

An Overview of Alternative Sources of Maritime Energy

Dr Prapisala Thepsithar Senior Scientist Maritime Energy and Sustainable Development Centre of Excellence

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- Potential of each alternative sources of energy
- GHG emission reduction of each source in comparison with conventional fuel oils

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- Technical, economic, environmental and social-political points
- Their levels of importance

Summary

SOURCES OF ENERGY FOR SHIPS

Past and present

Coal: till 2nd half of 20th century

Wind: till 19th century



HFO: till now





Source: IMO 3rd GHG study (2014)

• Currently, there are more than 50,000 ocean-going vessels with different types, sizes and age

million tons/ year

• Fuel consumption of around 250 million tonnes of fuels annually

MEASURES FOR GHG EMISSION REDUCTION

Technical & Operational Measures and Alternative Sources of Energy



GHG EMISSION AND REDUCTION POTENTIAL



GHG emission reduction potential

(Source: IMO/MEPC 72/7/3. Submitted by Japan. Calculation by MLIT, based on the Third IMO GHG Study 2014)

POTENTIAL SOURCES OF ALTERNATIVE ENERGY



GENERATION of alternative fuels/ energy	TRANSPORT	APPLICATION on board ships	
 Feedstock (current & future) Production technologies Capacity (current & planned) Usage (by other industries) Cost and other concerns 	 Storage requirement Logistics Safety & regulations 	 Applicability Operation, safety & environment: Emission reduction 	
Trend of adoption, issues for industry to overcomes prior to actual adoption, active parties (academia, industry and countries)			

LIQUEFIED NATURAL GAS (LNG)

World natural gas reserves ~180 trillion m³ R/P ratio 60-80 year



Source: BP Statistic Review 2005



Source: Engie, https://www.engie.com/en/journalists/press-releases/liquefiednatural-gas-supply-contract-lactalis-group/

Dual-fuel engine, fuel gas supply system and storage on board vessels (TRL 9) Requirement of a global network of infrastructure for its application worldwide



Feedstock



It is compatible with marine distillate and applicable with existing ships/ existing bunkering infrastructure (TRL 9).



Able to support industry only partially due to its insufficient supply. The utilisation of biodiesel blends can be considered.

Requirement of fuel specification standardisation (properties of biodiesel produced from different sources are different.

Source: Adopted from The Crop Site (2010), Biofuel Production - Greater Shares of Commodities Used.



Methanol can be produced from various feedstock.



Requirement of dual-fuel engine or engine modification/ bunkering infrastructure (TRL 9).



Presence as current commodity / existing distribution infrastructure

Overall environmental performance

Able to support industry partially (~7-8% of energy demand).

Low energy density (22.7MJ/kg)

BIO-GAS

Bio-gas (bio-methane) can be produced from waste and wastewater.



Similar nature as natural gas (TRL 9).

Potential for biogas production worldwide

Resources	Energy Production (PJ)	Billion m ³ CH ₄
From agriculture (Manure, residues, energy crops)	22,674	630
From waste Urban waste (organic fraction of MSW), agro-industry waste (organic fraction), Sewage	13,316	370
Total	35,990	1,000

Able to leverage on LNG infrastructure Presence as bioenergy providing further emission reduction

Requirement of sufficient production of biomethane and value chain development to support its application

Source: World Bioenergy Association releases biogas fact sheet (2013) Biomass Magazine

HYDROGEN

Feedstock: non-renewable to renewable



The application of H_2 requires fuel cell with electric motor (TRL 6).

H₂ Production 50 million tons/year



Requirement of the storage on board

Establishment of centralised H₂ production from renewable sources of energy and/or fossil fuel with carbon capture technology

Establishment of the value chain and a global network of infrastructure for its application worldwide

Feasible for the whole industry to adopt as a major measure for "zero emission".

Source: Industrial hydrogen and synfuel production and use, Global CCS Institute.

BATTERY PROPULSION

Power generation from non-renewable to renewable



Capable of achieving zero emission for all electric propulsion with battery (TRL 6-9).



Requirement of battery packs and charging station

Improvement of energy density of battery in order to enable the implementation of full electric for large vessels and/or deep sea shipping.

Electricity produced from renewable sources of energy and/or fossil fuel with carbon capture technology

Source: Energy Storage, http://homework.uoregon.edu/pub/class/hc441/bstorage.html

ENERGY COST



Source: Historical price of fuels obtained from www.afdc.energy.gov/data/, and Methanex Monthly Average Regional Posted Contract

Price History

CRITERIA FOR SELECTION TOWARDS SUSTAINABILITIY



SUMMARY

Emission factor of each alternative energy source according to feedstock and driver for adoption

From the important level of selection criteria towards sustainability:



Short- and medium- term 2018-2023 and 2023-2030

- Readiness of LNG infrastructure
- Enhancement of bio-methanol production
- Sufficient supply and consistent of biodiesel quality

- Sustainable production of energy source, value chain development and global network of infrastructure





Long-term 2030 onwards

