Making progress towards net-zero shipping through alternative fuels (hydrogen-based)

Paul Blomerus
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clearseas.org
Provide objective information to decision makers and the public on the topic of safe and sustainable marine shipping, to:

- Improve knowledge of key issues
- Make debate and discussion more inclusive and constructive
- Increase understanding of risks, benefits and best practices
- Support fact-based decision making
- Clarify complex issues to counter misinformation and disinformation
- Identify knowledge gaps and act to fill them using a holistic approach

**Audience**

- General public
- Industry decision makers and government policy makers
- Indigenous and coastal communities
COMMUNICATING COMPLEX ISSUES

Key Issues Pages

- Oil Tanks
- Ship Waste
- Responding to Oil Spills
- Underwater Noise
- Marine Shipping & You
- Who Pays for an Oil Spill
- Invasive Species
- Air Pollution
- LNG

Monthly Blog Posts

- Clear Facts Blog: Marine Shipping Issues, Simplified
- NECOPA
  - October 2, 2023
  - Canadian Marine Shipping Risk Forum
  - In the fall of 2019, the Marine Environmental Observation, Prediction and Response Network (NECOPIA) launched the Canadian Marine Shipping Risk Forum (CMSR), in collaboration with Clear Seas and IPEACE.
  - Read more

Research Reports

- In 2020... Supporting Inuit Rights and Marine Use
- NECOPA... Assessing Shipping Risk in Canada
- Clear Seas... Marine Shipping Trends in the Canadian Arctic
- Clear Seas... Maritime Commercial Incidents and Accidents
- Clear Seas... Vessel Traffic in Canada’s Pacific Region
- Angus Reid Institute... 2020 Public Opinion Poll: Canadans’ Attitudes Towards Marine Shipping
- Clear Seas... Assessing Sensitivity of Coastal Areas to Oil Spills
- Clear Seas... Availability of Tugs of Opportunity in Canada’s Pacific Region
- Clear Seas... Emergency Towing Vessel Needs Assessment
- Clear Seas... Vessels, Drift and Response Analysis for Canada’s Pacific Coast

clearseas.org

Workshops
Webinars
Newsletters
Infographics
GIS web data
NET-ZERO BY 2050?
A.P. Moller - Maersk accelerates Net Zero emission targets to 2040 and sets milestone 2030 targets

CMA CGM Group Targets Carbon Neutrality by 2050

MSC commits to net zero by 2050

Chief Soren Toft makes pledge as family-owned business is set to become world’s biggest shipping group
ELECTRIFICATION
Electrify the fuel
ELECTROLYSIS

2H₂O → 2H₂ + O₂

Electricity
**HYDROGEN**

Relative Energy Density
Equivalent range of 1 m³

- **Highly Flammable**
- Liquid at -250 dec C

Source: DNV 2019

Japanese-Australian HESC project, January 2022 (HESC)
The ammonia molecule (formula $\text{NH}_3$)
AMMONIA

- Toxic
- Liquid at -28 dec C

Source: DNV 2019
METHANE

The methane molecule (formula CH₄)
METHANE

Relative Energy Density
Equivalent range of 1 m³

Liquid at -160 dec C
Powerful Greenhouse Gas

Source: DNV 2019
The methanol molecule (formula CH$_3$OH)
METHANOL

Relative Energy Density
Equivalent range of 1 m³

Heavy Fuel Oil (Liquid)
Batteries (Solid)
Hydrogen (Compressed Gas)
Hydrogen (Liquid)
Ammonia (Liquid)
Methane (Liquid)
Methanol (Liquid)

Toxic
Liquid at 25 dec C

Source: DNV 2019
DIRECT AIR CAPTURE OF CARBON

Carbon Engineering

Ambient air → CO₂-free air → Concentrated CO₂

Water
Renewable Electricity
Natural Gas

Pure compressed CO₂ ready for use or storage from natural gas use
Canada is set to have one of the world’s biggest green hydrogen plants

- Costs $200 million
- Consume 88 megawatts of electricity
- Produces 11,000 tonnes of hydrogen annually
Steam Methane Reforming (SMR)

Natural Gas $\rightarrow$ H$_2$ + CO$_2$

Steam
HYDROGEN FROM PYROLYSIS?

Natural Gas $\rightarrow$ $\text{H}_2 + \text{C}$

Heat
MORE WORK TO GET TO ZERO EMISSIONS FUEL

Ship and engine technology ✓
Manufacture and transportation ✓
Bunkering ✓
Scalable sustainable Hydrogen source? △
Scalable sustainable Carbon source? △
Fossil fuel equivalents with higher GHGs ✗
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QUESTIONS
CLEAR SEAS NEW RESEARCH PRIORITY AREAS

1. Maritime Industry Progress on UN SDGs
2. GHG Emissions Footprint of Canadian Marine Trade
3. Small Tug Safety
4. Port State Control Inspections for Marine Safety – statistical analysis
5. Understanding Shipping Risk in Canada's Atlantic Region – tugs of opportunity changes
6. Role of Safety Management System in Shipping – does it need refreshing?
7. Changes in Risk for Shipping HNS
8. Demonstrating the Benefits of an Integrated and Data-informed Supply Chain
9. TMSA and SIRE System Applications to Other Ship Types
10. Reducing Crew Fatigue in Marine Shipping