The Association of Modified Asphalt Producers

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GLOBAL PETROLEUM OUTLOOK:

TRENDS DEFINING AN UNCERTAIN MARKET

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February 7, 2018

Global Refining Market

Developments

and

Trends

TRENDS DEFINING AN UNCERTAIN MARKET

- **Market turmoil**
- **Cloudy margin outlook**
- **Implementation of International Maritime Organization (IMO) MARPOL Annex VI**

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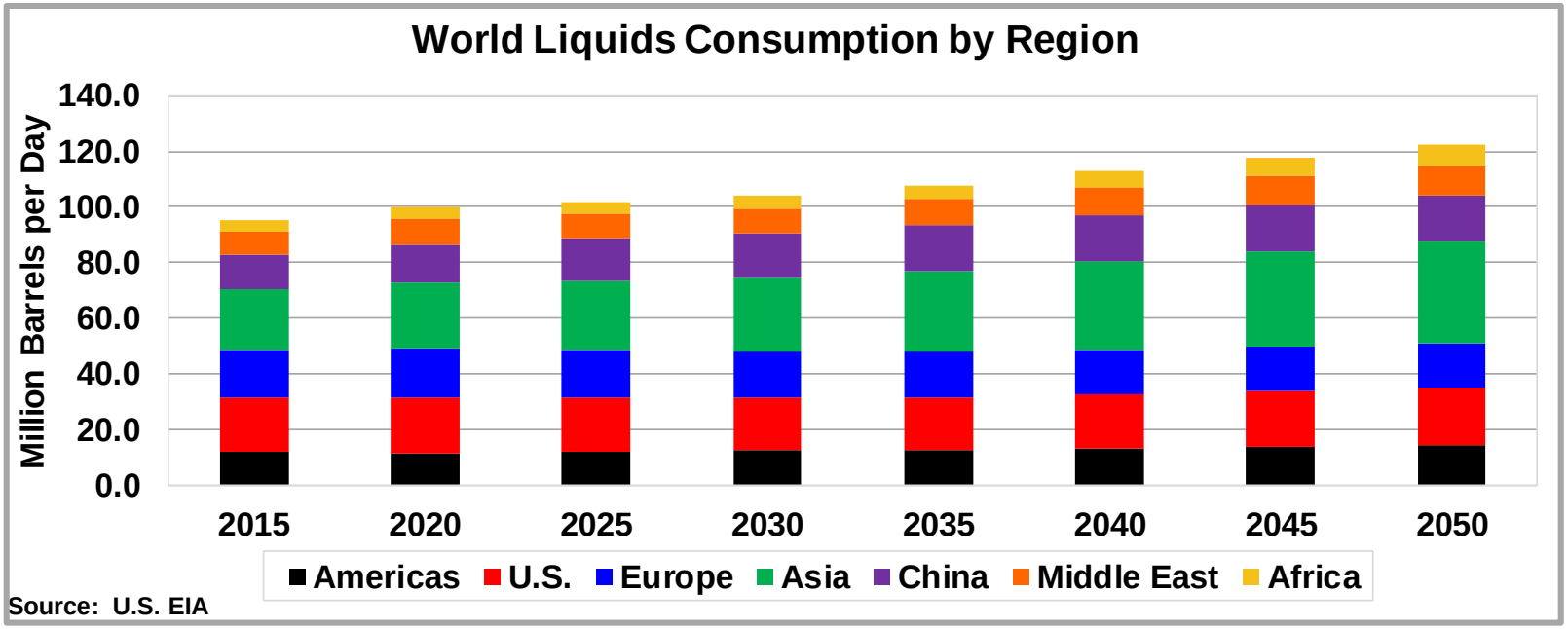
GLOBAL LIQUIDS DEMAND PROJECTION

- **Demand for refined products will remain essentially flat in Europe and the U.S.**
- **By 2030, demand in China will approach parity with the whole of Europe**
  - The rest of Asia, plus the Middle East, will account for More than one-third of total global demand

Percent Demand Growth by Region vs. 2015

	2025	2035	2045
Americas	2%	9%	20%
- U.S.	2%	-3%	2%
Europe	-5%	-7%	-10%
Asia	12%	31%	56%
- China	28%	40%	40%
Middle East	8%	11%	27%
Africa	7%	24%	59%
Total	**7%**	**13%**	**24%**



Source: U.S. EIA

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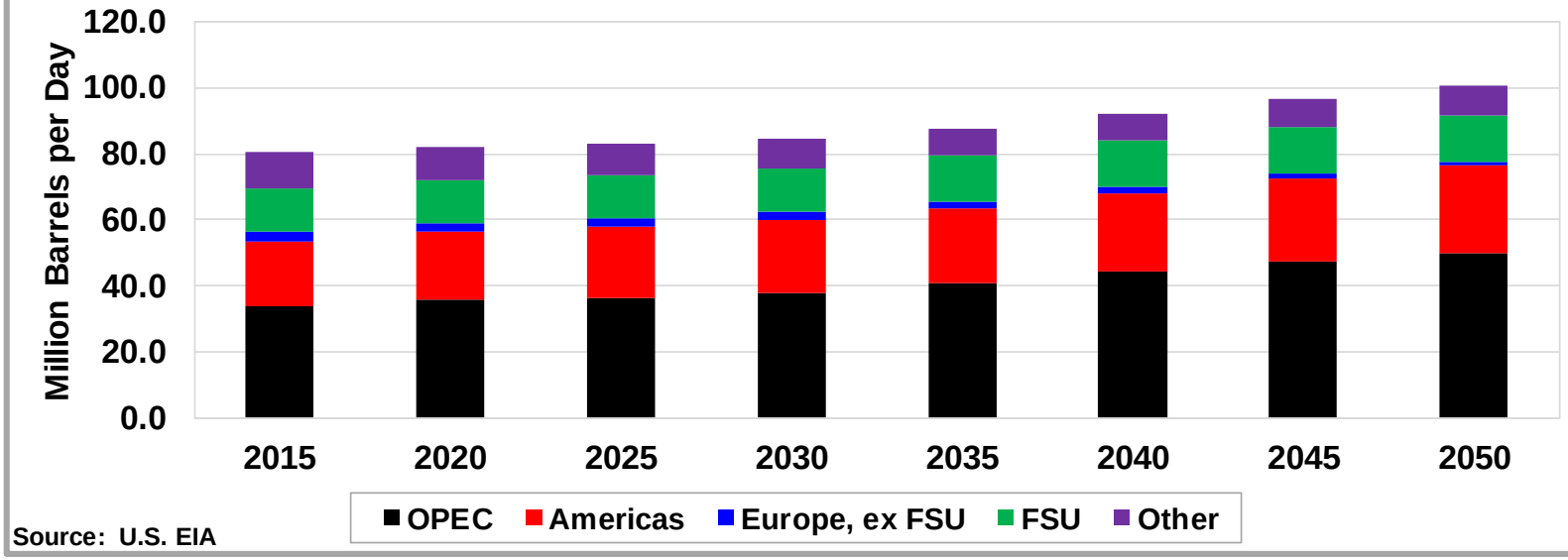
GLOBAL CRUDE OIL SUPPLY PROJECTION

- **Production from OPEC and the Americas grows from 65 percent of the global total to move than 75 percent over the forecast horizon with production growing at a slightly faster pace in the Americas**
  - This struggle for market share will define the global crude oil market over the next decade
  - U.S. production is forecast to plateau at just above 10 million barrels per day with very little decline in the outer years of the forecast

Percent Crude Oil Supply Growth (vs 2015)

	2025	2035	2045
OPEC	8%	21%	39%
Americas	8%	22%	48%
- U.S.	11%	9%	9%
Europe	-17%	-33%	-53%
- FSU	1%	4%	9%
Other	-13%	-24%	-24%
Total	**3%**	**9%**	**20%**



Source: U.S. EIA

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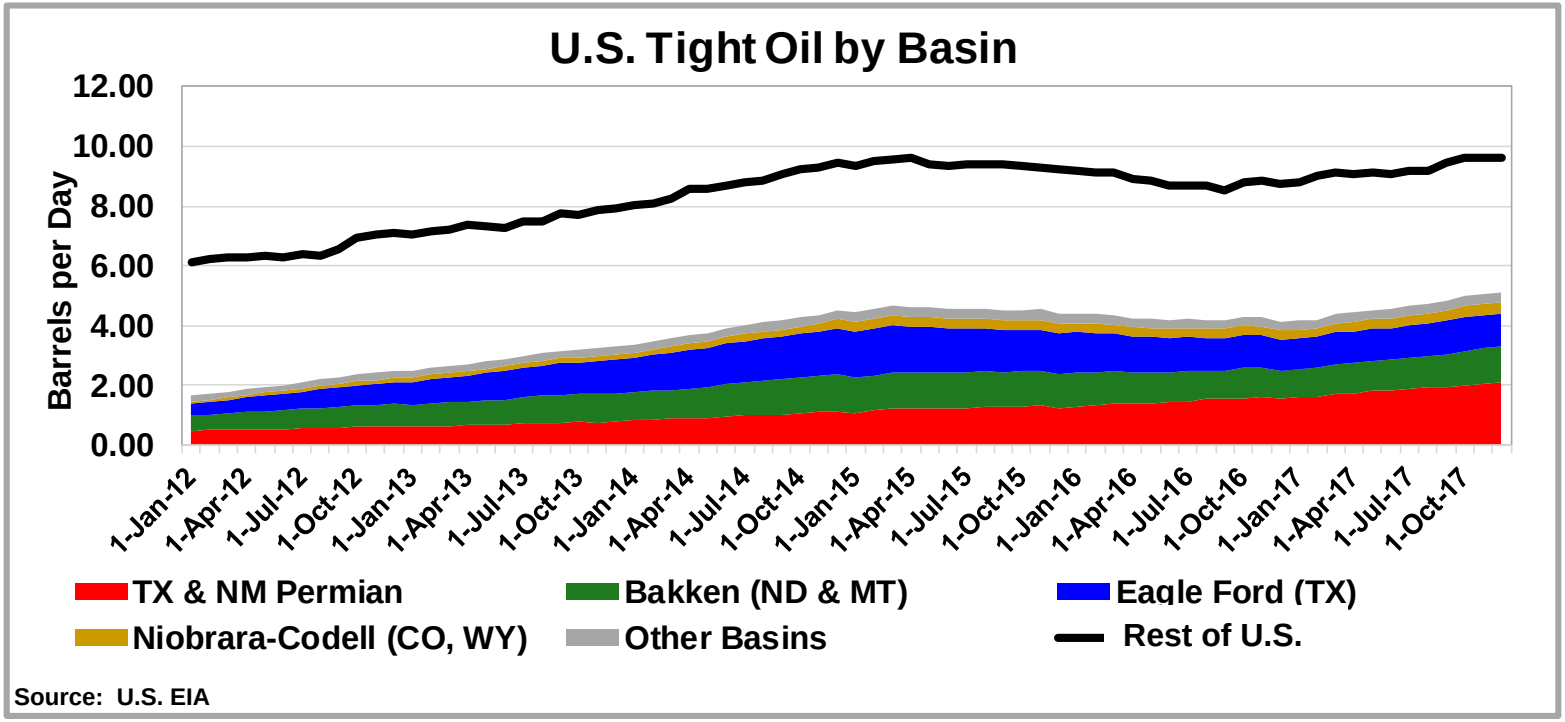
U.S. Crude Oil Production

- **The crash in crude oil prices that began in mid-2014 temporarily halted the rapid growth in tight oil supply**
  - The subsequent decline in production was moderate, ultimately reversing in mid-2016
  - The Eagle Ford play was most adversely affected, generally due to the large volumes of associated gas and condensate
  - On the other hand, production growth in the various formations of the Permian Basin continued with no interruption
  - Production current sits just under 10 million barrels per day
  - November 2017 recorded the second highest monthly production figure in U.S. history



Source: U.S. EIA

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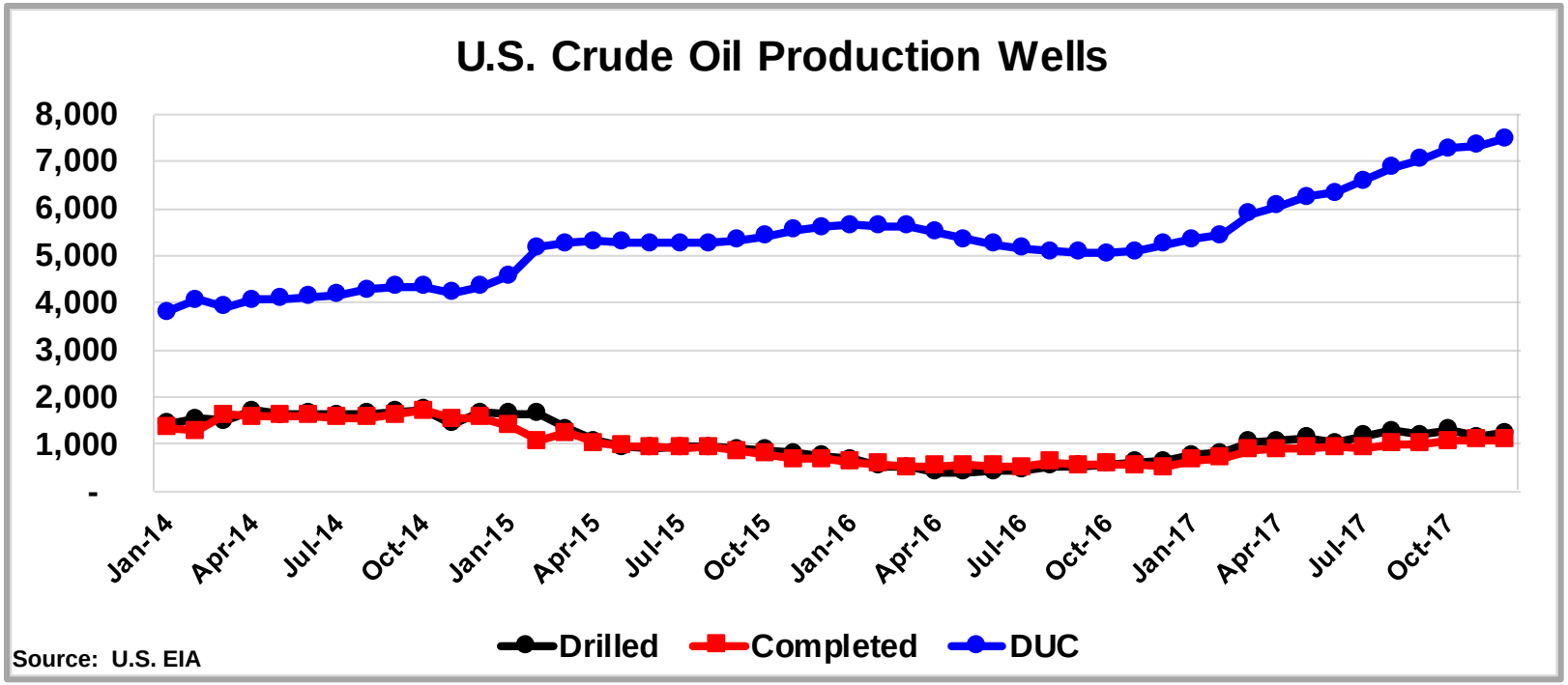
U.S. Drilling Activity

- **U.S. on-shore drilling is on a slow, but steady upward trend**
  - Completions, however, are lagging resulting in a growing backlog of drilled but uncompleted wells

- **A run-up in prices will induce a sharp response by producers to step-up well completions; albeit with some lag due to a temporary deficiency of skilled labor**
  - A flood of light oil could quickly swamp the market
  - OPEC and Russia will be forced to consider another round of production cuts or risk losing recent gains in global crude oil prices



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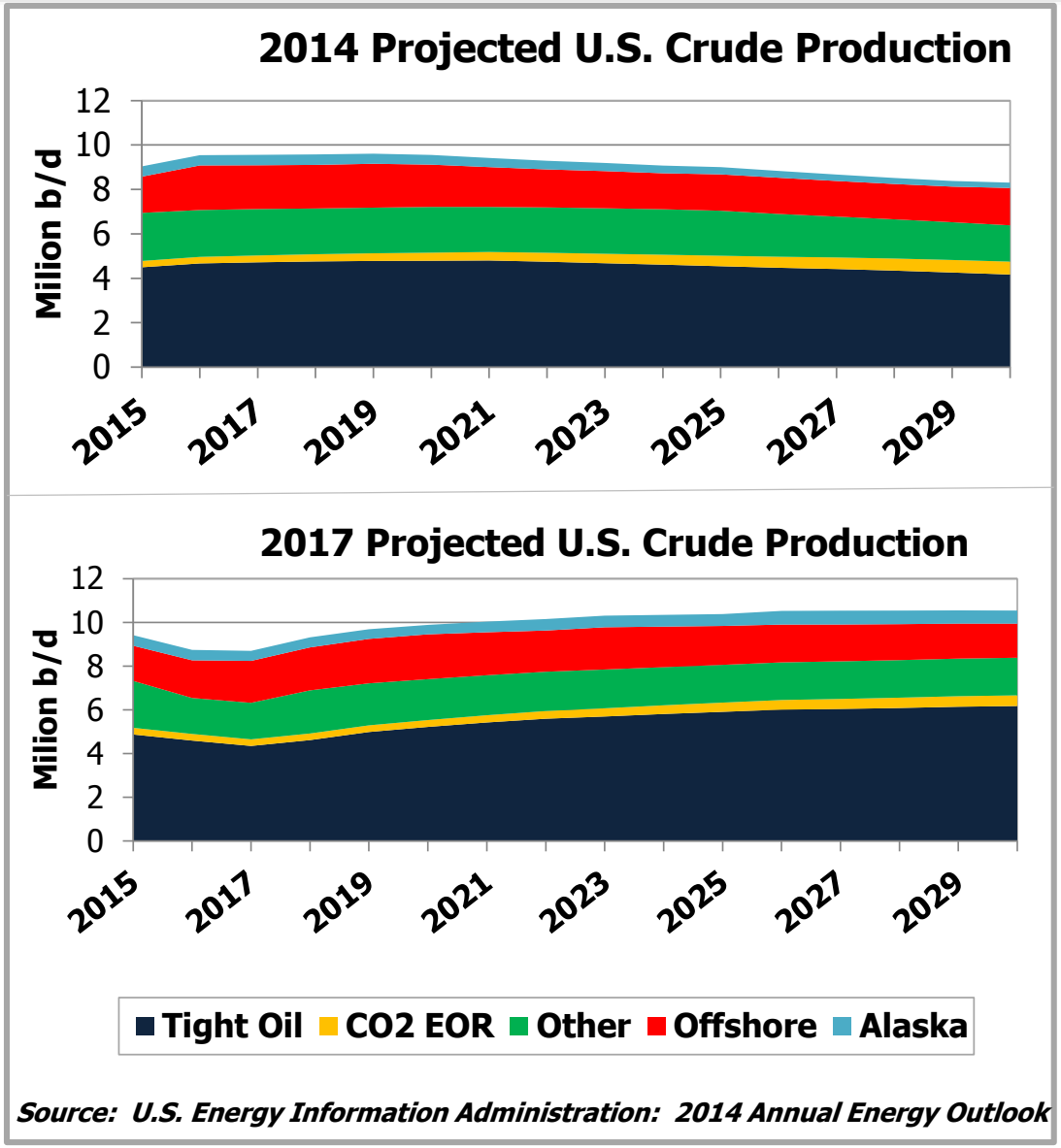
U.S. Crude Oil And Condensate Outlook

- **Rapid advances in drilling technology are changing the way U.S. crude production is forecast**
  - The top chart shows the 2014 EIA forecast which projected a continuous, shallow decline after a brief plateau from 2016 to 2020
  - The 2017 forecast assumed that tight oil production would accelerate later in the year, then shift to a shallow upward trend through the end of the next decade
- **The upward trend is a direct result of confidence gained in improved drilling efficiencies that have been demonstrated in the field over the last several years**
  - Cost per well
  - Decline rates



Source: U.S. Energy Information Administration: 2014 Annual Energy Outlook

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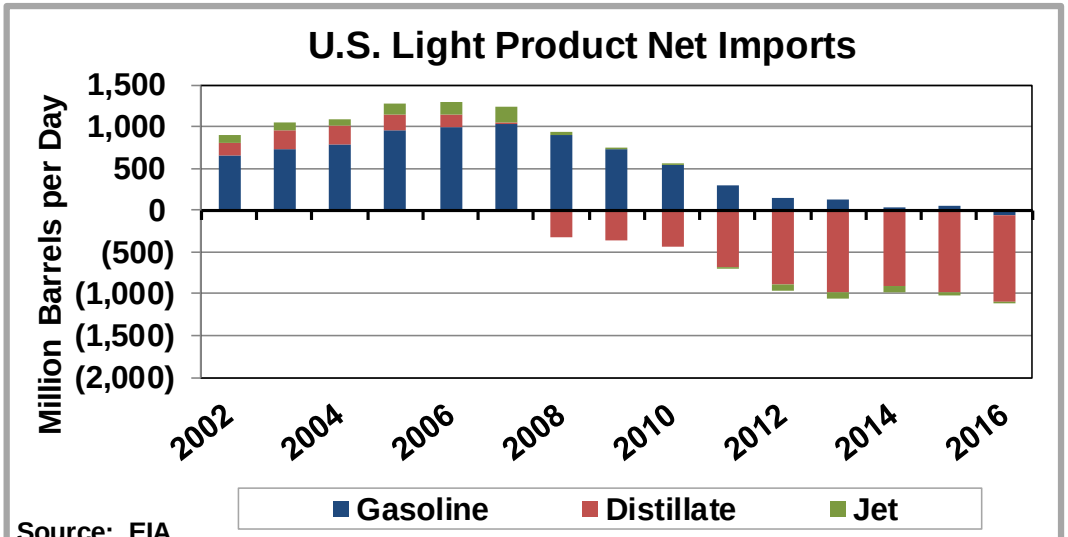
U.S. Petroleum: Global Disruptor

- **International trade flow of petroleum products experienced a sharp reversal that began about 10 years ago**
  - The U.S. became a net exporter of diesel in 2008. Current balance shows more than 1 million barrels of diesel exported daily
  - Gasoline lagged with the U.S. reaching import/export parity only about 3 years ago
    - Today the U.S. imports roughly 1 million barrels per day into the East Coast
    - At the same time, exports of about 1.1 million barrels per day depart the Gulf Coast

- **U.S. crude oil exports have taken off dramatically since the lifting of the export bank in late 2015**
  - Huge growth to Europe and China with both regions exhibiting an appetite for medium sour crude oil from the Gulf of Mexico



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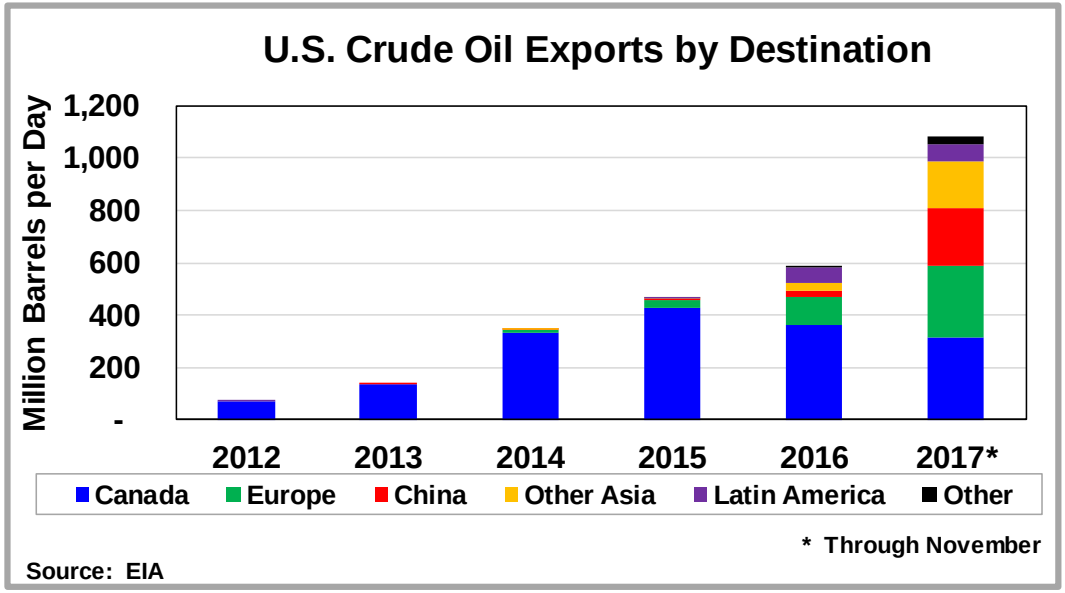

Source: EIA

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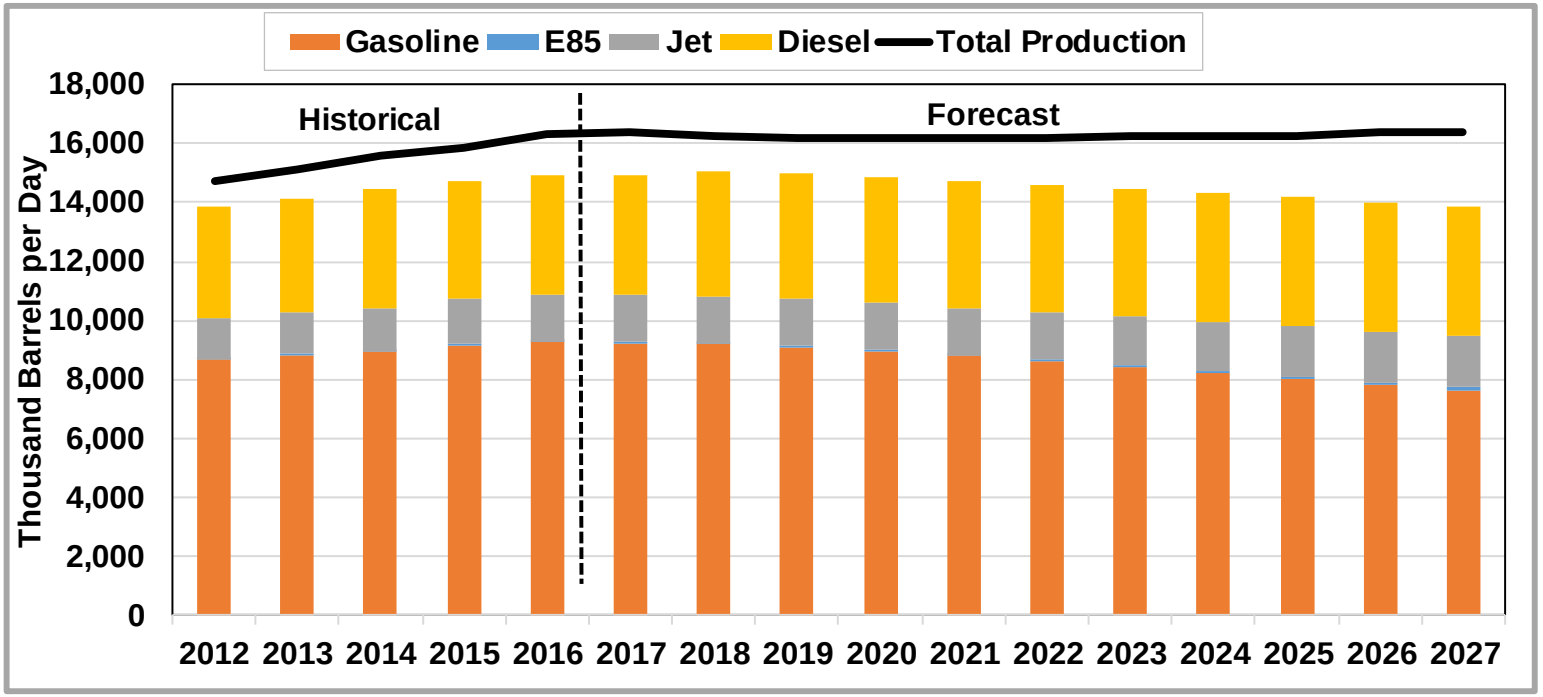
LIGHT PRODUCT SUPPLY/DEMAND OUTLOOK

- **The chart below show Muse's forecast for light product supply and demand over the next 10 years**
  - Demand has likely peaked and will begin an accelerating decline in gasoline demand partially offset by gains in total distillate demand
  - U.S. refineries are among the most competitive in the world. Expect a shallow growth trend in production leading to a growing surplus of refined product for export



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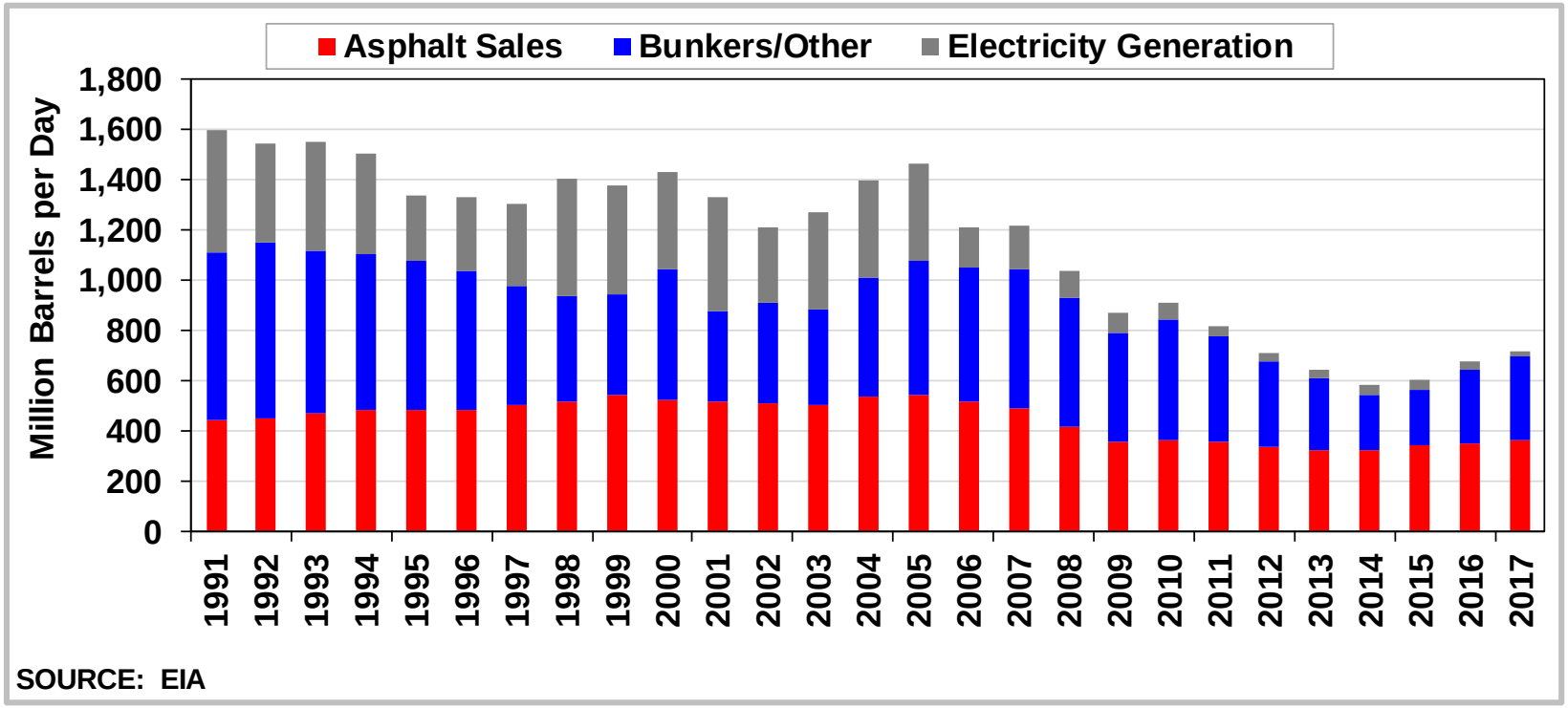
HEAVY PRODUCT DEMAND IS SLOWLY REBOUNDING

- **After dropping below 600,000 barrels per day several years ago, total U.S. heavy product demand has recently trended higher on the back of a modest gain in asphalt and a larger bump in bunker fuel**
  - After a nearly 10 year decline, asphalt sales have trended higher 4 years running
  - Bunker demand has improved by more than 50 percent since reaching a historical low in 2014
  - Demand for electrical generation continues a decades long fall and has been virtually eliminated from U.S. industry



SOURCE: EIA

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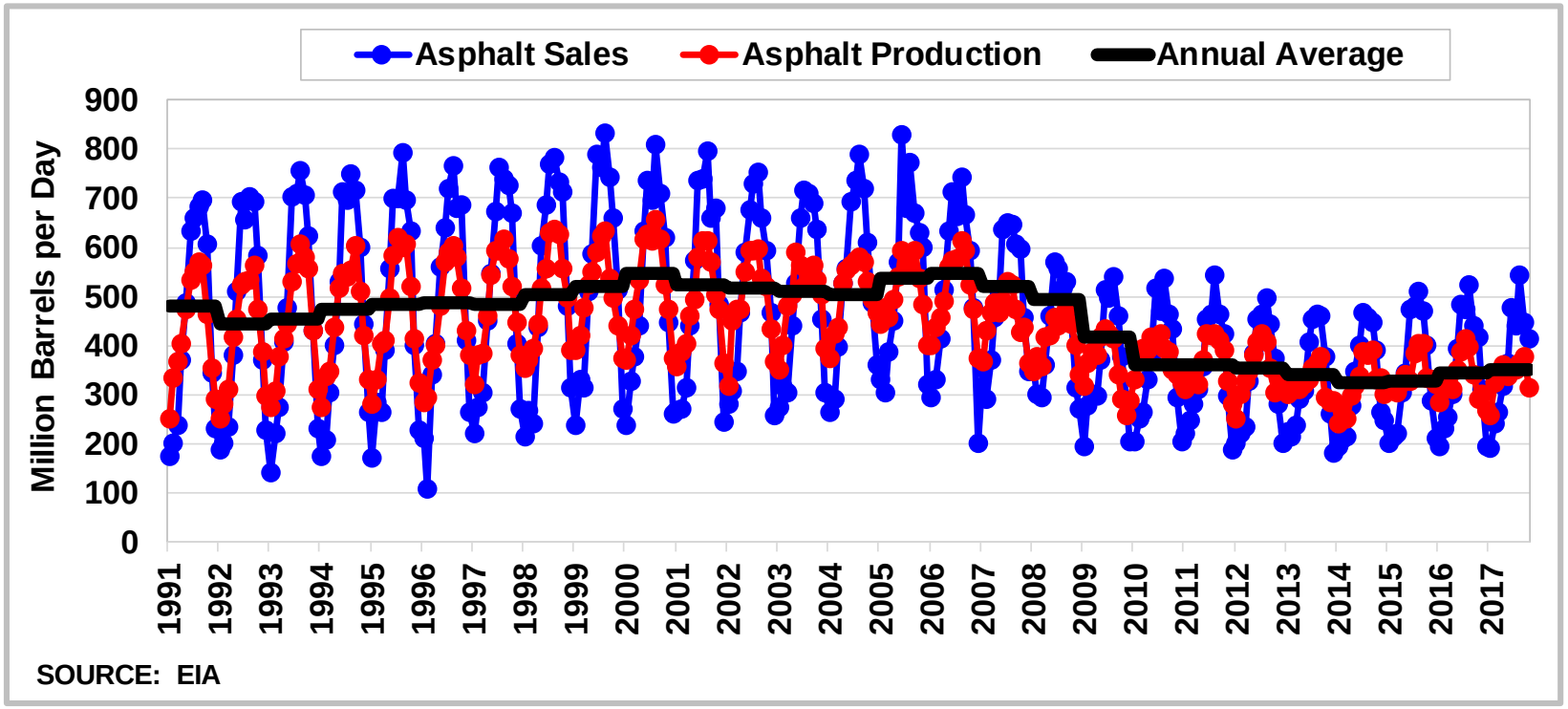
U.S. Asphalt Production/Consumption

- **The U.S. asphalt market in terms of supply and demand has been remarkably consistent over the past decade**
  - Production has remained generally flat
  - Seasonal demand swings are not as extreme
  - Recent year-on-year demand growth has been modest at best



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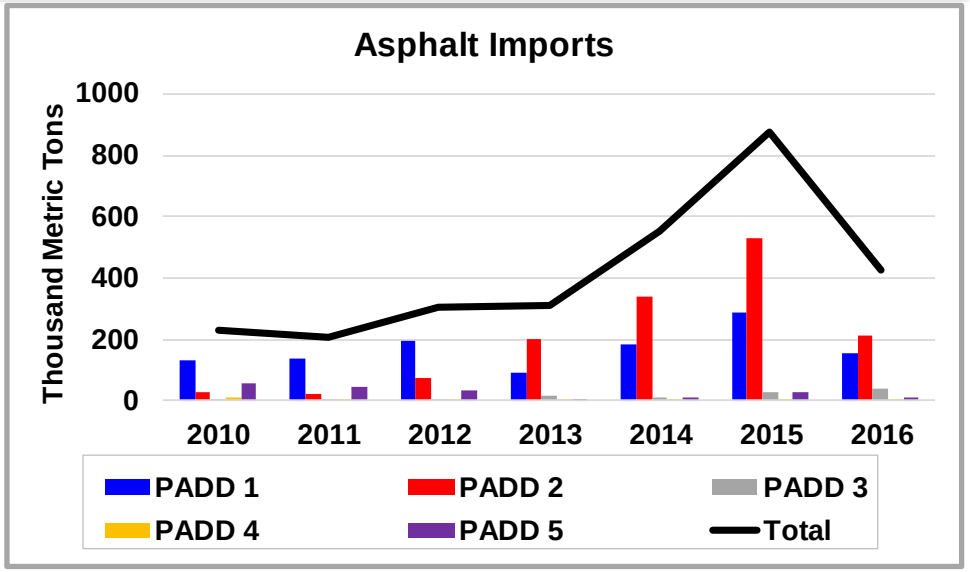
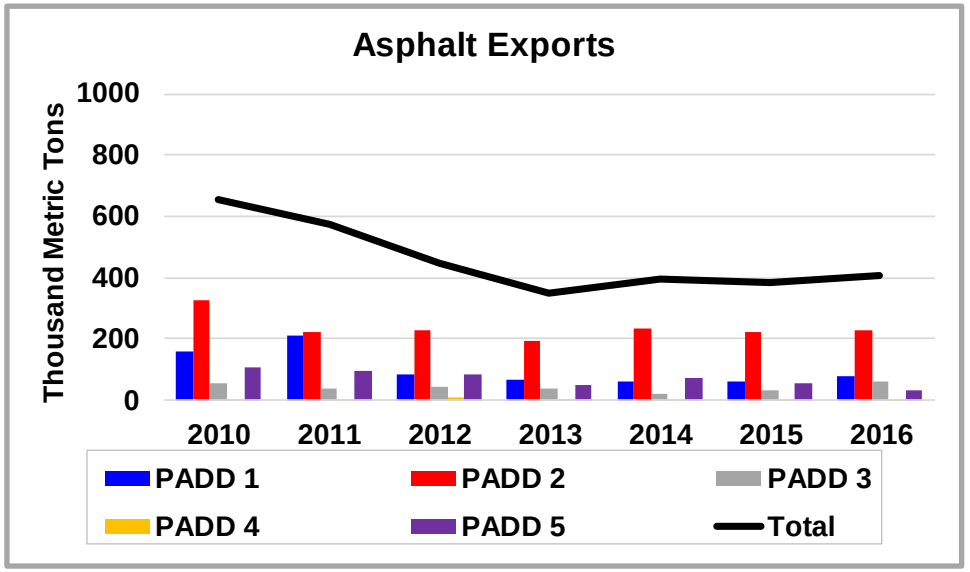
ASPHALT IMPORT/EXPORTS BY PADD

- **Asphalt imports land primarily in PADD's 1 and 2**
  - The largest import markets are Duluth, Minnesota (main port of entry for Canadian asphalt delivered by rail), and Savannah, Georgia
  - The large blip in 2015 East Coast imports may have been related to operating problems at the Axeon asphalt refinery in Paulsboro, New Jersey
  - With the closure of the Axeon refinery last spring, asphalt imports in PADD 1 may go up since the idle facility is apparently still operating as a terminal

- **Asphalt exports have been flat to trending down in all regions**
  - Most exports are from PADD 2 to Canada





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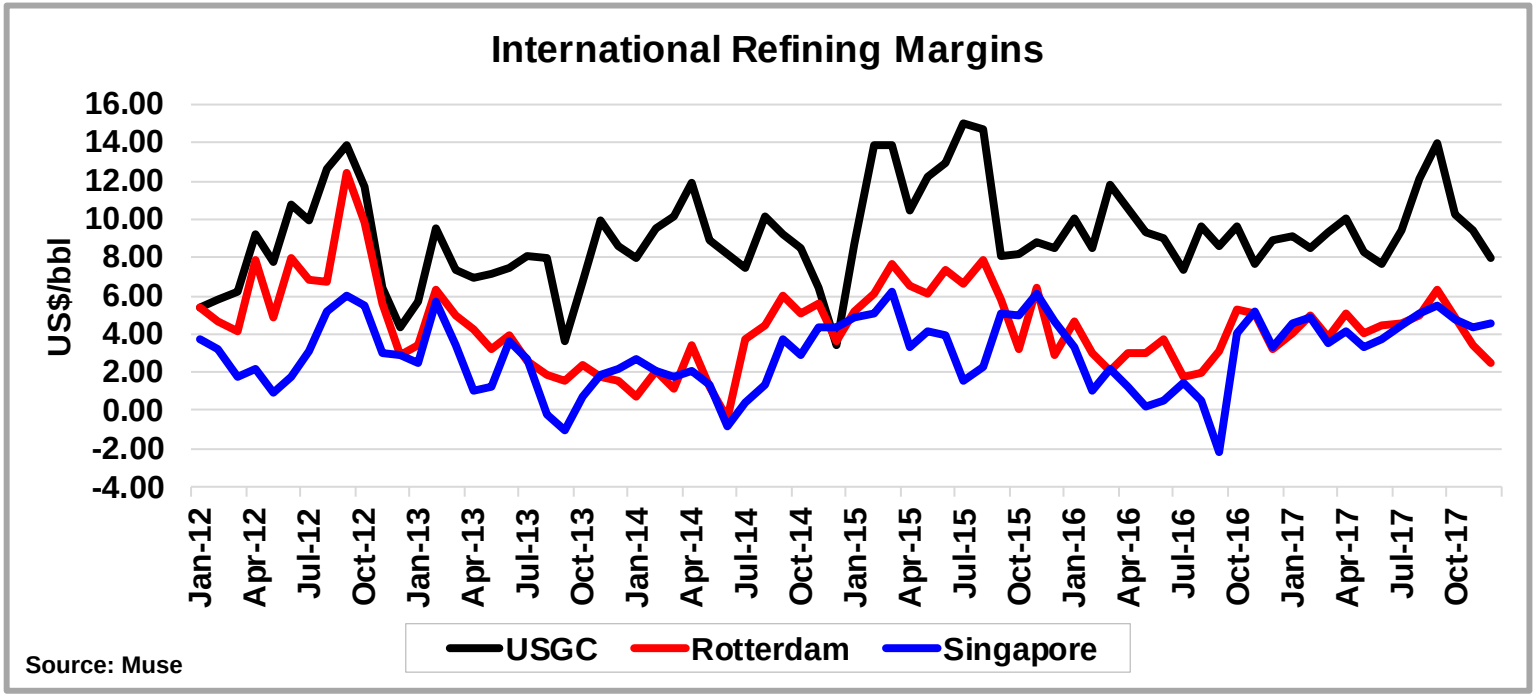
CONVERGING GLOBAL REFINING MARGINS

- **U.S. margins have retreated to a lower, more range-bound state as gasoline demand growth (which surged in 2015) has retraced back to a very shallow upward trend**

- **Asian margins have shown some recent life however, maintaining parity with Europe for the last several quarters**



Source: Muse

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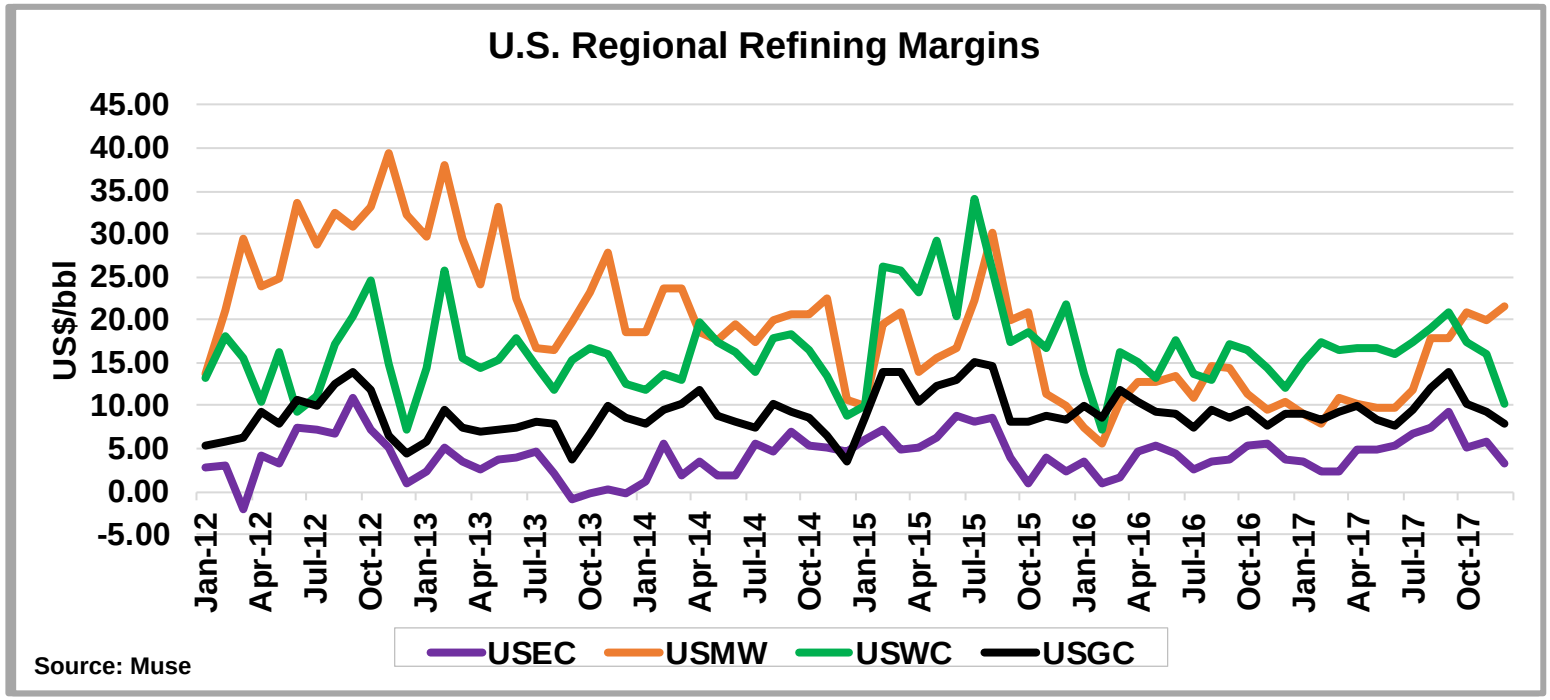
U.S. Refining Margins: Treading Water

- **Refining margins in all U.S. regions have remained relatively flat over the past 18 months**
  - Inland refiners have seen the huge crude oil price advantage erode away completely; now competing on more even footing versus rest of the U.S.



MARPOL ANNEX VI COMPLIANCE

OPTIONS AND TIMING

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MARPOL ANNEX VI OVERVIEW

- **MARPOL ANNEX VI requires all ships to use fuels with a sulfur content of no more than 0.5 wt.% on the high seas from 1 January 2020 forward**
  - Other, lower sulfur standards apply in Emission Control Areas (ECAs)
  - Currently 3.5 wt.% maximum on high seas

- **Recent study commissioned by IMO finds that lower sulfur, IMO-compliant fuel demand will reach 272 million tonnes per annum (~ 5.3 mb/d) beginning in 2020**
  - The study reference basis (in 2012) was 228 million tonnes per annum in with an average sulfur content > 2 percent

- **The largest producers are (in order)**
  - Asia 42 percent
  - Europe 23 percent
  - Middle East 11 percent
  - North America 9 percent

  } 85 percent

- **What does this change mean for the global refining industry?**

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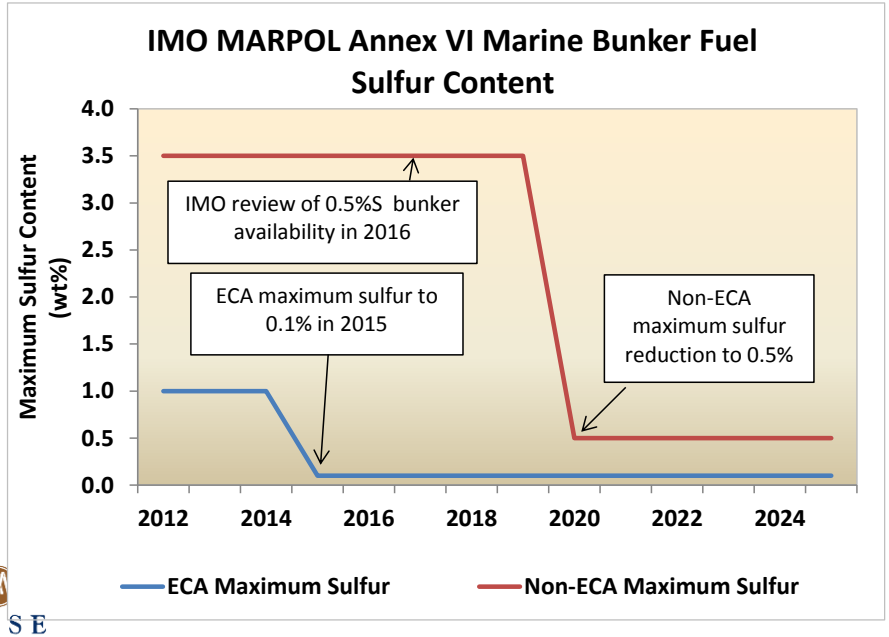
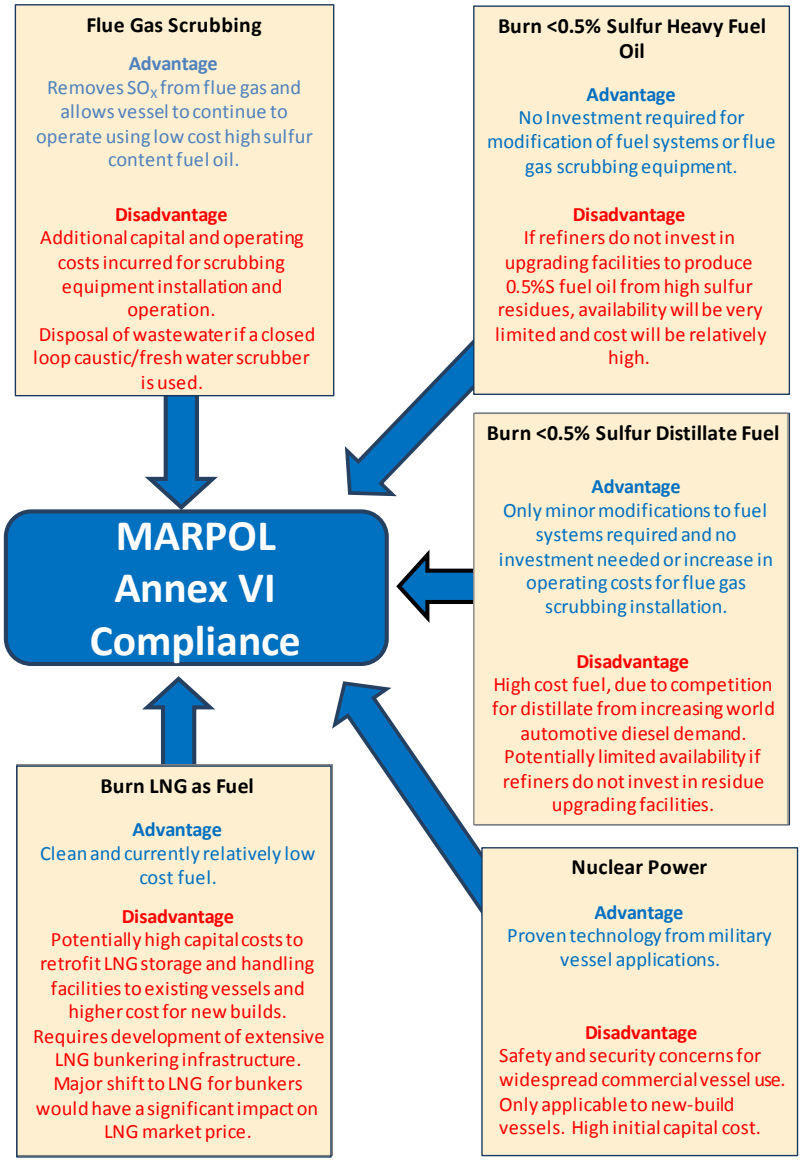
MARKET UNCERTAINTY: NON-FUEL OPTIONS AVAILABLE

- **The timing for implementation and the range of compliance options available to ship owners will be problematic for refiners wishing to continue serving the market**

- **Enforcement is a major concern**
  - Regulation leaves it to the individual countries to ensure compliance
  - Compliance in North America, Europe, and northeast Asia should be nearly universal
  - Elsewhere: Who knows for sure





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LIMITED CRUDE SELECTION AND BLENDING OPTIONS

- **Sourcing suitable crude oil feedstock to direct blend low sulfur bunker fuel will be a challenge for most current refinery suppliers**
  - There are only a handful of commercially available crude oils worldwide with sulfur levels low enough to consider blending a 0.1 wt.% sulfur bunker fuel for use within the ECAs
  - Blending 0.5 wt.% sulfur bunker fuel is technically and economically feasible but limits remain on the availability of suitable feedstock

Crude Oil Residue Sulfur Content

Crude Oil Name	*Source Country*	*Atmospheric Residue Sulfur (wt.%)*	*Vacuum Residue Sulfur (wt.%)*	*Total Crude API Gravity*	*Total Crude Sulfur (wt.%)*
Readily Blend 0.5% Sulfur Fuel Oil					
Saharan Blend	Algeria	0.27	0.34	43.6	0.07
El Sharara	Libya	0.20	0.28	42.2	0.09
Nkossa	Congo	0.10	0.14	39.9	0.06
BTC Blend	Azerbaijan	0.29	0.43	36.4	0.14
Agbami	Nigeria	0.22	0.47	48.1	0.05
Palanca Blend	Angola	0.36	0.52	37.0	0.21
Troll	Norway	0.24	0.55	35.9	0.14
Can Economically Blend 0.5% Sulfur Fuel Oil					
Bonny Light	Nigeria	0.34	0.60	35.1	0.15
EA Blend	Nigeria	0.23	0.62	35.0	0.09
DUC Blend	Denmark	0.46	0.63	33.5	0.25
Ekofisk	Norway	0.48	0.70	38.4	0.22
Uneconomic or Technically Infeasible to Blend 0.5% Sulfur Fuel Oil					
Girassol	Angola	0.56	0.78	29.8	0.34
Statfjord	Norway	0.50	0.81	39.5	0.22
Gullfaks	Norway	0.56	0.89	37.5	0.22
Oseberg	Norway	0.57	0.89	37.8	0.27
Dalia	Angola	0.71	0.89	23.1	0.51
Forcados	Nigeria	0.62	1.53	30.4	0.28
Es Sider	Libya	0.64	1.04	36.7	0.37
Kuito	Angola	1.04	1.28	22.0	0.72
Brent Blend	UK	0.87	1.33	38.5	0.41
CPC Blend	Kazakhstan	1.18	1.76	45.3	0.56
Tengiz	Kazakhstan	1.34	2.16	46.4	0.51
Forties	UK	1.81	2.68	38.7	0.79

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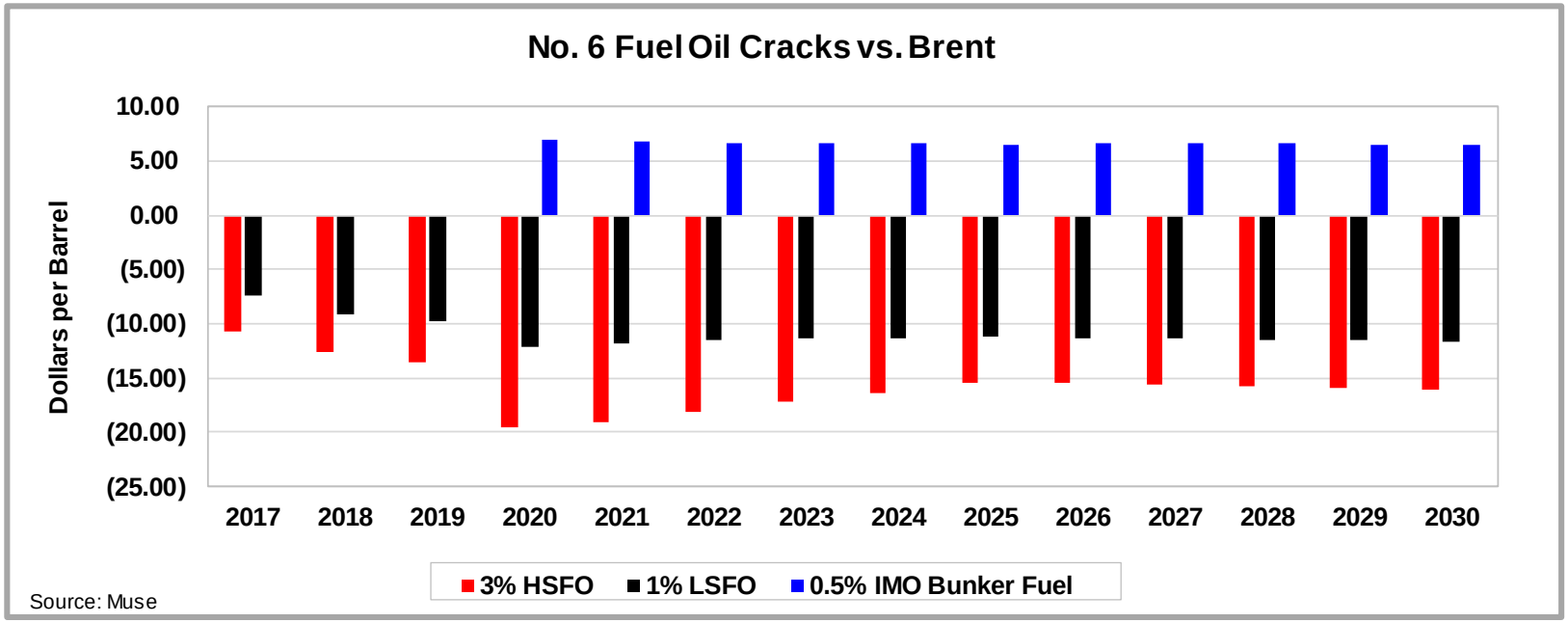
RESIDUAL FUEL OIL CRACK OUTLOOK

- LSFO can be blended with expensive, low sulfur gas oil to meet the specification limit
- HSFO prices expected to decline sharply with the implementation of IMO low sulfur bunker fuel standard in 2020
- IMO compliant bunker fuel will command a premium vs. HSFO of US$ 20 to US$ 26/barrel (US$ 140 to US$ 180 per MT)



Source: Muse

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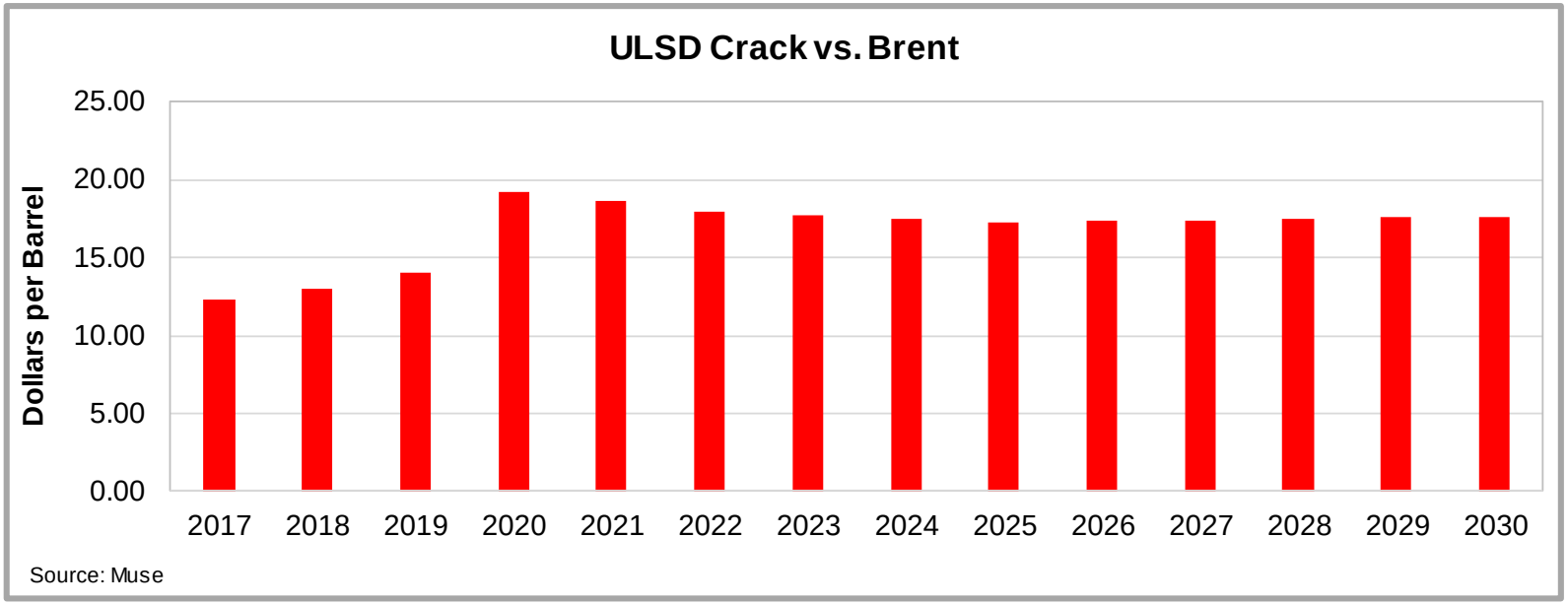
LOW SULFUR DISTILLATE CRACK OUTLOOK

- **Nearly 2 million barrels of low sulfur distillate are at risk of being diverted to the bunker market**
  - This will increase distillate cracks, allowing the necessary investment in hydrotreating/hydrocracking capacity to rebalance the market
- **Over time, new coking capacity will produce the incremental distillate barrels needed to replace the volume that will be diverted to the bunker market**



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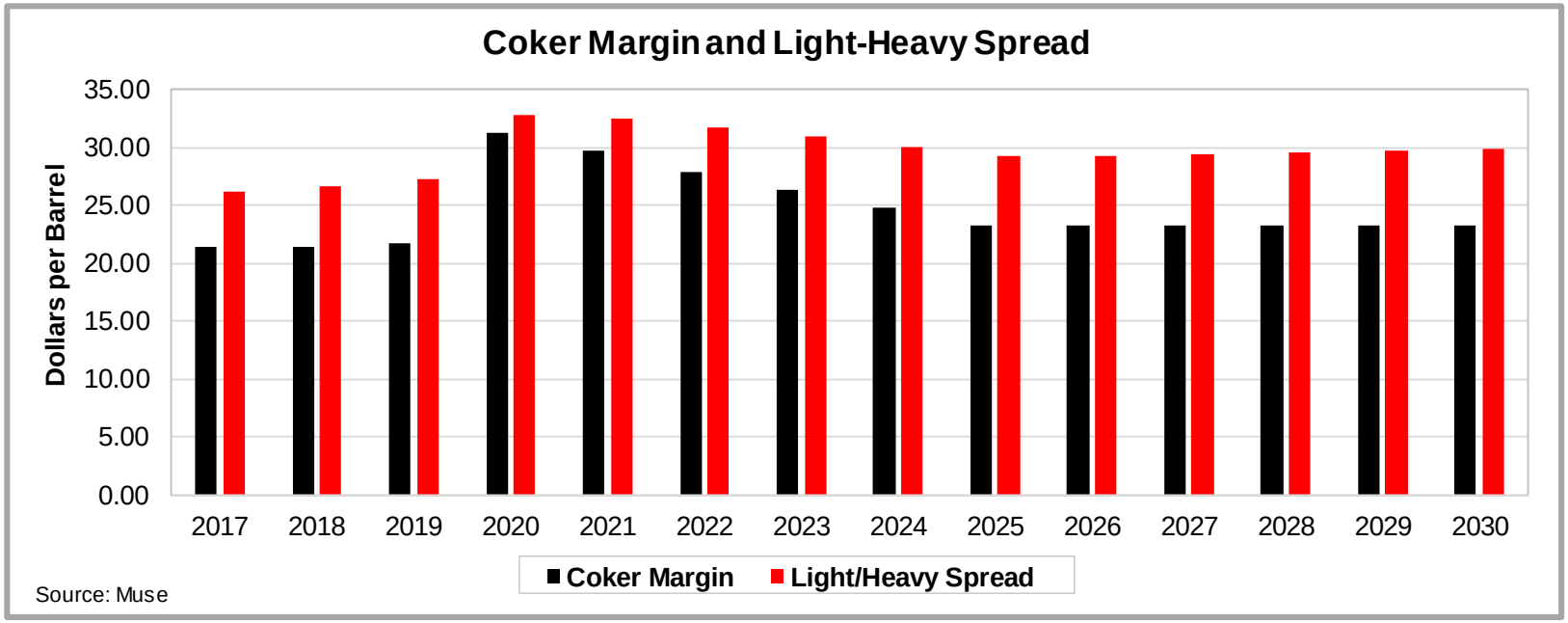
Residual Oil Processing Margins

- **Sharply wider LSFO – HSFO spreads will provide a strong incentive to add coker capacity**
  - Most likely markets for adding capacity will be the U.S. Gulf Coast, Middle East, and China
  - Light heavy spreads will widen, increasing the discount for medium and heavy sour crude oil



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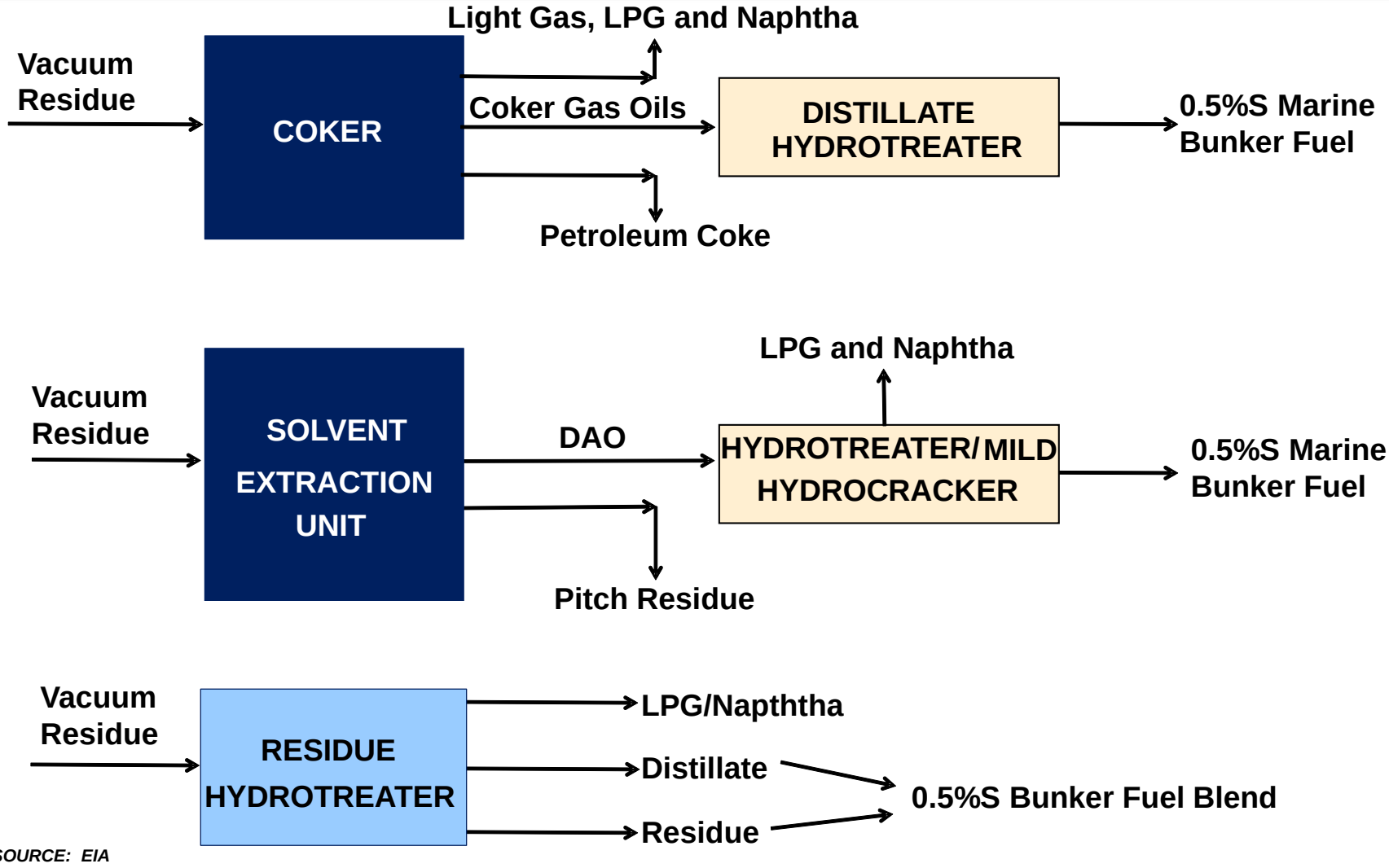
EXPENSIVE RESIDUAL OIL PROCESSING OPTIONS



SOURCE: EIA

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IMO Compliance Investment Costs

- **Processing options, while technically feasible, are not likely to generate compelling financial justifications given the forecast IMO – HSFO bunker fuel spreads presented previously**
  - Figures shown below assume upgrade of a typical 200,000 barrels per day European refinery

- **Furthermore, refiners may be reluctant to place very large capital spending wagers on a product that historically has traded well below the cost of the feedstock**

	Values in Million US$ except for price differential (US$/MT)		
	Coker	***SDA/Hydroprocessing***	***Residue Hydrotreater***
Investment Option			
Total Estimated Capital Investment	1368	1447	1731
Annual Margin For Capital Recovery (8-year simple payback)	171	181	216
Annual Incremental Operating Cost	68	94	112
Margin Adjustment for Yield Shifts	148	-12	-35
Value Uplift Required on 0.5%S Marine Fuel to provide 8-year payback and cover operating cost increase and yield adjustments	387	263	294
Price Differential Required for 0.5%S Marine Bunker Fuel versus HSFO (US$ per MT)	**312**	**205**	**180**

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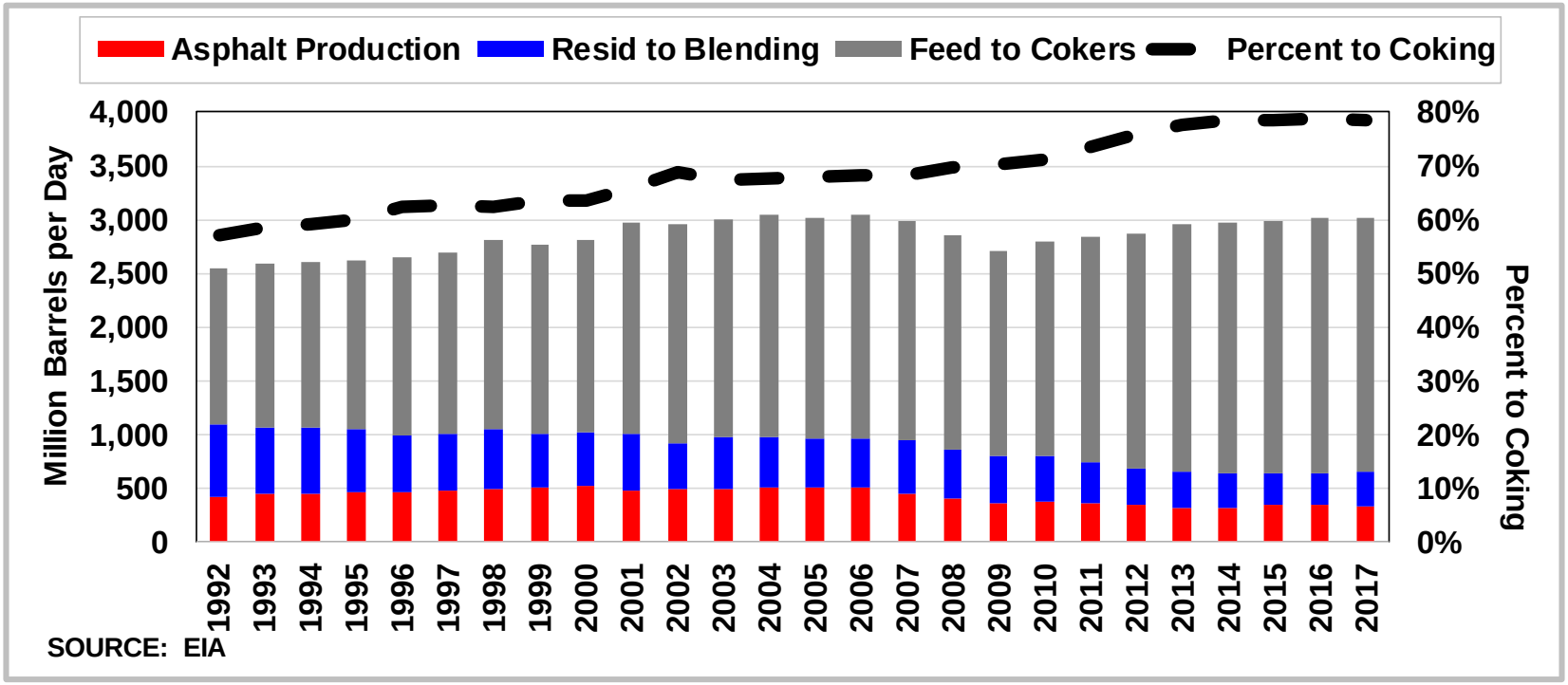
U.S. Exposure is Limited: Residual Oil Disposition

- **Total refinery residual oil production is slowly trending upwards with higher crude input**
  - Higher crude runs are partially offset by expanding inclusion of low bottoms yielding shale oils
- **The percentage of residual oil supply that is destroyed by coking has reached 80 percent**
  - Industry is rapidly approaching a limit, however, as the most recently installed coking capacity is absorbed
- **Asphalt production has leveled out, generally in balance with domestic demand**



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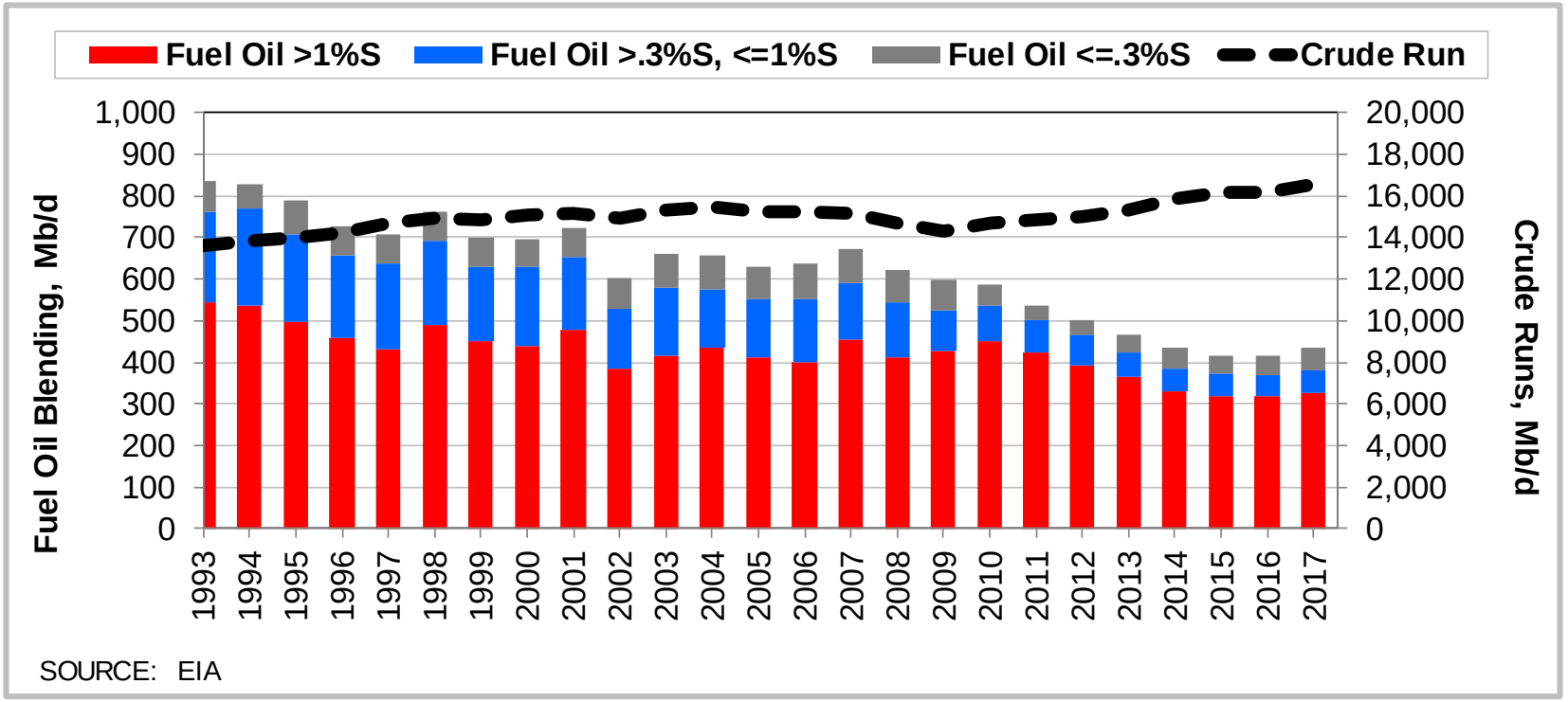
U.S. Residual Fuel Oil Blending is Limited

- **Lower sulfur fuel oil blends suitable for marine bunker fuel now make up less than 25 percent of the total residual fuel oil production in the U.S.**
  - Competing bunker fuel demand for LSFO blendstock may drive the last remaining oil-fired power plants in the U.S. to switch to natural gas
  - The remaining 300,000 barrels per day of HSFO will largely be absorbed by coking refineries
  - Will likely result in some crude switching to optimize coker input



SOURCE: EIA

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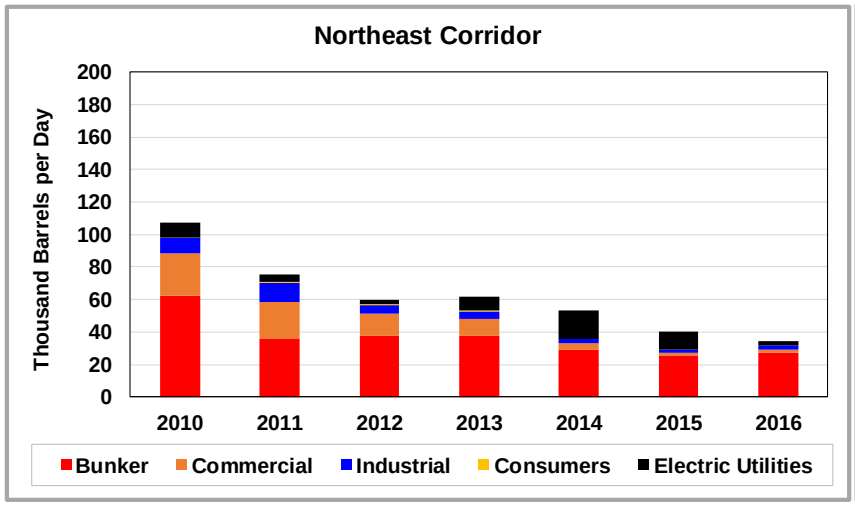
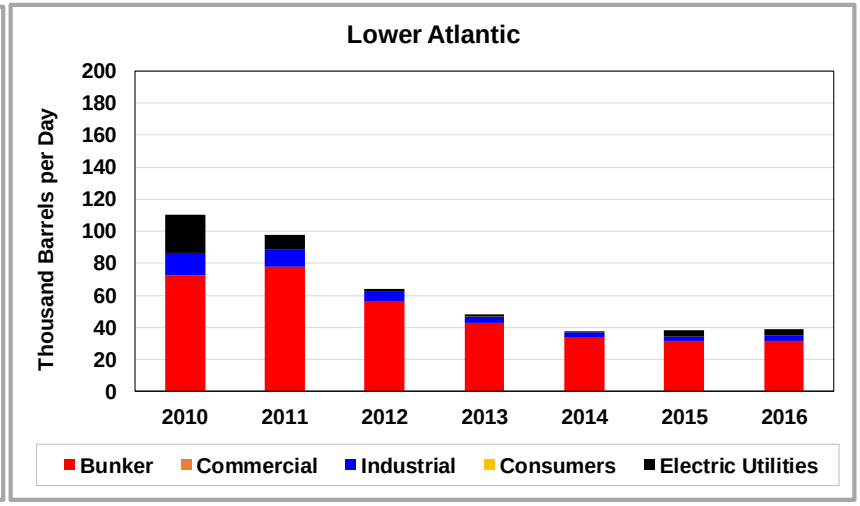
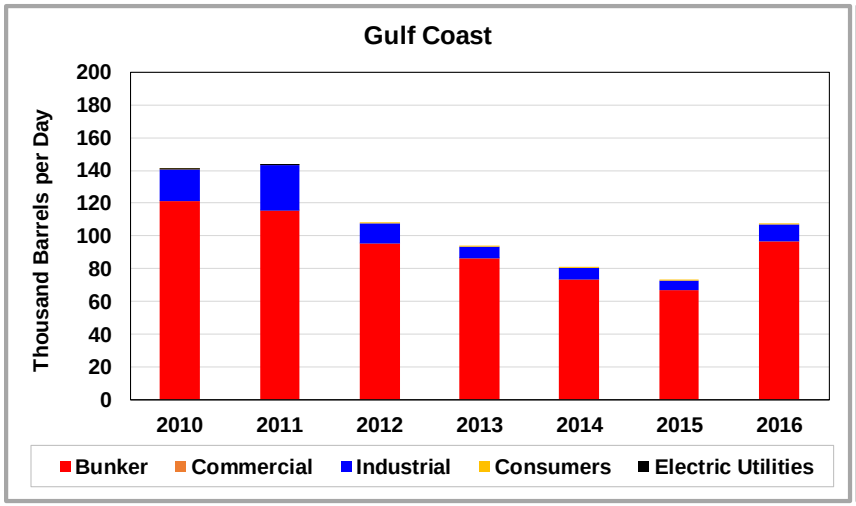
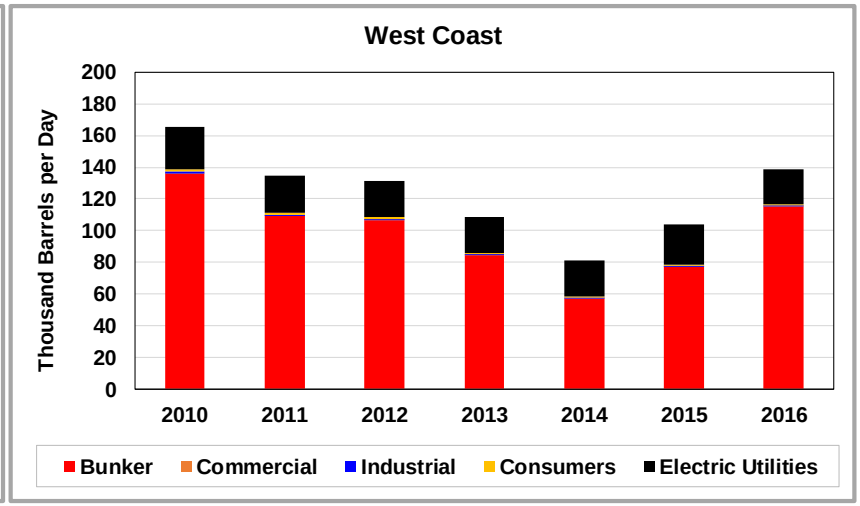
Fuel Oil Sales by End Use

- **Residual fuel demand for all coastal markets is predominantly for bunker fuel**









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Implications for the Refining Industry

- **Crude markets will be dominated by the ongoing battle for market share between entrenched OPEC producers on one side and increasingly competitive U.S. producers on the other**
  - Long-term fundamentals side with OPEC but the short- to medium-term struggle will be epic
  - The battle will reshape crude oil trade flow and could alter long-standing geo-political relationships

- **The U.S. refining industry's competitive advantage is eroding**
  - The opening of U.S. production to export markets is rapidly diminishing the parity discount for domestic crude oils
  - Slowing gasoline demand growth has largely eliminated the large light product premium in U.S. markets causing refining margins to retreat more in line with global markets

Implications for the Refining Industry

- **Certain refining markets will be affected disproportionately by the implementation of MARPOL Annex VI**
  - European refiners stand to lose the most due to heavy reliance on the marine bunker market for disposal of surplus heavy fuel oil
    - Weak market fundamentals also leave the most exposed refiners with little cash to address the problem
    - Expect further rationalization in this sector
  - U.S. refiners least exposed due to high residue upgrading capacity
  - Middle Eastern, Chinese, and North American refiners most likely to fund new residue destruction capacity
  - Window of opportunity for adding new conversion capacity will rapidly close in the years following the 2020 implementation deadline

Implications for the Asphalt Industry

- **Wider light-heavy spread after implementation of MARPOL Annex VI in 2020 will lead to greater discounting of extra-heavy crude oil preferred by asphalt producers**
  - That said, the market could develop a premium for quality, asphaltic crude oils as demand expands due to refiners trying to limit exposure to heavy fuel markets
  - Coking refiners will preferentially seek more discounted heavy crude oils that cannot be feasibly utilized for asphalt production

- **The asphalt market could experience a wave of new production after 2020**
  - Some of the new asphalt supply will come from displaced crude oil that previously had been purchased by coking refiners
  - Other supply will be of poor quality, produced from ill-suited crude oil by refiners desperately trying to avoid closure
    - Maintaining high quality standards will be one means of maintaining market share
  - Prices for paving grades are likely to soften for a few years until the residual oil market equilibrates
  - Specialty grades of asphalt may have less exposure due to less forgiving performance standards, greater restrictions on crude oil supply, and more interactive relationships between producers and buyers

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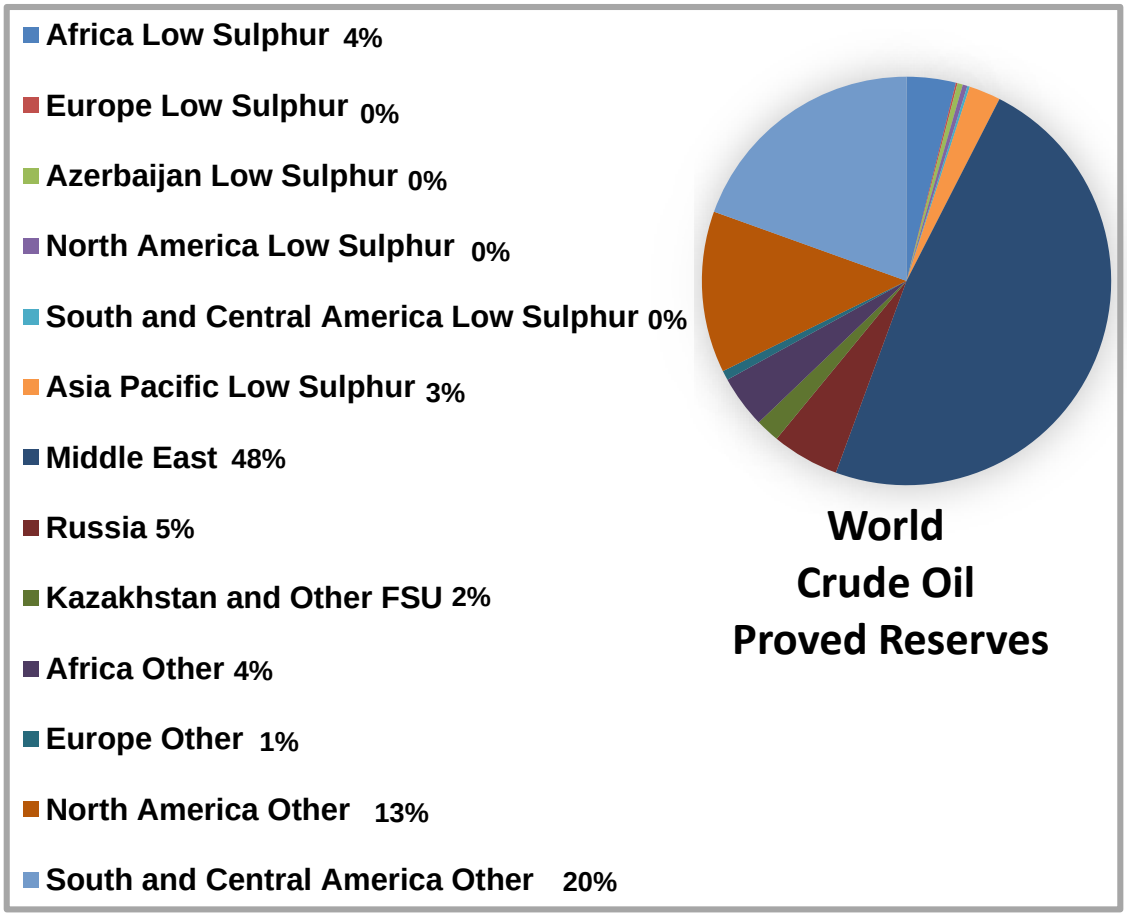
INADEQUATE GLOBAL LOW SULFUR CRUDE RESERVES

- **Proven crude reserves heavily favor production with sulfur levels that are far too high to make direct blending technically and/or economically feasible**
  - Muse estimates only about 7 percent of the proved global reserves contain crude oil suitable for future low sulfur bunker fuel blending
  - Location is another factor as some crude oils containing resid suitable for direct blending are geographically inaccessible to the bunker market



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