

TRB TRANSPORTATION RESEARCH BOARD

Seventh Biennial Conference on the Marine Transportation System

Innovative Science and Technologies Toward Greater Sustainability

Washington, D.C. • June 20–22, 2023

Closing Session



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Agenda

- Recap of Plenaries
- Overview of Breakout Sessions
- Interactive Q&A



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Plenary 1: Federal Perspectives on Decarbonization and Sustainability in the MTS

Moderator: Helen Brohl

Panelists: Major General William Graham USACE, Seong Kim BSEE, Adena Leibman NOAA, Karl Simon EPA, Daniel Yuska MARAD, Michael Emerson USCG, Josh Messner DOE

Plenary 1: Federal Perspectives

- Agencies are at a historic moment to make major changes
- Each agency coming from a different angle but need to work together to harmonize programs for the most benefit
- Main role should be to de-risk aspects of decarbonization
- Should work with industry to accomplish that



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Plenary 2: Decarbonization and Sustainability: Maritime Industry Perspectives

Moderator: Lee Kindberg

Panelists: Jennifer States, Tanja Grzeskowitz, Capt. Jennifer Williams (USCG-Ret.), Teresa Christopher, Bud Darr

Plenary 2: Industry Perspectives

- Decarbonization is possibly the biggest technical and regulatory challenge maritime has faced
- Need to tackle it from an entire Value Chain Approach and send clear demand signals
- Ports are incentivizing cleaner practices on ships and onshore
- Proper regulation needs to help define the pace, what solutions are available, and incentivize the right options
- Impossible to get anywhere without fuel supply chains scaling



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Plenary 3: Sustainability, Environmental Justice, and Social Equality in Maritime

Moderator: Heather Gilbert

Panelists: Karl Simon, Rich Brown, Terrance L. Bankston, Erica Rule

Plenary 3: Environmental Justice and Social Equality

- Communities surrounding ports are more negatively affected by pollution, often due to racist practices such as redlining
- Every port is different with different inputs and externalities
- Important for port officials and the community to be aware of each other's activities and to communicate
- Funding for technical assistance and capacity building is critical
- When communities and ports work together, can have huge benefits
- Need to meet the community where they are and be creative about it, provide daycare etc.



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Technical Breakout Sessions

Session 1A:
Alternative Fuel Distribution and Networks

Moderator:
Todd Ripley, Maritime Administration

Note Taker: Celina Harris

The Maritime Nexus Supporting a National Network of Hydrogen Hubs
Kirk Waltz, American Bureau of Shipping

Exploring Drivers for the Design and Construction of Offshore Hydrogen Production Facilities
James Abrams, American Bureau of Shipping

Distribution of Alternative Fuels Across Future Fleets
Steven O'Malley, Leidos

The Maritime Nexus Supporting a National Network of Hydrogen Hubs

Kirk Waltz, American Bureau of Shipping

- DOE Hydrogen Hub (H2 Hub)
  - Maritime industry does not support needed on national scale.
  - Maritime sector has competitive advantage to support majority of the hubs
  - Maritime component may not require significant new infrastructure
- Four areas of focus:
  1. Regionally-focused asset analyses - Understanding asset specific timelines and adoption pathways for commercial vessels, and economic feasibility with risk management. Leverage digital twins to identify risk.
  2. Hydrogen demand analysis - Forecast to 2050 in 5-year increments to identify what/where to scale.
  3. Policy needs for ports, pipelines, and vessel- Safety and risk are the biggest drivers; where are regulatory gaps? How do vessels respond to potential risk? How to engage the local communities?
  4. Stakeholder development capacity - Many stakeholders to engage – ports are critical to these hubs scaling to a global level. Engaging them and their local communities is essential to support growth.

Exploring Drivers for the Design and Construction of Offshore Hydrogen Production Facilities

James Abrams, American Bureau of Shipping

- Drivers
  - Climate Change and decarbonization; hydrogen can fill gaps in electrification when produced in a green manner.
  - Political pressures; tax credits, subsidies
  - Business opportunities; clean energy marketplace is expanding with green hydrogen prices coming down.
  - Technology advancement; increased availability of renewable energy and electrolyzer improvements.
- Hypothetical production project for available renewable energy to power facility
  - Suitable facility location - maybe as oil and gas goes down, facility can be converted?
  - Financial backing and governmental support with appropriate approvals, production techniques (based on size and lifespan for facility)
  - Storage and export (risk management)
  - Contractors and construction (available resources nearby and qualifications of workers)
  - Off-takers and consumers (earlier in the project is better than later)

Distribution of Alternative Fuels Across Future Fleets

Steven O'Malley, Leidos

- Characteristics of global fleet (Different types of ships use different fuel mixtures)
  - Majority of global fleet is fishing vessels but by tonnage fishing vessels are a minimal contribution (very small); bulk carriers and oil and chemical tankers are the biggest contribution to fleet tonnage.
  - Most efficient engine currently is a slow speed diesel with a direct drive. Most ships that need speed are gas turbine. Alternative fuels need to the look at dual fuel, hybrid options (80% of vessel time is spent at 20% engine output), or electric vessels.
  - Key point: desired operational speed impacts the engine size more than the size of the ship!
- Fuels being considered:
  - Biodiesel (drop-in fuel, pushed by aviation as its their primary option), quantities may be impacted over time do to demand for other applications.
  - Natural gas (widespread availability) – cryogenic, low flashpoint
  - Alcohols – low flashpoint, toxic and corrosive to certain metals
  - Ammonia – toxic, corrosive, low flashpoint, very cold liquid
  - Hydrogen (compressed may be useful; liquification costs are high) – cryogenic, low flashpoint

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1B: Electrification of Vessels, Ports, and Associated Infrastructure

Moderator: Cary Davis

Note taker: Lindsey Stadler

Surging: Seaports Have Will and Wherewithal to Electrify, but how about the Equipment and Grid Capacity?

Cary Davis – American of Port Authorities

Electrification at the Port of Oakland

Tim Leong – Port of Oakland

The Status of Technological Solutions Toward Zero-emission Port Stays

Thalis Zis – Cyprus University of Technology

Session: 1B Electrification of Vessels, Ports and Associated Infrastructure

- Current and projected funding for port infrastructure is historically robust
  - Increased by 71% overall and 423% for ports
- Clean ports program #1 program for electrification
- Working on energy resilience, shore power, alternative fuels, offshore wind
- Policy considerations include charging standards, permitting, net-metering, grant timelines, build American, buy American

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- We've been plugging in vessels for ~10 years, the cost has increased significantly in that time
- Shore power plugs take 2 MW of power (equivalent to 1600 homes)
  - 2 MW is today's average but vessels are projected to grow in size to accommodate more shipping capacity → power needs could exceed 3 MW for just vessels (not considering other equipment e.g. cranes)
- Completed zero emissions projects includes electric battery trucks (1st generation)
- Moving forward – mobile shore power outlets, upgrade infrastructure

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- ZEPS (Zero Emissions Port Stays)
- European Green Deal and Fit for 55 (legal obligation)
- There is not one solution fits all ("when you've seen one port, you've seen one port")
- In Europe the issue is global vs. local
- Sock on stack
- Electric boilers
- Many similar efforts in Europe

→ In the short-term electrification would have a negative impact but a positive in the long-term



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Session 1C: Regulatory Environment Influencing Decarbonization Strategies

Moderator: Richard Billings

Note taker: Sophia Troeh

Decarbonization – Opportunities and Challenges for Marine Operators.

Mary McCarthy, Moran Towing Corporation: Director of Sustainability and Corporate Responsibility

Pathways for Public/Private Cooperation for Advancing National Blueprint for Transportation

Megan O'Leary, Blue Sky Maritime Coalition: Director of Operations

Latest developments regarding MARPOL Annex VI and IMO's strategy for decarbonizing international shipping.

Wayne Lundy, U.S. Coast Guard: Senior Engineer Office of Design and Engineering

Decarbonization – Opportunities and Challenges for Marine Operators.

By Mary McCarthy, Moran Towing Corporation: Director of Sustainability and Corporate Responsibility

Goals: Coordinate policy developments, provide education for policymakers, share opportunities

- Opportunities of decarbonization include:
  - Increasing operational efficiencies
  - Investigating new designs, technologies, and systems with new build vessels

- Challenges include:
  - Safety- must be risk adverse when changing energy source/chemicals on board
  - Cost
  - Space limitations of tugboats
  - Port infrastructure- different fuel availability at different ports
- Collaboration between industry and government partners is key to success

  - How can we move forward working together with stakeholders?

Pathways for Public/Private Cooperation for Advancing National Blueprint for Transportation

By Megan O'Leary, Blue Sky Maritime Coalition: Director of Operations

Mission: Achieve net zero emissions in US & Canada

- Transparent communication & collaboration
  - All perspectives from chain must be included
- Challenges include risk profiles, communication, education & knowledge gaps
- Think big, start small, scale fast
  - Swift action
  - Efficiency
- Create a climate for change
  - Be open to partnerships
  - Expand workforce base
  - Communicate with everyone involved

Latest developments regarding MARPOL Annex VI and IMO's strategy for decarbonizing international shipping.

Wayne Lundy, U.S. Coast Guard: Senior Engineer Office of Design & Engineering

- Initial IMO GHG strategy
  - Reduce GHG emissions from International shipping ASAP
  - Reduce total GHG emissions by 50% by 2050 compared to 2008
  - Revision being considered next week may be **more ambitious**
  - Capacity building and technical cooperation
- MARPOL Annex VI, Chapter 4:
  - Application – ships 400 GT and over that sail internationally
  - Focus on reducing the '*technical carbon intensity*' (EEDI/EEXI) & '*operational carbon intensity*' (CII) of international shipping
  - Provisions for an enhanced Ship Energy Efficiency Management Plan (SEEMP)
- Future Work:
  - Maritime Safety Committee – "*Development of a safety regulatory framework to support the reduction of GHG emissions from ships using new technologies and alternative fuels*"

[Q&A] Key Take-Aways

Q: Does the current level of regulations positively support decarbonization?

- Regulatory structure has focused on Criteria pollutants, More is needed for encourage decarbonization
- Infrastructure (fuels) aren't there yet, making it unclear what specific regulations are needed
- In the meantime more guidelines are needed that provide an understanding of commercial aspect of alternative fuels and propulsion systems particularly regarding Safety aspects

Q: Is there any way for consumers to know if they are getting a product from a green ship or not?

- Not so far- some voluntary programs exist, not regulatory requirement
- Would be useful for end users, but complicated when incorporating entire carbon footprint of transportation for a product
- MARAPOL Chapter 4- ships must calculate annual operational carbon intensity and receive A-E rating
- EPA voluntary SmartWay program- uses benchmarking that participants use to compared their performance with comparable commercial transportation fleets

Q: Is there any decarbonization technology you're excited about in the next 5 years?

- Drop-in fuels like renewable diesel, or other affordable fuel alternatives that take place of diesel with reduced emissions
- Advancing training technology to overcome accessibility barriers
- Meeting to discuss and collaborate on larger scales
- Fuel cell developments

Session 2A:
Alternative Fuel Distribution and Networks

Moderator:
Kevin Bartoy, Washington State Ferries

Note Taker: Celina Harris

Technical Feasibility Assessment of Biofuels for Maritime Applications
Mike Kass, Oak Ridge National Laboratory

Onboard Carbon Capture – Challenges and Future Success
Quaim Choudhury, American Bureau of Shipping

Perspectives on Decarbonization within Short-Sea Shipping: Future Pathways for Ferries
Kevin Bartoy, Washington State Ferries

Session 2A: Technical Feasibility Assessment of Biofuels for Maritime Applications

Mike Kass, Oak Ridge National Laboratory

- Biofuels are an attractive renewable option because they are a good drop-in alternative with existing fuel and bunkering infrastructure.
- Pathway towards GHG reduction needs biofuels.
- Emissions improved with biodiesel despite increased NO_x.
- Particulate matter, CO_2, and SO_x concentrations were lower for biodiesel.
- Stability of biodiesel blend is highly sensitive on fuel chemistry.
- Many companies have said they run biodiesel but have not provided data to help add to the study.
- Need more stakeholder input and engagement.

Session 2A: Onboard Carbon Capture – Challenges and Future Success

Quaim Choudhury, American Bureau of Shipping

- Carbon Capture is necessary for reaching carbon neutral by 2070.
- Challenges & Considerations
  - Capture rate: can reach 90% but space issue exists once captured
  - Energy consumption: energy on ships is limited so additional generators may be needed
  - Integration into ship design: unlike land base systems, must safely integrate with the marine environment.
  - Onboard storage
  - Permanent storage/utilization: There is no infrastructure thus far
- Opportunities
  - Capture CO2 can become a feedstock to provide products for other industries or can be solidified with certain minerals for storage, injected into oil reservoirs to enhance pressure, or stored permanently in depleted oil/gas reservoirs or deep saline aquifers.
  - Not sure if we can get to 100% carbon captured to chemical byproducts from existing plants and technologies.

Session 2A: Perspectives on Decarbonization within Short-Sea Shipping: Future Pathways for Ferries

Kevin Bartoy, Washington State Ferries

- Efficiency does not get to decarbonization but is a critical stepping stone in the pathway. Examples:
  - Operating vessels at hull design speeds
  - Maintaining lower general energy consumption through simple things like closing the door when loading passengers adds up over many trips
  - Running one less engine with engines fully loaded versus more engines that are underloaded
  - Installing fuel gauges so that operators can actively see how their operations are impacting fuel efficiency
- Long-term solutions include electrification of the fleet through retrofitting and new builds/retirement, and the use of biofuels in the interim
- Challenges include the availability and pricing of biofuels, extensive work with utilities and shoreside infrastructure to deliver power needs, leading-edge technology has few off-the-shelf solutions, and the speed of technological change is outpacing the speed of design and construction.



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2B: Sustainable Routing and Navigation

Moderator: Daniel Hackett

Note taker: Lindsey Stadler

Marine Weather Enterprise – Adapting to the Major Transformation in Maritime Shipping to Promote Sustainability

A.J. Reiss - NOAA

Weather Observations via vessel AIS – Existing technology, exciting potential

Marin Kress – U.S. Army Corps of Engineers

Precision Marine Navigation

Darren Wright – NOAA/Office Coast Survey

Optimized Weather Routing Leveraging Global Buoy Network

Tosca Lichtenheld – Sofar Ocean Technologies Inc.

Session: 2B Sustainable Routing and Navigation

The Transformation in Shipping Includes a Proliferation and Refinement of Optimal Routing Tools

- Fuel efficiency can be supplemented by nature's efficiency
- Routing optimization requires good data – need more data to be able to properly predict nuances of wind & waves
- Automated observations would allow for more accurate data, but just 2% of vessels have automated, calibrated equipment
- The national programs are not going to get a lot bigger - trying to get more efficient but someone else has to fill the void
- Industries can fill the gap (e.g. Volunteer Observing Ships , AIS, deployment of ocean sensors)

The Potential of Existing Vessel-Based AIS to Automatically Report Weather Conditions

- Automating collection of data via AIS using on-board weather stations: weather information is safety information
- Just 12 vessels in the trial still generated 30-500 messages per day
- Processed data is accessible by researchers/forecasters in US and Internationally
- For sudden hazardous weather events, ship–to–ship reporting can allow vessels to share weather information across 80km+ distances
- Shore–to–ship reporting can be used to push weather info out to vessels within range of shore transmitters (80km++)
- Satellite reception can be used for bringing mid ocean weather data back to shore to be added to the GTS, and made avail to downstream users

Session: 2B Sustainable Routing and Navigation

Addressing the Need for Precision Marine Navigation

- Precision Marine Navigation involves notifications about proximity to a hazard, whether that's clearance below a bridge or weather related.
- Need for precision navigation is increasing as marine traffic increases and vessel sizes grow
- NOAA's navigation data is currently spread out across multiple locations
- Developing a range of S100 products that are internationally compatible, including dynamic maps (e.g. combining bathymetry and water level data → could allow vessels to "ride the currents" and increase operational efficiency)

Using an Ocean Sensor Network to Optimize Vessel Routing

- Fuel use can be reduced through trip optimization, and because weather changes every day there's a chance every day for optimization
- Data is hard to collect - currently Sofar has 550 buoys that are used to create a forecast to generate routes. This is an operational change that can be implemented now.
- While there are many factors, weather can make a significant difference to a vessel's efficiency
- It's not just avoiding bad situations, but also taking advantage of good situations

Issues that the panelists face in seeing greater adoption of their projects include awareness, costs, cultural changes/habits, and differences in international standards



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2C: Green Shipping Corridors

Moderator: Grant Voirol

Note taker: Colette Fletcher-Hoppe

Green Shipping Corridor (GSC), Digital Twin, Simulation, and Optimization

David Walker– ABS

Well-to-Wake Life Cycle Analysis for Promising Alternative Fuels

Kirk Waltz– ABS

Decarbonizing UK Maritime Sector and the Role of Green Corridors

Alexandra Beaumont – UK SHORE, DfT

Session 2C: Green Shipping Corridors (GSCs)

- David Walker, ABS: GSC Digital Twins, Simulation, and Optimization
  - Purpose of GSCs to enable accelerated progress of decarbonized shipping
  - Can range in complexity from 1 commodity b/w 2 ports to multiple commodities, multiple ports
  - Simulations can help us plug and play
  - Example simulation of a GSC between Singapore and Rotterdam using three alternative fuels (LNG, H_2, NH_3)
  - Need to be connected to other initiatives: DOE port electrification, hydrogen hubs etc.
  - Important to note that none of these fully exist or are standardized yet

- Kirk Waltz, ABS: Well-to-Wake Lifecycle Analysis for Alternative Fuels
  - Need to be looking at the entire lifecycle of fuels, well to tank and tank to wake
  - Identify the lifecycle emission parameters for fuels and integrate GHG Abatement Cost
  - Use the Signapore-Rottendam, GSC as a case study
  - **Green bio-Methanol**, Green Ammonia, and Wind-based Green LH2 best

Session 2C: Green Shipping Corridors (GSCs)

- Alexandra Beaumont, UK Shore: US-UK Green Corridors and UK shipping office for reducing emissions
  - UK decarbonization strategy: 1. Domestic policy and regulation, 2. International policy and regulation, 3. Domestic research and development
  - 1) work towards creating zero emission ports and hubs conduct feasibility studies to assist industry, establishing green corridors domestically
  - 2)Maintain UK leadership in the IMO,
  - 3)Invest in R&D, engineering, and demonstration contests
  - Next steps in developing US-UK GSC relations: international meetings at COP28 and the London International Shipping week

- General discussion:
  - LCAs should be more widely used
  - GSC look very different from each other, but terminology needs to be standardized

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Session 3A: Alternative Fuel Diversification

Moderator: Dr. Gareth Burton

Note taker: Thalia Eigen

Dual-Fuel Technology for Marine Applications
Dr. Essam El-Hannouny

Modeling of Ammonia Releases within a Vessel Engine Room
Dr. Zhongfu Ge

A Novel High-Lift Device for Ship Wing Sails, using Powered Distributed Propellers
Professor Sergio Perez

Modern Nuclear Reactor System Architectures for Decarbonized Civil Maritime Transportation
Jonathan Stephens

Reaching net zero is no small task. For emission reduction, estimated contributions are:

- 70% Alternative fuels
- 15% Efficiency gains
- 15% Improved voyage performance & data optimization

There is **no one-size-fits-all.** Diversification of fuels and energy sources is important.

Current technologies must be leveraged: For dual-fuel engines, alcohol-based solutions offer a potential solution

Innovative energy sources must be considered: propellers mounted on wing-sails

Nuclear should be considered

Safety: We cannot lose focus on the safety implications

Path forward: Collaboration among the stakeholders
Support from Federal agencies

Key Takeaways

Current technologies must be leveraged: For dual-fuel engines, alcohol-based solutions offer a potential pathway to decreasing NOx and Soot emissions

Innovative energy sources must be considered: by mounting propellers in certain configurations on wing-sails, lift forces as high as other sails can be achieved with minimal drag increases, potentially decreasing the need for fuel on sailing vessels.

Nuclear should be considered: while there are some economic and regulatory issues to overcome, nuclear is a potential option for the marine industry to meet current IMO decarbonization goals.

Safety: As we consider alternative fuels & energy sources, we cannot lose focus on the safety implications; Ammonia release within a vessel engine room can be modeled to inform optimization of ventilation and configuration of gas detection sensors to decrease toxicity and fire risks.

Session 3B:
Alternative Fuel Distribution and Networks

Moderator:
Joe Myers, ABS Group

Note Taker: Celina Harris

The Renewable Fuels Standard and the Maritime Energy Transition
Margaret Kaigh Doyle, Transparensea Fuels

Use of Alternative Fuels
Tim Meyers, US Coast Guard

Bulk Carriage of Alternative Fuels by Vessels
Daniel Velez, US Coast Guard

Alternative Designs for Emerging Technologies
Bryan Andrews, US Coast Guard

Alternative Designs for Emerging Technologies

Bryan Andrews, US Coast Guard

- Office of Design and Engineering Standards recently published policy letter to provide guidance to industry for building, designing, inspecting, and certifying vessels.
- Novel design proposals will be reviewed by Coast Guard to verify safety standards are met. If this is met, a Design Basis Agreement (DBA) can be drafted.
- DBAs are met to be the first stepping stone for novel, proprietary concepts with minimal history in applications when the work doesn't fit within the bounds of the CDR. They are meant to be interactive and collaborative with all necessary stakeholders.
- As more DBAs are issued and technology advances (becomes more normal), policy letters based on international standards and 3rd party organization standards are developed, this helps to become the basis for codifying the regulations.

Use of Alternative Fuels

Tim Meyers, US Coast Guard

- Focus for up and coming fuels: hydrogen fuel cells, meOH, and ammonia. Standards don’t yet comprehensive exist for these fuels.
- IMO Developed IGF codes but it only includes prescriptive guidance for LNG and a general scope is provided for alternative low flashpoint fuels
  - Amendments are being drafted to develop ongoing interim guidelines for other low flashpoint fuels
- Equivalence process is outlined in IGF code for fuels not explicitly addressed in the code.
  - Part of the alternatives approach permits the use of existing codes, guides, & standards from other industries for those same fuels in different applications
  - Federal regulations can use a similar equivalency approach to meet design standards of CFR

Bulk Carriage of Alternative Fuels by Vessels

Daniel Velez, US Coast Guard

- To carry hydrogen at bulk, it needs to be liquified. Liquified (or condensed) H_2 provides unique challenges and hazards.
  - Extra fire risks: burns clear, large range of flammability, and static electricity ignition hazard
  - Insulating layers needed for liquified hydrogen; don't anticipate explicit guidelines being given for this aspect.
  - IGC code cover liquified gases specifically. Upcoming interim guidance coverage from both IGF for fuels and IGC for cargo.
- Ammonia carriage has been done for many years – extra challenges when using it as a fuel (toxicity > corrosivity)
  - System design needs to consider affinity for air and density changes as a function of humidity
- MeOH transport has newer challenges as it is considered toxic carriage since 2020.
- Liquified CO_2 transport sees rising interest with carbon capture technology increase.

The Renewable Fuels Standard and the Maritime Energy Transition

Margaret Kaigh, Transparensea Fuels

- Renewal Fuel Standard targets based on percentages of total production and import; not a rule yet but guidance given through 2025
- Coverage does not extend to marine residual fuel, emission control area marine fuel, or ocean-going vessel fuel
- Adjusting RFS coverage to maritime industry would require a specific marketplace be developed.
  - Transparesea is currently investigating if there is enough supply to meet the market demand that these adjustments would bring – different transportation industries shouldn't need to compete with one another for renewable alternatives.

Key Takeaways:

- MTS - Drive to new technologies and uses.
- Process of Innovation outpaces ability to regulate.
- Challenge is to ensure safety while not restricting Innovation
  – Design Basis Agreements – POL Letter 01-23 –Documents process and requirements
- No Uniform Acceptable level of Risk – Case by Case
- IMO IGF – Based on LNG Fuels
  - Compliance through equivalence of designs for Alternative fuels / Alternate designs

Key Takeaways:

- Completed: Methyl/Ethyl Alcohol, Fuel Cells, LPG
- In Process: Hydrogen, Ammonia, Low FP Oil fuels
- Bulk Carriage Presents Significant Challenges.
  - H2 in Bulk will need to be Liquefied for transport
  - Much colder than LNG, Larger Flammability range, Invisible flame
  - Special Materials, Welding, Insulation
- Methanol is now considered a Toxic Material with additional control requirements
- Need for EPA to update ruling

BOTTOM LINE: Lots of work remains to be done to ensure safety while working toward greater sustainability



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Session 3C:
Decarbonizing Inland Water Systems and Underwater Noise

Moderator: Creighton Chong

Notetaker: Monica Rao

Dr. Leah Dundon –
Decarbonizing Maritime Shipping: Challenges and Opportunities in the Inland Marine Sector

- Inland waterways is unique with its own challenges.
- Modernizing maritime infrastructure is a constant challenge due to canals, dam structures etc.
- Age of the vessel is a unique challenge – Lot of the vessels were built in 60s and 70s and are still operating.
- Industries won't charter boats because of their date even though they have been retrofitted.
- Market growth not likely to adequately drive investment.
- Estimating Industry emissions are a huge challenge across all sector.
- EPA puts out total US GHG emissions for different categories (aviation, rail, ships, inland waterways) based on estimation and emission factors.
- It's a challenge to calculate emissions for inland waterways - Hard to know exactly how much emission is coming. Vessels are constructed specifically to navigate the river to be able to work in shallow waters.
- Placement of fuel and heavy equipment is essential to the balance of the vessel (different fuels have different requirements).
- Due to inland waterway systems electrification is not the best option - battery size, lack of charging stations etc.
- Fleet boats are good candidate since they operate close to shore in a limited area which makes it possible to have charging infrastructure. Also, because of their relative size you can fit a battery.
- Operational needs of the vessels are important to consider - how much fuel, area of operation etc.
- There is new money coming in with the IRA. Research and attention to maritime industry has exploded over the last few years.

Ben Emery –
Multi-Modal Transport of Upper Mississippi River System Sand to Support Coastal Beach Nourishment

- USACE - 25000 miles of navigable waterways, 400 major ports, maintains all waterways to congressionally authorized dimensions
- Transportation of dredged material is a limiting factor where there's no waterway (lack of barges in waterways and cost of steel)
- Federal standard/regulations could be a limitation
- Working with other agencies is important (Federal, State, Local, Tribal partners, etc.) to identify different restoration projects going on around the country.
- UMR Dredged Sands - clean non-contaminated sediment (chemically tested) - increasing capacity at existing dredge sites.
- Looking at new routes for dredged sand sites and beach restoration projects in the country.
- Modes of transporting dredge material - waterways/railways - lack of barges in waterways and cost of steel could make railway transportation cheaper.

Carol Yin –
Latest underwater Noise Reduction Efforts at the IMO and in the Puget Sound

- URN - Underwater Radiated Noise - low frequency noise radiated from vessels detrimental to species.
- IMO efforts to reduce URN - Guidelines for the reduction of underwater noise
- Intersessional correspondence groups (about 40 countries) to prioritize next steps to further prevent and reduce URN
- GloNoise Partnership - promote an intl policy dialogue to reduce URN and assist developing countries and building capacity for the same.
- Need partners across to reduce URN - academia, state, pvt etc.
- URN reduction in Puget Sound - Quiet Sound – to better understand and reduce physical disturbance and noise from huge vessels on endangered Southern Resident Killer Whale - Coalition between state, tribal, NGOs etc.
- MEPC - to get people in the same place to get the dialogue going, just like TRB
- OCAP identifies that federal agencies should incorporate new design and technology that co-benefits the environment such as reducing the URN
- There are efforts to better analyze and understand projected noise levels at an international and domestic level
- There is Intl and domestic investment in exploring energy efficiency and GHG emissions and also if it will help with URN - research is growing within this area.



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Real Time Discussion Questions

1) What gaps in research and development do agencies need to be focused on in order to achieve decarbonization goals by 2050? How do we balance potential IMO regulations with where the US and other countries are?

- Full spectrum decarbonization: need everyone involved from ships to grids and infrastructure, local communities, interagency state and community, regulators
- Underwater noise
  - Look for co-benefits, do what we know
  - Bubble technology – reduces friction and noise, no R&D needed
- Alternative fuels is one piece, but need to use earth systems prediction and maximizing efficiency based on the environment, use it to our advantage, optimizing routing to be in the right seas, winds, sun etc. Shouldn't be neglected, more ocean observations needed, and increase the science fed by these networks
  - Weather changes every day so every day there's an opportunity to optimize
- A need for pilot projects, actually partnering that will de-risk effort and show that it will work on the water. Need off-the-shelf solutions. Needs funding the science, the regulators, etc.
- Focus on actual fuels themselves, practical application in a marine environment isn't well known, opportunities for further research.
- Fully understand range of benefits and consequences of different fuels in the maritime sector, potential for carbon capture and need to understanding what is actually possible and why the levels of performance are different
- Need to tackle cross cutting issues, major incidents are generally tied to unmanaged change
- Evaluation and assessment of governance and oversight, might need to tweak how these are evaluated to be efficient and safe

2) With a move towards sustainability in the MTS, what changes to port infrastructure do we need and expect to see in the next 5-10 years? What are the biggest challenges in making the needed changes to port infrastructure?

- Understand regulations in ports with regards to nuclear energy, as well as policies that allow nuclear vessels to take port, current regulations may not apply to current smaller reactors
- Need to ask are there other issues with flashpoint fuels, ammonia etc. Number of permits and approvals required can be huge
- When moving towards electrification equipment, there is a critical bottleneck in how we manage the grid system. Drawing on shore power is limited by amount of electricity available and we need to ask are utilities and commissions prepared?
- When looking at ports as a hub, we will have many types of fuels coming in via water and out via land. We are going to need to connect many different systems and need to think critically about how we make that happen in regards to safety, training, building etc.
- When there are significant weather events and disruptions, how do we make sure that we can still accommodate nearby vessels and maintain structure and resiliency
- There will be changes in business structure for everyone in that node, from economics and intake and changes in tariffs, contracts and leases
- There will be changes in data infrastructure, communicating forecasting, scheduling, and arrival planning. Communication within and without the port is vital
- Acknowledge the importance of digitalization in achieving decarbonization. We need to ensure interoperability in optimization efforts, voyage routing needs to be linked to port scheduling and logistics chain
- Changing ports cyber awareness and need to look at the cyber security of the MTS

3) What opportunities do we have to educate and engage mariners, port communities, and other groups in the changes resulting from decarbonization, and how do we ensure neighboring communities benefit and are not negatively impacted?

- This is a key area for nuclear industry, need to have a mechanism to have stake holder engagement with the ports and the communities around them especially with regards to safety issues.
- EPA has EJ and outreach materials that could possible be updated
- “Build transformative not transactional relationships”
- Opportunity with ports through the IRA funding to incorporate strategies that inform mariners and communities
- Avoid unintended consequences like gentrification, want to promote growth in place
- Need to meet communities where they are in the hours that they have, provide childcare, meet at meals possibly, don’t use jargon
- “Don’t tell me what I think”
- Book and claim, needs to be consideration if regulatory environments move pollutant/emissions or co-benefits elsewhere

4) What steps can we take in the next few years to encourage and strengthen communication and collaboration in the maritime sector? What has worked thus far?

- Having these kinds of engagements between industry, gov, ports, etc is critical
- Trust needs to be built which can take a while. One example is the ECO program – brings NGOs, gov, industry, together. It took years to build trust, but once built it is very strong. Need more of these types of forums. Create more spaces where we can create trust
- Innovative approaches like Blue Sky can be interesting ways to build trust and communication. Are there best practices like this already in place that we can support?
- Federal funding programs to ports can include criteria for community engagement, strategies for engaging communities, most programs already come with communication pieces
- Coordination from the federal programs will support the industry
- Encouragement to publish results, sharing data and findings makes it more discoverable and usable for everyone
- Ports can list on webpages opportunities for community engagement

5) We heard our keynote speaker Bo Cerup-Simonsen state that we “need to create an energy system that is both sustainable and scalable” - and a lot of the opportunities discussed are not both sustainable and scalable. How can government and the private sector co-produce this?

- Need to look at not just fuels but a whole system, including electrification. Not just the grid but the entire propulsion piece
- Not just one or the other and avoid dead ends
- Industry going from a residual fuel to a product – total change from cost and structure
- Don’t be afraid to fail, failure gives us lessons learned. De-risking and taking risks are not incompatible, fail and fail fast
- Look for incentives and to use demand signals and build those signals
- Not how but if we can do this? None of these fuels are perfect for every situation, not a single candidate, so we need to understand the flaws and how they work into the system together
- Currently don’t have commercial renewable ports, shipbuilders need to build renewable ships. Having green shipping corridors and building supply chains between countries, provides mutual benefits to both countries

6) Anything else we missed?