



# **Great Lakes Maritime Research Institute**

*A University of Wisconsin - Superior and  
University of Minnesota Duluth Consortium*

Great Lakes Maritime Research Institute  
Scope of Study  
MARAD Great Lakes LNG/Repowering  
Phase I  
September 2011

Refer questions to:  
Carol Wolosz  
Executive Director  
(218) 726-7446  
cwolosz@d.umn.edu

Final – November 2011

## Background

The Great Lakes Maritime Research Institute (GLMRI) was established to pursue research efforts to support economically and environmentally sustainable maritime commerce on the Great Lakes. To fulfill that mission, GLMRI is supporting research in marine transportation, logistics, economics, engineering, environmental planning, and port management. The consortium can also draw on expertise in a wide range of other areas through affiliations with other Great Lakes universities.

As part of our ongoing effort, we have established formal affiliations with area universities, set up an external advisory board, developed a prioritized research focus, and provided annual reports on each year's funded research.

## Project Overview

**Benefits:** The concept of converting the existing fleet of approximately 55 large U.S. flag commercial Great Lakes vessels to using Liquefied Natural Gas (LNG) as their principal fuel source appears to have significant merit. LNG would be a clean burning fuel that would make the US flag fleet a world leader in reducing harmful air emissions including green house gases. The looming issue of a probable shortage of low sulfur diesel fuel would be resolved. The Great Lakes vessels that are so essential to our national steel supply chain would be using a reliable, relatively low cost domestic fuel source. The long life of the hulls of Great Lakes vessels enables the owners to spread the conversion costs over a longer period of time than ocean carriers. The conversion process may provide opportunities for carriers to also repower their vessels gaining fuel efficiency, increased productivity and operational improvements. Vessel conversion and operations would create and keep employment in the Great Lakes region not only for vessels but all along the supply chain. A significant number of vessel conversions will result in lowering the incremental costs for LNG and related engines and may precipitate new shipbuilding. Advances in engineering, technology, training and operations of Great Lakes vessels adapted for using LNG fuel could be transferred to U.S. flag coastal vessels. The use of LNG as the main fuel for Great Lakes vessels has the potential to benefit the carriers, shippers and public, along with the natural environment.

**Challenges:** Conversion of a vessel's main power plant is expensive, complex and engineered for that specific vessel. The existing laws and regulations do not reward carriers and their shippers for the substantial additional cost of moving beyond minimum compliance no matter how much the environment is improved. A carrier that is an early adopter of a cleaner fuel such as LNG may be penalized for being environmentally proactive. The capital costs, if no other options exist, will have to be captured in higher freight rates. Without incentives, shippers may elect to move cargo to vessels that meet minimum air emissions standards, have not incurred the capital expenditure for LNG conversion and will charge lower freight rates. Carriers will have difficulty obtaining financing for conversions if there are not clear monetary benefits that translate into income for debt repayment. Currently there are no LNG fueling ports on the Great Lakes and the fuel distribution system would have to be developed. The Great Lakes shipyards would have to adopt new technology, equipment and training for LNG conversion. LNG

has a lower British Thermal Unit (BTU) rating than petroleum based fuels on a per gallon basis. This means that vessels must not only have cryogenic LNG tanks but also have adequate storage space for intended voyages.

**Industry's Opinion:** Researchers from the Great Lakes Maritime Research Institute met with leaders from the carriers, shipbuilding and government agencies and informally discussed LNG conversion. These groups see clear long term advantages to LNG conversion and have already embarked on vessel conversion studies and to a very limited extent, fuel sourcing. However, there is guarded optimism about the opportunity because of the scope of change, availability of capital, the lack of cohesive and cooperative federal state and local government backing, and the potential to lose market share.

## **Scope of Feasibility Study**

**Task 1** - Determine if there is owner interest in pursuing LNG as an alternative maritime fuel for use on the Great Lakes.

Topics for discussion include: Vessel suitability, shippers' risk, public engagement, Federal, state and local support. LNG supply chain, distribution system and availability.

Deliverable: Physically hold a meeting with a group of key officials, MARAD representatives, and GLMRI representatives.

Time: August 2011.

**Task 2** - Explore the existing maritime usage for LNG.

Do a literature search of current publications documenting LNG use in marine applications. Work with European Union countries to exchange information and support an international exchange of information.

Deliverable: Support bringing international experts to Great Lakes maritime venues to present papers and findings to maritime focused audiences. Prepare an agenda to explore technology and knowledge transfer of maritime LNG use through an in-depth tour of the maritime applications in coastal Norway. Participate in global conferences and events to expand stakeholder knowledge of LNG applications.

Time: Ongoing throughout project.

**Task 3** - Explore the feasibility of and conceptual designs for the conversion of the remaining steam powered U.S. Great Lakes bulk carriers to LNG propulsion.

These vessels have the worst air emissions within the U.S. fleet and are currently grandfathered relative to EPA requirements. The goal of this research is to develop conceptual designs for the conversion of these vessels to LNG fuel using gas engines to achieve very low emissions and significantly reduced fuel consumption. They would then meet the air emissions requirements for the Emission Control Area (ECA) that will

come into effect on the Great Lakes in 2016. Their air emissions would move from worst to first among the U.S. Great Lakes fleet. The use of LNG will also likely result in a significant fuel cost savings that could provide added justification for their conversion and further economic life. Reduced manning would also be feasible. This study will consider arrangements, effects on cargo capacity at constant draft, fuel usage, air emissions, maintenance requirements, manning, and remaining ship life-cycle economics. The designs will be in accordance with the requirements of the ABS Guide “Propulsion and Auxiliary Systems for Gas Fueled Ships,” May, 2011. This study will also provide the fleet inputs (ships, demand, and routes) to a parallel LNG fuel logistics study.

Deliverable: Report on Findings, with quarterly progress reports.

Time: Project (Phase 1) Completion. (August 2012)

**Task 4** - Assess the existing availability of LNG in the Great Lakes Region.

Determine where LNG currently exist and would be required and the liquifaction facilities that currently exist, along with their production capabilities and expansion potential.

Deliverable: Report on each production/source and the potential output (maximum) for each existing facility to address demand capacity.

Time. (August 2012)

**Task 5** - Once the regional LNG sources are determined, address the supply chain requirements (macro level).

The study would identify the transportation needs to get the LNG to a port facility, to include storage at the port facility, tanks (size, shape, capacity, production of the tanks, special handling requirements, etc.), numbers of trucks (barges) and requirements for the trucks/tanks, permitting, facility security, safety provisions/OSHA, and other items necessary to have LNG accessible for fueling Great Lakes vessels (such as time to move from plant to port, amount of time to transfer LNG from port to ship).

Deliverable: Report identifying the findings

Time: (August 2012)

**Task 6** - Outreach to the public and government agencies on the opportunities and benefits associated with Great Lakes shipping.

Participate in meetings, events, conferences and other venues to address Great Lakes shipping, and provide presentations, materials and other items to educate and advocate the opportunities and benefits associated with shipping as sustainable transportation mode.

Deliverables: Involvement will be included in the GLMRI quarterly and annual report(s).

Time: Ongoing throughout project.

## **Scope of Demonstration Project**

In a planning meeting held in Cleveland, Ohio on 23 August 2011 (Task 1/above), industry members (representing the majority of the GL U.S. ships and tonnage), MARAD representatives and GLMRI team members agreed on a demonstration project utilizing the *S.S. Badger*. The *S.S. Badger*/Lake Michigan Car Ferry is on a short timeline to transition their fueling from coal to another power option. They are strongly considering the use of Compressed Natural Gas (CNG) as an alternative. The project will focus on engineering design and using the *S.S. Badger* business model as a case study to apply specific information to evaluate the operational impact of utilizing CNG/LNG as a primary fuel, while providing information technology to transfer to other industry platforms, such as other ships or even other modes for CNG/LNG usage. GLMRI will work with experienced engineering faculty and firms, such as Bay Engineering, Incorporated in Sturgeon Bay, WI to produce studies and technical information to provide to MARAD, industry and other stakeholders.

**Task B1** - Assess the existing availability of CNG/LNG in the Lake Michigan (accessible) area.

Determine where CNG/LNG can be sourced from in the Lake Michigan region to meet the operational demands for a shipping route and schedule to meet the demand. This task will look at quantity needs, transportation routing, stock pile requirements.

Deliverable: Report on each production/source and the potential output (maximum) for each existing facility to address demand capacity.

Time: (August 2012)

**Task B2** - Address the supply chain requirements to get the product to the demonstration vessel.

The demonstration would identify the transportation needs to get the CNG/LNG to specific port facilities, to include storage at the port facility, tanks (size, shape, capacity, production of the tanks, special handling requirements, etc.), numbers of trucks(and/or barges) and requirements for the trucks/tanks, permitting, facility security, safety provisions/OSHA, and other items necessary to have CNG/LNG accessible for fueling Great Lakes vessels (such as time to move from plant to port, amount of time to transfer CNG/LNG from port to ship).

Deliverable: Report identifying the findings

Time: (August 2012)

**Task B3** - Under the demonstration project, develop a conceptual design for installation with an emphasis on the use of common design features and components that could be transferrable technology to other Great Lakes vessels and assess the change in operating costs resulting from the conversion on the demonstration platform (i.e., *S.S. Badger*).

The study would identify the engineering design to get the CNG/LNG onto the vessel, to include the on shipboard systems for fueling, storage, tanks (size, shape, capacity, special handling requirements, etc.), fuel heating to gasify, and the fuel supply to the propulsion equipment, along with security, safety provisions (USCG and ABS), and other items necessary to utilize CNG/LNG for fueling Great Lakes vessels.

The design study will also examine (at a macro level in this phase) the shipyard capabilities/needs in the Great Lakes region to address re-fueling conversion to CNG/LNG.

Deliverable: Comprehensive Report

Time: Demo completion. (August 2012)

TASK	MONTH												
	Aug...	Sep...	Oct...	Nov...	Dec...	Jan...	Feb...	Mar...	Apr...	May...	Jun...	Jul...	Aug
Task 1	XXX												
Task 2	XX												
Task 3	XX												
Task 4	XX												
Task 5	XX												
Task 6	XX												
Task B1	XX												
Task B2	XX												
Task B3	XX												
Quarterly Reports/Full Report				XX			XX			XX			XX

## Staffing – Key Personnel

Dr. Richard Stewart, Co-Director of GLMRI is the department chair and professor in University of Wisconsin-Superior's Business Department, and the Director of the UW-Superior Transportation and Logistics Research Center. He is a recognized expert in marine transportation, with service as a maritime educator, a Master Mariner Unlimited Oceans, a shipping company executive, and was a Captain in the US Naval Reserves.

Dr. James P. Riehl, Co-Director of GLMRI is the Dean of the Swenson College of Science and Engineering at the University of Minnesota Duluth. He currently serves on the Advisory Boards for the University of Minnesota's Intelligent Transportation Systems Institute and the University of Minnesota Duluth's Natural Resources Research Institute (NRRI). In 2005, he received recognition as a McKnight Presidential Leadership Chair.

Dr. Michael Parsons is the Arthur F. Thurnau Professor Emeritus from the University of Michigan's Naval Architecture and Marine Engineering Department. Dr. Parsons earned his BSE in naval architecture and marine engineering from the University of Michigan. Following six years of active duty in the U.S. Navy, he earned his Ph.D. in applied mechanics from Stanford University. His research interests included design decision making, marine engineering, and ballast water technology.

Ms. Carol J. Wolosz, Executive Director of GLMRI is responsible for the management and administration of the Institute, and oversight of the research projects, grants and reports. Carol is a retired Air Force Officer, with an extensive background in Financial Management, Acquisition and Human Resources.

## **Reporting Requirements**

Quarterly progress updates will be provided to the US Department of Transportation, Maritime Administration, Congressional Offices (Great Lakes regional representatives), and other stakeholders. A full report on the findings will be submitted at the end of the study (Phase 1).

Quarterly reports will be submitted within 15 days following:

November 30, 2011

February 29, 2012

May 31, 2012

## **Future Efforts:**

GLMRI will actively work with the MARAD representatives over the course of the study to allow for flexibility in the focus as the findings are developed. Recommendations for extended work will be provided to MARAD to address specific areas as the project develops.