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IMO ROUNDTABLE: THE FUTURE OF MARINE TRANSPORTATION

The International Maritime Organization's (IMO) decision to slash sulfur emission from ships as of 2020, confirmed last October, carries implications that go well beyond the shipping industry and could send shockwaves through crude and product markets, the refining industry, and LNG and gas markets, among others. As the deadline nears, the path to compliance is only getting foggier, as the costs and benefits of the various options available to shippers to meet the new standards—switching to lower-sulfur fuel oil, converting to LNG, or scraping emissions with on-board abatement systems—vary greatly depending on how much of the fleet adopts them. This incentivizes industry participants to delay their plans for meeting the standards, at the risk of running out of time—and thus only heightens the already high chances of noncompliance. To shed light on these complex issues and assess the market's preparedness, the Center on Global Energy Policy, in partnership with Axelrod Energy Projects and the Royal United Services Institute, gathered a select group of senior energy leaders from the public and private sectors for a roundtable conversation in London on February 20, 2017. Dr. Edmund Hughes, Head of Air Pollution and Energy Efficiency at the IMO, keynoted the meeting. The following is a summary of some of the points touched upon in the discussion, which was held under the Chatham House rule, except for Dr. Hughes's remarks, which he agreed to make public.

Although shipping only accounts for somewhere around 6 percent of world oil use (estimates vary),[1] its role in the oil market far exceeds its share of the demand barrel and is widely expected to grow further in the coming decades.[2] Shipping also plays a vital role in the global economy as by far the main mode of freight transport. Accordingly, steep changes in emission standards from marine fuels due to take effect in 2020, which represent a significant challenge for the shipping industry, will resonate well beyond this niche market. A group of 50 senior representatives from the public and private sectors, including shipping, refining, oil trading, LNG, port authorities, and emission abatement, discussed these matters in London on February 20, 2017, at a joint roundtable of the Center on Global Energy Policy, Axelrod Energy Projects and the Royal United Services Institute. The meeting followed a first roundtable discussion hosted at the same venue a year earlier, on February 8, 2016.[3]

Shipping's central place in the global economy hinges on its role as the main mode of freight transportation, accounting for 80 percent of the trade in physical goods. The bunker fuel market's importance to energy markets in general stems in part from the fact that marine transportation takes up the bulk of the supply of high-sulfur residual fuel oil, a by-product of refining for which there are few other uses. By greatly reducing demand for that fuel, the new rules could make it difficult for refiners to dispose of this otherwise largely unwanted product.

The marine sector also matters greatly to climate and environmental policy as a leading and—until now—loosely regulated source of air emissions, including sulfur dioxide, nitrogen oxide, and CO2. According to some estimates, a single large container ship emits as much sulfur dioxide as 50 million diesel cars, while a medium- to large-size container ship running at 70 percent maximum power causes as much particulate emissions as 500,000 new trucks in China.[4] Most sulfur oxide emissions from ships occur within 400 km of coastal communities, leaving some 230 million people in the world's top 100 ports directly exposed.[5]

CLOSING A LOOPHOLE

Like aviation, shipping has long been largely left alone by environmental regulators. As emissions standards gradually tightened for the rest of the oil sector, shipping and aviation were left behind. As was widely noted during COP21, both sectors were excluded from the Paris agreement of December 2015.

Change is, however, in the air. For example, the International Civil Aviation Organization (ICAO) has set fuel efficiency targets that call for an average 1.5 percent annual gain for the sector, along with a goal to halve its net CO2 emissions by 2050 compared to 2005 levels.[6] China has made aviation—including civil air passenger transport, cargo transport, and airports—one of eight industries to be covered by its national emissions trading scheme (ETS) from 2017 onward.[7]

Likewise, the gap between air emissions from shipping and land transportation is slowly closing. The first steps go back to May 2006, when an emission control area (ECA) was established in the Baltic Sea, capping exhaust sulfur dioxide from ships to a level equivalent with the air emissions produced from burning fuel with a maximum sulfur content of 1.5 percent (1.5 percent S equivalent). In November 2007, that first European ECA was extended to the North Sea and the English Channel, and in July 2010 the cap was lowered to 1 percent S across the European ECAs. In August 2012 a North American ECA was established in a 200-nautical-mile coastal band around the United States, including Hawaii and Canada, subsequently extended to the US Caribbean Sea area in January 2014. Sulfur limits were further reduced to 0.10 percent in both Europe and the Americas as of January 1, 2015. More recently, China unilaterally established its own ECAs along parts of its coast, with an initial 0.5 percent sulfur limit to be progressively implemented (first at berth within port limits, then in coastal areas by 2019). That limit may subsequently be tightened to 0.1 percent S in 2020.[8] Outside of the ECAs, sulfur standards were cut from 4.5 percent to 3.5 percent of as January 1, 2012.

An IMO decision to further reduce sulfur emission levels from ships to 0.5 percent outside ECAs takes these efforts to a new level. The move was first announced in 2008 but with some uncertainty as to its timing; even as the IMO announced it, the IMO hinted at possible delays if low-sulfur fuel supply were found to be insufficient to let shippers meet the new standards in time. It advised that a final decision would be made by 2018; depending on the findings of a commissioned study of fuel-oil availability, the January 1, 2020, target date would be either upheld or postponed by up to five years. At the CGEP 2016 joint workshop on marine bunker fuels, however, Dr. Edmund Hughes, the IMO's head of Air Pollution and Energy Efficiency, went on the record to note that in order to give market participants more time to adjust, a final decision on timing would be moved up to October 2016.

The IMO's decision to stick to the 2020 deadline was greeted with a measure of surprise when it was duly announced in October 2016, as many analysts and market watchers had apparently bet on a delay. In the "New Policies Scenario," or base case of its November 2016 World Energy Outlook, the International Energy Agency thus noted that "the global cap on maritime sulfur is cautiously assumed to take effect from 2025."[9] Dr. Hughes took great care at the 2016 CGEP roundtable not to prejudge the outcome of the fuel availability study; however, nothing in his remarks could have been construed as supporting such expectations.

IMO FUEL STUDY: DEFINING "AVAILABLE"

Speaking at the second joint CGEP roundtable on bunker fuels in February 2017, Dr. Hughes delivered a generally soothing but nuanced report on the findings of the fuel availability study[10] and the IMO's assessment of the shipping industry's readiness. The bottom line is that low-sulfur fuel supply is expected to be sufficient to meet the new standards by 2020—hence the decision to stick with that target date. Yet the study's modeling also makes clear that significant shifts will need to occur in refinery utilization and capacity, crude slate, and trading patterns. No single solution will satisfy the market on its own, but there will be a need for an "all-of-the-above" mix of industry responses, including a large shift in demand from high-sulfur to low-sulfur fuel oil, continued demand for high-sulfur oil from ships fitted with exhaust gas cleaning systems (EGCS), or scrubbers, along with a higher penetration of LNG as shipping fuel.

The good news is that in each of the study's three scenarios, supply appears adequate—but in the high-demand case just barely so. "The modeling results indicate that the refinery industry can produce sufficient amounts of the required quality in the base case, the high case and the low case while at the same time supplying other sectors with the petroleum products that they require," Dr. Hughes said. In the base case, capacity is more than adequate: the refining industry can produce as much as 24 percent more compliant bunker fuel than required. In the high-demand case characterized by low scrubber penetration and robust shipping activity, however, excess capacity is marginal. In this scenario, refinery production only exceeds demand of compliant-quality bunker fuel by 2 percent.

Even in the low-demand case, "adequate" supply means breaking from business as usual, including a jump in interregional shipping of bunker fuels. That is because the global balance between bunker fuel supply and demand masks in all configurations pronounced regional imbalances. "In all cases," said Dr. Hughes, "but especially in the high-demand case, interregional transport of marine fuel will be required. If supply and demand is to be balanced in all regions, the Middle East and in some cases Europe and Latin America may have to export fuel with a sulfur content of 0.5 percent or less to other regions."

Diving into the model's main assumptions, Dr. Hughes noted that changing sulfur standards will increasingly force the shipping industry to compete for the same type of fuel with other industry sectors, such as road freight transportation, personal vehicles (in Europe), or power generation (in stand-alone diesel units common in many emerging markets), making it necessary to forecast both bunker demand for shipping and total oil demand. Projections to 2020 were based on 2012 estimates drawn from a 2014 IMO study of greenhouse gas emissions. Shipping demand is projected to grow by 8 percent in the base case, to 12,814 PJ in 2020 from 11,877 PJ in 2012. (This is a pace of growth broadly in line with consensus market expectations reflected in IEA forecasts.) The IMO study sees LNG use for marine transport rising to 12 million tons from 8 million tons—steep growth from a very low base. Scrubber adoption is a key input variable; in the base case, 3,800 ships are fitted with EGCS, versus 1,200 in the high-demand case and 4,100 in the low-demand case (the more ships are fitted with scrubbers, the less demand there is for low-sulfur fuel). Depending on these assumptions, 2020 bunker fuel demand ranges

by 1.5 million bpd, from a low of 282 million tons (5.17 million bpd) to a high of 364 million tons (6.67 million bpd), with a middle case of 320 million tons (5.87 million bpd), up from 300 million in 2012.

Current low levels of EGCS penetration would on the face of it support the IMO's high-demand scenario, unless the pace of EGCS orders picks up soon. On the other hand, some participants indicated on the sidelines of the meeting that they thought the IMO 2014 greenhouse gas study overstated bunker demand. Some participants also argued that the IMO fuel availability study underestimated the industry's recent fuel-efficiency gains, as well as the scope for further improvements, which would in turn lead to further overstatement of future needs.

Additional assumptions regard forecast changes in global and regional refining capacity, oil prices (Brent prices are projected at $77/barrel in 2020), and refinery utilization rates (hydroprocessing and desulfurization units, etc.). Crude distillation capacity is assumed to grow by 8 percent, coking capacity by 35 percent, hydrocracking by 37 percent, and catalytic cracking by 6 percent.

Most of shipping demand for low-sulfur fuel by 2020 ends up being met by a new low-sulfur residual fuel oil blend (LSFO) rather than marine gas oil (MGO). Global MGO production plunges by almost 40 percent to 39 million tons in 2020 from 64 million tons in 2012. In contrast, production of LSFO, a product that did not exist in 2012, surges to 233 million tons. High-sulfur fuel oil demand becomes restricted to a relatively small number of EGCS-equipped vessels and plummets by more than 80 percent, to 36 million tons, from 228 million tons in 2012.

To meet the new standards, a triple adjustment is needed. Refiners must change their crude slate in favor of lower-sulfur feedstock. This will likely entail shifts in crude oil markets and price spreads between light, sweet, and heavy, sour crude grades. Even Middle East refiners, which normally rely on a relatively high-sulfur diet, might have to switch to lower-sulfur crudes; the high-demand case "requires refineries in the Middle East and Asia to increase the utilization rates of their refining and processing units and to change their crude slates. For example, the average sulfur content of the crude slate in the Middle East will need to be lowered from 2.01 percent in the base case to 1.99 percent in the high-demand case."

In addition to changes in the crude slate, there will be shifts in the manufacturing process. Not only does meeting the new standards entail higher crude distillation, coking, and hydrocracking capacity, but new forms of blending will also be required. All compliant fuels, said Dr. Hughes, will be blends of several refinery streams.

Finally, the trading patterns of suppliers (or the bunkering patterns of ships) must be adjusted to correct regional imbalances: "In most cases the Middle East has an oversupply, while in some cases other regions have a higher production than consumption as well. Regional imbalances can be addressed by transporting fuels or by changing vessels' bunkering patterns."

ENFORCEMENT CHALLENGES

A major topic of discussion raised by Dr. Hughes's presentation was an issue on which it did not dwell prominently, that of enforcement and (non-) compliance. In addition to the three ways of meeting the new sulfur targets—scrubbers, LNG, low-sulfur compliant fuels—identified by the IMO study, participants cautioned that "as a ship owner there is a fourth, unconventional option to consider and that is not to comply with MEPC 70"; that is, the policy set at the 70th session of the IMO's Marine Environment Protection Committee (MEPC 70), the body that set January 1, 2020, as entry-into-force date of the 0.5 percent global sulfur in marine fuel cap.

Several discussants predicted noncompliance would be pervasive due both to the cost and difficulties of meeting the new specs and the IMO's lack of enforcement capacity. Lax inspections and toothless penalties in the ECAs hint at even weaker implementation on the high seas, where inspection is even more problematic. Indeed, participants suggested, noncompliance may constitute one of the industry's main responses to the new regulations.

The potential for lax enforcement and sporadic implementation of the new measures is an issue of grave concern to industry, since it would not make for a level playing field but would effectively penalize compliant companies and put them at a disadvantage versus delinquent ones.

Quality standards (such as the IMOs) are inherently more challenging to enforce than technical ones, since compliance is less straightforward to assess. As far as quality standards go, however, emission standards for ships are especially problematic due to a combination of jurisdictional and technical factors. There is no environmental police patrolling the high seas. The IMO does not have jurisdiction over international waters, nor does it have enforcement powers. It has not been mandated to verify compliance. The performance history and commitment of member states, which are responsible for enforcing maritime rules in coastal waters, varies greatly by country. On the high seas, that responsibility falls to flag states such as Liberia or the Marshall Islands, whose enforcement capacity is limited at best.

From a technical standpoint, too, enforcing sulfur emission standards for ships raises difficulties. In ECAs, compliance with sulfur rules is typically verified via book checking, which is easy to tamper with. In some circumstances the authorities request a fuel sample, but there are not many technically able inspectors who can carry out these checks. Inspections are usually done in ports; however, port authorities cannot test on previously used fuel.

Enforcement via sulfur "sniffers," satellite detection, and/or unannounced flyover was found to be the most efficient to date based on examples from monitoring efforts in ECAs. However, such techniques require a dedicated team and substantial investment, which few countries or flag states can afford.

Most ports find it difficult to impose fines on ships for violating environmental rules. When they do, the amounts tend to be negligible. Violations are treated as administrative offences rather than criminal ones. One participant cited a case in which the guilty party was charged a grand total of €15—less than a parking ticket. A $40 million fine imposed on a cruise ship in the United States for unlawful water discharge appeared to be an exception to the rule. Fine amounts tend to pale in comparison with the "rewards" that can be gained from bending the rules.

In the ECAs, according to research conducted by one of the participants, noncompliance may today be as high as 20 percent, even in the absence of any practical barrier to meeting the rules, considering that low-sulfur fuel supply today is more than adequate. This does not augur favorably for the implementation of standards that may raise much greater challenges to satisfy. Some discussants felt that marine fuel distribution and marketing made it easy for suppliers to "fall short" of contractual commitments and fostered a culture of fraud and chronic contract violation that could prove a fertile ground for noncompliance.

Participants noted that the challenge for IMO member states was to ensure collective enforcement of the new measures. Only a shared, credible threat of punishment if caught cheating can drive demand for new fuels, which in turn will drive the investments required to make those fuels available. There was widespread agreement around the table that enforcement was the biggest challenge. Effective enforcement measures require coordination and commitment from flag states and port authorities, as well as needed investments. The IMO lacks, however, both the funds and the authority to set up a flotilla capable of enforcing its rules on the high seas.

Dr. Hughes conceded that the strength of international regulations lies in their enforcement, with the need for a level-playing field in the industry important to ensure fair competition. But he pointed to positive signs as well. With regard to consistent enforcement of the requirements, the IMO had approved "guidelines for onboard sampling for the verification of the sulfur content of fuel oil used on board ships." It also approved the amendments of Appendix V of MARPOL Annex VI,[11] "Information to be included in the bunker delivery note," which requires bunker suppliers to provide fuel buyers with written, detailed information on their deliveries.[12] The expectation is that shipping industry players will lead by example because they know that widespread noncompliance could lead to a call for more rules, including, for example, a ban on the carriage of noncompliant fuels by ships not fitted with an approved EGCS. In certain jurisdictions, enforcement is taken seriously, Dr. Hughes noted. Compliant companies will exercise pressure to bring delinquent competitors in line, including requesting their flag states to work through IMO to toughen rules, if required.

Should the 2020 requirement fail to be uniformly implemented across the board, member states could take it up within the framework of the Paris Memorandum of Understanding on Port State Control (Paris MoU PSC). For example, already at its 49th Committee meeting of May 2016, the Paris MoU agreed on a "Concentrated Inspection Campaign" on MARPOL Annex VI in 2018, designed to bolster compliance with the existing rules and to prepare more PSC authorities for the forthcoming 2020 rule.

Finally, some participants took comfort in the high degree of concentration of the shipping industry, noting that noncompliance would not equally affect all firms but would likely be more characteristic of smaller players. Ship owners operating fleets of up to 500–600 vessels daily would be more likely to comply, despite the large initial investments that may be involved. Representatives of companies operating such large fleets present at the meeting expressed their resolve to lead by example. Economies of scale and the resulting efficiency gains might more than offset for these firms the cost of noncompliance by smaller players.[13] Technology may also help, with "smart engines" enabling effective quality control. Any country unsatisfied with the shipping sector's response to IMO regulations may take the matter into its own hands and issue new policies, a participant argued.

A participant asked if the IMO would establish a task force to deal with enforcement issues. Dr. Hughes said a draft work program had been prepared ahead of MEPC 71 in July 2017, the scope of which will consider enforcement and transitional issues, including those associated with fuel quality and supply.

BUNKER SUPPLIERS ON THE FENCE

Reviewing the various options identified by the IMO report for ship owners and operators to get into compliance with the new sulfur rules, roundtable participants noted that while the standards had been attracting growing scrutiny from all concerned parties, few investment decisions had been taken just yet. Even as they credited the IMO with bringing clarity to the market by upholding the January 2020 deadline, they cautioned that uncertainty on execution was only rising.

On the fuel-supply front, few refiners appear to be factoring the bunker rules into their planning. With a few exceptions, current refinery expansion plans, although they will directly or indirectly affect the supply of residual fuel oil and middle distillates, do not appear to be primarily driven by bunker fuel considerations. Given the shipping industry's uncertain response to the new rules, those refiners for whom the bunker market is only a sideline are sitting on the fence. For many refiners, participation in the bunker market is too peripheral to drive investment decisions, and the small volumes supplied do not justify the hefty cost of capacity upgrades.

Larger bunker suppliers have been experimenting with new LSFO blends and are positioning themselves to offer shippers multiple and flexible fuel options, including MGO, LSFO, regular high-sulfur residual fuel oil (HSFO), and even LNG. Those refiners with desulfurization capacity expansion projects underway will naturally tend to be at an advantage in supplying low-sulfur bunker fuels. The longer shippers defer their response to the new specs, the more likely they will be to rely, at least initially, on lower-sulfur fuel oil, since that is the option with the shortest lead time and lowest upfront investment. The resulting burst of lower-sulfur fuel demand from ships stands to deliver fuel suppliers with windfall earnings via steep, but perhaps brief price gains.

Many analysts reckon incremental refinery capacity projects may add up to 1 million bpd or more of global distillate production capacity by 2020. This will go some ways toward meeting what could amount to 2 million bpd-2.5 million bpd of incremental lower-sulfur fuel demand, according to market participants—leaving a 1 million bpd shortfall. Bridging that gap will call for increased refinery utilization rates, a shift in the crude slate toward lower-sulfur grades, and increased product blending and shipping.

Given the long lead time of refinery projects, all incremental processing capacity expansion plans that will come on line by 2020 have already been decided, participants said. In addition to favoring low-sulfur fuel producers, new bunker fuel demand will put a premium on blending. Much of the new demand will be met by hybrid fuels produced from multiple refinery streams. Companies with competitive access to storage tank farms and infrastructure assets used for shipping and blending fuel components will benefit, as will trading firms adept at spotting and seizing arbitrage opportunities.

Conversely, reduced demand for high-sulfur fuel oil will undermine smaller, less sophisticated refineries, notably in Europe, discussants noted. The market could be in for a new round of OECD refinery closures. Pressure will continue to build on simple Russian refineries—a leading source of global HSFO supply—to upgrade or close down. Large amounts of refining capacity have already been shuttered in Europe and Japan in recent years. A new round of industry restructuring, notably in Europe, would further concentrate the bunker market into the hands of a small group of mega-suppliers with great flexibility and diversity across products and geographies. Small refiners with comparatively high residual fuel oil yields would be at increased risk of closure. Others would benefit from their demise.

The benefits of increased low-sulfur fuel demand may prove fleeting, however, as a widening price spread between LSFO/ MGO and HSFO would incentivize investment in scrubbers, which in turn would support HSFO.

EGCS: MANY INQUIRIES, FEW ORDERS

Representatives from the scrubber industry reported a material increase in inquiries since November 2016, after the IMO reaffirmed its January 2020 deadline, but no meaningful impact on their order book just yet. Scrubbers are big-ticket items, with a price tag ranging from $1 million to $6 million depending on size and specifics. Typical scrubbers average around $2 million, with another $1 million for installation. Installing a scrubber also requires that the ship be put in dry dock for some time. And scrubbers take up space and may require cargo space to be sacrificed, which may not always be cost-effective. There are no enormous breakthroughs in term of size. Thus, retrofitting a vessel with EGCS technology only makes sense if HSFO trades at a deep enough discount to lower-sulfur fuel to offset costs and the vessel's life expectancy is long enough to allow for payback. Not surprisingly, most orders to date have been for new builds rather than retrofits.

The latest flurry of inquiries echoes the rush that preceded the tightening of sulfur standards in ECAs in January 2015, industry participants said. Shipping companies are scrambling to assess scrubber options and costs. Given both relatively long lead times and industry capacity constraints, however, the lack of investment decision so far makes it

unlikely that scrubbers will play a big part in the initial response to the new sulfur specs. In addition to the two weeks it takes to install most scrubbers, EGCSs take months to build to measure. They are not picked off the shelf. Thus, it takes approximately 6–7 months to build a retrofit for a tanker and 9–10 months for a container ship.

Scrubber manufacturing capacity is constrained, so a sudden rush of orders could further stretch wait times. Even dry dock space to accommodate fitting orders is finite.

One concern for scrubber manufacturers was that unless orders arrive in a reasonable timeframe, they would not be able to meet the expected demand by 2019. Suppliers are willing to invest to achieve production targets but depend on partners and subsuppliers who have their own constraints.

Participants noted additional concerns associated with scrubbers, notably as regards the disposal of wash water, which is discharged to sea. Some open-loop systems discharge the wash-water without any treatment or filtration, a practice that is questioned by some and restricted in some ports. Treating the wash-water onboard is a preferred option from an environmental standpoint, but also a source of additional costs.

Both open-loop and closed-loop systems discharge the wash water to sea, but the flow rates for a closed-loop system are much lower. While the open-loop discharge can be very acidic, the closed-loop discharge is closer to pH-neutral. The open-loop system is still in place and remains the preferred choice for most ship owners due to its lower cost and complexity. The IMO cannot recommend that ships not use it. The IMO has not yet reached this level of discussion, despite some countries being pressured by environmental NGOs to ban them. The Ballast Water Management Convention enters into force on September 8 2017.

Further tightening of emission standards could become a problem for EGCS-equipped vessels. While NOx standards have so far been limited to the North American ECA, they are next in line for tightening elsewhere. SOx scrubbers cannot handle NOx on their own but work well in combination with so-called Selective Catalytic Reduction (SCR) systems for NOx reduction. Potential plans to cut CO2 emissions from ships could not be addressed with current scrubbers. Installed scrubbers might become obsolete if the IMO passes more stringent regulations (NOx restrictions are imminent, and restrictions on carbon emissions are under consideration).

Restrictions on NOx emissions are currently limited to some ECAs (Tier 2 and 3 engines), but there is no proposal at the moment for international waters. NOx emission controls (Tier 3 limit for marine diesel engines) apply in designated NOx emission control areas in North America and US Caribbean Sea areas from January 1, 2016. NOx emission limits have been approved in the Baltic Sea and North Sea with a view to enter into effect from January 1, 2021.

LNG: A CHICKEN AND EGG PROBLEM

A new sense of abundance and affordability of natural gas in the wake of the US shale gas revolution and growing gas liquefaction capacity around the world is fuelling optimism about the potential of LNG as a shipping fuel. The commoditization and low sulfur content of LNG makes it a fuel of choice, not only to meet the IMO's new emission standards, but also possible future NOx or CO2 standards as well.

LNG is considered by many as their problem-solver. Supporters of LNG claim that it can reduce SO2, CO2, and NOx by 90 percent.

Natural gas production has gone up in the United States by 25–30 percent. Even at these levels, producers are making profits. The number of wells has diminished, and production has gone up—including in the form of associated gas extracted as a by-product of crude oil. Payback on investment is under a year.

LNG exports are on the rise from the United States and Australia, as well as Qatar. Imports are growing from an increasingly diversified list of new market participants. Low US natural gas prices, fuelled by robust shale supply, are spreading around the world as pricing disparities between the Americas, Europe, and East Asia start fading. Traded LNG accounts for a growing share of the LNG and natural gas markets, even as the LNG industry enjoys the prospect of growing flexibility through small modular liquefaction and regasification terminals.

The LNG industry is able to offer its products at a lower price than was previously the case. As of 1st quarter 2017, European prices for LNG are going down to $7/MmBtu. LNG is delivered to Japan at $4/MmBtu, a participant said, adding he believed that LNG costs would drop to $2/MmBtu. These are regional gas grid index prices, excluding logistics costs (terminal loading and transportation by truck or barge for into-ship delivery).

One participant in the meeting from the LNG industry boldly asserted that in two to three years' time, all new ships entering the market would run on LNG. In an oversupplied market, marketers clearly have an incentive to look for new outlets for natural gas. Shipping seems to have been picked as one potential market.[14]

Yet despite all its promise, LNG distribution infrastructure remains in its infancy, and relatively few ships are equipped to burn LNG. In order to support the development of LNG as bunker fuel, two things are needed: an extensive LNG supply infrastructure and a large fleet of LNG-fueled ships. One does not materialize easily without the other—a typical chicken-and-egg problem. Given the high cost of providing LNG loading facilities, many port authorities are reluctant to commit to such investments in the absence of a critical mass of LNG-powered ships capable of taking advantage of these services. At the same time, LNG-fueled ships require purpose-built or modified engines, special fuel tanks, a vaporizer, space for LNG tanks, etc. Shippers are naturally reluctant to invest in LNG engines as long as there are not more LNG ports available.

Most of the vessels that have been fitted with LNG burners are dedicated to short-haul fixed routes, such as Scandinavian ferries. Some cruise ships have also been converted to LNG, partly in response to customer preference for cleaner-burning, more odorless fuels. The fact that cruise ships are dedicated to fixed and predictable routes helps this transformation. Shippers requiring more flexibility in their routes are less likely to embrace LNG as long as the distribution infrastructure is not more developed and the fuel is not more widely available.

Although more and more ports are considering providing LNG bunkering, the number of ports currently offering such services or making the investments required to offer them in the near future remains limited. Most of these ports are located in Northwest Europe. As a result, the appeal of LNG as shipping fuel remains largely limited to vessels engaged in point-to-point transportation in markets where LNG bunkering is available.

Some roundtable participants expressed concern that the LNG industry is not mature enough to supply both the marine sector and the electricity sector. The necessary infrastructure to make LNG widely available for the marine sector is not yet in place.

Participants also noted the potential problem of methane leakage, a growing issue in climate-change policy. Large-scale adoption of LNG for shipping would likely invite greater scrutiny of methane emissions from ships.

The industry needs to be proactive to defuse this threat. Generally speaking, the greenhouse gas footprint of LNG is a topic that is still being discussed, chiefly because of methane emissions throughout the value chain, not just when producing natural gas, but also during the liquefaction and regasification processes.

Retrofitting ship engines to burn LNG can be very expensive; in the European Union and the USA there are governmental incentives that make it financially possible for some. Nonetheless, participants are worried that swings in natural gas prices due to changes in demand and supply could lead to a crisis. Retrofitting a scrubber will also take up less space than retrofitting an LNG engine.

MARKET CONSTRAINTS

Technology is offering shippers a growing menu of options to meet the IMO's new sulfur standards when they come into effect in January 2020, from LNG engines to emissions abatement devices to new low-sulfur fuels. Each solution has its costs and benefits, which depend to a large extent on the relative pricing of LNG, HSFO, and lower-sulfur fuels such as MGO and LSFO. The trouble is that future price spreads between these fuels will be a function of supply and demand, which in turn will largely depend on shifts in marine-sector demand for them. The more shippers adopt any given option, the less economically attractive that option will become. Thus, the cost-benefit advantages of switching to LSFO or adopting EGCS, respectively, are inversely correlated with the proportion of shippers that will adopt these measures. Awareness of this, compounding the fact that as one roundtable participant put it, the shipping industry is "not in great shape," is a powerful incentive for procrastination.

For LNG, the equation is complicated by the additional challenge of financing and developing a distribution infrastructure virtually from scratch. Like those of petroleum products, LNG prices are bound to the laws of supply and demand and may be subject to upward pressure as shipping demand increases. For now, however, the challenge is to reach enough critical mass to support the expansion of the global network of LNG ports and make it sufficiently dense and extensive to offer LNG-powered ships the same flexibility in their itinerary as oil-powered ones.

Given these constraints, it may not come as a surprise that shippers and other concerned industries are looking for flexibility from the IMO. Roundtable participants asked Dr. Hughes if the January 2020 target date could be revisited, or whether "sulfur averaging"—that is, the possibility of shippers to exceed sulfur emission targets in some cases if they outperform them in other instances, would be allowed. On both counts, there is little grounds for hope. Sulfur averaging was proposed and rejected by MEPC 65 in 2013 and will not be an option; it could potentially weaken the requirement environmentally. The 2020 target date is firm with MEPC 70 affirming the 2020 date by resolution. From a legal standpoint, the MEPC 70 decision is binding; any amendment to the rule should occur 22 months from the proposed approval before it enters into force. (The last date of an approved amendment entering into force before 2020 is during the next MEPC 71 meeting in July.) Moreover, postponing the rule's effective date would do nothing to solve the game-theory problem posed by it and would only kick the can down the road.

The only occasion for flexibility will come when adequate fuel supplies are deemed to be unavailable at a given port. It is the port's responsibility to provide ships with the compliant fuel they need to continue their journey; under international law, however, vessels cannot be delayed in their voyage. While supply and demand are balanced globally, regional shortages are projected to occur. In most cases the Middle East is projected to have an oversupply, while in some cases other regions will have higher production than consumption. Regional

imbalances can be addressed by transporting fuels or by changing vessels bunkering patterns. Still, the question was raised of whether ships can load noncompliant fuel if compliant fuel is not available. Under the draft work program, the IMO will develop a standardized system for reporting fuel oil nonavailability. It is also drafting a guidance that may assist member states and stakeholders in assessing the sulfur content of fuel oil delivered for use on ships, based on the consideration of mechanisms to encourage verification that fuels supplied to ships meet the specified sulfur limit as stated on the bunker delivery note.

While there are many ways in which market participants could in theory meet the new sulfur standards, in practice discussants saw scant evidence that industry is taking the right steps to get into compliance in a timely fashion. As industry participants are incentivized to procrastinate, a last-minute rush to get into compliance may bump against industry capacity constraints. This only reinforces the expectation that no-compliance will be a large part of the shipping industry's response to the new standards, at least initially—and that preparatory and transitional issues will arise from the shift to the new standards.

Despite the set date, the concerned industries still lack clarity and direction to commit to the large-scale investments needed to meet the deadline. The environmental incentives are there, and the political factor is understood, but the industry is skeptical about the unprecedented disruptive changes in the supply of compliant marine fuel. Ultimately, it boils down to the cost and timing of investments versus the prevailing cost of fuel at the time of enforcement. This will be a defining factor in the strategy that each stakeholder will adopt to comply with the global cap. Still, some participants foresee a deferral of the implementation date to 2025 at the MEPC 71 in July 2017.

NOTES

1 Estimates of the marine shipping market vary from a low of 3.5 percent of global oil demand to a high of 7 percent. Recent reports from the International Energy Agency offer slightly different assessments; in its latest medium-term oil market forecast, the IEA estimates it at 4 percent of world oil demand, or 4.2 million barrels per day (bpd), split unevenly between high-sulfur heavy oil (3.4 million bpd) and lower-sulfur gas oil (0.8 million bpd). In its long-term outlook, it assesses it at 3.8 million bpd, including 3.2 million bpd residual fuel oil and 0.6 million bpd diesel. International Energy Agency, Oil 2017: Analysis and Forecasts to 2017 (Paris, 2017), 104–105, and International Energy Agency, *World Energy Outlook* (2016), 117–118. The International Maritime Organization's estimate is higher, at 300 million tons (5.5 million bpd), or 6.8 percent of global demand as of 2012.

2 Rightly or wrongly, the IEA projects oil use in passenger cars, buildings, and the power sector will fall through 2040, but that oil use in maritime transportation will continue to rise.

3 See CGEP, Sulfur *Regulations on the High Seas: The Challenges and Implications of the IMO's Forthcoming Emission Limits* (2016).

4 International Gas Union, *Enabling Clean Marine Transport, Prepared for the G20 Energy Sustainability Working Group* (March 2017), 4, 10.

5 Ibid., p. 4. The IGU notes that "pollution from ports is a major contributor to premature deaths and economic losses for the developing countries" (Ibid., p. 13).

6 http://aviationbenefits.org/environmental-efficiency/open-letter/.

7 http://www.greenaironline.com/news.php?viewStory=2188.

8 http://www.nepia.com/insights/industry-news/china-emission-control-areas-starupdatestar/.

9 International Energy Agency, *World Energy Outlook* (2016), 121.

10 IMO, *Assessment of Fuel Oil Availability*, MEPC 70/5/3 and MEPC 70/INF.6.

11 MARPOL is short for the International Convention for the Prevention of Pollution from Ships. Annex VI of MARPOL addresses air pollution from ocean-going ships.

12 MEPC 70 formally adopted a mandatory data collection system for fuel consumption of ships. Ships will be required to collect consumption data for each type of fuel they use. Flag states will be required to subsequently transfer this data to an IMO ship fuel consumption database.

13 According to industry surveys, the top six container shipping companies thus account for as much as 60 percent of the world liner fleet in twenty-foot equivalent unit (TEU) terms, and the top four companies for nearly 50 percent of the fleet. See https://www.alphaliner.com/top100/.

14 See, for instance, a trade-organization report on the potential of LNG as bunker fuel released shortly after the CGEP workshop: International Gas Union, *Enabling Clean Marine Transport* (March 2017), accessible online at http://www.igu.org/sites/default/files/IGU_A4_CleanMarineTransport_Final percent20March percent202017.pdf.

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