"... 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
Moving towards net-zero carbon emissions for Canada’s ocean space
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.
• 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.
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.

RECOMMENDATIONS:
• 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.
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.
United Nations - International Maritime Organization, MO

- Environmental Regulations adopted by Member States
  - Double Hulled Tankers - MARPOL 1992
  - Ballast Water Management Convention 2004
  - EEXI – Energy Efficiency Existing Ships - 2022
Canadian LNG Powered Ferries

STQ Matane LNG Ferry

BC Ferries Salish Class

Quebec City LNG Ferry – Davie.

Trailer Ro-Ro Ship, B.C.
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

Noble Associates Inc.
Offshore, Marine & Arctic Technology Advisors
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

Noble Associates Inc.
Offshore, Marine & Arctic Technology Advisors
LNG Powered Ocean Tonnage

LNG Powered Cruise Ship

LNG Powered Container Ship

LNG Powered Oil Tanker

LNG Powered Container Ship - Alaska
Auxiliary Sail Power

Kite Sail

Flettner Rotors

Flettner Rotor

Wing Sails
Nuclear Ships?
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
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.