Washington Maritime Blue is a non-profit, strategic alliance formed to accelerate innovation and sustainability in support of an inclusive blue economy. Maritime Blue works to create a world-class, thriving, equitable and sustainable maritime and ocean industry through knowledge sharing, joint innovation, entrepreneurship, commercialization, business and workforce development.

Office Hours:
Pacific Northwest Hydrogen Ecosystem
Agenda

• Hydrogen Context
• DOE Hydrogen Hub
• PNWH\textsubscript{2} Association
• Policy Developments
• WA State Projects and Leadership
• Q&A
Decarbonization Challenge
Acceleration Needed for Maritime Fuels & Batteries

Lessons:
• Took LNG 20 years to climb these steps.
• Small, local transport, gradual transition.
• H2/Battery can leverage landside uses to expedite.
• Energy density challenge.
• Collaboration is key to accelerating uptake.

<table>
<thead>
<tr>
<th>Fuels20</th>
<th>Equivalent Weight By Lower Heating Value21 (million tonnes)</th>
<th>Equivalent Volume By Energy Density (million m3)</th>
<th>25% of Fleet Using Green Fuels in 2030 (million tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Oil (40.2 MJ/kg, 39.80 MJ/L, 991 kg/m3)</td>
<td>15.2</td>
<td>15.5</td>
<td>3.9</td>
</tr>
<tr>
<td>eLNG (48.0 MJ/kg, 20.6 MJ/L, 430 kg/m3)</td>
<td>12.9</td>
<td>30.0</td>
<td>3.2</td>
</tr>
<tr>
<td>Methanol (19.9 MJ/kg, 15.7 MJ/L, 790 kg/m3)</td>
<td>31.1</td>
<td>39.4</td>
<td>7.8</td>
</tr>
<tr>
<td>Ammonia (22.5 MJ/kg, 15.7 MJ/L, 790 kg/m3)</td>
<td>27.5</td>
<td>39.5</td>
<td>6.9</td>
</tr>
<tr>
<td>Hydrogen (120.2 MJ/kg, 8.51 MJ/L, 696 kg/m3)</td>
<td>5.2</td>
<td>72.7</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Figure 18. Zero Emissions Fuel Requirement of the NAWT Fleet
Why Focus on Hydrogen?

We are not picking the future fuel for maritime, but the momentum is building and H₂ likely to be part of the solution in some way going forward.

• Hydrogen Carrier - Energy Density
• Driving Use Cases - vessel/shoreside demos

https://www.linkedin.com/pulse/clean-hydrogen-ladder-v40-michael-liebreich/
Hydrogen Hubs are Part of The Bipartisan Infrastructure Law (BIL)

- DOE Office Of Clean Energy Demonstrations: Covers $9.5B for clean hydrogen:
  - $8B for at least four, up to 6 regional clean hydrogen hubs
  - $1B for electrolysis research, development, and demonstration
  - $500M for clean hydrogen technology manufacturing and recycling R&D

- BIL requires feedstock diversity across Hubs
  - Renewables
  - Nuclear
  - Fossil fuels

- BIL requires end use diversity across Hubs
  - Electric power generation sector
  - Industrial sector
  - Residential and commercial heating sector
  - Transportation sector
Anticipated DOE Hub Process

• Funding Opportunity Announcement (FOA) from DoE expected late September/early October
• Expected that a concept paper will need to be submitted within 6-8 weeks after FOA
• Concepts papers will be encouraged or discouraged approximately four weeks later
• DoE will invite full applications 4 months after notice of encouragement
• Final Hub award announcements expected in Summer 2023

• CHARGE will be actively engaging members to build beyond Hydrogen Hub
CHARGE, Commerce, WSU, and Industry are active building a public / private coalition

• Pacific Northwest Hydrogen Association (PNH₂ Association):
  • Commerce has created 501(c)(3) non-profit to house the hydrogen hub effort
  • Board members are elected, and board meetings started
  • Advisory board members recruited and notified
  • Formation of a project selection committee is in process

• Request for Information (RFI) issued for hydrogen hub applications
  • First RFI response window closed on July 26, 2022
  • Significant number of responses; being studied
  • PNH₂A expected to issue second call for RFI in September (to be open only for a few weeks)

• Procurement for integration firm
  • WSU and CHARGE began recruiting major integration firms experienced with multi-billion-dollar DOE contracts – handed off to Commerce for procurement
  • PNH₂A has issued a RFQQ (proposals due August 24) for hiring an M&O contractor
  • Contractor expected to be on board by end of September
  • Will help with sorting RFI responses and submission of concept paper to DoE, full proposal, hub construction and long-term hub management
WA's Port & Maritime Sector Can Accelerate DOE's Hydrogen Shot's Goal: $1 for 1 kg of clean hydrogen in 1 decade

“Projections for low-cost hydrogen are dependent on a future electricity price of <$30/MWh. In the Pacific NW, that future is now.”

- **Decarbonized Grid** at low price point, integration opportunities, engaged utilities, proactive policies.
- **Abundant resources** including water, transmission, refinery & pipeline capacity and more.
- **Abundant use case opportunities** in Heavy Duty Transportation clustered at Ports:
  - Disproportionally impacted near-shore communities
  - Hardest to decarbonize sectors=greatest potential for emissions reductions

<table>
<thead>
<tr>
<th>Vision Element</th>
<th>Hydrogen Use (kg/yr; Ultimate)</th>
<th>GHG Emissions Savings (MT CO2e/yr; Ultimate)</th>
<th>Anticipated Deployment Timeframe (Initiation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero Emission Ferries</td>
<td>250,000</td>
<td>2,222</td>
<td>1 to 3 years</td>
</tr>
<tr>
<td>Zero Emission Harborcraft</td>
<td>1,100,000</td>
<td>9,776</td>
<td>1 to 2 years</td>
</tr>
<tr>
<td>Fishing Fleet Transition</td>
<td>3,500,000</td>
<td>31,105</td>
<td>3 to 8 years</td>
</tr>
<tr>
<td>Zero Emission Ocean Going Vessels</td>
<td>184,000,000</td>
<td>1,635,208</td>
<td>3 to 10 years</td>
</tr>
<tr>
<td>Shorepower and Shoreside Infrastructure</td>
<td>1,200,000</td>
<td>10,664</td>
<td>0 to 5 years</td>
</tr>
<tr>
<td>Drayage and Transportation</td>
<td>850,000</td>
<td>7,554</td>
<td>1 to 5 years</td>
</tr>
<tr>
<td>Industrial Uses</td>
<td>3,000,000</td>
<td>26,661</td>
<td>3 to 8 years</td>
</tr>
<tr>
<td>Resiliency</td>
<td>1,200,000</td>
<td>10,664</td>
<td>1 to 8 years</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>195,100,000</strong></td>
<td><strong>1,733,854</strong></td>
<td></td>
</tr>
</tbody>
</table>
WA State Legislation Paves the Way for Building our Hydrogen Economy

- **SB 5910** effectively establishes the first statewide strategy for a renewable hydrogen economy in the U.S. and authorizes state financial support for a public-private partnership applying for the Bipartisan Infrastructure Law’s clean hydrogen hub funding.

- **HB 1988** allows for the deferral of taxes on investments in clean technology, fuels, and renewable energy storage, including renewable hydrogen production and zero-emission vehicle refueling infrastructure, such as stations that can supply hydrogen for fuel cell electric vehicles (FCEVs), which run on hydrogen and produce zero emissions.

- **SB 5974** requires that by 2030 all passenger vehicles sold in Washington have to be electric, including battery electric and FCEVs. The bill also requires the state Department of Transportation to examine using hydrogen in the state ferry system.

- 2019 Legislation **SB 5588** authorizing public utility districts to make and sell renewable hydrogen.
  - Paved the way for the Cummins partnership with the Douglas County Public Utility District (PUD) to build the largest electrolyzer of its kind in the United States. Allows the PUD to use excess hydroelectricity from its Wells Dam facility to generate H2, which will be used to supply proposed hydrogen fueling stations both at the utility and at a public station to be constructed on I-5.

- **Source:** Renewable Hydrogen Alliance, Michelle Detwiler, Executive Director, April 22, 2022
  [https://www.hydrogenfwd.org/washington-states-investment-in-hydrogen-is-a-model-for-the-country/#:~:text=SB%205974%20requires%20that%20by,in%20the%20state%20ferry%20system](https://www.hydrogenfwd.org/washington-states-investment-in-hydrogen-is-a-model-for-the-country/#:~:text=SB%205974%20requires%20that%20by,in%20the%20state%20ferry%20system)
New Federal Developments: Passage of Inflation Reduction Act

• $374 billion to climate and and energy measures over the next decade
• Includes tax credits to speed up the development of wind, solar, hydrogen and nuclear power; a tax credit to reduce the price of new electric and fuel cell vehicles; $27 billion funding for a new federal green bank; and money to address the disproportionate burden of pollution on low-income communities and communities of color.

  • Up to $3/kg Hydrogen PTC being called “Game Changer” for the industry
    • “Not only … make the renewable H₂ produced in the US the cheapest form of hydrogen in the world — but it will also light a fire under the many countries that aim to become major players in the nascent green hydrogen space.” Recharge

• IRA provides approximately $70 billion in new funds to the Department of Energy (DOE) Loan Program Office (LPO).

  • $3 BILLION IN FUNDING TO SUPPORT THE EXPANDED DOE ADVANCED TECHNOLOGY VEHICLES MANUFACTURING DIRECT LOAN PROGRAM
  • Will support manufacturing of medium-duty and heavy-duty vehicles that meet certain greenhouse gas emissions standards, along with, “a train or locomotive, a maritime vessel, an aircraft, and hyperloop technology.”
IRA Hydrogen Tax Credit Details

- Clean Hydrogen – Section 45V:
  - The IRA will create a PTC and an ITC for clean hydrogen; taxpayers will have the option to elect.
  - Clean hydrogen can be produced from different sources, including renewable electricity (green hydrogen) and natural gas reforming (blue hydrogen).
  - To qualify, hydrogen must be produced through a process resulting in lifetime GHG emissions of no more than 4 kgs of CO2e per kg of hydrogen.
  - The base credit amount will be 60 cents per kilogram of qualified clean hydrogen, multiplied by an emissions factor depending on the GHG emissions factor provided by the fuel. A bonus credit multiplier is offered if prevailing wage and apprenticeship requirements are met, wherein the applicable credit may be multiplied by five.
  - Taxpayers will be able to elect to receive an ITC in lieu of the PTC for a base credit of up to 6 percent, or 30 percent if prevailing wage and apprenticeship requirements are met.
  - This credit will be available for direct pay for the first five years under broad conditions and the credits are transferrable.
  - No clean hydrogen credit will be allowed for a facility which is already qualifying for the carbon sequestration credit.

Build Back Blue: Green Energy to Charge the Blue Economy

Key:
- Planning Component (Non-Construction)
- Component Projects (Construction—6)
- Entrepreneurship Component (Non-Constr.)
- Workforce Component (Non-Constr.)

Valley of Death

INCREASING JOBS, INCREASING ECONOMIC ACTIVITY →
**CHALLENGE**
Alternative fuels and energy are needed to reduce emissions from transportation and port operations. Hydrogen shows great promise, if it can be generated at scale in our region from renewable energy, as well as stored and transported in a safe manner.

**BENEFITS**
Provides large-scale local production and use for Hydrogen in maritime ports that can be stored as a liquid carrier in the form of Formic Acid, overcoming key storage and movement challenges. 1MW Mobile Fuel Cell for shore power demonstrates potential to ports, utilities, and maritime end-users.

**- PARTNERS -**

1. Green Hydrogen for Tacoma Maritime Joint Innovation Project
2. OCO: Use, Don't Waste, Carbon Dioxide
3. TACOMA POWER
4. Pacific Northwest National Laboratory
5. DNV
Maritime Blue Members - Leadership in Maritime Decarbonization

1st US All-Electric Ferry
Gee’s Bend, Alabama Ferry

1st US Hybrid-Electric Fleet
WA State Ferries

Glosten/Spear: Gee’s Bend Ferry
All American:
• Kitsap Waterman
• Enhydra PHEV
PURE Watercraft, Silverback, Photon Marine partnerships
Leadership in Maritime Decarbonization: Washington Built

Sea Change – The first ever hydrogen powered vessel that was constructed by All American Marine in Bellingham, WA. The ferry will operate in the Bay Area.

• Glosten Naval Architect for floating fueling system
Powerful Leaders, Achieving Great Things!

Maritime Blue seeks to co-create a workplace culture and community that aligns the values of the Blue Economy: diversity, equity, inclusion, & health.