February 2022

GHG-verified mechanisms for internationally traded crude oil and possible impact on oil benchmarks

OIES ENERGY COMMENT

Adi Imsirovic, Senior Research Fellow, OIES
Jonty Rushforth, S&P Global Platts

Introduction

The specter of climate change has impacted shareholder sentiment making many market participants evaluate their business models in accordance with Cop-26 pledges – looking for ways of winning the mandate for capital in a sustainable way.[1] The most familiar approach to reducing carbon footprint is by creating 'GHG-verified'[2] claims. Typically, these involve a verified account of supply chain emissions, which are then offset through the retirement of carbon credits – themselves generated by projects that aim to reduce or remove carbon-equivalent emissions and are traded in voluntary carbon markets (VCMs[3]). Trades have been reported for GHG-Verified or 'carbon neutral' (and carbon equivalent) LNG,[4] crude oil,[5] naphtha[6] and condensate[7] – with the largest share seen in the LNG market.[8]

The rationale for these trades to date seems to have been twofold – to capture a degree of environmental prestige and to test the market's ability to deliver an operational framework. While the former of these faces the challenge of convincing investors and consumers, the latter faces the need to convince not just the market but ultimately policymakers and regulators.

Already governments are looking at including carbon accounting not just in domestic frameworks but into trade legislation. Notably the European Commission has proposed a regulation to impose charges for high carbon imports on a range of commodities through the Carbon Border Adjustment Mechanism (CBAM[9]). Initially applicable to only a relatively limited array of commodities (including aluminum, steel, and power), an extension of CBAM to fossil fuels is possible. The EU has also proposed a Methane Regulation[10] which will impose charges for emissions from the full supply chain of fossil fuel imports especially oil and oil products.[11] IEA analysis shows that methane emissions from oil imported by the EU, Japan, China and South Korea are significantly higher than those from imported gas and LNG.[12] Within the next five years, significant additional charges for GHG emissions from both domestically produced and imported oil are likely to be introduced, at least for European Union member states (and possibly all European countries).

Despite: '… methane emissions from oil imports as important as (and in many countries more important than) those from pipeline gas and LNG…'[13], the research in the GHG emissions for crude oil has been relatively sparse. This is partly due to the complexity given hundreds of different grades of oil, transportation and widely different refining processes. The aim of this paper is to start a discussion regarding data, policy and commercial transactions in regards to the oil emissions and present some instruments which may provide tools to reduce such emissions or, at very least, promote transparency necessary for further progress. Our principal focus is a framework for internationally traded oil and we suggest a direction for further research.

---

1 Several organizations are providing companies with a clearly defined paths to achieving their goals in line with the Paris and Glasgow Agreements: such as Science Based Targets initiative (SBTI); Race to Zero campaign, an UN-backed global campaign rallying companies, cities, regions, financial and educational institutions and The Glasgow Financial Alliance for Net Zero (GFANZ), https://www.gfanzero.com/about/ which t is a part of the 'Race to Zero' umbrella organisation.

2 Term 'GHG-verified' far better reflects the issue than 'carbon-neutral' claims. See: OIES Paper ET06: Measurement, Reporting, and Verification of Methane Emissions from Natural Gas and LNG Trade' by Jonathan Stern.

3 For details about their application, see the OIES PAPER ET03: 'Voluntary markets for carbon offsets: Evolution and lessons for the LNG market' by A. Bose et.al.

4 https://www.shell.com/business-customers/trading-and-supply/trading/news-and-media-releases/tokyo-gas-and-gs-energy-to-receive-worlds-first-carbon-neutral-lng-cargoes-from-shell.html

5 "US' Occidental supplies first cargo of 'carbon-neutral crude' to India's Reliance", S&P Global Platts, Jan 29, 2021

6 "Trafigura, Braskem team up on first carbon-neutral naphtha trade", S&P Global Platts, April 26, 2021

7 "Australia's Woodside, Trafigura trade world's first carbon offset condensate cargo", S&P Global Platts, March 15, 2021

8 For a very detailed analysis of the issues involved in the LNG market, see OIES Paper ET06: Measurement, Reporting, and Verification of Methane Emissions from Natural Gas and LNG Trade' by Jonathan Stern, OIES, January 2002

9 https://ec.europa.eu/taxation_customs/green-taxation-0/carbon-border-adjustment-mechanism_en

10 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021PC0805&from=EN

11 This would also include coal which is being phased out in most European countries and therefore imports are becoming less relevant.

12 International Energy Agency, `Curtailing Methane Emissions from Fossil Fuel Operations', Figure 3.1, p.33.

13 J. Stern, ibid. p 2.

Measurement, Reporting and Verification (MRV) Standards and GHG-neutral Claims

To date there is no broadly agreed standard around MRV standards for crude oil(s) and GHG-neutral commodity claims. This is a problem since without credible MRV, it is not possible to have credible 'carbon neutrality' and associated GHG offsets. The British Standards Institute has a broader guideline for such standards[14] and the International Standards Organization is working on producing something similar.[15] At base these require a full account of emissions, reduction within a target-based plan, offsetting through carbon credits and verification of the whole.

To illustrate the problem is that within commodities, there has been a range of examples of execution, which may adhere to the letter of the guideline but have pushed the spirit of the claim. At their most opaque, some trades have been reported in the market as 'carbon neutral' with no further information as to the verification of emissions involved, the boundaries for any such verification or the credits employed. In some cases, this has led to negative press coverage,[16] particularly with reference to the quality of credits employed, but equally since the assessment and verification of emissions has been done 'in-house'. This is likely to be detrimental for the parties involved. Arguably being seen as 'greenwashing' is worse for climate credibility than being seen as doing nothing at all. And it is almost certain that any trade structured in such a way would fail to meet the requirements of future legislation.

At the other end of the scale, some trades have been reported that include a reference to a third-party verifier, a relatively full account of the boundaries involved and references to the specific underlying carbon projects from which credits were used for offsetting emissions. Even these claims have been subject to public scrutiny that implies a lack of rigour in their execution.[17]

Some trades have been reported as covering emissions purely from production to import; others have included broader, but undefined, 'lifecycle' coverage. The issue is that a lifecycle claim may have an arbitrary boundary.[18] Including initial exploration may give a sense of completeness, but it could create perverse incentives because of what are in effect sunk emissions costs. More limited boundary claims may be more realistic and direct investment towards achievable reductions (e.g. reducing flaring and venting), but for claims to be properly assessed these boundaries need to be consistent across a given commodity. Setting such boundaries to include the refining of oil present an additional difficulty. Problems with their inclusion are discussed in the last section. As Prof. Stern emphasized in a recent paper, focusing on gas[19] : '… measurement, reporting and verification of methane emissions using a transparent and globally accepted methodology has become a crucial issue… it has become absolutely vital that the gas industry takes proactive steps to create and implement a global plan both to reduce, but first to accurately document, methane emissions'.

GHG-Verification as a Backbone of the Market

Within oil markets there is a growing mandate at the corporate level to reduce emissions. The Oil and Gas Climate Initiative[20], representing some large oil producers[21], has pledged a range of emissions cuts in the years ahead. And the investment community continues to increase pressure on the entire industry to reduce emissions across their value chains.

This means that the market already needs baseline standards that can address the concerns raised by the handful of carbon neutral trades that have been reported so far. These concerns broadly fall into

14 https://www.bsigroup.com/en-GB/pas-2060-carbon-neutrality/

15 https://www.iso.org/standard/43279.html

16 "EXCLUSIVE: Discredited, ageing Kyoto offsets re-emerge to taint voluntary carbon market" - Carbon Pulse, March 22, 2021

17 https://www.bloomberg.com/news/features/2021-08-11/the-fictitious-world-of-carbon-neutral-fossil-fuel?sref=GUSUlraS

18 A boundary in this context refers to the processes included in the MRV.

19 See: OIES Paper ET06: Measurement, Reporting, and Verification of Methane Emissions from Natural Gas and LNG Trade' by Jonathan Stern.

20 Established in 2014: See https://www.ogci.com

21 OGCI members include Aramco, bp, Chevron, CNPC, Eni, Equinor, ExxonMobil, Occidental, Petrobras, Repsol, Shell and Total Energies. See: https://www.citizensenergycongress.com/sponsors-and-partners/decarbonisation-partner/ogci/#:~:text=OGCI%20members%20include%20Aramco%2C%20bp,Repsol%2C%20Shell%20and%20Total%20Energies

three groups: the need for third party verification of emissions; clarity on the boundaries covered; and a baseline quality of acceptable carbon credits employed. There are also some key issues that fall across these groupings, notably the need for a consistent standard around measurement and reporting (defined by the boundaries and employed in verification). And there is a broad question around transparency – to what degree will companies voluntarily provide public visibility to their emissions.

Commodity benchmarks in general, and oil in particular, will have to adapt to include GHG-verification, not just because of a few reported trades, but because it is likely to become part of the backbone of the market. This is because any mandate to limit the use of fossil fuels is not aimed at, in theory, an arbitrary reduction in use, but rather an efficient[22], verifiable reduction in environmental impact.

Not all oil production is equal in terms of environmental footprint. There are familiar debates around the impact of fracking and tar sands production techniques. When considering greenhouse gas emissions, however, there has historically been very little transparency on the full range of impact. A buyer of crude looking to meet limits on emissions will likely want to minimize use of the most carbon intensive crudes first (see Figure 1 below), which in turn will affect the demand for such differentiated crudes – and hence the associated crude markets and benchmarks. For that outcome to become a reality, however, the markets need new tools to analyse carbon intensity, and hence arrive at a valuation of that intensity.

One set of tools[23] is already available in this space: GHG-verified (in practice often referred to as 'carbon-adjusted') oil price benchmarks, price assessments of the value of individual types of crude oil adjusted for the cost of carbon equivalent emissions associated with their production and transportation. In June 2021, S&P Global Platts (Platts) launched the first ever daily Platts Carbon Removal Credit (CRC) assessment and followed this in October with the launch of monthly 'carbon intensity' (CI[24]) calculations for selected global crude oil fields. Combined, the two facilitate a calculation of the 'carbon intensity premium' (CIP) for individual grades of oil, alongside their oil market price assessment. For the carbon intensity calculations themselves, Platts is using the open-source model developed at Stanford University, Oil Production Greenhouse Gas Emissions Estimator (OPGEE 2.0)[25]. Although developed through a focus on applicability to California's Low Carbon Fuel Standard, the OPGEE model has been structured broadly to reflect a wide range of geologies and infrastructure. To date, the boundaries are marginal production through to import, with each element well-defined within the OPGEE model. Those elements include all upstream production, itemized by individual elements, as well as pipeline transportation and waterborne transport, where specified, to named trade or storage locations. Other elements will need to be added in the future – including post-import transportation and, substantially, processing. The latter is a non-trivial addition, given that roughly 7% of the total associated emissions for a barrel of crude are produced at the refinery,[26] and any such calculation would need to account convincingly for yields. Beyond the refinery gate there are further transportation emissions to consider – though these would be in line with prior steps covering pipeline and waterborne transport. It does not include final combustion – which can be derived from pure chemistry rather than measurement and is generally assumed therefore to be consistent across supply chains.

[22] Efficient in economic sense – abatement at lowest cost.

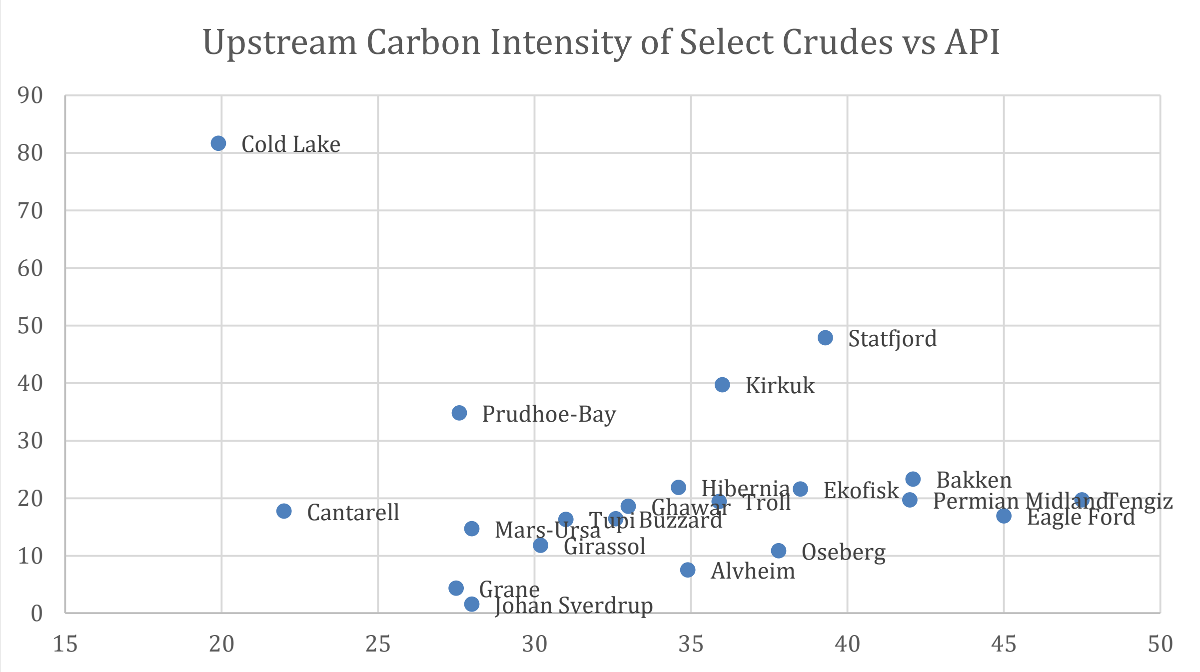
[23] Another example is the Methane Performance Certificates (MPCs), created for oil and gas producers to sell instruments representing zero methane emission from natural gas production. See: https://xpansiv.com/methane-performance-benchmark-launched-in-natural-gas-market/ also https://press.spglobal.com/2021-10-18-S-P-Global-Platts-and-Xpansiv-Launch-Methane-Performance-Benchmark-in-Natural-Gas-Market Each MPC represents 1 MMBtu of gas produced with zero methane emissions and their trade reveals the market value of reducing (methane) impact of such production.

[24] In reality, this is GHG intensity or carbon equivalent intensity, S&P Global Platts use 'carbon intensity' for short.

[25] https://eao.stanford.edu/opgee-oil-production-greenhouse-gas-emissions-estimator

[26] The US Department of Energy estimates 10% of emissions are produced in production, 1% in transportation, 7% at the refinery, 0.5% through subsequent transportation and 81.5% in end-use. The DOE uses the Greenhouse gases, Regulated Emissions, and Energy use in Technologies Model developed by its Argonne Laboratory (https://greet.es.anl.gov/), which estimates full life cycle emissions for fuels and builds on historic data for emissions across US supply chains. Specific supply chains (even within the US) may have markedly different outcomes than the generalized model provides.

Figure 1: Upstream CI of selected crudes and their density (API)



Note that the highest intensity grades, including San Joaquin (CI at 177.93 kgCO2eq) and Orinoco Belt (CI at 1,460.31 kgCO2eq), are not shown here due to scaling issues.
Source: S&P Global Platts. Grades selected cover a representative range of geologies and infrastructure, including older production (Statfiord), newer (Johan Sverdrup), tar sands (Cold Lake) and high flaring (Kirkuk).

With Carbon Intensity established in this way for covered crude fields, the CI could become just another attribute of any given type of crude oil, just like their specific gravity and sulphur. The CIP in turn shows the value of that attribute – akin to a 'hi-low' sulphur spread. A higher carbon intensity and the associated crude oil premium would indicate a greater environmental cost (using the voluntary carbon credits in this case) needed to offset emissions associated with such crudes. It still remains to be seen whether refineries would integrate these CI numbers into their models. Other PRAs are carefully watching this space[27] and it would not be a surprise if other, similar products were to follow.

Large variability of GHG intensity of different oils

The variation from the crudes produced so far is substantial. For example, in January 2022 the production of a heavy, bitumen-based Canadian crude oil, Cold Lake, extracted using hot steam and therefore a lot of energy is estimated to be associated with 79.98 kg of carbon dioxide equivalent emissions per barrel and a CIP on February 15, 2022, of $1.728 a barrel[28]. The carbon intensity of this process dwarfs the production of a Norwegian grade of North Sea, Johan Sverdrup, which was calculated to emit only 1.56 kgCO2eq/boe during December and a CIP of only $0.03 a barrel on February 15. The field itself is fairly new – with production starting in 2019 – and employs renewable energy for power input.

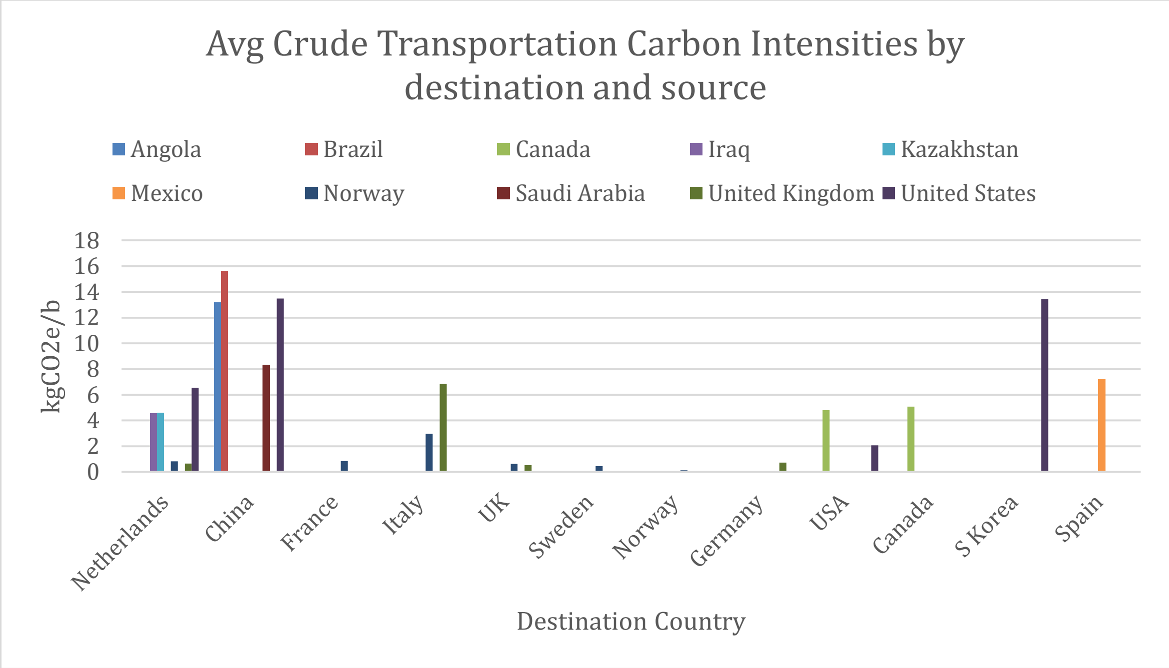
At more than a hundred times Johan Sverdrup's intensity, the San Joaquin basin in California produced 177.93 kgCO2eq/boe, giving a CIP on February 15 of $3.84/boe. The production basin is over a hundred years old and includes steam-flooded heavy crude production and very high-water producing areas with water cuts as much 98%. And at yet another order of magnitude higher, the Orinoco belt in Venezuela produced an incredible 1,460.31 kgCO2eq/boe and a CIP of $31.54/boe. The oil in the

[27] In a conversation with Argus, one of the authors was informed that they are 'carefully following the developments' in this space.
[28] As calculated by Platts in June 2021. See: https://www.spglobal.com/platts/en/about-platts/media-center/press-releases/2021/092721-platts-launches-crude-carbon-intensity-calculations-daily-carbon-offset-premiums

Orinoco belt is in a "foam" formation (ie has gas trapped in it), and this gas is being flared out giving the field an exceptionally high CI with most of it coming from flaring.

Notably, transportation is sometimes more marginal in terms of impact than might be expected. WTI, in the form of Permian crude from Midland, had a CI of 19.72 kgCO2eq/boe in January. Transporting this to Rotterdam, a key import hub in northwest Europe, adds just 6.7 kgCO2eq/boe, for a total of 26.42. Ekofisk has a slightly higher upstream CI, at 21.57 kgCO2eq/boe, but is much closer to Rotterdam – producing only 0.36 kg of CO2 equivalent through transportation, for a total of 21.93 kgCO2eq/boe. At current carbon prices that gives a landed CIP of 52 cents/b for Permian, only 8 cents more than for Ekofisk.

Figure 2: Average Crude Transportation CI by Destination and Source country



Source: Platts

The impact from transport is far greater when considering Atlantic arbitrage flows to China, however. Brazil's Tupi crude is relatively low impact, at just 16.33 kgCO2eq/boe for upstream production. But the emissions from transporting it to Qingdao in China amount to 15.64 kgCO2eq/boe – giving a total of 31.97 kg of carbon equivalent emissions per barrel, or almost double its baseline. Tupi is a very popular grade of oil among the Chinese 'independent' refineries and accounting for the GHG emission in transportation of oil may well change the arbitrage economics as we know them.

Refinery Economics and GHG-Verified Benchmarks

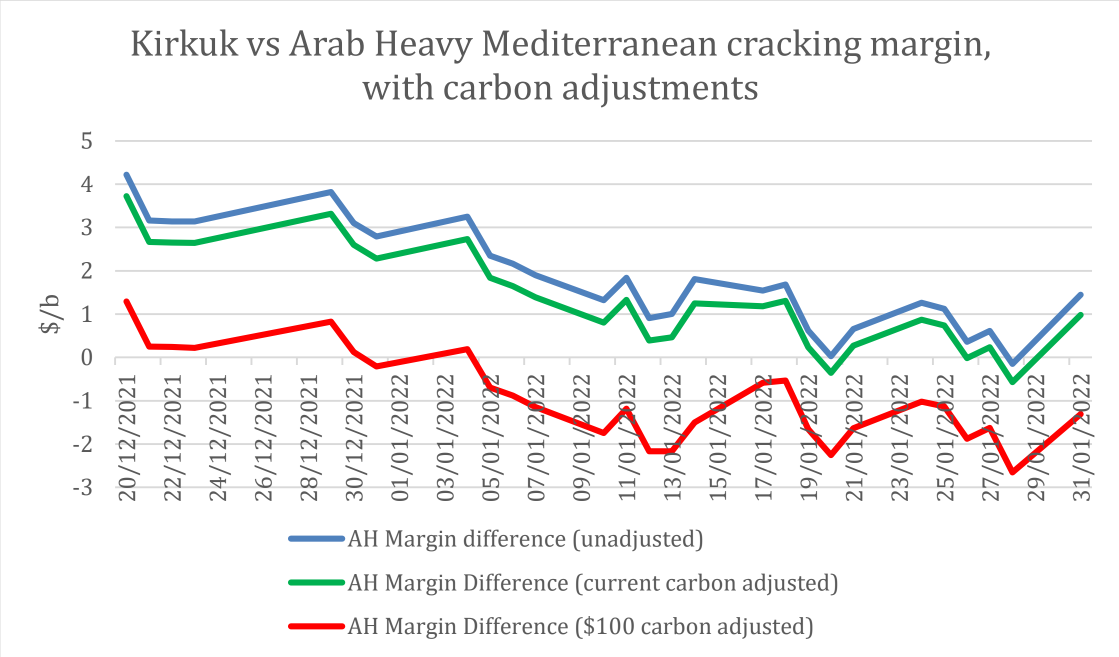
For now, these carbon intensity adjusted assessments primarily provide some transparency with regards to emissions and associated environmental cost of individual crudes. They could allow refineries to actively choose crude supply with a lower carbon intensity – in effect cutting the emissions impact of their products. If refineries start to discriminate in this way, and to either offset those emissions at the CIP value or simply include a lower CI crude in a subsequent claim, then CI could become part of the inherent value of crude oil trades.

For example, consider the situation of a complex refinery in the Mediterranean looking at buying Middle East crudes. A refinery margin is the difference between products prices and crude oil that products are refined from[29]. Based on underlying prices for crude oil and product yields, Iraq's Kirkuk crude would

[29] A simple refinery margin is based on a refinery using primarily crude unit for processing (as many old, simple refineries do not have complex, upgrading units), while complex margins include all the additional refinery units such as crackers, reformers, cokers etc.

have produced an average refinery margin of $1.02/b in January 2022[30]. In contrast, Saudi Arabia's Arab Heavy had an average margin of minus $0.27/b, or around $1.29/b lower than Kirkuk, reflecting the heavier, more sulphurous nature of the crude. But the carbon intensity of Kirkuk is relatively high – 39.74 kgCO2eq/boe in December 2021, compared with just 18.58 kgCO2eq/boe for Saudi Arabia's Ghawar field. Adjusting the margins for the current CIPs, Kirkuk becomes just 84 cents better than Arab Heavy, with the underlying carbon price averaging $16.90/mtCO2e. But if that price rose closer to the level of European Emissions Allowances (close to $100 as of January 2022), the Kirkuk premium would reverse (see Figure 3), and an adjusted margin would be $1.38/b below that of Arab Heavy. In effect, the sweet-sour spread of these crudes would be inverted, consistently.

Figure 3: Kirkuk and Arab Heavy netback values including CI adjustments



Source: Platts

The initial crudes covered by the CIP are identified by field, only some of which match traded grades that are a common part of spot markets. In terms of benchmarking, the key challenge is to broaden the methodology to encompass crude grades and markets that include multiple source fields. The US crude West Texas Intermediate (WTI) is a good example and will require an analysis of multiple fields to arrive at a baseline for the grade - and consequently for WTI as a price benchmark. In a similar manner, key global benchmarks such as Dated Brent and Dubai reflect a basket of crudes. Each of these grades would need to be analysed to arrive at a Dated Brent CI. And in the case of a key basket grade, Forties, multiple upstream fields need to be considered and monitored over time, since they do vary albeit on the whole at a slow rate. These are surmountable challenges, however, and represent a similar problem set as the downstream challenge - how to assign GHG verification through the refining complex.

It is possible to model the emissions associated with refining of certain products such as jet, diesel and gasoline using process-based life cycle assessment (LCA) methodology. An example of such study is the 'Life cycle greenhouse gas emissions of crude oil and natural gas from the Delaware Basin'[31]. However, such studies are possible for plants using relatively uniform grades of oil.

Most refineries, such as those in Europe and Asia process a diet of different grades that constantly change, making the task far more difficult. Estimating the environmental footprint may well require estimates done on the refinery-by-refinery basis, for each different grade of crude processed. This will have to be addressed in further research.

[30] Source: Platts Analytics Yields and Netbacks, January 4-28, 2022

[31] Wally Contreras a, Chris Hardy, Kaylene Tovar, Allison M. Piwetz, Chad R. Harris, Erin E. Tullos b, Adam Bymaster, John McMichael, Ian J. Laurenzi in Journal of Cleaner Production 328 (2021) 129530.

Conclusion

The key focus will remain to be on perfecting the MRV of individual cargoes. However, once the verification process gets perfected and if policies such as the EU's methane Regulation and Carbon Border Adjustment Mechanism are extended to oil and oil products, such ESG assessments could become the norm and the market participants may decide to trade crude oil at these prices. This would turn these assessments into 'environmentally adjusted' benchmarks. In principle, such instruments would enable the refiners to minimize their GHG footprint by choosing the grades of oil associated with lower emissions. Such decisions would transform into relevant price signals, with low CI grades of oil being bid up.

Once the transportation emissions are included, the nature of arbitrage flows may change as well with 'locally sourced' grades being even more attractive than usual. Including the emissions associated with refining adds yet another level of complexity due to widely different plant configurations and grades of oil processed. However, as the refining emissions are not negligible, their inclusion should be seriously considered in future research. The industry has made a start in some of these areas but far more needs to be clarified and then agreed to achieve a credible framework. This is because crude oil is far more complicated commodity in this respect compared natural gas and LNG, due to different grades and products.

Eventually, with advances in blockchain technology and digitising the supply chains using 'smart' contracts, it may be possible for individual crude oil cargoes to have their own associated carbon intensity (as well as other attributes such as sulphur, API density etc.) and a carbon adjusted price in a digitised (tokenized) form[32]. The owners of the cargo would simply own digital tokens, representing ownership of the cargo with the given attributes.

Ultimately, putting a value on these environmental attributes should drive investment to reduce the environmental impact of the underlying commodities. If these new market mechanisms and benchmarks are facilitated by greater public and private acceptance and greater investments in fossil fuels with lower GHG emissions, they can add value by providing for more sustainable and efficient allocation of resources and therefore smoother energy transition.

[32] So called non-fungible tokens (NFTs) have been all the rage in the art world for some time now. See: https://www.economist.com/the-economist-explains/2021/10/12/what-is-an-nft Also see: https://cms.abaxx.fi/uploads/Smarter_Markets_Maryam_Ayati_Energy_industry_veteran_vision_for_tokenizing_supply_chain_24d7911305.pdf