The Hague Centre
for Strategic Studies

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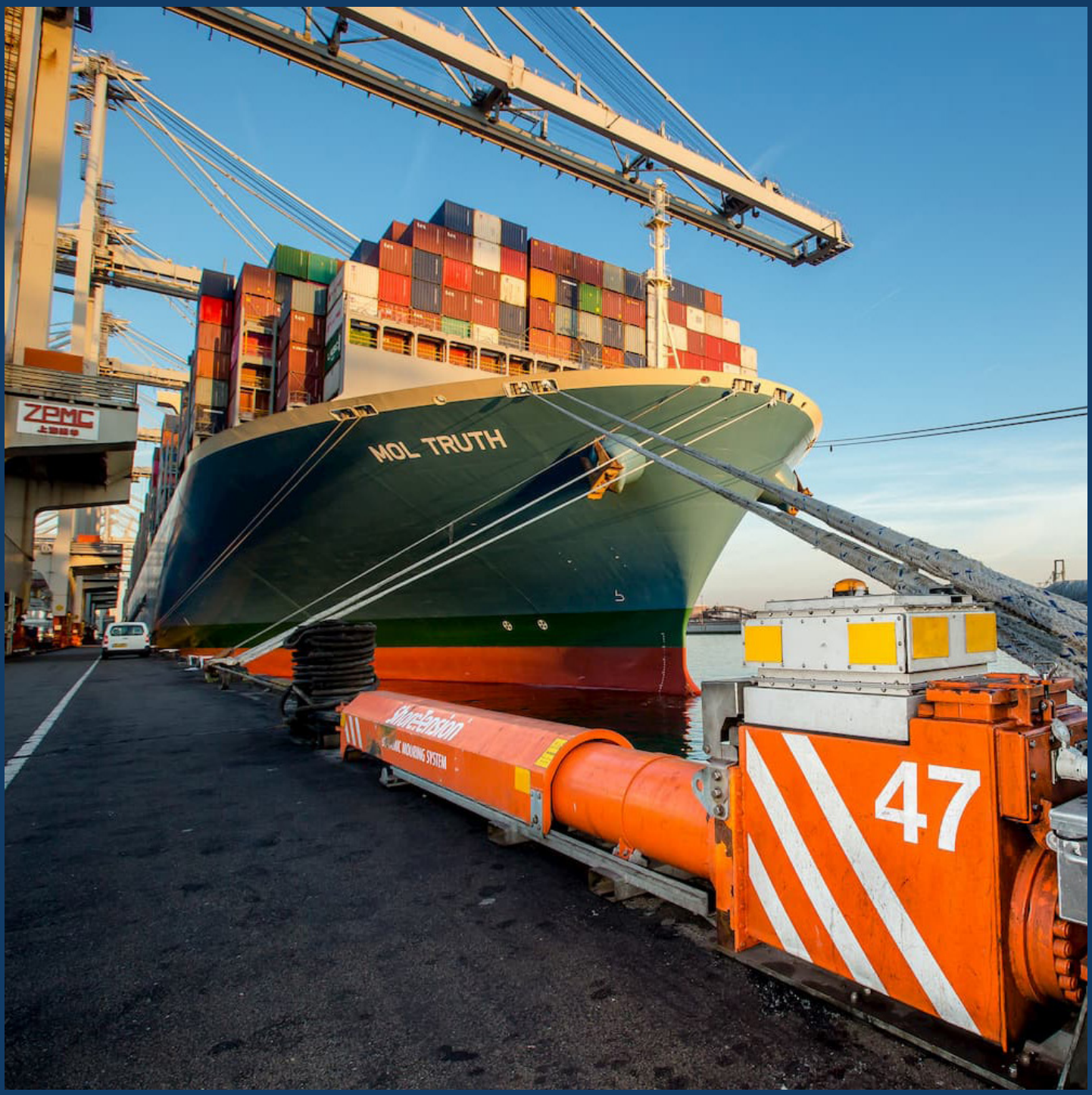
February 2023



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Summary

The European Union's (EU) sanctions on the import of Russian oil have far-reaching consequences for the global oil market and European security of supply. At the same time, Fit-for-55 (FF55) plans for decarbonizing maritime shipping are under development and the various legislative proposals are expected to start being implemented around 2025. Sanctions could have an impact on the international position and decarbonization trajectory of the ARA (Amsterdam-Rotterdam-Antwerp) region, an important energy trade hub and the second largest bunkering port in the world. This report develops qualitative storylines that focus on the impacts of the sanctions on Russian oil on bunkering in ARA and the implementation of FF55 plans.

In anticipation of the sanctions, companies in the EU have taken action to phase out Russian crude oil. Despite expectations of sharp increases in the price of Brent after the ban on Russian crude oil, the price remained stable under 86 $/barrel since the end of November 2022 until the end of January 2023.[1] Most ARA refineries are able to use a large variety of crude oil as feedstock, so the difference in yield of fuel oil from non-Russian crude has been relatively small after the December 5th sanctions.

Still, the EU remained Russia's main export market for oil in December 2022. It continued importing pipeline crude through Druzhba and oil products in preparation of the ban on February 5th 2023.[2] More than 8 million barrels of Russian diesel were imported by European countries in the first two weeks of January 2023.[3]

1 'Brent Crude Oil - 2023 Data', Trading Economics, accessed 20 January 2023, https://tradingeconomics.com/commodity/brent-crude-oil.

2 CREA, 'EU Oil Ban and Price Cap Are Costing Russia EUR 160 Mn/Day, but Further Steps Can Multiply the Impact', 11 January 2023, https://energyandcleanair.org/wp/wp-content/uploads/2023/01/CREA_Press-release_EU-oil-ban-and-price-cap-are-costing-Russia-EUR-160-mn_day-but-further-steps-can-multiply-the-impact.pdf.

3 Anna Cooban, 'Europe's Ban on Russian Diesel Could Send Pump Prices Even Higher', CNN, 17 January 2023, https://www.cnn.com/2023/01/17/energy/russia-diesel-ban-prices/index.html.

A slight increase in the price of ARA fuel oil – the main bunker fuel – is expected as a result of the sanctions on Russian oil products, relatively to other non-European ports. First, the supply of fuel oil in ARA could decrease. The imports of Russian fuel oil have decreased substantially since the fifth sanctions package was introduced in August 2022.[4] European refineries will be trying to maximise their diesel yield at the expense of residuals such as fuel oil. Feedstock such as vacuum gas oil that previously came primarily from Russia will be limited. As such, the supply of fuel oil in ARA could slightly decrease and drive up prices.

Second, Russian (fuel) oil is being re-routed toward other ports at a discounted price. The relative price of bunkering in ARA could increase compared to ports that do not sanction Russian oil.[5] The largest consumers of bunkering are large container ships with extra-EU voyages that can bunker at any point during their journey. Although high energy and food prices are causing economic issues worldwide and could lead to a decrease in the global demand for oil, those container ships making long-haul extra-EU voyages will likely choose to bunker wherever prices are lower, which immediately after sanctions is unlikely to be ARA.

Bunkering liquefied natural gas (LNG) is not directly impacted by the sanctions, but the reduced flow of Russian natural gas has nonetheless led to skyrocketing prices. As additional LNG supply is necessary to reduce cost burdens on households and industries, it seems unlikely that the market will gain additional supplies to be used for maritime bunkering in the short term.

In the longer term, the Dutch maritime bunker market could develop in two ways – it could rebound to levels similar to the pre-2022 situation or remain relatively depressed compared to pre-2022. The market could rebound as a result of the EU replacing Russian crude and products, (re)opening to Russian oil products and crudes, or through the global market balancing. If the EU remains cut off from Russian oil and cannot get sufficient alternative supplies at a low cost, bunker market volumes in Dutch ports will remain depressed and prices will increase relatively to other bunker ports.

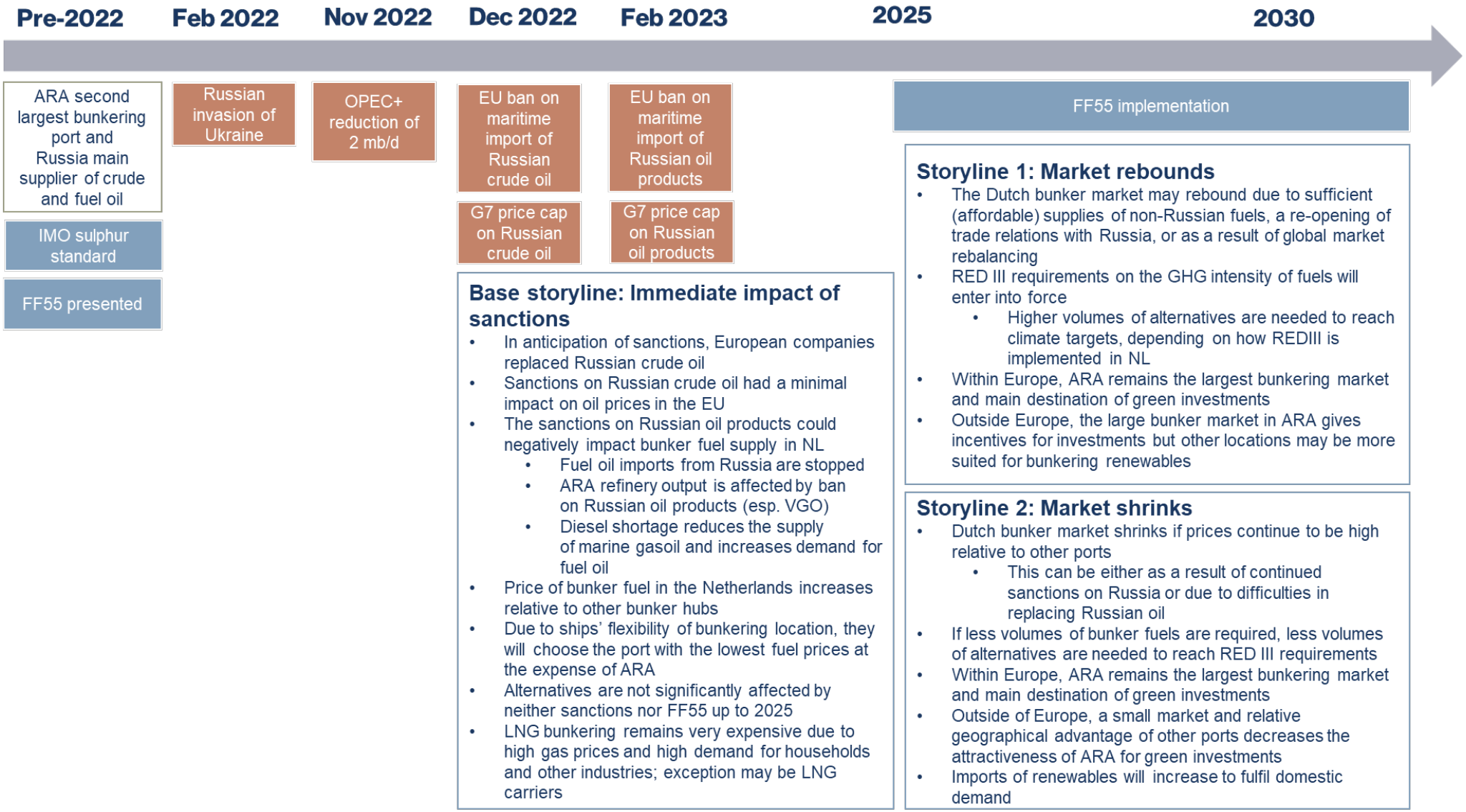
In both storylines, the development of LNG bunkering is largely dependent on the financial attractiveness related of LNG in the European energy system and shipping industry.

Up to 2030, the position of Rotterdam and ARA as the EU's largest bunker market is likely to remain the same across the two storylines. All ports in Europe face similar challenges as a result of the sanctions, and the efficient and reliable infrastructure, various transport modalities, large industry and connection with the hinterland will continue supporting the attractive position of Rotterdam as a bunker port and as a destination for green investments.

The storylines yield different results when Rotterdam is compared to other global rather than European locations. There are various other ports with similarly well-developed infrastructure, some positioned in or near locations where producing renewable fuels is less expensive than in North-Western Europe and regional demand for such fuels is rapidly growing. If the Rotterdam bunker market remains depressed, Rotterdam will be a less attractive investment location. As domestic production will not expand as fast as expected, renewable fuels will have to be imported to comply with the Renewable Energy Directive III. In the end, this could result in higher prices for bunker fuels in Rotterdam and a further decrease in the size of the market.

4 Reuters, 'EU Could Ban Some Russian Fuel Oil Imports Six Months Ahead of Deadline', *Reuters*, 15 July 2022, https://www.reuters.com/business/energy/eu-could-ban-some-russian-fuel-oil-imports-six-months-ahead-deadline-2022-07-15/.

5 Bassam Fattouh, Andreas Economou, and Ahmed Mehdi, 'Oil Markets in 2023: The Year of the Aftershocks' (Oxford Institute for Energy Studies, January 2023), https://a9w7k6q9.stackpathcdn.com/wpcms/wp-content/uploads/2023/01/Oil-Markets-in-2023-The-year-of-the-aftershocks.pdf.


Pre-2022
Feb 2022
Nov 2022
Dec 2022
Feb 2023
2025
2030
ARA second largest bunkering port and Russia main supplier of crude and fuel oil
IMO sulphur standard
FF55 presented
Russian invasion of Ukraine
OPEC+ reduction of 2 mb/d
EU ban on maritime import of Russian crude oil
G7 price cap on Russian crude oil
EU ban on maritime import of Russian oil products
G7 price cap on Russian oil products
FF55 implementation
Base storyline: Immediate impact of sanctions
• In anticipation of sanctions, European companies replaced Russian crude oil
• Sanctions on Russian crude oil had a minimal impact on oil prices in the EU
• The sanctions on Russian oil products could negatively impact bunker fuel supply in NL
◦ Fuel oil imports from Russia are stopped
◦ ARA refinery output is affected by ban on Russian oil products (esp. VGO)
◦ Diesel shortage reduces the supply of marine gasoil and increases demand for fuel oil
• Price of bunker fuel in the Netherlands increases relative to other bunker hubs
• Due to ships' flexibility of bunkering location, they will choose the port with the lowest fuel prices at the expense of ARA
• Alternatives are not significantly affected by neither sanctions nor FF55 up to 2025
• LNG bunkering remains very expensive due to high gas prices and high demand for households and other industries; exception may be LNG carriers
Storyline 1: Market rebounds
• The Dutch bunker market may rebound due to sufficient (affordable) supplies of non-Russian fuels, a re-opening of trade relations with Russia, or as a result of global market rebalancing
• RED III requirements on the GHG intensity of fuels will enter into force
◦ Higher volumes of alternatives are needed to reach climate targets, depending on how REDIII is implemented in NL
• Within Europe, ARA remains the largest bunkering market and main destination of green investments
• Outside Europe, the large bunker market in ARA gives incentives for investments but other locations may be more suited for bunkering renewables
Storyline 2: Market shrinks
• Dutch bunker market shrinks if prices continue to be high relative to other ports
◦ This can be either as a result of continued sanctions on Russia or due to difficulties in replacing Russian oil
• If less volumes of bunker fuels are required, less volumes of alternatives are needed to reach RED III requirements
• Within Europe, ARA remains the largest bunkering market and main destination of green investments
• Outside of Europe, a small market and relative geographical advantage of other ports decreases the attractiveness of ARA for green investments
• Imports of renewables will increase to fulfil domestic demand

Samenvatting

De sancties van de Europese Unie (EU) op de invoer van Russische olie hebben verstrekkende gevolgen voor de mondiale oliemarkt en de Europese leveringszekerheid. Tegelijkertijd zijn de "Fit-for-55"-plannen (FF55) voor het verduurzamen van de zeescheepvaart in onderhandeling en zullen de verschillende wetgevingsvoorstellen naar verwachting rond 2025 worden geïmplementeerd. De ARA-regio (Amsterdam-Rotterdam-Antwerpen) is een belangrijk knooppunt in de brandstoffenhandel en de op één na grootste bunkerhaven ter wereld. De sancties kunnen gevolgen hebben voor de internationale positie en het verduurzamingstraject van deze regio. Dit rapport beschrijft kwalitatieve verhaallijnen gericht op de effecten van de sancties op Russische olie voor het bunkeren in ARA en de uitvoering van de FF55-doelstellingen.

Vooruitlopend op de sancties hebben bedrijven in de EU reeds actie ondernomen om Russische ruwe olie uit te faseren. Hoewel de verwachting was dat de prijs van Brent na het verbod op Russische ruwe olie sterk zou stijgen, bleef de prijs van eind november 2022 tot eind januari 2023 stabiel onder 86 $/vat.[6] De meeste ARA-raffinaderijen kunnen een grote verscheidenheid aan ruwe olie verwerken. Hierdoor is het aandeel stookolie, dat na de sancties van 5 december uit niet-Russische ruwe olie werd geproduceerd relatief stabiel gebleven.

Nochtans bleef de EU in december 2022 Ruslands belangrijkste exportmarkt voor olie. Via de Druzhba pijplijn werden er nog ruwe olie en olieproducten ingevoerd in aanloop naar het verbod op 5 februari 2023.[7] In de eerste twee weken van januari 2023 hebben de Europese landen meer dan 8 miljoen vaten Russische diesel ingevoerd.[8]

Als gevolg van de sancties op Russische olieproducten, wordt er in ARA in vergelijking met niet-EU havens een lichte prijsstijging van stookolie - de belangrijkste bunkerbrandstof – verwacht. Dit komt ten eerste omdat het aanbod van stookolie in ARA zou kunnen afnemen. De invoer van Russische stookolie is aanzienlijk gedaald sinds de invoering van het vijfde sanctiepakket in augustus 2022.[9] De Europese raffinaderijen zullen proberen hun dieselaandeel te maximaliseren ten koste van residuen zoals stookolie. Grondstoffen (zoals vacuüm gasolie) die voorheen hoofdzakelijk uit Rusland kwamen, zullen beperkter beschikbaar zijn. Het aanbod van stookolie in ARA zou derhalve licht kunnen dalen waardoor de prijs opgedreven wordt.

6 Brent Crude Oil - 2023 Data', Trading Economics, accessed 20 January 2023, https://tradingeconomics.com/commodity/brent-crude-oil.

7 CREA, 'EU Oil Ban and Price Cap Are Costing Russia EUR 160 Mn/Day, but Further Steps Can Multiply the Impact', 11 January 2023, https://energyandcleanair.org/wp/wp-content/uploads/2023/01/CREA_Press-release_EU-oil-ban-and-price-cap-are-costing-Russia-EUR-160-mn_day-but-further-steps-can-multiply-the-impact.pdf.

8 Anna Cooban, 'Europe's Ban on Russian Diesel Could Send Pump Prices Even Higher', CNN, 17 January 2023, https://www.cnn.com/2023/01/17/energy/russia-diesel-ban-prices/index.html.

9 Reuters, 'EU Could Ban Some Russian Fuel Oil Imports Six Months Ahead of Deadline', *Reuters*, 15 July 2022, https://www.reuters.com/business/energy/eu-could-ban-some-russian-fuel-oil-imports-six-months-ahead-deadline-2022-07-15/.

Ten tweede wordt Russische (stook)olie tegen een gereduceerde prijs omgeleid naar andere havens. De relatieve prijs van bunkeren in ARA zou kunnen stijgen in vergelijking met havens in landen waar geen sancties op Russische olie gelden.[10] De grootste verbruikers van bunkerbrandstoffen zijn grote containerschepen met reizen buiten de EU die op elk punt van hun reis kunnen bunkeren. Hoewel de hoge energie- en voedselprijzen wereldwijd economische problemen veroorzaken en kunnen leiden tot een daling van de wereldwijde vraag naar olie, zullen containerschepen die verre reizen buiten de EU maken er waarschijnlijk voor kiezen te bunkeren waar de prijzen het laagst zijn. Na de sancties zal dit waarschijnlijk niet de ARA regio zijn.

Het bunkeren van vloeibaar aardgas (LNG) wordt niet rechtstreeks getroffen door de sancties, maar de verminderde aanvoer van Russisch aardgas heeft niettemin tot torenhoge prijzen geleid. Aangezien extra aanvoer van LNG nodig is voor huishoudens en industrieën, lijkt het onwaarschijnlijk dat de markt op korte termijn extra aanvoer levert voor maritieme bunkering.

Op langere termijn zou de Nederlandse maritieme bunkermarkt zich op twee manieren kunnen ontwikkelen: er zou een herstel kunnen plaatsvinden tot niveaus vergelijkbaar met de situatie van vóór 2022, of de markt zou (relatief) kunnen krimpen in vergelijking met vóór 2022. De markt kan weer aantrekken door voldoende beschikbaarheid van alternatieven, of doordat de EU zich (opnieuw) openstelt voor Russische olieproducten en ruwe olie, of door een nieuw evenwicht op de wereldmarkt. Als de EU afgesloten blijft van Russische olie en niet tegen lage kosten voldoende alternatieve aanvoer kan krijgen, zullen de volumes op de bunkermarkt in de Nederlandse havens krap blijven en zullen de prijzen stijgen ten opzichte van andere bunkerhavens.

In beide verhaallijnen is de ontwikkeling van LNG-bunkering grotendeels afhankelijk van de financiële aantrekkelijkheid van LNG in het Europese energiesysteem en de scheepvaartsector.

Tot 2030 zal de positie van Rotterdam en ARA als de grootste bunkermarkt binnen de EU waarschijnlijk dezelfde blijven in de twee verhaallijnen. Alle havens in Europa staan voor vergelijkbare uitdagingen als gevolg van de sancties, en de efficiënte en betrouwbare infrastructuur, diverse transportmodaliteiten, grote industrie en verbinding met het achterland zullen de aantrekkelijke positie van Rotterdam als bunkerhaven en als bestemming voor groene investeringen blijven ondersteunen.

De verhaallijnen leveren andere resultaten op wanneer Rotterdam wordt vergeleken met mondiale in plaats van Europese locaties. Er zijn diverse havens met een vergelijkbaar goed ontwikkelde infrastructuur, sommige gelegen op of nabij locaties waar de productie van hernieuwbare brandstoffen minder duur is dan in Noordwest-Europa en de regionale vraag naar dergelijke brandstoffen snel toeneemt. Als de Rotterdamse bunkermarkt onder druk blijft, wordt Rotterdam een minder aantrekkelijke investeringslocatie. Aangezien de binnenlandse productie niet zo snel zal groeien als verwacht, zullen hernieuwbare brandstoffen moeten worden ingevoerd om te voldoen aan de Richtlijn hernieuwbare energie III. Uiteindelijk kan dit leiden tot hogere prijzen voor bunkerbrandstoffen in Rotterdam en een verdere afname van de omvang van de markt.

10 Bassam Fattouh, Andreas Economou, and Ahmed Mehdi, 'Oil Markets in 2023: The Year of the Aftershocks' (Oxford Institute for Energy Studies, January 2023), https://a9w7k6q9.stackpathcdn.com/wpcms/wp-content/uploads/2023/01/Oil-Markets-in-2023-The-year-of-the-aftershocks.pdf.

ARA: 's werelds tweede grootste bunkerhaven en Rusland de belangrijkste leverancier van ruwe olie en stookolie

IMO zwavel standaard

FF55 gepresenteerd

Russische inval in Oekraïne

OPEC+ vermindering van 2 mb/d

EU verbod op maritieme import van Russische ruwe olie

G7 prijsplafond voor Russische ruwe olie

EU verbod op maritieme import van Russische olieproducten

G7 prijsplafond voor Russische olieproducten

FF55 implementatie

Basis verhaallijn: Direct effect van de sancties

- Vooruitlopend op sancties vervingen Europese bedrijven reeds Russische ruwe olie
- De sancties op Russische ruwe olie hadden een minimaal effect op de olieprijzen in de EU
- De sancties op Russische olieproducten kunnen een negatief effect hebben op de levering van bunkerbrandstof in NL
- De invoer van stookolie uit Rusland wordt stopgezet
- De productie van ARA-raffinaderijen wordt beïnvloed door het verbod op Russische olieproducten (met name VGO)
- Dieseltekort vermindert het aanbod van gasolie voor de scheepvaart en verhoogt de vraag naar stookolie
- Prijs van bunkerbrandstof in Nederland stijgt ten opzichte van andere bunkerhavens
- Door de flexibiliteit van schepen bij het bunkeren zullen zij de haven met de laagste brandstofprijzen kiezen ten koste van ARA
- Alternatieve brandstoffen worden tot 2025 niet significant beïnvloed door sancties noch FF55
- LNG-bunkeren blijft zeer duur door hoge gasprijzen en grote vraag van huishoudens en andere industrieën; uitzondering kunnen LNG-tankers zijn

Verhaallijn 1: Markt herstelt

- De Nederlandse bunkermarkt trekt weer aan door voldoende (betaalbare) aanvoer van niet-Russische brandstoffen, een heropening van de handelsbetrekkingen met Rusland of als gevolg van een nieuw evenwicht op de wereldmarkt
- De RED III-eisen inzake de broeikasgasintensiteit van brandstoffen worden van kracht
- Er zijn grotere hoeveelheden alternatieven nodig om de klimaatdoelstellingen te halen, afhankelijk van de wijze waarop REDIII in NL wordt toegepast
- Binnen Europa blijft de ARA de grootste bunkermarkt en de belangrijkste bestemming van groene investeringen
- Buiten Europa geeft de grote bunkermarkt in de ARA stimulansen voor investeringen, maar andere locaties worden wellicht aantrekkelijker voor het bunkeren van duurzame energie

Storyline 2: Markt krimpt

- Nederlandse bunkermarkt krimpt als prijzen hoog blijven ten opzichte van andere havens
- Dit kan het gevolg zijn van aanhoudende sancties tegen Rusland of van problemen bij de vervanging van Russische olie
- Bij een lager volume bunkerbrandstoffen, zijn er minder volumes alternatieven nodig om aan de RED III-doelstelling te voldoen
- Binnen Europa blijft ARA de grootste bunkermarkt en de belangrijkste bestemming van groene investeringen
- Een kleinere markt en het relatieve geografische voordeel van andere havens vermindert de aantrekkelijkheid van ARA voor groene investeringen in vergelijking met havens buiten EU
- De invoer van hernieuwbare energiedragers zal toenemen om aan de binnenlandse vraag te voldoen

List of abbreviations

ADNOC	Abu Dhabi National Oil Company
AED	Emirati Dirham
AFIR	Alternative Fuel Infrastructure Regulation
ARA	Amsterdam-Rotterdam-Antwerp
CN	Combined nomenclature
ECAs	Emission control areas
EEA	European Economic Area
ETD	Energy Taxation Directive
EU	European Union
EU ETS	EU Emission Trading System
FF55	Fit for 55
G7	Group of Seven
GHG	Greenhouse gases
HFO	Heavy fuel oil
HSFO	High sulphur fuel oil
IMO	International Maritime Organization
LNG	Liquefied natural gas
LSFO	Low sulphur fuel oil
Mb/d	Million barrels a day
MDO	Marine diesel oil
MGO	Marine gas oil
Mt	Million tonnes
OPEC+	Organization of the Petroleum Exporting Countries and 11 other non-OPEC oil producers
RED III	Renewable Energy Directive
RLF	Renewable and low carbon fuel
RFNBO	Renewable fuels of non-biological origin
TTF	Title Transfer Facility
UAE	United Arab Emirates
UCO	Used cooking oil
UNFCCC	United Nations Framework Convention on Climate Change
ULSFO	Ultra-low sulphur fuel oil
VGO	Vacuum gas oil
VLSFO	Very low sulphur fuel oil

Introduction

The shipping industry is undergoing significant transformations. The European Union's (EU) climate ambitions laid out in the Green Deal and the proposals in the Fit for 55 (FF55) package are driving a transition from petroleum-based shipping fuels to alternatives like liquefied natural gas (LNG), biofuels, green methanol or ammonia. The proposals foresee a gradual transition, starting in 2025 and accelerating after 2030. For maritime shipping, FF55 will become most impactful after 2030. Yet unanticipated developments in 2022 – the war in Ukraine and the EU's sanctions on maritime imports of Russian oil – are adding stress to current oil and bunkering markets.

The Port of Rotterdam, part of the so-called ARA region (Amsterdam-Rotterdam-Antwerp), is Europe's largest bunkering port and the second largest in the world, preceded only by the Port of Singapore.[11] The Port of Rotterdam supplies around 9.5 million tonnes of various bunker fuels to vessels annually.[12] As Russia has been a key supplier of crude and bunkering fuel to the Netherlands for decades, the EU oil sanctions could have far reaching implications for bunkering in the Port of Rotterdam. The sanctions are coming into force just before some of the FF55 requirements will have to be implemented.

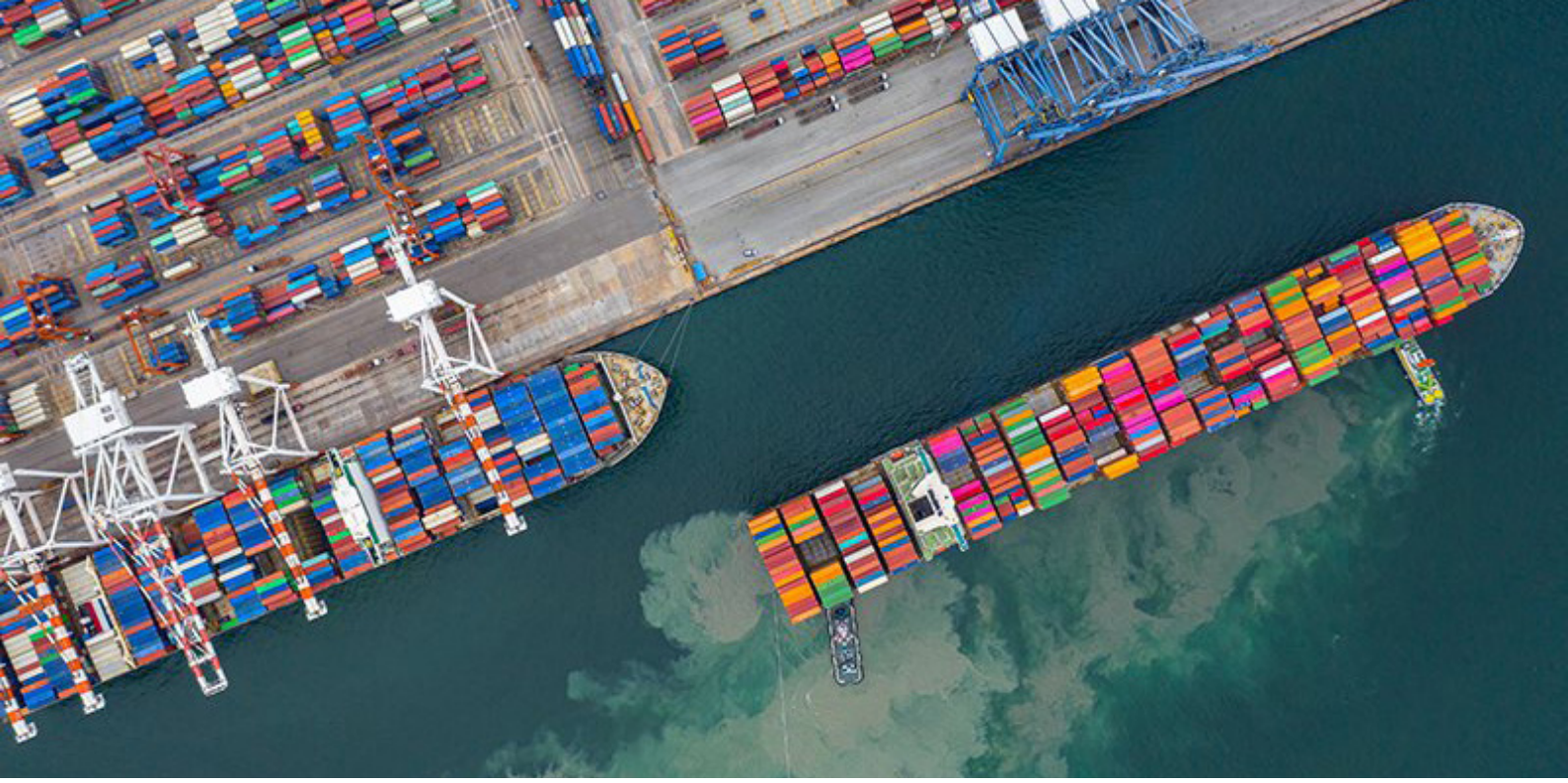
The Ministry of Infrastructure and Water Management (I&W) has commissioned CE Delft and *The Hague* Centre for Strategic Studies to analyze the consequences of the sanctions for the objectives of the Fit for 55 package with regard to the availability and supply of renewable fuels for the maritime sector until 2030 in the Netherlands.

This report analyses the impact of the EU's sanctions on Russian oil on the bunkering market in Dutch ports and on the efforts required for the transition to alternative bunkering fuels in these ports. The report proceeds as follows:

- A short methodological note sheds light on the definitions and indicators used to assess the ARA bunker market.
- The global bunkering market is introduced to provide some context about the position of ARA and its competitors.
- Bunkering in ARA is discussed in more detail, setting the scene of the situation before the 2022 invasion of Ukraine.
- The consequences of the war in Ukraine and the Fit for 55 measures that are relevant for bunkering in ARA are introduced, highlighting expected changes after 2022.
- Three storylines are developed. The base storyline is focused on the immediate effect of sanctions on bunkering in ARA. Two alternative storylines are developed for the period between 2025 and 2030.
- The report is concluded with a discussion of the implications of the storylines for the Fit for 55 goals in the Netherlands.

11 Maritime Fairtrade, 'TOP 10 BUNKERING PORTS', Maritime Fairtrade, 19 January 2019, https://maritimefair-trade.org/top-ten-bunkering-ports/.

12 Port of Rotterdam, 'BUNKERING IN ROTTERDAM: Europe's Largest Bunkering Port', Port of Rotterdam, n.d., https://www.portofrotterdam.com/en/sea-shipping/bunkering-in-rotterdam.



Methodological note

This report develops qualitative storylines that reflect possible consequences of the European sixth sanctions package[13] for the ARA bunker market and the FF55 objectives up to 2030. In this methodological note, the process of developing the qualitative storylines is explained.

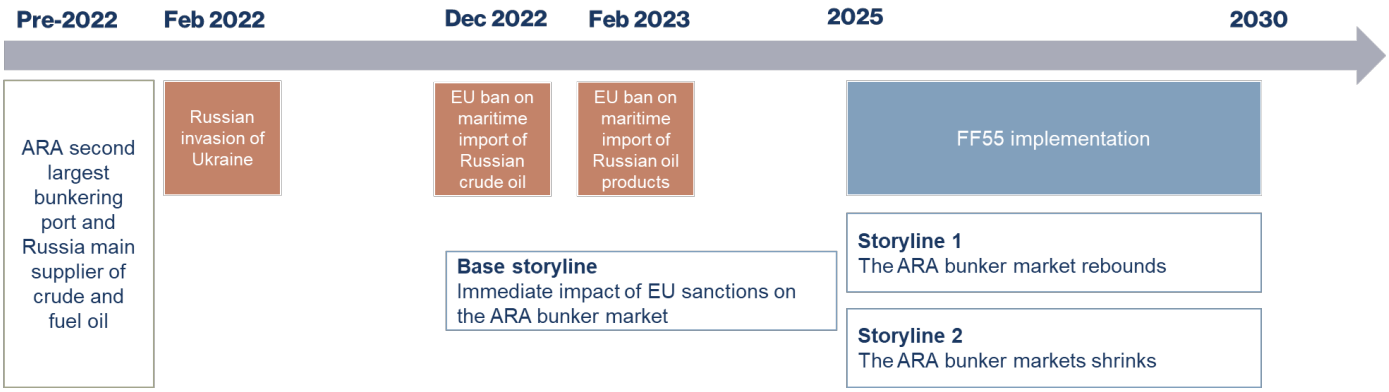
The focus lies on the Netherlands and, specifically, the Port of Rotterdam given its importance as a bunkering hub. The FF55 objectives are based on the original EU Commission proposals, and not on subsequent texts that may be intermediate results of ongoing negotiations.

The bunker market is defined as the supply (quality and quantity), demand and price of fuels. Within the scope of this paper, bunker fuels include oil products (various grades of fuel oil and marine gasoil) with a focus on fuel oil as the main bunkering fuel sold in Rotterdam, liquefied natural gas (LNG) and renewables (biofuels, methanol, ammonia, hydrogen). Throughout the report, a renewable fuel is defined as a fuel that has (near)-zero well-to-wake GHG emissions. The definition of alternative fuels in addition includes LNG and fossil ammonia, hydrogen, etc.

The base storyline includes the most likely consequences of the embargo on Russian oil on the ARA bunker market in the short term (2-3 years after entry into force of the sanctions). This storyline can then develop in two different ways. Storyline 1 assumes that the ARA bunker market would revert to a situation similar to the one before sanctions, i.e., pre-2022. Storyline 2 assumes a negative impact of sanctions on the bunker market in ARA, leading to a contraction of the market post-2025. This timeline is illustrated in Figure 1.

13 'EU Adopts 6th Package of Sanctions against Russia', Text, European Commission, June 2022, https://ec.europa.eu/commission/presscorner/detail/en/IP_22_2802.

Figure 1. Timeline considered in this research



The storylines are based on information available as of December 2022-January 2023, and give indications for a positive or negative impact of sanctions on the demand, supply and price of bunkering in ARA.

Given that this research has been conducted before the sanctions came into effect, before the implementation of the G7 price cap and before the proposals of the Fit for 55 package had been adopted, it represents a snapshot of the situation and expectations as of December 2022-January 2023 and does not take into account possible developments after that date, even though these could have significant impacts on the bunker markets and on the fuel transition. This analysis should be replicated at a later stage to provide updates on how the situation has changed.

Given the existing advantageous factors for bunkering in ARA (Textbox 1), the demand for bunkering at this location is therefore primarily influenced by the price of bunker fuels compared to other international ports. In turn, the price of bunker fuels in ARA is dependent on the price of feedstock used to produce bunker fuel, i.e., the price of crude oil. Different grades of crude oil can be more suitable to produce a certain quality of bunker fuel. For instance, large amounts of high sulphur fuel oil could be derived from Russian Urals, whereas producing low sulphur fuel oil from the same crude would require a more complex refining process, making it more expensive. As such, the price of bunker fuel is dependent on the price of the specific crude grade used to produce it together with the degree of complexity of the process.

In addition to price, geopolitics and legislation can influence the bunker market. For instance, the decision to place a ban on Russian oil imports in the EU is motivated by geopolitical and security reasons but directly impacts the oil bunker market. Moreover, legislation is a driver of markets especially for alternative fuels. The binding requirements to adopt alternatives in the maritime industry as part of FF55 will be key determinants of their demand in bunkering. The indicators affecting the ARA bunker market that are considered in this research are summarized in Figure 2.

Text box 1: The complex role of the ARA region

The Amsterdam-Rotterdam-Antwerp (ARA) region is one of the world's largest port-industrial complexes and the second largest bunkering port. Within the ARA region, Rotterdam is the largest port, the largest container port in Europe and a key logistics hub.

The Port of Rotterdam became dominant over time. Geographically, its location brought important advantages due to its connection to both the North Sea and the Rhine River. Rotterdam's New Waterway canal of 1872 connected the port directly to the North Sea, bringing significant advantages over neighbouring ports as bigger ships and, ultimately, the super tanker could directly enter Rotterdam.[14] After the Second World War, the demand for petroleum in North-Western Europe sharply increased. This was reinforced by the shift from coal to hydrocarbons in the chemical industry.[15] The expanding industrial capacity of Germany required large-scale imports of crude and oil products. These could be imported and refined in ARA and transported through pipelines and barges to North-Rhine Westphalia in Germany. Continuous investments and innovation to expand the capacity of receiving large ships, like the Maasvlakte I and II construction, consolidated the hub position of Rotterdam.

Rotterdam, and ARA in general, is placed on the maritime trade route from Russia, making it not only the main recipient of Russian oil but also an assembly point for further shipments. Relatively small tankers can bring crude and oil products from Russia to the Netherlands due to the shallow depth of the Baltic route. In Rotterdam, the products can be transferred to larger tankers and re-exported. A share of the fuels is also redistributed within Europe, with the remaining part processed in refineries in Rotterdam.

Large-scale container ships on international voyages tend to be the biggest customers of the bunker market in Rotterdam (and ARA).[16] These ships will bunker wherever the price is lowest, provided infrastructure is efficient and refuelling is fast. The Port of Rotterdam's (and ARA's) bunkering position has been supported by the large local production of fuels, low transport costs of imported fuels, efficient bunkering and refuelling processes, economies of scale due to the large demand for bunkering, well-developed and modern infrastructure, as well as deep sea access and the broader maritime hub function.

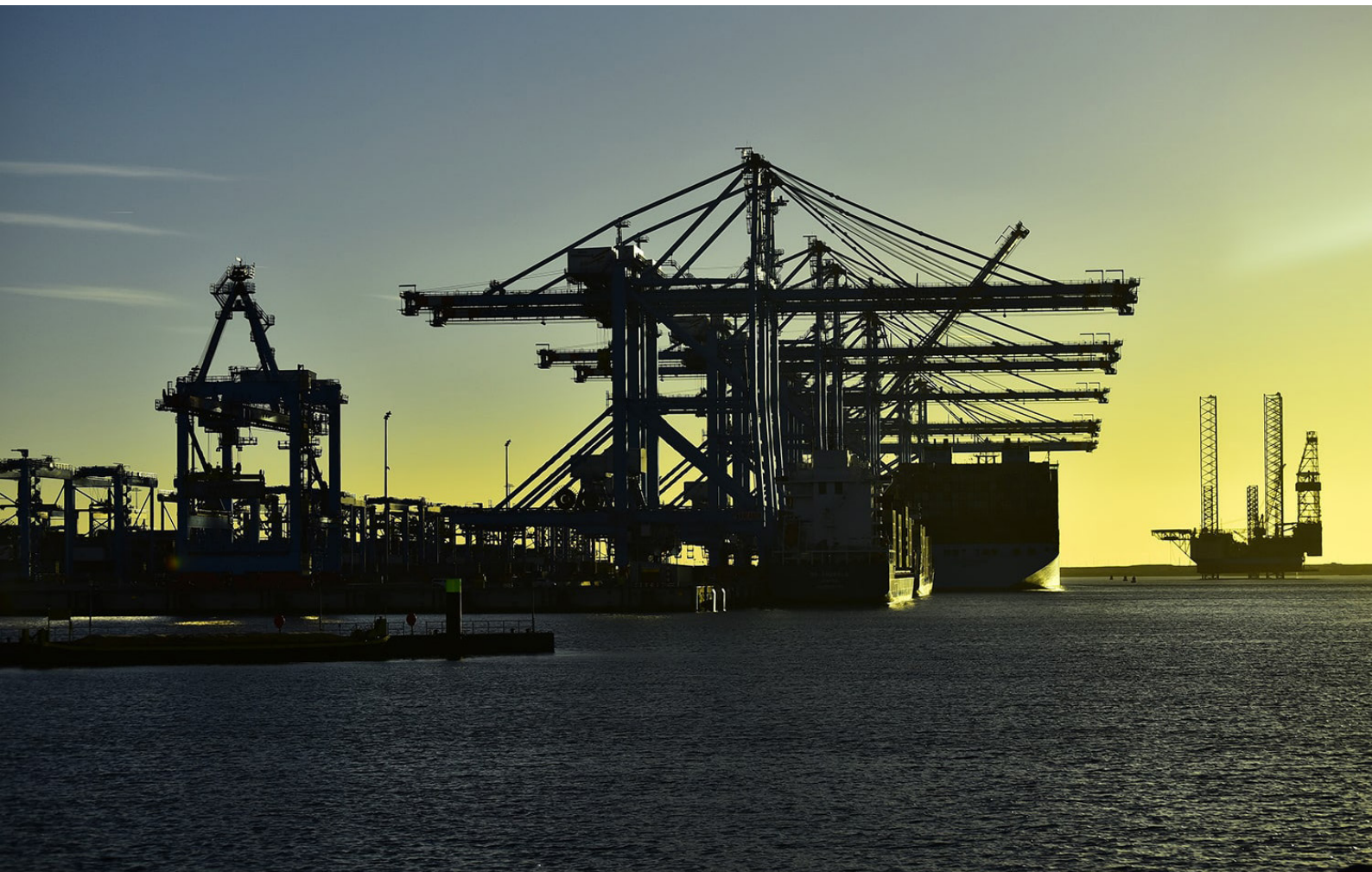
14 Karel Van den Berghe et al., 'Friends with Benefits: The Emergence of the Amsterdam–Rotterdam–Antwerp (ARA) Polycentric Port Region', *Territory, Politics, Governance* 0, no. 0 (12 January 2022): 1–20.

15 Odinn Melsted and Irene Pallua, 'The Historical Transition from Coal to Hydrocarbons: Previous Explanations and the Need for an Integrative Perspective', *Canadian Journal of History* 53:3 (2018), 395-422, https://doi.org/10.3138/cjh.ach.53.3.03

16 Port of Rotterdam. "Containerschepen Bunkeren Meer in Rotterdam," 2021. https://www.portofrotterdam.com/nl/nieuws-en-persberichten/containerschepen-bunkeren-meer-rotterdam.

Figure 2. Summary of indicators affecting the ARA bunker market

	Demand for bunker fuels in ARA	Supply of bunker fuels in ARA	Price of bunker fuels in ARA
Crude oil and oil products	• Price relative to other ports • Efficiency and reliability of processes	• Supply of non-Russian crude oil in ARA and EU • Ability of ARA and EU refineries to produce fuel oil from non-Russian oil • Supply of non-Russian fuel oil in ARA	• Price of bunkering non-Russian fuel oil in ARA • Price of bunkering discounted Russian fuel in non-EU ports • Price of crude oil and complexity of refining process to make fuel oil from various crude blends
Renewable fuels	• For methanol, ammonia, etc.: Number of ships with suitable engines entering the market • For bio- and synthetic fuels that can be used with existing engines: price • Legislation	• Domestic production capacity • Import capacity and international production capacity • Legislation	• Size of market: availability of supply and demand • Legislation
Liquefied natural gas	• Number of ships with suitable engines entering the market • Price	• Supply of Russian LNG • Supply of non-Russian LNG according to RePower EU • Demand in other markets, especially in South-East Asia	• Availability of LNG for bunkering vs. other consumers (households, industry)

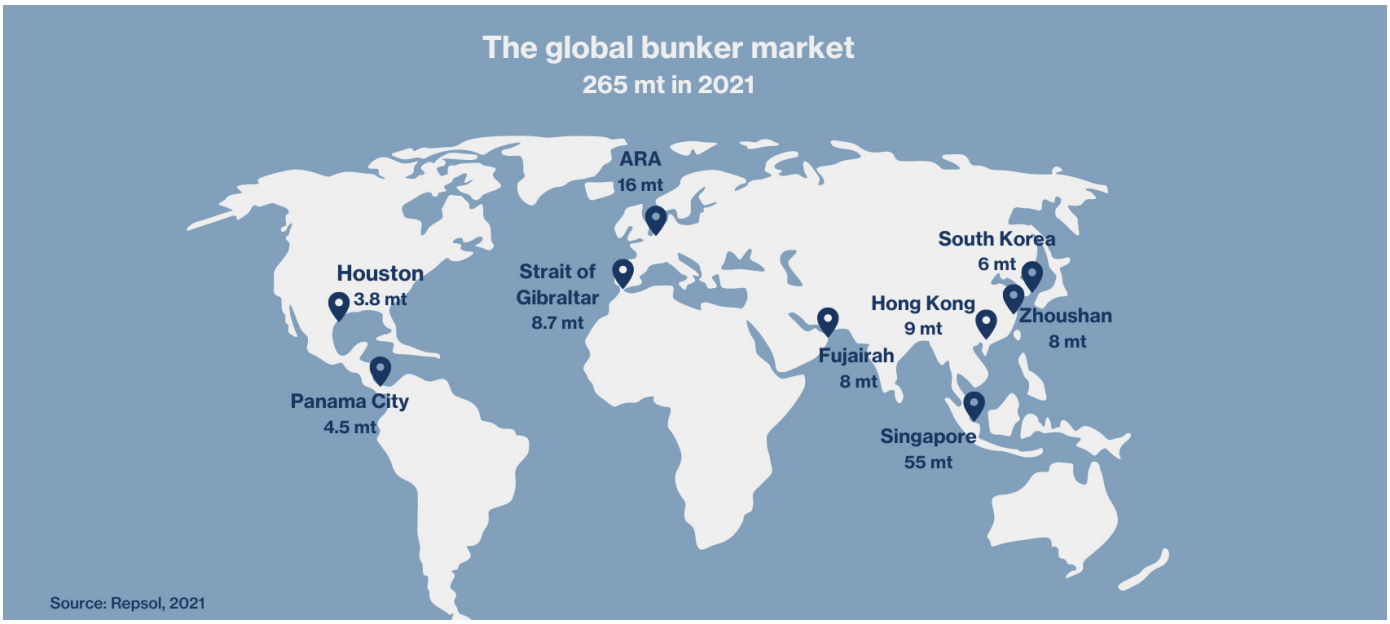


The global bunkering market

Singapore, ARA and Fujairah are widely considered the three largest bunkering ports in the world. While ARA was the second largest bunkering hub in the world in 2021, Singapore provided 3.5 times more fuel (Figure 3). ARA had a 6% share in the global maritime fuel market of 265 mt. The ports of Hong Kong, Gibraltar, Zhoushan, Busan, Panama City, and Houston also play a significant role in the global bunkering market.[17]

The size of Singapore's bunker market stems from its strategic location, compounded by massive investments in infrastructure, efficiency of operations and automation.[18] The shortest maritime route for vessels passing between the Indian and Pacific Oceans goes through the Malacca and Singaporean Straits and, therefore, through the Port of Singapore.[19] The Port has also been known for the lowest prices in the bunkering market worldwide.[20]

Figure 3. The largest bunkering ports in the world



17 'Top 10 Bunkering Ports in the World', *Maritime Fairtrade* (blog), 19 January 2019, https://maritimefairtrade.org/top-ten-bunkering-ports/.

18 Christl Li, 'Connecting to the World: Singapore as a Hub Port', Civil Service College Singapore, 6 July 2018, https://www.csc.gov.sg/articles/connecting-to-the-world-singapore-as-a-hub-port.

19 'Why Malaysian Ports Are Losing out to Singapore', TODAY, 14 September 2017, https://www.todayonline.com/world/why-malaysian-ports-are-losing-out-singapore.

20 'A Deep Insight into Bunkering Business', Live Bunkers, n.d., https://livebunkers.com/deep-insight-bunkering-business.

In a survey conducted by Argus Media, 78% of market participants believe that Singapore will remain the world's largest bunkering hub because of its location, infrastructure and regulatory framework.[21]

The Port of Fujairah also owes its importance to its strategic location.[22] Its location on the eastern bank of United Arab Emirates (UAE) allows the port to play an essential role in shipping crude oil and petroleum products from the Middle East to the rest of the world.[23] It also allows to bypass the Strait of Hormuz, the largest chokepoint of the international oil market.[24] Every day 1.5 million barrels of oil flow through the oil pipeline that connects the port with the Habshan fields, circumventing the Strait of Hormuz.[25]

Most of these ports have developed strategies to accommodate bunkering of renewable fuels in the future.[26] For instance, Singapore sets out to introduce bunkering standards and infrastructure for low carbon fuels such as methanol, ammonia, and hydrogen.[27] The Abu Dhabi National Oil Company (ADNOC) established a hydrogen alliance to build a green economy in the UAE and export green and blue hydrogen.[28] Still, these projects are currently at an early stage and it remains to be seen how each port will position itself in bunkering alternative fuels in the next years.[29]

21 Sammy Six, 'Alternative Bunker Fuels, Asian Competition to Shape Singapore's Future: Poll', Argus Media, 16 December 2021, https://www.argusmedia.com/en/blog/2021/december/16/alternative-bunker-fuels-asian-competition-to-shape-singapore-future-poll.

22 Emily Stromquist, 'Changes Afoot in Fujairah Aim to Boost the Port's Global Prestige', Castlereagh, 30 October 2019, https://castlereagh.net/changes-afoot-in-fujairah-aim-to-boost-the-ports-global-prestige/.

23 'Port of Fujairah: A Comprehensive Overview', *DFreight* (blog), 5 September 2022, https://dfreight.org/blog/port-of-fujairah-a-comprehensive-overview/.

24 'The Strait of Hormuz Is the World's Most Important Oil Transit Chokepoint', U.S. Energy Information Administration, 2019, https://www.eia.gov/todayinenergy/detail.php?id=39932.

25 Sultan al-Barei, 'UAE's Fujairah Port Grows in Strategic Importance', Al-Mashareq, 21 June 2021, https://almashareq.com/en_GB/articles/cnmi_am/features/2021/06/21/feature-03.

26 Nicola Contessi, 'INSIGHT: Alt Bunker Fuel Developments at Key Ports', Ship & Bunker, 2 November 2022, https://shipandbunker.com/news/world/725841-insight-alt-bunker-fuel-developments-at-key-ports.

27 Marcus Hand, 'Singapore Sets out Maritime Decarbonisation Ambitions', Seatrade Maritime News, 9 March 2022, https://www.seatrade-maritime.com/environmental/singapore-sets-out-maritime-decarbonisation-ambitions.

28 Jennifer Gnana, 'Adnoc, Mubadala and ADQ to Develop Hydrogen Alliance', The National News, 18 January 2021, https://www.thenationalnews.com/business/energy/adnoc-mubadala-and-adq-to-develop-hydrogen-alliance-1.1147882.

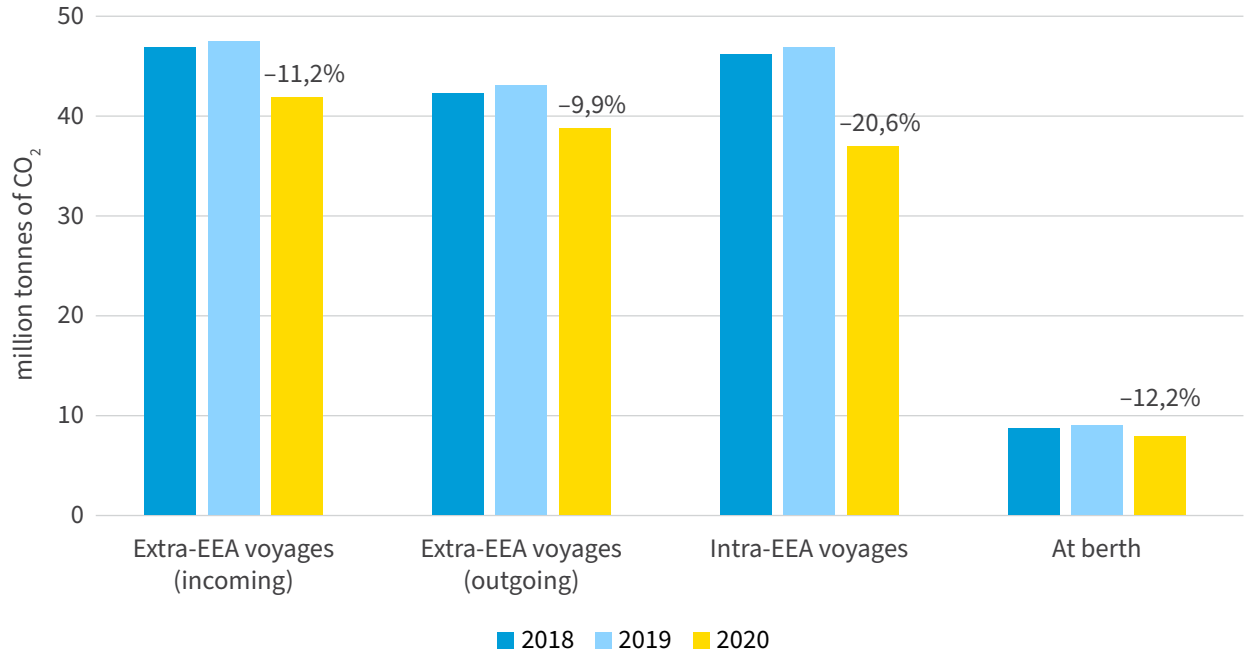
29 Contessi, 'INSIGHT'.

Bunkering in ARA

Most fuels and CO_2 emissions of maritime shipping to and from EU ports are related to extra-EU voyages, see Figure 4 (here displayed for the European Economic Area - EEA).

The type of fuel consumed by vessels that make a call in EU ports is shown in Figure 5. The most notable change to maritime bunkering came in 2020 when the International Maritime Organization (IMO) required that ships use fuel with a sulphur content of 0.50% m/m or less, or clean their exhaust gases with a scrubber. As a result, the use of high-sulphur fuel oil (HSFO) decreased and was replaced by ultra-low sulphur fuel oil (ULSFO) and very low sulphur fuel oil (VLSFO), with less than 0.10% and 0.50% sulphur concentration, respectively.[30] The consumption of gasoil and diesel oil in shipping grew slightly since 2018, and so did LNG bunkering.a The decline in 2020 was related to the decline in global trade due to the pandemic.

Figure 4. Emissions per type of voyage in the EU[27]

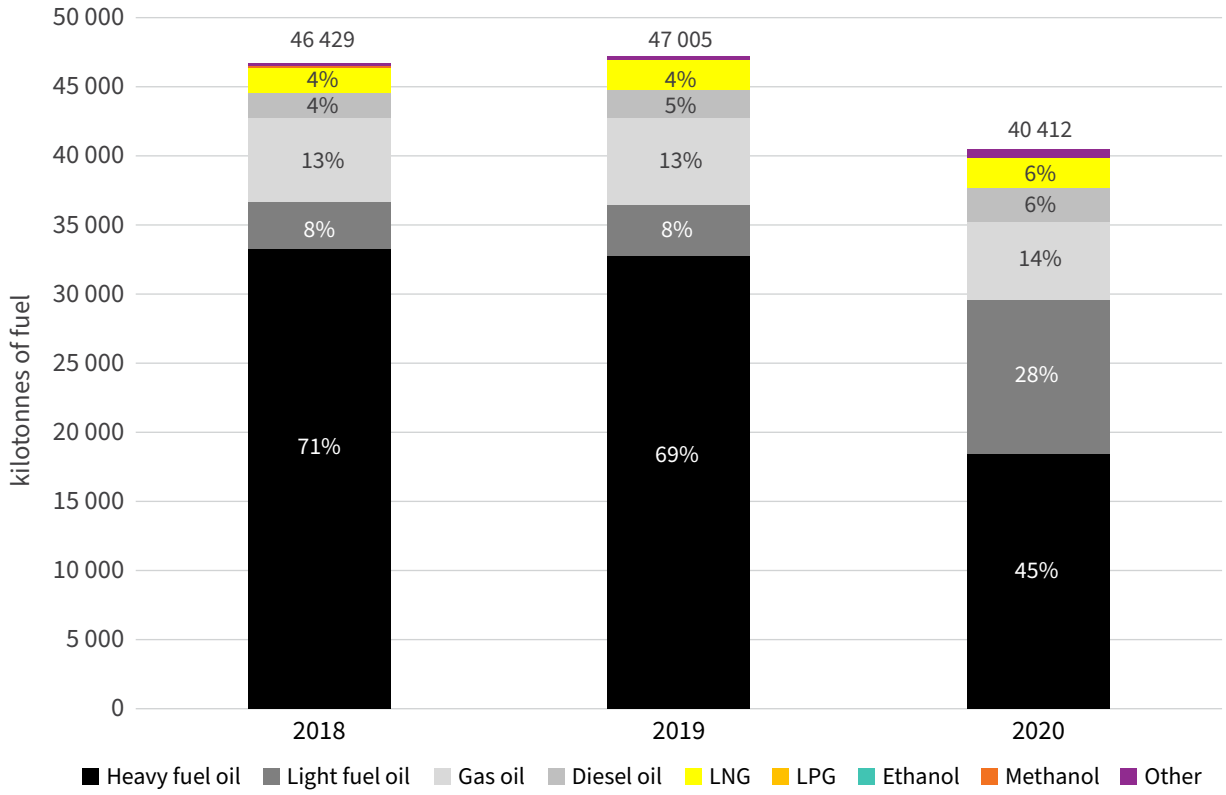


Note: emissions data relate to ships transporting cargo or passengers with a size of at least 5000 gross tonnes.

30 Lawyers Responding to Climate Change, 'Regulation of Bunker Fuels Emissions', Lawyers Responding to Climate Change, 7 February 2017, https://legalresponse.org/legaladvice/regulation-of-bunker-fuels-emissions/.

31 European Commission, 'Third Annual Report from the European Commission on CO2 Emissions from Maritime Transport (period 2018-2020)', 2022, https://climate.ec.europa.eu/system/files/2022-08/swd_2022_214_en_0.pdf

Figure 5. Fuel consumption of EU MRV fleet (vessels above 5000 GT and at least one port of call in the EU)[28]



About 14 million tonnes of fuel oil, 400,000 tonnes of marine gas oil (MGO) and 135,000 tonnes of lubrication oil are supplied annually in the Port of Rotterdam and Port of Amsterdam.[33] In the Port of Rotterdam alone, around 9.5 million tonnes of various bunker fuels are supplied to vessels annually.[34] Fuel oil in its various grades is by far the main bunker fuel sold in Rotterdam, as shown in Table 1. Marine gasoil (MGO) and marine diesel oil (MDO) are additional petroleum based products used in bunkering.

Blending of conventional shipping fuels with biofuels has increased over the last years, making Rotterdam one of the largest bio-bunkering ports in the world. Bio-blending of ultra-low sulphur fuel oil (ULSFO), very low sulphur fuel oil (VLSFO), high sulphur fuel oil (HSFO) but also marine gasoil and marine diesel oil is on the rise. In only one year, bio-blending of VLSFO grew 5 times comparing values in the first three quarters of 2021 and 2022, from around 78.395 tonnes to 400.444 tonnes (see Table 1).[35]

32 European Commission, 'Third Annual Report from the European Commission on CO2 Emissions from Maritime Transport (period 2018-2020)', 2022, https://climate.ec.europa.eu/system/files/2022-08/swd_2022_214_en_0.pdf

33 Nove, 'Bunkering Seagoing Vessels', Nove, n.d., https://www.nove.nl/bunkering.

34 Port of Rotterdam, 'BUNKERING IN ROTTERDAM: Europe's Largest Bunkering Port'.

35 'Bunker Sales Port of Rotterdam', 2022, https://www.portofrotterdam.com/sites/default/files/2022-10/bunker-sales-q3-2021-2022.pdf.

Table 1. Bunker fuel sales in Port of Rotterdam 2021-2022. Data from Port of Rotterdam, 2022.[32]

			Bio-blended		Bio-blended		Bio-blended		Bio-blended		Bio-blended			Bio-blended	
		ULSFO (tonnes)	ULSFO (tonnes)	VLSFO (tonnes)	VLSFO (tonnes)	HSFO (tonnes)	HSFO (tonnes)	MGO (tonnes)	MGO (tonnes)	MDO (tonnes)	MDO (tonnes)	Methanol (tonnes)	LNG (m^3)	LNG (m^3)	Lubes (m^3)
2022	Q1	213,075	9,520	930,481	137,051	707,312	819	286,996	11,998	209,529	365	-	111,804	-	10,894
	Q2	188,177	22,167	820,223	119,174	718,325	18,679	269,833	8,617	166,583	1,002	-	63,497	-	10,691
	Q3	205,451	8,793	986,058	144,219	835,812	30,462	299,045	5,718	162,113	3,583	-	113,701	-	8,903
	Q4														
	Total	**606,703**	**40,480**	**2,836,762**	**400,444**	**2,261,449**	**49,960**	**855,873**	**26,332**	**538,225**	**4,951**	**-**	**289,002**	**-**	**30,487**
2021	Q1	201,054	5,223	978,145	38,701	620,752	20,945	250,570	2,511	174,361	1,573	-	139,489	-	20,327
	Q2	227,099	6,010	1,021,119	17,338	614,098	17,844	249,386	7,265	177,640	5,348	250	157,027	-	16,932
	Q3	199,198	6,941	1,051,017	22,355	694,133	11,777	258,797	6,354	183,987	4,198	-	212,719	531	16,553
	Q4	186,993	13,650	1,009,610	71,148	745,271	18,665	242,081	17,904	205,795	5,302	-	94,454	-	12,558
	Total	**814,333**	**31,824**	**4,059,891**	**149,542**	**2,674,254**	**69,230**	**1,000,833**	**34,034**	**741,783**	**16,421**	**-**	**603,690**	**531**	**66,370**

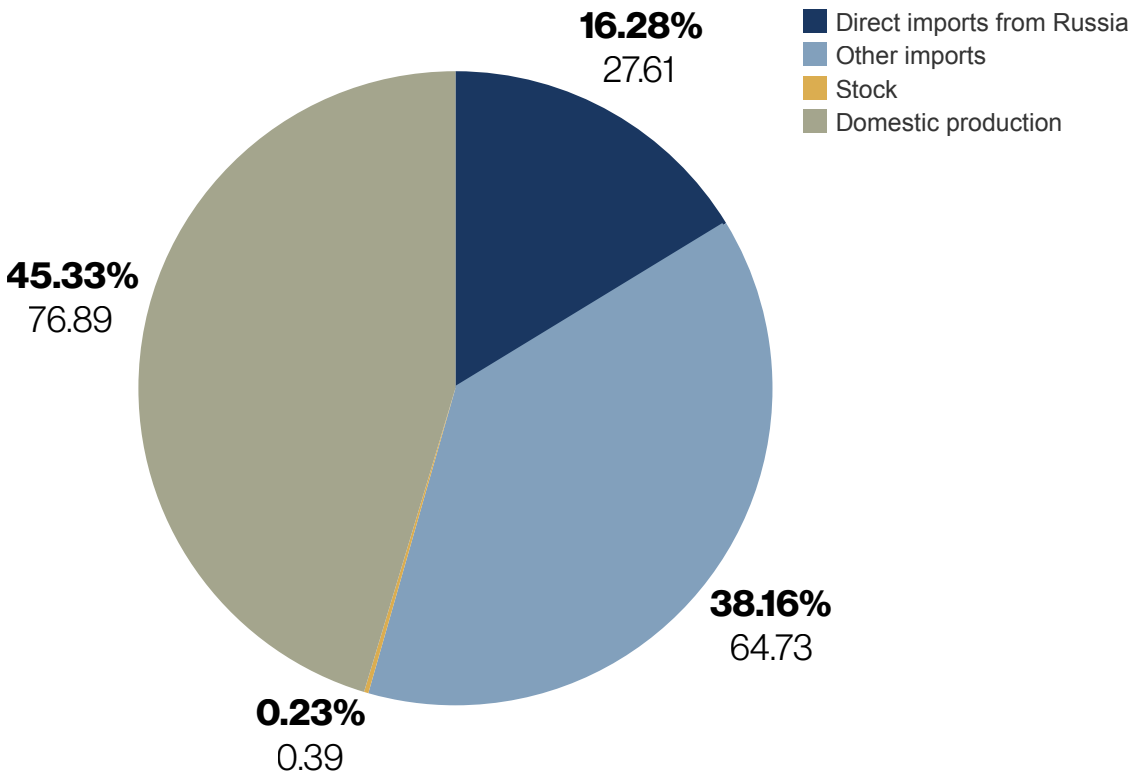
36 'Bunker Sales Port of Rotterdam'.

Over the last 10-15 years, infrastructure for the trade and production of biofuels was built around the ARA region as the pre-existing oil trade hub offered significant logistical advantages. Producing biofuels and blending them into gasoline and diesel can be effectively done in a place where oil infrastructure is already developed, such as in ARA. The European Union is the leader in biodiesel production (32% of the global market), which is dominated by rapeseed oil, palm oil and used cooking oils (UCO).[37] Spain and Germany lead European production followed by France, Italy and the Netherlands.[38]

Fuel oil in its various forms (ULSFO, VLSFO, HSFO) is the main bunker fuel in Rotterdam. It can be supplied to the Netherlands in two main ways: either imported or produced domestically from (imported) crude oil, as shown in Figure 6. Between 2016-2020, 45.3% of Dutch fuel oil was produced in domestic refineries, 16.28% was imported from Russia and 38.16% from other suppliers.

Russia has been the largest supplier of crude oil to the EU and the Netherlands (see Figure 7). Russian oil is suitable for producing middle-distillates like diesel and, in the process, residuals like fuel oil. In other words, a part of the imported Russian crude oil was refined into HSFO in the EU.

Figure 6. Composition of Dutch fuel oil supply in million tonnes (2016-2020)

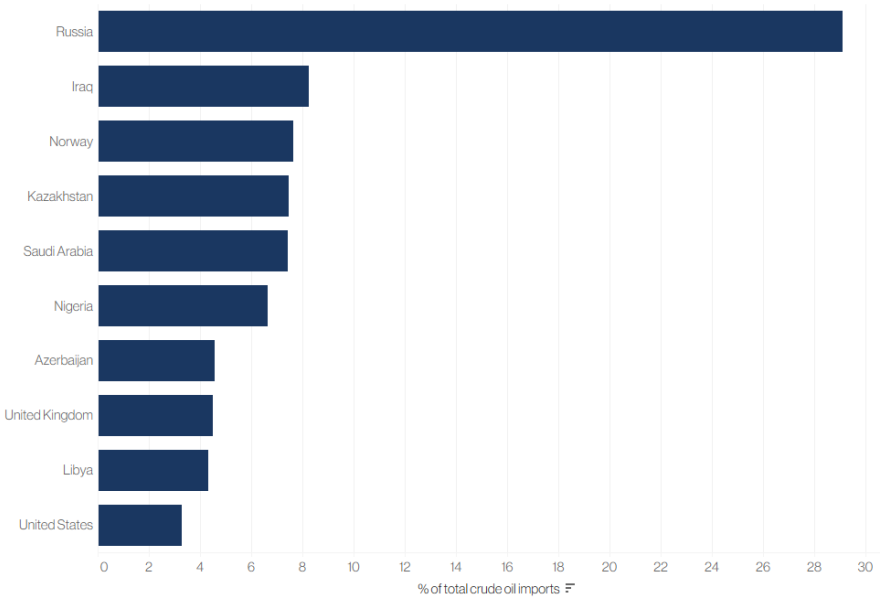


*Other imports include indirect imports from Russia
Source: CBS & Eurostat

37 OECD/FAO, 'OECD-FAO Agricultural Outlook 2021-2030', 2022, https://doi.org/10.1787/f1b0b29c-en.

38 Data from Eurostat, see https://ec.europa.eu/eurostat/databrowser/view/NRG_INF_LBPC/default/table?lang=en&category=nrg.nrg_quant.nrg_quanta.nrg_inf

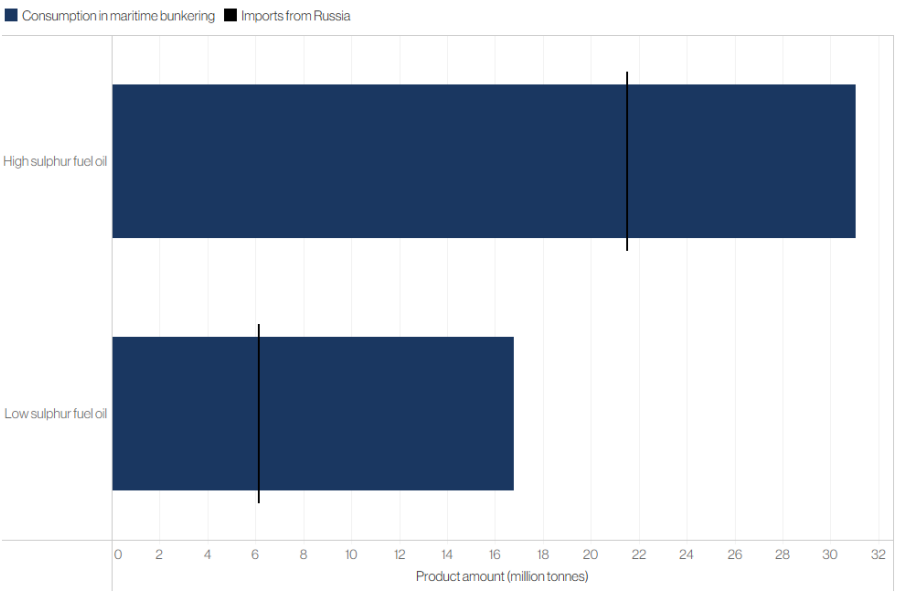
Figure 7. Largest suppliers of crude oil to the EU, 2016-2020



*EU refers to EU27, i.e. excluding the UK
Source: Eurostat

Comparing the amount of fuel oil imported from Russia to the amount used in maritime bunkering in the Netherlands, it becomes evident that a large part of the Russian imports were used for this purpose. About 31 million tonnes of high-sulphur oil were bunkered in the Netherlands between 2016 and 2020 and 21 million tonnes were imported from Russia (Figure 8).

Figure 8. Consumption of Russian fuel oil in Dutch maritime bunkering. Dutch imports of Russian fuel oil and consumption in maritime bunkers (2016-2020)



*Imports refer to total imports, not limited to use in maritime bunkering
**High sulphur and low sulphur meaning >= 1% and <1%, respectively

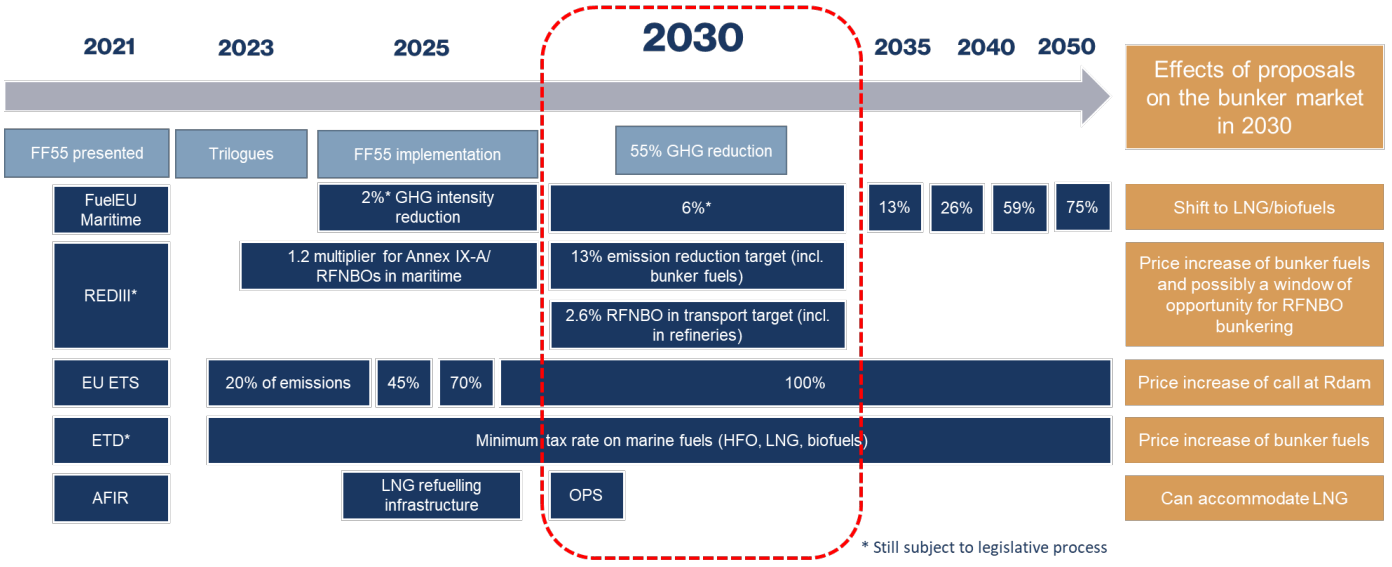
Fit for 55 measures

Maritime shipping relies completely on fossil fuels and is responsible for around 3% of global greenhouse gas (GHG) emissions.[39] Since the maritime shipping sector functions on a world-wide basis, it was excluded from the national obligations to reduce GHG emissions under the Kyoto Protocol and is generally not included in the nationally determined contributions (NDCs) which countries have submitted under the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC). Consequently, the GHG emissions of the sector have not been subject to market based measures or fuel standards.

This has changed with the publication of the European Green Deal in 2019, in which the European Commission included maritime transport in its emission reduction objectives. In 2021, this was further elaborated in a legislative package which addresses GHG emissions of shipping and fuel use both from the demand and supply side. Recognizing the capital-intensive character of the sector and the remaining challenges for the introduction of renewable fuels in shipping, the European Commission has set targets that amount to a long-term decarbonization scenario. In this report, the focus is on developments that may impact the bunkering market up to 2030.

There are five legislative proposals in Fit-for-55 that impact maritime shipping and bunkering: FuelEU Maritime, Renewable Energy Directive (REDIII), Emissions Trading System (EU ETS), Energy Taxation Directive (ETD) and Alternative Fuels Infrastructure Regulation (AFIR). An overview of their respective impacts is illustrated in Figure 9. FF55 addresses both supply and demand of marine fuels, and discourages the use of fossil fuels. The EU ETS and FuelEU Maritime target the GHG emissions of vessels, while the ETD and RED target fuel suppliers.

Figure 9. Overview of impact of FF55 on maritime shipping and bunkering



39 UMAS, 'A Strategy for the Transition to Zero-Emission Shipping; An analysis of transition pathways, scenarios, and levers for change,' 2021

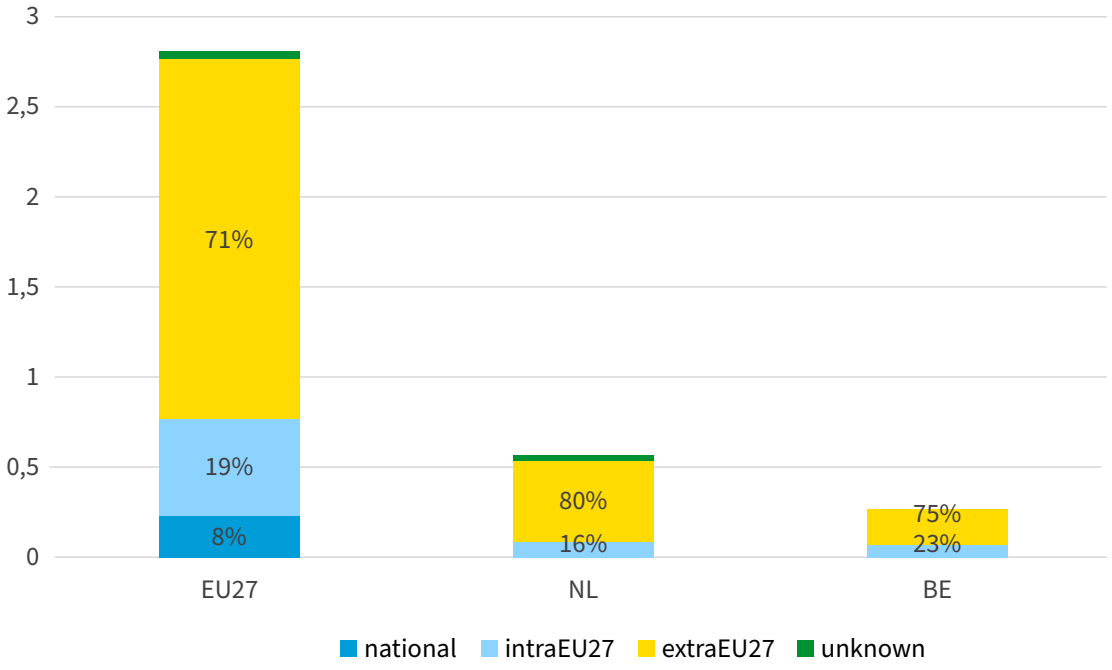
The FF55 package will have an impact on the bunkering sector in the EU. It is likely that the different proposals, especially in combination, will lower demand for fossil fuels and make bunkering of those fuels in EU ports more expensive. The separate impacts of the proposals are discussed below.

FuelEU Maritime

FuelEU Maritime is the key proposal advancing renewable and low carbon fuels in the shipping sector. It introduces a limit on the GHG intensity of energy used by ships in navigation on a well-to-wake (WTW) basis, which becomes more stringent over time until 2050. The Directive will apply to the complete voyages of vessels (above 5000 GWT) within the EU and to half of the voyages of ships inbound or outbound to or from the EU. The large majority of transported goods is by origin and destination from outside the EU, see Figure 10. This means that the majority of vessels sailing to or from the EU will have an option to bunker outside the EU.

FuelEU Maritime mandated reduction is related to the fleet average GHG intensity of the energy used on-board by ships in 2020 but this value which will be established at a later stage of the legislative procedure. In 2019 the GHG intensity of fuels used was 90.98 gCO2-eq./MJ.[40] The target is expected to become more stringent over time and will start having a significant impact during the 2030s (see Table 2).

Figure 10. Gross weight of transported goods by origin/destination 2020 (million)



40 Dagmar Nelissen, Anne Kleijn, and Jasper Faber, 'FuelEU Maritime and EU ETS. Sound Incentives for the Fuel Choice?', CE Delft, 2022, https://cedelft.eu/publications/fueleu-maritime-and-eu-ets/.

Table 2. Reduction in well-to-wake GHG intensity following from the FuelEU Maritime proposal (%)

WTW GHG Intensity	2025	2030	2035	2040	2045	2050
Reduction in %	-2%	-6%	-13%	-26%	-59%	-75%
gCO_2-eq./MJ*	89.16	85.52	79.15	67.33	37.3	22.75

* Based on 2019 fuel consumption value of 90.98 gCO_2-eq./MJ.

According to the Commission's Impact Assessment, FuelEU Maritime will result in an increased use of renewable and low-carbon fuels by ships sailing to and from EU ports, as shown in Table 3. Although further analysis has shown that the 2030 target can be met with lower shares of renewable fuels (because of the projected increase in LNG-fuelled ships),[41] it is clear that the demand for renewable and low-carbon fuels will increase.

Table 3. Share of renewable and low carbon fuels in maritime energy use

Share of renewable and low carbon fuels in maritime energy use (in %)	2030	2050
Total	8.6%	89.5%
Biofuels	6.2%	47.8%
Bio-LNG	1.2%	16.8%
e-liquids	0.0%	13.4%
e-gas	0.0%	4.9%
Hydrogen	0.0%	4.8%
ammonia	0.0%	0.2%
Methanol	0.0%	0.1%
Electricity	1.2%	1.4%

Source: European Commission, 2021. Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the use of renewable and low-carbon fuels in maritime transport and amending Directive 2009/16/EC. Brussels: European Commission. COM(2021) 562 final.

41 CE Delft, *Fit for 55 and 2030 milestones for maritime shipping: a pathway towards 2050*, Delft: CE Delft, https://cedelft.eu/wp-content/uploads/sites/2/2022/12/CE_Delft_220125_Fit-for-55-and-2030-milesstones-for-maritime-shipping_FINAL.pdf

Renewable Energy Directive III

The Renewable Energy Directive (RED) aims to promote renewable energy in electricity generation, transport, heating and cooling. Fit for 55 contains a revision of this Directive and adds a provision for industry to the Directive. The transport targets in the RED II are specifically aimed at road and rail transport, with optional contribution from other transport sectors such as shipping. In its revision, the legislative proposal of the RED III is aimed at all transport modes in the territory of the EU, including maritime bunkering and aviation fuels. Unlike FuelEU Maritime, REDIII is specifically applicable to 2030 (and does not include targets for the years thereafter, in contrast to e.g. FuelEU Maritime).

In the proposal, Article 25 prescribes a GHG intensity reduction target of 13% by 2030, with a sub-target of 2.2% advanced biofuels[42] and 2.6% RFNBOs (Renewable Fuels of Non-Biological Origin[43]). The cap of 1.7% for annex IX-B feedstock (used cooking oil, UCO) is to be applied without possibility for derogation, as is now the case. Cancelling the derogation might decrease the supply of UCO, which is considered an important component for biofuel.

These targets apply to the total amount of fuels supplied to the transport sector; advanced biofuels and RFNBOs supplied to the maritime and aviation sectors have a multiplier of 1.2 (i.e., they count 1.2 times towards the target). In the implementation phase, member states can decide how to divide these targets over transport sectors. Considering the size of the bunkering market in the Netherlands, which is very close to the size of the road fuel market, maritime bunkering has a significant impact on the total amount of renewable fuels required to meet the target , see Figure 11. If, for example, marine bunker fuels were to halve in 2030 compared to the projected data, the REDIII baseline – and therefore the amount of renewable fuels required for the Netherlands – will decline by around a quarter. Within the EU, the large share of bunkered fuels within the total amount of energy consumed in the transport sector is only applicable to the Netherlands, and, to a lesser extent, Belgium. It is evidence of the hub-function of the ARA region.

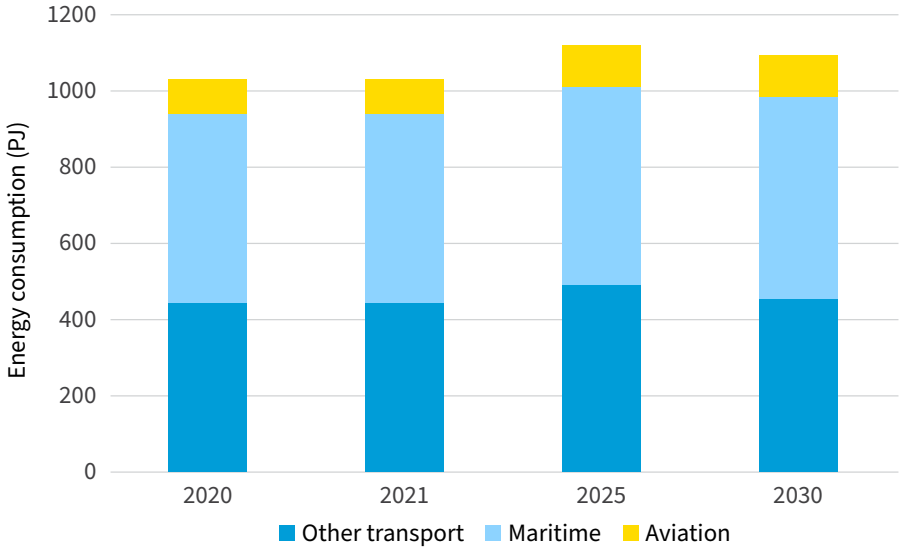
Direct (sectoral) application of the 13% reduction target to marine bunker fuels would lead to an increase in the prices of bunker fuels sold in the EU by 13–80%, depending on the price development of (advanced) biofuels and RFNBOs.[44] This is a larger price increase than the one resulting from the Energy Taxation Directive (ETD), discussed below. Therefore, implementation of the REDIII could result in a decrease of the amount of bunker fuels supplied in EU ports and more bunkering outside the EU, since price is the deciding factor on the global bunkering market. However, it is up to the Member States to decide which transport sectors contribute to the overall targets in 2030 and to which extent. The Netherlands (and Belgium) might for example choose to set the reduction target for the maritime sector lower than 13% and higher for others.

42 Advanced biofuels are biofuels produced from feedstocks that are included in Annex IX-A of the RED.

43 E-fuels produced from renewable electricity, in accordance with the definition in the RED.

44 CE Delft, 2021, *Cost of 'Fit for 55' to the Dutch shipping industry & ports*, Delft: CE Delft, https://cedelft.eu/publications/cost-of-fit-for-55-to-the-dutch-shipping-industry-ports/

Figure 11. Energy consumption (PJ) in transport Netherlands, reported and projected (KEV22). The projections are without the impact of FF55 and the possible impact of the sanctions.[41] The Energy Outlook does not split between aviation and maritime bunkering. The division between those two modalities for 2020 and 2021 is based on CBS data. The percentage of 2021 is used for the division in 2025 and 2030. Other transport is mainly road transport.



EU ETS

The Fit for 55 package also proposes to include maritime shipping from and to EU ports in the existing EU ETS from 2023. The amount of allowances will therefore be increased by 79 million to take into account the absorption of maritime transport. In 2021, the total cap amounts to around 1.6 billion allowances. Each year, the number of allowances is reduced by 4.2% in order to reduce the emissions by entities covered by the ETS.

The EU ETS generates revenues for the allowances that are auctioned. A share of the allowances is set aside for a Modernisation Fund (2% of the cap) and an Innovation Fund (450 million allowances from 2020 to 2030). These funds should be used for the climate transition, including for maritime purposes.

Unlike previously included sectors, the shipping industry would not receive free allowances, but instead would have a three-year phase-in period during which not all emissions will have to be covered. According to the impact assessment, free allocation is not needed because the risk of carbon leakage is limited and there are sufficient opportunities to pass on costs. But since carbon saving measures may be cheaper in other sectors of the ETS, the initial impact on reducing emissions in maritime shipping might be limited. Shipping companies will need to surrender allowances for:

— 20% of verified emissions reported in 2023;
— 45% of verified emissions reported in 2024;
— 70% of verified emissions reported in 2025;
— 100% of verified emissions reported in 2026 and every year thereafter.

45 PBL, 'Klimaat en energieverkenning 2022', https://www.pbl.nl/sites/default/files/downloads/pbl-2022-klimaat-en-energieverkenning-4838.pdf

Due to inclusion in ETS, the costs of using fossil fuels will increase. This does not apply to biofuels and fuels that do not contain carbon, such as hydrogen and ammonia – it is not yet clear how synthetic carbon-containing fuels would be treated, especially when produced outside the EU. By increasing the costs of the use of fossil fuels, the ETS would lower the price gap between fossil fuels and renewable and low-carbon fuels. The impact assessment of the proposal for the revision of EU ETS notes that the ETS is expected to reinforce the aims of the FuelEU Maritime initiative. Both by supporting energy efficiency improvements, thereby reducing fuel demand, and by bridging the price gap between conventional and sustainable fuels. However, the impact assessment also notes that the EU ETS would have limited contribution to achieving the goals of the FuelEU Maritime initiative in terms of uptake of renewable and low-carbon fuels by 2030.

The ETS price in the range of 45 to 55€ per tonne of CO_2 would improve the cost competitiveness of renewable and low-carbon fuels compared to fossil fuels but it would not be sufficient to bridge the entire price gap.[46] While the ETS would induce the uptake of efficiency measures that have a cost-effectiveness up to the price of allowances, it would not, by itself, induce a change to renewable and low-carbon fuels. Up to 2030, inclusion of maritime shipping in the ETS will most likely lead to a further uptake of LNG, not of renewable fuels.[47]

The Energy Taxation Directive

The revision of the ETD – which sets minimum tax tariffs - reflects the aim to encourage decarbonisation through taxation. Currently, bunkered fuels are not included in the ETD and in the Netherlands they can qualify for an exemption from taxation. After the revision, all fossil fuels will be taxed (at minimum) at the highest tariff. From 2033 this highest tariff also applies to biofuels from sustainable food and feed crops. Sustainable biofuels will have a lower tariff while RFNBOs, advanced sustainable biofuels and electricity will be on the lowest tariff, which is six times less than fossil fuels.

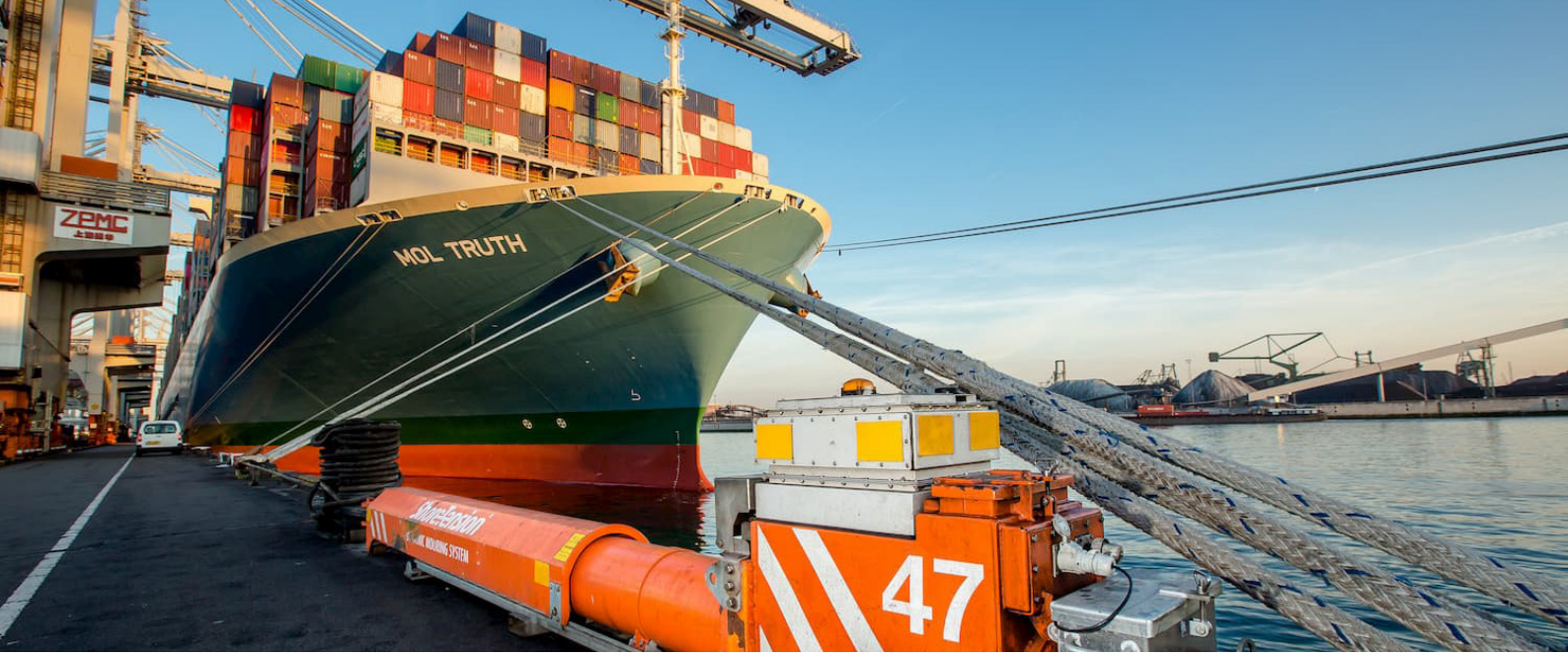
The contribution from tax differentiation is too limited to bridge the price gap between fossil and renewable fuels, but it contributes to the price increase of fossil bunkering in the EU.

The AFIR

The proposal for the Alternative Fuels Infrastructure (AFIR) affects the bunkering infrastructure for renewable and low-carbon fuels. It contains a target for a core network of refuelling points for LNG at maritime ports by 2025. Refuelling points for LNG include LNG terminals, tanks, mobile containers, bunker vessels and barges. With regards to renewable fuels, member states are merely obliged to draft a policy framework for the development of the market of alternative fuels in the transport sector and the deployment of relevant infrastructure. Further standardisation of alternative bunkering infrastructure can stimulate the market but does not have a significant impact on the bunkering market as a whole.

46 cf. Mærsk Mc-Kinney Møller Center for Zero Carbon Ship, 'Industry Transition Strategy,' 2021

47 CE Delft, 'FuelEU Maritime and EU ETS. Sound incentives for the fuel choice?,' 2022



EU sanctions on Russian oil and consequences of the war in Ukraine

EU sanctions

Until 2022, the ARA bunker market was supplied from multiple sources. On the one hand, crude oil from Russia and other suppliers was delivered to refineries in ARA to be made into a range of fuels. In this process, fuel oil is produced which can be used for bunkering. On the other hand, fuel oil and vacuum gas oil (VGO) [48] that had been refined outside of ARA were consumed by the bunkering market.

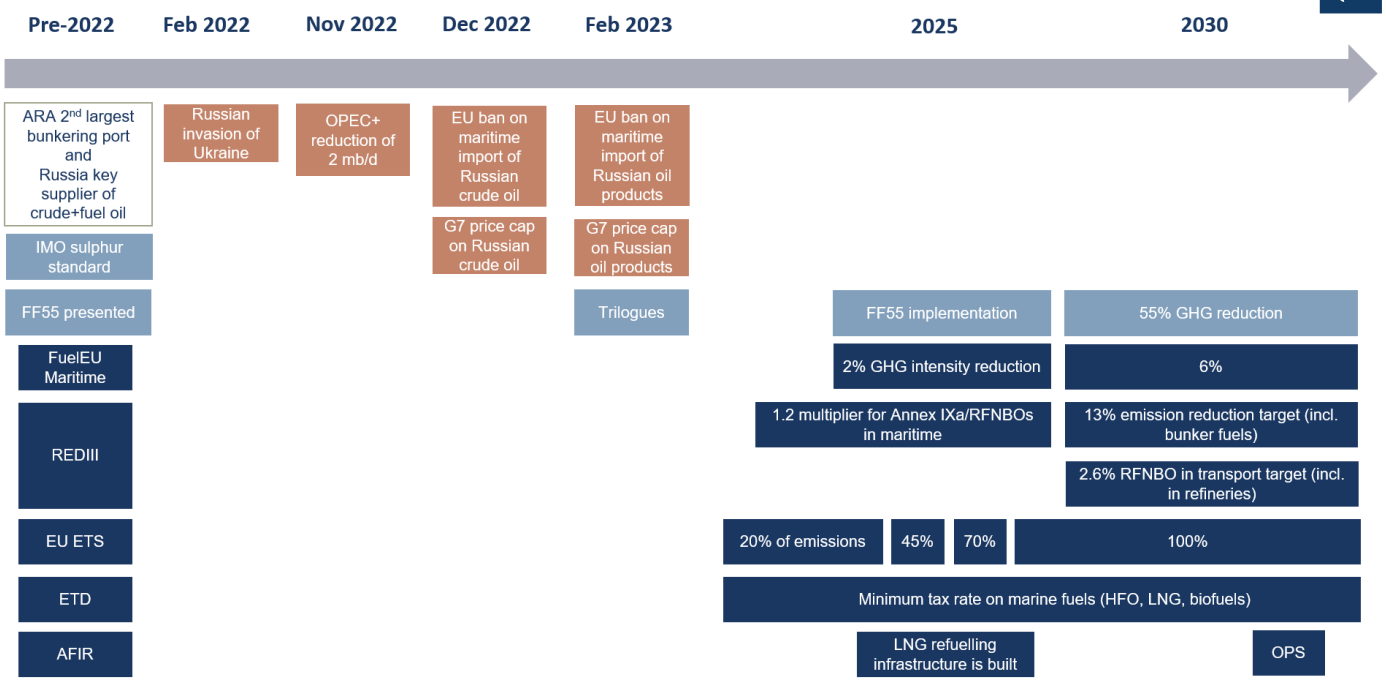
The EU's sixth package of sanctions against Russia prohibits seaborne imports of Russian crude oil and petroleum products into the Union.[49] The sanctions will be put in force as of 5 December 2022 for crude oil and as of 5 February 2023 for petroleum products (see Figure 12). The European Commission estimates that Russian oil imports will be reduced by 90% as of 2023, even though the Druzhba pipeline to Central Europe will remain active.[50]

48 Vacuum gas oil (VGO) is used as a feed into a valuable fuel – like gasoline and diesel. If not upgraded, VGO is blended into residual fuel oil. Europe is for the most part of its import of VGO dependent on Russia.

49 'Regulations: Council Implementing Regulation (EU) 2022/876 of 3 June 2022 Implementing Article 8a(1) of Regulation (EC) No 765/2006 Concerning Restrictive Measures in View of the Situation in Belarus and the Involvement of Belarus in the Russian Aggression against Ukraine', *Official Journal of the European Union* 65, no. L 153 (3 June 2022).

50 Jennifer Rankin, 'What Does EU's Partial Oil Ban Mean for Russia and Rest of Europe?', *The Guardian*, 31 May 2022, sec. World news, https://www.theguardian.com/world/2022/may/31/what-does-eu-partial-oil-ban-mean-for-russia-and-rest-of-europe; Jan Strupczewski, 'Factbox: EU's 6th Sanctions Package against Russia, Including Oil', *Reuters*, 3 June 2022, sec. European Markets, https://www.reuters.com/markets/europe/eus-6th-sanctions-package-against-russia-including-oil-2022-06-03/.

Figure 12. Timeline of EU sanctions and FF55 plans



The sanctions might deteriorate the competitive position of EU bunkering ports compared with non-EU ports by decreasing the availability of relatively cheap crude oil and imported fuel oil.

After December 2022, the supply of bunkering fuel in ARA will depend on whether enough non-Russian crude oil can be brought to European (and specifically ARA) refineries and whether these crudes yield a similar share of fuel oil. In addition, it will depend on whether alternative supplies of fuel oil can be found to replace Russian imports.

As a consequence of the sanctions' phase-in period, Russian oil exports have increased throughout the second half of 2022 to build inventories before it becomes illegal.[51] This led prices to go up and bring additional revenues to the Russian government, but it is expected to negatively affect the Russian economy in the long term.[52]

The value of trade in mineral fuels from Russia toward China and India has also increased (Figure 13).[53] India has increased its imports from 0.66 million tonnes in the first quarter of 2022 to 8.42 million tonnes in the second.[54] Indian refineries have been refining discounted Russian crude oil and selling diesel to the European Union and the United States.[55]

51 Ben Cahill, 'EU's Latest Sanctions on Russian Oil: What Are They and Will It Work?', *Energy Post* (blog), 14 June 2022, https://energypost.eu/eus-latest-sanctions-on-russian-oil-what-are-they-and-will-it-work/.

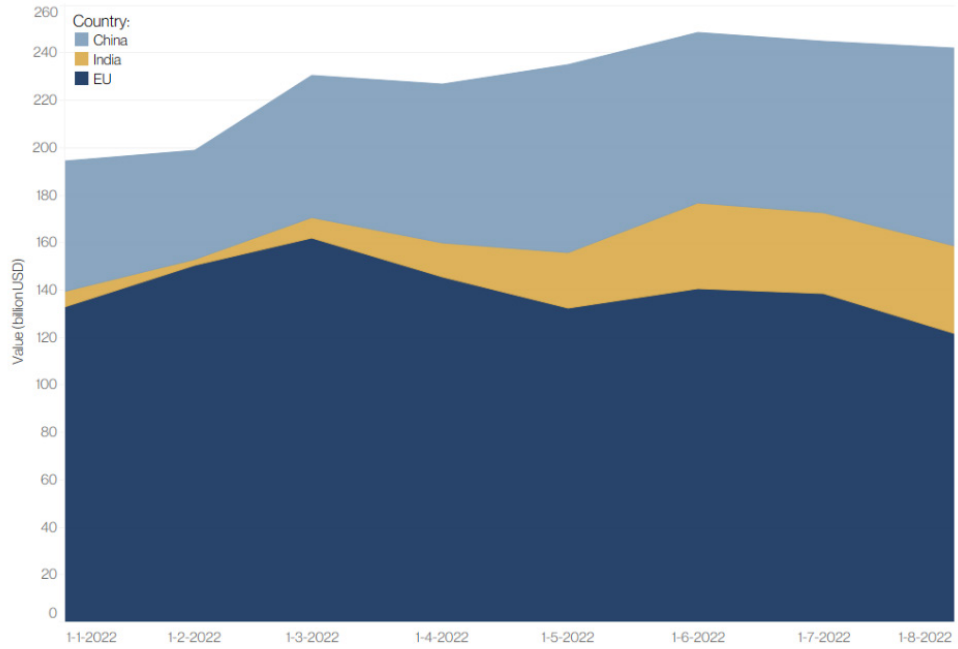
52 Rankin, 'What Does EU's Partial Oil Ban Mean for Russia and Rest of Europe?'

53 Cahill, 'EU's Latest Sanctions on Russian Oil'.

54 Andy Lin, John Reed, and Max Seddon, 'India and China Undercut Russia's Oil Sanctions Pain', *Financial Times*, 8 September 2022.

55 Leszek Kadej and Rafał Zasuń, 'Unijne embargo na rosyjską ropę jest pełne dziur', WysokieNapiecie.pl, 5 June 2022, https://wysokienapiecie.pl/71565-unijne-embargo-na-rosyjska-rope-jest-pelne-dziur/.

Figure 13. Imports of mineral fuels from Russia to the EU, China and India before and after the invasion of Ukraine, measured in billion USD per month.



Source: Eurostat, China's General Administration of Cutoms, India's Ministry of Commerce and Industry

The redirection of Russian oil from Europe was further impacted by a sanctions package that was implemented in the summer of 2022. In August, the fifth sanctions package banned the import of coal from Russia.[56] Import bans are based on combined nomenclature (CN) codes, which are assigned to different categories of goods. The code assigned to coal (2707) also includes "similar products in which the weight of the aromatic constituents exceeds that of the non-aromatic constituents".[57] In effect, this includes certain fuel oils, as some grades normally have more than 50% aromatics.[58] As such, the imports of fuel oil from Russia have been impacted since August 2022.

Insurance ban

The EU and G7 partners also agreed on banning the insurance and re-insurance of ships carrying Russian oil by EU companies.[59] This measure aims to make it harder for Russia to re-direct its tankers to buyers outside of Europe. As Western states enjoy a dominant position in the shipping insurance market, wielding about 90% of the share of the industry, the measure was expected to bring challenges for Russian cargoes to find coverage in a third country.[60]

56 'EU Agrees Fifth Package of Sanctions against Russia', Text, European Commission, 2022, https://ec.europa.eu/commission/presscorner/detail/en/ip_22_2332.

57 'Customs Tariff Number Position 2707', European Customs Portal, accessed 9 November 2022, https://www.tariffnumber.com/2022/2707.

58 Reuters, 'EU Could Ban Some Russian Fuel Oil Imports Six Months Ahead of Deadline'.

59 Strupczewski, 'Factbox'.

60 Jorge Liboreiro, 'The G7 Wants to Cap the Price of Russian Oil. It Won't Be Easy.', Euronews, 10 October 2022, https://www.euronews.com/my-europe/2022/10/10/the-g7-wants-to-cap-the-price-of-russian-oil-it-wont-be-easy.

Yet alternative insurance providers have stepped up to minimize the effects of European sanctions.[61] China and India have already accepted insurance provided by the Russia's state-owned National Reinsurance Company.[62]

G7 price cap

The implementation of the G7 price cap on Russian oil has been widely debated. The price cap limits the price for which Russian oil can be sold to countries that have not implemented import bans.[63] It is designed to align with the European sanctions scheme and thus it came into force simultaneously with the oil embargo in December 2022.[64] The cap has been set at $60/barrel of crude oil, which was calculated based on Russia's marginal production cost and the average price of Brent in 2019.[65] The wider the adoption, the more significant the impacts of the price cap on Russia. Still, Panama, Liberia and Marshall Islands account for the registration of 40% of the global maritime fleet and are unlikely to join the price cap, limiting the impact of the measure.[66] It is also highly unlikely that China and India, the new destinations of Russian oil, will adopt a price cap.

OPEC+ output reduction

As of November 2022, the Organization of the Petroleum Exporting Countries together with Russia and other partners (OPEC+) decided to impose output cuts of up to 2 million barrels/day (mb/d).[67] Given the production issues that these countries have been facing, the International Energy Agency estimates a real decrease of around 1 md/d.[68] The reasons behind this decision have been widely debated.[69] Geopolitically, the OPEC+ decision could be directed against the EU and US who have been adamant about decreasing current prices by increasing supplies. As Russia is a member of OPEC+, this could be a sign of Gulf states' support. Economically, OPEC+ argues that a production cut would balance the market as a global recession and demand destruction are expected in the next year. The real motivation is likely a mix of the two, leading to a further shrinkage of global oil supply.

61 Cahill, 'EU's Latest Sanctions on Russian Oil'.

62 Jonathan Saul, 'Russia's State-Owned RNRC to Reinsure Russian Oil Shipments, Sources Say', *Reuters*, 10 June 2022, sec. Energy, https://www.reuters.com/business/energy/exclusive-russias-state-owned-rnrc-reinsure-russian-oil-shipments-sources-say-2022-06-10/.

63 Arthur Sullivan, 'How Will the G7 Oil Price Cap Work?', DW, 2022, https://www.dw.com/en/what-is-the-g7-oil-price-cap-and-how-will-it-work/a-63020325.

64 Jorge Liboreiro, 'The G7 Wants to Cap the Price of Russian Oil. It Won't Be Easy.', African News, 10 October 2022, https://www.msn.com/en-xl/news/other/the-g7-wants-to-cap-the-price-of-russian-oil-it-won-t-be-easy/ar-AA12NyKj?ocid=hpwidget&pc=U531&cvid=4aeb5b4ea9cc403996b74465f48a1845.

65 Florence Tan, David Lawder, and Timothy Gardner, 'U.S. Says Russia Oil Price Cap Should Reflect Historical Prices, Curb Putin Profit', *Reuters*, 9 September 2022, sec. Energy, https://www.reuters.com/business/energy/us-says-russia-price-cap-should-risk-premium-out-oil-market-2022-09-09/; 'Questions and Answers: G7 Agrees Oil Price Cap', Text, European Commission - European Commission, accessed 14 December 2022, https://ec.europa.eu/commission/presscorner/detail/en/QANDA_22_7469.

66 Liboreiro, 'The G7 Wants to Cap the Price of Russian Oil. It Won't Be Easy.', 10 October 2022.

67 Sam Meredith, 'OPEC+ to Cut Oil Production by 2 Million Barrels per Day to Shore up Prices, Defying U.S. Pressure', CNBC, 2022, https://www.cnbc.com/2022/10/05/oil-opec-imposes-deep-production-cuts-in-a-bid-to-shore-up-prices.html.

68 'Oil Market Report - October 2022', IEA, 2022, https://www.iea.org/reports/oil-market-report-october-2022.

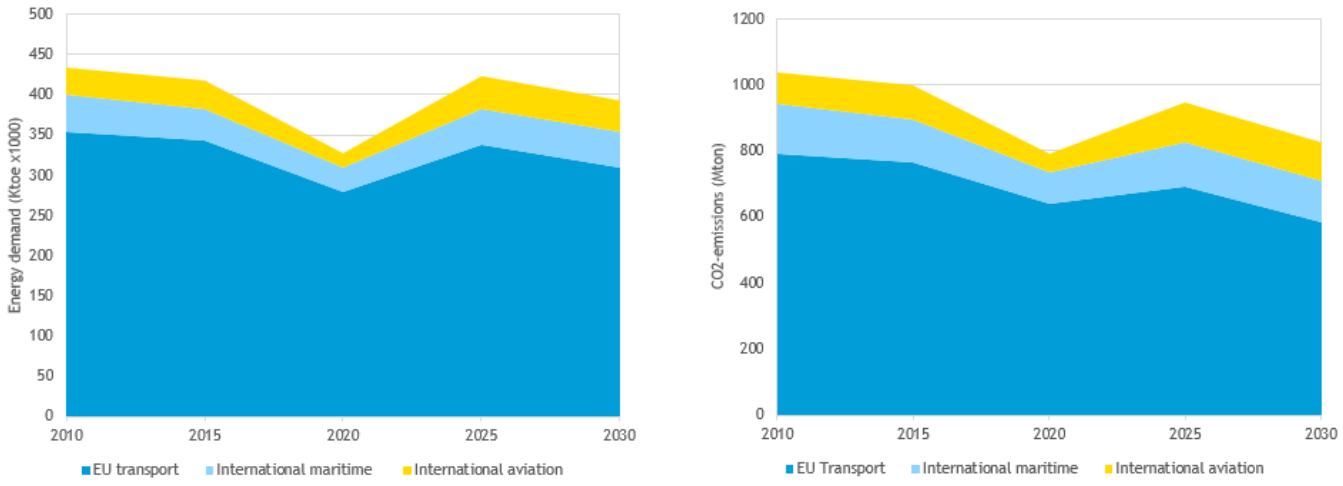
69 'Oil Market Report - October 2022'.

Impact of EU sanctions on the decarbonization of bunkering in ARA

The underlying scenarios of FF55 do not foresee a significant decline of energy demand or CO_2 emissions for international shipping in the EU towards 2030, compared with current levels of consumption.[70] After a decrease in 2020 due to the Covid-19 pandemic, energy demand for maritime bunkering is expected to recover.

Specifically for the Netherlands, the expectation was (before the sanctions and without taking FF55 into account), that the bunkering market would remain stable until 2030, see Figure 14.

Figure 14. Projections (based on EU Mix scenario) for energy demand (left) and CO_2 emissions of EU and international transport (right).[67]

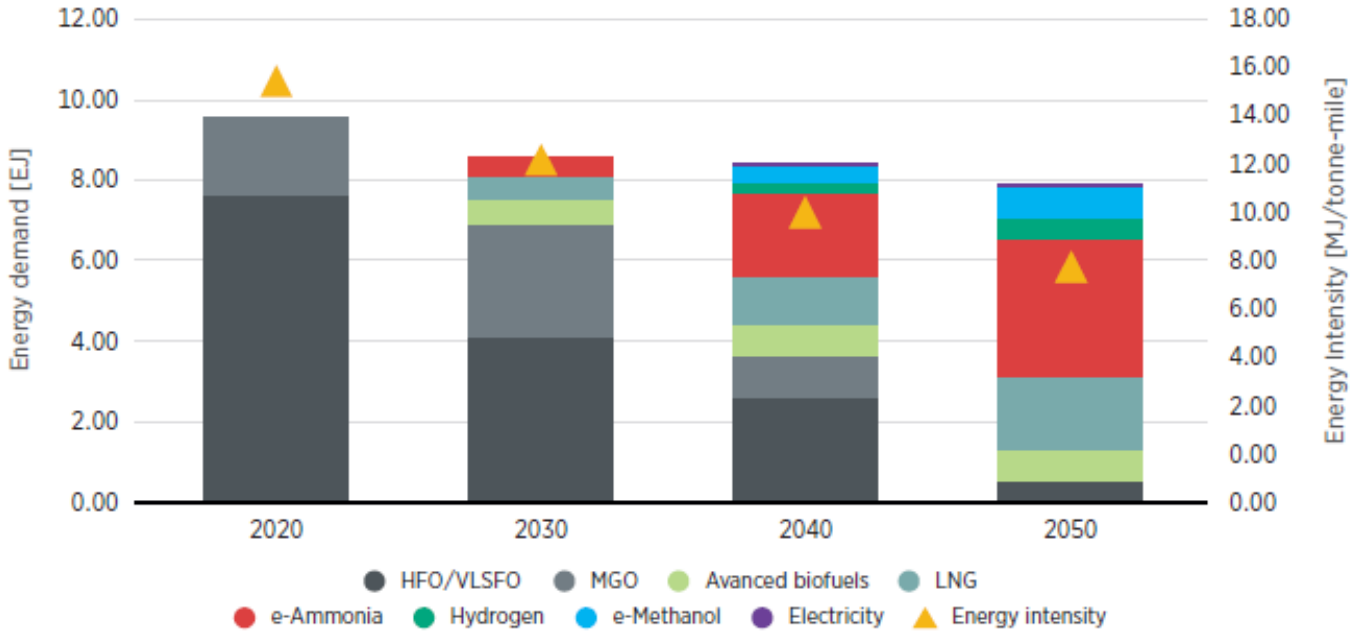


70 Compared with the baseline scenario however – the scenario before FF55 – there is a decline. The baseline scenario (not displayed here) forecasted a steady increase of energy demand and CO2-emissions of maritime shipping towards 2050. See European Commission, 'Policy scenarios for delivering the EU Green Deal', 2021, https://energy.ec.europa.eu/data-and-analysis/energy-modelling/policy-scenarios-delivering-europe-an-green-deal_en

71 European Commission, 'Policy scenarios for delivering the EU Green Deal', 2021.

Globally, scenarios that evolve from a (near) climate-neutral shipping sector in 2050, do not foresee a large shift in the fuel mix before 2030. Demand for shipping is expected to grow towards 2050, but efficiency gains result in lower overall energy demand. Due to a persistent price difference between fossil and renewable maritime fuels, the capital intensive structure of the maritime sector and remaining technical challenges for RLF, it is (under the condition of targeted climate policy) the expectation that the development of renewable fuels in maritime shipping will gain traction only around 2040, see Figure 15. The figure also shows that due to the ever-increasing global trade, energy demand for global shipping will remain almost stable, although energy efficiency is continuously improved. However, the scenario produced by IRENA is not a given. Due to uncertainties with regards to (technical) feasibility and cost-efficiency of different RLF, different scenario studies for global maritime shipping have different outcomes. But while the scenarios for the fuel mix in 2050 differ, most studies agree that significant quantities of RLF will only be used from 2030 onwards.

Figure 15. 1.5 degree fuel mix scenario for the global maritime shipping sector.[68]



72 IRENA, 'A pathway to decarbonise shipping by 2050', 2021

Immediate effect of sanctions: bunkering in ARA more expensive in the short term

As of December 2022 and February 2023 no more Russian crude and fuel oil respectively will have entered the European market, with the exception of oil imported via the Druzhba pipeline.

Supply of crude and oil products in ARA

Ahead of the sanctions, ARA ports, refineries and traders have already been looking for alternative (non-Russian) supplies of oil.[73] In the second quarter of 2022, EU's imports of oil from Russia decreased from 27.7% to 21.3%.[74] In August 2022, the sanctions on coal imports also impacted some of the fuel oil imports from Russia.[75] Even earlier, refineries had to switch to low sulphur fuel oil due to the IMO regulation in 2020.

The decline in imports from Russia was offset by increased flows from the United States, Norway, Angola, Saudi Arabia, Brazil and United Kingdom.[76] Refineries in Rotterdam have been blending alternatives like Forties from the North Sea or John Sverdrup from Norway to generate the needed oil products. They have also been blending other grades of fuels to produce similar crude oil to Russian Urals.

Attempts at bypassing the sanctions will likely be made, meaning that a degree of Russian oil may still indirectly enter European countries. Large scale imports of Russian crude into India or Turkey to be refined and sold to Europe are not technically allowed but could nonetheless take place if strict checks are not in place. Moreover, ship-to-ship transfers are not only very difficult to monitor but also increase the likelihood of spills.

Geopolitics can influence oil supply in ARA, as oil producers such as Middle Eastern state-owned companies may prefer to sell their supplies to ports in the region rather than to ARA. A part of ARA's market share could be overtaken by Port of Fujairah for instance, which is investing heavily in its fossil fuel infrastructure and is directly connected to oil fields in the UAE. As such, it is not only a matter of whether non-Russian supplies are available for Europe, but also of whether suppliers are willing to step in and help ARA maintain its position. Economically, the higher prices for bunker fuel in ARA may encourage suppliers to step in or consumers to bunker elsewhere, reducing the demand and, hence, price in ARA. Geopolitically, they may not believe this to be in their advantage given that many companies are state-owned and can act according to national strategic interests.

73 'Impact of Russia's Invasion of Ukraine on the Port of Rotterdam', Port of Rotterdam, July 2022, https://www.portofrotterdam.com/en/news-and-press-releases/impact-of-russia-ukraine-conflict-on-port-of-rotterdam.

74 'EU Imports of Energy Products - Recent Developments', Eurostat, September 2022, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=EU_imports_of_energy_products_-_recent_developments.

75 Reuters, 'EU Could Ban Some Russian Fuel Oil Imports Six Months Ahead of Deadline'.

76 'EU Imports of Energy Products - Recent Developments'.

Demand for crude and oil products in ARA

The shortage of diesel will be more problematic in Europe as a result of the sanctions than of fuel oil.[77] Yet the diesel shortage could increase the demand for fuel oil as a substitute in shipping. Diesel prices and cracks are respectively 70% and 425% higher than in previous years.[78] Already in the autumn of 2022, diesel storage units in ARA and the rest of Europe were at record low levels.[79] This shortage is already visible although the sanctions against Russia, Europe's main diesel supplier, are not yet in force. Germany and Poland in particular are struggling to fulfil their diesel demand.[80] During the pandemic global refining capacity had decreased by 3.5 mb/d.[81] The economic recovery of 2021 sharply increased diesel demand.[82] This demand could not be immediately matched by an increase in supply, putting pressure on the market. Strikes and maintenance at refineries in France have contributed to European shortages.[83] The ban on importing oil products from Russia will undoubtedly add further tightness to the market and push the prices upward. The supply of VGO, another feedstock for diesel in Europe and the US, is also primarily dependent on Russia and therefore scarce as a result of the sanctions.[84]

Economic circumstances will also impact the demand for bunkering. The high energy and food prices are increasing inflation and causing economic issues throughout the world, part of which could extend throughout 2023.[85] This may lead to demand destruction but also to a decrease in container movement in Europe, reducing the demand for bunkering in ARA. The economic conditions in China in relation to the Covid-19 lockdown and recovery will also impact container volumes.

The 2020 IMO regulations increased the demand for low sulphur fuel oil (LSFO) in bunkering, which can be refined from non-Russian crudes.

Implications for bunkering in ARA

Due to companies' adaptation to sanctions in the second half of 2022, the immediate effect of sanctions on crude oil have been minimal. Despite expectations of sharp increases in the price of Brent, it has remained stable under 86 $/barrel since the end of November until the end of January.[86] In December 2022, the EU remained Russia's main export market for oil as it continued importing pipeline crude through Druzhba and oil products in preparation of the ban on February 5th.[87] More than 8 million barrels of Russian diesel was imported into Europe in the first two weeks of January 2023.[88]

77 'Repsol: Parts Of Europe Are Running Out Of Diesel', OilPrice.com, accessed 9 November 2022, https://oilprice.com/Energy/Energy-General/Repsol-Parts-Of-Europe-Are-Running-Out-Of-Diesel.html; Benedict George, 'Europe Is Running Low on Diesel When It Needs It Most', 17 October 2022, https://www.argusmedia.com/en/news/2381339-europe-is-running-low-on-diesel-when-it-needs-it-most.

78 IEA, 'Oil Market Report', November 2022.

79 George, 'Europe Is Running Low on Diesel When It Needs It Most'.

80 Javier Blas, 'Germany's Switch to Diesel From Gas Comes at a Cost', *Bloomberg.Com*, 2022, https://www.bloomberg.com/opinion/articles/2022-08-04/european-energy-crisis-germany-s-switch-to-diesel-comes-at-a-cost.

81 IEA, 'Oil Market Report'.

82 IEA.

83 IEA.

84 Benedict George, 'Europe Would Struggle to Replace Lost Russian Products', Argus Media, 24 January 2022, https://www.argusmedia.com/en/news/2294752-europe-would-struggle-to-replace-lost-russian-products.

85 'World Economic Outlook, October 2022: Countering the Cost-of-Living Crisis', IMF, 2022, https://www.imf.org/en/Publications/WEO/Issues/2022/10/11/world-economic-outlook-october-2022.

86 'Brent Crude Oil - 2023 Data'.

87 CREA, 'EU Oil Ban and Price Cap Are Costing Russia EUR 160 Mn/Day, but Further Steps Can Multiply the Impact'.

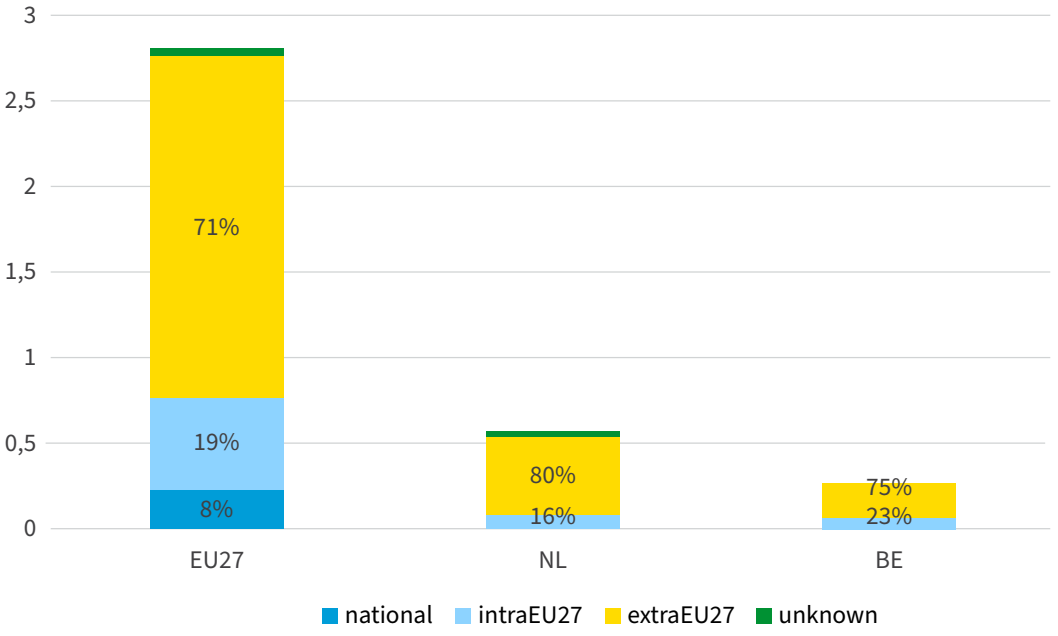
88 Cooban, 'Europe's Ban on Russian Diesel Could Send Pump Prices Even Higher'.

Most ARA refineries are able to use a large variety of crude oil as feedstock, so the difference in yield of fuel oil from non-Russian crude was relatively small after the December 5th sanctions. However, given the high demand for diesel especially after February 5th, European refineries will be trying to maximise their yield at the expense of residuals such as fuel oil. This could slightly decrease the domestic supply of fuel oil and increase price. The price increase could also be linked to the lack of short term barrels from Russia that are no longer be available to the EU after sanctions, reducing flexibility.

Not only could fuel oil sold in ARA be slightly more expensive than previously, but fuel oil sold in non-EU ports could simultaneously decrease in price. The Russian oil sold in ARA before sanctions will go to new markets at discounted prices, increasing the supply of cheap bunker fuel in Singapore or Fujairah. An increasing amount of Russian fuel oil has been re-directed to Fujairah since the second half of 2022.[89] This could decrease ARA's market share of global oil bunkering in the short term. At the same time, demand for consumer goods and therefore container movements could decrease not just in ARA but also in the rest of the world as a result of economic issues. As such, bunkering volumes in the short term would decrease everywhere and not just in ARA.

The ships that are bound to continue bunkering in ARA are those travelling on short distances within Europe. As seen in Figure 16, only 16% of the weight of goods traveling via Dutch ports are transported intra-EU. The rest are large-scale container ships – the main consumers of bunker fuels in Rotterdam[90] – that can bunker anywhere on their global route given the large storage capacities on board. As such, even if they continue their routes from Asia to Northwestern Europe, they will likely choose the location that sells the cheapest fuels.

Figure 16. Gross weight of goods transported by origin/destination in 2020 (million)



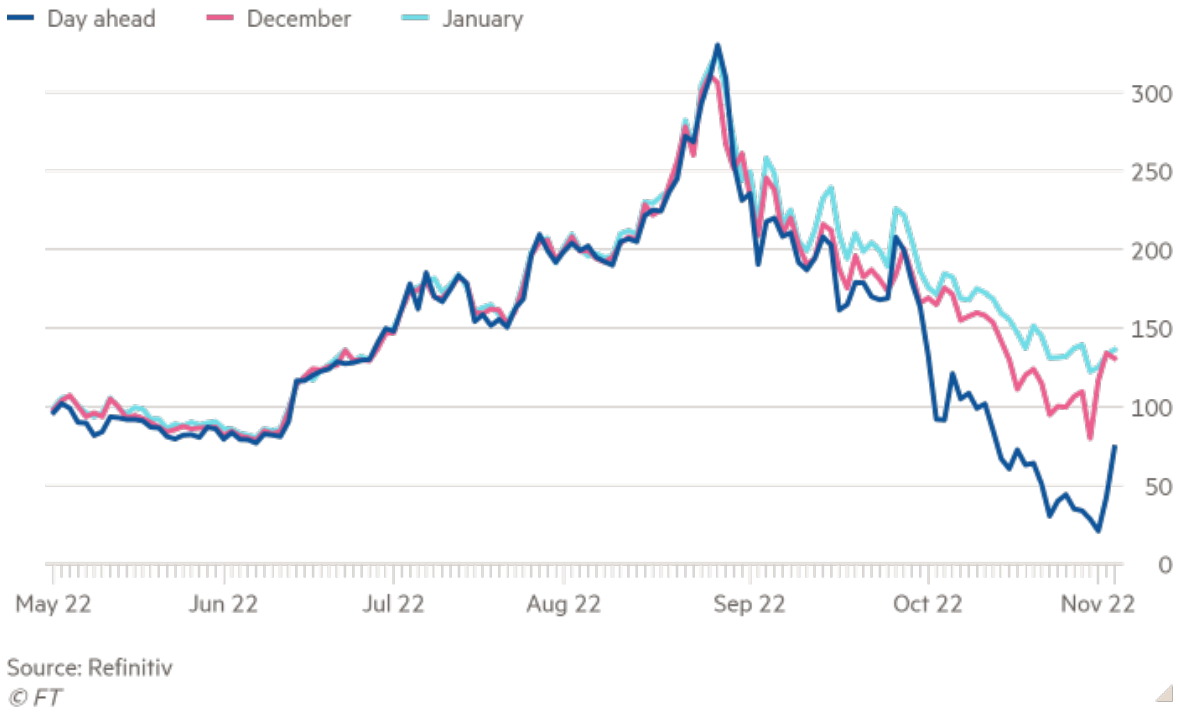
89 Fattouh, Economou, and Mehdi, 'Oil Markets in 2023: The Year of the Aftershocks', 6.

90 'Containerschepen Bunkeren Meer in Rotterdam', Port of Rotterdam, 2021, https://www.portofrotterdam.com/nl/nieuws-en-persberichten/containerschepen-bunkeren-meer-rotterdam.

Bunkering LNG is not directly impacted by the sanctions, but the reduced flow of Russian natural gas has nonetheless led to skyrocketing prices. As Europe's supply of pipeline gas from Russia is minimal, significant efforts for diversification with LNG have been made. Rather than pumping more gas and adding more supplies to the global market, this has primarily led to the rerouting of LNG carriers away from Asian markets to Europe at record high prices.[91] LNG prices at the Title Transfer Facility (TTF), the main trading platform for LNG in Europe, have been decreasing since the peak in September 2022 (Figure 17). Throughout November 2022 LNG carriers were queueing outside of Dutch ports in expectation of another increase in prices.[92] As additional LNG supply is necessary to reduce cost burdens on households and industries, it seems unlikely that in the short term the bunker market will gain additional LNG supplies.

The exception lies with LNG carriers. As of 2022, 86% of LNG used in maritime shipping was consumed by LNG carriers.[93] If LNG is transported as commodity, it is very likely that LNG is also used for propulsion. The current gas crisis and the reduced supply from Russia to the EU will cause a steady growth of LNG demand during the 2020s. As more LNG carriers will travel to Europe, an increase in LNG bunkering could also be expected, likely at the location where they also load their cargo rather than in Europe.

Figure 17. TTF price by delivery date (€ per megawatt hour)[90]



91 Shotaro Tani, 'LNG Tankers Idle off Europe's Coast as Traders Wait for Gas Price Rise', *Financial Times*, 4 November 2022, https://www.ft.com/content/19ad9f9f-e1cb-40f9-bae3-082e533423ab.

92 Tani.

93 European Commission, 'Third Annual Report from the European Commission on CO2 Emissions from Maritime Transport (period 2018-2020)', 2022, https://climate.ec.europa.eu/system/files/2022-08/swd_2022_214_en_0.pdf

94 Tani, 'LNG Tankers Idle off Europe's Coast as Traders Wait for Gas Price Rise'.

Bunkering of alternatives will likely continue growing modestly but will not be severely impacted by neither sanctions nor FF55 up to 2025. Renewables like methanol or ammonia are not directly linked to sanctions on oil, and the FF55 proposals will enter into force only after 2025, with the main effects after 2030. Bio-blending is on the rise in Rotterdam, but still remains marginal. New partnerships are being established. Port of Rotterdam committed to establishing a green corridor with the Port of Singapore for sustainable shipping by 2027.[95] Companies like Maersk are developing ships that can function on green methanol, for instance, but will only enter the market in 2025.[96] Bunkering of alternative fuels will moderately increase due to the forward-looking initiatives of fuel suppliers and carriers but it will not become substantial before 2025.

Storyline 1

Oil bunkering rebounds

In the base short-term storyline, the price of fuel oil in ARA is expected to slightly increase and lead to a decrease in demand for bunkering. In the longer term, two alternative storylines are presented: oil bunkering in ARA rebounds or it remains shrunk. This section describes the former, while the next section is focused on the latter.

The global demand for oil bunkering up to 2030 is assumed to be relatively stable.[97] The small decrease in demand due to alternatives and due to the 2022-2023 economic recession will, in the longer term, be offset by the continuous increase in maritime shipping.

The demand for oil bunkering in ARA, however, depends primarily on price levels. There are two ways in which the ARA oil bunker market could rebound up to 2030 from the expected decrease in 2023.

First, the market can balance itself**.** In the short term, sanctions on Russia will bring supplies of (discounted) fuel to non-European ports, where supply will increase and prices for bunkering could decrease. As a result, some of the demand for oil bunkering in ARA will shift to Singapore, Fujairah or other non-European ports as prices in ARA will rise. Higher supply and lower prices outside of Europe will match higher demand, which will in turn increase prices in non-European ports too. This match in supply and demand could rebalance the market and shift some[98] of the demand back to ARA.

The second way in which the ARA oil bunker market could rebound after 2025 is to ensure sufficient supplies of oil, either by replacing Russian oil or by resuming trade relations with Russia. The middle-distillate shortage, specifically of diesel, and expected high prices may be overcome within the next few years and sufficient alternative oil could be supplied to the market by non-Russian suppliers. Additional global refining capacity of 2.7 mb/d will become

95 'Maritime and Port Authority of Singapore and Port of Rotterdam to Establish World's Longest Green and Digital Corridor for Efficient and Sustainable Shipping', Port of Rotterdam, 2022, https://www.portofrotterdam.com/en/news-and-press-releases/maritime-and-port-authority-of-singapore-and-port-of-rotterdam-to-establish.

96 'A.P. Moller - Maersk Continues Green Transformation with Six Additional Large Container Vessels', October 2022, https://www.maersk.com/news/articles/2022/10/05/maersk-continues-green-transformation.

97 IRENA, 'A pathway to decarbonise shipping by 2050', 2021

98 It is unclear whether this demand would reach pre-2022 levels or not.

available by the end of 2023 in China, Kuwait, Nigeria and Mexico.[99] This could offset the decrease in supply from Russia.

Moreover, the tensions brought by the war in Ukraine in EU-Russia relations seem difficult to ever overcome. However, it is by no means certain that this is permanent. While unlikely, it remains nonetheless a possibility that EU will start importing Russian fuel again and that some of it will be used in bunkering, decreasing the price for refuelling in ARA and re-establishing its position in the global market.

If the bunker market rebounds, larger amounts of renewable fuels would be needed to meet the REDIII transport target than if the market remains depressed. However, the size of the market is dependent on how the RED will be implemented in the Netherlands. If the REDIII target is applied directly to the bunker market, this will result in an increase of bunker fuel prices by 13–80%, depending on the price development of (advanced) biofuels and RFNBOs.[100] In addition, fuels sold in the EU would need to have a lower GHG-intensity than required by FuelEU Maritime. The price increase and the mismatch between the regulations could result in more ships bunkering outside the EU and a smaller bunker market in the Netherlands. If, on the other hand, other sectors would be required to contribute more to the REDIII target and bunker fuels relatively less, the impact on the bunker market would be smaller.

Finally, LNG bunkering is dependent on the one hand on the tightness of the global market and on the other hand on its use as a transition bunker fuel. If more supply of LNG becomes available in the global market, either as a result of continuing relations with Russia or other suppliers expanding production, the prices will decrease. As a result, bunkering would no longer need to compete with households or industries for LNG. More LNG carriers enter the market, so bunkering for LNG might simultaneously increase since most LNG carriers use LNG as a fuel. The EU's Alternative Fuels Infrastructure Regulation (AFIR) mandates that all European ports should invest in LNG refuelling infrastructure by 2025. Moreover, stemming from pre-sanctions developments, the number of LNG powered ships will double within the next few years.[101]

Views are split regarding the use of LNG as a transition bunkering fuel. While it would contribute to the decarbonisation of shipping, burning LNG still produces GHG and it will need to be replaced eventually. LNG can play a role in the framework of FuelEU Maritime until the late 2030s (and might even be stimulated by it), but it does not have a role in a carbon free future. At the same time, if LNG prices remain high LNG might not become as attractive for other ship types.

99 IEA, 'Oil Market Report'.

100 CE Delft, 2021, *Cost of 'Fit for 55' to the Dutch shipping industry & ports*, Delft: CE Delft, https://cedelft.eu/publications/cost-of-fit-for-55-to-the-dutch-shipping-industry-ports/

101 Nicholas Watt, 'Ship Orderbook Suggests More LNG Bunker Usage', Argus Media, 20 January 2022, https://www.argusmedia.com/en/news/2293773-ship-orderbook-suggests-more-lng-bunker-usage.

Storyline 2

Oil bunkering shrinks

The alternative storyline developed in this study is that the increase in price for oil bunkering in ARA and decrease in bunker market in the short term could continue in the longer term. If tensions with Russia remain high and little additional global supply becomes available, the oil market could remain highly volatile and uncertain. One of the main reasons contributing to a tight oil market since 2014 has been the decreased investments in fossil fuel producing countries due to low prices and lack of financial attractiveness.[102] As of 2022, the energy transition is leading to low investments in fossil fuels by international oil companies due to the expected uptake of renewables.[103] Up to 2030 this could lead to higher consumer prices.[104]

As such, it is by no means a given that ARA – or other ports for that matter – will source sufficient affordable supplies for bunkering. Although the global demand for oil bunkering will remain relatively stable up to 2030[105], it is possible that other ports will become more important than ARA in this regard. For instance Fujairah is directly connected to oil fields in UAE, making it easier for that port to continue sourcing oil than for ARA ports that are dependent on imports. State-owned companies in the Middle East are leading investments in oil and gas as of 2022 while international oil companies are focusing on clean technologies.[106]

After 2030-2035, physical oil markets are expected to move to the Middle East and South East Asia due to the proximity of producers and consumers, given that oil demand will continue increasing in that region and decrease in Europe.[107] Traders will make use of storage and transport infrastructure outside of Europe given that the largest consumers will be India, China and other developing countries in the region. Whereas this trend is expected after 2030, the sanctions may accelerate the move away from high oil supplies in Europe used for bunkering. This would be matched with a decrease in demand for maritime bunkering in the EU.

The policy targets of FF55 will stay in place. Yet the effect might be weaker in absolute terms since the volume of bunkered fuels will decrease. The REDIII target will be lower for the Netherlands and therefore maybe easier to achieve, but – depending on the implementation - this also entails a lower share of RLF in the global maritime shipping sector. The obligations from the AFIR regarding LNG infrastructure remain in place, but development of LNG bunkering is largely dependent on the financial attractiveness related to the position of LNG in the European energy system. LNG bunkering will to a significant extent be related to the amount of LNG carriers coming into ARA. LNG demand will remain moderate since they will likely be able to receive LNG at lower prices than in ARA.

102 For more information, see Patrahau, I., van Geuns, L., & van den Beukel, J. (2022). *From the War in Ukraine to the Energy Transition: Searching for a New Balance in the Oil Market* (HCSS Energy and Natural Resources). The Hague Centre for Strategic Studies. https://hcss.nl/wp-content/uploads/2022/08/Searching-for-a-New-Balance-in-the-Oil-Market-HCSS-2022.pdf

103 'Overview and Key Findings – World Energy Investment 2022', IEA, 2022, https://www.iea.org/reports/world-energy-investment-2022/overview-and-key-findings.

104 'Overview and Key Findings – World Energy Investment 2022'.

105 IEA, 'World Energy Outlook 2022', 2022, https://iea.blob.core.windows.net/assets/830fe099-5530-48f2-a7c1-11f35d510983/WorldEnergyOutlook2022.pdf.

106 'Overview and Key Findings – World Energy Investment 2022'.

107 Irina Patrahau et al., 'European Tank Storage in Global Supply Chains: Outlook to 2030' (The Hague Centre for Strategic Studies, 2022), https://hcss.nl/report/european-tank-storage-in-global-supply-chains-outlook-to-2030/.

Implications for Fit for 55 goals

The two storylines describe plausible pathways to a smaller or larger ARA bunker market. This section analyses the impacts of the two pathways on the supply of renewable bunker fuels in ARA and especially on the attractiveness of the ARA region for the production of renewable fuels.

Regardless of how the ARA market develops relative to non-EU ports, none of the developments analysed in this paper suggest that its position as the EU's largest bunker market is likely to change. In addition, Rotterdam is an attractive location for the production of renewable fuels due to its well-developed energy cluster, good transport links, and the large demand in the EU for renewable fuels for other transport modes. Moreover, Rotterdam's cluster of chemical industry, linked with clusters in the rest of the ARA region and in Germany, implies that there will be demand for those low-GHG fuels which are also base chemicals, such as e- and bio-methanol and green hydrogen and ammonia.

Therefore, when investors would be considering where *in the EU* to produce and supply renewable bunker fuels, we expect that Rotterdam will remain a prime location.

When, on the other hand, investors would be considering where *in the world* to build up production capacity and bunkering infrastructure for renewable bunker fuels, the analysis changes. As noted above, many bunkering ports also have strong energy clusters and several have also strong links with chemical clusters, so this factor is not unique to Rotterdam. All bunkering ports have good transport links, and several are in or near locations where the inputs for renewable fuels (biomass or renewable electricity) have a lower cost-price than in North-Western Europe. Finally, demand for renewable fuels from other transport sectors is also growing in Asia, South and Latin America, and North America.[108]

Consequently, there are many attractive locations globally where renewable bunker fuels can be produced. And although the size of the local oil bunker market may not be the main factor deciding the choice for a location, we expect that a larger bunker market would make it more attractive, *ceteris paribus*, to invest in a certain location. This means that if the Rotterdam bunker market remains depressed, as per storyline 2, Rotterdam will be a less attractive location. This in turn means that probably a larger share of renewable fuels has to be imported to comply with the REDIII directive, as opposed to being produced locally, which could result in higher prices for bunker fuels in Rotterdam finally leading to a further decrease in the size of the market.

108 'Global Renewable Fuels Alliance', accessed 15 December 2022, https://www.globalrfa.org/biofuels-map/.

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