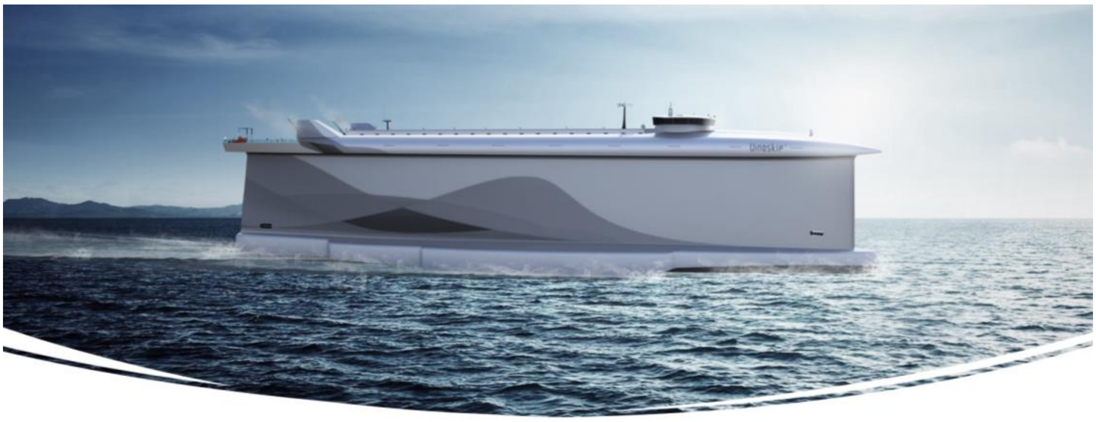


Vindskip®

A Pure Car and Truck Carrier
with the car-carrying capacity of 7.000 ECU

prepared for zero emissions

With its award-winning design, Vindskip® is communicating fuel efficiency and sustainability. It benefits from abatement measures such as wind power and its disruptive design, made ready for the future.

GERMAN DESIGN AWARD WINNER 2020

concept Vindskip®
– Excellent Product Design –

The Cargo-owners' expectations

The most influential actor in the ecosystem surrounding a shipowner is the one paying for the shipping services – the cargo owner.
They are subject to expectations from their customers throughout the supply chain which ends with the consumers.

Access to capital

There is an increased focus on green and sustainable activities from financial institutions and institutional investors. This "green driving force" will make access to capital dependent on environmental credentials and meet expected decarbonisation trajectories throughout the ship's lifetime.

Content

Vindskip® prepared for zero emissions

On the road to zero emission, Vindskip benefits from abatement measures such as wind power and its award-winning disruptive design.

To decarbonize the international maritime industry entirely, fuel other than low carbon liquified natural gas, LNG, will be needed.

However, when introducing alternative fuels, it will be vital to ensure that the entire Well-to-wake perspective is considered.

Low carbon liquified natural gas, LNG
LNG is a scalable and safe energy source available today. Though not entirely green, it is a transition fuel and provides a clear pathway to a zero-carbon future for shipping.

LNG has no negative effects on human health, compared to heavy fuel oil. It virtually eliminates local emissions of sulphur oxides (SOx) and particulate matter (PM) and cuts nitrogen oxide (NOx) by up to 95%. This is especially important in ports and heavily populated coastal areas.

This is fully compliant with all global Emission Control Areas (ECAs) and the IMO's global sulphur cap, and future-proofs ship owners against more stringent local emissions regulations.

LBG – the sustainable maritime fuel interchangeable with LNG
Decarbonising the maritime sector requires the use of a zero carbon fuel. For this purpose, LNG-powered ships can use liquefied biogas, LBG, without major modifications, and a technically mature LNG infrastructure needs only to be scaled up.

The Vindskip® concept has already taken this into account with a technology solution that allows mixing LNG with LBG, from zero to running entirely on LBG.
This gives freedom when it comes to bunkering, being able to bunker where these fuels are commercially available, and enables a reduction of emissions close to zero.

EU strategy & Global action in reducing emissions from shipping sector

Reducing emissions from the shipping sector

(Ref. https://ec.europa.eu/clima/eu-action/transport-emissions/reducing-emissions-shipping-sector_en)

International shipping is a large and growing source of greenhouse gas emissions. The EU supports global action to tackle these emissions and has put in place EU-wide data collection measures.

Maritime transport emits around 940 million tonnes of CO_2 annually and is responsible for about 2.5% of global greenhouse gas (GHG) emissions (3rd IMO GHG study).

These emissions are projected to increase significantly if mitigation measures are not put in place swiftly. According to the 3rd IMO GHG study, shipping emissions could under a business-as-usual scenario increase between 50% and 250% by 2050, undermining the objectives of the Paris Agreement.

EU strategy

Shipping emissions represent around 13% of the overall EU greenhouse gas emissions from the transport sector (2015).
In 2013, the Commission set out a strategy, consisting of three consecutive steps:
- Monitoring, reporting and verification of CO_2 emissions from large ships using EU ports
- Greenhouse gas reduction targets for the maritime transport sector
- The contribution of the shipping sector to emission reductions consistent with the temperature goals of the Paris Agreement remains a critical issue in the EU.

Global action

IMO Data Collection System
Following the adoption of the EU MRV Regulation, the IMO established an IMO Data Collection System.
As a result, from 2019, ships calling into EEA ports will have to report under both the EU MRV Regulation and the IMO Data Collection System.

Initial IMO greenhouse gas strategy

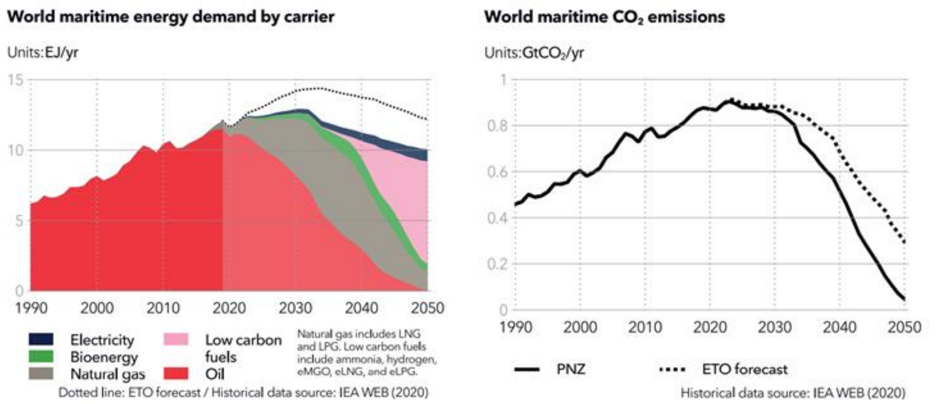
After considerable efforts over recent years, the IMO agreed in April 2018 on an initial greenhouse gas emissions reduction strategy.
In line with the internationally agreed temperature goals under the Paris Agreement, the strategy includes objectives to reduce total annual GHG emissions from shipping by at least 50% by 2050 compared to 2008 levels. Efforts to phase the emissions entirely in this century are being pursued.

A revised strategy will be adopted in 2023.

Maritime pathway to zero emissions

(Source: From DNV PATHWAY TO NET ZERO EMISSIONS (PNZ), Energy Transition Outlook 2021 (ETO))
"Maritime transport needs to reduce its emissions by at least 95% to contribute to a global and cross-sectoral net zero by 2050. Energy demand for global shipping will be about 20% lower compared to DNV's best estimate forecast (ETO)."

Technologies
Currently, the world fleet is mostly powered by diesel engines running on marine fuel oils.
Decarbonizing shipping will require higher energy efficiency, improved logistics and new fuels.
Irrespective of energy efficiency improvements implemented, a change to low carbon fuels will be required to decarbonize shipping by 2050.
There has been an increase in the uptake of alternative fuel in ships on order from 6% in May 2019 to 12% in June 2021. Except for the electrification underway in the ferry segment, the alternative fuels are currently still mainly fossil-based — and are dominated by liquefied natural gas (LNG).



Source:
From DNV PATHWAY TO NET ZERO EMISSIONS (PNZ). Energy Transition Outlook 2021 (ETO).

Natural gas includes LNG and LPG. Low carbon fuels include ammonia, hydrogen, eMGO, eLNG and e LPG.

Technical applicability and commercial viability of alternative fuels will vary for different ship types and trades.
Deep-sea vessels have fewer options compared with the short-sea segment.
For the latter, the shorter distances and highly variable power demand often make electric or hybrid-electric power and propulsion systems more efficient than traditional mechanical drives.

For the deep-sea segment, most of the energy consumption relates to propulsion at steady speed over long distances, which favours energy-efficient mechanical, direct- or geared-driven, two-stroke combustion engines.
The ships require fuel that is globally available, and the fuel energy-density is important to maximize the space available for the transport of cargo over long distances.

The future fuel and technology shifts must go together with greater energy efficiency of ships, requiring intensified uptake of both technical and operational energy efficiency measures.

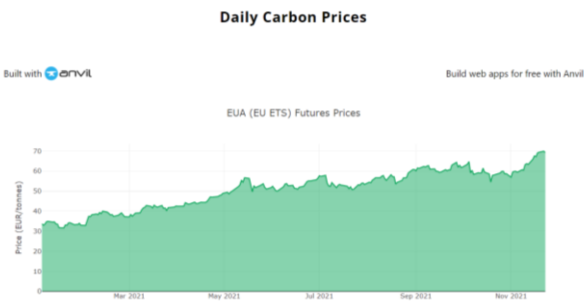
Three fundamental key drivers that will push decarbonization in shipping in the coming decade:

— Regulations and policies
— Access to investors and capital
— Cargo owner and consumer expectations

In addition to onboard investment needs, the energy transition in shipping will require major investments in infrastructure and production capacity for the supply of carbon-neutral fuels.

The onshore investment costs and the higher cost of producing zero-carbon or carbon neutral fuels will lead to a significant higher fuel cost for ships.

Ships fuel efficiency will be more important than ever with the phasing in expensive zero-emission fuel - even a high CO2 pricing will not be able to balance it



Today's EU ETS pricing of CO_2 emission is EUR 80 / ton CO_2
(Ref.: https://ember-climate.org/data/carbon-price-viewer/)

Future average fuel prices
The below fuel prices are given as future averages and reflect a scenario in which low-cost renewable electricity is available for production of carbon-neutral electro fuels:
(Ref.: DNV MARITIME FORECAST TO 2050)

Carbon-neutral:	
Ammonia	959 (USD/toe)
Methanol	1248 (USD/toe)
LNG	1285 (USD/toe)
Fossil	
MGO	578 (USD/toe)
LNG	327 (USD/toe)

Green ammonia – USD 1 196 / ton
Argus has modelled a weekly price for green ammonia delivered to northwest Europe based on a theoretical "typical" production plant in the Middle East, yielding a notional value of USD 1,196/t — more than twice the price of the conventional grey alternative.
(Ref.: https://www.argusmedia.com/en/press-releases/2021/green-ammonia-prices-double-that-of-regular-supplies).

Green hydrogen – lowest estimate USD 5 700/ton
Through the CertifHY-project, the EU are currently developing a guarantee of origin scheme for green hydrogen. The scheme is built up along the same principles as the market for guarantees of origin for electricity, where producers of hydrogen can purchase certificates to certify their product.
Current and future price of hydrogen - a retail price of 5-7 Euro/kg is realistic in 2030.
(Ref.: https://maritimecleantech.no/wp-content/uploads/2016/11/Report-liquid-hydrogen.pdf)

Well-to-wake GHG emissions
Well-to-wake GHG emissions include emissions from the production, transport, and storage of each individual fuel, as well as conversion to mechanical energy on board the vessels. The resulting comparative measure of well-to-wake emissions is the mass of CO2-equivalent emissions per unit of shaft output energy.

Tank-to-wake GHG emissions
The Tank-to-wake GHG emissions approach takes into account the emissions that result from burning the fuel once it is already in the tank. How a fuel is produced and transported to get to a vessel's tank is not included in this analysis.

To qualify as a carbon-neutral fuel using this approach, the fuel must have zero tailpipe emissions.

Battery-electric and hydrogen are two of the most common zero-tailpipe-emissions fuels when taking a tank-to-wake approach.

A fuel such as renewable natural gas that can be carbon-negative over its life cycle, would not qualify as carbon-neutral using this approach, since natural gas emits GHGs as it powers a vessel.

Using a tank-to-wake approach could misrepresent the total climate of shipping fuels.
While carbon-neutral tank-to-wake fuels such as hydrogen produce zero tailpipe emissions, the way hydrogen is produced has a significant impact on its life cycle emissions.
All hydrogen, whether produced using natural gas or renewable electricity, would be viewed as a carbon-neutral fuel because it does not release GHGs when it is used to power a vessel.

Initial IMO GHG Strategy

IMO has adopted mandatory measures to reduce emissions of greenhouse gases from international shipping, under IMO's pollution prevention treaty (MARPOL).
That is the Energy Efficiency Design Index (EEDI) mandatory for new ships, and the Ship Energy Efficiency Management Plan (SEEMP).

The initial GHG strategy envisages, a reduction in carbon intensity of international shipping by reducing the CO2 emissions per transport work, as an average across international shipping, by at least 40% by 2030. To pursue efforts towards 70% by 2050, compared to 2008.
Meaning that total annual GHG emissions from international shipping should be reduced by at least 50% by 2050 compared to 2008.
The strategy includes a specific reference to "*a pathway of CO2 emissions reduction consistent with the Paris Agreement temperature goals."*

A revised strategy will be adopted in 2023.

EEDI & SEEMP
The Energy Efficiency Design Index (EEDI) was made mandatory for new ships and the Ship Energy Efficiency Management Plan (SEEMP) for all ships at MEPC 62 in July 2011, by Parties to MARPOL Annex VI. This was the first legally binding climate change treaty to be adopted since the Kyoto Protocol.

The EEDI for new ships is the most important technical measure, and it aims at promoting the use of more energy efficient equipment and engines. The EEDI requires a minimum energy efficiency level per capacity mile, e.g., tonne mile, for different ship type and size segments.
It is a non-prescriptive, performance-based mechanism that leaves the choice of technologies to use in a specific ship design to the industry. As long as the required energy efficiency level is attained, ship designers and builders are free to use the most cost-efficient solutions for the ship to comply with the regulations.

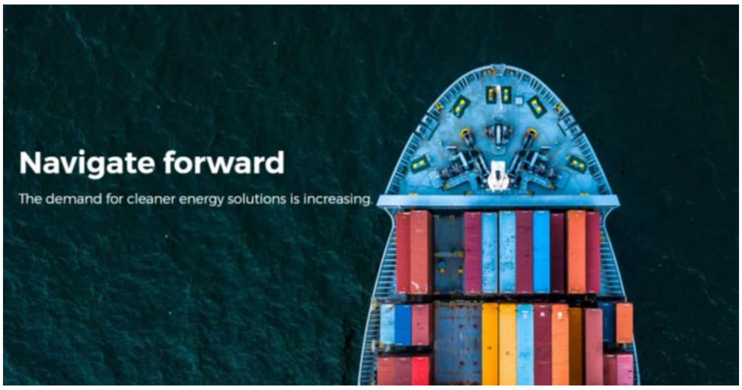
The Ship Energy Efficiency Management Plan (SEEMP) is an operational measure that establishes a mechanism to improve the energy efficiency of a ship in a cost-effective manner. The SEEMP also provides an approach for shipping companies to manage ship and fleet efficiency performance over time.

All shipping companies need to fulfil the minimum compliance requirements from the IMO. Depending on the strategy, environmental ambitions, and market situation, they may also aim for a leading position in decarbonization.

Vindskip® a zero emission ship could be a reality already tomorrow by replacing LNG with LBG as a fuel

GASUM a supplier of LNG and LBG from well to wake

(Ref.: https://www.gasum.com/en/sustainable-transport/maritime-transport/lng-for-maritime/)



Reducing emissions by running on liquefied gas

Liquefied natural gas (LNG) and liquefied biogas (LBG) are cost-effective solutions to respond to the emission challenges in transport logistics today and beyond.

By bunkering LNG instead of diesel, this will alone reduce the greenhouse gas emissions by up to 20% over the lifecycle of the fuel.
With LBG, greenhouse gas emissions are up to 90% lower, generating just a fraction of local emissions such as nitrogen oxides and particulates, which are harmful to human health.
As LBG is interchangeable with LNG, it is easy to switch to biogas at a later stage without additional investments. The same engine technology is compatible with both gas alternatives.

LBG is made out of biomasses and turned into gas by microbes
It is a renewable fuel, produced through the processing of several types of organic waste made from 100% local feedstocks.
By means of a biogas reactor, the microbial action begins. The biomass enters a gradual process of fermentation. Digestion conducted by these microorganisms' creating methane, which can be used as it is, locally or upgraded to a natural gas quality.

Liquefaction Plant for LNG and LBG at Risavika, Stavanger


Liquefaction Plant for LNG and LBG at Risavika, with a production capacity of 300,000 tonnes LNG/ year.

Natural gas is brought to the LNG plant by a subsea pipeline system from the Kårstø processing plant. Playing a key role in the transport and processing of gas and condensate/light oil from major sites on the Norwegian continental shelf.

At the LNG plant the gas first passes through a cleansing process where CO2 and water are separated out. Thereafter the gas is piped through the plant, which in principle functions in the same way as a freezer. Here, the natural gas cooled down to 163°C below zero and changes into liquid form.

The liquid natural gas is stored at atmospheric pressure in a large full containment tank, designed for up to 28,000 m3 of LNG. From the storage tank, LNG is loaded on board ships or trucks for transport to customers.

LBG – the sustainable maritime fuel interchangeable with LNG

Liquefied biogas – also known as liquefied biomethane and bio-LNG – is a 100% renewable fuel that can reduce CO2 emissions over its life cycle by up to 90% compared to conventional fuel.

The use of LBG emits close to zero oxides of nitrogen (NOx) and sulphur oxides (SOx), and no particulate matter (PM), contributing to cleaner air especially for inhabitants living close to the sea and busy ports.

Meeting IMO targets

Burning LBG releases only carbon dioxide (CO2) and water (H2O) into the air. Since the LBG is produced from biodegradable materials, the carbon dioxide is from sources that would anyway release CO2 in a natural combustion process. Thus, LBG is a sustainable and renewable product that does not add any new CO2 into the atmosphere.

A sustainable way to operate

Ship to ship bunkering a sustainable way to operate

As a premier supplier of LNG and LBG, Gasum is a partner for frontrunners in LNG propulsion that aims to optimize efficiency by looking for better and more sustainable ways to operate.
Since 2017, they have therefore offered ship-to-ship bunkering from their own LNG bunker vessel Coralius, a vessel that has performed hundreds of safe bunker operations both at sea and in port.
The ship has a capacity of approx. 5800 cbm (ca. 2450MT).
Bunkering of LNG ship to ship - can take place between two sea-going ships at anchor or in port.
In addition, depending on the port restrictions, bunkering can be done efficiently at the same time as the vessel receiving LNG performs simultaneous loading operations.

Vindskip® Outline Specification and Class Notation

Vindskip® is a low-emission ship design that will be competitive in the face of stricter CO2 regulations in the future by exceeding all current emission requirements.

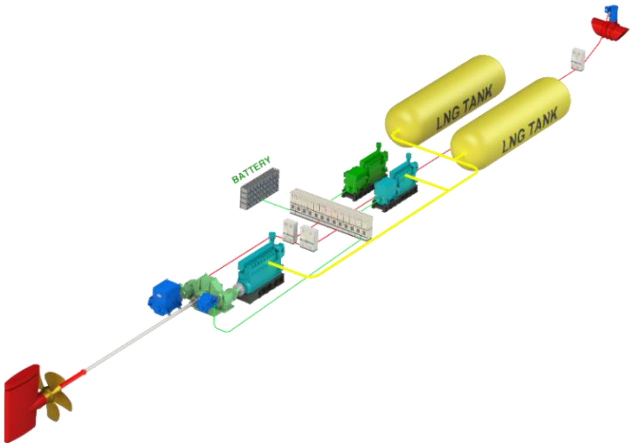
CLASS NOTATION

The following class notations is specified:

✠1A Car Carrier MCDK E0 Gas fuelled LNG

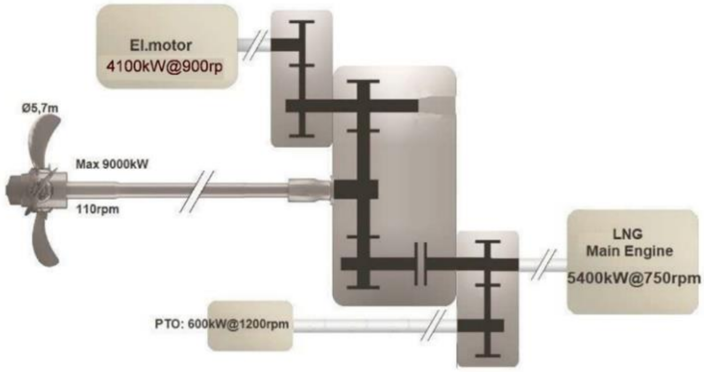
DNVGL Notation	Description	Note
✠1A	Main class	
Car Carrier	Ship type notation	
MCDK	Movable car decks	
Gas fuelled LNG	Gas fuelled engine installations	Mandatory for gas fuelled installations.
E0	Unattended machinery space	

Machinery main components:



Main propulsion engines

The Main Engine is of make Kongsberg Maritime CM AS, running on LNG fuel.
In addition, it has one electric motor for boosting power, coupled to a twin input/single output gearbox with a primary driven PTO, driving a 4-bladed Controllable Pitch Propeller with a diameter of 5700 mm.



The Main Engine is a four stroke, turbocharged, intercooled, Tier III, LNG engine, performing a MCR of 5400 kW at 750 rpm.
An electric motor for CPP main propulsion, is a three phase, water cooled, and frequency controlled induction motor giving 4 100 kW at 900 rpm.
A PTO generator of marine type, water cooled synchronous generator with 800 kVA rated power at 1200 rpm.

When operating on a defined Transatlantic Route by the owner of the cargo, making 9 Round Trips a year by this defining the service speed , savings compared to the reference ship running on HFO:

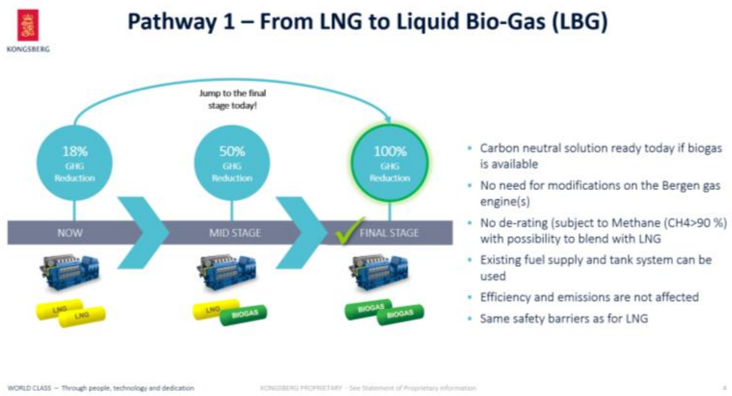
When running on LNG, estimated savings is:	**20 470 tonnes of CO_2 / ship / year**
Calculated savings in %:	**CO_2 63%** NOx 96% and SOx 100% - **GHG Equiv 57%**
When running on LBG, estimated savings is:	**34 000 tonnes of CO_2 / ship / year**
Calculated savings in %:	**CO_2 100%** NOx 97% SOx 100% - **GHG Equiv 97%**

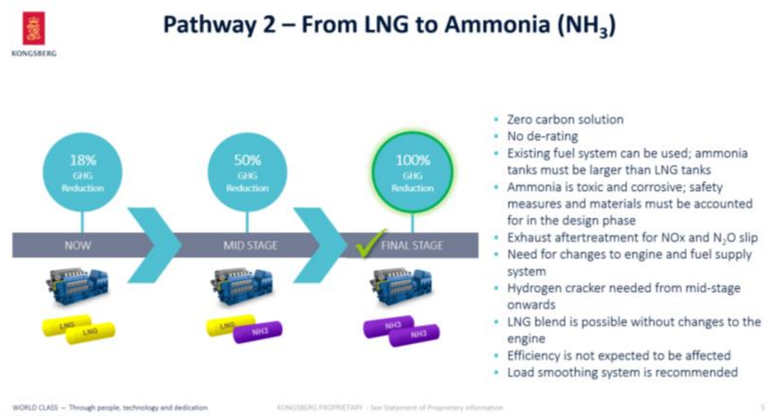
Cruising range

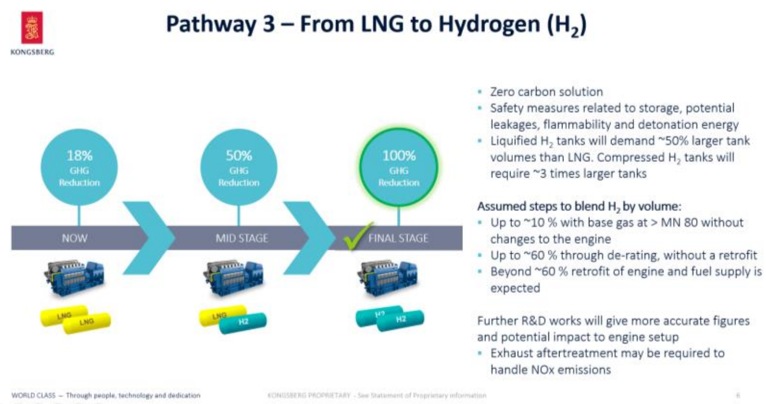
Cruising range when running only on the main engine, is **41 days** of sailing between bunkering, operating at the defined Service Speed.

When running on the electric motor powered by the two aggregates, with one unit running on biodiesel and one unit running on LNG/ LBG, it can perform **80 days** of sailing between each bunkering.

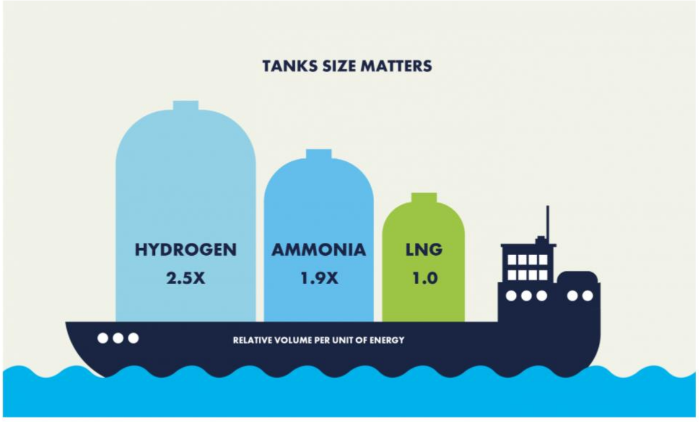
LNG – a bridging fuel towards zero emissions







Understanding the energy density of future fuels – gives a clearer decarbonisation decision-making picture



(Source: https://sea-lng.org/2021/07/understanding-energy-density-of-future-fuels-could-be-key-to-clearer-decarbonisation-decision-making/)

Vindskip® delivered with DNV Class Notation Fuel Ready Ammonia

DNV Class Notation Fuel Ready
The class notation applies to ships that are planned for, and/or partly prepared for, later conversion to one or more alternative fuels. It indicates that DNV has verified compliance with the rules for the applicable fuel for a future ship design or fuel tank installed at newbuilding. The alternative fuel(s) the ship is prepared for is represented by a qualifier in the class notation:
Fuel Ready (LPG, LNG, ammonia and/or methanol/ethanol).

A minimum level of preparation is required to qualify for the class notation.

Examples are given for the two possible
mandatory pathways to a Fuel Ready notation:

– Fuel Ready (Ammonia, D, MEc, S) means that the future ammonia-fuelled design is examined and found to be in compliance with rules for ammonia in force at time of the newbuilding (D), and the main engine is of a type that can be converted to ammonia (MEc). Structural preparations required to support the future ammonia containment system are conducted (S).

– Fuel Ready (Ammonia, Ti, S) means that fuel tank(s) are installed that can be used for ammonia (Ti). Structural preparations for storage of ammonia are conducted (S). Design verification outside scope of fuel tank(s) has not been performed