

# PROJECT SABRE

NH<sub>3</sub> Bunkering in Singapore  
Joint Feasibility Study  
Summary of Phase 1

06 APR 2022



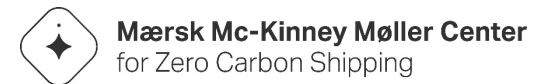
# The SABRE project

On 8 Mar 2021, SABRE partners entered into an MOU to conduct a year long feasibility study to assess the technical, commercial and regulatory viability in establishing an end-to-end supply chain to enable Ammonia Ship-to-Ship (“**StS**”) bunkering in Singapore (“**Study**”).

With the preliminary target to commence Ammonia bunker operation within 2020s, the scope of Study includes identifying potential sources of Ammonia, engaging local authorities to understand the current standing and plan for regulatory establishment, the infrastructure that needs to be put in place, as well as the availability of technology to enable Ammonia bunkering in Singapore.

The Study assumed the development of Ammonia bunkering in two (2) stages, i.e. Pilot stage (“**Pilot**”) before scaling up to Commercial stage (“**Commercial**”), based on a set of Ammonia bunker demand projections.

## SABRE Partners



# Phase 1 Report - Executive Summary

In recent years, it has been reported that International shipping accounting for 90% of global trade and contributing to approximately 3% of global greenhouse gas (“GHG”) emissions. With the International Maritime Organization (“IMO”) targeting 50% reduction in GHG emission by 2050, as compared to 2008 emission level, green and blue ammonia (“Ammonia”) have been considered by the maritime industry as one of potential alternative marine fuels to decarbonize the maritime trades due to reasons being a) ammonia is an existing industrial commodity, has been stored and transferred globally; b) various potential Ammonia production sites under development globally; c) scalable for other potential downstream uses, e.g. power generation and hydrogen-carrier.

## Production

While there are various global Ammonia production projects under planning, none has yet achieved FID at the time of reporting.

The largest capacities of green and blue ammonia production facilities under planning are reported to be up to 2 Million tons annum (“MTPA”) in Australia and 5 MTPA in Russia respectively.

Indicative price of Ammonia was obtained from preliminary discussion with potential suppliers as part of the Study. While cost of green ammonia is likely to be CAPEX driven, a significant part of blue ammonia cost is likely to be pegged to grey ammonia pricing. Further, life cycle assessment analysis (“LCA”) of selected Ammonia supplier has been conducted and preliminary findings show that the Well-to-Wake GHG emission of selected projects is expected to be lower than that of LNG and LSFO by up to 99%.

Subject to location of Ammonia source and size of carrier to transport from source to Singapore, we could estimate transport cost.

## Storage

To date, there is only one existing ammonia storage tank in Singapore (Jurong Island) meant for specialty chemical and other specific downstream applications. Various storage terminal operators with operations in Jurong Island have been engaged. Undeveloped lands in Singapore may be potential sites for Ammonia storage, but subject to various factors, e.g. Qualitative Risk Assessment, land allocation, etc. Subject to Ammonia carrier capacities and operation storage buffer requirements, various storage configurations were considered.

## Onboard safety

The parties have studied ideal size of Ammonia bunker vessel (“ABV”) for Singapore bunker operation. Preliminary requirements of the ABV has been discussed as part of the Study and hazard identification (“HAZID”) workshop has been conducted, with the objective to achieve Approval-in-Principle for the ABV.

In terms of safety standards and regulations on Ammonia bunkering, beside timely engaging with Maritime and Port Authority of Singapore (“MPA”), Global Centre for Maritime Decarbonization (“GCMD”) has embarked on a study to address technical, procedural and regulatory guidelines for ammonia transfer and bunkering, which is expected to be complemented with pilot trial. The parties are hopeful that such initiatives by the local authorities expedite the enabling of Ammonia bunker supply chain.

## Key findings and takeaways

- Well-to-Wake GHG emission of selected Ammonia production projects is expected to be lower than that of LNG and LSFO by up to 99%.
- Various storage terminal operators with operations in Jurong Island have been engaged.