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GREAT LAKES ST. LAWRENCE GOVERNORS & PREMIERS

ELECTRIFICATION OPPORTUNITIES

for

GREAT LAKES ST. LAWRENCE TUGS & HARBOR CRAFT

Tugboats and harbor craft are an essential part of the Great Lakes St. Lawrence Seaway (GLSLS) maritime transportation system. These vessels perform a range of tasks like assisting vessels in moving around harbors and in open water, construction, research, public safety activities, and even icebreaking. These vessels also contribute to the environmental footprint of the region's transportation system: prior studies by the Conference of Great Lakes St. Lawrence Governors and Premiers (GSGP) found that emissions from tugs and harbor craft make up about 18% of the region's total maritime emissions[1], and electrification of ferries and tugboats could reduce regional maritime emissions by up to 12% with current electricity generation sources.[2]

Electrification of tugs and harbor craft is gaining interest in the GLSLS region as States and Provinces look to support the modernization of their maritime systems and improve air quality, and as vessel operators seek to diversify their fuel sources and act as good neighbors to port communities. This summary builds on prior GSGP studies to provide stakeholders with an understanding of the feasibility of electrification for tugs and harbor craft in the region.

GLSLS TUG AND HARBOR CRAFT FLEET CHARACTERISTICS

Tugboats make up the greatest share of vessels in the category of "tug and harbor craft," which also includes vessels like work boats, research vessels, and some kinds of ferries. The operating context and characteristics of GLSLS tugs and harbor craft are different when compared with larger coastal ports. The operating environment of the GLSLS can be particularly harsh, and the freshwater environment of the GLSLS means that vessel hulls have longer lifespans than their saltwater peers. Considering factors like these, tugboat operators prioritize vessel reliability, since vessels must deal with challenging conditions and will operate for decades: it is estimated that the average age of the GLSLS tugboat fleet is 65 years old**. The fleet's age presents an opportunity: as aging vessels are replaced, modern technologies may be implemented in replacement vessels.**

ELECTRIFICATION FEASIBILITY FOR GLSLS TUGS AND HARBOR CRAFT

With current technology, not every vessel will be a suitable candidate for a battery-electric drive system. In particular, the energy density of batteries remains low when compared to diesel fuel, which means that the range of electric-powered vessels is limited compared to diesel-powered vessels. Therefore, the greatest opportunity for electrification is for vessels that have predictable and regular duty cycles or schedules to support frequent charging, short sailing distances, and which operate in areas where shore-based charging infrastructure can be installed. Based on criteria like these, **harbor assist tugs and passenger ferries are the key vessel types with a high degree of potential for future electrification**.

Many of these vessels are privately owned and operated, and the perspectives of vessel operators are important to consider when evaluating feasibility of electrification. Vessel operators have indicated concerns about the

[1] Rutherford, Dan. Technical Note: Great Lakes-St. Lawrence Emissions Inventory. International Council on Clean Transportation. October 13, 2023.

[2] Estimating Emissions Reductions from Technology Implementation. Conference of Great Lakes St. Lawrence Governors and Premiers. May 3, 2024.

relatively untested nature of new battery technology, as well as concerns about battery stability, space requirements, and fear of battery fires; crew safety will be an important consideration for the implementation of this technology in the future. Additionally, tug and harbor craft operators noted that electric power infrastructure capacity, and workforce capacity (to maintain electric drive systems) is lacking. **Finally, a major challenge for adoption is cost: battery technology is still relatively new, and costs more than traditional diesel systems.**

Many of these challenges may be addressed as battery-electric marine technology further evolves and matures. In the near-term, adoption of hybrid diesel-electric power systems may help vessel operators improve fuel efficiency while reducing operating costs and emissions.

LESSONS LEARNED FROM ELECTRIFICATION ELSEWHERE

As of 2025, there are between 65 and 70 electric tugboats in operation around the world. Key lessons learned from the implementation of electric tugs and ferries elsewhere in North America indicate that public-private partnership is often needed to help private vessel operators overcome the relatively high cost of new-built electric vessels. Additionally, the weight and space requirements of batteries mean that all-electric battery-powered tugs have been newly built, as retrofitting existing diesel-powered tugs to accommodate all-electric systems is seen as cost-prohibitive. By comparison, larger ferries are candidates for conversion to electric power systems.

A POTENTIAL PATH FORWARD

States, Provinces, vessel operators, and marine stakeholders interested in electrification of tugs and harbor craft could consider the following activities to support electrification in the future:

- Implementation of hybrid diesel-electric drive systems as a bridge technology to improve operational efficiency and reduce emissions while battery electric technology matures. Adoption of these systems may also help operators develop a workforce familiar with maintenance of electric drive systems.
- Engagement with local utility companies to evaluate grid capacity at ports and terminals and ensure sufficient power can be supplied for vessel charging. A further consideration is the source of local electric power: power generated from renewable sources will have a lower emissions intensity than power generated from fossil fuels.
- Benchmarking other state and provincial maritime electrification programs to understand and leverage best practices and lessons learned.
- Developing workshops to educate vessel owners and operators about new battery technologies, grant and funding sources for conversion to alternative energy sources.
- Tax credit or grant programs to help support the vessel owners with the transition to new maritime technologies which may be more expensive than traditional technologies.