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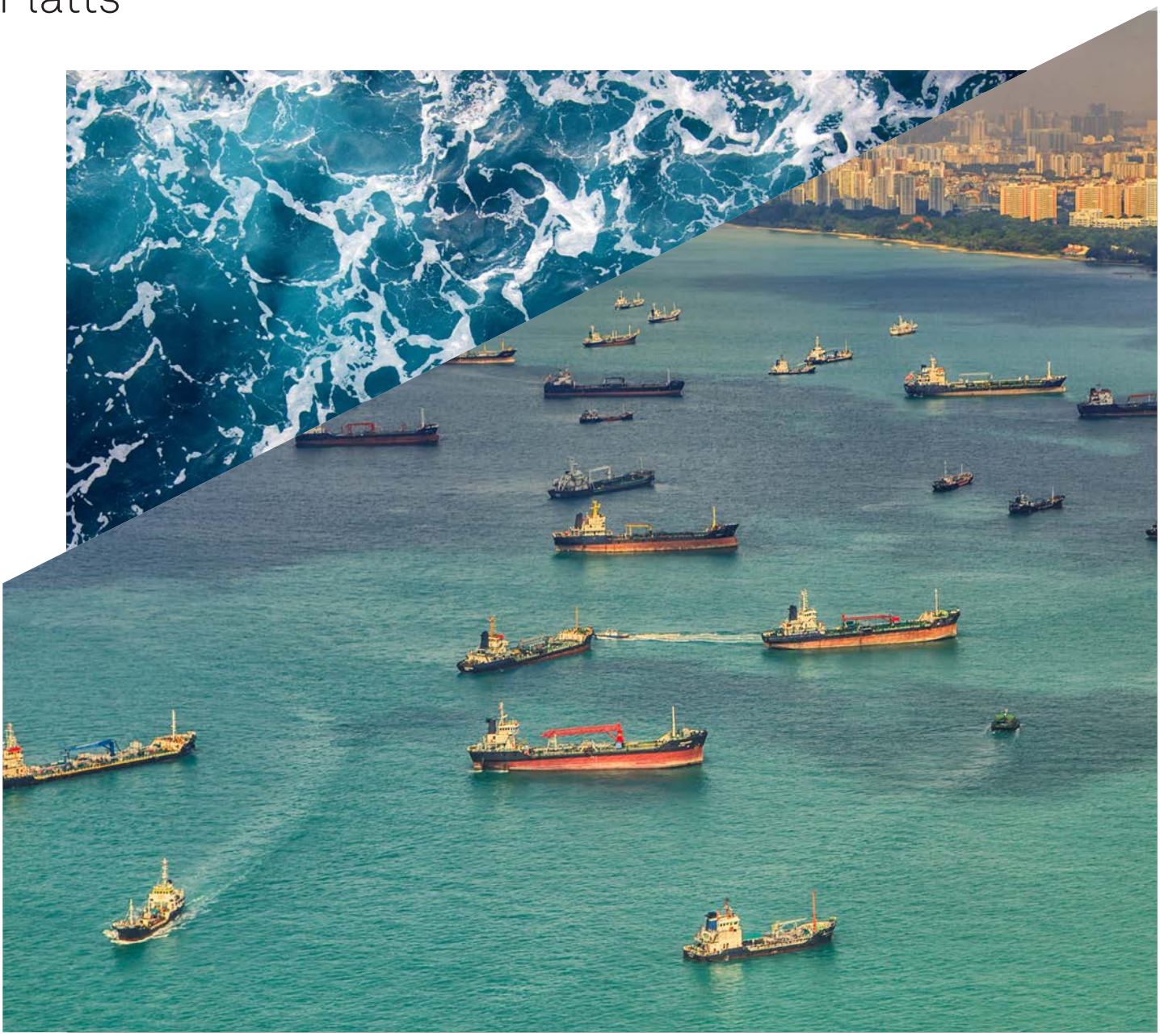

THE IMO'S 2020 GLOBAL SULFUR CAP
WHAT A 2020 SULFUR-CONSTRAINED WORLD MEANS FOR SHIPPING LINES, REFINERIES AND BUNKER SUPPLIERS

SHIPPING SPECIAL REPORT

OCTOBER 2016

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INTRODUCTION

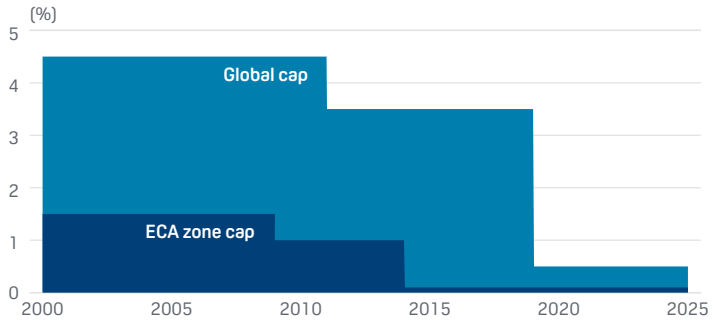
The International Maritime Organization on October 27 announced it was going ahead with a global sulfur cap of 0.5% on marine fuels starting from January 1, 2020, ending years of uncertainty.

Under the terms of the IMO's MARPOL Annex VI regulation, the 2020 date was "subject to a review, to be completed by 2018, as to the availability of the required fuel oil. Depending on the outcome of the review, this date could be deferred to 1 January 2025."

Now that the 2020 date has been confirmed by the IMO, a sharply more regulated shipping emissions sector looms into view in the near term. The current global sulfur cap on bunker fuel is much less stringent at 3.5%. The sharp, step change down to tighter sulfur specifications at sea will have knock-on effects throughout the global energy system, including on road fuels.

The cost of the IMO's regulatory change on the shipping industry is unknown, but every analyst expects it to be large. As well as shipping lines, the IMO's decision will also impact refiners, crude producers, bunker suppliers, and emissions and air quality affecting the health of millions of people.

MARPOL ANNEX VI SULFUR LIMITS



Source: IMO

IS IT ACHIEVABLE?

The IMO hired a consortium of consultants lead by CE Delft for an availability study on whether enough distillates could be produced by 2020 to meet the increased marine demand, and the answer it got back was positive. At the Platts Rotterdam bunker conference in May, Jasper Faber, aviation and maritime specialist at CE Delft, presented the preliminary results of the study, which were then sent to the IMO ahead of its October 24-28 meeting in London to be used as the basis of its decision.

In CE Delft's base-case scenario of an 8% increase in total energy use in the marine sector, global marine fuel demand will increase to 320 million mt in 2020, from 300 million mt in 2012.

However, secondary refining unit expansions until 2020 should allow the sector to meet the projected increase in distillates from the marine sector, Faber said. "Hydrocracking and hydrotreatment capacity of refineries is projected to increase faster than global petroleum fuels demand, which potentially creates the capacity to produce compliant fuels," he said.

Global CDU capacity will go up slightly less than the increase in fuel demand to 2020, he said, meaning run rates are likely to be higher. And investment decisions on desulfurization units will, of course, be made by individual refineries, he added: "Whether they will do it depends on strategic decisions by refineries, which is not something we can predict."

A rival study by consultants Ensys and Navigistics, who were not chosen by the IMO, was nevertheless submitted to the IMO as a "second opinion" to consider, by the International Petroleum Industry Environmental Conservation Association (IPIECA), an oil and gas industry group, and the Baltic and International Maritime Council (BIMCO), the largest shipowner's association.

The Ensys study comes to the opposing view that refining capacity will not be sufficient in 2020, estimating that 60%-75% additional sulfur plant capacity needs to be built by 2020, compared with planned projects.

CE Delft, meanwhile, does not see sulfur plant capacity as a problem. "We have assumed that all units have sufficient sulfur plant capacity," it said in the report. "If this assumption is not accurate, refineries will need to expand the capacity of their sulfur plants to fulfil 2020 demand."

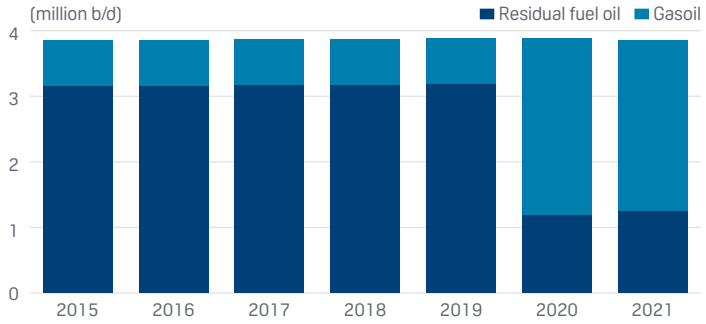
There are many variables to both studies' projections, of course. The uptake of Exhaust Gas Cleaning Systems (EGCS), commonly known as scrubbers, is a key factor. A scrubber is a piece of equipment that sprays alkaline water into a vessel's exhaust to remove sulfur and other unwanted chemicals. If marine fuel demand is greater than expected before 2020, more companies will invest in scrubbers and consequently there will be less demand for low sulfur bunkers come 2020.

The number of new-builds is also a variable; EGCSs are cheaper when incorporated into a new-build from the start, rather than being an add-on. More new-builds than expected should allow more EGCSs to be installed and less new-builds, less.

One of the major differences between the studies is the assumption in the CE Delft study that primarily the demand would be filled by blends. In the CE Delft study, all compliant fuels of 0.5% max sulfur are blends of several refinery streams, including "residue, cutter stock, unconverted hydrotreated oil, treated light distillate and very small fractions of kerosene in some cases."

Ensys/Navigistics, on the other hand, considers a preliminary scenario where up to 90% of the demand for 0.5% max sulfur fuel is met by middle distillates and only 10% by residual. The minimum draw on distillates they consider is 50%. They are not alone in seeing a widespread shift to MGO as a first choice come 2020. The IEA has said, "It is expected that the majority of shippers will revert to burning marine gasoil upon the

OIL-BASED MARINE FUEL CONSUMPTION, GASOIL vs RESIDUAL FUEL OIL



Source: IEA, Medium-Term Oil Market Report 2016

introduction of the global cap. As was seen in 2015, when faced with tighter environmental legislation, the majority of shippers decided upon the less capital intensive option and switched to compliant fuels when sailing in ECAs."

And the OECD-affiliated International Transport Forum estimates that of total oil-based marine fuel consumption in international shipping of around 3.9 million barrels per day in 2020, 30% would be residual fuel oil and 70% gasoil. This represents a demand shift of 2 million b/d from residual fuel oil into gasoil. (*Source: Corporate Partnership Report, OECD, 2016*).

As well as increased CDU capacity making more straight run fuel oil, the study said that "expansion of hydrocracking capacity increases the potential supply of unconverted gas oil with a very low sulfur content which can be blended with heavy fuel oil to lower its sulfur content."

However some refinery experts say that merely expanding hydro-desulfurization capacity will not be enough. "You can't just put the current residual fuels through a fuel hydrotreater and assume it will be 0.50%, that is unlikely to work," said Paul van Munster, fuels technical expert at Infineum in the Netherlands. "You need more advanced hydrocracker technology in order to get the lower sulfur content in these grades. You need to use newer generation catalysts. ENI for example has a special process, a slurry hydrocracker. People are finding different, more severe processes, to cut the sulfur down in these more heavy grades."

In case of higher-than-expected oil demand in by 2020, increased use of naphtha/kerosene in fuel oil blending is required. As these often have a lower flash point than the 60 degrees C min specified in ISO: 8217 standards, the CE Delft study points out that refineries will need to be careful that the flash point of their blending components is over 60 degrees C.

Even in the event that the capacity constraints can be overcome, the Ensys study paints a dramatic picture of higher road fuel costs globally as the costs of desulfurizing the marine pool ripples up the barrel. "…the effect of the global sulfur cap would be to increase open market prices by some $10/b to nearly $20/b average across all products in all regions worldwide – not just across marine fuels," it says.

CE Delft's official study on the other hand finds that the global refining system can meet demand for non-marine fuels at the same time as increased demand for middle distillates in the marine sector.

Professor James Corbett, a professor of marine policy at the University of Delaware in the US, and a member of the IMO's steering committee, said any predictions of global fuel price increases need to fully reflect demand elasticity. "There are number of reasons to think higher prices would cause a reduction in demand," Corbett said. "If you're holding demand constant, or rate of efficiency of all other segments, you're going to get a wrong prediction. That the market is too stupid to respond to price increases, and has to suffer them without innovation, seems to be a potential flaw."

IMPACT ON REFINING SECTOR

The more sulfur-constrained world of 2020 will have huge implications for the global refining sector, undermining margins for simple refineries that turn a significant share of their crude run into HSFO, but potentially boosting margins for complex refineries able to take advantage of it.

According to the UK Petroleum Industry Association (UKPIA), a change to 0.50% mass sulfur marine fuels "would have a massive impact on refinery configuration and operations," and would require some combination of the following four main approaches, each with its own drawbacks.

1) Substantial investment in upgrading fuel oil residues to gasoil grades (i.e. building secondary units such as crackers, visbreakers and cokers). But as many refiners are global companies they will only make such investments in locations with good returns (leaving the prospect of patchy availability).

2) Reduction of residue production through changes to a sweeter crude slate. The downside here is of course that such crude grades trade at higher differential, reducing refining margins, and will be in even more demand, and thus more expensive, in 2020.

3) Residue destruction, stopping the production of fuel oil. This also requires huge investment.

4) Desulfurization of residual fuel oil and blend with low sulfur gasoils. Similarly this requires huge investment. According to the IEA, these units are more expensive than upgrading units, and presently there is little demand for fuel oil desulfurisation units, with global capacity estimated to be less than 0.1 mb/d." *(Source: Medium-Term Oil Market Report, February 2016)*

As UKPIA explains, to make fuel oil meeting 0.50% sulfur, "new process units will need to be added to upgrade and/

or desulfurize the residue streams depending on economic choices. Refiners could choose to add heavy oil conversion processes to upgrade residues into higher value products. Gasoils from these upgrading projects would then source the marine requirement. The processes required are high pressure, high temperature and consume huge volumes of hydrogen which must also be manufactured (releasing further CO2). The capital cost is massive, operating costs are much higher and lead times for construction are in excess of five years." *(Source: http://www.ukpia.com/industry_issues/fuels/marine-fuel.aspx)*

Hydrogen is a particular issue perhaps not fully dealt with in the official CE Delft study, particularly the regional longs and shorts. Currently, supply of hydrogen is tight in Western Europe, requiring imports. "No refinery in Benelux is long hydrogen at the moment," said one refinery technician with knowledge of the matter, speaking to S&P Global Platts on condition of anonymity. "And hydrogen demand will definitely go up by 2020, to feed hydrocrackers."

Some refineries produce more hydrogen than they need, and sell it to others. Other refineries purposefully produce their own, from natural gas. However this is an energy intensive process. "You have to burn more gas to generate power for the process of producing the hydrogen," said the technician. "So there are more CO2 emissions."

More hydrocrackers are needed to bring fuel oil lower on sulfur content. However, given scarce capital within the oil majors following the 2014-15 oil price crash, some refineries will prefer to simply invest in producing higher quality road fuels, focusing on the high-value part of the barrel, and destroy the residual component.

The market context for these investment choices is stark, according to the IEA. "[In 2020] the price of fuel oil is expected to plummet in tandem with demand," it has said. "This will in turn put pressure on [fuel oil] cracks and simple refiners with high fuel oil yields. Conversely, it could become more attractive to modern, complex refiners who have the secondary units capable of upgrading fuel oil into higher value lighter products."

Independent refiners generally do not have plans in place to deal with the lower sulfur cap. One trader at an independent refiner in the Eastern Mediterranean told Platts: "We are a small refiner. We're not investing in any kit to respond to the 0.5% sulfur cap. But what I have heard, is that if fuel oil becomes much cheaper, then so will sour crudes that yield a lot of fuel oil – so we should be ok. I expect Urals [crude] will get much cheaper, and Kirkuk, it will affect the whole sour market." However, industry analysts generally see this optimism as misplaced, and expect a negative impact on simple refinery margins.

The increased refinery run rates that CE Delft envisions in 2020 would also come with issues of their own. As the IEA has put it, (source: Medium-Term Oil Market Report, February 2016) "Global refiners will be put under enormous strain by the shifting product slate. If refiners ran at similar utilization rates to today, they would be unlikely to be able to produce the required volumes of gasoil. If they increased throughputs to produce the required gasoil volumes, margins would be adversely affected by the law of diminishing returns. In order to increase gasoil output, less valuable products at the top and bottom of the barrel would be produced in tandem, which would likely see cracks for these products weaken and weigh margins down."

How hard is it for refineries to blend down to 0.5% from 3.5%? "It varies from impossible to very easy - depending on the crude slate," said Infineum's van Munster. "Many Far East crudes have less than 0.1% sulfur in the VGO fraction. You could blend that into the residue, which is also likely to be low sulfur. [In West Africa,] Doba has a problem in that it is extremely high in calcium, so a refinery needs to be able to cope with that, but it's also very low in sulfur." Doba has only 0.16% sulfur, yet is heavy at 20.4 API.

The timing of refinery upgrades is a major point of contention – particularly whether sufficient capacity of hydrodesulfurization (HDS) plants, also known as hydrotreaters, can be built in time for 2020.

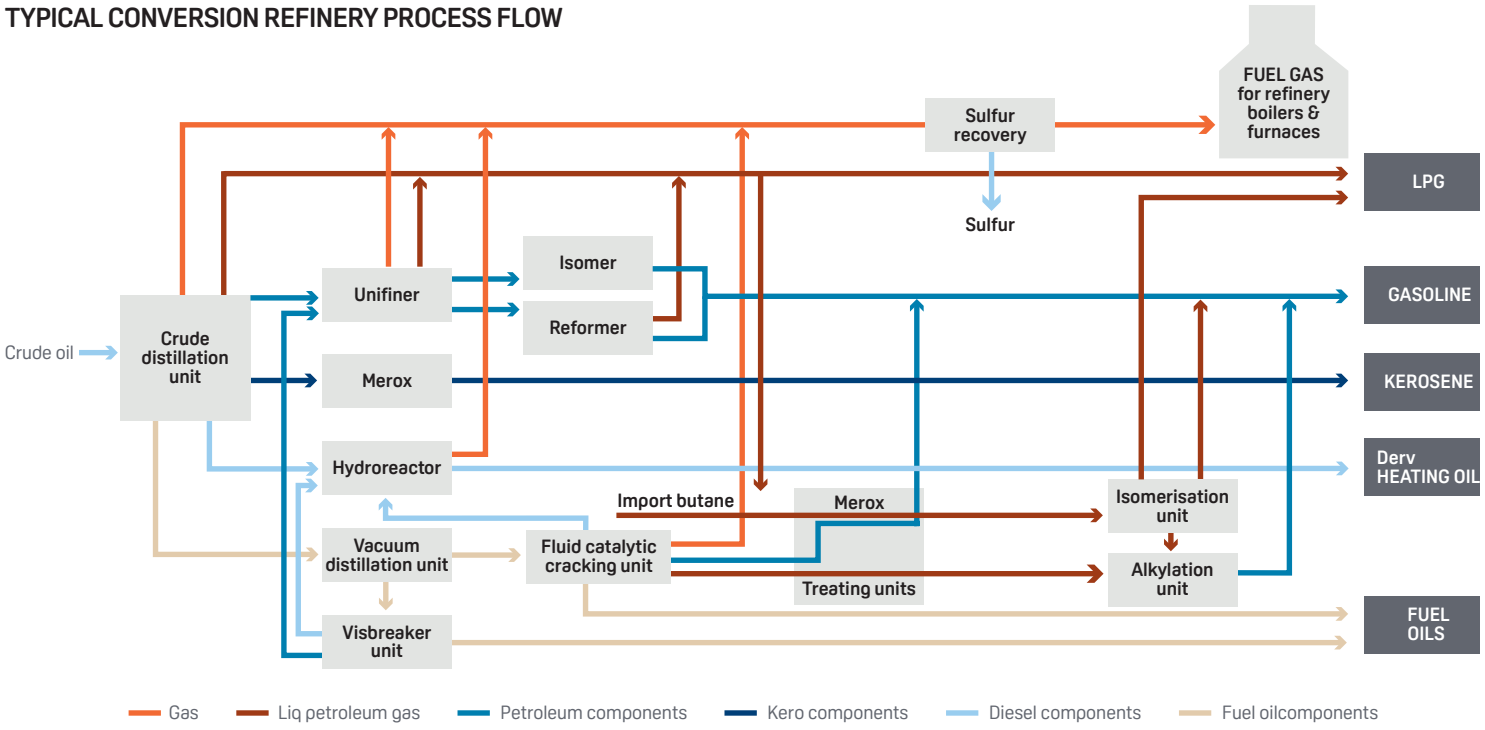
Before the 0.5% max blends become widely used, with higher ratios of residual fuel compared to the 0.1% blends, they will need years of research and development – time now in short supply. "We worked on HDME 50 for four years before it came onto the market," said one European fuel blending expert involved in the development of ExxonMobil's Premium Heavy Distillate Marine ECA 50 (HDME 50), one brand of ECA-compliant fuel. "Now, 2020 is tomorrow in terms of projects within a refinery. I can't really comment on whether the whole refining sector can meet the 2020 sulfur cap. Let's just say it's hard with uncertainty (for some refiners) to persuade management to invest."

ExxonMobil in July 2014 said it planned to install a new delayed coker unit at its Antwerp refinery, "to convert heavy, higher sulfur residual oils into transportation fuels products such as marine gasoil and diesel fuel." Market sources say the coker should be operational by some time next year, and that a lot of additional work was going to impact the blending system. The company has declined to comment on the specifics of meeting the 0.5% cap with a residual fuel blend.

While the oil majors are staying tight-lipped on the details of internal research and development into the mass-production of 0.5% blends, it is widely understood in the industry that probably all of them have such programs ongoing.

"Shell will offer a variety of fuel solution choices to the marine sector that will continue to help enable our customers to be competitive in 2020 or 2025," the company said in an email to Platts, prior to the IMO's decision. "These solutions will enable our customers to comply with the changes required by the IMO specification change in a flexible and timely manner."

TYPICAL CONVERSION REFINERY PROCESS FLOW



Source: UKPIA Statistical Review

In January this year, Shell awarded a contract to KBR to provide technology for a solvent deasphalting (SDA) unit at its 404,000 b/d Pernis refinery in the Netherlands. This will be equipped with residuum oil supercritical extraction (ROSE) technology, to split the residue from a mixture of crude grades into de-asphalted oil and asphaltenes. "That's another route to go," said the fuel blending expert. "You could go for deep conversion technology like cokers or slurry hydrocrackers, or, you remove the asphaltenes from it."

Meanwhile, BP has publically stated that the 2020 deadline for a 0.5% sulfur cap is achievable. "BP has long maintained that compliance with the rule in 2020 is technically and commercially feasible, so long as ample lead time and certainty were provided to enable investments decisions to take place," the company said in an email to Platts. "We still hold that view."

CRUDE IMPLICATIONS

The hundreds of crude grades used around the world vary immensely in sulfur content, among other factors, and their relative values will be affected by the sharp reduction in global demand for 3.5% sulfur fuel oil – easily the highest sulfur transport fuel used in the world.

Heavy oil and bitumen production are growing rapidly, and Canada and Venezuela together have the bulk of non-conventional heavy oil reserves (API 24 and below, with API 10 and below counting as extra heavy). The 0.5% global sulfur cap will likely result in a lowering of the forward value of heavy sour hydrocarbons, given the deeper discounts required by refineries to make up for higher investments in secondary processing units.

The highest sulfur crudes in the world will likely face lower differentials against the key global benchmarks than they would otherwise have. Standout grades in this category include unconventional crude such as Canada's Western Canadian Select, with a sulfur content of 2.8%-3.5%, then Middle Eastern grades like Iraq's Basrah light (2.92%) and Kirkuk (2%), Qatar's Al Shaheen (2.5%),and Iranian heavy (1.8%), before getting down to Russian Urals at 1.35%. Heavy sweet grades, meanwhile, are expected to rise versus heavy sours. This would include Angolan grades such as Dalia (API 24, sulfur 0.5%) and Pazflor (API 25.6, sulfur 0.41%).

The CE Delft study predicts changes to crude slates, but manageable ones: "The average sulfur content of the crude slate in the Middle East will need to be lowered from 2.01% in the base case to 1.99% in the high-demand case."

CE Delft's study analyses the impact of future crude production quality being worse than expected. It finds that when crude has a 10% higher sulfur content than in the base case, refineries in Russia and the former Soviet Union, Latin America and North America will have difficulties meeting gasoline specifications at the same time as the lower sulfur marine fuel specification, while Latin American refineries will also have problems meeting ULSD specifications.

SULFUR IN FUEL OUTPUT, BY CRUDE TYPE

Crude	Country	Crude oil, mass % sulfur	Fuel oil residue, mass % sulfur
Ekofisk	Norway	0.21	0.69
Brent	UK	0.42	1.27
Urals	Russia	1.35	2.78
Dubai	Dubai	2.13	4.05

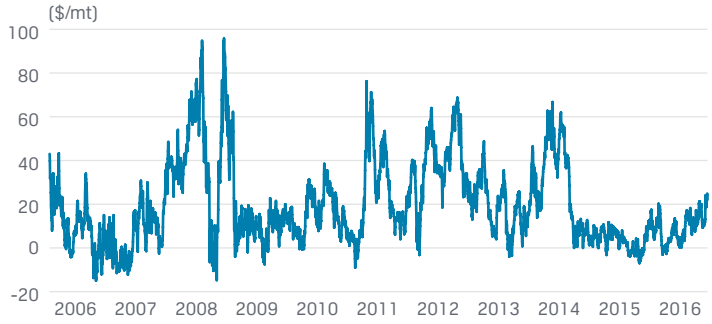
Source: Total

THE CHANGING FUEL OIL MARKET

Although we won't know the full price impact of the decision until we reach 2020, the forward curves are already pricing in the likelihood of a dramatically different fuel oil market. The calendar-year 2019 fuel oil crack (FOB Rotterdam 3.5% barges versus Brent frontline) has fallen to minus $14.78/b, its lowest-ever level, on the Intercontinental Exchange as of October 27, the day of the IMO's decision. This indicates the market's expectations of reduced demand for high sulfur fuel oil in the run-up to the 2020 implementation date.

This is encouraging for the minority of shipowners who are investing in scrubbers and will continue to use high sulfur from 2020. But most shipowners are far more interested in what they will have to pay for 0.5% sulfur bunker fuel, and there is no consensus over what price premium should be expected for it over the current global standard of 3.5%.

1%S FOB NWE CARGO VS 3.5%S FOB RDAM BARGE VALUE



Source: Platts

Looking for historical evidence, the most relevant data period is during the five years from the start of 2010 to end-2014, when the ECA zone sulfur limit was 1% max, and the addition of marine sector consumption of 1% max to power generation demand meant that 1% sulfur demand in Europe was up to 1 million mt per month. During this five-year period, the premium of FOB Northwest Europe 1% sulfur fuel oil cargoes over 3.5% FOB Rotterdam barges (the "hi-lo") averaged $24.95/mt, according to Platts data. Linearly, this gives $0.998/mt per 0.1% of sulfur, which would imply a $30/mt premium of 0.5% over 3.50% as a very rough starting point.

However, sulfur does not blend linearly, but closer to an exponential curve, meaning that as it is reduced in a fuel oil blend, it costs progressively more; the 0.1% reduction in sulfur from 1% to 0.9% costs much less than the 0.1% reduction from 0.6% to 0.5%. As well as the cost of desulfurization being inherently non-linear, there is also a smaller pool of blending components available at lower sulfur levels. The cost of these blending components will be partly determined by demand, so the historical data will not be an accurate guide to a world where every ocean-going vessel is seeking 0.5%. "I expect the curve of sulfur value to steepen [by 2020]," said one European fuel oil blender.

A global switch to 0.5% max sulfur would massively increase the value of blend components, including LSSR – supply of which at least in Europe has sharply reduced in recent years. However, West African output of LSSR is expected to remain stable to 2020, with no planned refinery upgrades that would convert LSSR to higher value products. The streams of LSSR that are sometimes used to blend into the LSFO pool, such as from the CORAF refinery in Congo Brazzaville, should see higher differentials in a sulfur-constrained world. Also, the value of few heavy yet sweet crudes that are sometimes used in fuel oil blending such as Chad's Doba crude (API 20.4 , 0.16% sulfur), should increase.

EXISTING ECA ZONE FUELS

Amid the widespread worries over the technical feasibility of mass-producing 0.5% fuel oil in 2020, it is worth remembering that ultra-low sulfur fuel oil [ULSFO] of 0.1% maximum sulfur content already exists, and is used in the ECA zones as a cheaper alternative to marine gasoil. ECA zone fuel oil typically trades at a $20/mt or more discount to MGO in Rotterdam, according to Platts data.

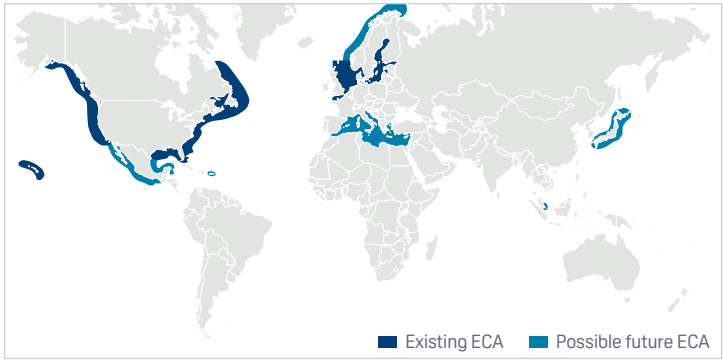
The use of ULSFO in Europe has grown in 2016, after it started being used in 2015 in response to the implementation of MARPOL legislation enforcing a lower 0.1% sulfur cap on bunker fuel used in ECAs.

In terms of volumes of ULSFO used, Amsterdam-Rotterdam-Antwerp monthly demand is about 170,000 mt and is expected to grow to around 200,000 mt by year-end, and supply around 350,000 mt next year, according to market sources. By comparison, ARA marine gasoil demand is about 320,000 mt per month, so as ULSFO takes more market share from MGO the ratio between the two is expected to move closer to 50-50.

Technically, "ECA category fuel sits between MGO and fuel oil," explained one European refining expert involved in the development of 0.10% ECA zone fuels.

"It's lower sulfur than typical bunker fuel, but higher viscosity and lower volatility than marine gasoil – it has to be heated just like normal bunker fuel, which reduces risk of engine and boiler damage from thermal shock," the expert said.

ECA ZONES, EXISTING AND POSSIBLE



Source: IMO

While some shipowners have reported compatibility issues between various ECA zone fuels used in different ports, some of these have been down to staff training, and the added complexity of using a distillate-rich fuel in an engine designed for residual fuel.

"Distillate will have a cleaning effect in a residual tank it can take away all the sludge that has built up in your tank, and you will recover this sludge in your filter and centrifuge," said the refinery expert.

When 0.1% sulfur blends started being used in ECA zones in late 2014, there were concerns from shipowners about how they would be produced, and how engines would react to them. According to a marine safety alert published by P66 in December 2014, some of the ECA-zone fuel was reportedly produced from desulfurized VGO, leading to high asphaltenes content. This can cause precipitation resulting in sediment clogging up and the accumulation of paraffin, potentially solidifying product in vessel pipes.

In both ECA zones, the practicalities of obeying the 0.1% sulfur cap are sometimes a world away from the models studied in the negotiation rooms that gave them force.

"From our experience with 0.1% in the North American ECA we can say compliance with our vessels has been a constant challenge due to the complete unavailability of 0.1% IFO, the lack of MGO capacity on board, and the unreliability of LS MGO supply in our trading range," one ship charterer said. "We've seen nothing to suggest suppliers are prepared to get sulfur down to 0.5%, as the heavy oil market has hardly responded at all to the 0.1% ECA regulation. If there were problems making 0.5% max sulfur fuel that also complied with ISO: 8217 standards, he added, then "retrofitting of tanks and engines will become essential in order that vessels will operate at all times with MGO."

Nevertheless, according to the oil majors, 0.1% sulfur ECA zone blends have a long-term future, as a cheaper alternative to marine gasoil in the ECA zones, and a necessary complement to whatever solutions are found for the global 0.5% cap outside ECA zones.

COSTS TO SHIPPING INDUSTRY

Taking the Ensys estimate of global switching out of HSFO into 195 million mt of marine distillates or other 0.5% fuel, at the extremely conservative estimate of a $30/mt premium for 0.5% blend over standard 3.5% fuel oil, and assuming all ships can access this type of blend, rather than resorting to MGO, the extra annual costs to shipping globally are only $5.85 billion (excluding the cost of scrubber installations for those ships sticking to 3.5% and not switching).

But as soon as the assumptions become more realistic, the cost estimates start to rocket. Analysts differ widely on the share of shipping demand that would use marine distillates to meet the 0.5% cap, and the share that would have access to a cheaper, ultra-low sulfur residual fuel blend. Ensys models both a 50-50 uptake of the two fuels and a 90-10 uptake (90% marine distillates, 10% residual) in 2020.

Over the last five years, the premium of MGO over 380 CST 3.5% bunker fuel in Rotterdam has averaged $270/mt. As an upper-case assumption, a 195 million mt switch purely to MGO to meet the sulfur cap would therefore cost the shipping industry an additional $52.6 billion annually.

"If we are thinking from 3.5% down to 0.50% sulfur on a global scale, and if that can be met in large part by a residual blend that meets combustion standards and complies with sulfur limit, I can't imagine that it would exceed middle distillate prices," said the University of Delaware' Corbett. "The MGO price has to be the upper bound of what it would cost the industry."

While the total costs of the 2015 ECA zone requirements were around $500 million, the 2020 requirements could add an annual total cost in the order of $5 billion-$30 billion for the container shipping industry alone, according to OECD figures.

Because of the sheer scale of the increased spending on fuel, and the fact that many shipping sectors have remained in dire financial condition amid structural overcapacity, some industry bodies were pushing for more time to deal with a lower sulfur cap.

Pushing implementation back to 2025 would save the shipping industry somewhere between $30 billion and $50 billion a year, media and communications manager at the International Bunker Industry Association Unni Einemo said at a Platts conference in May this year.

The IBIA, which represents both suppliers and end users of marine fuel, did not have an official stance on whether the IMO should implement this more stringent sulfur limit in 2020 or 2025, but Einemo said there are many issues that are unresolved ahead of the sudden drop to 0.5% from 2020. "It's such a brutal change, maybe it should be a phased introduction, even over six months would help," she said.

As the IMO gave a purely technical question to its consultants, on the availability of 0.50% sulfur fuel in 2020, economic considerations are not strictly within its mandate. However, many in the shipping industry worry about the increased costs that ultimately will be passed on to consumers.

As a sustained reduction in shipping costs was the underpinning of trade-fueled globalization in the 1990s and most of the 2000s, there are wider questions still to be answered about the impact of the global sulfur cap on trade, heavily import-dependent countries and inflation in the advanced economies.

TRADE FLOWS

The 0.5% global sulfur cap will shift trade flows of residual fuel as well as distillates. CE Delft/Stratas Advisors estimates that each region of the world will be self-sufficient on MGO and higher-than 0.50% sulfur fuel oil. However, on 0.5% blend, only Asia will be self-sufficient; North America, Latin America, Europe, Africa, Russian and the former Soviet states will be short and will need to import the fuel, with the Middle East looking to be the main corresponding source of oversupply. Their study predicts annual Middle East exports of 0.5% max fuels of 5 million mt to Africa, 12 million mt to Europe, 15 million mt to North America, 2 million mt to Latin America, and 2 million mt to Russian and the former Soviet states. This would be a dramatic change from current HSFO trade flows, in which Russia is a key exporter to Europe and Asia.

"A mass switch of bunker fuels from fuel oil to marine gasoil will have global repercussions," said the IEA (Medium-Term Oil Market Report, February 2016). "Regions such as Other Asia, home of Singapore, one of the world's largest bunkering hubs, will switch from a net gasoil exporter to an importer, while Europe will become even shorter of middle distillates."

The IEA goes on to say "the FSU will struggle to find markets for the overhang of fuel oil produced there. As regions flip from being net-exporters to net importers, infrastructure will have to be constructed and adapted. This will involve the reconfiguration of storage tanks to hold clean products rather than fuel oil, the construction and reversal of pipelines to take the middle distillates to coastal bunkering terminals while new bunker barges will be required as economies of scale are used to transport gasoil on larger and larger vessels, ports will have to be dredged and adapted to take larger ships."

Traders are already discussing a potentially large overhang of Russian fuel oil in the market by 2020 if there are further delays to its vast refinery upgrade program. Still, fuel oil production in Russia has been on a downward trend this year and last after a tax maneuver cut refining margins, prompting refiners to reduce throughput and boost crude exports instead. In addition, more fuel oil is being processed into higher-specification products due to the ongoing modernization of Russia's refineries. From the most recent official data available, Russian fuel oil production totaled 4.219 million mt in September 2016, down 20.8% year on year and down 9% month on month (of which exports were 3.521 million mt, down 13.3% year on year and down 6.8% from August).

The predicted switch by the shipping sector out of residual into marine distillates in 2020 is estimated by Ensys to entail a drop in global fuel oil demand of 44%, led by the decimation of marine sector fuel oil demand from 253 million mt/year in the no-cap scenario to 48 million mt/year in the capped scenario.

This will give renewed urgency to the refinery upgrade program of Russia, currently exporting more than 40 million mt/year, as well as other large exporters such as Venezuela, Malaysia and Japan. Singapore, while showing up as a significant fuel oil exporter in data, is more of a blending hub than a refiner/producer of fuel oil in its own right and if anything stands to gain from increased distillates storage and blending demand resulting from the 2020 sulfur cap.

There is not a shortage of uses for fuel oil outside the marine sector – as an energy-rich, compact fuel source it will continue to be used in industrial plants and power generation. Although the 1% sulfur cap on fuel oil used for power generation in the EU looks set to be lowered further by 2020, potentially driving it out of European electricity generation, plenty of power plants in the Middle East and Africa are bound by no such restriction and will keep burning residual.

The issue is price. The more fuel oil demand destroyed by the 2020 sulfur cap, the more supply will be pushed off the transport fuel value shelf altogether, facing a steep drop in value down and as last resort redirecting into increased bitumen production for roads.

Both of the key studies on the 2020 outlook foresee a large increase in the number of coking units – which destroy fuel oil by separating out its more valuable components to leave petroleum coke or "petcoke," a carbonaceous solid. Especially after the oil price crash, this refinery byproduct is increasingly displacing coal in power generation. In India, petcoke replaced nearly 14 million mt of high-grade coal in the last financial year, according to research agency CRISIL, primarily in kilns used by cement makers.

This type of adaptability of the energy system as a whole has plusses and minuses in terms of the goals of regulators. While the coal market weakening further, ultimately leading to a reduction in production, is a positive change in terms of reducing carbon emissions, the worry of Ensys is that the 2020 global sulfur cap of 0.5% on marine fuels, rather than just reducing sulfur emissions, also pushes some of them back on land, where they do more harm to humans.

CREDIT ISSUES

Record-low freight rates in many sectors, rising oil prices this year, and the bankruptcy of South Korean shipping company Hanjin, have put a renewed focus on credit risk. Ratings agencies do not usually monitor the credit of corporates as far ahead as three-four years, typically only making predictions up to a year ahead. However, privately they acknowledge that a 2020 global sulfur cap may well have negative credit implications for the shipping sector. But under their time horizons, the 0.5% global sulfur cap is not factored into their current ratings on shipping industry debt.

"This is a highly fragmented, competitive, cyclical and capital intensive sector with limited supply discipline, and the credit focus for most of the companies we rate at the moment is near term liquidity," one senior manager in a US ratings agency told Platts. "This is one of the highest risk sectors that we rate reflected by the low level of ratings seen and our rating and outlook horizons in this sector do not typically look further forward than the next 12 months."

ENFORCMENT

The global sulfur cap is meaningless if it is not enforced. Already some major shipping companies have formed the Trident Alliance, a group committed to "supporting robust and transparent enforcement of sulfur regulations, as well as to comply with said regulations." Its members include some of the world's largest container shipping companies including Maersk Line and Hapag-Lloyd, as well as bulk carriers including J. Lauritzen, reefer operators like Seatrade and ferry companies such as Stena Line. For companies such as these that are committed to complying, effective enforcement of the sulfur cap is the only way to ensure a level playing field with other companies that may not be as keen to comply, and through using cheaper, non-compliant fuel, undercut them on rates.

Maersk in particular has spoken out on the need for a strict enforcement of the global sulfur cap on shipping. "We at Maersk are very concerned that not everybody will comply with this," said Dea Forchhammer, senior business development manager at Maersk Oil Trading, at the Platts Rotterdam bunker conference in May. She argued that an unclear legal framework, no dissuasive sanctions, inadequate detection methods and limited resources have created a window for risk-free non-compliance with the upcoming global cap. In the 2015 ECA zone, non-compliance rates in port inspections conducted were 3% in the Baltic Sea and 9% in the North Sea, she said, but added: "Only 30% of violations were sanctioned, which is just silly… In some countries, fines are as low as $1,500, compared to savings of $100,000 per trip, per ship, in the current ECA zones [from using non-compliant fuel]. There are very few detentions, [and] very few cases of legal action."

PENALTIES FOR NON-COMPLIANCE TO SO_x REGULATIONS IN SELECTED COUNTRIES WITHING SECAs

Country	Maximum financial penalty
Belgium	Eur 6 million
Canada	CAD 25,000
Denmark	No maximum
Finland	Eur 800,000
France	Eur 200,000
Germany	Eur 22,000
Latvia	Eur 2,900
Lithuania	Eur 14,481
Netherlands	Eur 81,000 + gains
Norway	No maximum
Sweden	SEK 10 million
UK	GBP 3 million
USA	USD 25,000/d

Source: Trident Alliance

Sanctions are enforced by individual Parties to MARPOL, as Flag and Port states. There is no fine or sanction arranged by the IMO itself – it is up to individual State Parties to the convention. Since there is no global organization responsible for enforcement of emissions regulations in international waters, breaches of the global sulfur cap could lead to disputes about jurisdictional authority. However, all the key shipping organizations such as the International Chamber of Shipping have said their members will comply with the new regulation.

SCRUBBERS TO REMAIN MINORITY OPTION IN 2020

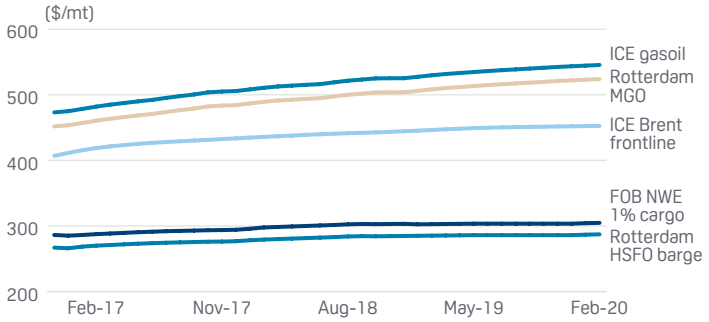
Beyond upgrading refineries to produce more middle distillates for shipowners, the other principal means of cutting marine sulfur emissions by 2020 is to clean the emissions on board the vessel. The more scrubbers are installed, the less switching from HSFO to 0.5% blend will be required, and the less strain will be placed on the global refining system.

However, scrubbers are expected to be installed on a minority of the global fleet by 2020: scrubbers are predicted by Ensys/Navigistics to be installed on ships consuming 48 million mt of in 2020 (out of total marine fuel consumption of 342 million mt/year).

Fitting a scrubber will allow a shipowner to continue burning high-sulfur fuel oil from 2020 while still complying with the new 0.5% limit. But retrofitting a vessel with this technology can cost between $3 million and $5 million, as well as some time at a shipyard in most cases.

To determine the profitability of fitting a scrubber, shipowners need to take a view on the price spread between 3.5% and 0.5% sulfur bunker fuel in 2020. If they believe 3.5% prices will plummet and 0.5% prices will climb as the demand shifts, the up-front capital cost of the equipment may appear a sensible investment. But if there is a significant uptick in shipowners fit scrubbers, the more high sulfur fuel oil demand will be preserved, and the price spread between the two fuels may be narrower than they expect. Space at shipyards may also run short over the next few years if a large percentage of the global fleet require scrubber retrofit work.

CURRENT FORWARD CURVES BY FUEL TYPE



Source: Platts

The cost-effectiveness of a scrubber is also a function of how long a vessel will spend in an ECA zone, and its remaining lifetime. Once sulfur is capped globally, all vessels will have an incentive to install one, but it will still make less financial sense for a vessel with 10 years or less of operational life.

The IEA sees scrubber installations only really picking up closer to 2020, when market signals are clearer. "As 2020 approaches, and forward curves better reflect reality, if there is a strong pricing signal – gasoil holding a high premium over fuel oil, there will undoubtedly be an increase in scrubber installation," it said (Medium-Term Oil Market Report, February 2016).

There are large differences between the penalties imposed on non-compliant vessels in various ECA zones. The penalties in North America are tougher than elsewhere: the US Coast Guard has the power to seize vessels in breach of sulfur regulations, with the owners liable for a heavy fine. In the Northwest European ECA zone, enforcement is less clear, as each EU state is responsible for policing its own territorial waters.

The ability to learn from and upscale the monitoring of compliance in ECA zones will be crucial to successful enforcement globally. Currently, enforcement is done through in-port verification of bunker fuel sulfur levels, and monitoring of vessel smokestack emissions at sea using airplanes and drones, and electronic "sniffers" on bridges. However, there is currently no failsafe detection measure for use on the open seas, said Maersk's Forchhammer. "How do you put something on a vessel that the people on the vessel can't tamper with, that's the question," she said. "We need a black box on every ship to measure what it is emitting."

HEALTH IMPACT

Given the huge costs to the shipping industry that have been covered in detail by the trade press, the question arises: Why do it? The rationale for a lower global sulfur cap is human health. Through a chemical reaction in air, sulfur dioxide (SO2) and the mono-nitrogen oxides (nitric oxide and nitrogen dioxide, commonly referred to as NOx) are converted into fine particles, sulfate and nitrate aerosols. As well as the particles directly emitted from ships such as black carbon, these secondary particles add to the health impact of pollution from shipping. Tiny airborne particles are linked to premature death, as the particles get into the lungs and are small enough to enter the blood. There they can trigger inflammations, leading to heart and lung failures.

According to Transport & Environment, a campaign group for greener transport policies, air pollution from shipping accounts for about 50,000 premature deaths per year in Europe alone, at an annual cost to these societies of more than €58 billion ($63.3 million at the current exchange rate). Therefore, forcing the shipping industry to pay billions of dollars extra each year for lower sulfur fuel is, according to supporters of the IMO's decision, merely making it pay for the externalities it has historically pushed on to the rest of society to bear. The picture becomes more complicated when the benefit to society of cheap imported goods – thanks to much cheaper shipping fuel compared to road fuels – is included. A 2020 global 0.5% sulfur cap may mean we all pay slightly more for imported consumer goods passed on through higher freight costs, in exchange for many of us living longer and for health costs to governments and individuals via insurance premiums being less than they otherwise would be.

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