Crackin’ the IMO
2020 Bunker fuel spec change has wide-ranging implications

Key points
- In 2020 the International Maritime Organization will require ships to use fuels with a maximum sulfur content of 0.5% (reduced from 3.5% currently)
- We expect this move to significantly increase pricing for global transportation fuels broadly, and diesel prices in particular
- Complex refiners are set to benefit from this regulation, but we see a high risk of inflationary pressure for global transportation cost and consumers

IMO sulfur regulations benefiting refiners, potential burden to transports/consumers

In 2020, the International Maritime Organization (IMO) will require bunker fuel used by the global shipping industry to lower sulfur content from 3.5% to 0.5%. As a result, fuels will require blending with low sulfur products like diesel. In our base case diesel demand will increase by 5-7% over the short to medium term, equivalent to nearly 3x historical annual demand growth. Further, regulations will oversupply high sulfur fuel oil, weakening heavy oil crudes with high sulfur content. We expect the IMO 2020 sulfur regulations will significantly increase pricing for global transportation fuels broadly. This stands to benefit those who can most efficiently produce low sulfur refined products (complex refiners) while potentially creating inflationary costs for global transportation and consumers.

IMO winners and losers - Upgrading PBF to Outperform

Global refiners stand to benefit from higher demand for light products/diesel. Our scenario-based analysis shows that refiners are set to gain incremental profits equivalent to 4-9% of their mkt cap on average. This upside becomes more material for those complex refiners that can efficiently process discounted medium and heavy oils with high diesel to fuel oil yield ratios: we see upsides of 43% for PBF Energy, 24% for S-Oil, 15% for IOCL and HPCL, 27% for Saras. On a regional basis US refiners are best placed to benefit, given their complexity and broadly lower production of HSFO. We highlight PBF Energy as our key global pick to play the IMO theme.

Major consumers of diesel/jet, like miners, shipping companies and airlines, could see fuel costs increase meaningfully. Fuel cost represents 30% of freight cost, 25% of airline costs and 9% of global miners’ operating cost. The need to pass on inflationary costs for low-margin products or discretionary services may create a negative catalyst and large global economic burden.

Oil storage companies have so far suffered from the environment of uncertainty related to the new IMO regulation. A steep backwardation market, combined with a more cautious view from clients, caused a significant reduction in storage utilization. By the time the IMO regulation comes into effect in 2020, the business environment for storage companies should improve significantly, as oversupply of high sulfur fuel oil increases storage utilization and pricing (VPK upgraded to Neutral from UP).
Executive Summary

IMO 2020 and its impact on global fuel supply / demand

The IMO 2020 (International Maritime Organization) bunker fuel policy change (also known as MARPOL ANNEX VI) is focused on a small segment of the petroleum complex – fuel used by the global marine fleets – yet is likely to have a significant impact on oil and product markets. The sulfur levels in bunker fuel, used by global shipping fleets, are set to be reduced from 3.5% to 0.5%, reducing the viability of high-sulfur fuel as a source of compliant shipping supply. We believe that neither the shipping industry (scrubbers) nor the refining industry (coking/hydrotreating/hydrocracking) have invested the necessary capital to make this adjustment within the targeted 2020 timeframe.

We expect that this lack of timely investment will cause a need, at least over the short term, for lower sulfur product blending in order to meet the new fuel standards. Thus, we expect the ~4MBD bunker fuel market will see 1.5-2 MBD lower High Sulfur Fuel Oil (HSFO) demand and be replaced with lower sulfur products (Diesel, Marine Gasoil, Straight Run Fuel Oil, and potentially Light Vacuum Gasoil). This required blending could generate YoY diesel demand growth near 1.2-1.5 MBD, as compared to a longer-term average of 300-350 KBD.

In this scenario, the petroleum complex must push HSFO towards a waste product and replace it with higher cost diesel/low sulfur products. In simple terms, until increased significant investments are made, the industry will replace the lowest value refined product with a blended compliant fuel that is among the highest, at approximately $40-50/bbl higher. With limitations to a diesel or middle distillate yield shift, we expect this will act like higher oil demand as refiners increase runs to meet higher value product demand (we estimate 1.0-1.5 MBD increase in runs). Lastly, this is a large yet limited duration event, in our opinion, as wide product and crude spreads should encourage appropriate capital investment to close the gap over a 3-5 year time horizon.

Global stock impacts will be material and not just across the refining space

In order to estimate the potential share price impact on refiners and integrated oil companies for the upcoming changes in regulation, we have analysed the financial impact under three separate scenarios onto our global coverage universe. The perimeter of our analysis includes 42 companies, responsible for refining 42mmb/d. The average market cap-weighted share price impact based on our scenarios is expected to range from 4% to 9%. On a regional basis US refiners are best placed to benefit from an IMO market given their complexity and broadly lower production of HSFO and we highlight PBF Energy as our key global pick to play the IMO theme. Asian refiners are also well placed while Europe as a region is in a less advantageous position given the low coking levels in bunker fuel, use of high sulfur products (Diesel, Marine Gasoil, Straight Run Fuel Oil, and potentially Light Vacuum Gasoil). Given the positive earnings outlooks, we make several recommendation changes across our global refining universe:

Fig 1  Recommendation changes across our global universe

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<tr>
<th>Company</th>
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<th>Old Recommendation</th>
<th>Target Price New</th>
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</table>

Source: Macquarie Research, July 2018

While the IMO regulatory change is largely a product spec change, we expect it will have meaningful ramifications for crude oil and downstream product spreads, as well as further implications for hydrocarbon consumers. In this report we also discuss how the IMO 2020 rules could have a material impact on a number of other industries:

- Major consumers of middle distillates like miners, shipping companies, and airlines could see fuel costs increase meaningfully.
- After a short period of falling utilization rates, oil storage companies should benefit from a highly oversupplied fuel oil market from 2020 as well as from more increased blending complexity.
Oil Price Implications: crude demand and widening heavy / light and sour / sweet diffs

- **Shift in grades spreads, wider light heavy differentials:** We expect sulfur and intermediate yields to drive meaningful premium/discounts for crude grades. Global refiners will be attempting to maximize their middle distillate yields while minimizing their higher sulfur content. For simple refiners without coking capacity, this will largely fall on optimizing the crude slate to sub 0.5% crudes and premiums for high intermediate yielding lights such as West African and Brent grades. Degradation of HSFO cracks will reduce the demand for lower API and high sulfur crudes, with medium sour and heavy differentials broadly moving to multi year lows. Less prevalent medium and heavy sweet crudes could see an increase in premiums due to LS content as well as increased VGO and distillate yield potential.

- **Increasing Crude Runs:** We expect the reduction in HSFO consumption and increase in diesel demand (or compliant fuel sources) will increase overall crude demand, potentially driving runs higher over the medium term. **We estimate that crude runs could potential increase by 1-1.5MBD in 2020.** This in part depends on the economic environment; a weak global growth backdrop could increase or lessen the pull on diesel. Further, we expect a relative diminishing value to higher crude runs as utilization pushes towards increasingly simple refiners, adding higher levels of fuel oil and smaller diesel yields.

- **Wide shale diffs:** The gulf coast refining system is among the most complex in the world yet has continued to shift its crude slate lighter. As OPEC reduced medium sour barrels though production cuts, and price supported increased shale production, medium and heavy grade differentials have compressed. Further, light shale availability in the gulf has pushed MEH and LLS Brent differentials to multi-year lows, moderating crude imports and increased gulf coast throughput volumes (including 275 MBD of splitter capacity). This substitution is in part a function of structural capacity shifts and light import replacement with shale. However, in our view, the reduction of medium and heavy crude imports also represents crude slate optimization to discounted lights which is reversible. As light heavy differentials move wider due to IMO regulations, Gulf Coast refiners should re-adjust their crude slate to more balanced levels, potentially pushing 1-2 MBD of shale towards higher exports or competitively wider basis differentials. Further, we estimate increased shipping costs due to higher fuel burdens ($1-2/bbl).

- **Tight diesel capacity utilization will drive cracks higher:** We estimate total diesel demand growth in 2020 could reach 1.2-1.5 MBD relative to the five-year average of 300-350 KBD. The bulk of that increase will be due to higher blending demand to create sufficient compliant bunker fuel. We expect this large diesel demand growth could drive heat cracks above prior peaks and potentially approach $30/bbl. We estimate heat cracks by looking at global adjusted diesel capacity utilization which we would expect to reach all-time highs. Refiners may optimize operations depending on relative values to increase Straight Run Fuel Oil or use Light Vacuum Gasoil to meet compliant fuel blending needs, yet we expect this creates a trade-off through starving conversion capacity feed. Lastly, the global economic growth backdrop will be significant in determining demand; global economic growth could increase or lessen the overall pull on diesel with a high correlation between diesel demand growth and global industrial production.

- **Fuel Oil falling to coal parity:** Non-compliant high sulfur fuel oil will potentially become a stranded product over the short run, with an expected floor near repurposing value or pet coke/fuel oil power generation prices. Pet Coke 3-5% sulfur is currently $14.50-20/bbl or still well below HSFO prices near $38-44/bbl and $(25)/bbl Brent Fuel Oil cracks. While heavily backwardated into 2020, we expect scrubber investments should permit a modest recovery in HSFO consumption and thus Fuel Oil margins post 2020.

- **Uncertain variables – Gasoline and VGO:** We believe the impact on gasoline is likely to be positive despite a rather neutral to flat futures market indication. If LVGO/SFRO is seen as having a better value as an incremental compliant bunker fuel blending source compared to feed for an FCC unit (a conversion unit source for gasoline) – this may decrease global gasoline yields and supply, leading to a wider gasoline crack. Further, vacuum gasoil or VGO is a primary input to high margin conversion capacity – if shifts to light sweet crude lower the availability of VGO and thus creates scarcity, it may shift crude pricing and complex refiner operational optimization.
IMO Base Case Assumptions

While all regulatory approvals for the IMO 2020 spec change have been achieved, we continue to view it as a risked event with varying outcomes still possible and subject to non-economic political factors. We view shipping industry compliance as a primary driver of an IMO 2020 hard start probability, and thus increasing oversight efforts should be reflected in the futures markets. Further, we believe physical trader expectations of an IMO hard start have moved higher (+85-95%), as reports of strong IMO messaging that they won’t bend on rules, increased measures to restrict port access to higher sulfur fuels, and the potential to use shipping insurance and access to bank credit as enforcement mechanisms. Via shipping insurance, IMO potentially reserves the right to designate non-compliant vessels as non-seaworthy.

While we expect the probability of a hard 2020 start are increasing, the conviction of impacts from investment, refiner operational adjustments, and the economic environment 18 months out remain more modest. So while directional confidence appears high, variation in impact and duration remain continued X factors.

1) **Scrapers**. The current shipping fleet approximates 70-80k vessels with ~400 currently installed with scrapers (mostly cruise ships and ferries) as compared to the original IMO study suggesting 3,800 ships by 2020. We expect that number can reach over 1,200-1,500 as economics are increasingly attractive yet financial flexibility is low and a portion of shippers view scrapers as only a short-run solution. Newer vessels are more likely to spend on scrubber capacity and thus industry scrap rates may be impactful. While scrubber investment and time to install may be the cheapest/quickest option, most shippers have been reluctant and dry dock space to complete upgrades may prove a limiting factor.

2) **Compliance**. Non-compliance or vessels using fuel above 0.5% sulfur is limited to ~20%, as volumes outside of EC zone destinations/originations is modest. We estimate ~70% of global fleet routes pass through an IMO signatory or ECA area, creating higher oversight potential. Further limiting access to non-compliant fuel as well as potentially denying insurance to non-compliant vessels or being deemed unseaworthy would deter commercial operations.

3) **Global growth**. Global economic conditions are normal or neither recession nor overheating. We expect this could add a meaningful delta or increase/decrease diesel demand tightness as global industrial production correlates with diesel demand growth. Further, inflationary fuel impacts are typically matched with a rising economic growth market. If this burden or sulfur tax hits a softer global economic market it could amplify negative impacts.

4) **Investments**. Capital investment will arbitrage wide spreads, creating a limited duration of 3-5 years. While investment has been slow to react given timing concerns, disjointed product markets should encourage increased HSFO consumption, heavy oil processing, and higher diesel yields through incremental capacity investment. The type of capacity adjustment dictates the window for wider spreads, with an extended scenario of 4-5 years, while we expect there is also a scenario where it could be as short as two years or a relatively brief.

5) **Yield shift**. Refiners will be able to ‘yield shift’ or optimize production to increase diesel/lower sulfur volumes (LVGO/LSFO) by 400-450 KBPD. This is a function of the industry’s ability to modify operations/crudes to optimize for the most price efficient yields. Part of our optimism reflects massive incentives which push the boundaries of prior operations. In contrast, we would recognize that given current market dynamics of strong heat cracks, we may already be skewed towards higher diesel production.

6) **Diesel cracks**. Net diesel demand growth year over year in 2020 will approximate 1.2-1.5 MBD relative to the five-year average of 300-350 KBD. This would drive a record high global adjusted diesel capacity utilization rate and reflect the potential for Brent heat cracks to approach $30/bbl vs current futures of $22/bbl.
IMO – Wide Ranging Impacts
Winners and Losers

Large yet limited duration event – adding a risk adjusted value to coverage

In 2020, the International Maritime Organization (IMO) will require bunker fuel used by the global shipping industry to have a lower sulfur content of 0.5%, from 3.5% currently. This seemingly small segment of the petroleum complex representing ~4 MM BPD, or 5% of global oil demand, could drastically shift the product landscape. Compliant bunker fuels will require blending from low sulfur feed (diesel the most likely) and the repurposing or removal of high sulfur fuel oils (HSFO). Our base case required blending will increase diesel demand over the short to medium term by 1.2-1.5 MM BPD, approximately 3x historical annual demand growth. Further, regulations should drive 1.5-2.0 MM BPD drop in heavy fuel oil consumption, weakening heavy oil crudes with higher sulfur content.

Fig 2  Regulation induced changes in bunker fuel supply composition

Source: Company data, Macquarie Research, July 2018

In the supply / demand environment outlined by our base case, refiners will strive if capable of producing a large share of middle distillates while minimizing fuel oil production and light crude intake. Aggregate production data provide a clear picture of which refining region is best placed to benefit from IMO. We highlight the main regional differences in the chart below and in the next page.

Fig 3  Regional Refining product yields. North America best placed, LATAM / FSU worst

Source: Company data, Macquarie Research, July 2018
US Refiners the largest beneficiary – Upgrading PBF to Outperform (PT 55/sh), DK Maintain Outperform (PT 61/sh)

US refiners stand to benefit from an IMO market given their complexity and broadly lower production of HSFO. On a relative basis we would highlight US refiner strength:

- Highly complex with an ability to process medium and heavy crudes and efficiently generate high value gasoline and diesel products. Specifically, high coker capacity limits fuel oil yields.
- High diesel to fuel oil yield ratios – while the US produces more gasoline than diesel, the ratio of diesel benefit to fuel oil drag is broadly attractive.
- Access to discounted crudes – we expect the IMO will create historically large medium and heavy crude discounts, with Gulf Coast refiners best positioned. In addition, shale oil production growth should continue and drive sizeable Gulf Coast and potentially inland light crude discounts as well.
- We upgrade PBF Energy to outperform, as their complex refining capacity should allow for consumption of meaningfully discounted medium and heavy crudes with modest fuel oil production. Further, we view their ratio of IMO benefit relative to current relative valuation is attractive.

European Refiners suffer from the lack of coking capacity but complex names like Neste and Saras are well placed

- Europe lacks the upgrading infrastructure capable of minimizing fuel oil production and therefore will be vulnerable to a material deterioration of the fuel oil cracks.
- Because of the middle distillate based demand structure of the European market, refiners in this region have historically focussed their investments on building hydrocracking units. For this reason, coking capacity as % of distillation is one of the lowest in the world (4%), particularly in North West Europe, which ranks better only than Africa.
- Despite the weak regional position, as we will highlight in the next section, when we move to a company-level analysis, Europe has some very complex listed refiners that produce minimal amounts of fuel oil and have high gasoil yields.
- Saras ranks among the most positively impacted globally. On the other hand, PKN is one of the least well placed names, yet based on our scenario modelling it should not face a negative earnings impact. Neste, the most complex European refiner, is set to benefit significantly on an absolute basis but little on a market cap-relative basis.

Asian refineries will show a barbell-like distribution in an IMO market.

- We think Korean and Indian refineries are, on average, well positioned to benefit from the rapidly changing industry backdrop, given they are better equipped not only for cheaper heavy crudes, but also for secondary units converting fuel oil into diesel. Out to year 2020, we believe KR and IN names will save crude costs meaningfully, while enjoying a potential rally of diesel-fuel oil spread (up to US$64/bbl vs. the current US$22/bbl). Most of all, the biggest beneficiaries will be (IN) RIL (upgrade to Outperform from Underperform) and (KR) S-OIL.
- We also like refiners ‘going up the complexity curve,’ with HPCL our preferred name with over 100% upside. While we acknowledge the risk of re-regulation in India, we see an asymmetric positive skew.
- On the other hand, Japanese simple refineries with big exposure to high sulfur fuel oil - such as Showa Shell (5002.JP, N/R), Idemitsu (5019.JP, N/R) and Cosmo Energy (5021.JP, N/R) - will be most threatened.
- As for Thai names, their exposure to expensive lighter and low sulfur crude will negate a lot of the benefits of making diesel. Among Thai names, our most/least preferred stocks are IRPC/SPRC, respectively.
**Fig 4  Macquarie base case IMO margin assumptions**

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Source: Bloomberg, Macquarie Capital (USA), May 2018
Picking global and regional winners and losers

In order to estimate the potential share price impact on refiners and integrated oil companies for the upcoming changes in regulation, we have analysed the financial impact under three separate scenarios onto our global coverage universe. The perimeter of our analysis includes 42 companies, responsible for refining 42mb/d. The average market cap-weighted share price impact based on our scenarios is expected to range from 4% to 9%, with single company impacts that range from 1% up to over 50%. Surprisingly, based on our initial expectations, none of the companies included in the analysis face negative financial impacts under any of the scenarios.

Assumptions and methodology

While the IMO policy change is a significant event for refiners, we caution against extrapolating 2020 estimates into perpetuity. Instead, we attempt to segment long term refining earnings power from IMO Market impacts. We believe the binary probability of a hard 2020 start date has increased to 85-95% or highly likely, yet size of impact and duration are more debated. Further, refiners’ ability to capture wide spreads is not certain. Separating conditions on normalized earnings power vs IMO provides a framework to stress test different assumptions or generate scenarios:

- Normalized earnings power based on economic re-investment margins, and normalized crude feed advantage. Refiner leverage to IMO based on 1) ability to process discounted medium and heavy crudes, 2) diesel yield margin benefits, and 3) fuel oil yield-based drag. These layers of margin are viewed as a premium to long-term or normalized conditions. We also include a gasoline margin view derived from the expected IMO impact on FCC feedstock availability.

- We incorporate tax effects and determine NPV value based on our base case margin scenario / duration (wide 2020 spreads quickly moderating). This value is then risk adjusted, as we expect size/duration are still uncertain and individual operational variables may impact capture capacity.

- Our analysis is organized across three key scenarios. The first scenario is based on the current futures curve, the second scenario is based on our base case impacts on supply / demand and assumes a shorter duration (2020-22 mainly). The third is based on an extreme case with higher compliance and gasoil supply constraints. The duration of this scenario is also longer, with the overall impact on product cracks only fading in 2024.

We outline in the table below the key assumptions behind our scenarios.

### Macquarie IMO scenarios

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</table>

Source: Company data, Macquarie Research, July 2018

9 July 2018

Macquarie Research
Crackin’ the IMO
Global Refining - Financial impacts

In the charts below we summarize the expected share price impact for each of the companies included in our analysis. Under all the scenarios, US-listed PBF Energy and European listed Saras are the most impacted names. This is a reflection of both IMO asset positioning, and the current market based implied value.

- Under Macquarie’s base case US refiners are the most positively impacted (13% market cap weighted average impact). PBF Energy is the most positively impacted (43% under Macquarie’s base case). Of the large cap names (>US$20bn market cap), Valero is the most positively impacted (14% under Macquarie’s base case).

- The second most-impacted group is the Asian / Pacific refiners (10% average impact). S-Oil is the most positively impacted name (24%), followed by IOCL and HPCL (15%). Of the large cap names, Sinopec is the most impacted (10%).

- European refiners, as a group, are less positively impacted (7% average impact). However, Saras is one of the most impacted names globally (27%); the company’s pure refining exposure and its crude intake flexibility make it well placed to exploit the IMO related pricing dynamics. Of the large cap names, Repsol is most impacted (8%); the company owns 25% of Europe’s coking capacity and is a large buyer of heavy / sour crudes with minimal fuel oil exposure.

- Among the integrated oil companies, Sinopec (10%), REP (8%) and OMV (7%) are the most impacted.

Fig 6  Crack Case A (forward curve) — expected share price impact

Source: Company data, Macquarie Research, July 2018
Fig 7  Crack Case B (Macquarie base) — Financial impacts

Source: Company data, Macquarie Research, July 2018

Fig 8  Crack Case C (Macquarie extreme base) — Financial impacts

Source: Company data, Macquarie Research, July 2018
### Fig 9  Cross sectors winners and losers — Significant Secondary Impacts

<table>
<thead>
<tr>
<th>Theme</th>
<th>Winners</th>
<th>Losers</th>
<th>Industry segment impacted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Refining</td>
<td>IMO policy changes stand to be broadly supportive of refiner earnings as it significantly increases demand for high value light products. We expect the strongest benefit to higher diesel to fuel oil yield ratios and complex configurations that can process discounted heavy/sulfurous crudes.</td>
<td>While broadly positive, simple refiners without access to light crudes or high diesel yields may see weaker relative margins. Regionally highest at risk being Latam and FSU refiners.</td>
<td>US Refiners + European Refiners Mixed Latam (pmex), FSU – Asia Complex Refiners + Asia High FO Yield Refiners - Global Light producers + Canadian Heavy Producers – South American producers – California Heavy –</td>
</tr>
<tr>
<td>Oil producers</td>
<td>We expect IMO changes will increase crude runs and downstream margins, supportive of oil demand. Further, lower sulfur and higher diesel yields naturally occurring in crudes the better - pushing up relative demand for benchmark Brent, and West African Crudes. Rare heavy sweet blends may see premiums for those that can process them.</td>
<td>Medium and heavy oil producers stand to see discounts to light benchmarks widen meaningfully due to higher sulfurful fuel oil yields. Further, shale crudes will benefit from low sulfur content and ATBs yet higher light end yields being a modest offset.</td>
<td>Retail – Food and beverage – Cruise lines with scrubbers – Cruise lines without scrubbers – Inflation linked securities – Airlines / Shipping – Trucking / Logistics – Farming diesel costs – Rail + Electric vehicles + Engine conversions + Thermal coal – Fuel Oil Power Gen +</td>
</tr>
<tr>
<td>Global Consumers</td>
<td>Inflationary product pricing</td>
<td>Consumers and long haul shipped products. We expect higher diesel and potentially mogas prices will be incrementally pushed to global consumers.</td>
<td></td>
</tr>
<tr>
<td>Transports</td>
<td>Increasing cost of transportation will drive an acceleration in relative efficiency spending. This could drive increased investment/sales of electric cars / trucks as well as logistics/rail as an efficient relative transport option. Engine conversions may benefit as the diesel/natural gas ratio will be historically high.</td>
<td>Consumers of diesel or middle distillates (Jet fuel) are likely to see relative price risk as diesel utilization reaches a multi-year high. Higher diesel costs and compliant bunker fuel costs will create an increase burden on almost anything that moves.</td>
<td></td>
</tr>
<tr>
<td>Global Power</td>
<td>While fuel oil generation capacity in the OECD is low, global fuel oil power generation could benefit lower feed costs.</td>
<td>Global thermal coal used for power generation may see increased competition for excess FO power generation.</td>
<td></td>
</tr>
<tr>
<td>Metals &amp; Mining</td>
<td>Inputs to electric vehicles or trucks</td>
<td>Higher freight costs as well as mining diesel costs stand to increase overall operating and delivery costs. Cost of Graphite Electrodes could be positively impacted by needle coke feedstock limitation (heavy slurry oil competing in the IMO blending pool).</td>
<td>Metals prices + Mining operators – Electric Arc Furnaces steel producers –</td>
</tr>
<tr>
<td>Lube Oils</td>
<td>Lower viscosity / sulfur burning in ship engines may increase demand for lubes to protect engines.</td>
<td>Lube feed costs may be driven up through tighter LS VGO markets.</td>
<td></td>
</tr>
<tr>
<td>Global Economic</td>
<td>On shoring or manufacturing closer to consumers to reduce long haul shipping costs may see competitive US manufacturing advantage.</td>
<td>Countries with proportionally higher finished goods exports as a percentage of GDP may see increased cost burdens. A mismatch between global economic strength and inflationary pressures may shave global GDP through a fuel tax.</td>
<td>Global GDP – Asia exports – Relative US Manufacturing +</td>
</tr>
<tr>
<td>Asphalt/Carbon Black</td>
<td>Products that use heavy sulphurous oils as inputs will benefit from lower feed costs given an oversupply of high sulfur fuel oil.</td>
<td></td>
<td>Housing / Roofing + Infrastructure / Roads + Tires / Paints + Unclear</td>
</tr>
<tr>
<td>Naphtha</td>
<td>While a swing factor - we expect FCC feed may compete for compliant fuel inputs and refiners will optimize for diesel production at the expense of gasoline (if that hasn’t already been done). Elevated gasoline prices may incrementally pull naphtha demand.</td>
<td>The alternative is that diesel demand pushing refining capacity utilization higher - over producing gasoline. Further a shift to lighter/sweeter crudes by simple refiners to limit HSFO will generate more light ends.</td>
<td></td>
</tr>
<tr>
<td>Refined Product</td>
<td>Oversupply of HSFO should increase storage utilization and terminal pricing. Further, the increased complexity of compliant fuels and blending may benefit logistics services</td>
<td>Crude and refined products remain in backwardation with only HSFO shifting to contango in 2020. This term structure is less favourable for storage.</td>
<td>Bunker Storage +</td>
</tr>
<tr>
<td>Storage and Logistics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Hydrogen - hydrotreating (sulfur removal) or hydrocracking (diesel making conversion capacity) both should see increased utilizations if not increases in capacity. Sulfur by-product - removing and disposal of excess sulfur may allow for cheaper fertilizer inputs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Macquarie Capital (USA), July 2018
What are the futures markets saying?

Forward products and spreads are directionally implying a higher IMO impact

- Primary markets for IMO impacts continue to imply a high IMO event probability
- HO/BR, FO/BR, and Light Medium crude differentials remain wide
- Sulfur spreads imply wider differentials relative to current, and FO remains heavily backwardated into 2020 before finding a modest recovery

Although somewhat illiquid, long-dated futures have reacted to IMO news, allowing some interpretation of the market view on IMO probability and impacts. When looking at futures markets today, we’re primarily focused on movements in 2020 heat cracks, fuel oil cracks, sulfur spreads, and med/heavy differentials, as these act as indicators of both higher diesel blending burdens and an increased sulfur cost drag. We would note that average annual heat cracks stand above prior cycle peaks ($+22.00/bbl), gulf coast 3% fuel oil cracks have moved from backwardated to highly backwardated into 2020, and gulf coast 3% fuel oil discounts to 1% fuel oil have moved towards record levels in 2020. Lastly, the Brent-Dubai 2020 spread (light medium) recently moved from $2.50/bbl to well over $5.00/bbl, compared to historical highs of $3.50-4.00/bbl, with a similar move in Mars-LLS 2020 spreads to over $6.00/bbl. In combination, this paints a picture of increasing IMO probability implied by futures markets.

Fig 10  Forward pricing shows increasing heat and fuel oil crack differentials

Source: Bloomberg, Macquarie Capital (USA), July 2018
Fig 11  Gulf Coast 3% Fuel Oil has shifted to heavily backwardated

![Graph showing GC 3%-Brent Backwardation and GC 3%-Brent Backwardation -6M]

Source: Bloomberg, Macquarie Capital (USA), July 2018

Fig 12  Long-dated medium sours have moved to a larger discount

![Graph showing Brent Dubai 2020 and LLS Mars 2020]

Source: Bloomberg, Macquarie Capital (USA), July 2018
We expect the summer of 2008 may provide a soft analogue to the IMO tight diesel market, as heat cracks approached $30-35/bbl, global diesel capacity utilization reached all-time highs, and oil reached record levels. We believe higher prices were in part due to increasing light crude demand from simple refiners to meet incremental diesel demand. In contrast, today’s oil market has grown production of light shale grades and thus reduced the scarcity feed for simple refiners.
Understanding IMO 2020

Emission standards rules were first discussed in 1973 during the International Convention for the Prevention of Pollution from Ships (MARPOL), and since 1997, these standards have become progressively more stringent, on a country-by-country basis, focusing on reducing greenhouse gas emissions (GHG).

Efforts have focussed on regulating the sulfur levels in fuels used while ships are operating in defined coastal areas defined as Emission Control Areas (ECAs). These are generally located in high trafficked coastal regions adjacent to Europe and North America (dark blue areas in the map below) and sulfur thresholds in these areas have systematically been reduced until the latest update in 2015 which reduced this limit to 0.1% sulfur.

![Fig 15 Current and future Emission Control Areas (ECA)](source: teamtec presentation, Macquarie Research, February 2018)

While the sulfur limits for bunker fuel usage in the ECA’s are tight (tight enough that they can only effectively be met by using marine diesel), their impacts have not been substantial because total usage in these areas is quite small. A much bigger impact is expected when the new standards for “open water” transit come into effect (“Global cap” in the chart below).

In 2008 the International Maritime Organization (IMO) voted to reduce the global cap on sulfur emissions for international shipping to 0.5% (from the 3.5% which has been in effect since 2012) starting from 1 January 2020. In October 2016, the IMO reiterated the 2020 deadline, reducing the odds of a last-minute deferral. The latest figures provided by the IMO showed that the yearly average sulfur content of the residual fuel oils tested in 2015 was 2.45%. As a comparison, the worldwide average sulfur content for distillate fuel is 0.11%.
The change will have dramatic consequences on the refining industry and both crude oil and product prices. Normally, refineries don’t make bunker fuel but instead they produce fuel oil (mostly vacuum tower bottoms and other related streams). Bunker fuel is primarily produced by blending terminals which purchase fuel oil from refineries along with distillates to produce a variety of bunker grades. Industry consultants have indicated that this market structure has the potential to constitute another source of problem for the industry in the 2020 transition.

Global fuel oil production was ~8mmb/d in 2016, of which ~4mmb/d (~38%) was used as bunker fuel, which represents the main application. Fuel oil is also used for electricity generation (a key area of potential future demand growth), heating and a variety of industrial purposes. The global oil product bunker market is dominated by residual fuel oil, accounting for ~80% of the market (with the rest being marine gasoil).

![Fig 16 Marine fuels sulfur limits](source)

![Fig 17 Fuel oil demand has been declining at an average rate of 1-2% over the last ten years](source)

![Fig 18 Uses of fuel oil. Bunker fuels account of 31% of global fuel oil demand](source)
IMO Mechanics and Compliance

While most may be focused on a binary result of whether IMO rules are implemented with a hard 2020 start date, the secondary mechanics are important in understanding wide variation in outcomes. Specifically, we focus on:

1) Compliance / enforcement mechanisms
2) Shipping industry response/positioning
3) Means of achieving compliant fuel availability
4) Capital investment options and duration of wide spreads

What are the rules and are they enforceable?

Our assumption on the IMO 2020 starting on time is highly reliant on building stakeholder or industry buy-in early, and thus we view compliance as a major driver of a hard start 2020 IMO rule change. As policy timeframes had been adjusted in the past (shipping ballast water management) and certain loopholes had not been closed (exceptions for lack of compliant fuel availability), expectations for a hard start were mixed in 2017. Despite this we believe efforts demonstrate compliance means as well as increased jawboning or verbally not bending on the 2020 date. Our primary assumption is compliance will be meaningfully high (80%) with a hard 2020 start date. Our largest driver is major industrialized and OECD country level buy-in matching a high percentage (80-90%) of global fleet destination/origin touching a large country port. Below we detail further IMO rules and means of enforcing compliance.

Non-compliance / cheating. The IMO has no authority to monitor or enforce its own regulations, but rather has relegated compliance to the member states. Currently, both direct and indirect methods are used to monitor compliance in ECAs. These include in-port verification of bunker fuel paperwork and the monitoring of vessel smokestack emissions at sea using aeroplanes and, more recently, drones. There are also large differences between the penalties imposed on non-compliant vessels in ECAs. The penalties imposed in North America are more severe than elsewhere.

- The US Coast Guard has the power to seize vessels found to be in breach of regulations with the owners liable to be heavily fined. However, how it is unclear how active the Coast Guard’s enforcement will be once the new rules are in place.
- The enforcement in Europe is less clear, with each EU state responsible for policing its own waters. Only a small fraction (less than 1%) of the vessels visiting Europe are examined and some EU countries have indicated they may not be able to issue sanctions for violations outside their jurisdiction (which raises the potential issue that a vessel could be fined only for the last 12 miles of a voyage even though it was not compliant for several thousand miles).
- Further discussions on compliance have implied limiting access to ship insurance with compliant fuel use or scrubbers. Given the majority of vessel insurance is derived from the US and Europe, financial insurance pressure through member countries could be very effective in limiting commercial shipping.
- Lastly, limiting the availability of non-compliant fuel or HSFO as well as incentivising the production of compliant fuel availability. For those that can create a compliant fuel and readily available and consistent for engine use at a discount to MGO, we would expect significant market share incentives. The potential limiting of HSFO at ports or shipping of HSFO would be a further constraint to cheating in major ports but also a deterrent to scrubber installation for the shipping industry.

Another source of potential confusion is that the IMO regulations allow the use of higher sulfur fuels in areas where there is no availability of compliant fuel. It is therefore possible that some vessel operators will be tempted to claim this excuse to justify noncompliant fuel on board the vessel. However, vessel log books should indicate where the bunker fuel was purchased and could be used to challenge the operator’s claims. Because of this potential for cheating, many of the large (and reputable) lines such as Maersk have pledged their intention to comply but have also been very vocal in their concerns, as stated by Niels Mortensen, head of regulatory affairs at Maersk Maritime.
Technology: “International shipping cannot operate on a skewed playing field where deliberate non-compliance puts some players at a competitive advantage, while others might be put out of business.”

A poll contacted at the beginning of the year suggested that non-compliance could be the strategy of choice for ~30% of industry, although a more recent poll, quoted by Maersk at Platts’ European Refining Summit, suggested that this % had already dropped to 15%.

**Fig 19** Penalties for non-compliance to sulfur regulations in selected countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Maximum financial penalty</th>
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<tbody>
<tr>
<td>Belgium</td>
<td>Eur 6 million</td>
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<tr>
<td>Canada</td>
<td>CAD 25,000</td>
</tr>
<tr>
<td>Denmark</td>
<td>No maximum</td>
</tr>
<tr>
<td>Finland</td>
<td>Eur 800,000</td>
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<tr>
<td>France</td>
<td>Eur 200,000</td>
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<tr>
<td>Germany</td>
<td>Eur 22,000</td>
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<tr>
<td>Latvia</td>
<td>Eur 2,000</td>
</tr>
<tr>
<td>Lithuania</td>
<td>Eur 14,481</td>
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<tr>
<td>Netherlands</td>
<td>Eur 81,000 + gains</td>
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<tr>
<td>Norway</td>
<td>No maximum</td>
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<tr>
<td>Sweden</td>
<td>SEK 10 million</td>
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<tr>
<td>UK</td>
<td>GBP 3 million</td>
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<tr>
<td>USA</td>
<td>USD 25,000/d</td>
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Source: Trident Alliance, Macquarie Research, July 2018

**Fig 20** Comparison of emission from different fuels

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<tr>
<th>Environmental Regulators</th>
<th>Emission component</th>
<th>Emission reduction with LNG as fuel</th>
<th>Comments</th>
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<tr>
<td></td>
<td>SO₂</td>
<td>100%</td>
<td>Complies with ECA and global sulphur cap</td>
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<tr>
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<td>NOx, Low pressure engines (Otto cycle)</td>
<td>85%</td>
<td>Complies ECA 2016 Tier III regulations</td>
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<td></td>
<td>NOx, High pressure engines (Diesel cycle)</td>
<td>40%</td>
<td>Need EGR/SCR to comply with ECA 2016 Tier III regulations</td>
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<td></td>
<td>CO₂</td>
<td>25-30%</td>
<td>Benefit for the EEDI requirement, no other regulations (yet)</td>
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<td></td>
<td>Particulate matter</td>
<td>95-100%</td>
<td>No regulations (yet)</td>
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Table 1

<table>
<thead>
<tr>
<th>Comparison of emissions from different fuels</th>
<th>CO₂ equivalent (g/MJ) (Tab 3, DNV-2012-0719)</th>
<th>% CO₂ (HFO=100 %)</th>
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<tbody>
<tr>
<td>Data from DNV No 2011-1449, rev 1 (Tab 16 mainly); DNV NO 2012-071</td>
<td>Well To Tank CO₂ emissions (WTI)</td>
<td>Tank To Propeller CO₂ emissions (TTP)</td>
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<tr>
<td>Oil fuel (HFO)</td>
<td>9.60</td>
<td>77.70</td>
</tr>
<tr>
<td>Oil fuel (MGO)</td>
<td>12.70</td>
<td>74.40</td>
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<tr>
<td>LNG (from Qatar used in Europe)</td>
<td>10.70</td>
<td>69.50</td>
</tr>
<tr>
<td>LNG (from Qatar used in Qatar)</td>
<td>7.70</td>
<td>69.50</td>
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</tbody>
</table>

Table 2

Source: DNV GL, Macquarie Research, July 2018
Investments to close the gap

Our base case assumption is a lack of pre-2020 investments will drive products spreads meaningfully wider, yet these wider spreads will attract capital to close the gap or normalize towards a ‘cost of sulfur removal’ over the long term. In simple terms, HSFO at a $-25-30/bbl discount relative to a $25-30/bbl diesel crack is a large incentive to change capacity structure or units capable of consuming HSFO, processing heavier/high sulfur oils, and producing higher diesel yields.

We expect that most shippers have limited capital spending in approaching the IMO challenge, and they view the wider scenario as a potential case with uncertain outcomes. Spending significant capital has game theory-like characteristics, where there is risk to being the player who expends upfront capital only to see rules change or better options appear later and thus be at a disadvantage to peers. We expect lack of clarity on successive environmental burdens, combined with relative positioning risk, has restrained shipping investment in scrubbers. In refining, we view the window of attractive spreads is still uncertain, and thus spending capital on expensive coker or other capacity results in a duration mismatch or 30-year asset life with 3-5 year window has kept spending to refiners that may not be operationally competitive without additions. We expect wider spreads will mirror the type of capacity built construction time frame. We see limited current spending thus most options won’t impact the initial 2020 start date if started today. Below we look at potential options for closing dislocated product and crude spreads from a short-run basis to longer-term capacity construction.

Meeting compliant fuel demand in the short run:

- **Blending and feedstock strategies** The best short-run source of low-sulfur fuel for shippers is marine gasoil (or a combination of marine gasoil and fuel oil), and, in our view, this will be the compliance strategy of choice for most of the shipping companies, at least in the early years. From a technical perspective, shipping companies are saying that technically it should be relatively easy to switch to a combination fuel (even if switching to pure gasoil may present challenges in some cases), with only minimal operational changes and no significant capital expense or time out of service. The two fuels combined could see an incremental demand of 1.2-1.5 MBD. Gasoil blending is the option of choice for Maersk. The largest benefit of this short-run option is flexibility, or capability to adjust to market dynamics. The largest negative could be lack of viscosity that impairs tanker engine performance with long duration untested fuel options.
Fig 21  Potential compliant fuel blending sources / options

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Description</th>
<th>Postives / Negatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>ULSD (Ultra Low Sulfur Diesel)</td>
<td>10ppm diesel - typically hydrotreated or sourced through straight run sweet crudes. Increased volume through hydrotreater which consumes LVGO feed and increased hydrogen demand</td>
<td>Most readily available globally as a source for blending. Expensive and lower viscosity might have unknown impact on engine performance over time</td>
</tr>
<tr>
<td>MGO (Marine Gasoil)</td>
<td>Blend of distillates generally higher density similar to heating oil</td>
<td>Available source yet sulfur cap on MGO is 1.5% or above the compliant fuel standard of .5%</td>
</tr>
<tr>
<td>Other Diesels</td>
<td>50 - 500ppm diesels</td>
<td>Cheaper sources yet sulfur content would likely require hydrotreating to be additive</td>
</tr>
<tr>
<td>SRFO (Straight Run Fuel Oil)</td>
<td>Straight run fuel oil, sourced from the distillation tower or LFO with less than .5% crude slate</td>
<td>Straight run sulfur content would require sweeter crudes to create compliant additives and takes away from conversion feed</td>
</tr>
<tr>
<td>LCO (Light Cycle Oil)</td>
<td>Typically middle distillate portion of FCC unit yield</td>
<td>Higher sulfur and density, not readily available in all markets</td>
</tr>
<tr>
<td>LVGO (Light Vacuum Gas Oil)</td>
<td>Gasoil yield from distillation / vacuum distillation</td>
<td>Available with heavier densities and lower sulfur yet in volume would starve global conversion capacity</td>
</tr>
<tr>
<td>Coker Gas Oil</td>
<td>Gasoil yield from coking units</td>
<td>Higher sulfur / density, less available. Typically FCC feed, thus lower conversion unit feed</td>
</tr>
</tbody>
</table>

Source: Macquarie Research, July 2018

- **Scrubbers.** Shipping companies can decide to equip vessels with exhaust gas cleaning systems (ie. scrubbers) which spray alkaline water into a vessel’s exhaust, causing the removal of sulfur dioxide. The advantage of this approach is that it allows burning high sulfur fuel oil (set to become increasingly cheaper from 2020). The disadvantages is the high upfront investment requirement ($5-10m) per vessel (including the lost income during the installation phase), it is less proven on 2-stroke and 4-stroke engines (used in large shipping vessels), and increases opex by ~$400k per vessel per year (e.g. requires specialized personnel). There are also several uncertainties associated with this solution: firstly, if MARPOL legislation proceeds along the same lines as has legislation regulating the emissions from terrestrial motor vehicles, then future legislation can be expected to impose limits on pollutants such as nitrous oxide (NOx) and particulate matter that are not filtered by scrubbers. It also raises the issue of waste water disposal. Many large shipping companies like Maersk believe that this is not a viable solution for existing vessels: even leaving cost considerations aside, there is just not enough spare capacity to install scrubbers on existing vessels by 2020. Industry estimates suggest that only 300-400 KBD of the 2.5MBD high sulfur bunker fuel consumption can be absorbed by scrubbers in 2020. Further, while spreads may incentivise scrubbers as an option, the available dry dock capacity to change over the fleet may be a limiting factor.
Longer term capital spending options:

- **LNG / Methanol.** LNG- or methanol-fuelled vessels should be cheaper than 0.5% sulfur bunker fuels, generate lower emissions and protect vessel owners from future changes in emission standards (carbon dioxide, NOx, particulate matter). The disadvantages of these technologies are the high upfront capex requirements (LNG is best suited for new builds), and the lack of high capacity supply location. From an environmental perspective, a key risk is the emission of unburnt methane in the combustion process (known as the "methane slip"), which can substantially limit the greenhouse gas reduction from using LNG. Recent studies suggest that this issue has been practically eliminated in the most recent LNG engines. However, a recent environmental impact study promoted by the European Commission continues to rank methane slip as a key issue “requiring further investigation” (LINK). LNG is certainly an important long-term driver, but we won’t see a widespread adoption of this technology in the shipping industry in the very near term. In 2016, there were only 60 ships in operations globally with another 60 under construction (compared to 60+25 in 2015)

- **Refining Capacity:** Refiners have several options to increase their configuration to better suit IMO conditions, yet we expect there is hesitation given some option’s high costs, long construction period, and less certain conditions. Large capacity additions likely require a high initial 2020 margin environment or risk their payback extending exceptionally further than IMO favourable crack spread environment. Simple or yield deficient refiners may be faced with a different decision – optimize configuration (lower their fuel oil yield through investment) or shut in. We look at several refining capacity options:
  - **Coker capacity** – Vacuum distillation is capable of processing atmospheric bottoms or the increased heavy ends from lower API and higher sulfur oils. This allows for production of low sulfur and high sulfur vgo which feed FCC and hydrocracker units. Vacuum resid can be further processed by a coker to produce coker naphtha and coker gasoil. This increased complexity allows for lower fuel oil yields, although at a high cost. Coker capacity costs are estimated to run at $25k/bbl or higher depending on location and configuration. This is an attractive option for IMO conditions that will increase spreads for medium and heavy oil, but we’ve seen reluctance to spend the necessary capital. Our global capacity growth estimates show coker capacity growth as below the longer-term growth rate of 300 KBPD per year.
  - **DHT or hydrodesulfurization** – The most common means of removing sulfur from refined products is through a hydrotreater, which uses a catalytic chemical process to remove sulfur from refined products or pre-processed feeds to conversion units. As the name indicates, hydro-treating uses increased amounts of hydrogen in removing sulfur. As this unit does not increase refined product volumes, its viability or attractiveness is demonstrated by high to low sulfur spreads, such as ultra-low sulfur diesel relative to 500ppm diesel and HSFO and LSFO.
  - **Hydrocracking capacity** – Hydrocrackers primarily consume heavy vacuum gasoil as a feed with a high middle distillate or diesel yield. Similar to other options, this will increase the call on hydrogen, and while a logical source of higher complexity to increase middle distillate yields, we would note a large source of increased complexity globally or conversion capacity has been focused on increased gasoline yields relative to diesel. Our estimate of hydrocracking capacity additions globally is to grow by 250 KBPD per year, or just below longer term trend levels.
  - **Resid Hydrocrackers** – A resid hydrocracker is a less common means of processing heavy resid through the hydrocracking process (catalytic cracking and hydrogen) to produce increased middle distillate yields. While attractive in capabilities, available resid hydrocracking capacity is a modest and, we expect, expensive option.
  - **Accelerated HSFO desulfurization** – Processing HSFO into LSFO via a desulfurization or an accelerated hydrotreating process would be an ideal processing capacity for IMO conditions, as this could turn global oversupply of HSFO to a compliant LSFO or equivalent of turning hay into gold. While attractive, and we believe efforts are being made to create this type of capacity, we expect it hasn’t been demonstrated in scale or high continuous utilizations.
Fig 22  Major capex options to minimize HSFO yields

<table>
<thead>
<tr>
<th>Technology</th>
<th>Crude Flexibility</th>
<th>Secondary Processing Required</th>
<th>Commercially Proven</th>
<th>Specific Bottoms Stream</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coking</td>
<td>++</td>
<td>Yes</td>
<td>Yes</td>
<td>Coke</td>
<td>$$</td>
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<tr>
<td>RFCC</td>
<td>+</td>
<td>Yes</td>
<td>Yes</td>
<td>Decant Oil</td>
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<tr>
<td>SDA</td>
<td>++</td>
<td>Yes</td>
<td>Yes</td>
<td>High Viscosity Residue</td>
<td>$$$</td>
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<tr>
<td>&quot;Slurry-Rx&quot; Hydrocracking</td>
<td>+</td>
<td>Yes</td>
<td>No</td>
<td>Residue w/Metals</td>
<td>$$$</td>
</tr>
<tr>
<td>Residue Hydrotreating</td>
<td>+</td>
<td>Yes</td>
<td>Yes</td>
<td>Residue</td>
<td>$$$</td>
</tr>
<tr>
<td>Gasification</td>
<td>++</td>
<td>Yes (blue)</td>
<td>Yes</td>
<td>None</td>
<td>$$$</td>
</tr>
</tbody>
</table>

$ Relative cost including secondary system investments

Source: KBC, Macquarie Capital (USA), April 2018

Fig 23  Regional refiner complexity vs global average nelson complexity

![Graph showing regional refiner complexity vs global average nelson complexity]

Source: Platts, OGJ, IHS, Macquarie Capital (USA), April 2018

Fig 24  Regional complexity: Upgrading complexity % of distillation capacity

![Graph showing regional complexity: Upgrading complexity % of distillation capacity]

Source: Platts, OGJ, IHS, Macquarie Capital (USA), April 2018
Fig 25  Regional Heating Oil (diesel) yield to Fuel Oil ratio

Source: Platts, OGJ, IHS, Macquarie Capital (USA), April 2018

Fig 26  Regional crude slate: API vs Sulfur content

Source: Platts, OGJ, IHS, Macquarie Capital (USA), April 2018
Diesel: Tight Capacity Utilization will Drive Cracks Higher

- Diesel demand in 2020 of 1.2-1.5 MBPD would be nearly 3x normal demand growth
- Adjusted Global diesel capacity utilization would imply heat cracks near $30/bbl
- Correlation to global industrial production and seasonal weather may create meaningful variation

While most expect short-run substitution of HSFO to be met with lower sulfur diesel blending to satisfy compliance requirements, there are multiple options with diesel being the most likely widely available product. Straight run fuel oil (SFRO) and low sulfur vacuum gasoil (LVGO) are both options that could move towards the blending pool, yet increasing production of these as end products to meet compliant bunker demand would starve feed for conversion capacity and reduce volumes of high-value gasoline and diesel. From a high level, the historical two standard deviation of global diesel yield would approach 30.3% or roughly an increase of 450 KBPD if the system stress tests capacity flexibility. This simple test would suggest in normal conditions, increased runs would be necessary to meet our estimated increase in diesel demand.

A major variable in diesel balances will be outside of the IMO construct in the typical economic cyclical trends as well potential weather impacts. As we view the IMO demand shift as ex-cyclical, the underlying economic environment can generate considerable shifts in underlying diesel demand growth. We expect over recent history global diesel demand growth has fluctuated around flattish to positive 550 KBPD with break-out demand having reached 1 MBPD and the 2008 Great Recession driving a contraction of greater than 500 KBPD. Current global economic growth has been supportive of diesel demand and heat cracks before we even reach the IMO. More specifically, we see industrial production as a core driver of global diesel demand. The two charts below show how diesel demand correlates to industrial production globally and in the US. A second consideration is winter weather, whereby cold weather drives increased middle distillate demand through heating oil. This impact is global; winter weather can drive significant demand in Northern Asia, Europe, and North America – the chart on the bottom right shows US diesel demand relative to IP and LEI with a spike above trend in January approximating 150 KBPD as cold weather shifted to above normal.

Fig 27  Global economic growth (per IP) and weather can have significant incremental diesel demand impacts

Configuration and crude slate shifts might provide relief, we expect based on historical references that it will be short of the potential incremental demand for middle distillates. This leads us to believe that increased global refining runs of 1-1.5MBD at a ~23% diesel yield (lower complexity – relative aggregated global yield closer to 30%) will be needed over the near term. This will drive a bump in global oil demand, likely light-sweet for incremental simple refiner processing, as well as drive heat cracks to above prior peaks. Our estimated adjusted global diesel capacity utilization has offered a positive correlation to heat cracks as opposed to simple YoY demand growth. Using this as our driving function for heat cracks, we view diesel capacity utilization stretching above stated capacity available.
and indicating a $28-32/bbl Brent heat crack in 2020. As this will be above the top of end of historical implied rates, we see potential for unexpected results or a possible spike that could rise above these levels.

**Fig 28  Global Adjusted diesel capacity utilization drives a higher Brent Heat Crack**

![Graph showing global adjusted diesel capacity utilization drives a higher Brent heat crack.](source)

Source: Bloomberg, Macquarie Capital (USA), July 2018

**Fig 29  Significant Diesel demand growth drives utilization above historical levels**

![Graph showing significant diesel demand growth drives utilization above historical levels.](source)

Source: Bloomberg, Macquarie Capital (USA), July 2018
Optimizing refining operations to generate compliant fuel or more middle distillates:

1) **Changing to a sweeter crude slate:** The first option a refiner could take to increase a compliant fuel source would be to change their crude slate to a sweet or lower sulfur feed. Simple refiners may find this among their only options and in a high demand environment bid up light sweet crudes. Lowering the sulfur of the crude should increase the production of a lower sulfur straight run fuel oil that can be blended into a compliant bunker fuel product. Shell Global Solutions estimates that a shift from Arab Heavy crude to Arab Light, for instance, would reduce fuel oil output by 37%. Lighter crude grades, however, are higher priced and have different yield patterns which may be incompatible with refinery hardware configurations. Many crudes (eg. Saharan Blend, Bakken, Eagle Ford) produce low sulfur resid suitable for producing 0.5% bunker fuel, but these volumes are often commingled with higher sulfur crudes when processed in refineries. The crudes which produce a low sulfur fuel oil are generally concentrated in North and West Africa and East Asia, along with a scattering of North American and North Sea grades.

2) **Shifting yields:** A second option is shifting refining yields to maximize middle distillates. This can occur at the distillation tower and at secondary conversion capacity, such as in the FCC and Hydrocracker. While shifting to the highest demand product is logical, there are limits and costs that need to be accounted for. Increasing middle distillates or running at max distillate mode will cut into high value lighter products that flow into the gasoline pool and produce increased lower value residual products. This also likely results in compressed jet/kero fuel yields and diluted jet fuel product. As the heavy end of jet is reduced or moved into diesel – volumes are likely replaced with lighter volumes with lower density and BTU content. The charts below show the historical relationship of heat cracks to jet cracks as both are middle distillates. 2020 futures indicate a continued relationship and elevated crack relative to history.

3) **Starving conversion capacity:** As we mentioned above, SRFO or LVGO can serve as a source of blending into a compliant fuel for bunkers or alternatively feed for conversion capacity. Thus, refiners, at a price, could opt to lower conversion capacity utilization to provide more sources to bunker fuel. As an example, turning off an FCC unit would allow for ~25% more LSFO while running a Urals type feed. Offsetting these gains would be a +20% drop in lighter/gasoline products as well as lower gasoil production.

**Fig 30** Jet cracks likely to elevate with diesel cracks

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Source: Bloomberg, Macquarie Capital (USA), July 2018
Fig 31  Shipping costs could almost double depending on route and vessel type

- HSFO
- .5% @ $180/ton
- .5% @ $400/ton
- .5% @ $500/ton

Source: Macquarie Research, Pira
Source: Platts, Macquarie Capital (USA), July 2018

Fig 32  2018-2020 Distillate demand bridge [MBD]

Source: IHS, Platts, IEA, Macquarie Capital (USA), July 2018
Fuel Oil: Dropping to power gen comparable

- Modest scrubber adoption and higher compliance leaves global HSFO oversupplied
- We expect there is a downside skew to our HSFO prices, with petcoke support nearly $20/bbl lower
- HSFO weakness feeds into our estimate of light heavy spreads which could reach record levels

High sulfur fuel oil’s main consumption sources are global power generation, some industrial purposing, and marine bunker fuel. Lower shipping consumption, or limited to modest blending to meet compliant fuel standards, creates a sizeable gap in S/D balances. In valuing fuel oil long-term, we view limited refinery investments to meet the 2020 deadline leaving us with expectations for surplus HSFO.

Degradation is already evident in futures markets; when determining a floor price value, we approximate repurposing / alternative demand pricing and view pet coke/power generation as the most readily available comparison. There is limited OECD fuel oil powered generation capacity, and thus we look for HSFO to compete with other global fuels in emerging markets for power generation demand. Available capacity is modest, but we expect switching opportunities could be attractive in select countries such as Saudi Arabia.

While we expect this scenario will create significant pressure on fuel oil into 2020, expectations are for a modest recovery post 2020 as heavy discounts spur capital investment, such as scrubbers, to allow for a consumption rebound.

Fig 33  Historical Fuel oil pricing v petcoke/power generation

Source: Bloomberg, Macquarie Capital (USA), July 2018
Fig 34  Balancing HSFO: The impact of IMO on HSFO in 2020

2020 HSFO Balance [MBD]

Source: IHS, Platts, IEA, Macquarie Capital (USA), July 2018

Fig 35  Bunker fuel demand historically correlates to global growth and trade

Source: Bloomberg, Macquarie Capital (USA), July 2018
Fig 36  GC 3% futures – expect to recover modestly post 2020

Source: Bloomberg, Macquarie Capital (USA), July 2018

Fig 37  Forecast bunker fuel demand to drop in 2020, before partial recovery

Source: IEA, IHS, Platts, FGE, Macquarie Capital (USA), July 2018
Oil Implications: Medium and Heavy crude diffs to widen

- Lower value for HSFO creates a larger drag on medium and heavy crudes with differentials reaching record levels
- Lack of compliant fuel blending sources will drive higher refining runs of 1-1.5 MM BPD
- Changing quality differentials will revert GC crude slates to higher medium and heavies, increasing the export burden on shale
- Medium and Heavy sweet crudes will benefit from tight VGO markets and demand for low sulfur products

In an effort to manage IMO 2020 requirements, downstream participants are likely to shift crude preferences and operations to manage both fuel oil drag and diesel benefits. This will create an intersection of specific crude dynamics with local refiner capacities and configuration.

Crudes with increased sulfur content stand to be discounted relative to lighter sweet crudes in part due to the falling associated yield value driven by lower HSFO prices. While medium and heavy references are typically defined by a measure of density (API measure), they also tend to have directionally higher sulfur content as well. Thus typically, medium and heavy crudes will have two challenges relative to a light sweet. First, Atmospheric Bottoms (ATB) increase in heavier crudes and thus require increasingly complex refineries to process the ATBs into higher value products. Second, increased sulfur content requires higher cost burdens to purify product yields to low sulfur premiums. Figure 37 shows light, medium, and heavy ATB proportions that could be discounted similarly to fuel oil at 35-50%. Further, Figure 38 shows the spread between GC 3% fuel oil and NY 1% fuel oil, a minor spread currently but moving to significant $16-18/bbl in 2020 and beyond. This represents an approximation of the cost of sulfur removal, as well an indication of the size atmospheric bottoms drag on heavier fuels.

Specific crudes will vary in discounts; higher middle-of-the-barrel yielding crudes should price at a premium due to the higher diesel yields, similarly a premium will be incurred for medium / heavy sweet crudes. For primary benchmarks, we expect medium and heavy sour crude discounts could more than double based on processing and higher sulfur challenges. While intermediates generate a premium, atmospheric bottoms create a drag with increasing significance tied to sulfur level. This scenario creates a difficult burden for simple refiners who can’t process medium and heavy crudes without outsized fuel oil yields or large negative drags.

A partial offset to this compared to historical challenges is the increase in light low sulfur shale crudes. We expect shale crudes will bias towards a high proportion of light ends volumes compared to middle distillate yields (negative in a short diesel market), but that lower atmospheric bottoms and sulfur will also permit simple refiners to limit higher fuel oil yields.

The chart on the next page aggregates shale, light, medium, and heavy crude assays and demonstrates how the light ends, intermediates, atmospheric bottoms, and typical sulfur content shift by crude type.

Our primary crude IMO impacts include:

- **Shift in grade spreads, wider light heavy differentials:** We expect sulfur and intermediate yields to drive meaningful premiums/discounts for crude grades. Global refiners will be attempting to maximize middle distillate yields while minimizing higher sulfur content. For simple refiners without coking capacity this will largely fall on optimizing crude slate to sub 0.5% crudes, with premiums for high intermediate yielding light crudes such as West African and Brent grades. Degradation of HSFO cracks will reduce the demand for lower API and high sulfur crudes, with medium sour and heavy differentials expected to move to multi-year highs.

- **Increasing Crude Runs:** We expect the reduction in HSFO consumption and increase in diesel demand (or compliant fuel sources) will increase overall crude demand, potentially driving runs higher over the medium term, ie higher crude demand. We estimate crude runs could potentially increase by 1-1.5MBD in 2020. This in part depends on the economic environment; a weak global growth backdrop could lessen the pull on diesel.
• **Wide shale diffs**: The Gulf Coast refining system is among the most complex in the world yet has continued to shift its crude slate lighter (Fig 41). As OPEC reduced medium sour barrels though production cuts, and price has supported increased shale production, medium and heavy grade differentials have compressed. Further, light shale availability in the gulf has pushed MEH and LLS Brent differentials to multi-year lows, driving lower crude imports and increased gulf coast throughput volumes (including 275 MBD of splitter capacity). This substitution is in part a function of structural capacity shifts and light import replacement with shale. However, in our view, the reduction of medium and heavy crude imports likely also represents crude slate optimization to discounted lights, which is reversible. As light heavy differentials move wider due to IMO regulations, Gulf Coast refiners should re-adjust their crude slate to more balanced levels, potentially pushing 1-2 MBD of shale towards higher exports or competitively wider basis differentials. Further, we estimate increased shipping costs due to higher fuel burdens could add an additional $1-2/bbl, driving wider breakevens.

**Fig 38  Light, Medium, and Heavy ATB proportions**

![Crude Assay Split Percentage Chart]

Source: IHS, Macquarie Capital (USA), July 2018

**Fig 39  Lower sulfur Fuel Oil premiums to high sulfur jump in 2020**

![Fuel Oil Premiums Chart]

Source: Bloomberg, Macquarie Capital (USA), July 2018
Fig 40  Gulf Coast Shale consumption may reverse 1-2MBD if heavy spreads widen enough

<table>
<thead>
<tr>
<th>Date</th>
<th>Refining KBPD</th>
<th>Gulf Coast Light Imports</th>
<th>Gulf Coast Medium Imports</th>
<th>Gulf Coast Heavy Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/01/2009</td>
<td>6,500</td>
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</table>

Source: EIA, Macquarie Capital (USA), July 2018

Fig 41  Medium and Heavy Sour crudes should see an wider discount to light sweets

<table>
<thead>
<tr>
<th>Crude Grade</th>
<th>2017 Production KBPD</th>
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<tbody>
<tr>
<td></td>
<td>NAM</td>
</tr>
<tr>
<td>Tight</td>
<td>4,523</td>
</tr>
<tr>
<td>Light sweet</td>
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</tr>
<tr>
<td>Light Sour</td>
<td>1,467</td>
</tr>
<tr>
<td>Medium Sweet</td>
<td>0</td>
</tr>
<tr>
<td>Medium Sour</td>
<td>877</td>
</tr>
<tr>
<td>Heavy Sweet</td>
<td>80</td>
</tr>
<tr>
<td>Heavy Sour</td>
<td>3,567</td>
</tr>
</tbody>
</table>

Source: IHS, Macquarie Capital (USA), July 2018
Uncertain Variables: Gasoline and VGO markets

Positive Gasoline skew relative to flattish forward markets

- US refiner operations will Maximize yields at the expense of gasoline
- If low sulfur fuel oil and VGO compete for compliant fuel inputs, FCC utilisations may moderate and support gasoline cracks
- VGO scarcity may put a floor in medium and heavy crudes and elevate medium heavy sweets

We believe the impact on gasoline could be positive or negative based on post 2020 refining and shipping complex decisions. If LVGO/SFRO is seen as having a better value as an incremental compliant bunker fuel blending source compared to feed for an FCC unit (a conversion unit source for gasoline) – this may decrease global gasoline yields and supply, leading to a wider gasoline crack. More broadly, we expect distillation and conversion capacity cuts will be shifted as far as possible to diesel relative to gasoline. Alternatively, if light crude slates (with higher light end yields) are maxed out to avoid heavy/high sulfur yields, and refining runs are higher to meet the incremental barrel of diesel demand, gasoline production might become a by-product and exceed demand. Or, more simply, if tight diesel markets drive refining decisions and cracks are wide enough to run at a profit with even flat gasoline cracks, refiners may drive excess gasoline supply.

Futures markets only have a modest uptick in gasoline cracks as compared to the 12m forward level of $10.28/bbl, rising to $11.75/bbl in 2020. This rather neutral forward indication provides a positive risk return in our view as we believe compliant fuel pricing will carry feed costs higher – even a small downtick in FCC utilization creates a meaningful impact in overall global adjusted gasoline capacity utilization and thus global gasoline cracks. If diesel cracks reach $30/bbl, we expect compliant fuel will trade at modest discount to this primary high value blending component, and even low value blending components such as 0.3% sulfur fuel oil will trade higher. NY 0.3% FO trades at a $5/bbl value over Brent in 2020 (in contrast to $2/bbl discount in 2018) yet if this approaches $11-12/bbl it may indicate FCC economics are stressed by higher feed costs and lower optimization, increasing gasoline margins. While our skew is higher, there may be more limited upside as 1) gasoline is more price-sensitive and would see a more direct demand impact, and 2) we view gasoline as a more political hydrocarbon and rapidly rising gasoline prices that consumers/voters see daily may put pressure on the IMO politically.

The chart below shows how historically gasoline cracks have correlated to global adjusted gasoline capacity utilization rates. Lower forward gasoline cracks relative to historical capacity utilization may already be indicating a high price impact on demand.

![Chart showing correlation between gasoline cracks and global adjusted gasoline capacity utilization](source: EIA, Bloomberg, Macquarie Capital (USA), May 2018)
Vacuum Gasoil scarcity could impact conversion capacity utilization and crude values

VGO or vacuum gasoil is primarily used as a feedstock for conversion capacity yet is available in lower quantities when lighter crudes are run. Thus, if global capacity attempts to shift to lighter crudes, it may reduce the amount of excess VGO available, and drive up feed costs for higher-margin conversion capacity at complex refiners. Further, VGO broadly is less available in part due to more being contained inside of Russia – a historically consistent exporter. VGO is derived from vacuum distillation of atmospheric bottoms; thus scarcity may create a floor for heavy crude prices in order to generate much needed VGO. Medium and heavy crudes maintain larger ATBs and thus potential VGO – the balance between higher sulfur costs and potential VGO scarcity is less certain with very few forward price indications.
IMO Wide-Ranging Impacts

While this report has primarily focused on impacts to crude, refined products, and refining equities, we expect the IMO hydrocarbon market distortion will have significant ripples throughout global industries and consumers. Below we detail our list of potential impacted industries in greater detail than what we already discussed previously in the report.

Heavy Sour Crudes: Canadian Oil Sands – Brian Bagnel

At a high level, Canadian heavy oil producers are likely to be negatively impacted by the IMO 2020 regulations. As discussed within this report, we expect the 4MBD bunker fuel market will see 1.5-2 MBD lower HSFO demand, which is likely to be replaced with lower sulfur products. Since Canadian heavy crudes are significant inputs for HSFO production in North America, lower demand should translate to lower realized heavy crude prices, regardless of whether those volumes are sold at Hardisty, the USGC, or any other delivery point.

That said, most of the largest heavy crude producers in Canada have an integrated platform, which provides some offsets to weaker heavy crude prices through better low-sulfur diesel cracks. Canadian Natural, Cenovus, Husky, Imperial, and Suncor all own upgrading and/or refining assets, although some have more than others. Aside from the five companies mentioned above, there are other companies that produce heavy crude but do not have any downstream exposure, including MEG, Baytex, Surge, and Cardinal.

We estimate each company’s net long heavy oil exposure in the chart below. This chart denotes each company’s proportion of heavy crude production that is not dedicated to its own upgraders or refineries.

Fig 44  Net long heavy oil exposure as % of total production

Source: Company reports, Macquarie Research, July 2018

Another factor to consider is likely improved synthetic crude (SCO) pricing, such as the crudes produced at Syncrude and Horizon. Those crudes produce a higher distillate yield than a typical light barrel, and may therefore see higher demand and higher pricing. We haven’t quantified that impact with this report but recognize that it may benefit companies with upgraders, including Canadian Natural, Suncor, Imperial, and Husky.

Since we estimate that the negative impacts to heavy crude prices will be similar to the benefits from higher low-sulfur diesel prices, one way to estimate the net impacts of the IMO 2020 regulations to the Canadian companies is to compare the net long heavy oil exposure shown in the chart on the next page with each company’s LSD production. Since we don’t have access to information specifically on LSD production, we use distillate production as a proxy.
Netting the two exposures can give us a sense of scale for each company’s net exposure (on a production basis) to the IMO 2020 regulations. Note that this chart does not take any positive benefits from SCO pricing into consideration.

Overall, MEG is the name in our coverage universe most likely to be most impacted by the IMO 2020 regulations as a pure-play oil sands producer. Within the Integrated Large Cap space, Cenovus appears to be the most exposed to the potential impacts from the regulations. We view Husky Energy as a net beneficiary of the IMO 2020 regulations, as the company’s heavy production is fully dedicated to its upgrading and refining assets, which means that it could simply reap the benefits of higher low-sulfur diesel pricing. Suncor may also end up as a net beneficiary, depending on the ultimate benefits seen from better SCO pricing.
Airlines – Susan Donofrio

As highlighted in the diesel section of this report, we believe that higher diesel prices could also cause an increase in jet fuel prices causing a negative impact on airlines for which fuel currently represent ~25% of their operating cost.

Our global airlines coverage team, which comprises of senior analysts in six different regions, polled over 20 carriers on questions related to the new standard in a report released in conjunction with this one. Our findings indicate that while expectations for the impact of IMO 2020 and current hedging programs vary by geographic region, the potential responses by and large show a reluctance to deviate from current strategy.

In North America, largely unhedged US airlines are anticipating another step-up in fuel prices, though at this point two-thirds of the airlines polled remain committed to their strategy of relying overall on fare increases to offset rising fuel prices versus a shift back toward hedging. However, Canadian airlines are of mixed views, with some expecting an increase in jet fuel prices and some unclear of the impact at this stage. Similar to their US peers, Canadian carriers don’t appear to be revising their fuel cost mitigation strategies at this point.

In APAC, despite a greater acceptance of higher fuel as a likely outcome, airlines also remain committed to upholding their existing hedging strategies. The same goes for the European airlines in our poll, with all respondents agreeing that prices are likely to rise and reiterating a commitment to ongoing long-term hedging."

Oil Services / E&Cs – David Farrell

IMO 2020 sulfur regulations, on their own, have not yet driven major refinery contract awards to the E&C industry although it is clearly a positive dynamic that is being monitored. Refiners are in our view exercising caution ahead of wholesale investments in altering product yields until there is better visibility on cracks. That is not to say there has been no investment. The table below shows that investments to reduce fuel oil production, which can loosely be linked to reacting to IMO 2020, have been focused on European refineries, with the largest being upgrades at Antwerp by ExxonMobil and Total.

<table>
<thead>
<tr>
<th>Refinery Operator</th>
<th>Country</th>
<th>Award</th>
<th>Investment</th>
<th>Cost ($m)</th>
<th>E&amp;C companies involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naantali / Porvoo Neste</td>
<td>Finland</td>
<td>SDA 2014</td>
<td>200</td>
<td>NestelJacobs (owned 60% Neste / 40% Jacobs)</td>
<td></td>
</tr>
<tr>
<td>Antwerp Total</td>
<td>Belgium</td>
<td>SDA, Hydrocracker, Coker 2013</td>
<td>1,200</td>
<td>KBR (SDA technology); Tecnicas Reunidas (EPC); Maire Tecnimont (EPC); Foster Wheeler (EPCm)</td>
<td></td>
</tr>
<tr>
<td>Antwerp ExxonMobil</td>
<td>Belgium</td>
<td>Coker 2014</td>
<td>1,000</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Permis Shell</td>
<td>Netherlands</td>
<td>SDA 2015</td>
<td>N/A</td>
<td>KBR (unit &amp; technology)</td>
<td></td>
</tr>
<tr>
<td>Slagen ExxonMobil</td>
<td>Norway</td>
<td>VDU 2014</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Rotterdam ExxonMobil</td>
<td>Netherlands</td>
<td>Hydrocracker 2015</td>
<td>N/A</td>
<td>Uses ExxonMobil's proprietary technology</td>
<td></td>
</tr>
<tr>
<td>Gdansk LOTOS</td>
<td>Poland</td>
<td>VDU and coker 2015</td>
<td>330</td>
<td>Maire Tecnimont (EPC)</td>
<td></td>
</tr>
<tr>
<td>Lysekil Preem</td>
<td>Sweden</td>
<td>VDU capacity expansion 2016</td>
<td>200</td>
<td>Chevron Lummus (Technology)</td>
<td></td>
</tr>
<tr>
<td>Castellon BP</td>
<td>Spain</td>
<td>VDU capacity expansion 2017</td>
<td>N/A</td>
<td>AMEC Foster Wheeler (EPCm)</td>
<td></td>
</tr>
<tr>
<td>Panceva NIS</td>
<td>Serbia</td>
<td>Coker 2016</td>
<td>330</td>
<td>CB&amp;I (EPCm) / Chevron Lummus Global (FEED)</td>
<td></td>
</tr>
<tr>
<td>Rijeka INA</td>
<td>Croatia</td>
<td>Coker 2018</td>
<td>400</td>
<td>NestelJacobs (PMC); Tecnicas Reunidas (FEED)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>3,660</td>
<td></td>
</tr>
</tbody>
</table>

Source: FGE, Company data, Macquarie Research, July 2018

However, IMO 2020 is very much part of the broader push towards producing lower emission products and is something that has been referenced across a number of refinery upgrades awarded over the past few years. The most notable is the US$16bn Clean Fuels Project in Kuwait, which should complete later this year and has involved multiple E&Cs from across the US, Europe and Asia.
Fig 48  There has, however, been significant investment in refinery modernisations and “Clean Fuels”

<table>
<thead>
<tr>
<th>Project</th>
<th>Award</th>
<th>Country</th>
<th>Operator</th>
<th>Value (US$m)</th>
<th>EPC Contractors</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean Fuels Project</td>
<td>2014</td>
<td>Kuwait</td>
<td>KNPC</td>
<td>16,000</td>
<td>Petrofac; Samsung Engineering, CB&amp;I; Hyundai Heavy Industries; Fluor, Daewoo E&amp;C; JGC; GS E&amp;C; SK E&amp;C</td>
<td>Reconfigured Minna Abdulla / Minna Al Ahmadi complex to produce gasoline with &lt;15 ppm sulfur compared to 500 ppm</td>
</tr>
<tr>
<td>Bapco Modernization Program (Sitra)</td>
<td>2017</td>
<td>Bahrain</td>
<td>BAPCO</td>
<td>4,200</td>
<td>TechnipFMC; Samsung Engineering, Tecnicas Reunidas</td>
<td>Increase CDU by 93kb/d, improve energy efficiency, valorization of the heavy part of the barrel, enhancing product slate and meeting environmental compliance</td>
</tr>
<tr>
<td>Heydar Aliyev Baku Oil Refinery Modernization</td>
<td>2017</td>
<td>Azerbaijan</td>
<td>SOCAR</td>
<td>2,200</td>
<td>Tecnicas Reunidas</td>
<td>Produce engine fuels, diesel and gasoline products that meet Euro-5 standards</td>
</tr>
<tr>
<td>Crude Flexibility Project (Ruways West Refinery)</td>
<td>2018</td>
<td>UAE</td>
<td>ADNOC</td>
<td>3,100</td>
<td>Samsung Engineering; CB&amp;I</td>
<td>Atmospheric Residue de-sulphurisation unit will upgrade heavy petroleum oils and residue into more valuable, environmentally friendly transportation fuels and convert residues to produce low-sulphur fuel oil</td>
</tr>
</tbody>
</table>

Source: Company data, Macquarie Research, July 2018

Looking at the refining landscape, the largest near-term opportunity is the modernisation and expansion of the Si Racha refinery in Thailand. With an investment budget of US$3.7bn, the Clean Fuels Product project, as it is known, will result in the refinery ceasing to produce any fuel oil, instead focusing on higher margin products such as diesel and jet fuel. As such, this very much appears to be an IMO 2020-driven investment plan.

Whilst the E&C universe are all capable of delivering refining projects on an EPC basis, ownership of process technologies is much rarer. The table below outlines the major process technology providers to the refining industry. From this, we see potential for IMO to drive greater demand for the units within the blue dotted box: Cokers, Fluid Catalytic Crackers, Desulfurization, Sulfur Deasphalting, Hydrotreating, Hydrocracking and visbreaking units. As such, those E&Cs with incremental leverage to IMO 2020 over and above typical EPC contracts are Chiyoda, KBR, McDermott (via the CB&I acquisition), TechnipFMC (via the Stone & Webster acquisition) and Wood Group (via the AMEC Foster Wheeler acquisition). Chevron Lummus, a JV between CB&I and Chevron, has been selected as licensor of residue and VGO hydrocracking units for the Si Racha refinery.

Fig 49  Chiyoda, KBR, McDermott, TechnipFMC and Wood Group own process technologies which could see incremental demand as a result of refineries adjusting to the refining environment that IMO 2020 triggers

<table>
<thead>
<tr>
<th>Unit</th>
<th>Coker</th>
<th>Fluid Catalytic Cracking</th>
<th>Desulfurization</th>
<th>Hydrotreating</th>
<th>Solvent Deasphalting</th>
<th>Visbreaker</th>
<th>Hydrocracking</th>
<th>Reformer</th>
<th>Alkylation</th>
<th>Isomerization</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Processes vacuum residue into gas, light products and petroleum coke</td>
<td>Converts heavy weight hydrocarbons into more valuable gasoline, olefinic gases and other</td>
<td>Removes sulfur from petroleum oil</td>
<td>Removes impurities such as hydrogen and sulfur</td>
<td>Converts vacuum residues into gas, naphtha, distillates and visbroken residue</td>
<td>Cracks heavier diesel into gasoline blending stocks</td>
<td>Changes the molecular structure of Naphtha into Gasoline</td>
<td>Combines small molecules to form alkylate, a clean gasoline</td>
<td>Rearranges atoms whilst keeping same chemical formula</td>
</tr>
</tbody>
</table>

Technology Providers

- ConocoPhillips
- Axens / TechnipFMC
- ExxonMobil Research & Engineering
- KBR
- Shell Global Solutions
- UOP (Honeywell)
- Lyondell Basell

Source: Company data, Macquarie Research, July 2018
Shipbuilding – James Hong

**Scrubber-equipped vessels are less than 1% of outstanding fleet.** The number of vessels reported to be fitted with scrubbers has risen steadily, reaching 240 at the end of 2017, including 57 Ro-Ros, as well as 62 cruise and ferry units. Meanwhile, 25 gas carriers and 23 tankers also featured in the total. In 2018 the scrubber installation activity has seen a small uptick, with ~660 scrubbers now on order. Whether vessels are scrubber-fitted appears to be closely related to the time they spend in ECAs, with most vessels that less frequently enter these areas opting to switch temporarily to MGO. In 2016, an estimated 27% of ferries and 26% of Ro-Ros spent more than 50% of their time in ECAs, while almost a third of cruise ships spent more than 30% of their time in ECAs. We estimate ~400 vessels have scrubbers today and only 1,200-1,500 will be installed by 2020. Other refining industry consultancy studies suggest that total scrubber installations could reach 2000 units by Jan 2020. Few (if any) still believe that the 3,800 units installed as forecast by the IMO could be reached. At Jun 2018 the scrubber orders pipeline was ~660 units strong.

**Scrubbers don’t seem to be the major option for global operators….MGO is, when considering series of regulatory measures (including carbon emission).** However, our discussion with shipowners indicated that demand for scrubber varied by vessel type. Obviously, scrubber is preferred option for regional operators who primarily spent time in ECAs. Global operators prefer other options, including MGO. For tanker and bulk operators, we noticed MGO is being preferred on 1) potential procurement difficulties in HSFO and 2) operational flexibility. Recently we are hearing growing number of bulk operators adopting scrubber as a solution. Decision making process of shipowners shows that there should be a certain equilibrium for adoption of scrubber and MGO/LSFO.

According to Niels Henrik Lindegaard, Head of Maersk Oil Trading, in his interview with *Ship and Bunker*, backed Maersk’s decision to disregard scrubber in that “it (scrubber) is not a long-term solution to place such complex machinery on our vessels”. It seems like Maersk is considering scrubbers’ vulnerability to regulations that may come after IMO 2020. Scrubbers can remove sulfur and nitrogen from emissions and with some modifications may also be useful in most particulate matter. However, if regulation is further extended to carbon emission (EEDI), they may lose efficacy.

**Scrubbers have a sulfur disposal issue.** On the sulfur disposal issue, the repercussions for scrubbers are less significant but still meaningful. There are two disposal options that a shipowner can choose from, open-loop scrubbers and closed-loop scrubbers. Open-loop scrubbers take in naturally alkaline seawater and then flush the discharge out to sea, while closed-loops add caustic soda to raise alkalinity of the water and dispose the water at port. Each has pros and cons. Using closed-loop can dodge disposal-related regulations that may potentially come ahead, but using open-loop is approximately $800k cheaper to install and doesn’t require caustic soda, a variable cost.

**Another is (dry dock) capacity issue.** Dry dock capacity is one side of scrubber installment story, but annual capacity that shipbuilders can take for scrubber installment is hard to quantify. However, the global fleet is currently being retrofitted with ballast water management systems (BWMS) to comply with the regulation. Also, the recent upturn in the newbuild order intakes among the global shipbuilders will limit their propensity to take scrubber installment orders without strong financial incentives. The other side of scrub supply is scrubber manufacturers. Currently, less than 500 vessels in the global fleet have scrubbers, and expectations are modest for annual additions due to the limited capacity of the scrubber manufacturers. One example, Wartsilla, an industry leader, only delivered 77 scrubbers in 2017. Even after considering entrance of new players, we remain sceptical about scrubber manufacturers’ ability to ramp up their capacity to meet the demand as early as 2020.

These potential risks give rise to LNG as an alternative fuel and engine system in the newly built vessels. LNG fuel can mitigate carbon emission regulations, cheaper than LSFO/MGO, and can make LNG engines compatible with MGO as well. However, transforming existing fleets into LNG fuel vessels essentially means building new ships, thus incurring significant cost to shipowners. Container shipping liners are ones who are most active in seeking long-term solutions. According to Korean shipbuilders who are major builders for the latest mega-containers (17,000-22,000 TEUs), containerships from Maersk and MSC are LNG-ready (with dual-fuel engine). LNG component maker Hankook Carbon has been awarded contracts to build LNG fuel tanks for CMA-CGM’s mega-container ships by Hudong-Zhonghua.
Potential LNG propulsion. Korean shipbuilders have commercialized dual-fuel engines with LNG. Daewoo Shipbuilding commercialized MAN’s ME-GI engine, LNG and diesel dual fuel, from 2012. Among LNG carriers, ME-GI engines accounted for ~30% of newbuild in 2015 thanks to their higher energy efficiency. Since then, ME-GI engine has been adopted into some of non-LNG carriers, such as Maersk Line’s new mega-containers (18,000 TEUs). We believe this gives greater operational flexibility for Maersk to adopt LNG as a propulsion at some point.

Globally, 77 vessels have adopted ME-GI engines, with LNG carriers accounting for ~60% of outstanding. Moreover, 27 vessels have ME-GI engines as an option.

Source: MAN Diesel, Macquarie Research, July 2018

Source: Clarksons Research, December 2017
Graphite Electrode and Steel makers – Sumangal Nevatia / Ioannis Masvoulas

The IMO 2020 regulations have implications for the Graphite Electrode (GE) supply chain. High grade Graphite electrodes (essential consumable for steel making through Electric arc furnace) are made from petroleum needle coke which can be either made from coal or from oil, using low sulfur decant oil as feedstock. Low sulfur decant oil (or slurry oil) is the heaviest cut of the FCC unit. We believe that in an IMO 2020 environment, this low cost fraction could be used a blending component in the bunker fuel blending pool due to its low sulfur content. This competing use could increase its cost and limit feedstock supply for production of petroleum needle coke.

Given the likely cost inflation and uncertainty around feedstock supply, the petroleum needle coke market should unlikely see any major capacity additions over the next 3-5 years. This should also limit Graphite electrode capacity addition and keep the entire supply chain tight.

GE industry is operating at +85% utilisation and despite a 5x surge in GE prices, given the supply chain tightness, we believe GE producers will be able to pass any potential cost inflation and sustain higher margins. As part of our global coverage the names we flag as being key potential beneficiaries of this market dynamic are GRIL and HEG:

Royal Vopak (VPK NA, €39.30, Underperform, TP: €32.00, Giacomo Romeo).

HEG (HEG IN, Rs3,641.40, Outperform, TP: Rs4,810.00, Sumangal Nevatia)

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Figure 52: Graphite Electrode Supply Chain

![Graphite Electrode Supply Chain Diagram](image)

Source: Company data, Macquarie Research, July 2018

Figure 53: Limited capacity addition potential to keep GE utilisation high

![Graphite Electrode Capacity Chart](image)

Source: Company data, Macquarie Research, June 2018

Figure 54: Despite the 5x surge in GE prices, it forms less than 5% of steel CoP

![Graphite Electrode Cost Components Pie Chart](image)

Source: Company data, Macquarie Research, June 2018

Graphite Electrodes are mainly used in Electric Arc Furnace (EAF) steel production, for which they represent less than 5% of steel cost of production.
Globally EAF steel production is ~28% of total steel production. This percentage is largely driven by Asia (17% EAF exposure) while other regions have a much more significant exposure (67% in North America, 40% in Europe). Among the European steel makers SSAB has a 30% exposure (at % of total capacity), ArcelorMittal 19%, Salzgitter 14% and Voestalpine 5%.

Reference material:
- Indian graphite electrode sector - 'Strategic resource', not 'commodity'
- Graphite India - Structural uplift yet to be priced in
- HEG - A lot of steam left!

Mining – Tom Price / Grant Sporre

In their most recent Commodities Compendium, Macquarie’s Commodities and Metals & Mining teams have recently flagged IMO 2020 as one of the two key “trade shock” risks to our commodities price forecasts (the other one being deteriorating global trade relations). Ultimately, we believe that the cost of IMO 2020 will somehow be distributed among all players linked to the commodity trade: the ship owners + the miners + the consumers. However, the price adjustment mechanism will take time and the impact will be different on different commodities.

- 1) Initial response will be from the ship owners (fuel switching; retrofit scrubbers/engines, etc.). They will attempt to pass on as much of the cost to their customers (for iron ore/coals, that includes both miners & consumers. Because ship owners operate in a near-perfect competition market (many players; none are price-makers), they will take on much of the cost of change, calculated as the cost of scrubber/propulsion/fleet replacement, an incremental exercise over many years, has been estimated by a number of specialists (Wood Mackenzie’s ‘full compliance’ of $60bn/year from 2020; Platts’ $1tn for 2020-25);
  - here though, we only consider the most likely short-term solution for the market: switching from HSFO to MGO (regardless of impact on shipping gear, etc.);
  - assuming boat always operate at optimal speed (12-15kts for >160Kdwt Capesize); HSFO spot price US$400/t; MGO, US$660/t (diff. +65%); about 50% of freight cost attributable to fuel, then HSFO-MGO switch lifts freight cost by about 30%.
  - 30% hike to freight (i.e. just on fuel switch option) = 10% hit to Brazil’s iron ore cfr-China price (+US$6-7/t vs. spot freight/ore); 5% hit to Australia’s iron ore cfr-China price (+$2-3/t); 2-3% hit to Australia’s landed thermal/met-coal prices (+$3/t).
- The miners will then attempt to negotiate longer-term contracts with the ship owners, to cap the new cost risk. They will also pass as much of the extra cost imposed on them by the ship owners, to their customers. The degree to which they can do this, depends on the market structure in which they operate: oligopolistic-to-perfect competition, basically a measure of the degree of each market’s supply-side consolidation.

1. iron ore
- market structure: seaborne features oligopoly (few producers, hold some pricing power); majors have high control over freight, directly exposed to cost shift.
- generally, major ore producers/exporters have short-term ability to pass on higher freight costs to consumers (i.e. oligopoly; no alternative suppliers, etc.);
- however, on-going competitive push between Australian-Brazilian miners to preserve market share + rise of scrap in Asia, may mitigate cost-transfer (hits fob price received);
- being a remote ore source for China/Asia, Vale’s most exposed to freight cost hike (regardless of grade differential, low impurities, etc.).

2. met-coal
- market structure: moderately consolidated; HCC-PCI-SSCC product-differentiation enhances oligopolistic elements; low control over freight, so low direct exposure to freight cost hike;
expected freight/delivered cost-hike is small vs. met-coal’s current high prices; long-term though, if prices report a sustained fall (e.g. China withdraws from seaborne market, as local supply lifts; as local EAF capacity/scrap flows lift; as total steel demand falls, etc.), producers/exporters would become increasingly exposed to substitution (in China, its domestic vs. seaborne; US’ most exposed swing exporter, on Asia-delivered basis).

3. thermal coal

- **market structure**: perfect competition (many producers/consumers; all are price-takers, etc.); low control over freight, so low direct exposure to freight cost hike;

- like met-coal, while freight/delivered cost-hike is small vs. thermal coal’s current high levels, if product prices report a sustained fall over medium-term (China boosts local supply; moderating industrial activity; invests to reduce dependency on coal-fired power, etc.), producers/exporters would become increasingly exposed to substitution: via power fuel options (switching ex-coal); seeking alternative coal supply (marginal coal trade routes include US PRB-to-India; Colombia-to-Asia).

Variations to consider

A complicating factor in determining cost distribution of IMO 2020, is the fact that some miners have control over shipping. For example, Vale has invested in building its own fleet, to reduce shipping costs to Asia, and remain competitive with the more proximal Australian producers. Vale has engaged ship owners to determine long-term contracts to install scrubbers; develop new IMO-compliant fuel options; alter specs of incoming vessels.

Conclusions

- Despite industry lobbying (basically seeking to push back event, to give industry time to invest/ restructure), the IMO appears determined to proceed with the imposition of the 0.5% sulfur ban by 2020 (continues to flag health risk of any delay).

In the most recent Commodities Compendium, the team lifted freight rate forecasts for the main iron ore and coal routes: 10% for the Brazil routes; 5% for the Australia routes. These revisions impact the landed price forecasts for iron ore (i.e. our coal price forecasts are free-on-board).

In addition on higher fright rates, mining companies will also be impacted by higher diesel prices which will increase the fuel bills for large scale open pit miners (iron ore, coal and copper to a lesser extent) and some of the remote gold miners (in West Africa) that rely on diesel generators to power their operations.

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**Fig 55** The cash cost structure in iron ore

![Cash cost structure in iron ore](source: BHP, Macquarie Research, July 2018)

**Fig 56** The cash cost structure in an average diversified miner

![Cash cost structure in diversified miner](source: Macquarie Research, July 2018)
Oil Storage – Giacomo Romeo / Sameer Rathod

Oil storage companies have so far suffered from the environment of uncertainty related to the new IMO regulation. A steeply backwarded market combined with a more cautious view from clients caused a significant reduction in storage utilization.

Amsterdam-listed Royal Vopak (VPK NA, Neutral, TP: €35.00) has seen a drop in the occupancy rates. In 1Q its Group occupancy rate was 87% (from 89% in 4Q17 and 91% in 1Q17).

Heavy and Residual storage represents 15% of Vopak’s total storage capacity. Its storage capacity is focused on Europe and Asia.

By the time the IMO regulation will come into effect in 2020, the macro environment for storage companies should improve significantly. Oversupply of high sulfur fuel oil should increase storage utilization and pricing. Additionally, the increased complexity of compliant fuels and blending could benefit those storage companies that provide this service.
Regional commentary

US Refiners – Best Positioned Globally: Upgrade PBF to Outperform; DK Maintain Outperform

US refiners stand to benefit among the most from an IMO market given their position as the highest complexity refining system in the world and several less complex refiners maintain crude slate advantages due to their proximity to increased shale (low sulfur) production growth.

Fig 57 Regional Differentiation within the US

<table>
<thead>
<tr>
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<td>7.1</td>
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<td>2,461.7</td>
<td>46.5</td>
<td>29.0</td>
<td>9.9</td>
<td>2.5</td>
<td>36.4</td>
<td>16.1%</td>
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</table>

Source: EIA, Macquarie Capital (USA), July 2018

US IMO Positives:

- PADD 1 and 3 complex refiners should benefit from cheaper Middle East, Latam, and Canadian heavy crudes. PADD 2 will largely access Canadian heavies for complex refiners. PADD 5 may have increased access to cheaper WCS (via pipeline expansions) as well as California heavy crudes (San Juquin) and waterborne medium and heavy imports.
- US refiners produce low amounts of fuel oil, as medium and heavy crude consumers maintain coking capacity while those that process shale crudes derive very low sulfur and FO yields.
- Several Midcon refiners have a higher than average diesel yield and sub 1% FO yield – creating a favourable benefit to drag ratio. Historical demand for diesel from agriculture can skew diesel to near 40% relative to a modest Jet/Kero yield.
- Asphalt and Road Oil, an alternative depository for vacuum residue approximates a 1.9% yield in the US but has capacity to nearly double if demand is available. Historically asphalt yields have reached ~3.5%. This would allow for some offset to HSFO if pricing deteriorates considerably.
- US product exports from PADD 3 will likely continue expand, given an increased competitive advantage relative to disadvantaged Latam refiners. Latam refiners may see both weaker refining positioning (high fuel oil yields and historical net exporters) as well as lower financial flexibility.
- Less complex PADD 3 refining capacity should benefit from light sweet over supply in the GOM. 2020 LLS-Brent Spreads are near $4-5/bbl, showing potential for regional over supply and increased shipping costs.

US IMO Concerns:

- Despite high coking relative to distillation capacity – PADD V has the highest FO yield and PADD V diesel yields are highly skewed to Jet/Kero. Further, given higher spec standards that increase product prices, California may see pricing impacts on product demand the earliest.
- We view gasoline as a more neutral factor, but it could swing on global FCC operating rates or excess global refining runs. Globally, the US would have higher leverage to gasoline crack spreads, with 45-50% gasoline yields.
- Simple PADD1 or East Coast capacity may be challenged given higher light sweet premiums and potential for Atlantic Basin light ends overflow. This represents a small portion of US refining capacity although some Canadian refiners may be exposed.
US refiners have meaningfully outperformed global refiners over the past three months, rationally discounting crude feed cost advantages, above mid-cycle heat cracks, and longer-term superior positioning for IMO conditions. Recent margin compression (even more so in gasoline) and a sharp reversal of WTI – Brent crude spreads contradict our longer-term view. This leads us to view a recent 12-15% pullback as an attractive opportunity for longer-term investors.

**Recommendation Summary**

We’re increasing our estimates and price targets for US independent refiners as we continue to see positive drivers supportive longer-term. Despite short-term weakness, we see 1) inland crude spreads remaining wide with potentially longer duration than current crude term structure indicates or deeper into 2019, 2) Diesel demand and inventory balances remain supportive of heat cracks medium term, and 3) IMO sulfur regulation driving record margins and quality spreads into 2020. Near term estimates may see some pressure due to gasoline margin compression in particular but we feel this is outweighed by positive structural drivers.
PBF – IMO leverage (Outperform PT $55/sh)

PBF Energy – short-run margin risk is offset by long-term IMO policy upside. We increase our PT to $55/sh from $47/sh or 37% total return potential.

- PBF refineries in PADD I/III/V are among the most complex, with high heavy crude slates and modest fuel oil yields
- We believe PBF has operational flexibility to improve their IMO exposure at reasonable costs; Chalmette idle coker of 10-12 KBD, and flexibility to increase diesel yields at the margin
- Low valuation relative to the group (PBF trades under 5.5x 2019 EV/EBITDA compared to a peer average near 6x)
- Higher financial leverage at 36% net debt to cap, concentrated refining earnings as a percentage of total, and tighter operating margins drive positive relative earnings improvement and financial metrics due to IMO conditions
- Near-term gasoline margin compression, RIN price uncertainty, and moderating West Coast profitability may keep PBF volatile into 2H18, yet we think drawdowns will present an opportunity as PBF is among the best positioned for highly impactful IMO sulfur regulation

DK – Inland crude advantage (Outperform, PT $62/sh)

Delek Energy – compressing inland spreads will be short lived, upside to long-dated differentials

- Mid-Cush and WTI-Brent spreads have compressed with Cushing inventories nearing operational stressed levels. We expect record runs, a Canadian upgrader outage, and record crude exports have over-extended, contributing to meaningful Cushing draws. This is giving an impression of scarcity despite continued strong shale production growth that should continue at current crude prices. We expect these trends to moderate over the next 3-4 weeks with increased potential for differentials widen further into fall turnarounds.
- We expect the longer-dated potential for wide WTI-Brent differentials is understated to Delek’s benefit. While pipeline constraints should alleviate with increased capacity in 2020, gulf light crude differentials to Brent expand to $4-5/bbl with WTI-Brent over $8/bbl vs the three-year average of $3.50/bbl. While Delek’s scale and complexity aren’t as high as peers, their ability to benefit from wide inland and gulf differentials is meaningful.
- We continue to see portfolio optimization and increased cash balances improving structural ROCE and return of capital potential.
- Despite fundamental improvement, Delek continues to trade at a meaningful discount to the peer average near 6x on 2019 EV/EBITDA

Valero (VLO, Neutral, PT $122.00)

We maintain a Neutral rating for VLO despite its superior asset base and leverage to positive long-term crack spreads while maintaining high financial flexibility. Further, we’re confident Valero’s assets and management will effectively capture value in a 2020 IMO environment. We expect management’s ability to efficiently deploy growth capital and manage high free cash balances will be a key driver of success. While a premium valuation is deserved for operational consistency, return of capital, and significant positive leverage to IMO policies, lower TSR potential keeps us rated Neutral.

HollyFrontier (HFC, Neutral, PT $71.00)

We maintain a Neutral rating on HFC and $71 target price. HFC maintains positive leverage to our widening mid-con crude differential view as well as a wider WCS basis. Further, we see their lubes business as an attractive niche and expect Holly to benefit from complexity in an IMO environment. Holly’s strong positioning should provide continued support although the premium valuation to the peer group largely discounts their structural advantages.
CVR Refining (CVRR, Neutral, PT $25.00)
While CVRR maintains positive leverage to inland crude differentials (WCS, Midland, and Cushing discounts), and potential lower RFS burdens. Near-term we view the CVI unit exchange offer as the primary catalyst and value driver.

Andeavor (ANDV, Neutral, PT $142.00)
We maintain a Neutral rating as we expect the MPC acquisition offer is the dominant catalyst with the core driver having shifted to the deal closing and pro-forma company fundamentals.

Asian Refiners –IMO’s sulfur restriction: A game changer
- **Diesel likely to further rally, while fuel oil to plunge**: In order to improve air quality, the IMO will require shipping fuels to lower their sulfur content to 0.5%S from the current 3.5%S in 2020. We believe the sulfur regulation will significantly affect refineries’ profitability. A dramatic demand shift from high sulfur fuel oil to diesel (an IMO-compliant product) will lift per bbl diesel spread to US$29 in 2020 from US$14, while dragging fuel oil spread to US$-35 from US$-5, in our estimate. This stands to benefit so called “complex” refineries which can produce diesel from fuel oil via secondary units.

- **Crude oil price differentials to widen between grades**: In an IMO market, heavier and high sulfur crudes, including Dubai, are more likely to get cheaper. As we move towards 2020, refineries’ efforts to minimize non-IMO compliant products by using “lighter and low sulfur crudes” will accelerate. This will further widen the Dubai-Brent 2020 discount to US$7/bbl (vs historical highs of US$3.5~4/bbl). Unlike in the past, we expect discriminative performance among Asian refining equities according to crude slate as well as product portfolio.

- **Collateral benefits for petrochemicals**: IMO’s regulation will also have big ramifications for petrochemicals. Given lighter crude tends to yield greater proportion of naphtha, we expect an increase in naphtha oversupply. Structural oversupply in naphtha will be ultimately beneficial to naphtha based petrochemicals including (KR) LG Chem/Lotte Chem. Plus, longer-term, we see demand-side opportunity for methanol makers such as (ML) PCHEM. Methanol can be considered as an alternative fuel for vessels under the IMO 2020 rule.

- **Winners and losers.** We think (IN) RIL and (KR) S-Oil/SK Inno are best positioned. These names are well equipped not only for cheaper heavy crudes but also for secondary units converting fuel oil into diesel. On the other hand, Japanese “simple” refineries with big exposure to fuel oil will be most threatened. As for Thai names, their exposure to expensive lighter and low sulfur crude will negate the benefits of making diesel.

  - With a middle distillate yield weighting of 47%-57%, and 0-3% fuel oil weighting in 2020e, the Indian refiners are set to witness a substantial margin expansion under our diesel / jet crack forecasts. Further with existing distillate hydro treating capacity equivalent to 41-56% of CDU capacity (RIL the highest), these refiners will also benefit from the substantial widening of sweet-sour crude differentials. In our base case, we see a 70%-130% expansion in gross refining margins by FY3. Unsurprisingly, on an absolute basis, RIL ranks at the top with refining margins expanding to $20 per barrel in FY3 from $12 today.

  - We expect China’s spare refining capacity to remain under-utilized, unless there is a commensurate expansion in product export quotas. As such, in our base case, we assume no margin or volume benefit from IMO for the Chinese. We continue to like Sinopec with material upside, but that’s driven by a robust FCF outlook and not IMO optionality.

- **We double upgrade (IN) RIL to Outperform, while downgrading (TH) SPRC to Neutral. Our 20E EPS for (IN) and (KR) names are 41% ahead of consensus.**
European refining – adjusting to an IMO 2020 world

IMO sulfur regulations benefits refiners but Europe is less well placed than other regions

- When we compare it to North America and Asia, Europe as a region is less well exposed to IMO-related market dynamics. The lack of coking capacity makes Europe exposed to negative views on fuel oil prices, which we expect to fall to coal parity (below the levels currently implied by the forward curve).

- Despite the weaker regional position, when we move to a company-level analysis, Europe has some very complex listed refiners that produce minimal amounts of fuel oil and have high gasoil yields.

- Based on our scenario analysis Saras ranks among the most positively impacted refiners globally, thanks to its crude intake flexibility, high middle distillates exposure and decent complexity. We increase our price target for the stock to €2.4/sh (from €2.3/sh) and reiterate our Outperform rating.

- Neste, the most complex European refiner is set to benefit significantly on an absolute basis but less than others on a market cap relative basis. We increasing our price target for the stock to €52/sh (from €46/sh) on higher IMO related profit expectations and improved US biofuel regulatory outlook. However, reiterate our Underperform rating, largely on valuation concerns.

- PKN Orlen is one of the least well placed listed names to benefit from an IMO environment due to their large fuel oil exposure (which is set to increase once the merger with Lotos is completed). On our base case scenario we expect the IMO impact to be Neutral.

IMO regulation will also benefit oil storage companies after 2020

- Oil storage companies have so far suffered from the environment of uncertainty related to the new IMO regulation. A steeply backwared market combined with a more cautious view from clients caused a significant reduction in storage utilization.

- However, by the time the IMO regulation comes into effect in 2020, the macro environment for storage companies should improve significantly. Oversupply of high sulfur fuel oil should increase storage utilization and pricing. Additionally, the increased complexity of compliant fuels and blending could benefit those storage companies that provide this service.

- For this reason we believe that the market will be willing to look past near earnings caused by temporary utilization.
Appendix

Fig 59  Light distillates yields across our global universe

Note: SOL value is due to inclusion of GTL / CTL yields
Source: Company data, Macquarie Research, July 2018

Fig 60  Middle distillates yields across our global universe

Note: SOL value is due to inclusion of GTL / CTL yields (truncated at 80%)
Source: Company data, Macquarie Research, July 2018
Fig 61  Fuel oil yields across our global universe

Source: Company data, Macquarie Research, July 2018

Fig 62  Crude intake comparison across our global universe

Source: Company data, Macquarie Research, July 2018
Important disclosures:

**Recommandation definitions**

Macquarie - Asia/New Zealand
Outperform – return >5% in excess of benchmark return
Neutral – return within 5% of benchmark return
Underperform – return <5% below benchmark return

Macquarie – Asia/Europe
Outperform – expected return >+10%
Neutral – expected return from -10% to +10%
Underperform – expected return <-10%

Macquarie – South Africa
Outperform – expected return >+10%
Neutral – expected return from -10% to +10%
Underperform – expected return <-10%

Macquarie - Canada
Outperform (Buy) – return >5% in excess of Russell 3000 index return
Neutral (Hold) – return within 5% of Russell 3000 index return
Underperform (Sell) – return <5% below Russell 3000 index return

Volatility index definition*

This is calculated from the volatility of historical price movements.

Very high–highest risk – Stock should be expected to move up or down 60–100% in a year – investors should be aware this stock is highly speculative.

High – stock should be expected to move up or down at least 40–60% in a year – investors should be aware this stock could be speculative.

Medium – stock should be expected to move up or down at least 30–40% in a year.

Low-medium – stock should be expected to move up or down at least 25–30% in a year.

Low – stock should be expected to move up or down at least 15–25% in a year.

* Applicable to Asia/Australian/NZ/Canada stocks only

**Recommendations – 12 months**

**Note:** Quant recommendations may differ from Fundamental Analyst recommendations

Financial definitions

All "Adjusted" data items have had the following adjustments made:

- EPS = adjusted net profit / earnings per share
- REA = adjusted/earnings before interest & tax
- ROA = adjusted net profit / equity
- ROE = adjusted profit / average shareholders' equity
- Gross cashflow = adjusted net profit + depreciation + amortisation

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