India

Underweight *(no change)*

Highlighted Companies

Reliance Industries

ADD, TP Rs3369, Rs2618 close

Reliance Industries is the best play on India's energy diversification. It is already in the process to establish a 10GW electrolyser plant and is well-placed to tap into new technological developments happening across the world in fuel cell, electrolyser, and liquid hydrogen transportation.

Clean Science and Technology

REDUCE, TP Rs847, Rs1512 close

Clean Science is one of the costliest stocks in the hyper-costly specialty chemicals sector. May be the market believes that Clean Science will discover some new chemical because of its superior chemistry skills. However, its foray into TBHQ and PBQ points to the contrary. Raw material cost increase will erode the margins.

Summary Valuation Metrics

P/E (x)	Mar22-A	Mar23-F	Mar24-F
Reliance Industries	25.98	16.13	14.65
Clean Science and Technology	70.36	60.51	53.53

P/BV (x)	Mar22-A	Mar23-F	Mar24-F
Reliance Industries	2.15	1.93	1.73
Clean Science and Technology	20.92	17.05	14.14

Dividend Yield	Mar22-A	Mar23-F	Mar24-F
Reliance Industries	0.29%	0.31%	0.32%
Clean Science and Technology	0%	0%	0%

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Oil & Gas - Overall

Ammonia & methanol as marine fuels

- With CII and EEXI norms to be implemented from 1 Jan 2023 by the IMO, we believe ammonia and methanol demand is likely to go up.
- Previously, VLSFO adoption went ahead, as per IMO guidelines for the shipping industry, because customers forced it. Similarly, we believe EEXI and CII norms are likely to be adopted at the insistence of customers.
- Sell users of ammonia and methanol as raw material cost pressure won't ease even after several years (as capacity is low). Clean Science has REDUCE and RIL has ADD rating on this theme. Urea prices may stay higher for a long time.

EEXI & CII norms in shipping to result in higher NH_3 & CH_3OH prices

The usage of ammonia (NH_3) and methanol (CH_3OH) as fuels, either in grey or green form, can have a wider implication than green hydrogen. Firstly, its handling is easy as ammonia can be stored at a much higher temperature compared to green hydrogen (-33^{0}C compared to -253^{0}C) while methanol can be stored at room temperature and at the same, both are much less volatile compared to green hydrogen. Hence, ammonia/methanol can have wider usage as a fuel in international bunkerage. In the likely scenario of 100% replacement of very low sulphur fuel oil (VLSFO), 50% replacement of heavy fuel oil (HFO) & 25% replacement of diesel oil by ammonia and methanol in equal proportion, there is likely to be shortage of both ammonia and methanol. Please note that even grey ammonia and methanol are better than using VLSFO, HFO or diesel oil vis-à-vis carbon emission perspective. Carbon emission and energy efficiency of shipping companies will become a key monitorable from 1 Jan 2023 when the **IMO** (**International Maritime Organization**) implements its new norms and ships are going to be graded as per **CII (Carbon Intensity Indicator) and EEXI (Energy Efficiency Existing Ship Index)**.

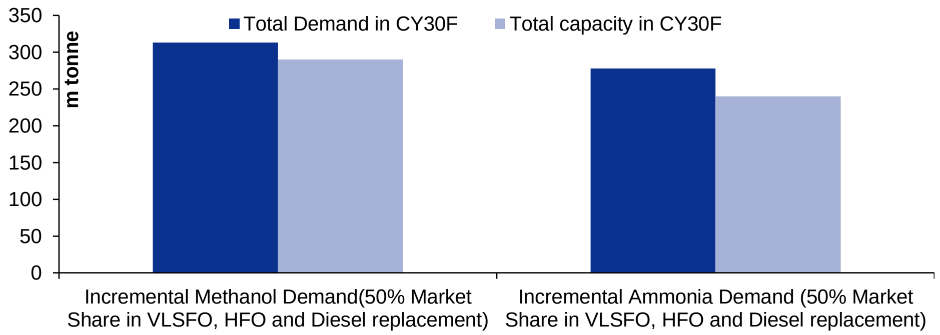
Will EEXI and CII norms be followed by shipping companies? Yes

Ultimately, it depends on the customers. When the IMO came out with a 0.5% sulfur-based fuel oil norm, shipping companies adopted it because customers forced them. Even now, if customers stop doing business with any ship having lower CII and EEXI than the threshold, shipping companies will be forced to change. There are indications that customers are already insisting on following the CII and EEXI certifications. Naturally, shipping companies will have to change, and this will create demand for fuels with lower carbon emission and thus, higher demand for ethanol/ammonia. Please note that green hydrogen-based ammonia and methanol are viable and as prices go up, green hydrogen projects will get further acceleration. Please click here for our note on green hydrogen

What to buy/sell based on this theme? Sell chemical names

Indian chemical companies are buyers of methanol and ammonia. Even grey ammonia and methanol (grey ammonia is made from fossil fuels without carbon capture) is better than using heavy fuel oil, VLSFO or marine diesel oil. While the technology to use ammonia as bunkerage is in an advanced stage of development and methanol has already been developed, capacity addition in these chemicals is not keeping pace. We expect a rise in the prices of these chemicals, which is a negative for users.

Figure 1: Incrementally, both ammonia and ethanol will be in short supply and their prices will be on the upswing as traditional bunkerage fuels gets replaced by them



SOURCE: INCRED RESEARCH, COMPANY REPORTS

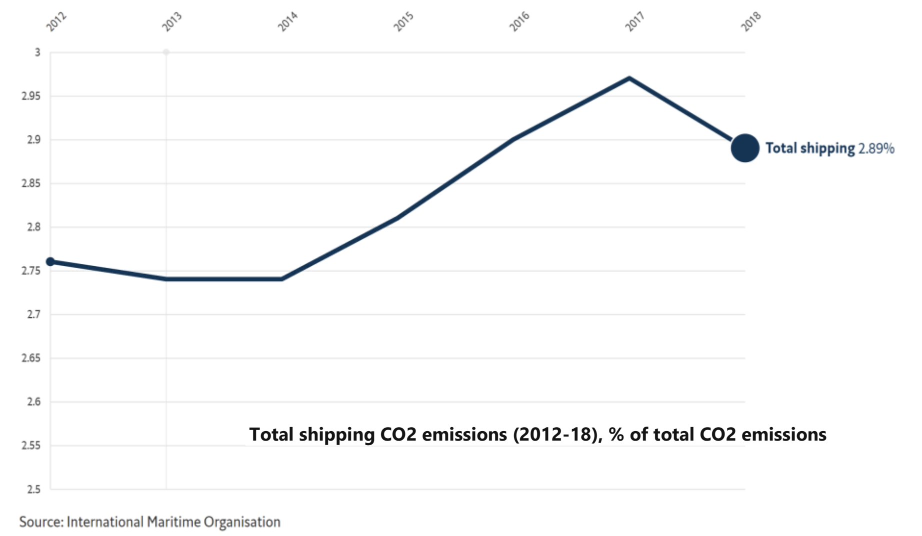
Ammonia & methanol as marine fuels

Ammonia and methanol usage as a fuel, either in grey or green form, can have a wider implication than green hydrogen. Firstly, its handling is easy as ammonia can be stored at a much higher temperature compared to green hydrogen (-33^{0}C compared to -253^{0}C) and methanol can be stored at room temperature and at the same time, both are much less volatile compared to green hydrogen. Hence, ammonia/ methanol can have wider usage as a fuel in international bunkerage. In the likely scenario of 100% replacement of very low sulphur fuel oil, 50% replacement of heavy fuel oil, and 25% replacement of diesel oil by ammonia and methanol in equal proportion, there is likely to be a shortage of both ammonia and methanol. Please note that even blue ammonia and methanol are better than using VLSFO, HFO or diesel oil vis-à-vis carbon emission perspective. Carbon emission by shipping companies will become a key monitorable from 1 Jan 2023 when the International Maritime Organization or IMO implements its new norms and ships are going to be graded as per CII (Carbon Intensity Indicator).

Shipping and carbon emission

Shipping is one the major contributors to carbon emission in the world.

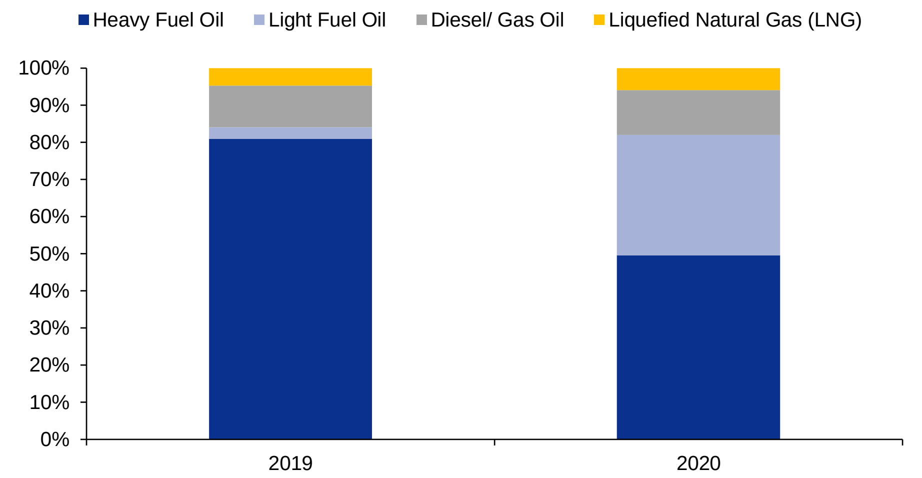
Figure 2: Shipping is one the major carbon emitters



SOURCE: INCRED RESEARCH, HTTPS://OCEAN.ECONOMIST.COM/INNOVATION/ARTICLES/TACKLING-CLIMATE-CHANGE-IN-THE-MARITIME-SECTOR-AT-IMO-UNEP-INNOVATION-FORUM?GCLID=CJWKCAIA7IGCBHA8EIWAFFUDSENNRJ67RQQ0UQJTUSVVYDNTYZUR4Z8VIVTLIF0UPNNSK-0GIENF8ROC8YSQAVD_BWE&GCLSRC=AW.DS

As of now, shipping Industry uses crude oil derivatives as bunker fuels ➤

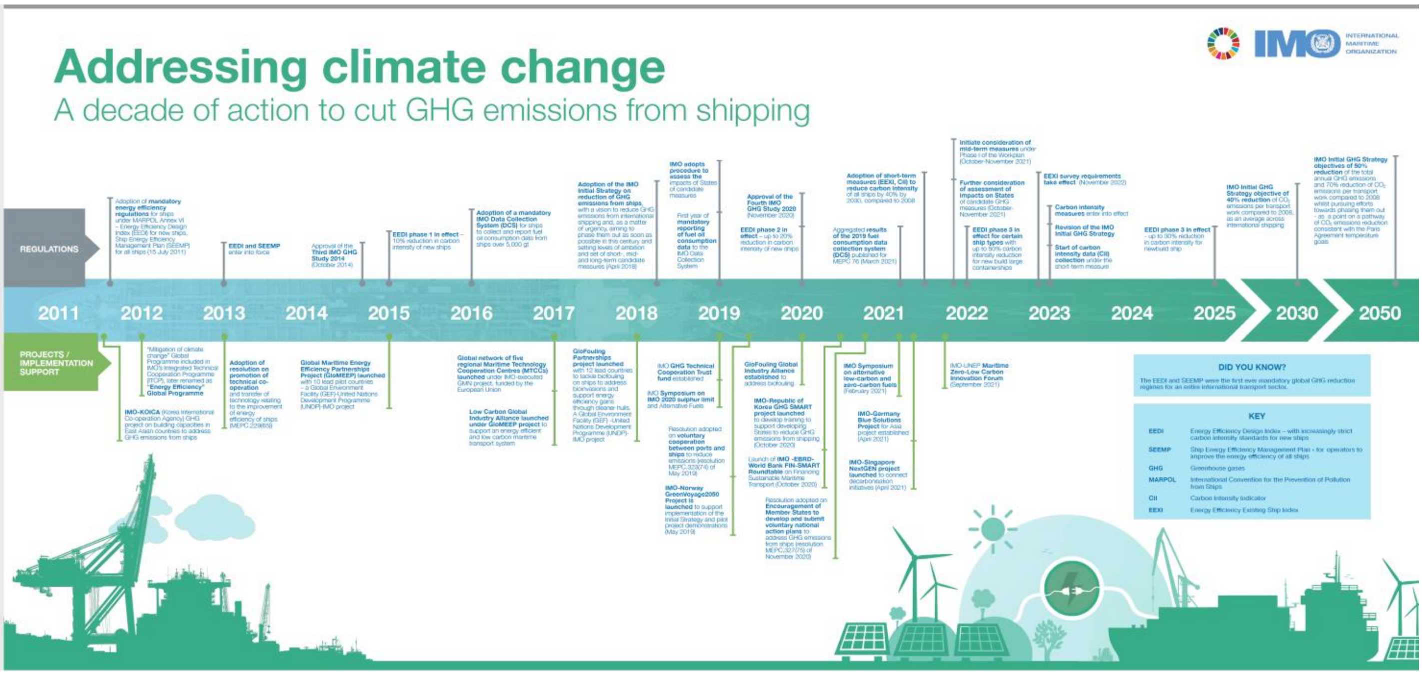
Figure 3: Annual fuel consumption by ships worldwide from 2019 to 2020, by fuel type



SOURCE: COMPANY REPORTS, INCRED RESEARCH

IMO has set an ambitious carbon emission reduction target for the shipping industry ➤

Figure 4: IMO has launched a mandatory carbon emission reduction regime across the world for the shipping industry, and it has been one of the first organizations to do so



SOURCE: COMPANY REPORTS, INCRED RESEARCH

IMO guidelines for the shipping industry are as follows: ➤

1. Carbon intensity of the shipping industry to decline through implementation of further phases of the energy efficiency design index (EEDI) for new ships to review with an aim to strengthen the energy efficiency design requirement for ships, with the percentage improvement for each phase to be determined for each ship type, as appropriate.
2. Carbon intensity of the international shipping industry to decline to reduce CO2 emission per transport work, as an average across international shipping, by at least 40% by 2030F, pursuing the efforts towards 70% by 2050F compared to 2008.

3. To reduce the total annual GHG emission by at least 50% by 2050F compared to 2008, while pursuing efforts towards phasing them out as called for in the Vision as a point on the pathway of CO2 emission reduction, consistent with the Paris Agreement temperature goals.

IMO's 2023 guidelines will lead to a sea change in the international shipping industry

The revised regulatory requirements from the IMO have come into force from 1 Nov 2022. Hence, the requirements for EEXI (Energy Efficiency Existing Ship Index) and CII (Carbon Intensity Indicator) certification will come into effect from 1 Jan 2023. This means the first annual reporting will be completed in 2023F, with the first rating given in 2024F.

So, what changes are expected with the IMO's 2023 guidelines and what is the objective behind each of these measures?

The attained Energy Efficiency Existing Ship Index (EEXI) is required to be calculated for most commercial vessels in accordance with different values set for vessel types and size categories. This indicates the energy efficiency of the vessel compared to a baseline. Vessels are required to meet a specific required EEXI, which is based on a required reduction factor (expressed as a percentage relative to the EEXI baseline). **All vessels must have a calculated EEXI.**

The Ship Energy Efficiency Management Plan (SEEMP) is a mandatory, ship-specific document that lays out the plan to improve the vessel's energy efficiency in a cost-effective manner.

A vessel's Carbon Intensity Indicator (CII) links the GHG emissions to a ratio of the amount of cargo carried and the distance travelled. The CII will determine the annual carbon reduction factor needed to ensure continuous improvement of the ship's operational carbon intensity within a specific rating level.

All vessels must have an established CII and will receive a rating (A, B, C, D, or E – where A is the best).

Any ship rated D or E for three consecutive years must submit a corrective action plan to show how the required index (C or above) may be achieved.

How can shipping companies adhere to these changes in the regulations?

1. There are many things a ship can do to improve its rating through various measures taken on existing capital. Many efficiency improvements and emission reduction pathways are being executed by carriers, such as hull cleaning to reduce drag, steam speed adjustment, routing optimization, and fuel switching.
2. The IMO is yet to set a net-zero emission target, but many individual ocean shipping companies—including container lines—already have.

Customer demand for green transport is pushing carriers and ship-owners to action and invest in carbon-neutral vessels. This is creating an environment where access to green shipping lanes in the not-so-distant future will offer a competitive advantage to BCOs (beneficial cargo owners) seeking to progressively reduce their global shipping carbon emission.

What are the advantages of these regulations?

The regulations will encourage the improvement of vessel efficiency, adoption of low-carbon alternative fuels, and lower carbon emission in international shipping. These coming changes create challenges and opportunities for vessel owners/operators seeking compliance and the beneficial cargo owners seeking opportunities to lower the energy cost and emission needed to get their goods to the customers. How all of these changes will impact the industry is a guess work at this point of time, and as per some opinions, the cost of ocean shipping will increase significantly while others feel that all these measures are needed to help solve and comply with the goals set.

How these measures can be enforced? Simple, by customers refusing to to use the vessels that do not adhere to the guidelines ➤

While the IMO cannot ban any ship, the most powerful tool will be the customers refusing to use the ships that don't adhere to the guidelines.

How can shipowners control their CII? ➤

The CII is based directly on:

1. The fuel consumption, which is influenced by how a specific ship is operated in combination with its technical efficiency and fuel.
2. Its value that will be affected by the type of fuel used (cleaner and greener fuel will lower CII).
3. Efficiency of the vessel.
4. Operational parameters such as the vessel speed, cargo transported, weather conditions and general condition of the vessel (e.g. biofouling).

Ammonia can emerge as a shipping fuel of choice with a lower CII

There are various fuels that can be used as alternative fuels but, in our view, ammonia stands out to be the best.

Figure 5: LNG can be an easier transition fuel, but cannot be used now as its prices are skyrocketing

Alternative Fuels	Advantages	Disadvantages
Liquified Natural Gas (LNG)	— Already in practical use — Infrastructure being developed — Lower in cost as compared to traditional marine fuels — High energy density — Specific regulations for LNG in IMO's International Code of Safety for Ships using Gases or other Low-flashpoint Fuels (IGF Code)	— Commonly known as a 'transition fuel' as reduction of CO2 emissions is limited — Requires a temperature of -162C to stay in liquid state — Low volumetric density (storage takes nearly twice the space of traditional marine fuels) — Bunkering, storage and handling requires much more care than traditional marine fuels — Methane slip (GHG impact 25 times greater than CO2 emissions) — Possible criticism for the use of fossil fuel
Liquified Petroleum Gas (LPG)	— Lower in cost as compared to traditional marine fuels	— Similar to LNG, reduction of CO2 emissions is limited — As with LNG, LPG storage requires larger tanks — Limited operational experience — Lack of bunkering infrastructure — Slippage factor (GHG impact 3-4 times higher than CO2 emissions) — Possible criticism for the use of fossil fuels
Biofuels	— Commonly used biofuels are hydrotreated vegetable oil (HVO) and biodiesel (FAME, fatty acid methyl ester) — Carbon neutral - derived from biologically renewable resources such as plant-based sugars, etc. — Usually blended with traditional marine fuels or used as a 'drop-in' fuel, compatible with current conventional marine engines.	— Higher in cost as compared to many fossil fuels — Technical issues that could lead to machinery breakdown if not managed properly - storage stability, biological growth (biofouling), acidity, plugging of filters, and increased engine deposits — Limited production capacity and availability
Hydrogen (H2)	— No CO2 emissions — Suitable for use in fuel cells for small vessels — 'Green' production by way of electrolysis powered by renewable energy is possible — Falling cost of renewable energy may lower green production costs.	— Does not exist naturally - produced mostly from fossil fuel sources (energy-intensive process). 'Green' production currently expensive — Low energy density — Large fuel volume (require 8 times more volume than fuel oils for equal power output) - consequent storage capacity issues — Fuel cells not currently capable of powering large vessels — Requires a temperature of -253C to stay in liquid state — Immaturity of bunkering technologies — Lack of bunkering infrastructure — Highly combustible and explosive, giving rise to safety issues — Combustion produces nitrous oxides (NOx emissions) — Large capital investment needed for storage and refuelling infrastructure for shipping
Ammonia (NH3)	— No CO2 emissions — Conversion process relatively cheap and uncomplicated — 'Green' production, using green hydrogen and renewable power for the conversion process, is possible — Higher energy density than hydrogen; storage requires refrigeration only — Already produced in substantial volumes for the chemical industry — Handling issues in relation to marine transportation are already well understood — Used for combustion in gas turbines	— Currently made using natural gas. The conversion process requires an additional input of energy compared to green hydrogen — Requires energy input for refrigeration — Less energy dense than fuel oils — Large fuel volume (approx. 2.7 times that of HFO) — N2O emissions (GHG impact is 300 times greater than that of CO2 emissions) — Highly toxic – requires careful handling — Technical challenges in combustion, such as low flammability (without pilot fuels) and difficulties in increasing engine output — Requiring larger storage capacity and/or more frequent refuelling — Large capital investment needed for storage and refuelling infrastructure for shipping
Methanol (CH3OH)	— Liquid at ambient temperatures, no need to heat or cool — Easy to store and handle — Low cost for conversion of existing engines — Minor modifications to existing storage and bunkering facilities — Widely traded, well understood and already available in some ports for bunkering — Biodegradable, with a lower impact on the environment in the event of spillage — More energy dense than hydrogen and ammonia — Clean burning fuel with low levels of SOx, NOx and particulate matter.	— Production mainly from natural gas or coal, as such reduction of CO2 emissions is limited — Lower energy density than fuel oil — Large fuel volume approx. 2.4 times that of fuel oil - requiring larger storage tanks and/or more frequent bunkering — Low flash point represents a fire risk — Toxic when inhaled, ingested or handled — Increased corrosion risks — Large capital investment needed for more widespread storage and refuelling infrastructure for shipping

SOURCE: COMPANY REPORTS, INCRED RESEARCH

Ammonia scores higher as an alternative fuel for the shipping industry ➤

Carbon emission

Ammonia is a compound of nitrogen and hydrogen. As ammonia contains no carbon, it does not emit any CO_2 when used to fuel an internal combustion engine. This creates the potential for truly zero carbon propulsion. An additional small quantity of pilot fuel is required for combustion, but it should also be zero carbon. However, what must be considered is that most ammonia today is produced from natural gas and so from a lifecycle perspective it is not zero-carbon, which is something the industry needs to address if ammonia has to be pursued as an alternative fuel.

Acceptable energy density

One attraction of current fossil-based fuels is their high volumetric energy density. Most alternative fuels are unable to match this, which means they take up valuable cargo space onboard a ship. Ammonia's volumetric energy density is broadly similar to methanol and is higher than hydrogen, making its onboard storage economically feasible, albeit not as compact as the heavy fuel oil (HFO) used currently.

Relatively easy to handle

Ammonia is often compared with hydrogen. Both are stored in a liquid form, but hydrogen requires cryogenic tanks maintained at -253°C while ammonia requires less cooling and can be stored at a temperature of around -33°C. Ammonia is manufactured from hydrogen, and so for zero-carbon ammonia we need 'green' hydrogen manufactured by using renewable energy.

Economics has a long-term potential. Ammonia is a global commodity with transparent pricing and so, a market already exists. A major portion of current supply comprises 'grey' ammonia, manufactured from hydrogen created from natural gas, which generates significant CO_2 emission. The shipping industry's goal is to produce 'green' ammonia from renewable energy. While this will be much more costly in the short term, we feel the prices should fall substantially as production is scaled up.

Major challenges are land-based

The focus is often on carbon emission generated from a ship's engine and ancillary systems on board. Yet, substantial emission is also generated in the production and supply of fuel, through extraction of energy sources, fuel manufacture, transport and storage at port. To avoid shifting the problem upstream, the shipping industry needs to consider the whole supply chain.

A 2020 study by University Maritime Advisory Services (UMAS) and the Energy Transitions Commission found that US$1-1.4tr is needed to achieve the IMO's carbon reduction target by 2050F. The study also highlighted that around 87% of the total investment is needed in land-based infrastructure and production facilities for low-carbon fuels. In many cases, the upstream challenges are also tougher to overcome, as they involve many more stakeholders and these huge infrastructure investments could have significant impact on the people and the environment.

A worldwide ammonia distribution system is already in place, but the fuel needs to be available at the right locations and at the right volume. The existing ammonia transport network connects production and storage locations that serve the industrial market; it does not reach the ports in a way that would allow ships to bunker.

The perception regarding ammonia by the wider community, outside fleet operators, needs to change for it to become accepted as a fuel. Port authorities and regulators are currently reluctant to permit bunkering of ammonia due to toxicity hazard, while the reaction of citizens to large-scale ammonia storage at ports is untested. While current regulations preclude the use of ammonia as a fuel for shipping, classification societies and other groups are working to assess the risk and provide guidance that will lead to new rules and standards.

The current stage of readiness for various sources as a bunkering fuel is given below:

Figure 6: Green hydrogen's standing as a green fuel is way below that of green ammonia; ammonia's energy density is higher and it's easier to carry and burn; it is also least risky

TRL	Bunkering			Storage onboard					Processing and conversion			Propulsion			
	Equipment	Procedures	Fuel quality standards	Structural tank	Membrane containment system	IMO type A tank	IMO type B tank	IMO type C tank	Venting system	Fuel supply system	Reformer	2-Stroke ICE	4-Stroke ICE	FC	Boiler
LSHFO ICE reference ship	9	9	9	9					9	9		9	9		9
Bio-diesel ICE	9	9	9	9					9	9		9	9		9
E-diesel ICE	9	9	9	9					9	9		9	9		9
Bio-methanol ICE	7	6	3	7					7	7		7	6		2
E-methanol ICE	7	6	3	7					7	7		7	6		2
Bio-methanol FC	7	6	3	7					7	7	3		6	7	2
E-methanol FC	7	6	3	7					7	7	3		6	7	2
Bio-LNG ICE	9	9	9		8		9	9	9	9		9	9		9
E-LNG ICE	9	9	9		8		9	9	9	9		9	9		9
Bio-LNG FC	9	9	9		8		9	9	9	9	4			7	
E-LNG FC	9	9	9		8		9	9	9	9	4			7	
E-ammonia ICE	7	2	2			7	7	7	3	7		3	2		2
NG-ammonia ICE	7	2	2			7	7	7	3	7		3	2		2
E-ammonia FC	7	2	2			7	7	7	3	7	2		2	7	2
NG-ammonia FC	7	2	2			7	7	7	3	7	2		2	7	2
E-hydrogen ICE	4	2	3				3	6	2	2		2	5		2
NG-hydrogen ICE	4	2	3				3	6	2	2		2	5		2
E-hydrogen FC	4	2	3				3	6	2	2			5	7	2
NG-hydrogen FC	4	2	3				3	6	2	2			5	7	2
Batteries	4	2	3				3	6	2	2			5	7	

SOURCE: INCRED RESEARCH, TECHNO-ECONOMIC ASSESSMENT OF ZERO-CARBON FUELS, HTTPS://MARITIME.LR.ORG/

Study of different fuels in a sample bulk carrier has been done and ammonia is set to be the cheapest fuel over the next few years

Figure 7: Total cost of operation of a bulk carrier which runs on E-ammonia-based ICE (internal combustion engine) is likely to go down

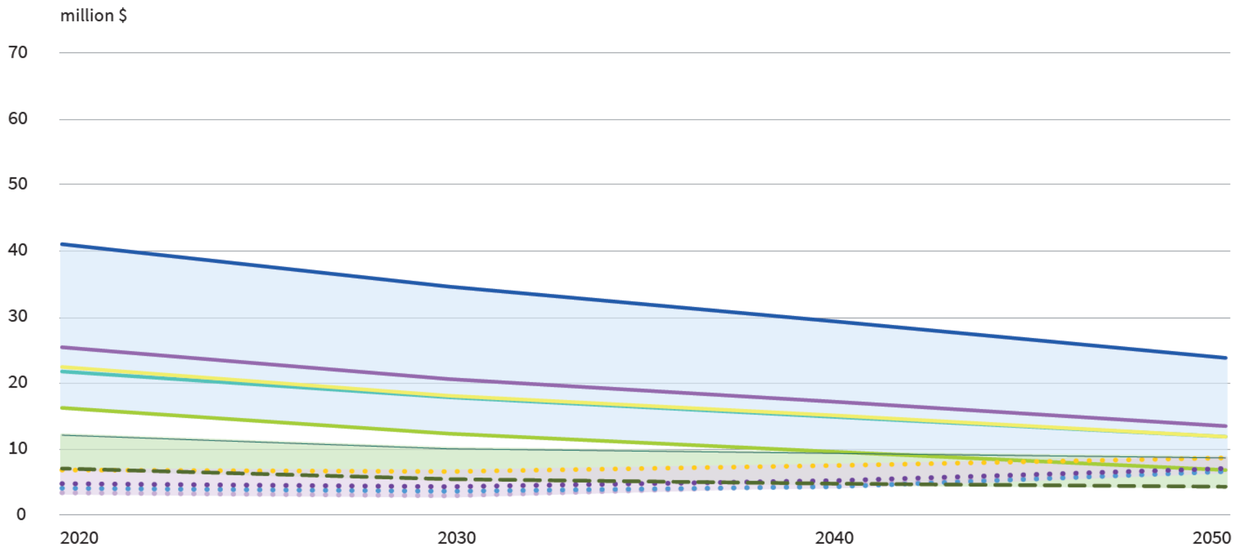


Figure 3c – Scenario 1; low-price scenario; TCO Trends for a Bulk Carrier (only ZEVs with ICE).

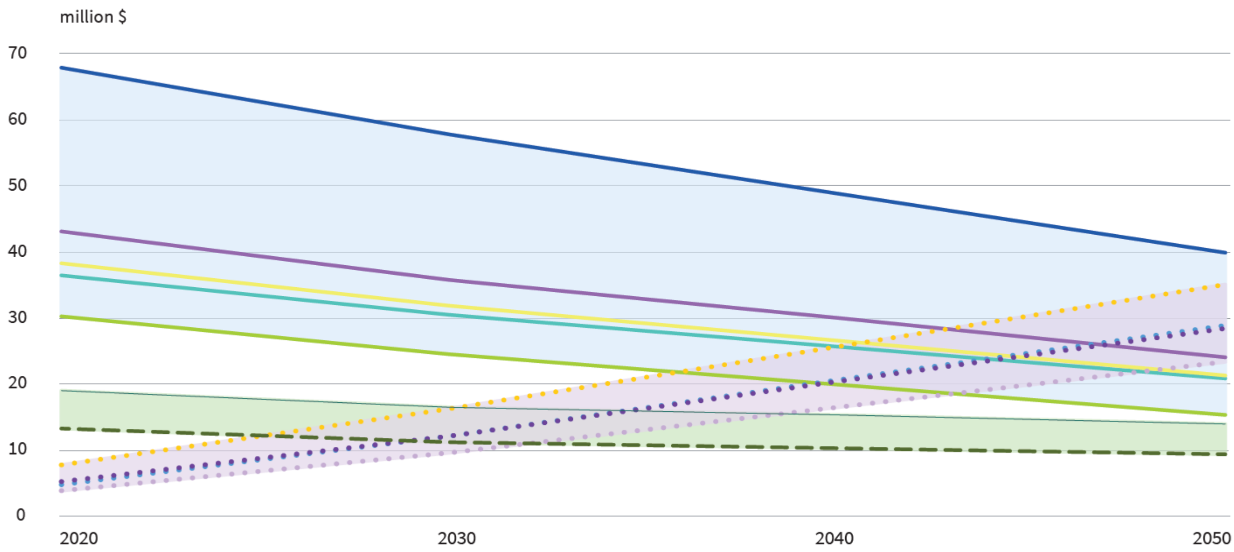
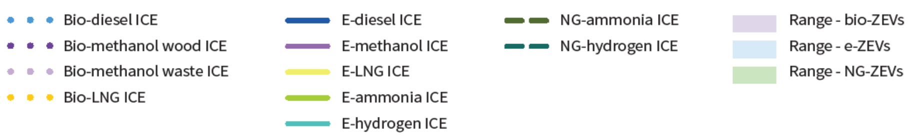


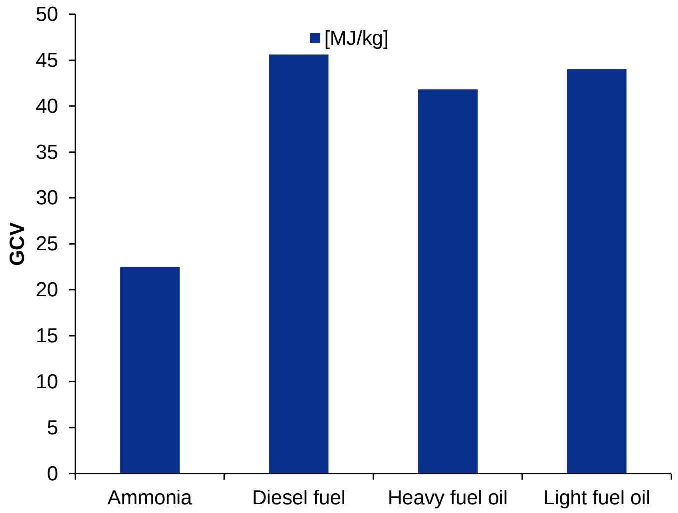
Figure 3d – Scenario 3; high-price scenario; TCO Trends for a Bulk Carrier (only ZEVs with ICE).



SOURCE: COMPANY REPORTS, INCRED RESEARCH

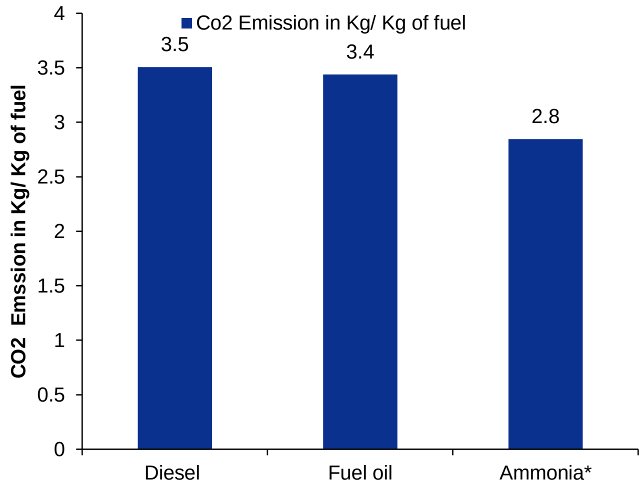
Even now, grey ammonia is better than using LNG or diesel fuel/ fuel oil ➤

Figure 8: GCV of ammonia is approximately half of that of prevalent fuel



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 9: However, even now, using ammonia (produced from natural gas) as a bunker fuel is less carbon-emitting than diesel or fuel oil



SOURCE: INCRED RESEARCH, COMPANY REPORTS
* AMMONIA DOESN'T GENERATE CO2 WHILE BURINING, BUT THE PROCESS OF MAKING AMMONIA WILL GENERATE CO_2

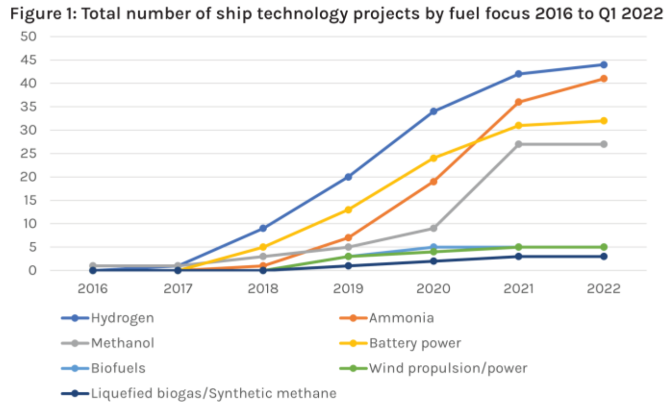
Is an ammonia-run engine available in the international market? May be just a year away ➤

There are multiple projects which are at a very advanced stage and some of them may become operational in the next one year.

1. https://www.ammoniaenergy.org/articles/cop27-the-green-shipping-challenge/
2. https://www.ammoniaenergy.org/articles/ammonia-powered-cargo-shipping-in-finland/

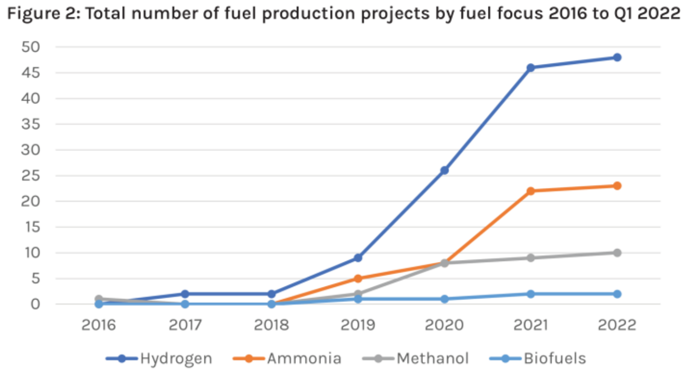
There has been a significant increase in ship technology projects based on ammonia and H2, with NH3 increasing at a faster pace ➤

Figure 10: NH_3 is catching the fancy of new development maritime fuel projects



SOURCE: INCRED RESEARCH, COMPANY REPORTS, THE DATA IS OF MARCH 2022 HENCE THERE MAY BEEN BIG DEVELOPMENTS AFTER THAT.

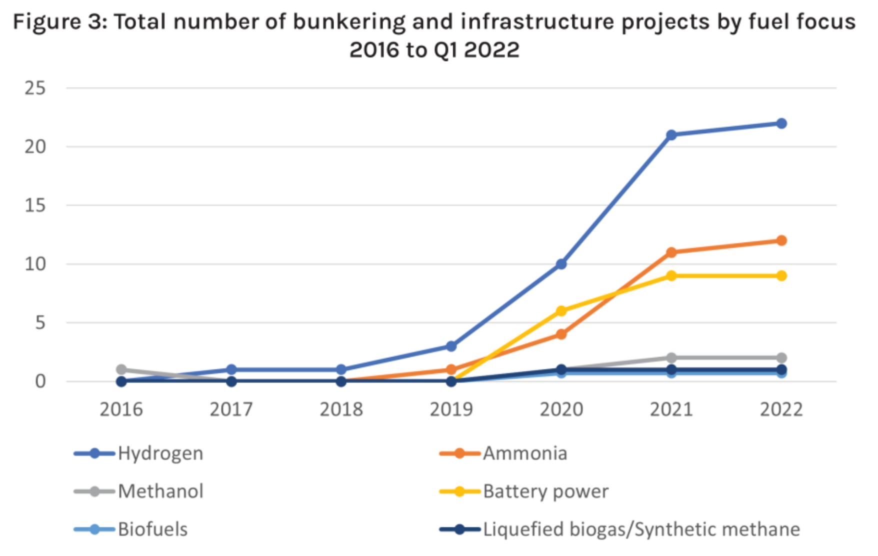
Figure 11: In fuel production projects, H2 is understandably taking a lead while green H2 can be used to produce ammonia



SOURCE: INCRED RESEARCH, COMPANY REPORTS

On the bunkering infrastructure side, H_2 is taking a lead as handling of NH_3 is a well-established technology

Figure 12: H_2 bunkering infrastructure is a new concept, but NH3 handling has a well-established standard operating procedure or SOP and hence, while lots of new projects are coming in H_2 infra they are not present in NH_3



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Ammonia is set to become one of the attractive zero-carbon fuels for the shipping industry ➤

Today, 80% of ammonia produced is used exclusively by the fertilizer industry. However, as pressure is exerted on the shipping sector to decarbonise and shift from its reliance on fossil fuels, ammonia is looking like an attractive alternative. If 30% of the shipping industry switches to ammonia as a fuel, then the current production of ammonia would have to nearly double.

While ammonia is the long-term solution, in the interim period methanol may be the only solution to lower CII ➤

Figure 13: With new IMO norms, ammonia & methanol are future fuels of the shipping industry

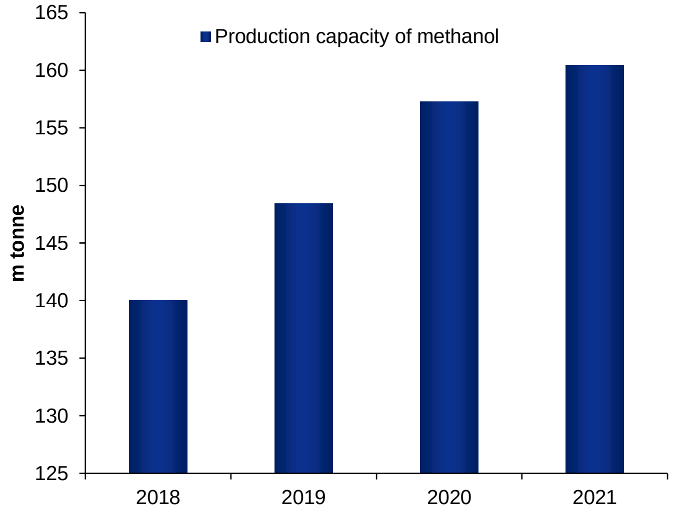
Type of Fuel	Carbon Content (m/m)	Fuel Coefficient (c_F) (kg CO_2/kg of Fuel) [1]
Marine gas oil	0.875	3.206
Marine diesel oil	0.875	3.206
Light fuel oil	0.86	3.151
Marine heavy oil	0.85	3.112
Methane	0.75	2.750
Propane	0.819	3.000
Butane	0.827	3.030
Propylene	0.857	3.141
Biodiesel	0.86	3.151
Methanol	0.375	1.375
Ethanol	0.522	1.913
Dimethyl ether	0.522	1.913
Ammonia	0	0

[1] Sometimes, the carbon dioxide emission coefficient is shown using the units kg CO_2/MJ or kg CO_2/kWh, where the lower heating value of is taken into consideration.

SOURCE: INCRED RESEARCH, COMPANY REPORTS

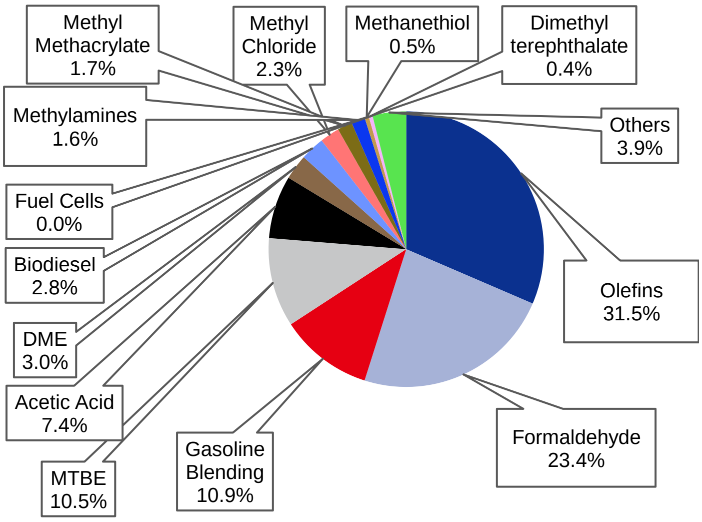
The world has enough methanol capacity in the short term ➤

Figure 14: Methanol production capacity is around 160mt



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 15: Demand for methanol is ~107mt

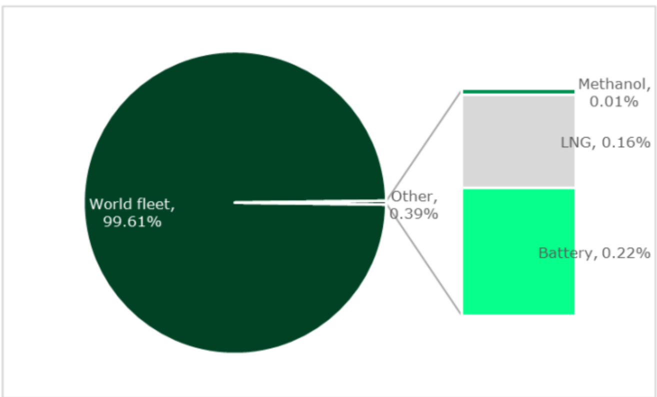


SOURCE: INCRED RESEARCH, COMPANY REPORTS

Currently, most of the ships are running on conventional fuels ➤

Figure 16: Currently, most of the ships are running on conventional fuels

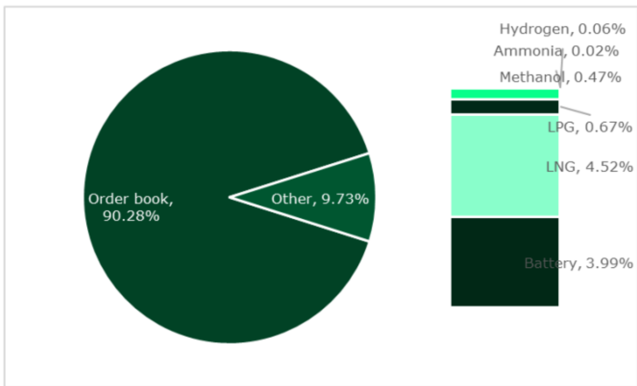
Alternative fuel uptake – ships in operation



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 17: In the future order book conventional fuels rule, but among lower carbon alternatives methanol still rules

Alternative fuel uptake – ships on order



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Existing ships can be modified to run on methanol ›

Figure 18: Existing shipping engines can be modified to run on methanol in the interim period

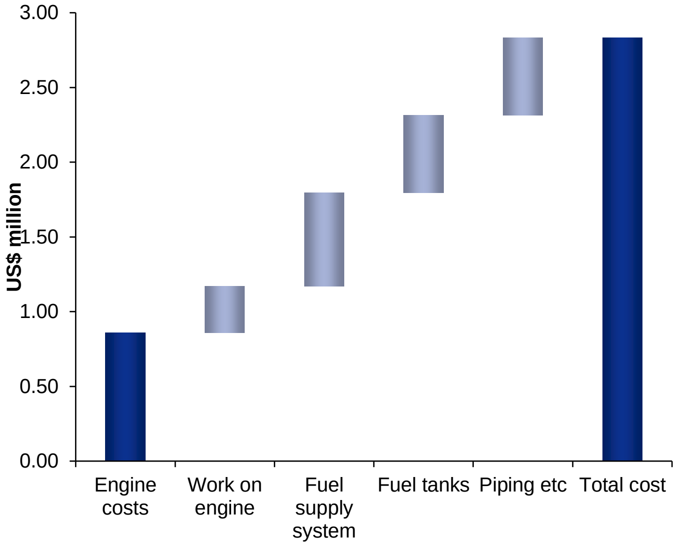
Table 4: Marine fuels' readiness

	HFO	Low-sulfur HFO	Marine diesel	Methanol	LNG
Engine technology	Existing	Existing	Existing	Some existing engines can be converted at similar cost as scrubber installations. Converted engines can be expected to perform at efficiency levels equal to or higher than scrubbers. Future engines built for methanol are expected to be more efficient. Methanol needs a pilot fuel/ignition enhancer.	Dual-fuel LNG engines on market. Retrofit of diesel engines can be performed at two to three times the cost of retrofitting to methanol. Gas-only engines are also available
Heating of fuel	Needed	Needed	May not be needed	Not needed. Cooling may be required	Not needed
Fuel separators	Needed	Needed	May not be needed	Not needed	Not needed
Piping	Standard	Standard	Standard	Double-walled. Purging possible	Vacuum-insulated, double-walled
Safety	Existing rules	Existing rules	Existing rules	Apart from low flashpoint, most properties are the same as diesel. Low-flashpoint fuel, risk-based rules, regulations coming based on LNG regulations. May be simplified in future	Low-flashpoint fuel with many demands due to low temperature and high pressure requirements. Boil-off from tanks has to be handled if not in service
Bunkering	Existing	Existing	Existing	Can use same type of barges as for HFO/MGO. Precautions for fire. System for purging the fuel supply system. Bunkering from mobile terminals on land developed	Special built barges. 20-30 times more expensive than for liquid fuels. Special precautions for bunkering including purging of system after bunkering
Terminals	Existing	Existing	Existing	Terminals can be built at low cost	LNG terminals are few and need large volumes to justify cost. About 10 times more expensive than methanol terminals
Distribution and logistics	Existing	Existing	Existing	Available globally. Transported in tank ships, barges, trucks and rail.	LNG terminals are under construction in Europe, but still relatively few are in operation.
Scrubber	Needed	Not needed	Not needed	Not needed	Not needed

SOURCE: INCRED RESEARCH, COMPANY REPORTS

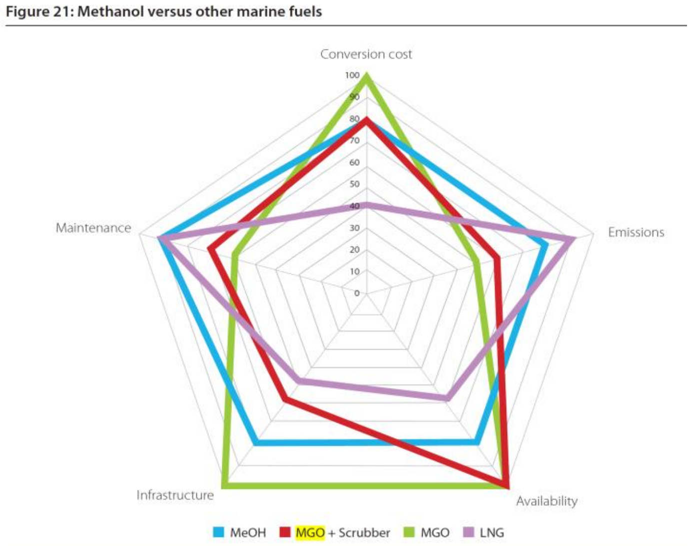
The cost of modifying a ship to be run on methanol is given below, but the infrastructure is not fully ready

Figure 19: Total cost of converting a 10MW tanker ship to run on methanol is ~US$2m



SOURCE: INCRED RESEARCH, COMPANY REPORTS

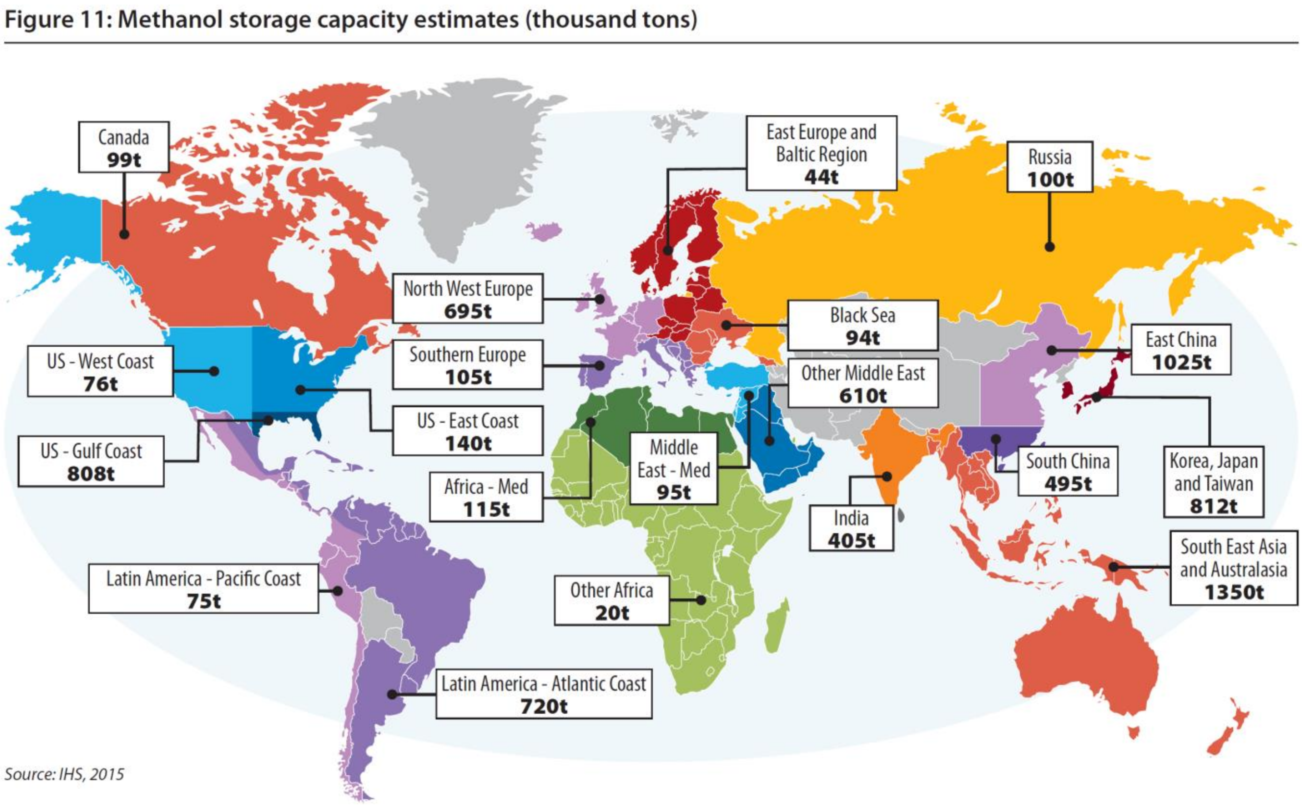
Figure 20: Methanol (MeOH) is still not fully ready to be used as a fuel



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Sufficient storage capacity needs to be built for widespread adoption of methanol as a fuel

Figure 21: Although the data is of 2015, we don't expect a change in global storage capacity of methanol that is needed for ship bunkering (2015 capacity was ~8mt)



SOURCE: INCRED RESEARCH, IHSREPORT

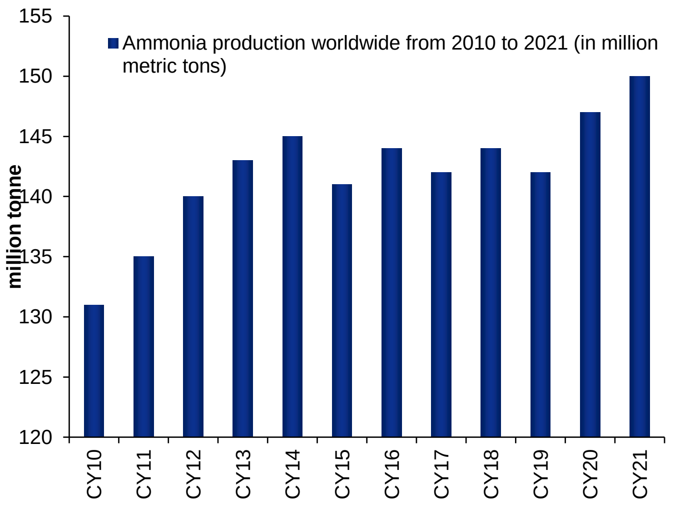
What is key for methanol adoption in the near term will be customer pressure rather than regulatory pressure ➤

1. The shipping industry is likely to be driven towards decarbonization by twin pressure of customer insistence and regulations. Leading shipowners are already making significant strides in the right direction.
2. Most deep sea shipping business is highly concentrated in the biggest segment, freight, with the top 10 shipping companies making up 84.7 per cent of the market. Just the top four companies such as A.P Moller - Maersk Group, Mediterranean Shipping Company (MSC), CMA CGM group and China Ocean Shipping Company (COSCO) account for 58% of total market share with 17%, 16.8%, 12.4% and 11.8% per cent individual share, respectively. All these companies are taking steps to decarbonize rapidly.
3. In addition to initiatives from major shipping companies, pressure from customers for zero-carbon shipping is likely to grow. The Cargo Owners Zero Emission Vessel Initiative now includes nine major shippers of consumer goods and will progressively ship all ocean freight to zero-emission vessels. The signatories are given below:
   - Amazon
   - Ikea
   - Unilever
   - Michelin
   - Inditex (Zara)
   - Patagonia
   - Brooks Running
   - Frog Bikes,Tchibo

The impact of potential usage of ammonia or methanol as a marine fuel is shortage of these chemicals

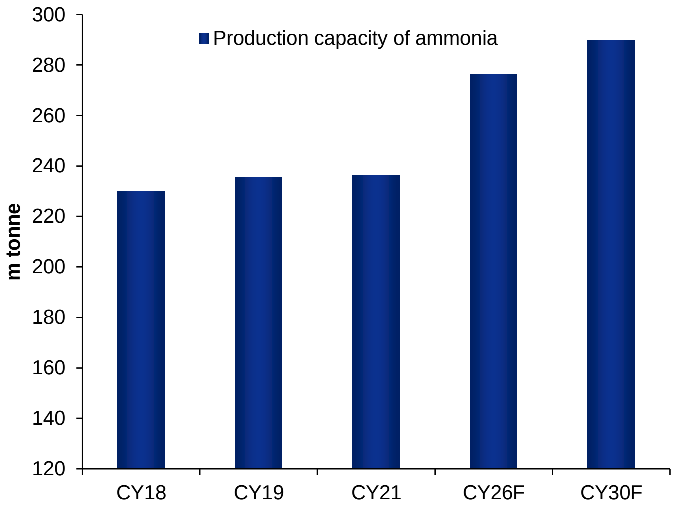
The world doesn't appear to be geared for even a minor shift in bunkerage fuel to ammonia

Figure 22: Global demand for ammonia was ~150mt, which has been growing at a 1.3% CAGR



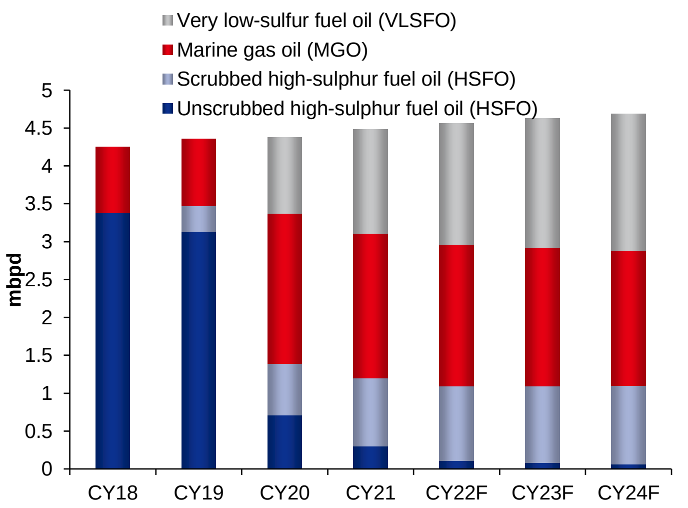
SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 23: With rising food demand, urea demand is bound to increase and thus propel NH_3 demand; hence, capacity addition doesn't appear to be geared for NH3 bunkering



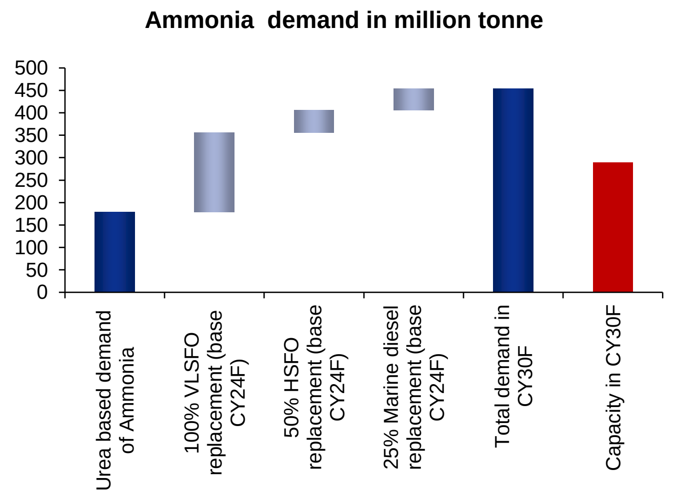
SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 24: As of now, IMO predicts 4.6mbpd demand for bunkerage fuel



SOURCE: INCRED RESEARCH, COMPANY REPORTS

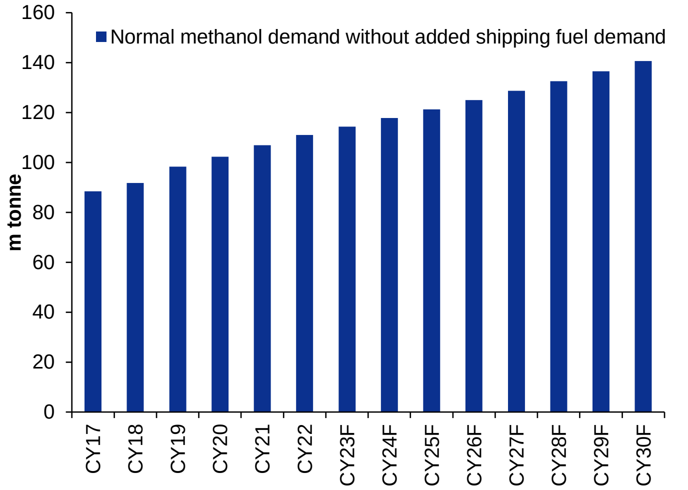
Figure 25: Even if we assume that HSFO is fully replaced by ammonia and VLSFO replacement is only 25%, even then NH3 demand in 2030F to exceed capacity



SOURCE: INCRED RESEARCH, COMPANY REPORTS

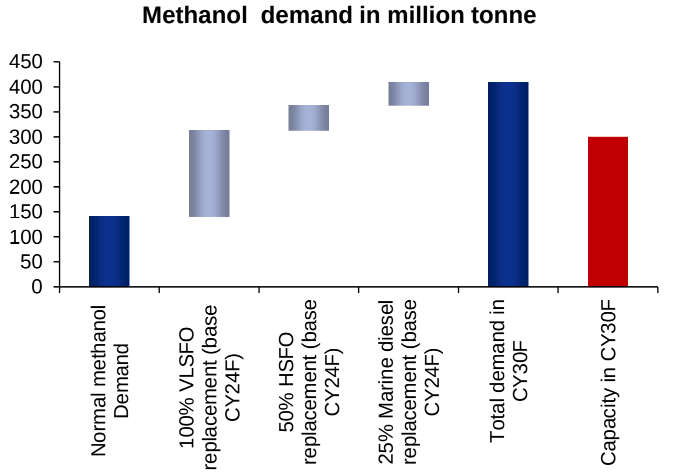
Methanol capacity appears to be sufficient now, but in case of full methanol replacement as a fuel by CY30F it won't be sufficient

Figure 26: Normal methanol demand is likely to touch 140mt by CY30F



SOURCES: INCRED RESEARCH, COMPANY REPORTS

Figure 27: Assuming HSFO is fully replaced, VLSFO replacement is only 25% and methanol is the only alternate fuel for shipping, then methanol capacity is not enough



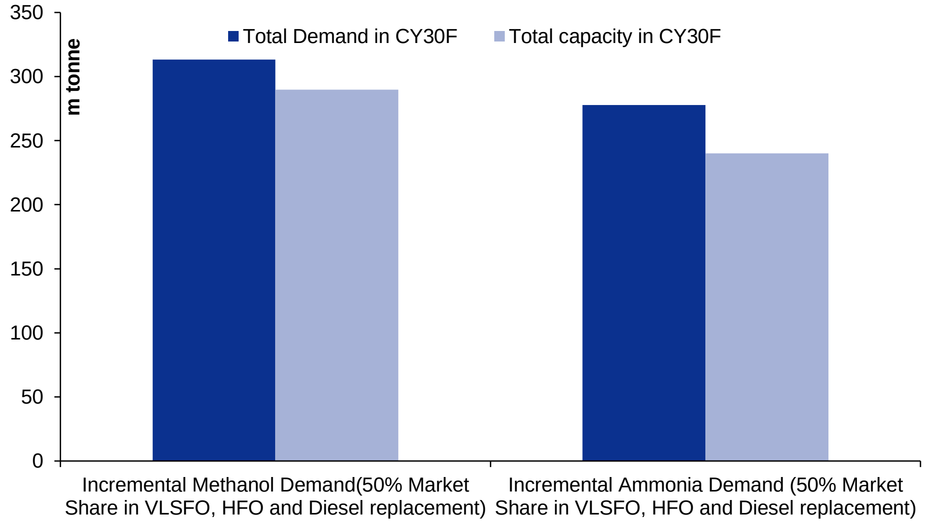
SOURCE: INCRED RESEARCH, COMPANY REPORTS

However, in a most likely scenario, neither ammonia nor methanol will fully replace crude oil derivatives

We present sensitivity analysis of ammonia and methanol demand by their relative share in the marine fuel replacement market. We have made following assumptions:

1. 100% VLSFO replacement
2. 50% HSFO replacement
3. 25% marine diesel replacement

Figure 28: Incrementally, both ammonia and ethanol will be in short supply and their prices will be on the upswing as traditional bunkerage fuels gets replaced by them



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Annexure-I: CII rating explanation

What is the CII and the CII rating scheme?

Carbon Intensity Indicator (CII) is a measure of how efficiently a ship transports goods or passengers and is given in grams of CO_2 emitted per cargo-carrying capacity and nautical mile. The ship is then given an annual rating ranging from A to E, whereby the rating threshold will become increasingly stringent towards 2030F. CII applies to all cargo, RoPax and cruise ships above 5,000 GT.

The yearly CII is calculated based on reported IMO DCS (data collection system) data and the ship is given a rating from A to E. For ships that achieve a D rating for three consecutive years or an E rating in a single year, a corrective action plan needs to be developed as part of the SEEMP and approved.

How is the CII calculated?

The basic CII is calculated as CO_2 emitted per cargo-carrying capacity and nautical mile. The CII calculation will be further improved through correction factors in a separate guideline that will be developed next year. For the time being, using actual cargo carried instead of capacity (i.e. the EEOI) can only be reported on a voluntary basis and not for the purpose of the CII rating.

What is AER/cgDist?

For different ship segments, the CII is based on different ways of measuring the carbon footprint of the transport work. The Annual Efficiency Ratio (AER) and capacity gross tonne distance (cgDist) are two such CIIs using different units. AER (emission per dwt-mile) is used for the segments where the cargo is weight-critical, and cgDist (emission per gross tonne-mile) for volume-critical cargo.

Why is AER/cgDist used as the CII and not EEOI (Energy Efficiency Operational Indicator)?

AER (emission per dwt-mile) and cgDist (emission per gross tonne-mile) are supported by data elements reported through the IMO DCS system. The IMO DCS system does not collect the cargo data required to calculate the EEOI (emission per tonne-mile). Therefore, EEOI is not an option to use for the CII currently. However, it will be possible to voluntarily report cargo data and report the EEOI for those who wish to do so.

How can a shipowner control the CII?

CII is based directly on the fuel consumption, which is influenced by how a specific ship is operated in combination with its technical efficiency and fuel. Its value will be affected by the type of fuel used, the efficiency of the vessel and operational parameters such as vessel speed, cargo transported, weather conditions and the general condition of the vessel (e.g. biofouling).

An owner can control the CII by optimizing operations and ensuring the vessels are in a good condition. Charterers will have a major influence over the CII of the ships they charter by selecting the speed. It will be beneficial for owners/operators to continuously monitor the CII performance of the vessel to avoid having to take drastic measures unexpectedly.

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