Columbia | SIPA
Center on Global Energy Policy

70 SIPA | Where the World Connects

COLUMBIA GLOBAL ENERGY DIALOGUES

Sulfur Regulations on the High Seas: The Challenges and Implications of the IMO's Forthcoming Emissions Limits

New international regulations for air emissions from ships, due to take effect as early as 2020, carry far-reaching implications not only for the shipping industry itself but also for oil and gas markets. Uncertainties about the rules, however, loom as large as their potential impact. Depending on the findings of a forthcoming study, the International Maritime Organization (IMO), which regulates marine transportation, could delay implementation by up to five years, to 2025. On February 8, 2016, the Center on Global Energy Policy at Columbia University, in partnership with Axelrod Energy Projects and the Royal United Services Institute (RUSI), hosted a roundtable with Dr. Edmund Hughes, Head of Air Pollution and Energy Efficiency at the IMO, to discuss the progress of the IMO study and how the new standards may impact the affected industries. The event brought to RUSI's London headquarters a group of about twenty-five experts and senior stakeholders from the port, shipping, refining, oil trading, and emission abatement industries. The following is a summary of the roundtable discussion.

The shipping industry today sits on the cusp of dramatic change in the form of sweeping new regulations for air emissions. Effective January 1, 2020, the IMO plans to cap sulfur oxide (SOx) emissions from all ships operating outside designated Emission Control Areas (ECAs) at the equivalent of 0.5% sulfur fuel (0.5%S), down steeply from 3.5%S today. Regardless of how ship owners opt to meet the standards, the impact on petroleum product markets is bound to be considerable, as marine transport accounts for a substantial part of global fuel oil demand, and an even larger share of high-sulfur residual fuel oil demand.

Of the many changes facing the oil and gas industry today—the advent of shale oil and gas, OPEC's move to give up its past price management practices, the rise of climate policies and renewable energy, and so on—the new marine emission standards, although they have remained relatively below the radar, may be among the most impactful. The very fact that they have received so little attention so far could make them all the more disruptive. Less than four years ahead of the planned implementation deadline, many questions about the regulations remain unanswered. Ship owners must make decisions on the timing of implementation and carefully calculate the future market conditions in order to remain competitive. The three main options for bringing ships into compliance with the emissions caps—switching to 0.5%S liquid fuel, installing scrubbers, or converting ships to burn liquefied natural gas—all carry different costs, benefits, and risks. Poor decisions could have a negative impact on the cost of shipping goods by sea. Thus, any insights provided by the IMO into the forthcoming regulations could be helpful to the planning of companies involved in global trade.

FOR FURTHER INFORMATION ABOUT THE CENTER ON GLOBAL ENERGY POLICY OR THE COLUMBIA GLOBAL ENERGY DIALOGUES SERIES, VISIT OUR WEBSITE AT: energypolicy.columbia.edu

REMARKS OF DR. EDMUND HUGHES, HEAD OF AIR POLLUTION AND ENERGY EFFICIENCY AT THE IMO

Dr. Hughes provided a brief overview of the IMO and the regulatory framework for marine shipping. The history of the IMO, a specialized agency of the United Nations, goes back to the UN's adoption of the IMO Convention in 1948. It wasn't until 1959, however, that the organization held its first meeting. Today the IMO comprises 171 member states. Its mission is "to develop and maintain a comprehensive regulatory framework for shipping" focused on safety, the protection of the environment, security, and the efficiency of shipping. Its realm includes legal matters and technical co-operation in the pursuit of "safe, secure, and efficient shipping on cleaner oceans."

IMO emission standards are governed by the International Convention for the Prevention of Pollution from Ships (MARPOL), first adopted in 1973, specifically its 1997 protocol "MARPOL Annex VI," which entered into force on May 19, 2005. Revisions of Annex VI were passed in October 2008 and entered into force on July 1, 2010. Chapter 4 on "Energy Efficiency" was adopted in July 2011 and entered into force on January 1, 2013.

Not all IMO member states are signatories of MARPOL Annex VI. As of January 20, 2016, there were only eighty-six contracted states bound by it, but their combined registered merchant fleets amounted to more than 95 percent of the world fleet's gross tonnage. The new standards have thus close to worldwide range.

Under Regulation 14 of Chapter 4, SOx and particular matter (PM) emissions from ships have already substantially declined. SOx emissions in the ECAs have been cut to the equivalent maximum of 0.10%S fuel in January 2015, down from a 1%S maximum previously and a 1.5%S maximum prior to July 2010. IMO-designated ECAs include the North Sea and Baltic Sea (where SOx alone is regulated) and a two-hundred-nautical mile area around US coasts, including Hawaii (where, in addition to SOx, regulations also target PM and nitrogen oxide [NOx]). There is also a US Caribbean ECA with capped emissions of SOx, PM, and NOx. Finally, China has unilaterally decided recently to apply sulfur limits to liquid fuels used by ships operating within some of its territorial waters.

In non-ECA zones, SOx emissions were capped at their current 3.5%S limit in January 2012, down from their earlier 4.5%S ceiling, and are due to be further lowered to 0.5%S as early as January 2020—provided that the IMO feels comfortable with the availability of the type of fuel (or fuels) needed to attain that level. Should it determine otherwise, the IMO has said it might delay implementation by up to five years. It has pledged to announce a decision by 2018, two years ahead of the implementation target date.

In fact, Dr. Hughes said, the study may reach a decision much sooner. The prospect of an early decision by the IMO offers the promise of regulatory clarity, which is critically needed for stakeholders to map out pathways to implementation and to identify along the way the challenges and roadblocks associated with each of the main options.

The IMO's 2018 deadline for releasing the findings of its fuel availability study was initially spelled out in Regulation 14.8, which required that a review of the 0.5%S standard set forth in Regulation 14.1.3 be completed by that date "to determine the availability of fuel oil to comply with the fuel oil standards set forth in that regulation." The review, Hughes said, must take into account the following elements:

1) the global market supply and demand for fuel oil;
2) an analysis of the trends in fuel oil markets; and
3) any other relevant issue.

The review was initiated in May 2015, when the sixty-eighth session of the IMO's Marine Environment Protection Committee (MEPC 68) approved its terms of reference and set up a steering committee to oversee it—the so-called "group of experts" tasked with developing the "appropriate information to inform the decision of the parties." The steering committee is made up of representatives from thirteen member states covering most main markets (Brazil, China, France, India, Japan, Korea, Liberia, the Marshall Islands, the Netherlands, Nigeria, Singapore, South Africa, and the United States), six nongovernmental organizations (the International Chamber of Shipping, the Baltic and International Maritime Council [BIMCO], the International Bunkering Industry Association, the International Petroleum Industry Environmental Conservation Association, the Clean Shipping Coalition, and the Institute of Marine Engineering, Science, and Technology) and one intergovernmental organization (the European Commission).

Following a competitive tender, the steering committee appointed a consortium of consultancies led by CE Delft, a Netherlands-based firm, to perform the relevant analysis and modeling work. In addition to CE Delft, the consortium includes two other members. Stratas Advisors, a Hart Energy subsidiary, will do work focused on supply modeling. UMAS, a partnership between the University College London (UCL) Energy Institute and MATRANS Ltd. (a "boutique management services consultancy working in collaboration with UCL Consultants Ltd." that "[delivers] and [promotes] the services of UMAS to the broad international maritime sector covering the entire maritime stakeholder space," according to its website), will support CE Delft with demand modeling. Work by the consortium started in September.

Dr. Hughes provided insights into the IMO's work to date and the timeline of its next steps: delivery of a draft report in May 2016; submission of the final report to the MEPC by the end of July 2016; review and discussion of the report at the MEPC's seventieth session at the end of October, at which point the parties to MARPOL Annex VI may decide whether to maintain the January 2020 target date for implementation of the 0.5%SOx standard or to postpone it by up to five years. If all goes smoothly, the IMO would thus finalize the implementation target date for the new standards two years ahead of schedule. It is highly likely that a decision could be made this year, Dr. Hughes said.

This was welcome news to the participants in the roundtable, as uncertainty about the standard's effective date had been widely regarded as a major roadblock to proper planning. Given the high costs involved, premature compliance with the new standards would be commercially punishing; industry participants affected by the rules (shippers and refiners) have an incentive to delay meeting them as much as possible. Simply put, early compliers incur compliance costs sooner than needed and find themselves at a disadvantage vis-à-vis those of their competitors that come into compliance closer to the target date. It was argued that assessing fuel availability might have been a misguided objective for the IMO, since fuel will generally only be made available if and when demand is expected to materialize. Making implementation—that is, demand for the fuel—conditional on the fuel's availability runs the risk of being counterproductive by prolonging uncertainty and delaying industry preparedness.

Many roundtable participants were apparently unaware that the European Union, as Dr. Hughes recalled, had adopted January 2020 as the target date for the 0.5%S, irrespective of the IMO's findings. Several participants thought that would make it more difficult for the IMO to consider delaying worldwide adoption beyond 2020.

In practice, the looming 0.5%S cap puts ship owners in front of a choice: switch from higher-sulfur fuel oil to 0.5%S maximum fuel (whether gas oil, fuel oil, or a mixture thereof); switch from oil to liquefied natural gas (LNG); or keep burning high-sulfur fuel oil (HSFO) and strip sulfur from air emissions with ship-borne scrubbers. Each of these options has costs and benefits. Each one will likely play a part in bringing industry into compliance with the rules. Forecasting their respective role—that is, projecting the mix of industry responses to the new standards—is what the fuel availability study is all about.

The study's outcome—the output of the modeling exercise—largely depends on its inputs—the set of underlying assumptions used in the model and the way in which it's structured. While Dr. Hughes did not preview or second-guess the study's findings, the insights he offered into the model's parameters and considerations were helpful.

Regarding demand, key parameters of the modeling include:

- Including all ships over 100 GT in the modeling;
- Using 2012 as the base case year, in line with an IMO study of greenhouse gas emissions completed in 2014;
- Giving appropriate consideration to nonmarine demand for low-sulfur fuels, as the marine sector's current share of global demand for those fuels is relatively small. Dr. Hughes said the Third IMO GHG Study 2014 had identified roughly 300 million tons/year of bunker fuel demand (or 5.5 million barrels per day at a 6.7 barrels/ton conversion rate), including roughly 40 million tons per year burnt in ECAs and 250–260 million tons/year in non-ECA areas. Given

the likely significant increase in bunker fuel demand for gas oil that is expected to result from the new emission standards, a key question entails assessing the competing demands for gas oil and distillate products of similar quality;
- Consideration of the market penetration of exhaust gas cleaning systems (ship-borne scrubbers), which Dr. Hughes noted depends on the projected price differential between HFO and MGO. Put simply, ship owners will only invest in scrubbers and burn discounted high-sulfur fuel if it costs less than burning higher-priced low-sulfur fuel without a scrubber. Hughes said that today there is a price differential of $150/ton (roughly $22/barrel) between HFO and MDO, however, this price spread might widen once the 0.5%S limit goes into effect and so could serve as an incentive to resort to scrubbers. The age of the vessel also matters: return on investment on a scrubber today cannot be expected before 2020, therefore the vessel's life expectancy must go past that point;
- On the regulatory front, China's move to designate a national ECA within some of its territorial waters, which is the only new development factored in by the model;
- The availability and cost of hydrogen (used in desulfurization) as possible constraints on MGO production.

On the supply side, key parameters of the modeling include:

- Using 2012 as the base case, same as for the demand modeling;
- Bottom-up forecasting of product supply: separate regional refinery models were developed, then combined into a global model;
- Addressing concerns about what components will be used to produce or blend the 0.5%S maximum fuel oil. MDO raises numerous challenges, including cost and flash point issues. Whereas road fuels have a flash point in the mid-50 degrees centigrade, for shipping fuels the flash point requirement is 60 degrees centigrade;
- Calibration and interregional trades, which are important considerations;
- Changes in refining capacity expected by 2020, though uncertainty remains over the exact timing of the commissioning of the new units;
- Refinery shutdowns expected in Europe by 2020;
- Use of specific sulfur content of refinery feedstock preferred (not weighted average);
- A global structured balance of all products (Term of Reference 6.2.1): "closed material balance on refining operations, making sure no products are assumed to be made for which there would be no corresponding demand";
- Supply projections for mid-2019, to ensure availability on the market by January 1, 2020.

Discussion by Participants

The review's terms of reference were perhaps as notable by what they left out as by what they included. Dr. Hughes noted that price considerations were not explicitly factored in as a variable or output in the modeling: assessing the availability of fuel oil was a requirement of the review, not its cost. This could be an issue, some participants noted, since in practice costs do drive investment and blending decisions. One participant observed that at a price, 0.5%S fuel would most certainly be available.

One participant objected to surveying SOx emissions in isolation, advocating instead for a holistic approach addressing both sulfur and carbon dioxide emission limits—since the freight and refining industries will eventually need to meet both those challenges at once. Given the high carbon intensity of desulfurization, it is important to take the two sets of constraints jointly into account. Dr. Hughes said his understanding was that the refining industry's plans for 2020 were already set, including plant shutdowns, product slates, and so on.

ENFORCEMENT

The issue of enforcement, though left out of the scope of the IMO review, came into focus during the discussion. Some participants identified the IMO's lack of enforcement powers as a shortcoming that raised concerns about implementation. It was feared that patchy enforcement would make for an uneven playing field, effectively penalizing compliance. Various solutions were suggested, including requiring ships to certify that they carry abatement technology on board; making port authorities responsible for enforcement; designing guidelines to enable the sampling of fuels onboard ships; elaborating guidelines for both carrying and burning fuel; setting guidelines for sharing the burden of enforcement costs (unlike other states, Sweden charges ship owners and operators for sampling their fuel). In ECAs and coastal areas, states can be made responsible for enforcing shipping air emission regulations, participants noted; not so on the high seas, where no one has jurisdiction. The IMO is reportedly looking into data collection systems for bunker fuels that would require ships to report relevant data to their flag states, and the latter to pass them on to the IMO. The possibility of turning port authorities into enforcement agents, or making them part of the enforcement mechanism, was also debated.

One participant raised two challenges associated with scrubbers: system integrity and ease of installation. On the one hand, the scrubber systems need to be tamper-proof and immune to fiddling of SOx sensors. On the other hand, the operational burden of installing scrubbers ought to be reduced. Currently, installing sensors requires that the engine be completely stopped. This can only be accomplished when the vessel is dry-docked. Furthermore, dry-dock capacity is limited.

COMPLIANCE OPTIONS

Scrubbers

Several participants offered insights into the scrubber market and industry. As for other options, policy clarity is of the essence, given the time-consuming nature of research and development. Companies need advance notice to allocate investment spending and meet regulatory targets in time. Scrubbers can be a good option to meet low-sulfur emission targets, but the scrubber industry will only have the capacity to deliver if it is allowed to plan ahead.

Emission abatement technology has already been tested under current market conditions. But while hundreds of vessels have been fitted with scrubbers as of today, incremental demand ahead of the 0.5%S cap has so far been relatively muted. There was a small boom in vessel retrofitting ahead of the 2015 ECA rule. Since then, however, the oil market crash and relatively low diesel prices due to weaker-than-expected demand have reduced the urgency of investing in scrubbers. Not only have fuel prices in general been a lesser concern for shippers, but the price spread between distillate fuels (such as MDO and MGO) and HSFO has narrowed, thus reducing the cost of low-sulfur distillates in both absolute and relative terms. Meanwhile, there is room for improvement in technology to meet the new phase of regulatory emission controls.

The size, capacity, and scalability of scrubbers was raised as a potential issue when dealing with relatively stringent emission standards. At the top of the range, only a handful of vessels have so far been equipped with scrubber installations of up to 100 MW capacity. Scrubbers are available in all sizes from 0.5 MW to 70 MW or more, with the largest installed unit having a capacity of approximately 45 MW per scrubber. Power and installation requirements vary by the type of vessels, with cruise ships being of higher complexity than container ships. Participants voiced concern over human resource constraints, noting a shortage of engineers capable of designing the systems to be installed onboard.

Closed- and open-loop designs have pros and cons. Closed-loop designs require that the water be cleaned before it is let out to sea, open-loop wash-water may in some conditions be discharged directly to sea, though cleaning systems are also available for open-loop. Some countries talk of banning the discharge of ballast water and scrubber wash-water in their waters. Closed-loop designs need less water to reduce SO2 and can use either fresh water or seawater, depending on the manufacturer. Hybrid scrubbers, as their name indicate, are a combination of the two. There is no clear trend in favor of any model so far.

From a ship owner's perspective, one of the downsides of scrubbers, a participant noted, is the increase of the operational complexity of the ship and thus the potential necessity of more hands on deck. This runs contrary to the industry's efforts to cut back on staff to reduce costs. Scrubbers are expensive and require high upfront capital expenditure, and the economic case for adopting them is not straightforward. Open-loop models can be a public relations risk as the public may frown upon discharging wastewater in open seas. There is a risk that ship owners may invest in scrubbers, only to find them obsolete and ineffective if regulations change again and sulfur and/or carbon emissions standards are further tightened. In addition, scrubbers may take away from cargo capacity. Thus, they may not be a silver bullet, especially on larger vessels.

LNG Bunker Potential

Although liquefied natural gas has been identified as a promising low-sulfur fuel for shipping, so far LNG adoption has been largely limited to inland vessels. Lower natural gas prices in the United States, compared to other markets, have made LNG a particularly attractive option in North America, though LNG lost its shine somewhat once oil prices started following natural gas prices' downward spiral. With the oil price collapse, LNG looks less attractive, but that could change again in the event of a rebound in oil prices.

Participants said the potential growth in LNG bunker demand was enormous. A port operator said the port had been talking to many ship owners who were considering the switch to LNG bunker fuel. While LNG bunker fuel may seem an answer to multiple problems, LNG transport prices remain challenging. Technical applications on large vessels are still new, and there is room for efficiency gains and other improvements. LNG looks a better option with new builds, according to some participants. In contrast, retrofits are too expensive, which limits the impact of LNG.

Low-Sulfur Resid

Roundtable participants also debated the potential of fueling ships with low-sulfur residual fuel oil. Currently, refinery production of such low-sulfur fuel is limited to Japan, and to a lesser extent Taiwan. Unlike most countries, Japan has extensive resid desulfurization capacity in its refining industry. Given the high cost of desulfurization, participants took the view that refiners would sooner invest in coking capacity and maximize their yields of higher value-added, versatile products such as diesel, rather than turn out high-cost low-sulfur residual fuel oil.

CONCLUSION

Participants generally welcomed the prospect of more policy certainty regarding the timetable for the implementation of the IMO's upcoming marine air emission limits. They, however, felt that many questions remained as to the pathways that shippers and other stakeholders were likely to adopt to comply with the new rules. While switching from residual fuel oil to marine gas oil might look attractive at today's prices, large-scale adoption of that option would inevitably cause the price spread between the two products to widen, thereby in turn increasing the appeal of scrubbers. LNG's attraction as a clean fuel varied across regions and vessel types, participants agreed. There would not be a one-size-fits-all solution to the challenge of the new rules. Instead, industry would likely rely on a mix of options, with compliance strategies and the rationale for investment decisions varying case by case. Some participants also noted that costs might not be a critical issue, assuming sufficient confidence in enforcement mechanisms. Many industry participants would likely pass down their costs, making the issue potentially less prohibitive than it might appear for ship owners, though it would raise the cost of shipping goods at sea. The new regulations could provide a boost to refining margins and would likely provide a generous fillip to the still-young ship-borne scrubber industry.

ABOUT THE CENTER ON GLOBAL ENERGY POLICY

The Center on Global Energy Policy provides independent, balanced, data-driven analysis to help policymakers navigate the complex world of energy. We approach energy as an economic, security, and environmental concern. And we draw on the resources of a world-class institution, faculty with real-world experience, and a location in the world's finance and media capital. Visit us at energypolicy.columbia.edu

facebook.com/ColumbiaUEnergy

twitter.com/ColumbiaUEnergy

ABOUT THE SCHOOL OF INTERNATIONAL AND PUBLIC AFFAIRS

SIPA's mission is to empower people to serve the global public interest. Our goal is to foster economic growth, sustainable development, social progress, and democratic governance by educating public policy professionals, producing policy-related research, and conveying the results to the world. Based in New York City, with a student body that is 50 percent international and educational partners in cities around the world, SIPA is the most global of public policy schools. For more information, please visit www.sipa.columbia.edu