TE MANATŪ WAKA
MINISTRY OF TRANSPORT

Domestic Transport Costs and Charges Annual Research

Working paper 2022/23-01: NZ Shipping Resilience

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Research, Economics and Evaluation

The Research, Economics and Evaluation team operates within the System Performance and Governance Group of Te Manatū Waka Ministry of Transport. The team supports the Ministry's policy teams by providing the evidence base at each stage of the policy development.

The team is responsible for:

- Providing sector direction on the establishment and use of the Transport Evidence Base (see below) – including the collection, use, and sharing of data, research and analytics across the transport sector and fostering the development of sector research capabilities and ideas.
- Leading and undertaking economic analyses, appraisals and assessment including providing economic input on business cases and funding requests.
- Performing the evaluation function for Te Manatū Waka, including designing monitoring and evaluation frameworks and approaches, developing performance metrics and indicators, and designing, conducting and procuring evaluations.

The Transport Evidence Base

The Transport Evidence Base Strategy creates an environment to ensure data, information, research and evaluation play a key role in shaping the policy landscape. Good, evidence-based decisions also enhance the delivery of services provided by both the public and private sectors to support the delivery of transport outcomes and improve wellbeing and liveability in New Zealand.

The Domestic Transport Costs and Charges study aims to fill some of the research gaps identified in the 2016 Transport Domain Plan (Recommendation R6.2), which forms part of the Transport Evidence Base.

Citation

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For more information

For more information about this project and associated report, please contact: info@transport.govt.nz.

Executive Summary

Scope

This paper follows up on shipping-related issues arising from Rockpoint's Coastal Shipping paper presented as part of Te Manatū Waka's "Domestic Transport Costs and Charges" (DTCC) study in 2021, with the scope covering the resilience of bunkers under an import-only model, NZ shipping cost structures, and Covid impacts on shipping and trade.

Part 1 – The resilience of ship bunker supply under an import-only model.

On 6th August 2021 shareholders of The New Zealand Refining Company Limited (RefiningNZ) voted to cease oil refining operations at Marsden Point and to become an import-only fuel terminal, operating the berths, storage tanks and the pipeline to Auckland. NZ's supply of refined petroleum products including ship bunkers would in the future become entirely sourced from imports. This paper considers the availability, reliability and resilience of the global oil supply chain comprising crude oil, refined petroleum products, shipping capacity and domestic product storage.

The world is not short of oil, with exploration since 1980 increasing proven crude oil reserves by 5% p.a., while global demand grew at over 1% p.a. Over this period, global (cross-border) trade in crude oil has risen from 50% of production to 75%. The world has clearly accepted its dependency on oil imports. NZ's oil demand has grown at 1.8% p.a. while domestic production has fallen from 50% of demand in 2010 to 20% in 2020. With its moratorium on granting new offshore oil exploration permits NZ's oil self-sufficiency will continue to decline.

Oil refining involves separation of crude oil into its chemical constituents. Outputs are high value distillates such as petrol, diesel, and jet fuel, and whatever remains, the residues, such as fuel oil (ship bunkers) and bitumen. The residues concentrated all crude oil contaminants such as sulphur.

Globalisation has affected oil refining as it has manufacturing and trade. While global refining capacity has grown at 1.1% p.a., the weight of refining capacity has moved from USA and Europe (from 57% global market share in 1980 to 38% currently) into the Asia-Pacific region (from 16% to 35%). China alone has moved from 2% to 16% share. While global refining capacity is forecast to fall as environmental policies drive down demand for transport fuels, strong expansion is still forecast from Asia, where 12% growth is expected by 2025. Global refinery output will progressively shift from transport fuels (petrol, diesel and jet fuel) into petrochemicals (plastics, textiles, packaging).

In NZ, refining capacity has been flat since a major expansion in 1986. While nominally 90% self-sufficient in all oil products, NZ has only been 62% self-sufficient in petrol and diesel, with the balance imported. NZ has "exported" 75% of jet fuel production to foreign aircraft refuelling in NZ, while 70% of fuel oil (bunkers) has been exported. With the refinery's closure, all product is now imported.

Ship bunkers is the generic term for fuel oil used in ship engines. Traditional bunkers such as high sulphur fuel oil (HSFO, >3.5% sulphur) are residues, concentrating contaminants, and were disproportionately polluting. The IMO, in line with wider policies on use of coal and land transport, imposed its MARPOL Annex VI regulations in stages, to reduce pollution from ships. Approved Very Low Sulphur Fuel Oils (VLSFO, <0.5% sulphur) are available in several grades as blends of both distillates and residues. NZ will adopt MARPOL Annex VI in May/June 2022.

Bunker fuel prices correlate closely with crude oil prices and vary according to grade (with distillates at the premium, and residues (HSFO) at a discount. VLSFO, introduced prior to

MARPOL VI, initially traded at a 25% premium, but has since settled into a 0-10% premium to crude oil – until the Ukraine war. Demand for HSFO has fallen markedly, and now trades at a 20% discount.

The global trade in oil and refined oil products has grown strongly, now accounting for 75% of oil production, of which most is moved by ship. Global capacity of the ship fleet has matched the trade, with ship size also increasing.

Over the last decade, RefiningNZ's Marsden Point facility received 40 million barrels (mmbbls) of crude oil annually on 60 ships (tankers), being principally LR2, AFRAMAX and LR1 class ships (capacity 1.0 mmbbls, 0.7mmbbls and 0.5mmbbls respectively). The pattern of deliveries was remarkably regular, averaging 5 days, the ships visiting no other NZ ports. Further, these ships were typically not making repeat visits, suggesting they were on spot (one-off, rather than term) charters.

Exports of fuel oil from Marsden Point occurred about 5 times annually, and also showed a pattern of spot charters. These ships only occasionally visited another NZ port, usually New Plymouth to collect domestic crude oil production for export. A further 17 ships annually loaded "other" refined oil products for export, of which almost half also visited other NZ ports.

While the refinery was operating, its customer-shareholders (bp, Mobil and Z Energy) delivered petroleum products to 8 other NZ ports on coastal ships. Its operation, COLL, made 35 voyages annually delivering 20 mmbbls using two LR2 class ships, with 1.6 days in port, and 8-10 days away. This operation has now ceased. Ports of Auckland operated a small tanker to refuel ships in Auckland.

As the refinery output fell behind growing demand, any shortfall was made up by direct imports to 8 NZ ports. The incomplete data suggests these ships were almost all LR2 class and typically delivered to 3 ports per voyage. Again, the lack of repeat voyages suggests these ships were spot chartered, indicating a ready availability of suitable ships.

Looking forward, we anticipate that imports of petroleum products will almost exclusively be on LR2 class ships, and expect ships these will be charted on a spot basis. Marsden Point would require 25 LR2 deliveries annually, while the other 8 ports collectively 45 LR2 deliveries. In practice, these ships would visit multiple ports per voyage, suggesting over 200 port calls annually.

Imported oil is stored in tanks until required. The largest tank facility is associated with Marsden Point refinery, although 75% of that capacity is crude oil and intermediary products tanks unsuited to storing refined product. RefiningNZ indicates it has 180 mm litres (1.12mmbbls) of product storage, and potential for another 100 mm litres.

MBIE's 2018 storage assessment concluded NZ had 847 million litres of storage. Rockpoint's independent assessment suggests 1010 million litres. RefiningNZ accounted for 180 million litres, and Wiri, Auckland another 120 million litres. The remaining 547 million litres was located on or adjacent to the 8 domestic ports. Mt Maunganui accounted for 240 million litres, Lyttelton 100, Wellington 90.

NZ, as a Member of the International Energy Agency (IEA), is obliged to hold emergency oil stocks equivalent to at least 90 days of net oil imports, some 12 mmbbls or 2 billion litres. To the extent these reserves are not physical stocks held in NZ, the Government makes up the difference by buying contract (tickets) with offshore parties. IEA records show NZ has maintained 97 days of reserves, of which 65% is as physical stock in NZ. The IEA average of other oil importing countries is 160 days (or which 90% is in-country).

In its 2020 report "Fuel Security and Fuel Stockholding Costs and Benefits" to MBIE, industry experts Hale&Twomey concluded: "If the refinery closes, New Zealand is likely to see a reduction of stocks held, primarily crude and intermediate product … to under 70% of the previous level" while "[moving to a] 100% product import supply will dramatically reduce the amount of stock held in New Zealand, [although] it will not have a major impact on fuel security [except] if there was a failure in normal global trading activity". Amongst other things, Hale&Twomey recommended that MBIE work to improve the stock reporting from fuel companies.

Following RefiningNZ's proposal to cease domestic refining, MBIE initiated its "Onshore Fuel Stockholding" consultation paper. Amongst other items "[they] propose requiring a minimum onshore fuel stockholding level similar to that proposed in Australia, namely 28 days of cover for diesel and its biofuels equivalent, and 24 days of cover for other liquid transport fuels (namely petrol and jet fuel)". That proposal presumes the Government will meet the balance of IEA 90-day emergency oil stocks through an expanded contract (ticket) programme.

We conclude that the closure of the refinery will not materially affect the resilience of the supply of petroleum products to NZ. Rather than importing crude oil, NZ will instead import refined product from Asian refineries (as it already does for 40% of supply). Asia being the region with the greatest growth in refining capacity, and currently excess capacity. Shipping has provided a reliable link to petroleum retailers (crude oil or refined products) for several decades, and there is no reason to suspect that resilience will now diminish. Closure of the refinery does diminish product storage, where past crude oil storage (pending product when the refinery was operational) is written off. There appears to be agreement that insufficient data is collected on storage capacity and actual product storage, representing a greater supply security risk at a time when the Government is expected to greatly expand its contract buying strategy to achieve the IEA's 90-day inventory target. There is merit in constructing further distributed petroleum product storage.

Part 2 – NZ Shipping Cost Structures

Rockpoint's "Coastal Shipping" Working Paper for DTCC observed that NZ domestic ship operating costs are double that of foreign ships, comprising crewing costs 2.55 times higher, other ship operating costs 1.5 times higher. Bunker costs in NZ are 1.3 times higher than in Asia.

The Government saw merit in promoting coastal shipping to reduce the freight task (and investment requirement) on road (and rail) modes, and the achieve improved environmental and social outcomes. Accordingly, the National Land Transport Programme 2021-24 added the Coastal Shipping Activity Class into the Government Policy Statement, allocating $30 million. On 24 May 2022, the Minister of Transport announced four recipients of these funds for new and enhanced coastal shipping services subject to their co-investment of $60 million.

Part 3 – Covid Impacts on Shipping

Through both good luck and good management, NZ has fared better than almost all countries during this Covid-19 pandemic. Until the Omicron variant arrived in February 2022, almost 2 years into the global pandemic, NZ's containment strategy had worked very effectively. The Government rolled out an effective health, monitoring and vaccination programme, and provided direct support for staff and businesses.

Even so, the NZ economy has taken a hit. As a comparison, the Global Financial Crisis (GFC, 2008) had driven NZ's GDP down for 5 quarters (for an average -1.6%), followed by a modest recovery. Under Covid, GDP dropped sharply for a single quarter (-10.4%) but enjoyed a more

robust recovery. In both cases, businesses and households curtailed spending, with imports dropping, although recover has been stronger under Covid. Exports fell harder under Covid, for longer, with a patchy recovery.

The Reserve Bank of NZ stimulated economic activity by lowering the Official Cash Rate (OCR – interest rates) with resultant record low mortgage rates being quickly reflected in a strong, unhelpful surge in house prices. The increase in demand for goods and rising prices of imported goods has since late 2021 driven inflationary pressures (both imported such as energy, and underlying domestic inflation). In March 2022, the RBNZ moved firmly to arrest emerging inflation by raising the OCR, with further robust OCR increases foreshadowed.

Global institutions such as the World Bank, World Trade Organisation and UNCTAD have provided commentary on the global economic outlook through the Covid pandemic (and the more recent Ukraine war). The World Bank has delivered $5 billion in debt relief to over 40 countries. 255 million full-time jobs were lost globally in 2020, while foreign direct investment fell by 42%. Commodity prices have risen following supply chain disruptions. As the impact of the Covid pandemic (and more recently the Ukraine war) have been observed, each successive forecast has revising down economic growth (and increasing inflationary concerns), with risk now of the downside.

UNCTAD observed that, with shipping and ports handling over 80% of global merchandise trade, rising demand for goods through the pandemic has placed heavy pressure on a strained global supply chain – reduced access to raw materials, lead time issues, cancelled (blank) sailings, port closures, reduced working hours at ports, equipment, and labour shortages, as well as truck/transport capacity constraints. Even small bottlenecks can quickly escalate to undermine the smooth movement of merchandise trade flows.

While the longer-term impact of the Covid pandemic is yet to be fully understood, the near-term challenges for shipping are clear, although these differ by maritime transport segment (container, bulk, reefer, tanker), domestic or international, and the strength and preparedness of each region. Countries with high Global Value Chain participation (that is, those part of multi-country production processes) are more immediately affected by supply chain disruptions, but UNCTAD suggests they may recover faster. UNCTAD's key message is that the Covid pandemic is far from over, and while economic growth is recovering faster than initially expected, downside risk remains.

NZ is a small trading nation, leveraging its primary sector competencies to export dairy, meat, fish and forestry, in exchange for imported manufactured products. Such trade has accounted for 20-25% of NZ's GDP since the 1960s. Global cross-border trade reached US$22 trillion in 2021, and represented a record 28% of global GDP, up from just 9% in 1960. Rising trade in goods and services, termed globalisation, has resulted in an increasingly inter-connected, mutually reliant world, where countries benefit from specialisation.

Globalisation is fundamentally highly reliant on transport and logistics systems, with maritime trade in goods increasing at 2-3x economic growth. Shipping capacity has grown to meet trade demand and efficiency, with investment in new, ever larger container ships, while industry consolidation has increased. When the Covid pandemic hit in early 2020, maritime shipping was soon disrupted, especially in Northeast Asia. Wary after the recent post-GFC pain, container shipping firms, responded to the emerging overcapacity by aggressively trimming schedules to consolidate on major ports, and when loads were low, cancelling scheduled sailings (termed "blank sailings").

Demand for goods unexpectedly returned mid-2020, as consumers, deprived of hospitality and tourism services during lockdown, switched their spending to goods. Container shipping firms

reduced blank sailings from 21% mid-2020 to 1% by later 2020. Yet they struggling to restore recently trimmed capacity given new constraints had emerged in the Global Supply Chain. Covid lockdowns greatly affected global manufacturing and logistics, with ports either locked down, burdened by slow-moving containers, or constrained by up- and downstream factors.

Even where ship capacity was deployed, its effective capacity fell as ships were unable to maintain schedule given extended port delays. Containership schedule reliability fell as shipping lines faced unpredictable port delays. On-time reliability, having reached 80% in mid-2019, fell to 35% later in 2020. Shipment times from China and West Coast US doubled, not due to slower voyages but waiting at anchor for a berth slot at port. The consensus of market commentators was that in April 2022 up to 20% of the world's 9,000 active container ships were being delayed by congested ports, with 30% of that backlog being in China.

Ports congestion reflects higher demand for goods, but also new constraints. Port and wider transport staff may become unavailable at short notice when infected with Covid, quickly affecting port and land transport efficiency and congestion. Port efficiency falls as containers accumulate in their yards. Shipping lines have similarly faced crew constraints, with travel restrictions affecting crew joining or ending a contract, with some stuck aboard for months. The movement of containers have been disrupted, with 20% being stuck on ships at anchor, others delayed clearing ports or held as temporary storage. Exporters face widespread unavailability of empty containers.

Port congestion has greatly compromised shipping, as observed from real-time data, affecting gateway ports such as Shanghai, Singapore, Long Beach and Rotterdam. Port calls are regularly dropped. As demand rose and effective shipping capacity fell, shipping lines raised maritime freight rates during 2020. The price to ship a container from China to the North American West Coast rose 7.2x from May to September 2020, although has since eased to 5.4x.

The Journal of Commerce observed the container shipping lines made pre-tax profits of $25.4 billion in 2020. Drewry, an independent maritime research consultancy, estimated that container shipping lines have made a record pre-tax profit of US$150 billion in 2021 and may make as much as $200 billion in 2022. These astonishing profits follow equally heavy losses in 2009 post-GFC, and show container shipping lines are taking full advantage of strong demand. And while demand for goods remains so high, companies and individuals appear willing to pay unsustainably high freight rates.

While the disruptions appear to be easing, the Covid pandemic has revealed the world's vulnerability to complex global supply chains. Under globalisation, these supply chains have evolved, being optimised to minimise cost, maximise efficiency and minimise inventory (Just-In-Time). They have become more complex, relying on advanced technologies, scale and complex inter-dependencies across many suppliers, sites and countries.

Under Just-in-Time Over time, inventories were kept to a minimum. Complex inter-dependencies with materials and component suppliers, often in different countries, placed great reliance on fast, efficient, well-priced transport. As an example, Apple's iPhone uses components from more than 200 suppliers from 43 countries. The Covid pandemic has revealed the fragility of Just-in-Time.

Customers will always seek quality, choice and availability – and low prices. During lockdown, as supply issues arose, the priorities changed. Following widespread disruption, the merits of a simplified supply chain and the value of in-house inventory are being recognised. Households panicked to stock up" on essentials (such as toilet paper!). Canny retailers such as Briscoes boosted inventories early in the pandemic - Just-In-Case – and made record profits.

Changing the widely adopted Just-In-Time model will take time and require investment, and may be impossible for many complex products. Near-Shoring (and On-Shoring) is gaining supporters, where supply lines are shortened (to home or adjacent countries), and the steps in the chain reduced or simplified. While there is ample commentary promoting Near-Shoring, there is not yet evidence to clearly demonstrate its merits.

Covid pandemic has accelerated several pre-existing trends in shipping and supply chains, such as e-commerce (conducting business online), digitalisation (including of supply chain management and DLT), automation, improving resilience – and continued industry consolidation.

NZ shipping has been as impacted by the Covid pandemic as most other countries. Ports have been congested (particularly Auckland which reported an average 3.4 day delay from schedule, and which subsequently abandoned its automation project). Container yards have been running at capacity (Auckland at 105%), with capacity reduced due to slow clearance. The reliability of NZ container shipping services is even worse than most countries, falling from 80% pre-pandemic to just 6% in June 2021, reflecting a cascade from delays in Asia and Australia. Port calls are regularly skipped, or entire voyages blanked. Empty containers have been in short supply (or the wrong type, or in the wrong place), and NZ has endured sea freight rates up 6-fold. While conditions in 2022 are improving, shipping services remain unreliable.

The Government has sought solutions, including engaging with shipping lines to encourage improved services. Yet the Government role is law-maker and regulator, and is not contractually involved as a shipper, or in ships, shipping or ports. This limits the levers it can pull to influence or secure more reliable shipping. Industry calls for the Commerce Commission to investigate shipping competition is perhaps best delayed to less fraught times.

The Government allocated $30 million in the 2021-24 National Land Transport Programme to make “coastal shipping a more viable alternative for moving freight within New Zealand’. On 24 May 2022, the Minister of Transport announced four applicants for co-investment in new and enhanced coastal shipping services (Coastal Bulk Shipping Ltd, Move International Ltd, Swire Shipping NZ Ltd (Pacifica Shipping) and Aotearoa Shipping Alliance).

Glossary

NZ Agencies

MoT	Ministry of Transport Te Manatu Waka
MNZ	Maritime NZ No te rere moana Aotearoa
MBIE	Ministry of Business Innovation and Employment Hikina Whakatutuki
RBNZ	Reserve Bank of NZ Te Putea Matua
Treasury	NZ Treasury, The Treasury Te tai Ohanga
Waka Kotahi	NZ Transport Agency Waka Kotahi

Reports

DTCC	Domestic Transport Costs and Charges - MoT
NFDS	National Freight Demand Study - MoT
NIP	National Infrastructure Plan – NZ Treasury
FIGS	Freight Information Gathering System - MoT
Drewry	Drewry “Ship Operating Costs Annual Review and Forecast Annual Report 2019/20”
BP	BP Statistical Review 2021 – a global energy database

Global Agencies

UN	United Nations
OECD	Organisation for Economic Cooperation and Development
WTO	World Trade Organisation
IMO	International Maritime Organisation
IEA	International Energy Agency
UNCTAD	United Nations Conference on Trade and Development

Refining in NZ

RefiningNZ	The NZ Refining Company, operator on NZ’s oil refinery located at Marsden Point, Northland, now renamed Channel Infrastructure which operates the Import Terminal System (ITS) comprising jetties, storage tanks and RAP pipeline for customer-shareholders being bp, Mobil and Z Energy
RAP	Refinery to Auckland Pipeline
TLF	Truck Loading Facility
COLL	Coastal Oil Logistics COLL

Refining Terms

Crude Oil	hydrocarbons as extracted from the ground, each unique
WTI	West Texas Intermediate - a common crude oil benchmark
Bunkers	Marine Fuel Oil Bunkers
HFO	Heavy Fuel Oil
HSFO	High Sulphur Fuel Oil such as IFO180, IFO380
VLSFO	Very Low Sulphur Fuel Oil– several grades such as MDO, MGO
Distillates	hydrocarbons vapourised (boiled off) in refining, then condensed
Residues	Crude oil once distillates have been removed comprising fuel oil, bitumens, solids and contaminants (such as sulphur)

API	American Petroleum Institute - regulates industry standards
MARPOL	International Convention for the Prevention of Pollution from Ships
Annex VI	MARPOL Annex VI “Prevention of Air Pollution from Ships” 2005
GHG	Greenhouse Gases
SECA	Sulphur Emission Control Areas
GFC	Global Financial Crisis GFC 2008

Shipping Terms

LOA	Length Over All LOA
GT	Gross Tonnes GT as measure of ship volume
DWT	Deadweight Tonnes DWT - weight the ship is carrying (cargo, bunkers, ballast)
Displacement	Weight of water displaced by ship and its cargo
LR1	Long Range 1, a class of ship, 183m, 50,000dwt, ~0.5 mmbbls
LR2	Long Range 2, a class of ship, 260m, 120,000dwt, ~0.8 mmbbls

Units and Conversions

Volume	Litres l	Barrels bbl	Gallon gal	cubic metres
Litres l	1	0.01	0.26	0.00
Barrels bbl	159	1	42	6.29
Gallon gal	3.79	0.02	1	0.00
Cubic Meter m^3	1000	0.16	307.90	1

Conversions	MJ/kg	kg/litre	t/bbl
Crude Oil	46.9	0.79	8.058
Petrol	47.0	0.75	8.35
Diesel	45.8	0.84	7.46
Jet Kero	46.2	0.72	7.88
Fuel Oil	43.0	0.95	6.35

Speed	kmh	mph	knots
kmh	1	1.602	1.852
mph	0.624	1	1.156
knots	0.540	0.865	1

Metrics	Unit	1
	Kilo k	10^3
	Mega M	10^6
	Giga G	10^9
	Tera T	10^12
	Peta P	10^15

1 Introduction

1.1 Study Scope

This paper follows up on issues arising from Rockpoint's "Coastal Shipping" Working Paper presented as part of Te Manatū Waka's "Domestic Transport Costs and Charges" (DTCC) study.

The agreed scope is:

Part 1 – Resilience of NZ Ship Bunker Supply

The resilience of the supply of bunkers (shipping fuels) following the decision by RefiningNZ to cease refining operations in NZ. While the focus will be on bunkers, it is apparent that parallel implications apply to all petroleum products.

The implications of MARPOL Annex VI on NZ shipping - with NZ set to follow international shipping in adopting these new fuel standards in January 2022. These fuels will necessarily be imported.

Part 2 - NZ Shipping Cost Structures

Domestic shipping faces materially higher operating cost structures than foreign ships in NZ waters, arising variously from bunkers, tax, employment, and environmental obligations. These issues reflect Government policy, and extend into specialist areas of tax and international law beyond the scope of this study. However, to the extent they affect the broad competitiveness of domestic shipping (including against other transport modes), this research project will provide context which may assist Government in its review of policy settings.

Part 3 - Covid Impacts on Shipping

The impact of Covid-19 on the international (and coastal) shipping sector has led to sharply higher freight rates and a decline in shipping availability and reliability as foreign shippers reduce their services to New Zealand. These effects will be reviewed and where possible quantified, and the likely path to a more stable market will be discussed.

1.2 Overview

Treasury's National Infrastructure Plan (NIP) presents a concept of resilience as the capacity of public, private, and civic sectors to withstand the disruption, and absorb disturbance, following natural disasters. It is to act effectively in a crisis, to adapt to changing conditions, and grow over time. It implies a measure of how quickly and effectively capacity can adapt and be restored. The two dimensions of resilience are technical (infrastructure robustness, redundancy, safe-to-fail) and organisational capability (change readiness, leadership and culture, networks resilience principles).

NZTA's qualitative framework generates a resilience score ranging from very high (meets all requirements), through high (acceptable performance), moderate (less than desirable performance, specific improvements identified) and finally low (poor performance and improvements required).

At the Special Meeting of The New Zealand Refining Company Limited (Refining NZ) on 6th August 2021 shareholders voted to approve the Company's transition to cease oil refining operations at Marsden Point and to become an import-only fuel terminal, under a new name 'Channel Infrastructure'. NZ's supply of refined petroleum products including ship bunkers would in the future become entirely sourced from imports.

While the key focus of this paper is ship bunkers – a heavy fuel oil – it is apparent that moving to an import-only supply structure will have parallel implications across the supply of, and infrastructure requirements for, all petroleum products consumed in NZ.

This section considers the availability, reliability and resilience of the global oil supply chain and the implications of NZ transitioning to an import-only supply model for petroleum products. The oil supply of oil comprises:

- crude oil
- refined petroleum products including ship bunkers
- shipping capacity
- domestic product storage

Consideration is given to fuel standards, both the adoption of international standards (such as MARPOL Annex VI for bunkers), and as set by NZ independently.

2 Crude Oil Supply

2.1 The world is not short of oil

Crude oil is a naturally occurring fossil hydrocarbon accumulated in underground reservoirs. The character of every accumulation of crude oil is unique, each being composed of various discrete hydrocarbon molecules and associated contaminants.

Proved reserves (being in-ground reserves considered under American Petroleum Institute (API) rules to be economically recoverable) represent over 50 years supply at current rates of production. Further, the quantum of proved reserves have grown steadily since 1980, by almost 5% p.a., so it seems adding reserves is not an issue. Changing market economics will continuously change how in-ground accumulations are classified. Proved reserves will increase with rising oil price and new improved production technologies (such as enhanced oil recovery and hydraulic fracturing) or will fall with the rising recovery costs.

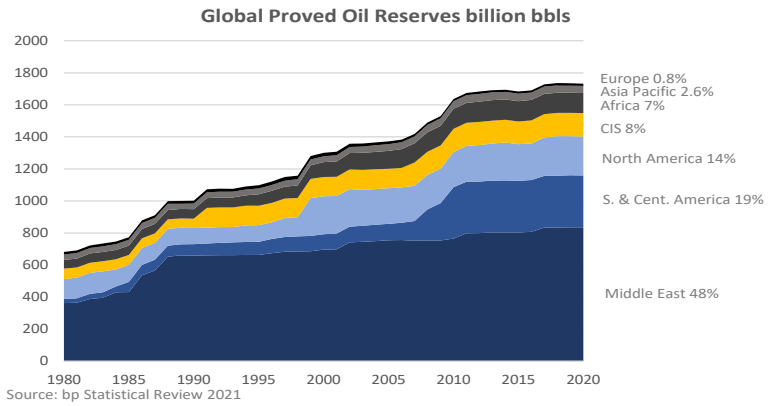


Figure 1: Global proved oil reserves (billion barrels)

Historically, countries were more heavily reliant on domestic crude oil production, but global trade is now dominant. Since 1980, oil consumed in the country of its production has fallen steadily, at -0.7% p.a., while cross-border trade has grown at 1.7% p.a., with international trade in oil rising from 50% to 75%. This emphasises a global acceptance of dependency on imports. Despite the abundance of reserves and production capacity, this dependency does not eliminate risk, as the current Russia-Ukraine war has highlighted. But it does reflect countries balancing their assessment of risk of imports against the price and availability of alternatives (such as domestic oil or renewables).

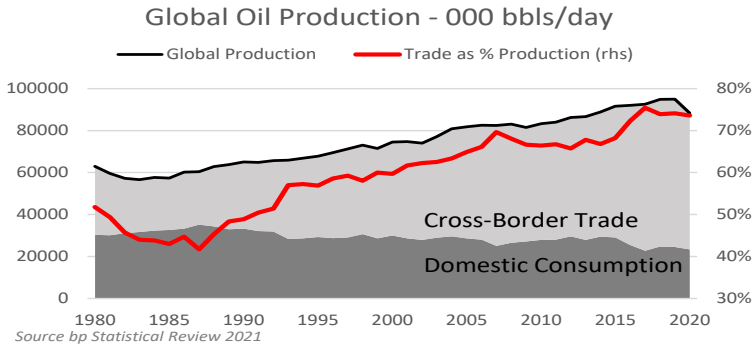


Figure 2: Global oil production (thousand barrels per day)

2.2 New Zealand oil consumption is low

The Middle East has long dominated, currently claiming 48% of proved oil reserves globally and 30%of annual production. Within this global sector, NZ is a minnow, its share of oil consumption just 0.17%.

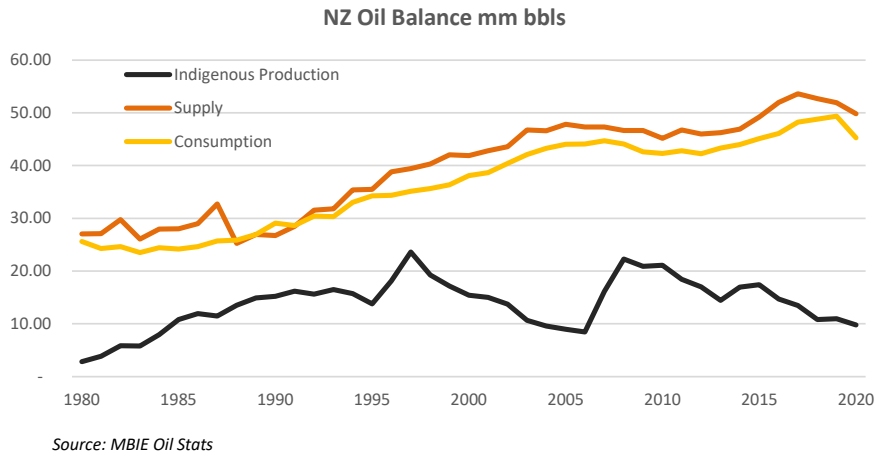
Table 1: Global oil statistics

Global Oil Statistics

	Proved Reserves	Production	Reserves Life	Refining Capacity	Consumption	Self Sufficiency	
	b bbls	b bbls pa	years	b bbls pa	b bbls pa	Production	Refining
New Zealand	**0.06**	**0.01**	**6**	**0.049**	**0.045**	**22%**	**109%**
Middle East	835.9	10.1	83	3.7	3.0	89%	81%
S. & Cent. America	323.4	2.1	152	2.3	1.9	95%	85%
North America	242.9	8.6	28	7.9	7.6	105%	95%
CIS	146.2	4.9	30	3.0	1.5	53%	50%
Africa	125.1	2.5	50	1.2	1.3	123%	106%
Asia Pacific	45.2	2.7	17	13.3	12.3	100%	93%
Europe	13.6	1.3	10	5.7	4.7	94%	82%
Total World	1732.4	32.3	54	37.2	32.4	96%	87%

Source: bp Statistical Review 2021

NZ's domestic oil production currently meets just 20% of NZ's annual consumption (down from 50% in 2008), with production from all domestic oil and gas fields now in advanced decline. This is unlikely to change given, since 2018, NZ has ceased granting new offshore oil exploration permits to target a carbon-neutral future.



Source: MBIE Oil Stats

Figure 3: New Zealand oil balance (million barrels)

Post-1986 expansion, Refining NZ's Marsden Point refinery was optimised to process globally abundant, imported heavy sour feedstocks. Consequently, NZ's sweet light crude oil production is exported. Post-expansion, capacity since remained essentially flat, while demand for petroleum products has risen steadily. Refinery capacity was exceeded in 2000, with imports making up any shortfall.

3 Global Oil Refining

3.1 An oil refinery separates crude oil into its constituents

Crude oil is a mixture of hydrocarbons, plus contaminants such as ground water and other liquids, and various solids (principally rock fragments). Hydrocarbon molecules themselves comprise carbon atoms linked into chains (and rings) of various lengths, with attached hydrogen atoms. Each crude oil is unique. Crude oil comprising short chain hydrocarbons are termed “light”, and are typically liquid, while those with more longer chains are usually solid, and termed “heavy”. Crudes low in contaminants (principally sulphur) are “sweet”, while high sulphur crudes are “sour”. Sweet light crudes are priced at a premium given they are easier to recover, less expensive to refine, and yield more high value hydrocarbon (petroleum) products. They have been preferentially exploited, with the consequence is that, over time, the world’s remaining in-ground proved reserves have become more weighted towards heavy sour crudes.

Each hydrocarbon molecule of a given chain length has a unique boiling point, which is exploited in the refinery’s distillation (heating) column. In a refinery, propane and butane (“LPG”) boil off (vaporised) at the lowest temperature and are then condensed (re-liquified) – a processed termed distillation. Longer chain fractions are sequentially boiled off then distilled with rising temperature – naphtha, then gasoline (petrol), jet fuel, kerosene, heating oil, then diesel. By 550degC gas oil and fuel oil (ship bunkers) can be vapourised and distilled. These boiled off fractions are collectively termed distillates and are chemically pure (without contaminants).

Table 2: Crude oil refining

Crude Oil Refining - Distillation Sequence

	C_nH_{2n+2}	Uses	Boil ^0C
natural gas	C_1 - C_2	home	-20-0
LPG	C_3 - C_4	BBQ	0-30
naphtha	C_5 - C_9	chemicals, blending	30-175
gasoline	C_5 - C_{10}	cars	30-85
kerosine, jet fuel	C_{10} - C_{16}	planes	175-250
diesel	C_9 - C_{20}	trucks	250-350
heavy gas oil	C_{15} - C_{20}	ships	350-650
residues - heavy fuel oil	C_{20} - C_{50}	ship bunkers	

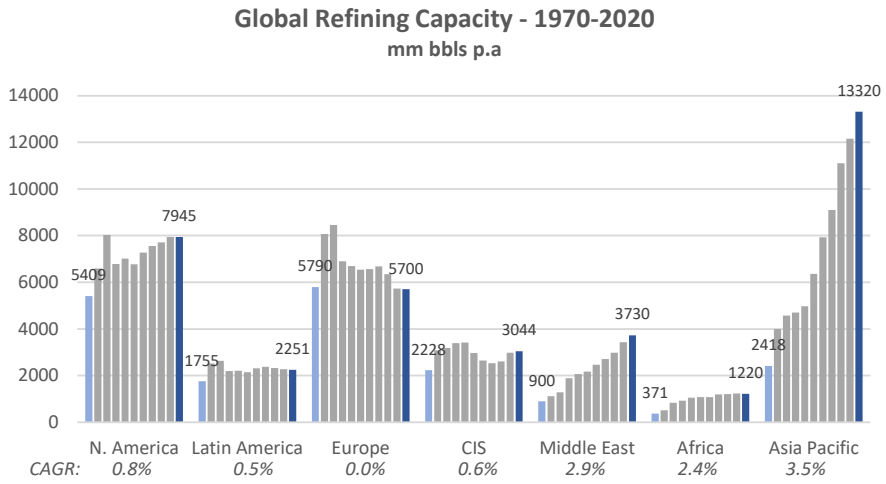
Some more sophisticated refineries incorporate additional processes (such reformers, catalytic crackers, and hydrocrackers) which can chemically cleave some of the remaining long-chain hydrocarbons into more valuable short-chain distillates. The economics of further recovery (the cost of heating, time and diminishing yield) dictate when the distillation process ends.

That dark viscous fraction left behind after the distillates have been removed are termed residues. These comprise predominantly longer chain hydrocarbons, but also concentrate all contaminants in the crude oil, both naturally occurring and as introduced during the drilling-production-transport-refining processes.

Residues in turn can be separated into marketable by-products. Residual fuel oil is a viscous combustible oil used primarily by industry and power plants (to fire steam boilers), or to fuel ships (as bunkers). There are a range of fuel oil grades which are blended with other petroleum fractions to create products the desired viscosity and flash point. The heavier remaining components such as bitumen and asphaltenes are the used primarily for civil (road) construction, or industry.

3.2 Global refining capacity

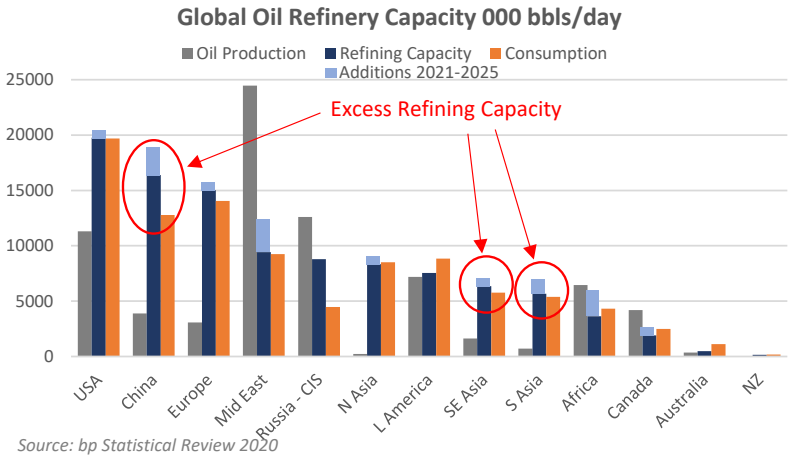
Just as countries once saw merit in being self-sufficient in oil production, most also saw merit in building refining capacity to capture economic benefit and perceived supply resilience. Based on the BP Statistical Review 2021, since 1985 global refining capacity has grown at 1.1% p.a., broadly matching growth in global oil production at 1.4%. The weight of refining capacity has moved firmly from USA and Europe into the Asia-Pacific region. Since 1985, capacity across Europe has fallen by -0.5% (with global share falling from 39% to 15%) as regional oil production has fallen, and imports became more available. Meanwhile, Asia-Pacific capacity has grown at 3.0%, with global share rising from 16% to 36%. China is the standout, with share rising from 2% to 16%.



Source: bp Statistical Review 2020

Figure 4: Historic global refining capacity 1970-2020

Global refining capacity is forecast to fall as environmental policies drive down demand for transport fuels, yet strong expansion (including for transport fuels) is forecast from Asia, which is transitioning into modern, growing, energy intensive economies. GlobalData identifies 416 upcoming refinery projects, of which 220 would come onstream between 2021 to 2025 to boost global capacity by 12.75 mmbd (12%) to 116 mmbd. China leads, having already tripled capacity to 17.4 mmbd since 2000, and will launch new projects adding 5.5 mmbd by 2025. India is similarly expanding fast.



Source: bp Statistical Review 2020

Figure 5: Global oil refining capacity per day

The growth in global refinery output will progressively shift from transport fuels (petrol, diesel and jet fuel) into petrochemicals, where distillates are altered into chemicals such as methanol, olefins and aromatics which are building blocks of plastics, textiles, electronics, cosmetics and packaging. According to the IEA, petrochemicals share of output will increase from 10% of refinery output currently to 30% of global refinery output by 2030 and to 50% by 2050.

4 Scenarios to 2030 – results

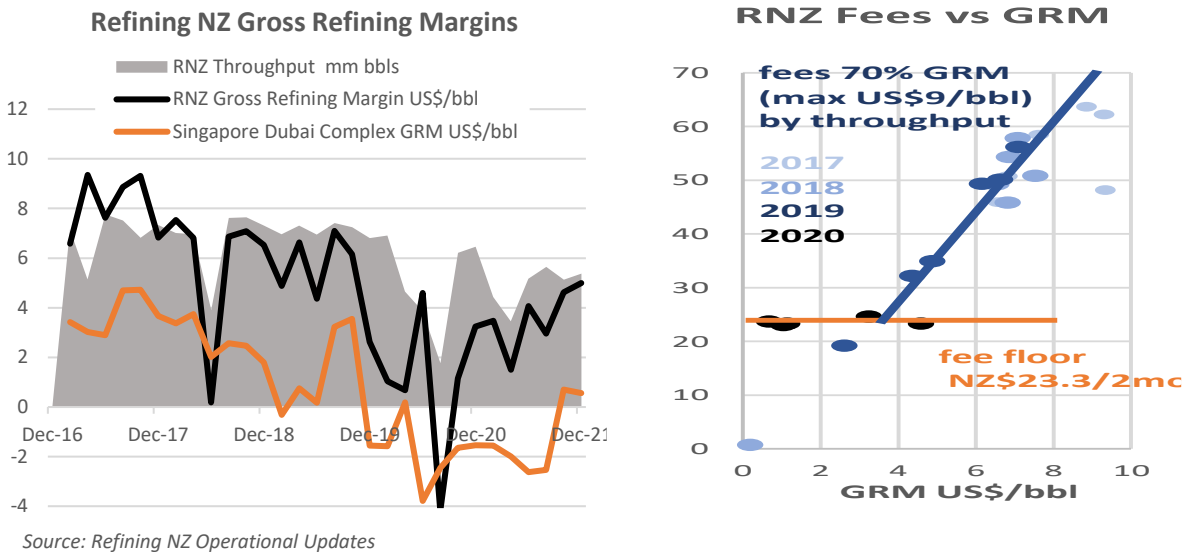
4.1 Growth to Closure

The NZ Government built the refinery at Marsden Point in 1964, sited for the strategic advantages of a natural deep-water port, low earthquake risk and proximity to Auckland. The refinery was expanded in 1986, and subsequently sold to the then-5 major petroleum retailers.

RefiningNZ operated as a tolling refinery, with its capacity fully contracted to its then-5, now-3 customer-shareholders (the fuel retailers bp, Mobil and Z Energy) under an agreed fee structure (linked to Asian Gross Refining Margin and incorporating a fee floor). The fee structure incentivises these fuel retailers to fully utilise refinery capacity. They each purchased and imported crude oil (often on shared ships) for the refinery processes subject to scheduling and capacity.

RefiningNZ is connected to NZ's largest market, Auckland, by its 170 km Refinery-to-Auckland Pipeline (RAP) which carries half of refinery output. The fuel retailers distribute the balance by their coastal ships to eight NZ ports, while Northland market is served by truck. While the fuel retailers are independent competitors, much of the infrastructure is shared (import ships, coastal distribution, storage facilities) requiring a degree of cooperation and coordination.

Sparked by persistent (and forecast) poor profitability and being a small old refinery facing rising capital investment, refining operations ceased in April 2022. NZ's supply of refined petroleum products now entirely sourced from imports.



Source: Refining NZ Operational Updates

Figure 6: Gross refining margins of Refining NZ

The Government is currently assessing implications for NZ's fuel security, including through MBIE's Onshore Fuel Stockholding consultation process. The Australian Government has similarly announced new fuel security measures, including a domestic stockholding obligation, after all but two refineries (Geelong, VIC and Lytton, QLD) either became import terminals (like RefiningNZ) or been closed.

Table 3: Australian Refineries

Australian Refineries

	State	Owner	Built	Status
Geelong	VIC	Viva Energy	1954	operating, 7.5 b l pa
Lytton	QLD	Ampol	1965	operating, 6.5 b l pa
Altona	VIC	Mobil	1949	closed 2021
Clyde	NSW	Shell	1925	converted to import terminal 2013
Bulwer Island	QLD	bp	1965	converted to import terminal 2015
Kurnell	NSW	Caltex	1956	converted to import terminal 2014
Port Stanvac	SA	Mobil	1963	closed 2003
Marsden Point	**NZ**	**Refining NZ**	**1962**	**converted to import terminal 2022**

4.2 Refinery Output

RefiningNZ's 1986 upgrade increased capacity by 75%, from 3.0mtpa to 4.8mtpa. Output briefly exceeded NZ's demand by 30%, with the new hydrocracker boosting distillate yield by 125% from 1.9mtpa to 4.2mtpa. Despite various debottlenecking and upgrade projects since, refinery output has been relatively stable since 1990. With domestic demand growing at more than 2% p.a., NZ's self-sufficiency progressively fell, to currently stand at a nominal 90%.

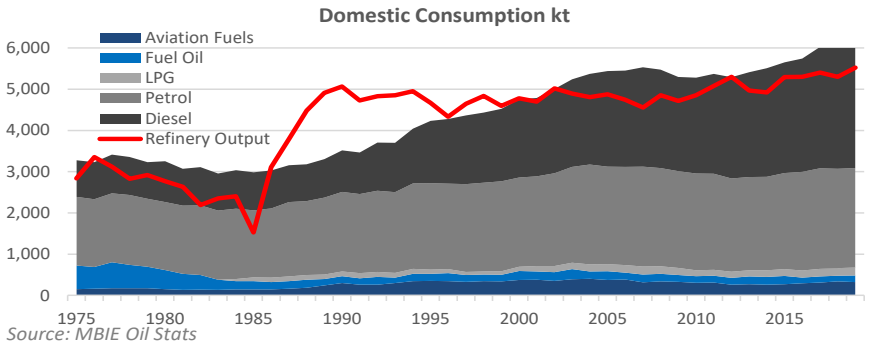


Figure 7: Domestic oil consumption (kilotonnes)

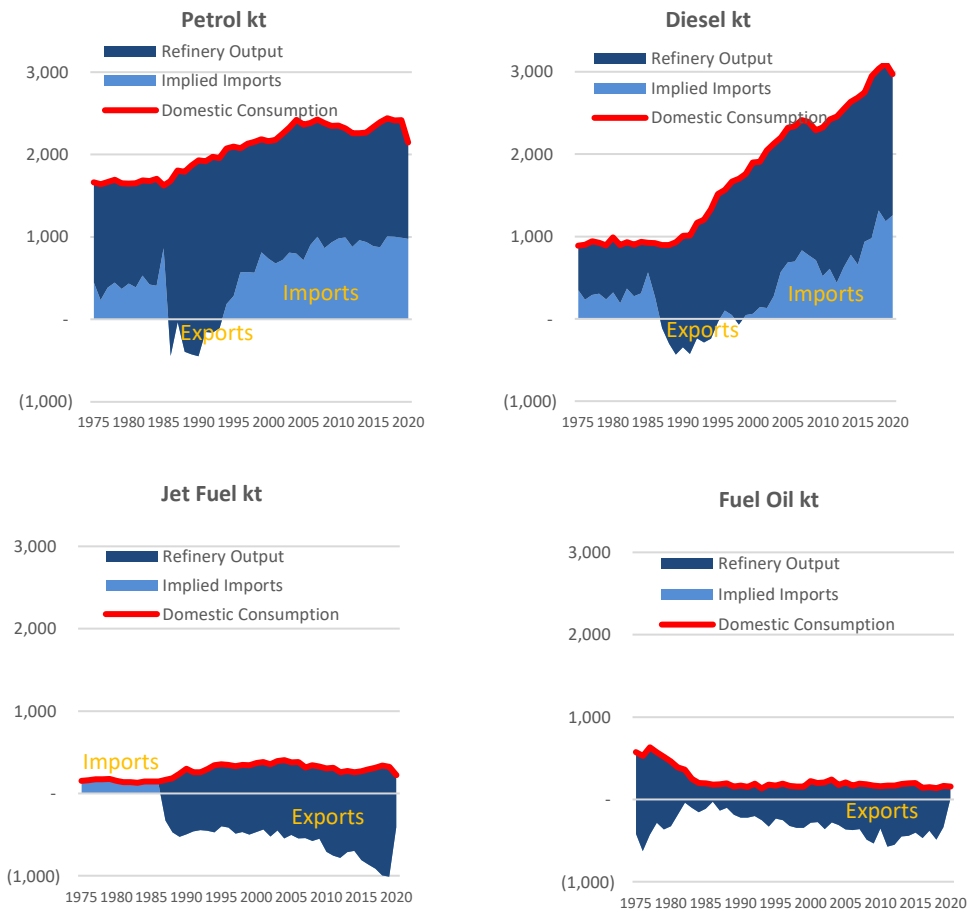


Figure 8: Imports, exports and domestic oil consumption

Petrol (gasoline): Pre-upgrade, the refinery's key output was petrol, largely achieved by processing high yield sweet light crude oil feedstocks. Post the 1986 upgrade, the refinery was optimised to process low priced heavy sour feedstocks, being the most globally abundant, with the hydrocracker able to boost the yield of higher value distillates. Petrol output reached 2.4mtpa in 1990, exceeding domestic demand, so briefly permitting exports. The refinery customers have since dialled back petrol output to 1.5mtpa in favour of diesel production. The refinery currently meets 62% of NZ's petrol demand.

Diesel: Demand for diesel has grown at 0.9mtpa to 3.0mtpa since 1990 (a 3.9% p.a.), driven by transport demand (a rising freight task and an increase of private diesel vehicles). As with petrol, the refinery currently meets 62% of domestic demand. Petrol and diesel account for 62% of refinery output.

Jet Fuel: Aviation (jet) fuel and fuel oil account for 24% and 11% respectively of refinery output. Jet fuel is a distillate, with domestic demand peaking at 0.4mtpa in 2004. The subsequent decline to 0.3mtpa masks a strong growth in domestic air travel utilising larger more efficient planes. NZ's jet fuel exports have grown from 0.5mtpa to 1.0mtpa, supplied to international airlines refuelling in NZ .

Fuel Oil: is a residual (non-distillate) petroleum product, largely used in shipping as bunker fuel and by industry for firing furnaces and boilers. Domestic demand fell as natural gas came onstream in the 1970's and has been flat at 0.2mtpa since 1990. As refinery output has grown, exports have increased from 0.2mtpa to 0.45mtpa today, supplying foreign ships bunkering in NZ and by direct export.

4.3 Channel Infrastructure

RefiningNZ was formally renamed Channel Infrastructure ("CI") on 1st April 2022, with its primary business owning, operating, and maintaining the Import Terminal System (ITS), comprising existing berths, storage, testing and distribution by RAP to Auckland and truck to Northland. Some refinery equipment which could be repurposed for production of alternative fuels may be temporarily preserved for a period, although the refinery decommissioning will be completed in 2023.

4.3.1 Berths

RefiningNZ owns a deep-water port at Marsden Point. Built for the refinery in the 1960s, it provides 3 dolphin berths (jetties), connected to land by a shared jetty.

- Jetty 1 was used to unload 42 million barrels (mmbbls) annually, with 70 to 100 crude carriers of Aframax or LR1 Class ships (each 100-120,000dwt loaded with 0.5-0.8 mmbbls).
- Jetty 2 was predominantly used to load refined product onto COLL's Matuku and Kokako, making 50 journeys and 200 calls to 8 ports annually.
- Jetty 3 was built in 2009 and serves the coastal fuel barge Awanuia.

Under ITS: Jetties 1 and 2 will discharge (unload) refined product imported by its shareholders, the mix reflecting Auckland (and Northland's) demand for petrol, diesel and jet fuel. COLL's operation will cease.

4.3.2 Storage

RefiningNZ has disclosed it:

- has "126 tanks of varying size and type on the refinery site" (2019 Annual Report).
- has "approximately 180 million litres of comingled product storage capacity at Marsden Point" (Terminal Conversion Proposal – Explanatory Booklet – 5 July2021)
- processed a peak 42.7 mmbbls crude oil (6790 mm litres) in 2019 – throughput dropped in 2020 due to Covid (2020 Annual Report)
- "discharges of a typical vessel approximately every five days during peak seasonal demand" (Terminal Conversion Proposal).

Turnover of its 180 million litres of refined product storage capacity is accordingly 38 times annually (or 10 days on average). A map in the Terminal Conversion Proposal shows five areas for refined product storage tanks: 7 tanks being for jet fuel, 10 for diesel and 7 for petrol. (see Sec 8.2.2)

Under ITS: The existing refined product tanks, by our calculation numbering 24, accounting for about 25% of Marsden Point's storage, now store imported product.

RefiningNZ has indicated that building new or converting existing intermediate product tanks may potentially add 100 million litres of product storage, at a cost of some $60 million, by. Most existing tanks are considered unsuitable for conversion.

4.3.3 Quality Testing

RefiningNZ provides onsite laboratory testing services for fuel quality through subsidiary, Independent Petroleum Laboratory Limited (IPL). Note: MBIE regulates maritime fuel standards under the Engine Fuel Specifications Regulations 2011.

Under ITS: IPL is expected to continue providing these services.

4.3.4 Distribution – RAP and TLF

RefiningNZ distributed its customers' refined product through three channels:

- Refinery to Auckland Pipeline (RAP) – 50%. Built with the 1986 expansion, this 170km 250mm diameter, underground pipeline carries diesel, petrol and jet fuel in "batches" to its customers' Wiri

fuel terminal in South Auckland, and from there jet fuel terminal to Auckland Airport. The RAP has carried over 21 mmbbls (3340 mm litres: 2018) in a year.

- Coastal Oil Logistics (COLL) – 47%. COLL was a coastal shipping operation owned by RefiningNZ's customer-shareholders. Pipelines connect refined product storage to Jetty 2 for loading onto COLL's 2 coastal tankers, Kokako and Matuku for distribution to 8 ports around NZ.
- Truck Loading Facility (TLF) – 3%. A short pipeline leads to the perimeter of the Marsden Point complex for loading refined product onto trucks for distribution to Northland.

Under ITS: Channel Infrastructure will handle customer product to serve only the Auckland market (via RAP) and the Northland market (via TLF). COLL has ceased operations, with other ports in NZ now served by direct imports.

5 Ship Fuel - Bunkers

5.1 IMO and MARPOL

Ship bunkers is the generic term for fuel oil used in ship engines. It comes in a wide variety of grades, differentiated by purity, viscosity, volatility and contaminants.

Global awareness of climate change has progressively driven measures to reduce emissions of CO2 and contaminants from the burning of fossil fuels, with policies controlling the use of coal and land transport fuels being widely adopted.

Shipping emitted 1,076 million tonnes of GreenHouse Gases (GHG) in 2020, 2.89% of global anthropogenic emissions . Shipping's share has been growing, as regulation of land transport and industry have tightened, as globalisation has raised demand for sea transport, and given traditional bunkers were very polluting.

Traditional ship bunkers were raw residues from refining, concentrating whatever contaminants were present in the crude oil. This lead the International Maritime Organisation (IMO, a United Nations entity) to introduce MARPOL Annex VI to restrict ship exhaust emissions of CO2 , GHGs and other contaminants. MARPOL VI rules were introduced in stages, initially to emissions in ports and harbours (Sulphur Emission Control Areas – SECAs), where permitted sulphur levels dropped to 1.5% from 2005, 1.0% from 2010 and 0.1% since 2015.

The next stage of MARPOL VI was imposing restrictions on global shipping operations (with IMO rules applying to over 99% of the global shipping fleet), again progressively from 4.5% sulphur from 2005, 3.5% from 2012 and 0.5% since 2020.

MBIE regulates maritime fuel standards in New Zealand under the Engine Fuel Specifications Regulations 2011, while NZ's accession to MARPOL Annex VI is expected in April 2022 (MaritimeNZ).

5.2 Bunker Grades

The common grades of ship bunkers are (with decreasing sulphur levels):

- High sulphur fuel oil (HSFO) – >3.5% sulphur fuel oil. Variants provided the traditional bunker fuels, most being unredacted residues of the refining process, blended to achieve the desired characteristics. The key variants were IFO380 CST and IFO180 CST, where CST refers to centistokes, a measure of kinematic viscosity. Under MARPOL VI regulations introduced in January 2020, HSFOs were no longer compliant with the 0.5% global limit on sulphur and could no longer be used unless the ship was equipped with expensive scrubber technology.
- Very Low Sulphur Fuel Oil (VLSFO). These marine fuels achieve the <0.5% sulphur required to meet MARPOL VI regulations. VLSFO are typically blends, with IMO's ISO 8217 Fuel Standard spanning distillate and residual fuels. The most common distillate grades are DMA marine gas oil (MGO), followed by DMB marine diesel oil (MDO).
- Marine gasoil (MGO) is a distillate product (not a residue), with sulphur content typically <0.1%. Demand for MGO increased in 2015 as SECAs were applied to North American and Northwest European ports, and further in 2020 when <0.5% sulphur was required for ships in transit.

Ship engines are designed for specific bunker fuel characteristics, so adopting a new IMO-compliant fuel may require engine modifications and may result in diminished performance or increased engine wear.

5.3 Bunker Pricing

Ship & Bunker (https://shipandbunker.com) posts prices for grades of ship bunkers and crude oil for numerous world ports, shown below for Singapore.

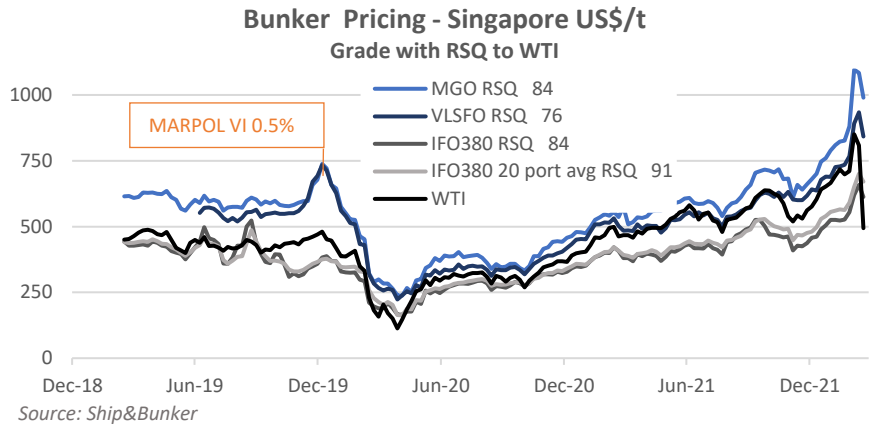


Figure 9: Bunker pricing – Singapore (US dollars per tonne)

Not unexpectedly, bunker fuel prices statistically correlate closely with crude oil prices, represented by West Texas Intermediate (WTI) – see correlation shown.

Bunker prices vary according to grades, with Marine Gas Oil (MGO, <0.1% sulphur), a distillate, priced at the greatest premium to the WTI benchmark. Very Low Sulphur Fuel Oil (VLSFO, <0.5% sulphur) are blends of distillates and residues introduced in mid-2019 in anticipation of MARPOL VI and became mandatory in January 2020. Initially, demand for VLSFO pushed prices up, although the differential to WTI has since fallen as demand broadened and refineries scaled up output. The market for traditional HSFOs such as IFO380, has narrowed sharply, and now sells at a price discount to crude oil.

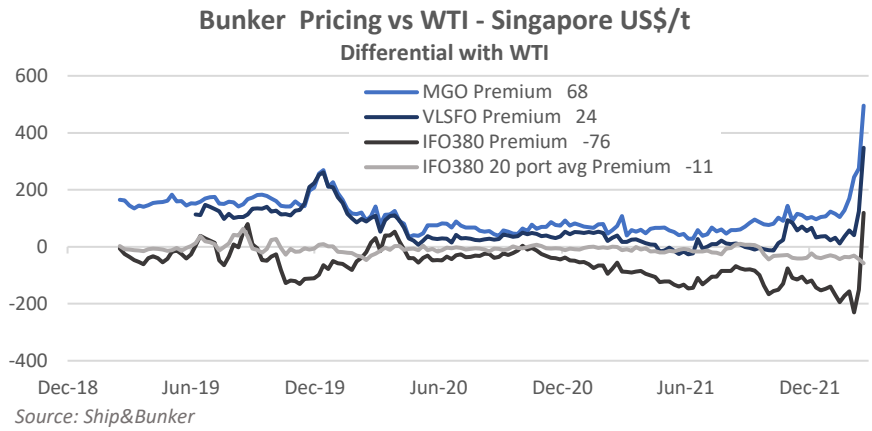


Figure 10: Bunker pricing vs West Texas Intermediate – Singapore (US dollars per tonne)

6 Shipping of Oil and Products

Shipping provides the primary global link between oil field and refinery, and refinery and market. NZ's long history of such trade highlights a wealth of local experience in the mechanics of selecting and buying crude oil and refined petroleum products. Over the last half century NZ has enjoyed an uninterrupted supply of petroleum products, notwithstanding risks posed by various economic and geopolitical storms.

6.1 Global setting

The global cross-border trade in oil (crude oil and refined products) has been growing, exceeding 2 billion metric tonnes since 2017. This has been facilitated by the growing capacity of the global oil tanker fleet, reaching 619 million deadweight tonnage in 2021. Crude oil tankers now account for 29% of global seaborne trade.

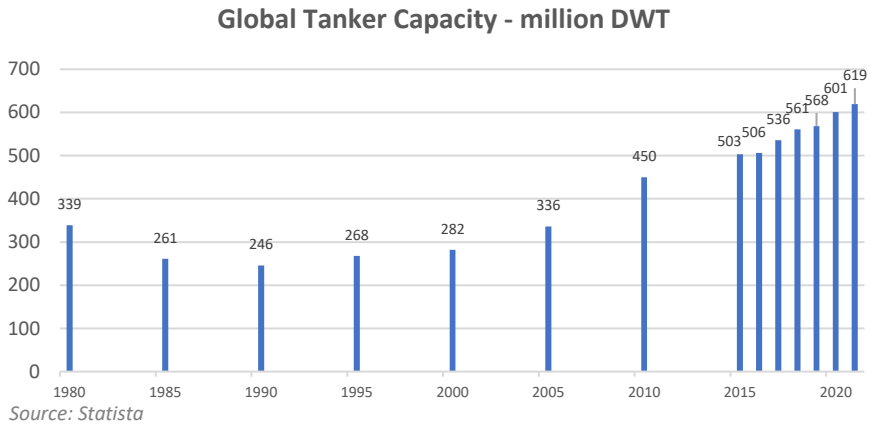


Figure 11: Global tanker capacity

Ships are classified according to their (range of) size, commonly using the Average Freight Rate Assessment (AFRA) system, which groups according to ship dimensions which dictate cargo carrying capacity.

Table 4: Oil tanker classification

Oil Tanker Classification - Average Freight Rate Assessment (AFRA) system

Class	Global Fleet	LOA	Beam	Draft	DWT (000)		Capacity 000 bbls		Product
	#	m	m	m	from	to	from	to	
Ultra Large Crude carrier	ULCC				320	550	2000	3700	Crude Oil
Very Large Crude Carrier	VLCC	810	315	58	29	160	320	1200	2200	Crude Oil
Long Range 2 (Suezmax)	LR2	571	261	48	23.2	80	160	600	1200	Refined or Crude
Aframax	AFRA	668	239	43.8	21	80	120	600	750	Refined or Crude
Long Range 1	LR1		190	32	15	45	80	345	615	Refined or Crude
Medium Range (Panamax	MR		170	32	14	25	45	190	345	Refined Product
General Purpose (Handy)	GP					10	25	70	190	Refined Product
Coastal						3	10			Refined Product

Some seaways are physically restricted to larger ships, hence Suezmax class is the largest ship able to transit the Suez Canal, similarly Panamax with the Panama Canal. The largest oil tankers (Ultra Large Crude carriers ULCC and Very Large Crude Carriers VLCC) operate only in unrestricted waters.

NZ's ports cannot accommodate the world's largest ships. The longest ship to visit NZ was a 348m cruise ship which, given its low draught, was able to visit several NZ ports. The largest by both volume (GT) and

cargo weight (DWT) was an 11,300TEU container ship, able to visit only Tauranga. The largest ship to Northport / Marsden Point was a 110,000dwt oil tanker in 2020.

Table 5: Largest ships

Largest Ships						
	Oil Tanker		**Container**		**Cruise**	
	NZ	World	NZ	World	NZ	World
	Ocean Lady	*Seawise Giant*	*Maersk Antares*	*OOCL Hong Kong*	*Ovation of the Seas*	*Wonder of the Seas*
NZ Port	Marsden Pt		Tauranga		several	
LOA m	245	458	338	400	348	362
GT 000	108	261	110	212	169	236
DWT 000	110	566	122	197	12	17
Draught m	13	24.6	14.1	14.1	8.8	9.3
TEU 000			11.3	21.1		

The age profile of the global tanker fleet emphasises that global economic cycles drive shipbuilding. The surge from 2003 to 2010 (which allowing for a 3-5 year lag between ordering and delivery) preceded the Global Financial Crisis, and surged again since 2016. China and South Korea dominate global ship building.

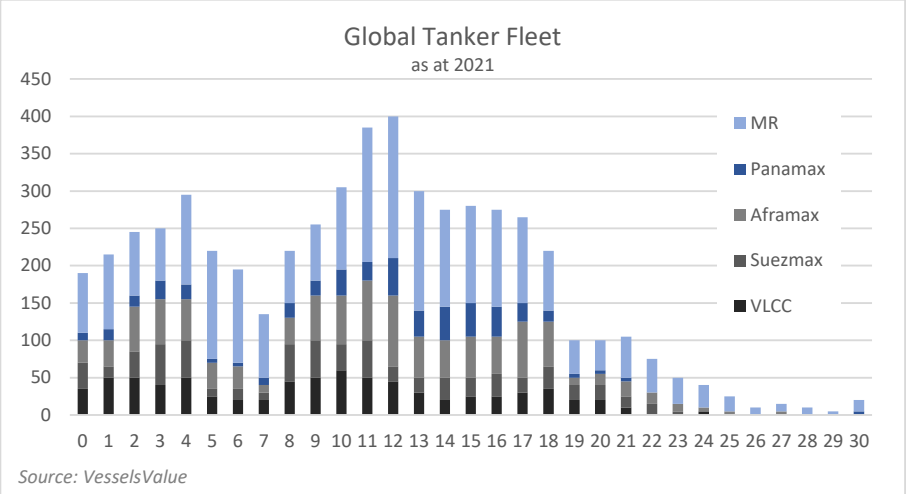


Figure 12: Global tanker fleet

As we have observed (Sec 3), 75% of global crude oil production, over 25 billion bbls annually, is sold across borders. 65% of this trade is by ship, from key producing regions (Middle East, Africa and Latin America) to remote markets (China, India, Asia).

Oil tankers carry crude oil and its various liquid-state by-products; distillates (such as petrol, diesel, jet fuel and light fuel oil) and residues (heavy fuel oil, ship bunkers and bitumen) in separate holds / tanks. Petroleum products which are solid at room temperatures can be heated in storage to ensure they remain liquid. To avoid product cross-contamination, customers require a ship's hold to be certified clean. Cleaning can be achieved either by flushing (with seawater on a ballast voyage – with consequent environmental impacts) or after multiple shipments of an intermediate, lighter product.

Considerations for leasing a ship are price and availability, size and nature of the shipment. Ships may be leased for a fixed time period (years) or a one-off voyage.

6.2 Foreign Ships Visiting Marsden Point

While RefiningNZ's refinery was operating, Marsden Point was the hub of NZ's shipments of crude oil and refined petroleum product, comprising:

- Marsden Point - crude oil imports (RefiningNZ feedstock) – dirty tankers
- Marsden Point - bunker exports (RefiningNZ by-products) and exports of NZ crude oil production – dirty tankers
- Import and export of refined petroleum products - clean tankers

The closure of refining operations will materially alter future shipping flows. Nevertheless, historic shipping patterns provide valuable insights into the character, availability, and resilience of petroleum tanker shipping.

Our analysis is based on public information, particularly the online record of ship visits to various NZ ports. Principal of these is Northport, which provides an extended record of all ship visits, helpfully breaking out those to jetties at the Marsden Point refinery, along with a description of cargo being discharged or loaded. Our analysis is based on this record across the full 9 years of data (May 2013 to March 2022) and is taken to be accurate.

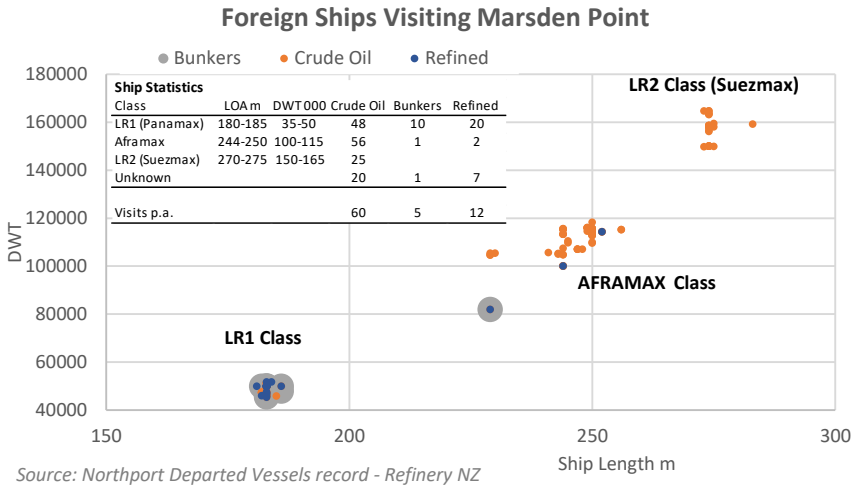
6.2.1 Marsden Point - crude oil imports

While the refinery was operating, the principal oil shipping task was importing crude oil into Marsden Point as refinery feedstock. Shipping economics encourage the use of largest practical ships to lower unit costs, although ship size is constrained by port infrastructure. Constraints are the port's channel (dimensions and draft), wharf/jetty structures, and the availability of adequate crude oil storage to fully accommodate the ship's cargo.

Northport's shipping database for crude oil deliveries to Marsden Point refinery spans the period May 2013 until March 2022. For visiting ships over the last 2.5 years (August 2019 to March 2022), we have supplemented that data with details of ships (size, capacity, age from www.marinetraffic.com and www.vesselfinder.com).

These datasets show:

- 607 ship visits delivered crude oil from foreign ports over 9 years, averaging 68 visits annually.
- Since August 2019, half of the 149 crude oil ships were mid-sized Aframax class ships, and a third were the larger LR2 (Suezmax) class. Note: a loaded LR2 ship would exceed to length and/or draft capacities of any other NZ port.
- RefiningNZ typically received 40 mmbls annually, indicating on average these ships each deliver 600,000 bbls. This is close to the estimated average hold capacity of visiting ships (650,000 bbls), suggesting they are making dedicated full deliveries of crude oil to NZ.
- Of the 607 ship visits over 9 years, 301 made only a single delivery, while 53 others made only 2 visits. Of those 306 ships making multiple visits (over 9 years), the median time between visits was over 300 days (noting that a return voyage to Middle East would take just 50 days). This strongly suggests that each ship visit is contracted on a spot basis rather than being chartered for multiple voyages, and highlights the confidence of refinery customers in the security and resilience of the ship spot market.
- Ship arrivals at Marsden Point were notably regular, with the time between crude tanker visits averaging just 5 days, and time in port discharging being 2 days. This further attests to the reliability of shipping.
- The covid pandemic has clearly affected domestic demand for petroleum products, and accounted for the longest interval between ship visits (41 days, from 16 April to 27 May 2020, although services thereafter returned to the regular pattern).



Source: Northport Departed Vessels record - Refinery NZ

Figure 13: Foreign ships visiting Marsden Point

Table 6: Marsden Point crude oil tanker visit frequency

Marsden Point Crude Oil Tanker Visit Frequency

	All Ships	LR1	LR2
	May2013 to curr	Aug2019 to curr	Aug2019 to curr
Count	607	59	90
Median - days	4.5	9.5	7.9
Average - days	5.3	15.5	10.3
Maximum - days	41.1	61.4	92.8
Minimum - days	0.0	0.5	0.2
Std Deviation - days	4.2	16.1	11.3
Time in Port - days	2.1	2.0	2.3

We have a wealth of data on ship visits to Marsden Point. However, we lack information on how ships are contracted for each voyage, or whether scheduled date match actual dates (was the ship delayed). We also lack information of where the ships came from (the port where the crude oil shipment was loaded) or went (destination port). What we can safely conclude from the regularity of time between ship arrivals is that shipping services appear very reliable.

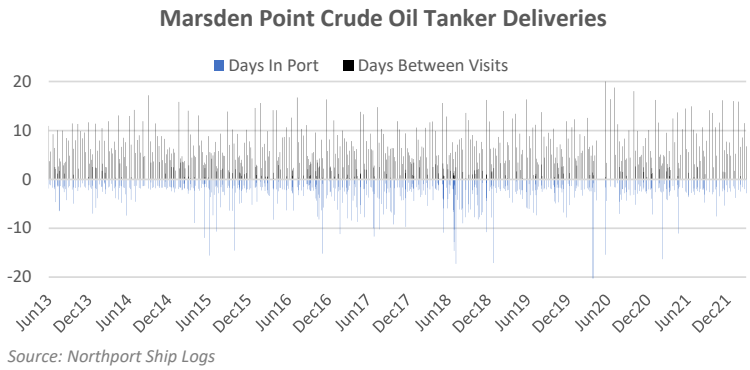


Figure 14: Marsden Point crude oil tanker deliveries

6.2.2 Marsden Point – bunker exports

As previously observed (Sec 5.2), NZ's domestic demand for fuel oil (bunkers), having peaked in 1975, halved by 1985 (principally being displaced by natural gas), and has since been flat. The crude oil feedstocks that the refinery processes yield a higher output of residues (fuel oil, bunker fuels) than required to meet domestic demand, with the difference being exported.

Excess fuel oil was exported, to bunker foreign ships in NZ or by direct export.

- Of the 46 foreign bunker ship visits to Marsden Point over 9 years, only 7 arrived from a domestic port (all from New Plymouth), and 9 departed to a domestic port (of which 6 were to New Plymouth).
- 27 of those 46 bunker ship visits over 9 years were repeat visits. The charter pattern did not suggest anything other than spot charters.
- Marsden Point's bunker ship visits were almost all smaller LR1 class.
- Notes:
- New Plymouth is the hub of all domestic oil and gas production, with almost all domestic crude oil exported for refining. Ships importing crude oil are readily able to backhaul both domestic crude oil and excess fuel oil.
- RefiningNZ historically produced up to 120,000 tonnes per year of bitumen, a solid refinery residue, meeting some 65% of NZ's demand. Weaker demand for oil products post-Covid saw RefiningNZ reduce production and cease sales of bitumen. With subsequent closure of the refinery, all bitumen must now be imported.

6.2.3 Marsden Point – unloading and loading refined oil products

9 years of Northport data showed Marsden Point jetties received foreign ships carrying petroleum products.

- 158 foreign ships (17 annually) were loaded with "refined oil product". None apparently imported refined oil product ("coals to Newcastle")
- 88 of these ships (10 annually) arrived at Marsden Point from and departed to foreign ports.
- 22 arrived from a NZ port (then departed offshore), while 34 others, having arrived from an offshore port, departed to a NZ port. 8 arrived from and departed to a NZ port.
- Of these 158 port calls by foreign ships over that 9 years, 52 ships were making repeat visits. One ship visited 12 times, another 9, another 7.
- These ships were almost exclusively LR1 class or smaller.

6.3 Coastal Movements of Oil Products

The half of the Marsden Point refinery output not delivered to Auckland via the RAP pipeline has been shipped to other NZ ports by 2 ship operators; Coastal Oil Logistics Ltd (COLL) operating Matuku and Kokako, while Seafuels operated the smaller Awanuia.

Table 7: New Zealand oil tankers

NZ Coastal Oil Tankers

	Coastal Oil Logistics		Bunker Shipz
	Matuku	Kokako	Awanuia
Class	LR1	LR1	
LOA	183.01	183.01	79.9
DWT	50143	49218	4014
GT	29735	29470	2747
Beam	32.23	32	15
Draft	8.3	9.8	7.32
Capacity 000 bbls	314	314	26
Year	2016	2017	2009
Owner	ASP marine	ASP marine	Port Auckland
Value	27.5m	31.1	

6.3.1 Coastal Oil Logistics Ltd (COLL)

RefiningNZ's customer-shareholders (bp, Mobil and Z Energy) collectively own Coastal Oil Logistics Ltd (COLL). COLL leases 2 ships from Silver Ferns Shipping (ASP Marine), being the Kokako and Matuku, which distribute to 8 NZ ports.

- COLL (Silver Fern Shipping) made 617 visits to Marsden Point over 9 years (35 annual voyages per ship), all to and from domestic ports.
- Matuku replaced Torea in 2016. Kokako replaced Kakariki in 2018.
- Both Kokako and Matuku recorded a median port time (at Marsden Point) of 1.6-1.7 days, while the time away (delivering to multiple ports on most voyages) was 7.8 days and 9.6 days respectively.

Each voyage route varied depending on the petroleum needs in each port / region, with some differences between the two COLL ships. Kokako returns most frequently from Dunedin, then Nelson, and departs mostly for Lyttelton, Tauranga and Napier. Matuku returns most frequently from Dunedin, then departs for Lyttelton then Wellington, is voyages being longer (10 days vs 8 days for Kokako). We have only an incomplete picture of COLL's intermediate port visits, typically 2 ports per voyage, incurring 1.0 days per port. The ships were presumed to depart Marsden Point full of multiple product grades, and return empty.

As part of the RefiningNZ restructure, COLL is ceasing shipping operations on 1 April 2022, and will terminate its leases for the Kokako and Matuku.

Table 8: COLL Marsden Point Visits 2019-2022

COLL Marsden Point Visits Sep-19 to Mar2022

	Kokako		Matuku	
	Time in Port (days)	Time Away	Time in Port	Time Away
days	1.58	7.83	1.67	9.63
Trips per Year	Visits #		Visits #	
	from	to	from	to
Auckland	1	2	1	3
Tauranga	13	23	5	7
Napier	3	22	2	7
New Plymouth			10	2
Wellington	6	1	8	14
Nelson	21	0	12	0
Lyttelton	5	28	0	18
Timaru	3	3	5	5
Dunedin	23	0	19	0
Bluff	3	2	3	7

6.3.2 Bunker Shipz

Ports of Auckland owns Bunker Shipz, which in turn owns the Awanuia. Awanuia is a small tanker operated since 2009 by Seafuels, a company which Ports of Auckland jointly owns with Pacific Basins Ships.

Awanuia operates exclusively between Marsden Point and Auckland. At 80m LOA, it has hold capacity of 2,900 tonnes of fuel oil (previously IFI380, now VLSFO) and 600 tonnes of marine gas oil (MGO, a distillate product similar to diesel). These are delivered directly to ships berthed in Auckland harbour.

Northport's Marsden Point data shows:

- Bunker Shipz Awanuia made for 378 visits to Marsden Point since 2013.
- Awanuia loaded only fuel oil and MGO at Marsden Point and did not apparently backhaul any product.
- Awanuia averaged 36 voyages annually, with median time at Marsden Point of 0.65 days, and average time away of 5.86 days.
- As the following chart shows, the time loading at Marsden Point is very consistent, with 96% visits being in port for less than a day.
- The voyage times varied, with 90% shorter than 17 days. A third of voyages were less than 5 days, suggesting longer trips ex-Marsden Point involved dwell/waiting time in Auckland, Awanuia's home port.
- Awanuia was under long-term charter to Z-Energy until inadequate returns saw that cancelled in 2021. In May 2021, bp contracted to use Awanuia to deliver VLSFO and MGO to ships in Auckland port. Records suggest Awanuia continues (May 2022) to operate to Marsden Point.

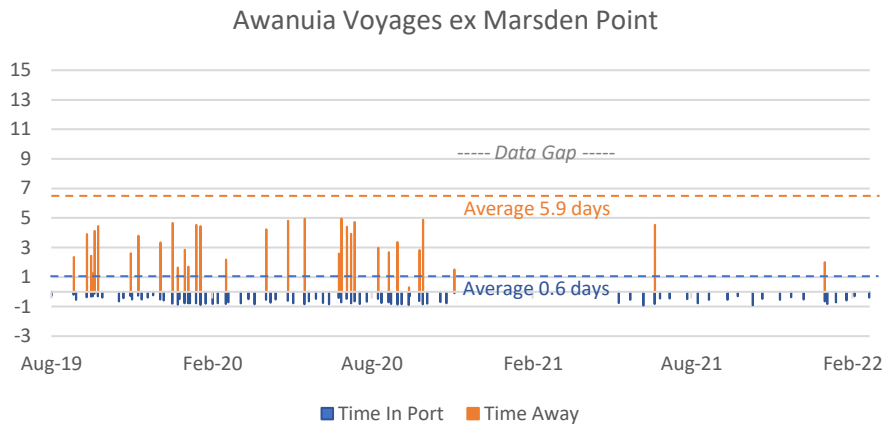


Figure 15: Awanuia voyages ex Marsden Point

6.3.3 Government data

Te Manatū Waka's "FIGS" publication provides domestic petroleum product delivery volumes to each port, helping fill gaps in Northport's coastal (COLL) shipping schedules.

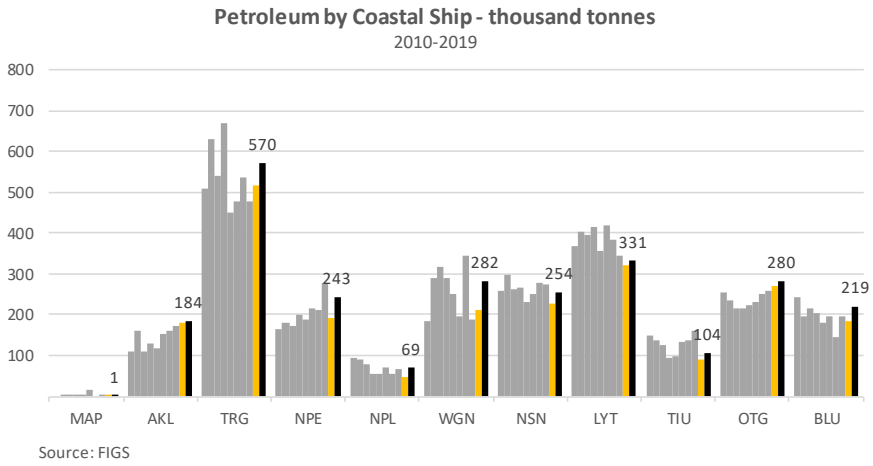


Figure 16: Petroleum by Coastal Ship

COLL delivers to 8 NZ ports, according to demand at each port/region, and does not follow a regular schedule

The volume delivered to each port will vary by visit, although broadly that volume will correspond to the number of ship visits.

MBIE's "Energy In NZ" annual publication monitors energy flows across all markets (oil, gas, renewables, electricity, coal and transport). This provides key data on the flows of oil products. The Energy Supply and Demand balance tracks all energy inputs into Primary Energy, then domestic transformation into energy products consumed in NZ. The following table breaks out only the oil components.

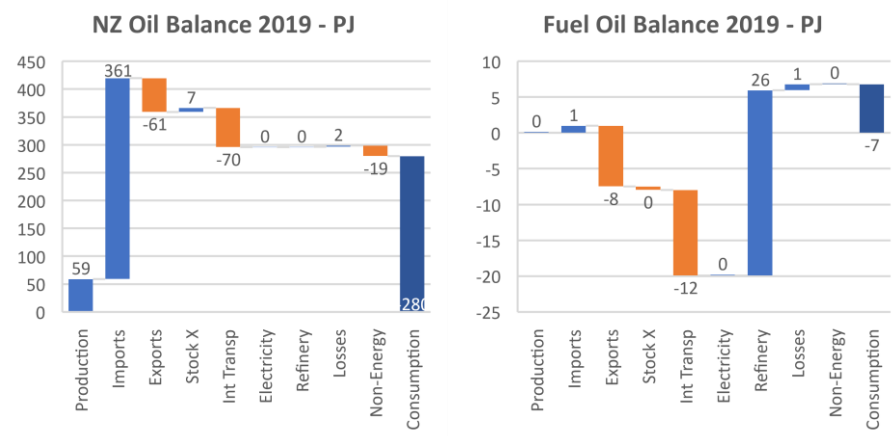


Figure 17: NZ oil and fuel balances in 2019

Table 9: New Zealand Energy supply and demand balance – oil

NZ Energy Supply and Demand Balance - OIL - Peta Joules (PJ)								
2019	**Crude Oil**	**LPG**	**Petrol**	**Diesel**	**Fuel Oil**	**AvGas**	**Other**	**Total**
Production	51	8						59
Imports	236	1	42	58	1	9	14	361
Exports	51			1	8			61
Stock Change	-11	0	2	2	0	0	-1	-7
Intl Transport				2	12	56		70
Primary Energy	**247**	**9**	**40**	**52**	**-20**	**-47**	**14**	**296**
Transformation	**-249**	**0**	**70**	**88**	**27**	**62**	**6**	**3**
Electricity				0				0
Cogeneration								0
Fuel	-249		67	88	26	62	8	0
Other								0
Losses			3	1	1	0	-2	2
Non-Energy							-19	-19
Consumption	**-2**	**9**	**110**	**140**	**7**	**14**	**1**	**280**

Key observations from NZ's 2019 (pre-Covid) Energy Balance for Oil are:

- Oil: Domestic oil production 59PJ was exported 61PJ. International Transport used 70PJ, while non-energy use (bitumen) was 19PJ. The refinery converts imported crude oil into various petroleum products with <1% loss. NZ consumed 280PJ of oil (net).
- Fuel Oil: The refinery produced 26PJ. NZ imported 1PJ while exporting 8PJ. International Transport used 12PJ. NZ consumed 7PJ of fuel oil (net).
- The "Energy in NZ" report also tracks flows of petroleum products (diesel, petrol and jet fuel) into NZ "ports". We observe:
- Port offtakes for Auckland and Whangarei are ex-Marsden Point refinery (via RAP pipeline and TLF truck respectively).
- Offtakes at ports are consistent with regional populations. The MoT FIGS chart above shows only petroleum product on coastal ship (COLL).
- Auckland receives 80% of Jet Fuel.

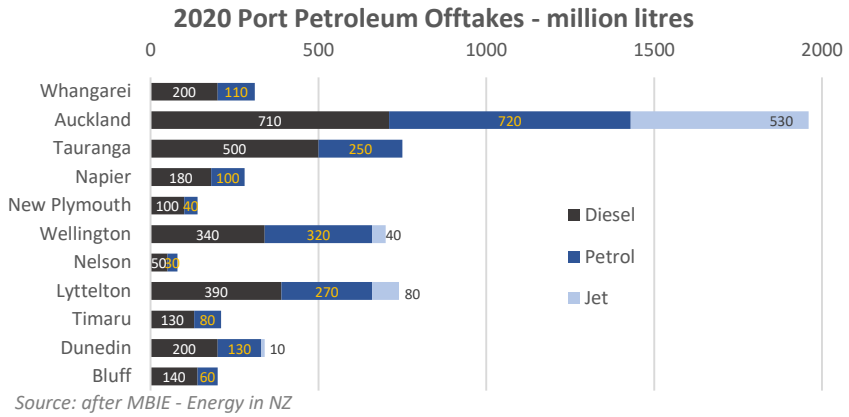


Figure 18: Port petroleum off-takes in 2020

6.4 Direct Imports of Oil Products

With rising domestic demand and fixed refinery output, NZ ports have been receiving increasing volumes of petroleum product by direct import on foreign ships. As with COLL schedules (but only more so), these ships make regular visits to multiple ports, but not apparently on any fixed schedule.

The imports are overwhelmingly arranged by the major fuel retailers, and sole customers of RefiningNZ, bp, Mobil and Z Energy. These imports will be closely co-ordinated with their RefiningNZ output and resultant COLL shipments. The key imports are covering shortfalls in petrol (in various grades) and diesel (Sec 5.2).

6.4.1 Domestic Ports

The public data available for ship visits to other NZ ports is generally more time restricted than the 9 years available from Northport. Wellington provides 2 years data, while some ports maintain just a week of data. Nevertheless, these records do describe a pattern of movements, identify the ships, and usually the cargo.

Our sample of 171 domestic port visits is summarised below.

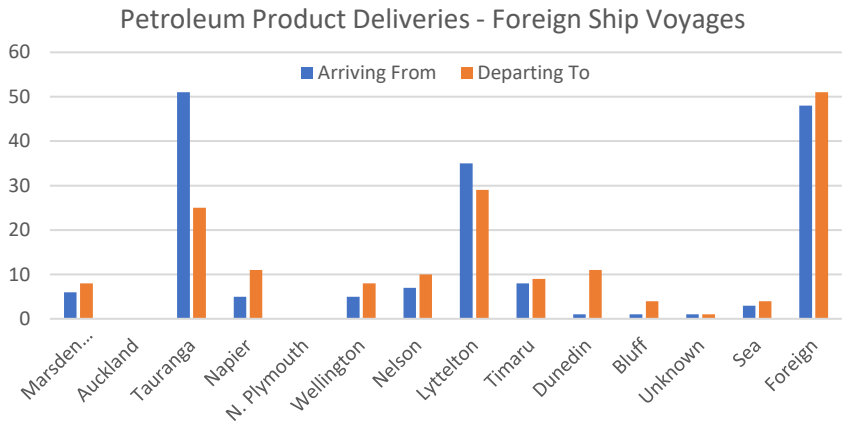


Figure 19: Petroleum product deliveries – foreign ship voyages

We observe:

- The data is biased towards those ports which post the longest shipping record, notably Wellington with 103 entries. (Marsden Point is not considered given it almost exclusively recorded COLL voyages).
- Domestic port records of direct arrivals from and departures directly to a foreign port account for 34% and 37% respectively of these visits. This implies that those visiting foreign ships on average visit 2 NZ domestic ports on each voyage.
- Tauranga is the most frequent "previous port" (ships arriving from), followed by Lyttelton. Similarly, Lyttelton and Tauranga were the most frequent "next port" (ships departing to). This is consistent with the regional population (correlating with petroleum consumption) and Te Manatū Waka FIGS data.

There appears to be no formal convention on how ports categorise petroleum product imports (and exports) passing over their wharves. The generic term is "petroleum" but some ports label the cargo "fuel" or "oil products". Products beyond petrol and diesel are mentioned at some ports: methanol (as recorded in Nelson), LPG (Lyttelton) and bitumen (Tauranga). New Plymouth, serving NZ's only oil producing province, lists "petrochemicals (Methanex export its methanol).

A Case Study

As an example of a recent (if more complex) voyage of a petroleum ship, the Axios visited 5 NZ ports during February 2022

Table 10: Axios voyage

***Axios* Voyage**

Port	Arrives	Departs	Hrs In Port	Cargo
overseas port				
Tauranga				
New Plymouth	23/02/2022 6:12	24/02/2022 3:26	21.2	Petrochemicals
Wellington	24/02/2022 0:42	25/02/2022 22:12	45.5	Petroleum
Lyttelton	26/02/2022 3:52	27/02/2022 12:13	32.3	Petroleum
Marsden Point	2/03/2022 9:00	3/03/2022 9:00	24.0	Bunkers
overseas port				

While these tankers can carry multiple products, we expect the variations in stated "cargo" reflect different port labelling conventions.

- New Plymouth loaded methanol for export and may receive petroleum product. Nelson often labels petroleum shipments as petrochemicals.
- In Wellington, tankers often visit both Seaview (petrol and diesel) and Burnham (aviation fuel), accounting for longer time in port.
- Axios' last call was Marsden Point where, with holds empty (other than the methanol) it was loaded with bunkers for export.
- Other ports would have received (various grades of) petroleum product.

6.4.2 Petroleum Import Ships

The selection of ship size will balance import demand with optimal service frequency. Larger ships offer scale economies, but this is balanced against less frequent deliveries, so requiring greater domestic storage, and better port infrastructure (channel draft and berth ratings).

The petroleum product carriers (tankers) chosen by domestic retailers were almost exclusively LR1 class ships (183m, 50,000dwt), notably the same as size as COLL's Matuku and Kokako undertaking coastal deliveries. The exceptions, smaller ships, were typically carrying other products (LPG, methanol, bitumen).

NZ receives its petroleum deliveries on a fleet of modern, safe ships. COLL's ships Matuku and Kokako were built in 2016 in 2017 respectively. Similarly, the average age of visiting petroleum tankers is 2015 (the oldest being 2005).

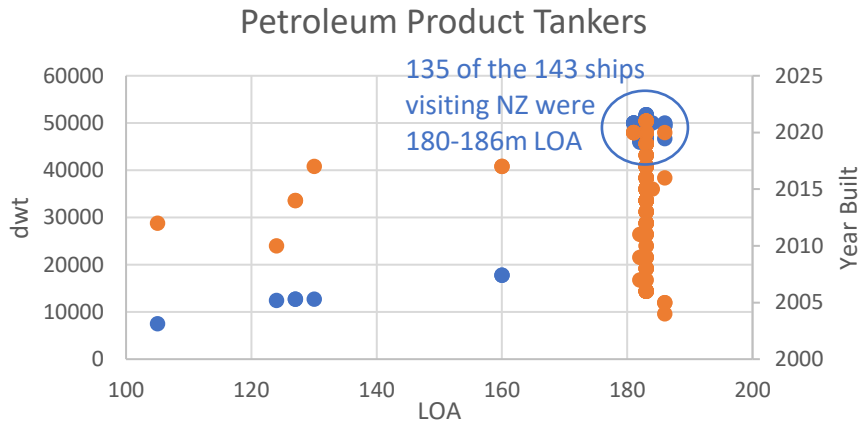


Figure 20: Petroleum product tankers

6.4.3 Import Model Voyages

Voyage distances from foreign refineries to NZ's ports are clearly longer than those from Marsden Point. The observed round trip for COLL ships ex Marsden Point is 12 days, delivering product to 2 or 3 ports, then reloading (and perhaps waiting). The incremental round-trip voyage duration would be 35 days ex Singapore and 36 days ex-Korea. Assuming equivalent port time,

Table 11: Voyage distances

Voyage Distances

	Voyage nm			Voyage days (at 12 kts)		
to \ from	Marsden Pt	Singapore	S. Korea	Marsden Pt	Singapore	S. Korea
Marsden Point		5102	5263		17.7	18.3
Auckland	84	5092	5307	0.3	17.7	18.4
Tauranga	157	5218	5379	0.5	18.1	18.7
Napier	391	5454	5611	1.4	18.9	19.5
Wellington	611	5312	5533	2.1	18.4	19.2
N. Plymouth	464	5151	5359	1.6	17.9	18.6
Nelson	581	5248	5469	2.0	18.2	19.0
Lyttelton	689	5463	5683	2.4	19.0	19.7
Timaru	775	5395	5761	2.7	18.7	20.0
Dunedin	853	5325	5829	3.0	18.5	20.2
Bluff	968	5210	5944	3.4	18.1	20.6

On an import-only model, refined petroleum product will principally be sourced from South Korea (40% of imports in 2020, 30% in 2019) or Singapore (39% and 53%). The incremental round trip travel time relative to Marsden Point would be 34 days to 40 days. Port time would be unchanged.

6.5 Outlook for Importing Oil Products

RefiningNZ, by moving to an import only model, will materially alter the configuration of NZ's petroleum shipments. The abundance of observations of past shipping movements allows us to anticipate what changes may unfold.

The two elements considered are import of petroleum product to Marsden Point, and directly to other NZ ports.

6.5.1 Product import to Marsden Point

Refined petroleum products destined for the Auckland market will be imported by clean product tanker into Marsden Point and unloaded into existing product tanks. Channel Infrastructure will serve the Auckland and Northland markets utilising existing infrastructure, the Refinery-Auckland Pipeline (RAP, capacity of 21 mmbbls) and the Truck Loading Facility (TLF). Batches of refined product (petrol, diesel and aviation fuel) will be sent via RAP, scheduled to optimise tank storage at both Marsden Point, Wiri and Auckland airport.

Northport shipping records confirm that Marsden Point can readily receive ships both Aframax and the larger Long Range 2 (LR2) class ships. The LR2 is considered the largest tanker suitable for transporting clean liquid-state petroleum products such as petrol, diesel and jet fuel. Marsden Point's median crude tanker was 245m and 110,000 dwt, an LR2 class, giving capacity to carry up to 0.7 mmbbls (120 million litres).

LR2. Auckland and Northland could be served by just 25 LR2 voyages annually (a delivery every 14 days). While there is a unit cost advantage employing larger LR2 ships, these raise key logistical issues.

Assuming the Auckland market to be 3,200 million litres (20 mmbbls):

- Marsden Point's existing product tanks (180 million litres) would meet 18 days demand in Auckland. Each LR2 tanker shipment would occupy 70% of Marsden Points existing storage. On a 14 day delivery cycle, tank storage would need to be run down to just 6 days of Auckland demand to accommodate an LR2 delivery.).
- On the basis the additional 100 million litres of storage is commissioned at Marsden Point, the tanks would meet 11 days demand from Auckland. Each LR2 tanker shipment would occupy 45% of Marsden Points expanded storage. On a 14 day LR2 delivery cycle, tank storage would need to be run down to 11 days of Auckland's demand.
- Note: these calculations exclude an estimated 130 million litres of existing product storage at Wiri.
- Importing on LR2 tankers requires product storage at Marsden Point to be run below prudent levels required to ensure supply resilience in event of an unplanned events (such as a ship delay). Since demolition of Wynyard storage tanks, Ports of Auckland no longer has the capacity to receive product delivery by ship.
- LR1. The median size product tanker serving Marsden Point and 8 other NZ ports was LR1 class (183m and 50,000 dwt, giving capacity to carry up to 0.35 mmbbls).
- 60 LR1 voyages annually would be required to meet Auckland's current demand (a delivery every 6.5 days). Each shipment would occupy 31% of Marsden points current storage (20% after expansion). To accommodate a full shipment, storage would need to fall to 70% (80% with expansion) of storage capacity, ensuring there was always 14 days (16 days) supply.

Table 12: Marsden Point shipping requirements

Marsden Point Shipping Requirement

			Current	Expanded
Auckland Annual Demand		mml bbls	20	20
Marsden Point Storage		mm litres	180	280
		mmbbls	1.13	1.76
		days storage	17.7	11.4
		mmbbls	20	20
		days	21	32
Ship Class	LR2	mmbbls	0.8	0.8
		% MP Storage	71%	45%
		% Auckland demand	4%	4%
		Voyages p.a.	25	25
	LR1	mmbbls	0.35	0.35
	days	% MP Storage	31%	20%
	LR1	% Auckland demand	2%	2%
		Voyages p.a.	57	57

LR1 ships would raise reliability of petroleum product supply to Auckland. Refinery customers, bp, Mobil and Z Energy, would achieve the most regular deliveries by sharing delivery ships, although with the anticipated frequency of visits, chartering individually would not appear to diminish resilience.

6.5.2 Product Import to Other NZ Ports

NZ has already been receiving 40% of its refined petroleum products through direct import shipments into 8 regional ports: Tauranga, Napier, Wellington, Nelson, Lyttelton, Timaru, Dunedin and Bluff. The closure of RefiningNZ's refining operations will not influence the volume or type of products these ports receive, but simply that all future deliveries will be direct imports.

Each of these ports has developed specific infrastructure to handle petroleum shipments. Some, such as channel and harbour, are shared with all visiting ships. Petroleum shipments will all be received at one nominated wharf, although other cargos may also use that wharf. Infrastructure behind the wharf face, being pipelines and tank storage, will likely be owned by the fuel retailers. For safety reasons, petroleum storage may be locate remote from port and other activities.

The 8 regional ports have been receiving petroleum product predominantly in LR1 ships; by COLL ex-Marsden Point, and by direct import. These appear well-matched to demand for petroleum product from each port's hinterland, and the ports' existing infrastructure (channel and berth draft, wharf length, and tank storage). It seems unlikely that other ship classes would be considered.

Shipping records confirm that both COLL and foreign ships made multiple (2-4) port calls on each voyage [COLL's website mentioned 50 voyages and 200 port calls annually]. Multiple port calls is most likely to be the pattern for future voyages.

MBIE reports provide port petroleum offtakes (corroborated by other sources). Based on Rockpoint's assessment of petroleum storage capacity at each port (Sec 8.2), we observe demand averages 4.7x existing storage tank capacity – 11 weeks – (noting Lyttleton's storage capacity may be overstated).

MBIE's port terminal storage capacity data shows the 9 regional ports having 547 million litres capacity. Based on MBIE's regional demand (table following), storage turnover of 6.3 time annually (or 58 days) which seems reasonable. It also seems reasonable to assume continued use of LR1 class tankers (0.5 mmbbls / 80 million litre hold capacity) for future petroleum product imports. LR1 capacity suggests 43 voyages would be required to deliver NZ's annual demand (ex-Auckland). However, the load capacity of LR1 ships is high relative to some port's demand. Nelson's annual demand, for example, could nominally be met with a single annual delivery – excepting that it exceeds available storage by 3x. Even assuming an LR1 tanker delivered only 1/3 of its load capacity, that would exceed storage at New Plymouth and Nelson, and more than 60% at all but Tauranga, Wellington and Lyttelton.

Table 13: Import ship modelling

Import Ship Modelling

	Regional Demand				Storage	*Turnover*		Port Visits per voyage			
mm litres	Petrol	Jet	Diesel	Total	at port	*x*	*days*	One	*%Storage*	Three	*%Storage*
Whangarei	*110*		*200*	*310*							
Auckland	*720*	*520*	*710*	*1950*							
Tauranga	250		500	750	162	*4.6*	*79*	9	*49%*	28	*16%*
Napier	100		180	280	34	*8.3*	*44*	4	*236%*	11	*79%*
New Plymouth	30		100	130	19	*6.8*	*53*	2	*418%*	5	*139%*
Wellington	320	40	340	700	127	*5.5*	*66*	9	*63%*	26	*21%*
Nelson	30		50	80	25	*3.1*	*116*	1	*313%*	3	*104%*
Lyttelton	270	80	390	740	74	*10.1*	*36*	9	*108%*	28	*36%*
Timaru	80		130	210	39	*5.5*	*67*	3	*206%*	8	*69%*
Dunedin	130	10	200	340	40	*8.5*	*43*	4	*198%*	13	*66%*
Bluff	60		140	200	28	*7.1*	*51*	3	*284%*	8	*95%*
Total (ex Akld)	1270	130	2030	3430	547	*6.3*	*58*	43		129	

Further modelling of deliveries is necessary to balance demand, storage, and ship capacity. Assuming an average of 3 port calls per voyage, the calculated 129 voyages could be appropriately spread across ports (this comparing with ~150 port calls by COLL). It is reasonable to assume each port will receive multiple (at least 5, likely 10) deliveries annually, with the key ports of Tauranga, Wellington and Lyttelton visited on most voyages.

Moving to an import-only petroleum supply model will not materially change the number or size of ships visiting NZ ports nor the products being discharged (excepting for Marsden Point where larger LR1 and AFRAMAX crude oil carriers will be replaced by more, smaller LR2 product tankers). However, harbourmasters and MaritimeNZ may wish to review the substitution of domestic ships (COLL's Matuku and Kokako, whose crews are familiar with NZ waters and ports) with foreign ships making one-off voyages. Similarly, foreign ships may trigger a review of Marine Pollution Response Service and regional council spill response plans

7 NZ Oil Storage

Supply and demand of petroleum products are separated both geographically and in time. Storage (and transport) is required to bridge these gaps. Historically, most of NZ's storage has been in the form of crude oil, imported to and stored in RefiningNZ's tanks at Marsden Point. Refined product accounts for about a third of RefiningNZ's storage, while customers have their own product storage tanks at various ports around NZ. The move to an import-only supply of refined products will accordingly materially lower available storage in NZ.

Crude oil and petroleum storage tanks are typically thin wall (sometimes double-skinned) low pressure cylindrical containers, constructed consistent with API design standards. Most are fixed roof design, suitable for storing high flash-point liquids (diesel, jet fuel, fuel oil, and bitumen). Floating roof tanks are suitable for high volatility petroleum products (such as petrol and crude oil) to reduce evaporation and avoid build-up of flammable vapours. Tanks must be contained within bund walls sufficient to contain the stored volume of a ruptured tank.

7.1 NZ Strategic Oil Reserve

NZ, as a Member of the International Energy Agency (IEA), is obliged to hold emergency oil stocks equivalent to at least 90 days of net oil imports . In event of a severe oil supply disruption, the Minister may require oil stocks to be released to the market, usually in conjunction with various demand-constraint measures. NZ's legislative framework comprises the International Energy Agreement Act 1976 and the Petroleum Demand Restraint Act 1981, with provisions also in Crown Minerals Act 1991 and the Civil Defence Emergency Management Act 2002.

Petroleum industry participants, as part of conducting their normal commercial operations, produce, acquire, store, distribute and supply petroleum products. To the extent these stocks do not meet IEAs 90 days, the NZ Government buys the balance as contracts (tickets) with foreign counterparties.

NZ's emergency oil stocks, as MBIE reports monthly to the IEA, have averaged 97 days since 2015, and fallen below 90 days in only 3 months. NZ industry participants hold 65% of this as physical stock in the country, as crude oil at Marsden Point and New Plymouth, and refined product in various storage facilities.

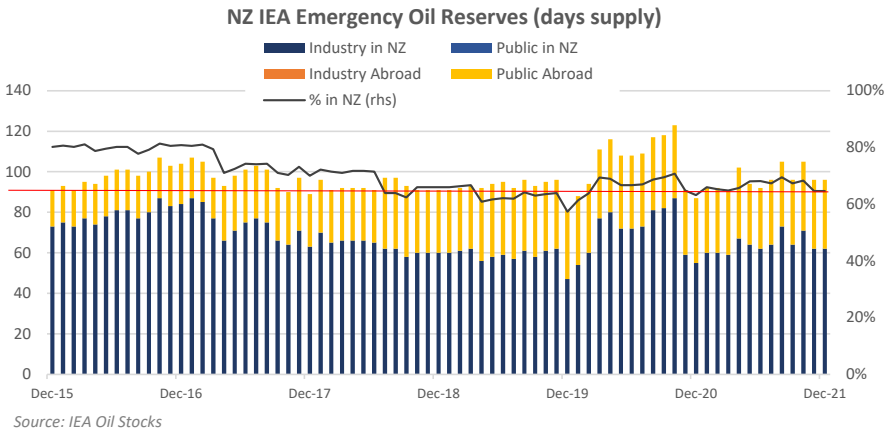


Figure 21: NZ IEA emergency oil reserves (days supply)

While complying with IEA guidelines, NZ falls well behind the 160-day average of the 32 oil-importing countries in the IEA database. The average IEA country holds 90% as physical stock held domestically, against NZ at 65%. Only Luxenbourg holds less than NZ. Regarding offshore stocks, NZ's 35% is held as "tickets" (contracts for supply entered in to by the Government with "public parties"). The average of 10% held offshore by other countries is principally held by industry players as physical stock. https://www.iea.org/articles/oil-stocks-of-iea-countries

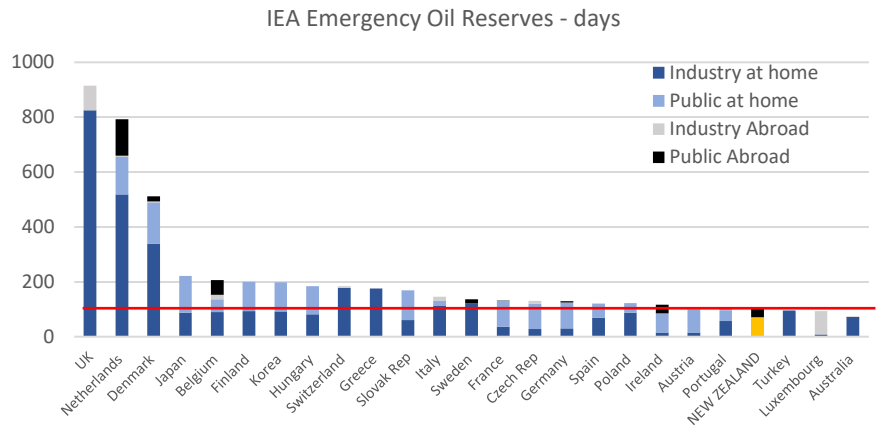
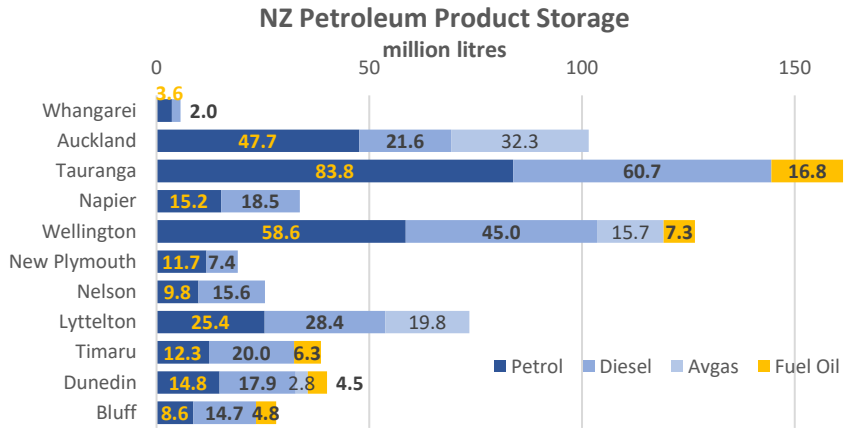


Figure 22: IEA emergency oil reserves (days)

7.2 NZ Storage Capacity

7.2.1 MBIE data for IEA

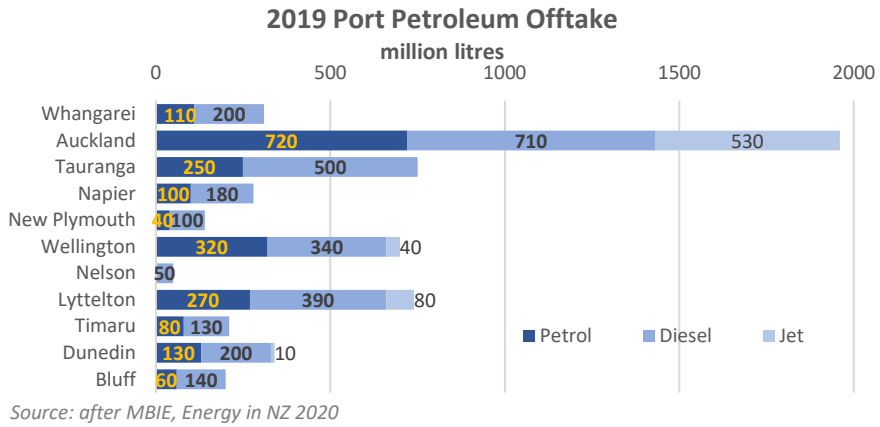
MBIE publishes annual its "Energy In New Zealand" report. Prior to 2018 this included net oil storage data by port, provided by the fuel retailers, as part of its monthly submissions to IEA – these breakdowns are no longer provided. In 2018, recorded year-end (spot) storage of refined petroleum products (excluding bitumen) at 654 million litres (547 million litres excluding Auckland and Northland). We note this data excludes Marsden Point storage.



Source: MBIE 2018 records for IEA

Figure 23: NZ Petroleum product storage

MBIE's Energy in NZ 2020 also provides 2019 port petroleum product offtakes.



Source: after MBIE, Energy in NZ 2020

Figure 24: Port petroleum off-take in 2019

We observe:

- MBIE product storage dataset does not include Marsden Point which materially supplement storage for NZ's largest market, Auckland.
- Port offtakes correspond to regional population, noting there are some inter-regional overland movements of petroleum product.
- While the data is noisy, indicated storage turnover is around 9x annually.
- Only 3 ports (terminal locations) show storage of fuel oil. Tauranga and Bluff record Heavy Fuel Oil (typically used for ship bunkers), while Wellington, Timaru and Dunedin recorded Light Fuel Oil (for ship bunkers and industrial use).

The Government has recently consulted on onshore fuel stockholding policy options in light of the shift to full reliance on fuel imports through MBIE's Onshore Fuel Stockholding consultation paper. Its Summary of Proposals states:

"We propose requiring a minimum onshore fuel stockholding level similar to that proposed in Australia, namely 28 days of cover for diesel and its biofuels equivalent, and 24 days of cover for other liquid transport fuels (namely petrol and jet fuel)"

MBIE would place stockholding obligations on fuel wholesalers, including:

- holding onshore fuel stocks at or above the minimum level set by the Government, based on market share,
- making financial contributions to [the Government's] stockholding agency,
- fulfilling information disclosure requirements,
- incurring penalties for breaching these obligations.

To paraphrase the paper, the Government has overriding responsibility for complying with IEA emergency oil stocks. Previously, where storage levels of fuel wholesalers' (based on their commercial decisions) fell short of 90 days, the Government made up any shortfall by buying contracts (tickets) from offshore parties. Under this proposal, the Government would consider establishing a Stockholding Agency to manage the compliance, enforcement and monitoring activities, and procuring tickets as required, and managing other fuel resilience mitigation measures, including. direct investment in storage and distribution.

7.2.2 Marsden Point

RefiningNZ's refining operation necessitated large inventories of crude oil and intermediate product components, making up around 18 days' cover for New Zealand's fuel demand. Under Channel Infrastructure's import-only model, the days' cover of domestic fuel inventories would drop significantly, reflecting both the loss of crude oil storage (being potential refined product) and lower average product stocks (tank capacity must be reserved to fully unload import ships).

RefiningNZ has stated it owns 180 million litres of product storage, indicating the locations/tanks for each product:

- Jet fuel (7 tanks 120-124, 129-130) - assessed storage 57 million litres
- Diesel (10 tanks 20-23, 50-55) – 62 million litres
- Petrol (7 tanks, 60-63, 170, 172, 174) – 62 million litres

Figure 25: Marsden Point storage

Note: our raw estimates of the volumes of these tanks are higher than RefiningNZ's stated 180 million litres. While the useable storage in a tank is less than its external dimensions, the discrepancy suggests some tanks may not always be operational.

RefiningNZ is in negotiations with its customer shareholders to provide private storage of up to 100 million litres of additional capacity. As Channel Infrastructure, it will only supply the Auckland and Northland markets.

7.2.3 Rockpoint Storage Capacity Assessment

The move by RefiningNZ to an import-only model places increased reliance on domestic storage of refined petroleum products. In the absence of complete public data, Rockpoint has independently assessed tank storage capacity at NZ's 9 key ports (including Marsden Point) based on Google Earth images:

Each fuel company's terminal facilities are located using confirmed street addresses (and signage observed on Google Earth Street View). Dimensions of each tank are measured:

- Non-petroleum and bitumen tanks excluded (where identified)
- Diameter measured using "ruler" function
- Height estimated from Street View (height scaled from diameter)
- Volume = pi*radius2*height

Our estimates provide only an approximation and where possible are calibrated against disclosed storage capacity (such as Marsden Point). Our volume estimates have proven typically 25-35% higher than confirmed actual volumes:

- we have scaled the external dimensions of the larger tanks, whereas useable storage reflects smaller internal dimensions, inaccessible volume at base, and head space for gases.
- we are unable to confirm whether a particular tank is in use or what product it stores - transport fuels, bitumen or other non-petroleum bulk liquids (although floating roof tanks usually denote petrol or crude oil).

The fuel companies own oil terminal(s) located at or near eight ports, storing refined petroleum product for distribution by truck to the regions. The Marsden Point terminal is owned by RefiningNZ (Channel Infrastructure) and delivers via RAP to a terminal at Wiri Auckland and jet fuel storage at Auckland Airport, which are jointly owned by the 3 oil majors bp, Mobil and Z Energy. A terminal in Miramar, Wellington has 2 tanks for storing jet fuel and is jointly owned by bp and Mobil. All other terminals are owned individually by the fuel companies. Two independent competitors are Gull Petroleum which operates 6 tanks at a site in Mt Maunganui, while Pacific Petroleum (Tasman Oil Services) owns 4 tanks in Timaru.

Rockpoint's assessment suggests 1010 million litres of product storage capacity (or 710 million litres excluding Marsden Point and Auckland). This compares with MBIE's 2018 storage of 847 million litres (including RefiningNZ's 180 million litres) (or 547 million litres excluding Auckland).

Table 14: NZ petroleum product storage

NZ Petroleum Product Storage

million litres	bp	Mobil	Z	JV	Gull	Tasman	Total	MBIE	diff
Whangarei								6	
Marsden Point				**180**			180	*180*	1.0
Auckland Wiri				110			110	114	1.0
Auckland Airport				10			10		
Mt Maunganui	20	40	60		120		240	162	1.5
Napier	20		30				50	34	1.5
New Plymouth	30						30	19	1.6
Wellington Seaview	30	30	20				80	127	0.6
Wellington Miramar				10			10		
Nelson	10		30				40	25	1.6
Christchurch Lyttelton	50	20	20				90	74	1.2
Christchurch Woolston		10					10		
Timaru			40			20	60	39	1.6
Dunedin	20		50				70	40	1.7
Bluff		20	10				30	28	1.1
NZ Total	180	120	260	310	120	20	1010	847	1.2
Total ex Auckland	180	120	260	10	120	20	710	547	1.3

Rockpoint estimates from Google Earth **bold** = known volume

Rockpoint's volume estimates are again 20-30% high. It is possible some more recently constructed tanks (such as Tasman Oil's in Timaru, 2020) are not reflected in MBIE's database, but more likely our calculations include tanks no longer used (such as some Mobil tanks at Naval Point, Lyttelton damaged by slips in 2014), or tanks not used for petroleum products.

Given NZ's increased reliance on storage under an import-only model, it does emphasise the need for reliable, comprehensive data on petroleum storage, both total capacity and regular spot volumes.

7.2.4 Hale&Twomey

Hale&Twomey are a NZ consulting firm providing specialist services to the energy sector. They have published several reports relating to RefiningNZ, and advising MBIE on oil supply and security issues. Their report to MBIE in December 2020 “Fuel Security and Fuel Stockholding Costs and Benefits” provided pertinent advice in event the Marsden Point refinery ceased operations. Key extracts are:

If the refinery closes, New Zealand is likely to see a reduction of stocks held, primarily crude and intermediate product … to under 70% of the previous level.

The analysis has found there is little change in the disruption impact for most scenarios modelled [given] disruption events primarily impact price.

New Zealand … ticket stock … can be released to the market should there be a supply disruption.

A hypothetical disruption to North Asian supply was modelled [which] could see up to 50% of New Zealand’s normal supply disrupted. [Alternative supplies could come] from the United States, India, Middle East and Europe … (with longer shipping times)

H&T found there is now greater likelihood of stock outages arising from RAP/Wiri disruption events because of the loss of the Wynyard Wharf facility for back up supply.

[Moving to a] 100% product import supply will dramatically reduce the amount of stock held in New Zealand, [although] it will not have a major impact on fuel security [except] if there was a failure in normal global trading activity.

[Fuel company] stock holding decisions have been left to commercial drivers in the past. Should the Government decide it requires higher stocks … it may be that stocks held separately (but in close proximity to) industry stock would be more economic than increasing [fuel companies’] minimum stock obligations.

Additional stock should be held where it can most flexibly respond to a range of outcomes - Auckland remains the most vulnerable location for infrastructure failure

H&T recommends that MBIE:

1. Work to improve the stock reporting from fuel companies.
2. Monitor … the fuel industry to implement the recommendations from the Auckland Fuel Supply Disruption Inquiry
3. the loss of Wynyard Wharf has impacted disruption response options in Auckland,
4. MBIE should closely monitor stock levels on an ongoing basis [and] consider implementing a minimum stock obligation at around the current minimum operating level (for finished stocks)
5. Investigate the value of holding additional stock within New Zealand above the average level expected to be held on a commercial basis
6. Review the New Zealand fuel specifications should the refinery close.
7. Implement an annual review of supply resilience (including the minimum stocks held over time) and the diversity of supply
8. consider undertaking supply security reviews
9. The ticket strategy should not change from the current approach should refining cease in New Zealand.

7.2.5 Commerce Commission Supply Study

The Commerce Commission assessed the competitive performance of the retail fuel market . Its key observations were:

- NZ uses 3.2 billion litres of petrol and 3.6 billion litres of diesel.
- 98% of petrol was sold at service stations (including unmanned sites and truck stops), and 73% for diesel (the balance is delivered in bulk to users).

- NZ consumers pay relatively high prices for petrol and diesel (amongst the highest in the OECD and have trended upward), and many fuel companies were achieving a persistently high level of profitability
- Competition in the market is limited by the small, distributed nature of the market, and a new competitor would require a large market share for a new terminal (at least 45 million litres per year) to be economical.

Rockpoint draws similar conclusions on the fuel oil and ship bunker market:

- Bulk supply (piped at port) of fuel oil appears widely available, although grades vary by location.
- Z Energy: grades of residual oils vary from LFO 40cst, MFO 80cst, HFO 180cst and Heavy bunkers 380cst. The latter are available from Marsden Point, Auckland and Tauranga and Bluff. These 2019 specifications now fall outside MARPOL VI.
- Mobil: provision of compliant VLSFO fuels, with Residual Marine Fuel Oil (RMFO) available in grades 10-700cst at Marsden Point, Tauranga, Wellington (Kaiwharawhara), Lyttleton and Bluff.
- bp Marine: based in Australia, supplies compliant VLSFO and MGO.
- Prices in NZ are materially higher than in Singapore (Sec 6.3).

7.3 Outlook for NZ Oil Storage

Under an import-only model, we conclude NZ currently has inadequate storage for petroleum products.

The principal metrics in our assessment are:

- The refinery net output in 2019 was 6.7 billion litres (Giga litres or G l) (being 41.2 mmbbls or 5.4 million tonnes). It met 62% of domestic petrol and diesel demand and exported excess jet fuel and fuel oil.
- NZ consumption of petroleum products in 2019 (pre-covid) was 7.1 G l.
- Auckland consumption (RAP pipeline throughput) was 3.3 G l (46% of NZ).
- Storage capacity at Marsden Point, Wiri and Auckland Airport combined is currently 0.30 G l,. Auckland demand is 11 times Marsden Point and Wiri storage (33 days storage turnover).
- An LR1 class oil tanker, 50,000 dwt, has capacity to carry up to 0.065 G l.
- Five LR1 deliveries would be required to fill Marsden/Wiri storage, while meeting Auckland's annual demand would require 50 LR1 deliveries.
- Storage at other terminals around NZ was assessed at 1.01 G l,. Rest of NZ demand is 3.1 times storage (120 days storage turnover).
- The rest of NZ will require 18 LR1 deliveries to fill storage tanks, and 60 LR1 deliveries to meet annual demancd (COLL made 65 voyages annually).
- COLL voyages averaged 10 days round trip. Each port call required 1.5 days for loading or discharging. On the basis of 4 port calls per voyage, 6 days would be spent in ports, and 4 days in transit, an 8 day round trip.
- Under an import only model, each LR1 ship voyage would involve 6 days in port (4 ports, 3 being in NZ) plus 35 days in transit to and from Singapore or South Korea. Such a ship could make 9 voyages annually.
- 12 LR1 ships would be needed to continuously make the 110 voyages to NZ each year.

NZ maintains 90 days emergency storage, of which 60 days is physical petroleum (crude oil and refined product, in storage and in transit). Much of that has been crude oil, imported to Marsden Point and produced in Taranaki for export, including that in transit.

The additional ships in transit (with 6 of the 12 full of refined product and in transit to NZ) would boost IEA capacity. Stationary ships however are not considered a useful option for boosting storage capacity except

perhaps in an emergency. Unit storage rates would be high (both fixed and operating costs), and the ships would not be welcome as permanent fixtures in ports or harbours.

8 Part 2: NZ Ship Operating Costs

Rockpoint's Coastal Shipping paper for Te Manatū Waka's DTCC study assessed that ship operating costs in NZ were double that of an equivalent foreign ship (including those operating in NZ) in 2019. Our cost analysis was based primarily on Drewry's comprehensive global report "Ship Operating Costs Annual Review and Forecast Annual Report 2019/20", which evaluated ship operating costs (crewing, insurance, repairs & maintenance, consumables, surveys, and administration) for all major ship categories (such as container ships, tankers, dry bulk carriers and RORO), each of various sizes and ages.

Cost elements Rockpoint's paper also considered were ship capital costs (for a new build, second hand, or to charter/lease) and voyage costs (bunkers, port, and channel charges).

While this analysis has not been updated, we have no reason to consider the operating cost differential between domestic and foreign ships has materially changed since.

8.1 Domestic Ships Costs – Double Foreign

While domestic ship operators are able to access global ship markets without disadvantage, ship operating costs in NZ are double foreign ships, while bunker costs in NZ are 30% higher than Asia. Even on the same coastal route in NZ, domestic ships incurred 1.6x the unit costs of foreign ships.

8.1.1 Crewing costs: 2.55x

- Crewing levels: Anecdotally NZ ships are required to operate with more crew than an equivalent foreign ship. We assess a NZ premium of 1.2x.
- Base rates: under NZ employment law and agreements, NZ crews are paid at a higher rate than an equivalent foreign crew. 1.25x.
- Leave: NZ ship crew work one month on, one month off, while foreign crew typically worked fixed contracts with limited leave. 1.7x.
- Collectively, we assess NZ crewing costs are 2.55x equivalent foreign crews

8.1.2 Ship operating costs (ex crew): 1.5x

The NZ marine industry lacks the scale of large offshore facilities while key consumables (lubricants, spares) must be imported.

- Spares, lubricants, and R&M. 2.0x.
- Survey. Undertaken offshore, incurring transit time. 1.5x
- Insurance and administration. 1.0x

8.1.3 Bunker costs: 1.3x

- Consumption: Ships consume bunkers whenever the engines are running. The rate of consumption (tonnes per day) varies **principally** by speed while in transit, and by ship size and design. Bunkers are consumed if engines are idling in port (most ship load is switched to smaller generators). Foreign ships travel longer sea-legs, so their voyages have proportionately more transit time than port time. 1.0x
- Bunker Price: NZ is a small and remote market for fuel oil. Until RefiningNZ ceased local refining in March 2022, it was the only supplier. Accordingly, prices were materially (30%) higher than major Asian ports. Foreign ships carry enough bunkers to make several voyages before refuelling, so will do so at ports offering the most favourable prices. 1.3x

Overall, the operating costs for a domestic ship are modelled to be double (2.0x) that of an equivalent foreign ship.

8.2 Caution Warranted

The Government will understandably approach policy changes or interventions with some caution. Any change to law, regulation or targeted funding may alter the commercial market and risk balance and have unforeseen consequences on private sector investment or participation.

The nominal benefits of changing current legislative and policy settings for shipping must be considered in light of NZ's current total reliance on foreign ships to carry 99% of its import and export trade, and their dominant (75%) role in coastal shipping of containers. Should rules for foreign ships tighten, there is a risk that, in such a fraught global shipping market, foreign shipping lines might reduce services to (or even withdraw from) the NZ market to pursue more attractive business elsewhere. Domestic ships may be able to provide any loss of coastal services, but unlikely to expand to provide international services.

Alternatively, rules (such as section 198) could be relaxed to enable more foreign flagged vessels to carry NZ's coastal cargo on purely domestic routes. Maersk's Sirius Star schedule, which barely skirts section 198 by visiting 2 Fijian ports in addition to 6 NZ ports, could then operate solely domestically. NZ seafarers are unlikely to be enthused.

[Note: On 15th June 2022 Maersk announced a new dedicated NZ coastal service, Maersk Coastal Connect, to commence on 12th July 2022. The service will replace the Sirius Star schedule, using two 2500 TEU container ships, Maersk Nadi, and Maersk Nansha. Employing NZ crews and working entirely in local waters, the new service will call at five ports - Timaru, Nelson, and Tauranga weekly and Auckland and Nelson fortnightly. The service will assist in shifting empty containers to ports with export demand transhipments for export cargos (dairy, meat, produce, seafood) and coastal services. The schedule will provide a buffer to absorb delays due to weather or operational disruption (particular for international services).

8.3 Initiatives

Waka Kotahi's National Land Transport Programme 2021-24, released in August 2021, added the Coastal Shipping Activity Class into the Government Policy Statement, with its allocated "investment of $30 million during this NLTP period will focus on investments in infrastructure, research and programme business cases, and projects that can support the objectives of the [coastal shipping] activity class". Investments will seek "the more efficient movement of freight between ports and distribution centres including through feasibility studies and/or business cases for infrastructure projects which support the coastal shipping industry," and to "improve domestic shipping services, reduce emissions, improve efficiency and upgrade maritime infrastructure".

On 24 May 2022, the Minister of Transport announced that the Government has worked with the wider freight industry to select four applicants for co-investment in new and enhanced coastal shipping services through the NLTP. The four preferred suppliers are:

- Coastal Bulk Shipping Ltd is a Whanganui-based firm providing shipping services around NZ using its small bulk carrier Anatoki
- Move International Ltd, part of national transport company Move Logistics which amalgamates Hookers, TNL and other transport firms. In 2021, Move announced its intention to provide inter-island services, initially with CBS's Anatoki.
- Swire Shipping NZ Ltd, part of the Swire Group providing shipping services the Asia and Pacific region for 150 years, owns Pacifica Shipping which operates Moana Chief, NZ's sole domestic container ship.
- Aotearoa Shipping Alliance - a nationwide network involving iwi and businesses (including Westland Mineral Sands).
- [Note: Maersk did not receive NLTP funding for its Coastal Connect service].

"Each of these four selected suppliers will bring at least one additional coastal shipping vessel into service, and together this will improve the resilience of the overall freight supply chain. The four preferred suppliers will invest over $60 million through their proposals, resulting in combined investment in the sector of over $90 million.

It is estimated they will remove around 35 million kilometres of truck travel from New Zealand's roading network every year.

8.4 Opportunities

8.4.1 Short Term

As a trading nation of often high-value perishable goods, NZ had accepted its dependence on foreign shipping to provide well-priced reliable shipping to its distant markets. Through the Covid pandemic international shipping has been sorely disrupted, with loss of effective capacity and a concerning drop in reliability. NZ has certainly felt these effects.

While policy is best suited to addressing long-term and structural issues, there are some opportunities for the Government to address current shipping reliability. We acknowledge above the Government's $30 million NLTP co-investment with 4 domestic shipping parties to provide additional coastal capacity.

These and other opportunities may already have been considered by Government agencies and been dismissed. They have not been rigorously analysed as part of this study. Further, if implemented, they may incur costs or change established market dynamics with potentially negative consequences. Foreign ships currently provide 75% of NZ's coastal capacity and compete for domestic freight.

Short-medium: Government to boost coastal shipping:

- encourage or incentivise foreign ships through (further) lobbying or subsidies to enhance (or at least maintain) their current services to and in NZ. Given their own capacity constraints, and the 6-fold increase in global shipping rates, other shipping routes may nevertheless be more attractive. [Note: Maersk's new Coastal Connect service, above].
- consider time chartering vessels (either directly or building a domestic stakeholder consortium(s) to do so) to increase the international service capability. We recognise the diversity of stakeholder needs, and the seasonality of import and export flows. We note that domestic interests have not provided international shipping services for some decades, nor directly chartered ships to do so - excepting perhaps the oil retailers importing petroleum products (and previously crude oil) on chartered ships.
- encourage domestic ship operators to add capacity through subsidies or some commercial guarantee/ underwrite [Note: NLTP funding above]. Given the current strain on trade capacity is principally in containers, NZ's sole container ship operator, Pacifica, could boost transhipment flows to better link exporters with the currently abbreviated / interrupted services being offered by foreign containerships.
- facilitate the relocation of empty containers using any available capacity (Pacifica's ship, rail, and road) to ensure devanned import containers (Auckland) are more readily available to exporters (through southern ports).
- assist ports with expediting the processing of ships and cargo via tracking, tracing, digitisation, and trade facilitation measures.

8.4.2 Boost Coastal Shipping

Opportunities which might assist strengthening coastal shipping could include:

- review of cabotage laws (where section 198 of the Maritime Transport Act 1994 permits a foreign flagged ship to carry coastal cargo on scheduled international routes). Since the law passed, NZ-flagged coastal ships carrying general cargo have fallen from 24 to three (Moana Chief, Anatoki and Southern Tiare) as NZ increased reliance on foreign ships and land transport (which provided faster, more frequent services). Although rarely exercised, under section 198 the Minister must be satisfied no NZ ships are available to carry that coastal cargo, providing some scope for the Minister to partially regulate foreign vessels. There are risks in such a strategy, given it alters the business case for foreign shipping lines at a time they are under capacity constraints. Note: the counter longer term strategy, to restrict scope for foreign ships to carry domestic cargo, would greatly

reduce coastal capacity given foreign ships currently provide 75% of capacity. The business case for enhanced domestic shipping service must rely solely on available coastal flows, whereas for foreign ships coastal cargos supplement core revenues from international services when they have spare capacity.

- to be viable, ships for any new domestic service must be immediately available for coastal operators (with chartering being the quickest option, buying next – a new build involves years delay), and further the business case must be sufficiently attractive and enduring. The wider economic benefits (environmental benefits of shipping, reduced traffic on roads, safety) cannot be captured by ship operators unless the Government "shares" them through subsidies or concessions.
- operating costs for foreign flagged ships are structurally lower than those for NZ flagged ships (sec 9.1, refer to Rockpoint's Coastal Shipping paper for the Ministry's DTCC study). Foreign ships (usually under flags of convenience) have identifiable cost advantages (lower crewing and ship operating costs, lower bunks costs) which cannot foreseeably be addressed.
- Foreign ships operate under international laws which allow them to greater tax flexibility; tax on profits, ETS, registration and regulation. Any change would require the coordinated efforts of most (even all) nations.

9 Part 3: Covid Impact on Shipping

Through both good luck and good management, NZ has fared well during this global Covid-19 pandemic. Until the Omicron variant arrived in February 2022, almost 2 years into the pandemic, NZ's containment strategy had worked very effectively.

The pandemic has been caused by the SARS-CoV-2 coronavirus first identified in Wuhan, China, in late 2019. Pandemics have formed part of human history, exacerbated by urban living and the global movement of people and animals. Most pandemics have been viruses jumping to humans from animals. The Black Plague in the Middle Ages spread from Asia to Europe via rodents, claiming up to half Europe's population. The Spanish Flu (1918-1920) had an avian source, claiming 500 million lives worldwide. Asian Flu, AIDS, H1N1, Ebola and Zika each claimed millions of lives. Consensus suggests that the Covid-19 virus jumped from bats.

9.1 NZ's Covid Experience

Restrictions imposed for Covid-19 impacted the NZ economy and everyday life. The Government has spent $74m supporting people and businesses. The economy has taken a hit. Our connections to the world and to our trading partners were impaired by disrupted, chaotic supply and transport systems. NZ is not alone in facing difficult pandemic legacy challenges, immediate and anticipated, direct and indirect.

Past pandemics have informed modern public health responses. Covid-19 proved highly contagious, with over 530 million cases globally and 6.3 million deaths. The mortality rate at 1.2% is thankfully lower than past or worst-case pandemics.

NZ locked down early, and vaccinated before widespread community transmission:

- Containment: restrictions on public movement, closure of non-essential businesses and closure of the border (with a 14-day MIQ).
- Medical: PCR testing, high vaccination rates (>80%).
- Economic policies: income/salary support, easing monetary settings.
- Health policies: masks, QR scanning, testing, isolation, vaccination.

Oxford University has developed a Government Response Tracker, with observed indicators covering policies for containment, economic support, health systems, and vaccination. With the borders closed, NZ was able to adopt more lenient settings.

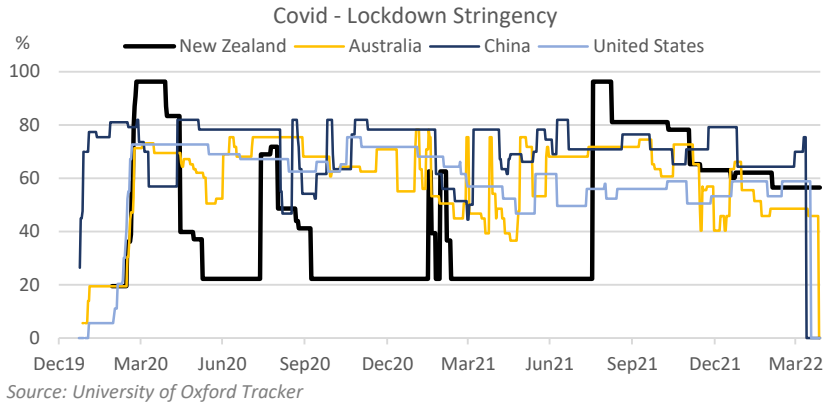


Figure 26: Covid lockdown stringency

Prior to January 2022, NZ had recorded just 16,000 Covid cases (0.3% vs global average of 6.5%) and 53 deaths (0.3% of case, world average 1.2%). Omicron's arrival saw community cases surge to 1.2million and deaths to 1140 (1 June 2022).

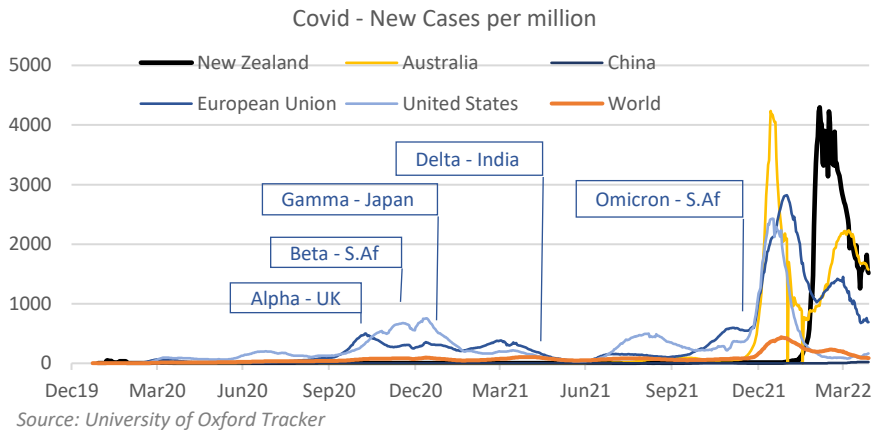


Figure 27: Covid new cases per million of population

The economic impact of the Covid pandemic was sharper than the Global Financial Crisis (GFC) in 2008, although the NZ economy did not suffer as badly as most.

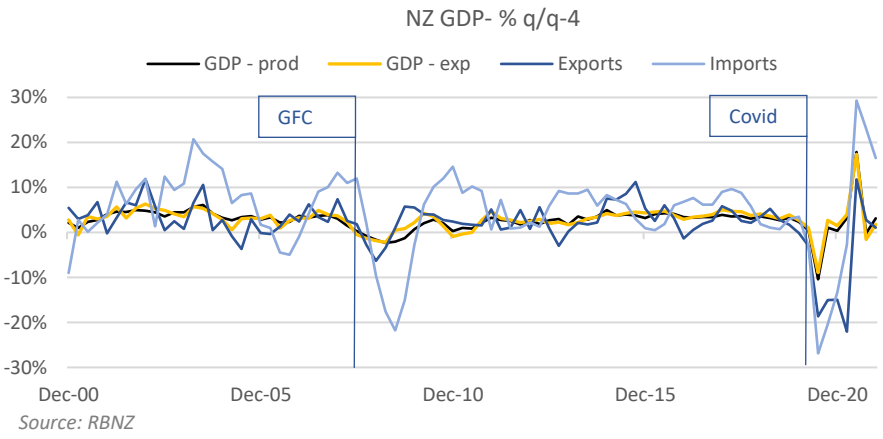


Figure 28: NZ Gross Domestic Product during GFC and Covid

The GFC drove NZ's GDP down for 5 quarters (for an average -1.6%), followed by a modest recovery. Under Covid, GDP dropped sharply for a single quarter (-10.4%) but enjoyed a more robust recovery. In both cases, businesses and households curtailed spending, with imports dropping, although recovering more strongly under Covid. Exports fell harder under Covid, for longer, with a patchy recovery.

Table 15: Economic impact of GFC and Covid

Economic Impact of GFC and Covid

q/q-4		GDP - production		GDP - expenditure		Exports		Imports	
GFC	Jun-08	0.3%		-0.5%		1.9%		12.0%	
	Sep-08	-0.8%		-1.3%		-2.8%		2.0%	
	Dec-08	-1.6%		-1.9%		-6.3%		-9.6%	
	Mar-09	-2.3%		-2.2%	-1.8%	-3.4%	-4.2%	-17.6%	
	Jun-09	-2.1%		0.5%		1.0%		-21.7%	
	Sep-09	-1.2%	-1.6%	0.9%		5.7%		-15.0%	
	Dec-09	0.7%		2.2%		5.5%		-2.7%	-13.3%
	Mar-10	2.0%		4.3%		4.1%		6.2%	
	Jun-10	2.8%	1.9%	3.5%	2.3%	4.0%	4.0%	10.2%	8.2%
Covid	Dec-19	2.4%		2.7%		-0.1%		3.5%	
	Mar-20	0.4%		1.0%		-3.0%		-3.0%	
	Jun-20	-10.4%	-10.4%	-8.9%	-8.9%	-18.6%		-26.9%	
	Sep-20	1.1%		2.7%		-15.0%		-20.4%	
	Dec-20	0.3%		1.5%		-15.0%		-13.3%	
	Mar-21	3.2%		4.0%		-22.0%	-14.7%	-2.7%	-13.3%
	Jun-21	17.9%		17.4%		11.7%		29.3%	
	Sep-21	-0.2%		-1.6%		2.8%		23.0%	
	Dec-21	3.1%	4.2%	1.7%	4.3%	1.1%	5.2%	16.6%	22.9%

In NZ, with the population in lockdown, economic activity changed – mirroring the economic and demand impacts being observed globally. Spending on services (recreation, tourism, hospitality) dropped sharply given lockdowns and restrictions. Households pivoted by increasing spending on goods, with a huge boost in online spending.

To stimulate faltering business activity, the Reserve Bank of NZ lowered the Official Cash Rate (OCR – interest rates) early in the pandemic, again mirror central bank responses worldwide. Resultant record low mortgage rates were quickly reflected in a strong surge in house prices. The increase in demand for goods has since late 2021 driven inflationary pressures (both imported such as energy, and underlying domestic inflation). In March 2022, the RBNZ moved firmly to arrest inflation by raising the OCR, with further robust increases foreshadowed.

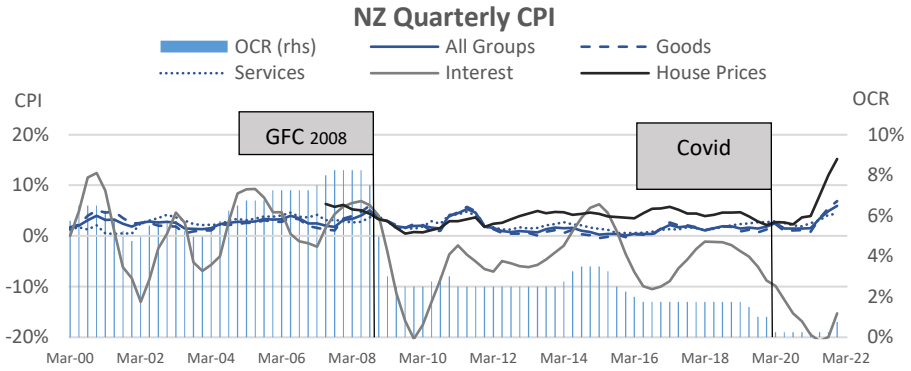


Figure 29: New Zealand quarterly consumer price index 2020-2022

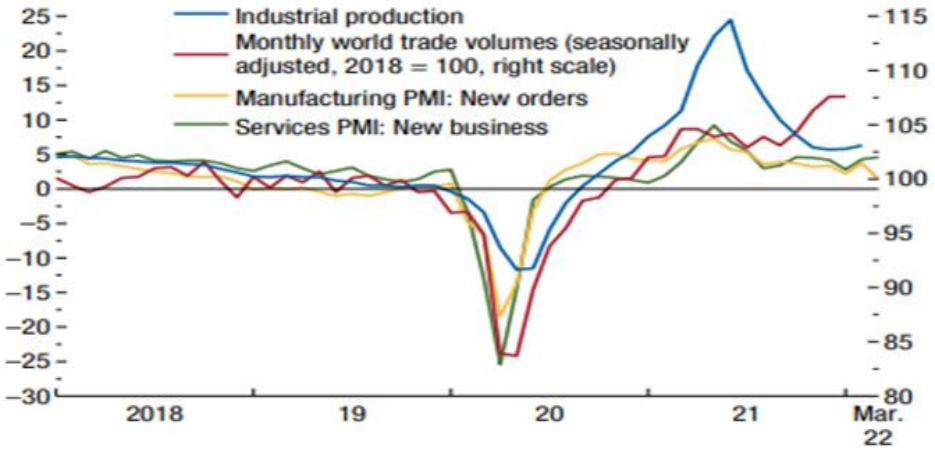
10 Global Economic Outlook

There is no shortage of reports and opinions on how the global and domestic economies have, and should, respond to the Covid pandemic. We cite reports from four authoritative global organisations, the International Monetary Fund (IMF), the World Trade Organisation (WTO) and the United Nations Conference on Trade and Development (UNCTAD) and Organisation for Economic Cooperation and Development (OECD), and three domestic organisations, The Treasury, the Reserve Bank of NZ (RBNZ) and ANZ Bank to provide context for our discussion on trade and shipping.

10.1 IMF – World Economic Outlook (April 2022)

In January 2022, the IMF's report "Rising Caseloads, A Disrupted Recovery, and Higher Inflation", the IMF downgraded its outlook for the global economy following the recent emergence of the Omicron variant. Omicron saw countries impose tighter restrictions, while inflation was being driven by rising energy prices and continued supply disruptions. Following 5.9% global growth in 2021, the January 2022 growth forecast for 2022 was dropped to 4.4% (from 4.9% in its October 2021 forecast), noting further downside risk from delays in US's Build Back Better policies and China's challenges with Covid elimination and financial stress Chinese property developers. The spectre of inflation was fuelled by continued supply chain disruptions and high energy prices.

By April 2022, these challenges were compounded by a war in Ukraine. The economic fallout would be severe in Ukraine (down 35%, with Russia down 8.5%) but would also be felt globally through commodity markets, trade, and financial channels. Inflation would require central banks worldwide to struggle to balance tightening interest rates without dampening economic activity. The IMF's revised 2022 global growth fell from 4.4% to 3.6% (and in 2023 from 3.8% to 3.6%).



Sources: CPB Netherlands Bureau for Economic Policy Analysis; Haver Analytics; Markit Economics; and IMF staff calculations.
Note: Units for industrial production are annualized percent change. For PMIs, units are deviation from 50. PMI above 50 indicates expansion, below 50 indicates contraction. PMI = purchasing managers' index.

Figure 30: Global activity indicators (three-month moving average)

The IMF notes the drivers of inflation (the war, sanctions, the pandemic, and supply chain disruptions) are largely beyond the control of central banks, where broad-based price pressures were not easily targeted. Most Government's faced high national debt following recent fiscal expansion (printing money), leveraging their exposure to rising interest rates and constraining their fiscal flexibility:

The report reviewed the global trading system's vulnerability to these crises. Governments must balance fighting inflation with safeguarding the pandemic recovery and addressing government debt arising. Responses considered include:

- Fighting inflation, although central banks cannot address imported inflation
- Geopolitical tensions which impede trade and undermine trust
- Supporting those made vulnerable by the pandemic
- Addressing global economic shifts, climate change and international tax
- Maintaining liquidity through fiscal responsibility and debt paydown

10.2 WTO – World Trade Report 2021: Economic resilience and trade

Government pandemic policies (restriction of economic and social activity) have stressed the global trading system, severely interrupting global trade, and supply chains. In 2020, the value of global trade in goods and services terms fell by 9.6%, while global GDP fell by 3.3%.

Global Value Chains (GVCs), where production is broken into tasks carried out in multiple countries, proved more resilient that originally feared, although weather disruptions, Covid shutdowns at ports, and a single ship aground in the Suez Canal bottlenecks, have impaired previously optimised GVCs. Merchandise trade has rebounded faster than gross domestic product, propelled by fiscal and monetary policies, and consumer demand switching from services to goods. Vulnerabilities are rising inequality, cyber-attacks, economic fragility, and geopolitical tensions.

The WTO report conveyed three main messages

- Globalisation supports resilience. The global economy is now characterised by deep trade links and interdependencies, with trade is a driver of productivity and economic growth, allowing specialisation and optimisation. Such interdependencies quickly transmit shocks, but globalisation boosts economic resilience.
- Economic isolation has downsides. Unwinding trade integration may actually decrease economic resilience. Restricting trade almost inevitably reduces economic efficiency, driving up prices, restricting access to goods and technologies, and increasing vulnerability to domestic supply constraints – and trade retaliation.
- Strength through global cooperation. Multilateral trade cooperation, backed by strong international trade rules, can support domestic strategies that avoid and mitigate risks and shocks. Cooperation also improves resilience by promoting the diversification of products, suppliers, markets, and economic performance.

WTO's report frequently referenced the Covid pandemic where some countries policies and responses were causing economic devastation – unemployment, business shutdowns, and the sharpest economic contraction since the Great Depression. The pain was spread unevenly, with certain groups and countries disproportionately harmed.

Trade contracting sharply at the beginning of the pandemic as countries scrambled to contain the virus's spread with lockdowns, border closures and travel bans. Nevertheless, with government fiscal stimulus supporting consumer demand, trade has proven to be more resilient, as it did after the GFC. After the initial Covid shock, merchandise trade recovered, with exporters benefitting from sustained foreign demand. Services remained depressed. Trade-oriented countries rebounded faster, while digital trade and procurement boosted recovery.

Shipping capacity and supply chains have been strained shipping capacity. Merchandise trade, having dropped 5.3% in 2020, and was forecast to rise 10.8% in 2021, a level higher than before the pandemic.

10.3 UNCTAD – COVID-19 & Maritime Transport Impact and Responses (Oct2021)

Maritime transport underpins Global Value Chains (GVC) and economic interdependency, with shipping and ports estimated to handle over 80% of global merchandise trade by volume and more than 70% by value. When events such as the Covid pandemic occur, policy responses often disrupt ports, shipping, and supply chains, which undermine trade and economic activity. Developing countries are particularly reliant on maritime trade and disproportionately affected.

Various industries have faced supply chain challenges – access to raw materials, lead time issues, cancelled (blank) sailings, port closures, reduced working hours at ports, equipment, and labour shortages, as well as truck/transport capacity constraints. Even small bottlenecks quickly escalate to undermine the smooth movement of merchandise trade flows.

While the longer-term impact of the Covid pandemic is yet to be fully understood, the near-term challenges are clear. These differ by maritime transport segment (container, bulk, reefer, tanker), domestic or international, and the strength and preparedness of each region. Countries with high GVC participation (that is, part of multi-country production processes) are more immediately affected by supply chain disruptions but appear to recover faster.

UNCTAD's key messages as of 31 March 2021 included:

- The Covid pandemic is far from over.
- Economic growth is recovering faster than initially expected. After steep early declines, global merchandise trade bounced in later-2020. Container ship port calls have recovered, air traffic remains depressed. Global manufacturing output is recovering if unevenly. Given negative repercussions on supply chains, nearly 40% of trade-restricting measures have been lifted.
- The World Bank delivered $5 billion in debt relief to 40+ countries - many are in or at a high risk of debt distress. 255 million full-time jobs were lost in 2020. Foreign direct investment fell by 42% in 2020. Commodity prices have risen following supply chain disruptions. Greenhouse gas emissions initially fell.

10.4 OECD - Economic Survey of New Zealand - January 2022

The OECD's "Economic Survey of New Zealand" was released in January 2022. The NZ economy has recovered quickly from the Covid shock, with expansionary macroeconomic policies and virus containment measures protecting jobs and incomes [noting that inflationary pressures have emerged after this report was released]. The Government has moved from a Covid elimination strategy to a minimisation and protection strategy. NZ productivity is low (muted competition, low innovation, skills mismatches). Inflationary pressures are building. Key recommendations include making growth more sustainable, increasing housing affordability, protecting displaced workers, boosting productivity (digitalisation), and lowering GHG emissions.

10.5 NZ Treasury - Half Year Economic and Fiscal Update, 15 December 2021

The NZ Treasury publishes regular articles reviewing the NZ economy. The latest commentary and forecasts, already showing greater volatility and being more weighted towards downside risk, have since been overrun by uncertainties raised by the Omicron variant and the war in Ukraine.

Table 16: NZ Treasury - Half Year Economic and Fiscal Update, 15 December 2021

June years	2021 Actual	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast
Real production GDP (annual average % change)	5.1	0.8	4.9	2.2	2.3	2.3
Unemployment rate (June quarter)	4.0	3.2	3.3	3.6	3.8	4.1
CPI inflation (annual % change)	3.3	5.1	3.1	2.7	2.4	2.2
Current account (annual, % of GDP)	-3.3	-5.8	-5.4	-4.8	-4.4	-4.0
Fiscal measures ($billions)						
Core Crown tax revenue	98.0	102.6	113.8	120.1	127.3	134.5
Core Crown expenses	107.8	128.0	120.2	124.8	128.5	133.6
Total Crown OBEGAL[1]	-4.6	-20.8	-0.8	2.1	5.9	8.2
Core Crown residual cash	-13.8	-34.1	-21.7	-8.0	14.5	12.5
Net core Crown debt	102.1	136.3	157.9	165.5	150.6	137.9
as a percentage of GDP	30.1	37.6	40.1	39.9	34.6	30.2
Net worth attributable to the Crown	151.5	127.3	131.4	139.3	151.5	166.4

The Fortnightly Economic Update (14 April) provides more timely commentary. Business and consumer confidence remain suppressed by the war in Ukraine, the Covid pandemic and supply chain disruptions. Forecasts are being downgraded. Inflationary pressures remain intense, with 6.9% annual inflation forecast in March 2022. The RBNZ faces having to tighten monetary policy as real growth and employment prospects are waning.

10.6 Reserve Bank of NZ - Monetary Policy Statement February 2022

The NZ economy has remained robust through the Covid pandemic, aided by high export prices (especially dairy), low interest rates and Government support for workers and business. Yet economic activity will likely remain volatile in the near term, with Omicron weighing on household and business spending in 2022.

Strong demand has put pressure on available resources, worsened by supply-chain bottlenecks and border restrictions denying NZ key foreign workers. The labour market remains tight, unemployment at record lows and wage inflation is rising.

CPI inflation increased to 5.9% in 4Q2021. External inflation (oil prices and imported goods) has compounded rising core (domestic) inflation, with expectations increasing significantly. Expectations for further increases in the Official Cash Rate (OCR) have been quickly reflected in interest and mortgage rates.

10.7 ANZ World Commodity Price Index – March 2022

ANZ reports that commodity prices remain elevated, with its World Commodity Price Index rising 3.9% in March 2022 to hit a new record. The impact on NZ$ prices was small given a rise in the Trade Weighted Index (TWI – exchange rates).

- Most export commodity prices are rising, with dairy up 7.6% m/m-1, forestry up 3.3%, aluminium up 8.4%, while horticulture was flat and meat and fibre weaker.
- Global shipping prices (containers and bulk) are again rising towards record levels, with availability and reliability in question.

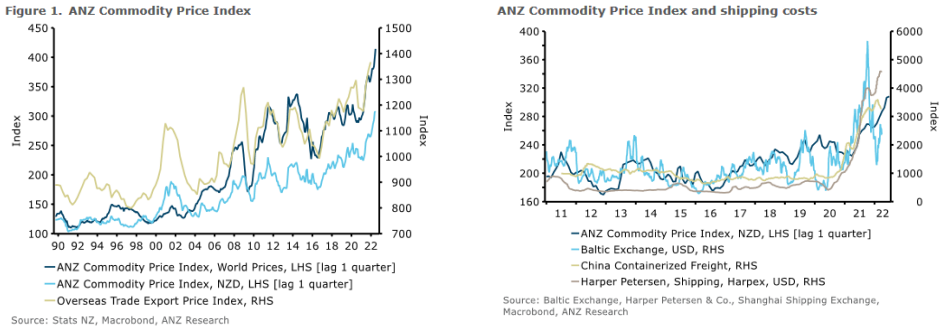


Figure 31: Consumer price index and shipping costs (source: ANZ)

11 Impact on Trade and Shipping

Government policies worldwide sought seemingly contradictory outcomes; containing the spread of Covid by lockdowns of population and non-essential businesses, while seeking to stimulate economic activity. The interplay of these two objectives created an unpredictable cascade of outcomes around the world.

11.1 Merchandise Trade

Cross-border trade and cultural exchange has driven an increasingly inter-connected world. Termed globalisation, this process has accelerated since the 1950s. Merchandise (physical goods) trade reached US$22 trillion in 2021, and represented a record 28% of global GDP, up from just 9% in 1960. NZ has long been a trading country, with overseas trade averaging 20% of GDP since 1960.

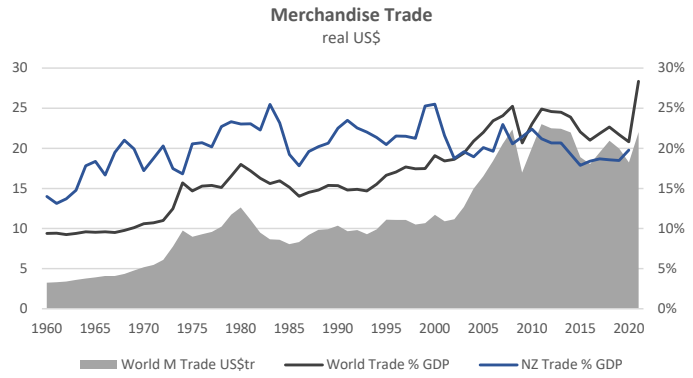
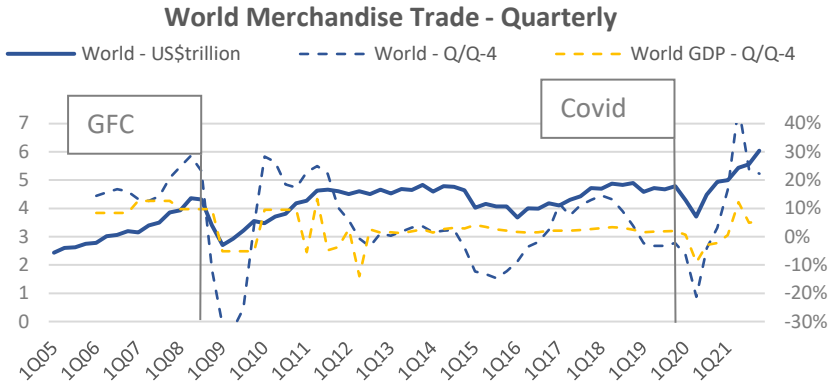


Figure 32: New Zealand merchandise trade

Land transport is well suited to short-medium haul tasks. Most of the world's cross-border merchandise trade is by ship – containerships, bulk carriers, tankers, RORO.

The rapid spread of Covid and the rising death toll brought worst case scenarios to the forefront. Governments quickly restricted population movement, both international and increasingly domestic. Lockdowns directly reduced demand for hospitality and non-essential retail consumption. Retail demand for goods initially fell as households' belt-tightened, resulting in a 1H2020 decline in maritime trade.



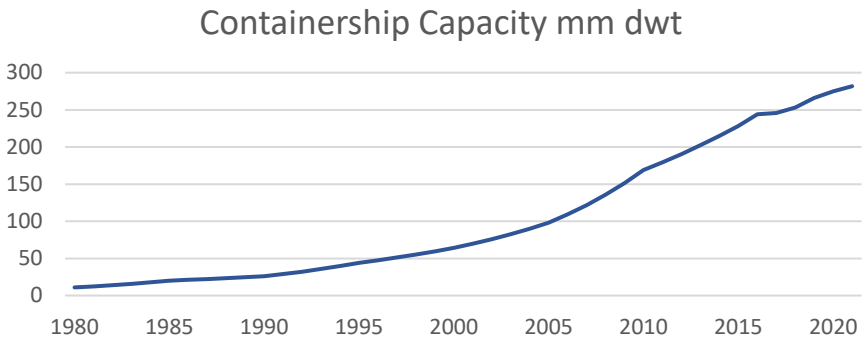
Source: WTO, World Bank

Figure 33: World merchandise trade (quarterly)

The conventional wisdom was that the Covid pandemic would stall economic activity, resulting in a drop in merchandise trade. However, while lockdown restrictions continued to suppress demand for services, by the second half 2020 government stimulus packages to support economic activity raised business and consumer confidence. Demand for goods accelerated quickly. In the US, container imports, having fallen 7% in the first half, were restored to trend by rising 9.5% in the second (and 16.4% in the last quarter) (USITC). By mid-2020, rising consumer demand for goods boosted merchandise trade, especially online purchasing.

11.2 Container Shipping

Since their introduction in the 1960s, containers have captured global share of merchandise trade. Container ship capacity has grown to meet this demand.



Source: Statista

Figure 34: Containership capacity

The lead up to the Global Financial Crisis (GFC) in 2008 was accompanied by a burst of ship building. Drivers were the growth in trade, the pursuit of a modern fleet of larger, faster, more efficient ships, and a driver for industry consolidation.

The aftermath of the GFC proved particularly bruising for the shipping sector. The decline in global merchandise trade created severe shipping over-capacity, coinciding with high bunker prices. Ship utilisation dropped, driving down freight rates, requiring widespread ship layups and scrapping. Shipping lines responded by aggressively reducing costs and trimming services. Bunker expenditure, some half of ship operating costs, was contained by widespread adoption of slow steaming, where bunker consumption could be halved by reducing speed by 20%. This extended voyage times, but also utilised more ships.

Slow steaming is now considered standard practise. This has implications for New Zealand given agricultural goods dominate the value of its exports. These goods, such as dairy products, chilled meat and fish, and fruit and vegetables, have limited shelf life, and slow steaming consumed an increasing portion of that.

When the Covid pandemic hit in early 2020, maritime shipping was soon disrupted. Routes involving Northeast Asia were particularly badly affected, principally given the scale of manufacturing and shipping activity in the region, and so its vulnerability to emerging bottlenecks.

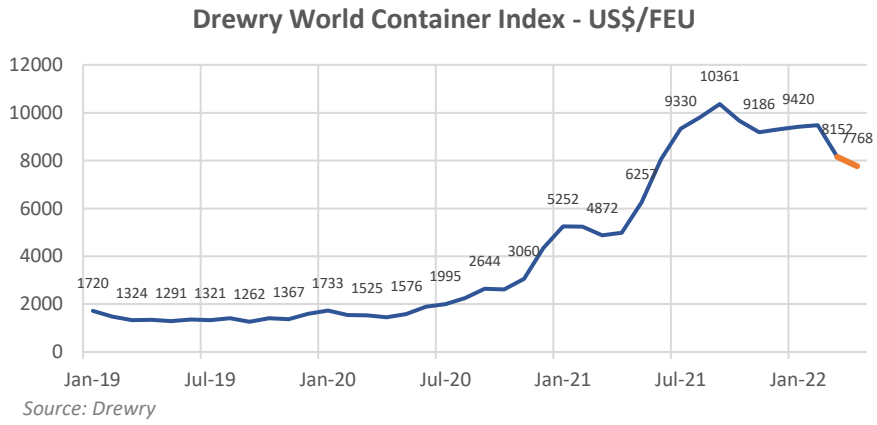
Container shipping firms, wary after the recent post-GFC pain, responded to the emerging overcapacity by aggressively rearranging schedules and regularly cancelling scheduled sailings (termed “blank sailings”). In June 2020, the three largest container shipping alliances (THE Alliance, 2M Alliance, and Ocean Alliance) announced their intent to cancel 126 scheduled sailings between Asia and North America through August 2020, and another 94 sailings between Asia and Europe, while container shipping firms collectively cancelled (blanked) more than 1,000 voyages in the first six months of 2020. Shipping routes were consolidated on major ports, and costs aggressively managed. These actions stabilised maritime freight spot rates in mid-2020 slightly above their 2019 levels. Supply-side constraints in container shipping are also rocking maritime

transport and trade. While new ships orders declined by 16% in 2020, shipping companies have now surged new orders.

11.2.1 Freight Rates

When demand for goods unexpectedly returned mid-2020, container shipping firms struggled to restore recently trimmed capacity. In part they were caught by their own caution, but also by new constraints in supply chain and logistics systems (disruptions in the wider supply chain labour force, and to lesser extent their own crewing shortages). By late 2020, they were again operating near full capacity, with blank sailings declining from 21% of all voyages to 1%, but had limited flexibility to accommodate inevitable disruption.

Maritime freight rates rose significantly during 2020. Shipping costs began to increase during the Covid pandemic, as shipping lines struggled to reposition containers and crew availability. Research by Freightos monitors shipping rates. Its weekly index of the price to ship a container from China to the North American West Coast increased from the US$1,435/FEU (average of the year to May 2020) to a peak of US$10,360/FEU in September 2021, up by 7.2x. It has since eased to US$7,770/FEU, still up 5.4x.

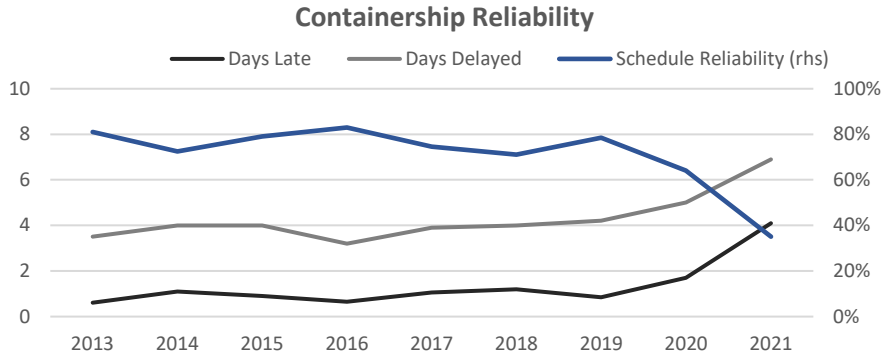


Source: Drewry

Figure 35: Drewry world container index – USD/FEU

11.2.2 Reliability

Containership schedule reliability has been a growing problem through the Covid pandemic, principally as shipping lines face unpredictable delays in port. Having peaked at 80% in the mid-2019, the pandemic has seen reliability fall to 35%. The largest container lines fared best, with Maersk being the 46% reliable in 2021 (down from 70% in 2020), while the Top 14 fell to 29.5% (from 63%).



Source: Sea_Intelligence

Figure 36: Containership reliability

Shipment times from China and West Coast US have doubled through the Covid pandemic. The time on the high seas has not changed. That extra time is ships waiting to be loaded and waiting to be admitted into port before being unloaded. Even ignoring the manufacturing delays (with manufacturers waiting on their own GVC supply lines), there are a myriad of factors behind these delays, variously including land transport to feed the ports, lockdowns which reduce port capacity, and health protocols which stretch systems and timeframes.

Source: Freightos

Figure 37: Less than container load shipping time – China to USA

Shipping analytics firms such as Drewry, Alphaliner, Sea-Intelligence and Windward all monitor ship delays and port congestion. While the measures differ, the consensus is that in April 2022 up to 20% of the world's 9,000 active container ships were delayed by congested ports, with 30% of that backlog being in China (exacerbated by Shanghai, the world's largest port, in full Covid lockdown).

11.2.3 Shipping Profitability

Shipping lines endured devastating losses in the aftermath of the Global Financial Crisis from 2008 due to falling trade demand and over-capacity. The Covid pandemic in contrast has resulted in record shipping line profits. These boom-bust patterns appear to be a feature of global shipping, amplifying wider economic cycles.

The Journal of Commerce observed the container shipping lines made pre-tax profits of $25.4 billion in 2020. Drewry, an independent maritime research consultancy, estimated that container shipping lines have made a record pre-tax profit of US$150 billion in 2021 and may make as much as $200 billion in 2022. AP Moller-Maersk A/S, the world's biggest container shipping line, alone made a $17 billion in operating profits in 2021, up from predictions of $4.5 billion at the beginning of the year.

These astonishing profits show container shipping lines are taking full advantage of strong demand for limited capacity and have responded by fulsomely raising freight prices. And while demand for goods remains so high, companies and individuals appear willing to pay unsustainably high freight rates in the near term.

11.2.4 Port Capacity

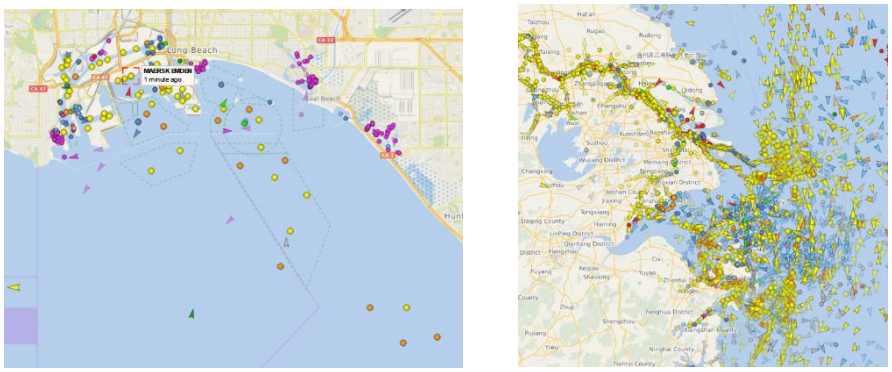
Ports around the world are currently congested, less by trade volumes (most had business-as-usual capacity headroom leading into the Covid pandemic), but because they cannot overcome new uncertainties facing their own operations:

- Port staff when infected are required to immediately self-isolate - becoming unavailable at short notice. Available staff needed to be trained to be multi-skilled and flexible in ways were never previously necessary.
- Disruptions and congestion in land transport (due to new controls and screening) delayed the dispatch of import containers, or the arrival and clearance of export containers. Port container yards

became congested and less efficient when dwell times swelled. To avoid becoming container dumping grounds, ports are introducing new long-dwell charges.

- Port wharfside capacity was compromised by staff availability, delaying unloading, and loading ships at berth. Arriving ships were increasingly being held at anchor while their berth was vacated.

Long Beach, California Shanghai, China



Rotterdam, Holland Singapore

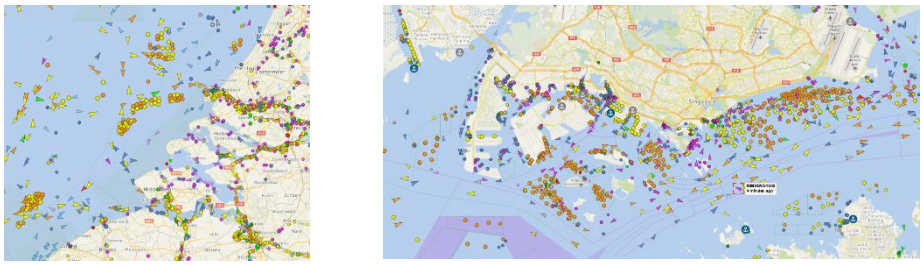


Figure 38: Sailings for selected ports

Port congestion greatly compromised ship schedules. While blank sailings involved an entire voyage being dropped, shipping lines also regularly dropped port calls should a port signal a material berthing delay. This congestion can be observed from ship locations (using AIS sites such as https://www.vesselfinder.com/ or https://www.marinetraffic.com). A circle on these screenshots depicts a stationary ship (being at anchor or waiting-on-berth). Normally the exception, globally 20% of the operating container ship fleet is now (April 2022) at anchor, double the level in February 2022. Under the March lockdowns, Shanghai has been particularly severely affected. Long Beach California, which normally handles 40% of US container imports, had accommodated 60-100 cargo ships at anchor since August 2021, in part given up to 10% of the port workforce was unavailable for Covid-related reasons, in part given the 20% surge in import volumes.

11.2.5 Ship Crews

Shipping was being affected by challenges maintaining an operational crew. Of the estimated 1.7 million seafarers worldwide, more than half are from developing countries such as India and the Phillipines. For decades shipping was an attractive career given wages were up to 10 times higher than crew homelands. International ship crew typically enter time-based contracts (up to 11 months) and work shifts (month on - month off, or six months at sea - one months ashore). They join or leave their ship wherever it may happen to be. Under Covid, cycling crew out became challenging:

- travel restrictions were imposed at the start of the pandemic, greatly restricting the ability of ships to cycle out crew. Even at end-of-contract, crew often remained trapped aboard. The International Maritime Organization (IMO) estimated that as at December 2020 “400,000 seafarers are … stranded on their ships beyond the end of their original contracts and unable to be repatriated, due to Covid-related travel restrictions”, some for several months, while another 400,000 were “stuck at home, unable to join ships”. Maritime crew costs have risen, one estimate by over 6%.

- in NZ, crew who had been in transit for 14 days were considered to have met isolation requirements. Crew being flown in for a shift were required to enter 14-day MIQ before being released to their ships.
- many ports/countries prevented crew going ashore, while a single crew infection required the entire crew to isolate. This often confined an entire crew to ship for extended periods, with stories of seafarers being on board ships for up to 17 months.

International maritime organizations have been pushing governments and companies for more protections for the seafarers. The Neptune Declaration on Seafarer Wellbeing and Crew Change committing "to take action to resolve the crew change crisis" has been signed by some 300 shipping, logistics and transport businesses, as well as the World Economic Forum. Meanwhile, the U.N. General Assembly passed a resolution urging countries to designate seafarers as essential workers, a designation that would allow them to get off ships and would help repatriation of stranded seafarers. IMO disclosed 46 countries had done by 2020.

11.2.6 Shipping Containers

During the Covid pandemic, a global shortage of shipping containers has emerged, with key factors being:

- ports facing a changed balance between import and export container flows, with empties accumulating at many US ports.
- 20% of the global container ship fleet being delayed berthing by port congestion. Shipping's on-time performance has fallen from 80% pre-pandemic to 36% mid 2021 (SeaIntelligence)
- stranded across a disrupted distribution system
- being used for temporary storage.
- shipping lines receiving financial incentives to return containers to Asia, with one estimate suggesting 35% of all containers being exported from the US were empty, despite albeit reduced demand from US exporters.

Meanwhile, lockdowns hampered the construction of new containers (especially in China and South Korea), with construction capacity proving hard to restore. The cost of new containers has doubled through the pandemic.

11.3 Complex Supply Chains

11.3.1 All On Site

Traditional (pre-globalisation) supply chains were simple and linear, with a manufacturer depended on itself or a few nearby suppliers to produce the goods. Demand management was based on judgement, with inventories maintained to accommodate peaks in demand.

Over the last half century, supply chains have evolved, optimised to minimise cost, maximise efficiency and minimise inventory (Just-In-Time). In doing so, they have become ever more complex, relying on advanced technologies, scale and complex inter-dependencies across many suppliers, sites, and countries. And crucially they are reliant on an efficient global transport system and advanced inventory management.

11.3.2 Just in Time

Over time, as inventory and demand management improved, and manufacturing facilities matured, supply chains were based on Just In Time. Inventories were kept to a minimum, depended on complex inter-dependencies with suppliers. Manufacturing was often located offshore where input costs (wages and health and safety) were low (notably China, Vietnam, India, Bangladesh). Flexibility was required to allow for quick responses to changes in demand (quantity or a new product). Great reliance was placed on transport, delivering raw materials and components through the supply chain, and to quickly move completed goods through lean distribution centres then to lean retailers. As an example, Apple's iPhone uses components from more than 200 suppliers across 43 countries.

The Covid pandemic has revealed the fragility of Just in Time – the myriad of factors which can trip the process, and exposed consumers to delivery delays, or simply a lack of inventory. While numerous responses will emerge, two key options are emerging, Just In Case and Near-Shoring.

11.3.3 Just In Case.

What the Covid pandemic has made abundantly evident is that these complex supply chains are vulnerable at every link in the supply chain.

Retailing is a competitive business often with low margins. While customers will always seek quality at low prices, what they assume and demand is service – the availability of choice and product at hand. Just In Time could deliver all these – so long as the supply chain (manufacturing transport system) was operating efficiently.

Just as consumers "stocked up" on essentials (such as toilet paper!) during Covid lockdowns, wholesalers and retailers are recognising that the ability to quickly/ immediately supply customers with merchandise may offset the higher cost maintaining larger inventories – Just In Case. Ironically, building inventories has exacerbated pressure of shipping and supply chains.

11.3.4 Near-Shoring

Where manufacturing had previously been "off-shored" to low cost countries, there is wide commentary (but not yet evidence) now emerging regarding the merits of "reshoring" and "near-shoring" manufacturing. Both reshoring and near-shoring reverse the trend of globalisation, with supply lines shortened (to home or adjacent countries), and the steps in the chain reduced or simplified. Several parallel near-shoring sites might be established, each serving a "local" market. While costs are inevitably higher, they will provide greater reliability in the face of transport disruption, and where disruption occurs at one site, that region may be serviced from the others. In addition to other considerations, manufacturing will be more explicitly optimised for security of delivery.

11.3.5 Air Freight

In the near-term, high value goods are being air-freighted. Airlines, in the absence of passengers, have maximised the use of their holds. In one example, imports by air into US of Asian textile and apparel goods rose from 9% in 2019 to 22% in 2020.

11.4 Other Trends in Global Shipping

The Covid pandemic has accelerated wider trends that could transform global shipping.

11.4.1 E-Commerce

We have become more familiar with the opportunities and benefits of the online world - shopping, banking, research, and entertainment. However, with much of the global population confined to home during the Covid lockdowns, businesses and households by necessity pivoted to existing capabilities in e-commerce. Staff worked from home, face-to-face contact with customers was substituted with video calls. Remarkably, this pivot did not material impair economic activity – excepting face-to-face sectors such as hospitality and tourism. The changes occurred in consumer shopping and spending habits where, deprived on services, household boosted demand for digitally enabled supply chains (distribution facilities, warehouses, logistic, on-demand and last mile delivery – such as Amazon). These are amongst the highest growth sectors as a result of the Covid. While the world is now learning to live with Covid, many anticipate it has heralded permanent structural change towards these new household online spending habits. The extent to which these shifts from online retailers towards direct trading with manufacturers (or platforms such as AliExpress) is yet to be established. This demand for goods, many sourced from remote suppliers, will play into new business opportunities for shipping and ports.

11.4.2 Digitalisation

Managing the logistics supply chain is becoming more complex, and increasingly managed through connectivity and Artificial Intelligence systems. Tracking containers and real-time monitoring of refrigerated containers has been around awhile. More widespread remote management and monitoring of containers will further transform risk management, especially goods with special requirements (such as temperature management of food or vaccines) to reduce spoilage of time-sensitive products. Distributed ledger technology (DLT), employing blockchain, is claimed to enhance efficiency, reduce costs, and ensure immutability, traceability, security, and transparency, and studies have shown it can help to solve several problems, including external barriers, such as problems with contracts, financing, lack of trust, raw materials, lack of information, domestic and international market limitations, IP rights, and governmental regulations as well as bureaucracy. It is being adopted by the maritime insurance industry, to help streamline and certify multiparty arrangements and has claimed to reduce overheads by up to 40%.

11.4.3 Automation.

The need to operate remotely, and more difficult access to a skilled workforce, have encouraged digitalization and automation. These have permitted commerce to resume under lockdown restrictions and should in time deliver efficiency and cost savings. New technologies and systems on ships, such as navigation, remote monitoring and automation, have permitted ship operators to progressively trim crew numbers of on-board modern ships.

11.4.4 Resilience

In addition to the required changes in outputs (service frequency and reliability), ship operators also face changes to inputs, and tests of flexibility and resilience. Tightening environmental standards (MARPOL VI) have required changes to ship bunkers and operating efficiency, biosecurity issues have affected operating protocols (import clearance, ballast water, crew changes), while the Covid Pandemic has required major changes to managing and cycling crew.

11.4.5 De-globalisation

Should near-shoring and reshoring accelerate, this could arrest (or even reverse) five decades of globalisation-driven growth in ocean trade. Shipping lines will need to mirror manufacturing's move to near-shoring by becoming more flexible. This may require material changes to schedules, ports of call, distances travelled, with implications for vessel types and sizes.

11.4.6 Consolidation

The largest shipping lines are getting larger through acquisition, and even the largest form alliances to optimise efficiency. As similar trend is evident in maritime connectivity and logistics. The stresses arising from the Covid pandemic have accelerated these trends.

All of these trends have been evident for some years, although the Covid pandemic has demanded a quick pervasive recalibration across economic and social activity. The immediate disruption from the Covid pandemic is widely expected to continue into 2023. Yet even then the world may never return to the old normal, but rather these adaptions may become permanent features of the way our lives and commerce are conducted. With the inter-connectedness borne of globalised supply chains, any structural changes will need to be facilitated by a smart, resilient, and sustainable maritime transport system.

11.5 Other Commentary

11.5.1 Deloitte – NZ Ports and Freight Yearbook 2022

Building resilience through disruption

Deloitte publishes an annual review of the NZ port and freight sector. Despite the strong recovery in 2021, it raises doubts about the global economy following disruption of the Delta and Omicron Covid variants disrupted undermining what promised to be strong economic recovery. Heightened demand from loose

monetary policy and fiscal stimulus, supply chain disruptions, a tight labour market, and strong wage inflation have all led to strong inflationary pressures. Inflation is evident in the headline numbers but also the underlying drivers (excluding imported price changes), affecting both tradable and non-tradable goods. Consumer Price Index hit 5.9% in the year to December 2021 – a level not seen since 1991, and has spurred the Reserve bank to raise the OCR - likely to reach more than 3% by the end of 2023.

11.5.2 S&P

The pace picks up for marine decarbonization

Scrubber retrofits postponed: The price spread between 0.5%S and 3.5%S bunker fuel oils (known as the Hi-5) has remained stable at over US$100/mt. Nevertheless, in 2021 interest in retrofitted scrubbers has fallen while appetite for alternative marine fuels has risen to meet the IMO's 2030 and 2050 climate targets. Currently 3.9% of the seaborne fleet and 31.2% of the order book (170 ships) are capable of using alternative fuels or battery-hybrid propulsion. IEA studies showed that hydrogen and ammonia will be the main marine fuels to achieve net-zero in 2050.

EU proposes curbs on shipping fuel emissions: The European Commission proposed July 14 limits to greenhouse gas content of ship bunkers, a minimum taxation rate for marine fuels, and the inclusion of shipping emissions in the EU's emissions trading scheme.

11.5.3 Upply

The prospects for container shipping in 2022

Tailwinds: After an exceptional financial year in 2021, the shipping companies hold all the cards to do even better in 2022. Demand in Western countries for products manufactured in Asia, particularly China, remain strong. Shipping capacity is fully deployed, supporting freight rates. Port congestion remains a major issue. The three leading shipping alliances control the market. Shipping companies are exploiting market power, while governments remained focussed on ports.

Headwinds: Shippers and forwarders distrust shipping lines who have taken excessive advantage of market power. Nearshoring and reshoring is developing. Supply chains which relied on low-cost transport must now adjust to rates stabilising at high levels. The pressure to decarbonise is driving supply chain decisions. Inflation is affecting Western countries, not being matched by salaries, so purchasing power is falling. Some shipping lines are breaking ranks, integrating into logistics and adopting more shipper-friendly approaches, splitting the existing consensus between Chinese and Western shipping groups.

Upply's three scenarios for 2022

- Scenario 1: the shipping companies continue to lead the dance. Congestion maintains pressure on capacity, which may blocking the entire supply chain.
- Scenario 2: the global supply chain seizes up. The leading shipping companies have focussed on the biggest, most profitable trade lanes, and are neglecting some secondary markets – creating opportunity for smaller local shipping companies.
- Scenario 3: the smaller operators gain market share. Second tier operators seek market share by discounting to the big four companies.

Conclusion. Shipping companies are keeping control of the market, expanding into forwarding/logistics, and becoming players in financialisation of environmental issues (that is, gaining influence over economic policy and outcomes).

12 Impact on Shipping in NZ

The impact of the Covid pandemic on shipping in NZ mirrors that observed globally, with the surge in demand for goods compounding supply chain disruption. The general challenges include port congestion (particularly Auckland), delays and cancellations of ship sailings, shortages of containers and high sea freight rates. NZ is particularly dependent on shipping for trade, and its small scale (relevance, priority to shipping lines) and remoteness make it more vulnerable.

Our "business as usual" baseline is Rockpoint's Coastal Shipping paper forming part of Te Manatū Waka's Domestic Transport Costs and Charges study covering the year to June 2019.

12.1 Observations Through Covid Pandemic

12.1.1 Strong demand for sea freight

NZ's demand for manufactured consumer goods has been surged through the pandemic, although most goods purchased by individuals online are imported by air freight. NZ's challenge therefore is less record sea freight, but managing flow-on effects of the global demand for container shipping.

12.1.2 Ports are congested

Global ports have never been busier, a combination of both a surge in throughput, compounded by pandemic constraint and disruption. NZ similar faced port congestion, particularly in Auckland before its container terminal automation project was deferred in June 2021. By mid-2021, Auckland's average berthing delay time (scheduled ETA to at berth) was 3.4 days while updated vessel ETA to at berth was 0.5 days (POAL Operational Update 30 June 2021). This indicated that ships were arriving 3 days late (on a rising trend), while there were only short delays in the ships being received at berth (improving trend, limited requirement to wait on anchor). The container yard was operating at 105% capacity, with average container dwell times 2.7 days for imports and 5.8 days for exports. Truck turn times were high due to congestion in the container yard.

12.1.3 Falling schedule reliability

Mirroring global trends, but worse, reliability shipping schedule to NZ have plunged from above 80% before the pandemic to a historic low of just 6% in June 2021, according to Sea Intelligence. The reflected cascade of port delays in Asia, Sydney and also Auckland, resulting in port calls being skipped, or voyages being blanked.

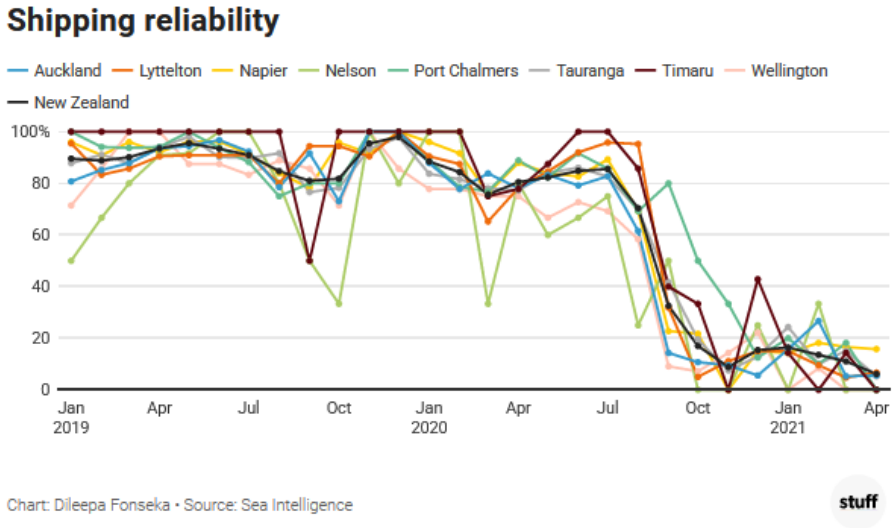


Figure 39: Shipping reliability

Lyttelton confirms its export capacity has been reduced and container dwell times increased. Napier says 40 container ships have missed scheduled calls in the eight months to May 2021, offset by 23 unscheduled calls. Ports expect disrupted shipping schedules will persist into 2023.

12.1.4 Freight pricing extreme.

Global shipping rates are up more than 6-fold from pre-pandemic. These market dynamics are reflected in NZ, with extreme rates combining new congestion "surcharges" despite a reduction in capacity and reliability.

12.1.5 Shortage of containers.

The 20% spike in demand for sea freight during the pandemic does not fully account for the dire shortage of available containers in NZ and worldwide. Global container flows have been badly disrupted, resulting in more than 20% being stuck on ships, in ports or inland freight hubs, or used as temporary warehousing. Locating and tracking shipping containers has become problematic.

NZ's shortage is compounded by the structural imbalance in container flows.

- Imports of goods are predominantly focussed on Auckland, while exports are ultimately from southern ports
- Imports are largely in dry containers, while exports are weighted towards refrigerated containers (for perishable products such as dairy, meat, fish and fruit and vegetables). (FIGS)
- The flows, particularly export produce, are seasonal, requiring shortfalls to be brought from or taken overseas.
- International shipping lines historically repositioned containers to meet market demands but, under pressure, currently consider that business stream unattractive. This places NZ's only domestic container ship, Pacifica's Moana Chief (small at 1740TEU against the 5000 TEU average of foreign container ships), under mounting pressure to keep up, noting that pre-pandemic it was already operating close to capacity on the pivotal Auckland-Lyttelton leg of its weekly schedule.

12.2 Government Risks and Opportunities

While the Government has responding effectively to businesses calling for intervention, the dynamics of the container shipping sector are complex, and the Government has few levers to influence or secure more reliable shipping.

Unquestionably, Covid has brought severe disruption to NZ's trade flows, a major issue which may cost more than $10 billion annually until resolved. However, the factors driving the disruption are predominantly offshore – high global demand for shipping capacity, offshore port congestion, shipping lines overstretched and focussing on high-volume routes, lack of containers and record-high freight rates. These are not factors the NZ Government can influence. The Government has already directly lobbied the shipping lines, appealing for restraint on prices and surcharges, with some success. While some NZ stakeholders have called for the Commerce Commission to investigate competition between the shipping lines, arguably this is not the right time to be pushing that button.

12.2.1 NLTP Funding

In August 2021, in the release of the 2021-24 National Land Transport Programme (NLTP), the Government allocated $30 million to "strengthening our domestic supply chain by making coastal shipping a more viable alternative for moving freight within New Zealand'. In December 2021 Waka Kotahi released an initial report on coastal shipping to assist the Government decide how best to invest that $30 million funding. Waka Kotahi proposes it will invest that fund in business case proposals which:

- Enhance domestic shipping services, through new services, increased frequencies, and additional ships for new or existing container and bulk services.
- Reduce shipping emissions through testing emerging technologies.
- Improve efficiency with upgrades to rail or road links to and from ports.

- Upgrade maritime infrastructure including shore power connections at ports, small new regional ports, and expan

On 24 May 2022, the Minister of Transport announced four applicants for co-investment in new and enhanced coastal shipping services (Coastal Bulk Shipping Ltd, Move International Ltd, Swire Shipping NZ Ltd (Pacifica Shipping) and Aotearoa Shipping Alliance) - Sec 9.3.

Domestic Transport Costs and Charges annual research

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