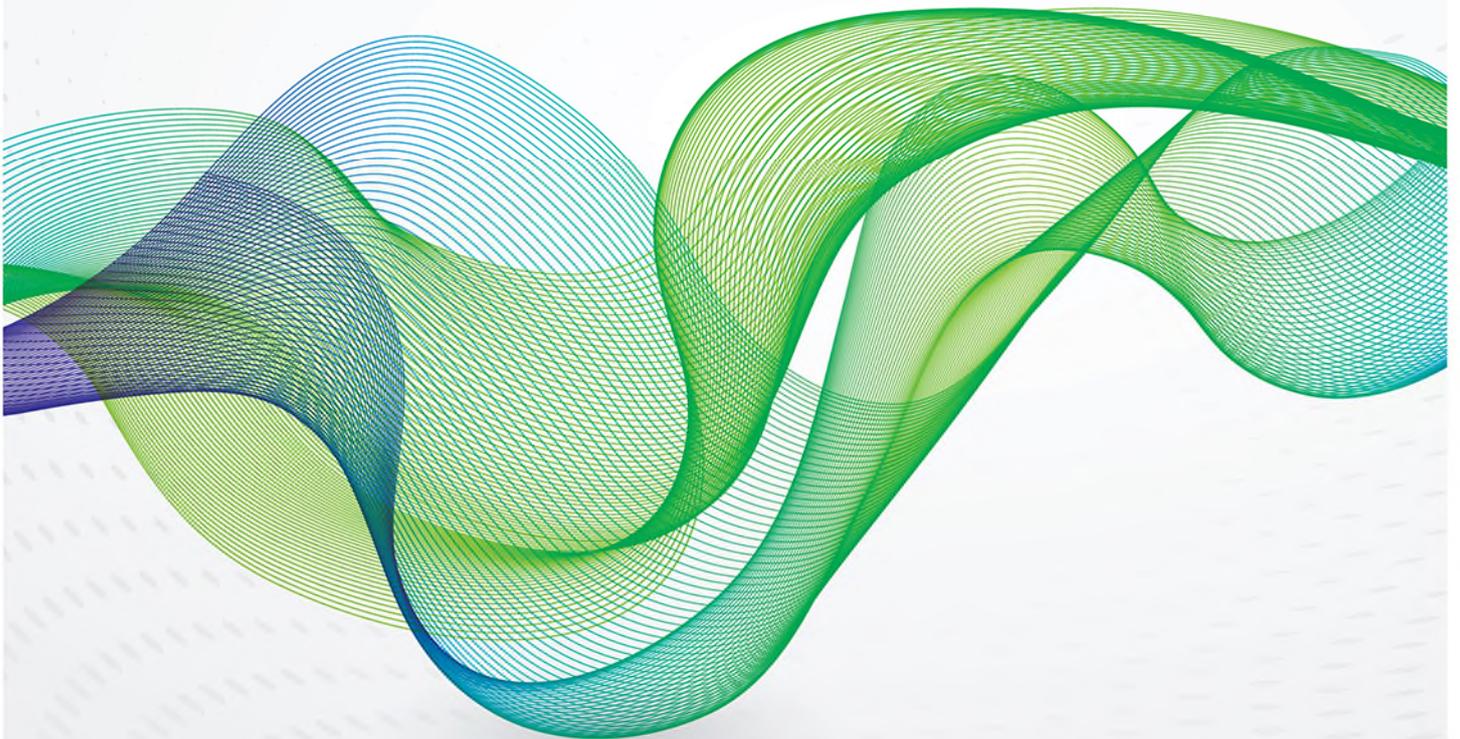




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# The COVID-19 Shock and the Curious Case of Missing Barrels



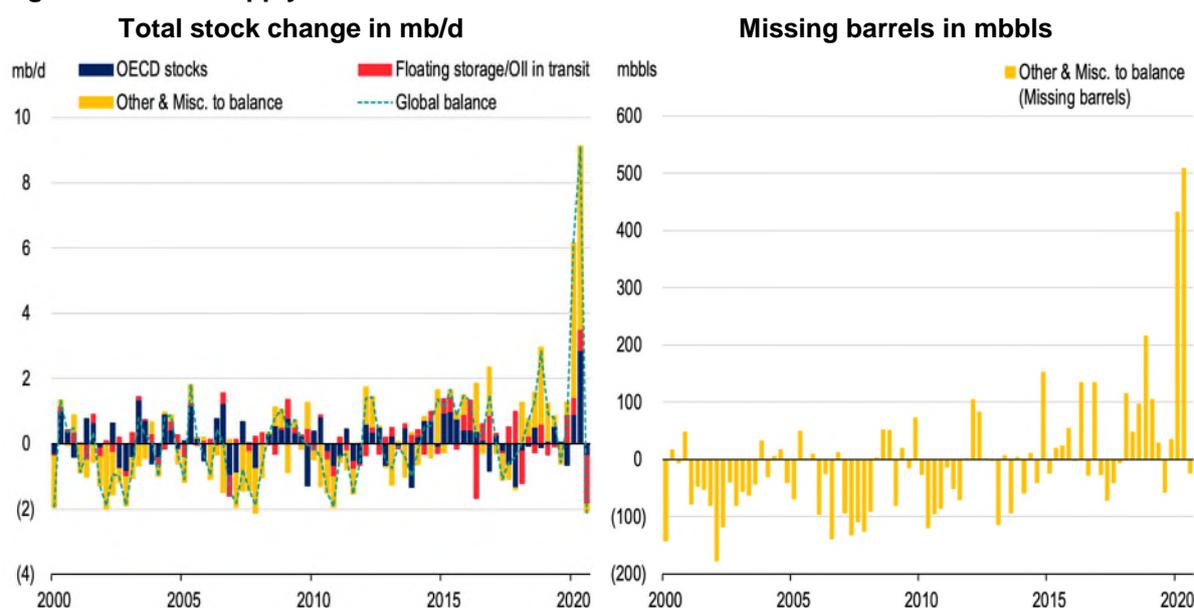
OXFORD ENERGY COMMENT

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## Introduction

In almost every oil cycle, the market is confronted with the problem of ‘missing barrels’, the gap between the change in inventory implied by global supply-demand balances on the one hand and the observed change in inventory levels by commercial and government entities (adjusted for floating storage and oil in transit) on the other hand. Based on IEA global oil balances, the surplus during the first three quarters of 2020 averaged around 4.4 mb/d, with the surplus in the first half of 2020 reaching a record level of 7.6 mb/d due to the severity of the demand shock and the break-up of the OPEC+ agreement in March. This implies an inventory increase in H1 2020 of 1,390 million barrels (mbbls), before declining by 194.2 mbbls in Q3. According to the IEA, out of the total stockbuild in the first half of the year, total OECD stocks accounted for 344.3 mbbls or 25% of the total increase, floating storage and oil in transit accounted for 105.3 mbbls or 8% of the total increase and the remaining 940.4 mbbls or 68% of the total increase to balance is essentially unaccounted for including changes in non-reported stocks in OECD and non-OECD areas that the IEA labels as “Other & Miscellaneous to balance” (see Figure 1). The volume of missing barrels in H1 2020, is the largest ever recorded gap between observed and implied stocks since at least 1990, being three times larger than previous historical downturns such as in H1 1998 and more recently the H2 2018 downturn and nearly 10 times larger than the imbalance of H2 2008 in the aftermath of the global financial crisis.

**Figure 1: Global supply/demand balance**



Source: IEA, OIES.

As discussed by Mabro<sup>1</sup> and Horsnell<sup>2</sup>, the ‘missing barrels’ problem can arise due to a number of factors. The most obvious reason is that models could be generating ‘artificial barrels’ by underestimating demand and overestimating supply. As noted by Horsnell<sup>3</sup>, ‘the truth is we observe the oil market with very little precision.... Demand is observed imprecisely with huge lags’ and ‘supply is

<sup>1</sup> Robert Mabro, ‘Transparency in the Oil Market and Other Myths’, Oxford Institute for Energy Studies, <https://www.oxfordenergy.org/publications/transparency-in-oil-markets-and-other-myths/>

<sup>2</sup> Paul Horsnell, ‘The Strange Case of Missing Barrels’, Oxford Institute for Energy Studies <https://www.oxfordenergy.org/publications/the-strange-case-of-the-missing-barrels/>

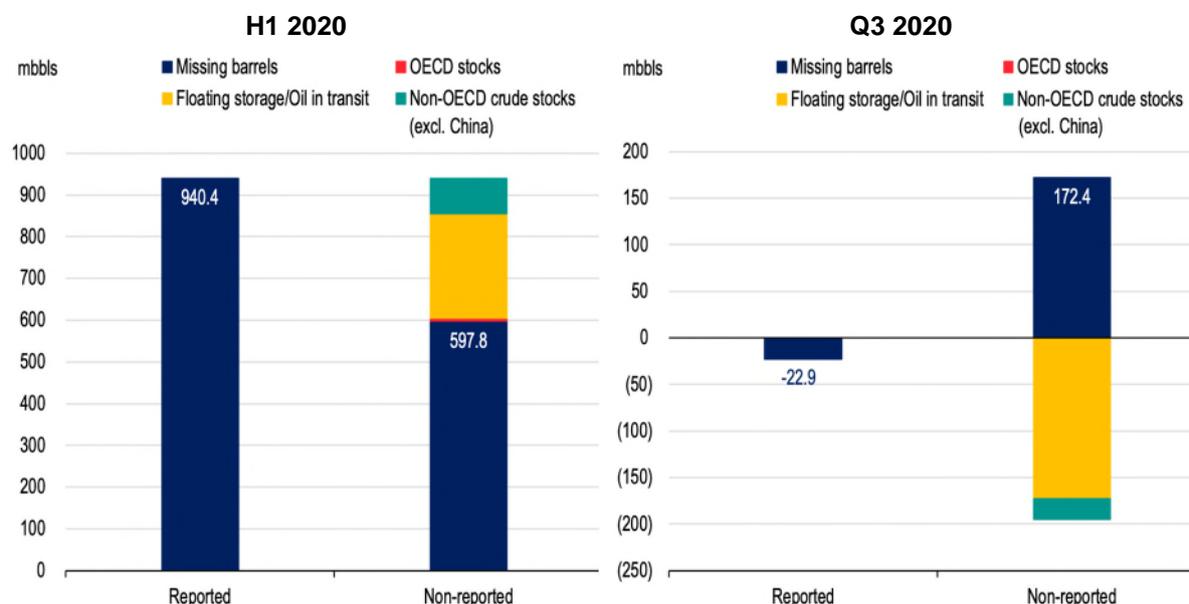
<sup>3</sup> Paul Horsnell, ‘The Strange Case of Missing Barrels’, Oxford Institute for Energy Studies <https://www.oxfordenergy.org/publications/the-strange-case-of-the-missing-barrels/>

observed imprecisely particularly from OPEC countries<sup>4</sup>. The severity of the oil crisis in 2020 due to the global coronavirus pandemic led to the break of some key relationships (for instance between economic growth and oil demand) and models had to be calibrated to account for the severity of the shock (for instance, including indicators of the severity of restrictions across countries).

Another factor is the coverage and quality of data on stocks. As noted by Mabro<sup>5</sup>, ‘very little publicly reported, accurate information exists for oil stocks outside of the United States. And yet the US oil stocks many not be an accurate reflection of the world situation’. This observation increasingly holds as demand growth has shifted from OECD to non-OECD, especially given the key role that China is playing in global crude demand. In this latest cycle, China’s position as a key equilibrating mechanism was further highlighted as it absorbed surplus barrels from all over the world as it took advantage of relatively cheap crude to fill its large and growing storage capacity.

To put this in perspective, we utilize crude inventory and fleet metrics data from Kpler and attempt to identify some of the missing barrels implied from IEA balances. As Figure 2 shows, even accounting for additional floating storage and oil in transit (+250.4 mbbls), as well as OECD and non-OECD crude stock changes excluding China (+85.2 mbbls), all of which are not previously reported by IEA, we are still missing 597.8 mbbls or 64% of the total missing barrels in H1 2020. This issue becomes more complex in Q3 2020 for which the IEA balances imply a 194.2 mbbls deficit of which 171.3 mbbls are accounted for and 22.9 mbbls are missing. Kpler data, however, show a much larger draw of floating storage, suggesting one (or a combination) of three possibilities: the actual deficit is much larger than estimated by the IEA (by about 150 mbbls); there was a large build in non-OECD stocks, or the implied market surplus in H1 2020 was overestimated and carried over. Indeed, a large build in unaccountable stocks in Q2 2020 followed by a draw in Q3 2020 suggests that barrels were stored and drawn in places where they currently cannot be tracked.

**Figure 2: Missing barrels in 2020**



Source: OIES estimations using IEA and Kpler data.

A few methodological points are worth noting in this context: Intelligence companies that use satellite imagery and tanker tracking do not tend to include inventories in underground tanks, fixed-roof above ground tanks or stocks required for linefill in new pipelines when they are built. While intelligence

<sup>4</sup> It is also worth noting that one source of uncertainty, and potentially of missing barrels, lies in the conversion of both supply and demand from tonnes to barrels.

<sup>5</sup> Robert Mabro, ‘Transparency in the Oil Market and Other Myths’, Oxford Institute for Energy Studies, <https://www.oxfordenergy.org/publications/transparency-in-oil-markets-and-other-myths/>

providers can assess filling in underground tanks based on ship tracking and port loading data, there is a margin of error that should be taken into account.

Moreover, not all underground caverns are used in the same way. For example in some countries such as China, Japan or Germany, they are used for strategic petroleum reserves (SPR) and therefore stored volumes do not change, or change marginally over time. However, the US offered spare capacity in its SPR caverns to commercial users in April, which was indicated by DOE data, suggesting that underground SPR facilities elsewhere could have been used in a similar way. In the past, Japan has also leased some SPR storage capacity to producing countries while other underground storage facilities (in Sweden and South Africa, for example) are for commercial purposes<sup>6</sup>.

Similarly, in Russia, considerable volumes are held in fixed-roof tanks and even though data is published for stocks in refineries and stocks held by Transneft, other stocks including crude in rail cars, in operational tanks and in port facilities not related to Transneft—which can constitute a significant volume—are not tracked<sup>7</sup>.

The issue of missing barrels is not incidental. If the missing barrels are ‘artificial’, the result of imprecise measuring of supply and demand, then the buffers in the system are thinner than currently estimated and OPEC+ task in reducing stocks is less of a challenge. If the missing barrels are ‘real’, then most of these barrels are to be found in non-OECD particularly in China given its large storage capacity. This would have a number of implications. First, it may reveal the fact that while demand has been strong, China’s high level of imports reflect mainly stockpiling and China’s stocks are already at an elevated level. Second and related to this, looking ahead, China’s crude import flows may ease representing a bearish factor for the market.

## The China conundrum

The issue of ‘missing barrels’ has long plagued Chinese data, but much like in the rest of the world, has become more pressing and perplexing in 2020. Net crude imports in the year-to-October averaged 11.09 mb/d, rising from 2019 levels by over 1 mb/d and maintaining their 2019 growth rates. This is astounding given that economic activity has been considerably weaker and runs have averaged 13.3 mb/d in the first ten months of 2020, growing by an impressive 0.47 mb/d, but still lower than the 0.82 mb/d increment seen over the same period last year. Put simply: the data suggest China has overbought crude to put in storage. But the key question is, how much has gone into storage and perhaps more critically, how much is likely to come back out?

Assessing how much crude has gone into storage has become both an art and a science, given the limited official data. When looking at implied stockbuilds (i.e deducting crude used for refinery runs from the sum of domestic production and net imports), in the year-to-October, China has stored on average 1.6 mb/d, or a staggering 488 mbbbls of crude. While it has been clear that large volumes of crude oil have headed to China, judging by port congestion at Chinese shores, differentials and benchmarks, such volumes seem overstated as they would have likely led to tank tops earlier this year. According to our estimates, China had close to 1,100 mbbbls of crude storage capacity at the end of 2019. Assuming a roughly 60 per cent utilization rate, crude stocks would have reached 650-680 mbbbls. A build of an additional 500 mbbbls, even when taking into account 250 mb of new tank space added over the year, would have overwhelmed China’s storage capacity leading to a slowdown in crude arrivals already earlier this year. And even though imports into China are slowing somewhat and storage utilization rates are likely at over 75 per cent currently, there are signs of a recovery in crude buying for early 2021.

It is therefore useful to look more closely at implied stockbuilds. First, many crude balances for China do not account for crude losses during the refining process or burnt at the field, which between 2000 and 2017, according to the National Bureau of Statistics, have averaged 0.30 mb/d<sup>8</sup>. In the five years prior to 2017, losses in refining increased to average 0.35 mb/d, so when deducting these losses, the

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<sup>6</sup> The authors thank Joel Couse for this comment

<sup>7</sup> The authors thank Joel Couse for this comment

<sup>8</sup> This is based on NBS reporting for previous years (with published data only up to 2017) as well as authors’ interviews



implied stockbuild for the year-to-date falls to an average 1.3 mb/d, or just over 375 mbbbls. While this is still a monumental build, it is more plausible.

At the same time, Chinese demand could also be underestimated. China's independent refiners have been infamous for tax evasion<sup>9</sup> and especially between 2016 and 2018 were estimated to have underreported refining throughputs by 0.3-0.8 mb/d<sup>10</sup>. So historically, Chinese crude demand has been understated. The shift to new tax reporting practices in early 2018 have limited the independents' ability to under report runs, although a number of them subsequently turned to misrepresenting their product output<sup>11</sup>. In late 2020, following an announcement by Shandong officials that they will be levying a windfall tax this year<sup>12</sup>, which is based on product output, the independents may be resorting to some under reporting again, although any such volumes are likely small, given that China's demand is recovering slowly and product tanks are also estimated to be two-thirds full.

Some combination, therefore, of underestimated demand and crude in storage suggests that China could well be responsible for as much as half of the missing barrels and that these are indeed 'real'. The next question is then, how likely are these barrels to be drawn down, and will they weigh on Chinese imports?

Roughly a third of these volumes could have gone into bonded tanks. When looking at China's crude imports, there is a discrepancy between waterborne flows as assessed by Kpler and arrivals reported by customs data, with assessed arrivals higher than customs data by 0.47 mb/d for the year-to-October (Figure 3). In previous years, the difference in assessed volumes and customs data were smaller, mostly due to discrepancies between the timings of arrival and discharge, alongside some crude going into bonded tanks.

This year, the discrepancy is more substantial and points to a large accumulation of crude in bonded tanks, which are not consistently counted as imports. Not only has the INE increased its storage capacity this year<sup>13</sup>, with its tanks holding 34 mb of crude at the end of October according to the exchange but sanctioned barrels may have also gone into bonded tanks. For example, in the year-to-October, Kpler estimates point to 0.15 mb/d of Iranian crude going to China (compared to 75,000 b/d recorded by customs) as well as 0.21 mb/d of Venezuelan crude flowing to the country (although customs have reported no Venezuelan crude going into China). Theoretically, then, at the end of October, China had accumulated as much as 85 mb of Iranian and Venezuelan crude in bonded storage tanks over the course of the year, although some of these will have likely been drawn down by refiners, and if they have not been yet, they will be.

But that still leaves over 200 mbbbls of crude in storage, of which only a fraction is likely to return to the market. This is because these volumes have gone into both commercial and strategic petroleum reserve (SPR) tanks that are used as buffer, both for refiners' forward cover and strategic reserves. China has a small number of designated SPR tanks of close to 400 mbbbls, that are likely 300 mbbbls full, with Argus estimating 32 mbbbls of fills this year alone (see Figure 4). At the same time, the government has been leasing out commercial tank space for its SPR programme, as the construction of dedicated SPR sites has been slow. But even with close to 150 mbbbls of commercial tanks that are

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<sup>9</sup> Michal Meidan, "China's Independent Refiners: A New Force Shaping Global Oil Markets", Oxford Energy Insight no 12, May 2017, <https://www.oxfordenergy.org/wpcms/wp-content/uploads/2017/05/Chinas-Independent-Refiners-A-New-Force-Shaping-Global-Oil-Markets-OIES-Energy-Insight.pdf>

<sup>10</sup> Michal Meidan, "China and IMO 2020", OIES Paper CE1, December 2019, <https://www.oxfordenergy.org/wpcms/wp-content/uploads/2019/12/China-and-IMO-2020-CE1.pdf>

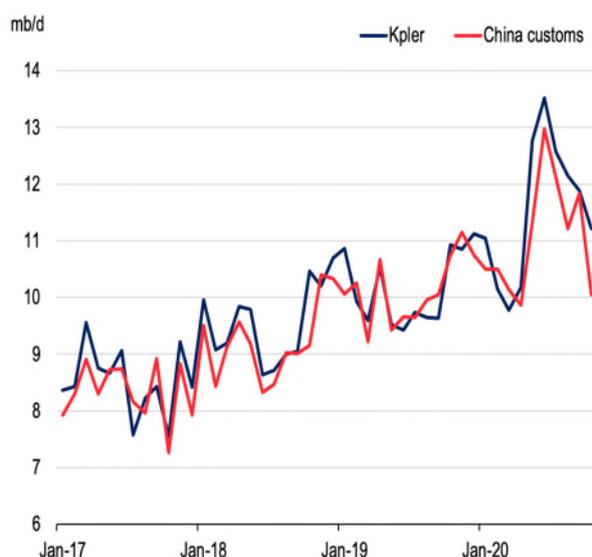
<sup>11</sup> Michal Meidan, "China and IMO 2020", OIES Paper CE1, December 2019, <https://www.oxfordenergy.org/wpcms/wp-content/uploads/2019/12/China-and-IMO-2020-CE1.pdf>

<sup>12</sup> The windfall tax has been in place since 2016, when the new domestic product pricing system was introduced, suspending retail fuel price adjustments whenever a basket of crude prices falls below \$40 per barrel. Tax authorities then levy the windfall tax on the additional profits that are earned from the difference between crude and fuel prices. The tax is paid into a special reserve fund to be used for emissions reductions, improving oil products quality and oil sector safety measures. But the windfall tax has not been widely enforced. State-controlled refiners have received tax demands, and paid, but independents and private-sector refiners have not as collecting the levy is challenging, given that it depends on self-declaration of sales volumes.

<sup>13</sup> Adi Imsirovic, Michal Meidan, "The Shanghai Oil Futures Contract and the Oil Demand Shock", OIES Comment, July 2020, <https://www.oxfordenergy.org/publication-category/china-energy-programme/>

widely assumed to be leased out to the SPR, the SPR programme only meets around 40 days of import cover (as 90 days at current import volumes would imply over 1,000 mbbbls).

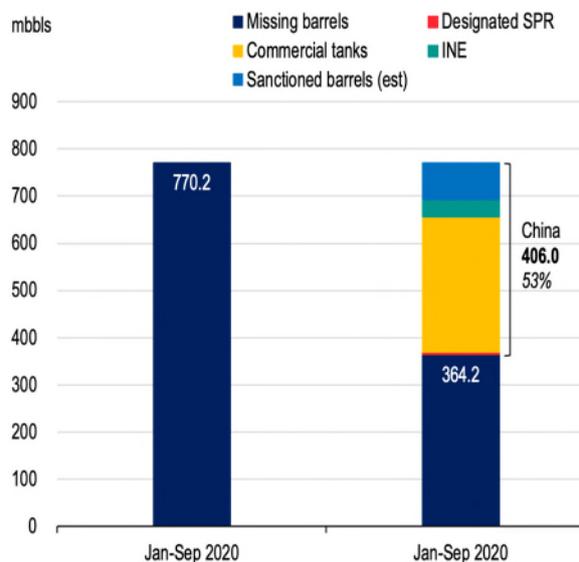
**Figure 3: China's crude imports  
Kpler vs Customs**



Source: Kpler, China customs, OIES.

**Figure 4: Missing barrels in 2020**

**China's implied contribution by type**



Source: OIES estimations using NBS, China customs, INE, Argus and Kpler data.

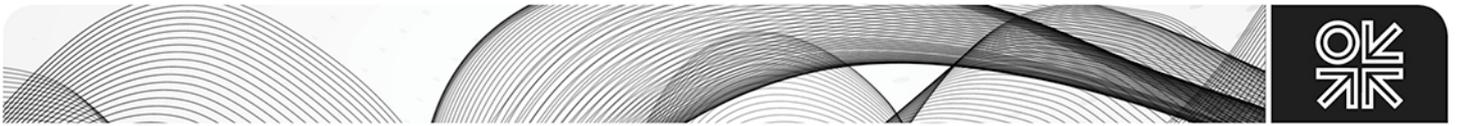
In addition, China's refiners are mandated to hold 15 days of forward cover, which, for a system of close to 19 mb/d of nameplate capacity, means almost 300 mbbbls of forward cover. Indeed, part of the increase in import licences awarded to non-state refiners this year was intended for them to build up their crude stocks while prices remain at relatively low levels.

In sum, when taking into account the crude requirements of storage tanks at the various ports and other commercial sites as well as pipeline fills, the crude requirement for China's oil system is massive. As a result, most of the crude flowing into China this year has helped meet these needs. All in all, we estimate China now holds close to 1,000 mbbbls in storage, which is roughly 90 days of its import needs, with capacity by year end reaching 1,300-1,400 mbbbls. The good news for markets is that only a small part of these barrels will be drawn down, but the bad news is that China's future stockpiling needs are now shrinking.

This is not to say that China's crude imports will fall: with over 1 mb/d of new refining capacity starting up over the next two years, refiners will continue sourcing crude as refining throughputs continue to rise and as new plants require operating stocks. Moreover, additional infrastructure including tanks and pipelines will need filling. But over the next two years, incremental demand for strategic stocks will slow, and crude imports will become more closely aligned with refiners' needs.

### Concluding remarks

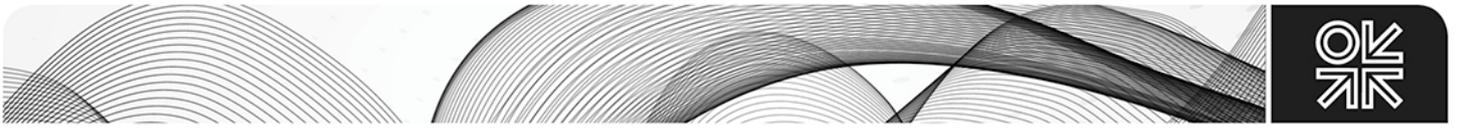
Given the severity of the oil shock in 2020, the focus has been on supply-demand balances. But once the dust settles, the focus will shift to the size of available stocks and OPEC+ efforts in drawing down these stocks to 'reasonable' levels. As in past cycles, the debate will center on which stocks to target (OECD stocks versus global stocks) and the appropriate average (previous 5-year average or 2010-2014 average which excludes years when stocks reached very elevated levels). The above analysis shows that while the missing barrels in this current crisis are large, in reality, they are related, at least in part, to the shift in global oil demand dynamics towards non-OECD and the increasing importance of Asian players particularly China where transparent, reliable and frequent data are lacking.



Developments in tracking and measuring technologies are helping to fill some of the gaps, but there is still a long way to go.

The large accumulation of barrels in China suggests that 'artificial' or 'imaginary' barrels, as a result of imprecise measurement of global oil supply-demand balances, are not the only explanation to the missing barrels question. Indeed, even though China's crude balances are riddled with inconsistencies, it is clear that the country has amassed large volumes of crude this year—potentially close to 400 mbbls—which have contributed both to the country's strategic reserves and commercial forward cover. At the same time, Chinese demand may well be underestimated given refiners' tax avoidance practices. So, as global supply and demand numbers get adjusted with the arrival of new information—which likely includes other Asian countries for which both demand and storage estimates are imperfect—the volume of missing barrels will shrink further, if we are indeed correct in suggesting that roughly half have ended up in Chinese storage tanks and are unlikely to be released back into the market. In addition, some of the missing barrels are a result of unobservable barrels in important consuming centers and perhaps also stocks held at the distribution level and by final end consumers (often referred to as tertiary stocks).

The complexities of global crude balances, despite the important contribution made by new technologies, highlight the ongoing challenges facing OPEC+ in estimating how long it will take to rebalance the market. In addition to the uncertainties surrounding the demand outlook in these unprecedented times, assessing the extent and nature of buffers in the system has become more complicated. Going forward, can OPEC+ afford ignoring non-OECD stocks? But if these stocks are being stored for strategic purposes and the bulk of these stocks will not be released back into the market, does targeting non-OECD stocks really matter for oil policy purposes? Should we exclude years of elevated stocks from the averages or have these become main features of the new cycles and the adjustment process? As we go into 2021, these questions will become more pressing.



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