Turning tides

The future of fuel oil after IMO 2020

February 2019

IMO beyond 2020
Future emissions regulation for shipping

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This report provides a thorough introduction to the IMO's sulfur cap on marine fuel, its impact on markets and what to expect from the new regulatory framework. Aiming to provide market-leading insight and analysis, we outline the regulation's impact on refiners and shipowners and analyze how markets will adapt, as well as taking a birds-eye view on the environmental impact it could have.

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Foreword

Martin Fraenkel
President
S&P Global Platts

The use of fuel oil in ships has a history encompassing most of the modern oil era. Warren Platt's National Petroleum News was in just its fourth year of publication when Winston Churchill instigated the Royal Commission on Oil Fuel and Oil Engines in 1912, sparking off a shift first by the UK's Royal Navy and subsequently by the global commercial fleet to using oil-based bunker fuels instead of coal.

Just over a century later, another sea-change in marine fuels is under way – prompted this time not by military interests but environmental and health concerns.

The International Maritime Organization's lowering of the global marine fuels sulfur limit in 2020 poses a formidable set of challenges to the oil industry, with S&P Global Platts Analytics forecasting a shift in bunker demand of more than 3 million b/d. The industry will have to cut excess fuel oil production and increase middle distillate output, all while coping with an upended geographical distribution of bunker demand, changing arbitrage flows and variable degrees of compliance with the regulation across the world.

In time these changes will make their presence felt across almost every commodity market covered by S&P Global Platts.

Our price assessments will of course evolve to reflect the upcoming specification change. We hope our decision to start publishing 0.5% sulfur assessments a year before the IMO's deadline will help ease the transition to new fuels for both the oil and shipping industries.

But 2020 will not be the end of the road for fuel oil. Some 235 million barrels of physical fuel oil trades are currently carried out in the S&P Global Platts Market on Close process globally every year, and around 18 billion barrels' worth of fuel oil derivatives related to S&P Global Platts price assessments are traded on exchanges every year; this is not a market that can disappear overnight.

A significant portion of the shipping industry intends to continue using fuel oil after 2020 by cleaning emissions on board with scrubber systems. Power generation in parts of the world with less stringent sulfur restrictions will absorb some of the surplus product, and more innovation in wider industrial uses of fuel oil can be expected as prices drop – desalination plants in the Middle East in particular are already establishing a bulwark for this market.

This special report addresses the future of fuel oil: how this market may develop once the psychodrama of the IMO changes passes in 2020, and where its future sources of demand will spring from. Bringing together insights from across S&P Global, we aim to help shape the debate about how the fuel oil market can move on from 2020 and set out its future position.

Executive summary

The IMO's lower sulfur cap is set to take away the bulk of marine fuel oil demand from the start of next year. Most shipowners and operators will switch to burning new low-sulfur bunker blends, meaning an almost overnight shift of 3 million b/d of demand.

The change poses a tough challenge to fuel oil producers, and prices are expected to drop dramatically towards the end of 2019. Ships fitted with scrubbers to clean their emissions on board are set to benefit from this drop in their fuel bills, but only a small fraction of the global fleet are expected to invest in the systems by 2020.

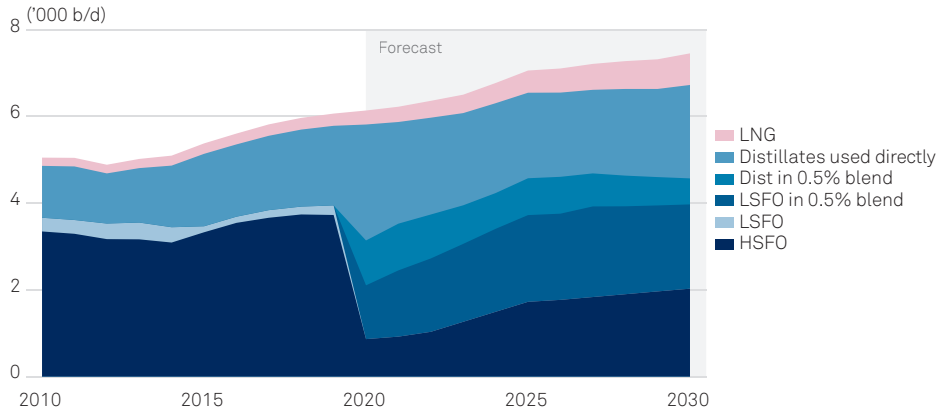
LNG producers can expect to see some new demand for their product as an alternative marine fuel. But the IMO's greenhouse gas strategy may hold back interest in LNG bunkering beyond the 2020s.

The global refining industry is investing in new units aimed at reducing fuel oil output and maximizing middle distillate production. Russian fuel oil exports in particular have fallen dramatically over the past two years.

But new sources of fuel oil demand can be expected to emerge in the coming years, partly offsetting the decline in marine demand. Saudi Arabia has already increased fuel oil consumption for power generation and its water desalinization plants, and Bangladesh is expected to become another key consumer.

2020 will not be the end of the road for fuel oil. A century after its first move to widespread adoption in shipping, fuel oil still has a significant role to play in the oil industry.

GLOBAL BUNKER FUEL DEMAND (see page 13)



Source: S&P Global Platts Analytics

Scan the code or follow the link to watch Jack Jordan, the editor of this report, explain the new shipping emissions rules, why they matter to the oil industry, and the potential knock-on effects to the rest of the global economy
spglobal.com/fuel-oil-video

IMO 2020 and beyond

Changing marine emissions regulations are at the core of current uncertainty over fuel oil's future – and the lower sulfur cap in 2020 won't be the last we hear from the IMO.

Jack Jordan
Editorial Lead, Bunkers
S&P Global Platts

The present uncertainty over fuel oil's prospects has been driven by the International Maritime Organization, a UN body to which much of the oil industry is now begrudgingly paying attention for the first time.

The IMO's lower sulfur limit for marine fuels in 2020 should not have come as a surprise to the oil and shipping industries. This change has been on the cards since at least October 2008, when the IMO set in place its revised Marpol Annex VI agreement on marine pollution.

Nonetheless, the final decision in October 2016 to proceed with the 2020 deadline has occasioned a degree of angst among shipowners, operators and in the wider commodity markets in the two years since then.

The effect on commodity markets will be profound: a large majority of the world's commercial fleet will shift from burning fuel oil to middle distillate-based bunkers, and refiners are expected to increase crude runs to maximize distillate output for the shipping industry's needs. S&P Global Platts Analytics forecasts a bunker demand shift of more than 3 million b/d and Brent crude price rise of as much as $7/b in 2020.

The main problem the shipping industry has to address is how it will cope with an unfamiliar set of new fuels in 2020. Little is yet known about the new 0.5% sulfur blends the refining industry is developing, but a wide range of products is expected to be on offer.

Refiners will blend new marine products primarily using the 0.5% sulfur limit as their target – rather than the 380 CST viscosity specification they currently aim for when blending high sulfur fuel oil – and they will have a broad array of options for how to meet it.

Products could range from a largely unaltered low sulfur straight run fuel oil to a primarily distillate-based product, or use other refinery streams including VGO and hydrocracker bottoms. The trouble will come when the products are mixed and some blends prove incompatible with one another: when a more aromatic 0.5% product comes into contact with a more paraffinic blend, the products are likely to separate and form sludge, blocking filters.

The risk of a spate of engine failures across the world in 2020 is currently keeping marine engineers awake at night. A contamination crisis in the bunker fuel industry in 2018 after harmful off-specification product seen first in the US Gulf was exported across the global supply chain has also concentrated minds

on how similar problems may arise with the new fuels.

And 2020 will not be the end of the shipping industry's struggle with emissions regulation. A proposal to extend the European Emissions Control Area to include the Mediterranean is currently under discussion at the IMO – a measure that would impose an even more stringent 0.1% marine fuels sulfur limit across European waters, further tightening middle distillate supplies.

IMO member states are also examining the possibility of banning the use of fuel oil – and possibly some of the new 0.5% sulfur blends – in the Arctic, where marine traffic is expected to increase significantly in the years ahead.

But the biggest challenge for the shipping industry after 2020 will be in meeting the IMO's initial strategy for reducing greenhouse gas emissions, adopted in April 2018 and due to be revised by 2023.

The strategy aims for GHG emissions to peak as soon as possible and for the shipping industry's total emissions to drop by at least 50% from 2008's levels by 2050. Given the rate of growth expected in shipping over the coming decades, this strategy will need zero-GHG-emission vessels to come into service at commercial scale sometime in the 2030s.

The shipping industry's options for reducing GHG emissions are limited at present, and much research and development work will need to be done over the next decade before zero-GHG designs are viable at the right scale.

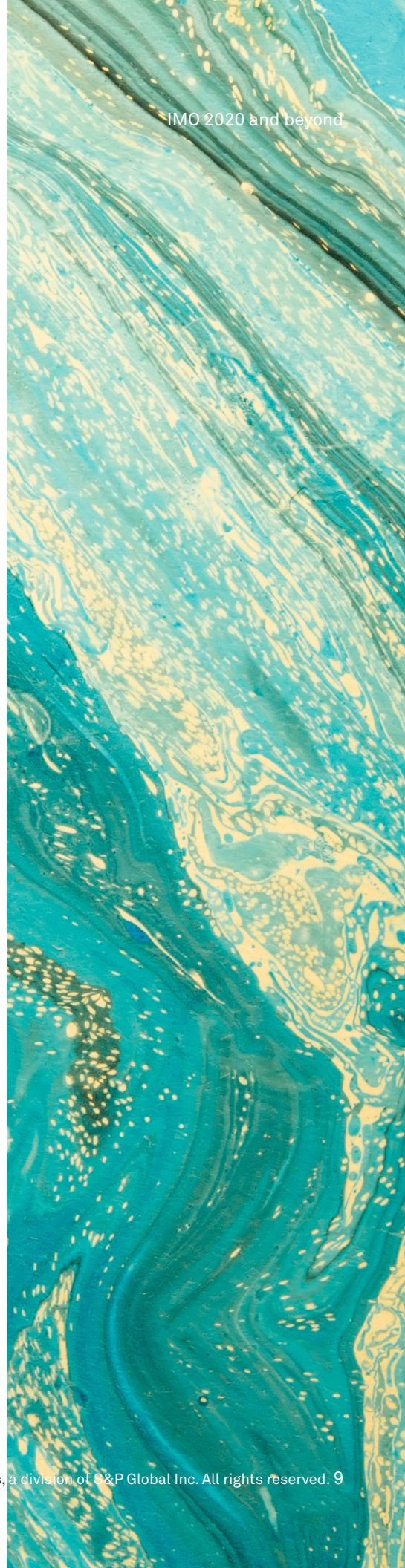
One option in the short term could be mandatory slow steaming and energy efficiency measures across the global fleet. Reducing speed to maximize fuel efficiency and mandating other energy-efficiency measures like using LEDs instead of light bulbs could deliver significant savings within a short time-frame.

But over the longer term the shipping industry will need to take on new energy sources. Switching to methanol or LNG derived from biomass may be suitable for some segments of the industry. Some owners may opt for hybrid ship designs that incorporate conventional fuel sources as well as wind-powered rotor technology, batteries or solar power – although none of these technologies alone are likely to be viable as the only energy source for a large commercial vessel for some time yet.

Most of the industry for now is pinning its hopes to developments in hydrogen fuel cells. Several companies are already developing the technology – which produces no emissions – for use in ships.

The challenge will be in whether the technology can be developed – and delivered at the scale required by the shipping industry – within the relatively short timetable set by the IMO.

If progress in research and development appears prohibitively slow, or if the implementation of the sulfur cap in 2020 is widely seen as flawed among the world's politicians, IMO member states may be inclined to set less ambitious targets when they revise the initial strategy on GHGs in 2023.



Sulfur warrior

Dr Edmund Hughes, the IMO's head of air pollution and energy efficiency, discusses the UN body's approach to emissions regulation in an interview with S&P Global Platts.

Dr Edmund Hughes
Head of Air Pollution and Energy Efficiency
International Maritime Organization

Jack Jordan
Editorial Lead, Bunkers
S&P Global Platts

What can the IMO do to help ensure widespread compliance with the 0.5% sulfur limit in 2020?

Shipowners and operators must make sure their ships comply with IMO regulations. Day-to-day responsibility will also lie with ship masters, chief engineers and other crew.

Monitoring, enforcement and compliance is the remit and responsibility of states, as flag states and as port and coastal states. Flag states issue certificates and must ensure ships meet requirements, while port states can exert port state control on ships of any flag. So enforcement will come from all sides.

IMO as an organization is helping by providing a forum where any issues relating to compliance can be discussed and by developing and issuing supporting guidelines and guidance.

What lessons from the lowering of the marine fuels sulfur limit can be applied to how the IMO approaches emissions regulation in future?

This was a timely process, based on widespread research, with appropriate industry input from the beginning. It was adopted by consensus among IMO member states and will achieve a specific result with clearly identifiable benefits.

This is how IMO regularly operates, so it confirms that IMO's model for developing and amending shipping's regulatory framework is an effective one.

Do you see any argument for regulating shipping's emissions at the regional level when IMO member states are unable to agree at the global level?

A universal set of regulations and level playing field for all is desirable. However, international law recognizes that states can take "other measures" to control emissions from ships supplementary to those measures adopted by IMO. To reflect this possibility, IMO does have provisions for special areas and Emission Control Areas.

There is an established procedure, set out in Appendix III of Marpol Annex VI, for bringing a proposal to IMO, in order to establish such an area. In this way, any areas needing special protection can have that special status – but the proposal is brought to IMO so that all states can have input to the decision to designate an Emission Control Area. This does not preclude member states from taking unilateral action, as permitted under [the UN Convention on the Law of the Sea] in territorial waters, as we have seen in China.

Do you see the use of scrubbers as a short-term solution for reducing sulfur emissions in time for 2020, or as something that is likely to be a feature of the shipping landscape for a long time to come?

IMO regulations allow for "equivalents" to meet the required emission standards set out in the regulations. Under Marpol Annex VI, ships are allowed to be fitted with an "approved equivalent arrangement" to meet the sulfur limit - such as an exhaust gas cleaning system, or so-called scrubber.

With a view to addressing the concerns regarding the possible impacts on the marine environment by washwater discharged from scrubbers, in particular those of the "open loop" type, the Sub-Committee on Pollution Prevention and Response is undertaking a review of the 2015 guidelines for exhaust gas cleaning systems.

The forecasts are that scrubbers will be used by a minority of ships. It remains to be seen whether those ships that employ scrubbers now will continue to do so in several years' time. The continued availability of heavy fuel oil in bunkering ports may be a factor in their future use.

How soon do you expect to see marine fuels with zero greenhouse gas emissions become available for the commercial fleet?

Biofuels and batteries are already available and being trialed, while other energy sources such as wind, solar and hydrogen cells are also in development. Of course, it is important to ensure that any new fuels are sustainably sourced.

I am not in a position to make a market prediction. It is clear that, as noted in the initial IMO GHG strategy, technological innovation and the global introduction of alternative fuels and/or energy sources for international shipping will be integral to achieve the overall ambition in the GHG strategy, which is to peak GHG emissions from international shipping as soon as possible and to reduce the total annual GHG emissions by at least 50% by 2050 compared to 2008, whilst pursuing efforts towards phasing them out. This aims for a pathway of CO2 emissions reduction consistent with the Paris Agreement temperature goals.

The initial IMO GHG strategy is ambitious, and I believe it will encourage innovation and R&D to reach the goals. The GHG strategy has sent a clear signal to the shipping industry and we have seen a reaction already from one of the largest shipowners that has set a goal to have a commercially viable carbon neutral ship by 2030 and have a net-zero CO2 emission target by 2050, and also a main engine manufacturer announcing plans to develop a propulsion system using hydrogen.

Could the IMO mandate slow steaming across the whole shipping industry as a means of cutting GHG emissions in the short term?

This would be a decision for the member states to make. Theoretically, member states could propose, discuss and agree to such a proposal. In addition to directly reducing GHG emissions from an individual ship, such a measure could arguably provide an incentive for the adoption of zero carbon fuels, as ships using these "alternative fuels" would not be subject to the same speed requirements and so could well have a significant market advantage. However, some member states and industry representatives have raised concerns about such an approach to reducing GHG emissions, stating that it may lead to market distortion and potentially impact trade in perishable goods.

The initial IMO GHG strategy lists, as a candidate short-term measure, "consider and analyze the use of speed optimization and speed reduction as a measure, taking into account safety issues, distance travelled, distortion of the market or to trade and that such measure does not impact on shipping's capability to serve remote geographic areas."

Possible short-term measures could be measures finalized and agreed by the Marine Environment Protection Committee between 2018 and 2023. Dates of entry into force and when the measure can effectively start to reduce GHG emissions would be defined for each measure individually.

At this stage, member states have been invited to submit concrete proposals to the next MEPC in May 2019.

Refining reoriented

Disruptive changes to the global oil and refining industry beckon as a result of IMO 2020. S&P Global Platts Analytics examines how refining economics is likely to be affected.

Rick Joswick
Head of Oil Pricing and Trade Flows
S&P Global Platts Analytics

Global bunker specification changes in 2020 require large-scale shifts in refinery operations and will be very disruptive, both within the industry and more broadly.

From a refining standpoint, there will be a major switch in the blendstocks used for bunker fuels, initially creating a huge disposition issue for roughly 3 million b/d of high sulfur fuel oil. That volume will be replaced by marine gasoil and various low sulfur blends of gasoil/residuals. Prices for marine gasoil and the new blended fuel are expected to rise sharply, while HSFO prices will fall.

Relatively expensive steps will be required throughout the refining circuit to rebalance products, resulting in much wider price spreads for all middle distillates compared with HSFO. At times in 2020, the refining circuit may need to run additional crude to make sufficient compliant marine fuel, and may not have the capability to completely destroy the surplus high sulfur fuels, forcing them to price lower into power generation or storage. Diesel and jet cracks will soar. Gasoline cracks may also see support, as yields shift towards middle distillates. The price of the new 0.5% sulfur fuel will initially be close to marine gasoil. Refinery operations, crude oil and product trade flows will change dramatically.

However, all these initial price effects will dissipate over the following few years as refinery conversion capacity expands and ships add scrubbers.

Key refining implications include:

- High crude runs in 2020 and a broader set of refineries seeking light, sweet crude. Likely bullish market sentiment for sweet crude will drive overall prices higher for key sweet benchmarks, such as Brent and WTI.

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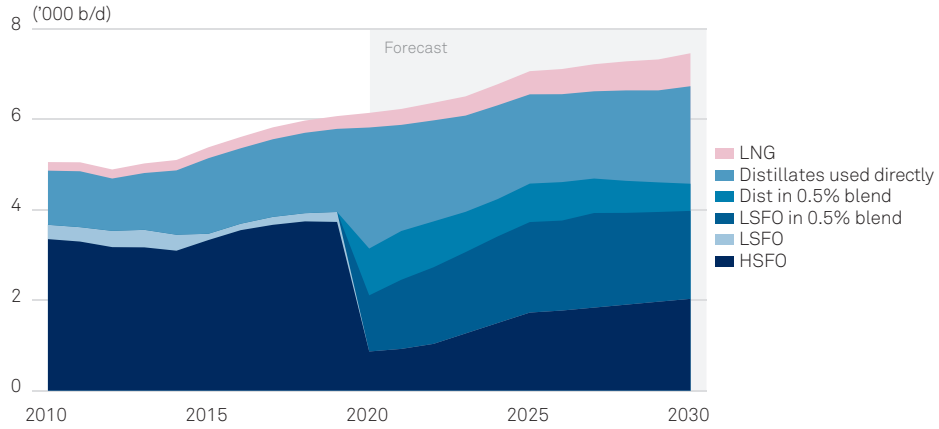
- Middle distillate cracks will increase in 2020 from current levels, before declining during 2021-23. Gasoline cracks will also see strength, but much less so compared with distillates. HSFO cracks will fall in 2020 and HSFO absolute prices may approach low levels at times, with increased use in power generation.
- Clean-dirty product spreads will widen from current levels, driven by marginal refinery economics. At times, spreads could widen even more than typical refinery-driven spreads if HSFO disposal requires lower pricing to compete outside of baseload power generation.
- Crude quality differentials will widen dramatically in refinery parity with light-heavy and sweet-sour product spreads. Refineries with deep conversion will see very strong margins.
- Medium conversion refiners will also see substantial margin improvement, especially in 2020.
- Reforming margins and utilization rates should strengthen, due to lower gasoline production from fluid catalytic cracking and a need to backfill from the virgin naphtha pool. This will also pull up naphtha prices. On the margin, this shifts petrochemical feed preferences towards LPG/ethane.

Global crude quality getting lighter, sweeter helps, but is not enough by itself for 2020

On average, global crude quality has been getting lighter and sweeter since 2005. Initially, this was due to a sharp slowing in the growth of heavy sour crudes, while medium grades continued to expand. Beginning in roughly 2010,

GLOBAL BUNKER FUEL DEMAND



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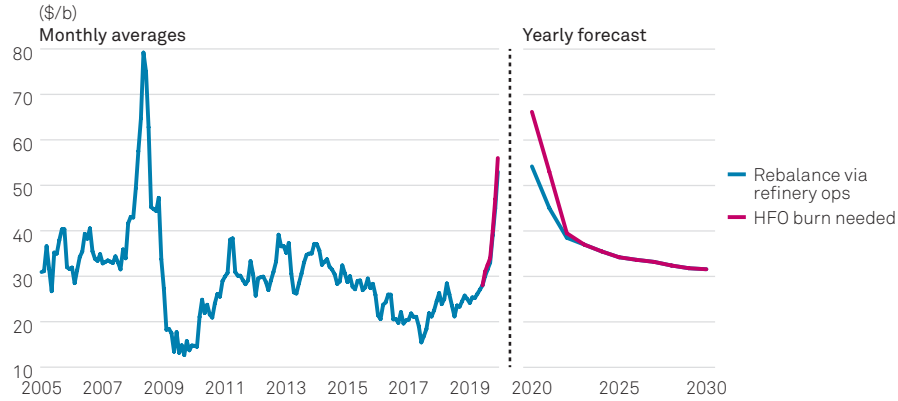
GASOIL - FUEL OIL PRICE SPREAD



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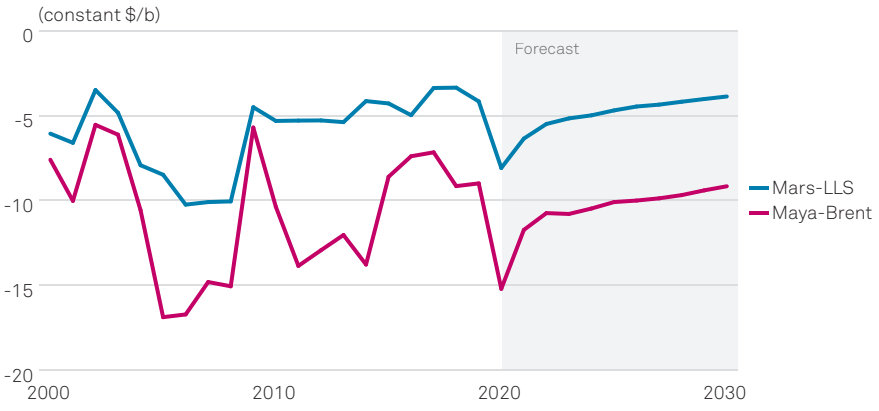
CRUDE PRICE DIFFERENTIALS



Source: S&P Global Platts Analytics

this was followed by explosive growth in US light sweet shale crude and condensate production.

With a rapid increase in average API gravity and a consequent decrease in average residual fuel oil content, the total volume of 650 F atmospheric resid contained in crude runs has effectively leveled off since 2016, despite the growth in total runs.

New refinery capacity helps, but is not enough by itself for 2020

Planned refining facilities starting up by 2020 will also play a large role in helping to destroy surplus HSFO. Conversion capacity additions are averaging around 1 million b/d per year, split among coking, hydrocracking, and cat cracking. The geographical distribution of the new capacity will also be a factor, with many of the conversion additions occurring in China and some in other countries that are not normally bunker supply hubs. Although they may be a sink for higher sulfur resids, they will not necessarily be a source for lower sulfur residual bunker blend components.

Additions of heavy oil desulfurization facilities will also help, 70% of which will be atmospheric resid desulfurization – with the remainder VGO desulfurization. Most of these new facilities are in Asia. However, they may not all directly contribute to solving the bunker spec transition problem. They were all planned before the IMO's decision to implement the bunker spec change in 2020. As such, they probably have other processing objectives or requirements – for instance, to help meet FCC feed sulfur specs – and may not be able to readily shift operating modes.

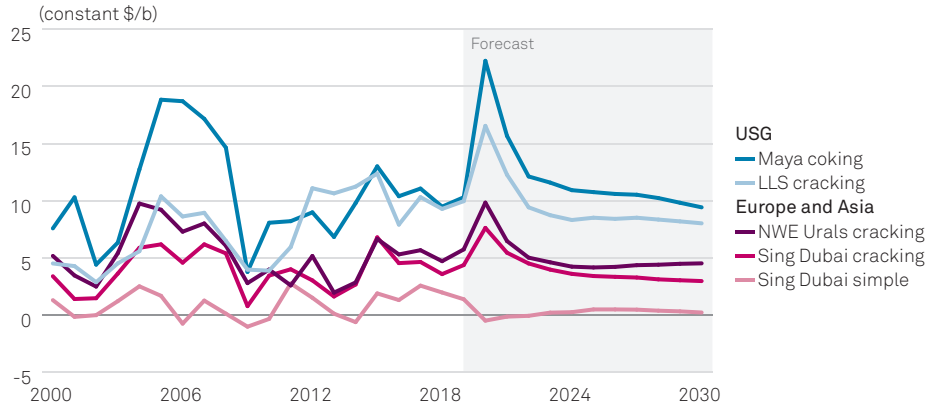
Steps needed to close the balance in 2020 will be increasingly expensive

Consequently, given the size of the change, there will not be enough deep conversion available for HSFO initially to clear in conventional refining steps. This first tranche of HSFO destruction corresponds roughly to a $30/b gasoil-HSFO spread in Europe. Subsequent processing layers for HSFO destruction require the price of HSFO to fall further to incentivize less attractive refining options (about a $30-$50/b spread) and a third tranche involves incremental consumption in land trade, backing out other fuels (high sulfur crude burn, coal or gas), implying even wider gasoil-fuel oil spreads, depending in part on the absolute price levels of oil and competing fuels. Our reference case corresponds to pricing in the second tranche, while a possible high impact case corresponds to the third tranche. In both cases, while differentials may be very wide initially, investments in scrubbers and refinery conversion capacity will drive differentials narrower and likely into the first tranche over 2021-23.

Total global demand for major petroleum products produced from refining – excluding products such as biofuels and NGLs – is expected to continue to grow around 1.0-1.4 million b/d per year, which implies a comparable level of refinery runs growth. Included in this demand is baseload HSFO in power generation, representing new plants in Saudi Arabia and Bangladesh (see page 28). Incremental crude runs are effectively from US low sulfur crude and condensate, as reductions in Venezuelan and Iranian production are effectively backfilled by growing US production. After factoring in new refining facilities by 2020 and incremental asphalt and power plant demand, roughly 2 million b/d of HSFO can be destroyed. This is still nearly 1 million b/d short of the HSFO destruction required. Production of middle distillates, including jet kerosene as well as gasoil, will also be well short of its required target. Strong middle distillate demand will require further substantial yield shifts above what has been achieved to date, also reducing gasoline production.

Even after these changes, some additional refining steps will be needed. One step, for example, will be to

REFINERY MARGINS



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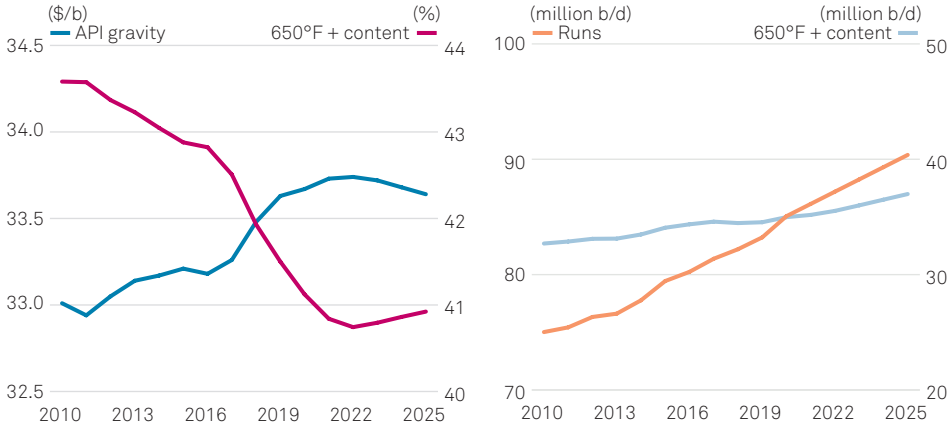
increase coker utilization rates. US data shows that recent utilization rates (of about 89%) are lower than the very high utilization rates (above 94%) seen historically. If all cokers globally raised their utilization rate by 4% – and the incentives should certainly be there – that would reduce HSFO production by another 350,000 b/d.

Other stretch refining steps, such as deeper vacuum distillation cut points and some substitution of high sulfur resid for low sulfur resid in resid FCC, primarily in the US and Europe, could provide additional flexibility – albeit with some FCC capacity or other debits – assuming environmental restraints on FCC emissions are not violated. Better segregation or optimized blending could also free up some LSFO at the expense of HSFO, and there will be incentives to store HSFO – particularly in 2020, when the market will likely move strongly into contango.

However, changes in the supply/demand balance of only a few hundred thousand b/d could have rather substantial price implications – for instance, by raising the diesel-fuel oil spread above $50/b. The severity of price effects is set on

GLOBAL CRUDE QUALITY



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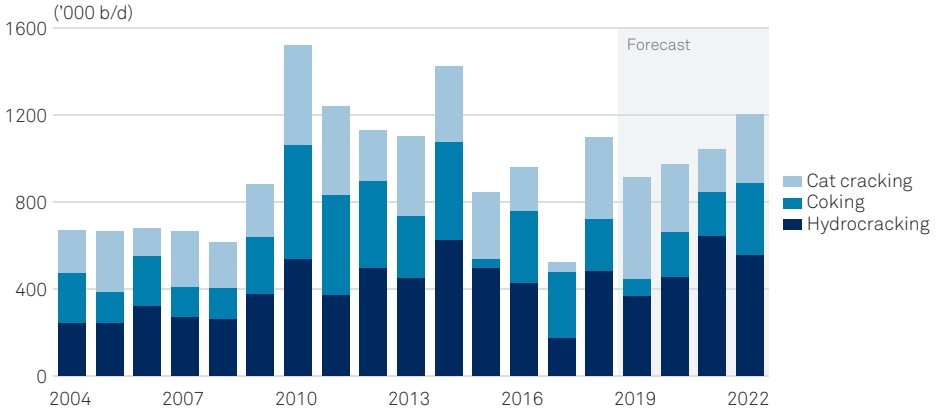
CONVERSION CAPACITY ADDITIONS



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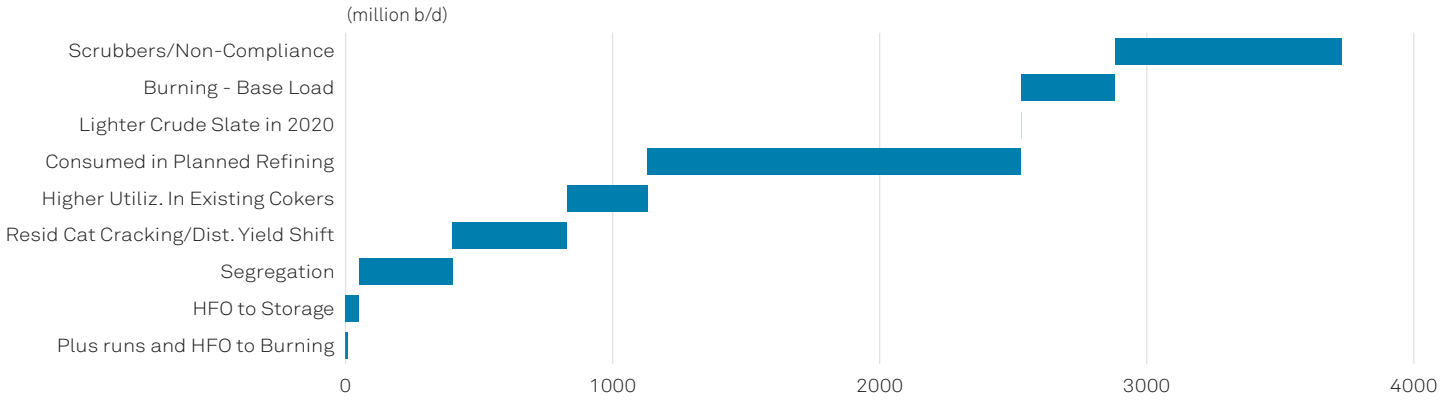
HSFO BALANCE IN 2020



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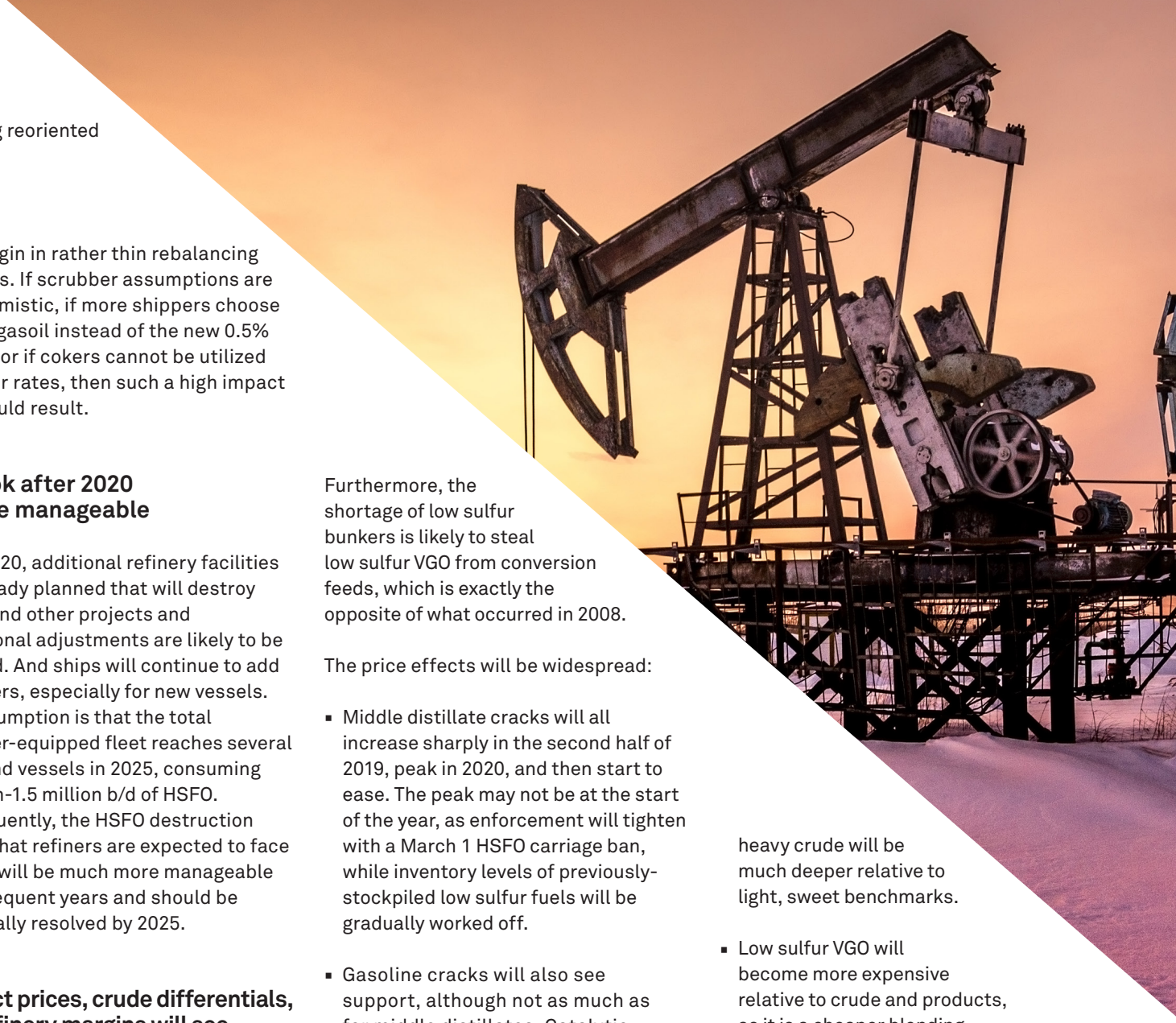


the margin in rather thin rebalancing tranches. If scrubber assumptions are too optimistic, if more shippers choose marine gasoil instead of the new 0.5% fuel oil, or if cokers cannot be utilized at higher rates, then such a high impact case could result.

Outlook after 2020 is more manageable

After 2020, additional refinery facilities are already planned that will destroy HSFO, and other projects and operational adjustments are likely to be initiated. And ships will continue to add scrubbers, especially for new vessels. Our assumption is that the total scrubber-equipped fleet reaches several thousand vessels in 2025, consuming 1 million-1.5 million b/d of HSFO. Consequently, the HSFO destruction issues that refiners are expected to face in 2020 will be much more manageable in subsequent years and should be essentially resolved by 2025.

Product prices, crude differentials, and refinery margins will see disruptive changes in 2020 before reverting to trend in later years

As already noted, wider spreads between light, sweet products and heavy, sour ones will be required to allow more expensive rebalancing steps to be carried out economically. For 2020, the situation looks similar to 2008 in some ways, in that conversion capacity will be straining to balance. But in other ways it will be different from 2008, as absolute price levels will likely be much lower and absolute demand growth for all products, including gasoline, will likely remain fairly healthy – whereas demand for gasoline collapsed in 2008-09.

Furthermore, the shortage of low sulfur bunkers is likely to steal low sulfur VGO from conversion feeds, which is exactly the opposite of what occurred in 2008.

The price effects will be widespread:

- Middle distillate cracks will all increase sharply in the second half of 2019, peak in 2020, and then start to ease. The peak may not be at the start of the year, as enforcement will tighten with a March 1 HSFO carriage ban, while inventory levels of previously-stockpiled low sulfur fuels will be gradually worked off.
- Gasoline cracks will also see support, although not as much as for middle distillates. Catalytic cracking units will likely be operated differently in order to consume high-sulfur feeds and increase distillate production. This will lower gasoline production and should increase emphasis on reforming operations to backfill gasoline.
- HSFO cracks will be the inverse of middle distillates, getting quite weak in 2020.
- Low sulfur-high sulfur fuel oil spreads will widen sharply.
- Crude quality differentials will move with products, also getting very wide in 2020. Discounts for medium sour and heavy crude will be much deeper relative to light, sweet benchmarks.
- Low sulfur VGO will become more expensive relative to crude and products, as it is a cheaper blending component for low sulfur bunkers than using gasoil.
- Light cycle oil will become more valuable. Normally, LCO has a relatively lower value as it cannot easily be desulfurized to 10 ppm for use in road diesel, but lower severity desulfurization will readily get it down to 0.5% sulfur. Furthermore, LCO is aromatic and thus may be useful in reducing compatibility issues when blending with resids.
- Higher freight costs will widen all inter-regional arbitrage differentials.

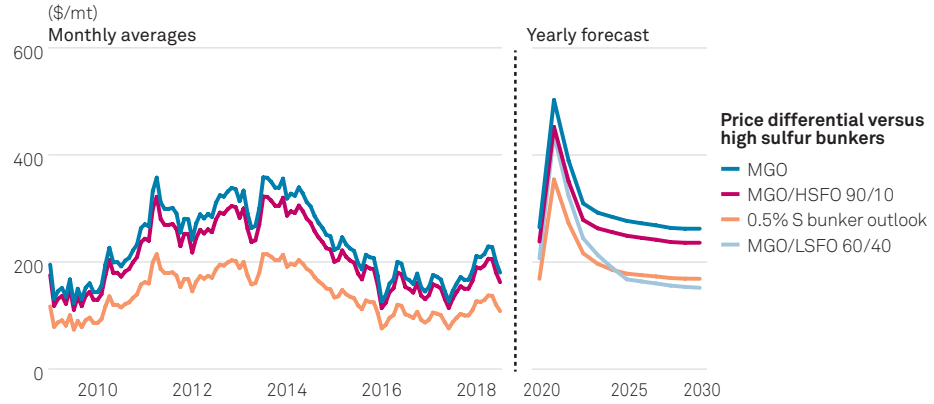
- Refinery margins for deep conversion facilities will increase dramatically as they produce essentially all light products and no fuel oil, and they can do that using cheap heavy, high sulfur feeds. Margins for medium conversion facilities, even when running sour grades, will also increase, but not by nearly as much. Total refinery runs will need to be maintained to satisfy demand for all products, which will help maintain margins, even for simpler or sour refiners.

The price for the new 0.5% sulfur marine fuel will likely be somewhere between a blend of gasoil with 1% sulfur fuel oil, and marine gasoil. Specifically, a price set at 60% marine gasoil/40% LSFO could be viewed as a lower bound, whereas a price set at 90% marine gasoil/10% HSFO could be viewed as an upper bound.

Since the market will initially be quite tight in 2020, we expect the price for the new 0.5% sulfur fuel to be close to the upper bound. Longer term, low sulfur bunkers will price near blending parity with 1% low sulfur fuel oil and gasoil – and ultimately lower as gasoil use is reduced, being replaced by 0.5% sulfur blends as shippers become more comfortable with the quality of these blends.

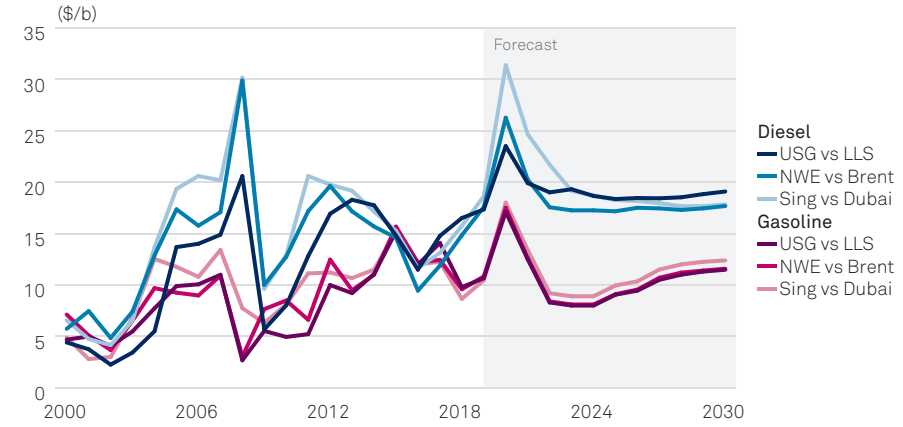
Light-heavy crude differentials will also widen, set by refinery economics on the margin. These price-setting layers are not deep conversion, but rather the more moderate layers, such as FCC or visbreaking in a European refinery exporting gasoline and fuel oil. That requires fairly wide light sweet versus medium sour spreads. For heavy sour, the competition is versus the sour straight run resids from medium sour crudes. Heavy crude discounts will nearly rival 2008, even though the absolute price levels are much lower.

LOW SULFUR BUNKER PRICE OUTLOOK



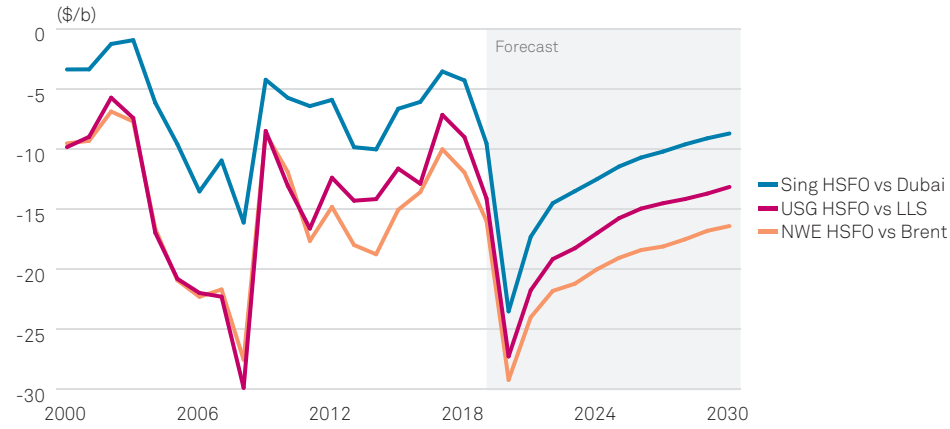
Source: S&P Global Platts Analytics

DIESEL AND GASOLINE PRICE CRACK SPREAD



Source: S&P Global Platts Analytics

FUEL OIL PRICE CRACK SPREAD

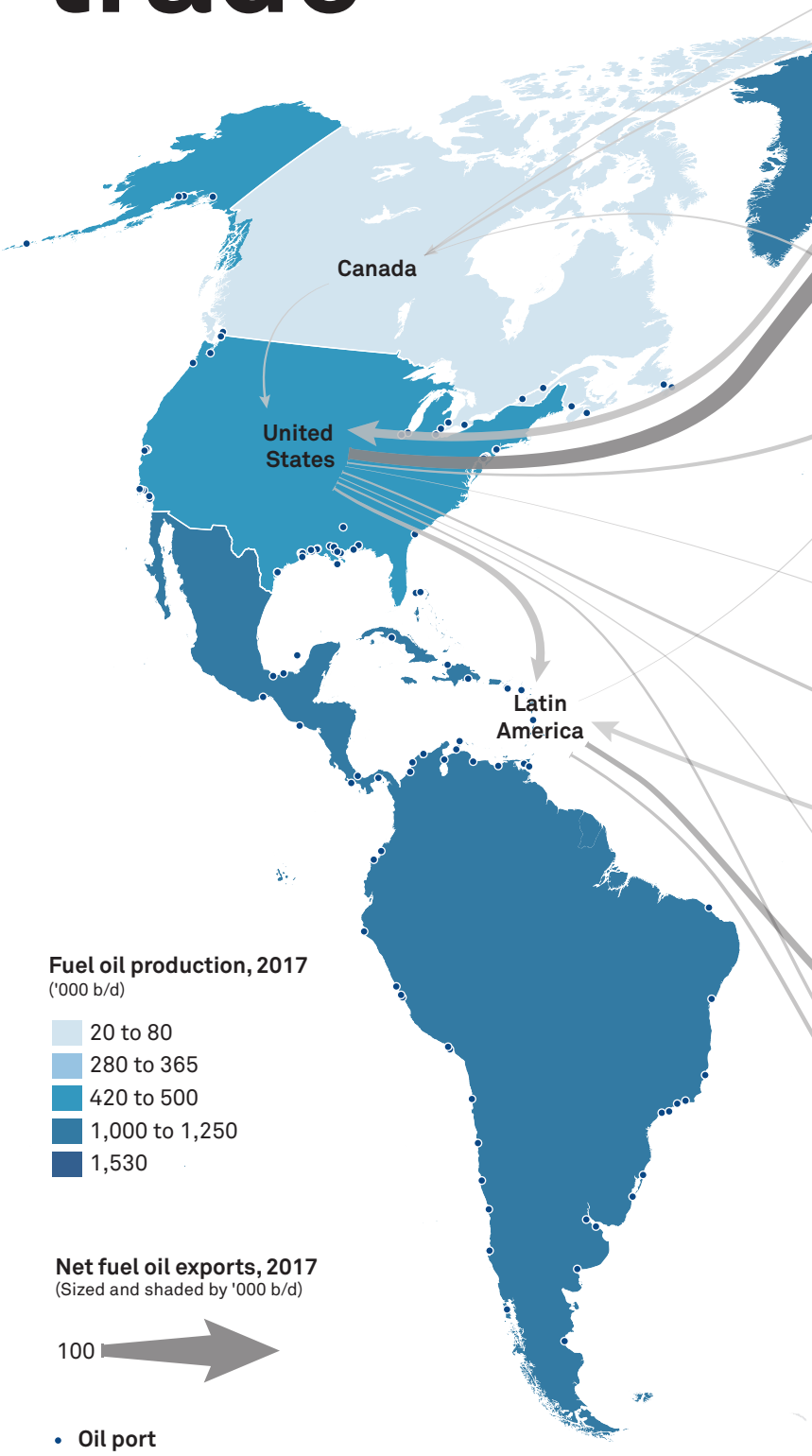


Source: S&P Global Platts Analytics

Currents of trade

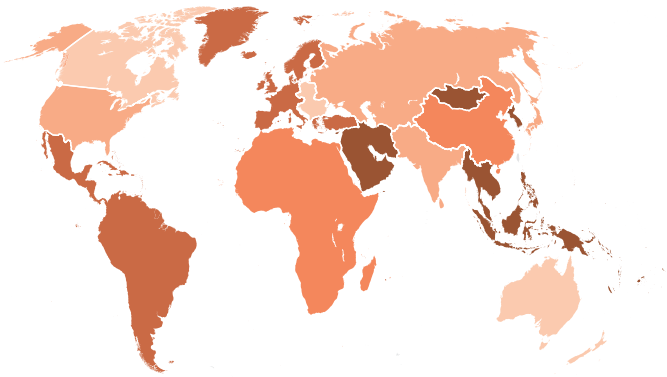
Visualizing the flow of fuel oil around the world demonstrates how complicated this market is; the average barrel of this product is consumed far from the refinery that produced it. This map shows 2017 interregional net trade flow balances produced by S&P Global Platts Analytics to give a clearer view of how the bottom of the barrel is traded globally. In the notes we set out how those flows might change.

The main impulse behind the global fuel oil trade is to take the surplus produced by older, simpler refineries in Europe and the former Soviet Union and deliver it to growing markets in the Middle East and Asia-Pacific. This general dynamic should continue in the years after 2020 even after the majority of marine fuel oil demand disappears, but individual arbitrage routes may shift.



Fuel oil demand, 2017
('000 b/d)

25 to 60
280 to 425
550 to 630
850 to 950
1,570 to 1,650



Fuel oil production, 2017
('000 b/d)

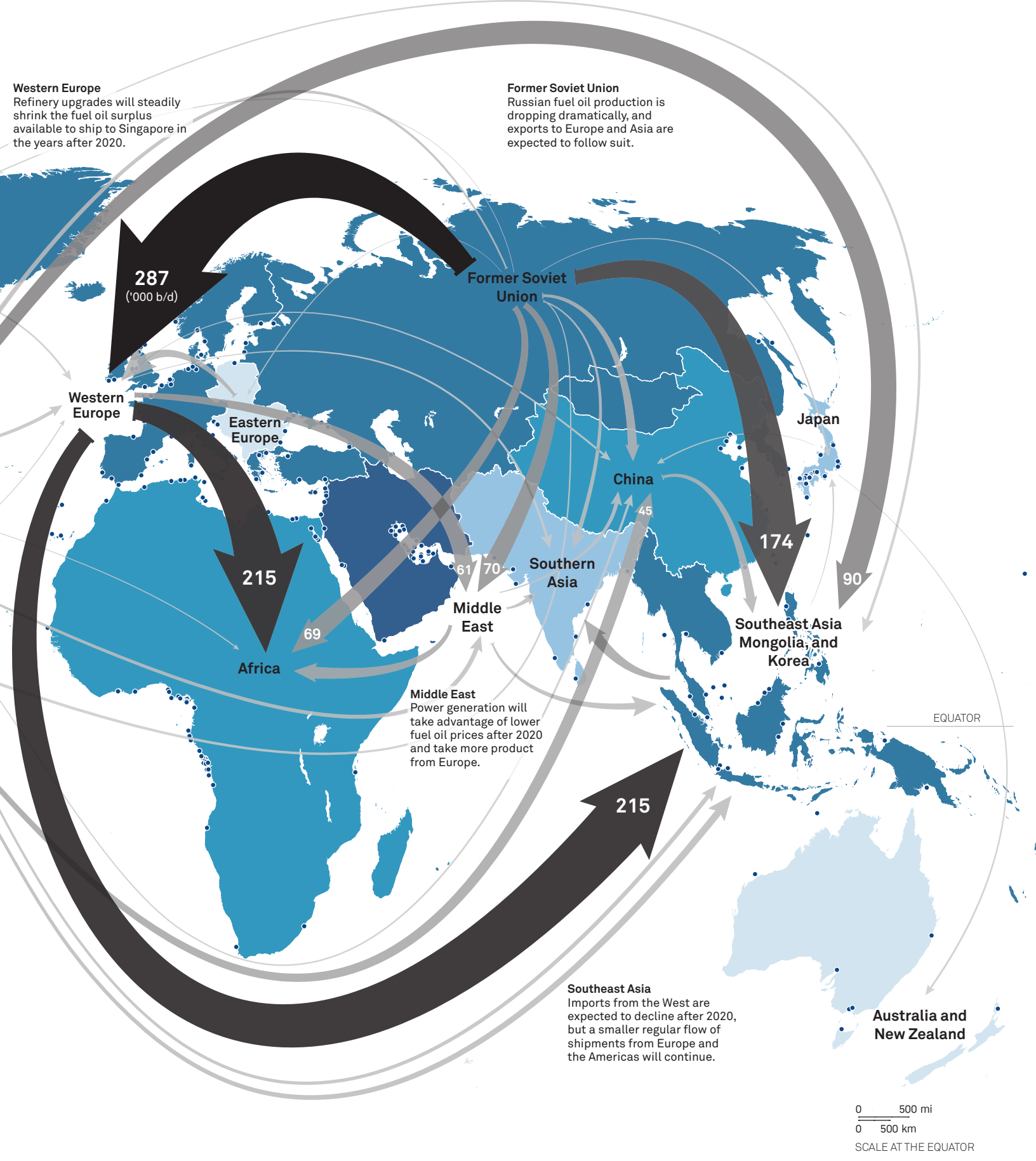
20 to 80
280 to 365
420 to 500
1,000 to 1,250
1,530

Net fuel oil exports, 2017
(Sized and shaded by '000 b/d)

100

• **Oil port**

Source: S&P Global Platts Analytics



Course corrections

Refiners are already investing in changes to their operations ahead of 2020, with European and Russian firms – the world's largest producers of fuel oil – most affected.

Elza Turner
Senior Editor, EMEA Oil
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With the specification change now uncomfortably close, producers have stepped up the implementation of their planned upgrades aimed at reducing fuel oil output of fuel oil and increasing the yield of distillates.

In October 2018 Shell commissioned its new solvent deasphalter (SDA) unit at its Pernis refinery in the Netherlands, and converted a hydroprocessing unit into a hydrocracker to process the deasphalted oil from the SDA unit.

The new unit, the first major investment at the site since 2011, will enable Pernis to "process a larger proportion of its oil intake into cleaner transport fuels, including marine gasoil compliant with IMO 2020," it said.

Almost a year earlier, in nearby Antwerp, Total also launched an SDA unit and a mild hydrocracker – "in anticipation of the new marine fuel regulation that will take effect in 2020," it said at the time.

The market's focus has been on the cluster around Northwest Europe, as it hosts some of the continent's biggest refineries and is pivotal in the supply of bunker fuel.

Throughout 2018 traders in Northwest Europe were eyeing the delayed coker launch at ExxonMobil's Antwerp refinery, starting up at the end of the year. The company is also building a new hydrocracker at its Rotterdam refinery.

The market is also closely monitoring the progress of another delayed coker, at Poland's Gdansk. Grupa Lotos is yet to set the deadline for its launch after experiencing delays.

Further north, in Sweden, Preem is also gearing up to meet the IMO requirements with plans to start up a new vacuum distillation unit at Lysekil and a new hydrogen unit at Gothenburg. Both units are due online in 2019 and will help to "have less than 20% high sulfur fuel oil left in the product slate from the two Preem refineries," it said.

In neighboring Finland, Neste commissioned a new SDA unit at its Porvoo refinery in 2017.

ExxonMobil has announced plans for "significant upgrades" at its UK Fawley plant involving the construction of a new hydrotreater and a new hydrogen plant.

But as the deadline for the 0.5% sulfur cap comes nearer, some refineries have found that embarking upon new investments might be too late or not make economic sense.

Shell decided to "demobilize" the project of constructing a SDA plant at

Wesseling, in the Rhineland refinery, as the planning has shown that "it might not be successfully implemented within the set framework."

In August 2018 commodities trader Gunvor said it had "decided to put on hold the construction of a delayed coker unit" at its Rotterdam refinery as "the price environment and other relevant economics have changed considerably since Gunvor first began exploring the concept a year ago."

But the pending IMO regulation is likely to bring back to life at least part of the mothballed Wilhelmshaven refinery in northern Germany, whose vacuum distillation unit might be restarted this year.

At the end of last summer, BP started up the upgraded VDU at its Castellon refinery in Spain, which will enable the refinery to increase fuel oil conversion capacity by around 10%.

However, the majority of Spanish refineries had already completed their modernization plans by the early 2010s and as Repsol's head of refining, Francisco Vazquez, said at a conference in 2017, at Repsol's Spanish refineries the yield of fuel oil was close to zero. "We have five cokers in four refineries," he said.

Upgrades at Cepsa's Spanish refineries around the same time also contributed to their increased middle distillate capacity in a drive to help reduce Spanish diesel imports.

Another Mediterranean country, Greece, also completed an upgrade involving a hydrocracker and flexicoker in the early 2010s.

Russian refineries have been heavily investing in hydrocracker units since 2011 as part of the downstream modernization agreement the companies and federal authorities signed in October 2011. But initially the upgrade in conversion units was accompanied by primary processing capacity expansion, resulting in higher fuel oil output.

As the upgrades were gathering speed, sanctions restricted access to foreign equipment and capital, leaving some projects facing delays. Rosneft, Russia's largest oil company, has put off the completion of its modernization to 2025.

But Russia's own manufacturing has increasingly stepped in to fill the gap, and new projects have been launched.

Lukoil's Nizhny Novgorod refinery is on track to start up a delayed coker in 2021 and its Perm refinery fully halted fuel oil output after launching its coker three years ago.

Gazprom Neft is also looking forward to fuel oil-free production with the completion of deep conversion upgrades. Both its Moscow and Omsk refineries are undergoing large-scale upgrades due for completion in the next few years.

Another big fuel oil reduction project in Russia, expected to come fully online this year after experiencing some delays, is the new complex for deep processing of residue at Taif's Nizhnekamsk.

In addition to the upgrades, changes in the country's taxation have made fuel oil exports less attractive, resulting in a gradual decline of fuel oil output.

Increasingly, medium-sized refineries have also started working on new projects that will help reduce their heavy fuel output.

In the Middle East, recently built refineries as well as projects due for completion in the next few years are well geared to produce light products. Saudi Aramco is soon due to start up its greenfield 400,000 b/d Jizan refinery, which will be producing no fuel oil.

As a result of the Clean Fuels Project, which includes new units at Kuwait's Mina al-Ahmadi and Mina Abdullah refineries, their pooled fuel oil yield is expected to be slashed from 20.7% to just 5.7%. Separately, the new 615,000 b/d refinery at Al-Zour in the south of Kuwait, due to start operations in the next two years, is also set to minimize fuel oil production as it will most likely be using gas as the main source of feedstock for power generation rather than low sulfur fuel oil for power generation, as originally planned.

China's greenfield 20 million mt/year Hengli Petrochemical refinery, which had its trial runs in December, does not have any fuel oil in its marketing plan. Meanwhile, the 20 million mt/year Zhejiang Petrochemical refinery plans to start operations early this year and mostly produce light products. PetroChina's currently under construction Guangdong Petrochemical refinery also does not list fuel oil on its product list.

In addition to running new sophisticated units, European refiners have learned that optimizing the crude slates makes a big difference.

What "can turn the economics [is...] how many heavy crudes you can process," Hellenic Petroleum CEO Grigoris Stergioulis said in 2017.

Hellenic's refineries have doubled their crude slate over the last few years. Repsol's refineries now process 70 different types of crude, and Saras' Sarroch typically processes 40 different types of crude.

With demand for fuel oil waning, heavy crude is likely to lose in value and benefit the complex refineries. For those refiners that can't rely on sophisticated conversion units, running light sweet crude would be a must.

While European refineries in 2018 were predominantly running heavier barrels, capturing strong fuel oil cracks, with the approach of 2020 demand is likely to turn away from those crudes.

Destination in sight

New price assessments from S&P Global Platts have brought transparency to the 0.5% sulfur bunker market – a full year before the IMO's lower sulfur limit comes into effect.

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S&P Global Platts launched a suite of new daily assessments for cargoes and barges of marine fuel with a maximum sulfur limit of 0.5% across the globe starting January 2, 2019, laying important groundwork for plans to launch bunker assessments for the grade from July 1, 2019.

The launch of cargo and barge assessments came 12 months ahead of the IMO's new global sulfur limit – in response to strong demand from market participants around the world for visibility into how this new fuel will be valued by the market.

The industry has reacted positively to receiving price information well before the 2020 deadline – on the very first day of assessing the market, S&P Global Platts published bids and offers for the new grade of fuel in the Singapore market.

S&P Global Platts received feedback from a cross-section of stakeholders including refiners, shipowners, physical suppliers, traders, exchanges, government agencies, brokers, storage terminal owner/operators and utility companies. Following an extensive consultation, on March 26, 2018, the methodology and specifications were announced for the cargo assessments to be launched at the start of 2019.

The new cargo and barge assessments are named "Marine Fuel 0.5%," and are being published for product loading from the key hubs of Singapore, Fujairah, Rotterdam, Houston and New York Harbor.

The new assessments reflect specifications for RMG fuels as defined by the International Organization for Standardization (ISO) 8217:2010 specifications, but with a sulfur cap of 0.5%. There has been widespread debate and varied views over how fuel producers will meet this new spec, and the route chosen to meet the spec would have a big impact on the potential density of the fuels. While specifications are still evolving, S&P Global Platts has standardized the

GO DEEPER

Our new 0.5% sulfur marine fuel assessments can be accessed on Platts Global Alert using the codes below:

AMFSA00 (Singapore)
AMFFA00 (Fujairah)
PUMFA00 (Rotterdam)
AUGMA00 (US Gulf Coast)
AUAMA00 (US Atlantic Coast)

reference conversion factor for these new price assessments as 6.35 barrels per metric ton, aligned with the conversion factor for other fuel oil assessments at these locations.

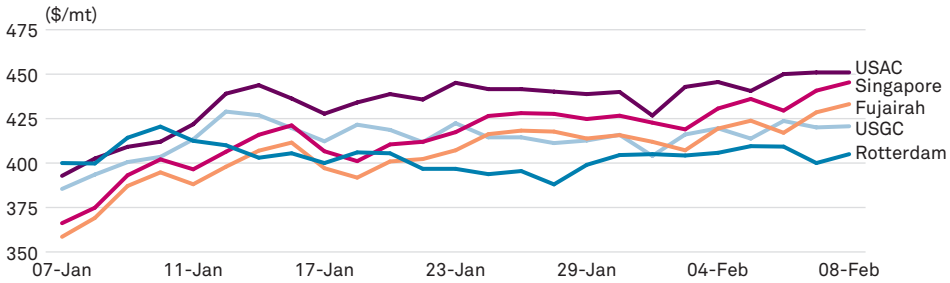
The new assessments reflect existing parameters for volume, delivery period, size, and pricing basis for HSFO cargoes in Singapore and Fujairah, and HSFO barges in Houston, New York Harbor and Rotterdam. While S&P Global Platts reported bids and offers for this fuel in January, these new markets are for the moment generally thinly traded. In the absence of an active spot market, the new assessments reflect the tradeable value of low sulfur marine fuels, established using information on blend economics from related fuels as an important reference point.

In the run up to the launch of these assessments, S&P Global Platts started internally assessing the value of 0.5% sulfur marine fuel from November 1, 2018. This helped garner feedback around the assessment and methodology applied in the absence of an existing compliant fuel market, while also ensuring robustness and consistency leading up to the launch itself.

Asia

For Asia, Platts launched assessments for Marine Fuel 0.5% cargoes loading FOB Singapore and FOB Fujairah. It is widely believed a spot market may be emerging first in Asia as China has started to implement the 0.5% sulfur fuel requirement from October 1, 2018, and Taiwan began to impose the requirement for ships calling at its ports to consume the new marine fuel from January 1, 2019.

0.5% MARINE FUEL ASSESSMENTS



Source: S&P Global Platts

Europe

In Europe, Platts launched a daily assessment for FOB Rotterdam Marine Fuel 0.5% sulfur barges. This market is still developing, but trading sources expect pricing levels to become clearer when more shipowners begin to test compliant fuels in 2019.

While Platts prioritizes transparent bids, offers and trades when assessing, there are a number of other indicators which are relevant to understanding price for this product, including HSFO, LSFO, LSSR, VGO, gasoil, and the ULSFO currently traded in the European Emission Control Area.

Americas

In response to feedback from US Atlantic Coast sources following the March announcement including a Houston barge assessment, Platts in November 2018 announced the launch of a 0.5% sulfur barge assessment loading out of New York Harbor, which launched on January 2.

Blending to the new 0.5% sulfur specification presents a unique challenge due to the pricing of residual fuel in the US on a dollars per barrel basis, compared to dollars per metric ton in Europe and Asia.

For the US, suppliers have said that making a compatible fuel with the lowest possible gravity will be essential when working the volume to weight conversion that occurs when moving from a fuel oil barge market to a retail bunker market.

For example, a 0.5% sulfur marine fuel that costs $70/b with an API of 11.2 (6.35 barrels/metric ton conversion factor) would result in a value of $444.50/mt.

The gravity will be especially important with the increased use of diesel in fuel oil blends, with US diesel and heating oil typically having a minimum API of 30.

A blend that costs $70/b that has an API of 20 (6.75 conversion factor) would translate to a cost of $472.50/mt. Sources in the US said that this conversion from volume to weight is the defining factor of what fuels the market decides to use when blending.

A widely shared view from market participants in the US for a 0.5% sulfur marine blend is a combination of low-sulfur straight run fuel and ultra-low sulfur heating oil, along with any low sulfur component with a low API, such as low-sulfur slurry.

Countdown to 2020

2016

October 28, 2016
IMO formally decides to impose global 0.5% sulfur cap in 2020

The 70th meeting of the IMO's Marine Environment Protection Committee (MEPC) had the option of postponing the lowering of the sulfur cap to 2025, after considering the results of an independent study looking at whether enough low-sulfur fuels would be available in 2020. The report concluded that availability would be sufficient, and the committee decided to proceed with the sulfur cap in 2020, as planned.

2017

May 4, 2017
Maersk announces intention to use only 0.5% sulfur fuels in 2020

Danish container line Maersk is the largest shipping company in the world, and its announcement that it would not be using scrubbers to comply in 2020 came as a bombshell to the manufacturers and other supporters of that technology.
Many in the shipping industry follow Maersk's strategic decisions closely, and its vote against scrubbers was the final nail in the coffin for the idea that they would be the solution for the majority in 2020.

August 11, 2017
Arrival of Shell's LNG bunker barge Cardissa at Rotterdam

While politicians and regulators have been strong supporters of LNG bunkering as a means of lowering shipping's sulfur emissions, the shipping industry itself has been cool on the idea — not least because of a lack of infrastructure to deliver natural gas as a bunker fuel at scale.
Where previously LNG bunker deliveries in northwest Europe were mostly carried out by truck — far too slow a method for the larger vessels that take up the majority of global bunker demand — the arrival of the Cardissa meant buyers could bunker directly from a barge with the capacity to carry 6,500 cu m of the fuel.

November 7, 2017
CMA CGM announces order of nine LNG fueled container ships

Further support for LNG bunkering came with French company CMA CGM's decision to order nine new LNG fueled container ships.
This was the biggest vote of confidence for LNG bunkering so far, as it demonstrated that even the operators of some of the largest ships in the world found it a workable solution.

2018

January 1, 2018
Last chance to start work on a refinery upgrade

The refinery upgrades necessary to minimize fuel oil production and maximize middle distillate output ahead of 2020 are enormous projects taking years to complete.
Any refinery upgrade on which work has not started two years before the IMO's deadline is highly unlikely to be supplying compliant fuels by 2020.

February 9, 2018
IMO agrees plans to ban carriage of non-compliant bunkers in 2020

The IMO's Pollution Prevention and Response subcommittee put together a plan to ban ships from carrying bunker fuel with more than 0.5% content after 2020.
If later adopted at MEPC 73, the plan will strike a blow against non-compliance with the sulfur cap; it empowers ports to inspect and prosecute vessels leaving their waters with insufficient compliant fuel for their whole journey, rather than leaving it to the flag state where the vessels are registered.

February 22, 2018
BP showcases two new 0.5% sulfur fuel blends

In a private meeting with shipowners in IP Week, BP was the first oil refiner to show to the shipping industry what the new 0.5% sulfur bunker fuels may look like.

April 13, 2018
IMO adopts initial greenhouse gas strategy

At the 72nd MEPC meeting, the key IMO committee finally agreed an initial strategy of reducing the shipping industry's total greenhouse gas emissions by 50% from 2008's levels by the year 2050.
While not directly related to the sulfur cap, this new plan may further complicate its implementation. Solutions like LNG bunkering that help with sulfur emissions in the short term may prove not to be workable with the greenhouse gas strategy in future decades. And refiners considering whether to upgrade their facilities to supply the marine market may reconsider their plans, if oil as a marine fuel has a limited future.

IMO
Company
Deadline

Source: S&P Global Platts

April 13, 2018
Last chance for IMO to adopt any new measures before 2020

Because of the slow pace at which IMO processes operate, MEPC 72 was the last chance for the IMO to adopt a measure that would be in effect by the start of 2020.

July 1, 2018
Last chance to start building an LNG fueled ship

The construction of a new LNG fueled ship is another large project that needs to get under way long before the sulfur cap comes into effect. Any large commercial ship that is not under construction 18 months before the IMO's deadline is not going to leave the shipyard before 2020.

September 1, 2018
Maersk changes course on scrubbers

Maersk announced an apparent change of course from its previous statements on scrubbers, saying it would now install the equipment on some of its fleet.

October 3, 2018
Shell announces supply ports for new 0.5% sulfur fuels

Global oil producer Shell announced supply locations for its new 0.5% sulfur marine fuels at ports across the US, Europe, the Middle East and Asia.

October 26, 2018
IMO adopts non-compliant fuel oil ban

At the end of the 73rd meeting of the IMO's MEPC committee, the body formally adopted a ban on the carriage of non-compliant bunker fuels after 2020. The ban will come into force at the start of March 2020. This MEPC meeting was also the last opportunity to adopt any measures that would come into effect in March 2020.

2019

January 2, 2019
S&P Global Platts 0.5% sulfur fuel price assessments launch

S&P Global Platts has launched a set of cargo and barge price assessments price assessments for 0.5% sulfur marine fuels a year ahead of the IMO deadline. The assessments initially reflect information on blend economics from related fuels.

May 1, 2019
Last chance to order a scrubber retrofit

While retrofitting a ship with a scrubber can take as little as 2-3 weeks in theory, in practice any shipowner expecting to use one from the start of 2020 should order it several months before the deadline — at the latest. The order books of scrubber manufacturers are likely to fill up quickly in 2019, and dry dock space may also be harder to find.

May 13, 2019
ISO expected to present 0.5% specification information to IMO

The 74th MEPC meeting at the IMO headquarters is due to take place May 13-17, and a representative of the International Organization for Standardization (ISO) is expected to present information about 0.5% sulfur bunker fuel specifications. A new full set of bunker specifications is unlikely to come out until 2022, but an ISO working group is developing a publicly available specification due to be announced in late 2019 that can act as a guide for the market in the interim.

July 1, 2019
Largest vessels start using 0.5% sulfur bunker fuels

The largest ships and those operating on the longest routes may start burning 0.5% sulfur bunker fuels as much as 6 months before the IMO deadline, to iron out any operational difficulties before the rule comes into force.

October 1, 2019
Majority of global fleet starts using 0.5% sulfur fuels

Global demand for 0.5% sulfur bunker fuels is expected to pick up in the fourth quarter of 2019 as most shipowners start working with the new fuels before the deadline. Fuel oil demand will also drop off at the same time.

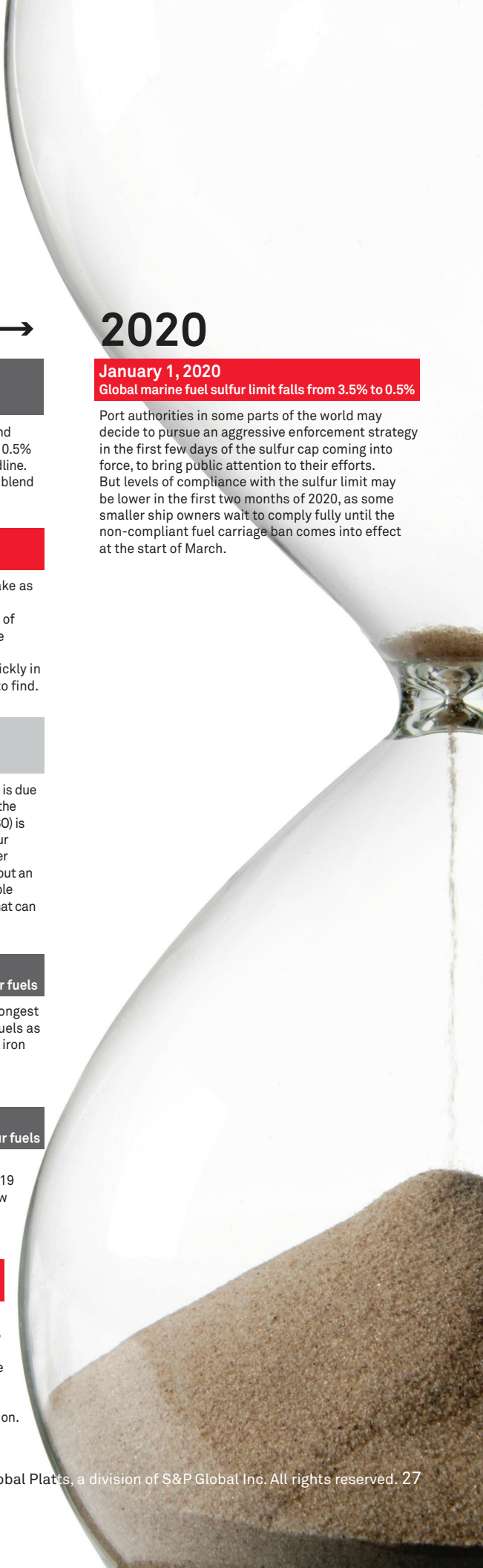
December 10, 2019
Final deadline to switch to 0.5% sulfur fuels

Any ships planning on complying with the new regulations should start switching to using 0.5% sulfur fuels three weeks before the deadline, at the very latest. Switching to the new fuels will be a lengthy process involving cleaning all of the equipment that bunker fuel comes into contact with throughout the vessel, to avoid contamination.

2020

January 1, 2020
Global marine fuel sulfur limit falls from 3.5% to 0.5%

Port authorities in some parts of the world may decide to pursue an aggressive enforcement strategy in the first few days of the sulfur cap coming into force, to bring public attention to their efforts. But levels of compliance with the sulfur limit may be lower in the first two months of 2020, as some smaller ship owners wait to comply fully until the non-compliant fuel carriage ban comes into effect at the start of March.



Fuel oil's new buyers

While demand for high-sulfur fuel oil from the shipping industry will be limited going forward, other sectors such as power generation are likely to pick up the slack.

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As the shipping industry retreats from fuel oil as its primary energy source, power generation and industrial uses will increasingly dominate the future of this product. This was already clear in 2018, as Saudi Arabian demand was the driving force behind the strength of the European fuel oil complex over the summer, with demand centered on power generation for desalination and to meet increased air-conditioning requirements in the summer months. Saudi Arabia has long sought to reduce crude consumption in its power sector in favor of burning fuel oil, and the specification change in 2020 provides a greater incentive to do so with falling fuel oil prices.

S&P Global Platts Analytics expects an initial bunker demand displacement of about 3 million b/d of fuel oil in 2020, and sees fuel oil displacing 200,000 b/d of crude burn by 2020 as Saudi Arabia ramps up use of the product. Over 10 GW of HSFO capacity is slated to come online by 2020, bringing the country's fuel oil burn up substantially.

Traditionally, the fuel oil arbitrage from Europe into the Red Sea is a seasonal summer trend from April to October, when Saudi Arabia and other Middle Eastern nations buy fuel oil to power air conditioning. Saudi Arabia drew just under 5 million mt of fuel oil from Europe between May and October 2018, according to S&P Global Platts trade flow software, cFlow. But with the country increasing its desalination capacity by about 3%, buying interest is increasingly expected to emerge even in the winter.

New gas and fuel oil projects in Saudi Arabia are expected to meet increasing power demand growth, particularly in the west and south regions, while gas projects will expand in the central and eastern regions.

The western region is crammed with oil plants, with 52% of these plants burning fuel oil, 35% burning crude and 5% burning gas. There is a push to increase gas use, with the introduction of the 0.5 GW Green Duba plant and the 2.1 GW Rabigh project. However the 3.1 GW fuel oil plant, Yanbu 3, is also in the pipeline to meet increasing desalination requirements. A further push for fuel oil could also come as it replaces crude in steam units, as fuel oil becomes more attractive amid price falls in 2020 given the impending IMO regulations.

As Saudi Arabia continues to burn heavy fuel oil and crude in power plants, emissions concerns seem far from the primary priority. Scrubbers could be used on power stations to help capture some of the sulfur emissions, but they require vast investment capacity and also disposal of the sulfur residue.

"The retrofitting in principle is straightforward and it takes around

two to three weeks, but as you make a specialized design for certain plants it can take much longer, six to nine months, and this could also increase if you have a high demand," said Yousef Alshammari, CEO of UCERGY Analysts.

Looking forward, Saudi Arabia will not remain a source of fuel oil demand indefinitely, as it seeks to boost its renewables mix to decarbonize power production. Considering peak electricity requirements are in the afternoon – between 2:00-3:00 pm in the summer months – the introduction of solar capacity would be a logical means to meet requirements. This includes recently commissioned projects such as the integrated solar systems at Waad Al-Shamal gas plant and the Green Duba Plant.

Moreover, the Saudi energy price reforms that began in 2015 have resulted in a slowdown in electricity demand growth. Prices for natural gas, gasoline, diesel, electricity and water were all raised in 2015, albeit from a very low base. A second round of increases was established in 2018 for gasoline and electricity. In other words, the Saudi government has been phasing out subsidies, in part to address its fiscal deficit. Higher electricity prices have been leading to a change in behavior, especially in the residential sector. Electricity demand growth slowed to 0.7% year on year in 2016 (down from 4.8% growth in 2015), with peak demand down by 2.3% on the year, the first decline in over 20 years. While peak demand may continue to be impacted by these measures, the kingdom is making efforts to attract energy-intensive industries, as part of its reforming agenda, and this will be still supportive of baseload demand growth.

Capacity growth

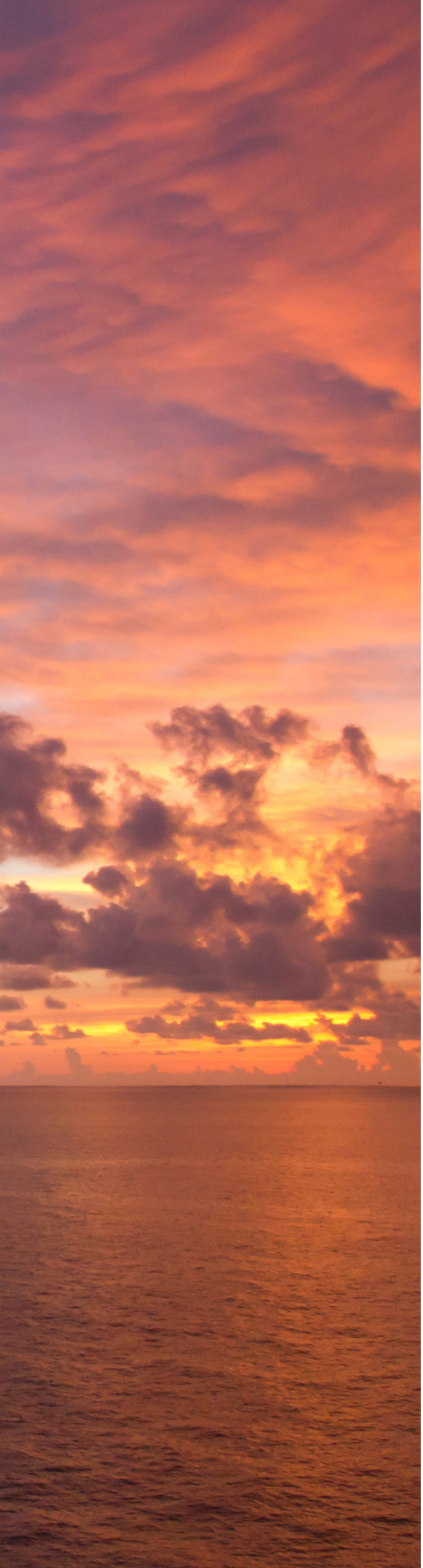
Fuel oil-fired capacity growth is not limited to Saudi Arabia. Bangladesh will be a key outlet for surplus fuel oil in 2020, with emission standards that allow its use in power generation and stronger growth than other parts of the world.

Underpinned by a rapidly growing population and industrial base, Bangladesh has seen power demand growth in the order of 10% over the past few years, but shortages of domestically produced gas and inadequate capacity additions in the prior few years are resulting in persistent load shedding. Extra availability of LNG is helping offset some of the gas shortages and shrinking domestic gas production, but the country is adding fuel oil and diesel-fired generation capacity to meet its chronic power shortages.

Installed fuel oil capacity, both public and private, is around 4 GW as of February 2019, with an additional 1 GW expected to be available by 2020. While maximum generation generally falls about one-third short of installed capacity across the Bangladeshi power system as a whole, the country has capacity to increase generation from existing and new oil-fired installations, potentially absorbing more than 150,000 b/d in 2020.

What's interesting is that a number of these fuel oil units are rental power plans or quick-rental power plants – units designed to meet the short-term and emergency requirements of a country, and typically commissioned within four to six months. In Bangladesh, rental periods are normally three to five years (for QRPP) to 15 years (for RPP, depending on the country's need). In these cases, the Bangladesh Power Generation Board purchases a service, paying agreed tariffs per gigawatt-hour of power. From this perspective, rental plants provide a cash float to the BPDB, as it could not mobilize the huge resources required to set up or build the plants. In other words, the rental plants do not involve capital investment on the part of the government.

Generally, the power producing equipment is easily moveable and quickly installable. About 20% (or 800 MW of the 3.7 GW burning fuel oil) are short-term rentals (QRPP) as of November 2018 and load factors were as high as 55% in the 2016-17 period.



"Cost is the main driver for energy options. In the absence of stringent environmental regulations, cheap and polluting fuels will certainly find a market, regardless of their environmental impact."

— Yousef Alshammarim, CEO, UCERGY Analysts

These are plants with engines as small as 8-17 MW, which are grouped together to make up 50 to 100 MW plants. Efficiency is fairly high considering that these are open cycle plants, at 40%-43%. The prices for purchasing power from these rental units were reported to be Taka 9.64/kWh, or about $110/MWh at current exchange rates.

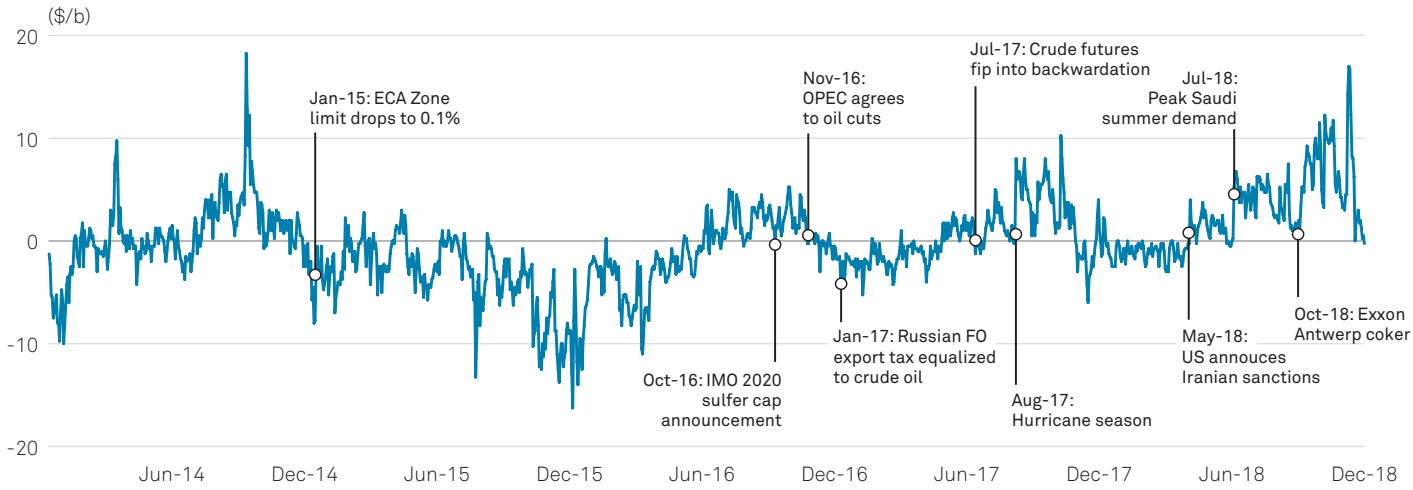
Among the players in this space, Summit Power Limited is worthy of note. It owns and operates over 1.9 GW of fuel oil-and gas-based reciprocating engines in Bangladesh. Interestingly, the fuel oil units are part of a multi-portfolio strategy, with LNG also part of the mix. In fact, in 2017, Summit LNG received a concession from Petrobangla, Bangladesh's state-owned company, to develop a floating LNG terminal facility comprising a storage and regasification unit on a build, own, operate, transfer basis in Moheskhali, Cox's Bazar, to supply approximately 500 MMcf/d of natural gas to the national grid. Summit operates a number of gas-based reciprocating engines in the country, but is also developing a 590 MW combined cycle gas turbine expected by January 2021.

Reliability benefits

More generally, fuel oil- or liquid-based reciprocating engines are seen as solutions that offer the benefit of reliability. While relatively low in terms of capital and installation costs, these units have fairly high marginal or variable costs to operate, considering the cost of the fuel and lower efficiency than a CCGT. However, the cost of not supplying a kWh of electricity could be high enough to justify its installation and operation. Economists and regulators use the concept of Value of Lost Load (VoLL) or Value of Lost Adequacy (VoLA) to quantify costs tied to lack of electricity supply, or the loss of socioeconomic activity that takes place when electricity is not provided to consumers. In a recent study for the EU Agency for the Cooperation of Energy Regulators, the cost of not supplying electricity is quantified in ranges of €1,500-22,940/MWh (roughly $1,700 -26,300/MWh) for the domestic sector in Europe, while for the industrial sector that range tends to be wider.

Reliability concerns tied to extreme weather events have driven the installation of these units in other countries. In addition, liquid fuels

3.5% FOB ROTTERDAM BARGE PHYSICAL TO PAPER STRUCTURE



Source: S&P Global Platts

such as fuel oil represent a more secure source, especially as gas could be unavailable in some regions or scarce at times – for example, during extreme cold weather events. Outside of Saudi Arabia, where fuel oil plants are being built in tandem with large refining complexes, or to substitute crude plants for baseload generation, a vast majority of HSFO plants are essentially being built for such reliability or short-term emergency needs. According to the S&P Global Platts World Electric Power Plants Database, there are about 7 GW of fuel oil-based units being built or at a planning stage across the world outside Saudi Arabia. What's interesting is that the average size of these projects is 44 MW, with almost 100 projects below the 20 MW threshold.

Islands also represent excellent sites for small fuel oil-based units, with 1.2 GW of fuel oil-based units in construction or planned on islands, according to the S&P Global Platts World Electric Power Plants Database. This is about 17% of total fuel oil units being built outside of Saudi Arabia. Among these islands, the largest plants are in Cuba (200 MW), Sri Lanka (170 MW) and Madagascar (170 MW).

In this context, it is interesting to note that 3 GW of floating power plants have been built and operated by the Karadeniz Energy Group, through their subsidiary Powership and fueled by HFSO, diesel or natural gas. A large portion of this floating power capacity is currently in Indonesia; six floating plants for a total of almost 1 GW.

Lebanon hosts two of these floating power plants – for a total of 370 MW – while a third one was also used to mitigate the country's electricity shortages during the summer.

Traditionally a devoted user of fuel oil for power generation, Lebanon is now looking towards natural gas to fuel its future. The government had a tender in December to build two FSRUs running on LNG. Fuel oil will begin to be phased out from the Middle East nation, and one local power generation consultant expects the trend away from fuel oil to become global as the World Bank become more stringent on emissions.

While scrubber installations on power stations are an option, the significant expense may not be justified if new emissions standards are introduced. Additionally, in countries such as Lebanon, there is a lack of facilities to store and dispose of the high sulfur residue, the consultant added.

The supply and demand imbalances caused by the IMO's 0.5% sulfur cap could be subject to the law of unintended consequences. While the 2020 sulfur cap will endeavor to protect the marine environment and human health in an act of stewardship, the excess cheap HSFO sidelined from the bunker industry could prove attractive to nations trying to save on costs for power generation.

"Cost is the main driver for energy options. In the absence of stringent environmental regulations, cheap and polluting fuels will certainly find a market, regardless of their environmental impact," UCERGY Analysts' Alshammari said.

While stringent sulfur or air-quality regulations have translated into strict limits to operation of oil units in a number of countries, fuel oil has also been typically priced at higher levels relative to coal or other alternatives. As such, even if scrubbers are effective at removing sulfur in oil units, the operational fuel oil capacity globally has not been subject to environmental upgrades. In fact, the the S&P Global Platts World Electric Power Plants Database shows that out of the 132 GW of units identified as burning HSFO and currently operationally globally, only about 11 GW are known for having flue-gas desulfurization or scrubbers installed, with the largest regions being Asia and the Middle East.

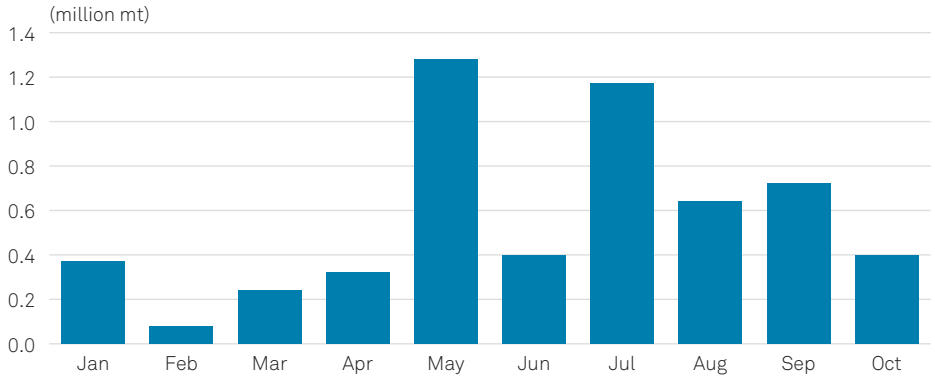
Analysts believe the power sector could end up playing a pivotal role in propping up the fuel oil market, even though environmental policies in some countries might prevent this from becoming a major trend.

Fuel oil use in power generation is restricted by regulations on sulfur and carbon dioxide emissions. For instance, Japan traditionally used low sulfur crude and low sulfur fuel oil for power generation, but has changed track more recently. This includes limiting the sulfur content of fuel burned in power plants to 0.5%. It is also increasing renewables and nuclear unit use, reducing fossil fuel needs. South Korea has similarly stepped towards a cleaner future, despite having 4 GW of oil-fired capacity on government air standard regulations, a focus on LNG imports and flue-gas delsulfurization capacity.

China has also had a renewables drive, taking measures to reduce urban air pollution and has significant spare generating capacity from less polluting plants. Growing Chinese LNG demand is coming from industry, city gas, and heating requirements rather than the power generation sector.

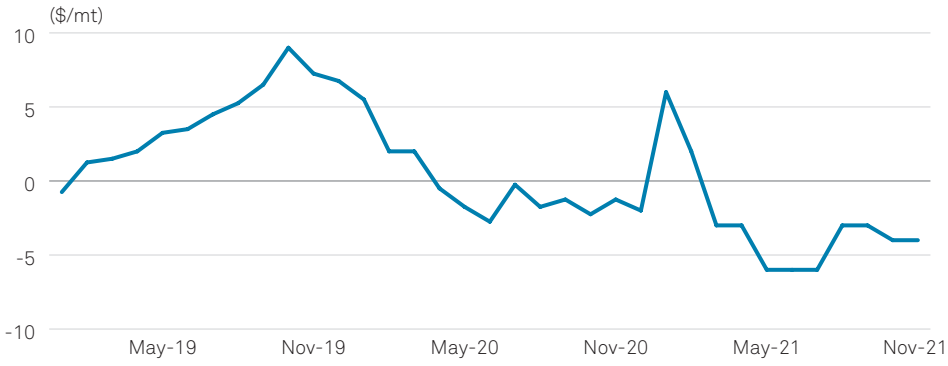
Additionally, Pakistan was once a major demand center for fuel oil, and burned 158,000 b/d of fuel oil in 2016, according to S&P Global Platts Analytics. Now the country's increasing use of LNG for power generation at the expense of oil has resulted in Pakistan State Oil cutting fuel oil imports drastically last year, even during the peak summer demand season of May-September. Pakistan's fuel oil demand plummeted by 120,000 b/d from August 2017 to the same month of 2018, reflecting the country's switch to natural gas, the October monthly oil report from the International Energy Agency said.

EUROPEAN EXPORT VOLUMES TO SAUDI ARABIA



Source: cFlow

3.5% FOB ROTTERDAM BARGE FORWARD CURVE



Source: S&P Global Platts

Fuel for thought

Jeff Currie, global head of commodities research at Goldman Sachs, sits down with S&P Global Platts to discuss the future of fuel oil and marine emissions regulation.

Jeff Currie
Global Head of Commodities Research
Goldman Sachs

Paul Hickin
Associate Director, Oil News
S&P Global Platts

How do you see demand for fuel oil storage developing after 2020? Will it drop proportionately with demand for the product itself?

No it won't drop proportionally, demand for storage will increase. When you get different grades you have to segregate and then you need more oil for the different grades. Storage demand increases as complexity increases, which can be seen by the comparison with gasoline and diesel. The global shipping industry is burning 3.3 million b/d of fuel oil and even with demand for HSFO falling to 1.1 million b/d you will still need more storage. Some 1.7 million b/d will be met by upgrading and half a million b/d by non-compliance.

Are oil companies adequately prepared for the rapid drop in fuel oil demand expected in late 2019 and early 2020?

It will be difficult but manageable. There is adequate upgrader/refining capacity to handle the changing demand, you just have to get oil to the right place – matching crude slates with upgrading capacity. It's really a case of redirecting fuel oil around the world and the economics of that.

Would you expect to see the Trump administration take any steps to mitigate the effects of the new sulfur regulations in 2020, once the impact on crude prices is more clear?

We see a non-trivial probability that the 2020 US elections will have an influence. There is a risk on the horizon but it is not our base case. We wouldn't discount any involvement if prices were to rise significantly.

Goldman Sachs has shown some interest in financing the installation of scrubbers. Do you see them as a long-term feature of the shipping industry?

Scrubber investments will soar in preparation for the International Maritime Organization's 0.5% global marine sulfur cap in 2020. For a large vessel the economics of scrubbers are extremely compelling, with very short paybacks. Scrubbing the fuel is a last resort as it's more expensive. You should really scrub the exhaust. Scrubbers will be a long-term feature like catalytic converters in cars.

Given the IMO's initial strategy on dealing with greenhouse gas emissions, would you expect to see shipping moving away from oil-based fuels more quickly than road transportation over the coming decades?

No. Petroleum still packs the biggest punch in terms of weight, so there is the energy density argument.

Cleaning up

While the bulk of the shipping industry will move towards cleaner fuels from 2020, scrubber technology means the deadline will not be the end of fuel oil's use at sea.

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Exhaust gas cleaning systems, or scrubbers – a technology long familiar to the power generation industry on land – have seen renewed interest from the shipping industry in recent years, and a surge in orders in 2018. The systems clean a vessel's emissions on board, allowing it to continue burning high sulfur fuel oil while still complying with the new sulfur limit.

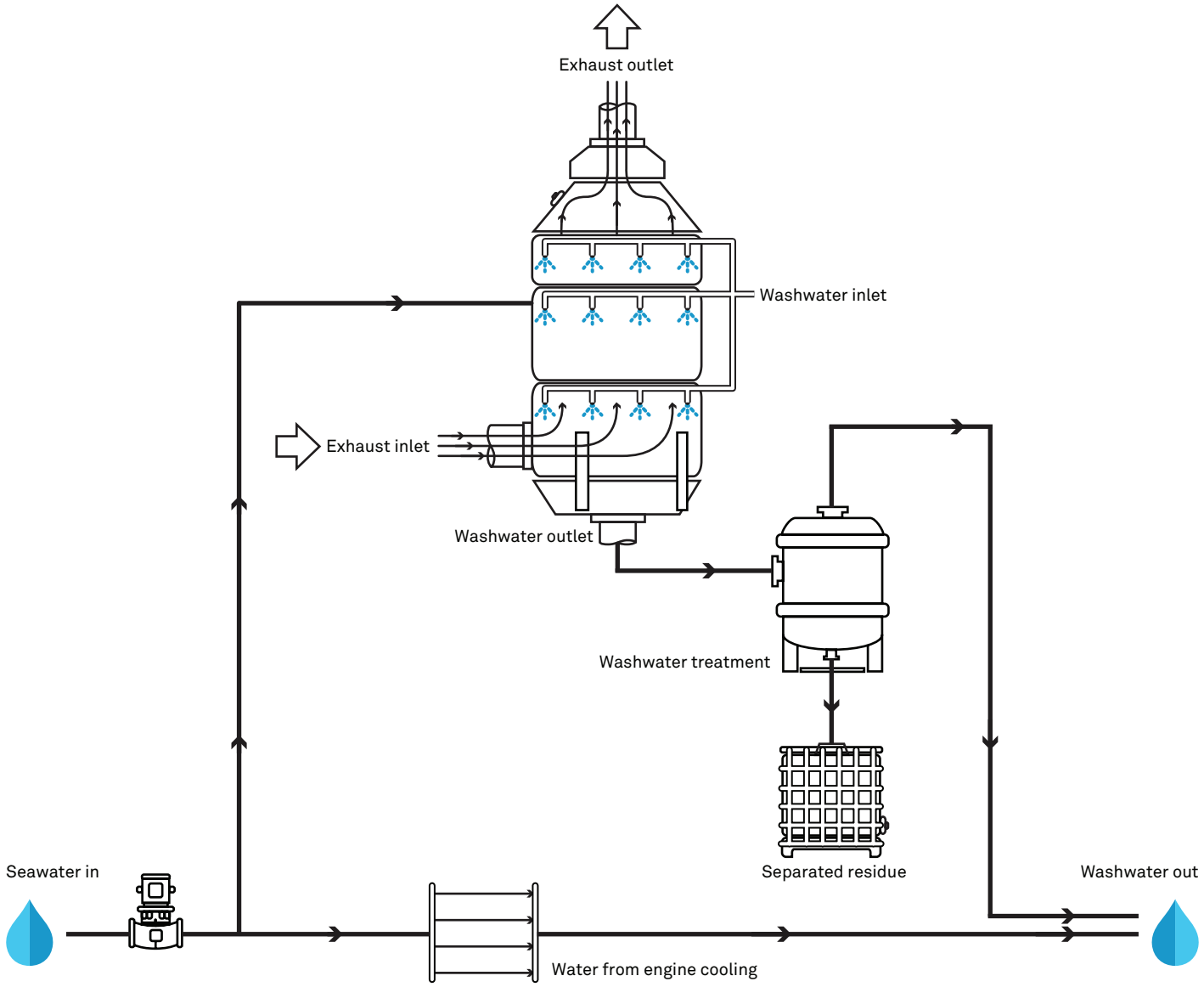
The technology works by spraying alkaline water into the vessel's exhaust, capturing sulfur and other unwanted emissions as they are produced. The systems require an upfront capital investment of about $2 million-$6 million per vessel, as well as a running cost, and the shipowner hopes to see this paid back over time by the savings made from buying high sulfur fuel oil instead of more expensive alternatives.

The installation period can be relatively painless – one shipping executive who has overseen scrubber installations said it can be done without dry-docking in some cases, with an installation time of as little as seven to nine days.

S&P Global Platts Analytics estimates around 490 vessels now have scrubbers installed, and another 400 have them on order. The company forecasts 2,200 vessels will have scrubbers installed by 2020, burning around 500,000 b/d of HSFO. But the outlook for 2030 is less clear – the company has recently raised the possibility of total installations peaking at 6,000 as the financial incentives worsen over time.

The pace of installation accelerated sharply in 2018 with the deadline rapidly approaching, and some shipping companies previously skeptical of the technology appear to have been turned around.

A common open-loop scrubber design



Source: S&P Global Platts, Exhaust Gas Cleaning Systems Association

Container line Maersk, the largest shipping company in the world, says it now intends to install scrubbers on "a limited number of vessels in our fleet" – having previously said it did not plan to use the technology.

In August, Hong Kong's Pacific Basin Shipping, said it was assessing two main methods – low sulfur compliant fuel oil versus scrubbers – as it geared up for the 2020 specification change. The shipping company had earlier said it thought that scrubbers were neither technically nor environmentally an effective solution.

Recently, VLCC new buildings fitted with scrubbers, for delivery in 2019, were snapped up by charterers for three years at a hefty premium of around $10,000/day over the prevailing rates for non-scrubber ships.

"We are prepared to install scrubbers if the charterers need them and agree on higher time charter rates," Alexandros Tsirikos, CFO of Top Ships Inc, said in September.

One of the company's Medium Range new build orders has a scrubber fitted, while the other is scrubber-ready, he said. Both the ships will be delivered early in 2019.

In October 2018, global dry bulk shipping company Seanergy Maritime Holdings Corp said it had inked agreements with three dry bulk charterers for installing scrubbers on five of its Capesize bulk carriers.

Upon completion of the installation, the vessels will begin index-linked period employment with the charterers ranging from three to five years, it said in a statement.

As part of the time charter agreements, the charterers will cover 100% of the equipment and installation cost for retrofitting the vessels with scrubbers, it said, adding that the total investment, to be covered by the charterers, is expected to exceed $12.5 million.

Price gap

The fuel oil forward curve is currently projecting a significant price gap between HSFO and low sulfur marine fuels from 2020, indicating a swift payback time for scrubber investments. S&P Global Platts Analytics forecasts a payback time of less than one year in some cases.

This is prompting many shipowners and charterers, particularly in the tankers segment, to order scrubbers. And the attractive potential returns are also opening new financing options.

In June, Norwegian independent tanker operator Frontline said it was raising equity to finance its growth, including the purchase of scrubbers.

More recently, Star Bulk Carriers said it had entered into a $310 million loan agreement to grow its business. The loan included a $70 million tranche to exclusively finance the procurement and retrofitting of scrubbers for up to about 50 vessels in Star Bulk's fleet, it said in October.

Banks and private equity funds have also become increasingly proactive to assist shipowners with scrubber purchases. These new sources of funding coming into the shipping industry – at a time when banks have generally retreated from shipping – have played a pivotal role in supporting the rapid growth in installations.

In May, Goldman Sachs said it set up a financial entity to help shipowners finance marine scrubber installations. Under this arrangement, the bank would seek to recoup its investment over one to two years from the savings the shipowner can secure by burning HSFO rather than paying more for a 0.5% sulfur product.

In another innovative model, one tanker operator has taken a stake in a scrubber manufacturer to secure access to the systems for its ships and get a share in the potential profits.

In June 2018 Frontline said it had acquired a 20% stake in scrubber manufacturer Feen Marine Scrubbers. The tanker operator agreed to order FMSI exhaust gas cleaning systems for 14 vessels, with options to order an additional 22 systems at fixed prices.

Some shipowners have told S&P Global Platts that they see scrubbers as a short-term solution, meant to help them tide over the initial period of uncertainty when the availability of the new 0.5% sulfur fuels may be limited. They see the pricing economics for scrubbers worsening over time, with refiners continuing to cut fuel oil production and more 0.5% sulfur product becoming available.

Meanwhile, the question of the choice of scrubber has also fixated some shipowners, particularly due to the possibility of stricter water discharge regulations in future.

Open-loop scrubbers take in naturally alkaline seawater and then flush the discharge out to sea. Some have argued that this simply moves the pollution from the air to the sea. Further, open-loop scrubbers have already been banned in Belgium, California and Massachusetts in the US and along the Rhine river in Germany, with the fear that many new regions worldwide could follow rendering their long-term viability uncertain.

Singapore's announcement in December that it would ban open-loop discharge has been another major blow to the industry, with the Exhaust Gas Cleaning Systems Association attacking the decision as "disappointing" and "politically motivated."

Closed-loop systems have the option of the discharge being retained to dispose of at port but the systems use caustic soda to raise the alkalinity of the water being used. There may be difficulties involved in purchasing it due to restricted usage at many ports. Availability of shore reception and sludge landing facilities at ports also remains limited.

Hybrid systems with the option to work in either open- or closed-loop modes are available, but they are usually more expensive.

There are also potentially some mechanical challenges associated with scrubbers. The systems can potentially break down or malfunction for a number of reasons, including mechanical failure of pumps and pipe leakages. Corrosion of overboard discharge pipes also presents a threat. Owners need to provision for this contingency, including complexities involved in repairing scrubber units while the vessel is located in remote regions.

Still, despite the capital expenditure involved and other challenges, scrubbers remain an economically attractive and favored solution for many owners not only in the run up to 2020 but also in the immediate years that would follow it.

Winners and losers

The effects of the IMO's 0.5% cap on marine fuel sulfur are set to ripple across the global economy. Is this good or bad for the industries, countries and other groups affected?

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Senior Editor, Europe and Africa Oil News
S&P Global Platts

Tom Washington
Associate Editor, Bunker Fuel
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The change in sulfur regulation for marine fuels in 2020 sounds like an obscure point that should have limited interest for those outside the bunker industry. But a major structural shift hitting both oil and shipping simultaneously has the potential to touch upon almost every market on the planet.

In this section we have gathered details on some of the industries, countries and other groups that stand to gain or lose the most in 2020.

✗ Petrochemical buyers

Buyers of petrochemicals should be worse off as the ripple effect of IMO 2020 comes into contact with their market.

Increased refinery runs may grow the supply of naphtha – a key petrochemical feedstock – by as much as 150,000 b/d globally in 2020, according to S&P Global Platts Analytics. But refiners maximizing middle distillate production will deliver tighter gasoline supply, which should deliver a net draw on naphtha into gasoline blending and away from petrochemicals, increasing prices for petrochemical buyers.

In turn that could be expected to shift steam cracker feed preferences away from naphtha and towards LPG or ethane.

✓ Power generation

The power generation industry in parts of the developing world with less strict emissions regulation will benefit from the option of switching to oil-fired capacity (see page 28).

Fuel oil prices are unlikely to drop to the same level as coal, but they are likely to be low enough to beat gas-fired generation, particularly for plants located near refineries with a fuel oil surplus.

The power industry will also face higher freight costs across all of its raw materials.

— Saudi Arabia

Saudi Arabia will see a mixed impact from the specification changes in 2020.

In the short run, the oil-rich kingdom looks well placed to benefit. Its light, sweet crude exports will be in demand to produce low-sulfur fuels, its complex refineries will see strong demand for middle distillate

exports to plug Europe's deficit and its desalination plants will see lower prices for the fuel oil they burn.

But it's notable that the Saudi delegation at the IMO has been in regular opposition to the 2020 implementation date. In February the Saudi representatives told S&P Global Platts they were supporting an initial "transition period" for the 0.5% sulfur cap, giving the shipping and refining industries more time to prepare.

The longer-term impact of the lower sulfur limit may help to explain Saudi opposition. While the short-term advantages are clear, the longer-term consequences of refining capacity gradually shifting to the east after 2020 may be less beneficial to refiners in the Gulf. The regulation may also provide a boost to shale oil producers in the US.

And it can be argued that emissions regulation of any kind tends to accelerate the shift away from the use of oil over the longer term – a move that is not in Saudi Arabia's immediate interests.

Aviation and road haulage

The largest buyers of middle distillates – the aviation and trucking industries – are set to see unwelcome cost rises as the shipping industry increasingly competes for access to the same pool.

Airlines are particularly sensitive to sharp movements in the price of jet fuel: rising crude prices in the first half of 2018 were one of the biggest factors that affected their earnings, according to company statements. A higher outright crude price in 2020, combined with wider distillate crack spreads, would put the airlines under significant pressure.

Russia

As the world's largest producer of fuel oil, Russia's loss from the marine market moving on to cleaner fuels is clear.

While the specification change has incentivized the country's refinery modernization program, bringing down its fuel oil production, Russia was on track to export almost 35 million mt of the product in 2018. This number will not be reduced to zero in the near future.

Russia also faces the prospect of weaker demand for its heavy crude as refiners shift to lighter slates with a lower fuel oil yield.

Consumers

The general public can expect a hit to their wallets from several different directions in 2020, but the direct impact of higher shipping costs on consumers should be limited.

Denmark's Maersk Line, the largest shipping firm in the world, currently burns on average around 0.874 mt of fuel for each forty-foot container it ships around the world, and with an initial spread of $425/mt between fuel oil and 0.5% sulfur bunkers that would give a price difference of around $370 per container. As an example, each of those boxes can hold about 10,000 pairs of shoes – so for a pair of trainers shipped from China to Europe, the consumer is looking at a price rise of less than 4 cents.

A car carrier shifting 6,500 new Mercedes from Hamburg to Shanghai will consume around 1,050 mt of fuel along the way – so with that $425/mt spread each of those cars' buyers could expect to pay an extra $70 or so for their purchase.

A VLCC taking 2 million barrels of crude oil from northwest Europe to Singapore would get through about 4,500 mt of bunker fuel to get there – meaning a price increase of 96 cents/b.

All of that would seem manageable, even with several instances of these cost increases being repeated throughout various stages of supply chains and being passed on to consumers. But the financial impact won't stop there.

An estimated increase of $7/b in the price of Brent crude driven by increased refinery runs in 2020 will be the impact most noticeable to consumers – at the pump as they refuel their cars, and in increased energy costs for industry. Some economists have gone as far as to suggest the changes in 2020, combined with other economic headwinds, may be enough to bring about a global recession.

Public health

While the general public will suffer financially, they can also expect to see health benefits. Trucost, part of S&P Global, predicts that reducing the marine fuel sulfur limit to 0.5% should deliver significant public health benefits (see page 50).

Respiratory health in coastal communities in the developing world will see the strongest benefits – one study estimated that making the change in 2020 rather than postponing it to 2025 would result in as many as 200,000 fewer premature deaths.

Agriculture

The market for agricultural products is particularly reliant on low freight costs, and will feel the rise in fuel bills more than most as a result.

Arbitrage flows covering a longer distance are the most likely to come under pressure. Corn exports from Brazil and the US to Europe, Black Sea corn and wheat shipments to the Far East and biodiesel imports to Europe from China may all be under threat in 2020.

Metals

The metals industry is another group that will face pressure on its raw materials after 2020.

The supply of anode coke, a key component in the anodes used to produce aluminum, will be restricted as low sulfur residues are taken away from coking units to produce low sulfur fuels. Higher-sulfur residues cannot readily be used to produce the product.

Anode costs account for around 10-15% of aluminum manufacturing costs, and this change could add 1-2% to them, according to S&P Global Platts Analytics. That would add to the cost of increased freight rates for the transport of both finished metals and ore around the world.

From A to B with LNG

The global LNG industry is hoping to gain from fuel oil's misfortunes by drawing away a portion of marine demand as emissions regulations are tightened. But there's a catch.

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Senior Pricing Specialist, LNG
S&P Global Platts

Jack Jordan
Editorial Lead, Bunkers
S&P Global Platts

LNG produces negligible sulfur emissions when used as a fuel, as well as significantly lower nitrogen emissions than oil-based fuels, making it one possible candidate as a compliance option for the 0.5% sulfur cap in 2020.

But the shipping industry has yet to be convinced. Take-up has been extremely limited so far; the latest data from classification society DNV GL shows just 125 LNG-fueled ships are in operation and another 136 on order.

S&P Global Platts Analytics estimates total LNG bunker fuel demand – including boil-off consumption by LNG carriers – represents just a 3% share of the marine fuels market.

The main barrier in the past has been the cost involved in switching to LNG. While scrubber systems can be retrofitted to ships relatively quickly and cheaply, in almost all cases retrofitting to LNG-fueled propulsion is not economically viable.

LNG engines have to be included in the design – at a higher cost than conventional engines – when a new ship is first ordered. The space on board a vessel needed for LNG tanks is also larger than that for conventional oil-based bunkers, adding an ongoing cost to the LNG-fueled vessel.

The slow pace of development of infrastructure for LNG bunkering has also stymied widespread investment in it by shipowners. Bringing LNG supply and delivery infrastructure to the world's bunker ports is a slow and expensive business, and uncertainty over demand prospects has limited the appeal of this new market for suppliers.

But this chicken-and-egg situation – with both suppliers and potential buyers nervous about taking investment decisions before the other side – appears to be resolving itself, with significant investments by both sides of the market over the past two years.

The biggest boost to the market came with the announcement by French container line CMA CGM in late 2017 that it would order nine new 22,000 TEU ships with LNG propulsion for delivery from 2020. This was taken as a vote of confidence that LNG bunkering could be viable even for some of the largest commercial ships in the world.

The ships have been designed with tanks large enough to carry enough fuel for an entire round voyage from Europe to Asia and back, and the company plans to bunker them primarily at Rotterdam. Total Marine Fuels Global Solutions has agreed to supply CMA CGM with around 300,000 mt/year of LNG from 2020, and plans to use a 20,000 cu m barge to bunker the container ships.

Other suppliers have also come forward with plans for LNG bunker barges – an essential step to delivering LNG as a bunker fuel to the largest commercial ships, as deliveries by truck are too slow. LNG bunker industry group Sea\LNG estimates that as many as 20 LNG delivery vessels are now either on order or already in operation across the world.

For suppliers, the cost of providing LNG as a bunker fuel will be determined by the underlying LNG itself and the logistical cost involved in bunkering the fuel.

The breakbulk costs, though significant, should be relatively constant or start to decline over time as economies of scale increase.

The global benchmark for LNG is the S&P Global Platts JKM, which reflects the delivered value of LNG cargoes delivered to Northeast Asia. A spot price for LNG bunker supplied from this region would likely reference this marker as a base price on which addition breakbulk cost and profit would be added. Spot prices in the region can, however, be quite variable during the year due to unseasonable weather, supply outages, and European hub prices.

The average JKM front-month price for 2017 was $7.129/MMBtu, however at its highest point going into winter 2017-18 the JKM reached as high as $11.20/MMBtu and as low as $5.350/MMBtu in March.

Given the relative size of demand in Northeast Asia, pricing in the region tends to also have an impact of other LNG-importing regions that have to compete on price to secure spot LNG cargoes. S&P Global Platts markers for the Middle East and India, for example, were both more than 98% correlated with the JKM in 2017.

As a result, when JKM maintains a strong premium to other gas markets, all other markets have to compete with the Northeast Asian price in order to attract the marginal cargo on a netback basis.

In Europe, the spot price of delivered LNG also depends on the prices traded on onshore gas hubs, such as NBP or TTF. During periods when the netback value – or the cost of JKM less shipping – from Northeast Asia to Europe is below prices on liquid European hubs, the value of delivered LNG will tend to be a discount to the relevant hub price to reflect the base market for the gas arriving at European terminals. In short, LNG sellers are seeking to either beat JKM on a netback basis, or the European gas hubs, whichever is higher.

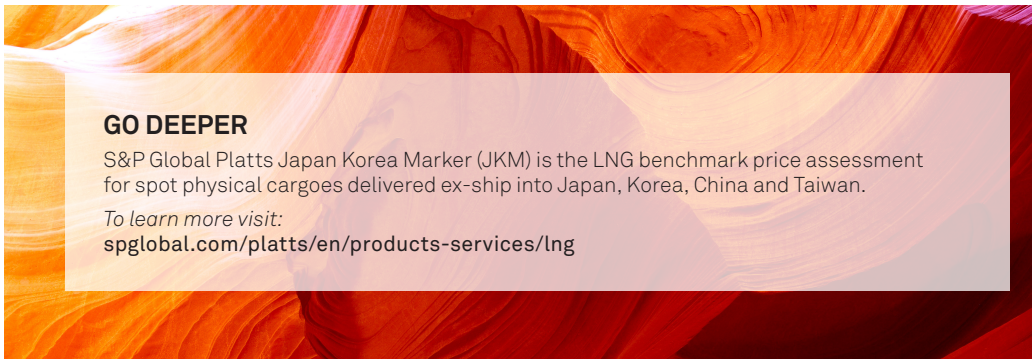
S&P Global Platts Analytics forecasts steady growth in LNG bunkering after the 0.5% sulfur cap comes into effect in 2020, with LNG's share of the bunker market climbing to around 7% by 2030 from just 3% a decade earlier.

With LNG bunker infrastructure now being developed at a faster pace, the biggest obstacle to this industry now comes from the IMO. While tightening sulfur emissions regulation by the IMO previously boosted the industry, the UN body's greenhouse gas initial strategy now threatens future growth (see page 9).

Burning LNG offers a significant saving in carbon dioxide emissions versus conventional bunker fuels – somewhat pared by the warming effect of the methane released into the atmosphere during its delivery – but the saving is not enough to be consistent with the IMO's target of cutting shipping's total GHG emissions by at least 50% by 2050.

Burning bio-LNG produced from renewable resources that offset the subsequent carbon emissions could be one solution to this, but at present the provision of bio-LNG to the bunker industry is far from widespread.

With new zero-GHG-emission vessel designs needing to come into service by the mid-2030s, the window of opportunity for LNG bunkering may be narrow if the IMO's strategy remains on its current course.



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S&P Global Platts Japan Korea Marker (JKM) is the LNG benchmark price assessment for spot physical cargoes delivered ex-ship into Japan, Korea, China and Taiwan.

To learn more visit:
spglobal.com/platts/en/products-services/lng

Full steam ahead

Carnival Corporation, the world's largest cruise company, is making big investments in scrubbers and LNG, says Tom Strang, SVP for maritime affairs, in an interview with S&P Global Platts.

Tom Strang
Senior Vice President, Maritime Affairs
Carnival Corporation

Jack Jordan
Editorial Lead, Bunkers
S&P Global Platts

How much do you expect complying with the 0.5% sulfur cap to cost your company – and is this a cost that can be passed on to your customers?

We have invested hundreds of millions of dollars to date in our efforts to install advanced air quality systems throughout our fleet and have more installations planned over the next few years. It is part of our ongoing research and development efforts to develop new technology solutions that benefit the environment and our world's leading cruise lines.

Carnival has made large investments in scrubbers to allow some of your ships to continue burning fuel oil. Do you see this technology as just covering a brief transition phase while the industry pivots to burning cleaner fuels, or is it something you could imagine using for decades to come?

The use of our environmentally friendly advanced air quality systems is not intended to be a short term measure. They provide as good or better emissions performance than other compliant-fuel solutions.

And how about LNG? Do you hope to find ways of making your LNG-fueled ships compliant with the IMO's greenhouse gas strategy over the longer term, or is this a solution with a brief window of opportunity?

LNG is the most environmentally friendly fuel available today and Carnival Corporation has led the development of LNG for cruise ships. We will take delivery of the first ship to use LNG in port and at sea later this year and we have 10 more on order. We continue to work with our suppliers on technological improvements to equipment that will improve upon and reduce GHG emissions.

> *"There are currently no zero-emission fuels available in any quantity, and if there were there is a very long way to go to develop sufficient infrastructure to deliver them."*
>
> *— Tom Strang, Carnival Corporation Senior Vice President, Maritime Affairs*

How soon would you expect to see oil largely phased out as a marine fuel?

There are currently no zero emission fuels available in any quantity and if there were there is a very long way to go to develop sufficient infrastructure to deliver them.

Do you have any concerns about whether the right technology solutions can be found to deliver the IMO's GHG strategy soon enough – with some zero-GHG-emission designs coming into use as early as the late 2030s?

Although there is no clear solution yet in sight, as a naval architect I expect that we will find a pathway that allows us to address GHG emissions while continuing the growth of shipping as the most environmentally friendly means to transport goods and people, deliver fantastic experiences.

Good health and fortune

What are the health and environmental consequences of the coming shift in bunker demand? S&P Global environmental data and risk analysis firm Trucost assesses the impact.

Anna Shkuratova
Senior Analyst, ESG and Client Delivery
Trucost, part of S&P Global

The latest IMO regulation is designed to reduce sulfur emissions by lowering the sulfur emissions cap to 0.5%. To comply, vessels can either install exhaust gas treatment systems – or scrubbers – or switch to using alternative lower sulfur fuels. There are a number of challenges linked to the availability and cost of scrubbers, as well as a high spread in fuel prices and engine modifications required to adapt them for alternative fuels like LNG.

Trucost has assessed the impact of this regulation on human health and climate change based on the projected mix of the most likely solutions to be implemented in 2020. The bunker fuel mix included high sulfur fuel oil used with and without scrubbers, existing low sulfur fuel oil, new fuel blends, marine gasoil and LNG.

Human health impact

Bunker oil is generally a low quality, low-grade fuel, which is considered highly toxic and harmful. The shipping industry is one of the highest contributors to global air pollution, and sulfur emitted during bunker fuel combustion is particularly damaging to human health. Effects of sulfur dioxide start immediately after inhalation, causing coughing, wheezing, shortness of breath, and can result in long-term respiratory diseases like asthma. Recent studies by the World Health Organisation and a number of research institutions are highlighting a correlation in long-term exposure to sulfur (over 24 hours) and cause-specific mortality rates.

The shift towards lower sulfur solutions is directed at reducing adverse effects of HSFO combustion by either capturing the end of pipe emissions or using lower sulfur content fuels. The resulting decrease in sulfur emissions can be assessed in absolute terms, by measuring the emissions trend over time. However, it is also useful to understand the impact this decrease in sulfur emissions may have on human health in monetary terms. Monetary

GO DEEPER

Trucost, part of S&P Global, assesses risks relating to climate change, natural resource constraints, and broader environmental, social, and governance factors.

To learn more visit:
trucost.com

valuations can help quantify the external cost savings of air emission reductions by considering the increased productivity and better health outcomes of the population.

Trucost has evaluated the external cost of air pollution caused by three pollutants: sulfur dioxide, nitrogen oxide (NOx) and particulate matter (PM). It is worth noting that, while lower sulfur fuels reduce the amounts of PM, only the use of LNG as an alternative fuel leads to a significant reduction of NOx emissions. Both NOx and PM cause respiratory diseases and thus their contribution should not be taken out of the equation.

The current external cost of bunker fuel emissions has been estimated to be $128.54 billion per year. Between now and 2020, we expect to see this number decrease by 27%, mainly due to the reduction of HSFO use on vessels with no scrubbers from 64% of total fuel use last year to 4% in 2020. For comparison, the external cost of sulfur emissions is expected to reduce rom $21.43 billion last year to $3.68 billion in 2020, driven by a larger proportion of lower sulfur blends in use.

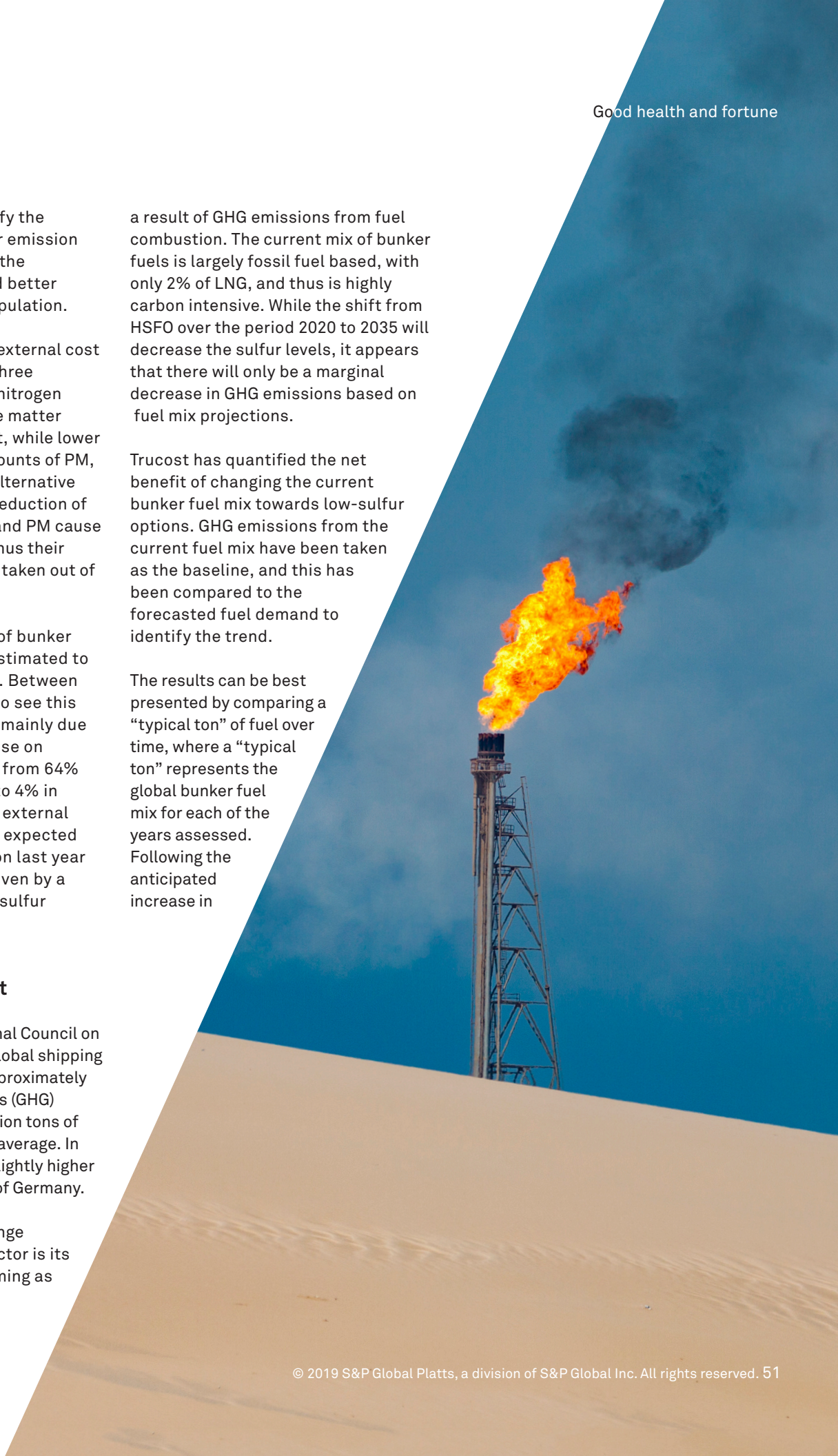
Climate change impact

According to the International Council on Clean Transportation, the global shipping sector is responsible for approximately 3% of global greenhouse gas (GHG) emissions, emitting one billion tons of GHG emissions per year on average. In comparable terms, this is slightly higher than the annual emissions of Germany.

One of the key climate change impacts of the shipping sector is its contribution to global warming as a result of GHG emissions from fuel combustion. The current mix of bunker fuels is largely fossil fuel based, with only 2% of LNG, and thus is highly carbon intensive. While the shift from HSFO over the period 2020 to 2035 will decrease the sulfur levels, it appears that there will only be a marginal decrease in GHG emissions based on fuel mix projections.

Trucost has quantified the net benefit of changing the current bunker fuel mix towards low-sulfur options. GHG emissions from the current fuel mix have been taken as the baseline, and this has been compared to the forecasted fuel demand to identify the trend.

The results can be best presented by comparing a “typical ton” of fuel over time, where a “typical ton” represents the global bunker fuel mix for each of the years assessed. Following the anticipated increase in



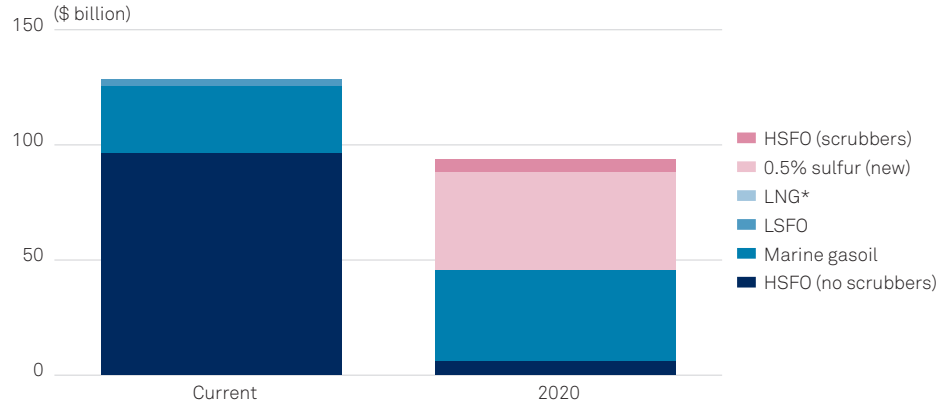
scrubber installation demand, and switching to lower sulfur fuels, Trucost estimates that GHG emissions per ton of fuel would decrease by 13.2% – from 3.23 tons of CO2-equivalents in 2018 to 2.80 tons of CO2-equivalents in 2023.

However, as the fuel demand is expected to increase annually by approximately 2.5%, the absolute level of GHG emissions is going to increase as well. By 2035, 90% of fuel would remain fossil fuel based, with a third of this amount being HSFO used on vessels with scrubbers. While the scrubbers help minimize sulfur and PM emissions, their installation does not reduce GHG emissions, and sometimes may even lead to GHG emissions increasing by 1.5-2%.

This means that the industry will need to identify solutions to reduce GHG emissions. One option would be increasing the energy efficiency of the vessels' equipment and engines. The IMO's Energy Efficiency Design Index specifies the minimum energy efficiency requirements per capacity mile depending on the vessel type and size. Another option is exploring alternative fuels that are sulfur free and more environmentally friendly, such as algae fuel, methanol, HDRD, and pyrolysis oil.

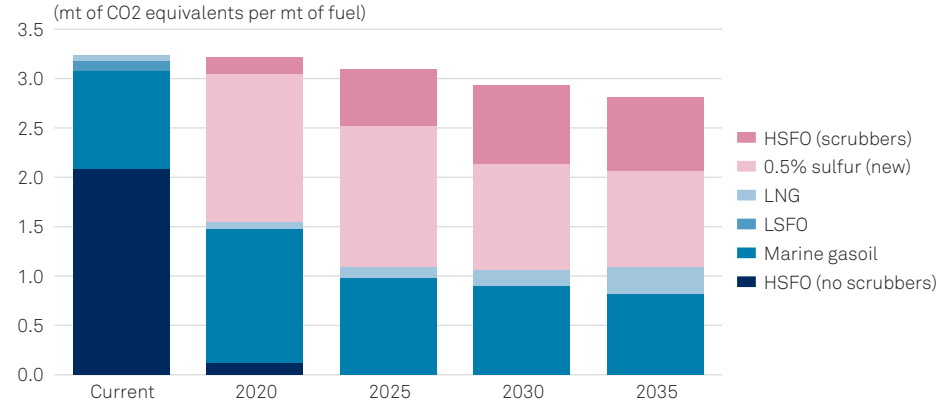
With regulation on GHG emissions and environmental impacts intensifying globally, it is important that companies and their investors consider environmental and social benefits alongside the traditional financial returns on their investments. This will help companies and investors capitalize on low-carbon opportunities and help direct capital to those business models that are well positioned for the transition to a low carbon economy.

HUMAN HEALTH IMPACT



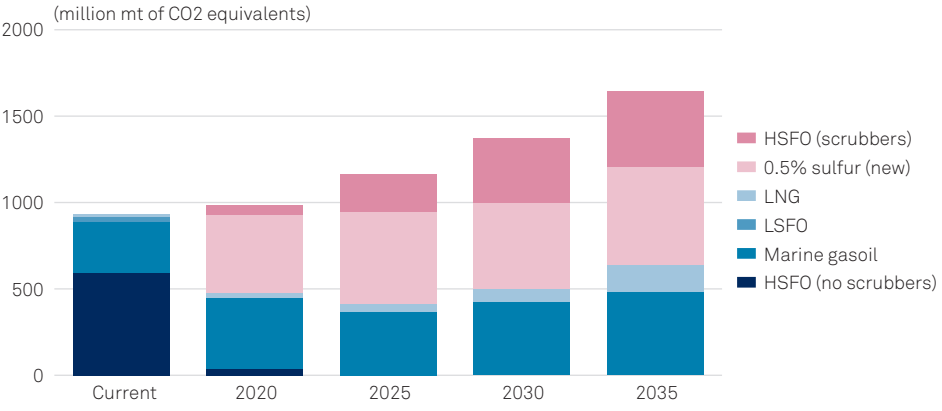
*($ billion) Current= 0.002 , 2020= 0.003
Source: Trucost

GHG INTENSITY OF A 'TYPICAL TON'



Source: Trucost

GLOBAL GHG EMISSIONS



Source: Trucost

The last word

IMO 2020 poses the largest and most disruptive challenge the industry has had to face, but the industry is remarkably resilient and will quickly adapt, writes Chris Midgley.

Chris Midgley
Global Head of Analytics
S&P Global Platts

"Problem – what problem?" That is what many may have been saying about IMO 2020 at the end of last year, when fuel oil was trading above gasoline in some regions. As a result, simple conversion refineries were looking more attractive to run than cat cracking refineries; so, why all the fuss?

While many have accused both the shipping and refining industries of having their heads in the sand in their response to IMO 2020, the last 18 months have clearly demonstrated that this is a case of "chicken and egg" — which comes first, refinery investment to destroy fuel oil, or the shipping industry's response to consume it?

The refining industry has made multi-billion dollar investments in raising conversion capability (refinery complexity). These investments have in general been made under strategies to increase conversion yield based on long-term planning assumptions, refinery and/or chemicals integration, or – as in the case of Russia – tax incentives. They often take around five to seven years to come to fruition and are based on paybacks over many years. While IMO 2020 may have been seen as a window of opportunity for short-term gain, it would have been unlikely to have driven the investment decision on its own.

On the other hand, the shipping industry has had tight margins which have not generated a large free cash flow to allow capital investment in conversion to LNG or the addition of scrubbers without an economic incentive. Given the relative short cycle time for conversions or scrubbers, inevitably the industry has been sitting on its hands until the time is right. In the last six months, as we forecasted, the number of scrubber orders and installations has increased dramatically – from less than 500 in operation at the start of the second half of last year, likely rising to 2,200 in time for 2020, which would enable the sector to still consume over 500,000 b/d of high sulfur fuel oil.

As we approach IMO 2020, one could be forgiven for starting to believe it will be a non-event. The economic tragedy of Venezuela and the US oil export sanctions re-imposed on Iran have meant the quantity of heavy, sour grades falling by more than 500,000 b/d over the last two years while light, sweet grades have increased by over 3 million b/d (mainly due to the rise of US shale oil). This has forced analysts such as ourselves to revise down our residue forecasts by almost 1 million b/d. In addition, as we welcome in 2019, the macroeconomic gloom is deepening. In general, when the economy heads into recession, any slowdown in distillates demand tends to lag as industrial activity is slower to respond. However, with much of this slowdown being driven by trade conflicts, we are seeing trade and

industrial activity being hit, which is starting to affect distillates demand earlier in the cycle.

Despite fuel oil being in tighter supply today, especially during the Middle Eastern summer when Saudi Arabia demonstrated its ability to increase HSFO burn over crude, and with light distillates being in ample supply due to the growth in light crude production, IMO 2020 still poses the largest and most disruptive change that that the industry (shipping or refining) has had to face. Whichever way you look at it, some 3 million b/d of HSFO (up to 3.5% sulfur) will have to switch to 0.5% fuel oil. As ever, the industry will be quick to adapt and with some simple segregation and changes to blends can easily mitigate this problem to the extent of around 1.5 million b/d of HSFO length and a short of 1.5 million b/d of distillates. However, beyond this, economic incentives will be needed to optimize refineries to maximize gasoil yield and find outlets for surplus HSFO.

With US cokers only operating at 89%, only a small shift in the clean-dirty spread (gasoil-HSFO) will be needed to increase their utilization, thus raising fuel oil destruction and gasoil yield. Further economic incentives will be needed to de-optimize catalytic crackers (FCCUs) to free up low sulfur blendstocks, thus affecting gasoline and some petrochemical yields. Depending on the health of the economy, it remains likely that the world will still be short of distillates, requiring simple refineries to be incentivized to run harder and as a result increasing the HSFO length, which will need to seek new outlets, such as power plants – first into new-build plants such as in Bangladesh, then displacing cheap natural gas (for example, in Russia) and then more expensive LNG or crude in places such as Saudi Arabia and maybe Pakistan. This will of course result in HSFO prices being discounted and thus require gasoil to increase reciprocally to maintain simple margins just above zero.

Of course, the irony of all this is that legislation intended to reduce sulfur dioxide emissions, especially where it has a health impact (close to coastlines), has simply pushed some of it into static sources (power plants), which by definition are inland (or just offshore in the case of floating power) and close to populations. The increased desulfurization of distillates will add to the growing sulfur surplus for industry to consume and higher coker utilization will result in a greater supply of coke to compete with coal.

The wide range of blend components and increased percentage of distillates that will be used for 0.5% fuel oil will create a host of compatibility issues. Some blends have even been patented by some of the international oil companies. Shipowners have had some experience of this from the Emission Control Areas (ECAs), but this greater volume will require good tank turnover and cleaning, and effective engine fuel switchover. In addition, bunker suppliers will need to supply a range of fuels from HSFO, marine gasoil and a range of 0.5% sulfur blends, creating even more complexity to fuel management and supply chains, especially on their bunker barges. The cost of this compliance will ultimately drive up crude prices or the key sweet (low sulfur) benchmarks – with tightness in gasoil and gasoline resulting in wider product cracks.

All of this will hit consumers and impact the global economy, potentially pushing it into recession, if it has not already entered it this year!

While all these factors will be disruptive in 2020, the industry is remarkably resilient and will quickly adapt to the new circumstances. Scrubber investments are forecast to continue, and while I have seen forecasts of up to 18,000 scrubbers, I have also suggested that we may not need many more than 6,000 to be installed. At this level, the amount of demand for HSFO would increase to above 1.5 million b/d which in itself would tighten the HSFO market, pulling supply back out of power plants and into marine bunkers. At this point, fuel oil would price back up to the breakeven point for ships with scrubbers to burn fuel oil over gasoil (taking into account loss of efficiency). With over a third of the scrubbers being installed on new build vessels, this demand is likely to be here to stay for many years to come – and with the inevitable overinvestment in refinery complex capacity we will no doubt see fuel oil markets once more returning to strong cracks post-2020.

The tide may well be turning for fuel oil right now, but just as the tide goes out, it is inevitable that it will come back in again not too long after 2020. Following this, there will be fresh challenges for the refining and shipping industries, perhaps as Venezuelan and Iranian crude returns more residue to the market, as the shipping industry learns to deal with new tighter fuel efficiency targets (for lower greenhouse gas emissions), or low refinery margins lead to consolidation of simple refineries, all resulting in fuel oil tightness continuing to ebb and flow.

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