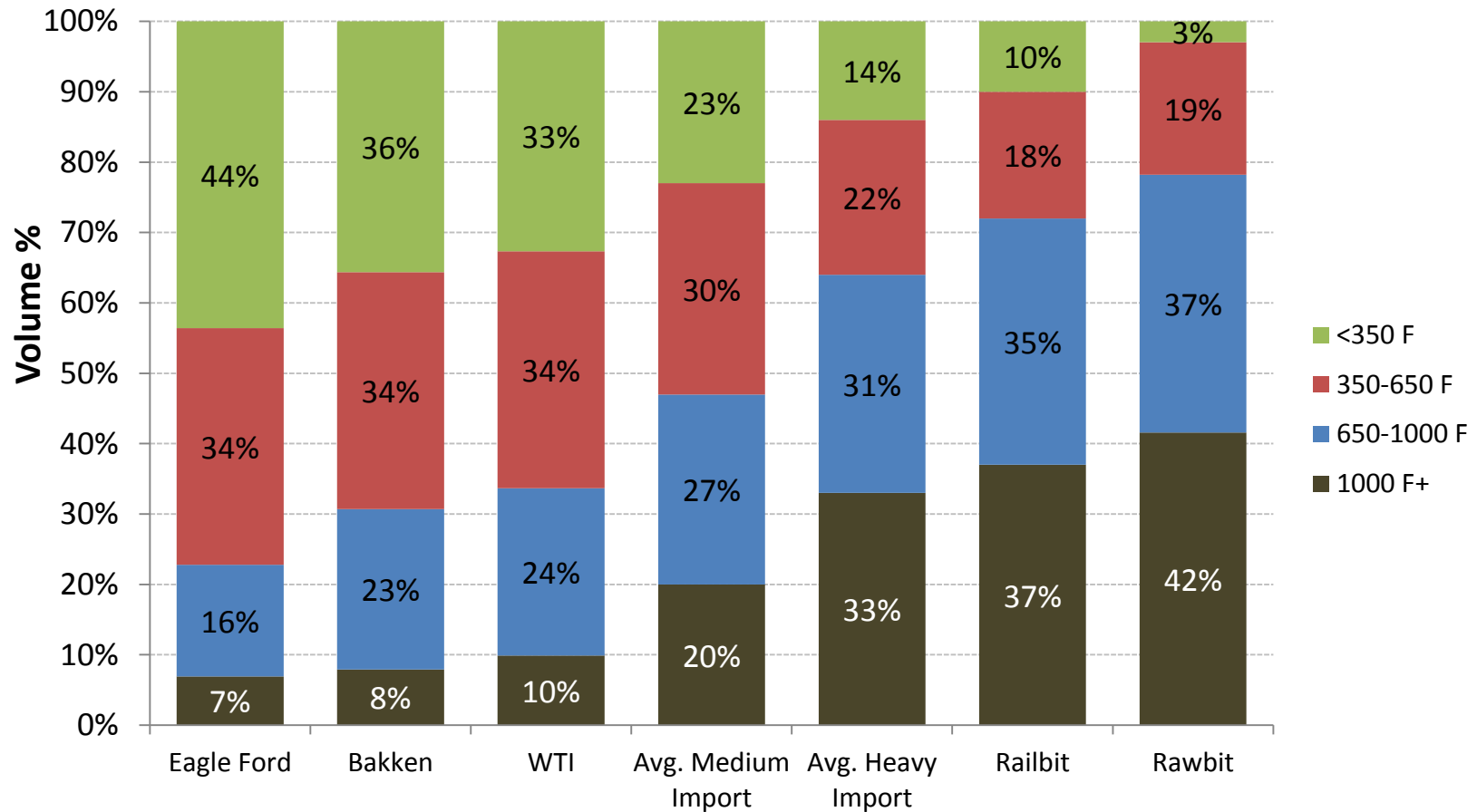


- **Expect some “capacity creep” in ability to run more LTO.**
- **Medium grades are likely to be backed out.**
- **West Coast LTO logistics bottlenecks are overcome.**
- **More stabilized condensates will be exported.**

The Key LTO Processing Constraint: Light Ends Handling

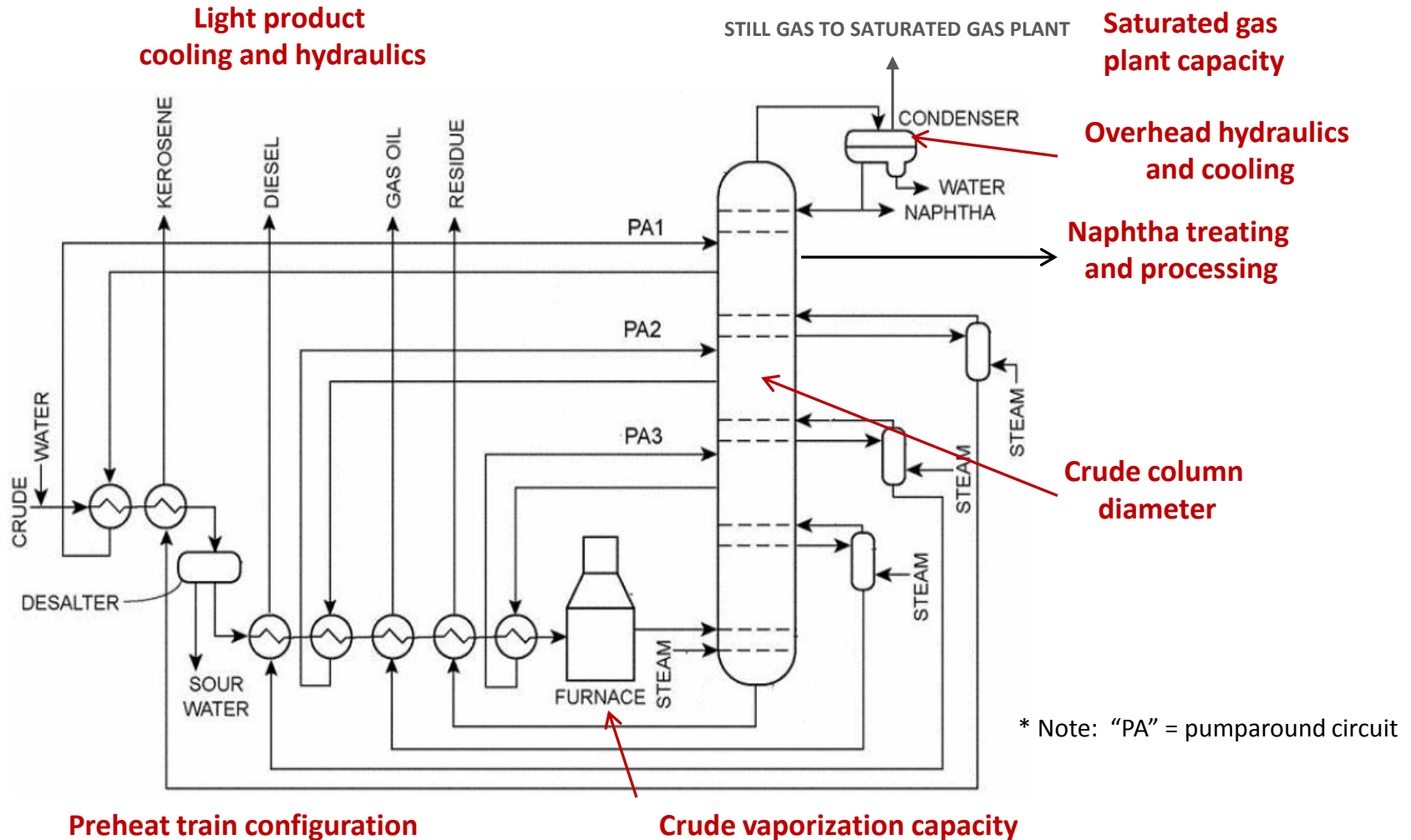
- Refineries designed to process medium and/or heavy crude oils often cannot handle the naphtha and lighter material (<350°F) contained in LTO.

Crude Oil Distillation Yields



Typical LTO Handling Constraints

- Physical constraints to processing LTO vary by refinery but are generally centered around crude oil distillation and light ends handling.

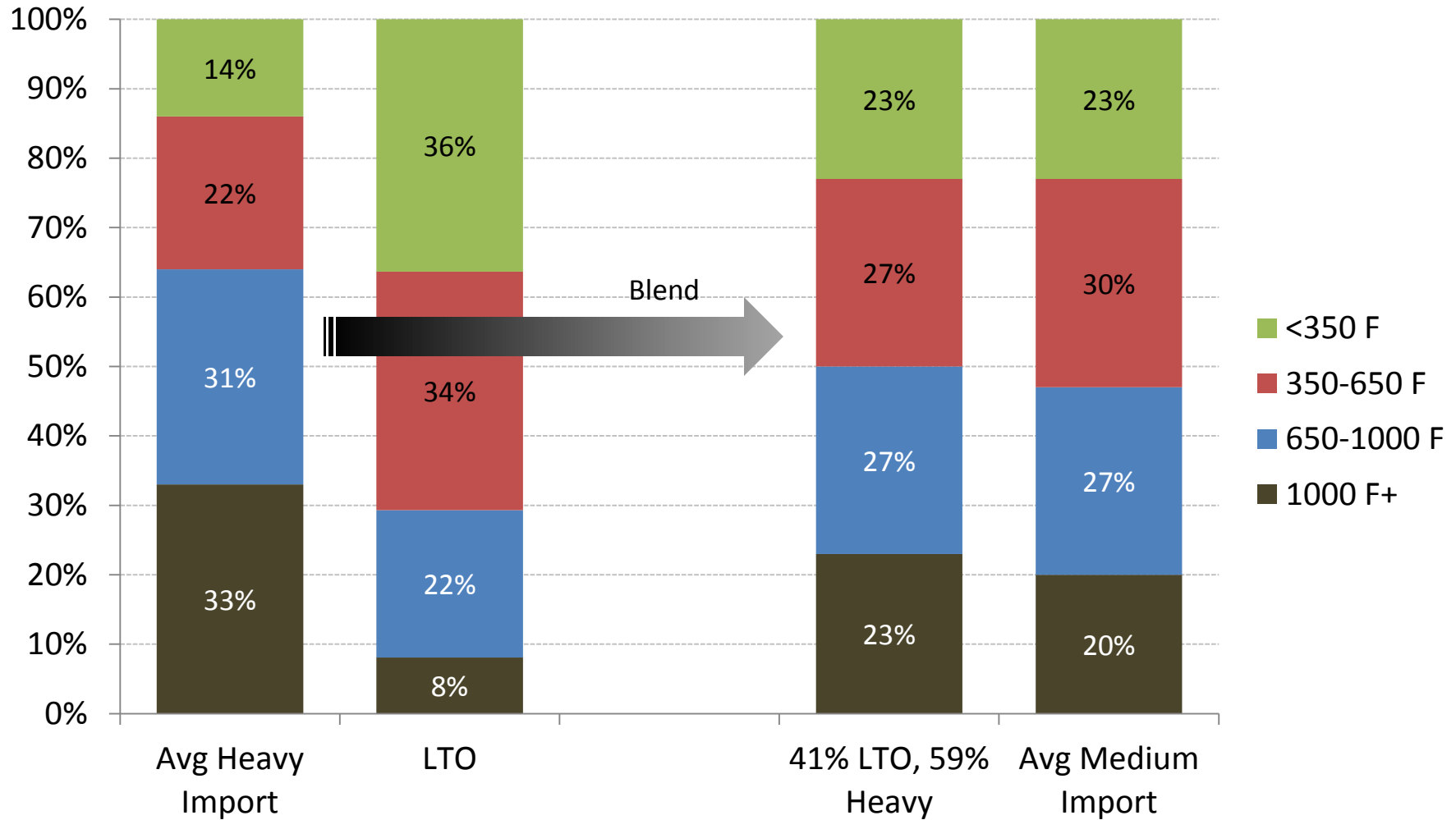


Options for Replacing Medium Crude Oil with LTO

- **Direct substitution of medium crude with LTO:**
 - Refiners would generally need to sacrifice some throughput in order to substitute light for medium without some additional investment.
- **LTO/heavy blends can substitute for some medium grade imports:**
 - Advantages: Enables refiners to maintain crude throughput and keep downstream units full.
 - Challenges:
 - ❖ Blending exact substitute for medium grades
 - ❖ Asphaltene precipitation issues
 - ❖ Crude oil blending facilities
 - ❖ Availability of heavy crude oil
 - ❖ Possible high acid (TAN) constraints

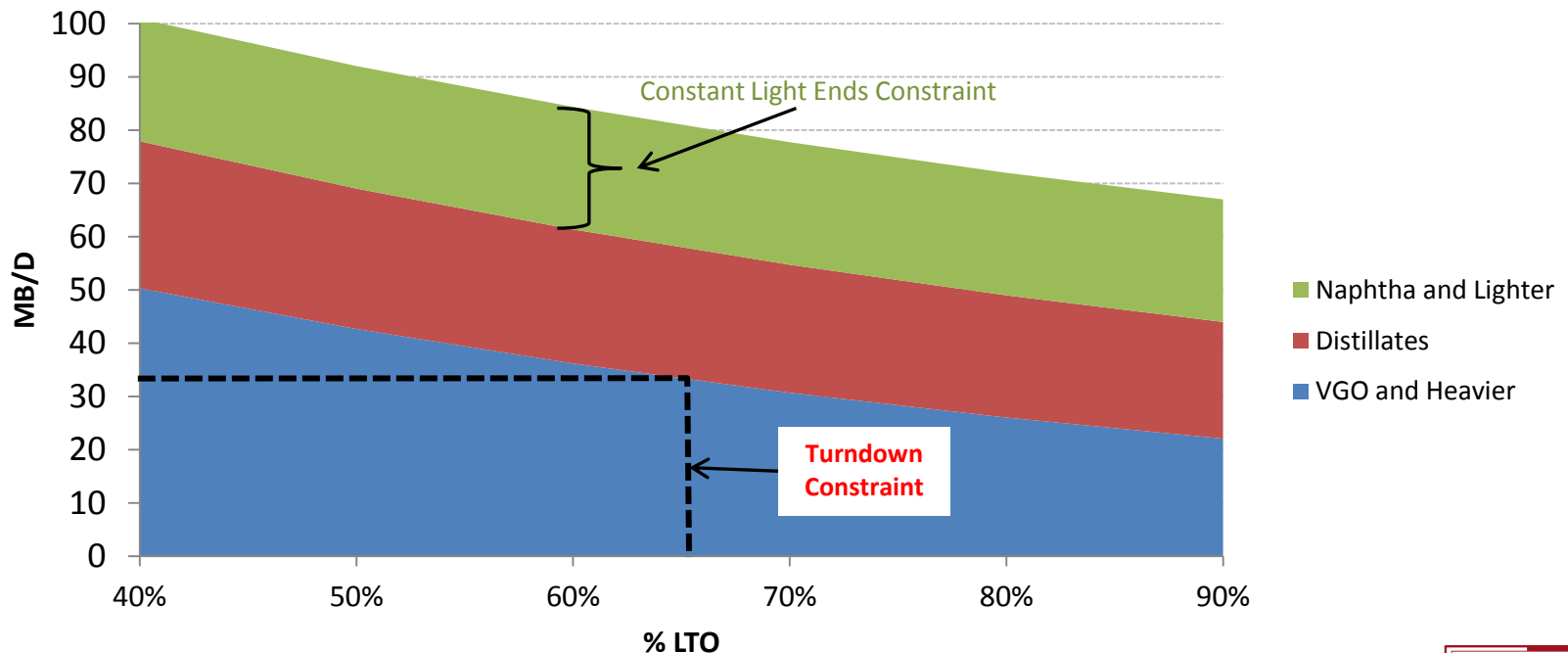
Options for Replacing Medium Crude Oil with LTO

Distillation Yields, vol %



Case Study: Replacing Medium Crude with LTO/Heavy Blend

- **Case Study: A 100,000 Bbl/day refiner of imported medium crude oil, constrained by the volume of naphtha and lighter material that can be processed.**
- **As the proportion of LTO in a substitute LTO/Heavy blend increases above 40%, crude throughput declines and feedstock available for downstream conversion units declines.**
- **Unit turndown constraints become a factor when downstream feedstock (VGO and heavier) falls to <70% of downstream capacity, suggesting 65% maximum LTO in the blend**
 - Conversion units might be partially filled with atmospheric tower bottoms available from new condensate splitters

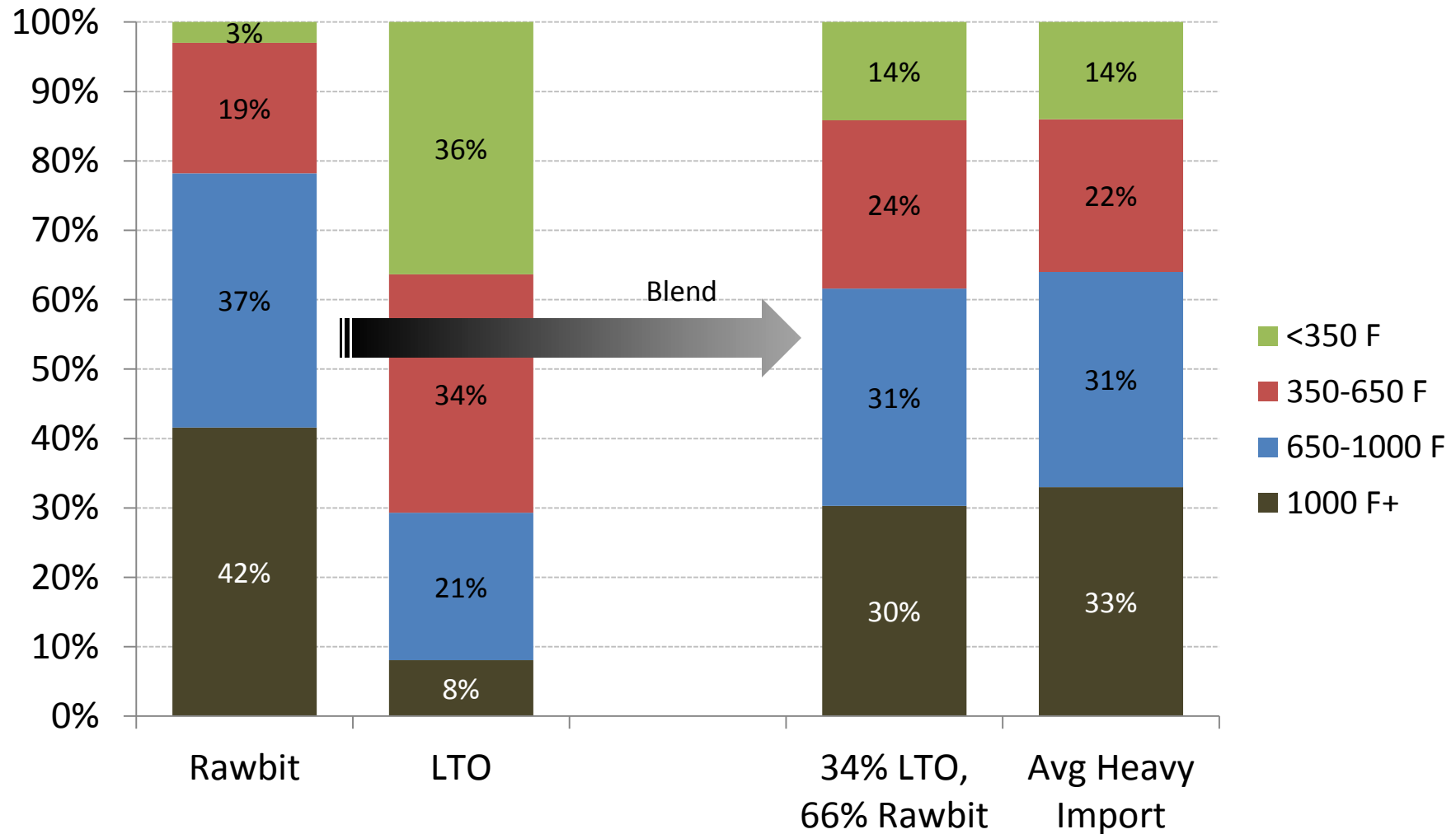


Alternative for Replacing Heavy Crude Oil with LTO

- **Direct substitution of LTO for heavy crude imports obviously has turndown limitations. This turndown limit could be alleviated by blends of LTO and bitumen.**
- **Blends of LTO with Canadian “rawbit” or “railbit” (10-25% diluent) could substitute for some heavy crude imports:**
 - Advantages: Similar to that for displacement of medium grades
 - Challenges:
 - ❖ Getting the right blend
 - ❖ Asphaltene precipitation
 - ❖ Crude blending facilities
 - ❖ Availability of rawbit and railbit
 - ❖ Possible high acid (TAN) constraints.

Alternative for Replacing Heavy Crude Oil with LTO

Distillation Yields, vol %



How Will Refined Products and Intermediates be Impacted?

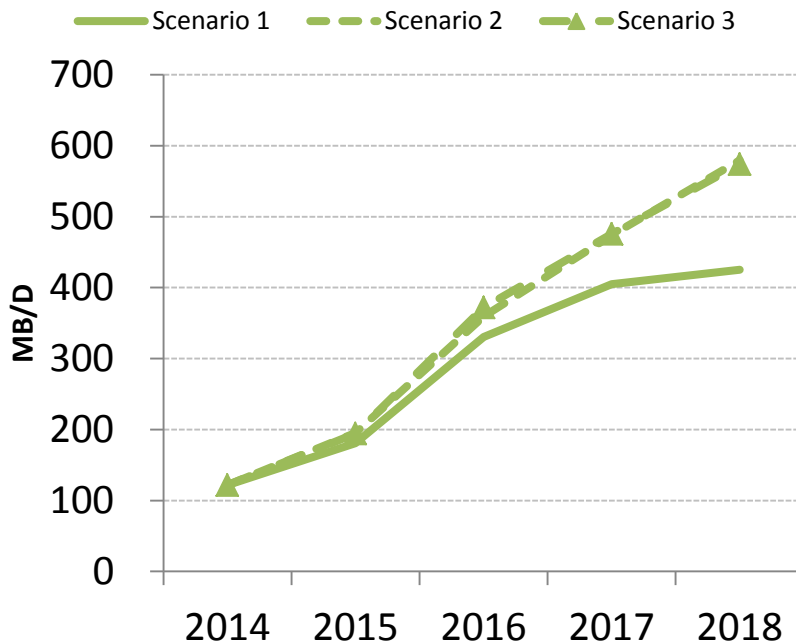
- **U.S. production of refined product and intermediates will be influenced by a number of factors:**
 - LTO production volume and timing
 - U.S. refinery capacity additions and timing
 - Crude oil and condensate export volumes
 - Availability of heavy crude oil and bitumen and logistics for bringing it to market
 - LTO absorption mechanisms chosen by individual refiners
- **Given these uncertainties, three scenarios for processing LTO were modeled.**

SCENARIO	1	2	3
LTO Production	EIA Reference	EIA High Resource	EIA High Resource + 20%
% LTO in Blended Medium Crudes	Base (41%)	Base (41%)	High (70%)

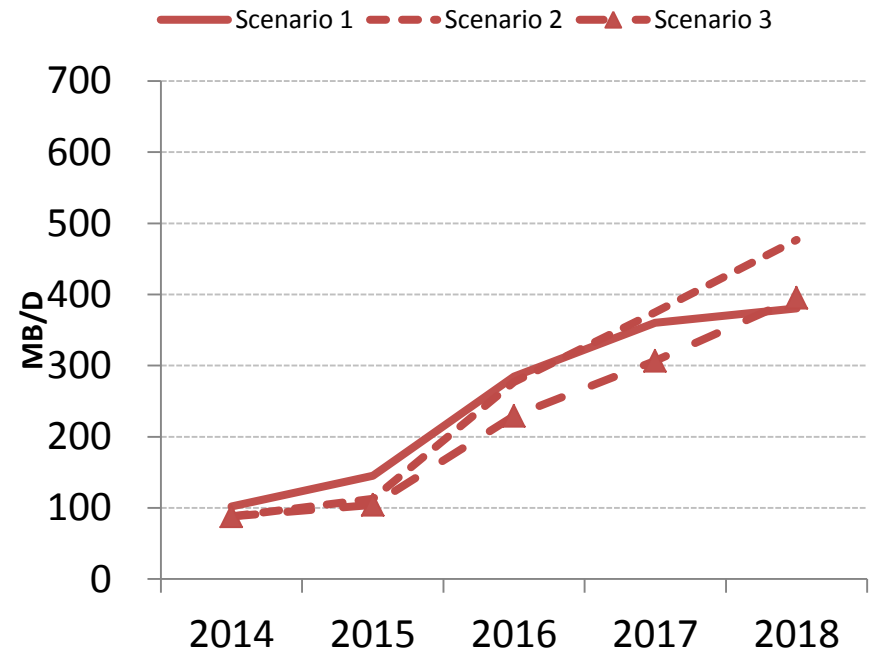
Implications for Refined Products

- In all LTO absorption scenarios, LPG, naphtha, and distillate production increase.
- Surplus virgin naphtha may be exported (similar to processed condensate).
- Distillate exports will increase in all scenarios.

**Naphtha and Lighter Production
versus 2013**



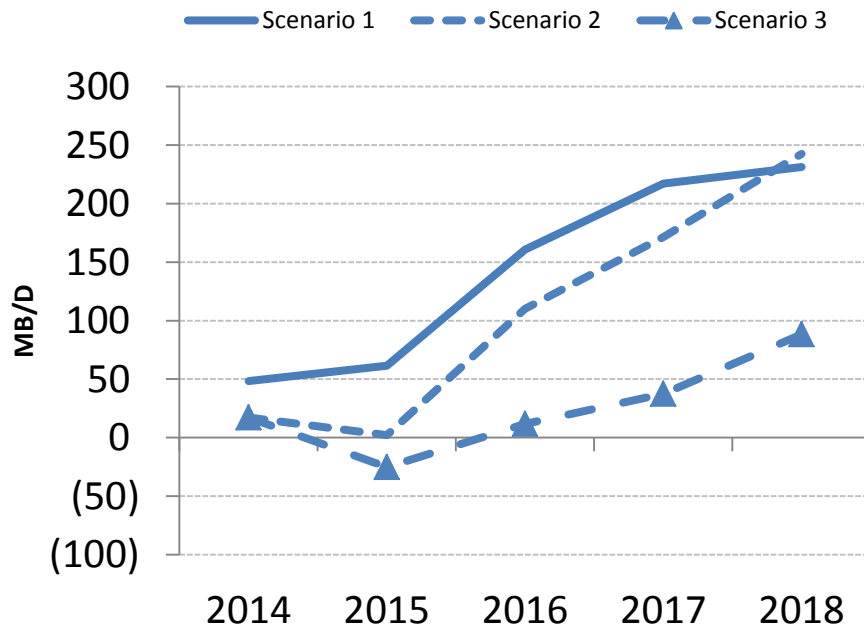
**Distillate Production
versus 2013**



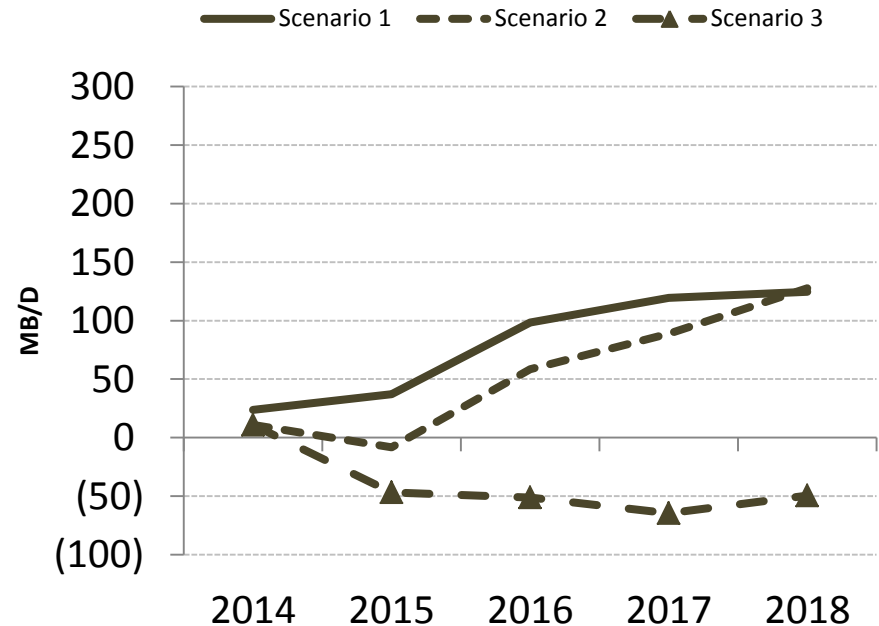
How LTO Affects the Bottom of the Barrel

- **VGO and Resid production would grow with moderate LTO growth**
 - There are almost 400 MB/day of VGO imports, and over 450 MB/day of heavy fuel imports that have the potential to be displaced
- **In the short term, VGO and vacuum resid (VR) production may decline until condensate splitters and crude unit expansions come online**

AGO/VGO Production versus 2013

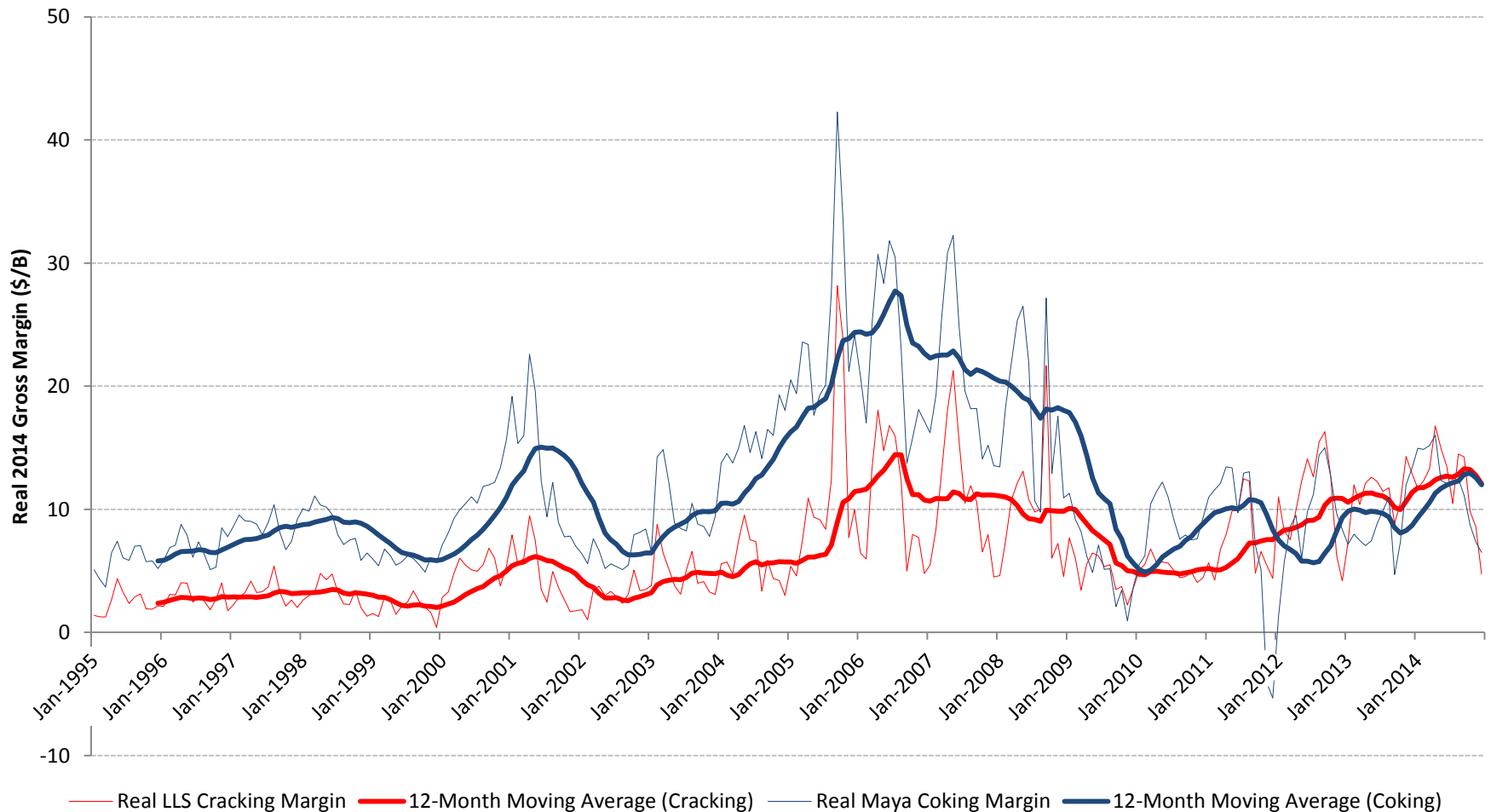


Vac Resid Production versus 2013



The Case for Investment – Other Factors

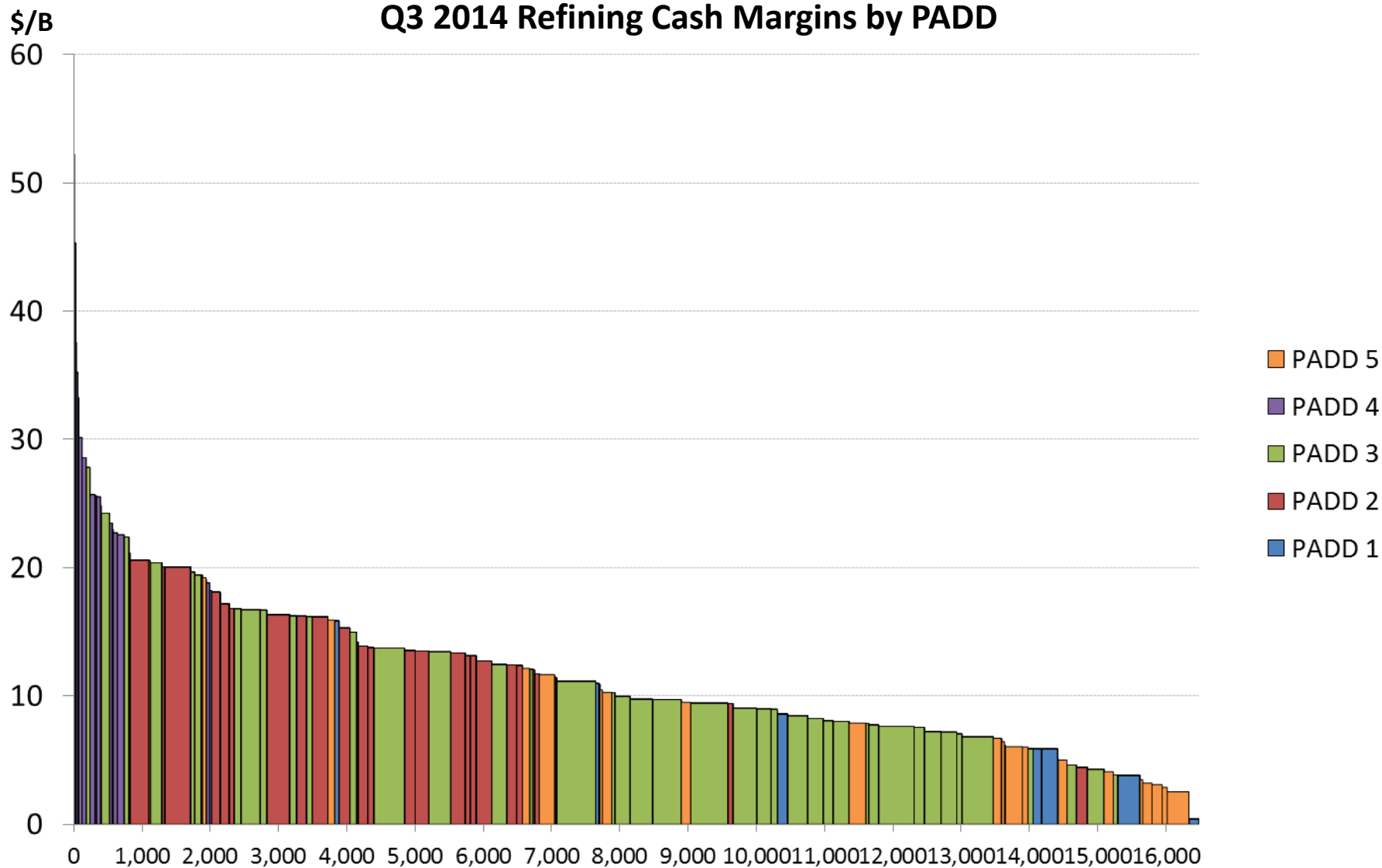
USGC Historical Refining Gross Margins (LLS Cracking Gross Margin, Maya Coking Gross Margin)



Source: Baker & O'Brien Analysis

The Case for Investment – Other Factors

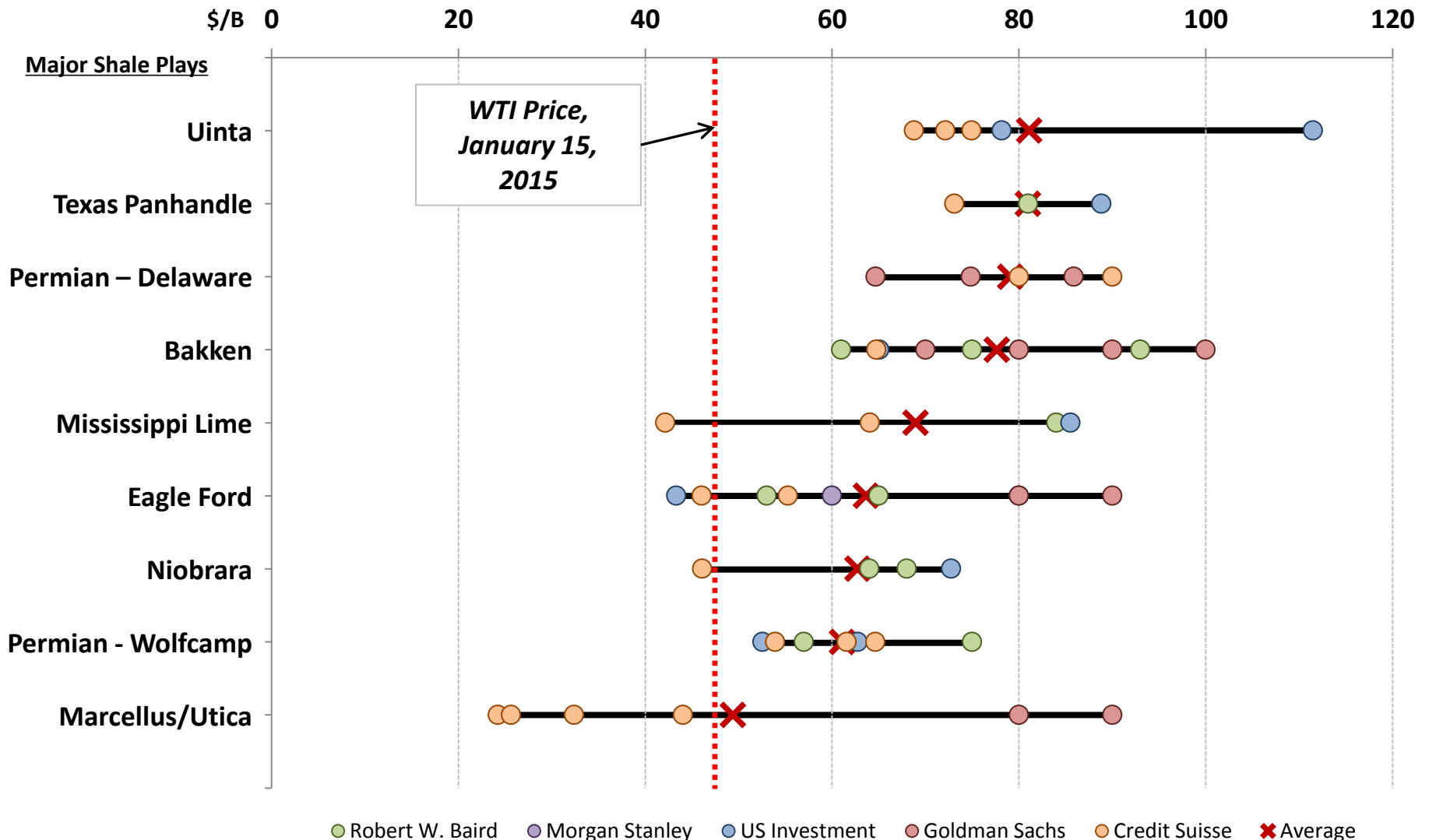
Q3 2014 Refining Cash Margins by PADD



Source: PRISM

The Case for Investment – Other Factors

Marginal Production Economics of Major U.S. Shale Plays

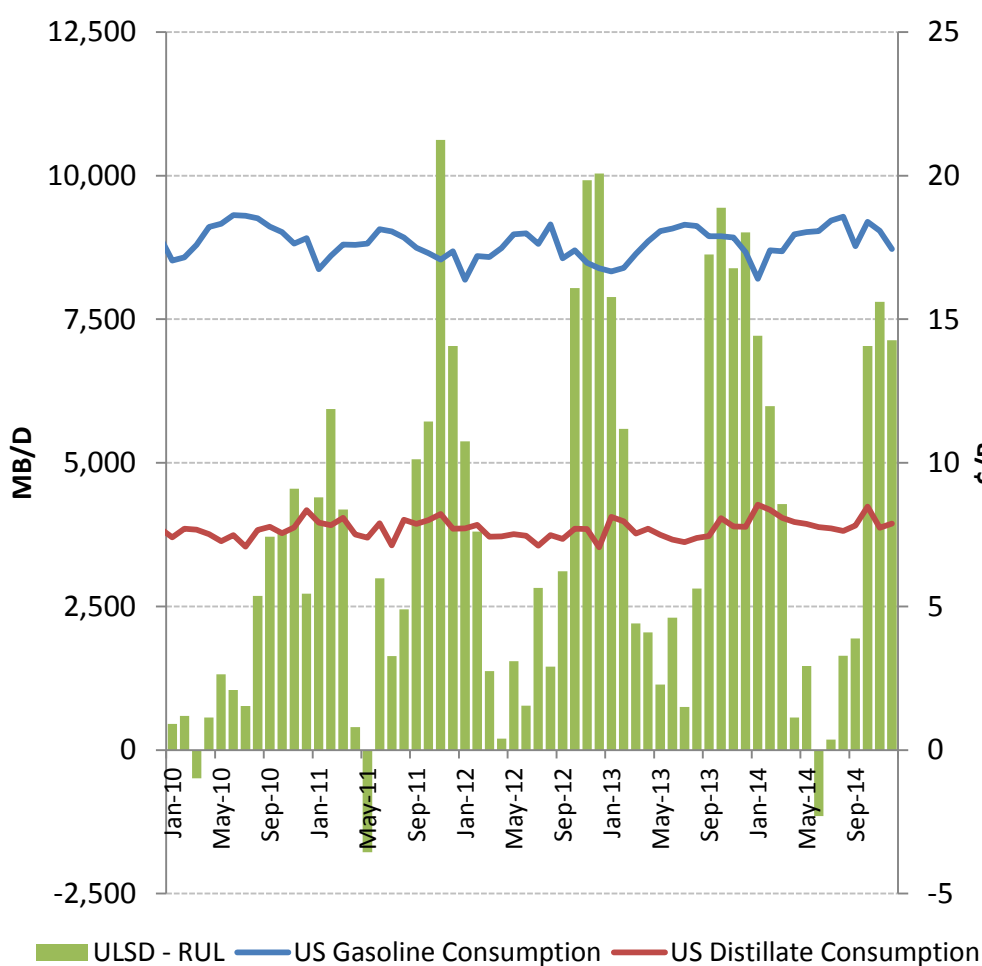


Note: Some companies report estimates for subplays such as “Uinta-Green River”, “Uinta-Vertical”, and “Uinta-Horizontal”. For this analysis, those estimates have been grouped together in the major play.

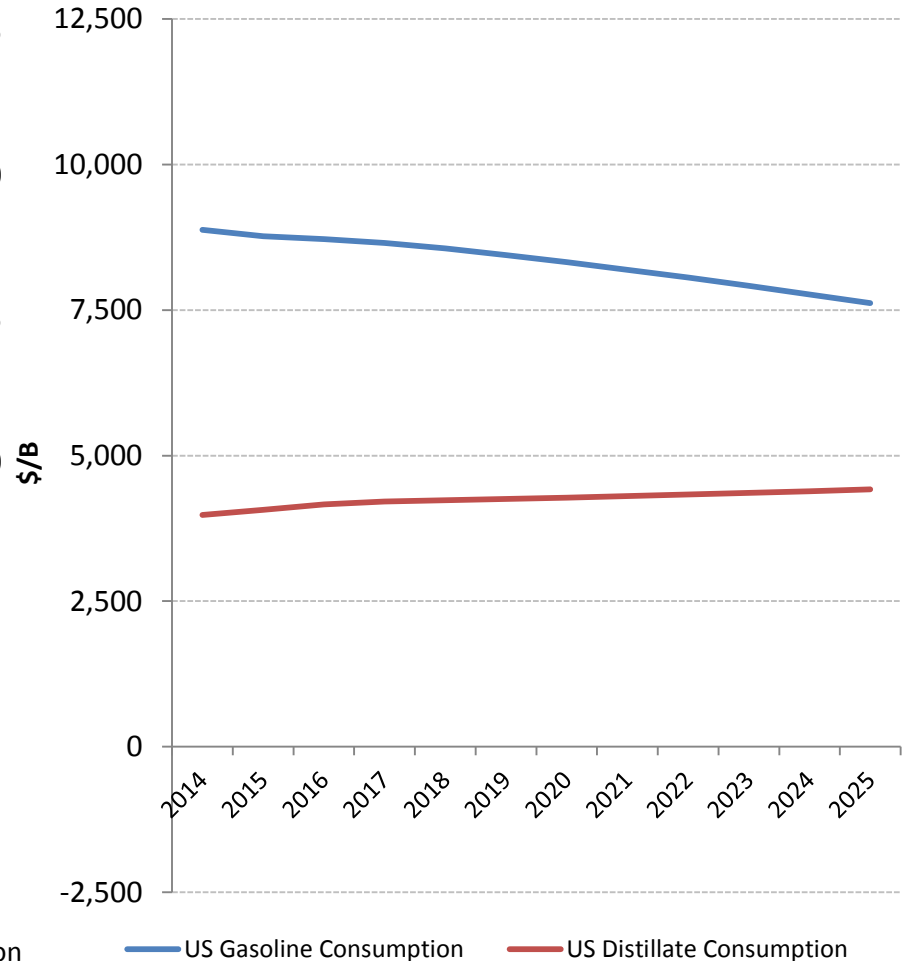
- **Diesel:**
 - LDV diesel sales up ~40% from 2013
 - Emissions match those of gasoline-powered vehicles
 - Lags Europe – and likely to continue
- **Diesel Uptake Lags Europe**
 - Availability
 - Price
 - Emissions Regulations
 - Government Actions

The Case for Investment – Others Factors

US Gasoline and Distillate Consumption vs Differential

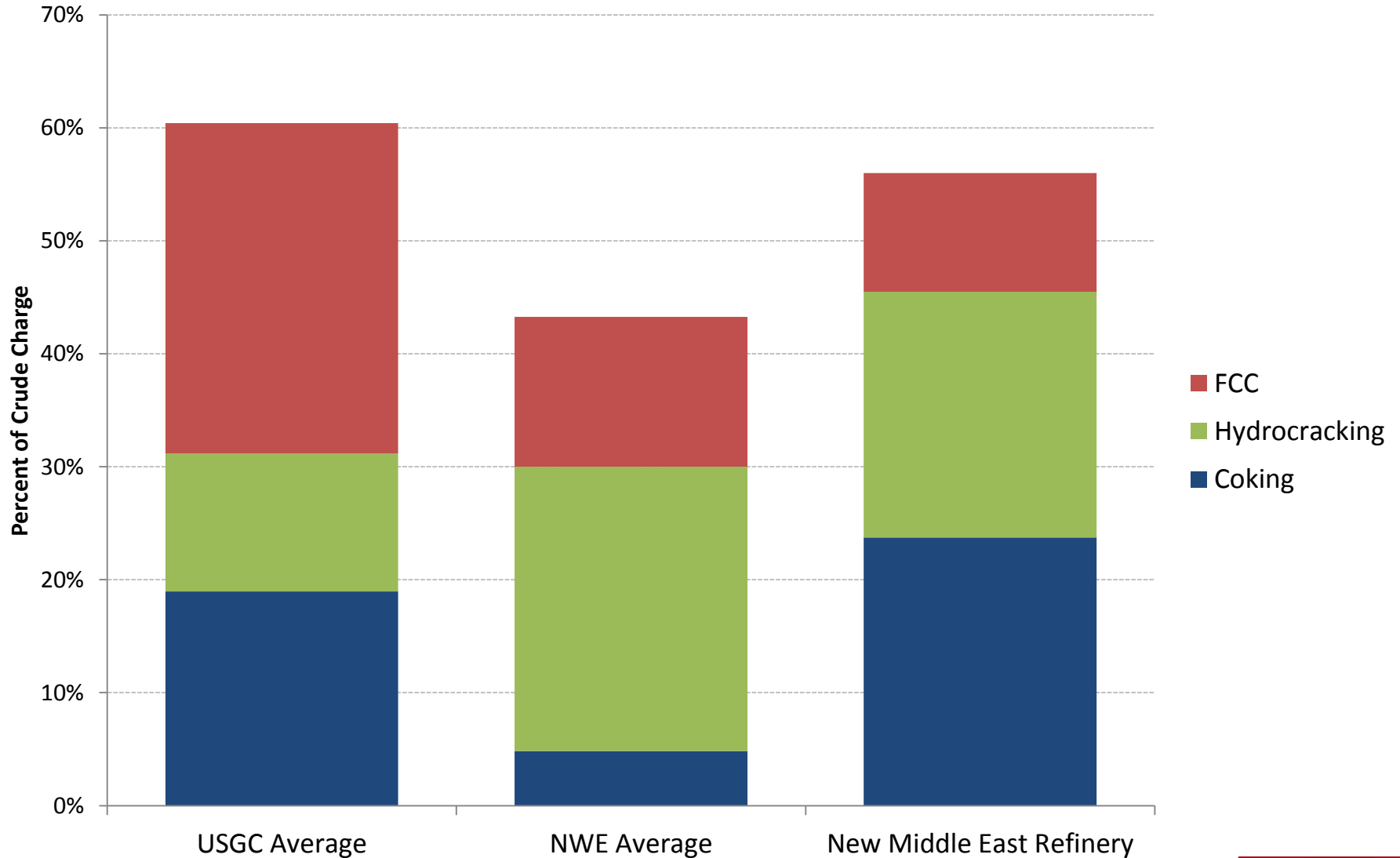


AEO 2014 Projected US Consumption of Gasoline and Distillate



The Case for Investment – Others Factors

Conversion/Upgrading Units - USGC vs. NW Europe and Middle East



- **US crude oil production has increased significantly since 2010 and is expected to continue to rise.**
- **Continued investigation of displacement of crude imports.**
- **Opportunistic capital options for overcoming light ends limitations.**
- **Light virgin products will increase.**
- **The case for investment will continue to evolve.**

Baker & O'Brien – Independent Energy Consultants



Dallas Headquarters

12001 N. Central Expressway
Suite 1200
Dallas, TX 75243
Phone: 1-214-368-7626
Fax: 1-214-368-0190



Houston Office

1333 West Loop South
Suite 1350
Houston, TX 77027
Phone: 1-832-358-1453
Fax: 1-832-358-1498



London Office

146 Fleet Street
Suite 2
London EC4A 2BU
Phone: 44-20-7373-0925

www.bakerobrien.com