Executive Summary

A recent regulation by the International Maritime Organization (IMO) sets a global limit for sulphur in fuel oil used to power ships at 0.5% (by mass) from the current 3.5% starting in January 2020. This more stringent regulation restricting emissions from ships plying international waters could significantly change the crude oil landscape at regional and global levels. For example, the 2020 IMO sulphur regulation would require the removal of up to 12,000-16,000 tonnes per day of sulphur contained in the 3-4 million barrels/day of high sulphur bunker fuel used for marine transport. This change will propagate through the value chain; from the marine industry that will seek replacement fuels to refiners that produce bunker fuel, and to upstream oil producers who produce crudes that generate high sulphur residues used in bunkering.

Canada is one of the major producers of high sulphur heavy crude oil with production growing steadily since 2008. Bitumen production is expected to reach 3 million bbl/day by the end of 2018 and continue increasing. Canadian heavy sour crude is refined primarily in Canada and the United States (US) where there are sufficient capacities of complex refineries to handle this type of crude. Canadian bitumen contributes very little to bunkering since it is consumed by the complex refining in Canada and the US. Instead, Canadian crude will have to compete for US refining space on netback refining value with other crudes that currently contribute to High Sulphur Fuel Oil (HSFO) supply. The Canadian Energy Research Institute (CERI), therefore, used a refinery modelling and optimization approach to investigate the impact of the IMO regulation on Canadian crude production and price.

CERI Refinery Optimization Modelling

CERI developed an optimization model to account for US refinery configurations and their operating costs, capital investments, crude oil blending, and the associated refinery acquisition costs of crude blends, product slates and their market values, thus requiring the development of revenue forecasts from the sales of refinery products. The results show that the optimization of US refineries at a Petroleum Administration Defense District level (PADD-level) can lead to a potential displacement of some volumes of certain crudes that have historically been processed in some PADDs. Also, our results indicate that heavy sour crudes are likely to displace mostly light sweet and medium crudes in a logistically and operationally unconstrained environment. In addition, increases in heavy sweet crudes are expected in some PADDs.

With the imposition of more realistic constraints, the magnitude of these displacements is reduced - mirroring recent crude receipts with optimal refinery margins. These results are driven by cheaper heavy crudes, yield levels of high-value product slates, and profitability of the process. The refinery margin improvements obtained from the realistic optimal case range from a 75% to 300% increase in profit, with the most notable improvement coming from PADD 1 (the US Eastern region) but no improvement recorded for PADD 4.

Non-Compliance Scenarios

Non-compliance regarding this new regulation is a serious concern for the IMO. CERI developed scenario and price outlooks for various crude diets and refinery products for 2020, 2025 and 2030. This facilitated the analysis of future prices for middle distillates, represented by ultra-low sulphur diesel. Three non-compliance scenarios are assessed:

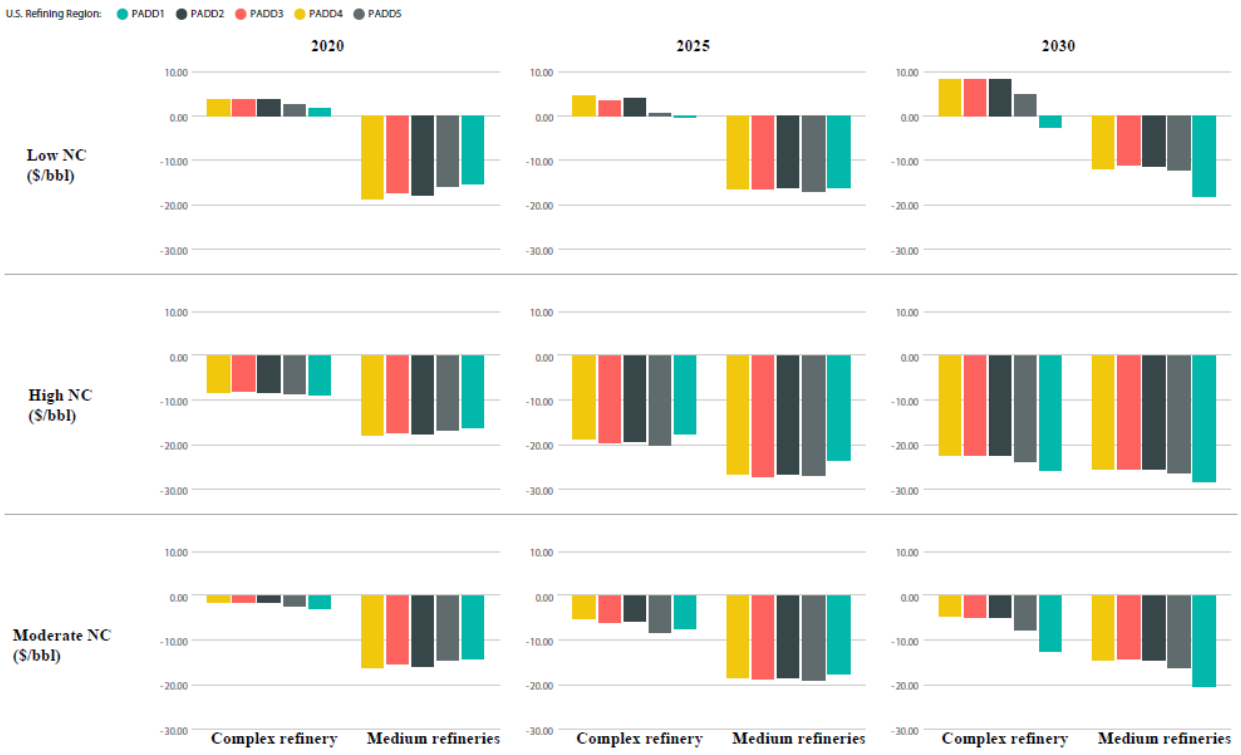
- **Low non-compliance** (Low NC) – assumes 80% compliance (20% non-compliance) by 2020 given up to 80% of global trade occurs between regions where ECA is in force and other regions of the world.
- **Moderate non-compliance** (Moderate NC) – assumes 75% compliance (25% non-compliance) by 2020.
- **High non-compliance** (High NC) – assumes 70% compliance (30% non-compliance) by 2020.

These scenarios consider the fact that non-compliance will differ across geographical regions, for example in regions known for strict enforcement versus those known for less rigid enforcement.

IMO Regulation: Impact on US Refinery Margins

Changes in resid and distillate prices will reduce refinery margins to a notable degree, particularly those of simple and medium refineries (Figure E.1).

Figure E.1: Refinery Margin Impacts Due to IMO 2020 Regulation



Our analysis indicates a general trend of decreasing refinery netbacks in the years after 2020 in all the non-compliance scenarios for medium refineries; complex refineries enjoy increased margins in the Low NC scenario. Under the Low NC and Moderate NC scenarios, which are considered the plausible scenarios given the low probability of the High NC, the IMO regulation impacts will bring about a refinery margin loss of $16/bbl to $20/bbl between 2020 and post-2025 relative to average 2017 margins.

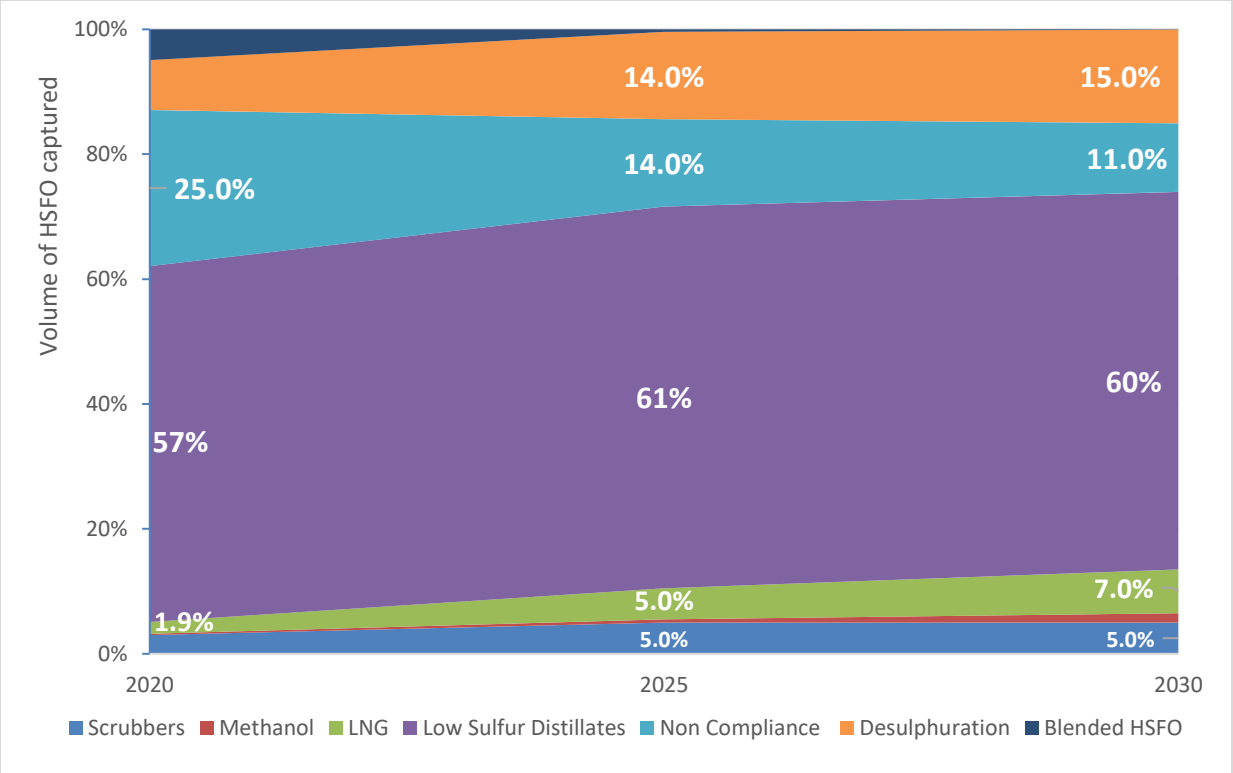
Although some PADDs will have low margin reductions and even an increase in margins for some by 2020, we expect the highest margin reduction refineries, in this case, the medium refineries in the US, to set the prices for heavy sour crudes and determine the light-heavy crude price differentials.

A general trend of declining margins for some years after 2020 results from an expected drop in prices of middle distillates as the market rebalances and the distillate prices drop to normal levels. Unfortunately, the price of resid will not recover at a rate that can stabilize the refinery margins, and thus, cannot cushion the effect of the rebalancing middle distillates prices. This is because the effect of price movements of the middle distillates outweighs the margin-boosting effect from slowly increasing resid prices.

Scenario Assumption and Compliance Options

The Moderate NC scenario is chosen to assess how different options can substitute resid bunker fuel volumes by 2020, 2025 and 2030 (see Figure E.2).

Figure E.2: Resid Bunker Fuel Substitution Effects under the Moderate NC Scenario



Once the rules take effect, almost 60% of the shipping industry fuel currently using high sulphur resid will need to switch to either marine gasoil or a blend of high sulphur and ultra-low sulphur middle distillate marine fuels. Under the Moderate NC scenario, we estimate that scrubbers will be used for only about 3% of the HSFO volume by 2020. Adoption of scrubbers is likely to increase moderately and peak by 2025 where about 5% of the resid bunker demand is consumed in tandem with scrubbers. CERI projects that LNG will replace about 1.9% to 7% of resid bunker fuel volume during the study period.

Conversion additions, mainly in China and India refineries, between end-2017 and the beginning of 2020, amount to 1.7 million bbl/day, nearly split between coking, hydrocracking and catalytic cracking (S&P Global Platts, 2018). The location of the refineries makes it improbable that these conversion capacities will contribute significantly to low sulphur marine bunker fuels.

About 240,000 bbl/day resid hydrodesulphurization capacity can be assumed to contribute to low sulphur fuel oil by 2020. This number will increase in the future as the increase in the light-heavy product differentials is expected to motivate investments in desulphurization. Desulphurization will capture up to 14% planned additional refinery resid hydrodesulphurization capacity by 2025.

Increasing refinery utilization capacities will be part of the solution to the bunker fuel availability problem but will equally add to the problem of resid glut. This is because more resid will be produced as refiner's process more crude. World refineries can produce about 1.3 million bbl/day of distillates together with 1.2 million bbl/day heavy fuel oil and related products. A 10% increase in the global refinery capacities will result in 2.6 million bbl/day of distillates together with 2.3 million bbl/day heavy fuel oil and other products by 2030. In each case, large amounts of distillates that can bridge the gap of cleaner bunker fuel demand can be produced, thereby keeping high sulphur fuel oil prices low. Additionally, the world is reaching peak gasoline demand and would not need the additional naphtha generated by the added crude processing.

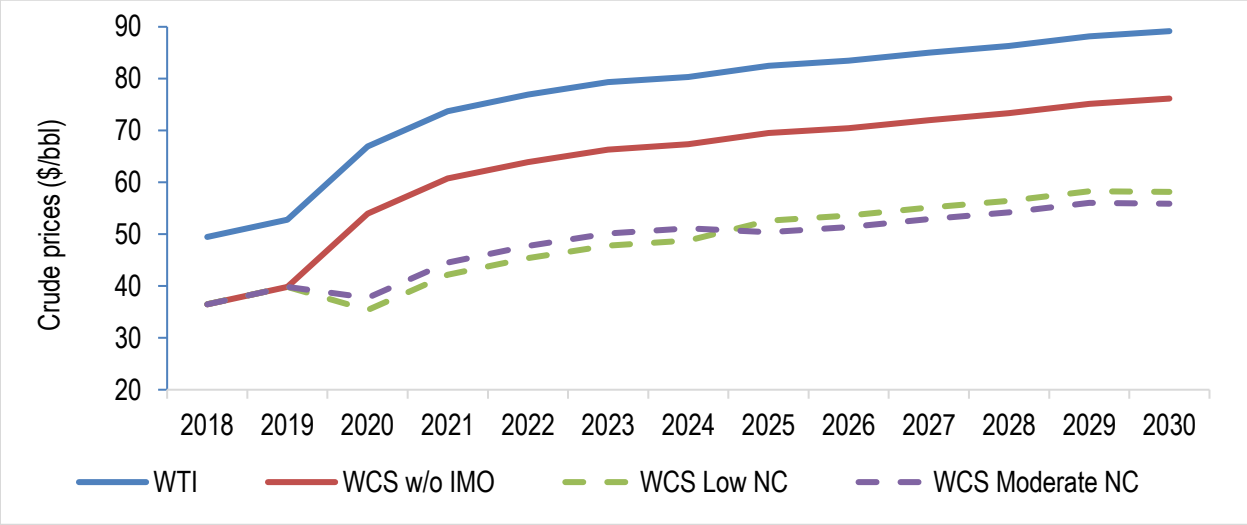
The reason refiners are not making costly refining modifications like adding new coking capacities at faster rates may be because the price volatility that will be created from the IMO rule implementation is not expected to last long enough to make such investments viable. Markets are expected to rebalance in a couple of years, and this discourages significant capital investments in complex refining units, which have payback periods of at least two decades. Also, there seems to be enough room to process more crudes to meet the expected increases in demand for distillates for marine fuel use, but this does not address the problem of the residual oil glut arising from the introduction of the IMO regulation.

Slow-steaming of ships is another approach the shipping industry may likely employ to save fuel costs by consuming less fuel. Given that shipping fuel consumption has a velocity-squared relationship, a slight reduction in ship speeds by a few knots (equivalent to 1.85 km/hour) will lead to a significant reduction in fuel consumption and costs. Our analysis shows that reducing ship's speed to achieve a 25-50% reduction in fuel consumption is possible if the compliant fuel prices skyrocket.

Impacts on Canadian Heavy Oil

The price discount on Western Canada Select (WCS) crude with respect to the West Texas Intermediate (WTI) price point will expand significantly due to the IMO regulation. Figure E.3 illustrates how the refinery margin loss affects the WCS (heavy sour) pricing relative to WTI (light sweet). The dotted lines represent the WCS pricing that is historically discounted at $13/bbl plus the discounts resulting from the IMO regulation for the three scenarios considering a medium refinery in the US.

Figure E.3: WTI and WCS Price Differential (2017 US$)



Source: CERI

Under the plausible scenarios, a refinery margin loss of $16/bbl to $20/bbl between 2020 and post-2025 is expected to be directly transferred to a light-heavy differential. The cumulative differential which includes the historical WTI-WCS discount of $13/bbl sums up to $31/bbl-$33/bbl of WTI-WCS differential within the study period.

Our analysis shows that new SAGD projects with SORs of less than 3 m^3/m^3 are likely to break even when the IMO regulation is introduced whereas those with SORs greater than 3 m^3/m^3 will operate at a loss. A significant volume of SAGD-derived bitumen production could be affected. Based on SAGD production data, about 574,000 bbl/day of bitumen produced in Alberta has an SOR of more than 3 m^3/m^3 (CanOil, 2017).