ENERGY TRANSITION FOR THE U.S. COMMERCIAL FISHING INDUSTRY: TECHNICAL AND OPERATIONAL ADVISORY

September 2025

TABLE OF CONTENTS

This project was supported by the United States Coast Guard and the Centers for Disease Control and Prevention – National Institute for Occupational Safety and Health through a cooperative agreement to The American Bureau of Shipping; Cooperative Agreement # (or Training Project Grant #): 1 U01 OH0XXXXX-01 or 1 T03 OH0XXXXX-01

INTRODUCTION

The National Institute of Occupational Safety and Health (NIOSH), under the CDC, and the United States Coast Guard (USCG) funded research through the Commercial Fishing Occupational Safety Research Cooperative Agreement to improve worker safety in the commercial fishing industry. This research focused on data analysis, risk assessment and mitigation options addressing safety and health risks related to energy transitions affecting the U.S. Commercial Fishing fleet. As global and domestic clean energy agendas accelerate the adoption of decarbonization technologies across the maritime industry, including commercial fishing, this transition represents a transformative challenge for the sector over the next decade.

BACKGROUND

The U.S. commercial fishing vessel (CFV) industry is a vital component of the American blue economy, supporting approximately 700,000 jobs and generating $55 billion in sales annually. With an estimated 51,000 active vessels ranging from small inshore boats to large offshore trawlers, the fleet reflects the diversity of fisheries and regions across the nation [1]. These regions include the small-boat fleets of New England and the Mid-Atlantic, the large trawlers of the Pacific Northwest and Alaska and the shrimpers in the Gulf of America and South Atlantic, each facing unique conditions that shape their energy transition pathways.

Despite its economic importance, the industry is almost entirely reliant on fossil fuels, with diesel and gasoline engines powering virtually all wild-capture fisheries. This dependence not only contributes to greenhouse gas (GHG) emissions but also exposes the sector to fuel cost volatility. Globally, fishing fleets account for 0.5 percent of carbon dioxide (CO_2) emissions, with U.S. fisheries ranking as the fourth-largest emitter, producing 41 million tonnes of carbon dioxide equivalent (CO_2e) annually [2]. Fuel use varies significantly by fishery, with crustacean fisheries being particularly fuel-intensive, highlighting the need for improved energy efficiency as climate change drives policy goals for deep decarbonization.

This advisory outlines the challenges and emerging risks posed by the energy transition in the commercial fishing industry. It focuses on three critical areas: the adoption of electrification and alternative fuels; changes in vessel performance; and design and the impact of offshore clean energy projects. It also details the specific aims of the research project, including scenario analysis; regulatory gap assessments; safety and risk evaluations; and the development of education and outreach resources.

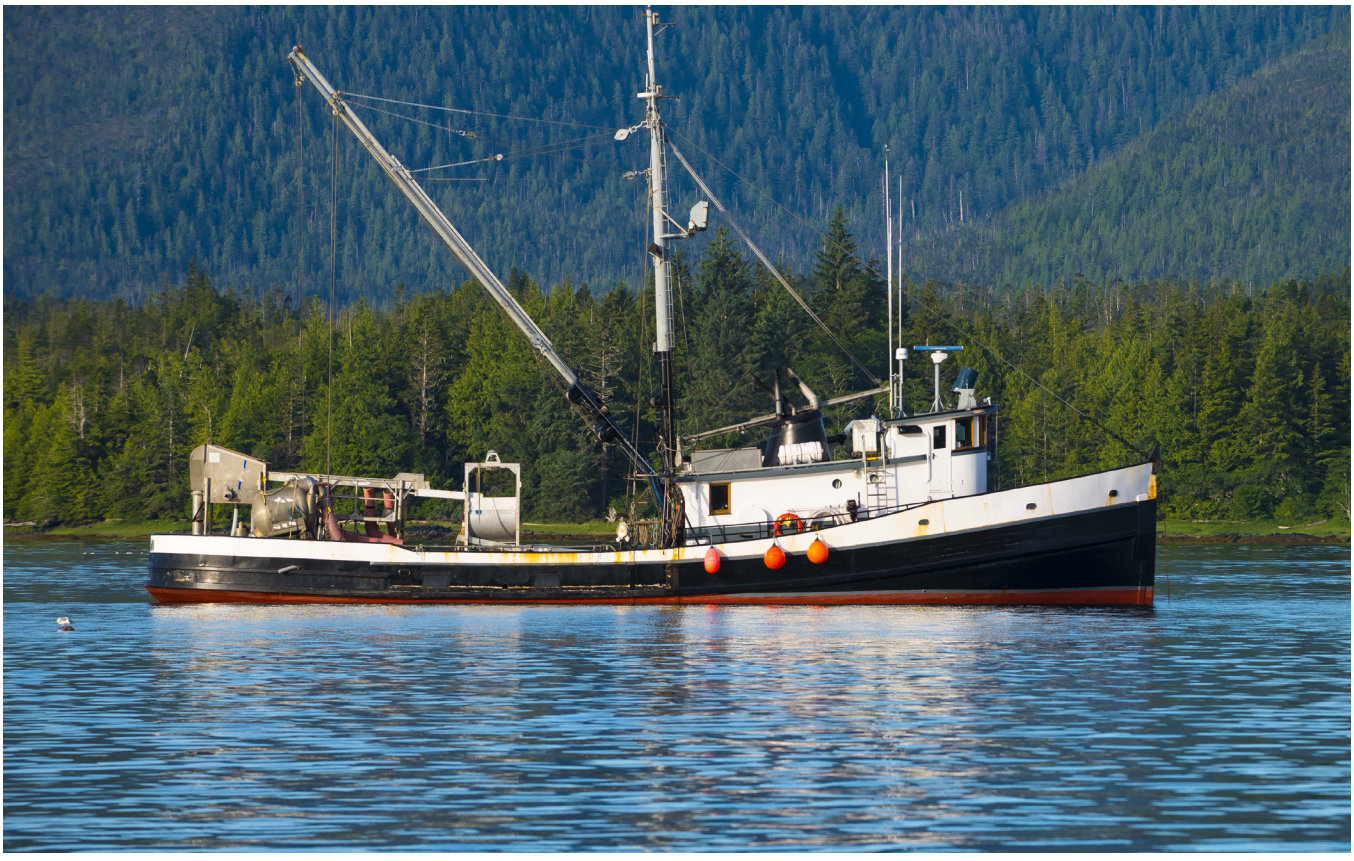
By addressing these challenges, ABS and its partners aim to provide practical, actionable recommendations and raise industry awareness to ensure a safe and sustainable transition for the commercial fishing sector.

ADOPTION OF ELECTRIFICATION AND ALTERNATIVE FUELS

The U.S. CFV industry primarily relies on conventional diesel engines and high-carbon fuels but growing pressure to transition to renewable and low-carbon energy is making this reliance increasingly unsustainable. Diesel's energy density and established infrastructure have long made it the default choice, but the aging fleet's poor fuel efficiency and high emissions contribute significantly to GHG emissions, estimated at 1.9–2.2 kg of CO_2e per kilogram of landed fish [2]. Incremental fuel efficiency improvements have been made, but transformative changes are needed to meet climate goals.

Policy and regulatory pressures are driving this transition. The International Maritime Organization's (IMO) GHG reduction strategies and California's Commercial Harbor Craft rule, which mandates zero-emission capability for certain vessels by 2026, signal a clear trajectory toward decarbonization. Broader national and international goals, such as achieving net-zero emissions by 2050, further encourage the industry to prepare for reduced fossil fuel reliance. Initiatives like the European Union's (EU) Maritime and Fisheries Fund and the U.S. Department of Energy's (DOE) Energy Technology Innovation Partnership Project are supporting sustainable fishing practices and innovative technologies, including hybrid power retrofits and carbon-free fishing pathways. Fisheries targeting crustaceans and large pelagic fish, which have the highest emissions intensity, are likely regulatory priorities. Near-term alternative fuel options include electric/battery power, liquefied natural gas (LNG), and hydrogen fuel cells, while ammonia shows long-term potential but lacks practical application in fishing vessels.

Electrification of commercial fishing vessels has gained traction in Northern Europe, with countries like Norway, Denmark and the Netherlands successfully implementing hybrid electric propulsion systems across fleets ranging from small (11 meters) to moderately large (87 meters) vessels. Transitioning electrification to the U.S. fleet offers opportunities to enhance sustainability, reduce operating costs and improve environmental performance. Key benefits include fuel cost savings, reduced GHG emissions; improved efficiency with lower maintenance needs; noise reduction for better crew conditions and marine ecosystem health; and the potential for integration with renewable energy sources. However, challenges such as high upfront costs, limited charging infrastructure and battery range limitations must be addressed to fully capitalize on these advantages.



	Key Characteristics	Commercial Availability
Hybrid and Electric Systems	Combines internal combustion engines with batteries (hybrid) or relies entirely on batteries (fully electric) to reduce fuel consumption and emissions. Batteries pose risks such as thermal runaway, toxic gas release, sensitivity to environmental conditions, and operational challenges.	Emerging in the marine sector, with proven reliability in other industries. Adoption is supported by ongoing research and development, but fully electric systems face infrastructure and safety challenges.

ALTERNATIVE FUELS

While the commercial shipping industry is exploring and implementing conversions to a range of alternate fuels, significant capital costs, logistical challenges and technical hurdles currently limit their applicability to commercial fishing. The table below describes the key characteristics and commercial availability of the more common alternate fuels.

Fuel Type	Capacity	Commercial Availability
LNG	A cryogenic fuel primarily composed of methane, offering lower emissions but requiring specialized storage and handling.	Limited availability for commercial fishing due to high infrastructure costs and lack of bunkering facilities.
Biofuels	Renewable fuels derived from organic materials, compatible with existing engines when blended with diesel.	Readily available and mature for commercial fishing, but dependent on further product development to mitigate operational issues.
Methanol	A liquid fuel that is inexpensive to produce, easy to store, and reduces emissions compared to traditional fuels.	Limited availability; dual-fuel (DF) technology is mature, but safety regulations and infrastructure are still developing.
Ammonia	A zero-carbon fuel stored in liquid form, with potential for use in DF engines or as a hydrogen source.	Not yet commercially available; infrastructure and engine designs are under development.
Hydrogen	A high-energy fuel with zero emissions, primarily used in fuel cells, but requiring cryogenic storage.	Limited availability; suitable for smaller vessels with shorter voyages due to infrastructure and storage challenges.

SAFETY AND HEALTH RISKS OF ALTERNATE FUELS

The transition to alternative fuels and energy systems in the commercial fishing industry introduces a range of hazards that must be carefully managed to ensure the safety of vessels and crews.

Fuel Type	Toxic Inhalation Hazard	Flammability	Explosive	Cryogenic Storage
Ammonia	X	X	X	X
Methanol	X	X	X	
Hydrogen Fuel Cell		X	X	X
LNG		X	X	X
Biodiesel		X	X	
Batteries	X	X	X	

Liquefied Natural Gas – Poses several risks due to its cryogenic properties. While LNG is non-flammable in its liquid state, it can vaporize at atmospheric pressure, creating a risk of asphyxiation and gas fires if the vapor ignites. The extremely low boiling point of LNG (-162° C) can also lead to cold burns and potential material damage to the vessel's hull. Additionally, methane slip during LNG use is a significant environmental concern, as methane is a potent greenhouse gas.

Biofuels – Although more compatible with existing infrastructure, can present hazards such as corrosion of traditional materials, including rubber seals and hoses. This can lead to leaks and operational inefficiencies. Furthermore, the chemical properties of biofuels may increase the likelihood of filter clogging, which can affect engine performance and reliability, particularly in colder temperatures.

Methanol – Another alternative fuel that carries significant risks. It is highly toxic and flammable, with a flammability range of 6 to 36 percent. Methanol vapor can be dangerous when inhaled, and exposure can lead to severe health effects, including central nervous system damage. Proper storage and handling are critical to prevent vapor accumulation in enclosed spaces, necessitating adequate ventilation and safety measures.

Ammonia – While offering the advantage of no carbon emissions during combustion, is highly toxic and corrosive. It poses risks of irritation and severe health effects upon exposure, including respiratory distress and potential fatalities. The use of ammonia as a fuel requires stringent safety protocols, including proper training for crew members in handling and emergency response.

Hydrogen – Presents unique challenges due to its high flammability and low ignition energy. It requires specialized storage systems to manage its low energy density and cryogenic state (-253° C). Hydrogen can also displace oxygen in enclosed spaces, creating asphyxiation hazards. The risk of leaks is heightened due to hydrogen's small molecular size, necessitating robust safety systems and monitoring.

Fuel-electric Hybrid Systems – Introduce additional hazards related to battery management. Batteries can experience thermal runaway, leading to fires or explosions, and may release toxic gases during such incidents. The integration of these systems requires careful consideration of their operational risks and the implementation of appropriate safety measures.

CHANGES IN VESSEL PERFORMANCE AND DESIGN

Marine diesel oil (MDO) is the primary fuel used in commercial fishing vessels and serves as a baseline for comparing alternative fuels. The lower energy density of most alternative fuels, except biodiesel, impacts fuel storage, vessel design and operational range, requiring larger storage volumes to achieve the same range. Lighter fuels affect vessel stability by altering the center of gravity and weight distribution, leading to changes in list (side-to-side tilt) and trim (fore-and-aft tilt). Cryogenic tanks, often used for fuels like LNG, are larger and require specific placement to avoid asymmetrical weight distribution and stability issues.

Furthermore, alternative fuel consumption patterns, such as LNG's pressure-maintaining emptying process, may not align with ballast systems, necessitating frequent ballast adjustments to maintain stability. This is particularly important as the vessel's stability changes with fuel consumption and increasing weight in the hold as more product is caught. Retrofitting vessels for alternative fuels requires significant design changes, including new tanks, piping and fuel handling systems, which can further impact weight distribution and stability.

Additionally, partially filled tanks for fuels like LNG can cause sloshing, where liquid movement affects stability and creates dynamic changes in list and trim. Proper tank design, baffling systems, and careful planning are essential to mitigate these effects and ensure safe operations.

Mitigation measures to address the effects of alternative fuels on list and trim:

1. **Experience** – Choose a designer and yard that has experience working with alternative fuel.
2. **Optimize Tank Placement** – Ensure tanks are symmetrically placed and as close to the center of gravity as possible.
3. **Use Ballast Systems** – Adjust ballast water to compensate for changes in weight distribution during fuel consumption.
4. **Advanced Stability Analysis** – Conduct detailed stability assessments during the design and retrofitting phases for multiple loading scenarios based on fuel consumption, gear on deck, catch on board, and ballast conditions.
5. **Tank Design** – Incorporate features like baffles to reduce sloshing and ensure even weight distribution.
6. **Dynamic Monitoring** – Use onboard systems to monitor and adjust for list and trim in real-time.
7. **Training** – Crew training on the effects of storage of the alternative fuel on list and trim.
8. **Drills** – Drills to simulate stability failure scenarios for the crew.

CFV COMPATIBILITY

Retrofitting vessels is a complex process, often requiring over a year of preparation. Challenges include limited availability at shipyards, unpredictable future energy costs and the need to tailor fuel and retrofit solutions to each vessel's unique design. Among the most feasible alternative fuel options are LNG and biodiesel, which are more widely available and offer practical choices for various vessel types. Battery-electric propulsion provides a cost-effective solution for smaller vessels and nearshore activities. Promising technologies like hydrogen fuel cells and ammonia offer potential long-term benefits but may face barriers due to infrastructure and design limitations, particularly for smaller fishing vessels.

Methanol with DF technology is a viable option for medium-to-large vessels with access to bunkering facilities. Biofuels are mature alternatives but require manufacturer collaboration to ensure safe and compatible use. Hybrid engines, which combine electric and diesel power, are gaining popularity as an efficient option for larger vessels, offering reduced fuel costs and lower environmental impacts.

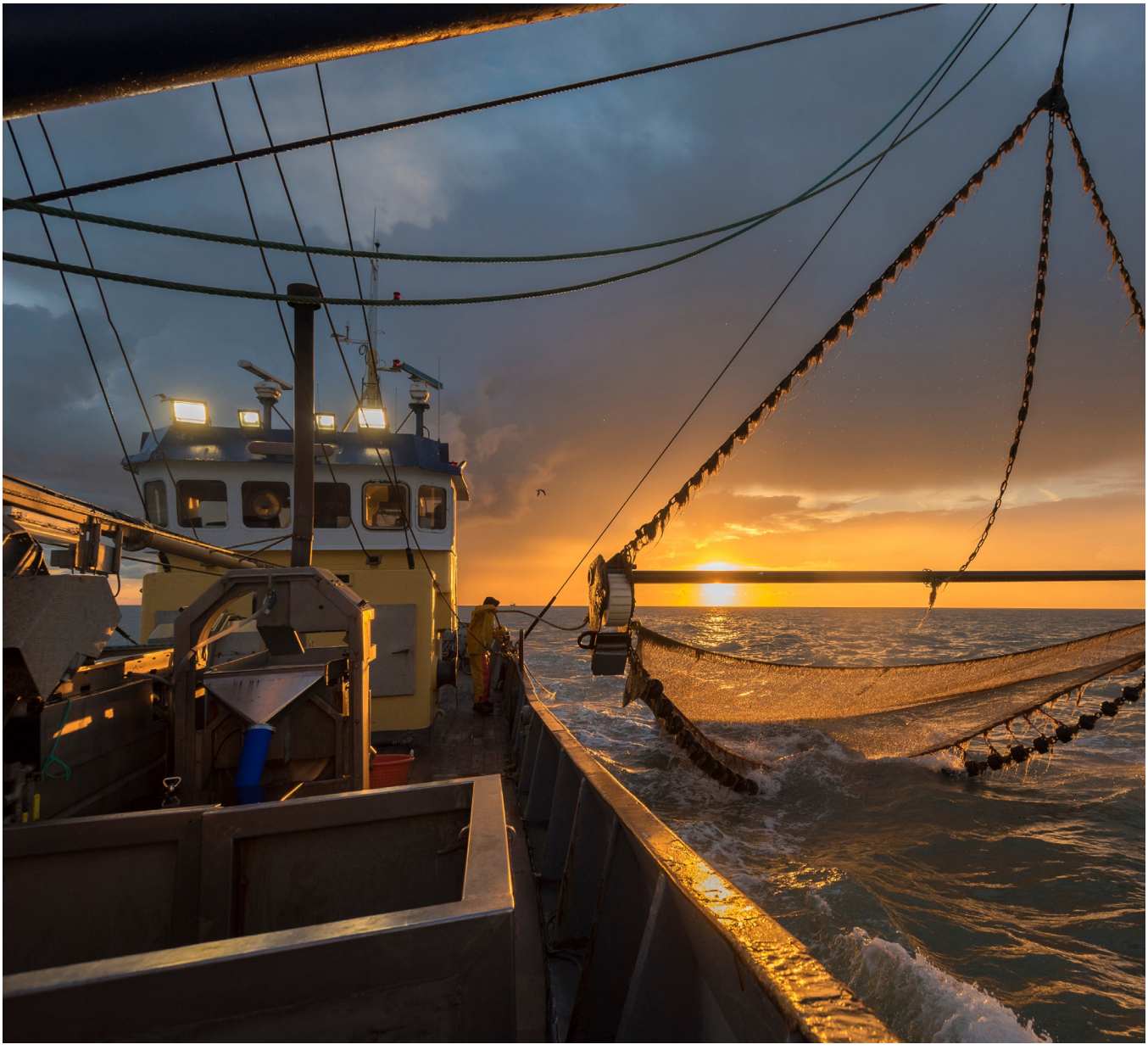
Alternative fuels represent an exciting opportunity to modernize fleets; however, widespread adoption will depend on expanding refueling infrastructure, lowering upfront costs and ensuring safety and reliability. Overcoming industry challenges and achieving a sustainable future will depend on strong collaboration and the development of innovative energy solutions that prioritize efficiency, affordability and durability for fishing vessels.

IMPACT OF OFFSHORE CLEAN ENERGY PROJECTS

The increase in offshore renewable energy installations (OREIs), such as wind turbines and wave energy systems, presents external risks to commercial fishing vessels and crews. These risks include changes to fishing areas, longer transit times that contribute to fatigue, increased vessel traffic and a heightened risk of collisions, allisions, and groundings.

Offshore renewable energy installations can disrupt vessel radar systems and complicate navigation, especially when navigation aids lack comprehensive OREI data. Additionally, construction and maintenance activities can temporarily disrupt vessel traffic, while inadequate lighting and marking of OREI structures may lead to accidents.

Search and rescue (SAR) operations face unique challenges in OREI areas, as restricted maneuverability can hinder vessel assistance and delay response times during emergencies. Improper training or inadequate emergency procedures can further exacerbate these risks. To address these challenges, comprehensive training programs that focus on navigation, emergency response and SAR operations in OREI environments should be developed for crew members, operators and shore support personnel.



CONCLUSIONS AND RECOMMENDATIONS

The U.S. commercial fishing industry is facing a complex regulatory landscape as it moves toward adopting alternative fuels and cleaner energy systems. Federal regulations, primarily overseen by USCG and the Environmental Protection Agency (EPA), currently provide a foundation for safety and environmental compliance.

However, these regulations lack specific provisions for alternative fuels like ammonia, hydrogen, methanol and lithium-ion batteries which are fuels that bring unique risks such as thermal runaway, flammability, toxicity and cryogenic exposure. To support a safe and effective transition, standards established by organizations like the IMO and classification societies must be updated to reflect the specific needs and challenges of the fishing industry.

Ensuring Safety for the Fleet – Alternative fuel systems require careful design, such as reinforced containment structures, secondary barriers and insulation to prevent leaks, fires and thermal runaway. Tank pressure monitoring, temperature sensors, vapor detection and automatic shutdown systems should be integrated into onboard monitoring to mitigate risks. Providing crew training on new hazards and personal protective equipment, like gas detectors, infrared cameras and eye wash stations, enhances crew safety. Additionally, firefighting systems must meet applicable standards, utilizing appropriate extinguishing agents and ongoing maintenance to detect and address material degradation. Emergency preparedness and response are essential for vessels using these alternative fuels. Measures such as evacuation plans, remote emergency shutoff systems and restrictions on bunkering during harsh weather are vital.

Training Crews for a Changing Industry – Adapting to alternative fuels requires equipping crews with the knowledge and skills to handle the risks. Specialized training on the properties, safe handling and hazards of ammonia, methanol, hydrogen, LNG, biodiesel and batteries is critical. Regular emergency drills should simulate realistic scenarios, such as vapor leaks, fires, or thermal runaway events, ensuring crews are fully prepared. Training should also cover how fuel storage and new energy systems can impact vessel stability and effective navigation around OREIs. Enhanced communication protocols, updated nautical charts, and remote monitoring technologies are additional tools to mitigate risks in these areas.

Looking Ahead – The commercial fishing industry can safely embrace alternative fuels and modern energy systems by updating regulatory frameworks, bolstering emergency preparedness and prioritizing specialized crew training. These changes not only reduce greenhouse gas emissions and improve environmental performance but also ensure the safety, resilience and economic viability of the fleet as it takes on the challenges of decarbonization.

ACKNOWLEDGMENTS

Alaska Marine Safety Education Association (AMSEA) will provide direct connections with commercial fishing vessel captains/crews as well as insights about how new technology is likely to be used on commercial fishing vessels. AMSEA will provide Subject Matter Expert input to hazard/risk assessment work led by ABS. Additionally, AMSEA will help facilitate education and outreach on research projects for the industry.

Washington Maritime Blue (WMB) is a not-for-profit consortium for accelerating the Blue Economy in the Pacific Northwest (particularly Washington State) with maritime clean technology innovation and best management practices. The consortium brings together an extensive set of partners from all segments of the maritime industry to address key challenges and opportunities.

Glosten is a naval architecture and marine engineering firm which specializes in the design of new and innovative clean energy vessels.

REFERENCES AND GUIDANCE DOCUMENTS

1. GAO. (2022). *Commercial Fishing Vessel Safety: Coast Guard Needs to Improve Its Data and Oversight*. United States Government Accountability Office (GAO-23-105289).
2. Parker, R. W. R., Blanchard, J. L., Gardner, C., Green, B. S., Hartmann, K., Tyedmers, P. H., & Watson, R. A. (2018). Fuel use and greenhouse gas emissions of world fisheries. *Nature Climate Change*, 8(4), 333–337.

ACRONYMS AND ABBREVIATIONS

ABS	American Bureau of Shipping
ABSG	American Bureau of Shipping, Group
AMSEA	Alaska Marine Safety Education Association
CDC	Center for Disease Control
CFV	Commercial fishing vessel
DF	Dual-fuel
EPA	Environmental Protection Agency
EU	European Union
GHG	Greenhouse gas
IGF	International Code of Safety for Ships Using Gases or other Low-Flashpoint Fuels
IMO	International Maritime Organization
LNG	Liquefied natural gas
MDO	Marine diesel oil
NIOSH	National Institute for Occupational Safety and Health
OREI	Offshore renewable energy installations
SAR	Search and rescue
SOLAS	Safety of Life at Sea
U.S.	United States
USCG	United States Coast Guard
WMB	Washington Maritime Blue

CONTACT INFORMATION

NORTH AMERICA REGION
1701 City Plaza Dr.
Spring, Texas 77389, USA
Tel: +1-281-877-6000
Email: ABS-Amer@eagle.org

SOUTH AMERICA REGION
Rua Acre, n° 15 - 11° floor, Centro
Rio de Janeiro 20081-000, Brazil
Tel: +55 21 2276-3535
Email: ABSRio@eagle.org

EUROPE REGION
111 Old Broad Street
London EC2N 1AP, UK
Tel: +44-20-7247-3255
Email: ABS-Eur@eagle.org

AFRICA AND MIDDLE EAST REGION
Al Joud Center, 1st floor, Suite # 111
Sheikh Zayed Road
P.O. Box 24860, Dubai, UAE
Tel: +971 4 330 6000
Email: ABSDubai@eagle.org

GREATER CHINA REGION
World Trade Tower, 29F, Room 2906
500 Guangdong Road, Huangpu District,
Shanghai, China 200000
Tel: +86 21 23270888
Email: ABSGreaterChina@eagle.org

NORTH PACIFIC REGION
11th Floor, Kyobo Life Insurance Bldg.
7, Chungjang-daero, Jung-Gu
Busan 48939, Republic of Korea
Tel: +82 51 460 4197
Email: ABSNorthPacific@eagle.org

SOUTH PACIFIC REGION
7 Science Park Drive
#09-21/32 Geneo, Singapore 119316
Tel: +65 6276 8700
Email: ABS-Pac@eagle.org

ABS®