

DECARBONISING OF SHORT SEA SHIPPING

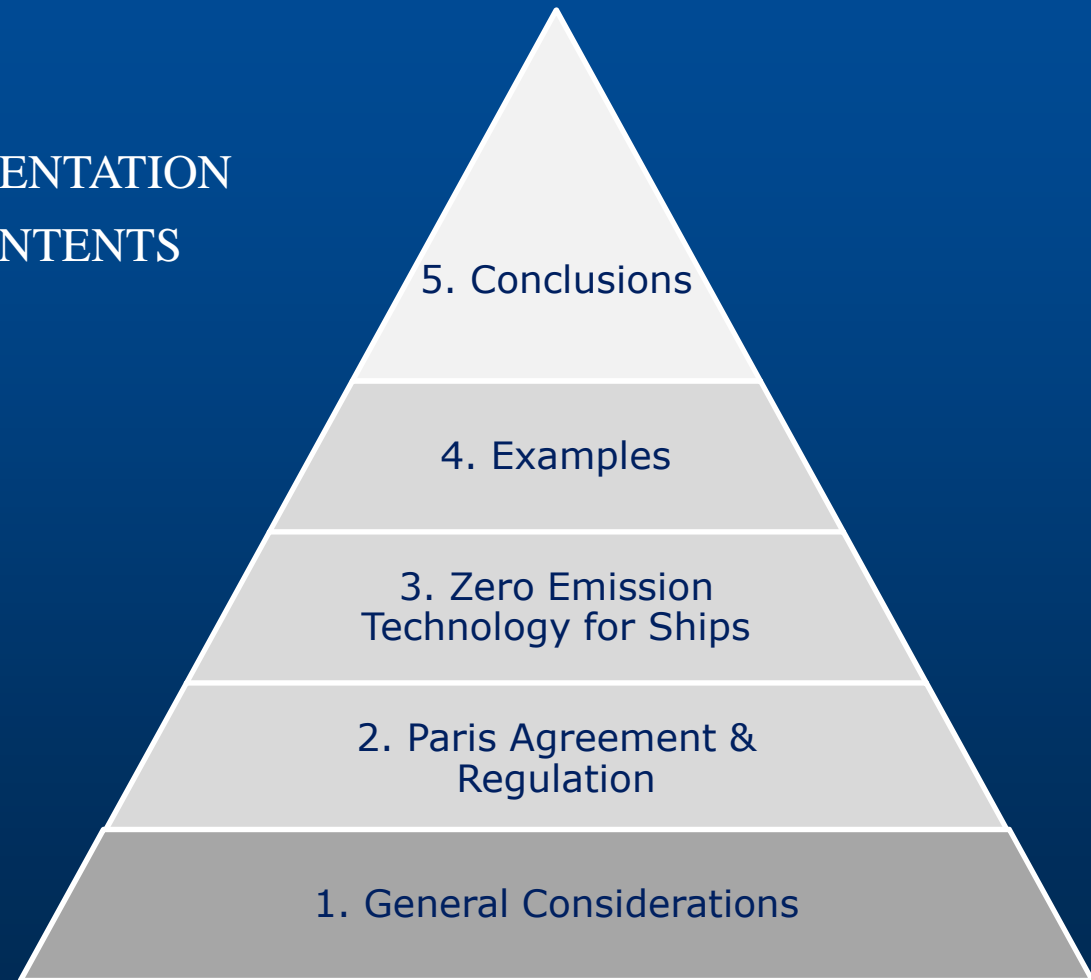
Darko Bandula

Dubrovnik, May 6 2019.





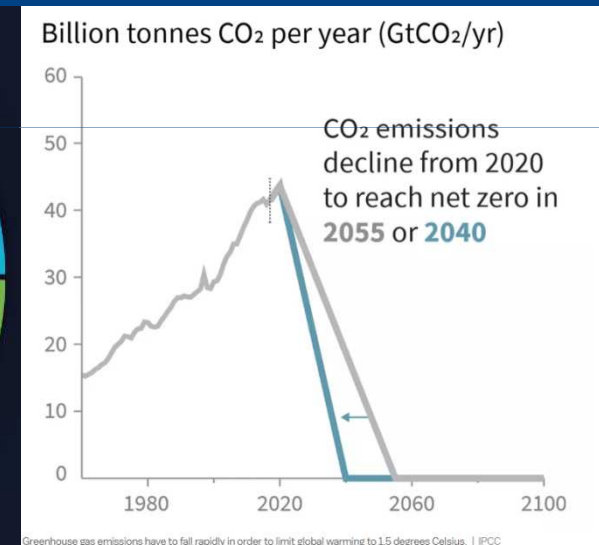
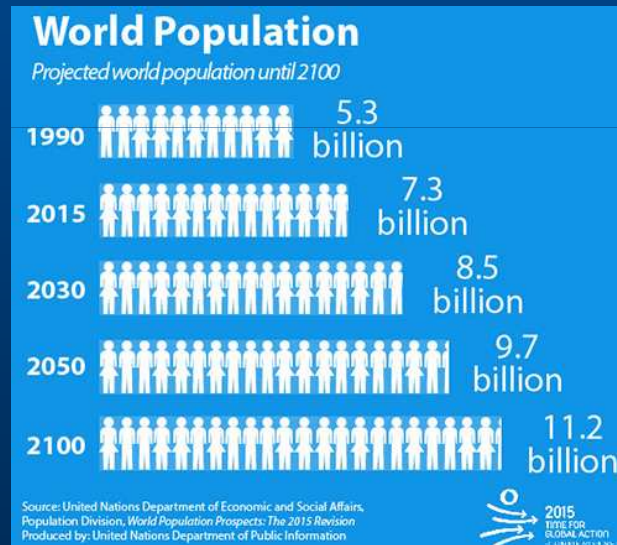
PRESENTATION CONTENTS



Decarbonising of Short Sea Shipping

General Considerations

To limit global warming to moderate levels – to avoid rising of the sea levels to more devastating droughts, damaging storms, famines, diseases, economic tolls and refugee crises – drastic reduction of GHG has to be undertaken. Meeting this goal demands extraordinary transitions in transportation; in energy, land, and building infrastructure; and in industrial systems. It means reducing our current coal & oil consumption + vast scale-up of emerging technologies, such as those that remove carbon dioxide directly from the air.



FPOPULATION HEALTH AND CLIMATE CHANGE



Decarbonising of Short Sea Shipping

General Considerations

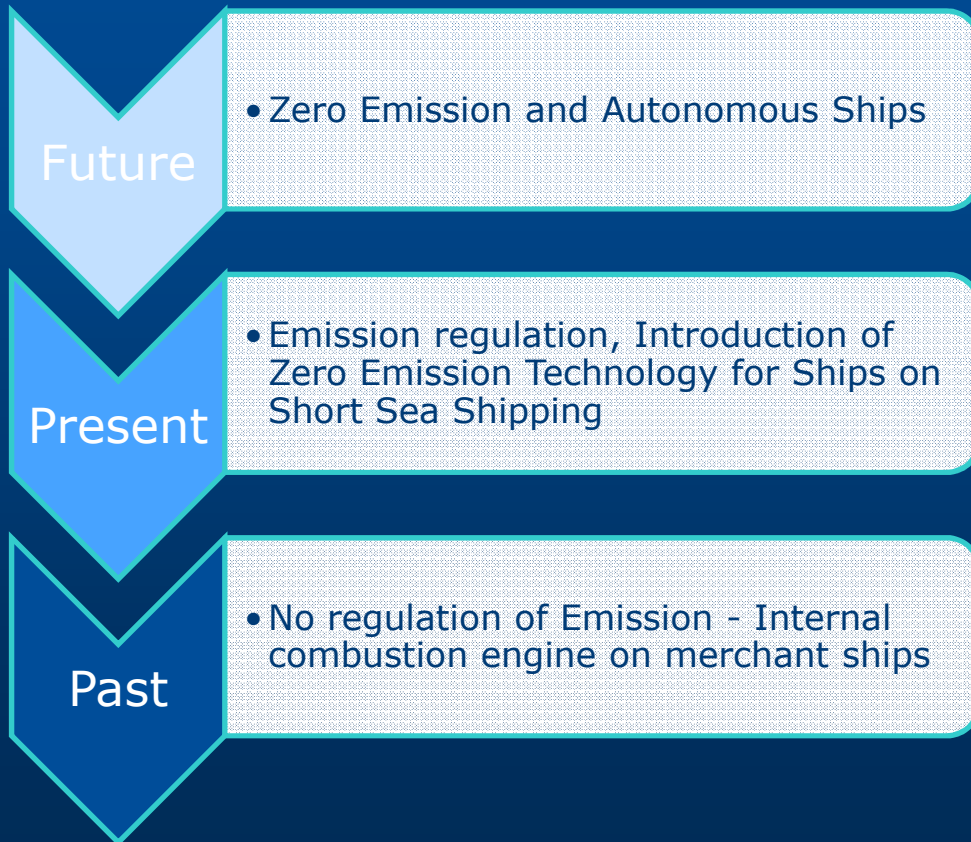


TRANSFORMATION OF SHIPPING AND SHIPBUILDING TECHNOLOGY



Decarbonising of Short Sea Shipping

Zero Emission Technologies



Decarbonising of Short Sea Shipping

Zero Emission Technologies



Decarbonising of Short Sea Shipping

Zero Emission Technologies

Today - ships energy for propulsion, on-board electricity generation and on-board heating and cargo operations are generated from the heavy fuel oil, marine gas oil or diesel oil. While the main engines are switched off at berth, auxiliary engines and boilers are kept running to sustain on-board operations. For example, a typical large ocean going cruise ship could burn around 220 MWh worth of fuel per 10-hour port call in order to satisfy on-board energy demand. As a comparison, the main (propulsion) engines of the same ship could use 220 MWh energy (fuel) to sail some 100 km out in the sea.

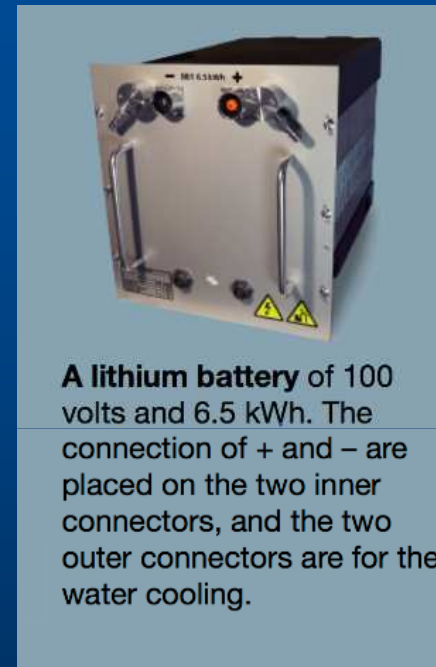
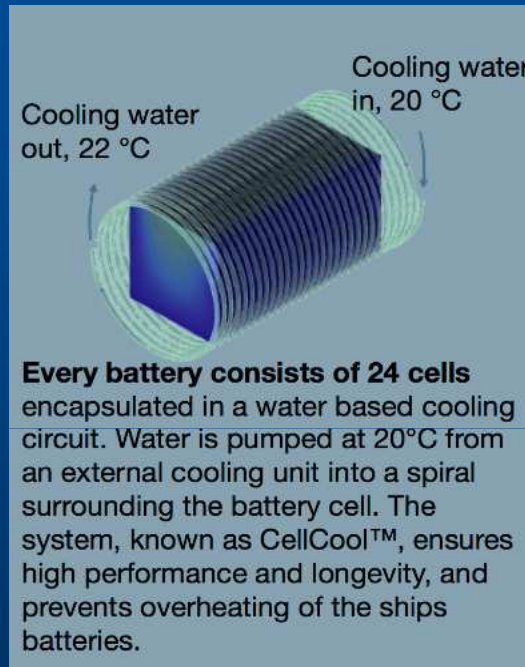
In the future - standard ICE fuel will be replaced by energy stored in batteries or other kinds of fuel such as liquid hydrogen or ammonia which generate no GHG emissions at the vessel level. In order to smooth the transition to zero emission shipping with gradual increase in additional renewable electricity demand decarbonising SSS would be preferable due to smaller ships and shorter individual journeys associated with SSS.

Technology	Propulsion	Energy storage	Energy transformation
Battery ships	Electric motor	Batteries	Directly from batteries to electric motor
Hydrogen fuel-cells	Electric motor	Liquid H ₂	Electrochemical via fuel-cells
Hydrogen ICE	Internal combustion engine (ICE)	Liquid H ₂	Direct combustion of liquid H ₂ in ICE
Ammonia fuel-cells	Electric motor	Liquid ammonia	Extraction of H ₂ from ammonia via on-board reformers and electro-chemical transformation via fuel-cells
Ammonia ICE	ICE	Liquid ammonia	Direct combustion of liquid ammonia in ICE



Decarbonising of Short Sea Shipping

Maritime Batteries



Decarbonising of Short Sea Shipping

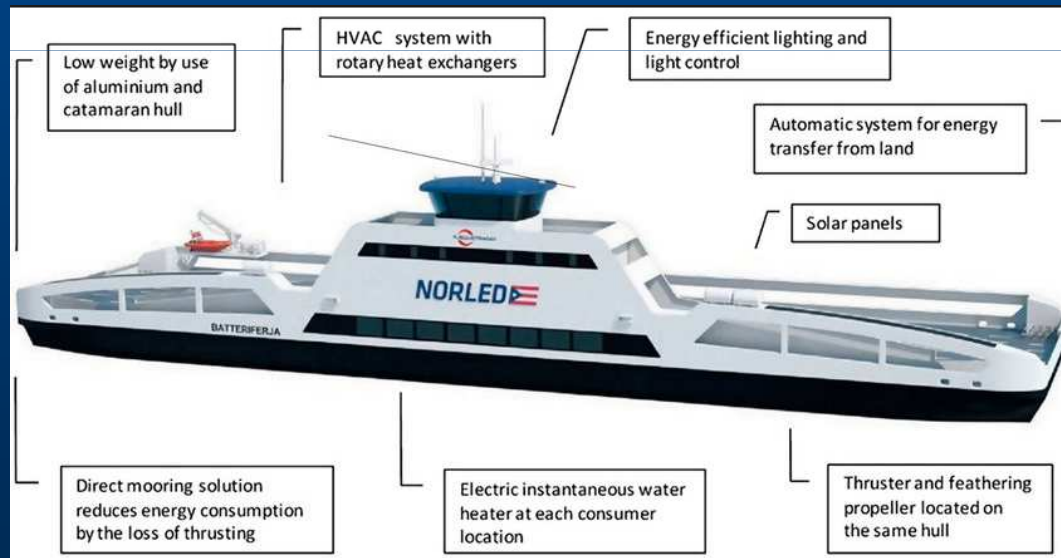
EXAMPLES OF ENVIRONMENTALLY FRIENDLY VESSEL



Decarbonising of Short Sea Shipping

Ampere

Ampere is the world's first electric-powered car ferry. It was delivered in October 2014 and commercial operations began in May 2015. The ferry is designed as a catamaran with two hulls. It is 80m-long and 21m-wide with seven crew cabins and 140 chairs. It accommodates up to 120 cars and 360 passengers. It has two onboard 450kW electric motors, one of them driving the thrusters. The motors are powered by lithium-ion batteries with an overall output of 1,000kWh and a weight of 10t.



Decarbonising of Short Sea Shipping

Aurora & Tycho Brache

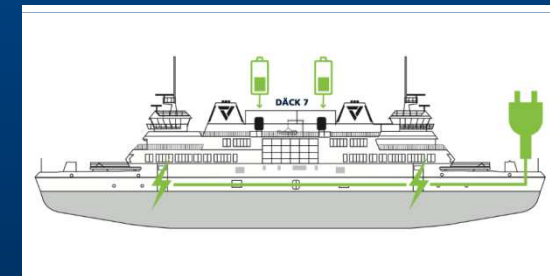
Two 111 m length ferries, the Tycho Brahe and the Aurora, operate a 4-km (2.5 miles) ferry route between Helsingborg (Sweden) and Helsingør (Denmark). Therefore, the route that they are converting to all-electric transport is not exactly impressive, but the actual ships themselves are something. "640 batteries of 6.5 kWh are installed on top of each ferry along with two deckhouses for transformers, converters and cooling of the batteries. Cables run from the deckhouses to connecting points at each end of the ship, so that the batteries can be quick-charged."



Decarbonising of Short Sea Shipping

Aurora & Tycho Brache

The battery project on Tycho Brahe and Aurora has lasted more than three years, and with a financial scope of around SEK 300 million, it is HH Ferries Group's largest single investment ever. INEA, the EU's executive agency for innovation and network, has supported the project with around SEK 120 million. In each port, automatic land-based charging stations equipped with industrial robots perform the connection and maximizes the charging period to enable efficient charging of each vessel's 640 batteries within a few minutes. The combined battery power of 8,320 kWh for the two ferries is equivalent to 10,700 car batteries.



Decarbonising of Short Sea Shipping

Future of the Fjords

Future of the Fjords - all-electric sightseeing vessel built by Brødrene Aa for Norwegian marine transportation company. It was built at a cost of approximately \$17m which is 60% more than its predecessor. The shipbuilding programme was funded by The Fjords, while Enova, owned by the Norwegian Ministry of Petroleum and Energy, also sourced \$2.1m to support the construction of the vessel. Construction of the vessel began in May 2017 and it was delivered to The Fjords in April 2018. The 40m-long vessel carries up to 400 tourists in the fjord between Flam and Gudvangen, UNESCO site.



Decarbonising of Short Sea Shipping

Yara Birkeland

Yara Birkeland will be the world's first fully electric and autonomous 80 m container ship, with zero emissions. With this vessel, Yara company will reduce diesel-powered truck haulage by 40,000 journeys a year. Today, every day, more than 100 diesel truck journeys are needed to transport products from Yara's Porsgrunn plant to ports in Brevik and Larvik where they ship products to customers around the world. With this new autonomous battery-driven container vessel move of the transport from road to will be achieved (reduce noise and dust emissions, improve the safety of local roads) The Norwegian Government gave a grant of 8 M USD for construction of the ship.



Decarbonising of Short Sea Shipping

E-Ferry ELLEN

Danish project intended to demonstrate energy efficient design concept of a 100% electric, emission free, medium sized ferry for passengers and cars, trucks and cargo in full-scale operation on Danish part of the Baltic Sea connecting the island of Aere to the mainland on abt. 10 Nm sailing routes. The capacity of 60 m over all length of the vessel are 31 cars or 5 trucks on open deck, 147 passengers at winter or 198 passengers at summer. Light ship weight is aprx. 650 tons and maximum speed is 13 knots for 750 kW engines. The project is supported by 15 M Euro from EU H2020 fund (total cost 21.3 M Euro).



Decarbonising of Short Sea Shipping

Aranda

Aranda is 60 m length an ice strengthened Finish research vessel suitable for multidisciplinary marine research all year round with a hybrid drive. After the renovation, the vessel can be driven by electricity produced by a generator connected to a diesel engine and electricity received from a powerful battery unit. By reducing the use of diesel engines with batteries, it is possible to significantly reduce sulphur emissions.



Decarbonising of Short Sea Shipping

Port Liner Barges

Port liner barges are inland waterway electric vessel of ideal dimensions to carry the weight of the batteries, while using none of its cargo capacity. The E-Powerboxes are stored under the wheelhouse. As there is no need any longer for an engine room, the container capacity of such ships actually increases, by 8%. This all combined with higher loading efficiency thanks to optimized loading bay length, accommodating a length of 14 containers of 20 ft or 7 cont. of 40 ft, or any combination of the two sizes.



Decarbonising of Short Sea Shipping

Grimaldi GG5G

Six of these ships (Grimaldi Green Fifth Generation GG5G) worth 400 M USD have been ordered at Jinling by Grimaldi Group members Finnlines and Grimaldi Lines. The new vessels, the first of which is expected to be delivered in 2020, will have a length of 238 metres, a beam of 34 metres and a gross tonnage of 64,000 tonnes. They will be able to transport over 7,800 lane meters of rolling units, equivalent to approximately 500 trailers; Beam: 34 m ; Gross tonnage of 64,000 tonnes. The ships will emit zero emissions thanks to mega lithium batteries – equivalent to 90 Tesla cars or 9,000kWh. These batteries will be recharged during navigation, via shaft generators using peak shaving, and with the aid of 600m² of solar panels.



Decarbonising of Short Sea Shipping

Cargo Guangzhou

The world's first 2,000-tonne cargo ship with electric propulsion (length of 70.5 meters, a width of 13.9 meters, a depth of 4.5 meters and a design draft of 3.4 meters). The ship is equipped with 26 tons of super capacitor + super-power lithium battery, the entire battery capacity of about 2400 kWh. Under full load conditions speed is up to 12.8 km / h, battery life up to 80 km. The ship charging time only 2.5 hours, the completion of the whole cargo handling time is about 2 hours .



Decarbonising of Short Sea Shipping

Navtek Tug NV-712

The Navtek 18,7 m length NV-712 ZeeTUG, which stands for Zero Emissions Electric Tug, is first electric tug operated primarily in Istanbul harbor. The Corvus battery, with energy storage capacity of 1500 KWh, will provide power for two SIEMENS propulsion motors driving conventional propulsion system through ABB thrusters and drive systems, integrated by Turkey's BMA Technology.



Decarbonising of Short Sea Shipping

Workboat

A new all-electric skimmer 12 m length workboat, worth 26 Mil NOK equipped with battery system for full five hours working mode (full battery charge will take just 2 hours). In addition, the vessel has solar panels on board.

The vessel will be a replacement for the current litter skimmer boat *Pelikan* which during the course of 30 years has picked up about 1,500 tons of trash from the Oslo harbour water surface.

The zero emission boat is 7.5 meters wide, while with a hydraulic front loading basket (in the bow) it can pick up trash from the water surface more effectively.



Decarbonising of Short Sea Shipping

Damen Commuter

Damen 23 m length vessels are designed for Danish public transport agency MOVIA, in the country's capital city Copenhagen. The 80 passengers capacity vessel is tailored so that the vessels can dock – bow first – at the existing jetties. A robust, steel-hulled ferry is equipped with strong fenders. These features, combined with the electric propulsion, guarantee lowest possible maintenance requirements.



Decarbonising of Short Sea Shipping

New Norway coastal route ships

The newbuilds for Norway coastal route with length of 125 meters and a width of 20 meters will be able to accommodate 700 passengers. They are part of Havila's contract with Norwegian Ministry of Transport for the construction of four environmentally-friendly vessels that will operate on the Bergen-Kirkenes coastal route. Two of the vessels will be built by Turkish shipbuilder Tersan and the remaining by Spanish Barreras.

The vessels will have a hybrid gas-electric propulsion system with battery, where four gas-powered engines in each vessel run the generators. The system is also adapted to the next generation of technology, using hydrogen fuel cells. The equipment from Corvus Energy is scheduled for delivery in 2020 and the coastal route vessels will be in service from 2021.



Technology

For shipping, prioritisation of battery-electric and hydrogen (ammonia) as technologies from sustainable renewable sources to decarbonise SSS. Battery electric propulsion appears to be the most efficient use of primary energy, however combinations of battery-electric and carbon-free fuels are likely to be pursued depending on the available renewable energy and operational needs of individual ship owners.

Incentives

Port discounts for zero emission ships. Subsidies from national and regional level as well as ports who can decide on the offered discount levels (Norway scheme for NoX fund and Green Coastal Shipping Programme.)

Execution

Mandate zero emission for SSS following Norway example, starting with passenger ships and gradually extending to other ship types. For deep-sea shipping a 12 and then 200 nautical miles CO2 emission control area should be explored in order to incentivise the gradual uptake of zero emission technologies.



Decarbonising of Short Sea Shipping

THANK YOU

ANY QUESTIONS
darko.bandula@zg.htnet.hr

