

CANADA IS MARITIME NATION

"..... a mari usque ad mare, et a flumine usque ad terminos terrae"

"..... from sea to sea, and from the river to the ends of the earth"

Psalm 72:8





NORTH



EAST



WEST



SOUTH

Moving towards net-zero carbon emissions for Canada's ocean space



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Specific Focus – Ships and Marine Craft

Canada is an active arena for two sets of marine vessels, namely the domestic fleet and the international fleet

The domestic fleet includes:

Ferries, coastal shipping, fishing vessels, naval and government ships and craft, tugs and harbor craft, etc.

The international fleet includes:

Bulk carriers, container ships, cruise ships, tankers etc.



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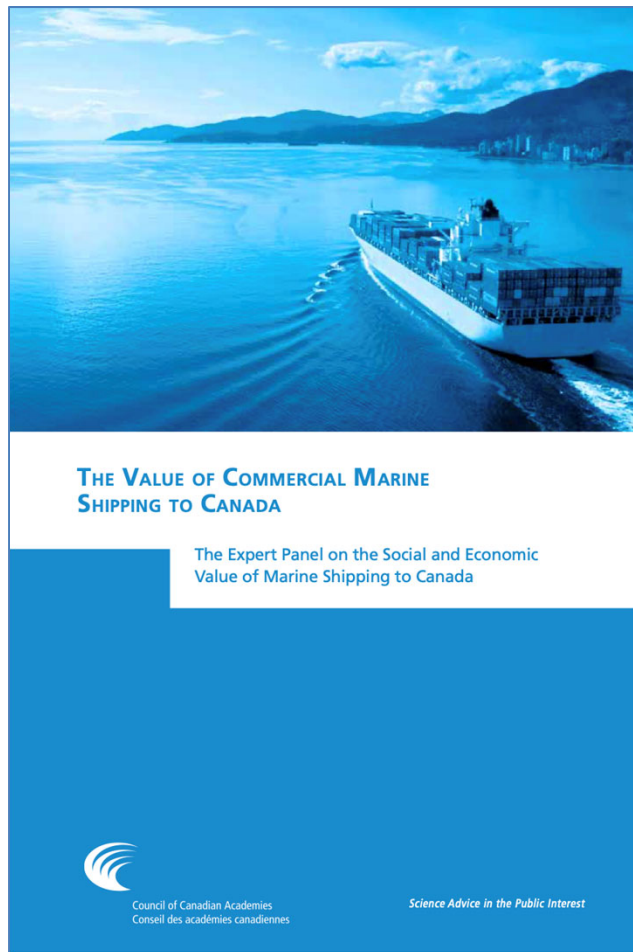
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Relevant Council of Canadian Academies Report – May 2017



- As a maritime nation, Canada's economy, culture, environment, and security have long been interlinked with commercial marine shipping.
- Critical to Canada's historical development, marine shipping continues to be vital to international trade and the development of communities.
- It is often the only means by which food and essential goods reach Canada's island, remote, and northern communities.



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Relevant Canadian Academy of Engineering Report - April 2016



Engineering in Canada's Northern Oceans Research and Strategies for Development

A Report for the Canadian Academy of Engineering

Final

Ken Croasdale
Robert Frederking

Ian Jordaan
Peter Noble



OBJECTIVE:

- To assess Canada's offshore Arctic engineering capabilities, past achievements and future challenges; and to provide recommendations for developing future opportunities and maintaining expertise.

RECCOMENATIONS:

- Create visionary projects to enable development in Canada's northern seas.
- Possibly integrate some of the proposed ideas, for example develop small scale Arctic LNG and use it to power Arctic Railway and Mobile Arctic Engineering Research Platform.
- Develop Arctic Engineering Field Research by extending Cambridge Bay CHARS to include the proposed IAEES
- Develop the "people" aspects of Arctic Engineering through University-Government-Industry partnerships to maintain Canada's global leadership in Engineering for Northern Seas.
- In all of the above, create opportunities for Northern residents.



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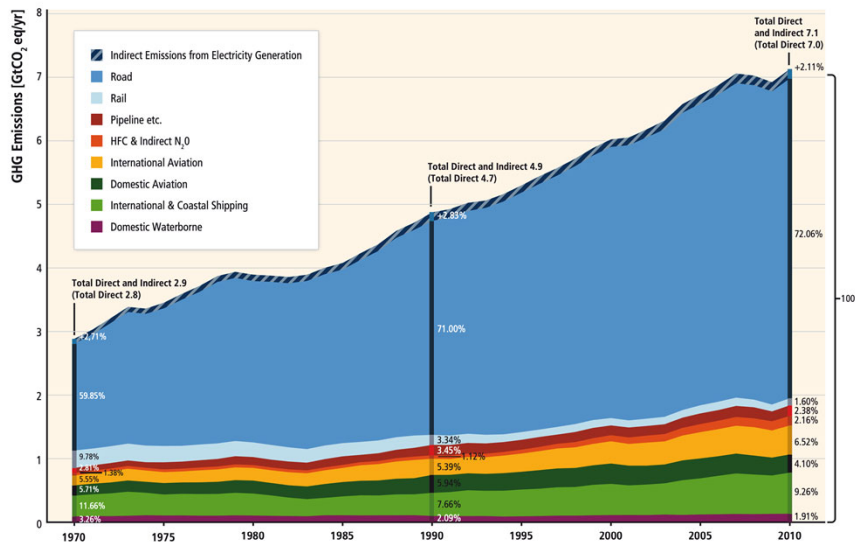
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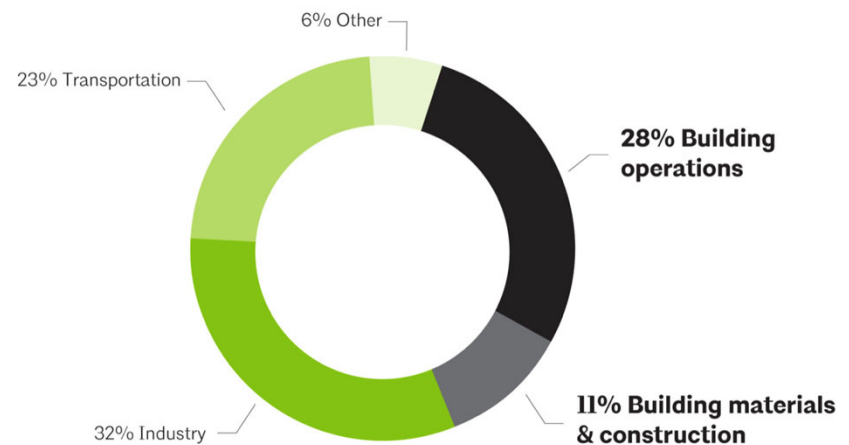
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Marine Shipping GHG Emissions



Global CO₂ Emissions by Sector



Global Alliance for Buildings and Construction, 2018 Global Status Report; IEA

Transport accounts for around 25% of CO₂ emissions and marine accounts for less than 10% of that. Therefore, marine transport accounts for less than 3% of total GHG emissions.



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United Nations - International Maritime Organization, MO

- Environmental Regulations adopted by Member States
 - Double Hulled Tankers - MARPOL 1992
 - Ballast Water Management Convention 2004
 - SOX and NOX MARPOL Annex VI 1997, 2010, 2015, 2021
 - EEDI – Energy Efficiency Design Index – 2015
 - EEXI – Energy Efficiency Existing Ships - 2022



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Canadian LNG Powered Ferries



ST LAWRENCE FERRY 'FA GAUTHIER', POWERED BY DUAL-FUEL ELECTRIC PROPULSION,
EMPLOYS MAIN AZIMUTH THRUSTERS EQUIPPED WITH CONTRA-ROTATING PROPELLERS

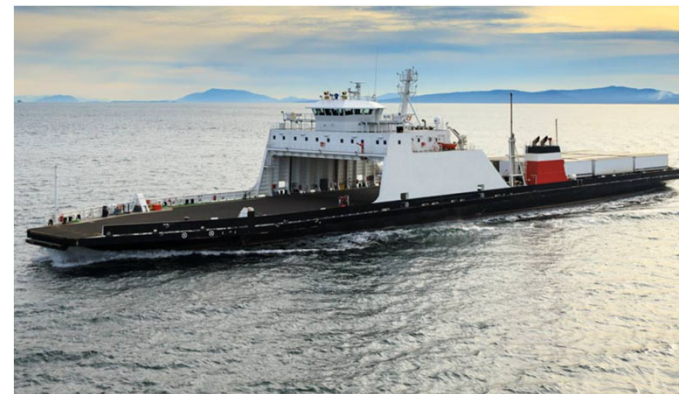
STQ Matane LNG Ferry



BC Ferries Salish Class



Quebec City LNG Ferry – Davie.



Trailer Ro-Ro Ship, B.C..



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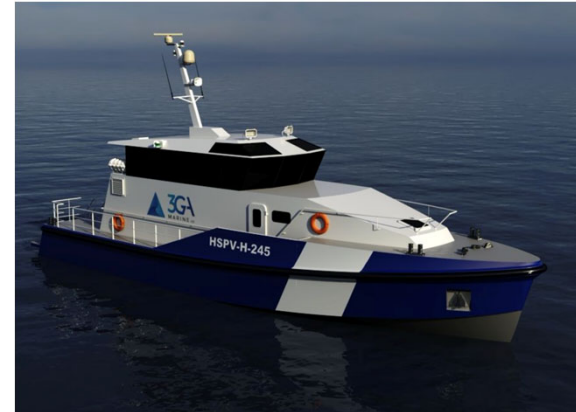
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Hybrid & Battery Powered Vessels



Electric Cable Ferry – Arrow Lakes, BC



Hybrid Electric-diesel Patrol Boat- 3GA Marine, Vancouver



BC Ferries' Island Class Hybrid vessel



Electric Ferry – Kootenay Lake, BC



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LNG & Battery Powered Craft



LNG Tug – Robert Allan Ltd., Vancouver



Fishing Boat - Glas Electric, Nova Scotia



Electric Fishing Boat – Norway, Corvus battery system, Canada



Battery Powered Pilot Boat Concept – Robert Allan Ltd



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LNG Powered Ocean Tonnage



LNG Powered Cruise Ship



LNG Powered Container Ship



LNG Powered Oil Tanker



LNG Powered Container Ship - Alaska



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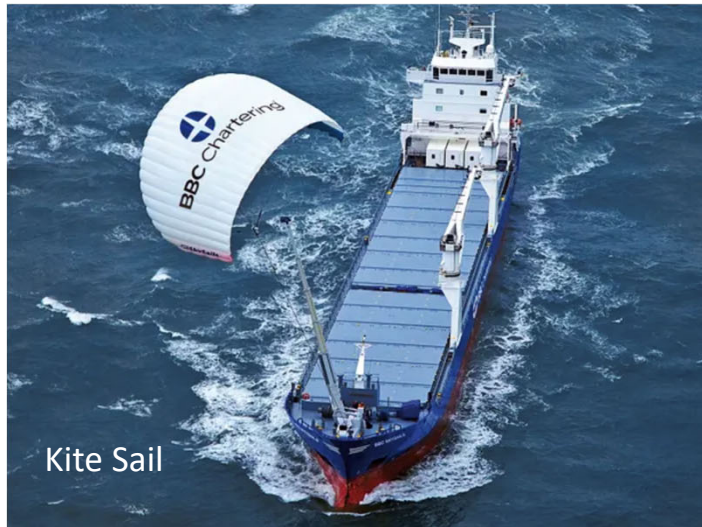
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Auxiliary Sail Power



Kite Sail



Flettner Rotors



Flettner Rotor



Wing Sails



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Nuclear Ships?



IE



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Quo Vadis – Where are We Going?

EFFICIENCY IMPROVEMENTS – Less Fuel Used:

- More marine transport systems and ship improvement:
- Supply chain improvements to optimize ship time at sea and in port.
- Improved ship designs and construction - digital
- Improved ship operations – digital twins
- Improved hull coating & cleaning
- Improved propulsion systems
- Minimize cargo emissions
- Port infrastructure improvements

ALTERNATIVE FUELS/ENERGY SYSTEMS – Lower Emission Fuel/energy used:

- Bio-fuels
- LNG
- Ammonia
 - Green ammonia: Carbon-free ammonia synthesized from nitrogen and carbon-free hydrogen produced from renewable energy.
 - Blue ammonia: Carbon-neutral ammonia produced from natural gas, with the CO₂ produced from the processes captured and prevented from entering the atmosphere.
 - Brown ammonia: Conventional ammonia produced from natural gas.
- Hydrogen production
 - Green/Blue/Brown
- Hydrogen - Combustion
- Hydrogen - Fuel Cells
- Electric Batteries
- Nuclear – Modular SMR
- Wind energy – Sails & Kites



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Conclusions

- The international marine shipping sector has recognized the need to minimize GHG and has started to implement regulatory requirements and technical solutions. More needs to be done to meet established targets
- Parts of the Canadian marine industry; ferry operators, ship owners, naval architects, battery researchers, etc. are at the leading edge of technology development and applications both domestically and internationally.
- There is an initiative within the Government of Canada with respect to the National Security Service fleet. However, the net zero target does not appear to be a major part of the current National Shipbuilding Initiative.



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