

THE NORTHWEST SEAPORT ALLIANCE
MEMORANDUM

MANAGING MEMBERS
STAFF BRIEFING

Item No.	10B
Date of Meeting	November 7, 2023

DATE: October 30, 2023

TO: Managing Members

FROM: John Wolfe, CEO

Sponsor: Jason Jordan, Director, Environmental & Planning Programs

Project Managers: Steve Nicholas, Senior Manager, AQSP

Graham VanderSchelden, Project Manager II, AQSP

SUBJECT: US-Korea Green Corridor Study Briefing

A. SYNOPSIS

The US-Korea Green Corridor Study was launched at COP27 in Egypt in December 2022, as part of the US-Norway Green Shipping Challenge. The goal of the study is to explore “green cargo corridor” possibilities between the Seattle-Tacoma region of the US and the Busan region of Korea. The pre-feasibility phase of this study is nearing completion, and the Maersk McKinney Moller Center for Zero Carbon Shipping – which is serving as project manager for the study – has delivered a draft report featuring the results of the analytical work that has been done so far, and their recommended way forward.

Based on the analysis conducted to date, the report identifies three potential “first wave” green corridors between the US and Korea:

- A container route between the Busan Port Authority and the NWSA operating on green methanol by 2026;
- A container route between the Busan Port Authority and the NWSA operating on green ammonia by 2033; and
- A car carrier route between the Port of Masan and the NWSA, potentially operating on green ammonia

As a next step, the Maersk Center recommends a Consortium Incubation Workshop – a meeting of key stakeholders in the three potential “first wave corridors (ports, BCOs, ocean carriers, fuel providers, relevant government agencies, etc.) to gauge interest and willingness to engage in further exploration. The results of that workshop, coupled with the findings from the pre-feasibility phase of the study, would drive the decision on which potential green corridors would advance to the next stage: a full-blown feasibility assessment with more intensive data-gathering and analysis and more expansive stakeholder engagement.

The US government, along with their counterparts in the Republic of Korea, have expressed a keen interest in announcing next steps for the US-Korea Green Corridor Study at COP28 (early December in Dubai) -- and an interest in continuing to support the work. The Maersk Center also seems keen to continue, especially on potential green cargo corridors emerging from the

Consortium Incubation Workshop with identified “commercial momentum” – that is, interest in the part of key commercial stakeholders who would need to take action and make investments to “green” those corridors.

Staff briefed the Environmental Working Group on October 3; the EWG expressed strong support for this proposed way forward. (See details below.)

B. BACKGROUND & STATUS

Overview

The pre-feasibility phase of the study was launched at COP27 in Egypt in December 2022, as part of the US-Norway Green Shipping Challenge. The goal of the pre-feasibility phase is to assess a wide range of possible green shipping corridors between the Busan region of Korea and the Seattle-Tacoma region of the US, and hone-in on the most promising potential corridors – those most warranting further exploration. The study is looking at three cargo types (container, bulk, and car carrier) from three ports in both countries – Seattle, Tacoma, and Everett in the US; and Busan, Ulsan, and Masan in Korea. The Maersk McKinny Moller Center for Zero Carbon Shipping is serving as project manager. The US Government (State Department and Department of Energy) are coordinating across the two countries and guiding the effort from the national government perspective. Three national laboratories – Pacific Northwest National Laboratory, National Renewable Energy Laboratory, and Oak Ridge National Laboratory – are doing much of the data-gathering and analysis, with counterparts in Korea. NWSA staff, along with counterparts from the Busan Port Authority, are providing data, analytical support, and guidance from a local/port perspective.

Draft Report Summary

Cargo Flows: The report summarizes existing cargo flows between the US and Korea, and between the six ports being studied. The US is Korea’s #1 export market and #3 importer; Korea is the US’s #4 export market and #5 importer. Korea exports to the US are nearly \$96B, led by cars and related parts and accessories. US exports to Korea are \$66B, led by petroleum products. Nearly 70% of all cargo flowing from Korea is from the three ports included in this study, with most of that coming from Busan. Nearly 75% of the imports and exports to and from the US are handled at the Busan port. Other key findings include:

- The vessel shipments between the USA and the ROK are expected to grow by 67%–90% from 2021 to 2050.
- The major cargo types are quite different depending on the trade type (imports vs. exports). The most contributing cargo shipments are all manufactured equipment, machinery, and products (53%) for imports and animal feed, grain mill products, flour, and processed grains (27%) for exports.
- The majority (over 90%) of vessel shipments within the scope are container ships.
- The top corridors for each vessel type are different: Seattle-Busan for the container ships, Tacoma-Busan for the bulk carriers, and Tacoma-Ulsan for the RO-RO carriers.
- The container ships between Seattle and Busan, the top segment among all, account for about 61% of the total estimated fuel consumption among all the vessels within the scope.
- The RO-RO carriers tend to use cleaner fuels, such as lower sulfur-level diesels and marine oils that are more expensive than the HFOs (Heavy Fuel Oil) (Heavy Fuel Oil). This bunkering fuel type analysis indicates that the RO-RO carriers might be more favorable to cleaner alternative fuels.

US - South Korea Corridor Briefing

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Carbon Emissions: According to a high-level analysis of the carbon emissions associated with the existing cargo flows between the US and Korean ports, about 90% of those emissions are from container ships:

2021y	Ro-Ro	Bulk carrier	Tanker	General cargo	Container
Ships (port calls)	52	25	15	12	437
CO₂ Emissions (tonCO₂)	90,014	41,501	21,816	17,241	1,888,275

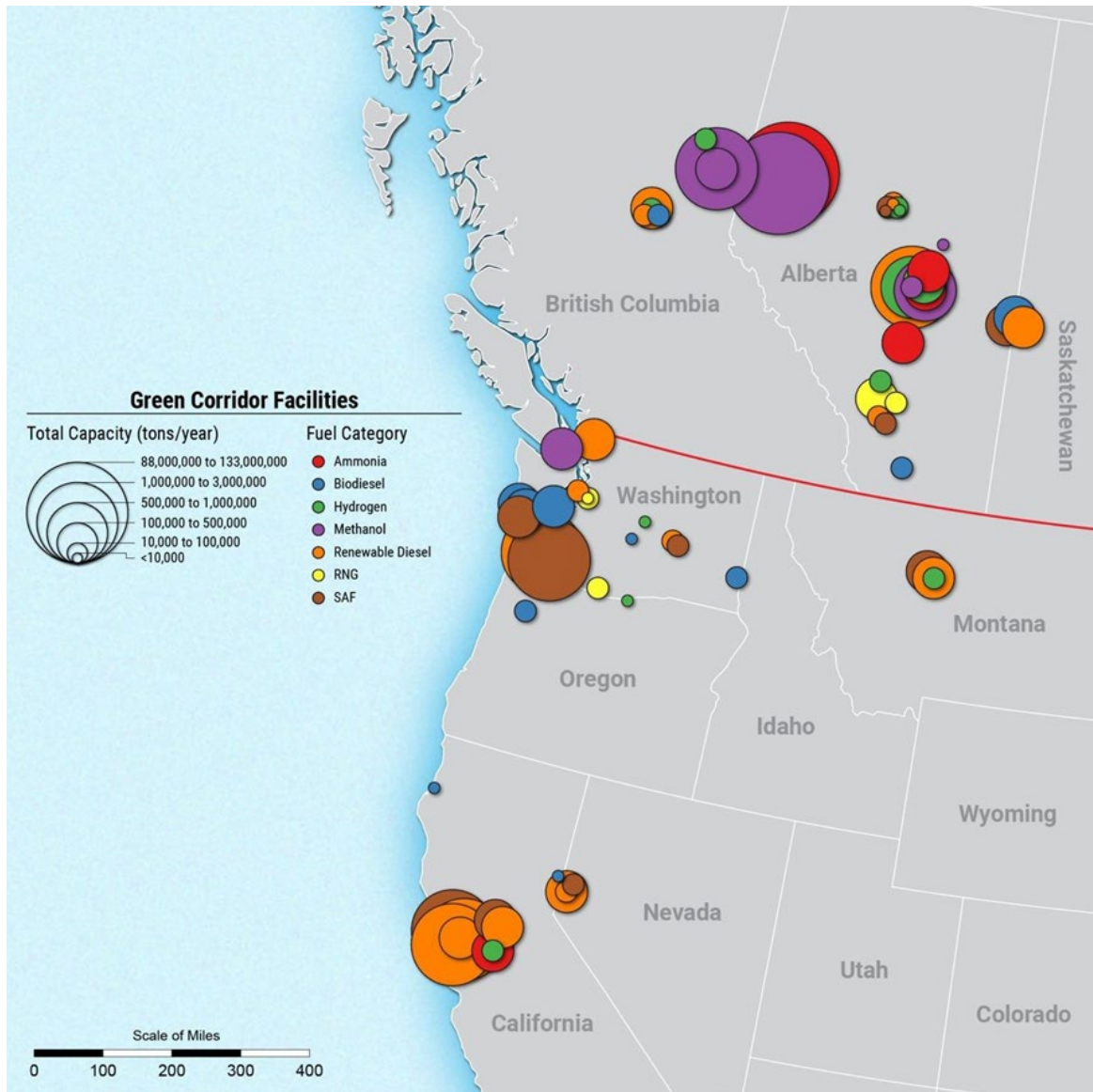
2022y	Ro-Ro	Bulk carrier	Tanker	General cargo	Container
Ships (port calls)	53	48	5	16	427
CO₂ Emissions (tonCO₂)	91,250	80,759	6,747	20,141	1,883,856

Next-Generation Fuels: Zero-emission and near zero-emission fuels will be the linchpin in “greening” shipping corridors. The pre-feasibility study assesses the current and potential supply and use of next-generation marine fuels in both Korea and the Pacific NW (US and Canada), including methanol, ammonia, hydrogen, biofuels, and renewable natural gas (RNG). Interest and investment in next-generation marine fuels, especially methanol, is on the rise in Korea.

For example, green methanol already is being bunkered at the Port of Ulsan (already a hub for liquid fuel storage and bunkering), and Korea-based shipbuilders are building green methanol and green ammonia capable ships. A Korea-based ocean carrier (Hyundai Merchant Marine) recently ordered \$1B worth of methanol-powered vessels, and the government recently created a Clean Methanol Council to study the feasibility of methanol production in Korea.

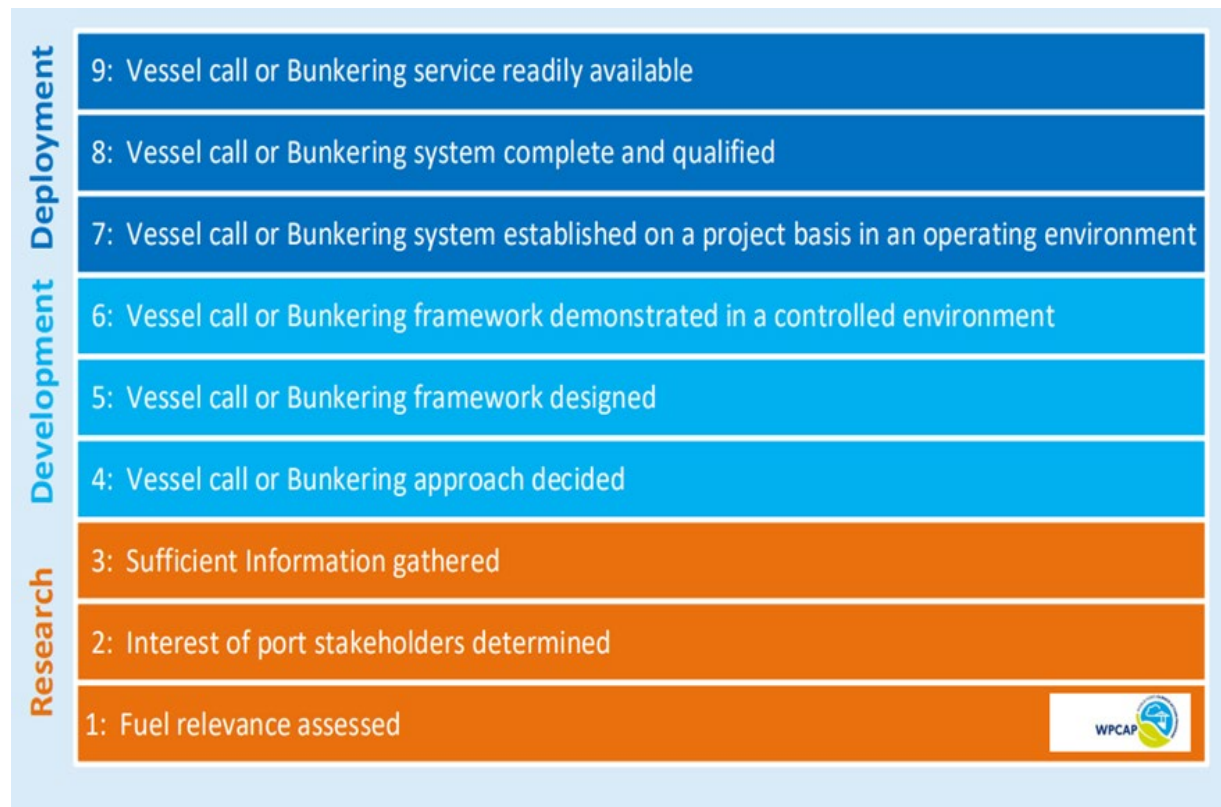
Alternative fuel production on the US side to date is mostly focused on biodiesel, renewable diesel, and sustainable aviation fuel (SAF). “There is relatively little existing production capacity for green or blue ammonia or methanol in the region. These fuels are expected to play a critical role in sustainable marine shipping, and thus their absence from existing production is noteworthy.” There are many renewable natural gas (RNG) projects proposed in the region, but “due to legislation and commitments by utilities, nearly all of the RNG from these proposed projects is committed to local natural gas grids for commercial and residential heating.” A proposed facility in Grand Prairie, Alberta would significantly increase production of methanol and ammonia in the region; a final decision is expected in 2024. Also, if the PNW (Pacific Northwest) wins a Regional Clean Hydrogen Hub grant from the USDOE, currently under consideration, “this could greatly increase the anticipated hydrogen production in the region.”

“Blue” projects, including ammonia, methanol, and hydrogen, are expected to be more common than “green” projects, due to the availability of natural gas in the region. “Many of the proposed green projects include the financing, siting, and construction of renewable electricity projects to power the proposed fuel production, most likely because all existing renewable energy generation in the region is already committed to power users. This will add an additional layer of complexity to the green fuel projects proposed.”



Existing and proposed fuel production facilities by type and size

Port Readiness Levels: Another key factor in determining the feasibility and likely success of a green corridor is the “readiness” of the ports in the corridor to serve vessels running on next-generate marine fuels such as green methanol and green ammonia. The Maersk Center is using a “port readiness level” framework developed by the World Ports Climate Action Program (WPCAP) to assess the current and projected readiness of ports in the US and Korea.



Currently, Korean ports are much further along this readiness continuum. Ships powered by LNG (Liquefied Natural Gas), methanol, and ammonia already are allowed to call on the Port of Ulsan, where bunkering facilities will be developed for LNG and e-methanol by 2025, and for e-ammonia by 2030. The world’s first bunkering of e-methanol (1,000 tons produced in Houston) to a container ship (a 2000 TEU Maersk vessel) occurred at the Port of Ulsan this past July. In the US, where bunkering costs tend to be higher, bunkering infrastructure tends to be less developed. While most international vessels are not using the Pacific Northwest as their primary bunkering location, significant bunkering does occur in the NWSA gateway, but mostly involving conventional fuels. Aside from the LNG facility at the Port of Tacoma, there are no known storage or bunkering facilities for next-generation marine fuels,” the report notes. Entirely new infrastructure will be needed to support the storage and bunkering of these fuels, “Building this infrastructure will be complicated and time-intensive, since it will be the first time such a thing is done in the region. Specifically, significant permitting processes will be required, and construction will be highly capital-intensive and time-consuming.”

The estimated longer-term outlook for port readiness in the Korean and US ports is as follows:

Country	Port	Alternative Fuel (Current)									
		LNG		Methanol		Ammonia		Hydrgen		Bio diesel	
		Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo
ROK	Ulsan	0	9	6	9	3	9	2	4	9	9
	Busan	4	4	3	3	2	2	2	2	9	9
	Masan	7	-	7	-	2	-	2	-	9	9

Country	Port	Alternative Fuel (In 2025)									
		LNG		Methanol		Ammonia		Hydrgen		Bio diesel	
		Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo
ROK	Ulsan	8	9	9	9	5	9	3	6	9	9
	Busan	7	6	6	5	4	4	4	5	9	9
	Masan	9	-	6	-	6	-	6	-	9	9

Country	Port	Alternative Fuel (In 2030)									
		LNG		Methanol		Ammonia		Hydrgen		Bio diesel	
		Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo
ROK	Ulsan	9	9	9	9	9	9	5	7	9	9
	Busan	9	7	9	7	9	6	5	6	9	9
	Masan	9	-	9	-	9	-	5	-	9	9

Country	Port	Alternative Fuel (Current)											
		LNG		Methanol		Ammonia		Hydrgen		Renewable FO		Bio Oil	
		Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo
USA	Tacoma	8	9	1	1	1	1	1	1	3	3	1	3
	Seattle	2	9	1	1	1	1	1	1	3	3	3	3

Country	Port	Alternative Fuel (in 2025)											
		LNG		Methanol		Ammonia		Hydrgen		Renewable FO		Bio Oil	
		Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo
USA	Tacoma	8	9	3	3	3	3	3	3	9	9	5	9
	Seattle	3	9	3	3	3	3	3	3	9	9	5	9

Country	Port	Alternative Fuel (in 2030)											
		LNG		Methanol		Ammonia		Hydrgen		Renewable FO		Bio Oil	
		Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo
USA	Tacoma	9	9	6	7	6	7	6	7	9	9	9	9
	Seattle	6	9	6	7	6	7	6	7	9	9	9	9

Country	Port	Alternative Fuel (in 2035)											
		LNG		Methanol		Ammonia		Hydrgen		Renewable FO		Bio Oil	
		Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo
USA	Tacoma	9	9	7	9	7	9	7	9	9	9	9	9
	Seattle	7	9	7	9	7	9	7	9	9	9	9	9

Regulatory Context: The prefeasibility study included a review of relevant national and state policies in both Korea and the US. Korea appears to have a stronger national policy framework focused on maritime decarbonization, including the Green Shipping Act of 2018 and the 2050 Carbon Neutrality Roadmap for the Marine Sector, which includes a roadmap for carbon neutral ports. In the US, the report notes new federal funding opportunities through the Inflation Reduction Act and other programs. It also notes NEPA/SEPA and the Rivers and Harbors Act, which likely will make permitting of new energy and fuel storage and bunkering facilities complex and time-consuming. The report also mentions new State of Washington policies such as the Clean Fuel Standard and the Climate Commitment Act, but notes that, because marine fuels are exempt from both policies, next generation marine fuel production will not necessarily be incentivized by these programs.

“It is possible that the lack of coverage for marine fuels may result in increased competition in other sectors, reducing the amount of renewable fuels going to the marine sector.”

Proposed Way Forward: Based on the assessment performed to date, the study identifies the three preliminary “first wave” green corridors between the US and Korea, described above in the synopsis. As a next step, the Maersk Center’s feasibility study methodology calls for organization of a Consortium Incubation Workshop (CIW), a meeting of the project team and key stakeholders in these three corridors, to review the findings and gauge interest in next steps. The list of potential “first wave” corridors – those most warranting a full-blown feasibility assessment – would be finalized based on that input.

10/3 Briefing for Environmental Working Group

After receiving this update on the Green Corridor Study, the EWG expressed strong support for the proposed way forward emerging from pre-feasibility phase of the study. The EWG also expressed support for the NWSA participation in the announcement of next steps at COP28, and expressed interest in staff further exploring other next steps:

- Establish direct working relationship with Busan Port Authority and other Korean ports
- More systematically track/engage in discussions and developments regarding the development and use of cleaner marine fuels in our state/region. In doing this, the EWG emphasized the importance of the NWSA and the homeports closely coordinating, collaborating, and remaining “fuel agnostic.”

D. FINANCIAL IMPLICATIONS

The nonprofit Maersk McKinney Moller Center for Zero Carbon Shipping is serving as project manager out of their own budget – that is, at no cost to the NWSA and the other partners. The US Government (State Department/Department of Energy) is providing approximately \$600,000 in funding to three national laboratories -- Pacific Northwest National Laboratory (PNNL), National Renewable Energy Laboratory (NREL), and Oak Ridge National Laboratory (ORNL) to do much of the data collection and analysis in support of the project.

To date, the NWSA has contributed about .25 FTE (across two staff) to this effort. The Environment & Planning Services Department’s proposed 2024 budget includes a modest increase in resources to support next steps: approximately .5 FTE (across three staff) and approximately \$50,000 in outside services.

E. PREVIOUS ACTIONS OR BRIEFINGS

- October 3, 2023: Briefing for Environmental Working Group

F. NEXT STEPS

- Work with the Maersk Center and other partners to organize/host the Consortium Incubation Workshop, simultaneously in Busan and Seattle (November 29-30, 2023)
- Work with project partners to agree on specific next steps emerging from the Consortium Incubation Workshop (November-December 2023)
- Participate in the announcement of next steps at COP28 (December 2023)
- Work with partners to implement agreed upon next steps (January 2024 and beyond)

Item No.: 10B

Date of Meeting: November 7, 2023

US-South Korea Green Corridor Study: Briefing



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Steve Nicholas & Graham VanderSchelden
Air Quality & Sustainable Practices

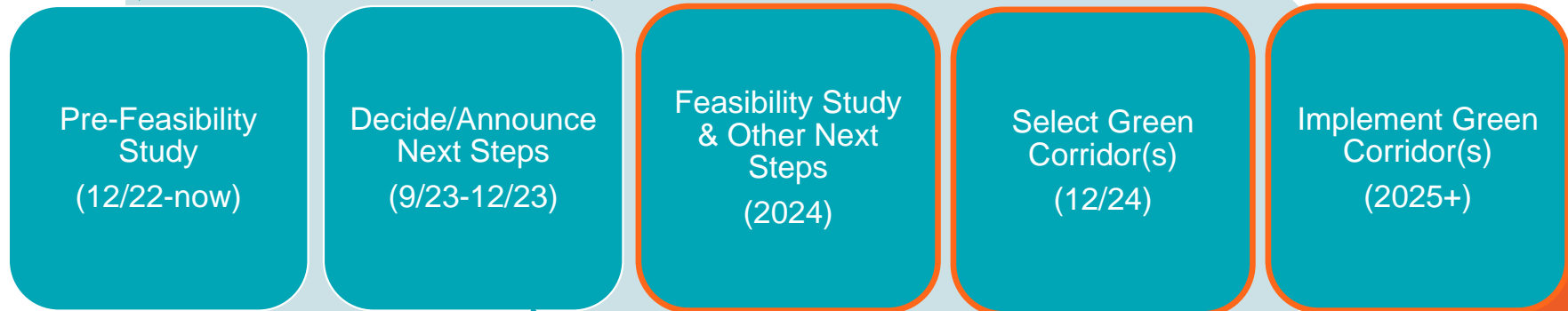
Goals of this Briefing

- Provide update on the US-Korea Green Corridor Study
- Provide summary of Environmental Working Group discussion on October 3, 2023
- Get feedback and guidance on next steps



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The road we're on...



We are here!

























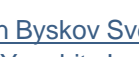


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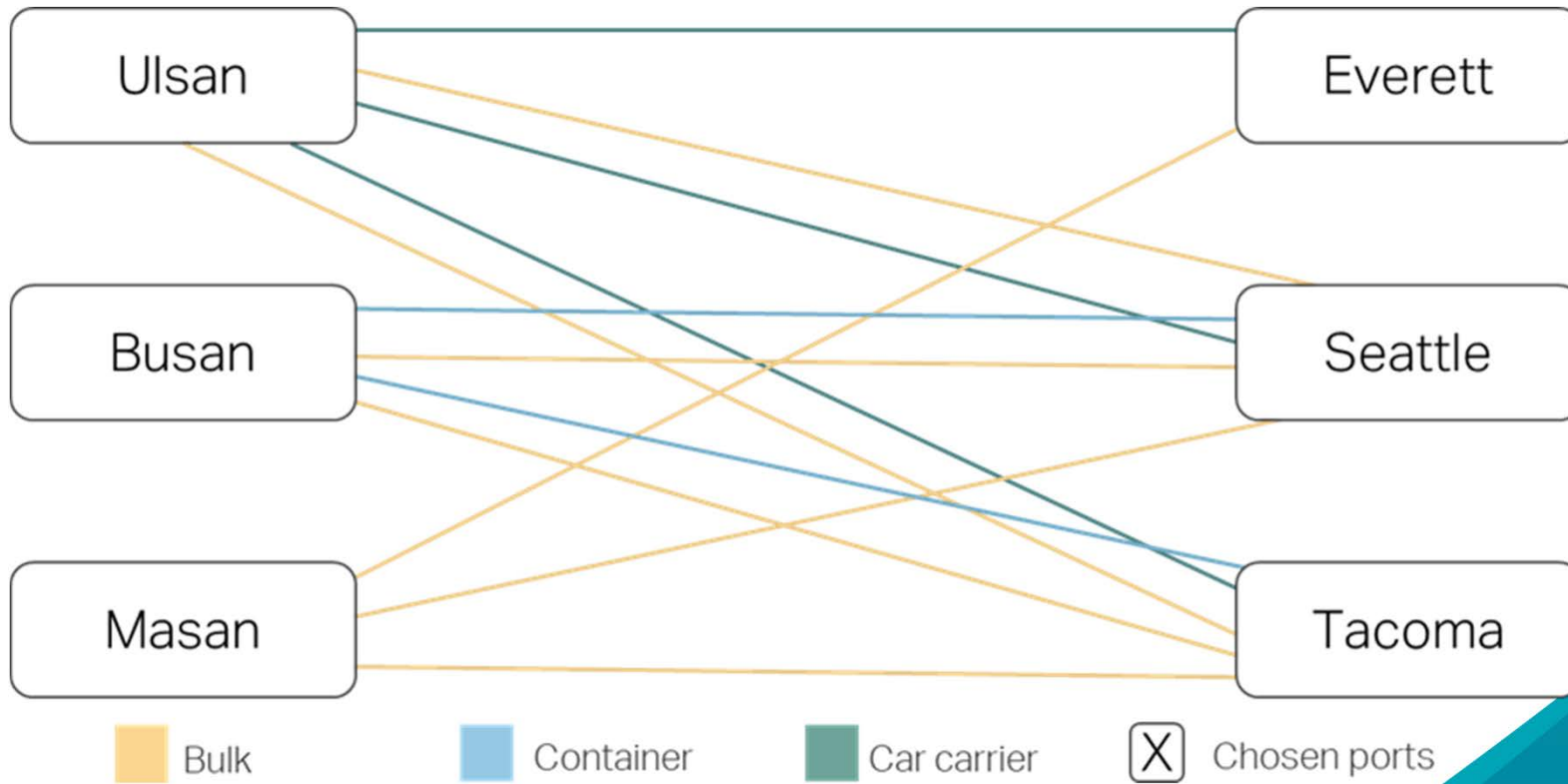
Who's doing what...

Chapter Leader

Chapter Support

1 Introduction	 Johan Byskov Svendsen (Program Manager) Oliver Yasuhito Imaizumi (Project Manager)	 Byung Joon Lim  Josh Messner
2 Fuel	 YunHo Kim  Emily Newes Kelcie Kraft	 Sung-Woo Kim
3 Port & Bunkering	 Chongmin Kim  Steve Nicholas Graham VanderSchelden	 Ted R Jeon  Emily Newes Kelcie Kraft  Young Joe Ryu
4 Cargo, Services, Trade Routes & Vessel	 Ted R Jeon  Hyeonsup Lim	 Jeong Eun Park  Steve Nicholas Graham VanderSchelden
5 Regulatory Landscape	 Han-Seon Park  Josh Messner	 Jong Hun Lee  Hyeonsup Lim
6 Selection Criteria	 Byung Joon Lim  Josh Messner	 Johan Byskov Svendsen Oliver Yasuhito Imaizumi
7 Final Paper & Way Forward	 Johan Byskov Svendsen Oliver Yasuhito Imaizumi	 Ted R Jeon  Steve Nicholas Graham VanderSchelden

Exploring different cargo types and routes...



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Cargo Flows

- US is Korea's #1 export market; Korea is US's #4 export market
 - Korea exports to US = \$96B (cars, related parts and accessories)
 - US exports to Korea = \$66B (oil and gas)
- Vessel shipments between the USA and the ROK are expected to grow by 67%–90% (2021 to 2050)
- Over 90% of vessel shipments within the scope are container ships
- 75% of imports and exports to/from US are handled at the Busan Port
- Top corridors for each vessel type: Seattle-Busan for the container ships; Tacoma-Busan for bulk carriers; Tacoma-Ulsan for car carriers
- RO-RO carriers tend to use cleaner fuels, such as lower sulfur-level diesels. Bunkering fuel type analysis indicates that the RO-RO carriers might be more favorable to cleaner alternative fuels.



Carbon Emissions

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Ships (port calls)	52	25	15	12	437
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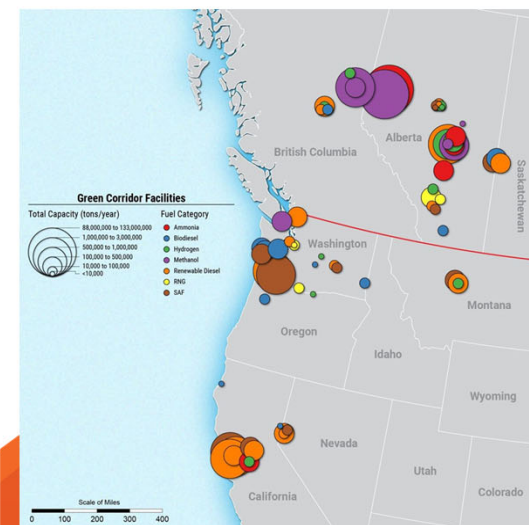
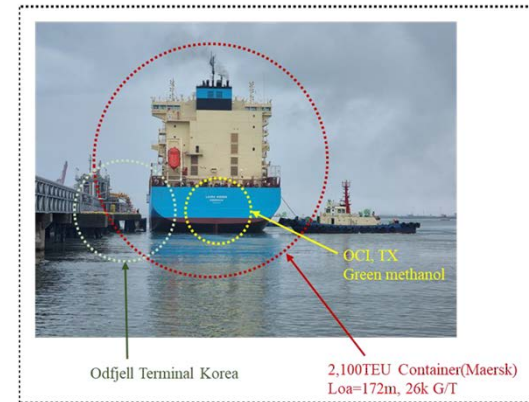


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Next Generation Marine Fuel Production/Supply

Organized by UPA

Korea	US
Efforts to increase supplies of alternative marine fuels on the rise	Alternative fuel production in US/PNW currently limited to biodiesel, renewable diesel, renewable natural gas, and SAF
“Green methanol” already being bunkered at Port of Ulsan	Several RNG projects planned, but supply committed to local gas grids
Korea-based ship-builders building green methanol and green ammonia-capable ships for Maersk and others	Little existing production capacity for blue or green methanol and ammonia; many financing, siting, permitting challenges
Korea based ocean carrier (Hyundai Merchant Marine) recently ordered \$1.1B worth of methanol-fueled ships	Proposed facility in Alberta (Canada) would significantly increase production of methanol and ammonia nearby.
Clean Methanol Council recently established to develop national strategy	PNW Clean Hydrogen Hub, recently selected for up to \$1B in federal funding, could play a role over time.



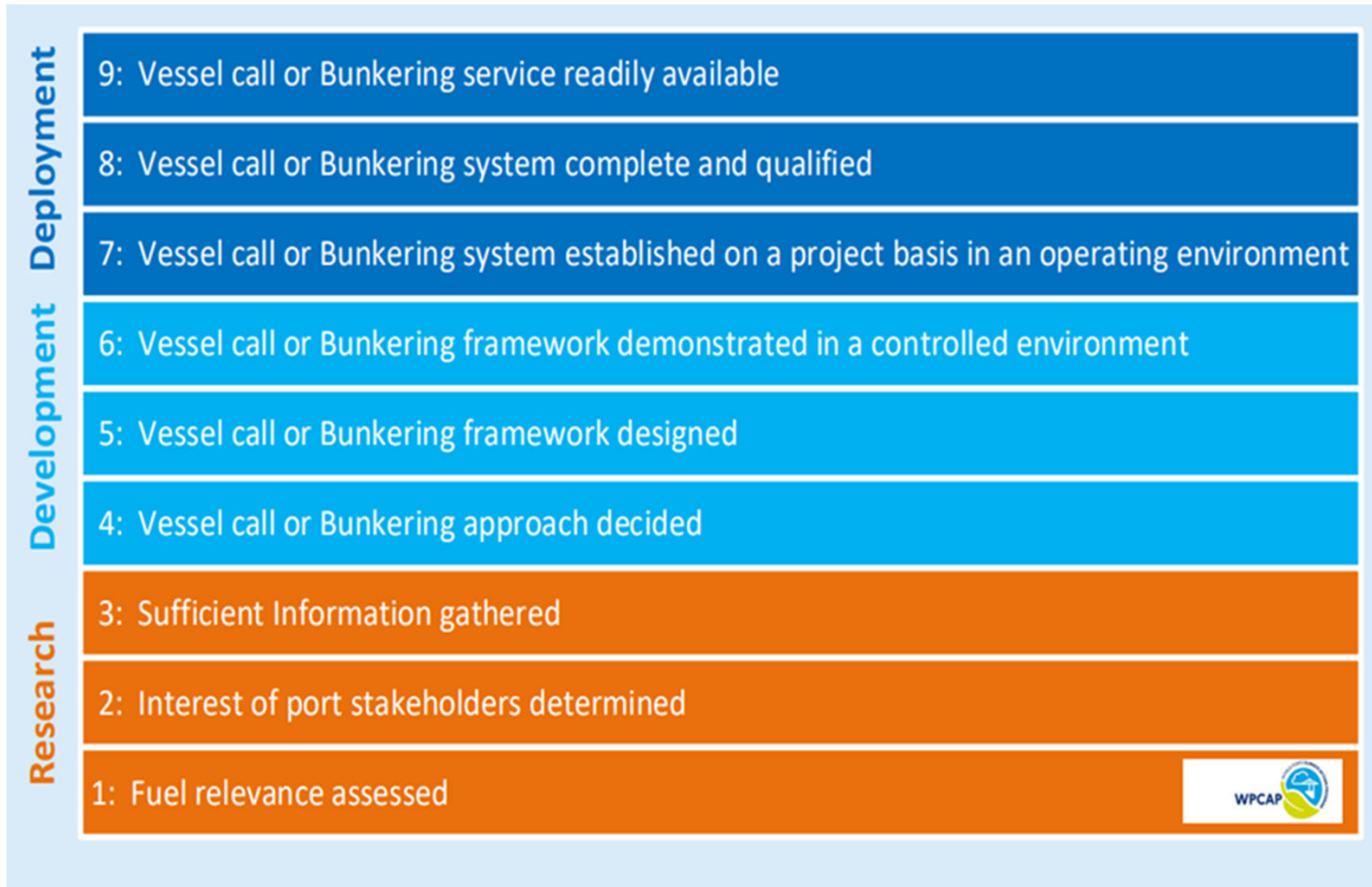
PNW Hydrogen Hub: Update

- Led by PNW Hydrogen Association; 1 of 7 winners
- USDOE will invest \approx \$1B over next several years in clean hydrogen production, distribution, use
- NWSA featured “off-take partner; facilitate demonstration of clean hydrogen in drayage trucks and CHE
- May also be a catalyst for low carbon marine fuels production in the region out into the future
- Grant award negotiations begin in November (3-9 months)



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Gauging “port readiness levels”...



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Current and projected “port readiness”

@ Korean ports

Country	Port	Alternative Fuel (Current)									
		LNG		Methanol		Ammonia		Hydrgen		Bio diesel	
		Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo
ROK	Ulsan	0	9	6	9	3	9	2	4	9	9
	Busan	4	4	3	3	2	2	2	2	9	9
	Masan	7	-	7	-	2	-	2	-	9	9

Country	Port	Alternative Fuel (In 2025)									
		LNG		Methanol		Ammonia		Hydrgen		Bio diesel	
		Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo
ROK	Ulsan	8	9	9	9	5	9	3	6	9	9
	Busan	7	6	6	5	4	4	4	5	9	9
	Masan	9	-	6	-	6	-	6	-	9	9

Country	Port	Alternative Fuel (In 2030)									
		LNG		Methanol		Ammonia		Hydrgen		Bio diesel	
		Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo
ROK	Ulsan	9	9	9	9	9	9	5	7	9	9
	Busan	9	7	9	7	9	6	5	6	9	9
	Masan	9	-	9	-	9	-	5	-	9	9

@ US ports

Country	Port	Alternative Fuel (Current)											
		LNG		Methanol		Ammonia		Hydrgen		Renewable FO		Bio Oil	
		Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo
USA	Tacoma	8	9	1	1	1	1	1	1	3	3	1	3
	Seattle	2	9	1	1	1	1	1	1	3	3	3	3

Country	Port	Alternative Fuel (in 2025)											
		LNG		Methanol		Ammonia		Hydrgen		Renewable FO		Bio Oil	
		Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo
USA	Tacoma	8	9	3	3	3	3	3	3	9	9	5	9
	Seattle	3	9	3	3	3	3	3	3	9	9	5	9

Country	Port	Alternative Fuel (in 2030)											
		LNG		Methanol		Ammonia		Hydrgen		Renewable FO		Bio Oil	
		Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo
USA	Tacoma	9	9	6	7	6	7	6	7	9	9	9	9
	Seattle	6	9	6	7	6	7	6	7	9	9	9	9

Country	Port	Alternative Fuel (in 2035)											
		LNG		Methanol		Ammonia		Hydrgen		Renewable FO		Bio Oil	
		Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo	Bunker	Cargo
USA	Tacoma	9	9	7	9	7	9	7	9	9	9	9	9
	Seattle	7	9	7	9	7	9	7	9	9	9	9	9



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Regulatory Context

Korea	US
Relatively strong national policy framework focused on maritime decarbonization, e.g., Green Shipping Act of 2018, Carbon Neutrality Roadmap for Marine Sector, etc.	No equivalent national policy framework in US, but new federal funding opportunities (e.g., Inflation Reduction Act, Bipartisan Infrastructure Law) are helpful.
	NEPA/SEPA and Rivers and Harbors Act will likely make permitting of new energy production and fuel storage/bunkering facilities complex and time-consuming.
	New state policies (e.g., Clean Fuel Standard and Climate Commitment Act) helpful, but marine fuels exemption may diminish impact in the maritime sector.



Proposed Way Forward

- Preliminary “first wave” corridors based on analysis to date:
 1. Container route between the Busan Port Authority and the NWSA operating on green methanol by 2026;
 2. Container route between the Busan Port Authority and the NWSA operating on green ammonia by 2033; and
 3. Car carrier route between a Korean port and the NWSA, potentially operating on green ammonia
- Organize “Consortium Incubation Workshop” (CIW) to engage stakeholders, identify “commercial momentum”
- Finalize list of “first wave” corridors based on CIW
- Conduct full-blown feasibility assessment of potential “first wave” corridors



Financial Implications

To date:

- Maersk Center serving as project manager
- US government funding data collection and analysis via national laboratories (NREL, PNNL, ORNL)
- NWSA contributing staff time (\approx .25 FTE)

Looking forward:

- Expect Maersk Center and US government to continue their support
- Propose increasing NWSA investment to .5 FTE plus \$100,000 in outside services



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10/3 Environmental Working Group Summary

- Strong support for proposed way forward emerging from pre-feasibility phase
- Support for participating in announcement of next steps at COP28
- Interest in further exploring other next steps:
 - Establish direct working relationship with Busan Port Authority and other Korean ports
 - More systematically track/engage in discussions and developments regarding the development and use of cleaner marine fuels in our state/region
 - NWSA and homeports should coordinate closely
 - Ports should remain “fuel agnostic”



Next Steps

- Help organize and host “Consortium Incubation Workshop” (slated for November 29-30)
- Work with US government and Korean partners to agree on next steps (October-November 2023)
- Participate in announcement of next steps (December 2023)
- Implement next steps (January 2024 and beyond)



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