

Decarbonizing the Local Maritime Industry

An Assessment of Renewable Fuel
Potential for Harbor Craft in the Puget
Sound

Summary Report | December 2025

This report and the associated supplemental materials were prepared by Earth Finance in support of the Port of Seattle, based on the research, technical assessment, and stakeholder interviews conducted during the project period. The analysis, findings, and recommendations represent Earth Finance’s best judgment at the time, drawing on information available as of the publication date, and are provided for informational purposes only. The opinions, findings, and conclusions expressed in this report are those of Earth Finance and do not necessarily reflect the views of the Port of Seattle or any of its commissioners, employees, or partners.

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Executive Summary

The Port of Seattle, in coordination with the Port of Tacoma and regional partners, has committed to achieving carbon neutrality across all emissions by 2050. Decarbonizing maritime activity, particularly harbor craft such as tugs, fishing vessels, workboats, ferries, and government fleets, is a critical component of this goal. These vessels are among the most energy-intensive assets operating in Puget Sound and face technical, operational, and economic barriers to near-term electrification.

Drop-in biofuels, particularly renewable diesel (RD), and to a more limited extent biodiesel (BD), offer a pragmatic near-term pathway to reduce greenhouse gas (GHG) emissions while zero-emission vessel technologies mature. RD is chemically similar to petroleum diesel and can fully replace it in existing engines, while BD is typically used in blends. Both fuels are compatible with existing vessels and fueling practices and are already in use at scale in other jurisdictions.

This assessment evaluates the readiness, constraints, and deployment potential of RD and BD for harbor craft operating at the Ports of Seattle and Tacoma. The analysis examines the Washington State supply landscape, including available producers, in-state versus imported supply, near-term production and import outlook, and delivery pathways such as rail, barge, and truck. It also characterizes existing fueling infrastructure and operations serving harbor craft, including fueling locations, fuel availability and blend levels, seasonal variability, storage capacity, and customer mixes. Physical, regulatory, and logistical barriers are documented alongside high-level mapping of key assets and opportunities for future planning.

The report further synthesizes perspectives from fuel producers, distributors, terminal operators, vessel owners, engine OEMs, and peer ports to identify systemic barriers, market failures, and enabling conditions for scale. The result is a fact-based foundation to inform Port policy, infrastructure planning, and market-shaping action.

Key Findings

- **Washington is technically ready for renewable marine fuels, but the surrounding market system is not.** RD performs as intended, vessels can use it without modification, and operators are interested. However, inconsistent supply, weak and volatile clean fuel

credit signals, fragmented demand, limited tankage, permitting uncertainty, unresolved warranty concerns, and the absence of a mechanism to recover green premiums prevent RD from becoming a dependable option for harbor craft.

- **Clean fuel market dynamics disadvantage Washington relative to neighboring jurisdictions.** RD volumes flow preferentially to California, Oregon, and British Columbia, where clean fuel credit programs are more mature and predictable. Washington's newer Clean Fuel Standard and evolving implementation of HB 1409 leave the state structurally short on RD, resulting in intermittent availability, particularly for marine users.
- **Marine adoption lags due to parity, certainty, and logistics – not technology.** On-road and aviation markets benefit from clearer credit eligibility, consistent demand signals, and streamlined delivery models. Marine users face dock-specific fueling requirements, thin margins, delayed credit clarity, and higher operational risk, leaving them last in line even when fuel is regionally available.
- **Infrastructure, permitting, and tankage are binding constraints.** Puget Sound lacks sufficient dedicated renewable fuel tankage, segregated systems, and flexible delivery pathways. Adding or converting storage typically requires 18–36 months, and permitting uncertainty further deters private investment.
- **Harbor craft are diverse, not monolithic.** Fishing vessels, tugs, workboats, ferries, and government fleets have distinct operating profiles, risk tolerances, and fueling needs. One-size-fits-all deployment strategies are unlikely to succeed.
- **There is no functioning Scope 3 value proposition for marine fuels.** Unlike aviation, harbor craft operators have limited ability to monetize emissions reductions or pass through modest fuel premiums, suppressing voluntary adoption despite technical readiness.

Market Signal Gap and the Need for Multimodal Fuel Aggregation

A central finding of this assessment is that the barrier to scaling renewable marine fuels in Puget Sound is not insufficient demand, but insufficient coordination of that demand. Total harbor craft fuel use in Puget Sound is estimated at ~53 MM gals/yr, a volume that exceeds the minimum thresholds producers and distributors indicated are necessary to justify dedicated renewable diesel supply and infrastructure investment. Stakeholders consistently cited ~5 MM gals/yr under multi-year offtake agreements as the minimum investment-grade signal.

Despite sufficient aggregate demand, fuel use is fragmented across vessel classes, operators, and fueling arrangements and is not currently organized into aggregated, long-term

commitments that enable suppliers to dedicate volumes or invest in tankage and delivery infrastructure. This results in a market coordination failure: producers and distributors do not invest due to the absence of bankable demand signals, while operators cannot access reliable fuel precisely because supply and infrastructure have not materialized.

Breaking this cycle requires multimodal demand aggregation, using harbor craft as an entry point, but not the ceiling. Stakeholders frequently pointed to Washington State Ferries as illustrative. As the largest publicly owned marine fleet in the region, ferries alone represent on the order of ~16 MM gals/yr and could support long-term offtake commitments if policy direction is clear. When combined with other commercial harbor craft, and eventually with other port-adjacent diesel users such as drayage trucks and cargo-handling equipment, multimodal aggregation can provide the scale, certainty, and duration of demand needed to unlock supply, justify tankage investment, and stabilize delivery pathways.

The purpose of this report is not only to document barriers, but to help clarify and organize market signals. By demonstrating that sufficient aggregate demand exists, and that public coordination can convert it into investable commitments, the assessment provides a framework for moving from fragmented, opportunistic fuel access to a coordinated renewable fuels market.

Recommendations and Path Forward

Progress will require coordinated, sequenced action to move from technical readiness to a reliable, scalable market. The Port of Seattle can play a catalytic role as a market convener, helping mitigate risk across the value chain and align stakeholders around shared solutions.

Key recommended actions include:

- Establish economic clarity through multi-state, multi-year modeling of credit pricing and carbon-intensity trajectories to identify when Washington becomes competitive and what parity conditions are required for marine users.
- Resolve warranty and technical confidence barriers by convening OEMs and fuel producers to publish Port-endorsed compatibility guidance and warranty assurances.
- Design segment-specific decarbonization pathways tailored to the operational realities of tugs, fishing vessels, workboats, ferries, and government fleets.
- Aggregate demand to unlock supply and infrastructure through multimodal coordination, potentially via a Sustainable Maritime Fuels Consortium.

- Plan infrastructure to scale with demand by developing a future-focused renewable bunkering strategy for Seattle and Tacoma in partnership with private terminal operators.

Final Takeaway

Renewable marine fuels, particularly RD, can deliver meaningful emissions reductions today for Puget Sound’s harbor craft and marine fleets. The barrier to scale is not fuel performance, but market design, infrastructure readiness, and demand coordination. By advancing the coordinated actions outlined in this report, the Ports can help transform fragmented conditions into a resilient, multimodal renewable fuels ecosystem that supports local fleets, strengthens regional competitiveness, and accelerates the transition toward zero-emission maritime operations.

1. Introduction

Washington State is at an inflection point in its transition to low-carbon fuels for maritime operations. Transportation is the largest source of greenhouse gases in the state, and the Clean Fuel Standard (CFS), launched in 2023, is now in full effect. In 2025, the Washington State Legislature strengthened the CFS¹ by ramping up carbon-intensity (CI) limits on conventional fuels in future years, targeting a 45% reduction in CI by 2038 (from 2017 levels).

In Washington State alone, maritime operations consumed ~538 MM gallons of fuel in 2019². Harbor craft are a significant source of greenhouse gases (GHGs) and local air pollutants in port cities. Among maritime emissions sources, harbor craft accounted for 45% of diesel particulate matter (DPM), 40% of PM_{2.5}, 30% of GHG emissions, one-third of all NOx and 70% of black carbon in the region³. These emissions are not abstract statistics as they directly affect community health.

In addition to contributing to climate pollution, maritime activity plays a meaningful role in localized air quality impacts in near-port communities. Washington State’s Environmental Health Disparities Map consistently identifies neighborhoods adjacent to major ports and freight corridors, such as the Duwamish Valley and Tacoma Tidelands, as among the most overburdened in the state, reflecting elevated diesel particulate matter exposure combined with higher social and health vulnerability. These findings are consistent with regional air quality planning efforts and the Northwest Ports Clean Air Strategy, which identify harbor craft and other diesel-powered maritime sources as priority targets for near-term emissions reductions to protect community health.

¹ Climate Solutions – Doubling down on climate leadership: WA Senate votes to strengthen Clean Fuels – [Link](#)

² Port of Seattle – Sustainable Maritime Fuels - [Link](#)

³ Puget Sound Maritime Air Forum – Puget Sound Regional Emissions Results Summary – [Link](#)

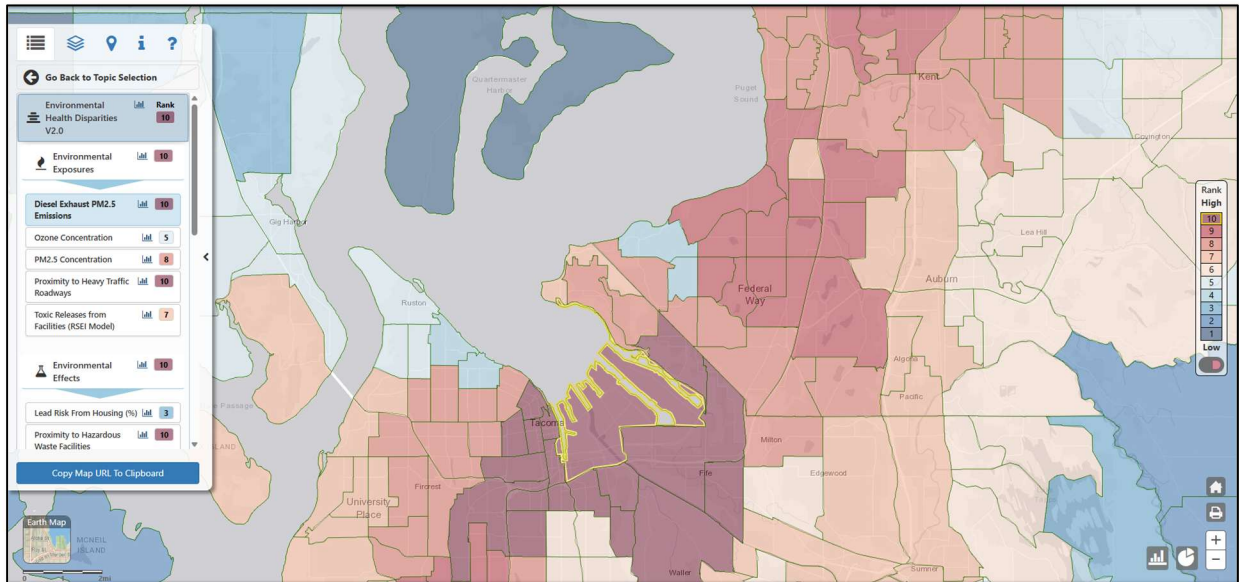


Fig 1: Washington State Environmental Health Disparities Map (DOH/Ecology)⁴

The map illustrates cumulative environmental exposure and vulnerability indicators, with darker shading indicating higher relative burden. Near-port and freight-adjacent census tracts in the Tacoma Tideflats exhibit some of the highest relative environmental health burdens in Washington State.

In response, the Port of Seattle and its regional partners have set ambitious goals under the Northwest Ports Clean Air Strategy (NWPCAS). This joint strategy commits the ports of Seattle, Tacoma, and Vancouver (BC) to phase out seaport operations-related emissions by 2050⁵. Harbor craft are a key part of these efforts, as they spend the majority of their time operating within the ports' airshed.⁶

The Northwest Ports Clean Air Strategy (NWPCAS) recognizes that many harbor craft have long asset lifetimes, often 30 to 40 years, and operate under demanding duty cycles characterized by intermittent heavy loads and on-call service requirements⁶. Other vessel types operating in Puget Sound, including ferries and commercial fishing vessels, exhibit a wide range of operating profiles, many of which have not yet been demonstrated at scale using zero-emission technologies⁶. As a result, a full transition to next-generation zero-emission vessels will take time, underscoring the importance of achieving meaningful emissions reductions from the existing fleet in the near term⁶.

⁴ WA Dept of Health – Washington Environmental Health Disparities Map – [Link](#)

⁵ Northwest Seaport Alliance – Northwest Ports Clean Air Strategy – [Link](#)

⁶ Port of Seattle – Northwest Ports Clean Air Strategy 2020 – [Link](#)

Consistent with this approach, the Ports have committed to “continually increase vessel efficiency and decrease emissions from existing vessels” as an interim strategy⁶. Near-term actions identified under NWPCAS include repowering or retrofitting older engines with cleaner Tier 3 and Tier 4 diesel engines, deploying hybrid-electric systems where feasible, improving operational efficiency, and increasing the use of drop-in renewable fuels such as biodiesel (BD) and renewable diesel (RD)⁶. These measures are intended to deliver immediate reductions in diesel particulate matter, nitrogen oxides, and greenhouse gas emissions while longer-term zero-emission vessel technologies and supporting infrastructure mature⁶.

This report is fundamentally about understanding the barriers to adoption in order to close this gap. In support of its Clean Air Strategy goals, the Port of Seattle has commissioned this comprehensive assessment to understand why RD use in Washington’s harbor craft sector remains limited, and what actions could accelerate deployment. The importance of this work is driven by several converging factors:

- Washington’s climate targets cannot be met without emissions reductions across all sectors, including marine.
- The Port is well positioned to play a leading role in advancing clean fuel deployment in the marine sector through its policies, programs, partnerships, and educational efforts.
- The Port’s Century Agenda vision of zero-emission operations depends on near-term progress in reducing harbor craft emissions.
- Near-port communities are seeking immediate reductions in diesel pollution to improve local air quality and protect public health.
- Widespread adoption of electric and hybrid harbor craft will take time, as technologies mature and become technologically and financially feasible across diverse operating profiles.
- Washington’s Clean Fuel Standard will become increasingly stringent in coming years, likely requiring significant expansion of renewable diesel in the overall fuel mix; if harbor craft remain on the sidelines, compliance burdens will fall more heavily on the on-road sector, potentially increasing costs and reducing overall program effectiveness.

In short, identifying near-term strategies to integrate harbor craft into Washington’s clean fuels transition is both a climate imperative and a matter of equity for local communities and the maritime industry.

2. Project Scope, Methodology & Desired Outcomes

Scope and Objectives of the Assessment

This analysis outlines a data-driven overview of Washington’s biofuel Renewable Diesel (RD) and Biodiesel (BD) landscape for the maritime sector, from production to distribution to end-use, and to identify practical strategies to unlock reliable RD supply for harbor craft. In support of the Port of Seattle’s Century Agenda and Maritime Climate and Air Action Plan, which call for reducing emissions from port operations and facilitating the transition to sustainable maritime fuels, this study will address several key questions:

- **Biofuels Supply and Availability in Washington:** Outline the current status of RD and BD usage in marine vessels within Washington. Determine which fuel suppliers currently serve the maritime sector, especially harbor craft, or could potentially supply this market. This includes an inventory of fuel producers, importers, and distributors that have RD available in the region, along with any planned expansions or new production facilities that could increase supply within a 10-year timeframe. Including an evaluation of Washington’s production capacity and import flows for RD. For instance, BP’s refinery at Cherry Point (Blaine, WA) recently began co-processing renewable feedstocks, and additional projects in California and the Midwest could deliver volumes into Washington.
- **Fueling Infrastructure and Distribution for Biofuels:** Understand where and how harbor craft operating across the Puget Sound can obtain renewable fuels today. Determine key fueling infrastructure used by harbor craft operating at the Ports of Seattle and Tacoma, and the Northwest Seaport Alliance. This includes identifying fueling locations and methods. Assess the storage and handling capabilities at these sites and pinpoint infrastructure barriers that might be holding back RD deployment to harbor craft. These could include physical limitations (e.g., storage tank space or pump equipment that is incompatible with higher biofuel blends), permitting or regulatory constraints, and logistical challenges, factors that contribute to the “last mile” problem of getting renewable fuel into harbor craft.

Time Horizon

This assessment applies a 10-year view (2015–2025 YTD) to understand how RD and BD markets, supply chains, and infrastructure have evolved in Washington and across the West Coast. This approach enables long-term pattern recognition, such as shifts in import flows, the emergence of new production assets, and the gradual tightening of CI requirements under the WA Clean Fuel Standard. Within that broader horizon, this report places particular emphasis on the most recent three years (2023-2025 YTD), when the implementation of the CFS, rapid RD production expansions, and significant changes in blending practices have had the greatest effect on fuel availability for marine users. This combination of long-range perspective and recent-year focus ensures recognition of both structural trends and the near-term dynamics shaping RD access for harbor craft today.

While the report references emerging trends and provides qualitative expectations for how markets may evolve, forward-looking projections beyond this period (2025–2045) are not part of the technical scope of this assessment.

Methodology

This assessment was conducted in three phases: an initial scoping assessment, a structured interview process with industry stakeholders, and the synthesis of findings into recommendations.

1. Scoping Assessment: Comprehensive review of zero- and low-emission technologies applicable to commercial harbor craft, as well as prior work completed by the Port of Seattle. This included understanding ongoing adoption efforts in the Puget Sound region and analyzing local and regional markets that could realistically be served through a strengthened RD supply chain.

The vessel categories included in the study are fishing vessels, tugboats and barges, research vessels, and small excursion vessels. This definition of “commercial harbor craft” framed the technology review and helped focus the assessment on vessel types most relevant to the Port’s climate and air-quality goals.

In parallel, this report assessed Washington’s RD and BD supply flows using the Department of Ecology’s Advance Notice of Transfer (ANT) data to understand where fuels were being produced, imported, and ultimately consumed. The assessment also considered the Port’s

terminal properties and fueling assets to identify potential constraints, opportunities, and points of leverage within the existing infrastructure.

2. Industry and Value-Chain Interviews: Structured interviews with stakeholders representing the full marine fuel value chain enabled real-time stakeholder feedback and insights. Interviewees were grouped into eight categories: producers, fuel distributors, terminal operators, port service providers, blending terminals, end users (operators), port authorities, technology providers, advocacy and trade organizations.

Using a structured and repeatable interview questionnaire, 42 organizations were contacted and 24 separate interviews were completed. These insights were synthesized alongside desktop research to generate a detailed picture of RD availability, constraints, market perceptions, and infrastructure considerations across the region. The market assessment phase concluded in early December 2025.

3. Recommendations Development

Following interviews, consolidated insights were summarized in a database organized by topic area and stakeholder type. An analytical matrix was then used to crosswalk interview findings with the scoping assessment to identify where interview insights validated or contradicted the initial research. Desktop research and ongoing conversations further refined the analysis, ensuring that final recommendations reflect the full breadth of available knowledge and a balanced interpretation of stakeholder perspectives.

Desired Outcomes

With this report, the Port and its partners will have a market informed understanding of the numerous opportunities and challenges across the entire renewable fuels value chain that would support availability and affordability for stakeholders eager to transition to low-carbon fuels. Bridging this gap is a crucial step toward the Port of Seattle’s clean air goals and toward a more sustainable, low-carbon maritime industry in Washington State.

3. Harbor Craft

Harbor craft are watercraft that operate primarily within or near port boundaries, performing short-range, high-frequency movements that support commercial, government, and recreational marine activity. Their operations are distinct from deep-sea or ocean-going vessels because they remain within the local airshed, such as the Puget Sound airshed, and their activity patterns, and engine characteristics reflect this localized operating profile.⁷

Harbor craft activity typically cycles between:

- **Transit:** Movement to and from berth within the harbor boundary. During transit, vessels rely on both main engines and one auxiliary engine.
- **At Berth:** Main engines are shut down, and only auxiliary engines are used, unless the vessel connects to shore power or shuts down auxiliary engines entirely.

Typical Engine Configuration & Operations

Most commercial and government harbor craft operate with two main propulsion engines, used during active transit. These vessels also typically rely on several auxiliary engines (diesel generators) used to provide electrical power. Auxiliary boilers are generally not present, except on Washington State Ferries (WSF)⁸.

Types of Harbor Craft

Harbor craft generally fall into two broad categories:

1. Commercial and Government (non-military) harbor craft – Includes tugboats, ferries, pilot boats, port security vessels, research vessels, small workboats, and other utility craft.
2. Recreational Vessels – Privately owned boats such as leisure craft, sailboats, and personal motor vessels used for non-commercial activity.

They can be further broken into:⁷

- **Assist tugboats:** Assist tugboats help ocean-going vessels maneuver in the harbor during arrival, departure, and shifts.

⁷ Puget Sound Maritime Air Forum – Puget Sound Maritime Air Emissions Inventory – [Link](#)

⁸ NOTE: Ferry vessels are outside the scope of this assessment

- **Harbor and ocean tugboats:** Tugboats, towboats and push-boats transport barges and other vessels. Harbor tugs work locally near the harbor and ocean tugs provide linehaul and ocean-going services.
- **Ferry vessels:** Ferry vessels transport passengers and vehicles throughout Puget Sound. They range from larger WSF to smaller local county and city ferries.
- **Excursion vessels:** Excursion and charter vessels are smaller than ferry vessels and are used for harbor cruises, dining cruises, whale watching, and other specialty cruises.
- **Government vessels:** Coast Guard vessels, research vessels, police patrol boats and fireboats, are included in this vessel type. Pilot boats are also included in this category because they all have similar operations. Military vessels are excluded.
- **Work boats:** Vessels that perform duties such as utility inspection, surveying, spill response, training, and construction.
- **Commercial Fishing:** Vessels dedicated to procuring fish. They range from small fishing vessels to larger commercial fishing vessels that go to Alaska.
- **Barges:** Flat-bottomed vessels that transport goods like construction materials, containers, and fuel. They can be pushed or towed by tugboats, with pushing being common in confined harbor areas.

Source Category	NO _x	VOC	CO	SO ₂	PM ₁₀	PM _{2.5}	DPM	BC	CO _{2e}
Ocean-going vessels (OGVs), transit	36%	10%	4%	48%	20%	20%	23%	1%	19%
OGVs, hotelling & maneuvering	17%	6%	2%	50%	20%	19%	15%	1%	19%
Harbor vessels	34%	18%	14%	1%	40%	41%	45%	70%	30%
Recreational vessels	5%	62%	75%	0%	8%	8%	2%	4%	8%
Locomotives	4%	2%	1%	0%	7%	6%	8%	11%	4%
Cargo-handling equipment	1%	1%	1%	0%	4%	4%	5%	8%	4%
Heavy-duty vehicles	4%	1%	3%	0%	2%	2%	2%	4%	15%
Fleet vehicles	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%

Fig 2: 2021 Total Study Area Maritime-related Emissions Contribution by Source Category, % (PSEI)⁹
 Ocean-going vessels account for a disproportionate share of SO_x emissions because sulfur oxide formation is directly tied to fuel sulfur content, and OGVs historically burn much higher-sulfur fuels and in far greater volumes than harbor craft, fishing, or recreational vessels, which primarily use ultra-low-sulfur diesel. By contrast, harbor craft account for a relatively large share of CO_{2e} emissions because they operate almost entirely within the Puget Sound airshed, with frequent starts, idling, and maneuvering captured in the inventory. Only a limited portion of OGV fuel use and emissions are attributed to Washington waters, as the majority of OGV transit and propulsion occurs outside the regional airshed and is therefore not reflected in the inventory totals. (Refer Appendix for more details)

⁹ Puget Sound Maritime Air Forum – Puget Sound Maritime Air Emissions Inventory – [Link](#)

Decarbonization Pathways

There are several technological pathways and approaches being pursued to reduce harbor craft emissions, each with a different time horizon and suite of opportunities and challenges.

- **Engine Modernization:** Replacing 20+ year-old diesel engines with newer Tier 3 or Tier 4 engines (or installing after-treatment filters) can dramatically lower DPM and NO_x emissions. Many harbor craft operators have already begun to repower older engines, and regulators have pushed this as well. In California, for instance, a 2008 state rule, which was later amended in 2022, has led to many old engines being upgraded, yielding significant cuts in diesel soot and NO_x¹⁰.
- **Electrification and Hybridization:** Battery-electric and hybrid propulsion systems reduce fuel consumption and emissions during standby, maneuvering, and low-speed operations. Globally, passenger ferries have been the most widely electrified vessel type to date, due to their fixed routes and schedules and frequent dock stops. Tug Crowley's eWolf, which entered service in San Diego in 2023, was the first deployment of an all-electric tug in the United States. Similarly, HaiSea Marine deployed an all-electric tug, the Wamis, at the Port of Vancouver, BC, in 2023. Hybrid-electric tugs have also been deployed, such as the MV Green Diamond inland towboat operating in Houston. Other harbor craft types with smaller power needs, such as pilot boats or workboats, could be good candidates for electrification in the near-term if there is an operational fit. The Port of Anacortes, WA, recently received grant funding to deploy two all-electric pilot boats.
- **Renewable fuels (Drop-in Fuels):** Renewable fuels offer immediate emissions reductions using existing engines and fuel systems. RD is the only true "drop-in" fuel currently available for harbor craft, as it is chemically similar to ultra-low sulfur diesel (ULSD), can be used at R100 without engine or infrastructure modifications, and delivers ~65% lower lifecycle GHG emissions along with near-zero sulfur and reduced particulate matter and NO_x emissions. Biodiesel blends can also reduce emissions but may be constrained by blend limits, cold-weather performance, and OEM guidance. Among near-term options, RD represents the most readily scalable pathway for broad deployment across the existing harbor craft fleet.¹¹
- **Liquefied Natural Gas (LNG):** LNG is not a drop-in fuel and requires dedicated engines, onboard storage, and fueling infrastructure. LNG-fueled tugs operating in British Columbia demonstrate improved local air-quality performance compared to conventional diesel, particularly for NO_x and particulate matter. However, LNG remains a fossil fuel with limited

¹⁰ CA Air Resources Board – Commercial Harbor Craft – [Link](#)

¹¹ US Dept. of Energy (AFDC) – Renewable Diesel – [Link](#)

lifecycle GHG benefits and potential methane slip concerns. Its primary advantage is commercial maturity, as LNG fuel and vessel technology are already widely available relative to other alternative fuels.¹²

- **Hydrogen Fuel-Cell Vessels:** Hydrogen fuel-cell propulsion represents a zero-emission pathway at the point of use, with early pilot projects underway globally¹³. These systems are still at a demonstration stage for harbor craft and face challenges related to fuel storage, bunkering infrastructure, vessel integration, and cost. Hydrogen may become viable for select applications as infrastructure and supply chains develop in the 2030s.
- **Ammonia and Methanol-Fueled Vessels:** Ammonia and methanol are emerging marine fuels under active development, particularly for larger vessels^{14 15}. These fuels require purpose-built engines, new safety systems, and dedicated fueling infrastructure. Methanol-fueled tug deployments in the Pacific Northwest and British Columbia signal early momentum, but both fuels remain at a pre-commercial stage for most harbor craft applications and are likely longer-term options.
- **Vessel Efficiency Retrofits:** Incremental upgrades, including optimized propellers and nozzles, improved hull coatings, and refined engine tuning, can reduce fuel use and emissions by 5–15%. These retrofits are typically integrated into normal maintenance cycles, making them a cost-effective complement to larger propulsion upgrades.¹⁶
- **Operational Measures:** Emissions can also be lowered through better dispatch management, reduced idling, optimized routing, and speed adjustments. These no- or low-cost strategies provide immediate reductions in fuel use and local pollutants, especially for vessels with frequent short transits.⁵
- **Shore Power and Port Electrification:** When vessels can plug in at berth, at-dock emissions of CO₂, NO_x, and DPM drop sharply. Ports across Washington, Oregon, and California have already begun deploying shore power and broader port electrification, most commonly at cruise and container terminals, to reduce localized pollution. Expanding access and extending these systems to harbor craft applications where feasible (e.g., longer dwell times, predictable berths, compatible electrical upgrades) offers a practical pathway to cut emissions for vessels that spend significant time alongside between jobs.⁵

¹² Port of Seattle – Northwest Ports Clean Air Strategy 2020 – [Link](#)

¹³ California Energy Commission – The Hydrogen Zero-Emission Tugboat Project – [Link](#)

¹⁴ AP News – Tugboat powered by ammonia sails for the first time – [Link](#)

¹⁵ Kotug – KOTUG Canada Provides First State-of-the-Art Dual Fuel Methanol Escort Tugs – [Link](#)

¹⁶ US Dept. of Transportation (Maritime Admin.) – Energy Efficiency and Decarbonization Technical Guide – [Link](#)

The NWPCAS forecasts that by 2030 the necessary infrastructure should be in place to enable early adoption of zero-emission harbor craft (e.g., ample electric charging capacity, hydrogen fueling where needed), and by 2050 the vision is to have 100% of harbor craft be zero-emission¹².

In summary, the short-term strategy for harbor craft is to “green” the existing fleet as much as possible, replacing old engines, adopting hybrids, and switching to cleaner fuels like RD, to cut emissions immediately. The long-term strategy is to facilitate a smooth shift to true zero-emission vessels by investing in infrastructure and pilot projects this decade, so that by 2030 the groundwork is laid for wider deployment of electric or hydrogen vessels. This balanced approach acknowledges the urgency of cutting pollution now, especially to improve air quality in nearby communities, while keeping the ports on track for deep decarbonization by 2050.

4. Renewable Diesel

Renewable diesel (RD) is a hydrotreated, paraffinic “drop-in” diesel fuel produced from a wide range of lipid-based feedstocks, including used cooking oil, animal fats, and vegetable oils. RD meets ASTM D975 and EN 15940 specifications and is chemically and physically very similar to ultra-low sulfur diesel (ULSD), with no oxygen content, very low sulfur, and low aromatic levels. Because RD is a true hydrocarbon fuel, it can fully replace petroleum diesel in existing engines and infrastructure without modification.

From an energy standpoint, RD is closely comparable to ULSD. Neat RD (RD100) contains ~96% of the energy per gallon of petroleum diesel, resulting in a ~3–4% potential fuel-economy difference that is often operationally indistinguishable in marine duty cycles. RD typically has a higher cetane number than ULSD, supporting more complete combustion and smoother engine operation.¹⁷

Lifecycle GHG performance is a key strength of RD. Typical RD pathways deliver ~50–80% lower lifecycle GHG emissions compared to ULSD, depending on feedstock and production pathway. California LCFS data indicate average CI reductions of ~65–70%, with some waste-based pathways achieving even lower carbon intensities¹⁸.

At the tailpipe, RD consistently performs as well as or better than ULSD. Studies summarized by federal and state agencies show reductions in particulate matter (PM), visible smoke, carbon monoxide (CO), and hydrocarbons, driven by RD’s high cetane and zero aromatic content. Nitrogen oxides (NOx) impacts are generally neutral to modestly lower than ULSD, depending on engine calibration and duty cycle¹⁹.

Operationally, RD’s drop-in nature is a major advantage. It can be used as RD100 in existing diesel engines, tanks, pipelines, and bunkering systems without blending limits or material-compatibility concerns, and it is fully miscible with ULSD. RD also exhibits better cold-flow performance and oxidation stability than FAME biodiesel, with storage and handling characteristics that closely mirror conventional diesel.

¹⁷ US Dept. of Energy (AFDC) – Fuel Properties Comparison – [Link](#)

¹⁸ Stillwater Associates – California LCFS – [Link](#)

¹⁹ US Dept. of Energy (AFDC) – Renewable Diesel – [Link](#)

However, RD faces important market and economic constraints. Production costs are higher than ULSD, making RD economics on the West Coast highly dependent on LCFS, RFS, and tax incentives. Changes in credit prices or policy design can quickly shift RD availability and pricing across states and sectors. RD also competes directly with sustainable aviation fuel (SAF) and biodiesel for limited waste-based feedstocks; strong SAF demand in particular can divert feedstock and hydrotreating capacity away from on-road and marine RD markets.

Finally, while RD closely resembles ULSD, neat RD can have lower natural lubricity than biodiesel. In some applications, additives, or small biodiesel blends (e.g., B2–B5) are used to ensure lubricity margins comparable to or better than ULSD, particularly for legacy fuel-system components.

Current Market Pricing

On the West Coast, particularly in California, retail RD prices are often at or near parity with ULSD because LCFS and RFS credits materially close the cost gap. Recent DOE AFDC price snapshots illustrate this dynamic, with California RD averaging slightly below diesel in several months (for example, in April 2025 RD averaged \$4.94/gal versus \$4.97/gal for diesel, and in January 2025 \$4.69/gal versus \$4.78/gal, respectively). Behind the pump, however, wholesale RD remains structurally more expensive than ULSD, and its market competitiveness depends heavily on the combined value of LCFS credits, RFS RINs, and the federal Blenders Tax Credit, without which RD would not consistently price at parity with conventional diesel.

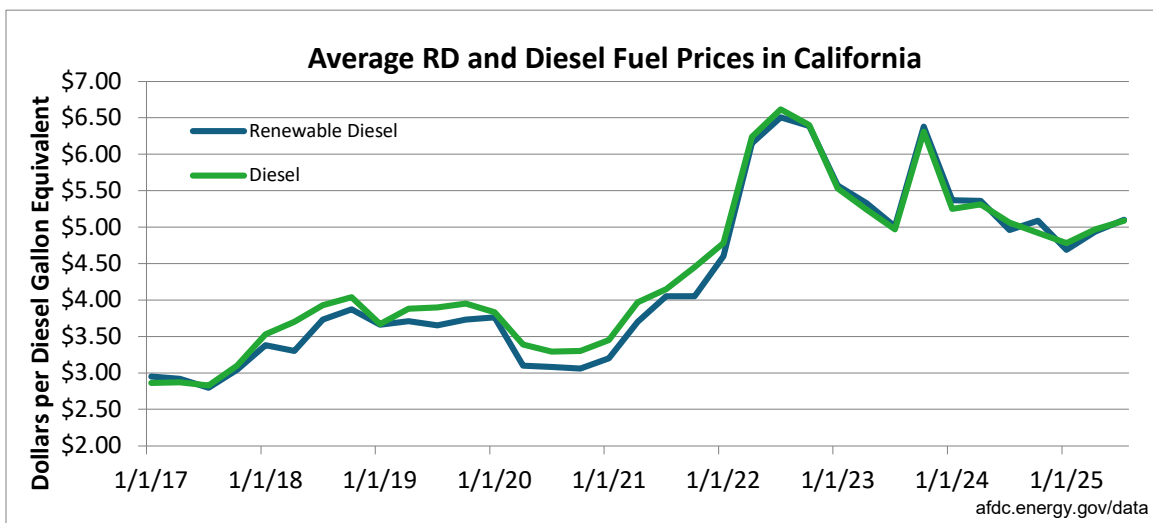


Fig 3: RD has been at or below price parity with ULSD in CA since 2017

Washington - COLEMAN - Monthly Avg. Price/1M BTU

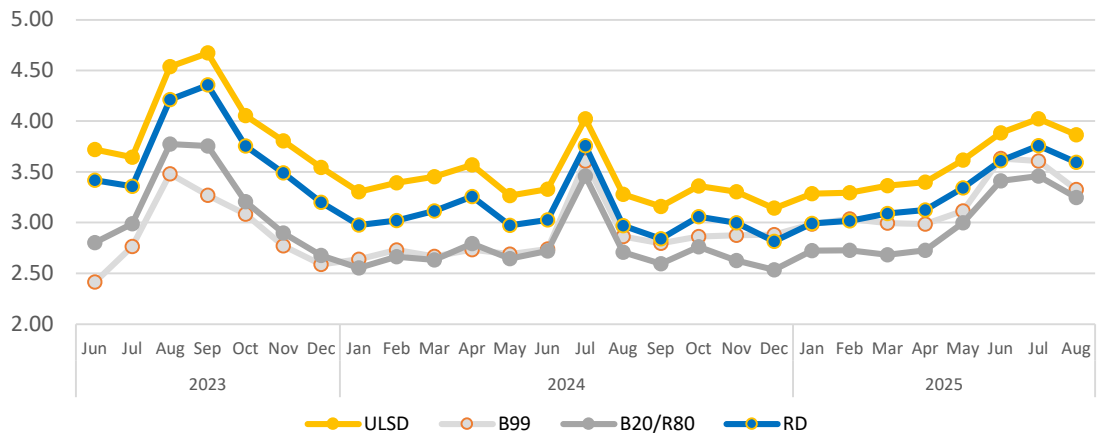


Fig 4: Coleman’s RD prices (before CAR) are consistently ~\$0.3 cheaper than ULSD²⁰

RD Value Chain

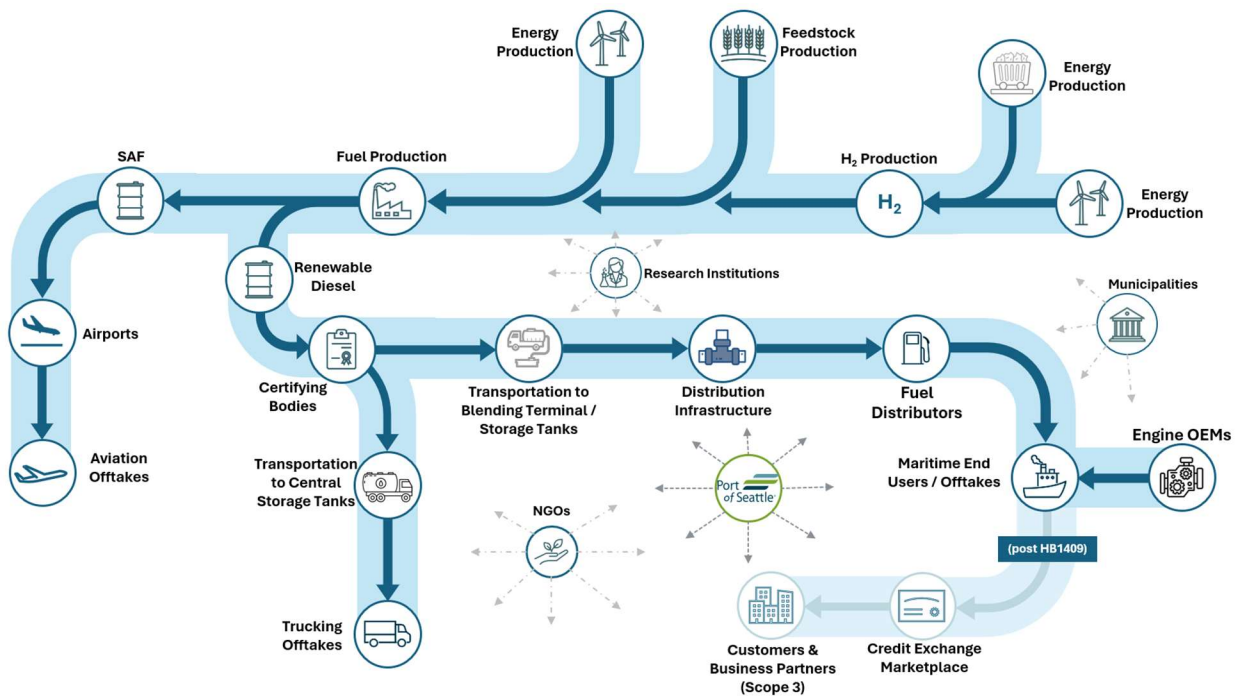


Fig 5: This illustration shows the end-to-end system for supplying RD to maritime users, from feedstock and hydrogen inputs through refining, certification, storage, and dockside delivery.

²⁰ WA Dept. of Enterprise Services – Current Commodity Pricing – [Link](#)

RD production begins with a variety of feedstock, such as biogenic feedstocks, processed at refineries that rely on hydrogen inputs, predominantly fossil-derived (grey) hydrogen today, with the diagram reflecting a forward-looking, idealized transition toward low-carbon hydrogen over time. While RD uses much of the same infrastructure as conventional diesel, scaling certified low-carbon fuel for marine use requires coordinated investment in tankage and logistics, supportive policy signals, and port-enabled market alignment. The Port of Seattle plays a central convening and enabling role by aggregating demand, de-risking infrastructure investment, coordinating distributors and terminal operators, and aligning public policy with private offtake. Engine OEMs, municipalities, NGOs, and Scope 3 customers further shape fuel standards, credibility, and demand signals that determine whether RD can reliably reach maritime end users at scale.

5. Biodiesel

Biodiesel (BD) is a fatty acid methyl ester (FAME) fuel produced by trans-esterifying vegetable oils, used cooking oil (UCO), or animal fats. Neat biodiesel (B100) meets ASTM D6751 specifications²¹ and is most commonly blended with petroleum diesel at B5–B20 levels for marine and heavy-duty use²². Unlike ULSD, BD is an oxygenated ester rather than a pure hydrocarbon, which underpins both its emissions benefits and operational constraints²³.

BD has slightly lower energy density than ULSD. Neat biodiesel contains ~7% less energy per gallon, while B20 contains ~1–2% less, translating into a ~1–8% fuel-economy penalty depending on blend and duty cycle²². At low blends (B5–B20), this impact is generally modest and not operationally limiting for harbor craft.

Tailpipe emissions benefits are well established. BD reduces lifecycle GHG emissions by up to 86% compared with petroleum diesel²³. B20 blends typically reduce particulate matter by ~10–20%, carbon monoxide by ~10–40%, and unburned hydrocarbons by ~20–50%, with near-zero sulfur emissions relative to ULSD. Nitrogen oxides (NOx) impacts vary by engine and blend and may range from neutral to ~0–2% increases, but are managed in modern engines equipped with after-treatment systems²³.

BD also improves fuel quality. Even low blends (B2–B5) significantly enhance lubricity, often reducing HFRR wear scar measurements²⁴ by ~30–60%, and modestly increase cetane, helping offset lubricity losses associated with ULSD and protect fuel-system components²⁵. However, BD requires more active fuel management. Cold-flow performance is a key consideration: higher blends can gel in cold conditions without additives or heated infrastructure, though B5–B20 blends are generally manageable in Washington with proper seasonal handling. BD blends can also hold 15–25X more water than ULSD, increasing the risk of microbial growth, oxidation, and filter plugging if storage tanks are not maintained²⁶.

Finally, OEM compatibility sets practical limits²². Most heavy-duty engine manufacturers approve biodiesel blends up to B20, while higher blends may fall outside warranty coverage,

²¹ US Dept. of Energy (AFDC) – ASTM BD Specifications – [Link](#)

²² US Dept. of Energy (AFDC) – Biodiesel – [Link](#)

²³ US Dept. of Energy (AFDC) – Fuel Properties Comparison – [Link](#)

²⁴ ScienceDirect – HFRR – [Link](#)

²⁵ Diesel Technology Forum – Renewable Biofuels – [Link](#)

²⁶ US Dept. of Energy – Biodiesel Basics – [Link](#)

particularly for older engines and fuel-system materials. As a result, B5–B20 represents the lowest-risk, most widely accepted BD pathway for near-term marine applications²⁵.

Current Market Pricing

Average Diesel and B20 closely track each other, with B20 typically priced slightly lower \$3.12/gal vs. \$3.24/gal for diesel as of Apr 2025. In contrast, B99/B100 remains significantly higher at ~\$4/gal, reflecting production costs and limited incentives outside LCFS markets.

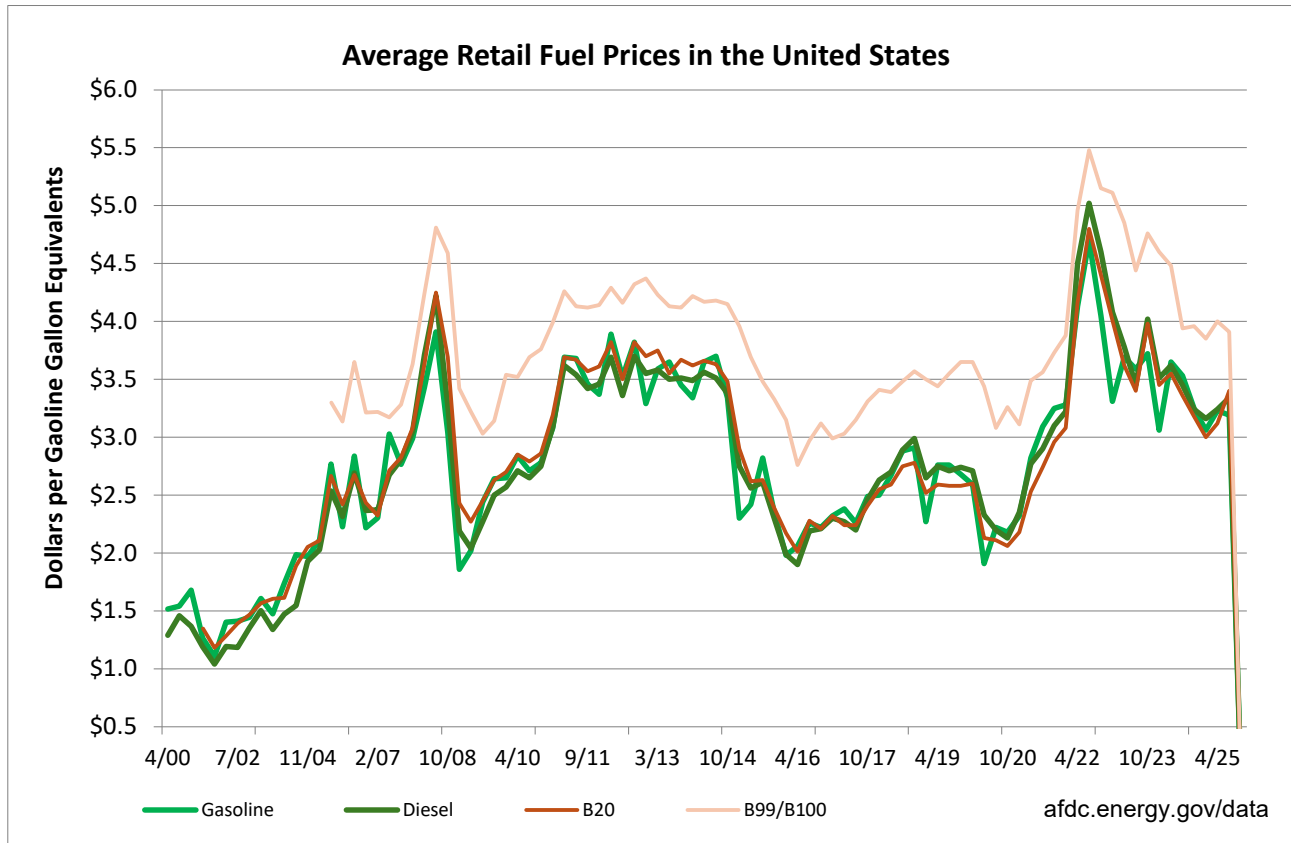


Fig 6: Across the 25-year period, diesel and B20 prices move in near-lockstep, mirroring each other’s volatility and long-term trends. B99/B100, by contrast, consistently sits at a higher price point, reflecting its different production costs and more limited policy support.²⁷

²⁷ US Dept. of Energy (AFDC) – Fuel Prices – [Link](#)

6. Renewable Fuel in Washington State

Fuel Production

Renewable Diesel (RD)

Recent data show that RD production on the West Coast reached over 90,000 bpd²⁸ in late 2024, a volume that, by itself, supplies roughly 45% of the region's RD consumption. The West Coast remains the nation's largest RD market and, due to the presence of strong clean fuel standards (CFS/LCFS), is effectively the only region where RD deployment is consistently economical at scale. These policies, combined with sustained demand for low-carbon diesel across transportation and industrial sectors, continue to concentrate RD production, distribution, and investment in the West Coast market.

Washington

Washington's current RD production is limited but growing, primarily through co-processing at an oil refinery. In 2018, BP's Cherry Point refinery became the first facility in the Pacific Northwest to produce RD by co-processing bio-based feedstocks (like waste vegetable oils and animal fats) alongside crude oil in an existing diesel hydrotreater. This means renewable feedstock is co-mingled with conventional diesel during refining, yielding a fuel identical to regular ULSD but with a lower carbon footprint. BP expanded this initiative in late 2022, doubling Cherry Point's RD output capacity – it can now co-process up to 110 MM gals/yr of RD²⁹. This expansion alone could reduce CO₂ emissions by an estimated 600,000 tons annually (equivalent to removing ~130,000 cars from the road). No other refineries or standalone RD plants in the state are yet producing RD, although converting existing refineries to RD is actively being explored. For example, Phillips 66 and Renewable Energy Group once proposed a new 250 MM gal/year RD facility at Ferndale, WA, but that project was canceled in 2020 due to permitting challenges³⁰. Washington's new Clean Fuel Standard is expected to drive higher demand for RD, and industry watchers have discussed repurposing other Washington refineries to produce RD in the future.

²⁸ Industrial Info Resources – EIA: West Coast RD Production, Consumption on the Rise – [Link](#)

²⁹ Biobased Diesel Daily – BP completes RD coprocessing expansion project in Washington – [Link](#)

³⁰ Fuels Market News – P66 and REG Withdraw Renewable Diesel Project in Washington State – [Link](#)

Nearby Renewable Diesel Sources (Oregon, California, Montana)³¹

Because in-state RD production is limited, Washington can source renewable diesel from nearby states to meet growing demand. Key regional sources include:

- Oregon: Oregon currently has no large-scale RD production of its own. RD consumed in Oregon is largely imported.
- California: California has rapidly become a major RD producer due to refinery conversions. Several petroleum refineries are being converted to make RD and SAF to serve California’s LCFS market and potentially Washington and Oregon. Notably, Phillips 66’s Rodeo refinery and Marathon’s Martinez refinery (near San Francisco) were converted to produce ~1,500 MM gal/yr of RD. These massive projects, along with existing RD plants (like World Energy’s Paramount facility ~45 MM gal/yr), make California a leading RD supplier on the West Coast. RD produced in California could be transported to the Pacific Northwest, provided infrastructure is available to trans-load the fuels to distribution points and users.
- Montana: The Montana Renewables biorefinery in Great Falls, MT is a significant RD source within reach of Washington. This converted petroleum refinery began producing on-spec RD in late 2022. Current production capacity is about 230 MM gal/yr output. Montana Renewables has the advantage of rail connections to the West Coast.
- Other neighboring states also contribute to RD supply. For example, North Dakota’s Dickinson refinery (Marathon) produces ~180 MM gal/yr of RD, and international imports (e.g., Neste from Singapore) arrive at West Coast ports. However, Oregon, California, and Montana are the primary nearby sources specifically noted for Washington’s sourcing, as transport would be cost prohibitive.

³¹ University of Illinois – Updated Estimates of the Production Capacity of US RD Plants Through 2026 – [Link](#)

Table 1. Annual Nameplate Production Capacity (million gallons) of HEFA Renewable Diesel Plants in the U.S., Actual for 2020 - 2023 and Projected for 2024 - 2026

Company	City	State	Starting Year	2020	2021	2022	2023	2024	2025	2026
REG-Geismar LLC	Geismar	LA	2010	100	100	101	100	340	340	340
Diamond Green Diesel LLC	Norco	LA	2013	337	982	982	982	982	982	982
Altair Paramount LLC	Paramount	CA	2016	42	42	42	42	42	42	42
East Kansas Agri-Energy Renewable Dies	Garnett	KS	2017	3	3	-	-	-	-	-
Wyoming Renewable Diesel CO	Sinclair	WY	2018	117	117	117	117	117	117	117
Dakota Prairie Refining LLC	Dickinson	ND	2020	192	192	192	192	192	192	192
Phillips 66 Co	Rodeo	CA	2021	-	120	180	180	800	800	800
Cheyenne Renewable Diesel Company LL	Cheyenne	WY	2021	-	92	92	92	92	92	92
BP Products North America	Blaine	WA	2021	-	66	111	111	111	111	111
Chervron USA Inc	El Segundo	CA	2021	-	31	31	184	184	184	184
Kern Oil & Refining	Bakersfield	CA	2021	-	6	6	6	6	6	6
Diamond Green Diesel LLC	Port Arthur	TX	2022	-	-	537	537	537	537	537
Montana Renewables LLC	Great Falls	MT	2022	-	-	184	184	230	230	230
HF Sinclair Renewables Holding Co LLC	Artesia	NM	2022	-	-	141	141	141	141	141
CVR Renewables Wynnewood LLC	Wynnewood	OK	2022	-	-	121	121	121	121	121
Seaboard Energy Kansas LLC	Hugoton	KS	2022	-	-	85	85	85	85	85
Shell Oil Products U.S.1	Norco	LA	2022	-	-	54	54	54	54	54
Jaxon Energy, LLC	Jackson	MS	2022	-	-	25	25	25	25	25
Martinez Renewables LLC	Golden Eagle	CA	2023	-	-	-	731	731	731	731
St Bernard Renewables	Chalmette	LA	2023	-	-	-	307	307	307	307
Vertex Renewables LLC	Mobile	AL	2023	-	-	-	115	-	-	-
Monroe Energy LLC 1	Trainer	PA	2023	-	-	-	18	18	18	18
US Oil & Refining Co 1	Tacoma	WA	2023	-	-	-	5	5	5	5
Love's Heartwell Renewables	Hastings	NE	2025	-	-	-	-	-	80	80
Total Nameplate Capacity				791	1,751	3,000	4,329	5,120	5,200	5,200

Notes: Production capacity for 2020-2023 is from annual EIA surveys. The date of the surveys is January 1 of each calendar year. We assume that EIA data are as of December 31 of the previous calendar year in order to be consistent with our previous work where we defined capacity as end-of-year. For example, the capacities listed in the table for 2020 are reported by the EIA as of January 1, 2021. Several sources were used for the 2024 - 2026 production capacity estimates, including *Render* and *Biodiesel* magazines, Argus, and other industry sources. If no other data were available, we used the 2023 EIA survey results.

farmdocDAILY

Fig 7: US RD production capacity has expanded rapidly since 2020, with West Coast facilities, including BP Cherry Point and Montana Renewables, emerging as important regional supply sources for the PNW.³⁴

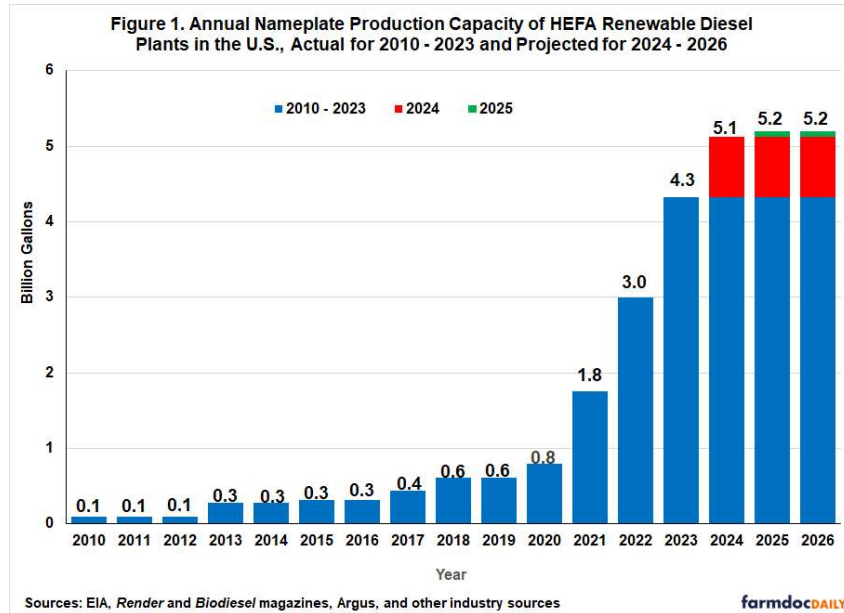


Fig 8: US HEFA RD nameplate capacity has risen sharply since 2020 and is projected to exceed 5 B gal/yr by 2025–2026, driven by refinery conversions and expansions, particularly on the West Coast.³²

Biodiesel (BD)

BD production is far more limited and concentrated. Washington State has been a pioneer in biodiesel production and usage, with significant in-state capacity driven by local agriculture and policy support.

Washington

The state currently has about 107 MM gal/yr of BD production capacity, making it one of the top BD-producing states. The vast majority of this capacity comes from a single large facility: Renewable Energy Group’s Grays Harbor biorefinery (now owned by Chevron). After REG’s acquisition in 2015, production at Grays Harbor increased (reaching ~72 MM gallons in 2016) and REG invested in upgrades. Now under Chevron’s ownership (as of 2022), this refinery is a cornerstone of Washington’s biofuel industry and is strategically located with a deep-water port for both receiving feedstocks and shipping fuel.

Other Major US BD Production Centers

³² University of Illinois – Updated Estimates of the Production Capacity of US RD Plants Through 2026 – [Link](#)

Most US BD production capacity is concentrated outside the Pacific Northwest, particularly in the Midwest and Gulf Coast, where feedstocks (soybean oil, animal fats, used cooking oil) and established logistics support large-scale blending and distribution. The EIA reports total US BD capacity of roughly ~2.0 billion gal/yr (as of Jan 1, 2025), with the largest share in the Midwest (PADD 2).³³

U.S. Biodiesel Plant Production Capacity as of January 1, 2025

PAD District	Number of Plants	Production Capacity	
		(MMgal/yr)	(Mb/d)
PADD 1	9	128	8
PADD 2	28	1,419	93
PADD 3	6	256	17
PADD 4	0	0	0
PADD 5	5	183	12
U.S. Total	48	1,986	130

Biodiesel Production Capacity measures estimated gallons of biodiesel that a plant is capable of producing over a period of one year (365 consecutive days) starting on the first day of each report month.

Fig 9: US BD production capacity by PAD district, showing strong concentration in the Midwest (PADD 2) and Gulf Coast, with comparatively limited capacity in the PNW.

Examples of Key Customers Served from All Sectors

Entity	Usage	Reference
Renewable Diesel		
Port of Seattle	Has used RD in its fleet since 2018; consumed ~40,000 gallons in 2023 across port-owned vehicles and equipment.	Port of Seattle
Port of Tacoma	Switched all port-operated diesel equipment to R99 in May 2024, covering vehicles and material-handling equipment.	Port of Tacoma - News
SSA Marine	Began using RD in drayage and yard equipment in summer 2025 at Terminals 5 and 18. Part of terminal-level clean air commitments.	Clean Air Quarterly
Husky Terminal (Pier 3/4, Tacoma)	Converted its entire cargo-handling fleet to R99 in 2024, reducing lifecycle emissions by ~50% compared to ULSD.	Clean Air Quarterly
WSDOT (Maintenance Division)	Began using RD in Eastern WA maintenance fleets in mid-2023, displacing ~225,000 gallons of fossil diesel that year.	WA DES
King County Water Taxi	Converted both passenger ferries to RD in 2025; each vessel uses ~125,000 gallons annually.	King County Metro
City of Seattle Fleet	Transitioned from BD blends to RD for municipal diesel vehicles by 2023–2024 as a drop-in decarbonization step.	Seattle (Office of Sustainability & Environment)

³³ EIA – US Biodiesel Plant Production Capacity – [Link](#)

City of Tacoma (TPU Fleet)	Committed to R99 as the primary diesel fuel for city and utility fleets, with ULSD only as a backup.	City of Tacoma
(Upcoming) King County Metro (Transit Bus Fleet)	Historically used low BD blends, but is transitioning remaining diesel buses to RD instead.	King County Metro
Biodiesel		
Washington State Ferries (WSF)	All ferries operate on BD blends; used ~1.4 million gallons in 2023 (8–10% blend).	WA DES
WSDOT – (Maintenance & Fleets)	Maintenance and fleet vehicles use BD seasonally; ~250,000 gallons of B100 used in 2023 across non-ferry divisions.	WA DES
Non-WSDOT agencies (e.g., Dept of Corrections)	Small volumes used by agencies such as Corrections, DNR, and WDFW; collectively <5,000 gallons of B100 in 2023.	WA DES
University of Washington	Uses biodiesel blends in diesel fleet vehicles as part of campus sustainability efforts; volumes not disclosed.	University of Washington

Importance of In-State Production for Supply Security

While Washington already supports a growing set of RD and BD end users across public fleets, ports, terminals, and transit agencies, nearly all volumes are currently imported from out-of-state production facilities. This dependence on external supply exposes the market to volatility driven by credit pricing, logistics constraints, and competing demand from California, Oregon, and aviation markets. Establishing in-state renewable fuel production is therefore critical to long-term supply security, reducing delivery risk, improving price stability, and ensuring that Washington’s public and maritime users can reliably access low-carbon fuels as demand scales. Local production would also strengthen the state’s ability to align fuel availability with policy goals, port-led decarbonization strategies, and emergency or resiliency needs.

Fuel Delivery Pathways and Delivery Modes to the Puget Sound

RD and BD can reach Washington through a limited number of delivery pathways, each with distinct implications for cost, reliability, fuel quality, and suitability for marine end use. Unlike on-road markets, where rack access and trucking provide flexibility, marine supply is constrained by bulk transport modes, terminal tankage, and dock-level infrastructure.

Today, there is limited RD or BD use in Puget Sound’s marine sector, which constrains the availability of operational data and real-world marine fueling examples. However, there was broad consensus across distributors and terminal operators that truck-based delivery could

serve as a near-term bridge for early marine demand while rail, barge, and terminal infrastructure develops.

(NOTE: The delivery pathways described below must be understood in the context of limited renewable fuel storage in Seattle, which currently constrains which modes are viable at scale and reinforces reliance on Tacoma-based terminals and interim truck-based solutions.)

Renewable Diesel:

- **Marine tanker and barge deliveries into Tacoma:** Based on interviews and market observations, marine-grade RD entering Puget Sound today primarily flows through Tacoma, which remains the only location with consistent barge and tanker access and meaningful renewable fuel storage.
 - US Oil & Refining can deliver RD into Washington via marine tanker and barge movements to Tacoma-area terminals, enabling bulk volumes appropriate for marine use.
 - Once received at Tacoma terminals, RD is typically redistributed by truck to end users or downstream fueling locations.

This is the most viable for supplying sustained RD volumes, as they support bulk movement, fuel segregation, dyeing, and quality control where dedicated tankage exists.

- **Rail and truck deliveries from inland producers:** Montana Renewables' RD is expected to reach Washington primarily via rail, with secondary truck distribution. These pathways can serve on-road markets and limited marine pilots but face higher delivered costs, constrained offloading capacity, and challenges supplying dyed or marine-specific product at scale. As a result, rail-based RD is generally less reliable for sustained marine fueling unless paired with dedicated terminals and long-term offtake.
- **Multi-modal terminal capability:** Industry interviews indicated that only a small number of terminals in Washington can receive RD by water, rail, pipeline, and truck and then redistribute it across modes, a capability that materially improves supply resilience.
 - TransMontaigne invested in RD infrastructure more than eight years ago and can receive RD by marine tanker, rail, and pipeline, and move product out by truck or water.
 - The terminal is connected to the Olympic Pipeline, allowing commingled ULSD to be blended with RD and redistributed, an advantage not shared by most Seattle-area terminals.

- Large-scale rail access (68 rail spots) allows renewable fuels to be brought into the region even when marine movements are constrained, supporting broader regional redistribution.

These features explain why Tacoma-area terminals function as regional supply anchors, rather than simple point-of-delivery facilities.

Biodiesel:

Rail and truck deliveries into blending facilities: Based on discussions with Chevron REG, BD is delivered primarily by rail and truck into blending facilities, where it is mixed with ULSD or RD for downstream use. These pathways are well established for on-road and terminal equipment markets, but face constraints for marine use. While BD can technically be moved by barge or tanker, this pathway is typically not preferred for marine applications due to BD's hygroscopic nature and sensitivity to water exposure. Operators expressed concern that water contamination during marine transfer or storage could create operational risk for vessels. That said, REG noted that newer BD formulations, with improved cold-flow properties and tighter quality control, are beginning to address historical concerns, suggesting that some of these limitations may ease over time, particularly for controlled, near-shore applications.

Key Limitations and Implications for Marine Users

- **Mode dependence drives reliability:** Marine RD supply remains highly sensitive to terminal availability, tank segregation, and dock access. Disruptions at any point in the chain can quickly translate into supply interruptions.
- **Infrastructure concentration, not demand, defines access:** Bulk renewable fuel access is currently anchored in Tacoma due to terminal capabilities (water, rail, pipeline), not because Seattle lacks demand. Expanding Seattle access depends on midstream investment, permitting outcomes, and demand aggregation rather than upstream production alone.
- **Quality and certification requirements matter:** Maintaining CI eligibility, dye status, and marine-grade specifications requires segregated storage and clear custody chains; commingling across terminals or modes can limit credit eligibility.
- **Cost impacts remain material:** Rail-and truck-based pathways generally result in higher delivered costs to Puget Sound than marine tanker supply, reducing competitiveness for price-sensitive marine operators.

Final Takeaway:

In the near term, marine renewable fuel access in Puget Sound is constrained less by upstream supply than by midstream logistics and terminal capability. Tacoma currently functions as the regional entry point for bulk renewable fuels because it combines marine access, rail, pipeline connectivity, and scale, features that are not as readily available in Seattle today. Early marine adoption in Seattle is therefore most likely to rely on truck-based bridging strategies while longer-term investments in storage, permitting, and dock access are developed.

Assessment of Storage Capabilities at the Ports

Across Puget Sound, storage capacity, not fuel availability, is the primary physical constraint limiting RD and BD use in the marine sector. Existing terminal infrastructure in Seattle is largely optimized for ULSD, with little to no spare tankage available for renewable fuels. Terminal operators consistently reported that tanks are fully utilized, and in some cases, ULSD throughput is increasing, further reducing flexibility to repurpose storage without displacing existing business.

Renewable Diesel:

In Seattle specifically, stakeholders indicated that there is effectively no dedicated RD or BD tankage available today. Most tanks are committed to ULSD or other refined products, and operators are reluctant to convert tanks without clear, long-term demand signals. Tank conversion is not a simple switch: it requires cleaning, inspection, downtime, and sometimes equipment upgrades, introducing cost, operational risk, and lost revenue. As a result, conversion is rarely pursued without multi-year, bankable offtake commitments.

Interviews with major fuel suppliers reinforce this point. One supplier noted that while it operates terminal assets on Harbor Island, those assets face tankage and dock-side constraints, and that any meaningful expansion of RD storage in Washington would require aggregated demand of roughly ~5 MM gals/yr sustained over multiple years (ideally five or more) to justify investment. Even with demand certainty, stakeholders emphasized that new

or converted tankage typically requires 18–36 months to permit, followed by additional time for construction and commissioning.

Given these constraints, Tacoma currently hosts the primary terminals in Puget Sound with renewable fuel storage at scale, while Seattle remains dependent on secondary logistics and midstream redistribution. This dependence adds cost, reduces reliability, and limits the ability to scale marine fueling in Seattle without new storage investment.

Biodiesel:

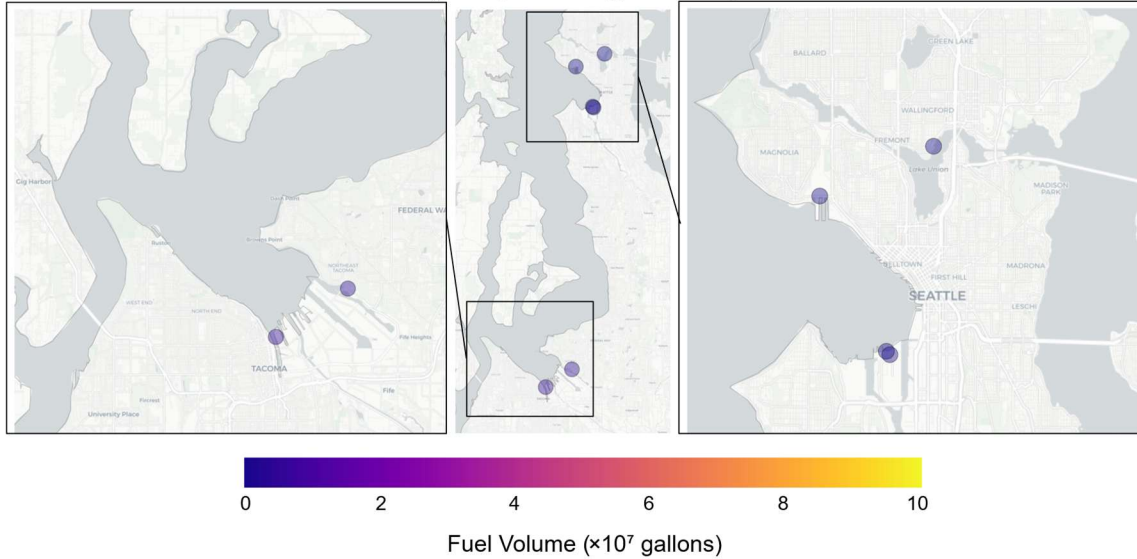
For BD, storage challenges are further shaped by water-management considerations. While BD quality has improved, including better fuel stability, most operators remain cautious about dedicating waterfront tankage to higher BD blends without clear operational boundaries and sustained demand.

Final Takeaway:

Current RD and BD use in the Puget Sound marine sector remains limited, which constrains the availability of empirical storage data. Despite this, stakeholders universally agreed that truck-based delivery can serve as a practical near-term bridge, enabling early adoption while longer-term investments in storage, rail access, and dock infrastructure are permitted and developed. Ultimately, the lack of renewable fuel tankage in Seattle reflects a market-signal and risk-allocation challenge rather than a technical limitation: without aggregated demand and greater permitting certainty, suppliers are unwilling to absorb the cost and risk associated with new or converted storage.

Fueling Facilities in the Seattle-Tacoma Region

Renewable Diesel
(per Dept. of Ecology ANT Data)



Fueling Facilities in the Seattle-Tacoma Region

Ultra Low Sulphur Diesel
(per Dept. of Ecology ANT Data)

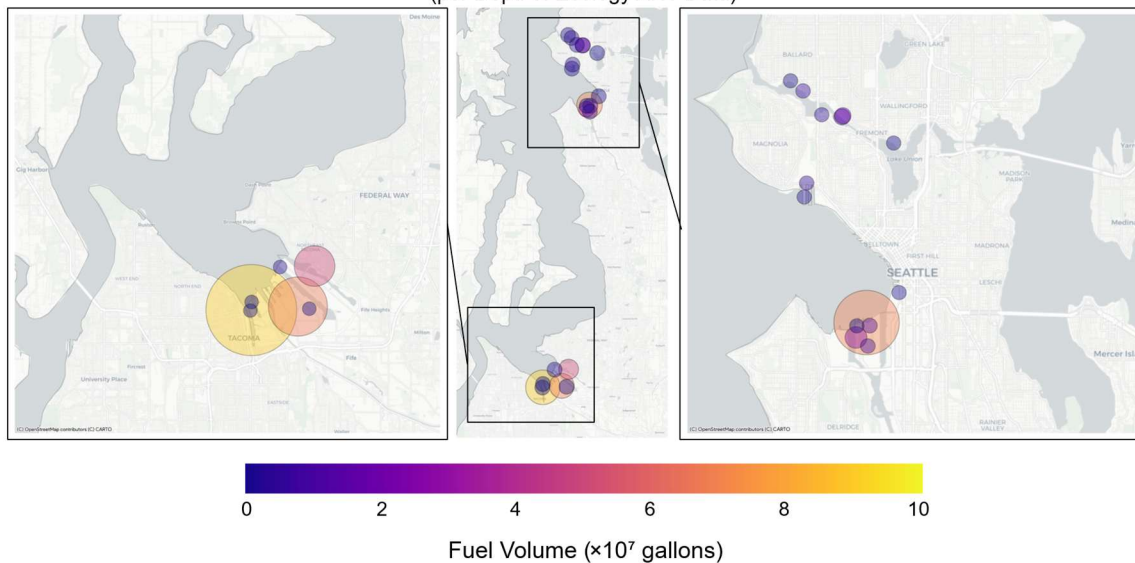


Fig 10 (A & B): These maps illustrate RD (top) and ULSD (bottom) fueling facilities in the Seattle–Tacoma region using Washington Dept. of Ecology ANT data. The ULSD map highlights the location, scale, and concentration of existing diesel fueling infrastructure that currently serves maritime and industrial users. Since RD is a drop-in fuel compatible with the same tanks, terminals, barges, and delivery systems, the ULSD distribution provides a reasonable proxy for the volume of fossil diesel that could be technically and operationally displaced by renewable diesel over time, subject to supply availability, pricing, and policy conditions.

Assessment of Fueling Capabilities at the Terminals

Seattle (Port of Seattle – North Harbor)

Harbor Island Fuel Terminals (Core Regional Hub)

- The primary fuel storage and distribution hub for Seattle and much of Puget Sound.
- Major terminals include:
 - Shell
 - Kinder Morgan
 - TransMontaigne (BP-associated assets)
- Combined infrastructure supports:
 - Gasoline
 - ULSD (marine gas oil)
 - Biodiesel blends
 - Limited renewable diesel (RD)
 - Jet fuel / SAF blends
- Example scale:
 - TransMontaigne Seattle terminal (1652 SW Lander St): ~710,000 barrels of storage.
- Supply modes: Olympic Pipeline, Marine tanker and barge, Rail, Truck
- Key constraint: Terminals are effectively ~100% utilized, with little or no idle tankage.
 - New fuels must displace existing products or require new tank construction.
 - New tank construction is constrained by land availability and permitting.

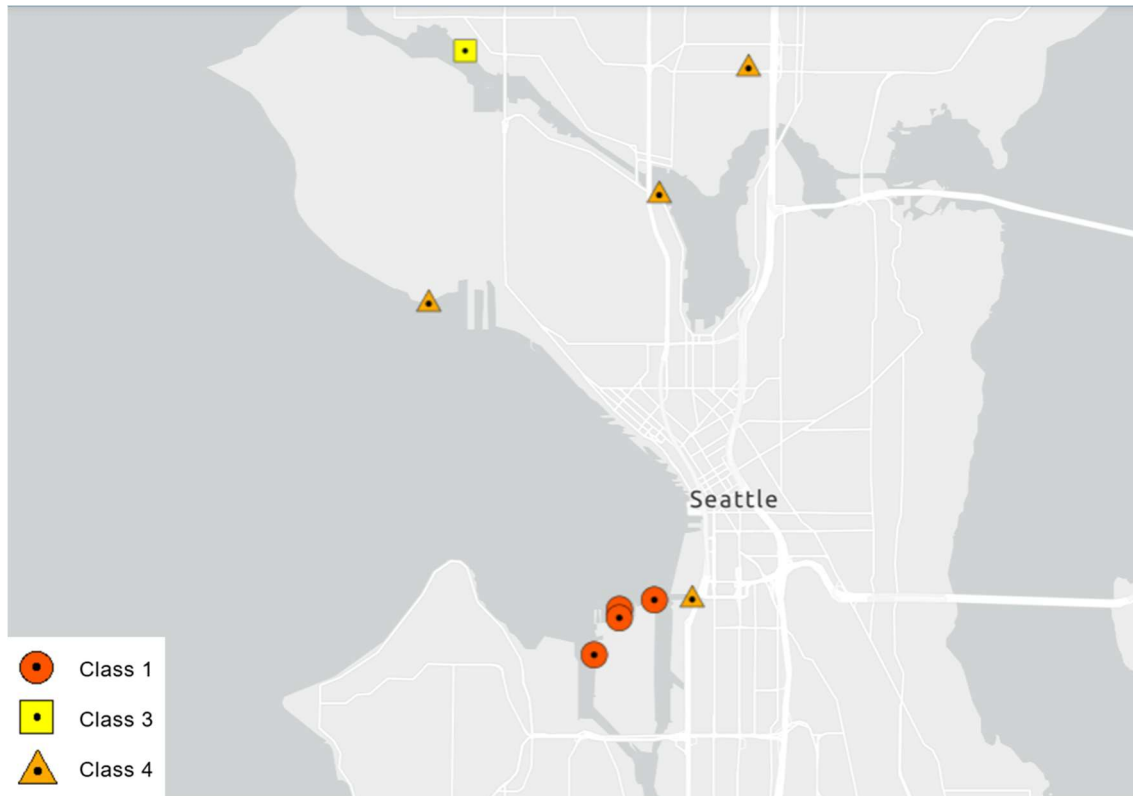


Fig 11: Oil-Handling Facilities by Class in the Seattle Harbor Area³⁴

Map showing the distribution of regulated oil-handling facilities by class around Seattle.

- Class 1: Large, fixed shore-side terminals and refineries are concentrated along the Duwamish and industrial waterfront.
- Class 3: Small tank farms and terminals serving non-recreational vessels $\geq 10,500$ gallons.
- Class 4: Marinas and small fueling facilities $< 10,500$ gallons are dispersed along the working waterfront.

Oil-Handling Facilities by Class in the Seattle Harbor Area:

- Class 1:
 - Kinder Morgan Liquids Terminal - Harbor Island
 - Maxum Petroleum - Pier 15 Facility
 - SeaPort Seattle Terminal (TLP)
 - Shell Oil LP Seattle Distribution Terminal

³⁴ WA Department of Ecology – Spills Maps – [Link](#)

- Class 3:
 - Covich Williams Co Inc
- Class 4:
 - Seattle Boat Company (Lake Union Fuel Dock)
 - Elliott Bay Fuel Dock
 - Morrison's North Star Marina
 - USCG Integrated Support Command

Fuel Blending & Renewable Fuel Capability (Seattle)

- Existing terminals support biofuel blending into diesel, including:
 - FAME biodiesel blending (e.g., B5–B20).
 - Automated rack blending (e.g., TransMontaigne “Dial-A-Blend” system).
- Renewable Diesel (RD):
 - Technically compatible with existing diesel infrastructure.
 - No dedicated large-scale RD tanks currently in Seattle.
 - RD use today is limited, and often trucked for specific deliveries.
 - Dependent on temporary tank repurposing or segregated batches.
- Current marine diesel bunkers are predominantly:
 - Petroleum ULSD
 - With small BD blends
- Infrastructure could support greater RD volumes if dedicated tank space were made available.

Marine Bunkering Operations (Seattle)

Seattle does not have permanent on-dock bunker fuel storage at cargo or cruise terminals as bunkering is conducted via barge-to-ship transfers, supplied from Harbor Island terminals.

Key bunkering locations include:

- Terminal 18 (containers; pipeline/manifold access)
- Terminal 5 (containers)
- Terminal 91 (cruise)
- Fuel service providers include:
 - World Fuel Services (Rainier Petroleum)
 - Vane Brothers

- Centerline Logistics (formerly Harley Marine)
- Post-2020 sulfur regulations:
 - Heavy fuel oil (HFO) largely phased out.
 - Bunkers are primarily 0.1% sulfur MGO and 0.5% VLSFO, where available.
- Kinder Morgan is noted as a location capable of blending and supplying bunker-grade fuels.

Smaller & Specialized Seattle Marine Fuel Facilities

- Covich-Williams & Ballard Oil (Salmon Bay / Ballard):
 - Serve fishing vessels, tugs, and workboats.
 - Small tank farms (diesel, gasoline).
 - No RD or alternative fuels stored on-site.
- PTL Marine (Harbor Island):
 - Modest storage (~1 million gallons).
 - Barge-capable dock.
 - Ship to ship bunkering for market that's smaller than cruise and cargo vessels.
 - Supplies ULSD, MGO, and advertised RD99 availability in limited volumes.

Distribution System & System Constraints (Seattle)

- Seattle terminals are integrated into the Olympic Pipeline system, linking:
 - Puget Sound refineries
 - Tacoma
 - Portland
- Terminals also serve:
 - Regional trucking markets
 - Gas stations
 - Commercial customers
- Key constraint for marine fuels:
 - Intense competition with on-road fuel demand.
 - Marine fuels must compete for the same tankage, racks, and logistics capacity.
- Result: Limited flexibility to introduce new marine fuel streams without displacing existing demand.

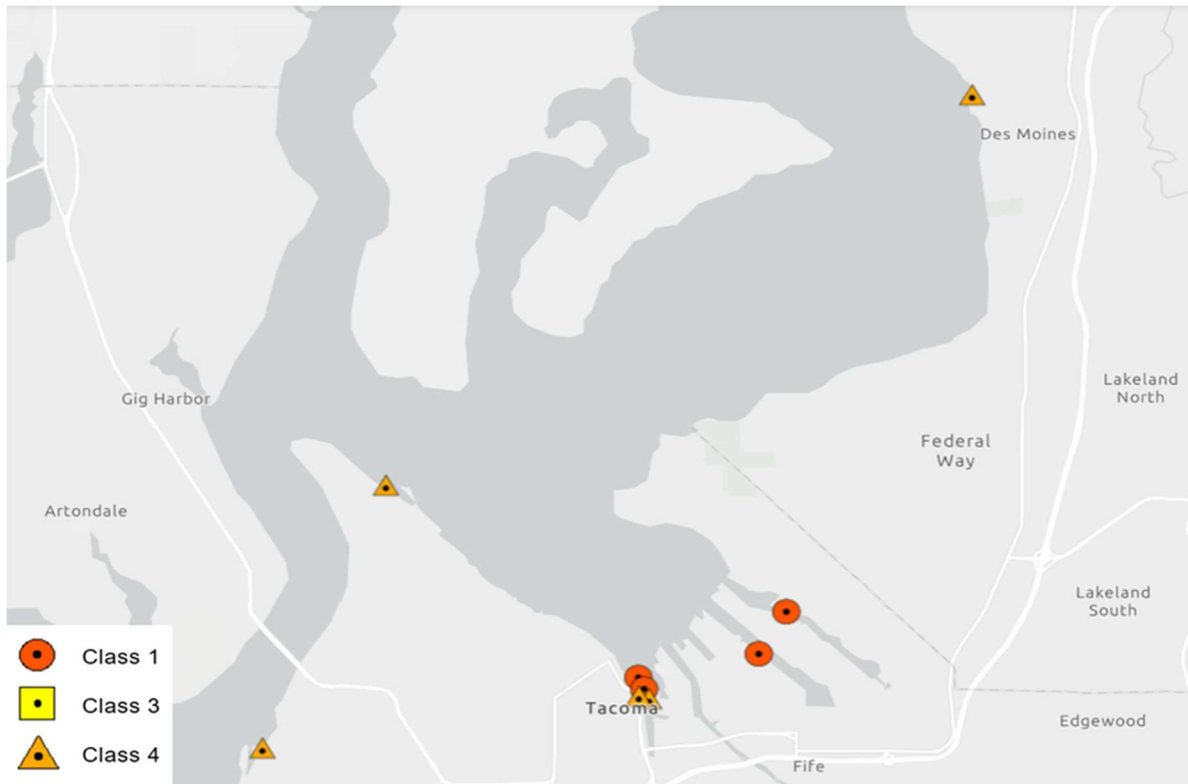
Physical & Regulatory Constraints (Seattle)

- Harbor Island is effectively the only viable location for new deepwater fuel infrastructure.
- Major constraints include:
 - Lack of available land
 - Brownfield contamination at other terminals
 - Fire code and safety concerns
 - Seismic regulations
 - Proximity to residential areas
- Implication:
 - New fuel pilots may require:
 - Temporary or barge-based storage
 - Small-scale installations
 - Repurposing of existing tanks with strong offtake commitments

Tacoma (NWSA South Harbor) Fuel Infrastructure

Seaport Sound Terminal (Primary South Sound Bunker Hub)

- Located in Tacoma Tideflats (Blair Waterway).
- Storage capacity: ~1.48 million barrels.
- Handles:
 - ULSD / MGO
 - Renewable Diesel
 - Biodiesel (FAME)
 - Ethanol
 - Marine fuel oils (LSFO, limited HSFO)
- Multimodal access:
 - Olympic Pipeline
 - Rail (unit trains)
 - Deepwater marine berths
 - Truck loading
- One of the only Puget Sound facilities with integrated RD handling at scale.
- Utilization remains high (~90%), but limited flexibility exists for pilots with committed demand.



12: Oil-Handling Facilities by Class in the Tacoma Harbor Area³⁴
(for details on facility classifications, see Fig. 10)

Oil-Handling Facilities by Class in the Seattle Harbor Area:

- Class 1:
 - Nustar Energy Tacoma
 - Phillips 66 Tacoma Terminal
 - U.S. Oil & Refining
 - SeaPort Sound Terminal
- Class 4:
 - Point Defiance Boathouse
 - Narrows Marina
 - City of Des Moines Marina
 - Tacoma Fuel Dock (CommBay)
 - Foss Harbor Marina

Par Pacific Tacoma Refinery

- ~40,000 bpd petroleum refinery adjacent to Seaport Sound.
- Supplies diesel suitable for marine use.
- Strong integration with port fuel ecosystem.
- Long-term potential:
 - Co-processing or RD production could significantly increase local RD availability.
 - Currently focused on conventional fuels.

Tacoma Bunkering & Alternative Fuels

- Most Tacoma bunkering occurs via barges loaded at Seaport Sound.
- Key bunkering locations:
 - Husky Terminal (Pier 4)
 - Blair and Sitcum Waterway terminals
- Unique asset:
 - TOTE LNG bunkering system at Pier 3.
 - Demonstrates feasibility of alternative fuel infrastructure when demand is firm.
- Tacoma frequently supplies specialty fuels to Seattle via barge.

Expansion Potential (Tacoma)

- More headroom than Seattle for future fuel infrastructure:
 - West Hylebos identified as a strong candidate for renewable fuel tankage.
 - Rail and waterfront access are available.
- Port governance has experience with:
 - Petroleum leases
 - Public-private partnerships
- Tacoma is likely to be:
 - An early pilot location for renewable marine fuels
 - A supply backstop for Seattle-based pilots

Analyzing Over the Water Fuel Movement

Washington’s use of RD and BD has grown over the past several years, but these fuels still represent only a small share of the state’s total distillate pool. The tables below summarize statewide fuel volumes as well as Puget Sound marine fuel volumes from 2022 through 2025 (YTD), showing how much ULSD, marine diesel, RD, and BD were moved over-the-water to marine vessels in Washington and the Seattle–Tacoma ports. This view helps illustrate the recent expansion of RD deliveries, particularly into Puget Sound. Together, these datasets provide the baseline for evaluating renewable fuel availability today and the potential impact of different RD-adoption scenarios on harbor-craft emissions.

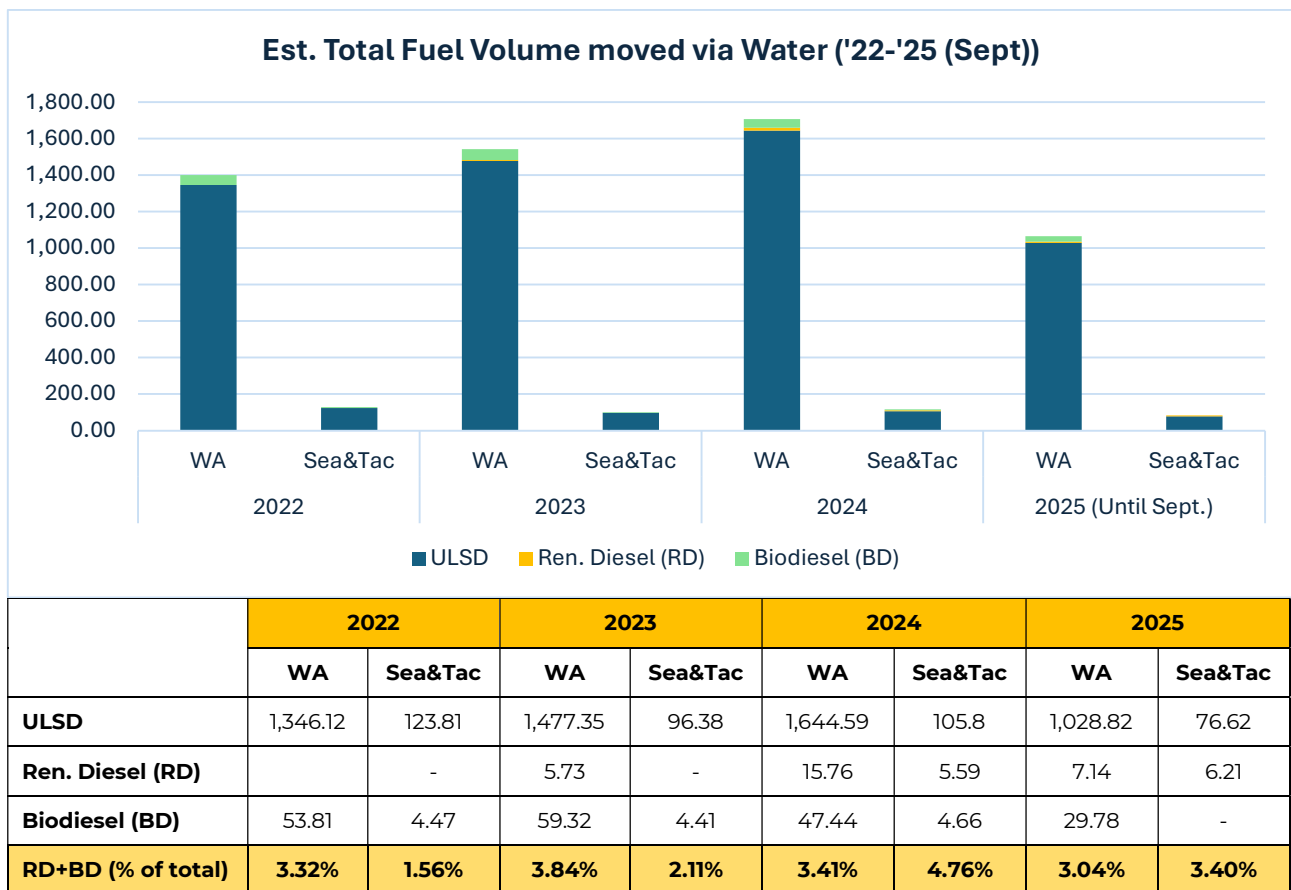


Fig 13: Est. Total Fuel Volume moved via Water (2022-25 (Sept)). RD and BD remain a very small share of Washington’s distillate pool, under 4% statewide and 3–4% in Seattle–Tacoma, highlighting how limited

In 2025 (YTD), 17% of all RD and 99% of all BD in WA went to Umatilla, Oregon. A big reason those volumes go to Umatilla, OR is that it’s a regional petroleum distribution hub on the Columbia River with multi-modal connectivity (river barge + rail + truck + pipelines +

storage)³⁵. Renewable fuels often get received, stored, and/or blended there and then re-dispatched into Eastern OR, Eastern WA, and ID as finished product. The Port itself describes having a petroleum distribution complex with road/rail/river connectivity.

Tidewater Terminal Company is the key operator tied directly to the Port of Umatilla’s petroleum logistics:

It owns and operates the Port of Umatilla Dock for shipping/receiving petroleum products and notes pipelines connecting the wharf to multiple storage tanks (including one tank owned by Union Pacific Railroad)³⁵.

It also operates petroleum pipelines in Umatilla, OR (and Pasco, WA), consistent with Umatilla’s role as a distribution node³⁶.

RENEWABLE DIESEL	2022	2023	2024	2025 (Until Sept.)
Washington	-	5.73 M	15.76 M	7.14 M
Seattle & Tacoma	-	-	5.59 M	6.41 M
Sea & Tac as % of Total	-	-	29.37%	66.98%

Fig 14: Puget Sound RD deliveries are rising sharply – up ~10% YTD and on pace for ~8.5M gallons in 2025 (a 51% YoY increase) – even as statewide RD volumes are expected to fall 38% from 2024, highlighting a growing regional concentration of renewable diesel use in Seattle and Tacoma. Error! Bookmark not defined.

BIODIESEL	2022	2023	2024	2025 (Until Sept.)
Washington	53.81 M	59.32 M	47.44 M	29.78 M
Seattle & Tacoma	4.47 M	4.41 M	4.66 M	-
Sea & Tac as % of Total	8.31%	7.44%	9.81%	0.00%

Fig 15: BD volumes in the Puget Sound remained essentially flat from 2022 to 2024 before falling sharply in 2025

Across Washington, RD and BD remain under 4% of all distillate fuel, underscoring how limited market adoption remains. But Puget Sound is beginning to emerge as a regional hub: RD deliveries into Seattle–Tacoma increased sharply in 2024–25, reaching nearly 67% of all RD delivered in the state YTD 2025. At the same time, this year, nearly all BD is diverted to Umatilla, OR. Combined, the tables show a system at an early stage of transition, where RD availability is improving locally, but renewable fuels remain far from displacing the dominant ULSD and marine diesel pools.

³⁵ Port of Umatilla – Resources – [Link](#)

³⁶ Tidewater – Pipeline Safety – [Link](#)

7. Strategic Alignment with Port Climate and Clean Air Goals

Northwest Ports Clean Air Strategy (NWPCAS) and Maritime Climate Air Action Plan (MCAAP) establish a clear trajectory for the maritime sector: deep emissions reductions by 2030 and a full phase-out of seaport-related emissions by 2050. Achieving these goals will require a combination of long-term zero-emission technologies and near-term, scalable actions that can be deployed across today's fleet. Within this framework, RD and BD play a defined enabling role, providing immediate emissions reductions from existing harbor craft while infrastructure, supply chains, and vessel technologies necessary for a zero-emission maritime sector continue to mature. This assessment, therefore, focuses on understanding how RD and BD can be effectively integrated into Washington's commercial harbor craft sector as a practical step toward meeting the Port's 2030 targets and maintaining alignment with its 2050 net-zero vision.

Northwest Ports Clean Air Strategy (2020)⁵

The NWPCAS is a joint, voluntary strategy adopted by the Port of Seattle, Port of Tacoma, Northwest Seaport Alliance, and the Vancouver Fraser Port Authority to align regional action on seaport-related air pollution and greenhouse gas emissions. The Strategy sets a shared regional vision to phase out emissions from seaport-related activities by 2050, supporting cleaner air for local communities and contributing to global efforts to limit warming to 1.5°C.

NWPCAS recognizes that achieving this 2050 vision requires a phased transition: near-term progress through efficiency and emissions reductions in existing fleets, paired with coordinated planning and investment to enable broad deployment of zero-emission technologies. The Strategy emphasizes that low-emission electricity and alternative fuels are critical, so emissions are not simply shifted elsewhere in the lifecycle.

Role of biofuels in NWPCAS: NWPCAS explicitly identifies drop-in fuels like renewable diesel as a near-term mechanism to reduce tailpipe emissions using existing engines, while the region builds toward the longer-term 2050 zero-emission transition.

Key Highlights:

- Establishes regional alignment on emissions goals and a shared decarbonization framework across ports.
- Anchors the long-term objective to phase out seaport-related emissions by 2050, consistent with a 1.5°C trajectory.
- Emphasizes interim actions, efficiency, fleet modernization, and enabling infrastructure, needed to stay on course before 2030.
- Positions interim fuels (including RD/BD) as near-term tools to reduce emissions from existing equipment and vessels while zero-emission technologies mature.
- Embeds community health, equity, and climate urgency into port decision-making.
- Guides coordinated planning and investment in zero-emission-ready infrastructure and commercialization pathways before 2050.

Charting the Course to Zero: Maritime Climate & Air Action Plan³⁷

Charting the Course to Zero is the Port of Seattle’s implementation plan to address climate change and air pollution from maritime sources, and to operationalize both the Port’s Century Agenda targets and the NWPCAS 2020 Strategy vision to phase out seaport-related emissions by 2050. The Plan is designed to deliver measurable reductions over the next decade while maintaining a clear trajectory toward a zero-emission maritime sector by mid-century.

MCAAP reinforces the Port’s interim and long-term decarbonization milestones, including a goal to cut emissions in half by 2030, and a long-range commitment to decarbonize maritime activity and make Port operations carbon neutral or carbon negative by 2050, while also reducing Port-influenced (Scope 3) emissions substantially by 2050. The Plan also clarifies that most maritime emissions are not directly controlled by the Port: Maritime Activity sources account for the vast majority of emissions, requiring collaboration with tenants and industry partners to achieve the 2030 and 2050 targets.

Role of biofuels in MCAAP: The Plan recognizes that while zero-emission pathways are still emerging for many maritime applications, near-term emissions reductions must come from

³⁷ Port of Seattle – Charting the Course to Zero (MCAAP) – [Link](#)

strategies deployable in the existing fleet. This is where renewable fuels and other interim measures support progress toward the 2030 targets while enabling infrastructure and zero-emission vessel technologies develop.

Key Highlights:

- Converts high-level Port climate goals into sector-specific strategies across Scopes 1–3, consistent with a 2030 interim target to cut emissions by half.
- Reinforces the long-term objective to decarbonize maritime activity and achieve carbon-neutral or carbon-negative operations by 2050.
- Aligns Port implementation with the NWPCAS regional framework and its 2050 phase-out vision.
- Embeds equity and near-port community health considerations into maritime decision-making.
- Identifies funding pathways, partnerships, and enabling policies required for delivery.
- Recognizes that the Port must work through collaboration to reduce Port-influenced emissions (Scope 3), since most maritime emissions occur in assets the Port does not own.

8. Prior Analyses and Market Context for Harbor Craft Decarbonization

This section summarizes prior analyses and stakeholder insights that inform the assumptions, boundaries, and strategic framing of this assessment. It draws primarily on *Advancing Zero-Emission Fuels in Washington’s Shipping Sector: Roadmap to 2050* and past Port-led interviews to provide context on long-term maritime decarbonization pathways, relative fuel roles, and anticipated infrastructure and market constraints. These sources help distinguish what is technically and commercially feasible today from longer-term transition pathways, and clarify how interim fuels such as RD is positioned within broader 2030 and 2050 decarbonization trajectories. While these works do not prescribe outcomes for harbor craft, they provide essential reference points for evaluating near-term opportunities and gaps.

Advancing Zero-Emission Fuels in WA’s Shipping Sector: Roadmap to 2050

A state-level roadmap developed by RMI and partners that focuses primarily on decarbonizing ocean-going vessels (OGVs) calling at Washington ports in alignment with International Maritime Organization (IMO) targets. The report defines zero- or near-zero-emission fuels (ZEFs) as those capable of achieving at least a 90% lifecycle GHG reduction and evaluates candidate fuels based on emissions performance, scalability, cost, and commercial readiness through 2050.

The roadmap positions Washington’s ports as potential early ZEF bunkering hubs by 2030 and anticipates a fully decarbonized shipping fuel system by mid-century, with interim adoption targets beginning this decade.

Key Highlights

- Establishes a pathway for Washington ports to support net-zero maritime fuel use by 2050, consistent with IMO goals.
- Prioritizes e-methanol and e-ammonia as the most scalable long-term fuels for deep-sea shipping.

- Recognizes that early ZEF deployment must begin by 2030 to remain competitive and policy-aligned.
- Emphasizes coordinated port planning, early infrastructure investment, and alignment with global fuel supply chains.
- Differentiates fuel pathways for OGVs versus harbor craft, acknowledging distinct operational and technical constraints.

Role of Biofuels in the RMI Roadmap

While the RMI roadmap is primarily focused on long-term zero-emission fuels for ocean-going vessels, it recognizes a limited but key role for biofuels within the broader maritime energy transition. Conventional biofuels (e.g., FAME biodiesel and fuels derived from fats, oils, and grease) are acknowledged as being used today to achieve partial emissions reductions, but are not considered scalable or sufficient for full maritime decarbonization and are therefore excluded from core zero-emission fuel pathways. Second-generation biofuels, including bio-methanol and bio-LNG derived from waste and residue feedstocks, are identified as having potential to deliver high lifecycle emissions reductions in the near- to medium-term, but face constraints related to feedstock availability, cost, and commercial maturity. The roadmap emphasizes that competition for sustainable biomass across sectors, including aviation, materials, and carbon removal, will limit the long-term role of biofuels in global maritime fuel supply. At the same time, it notes that bio-methanol and bio-LNG are chemically identical to their fossil and e-fuel counterparts, allowing them to leverage the same vessels and bunkering infrastructure where supply is available.

Previous Report: Port of Seattle Commercial Harbor Craft Decarbonization

The previous Port of Seattle–commissioned study engaged 13 commercial harbor craft operators across tug, fishing, tourism, and shipyard segments to assess decarbonization pathways, with a primary focus on electrification and hybridization and a secondary lens on alternative fuels. The study found strong interest in hybrid and electric vessels, particularly for short, predictable routes, but identified significant constraints related to battery size, vessel power requirements, capital costs, charging standards, grid capacity, and permitting. Operators broadly viewed renewable diesel (RD) and biodiesel (BD) as practical, low-disruption, near-term options, especially while planning hybrid or electric transitions or

operating vessels with long replacement cycles. Overall, the study concluded that while electrification and hybridization represent the long-term direction for harbor craft decarbonization, RD and BD can play a complementary, transitional role in delivering immediate emissions reductions where zero-emission solutions are not yet technically or economically feasible.

Stakeholder Insights from Prior Industry Engagement

Interviews with vessel operators, shipyards, fuel suppliers, port authorities, and regulators across the Pacific Northwest reinforced that no single pathway could decarbonize the maritime sector. Hybrid vessels are gaining rapid traction and can deliver meaningful near-term fuel savings, while full electrification remains limited by battery constraints, charging infrastructure, and regulatory requirements. Renewable diesel emerged as the fastest and lowest-risk near-term decarbonization option, offering strong emissions reductions without operational changes, but its availability in Washington is constrained by competition from California and other sectors. Biodiesel is viewed as useful but operationally inconsistent, methanol as the most promising long-term liquid fuel requiring major infrastructure investment, and hydrogen, ammonia, and LNG/RNG as longer-term or niche solutions facing safety, policy, and maturity challenges. Collectively, these interviews underscore that near-term progress will rely on hybrids and drop-in fuels like RD, while long-term decarbonization depends on coordinated infrastructure development, policy alignment, and technology maturation.

Key Takeaway

Maritime decarbonization will require a portfolio of solutions applied over time, as no single fuel or technology can meet the sector's diverse operational needs. Electrification, particularly through hybrid vessels, offers meaningful near-term emissions reductions where feasible, but remains constrained by vessel power requirements, charging infrastructure, grid capacity, and cost. In this context, renewable fuels play a critical near-term role.

RD represents the fastest and lowest-disruption pathway to reduce emissions across the existing fleet, even as supply limitations and competition from other sectors constrain long-term scalability. Biodiesel can contribute to specific applications but presents operational and reliability challenges at higher blends.

Over the longer term, fuels such as methanol, hydrogen, and ammonia may support deeper decarbonization but will require significant investment in vessels, infrastructure, and regulatory frameworks before broad deployment. Taken together, the evidence underscores that near-term progress in Washington’s maritime sector will depend on expanding access to renewable fuels, while longer-term success hinges on coordinated infrastructure development, policy alignment, and technology maturation.

9. RD & BD Policy Landscape Analysis

Federal Renewable Fuels Standard

The Renewable Fuel Standard (RFS) is a federal market-based policy established under the Energy Policy Act of 2005 that requires a certain percentage of petroleum in fuels to be reduced or replaced. Expanded by the Energy Independence and Security Act of 2007, the goal of the program is to enhance energy security, support rural agricultural development and the renewable fuels industry, and reduce greenhouse gas emissions.

The program works by requiring obligated parties to demonstrate compliance by retiring Renewable Identification Numbers (RINs), which can be bought and sold in the independent market. Each year, the EPA sets a renewable volume obligation (RVO) based on projections of production volumes. Each fuel is assigned a “D-code” which confirms its feedstock, fuel type, energy inputs, GHG reduction, and other notable identifiers.

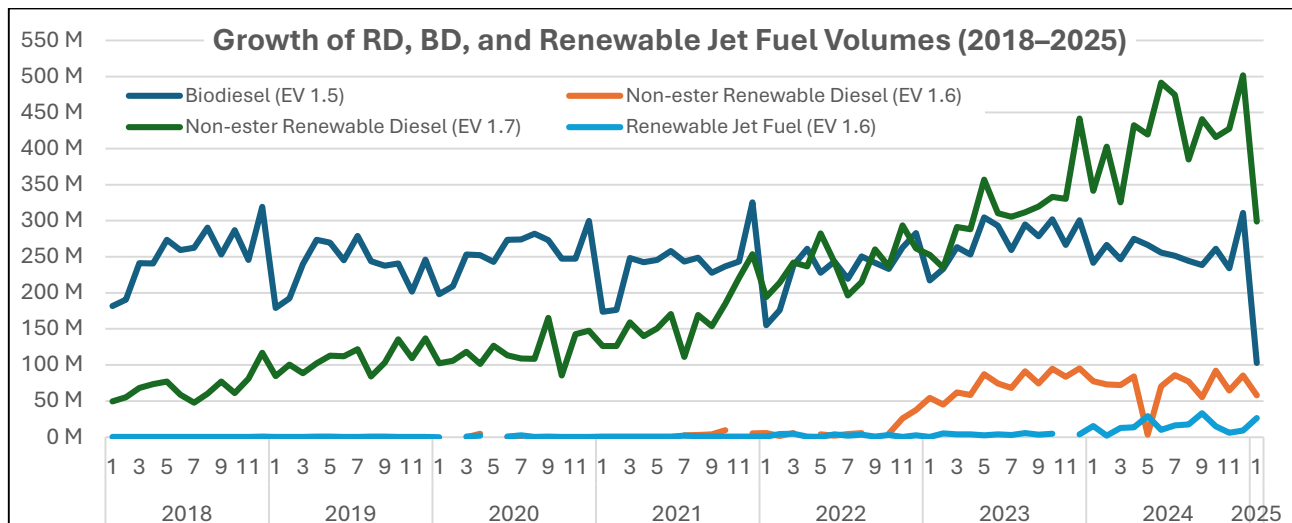


Fig 16: Growth of Renewable Diesel and Biodiesel Volumes Over Time. RD volumes have grown rapidly since 2021, outpacing BD and capturing an increasing share of total renewable fuel supply, highlighting strong market momentum toward drop-in fuels and intensifying competition for limited renewable molecules across sectors.

Clean Fuel Standard (CFS)

Overview:

Clean Fuel Standards are state-level, market-based policies designed to reduce the carbon intensity of transportation fuels over time by requiring fuel suppliers to gradually shift toward lower-carbon alternatives. These programs create tradable credits that reward fuels with lower lifecycle emissions and serve as a primary mechanism for scaling renewable diesel, biodiesel, and other low-carbon fuels. Today, several states have implemented Clean Fuel Standards, including California (LCFS), Oregon (CFP), Washington (CFS), and New Mexico (CTFP), while a growing number of states, including New York, Minnesota, Illinois, Michigan, New Jersey, Massachusetts, Vermont, and Hawaii, have been evaluating and debating programs. Beyond these states, others are actively studying CFS-like approaches, often modeled on California’s Low Carbon Fuel Standard or Washington’s Clean Fuel Standard, as part of broader climate and transportation decarbonization strategies. While not all proposed programs will advance on the same timeline or with the same stringency, the overall trajectory points toward continued expansion of clean fuel standards nationwide, particularly in states with aggressive climate goals, large transportation fuel demand, or strong regional policy alignment.

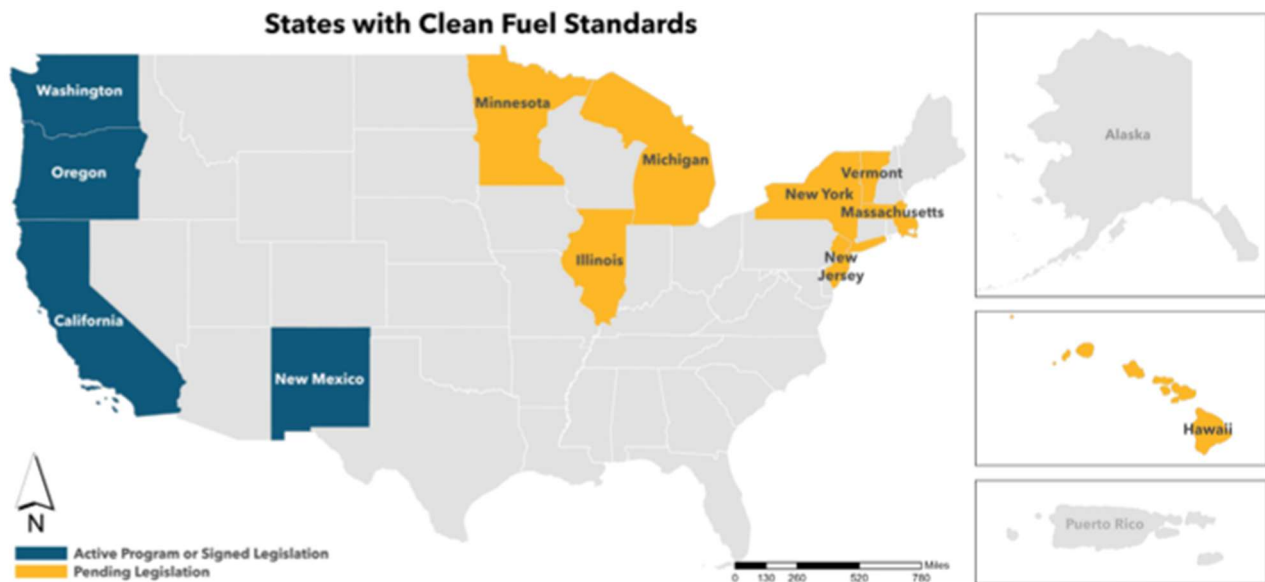


Fig 17: US states with active or pending clean fuel standards, highlighting the expanding adoption across the country.³⁸

³⁸ California Air Resources Board – California Low Carbon Fuel Standard Regulatory Update – [Link](#)

Impact of CFS Expansion on Low-Carbon Fuel Markets:

As more Clean Fuel Standards come online, demand for low-carbon fuels is expected to increase significantly. For Washington’s CFS to be successful a strong, stable, predictable credit market with clear demand signals and reliable supply are necessary to remain on track for its net-zero goals. Strong clean fuel policies provide producers with long-term confidence to invest in new refining capacity and distributors respond to the demand signals by preparing for distribution and storage capacity. The existence of this market helps scale production and, over time, has shown to reduce the cost of cleaner fuels. CFS markets, when credit prices are competitive, also influence where producers allocate limited low-carbon fuel supply: states with stronger, more certain credit markets tend to attract the cleanest, lowest-carbon fuels first. With more mature programs to the south in OR and CA and to the north in BC, Washington risks being outbid and receiving smaller or less consistent volumes. One of the future imperatives is to attract renewable fuel production to Washington to supply the state’s demand and support state CFS policies in reaching net-zero.

Washington’s Clean Fuels Standard (CFS)³⁹

Washington’s CFS, first passed in 2021 by HB1091 and implemented in 2023, is a market-based policy requiring fuel suppliers to gradually reduce the carbon intensity (CI) of transportation fuels. The program was strengthened by HB1409 in 2025, raising the 2038 target from a 20% to a **45% CI reduction below 2017 levels**, signaling a more aggressive push toward low-carbon alternatives⁴⁰. Modeled after California’s LCFS and Oregon’s CFP, the CFS uses a credit system. Fuels with CI above the annual limit generate deficits, while lower-CI fuels such as BD, RD, ethanol⁴¹, and electricity generate credits. Suppliers must balance deficits by either reducing fuel CI or purchasing credits. CI is measured using Argonne National Laboratory’s GREET model, and certain exempt sectors, including maritime, aviation, and rail, may opt in to generate credits under specific program provisions (CFP Rule: Chapter 173-424 WAC adopted October 20th 2025).⁴²

As CI targets tighten, demand naturally shifts toward cleaner fuels. California’s LCFS illustrates this progression: after launching in 2011, RD grew from nearly nonexistent

³⁹ Washington Dept of Ecology – Clean Fuels Standard – [Link](#)

⁴⁰ Stillwater Publications – Washington Clean Fuel Standard (CFS) 101 – [Link](#)

⁴¹ Note: While ethanol is primarily credit generating (~825,000 in 2024), it does generate deficits as well (~193,000 in 2024). For more information, kindly refer [Link](#)

⁴² Dept of Ecology – Concise Explanatory Statement Chapter 173-424 WAC Clean Fuels Program Rule – [Link](#)

compliance fuel to a major compliance fuel by 2022 because of its favorable CI, cost-effectiveness, and drop-in compatibility with existing diesel engines.

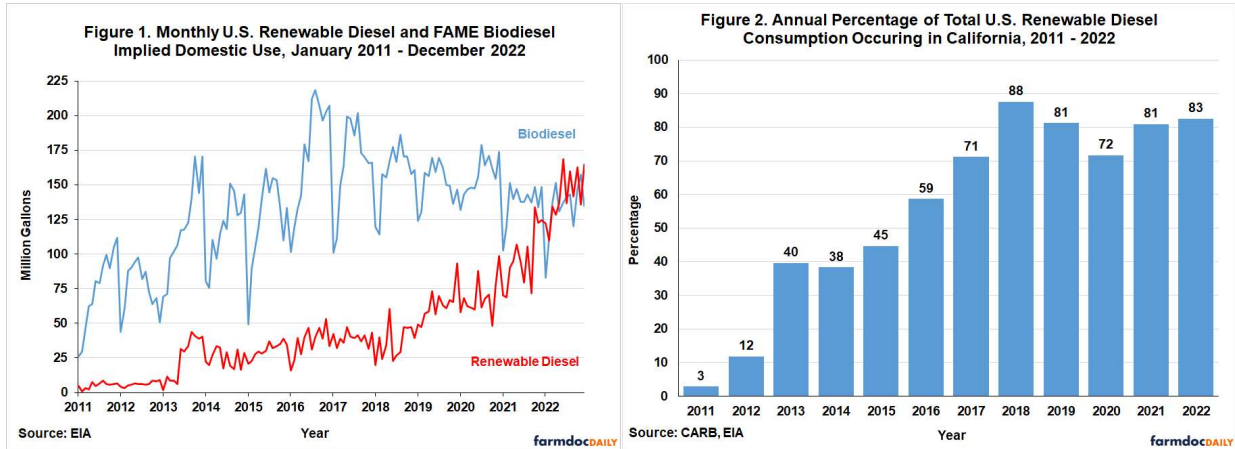


Fig 18: There has been a significant increase in the % of RD consumed in California. RD use in California increased dramatically from 2011 through 2018, jumping from 3 to 88 percent of total U.S. consumption. Since 2018, California has consistently been by far the largest consumer of RD, averaging 81% of total annual use in the US⁴³

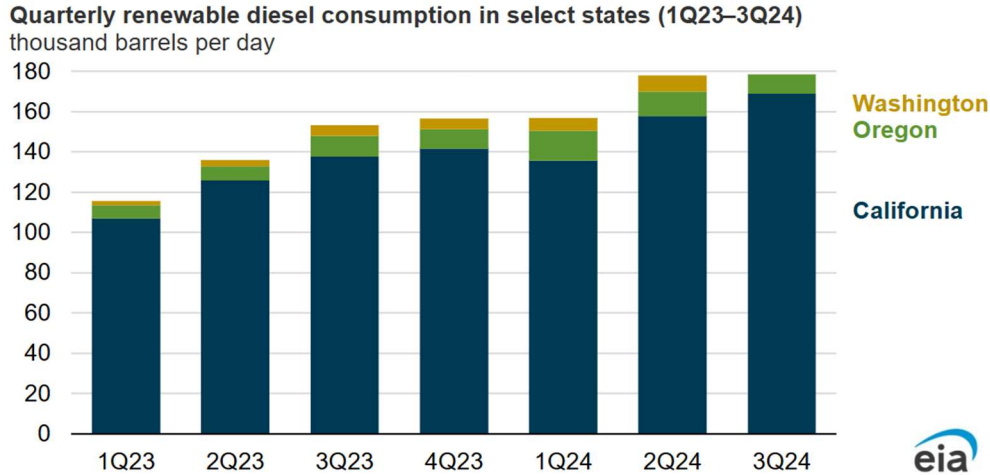
Early market data show that Washington, despite weaker credit prices, is following California’s trajectory at a macro level; but electrification, as a percentage of credit generation, has been growing at a record pace and has now leveled off due to changes in federal policy.

A critical distinction in Washington’s CFS is that maritime fuels are not a covered fuel category and therefore do not generate deficits under the program. Conventional marine fuels are exempt from deficit generation due to federal pre-emption and Commerce Clause considerations. However, in response to strong advocacy from ports and maritime stakeholders, the Washington Legislature directed the Department of Ecology to establish an opt-in credit pathway for maritime fuels.

Ecology formally adopted the Alternative Marine Fuel (AMF) provisions into rule on October 20, 2025, with an effective date of November 20, 2025, under Chapter 173-424 WAC (Clean Fuels Program Rule). This action fully enables vessels operating in Washington to opt into the CFS and generate credits for qualifying low-carbon fuels, including renewable diesel, biodiesel, and other approved alternatives.

⁴³ University of Illinois – RD and BD Usage Trends over 2011–2022 – [Link](#)

To avoid unintended credit oversupply and downward pressure on CFS credit prices, given that marine fuels do not generate corresponding deficits, Ecology limited AMF credit generation to fuel that is combusted within Washington waters, rather than fuel merely dispensed in the state. As stated in the adopted rule and supporting Concise Explanatory Statement, any credit generation from alternative marine fuel represents excess credit supply in the CFS market, necessitating safeguards to preserve market balance and credit value.



Data source: California Air Resources Board, Oregon Department of Environmental Quality, and Washington Department of Ecology
 Note: Washington publishes its quarterly data later than California and Oregon. 1Q23=first quarter of 2023

Fig 19: Quarterly RD consumption in select states (1Q23-3Q24)⁴⁴

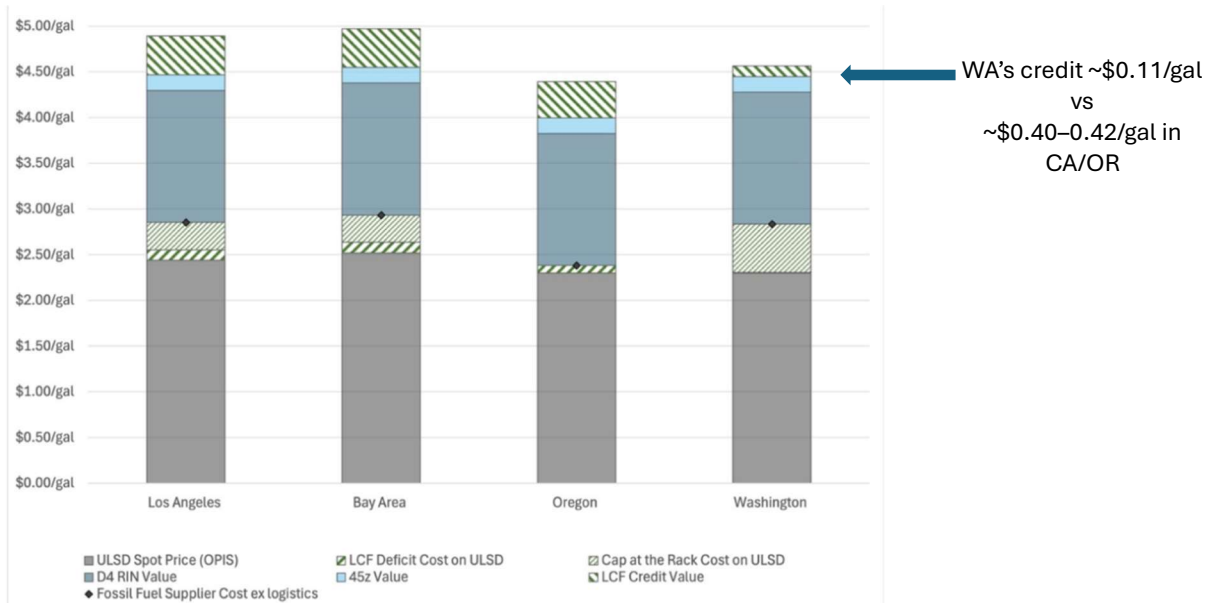


Fig 20: West Coast Markets RD Value Stack Comparison – February 2025⁴⁵

⁴⁴ EIA – Consumption of renewable diesel continues general growth trend on the U.S. West Coast – [Link](#)

⁴⁵ Stillwater Associates – Tracking the Stacks: Comparative Values for RD and SAF in West Coast Markets – [Link](#)

(contd.) Washington has similar underlying ULSD costs to neighboring states, but also faces the highest Carbon Allowance Requirement (CAR) compliance cost⁴⁶ resulting in an already elevated baseline fossil diesel price. At the same time, Washington's CFS credit value remains weak, ~\$0.11 per gallon compared to ~\$0.40–0.42 per gallon in California and Oregon, providing insufficient incentive to offset RD's higher production costs. As a result, RD remains relatively more expensive in Washington than in other West Coast markets. While recent U.S. Treasury guidance clarifies that certain marine fuels may be eligible for the federal 45Z Clean Fuel Production Credit, whether marine fuel purchasers realize any price benefit depends on whether the producer and suppliers contractually pass credit value through to marine transactions.

In summary, the policy direction is clear: Washington is structurally positioned for a major increase in low-carbon fuel adoption. While maritime fuels are not deficit-generating under the CFS, the newly adopted Alternative Marine Fuel opt-in pathway allows vessels to generate credits for qualifying fuels combusted within Washington waters beginning in November 2025. This represents a critical enabling condition for maritime decarbonization, but on its own is insufficient to drive rapid market transformation.

By contrast, California's LCFS operates as a more prescriptive regulatory regime. The California Air Resources Board (CARB) had the authority to mandate fuel transitions and, in 2023, required R99 renewable diesel for all commercial harbor craft, rapidly accelerating RD adoption and enabling the build-out of a stable marine fuel supply chain⁴⁷. Notably, California's mandate was implemented after more than a decade of LCFS market maturation and renewable fuel infrastructure investment, conditions that Washington does not yet have.

Today, much of the RD produced or imported on the West Coast is drawn toward California and Oregon, where LCFS-style programs provide stronger and more predictable value. While Washington's policy framework now allows maritime credit generation, the state lacks sufficiently strong price signals, aggregated demand, and dedicated marine fuel infrastructure to compete effectively for limited renewable fuel supply. As a result, the maritime sector in Washington continues to lag neighboring jurisdictions in access to low-carbon fuels, despite growing interest and regulatory momentum.

⁴⁶ Carbon Allowance Requirement (CAR): Washington's CAR adds a per-gallon compliance cost to fossil fuels at the rack, raising the baseline price of ULSD and shaping the relative competitiveness of renewable alternatives.

⁴⁷ California Air Resources Board – CHC Factsheet: Renewable Diesel (R100 or R99) – [Link](#)

California's Low Carbon Fuel Standards (LCFS)⁴⁸

The LCFS, adopted by the California Air Resources Board (CARB) in 2009 under AB 32, is a market-based regulation that requires fuel producers and importers to reduce the lifecycle CI of transportation fuels sold in the state relative to a 2010 baseline. The LCFS sets declining CI benchmarks for the overall fuel pool (gasoline, diesel, and substitutes) annually, with recent amendments tightening targets to a 30% CI reduction by 2030 and 90% by 2045.

Fuels with CI below the benchmark generate tradable credits, while higher-CI fuels generate deficits; regulated parties must balance their position each year through a mix of cleaner fuels, process improvements, and credit purchases. CI is calculated using CARB's CA-GREET life-cycle model, and a wide range of fuels, including RD, BD, SAF, biomethane, electricity and hydrogen, can participate as credit generators.

LCFS – 2024 Amendment Package

Scope and History⁴⁹

The LCFS is California's primary market-based policy to cut the lifecycle carbon intensity (CI) of transportation fuels relative to a 2010 baseline, using tradable credits for fuels below a declining CI benchmark and deficits for higher-CI fuels. Adopted in 2009 and implemented in 2011, LCFS has driven large uptake of RD, BD, ethanol, electricity, and renewable gas in the state's fuel mix, especially in heavy-duty and fleet applications. The program is administered by CARB and is designed to complement other policies such as Cap-and-Trade, Advanced Clean Trucks, and the Commercial Harbor Craft (CHC) rule.

2024–25 Amendment Package⁵⁰

In November 2024, CARB approved a major LCFS amendment package that has the following areas of focus:

- Focus 1: Tightens CI reduction targets through 2045.
- Focus 2: Introduces company-level caps on crop-based biomass-based diesel (BBD) from soy, canola, and sunflower oil.
- Focus 3: Establishes mandatory sustainability and no-deforestation requirements for non-waste biomass feedstocks.

⁴⁸ California Air Resources Board – Overview of LCFS (November 2025) – [Link](#)

⁴⁹ California Air Resources Board – Low Carbon Fuel Standard – [Link](#)

- Focus 4: Prohibits palm-derived fuels from generating LCFS credits.

Focus 1: Strengthened CI Targets

- Updated LCFS targets now require a 30 % reduction in the average CI of California’s transportation fuel pool by 2030 and a 90 % reduction by 2045, relative to 2010.⁵⁰
- This steeper CI trajectory is intended to keep LCFS aligned with California’s broader carbon neutrality and zero-emission vehicle (ZEV) goals.

Implicit Takeaway: Higher targets increase long-term demand and credit value for very low-CI fuels (waste- and residue-based RD/BD, SAF, electricity, green hydrogen), while making mid-CI crop fuels less competitive.

Focus 2: Guardrails on Crop-Based Biomass-Based Diesel (Soy, Canola, Sunflower)

- The amendments introduce a company-level 20% cap on LCFS crediting for biomass-based diesel (RD + BD) produced from virgin soybean, canola, and sunflower oils.⁵⁰
- For each entity participating in LCFS, BBD made from these three crops can earn LCFS credits only up to 20% of that company’s total annual BBD volume reported under LCFS.
- Volumes above 20% may still be sold in California but are treated as fossil diesel for LCFS purposes.
- For new BBD pathways using soy, canola, or sunflower oil certified after the amendments take effect (July 1, 2025), the 20% cap applies immediately once they begin crediting.
- For existing certified BBD pathways using these crop oils, the 20 % cap becomes binding January 1, 2028, effectively grandfathering them until that date.
- CARB and external analysts describe this as “guardrails” or a soft cap rather than a ban – LCFS does not prohibit these fuels, it simply limits how much of a company’s LCFS credit book can come from them.

Implicit Takeaway: The amendment functions as a structural guardrail rather than a ban: crop-oil RD/BD remains eligible in California, but only up to a limited share of a producer’s LCFS credit portfolio. Once a company exceeds the 20% threshold, incremental gallons lose all LCFS credit value and effectively price against fossil diesel, eliminating the economic rationale for additional crop-oil expansion in California. As a result, producers are expected to

⁵⁰ California Air Resources Board – CA LCFS Regulatory Update – [Link](#)

diversify toward lower-CI waste oils, residues, and SAF pathways, while **crop-dependent producers, particularly in the Midwest, will likely seek alternative state or regional markets beginning in 2028 to place volumes no longer advantaged under LCFS.**

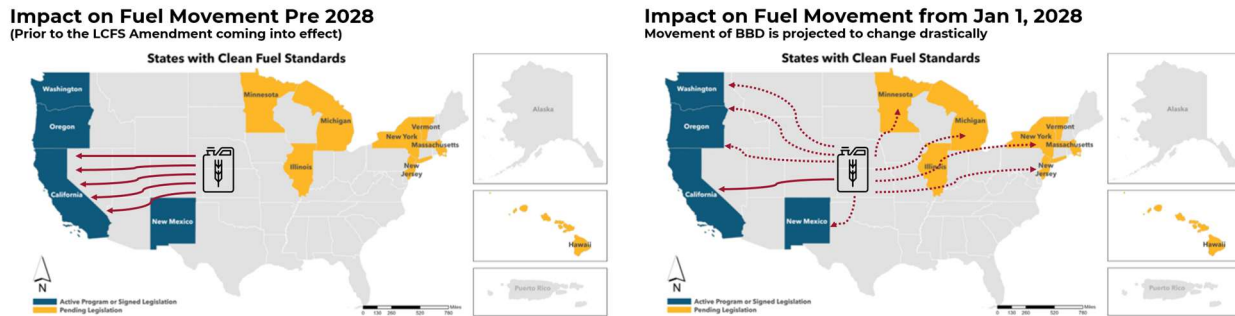


Fig 21: Beginning in 2028, LCFS caps LCFS-creditable crop-oil BBD at 20% of each producer’s BBD portfolio, reducing the economic pull of CA for excess Midwest volumes. If WA develops a stable, attractive market, it could capture a large share of the redirected renewable gallons.

Potential Market Outcomes

Overall, the crop-oil cap reshapes the strategic landscape for RD and BD producers.

- RD production shifts to SAF: Many hydrotreaters will prioritize SAF production because SAF generates significantly higher LCFS value per unit of feedstock. This shift also helps producers stay under the 20% crop-oil cap for RD.
- Feedstock switching accelerates: Producers will increasingly pivot toward UCO, tallow, DCO, and other residue-based feedstocks like woody biomass to maintain creditability. This may increase competition and prices for waste oils across North America.
- Though not of less value from a carbon reduction benefit, excess BBD from specific crops could be diverted to other markets: If producers exceed the 20% limit of specific crops feedstocks RD/BD they will not generate the same credit value in California. These RD volumes could flow to OR and WA markets without similar restrictions.
- Crop-oil RD/BD sees margin compression: Once volumes lose access to LCFS credits, producers selling crop-based volumes into CA may face sharply reduced margins. This could slow or reverse some planned capacity expansions that were predicated on LCFS economics. However, this industry has consistently innovated to produce ever lower carbon fuels.
- Increased demand for “verified” sustainable crop pathways: Some producers may differentiate by certifying low-land-use-change (LUC) crop-oil production, though the cap

still applies. However, high-integrity certification could help them retain customers in premium markets.

- Potential shift toward co-processing at petroleum refineries: Some refiners may co-process small amounts of crop oils within their existing hydrotreaters to stay under the cap while still producing lower carbon fuels but not renewable fuels.
- More BBD shipped overseas: Certain producers may find export markets (e.g., EU, Asia) attractive for volumes that no longer generate credits in California. While these markets have quality and sustainability requirements, they may offer better economics than selling as fossil diesel in CA.
- New/expanded non-food feedstock pathways become more commercially attractive: As crop-based RD/BD becomes less competitive in California, higher-cost alternative pathways, such as woody biomass, municipal solid waste (MSW), and algae, may become comparatively more viable, especially if technology learning curves, policy incentives, and LCFS market signals increasingly reward residue- and waste-based fuels. Over time, crop-cap dynamics could accelerate investment in these “next-generation” feedstocks and conversion routes (e.g., gasification-to-liquids, advanced pyrolysis, or emerging biochemical pathways) that were previously marginal versus low-cost crop oils.

Focus 3 – Sustainability and no-deforestation requirements

The amendment requires that non-waste biomass feedstocks (like crop oils or residues) meet stricter sustainability criteria to qualify for LCFS credits. Producers must now demonstrate that these feedstocks are not associated with deforestation or conversion of high-carbon or high-biodiversity lands, tightening oversight of land-use impacts. It is noted that most of the supply chains already conform to these international standards.

Focus 4 – Palm-derived fuels ineligible for LCFS credits

The amendment makes fuels derived from palm oil and its co-products entirely ineligible to generate LCFS credits. This reflects longstanding concerns about palm expansion driving deforestation, peatland drainage, and high land-use change emissions. By removing LCFS credit value for palm-derived fuels, CARB effectively steers investment and compliance strategies away from palm and toward lower-risk, lower-CI feedstocks.

California's Commercial Harbor Craft (CHC) Regulatory Framework

Scope and History

The CHC regulation covers various harbor-craft types – crew and supply boats, fishing vessels, ferries, excursion vessels, tugboats, barges, dredges, and others⁵¹. Adopted in 2008 and amended in 2010, it required owners to replace older engines with cleaner ones, reducing diesel particulate matter (PM), fine PM, NOx, SOx, reactive organic gases, and greenhouse gases¹.

2022 Amendments⁵²

- Amendments adopted on December 30 2022 (effective January 1 2023) expanded the rule to more vessel types, mandated cleaner upgrades and technologies, and aimed to protect workers and passengers by reducing exposure to combustion pollutants¹.
- Regulated vessels must install engines meeting the most stringent federal marine or off-road standards (Federal Tier 3 or Tier 4) plus a level-3 diesel particulate filter (DPF), making California's requirements stricter than federal Tier 4 standards⁵³.
- Compliance deadlines vary by vessel type and engine model year; pre-Tier 1 and Tier 1 engines on most vessels must upgrade between 2024–2026, and other categories must meet Tier 4 + DPF standards between 2025–2032.

Renewable Diesel and reporting

- All CHCs must use R100 or R99 beginning January 1 2023.²
- Owners must file annual activity reports (first due March 31 2023) and document fuel purchases when RD is not available at out-of-state ports or under existing contracts, switching to RD once contracts expire or by December 31 2025.^{54 55}

⁵¹ California Air Resources Board (CARB) – Commercial Harbor Craft – [Link](#)

⁵² Note on Compliance flexibility: (1) Operators can request extensions when infrastructure delays, equipment unavailability, financial hardship or scheduling issues make immediate compliance infeasible.² (2) Extensions provide one- to two-year delays (longer in some cases), allowing time for technology to become available.

⁵³ California AB 1122 – Commercial harbor craft: equipment – [Link](#)

⁵⁴ CARB – CHC Factsheet: Renewable Diesel (R100 or R99) – [Link](#)

⁵⁵ CARB – Do you operate a Harbor Craft engaged in commercial activity? – [Link](#)

Requirement for Tier 4 Engines

Federal Tier 3 and Tier 4 Marine Engine Standards

Tier 3 – Applies to new engines in Emission Control Areas such as North American waters and primarily targets reductions in NOx. Compliance relies on selective catalytic reduction (SCR), exhaust-gas recirculation (EGR), and other after-treatment technologies. Implementation began in 2016 and has spurred innovation in marine engine design⁵⁶.

Tier 4 – Imposes stricter limits on NOx, particulate matter, hydrocarbons, and carbon monoxide. Engines incorporate diesel particulate filters (DPFs), advanced SCR and enhanced EGR systems. These technologies reduce multiple pollutants simultaneously and improve fuel efficiency.

Renewable Diesel (RD) Mandate for Harbor Craft

The 2022 amendments require all harbor craft in California waters to use RD with at least 99% renewable content (R99 or R100) starting January 1, 2023 and that RD is produced from non-petroleum sources and meets federal fuel registration and ASTM D975 specifications.⁴

Purpose and impact

- Using RD achieves additional emission reductions beyond those from Tier 3/4 engines and DPFs.⁵⁷
- The mandate replaces the ULSD requirement and could shift about 55 MM gals/yr to RD, representing roughly 1.5 % of California’s total diesel use and potentially increasing statewide RD demand by 4%.⁷

Availability and exceptions

R100 and R99 are widely available in California, with supply delivered by marine vessel, rail, and in-state production; major harbors are well supplied, though smaller or remote ports may face constraints.⁷ Operators must document unavailability when fueling outside California or under existing contracts and must transition to RD once contracts expire or by December 31, 2025.⁴ BD blends do not count toward compliance, and CARB provides guidance on procuring marine-grade RD and maintaining records during supply shortages.⁴

⁵⁶ Marine Safety Consultant – Understanding Tier 3 and 4 Engine Regulations for Commercial Vessels – [Link](#)

⁵⁷ Stillwater Associates – CARB Commercial Harbor Craft (CHC) Regulation Amendments – [Link](#)

10. Key Market Insights & Observations

Stakeholder interviews across the marine fuel supply chain reveal that barriers to renewable marine fuel adoption in Washington are systemic rather than technical. These challenges fall into a small number of recurring themes that explain why access, pricing, and readiness vary widely across vessel types and locations in Puget Sound. The insights that follow are organized around six core themes.

- **Market economics and credit design** determine when renewable fuels are competitive in Washington and whether volumes flow into the region at all.
- **Infrastructure, permitting, and physical access** govern whether fuel can reliably reach marine users once supply exists.
- **Fleet segmentation and operational realities** mean that fishing vessels, tugs, workboats, and government fleets face very different risks, margins, and adoption constraints, making uniform approaches ineffective.
- **Technical confidence, fuel quality, and warranty clarity** continue to shape operator decisions, even where fuels are technically viable.
- **Demand aggregation and the Port’s convening role** influence whether private investment in storage, blending, and supply becomes viable without the Port acting as a fuel buyer.
- **Long-term transition planning**, including alignment between RD and electrification, will shape whether near-term actions support or complicate future decarbonization pathways.

The insights that follow are organized around these themes and reflect consistent perspectives shared by producers, distributors, terminal operators, and vessel owners operating across Puget Sound.

Market Economics and Credit Design	
1.	Clean fuels market conditions leave Washington less competitive, making RD supply unreliable
2.	Marine RD adoption lags because it lacks parity, certainty, and easy logistics
3.	The biggest future risk: BD/RD supply is plateauing because demand signals and policy certainty are weak
4.	California’s LCFS crop-oil guardrails could redirect RD/BD flows and reshape Washington’s marine supply planning
5.	There is no functioning Scope 3 market to absorb green premiums for marine fuels

Infrastructure, Permitting and Physical Access	
6.	Technology is not the core barrier; infrastructure, permitting, and tankage are
7.	Tacoma may be the most viable renewable fuel hub in Puget Sound today for continued expansion of renewable fuels
8.	Fragmented infrastructure makes RD supply unreliable for marine users
9.	Port restrictions on truck-to-vessel fueling limit a safe, regulated, near-term supply pathway
10.	Infrastructure risk is misaligned, with midstream bearing costs while others capture value
11.	Permitting uncertainty, not just duration, is the primary deterrent to infrastructure investment
Fleet Segmentation and Operational Reality	
12.	Policies need to be based on vessel type and how vessels are typically used
13.	Fishing fleets face high operational risk and have low tolerance for fuel premiums
14.	Tug operators will switch only with parity pricing, guaranteed supply, and collective movement
Technical Confidence, Fuel Quality and Warranty	
15.	BD quality stigma is still widespread, and operators wrongly conflate BD and RD
16.	Warranty uncertainty is one of the top psychological and operational barriers
17.	High-blend BD has a limited role and is not suited for most waterfront marine use
Demand Aggregation and the Port's Role	
18.	Aggregating demand is the key unlock, and it is a role the Port can play without buying fuel
Long-Term Transition and Future Alignment	
19.	RD and electrification are being planned on parallel, uncoordinated tracks

A: Market Economics & Credit Design

1. Clean fuels market conditions leave Washington less competitive, making RD supply unreliable.

Details: Producers and distributors consistently send RD to markets with stronger and more predictable credit value. Washington's CFS is newer, more volatile, and still evolving, which leaves the state structurally short on RD compared to California, Oregon, and BC. As a result, RD availability in Washington is intermittent rather than steady, especially for marine users.

This dynamic is reinforced by California's harbor craft regulations, which mandate the use of R99 for certain vessel classes. These mandates convert policy signals into guaranteed demand, giving suppliers confidence to dedicate volume, infrastructure, and logistics to the marine sector, something that is largely absent in Washington today.

Potential Next Steps:

- Strengthen Washington CFS credit value and provide clearer, more durable guidance on HB 1409 implementation.
- Improve market transparency by publicly tracking and forecasting credit values to reduce uncertainty for suppliers and investors.
- Review California’s harbor craft R99 mandates and observed outcomes to assess whether targeted marine fuel requirements, or alternative demand-certainty mechanisms, could be viable in Washington.

2. Marine RD adoption lags because it lacks parity, certainty, and easy logistics.

Details: RD volumes consistently flow first to on-road and aviation markets because those sectors benefit from automatic credit eligibility, mature compliance systems, and workable aggregation and delivery logistics. On-road markets access RD easily at the rack with well-established credit pathways, while aviation has largely solved demand aggregation and delivery, allowing fuel to move quickly when economics align.

Marine, particularly harbor craft in Washington, faces a different reality. Credit eligibility remains uncertain during the CFS ramp-up under HB 1409, margins are thin, and logistics are fragmented and dock-specific. As a result, marine operators cannot absorb RD price premiums without CFS market support, even when RD is available regionally. Without explicit parity mechanisms, marine demand is consistently deprioritized relative to higher-value compliance markets, leaving harbor craft structurally disadvantaged.

Potential Next Steps:

- Make marine credit eligibility automatic, predictable, and easy to claim, with clear guidance tailored to tug, workboat, and other non-ocean-going vessels.
- Implement parity mechanisms during the CFS ramp-up, such as a marine-specific credit adder or equivalent “tax relief,” to prevent RD from being priced above conventional fuels for harbor craft.
- Offer complementary Port-based incentives, including dockage fee reductions or similar concessions for vessels using high RD blends (R50–R99), to bridge the period before full CFS parity is achieved.

3. The biggest future risk: Renewable Fuel supply has plateaued because demand signals and policy uncertainty have sent weak market signals

Details: Producers report that RD and BD capacity is not growing rapidly enough, not because clean fuels markets do not exist, but because of the lack of demand signals and policy certainty. Outside of California, credit programs have not consistently translated into bankable, long-term offtake, slowing investment in new capacity. Washington is especially exposed because it has no in-state RD production. Even when fuel is available elsewhere, transportation, logistics, and terminal constraints add cost by the time it reaches Puget Sound, making demand harder to sustain and reinforcing a cycle of low adoption and unreliable supply.

Potential Next Steps:

- Build a PNW renewable fuel production strategy.
- Pair marine decarbonization plans with long-term supply commitments and clearer demand signals to support new investment.

4. California's LCFS crop-oil guardrails could alter RD/BD market dynamics, with uncertain but potentially favorable implications for Washington marine supply planning.

Details: CARB's 2024 LCFS amendments cap crediting for RD and BD produced from virgin crop oils (soy, canola, sunflower) at 20% of a producer's annual portfolio. Volumes beyond this threshold are ineligible for LCFS credits. For new pathways, the cap applies immediately upon certification; for existing producers, it takes effect beginning in 2028. The net impact on regional RD/BD flows remains uncertain and will depend on producer responses, feedstock flexibility, and relative credit economics across jurisdictions. While the policy is intended to shift California production toward waste-based fuels and SAF, it may also reduce the marginal value of crop-oil RD/BD in California, potentially redirecting some volumes to other markets, including Washington. If this occurs, Washington could see intermittent increases in RD/BD availability, particularly from crop-oil pathways. However, these volumes may carry higher CI scores and less predictable supply, complicating marine fuel planning and reinforcing the need for scenario-based infrastructure and procurement strategies rather than reliance on stable baseload supply.

In summary, the policy direction is clear: Washington is structurally positioned for a major increase in low-carbon fuel adoption. While maritime fuels are not deficit-generating under

the CFS, the newly adopted Alternative Marine Fuel opt-in pathway allows vessels to generate credits for qualifying fuels combusted within Washington waters beginning in November 2025. This represents a critical enabling condition for maritime decarbonization, but on its own is insufficient to drive rapid market transformation.

By contrast, California's LCFS operates as a more prescriptive regulatory regime. The California Air Resources Board (CARB) had the authority to mandate fuel transitions and, in 2023, required R99 renewable diesel for all commercial harbor craft, rapidly accelerating RD adoption and enabling the build-out of a stable marine fuel supply chain. Notably, California's mandate was implemented after more than a decade of LCFS market maturation and renewable fuel infrastructure investment, conditions that Washington does not yet have.

Today, much of the RD produced or imported on the West Coast is drawn toward California and Oregon, where LCFS-style programs provide stronger and more predictable value. While Washington's policy framework now allows maritime credit generation, the state lacks sufficiently strong price signals, aggregated demand, and dedicated marine fuel infrastructure to compete effectively for limited renewable fuel supply. As a result, the maritime sector in Washington continues to lag neighboring jurisdictions in access to low-carbon fuels, despite growing interest and regulatory momentum.

California's Low Carbon Fuel Standards (LCFS)

The LCFS, adopted by the California Air Resources Board (CARB) in 2009 under AB 32, is a market-based regulation that requires fuel producers and importers to reduce the lifecycle CI of transportation fuels sold in the state relative to a 2010 baseline. The LCFS sets declining CI benchmarks for the overall fuel pool (gasoline, diesel, and substitutes) annually, with recent amendments tightening targets to a 30% CI reduction by 2030 and 90% by 2045.

Fuels with CI below the benchmark generate tradable credits, while higher-CI fuels generate deficits; regulated parties must balance their position each year through a mix of cleaner fuels, process improvements, and credit purchases. CI is calculated using CARB's CA-GREET life-cycle model, and a wide range of fuels, including RD, BD, SAF, biomethane, electricity and hydrogen, can participate as credit generators.

LCFS – 2024 Amendment Package

Potential Next Steps:

- Model multiple post-2028 supply scenarios to assess how potential inflows of crop-oil RD/BD into Washington would affect availability, CI outcomes, and CFS credit exposure under a range of market responses (as recommended by CFA).
- Engage producers early to signal Washington marine and on/off-road demand for waste- and residue-based RD, reducing the risk that Washington becomes a residual or “spillover” market for higher-CI crop-oil diesel displaced from California.

5. There is no functioning Scope 3 market or value proposition, like there is for SAF, to absorb green premiums.

Details: Marine operators consistently say the same thing: there is no customer or contract willing to pay for their emissions reductions. Unlike aviation, harbor craft have no Scope 3 buyers, no monetization framework, and no way to recover even modest fuel premiums. As a result, RD, and BD adoption stalls despite technical readiness.

Potential Next Steps:

- Develop a Port-facilitated Scope 3 accounting and attribution framework that enables marine operators to document and transfer emissions reductions to customers.
- Explore green-corridor agreements, shipper–operator procurement models, or a Port-led voluntary “Low-Carbon Marine Fuel Program” to create a recoverable revenue stream.
- Integrate Scope 3 value mechanisms into broader decarbonization pathways so early adopters are not financially disadvantaged.

6. WA’s lack of in-state RD production keeps delivered costs high and supply inconsistent.

Details: Washington relies on imported RD and BD, so supply is constrained by upstream availability and competing demand in California, Oregon, and British Columbia. Moving fuel long distances adds transportation and logistics costs before it reaches Puget Sound, and limited local storage and handling capacity can make deliveries intermittent and even dock-specific. It’s also important to distinguish “near-RD” from true RD: co-processed products can have a lower CI, but it doesn’t provide the same drop-in RD volume signal marine users need. Without local production, Washington risks becoming a high-cost, unreliable last-mile market where operators can’t confidently plan around steady RD availability or pricing.

Potential Next Steps:

- Coordinate with local producers to understand near- and long-term RD supply plans, constraints, and the demand signals needed to unlock volumes.
- Present a fuel aggregation strategy to create bankable demand and justify dedicated logistics/tankage for WA.
- Partner with terminals/distributors to scope the specific last-mile investments and operating model (dedicated tankage, delivery windows, throughput agreements) needed for reliable, consistent supply into Puget Sound.

B: Infrastructure, Permitting and Physical Access

7. Technology is not the core barrier; infrastructure, permitting, and tankage are.

Details: Washington has the technical expertise to manage and distribute RD today. Industry participants reported that the limiting factor is not fuel compatibility or operational know-how, but the inability to dedicate scarce storage, blending, and delivery infrastructure while RD demand remains relatively low and conventional fuels fully occupy existing capacity. The primary constraints are tank scarcity, limited blending and handling availability, quality-control challenges associated with commingled product, and slow, uncertain permitting for expanded infrastructure such as docks, rail access, and new or converted storage. Adding new tankage typically requires 18–36 months, long enough that market conditions or demand pathways may shift, pushing operators to convert existing tanks instead. These conversions are costly, require full cleaning and downtime, and are rarely justified without long-term offtake commitments that can reliably support RD utilization.

Potential Next Steps:

- Build a Renewable Fuels Infrastructure Plan (co-developed by public and private industry partners) that identifies priority tanks, segregated piping, blending capability, and dock access required to support marine RD and BD adoption.
- Advance policy and permitting reforms tied to energy security and essential fuel infrastructure, including clearer, faster, and lower-risk permitting pathways that prioritize renewable fuel capacity expansions.
- Leverage Port assets and public–private capital to de-risk tank conversions and new storage or blending investments in the near term, unlocking dedicated RD/BD capacity while longer-term permitting challenges are addressed.

8. Tacoma may be the most viable renewable fuel hub in Puget Sound today for continued expansion of renewable fuels

Details: At present, Tacoma is the only location in Puget Sound with barge access, established renewable fuel handling operations, and meaningful RD storage capacity. This combination of logistics, tankage, and operational readiness makes Tacoma the most viable hub for near-term RD supply and expansion.

By contrast, Seattle’s marine fuel system remains constrained by limited renewable fuel storage and handling infrastructure. Distributors and terminal operators consistently indicated that investment in new or converted RD tanks in Seattle would require long-term demand commitments and stronger, more durable market signals from Washington’s CFS. Until those conditions are met, Tacoma is likely to continue serving as the primary entry point for RD into the region, with Seattle positioned as a future expansion node rather than an immediate hub.

Potential Next Steps:

- Explore whether Port-owned or controlled real estate in Seattle could be leveraged to support or partner on the construction of dedicated, segregated RD storage and handling infrastructure.
- Develop a strategy for a Seattle-based renewable bunkering node (i.e., a centralized marine fueling hub for receiving, storing, and delivering renewable fuels) including consideration of other uses (e.g., non-road, heavy-duty vehicles, OGVs) once demand aggregation, CFS and other policy measures improve.
- Advance Port-terminal co-investment models to reduce risk and accelerate tank development in both Tacoma (near term) and Seattle (medium term).

9. Fragmented infrastructure makes RD supply unreliable for marine users

Details: RD availability breaks down at multiple points along the supply chain. Fuel may be available at racks, but terminals lack tank space; blenders struggle to track CI; distributors cannot guarantee supply; and many marine docks lack the infrastructure to receive or blend renewable fuels. The result is inconsistent availability, even when regional supply exists.

Potential Next Steps:

- Create a Port-led mechanism to aggregate demand and secure firm supply (e.g., pooled volumes, shared offtake, or supply guarantees).
- Align and standardize CI tracking and reporting requirements across Puget Sound terminals.

10. Port restrictions on truck-to-vessel fueling limit a safe, regulated, near-term supply pathway

Details: While USCG and Washington Ecology rules allow truck-to-vessel fueling when proper safety procedures are followed, the Port of Seattle’s own Best Management Practices (BMPs) prohibit this practice at certain piers, including Pier 90/91. This removes a well-understood, tightly regulated fueling method that suppliers and operators have safely used for decades elsewhere in Washington. Several distributors noted they could deliver renewable diesel to vessels immediately via truck if this pathway were allowed. Instead, fueling is pushed into a small number of barge-based options, reducing competition, flexibility, and resilience. In practice, this creates an avoidable near-term supply bottleneck at the same time the Port is trying to expand access to lower-carbon marine fuels, without waiting years for new tankage or dock infrastructure.

Potential Next Steps:

- Reevaluate and update Port fueling policies to allow truck-to-vessel fueling at Pier 90/91 and/or designate specific berths or windows for compliant truck fueling, minimizing operational conflicts, and ensuring safety standards equal to or stricter than existing over-water fueling practices.
- Integrate truck-to-vessel fueling into the Port’s renewable fuels strategy, enabling immediate RD access for Harbor Craft without waiting for new infrastructure to be built.

11. Infrastructure risk is misaligned: midstream bears the cost while others capture the value

Details: In Washington, the cost and risk of new tankage, blending systems, and dock upgrades sit almost entirely with terminals and distributors. But most of the economic upside flows elsewhere, to producers through credits and SAF premiums, and to end users through compliance and reporting benefits. That mismatch makes midstream investment in Washington hard to justify without long-term volume certainty or policy backstops.

Potential Next Steps:

- Treat renewable fuel storage and bunkering as enabling infrastructure, not just private assets.
- Use Port or State tools (grants, guarantees, demand floors) to share infrastructure risk.
- Look seriously at utility-style or shared-infrastructure models already used in California.

12. Permitting uncertainty, not just duration, is the primary investment deterrent

Details: Stakeholders emphasized that long timelines (18–36 months) are manageable if predictable. What drives capital away from Washington is uncertainty: SEPA scope creep, appeals risk, shoreline challenges, and shifting interpretations by agencies or ports mid-process. This unpredictability pushes investment toward California, Oregon, and BC even when Washington’s economics are otherwise close to parity.

Potential Next Steps:

- Create a Port-endorsed renewable fuels permitting playbook with predefined pathways.
- Establish a clean-fuel permitting single-point coordinator.
- Partner with the Energy Facility Site Evaluation Council (EFSEC) to understand opportunities for process optimization and streamline permitting.

C: Fleet Segmentation and Operational Reality

13. Policies need to be based on vessel type and how vessels are typically used.

Details: Harbor craft are not a single category. Fishing vessels run multi-week offshore trips in harsh conditions and require reliable RD availability (ideally in both Washington and Alaska). Tugs and towboats operate short, frequent routes with strict uptime requirements and rely on dock-specific fueling. Workboats and government vessels fall somewhere in between. These differences drive vastly different risk profiles, margins, and fuel tolerance, making one-size-fits-all policy ineffective.

Potential Next Steps:

- Design decarbonization policies and incentives by vessel type and use case (e.g., fishing, tugs/tows, workboats, government fleets).

- Explicitly account for trip length, fueling locations, uptime needs, and seasonal operations when setting requirements or incentives.

14. Fishing fleets face high operational risk and have low tolerance for fuel premiums.

Details: Fishing fleets operate on thin, commodity-driven margins and cannot absorb green premiums. Long offshore trips require absolute fuel reliability, consistent fuel chemistry, clear OEM assurance, and dependable access at both ends of the route. For Washington-based fleets, which means dual-port availability in Puget Sound and Dutch Harbor, since vessels routinely leave Washington and operate in the Bering Sea and Alaska.

Potential Next Steps:

- Develop a fishing-specific RD adoption pathway that reflects long voyages, risk tolerance, and operational realities.
- Design pilots carefully around these operational realities – set clear fuel specs, plan for weather/seasonality, and put contingency supply options in place so vessels are not left stranded and/or forced to switch back mid-season.

15. Tug operators will switch only with parity pricing, guaranteed supply, and collective movement.

Details: Tug and tow operators compete in markets with elastic demand. Switching fuels unilaterally introduces cost and operational risk that competitors may not face. As a result, adoption depends less on technical readiness and more on parity pricing, reliable dock-level access, and assurance that peers are moving together, either through policy alignment or port-enabled coordination.

Potential Next Steps:

- Develop a tug-focused pooled procurement or demand-aggregation approach tied to specific fueling locations.
- Use Port-enabled mechanisms or policy tools that support collective movement rather than relying on voluntary, one-off adoption.

D: Technical Confidence, Fuel Quality and Warranty

16. BD quality stigma is still widespread, and operators wrongly conflate BD and RD

Details: Many marine operators still associate BD with gelling, contamination, and reliability problems from early, poorly controlled blends. Without clear information, RD is often conflated with BD and treated with the same caution, even though RD behaves very differently. This spillover effect slows RD adoption and keeps BD pathways off the table, despite strong performance data.

Potential Next Steps:

- Launch a Port-led “RD vs. BD Facts” education and training initiative in partnership with engine OEMs, fuel producers, and distributors, clearly explaining fuel properties, performance differences, and handling requirements.
- Publish and consolidate existing OEM warranty guidance, fuel specifications, and “safe-use” operating conditions into practical reference materials that operators can rely on.
- Leverage real-world testimonials and operating data from California harbor craft using R99 to demonstrate day-to-day performance and build confidence among parallel industries in Washington.
- Develop durable, industry-facing resources (fact sheets, SOPs, FAQs) that directly address common harbor craft questions related to fuel quality, storage, cloud point management, and conditions for use.

17. Warranty uncertainty is one of the top psychological and operational barriers

Details: Many operators are hesitant to use RD, particularly on older engines, without clear, written OEM guidance confirming fuel compatibility and warranty coverage. Even where OEM approvals or specifications exist, operators reported that this information can be difficult to locate, inconsistently communicated, or not well understood by local OEM representatives.

In the absence of accessible, marine-specific fuel SOPs, operators perceive heightened risk of warranty invalidation, equipment damage, or unplanned downtime. This uncertainty slows adoption despite RD being widely used as a drop-in fuel in other sectors and jurisdictions, and mirrors challenges repeatedly observed in early-stage renewable fuel markets elsewhere.

Potential Next Steps:

- Convene OEM–operator roundtables to align on practical, marine-specific guidance for RD use, with facilitation support from organizations such as Diesel Technology Forum and Clean Fuels Alliance.
- Publish a Port-endorsed OEM compatibility and guidance matrix consolidating approved fuel blends, warranty considerations, and operating parameters that vessel operators can rely on with confidence.

18. High-blend BD (B50–B100) is viable with certain hardware and can often be cheaper than RD; but high blends are not suited for most waterfront marine use

Details: While high-blend BD has performed well in some controlled applications, most marine operators remain cautious, especially on the waterfront, due to concerns about water absorption, contamination risk, and operational reliability. BD’s FAME content and hygroscopic properties make it poorly suited for vessels operating offshore or in harsh marine environments where fuel contamination can shut down operations. As a result, BD is unlikely to see broad adoption across harbor craft, particularly for vessels that operate far from shore.

Potential Next Steps:

- Limit marine BD use to low blends or specific near-shore vessel classes where fuel handling and risk can be tightly controlled.
- Focus BD deployment on non-marine applications, such as drayage trucks, terminal equipment, and other landside fleets, where storage conditions are more manageable and reliability risk is lower.
- Include BD pathways in carbon-intensity modeling and cost curves, but clearly distinguish where BD is appropriate versus where RD is the preferred marine solution.

E: Demand Aggregation and the Port’s Role

19. Producers/distributors and end users are willing to aggregate demand, and want ports to play a bigger convening role (e.g., a Buyers Alliance) with coordinated regional policy.

Details: California ports consider the transition to RD as complete, focusing more on ZEVs and infrastructure. They consistently state: “We convene, plan, harmonize, and permit; we don’t sign offtake.”

Potential Next Steps:

- Use Port of Seattle’s convening power to lead alignment of coordinated Tacoma and Seattle buying collaborations.
- Build PNW port coordination to avoid fragmented alt-fuel pathways.

F: Long-Term Transition & Future Alignment

20. RD and electrification are not being planned on parallel tracks

Details: RD is often framed as a “bridge,” but in Washington it is not being deliberately planned alongside electrification. That creates risk of mismatched investments (overbuilding RD logistics or underbuilding charging/grid capacity) and uncertainty for operators if policy or funding priorities shift quickly. California ports have been more explicit about sequencing; Washington hasn’t yet done the same.

Potential Next Steps:

- Tie RD logistics/tankage decisions to CHE and vessel electrification timelines by segment and site.
- Design RD assets to be modular/convertible (e.g., flexible tankage, shared footprint) to avoid stranded infrastructure.
- Communicate a clear “role over time” for RD, where it’s interim, where it’s long-duration, and what triggers a shift.

11. A Sequenced Pathway to Accelerate Renewable Marine Fuels in Puget Sound

This assessment makes one thing noticeably clear: Washington is ready for biofuels, especially RD, from a technical standpoint, but barriers exist across the broader biofuels value chain. The fuel works, vessels can use it, and operators are interested, but inconsistent supply, weak credit signals, fragmented demand, and limited infrastructure keep RD from becoming a dependable and affordable option for the harbor craft that want it.

To change this, **the Port of Seattle can play a catalytic role**. What is needed now is a clear, practical sequence of steps that builds the economic case, removes operational barriers, and creates the market conditions for renewable marine fuels to scale. The pathway below reflects local stakeholder sentiment, and what leading ports around the world (from California to Rotterdam and Singapore) have already demonstrated in their own transitions.

1. **Model Credit Pricing and CI Trajectories to Understand When WA Becomes**

Competitive: Before major investments or commitments can take hold, the Port must understand when and under what conditions WA becomes an attractive market for RD relative to California and Oregon.

Next steps:

Develop a multi-state, multi-year credit pricing model incorporating LCFS/CFS/CFP trajectories, CI curves, HB 1409 impacts, crop-oil guardrails (2028), and federal incentives (45Z). This analysis will reveal:

- When WA becomes cost-competitive for renewable molecules.
- What volumes WA can attract in different credit environments.
- What CI reductions are required to unlock parity pricing for marine users.
- This insight becomes the economic foundation for all subsequent actions.

(see Supplemental Doc I for more details)

2. **Resolve Warranty Barriers Through an OEM & Fuel Producer Engineering**

Collaboration: Warranty uncertainty remains one of the most powerful blockers for

operators, especially tug and fishing fleets with older engines and high uptime requirements.

Next steps:

Convene key producers with major OEMs (CAT, Cummins, MTU etc.) to co-develop and publish:

- A Port-endorsed compatibility matrix.
- Standardized RD safe-use guidelines (including cloud point and storage management).
- Clear warranty assurances or “letters of no objection”.

This mirrors successful efforts in California, where coordinated messaging eliminated hesitation and helped enable near-100% R99 adoption in harbor craft.

- 3. Develop Segment-Specific Decarbonization Pathways for Tugs, Fishing, Workboats, and Government Fleets:** Decarbonization cannot be one-size-fits-all. Each fleet segment faces distinct operating conditions, risks, and economic realities.

Next steps:

Build tailored pathways that integrate:

- Fuel adoption scenarios (RD, BD pilots, hybridization)
- Trip-profile modeling (Alaska-route fishing vs local tugs)
- Warranty alignment
- Pricing needs and risk tolerance
- Future readiness for methanol/hydrogen/electric

This ensures each segment progresses along a realistic, operator-informed trajectory and positions pilots where the impact and feasibility are highest.

- 4. Launch a Multi-Vessel Renewable Fuel Pilot to Validate Operational, Economic, and Supply Feasibility:** A coordinated pilot provides real-world data, builds operator confidence, and helps surface remaining bottlenecks before demand scales.

Next steps:

- Analyze successful global pilots such as Amsterdam’s biofuel harbor tug trials and San Diego’s R99 rollout.

- Identify 2-3 fleets across different segments (e.g., tug, fishing, workboat).
- Work with a fuel producer or distributor to track the carbon intensity (CI) of renewable diesel supplied to the pilot.
- Implement mechanisms to monitor exhaust emissions, including particulate matter (PM), along with engine performance, operational impacts, fuel quality, and blend consistency, and delivered fuel costs throughout the pilot period.
- Report findings publicly to demonstrate feasibility and build regional momentum.

5. Aggregate Demand to Unlock Supply, Tankage, and Pricing Stability: Every fuel producer and distributor interviewed emphasized the same point: while total harbor craft fuel demand in Puget Sound is substantial, it is too fragmented and uncoordinated to justify dedicated renewable diesel supply or new infrastructure investment. Estimated harbor craft fuel use in Puget Sound is ~53 MM gals/yr⁵⁸) a volume that exceeds the minimum demand thresholds suppliers indicated are needed to commit capital. The lowest volume cited was approximately 5 MM gals/yr under multi-year offtake agreements, with larger, longer-duration commitments viewed as materially more bankable. Despite sufficient aggregate demand, the market exhibits a coordination failure. Producers and distributors are unwilling to invest without visible, aggregated, multi-year demand commitments, while individual operators are unable to access reliable and competitively priced RD precisely because supply and dedicated infrastructure have not materialized. Breaking this cycle requires intentional demand aggregation across operators, vessel classes, and public and private fleets to translate existing demand into bankable market signals.

Next steps:

- Stand up a Sustainable Maritime Fuels Consortium anchored in marine demand but explicitly designed to aggregate demand across modes and fleets, including:
 - Tug operators
 - Fishing cooperatives
 - Workboat operators
 - Port public fleets
 - Large anchor fleets (e.g., ferries)
 - Fuel producers and distributors (as non-exclusive supply partners)

⁵⁸ Note: This number was estimated based on the CO₂e, SO_x and NO_x values from the Puget Sound Maritime Air Forum – 2021 PSEI (Table 4.3) – [Link](#) – and then estimated using [EPA GHG Equivalencies Calculator](#)

- Structure aggregated, multi-year offtake commitments that translate existing but fragmented demand into bankable volumes, by combining harbor craft fuel use with larger, creditworthy diesel consumers (e.g., ferries and other port-adjacent fleets) to reach investment-grade thresholds (e.g., ≥ 5 MM gal/yr over 5+ years).
- Use pilot outcomes and credit modeling to inform pricing, CI specifications, delivery logistics, and contract structures, reducing perceived risk for both suppliers and operators.
- This multimodal aggregation approach sends the durable market signal producers and distributors need to:
 - Dedicate renewable diesel volumes to Washington
 - Invest in segregated marine tankage and blending infrastructure
 - Improve pricing stability and delivery reliability for harbor craft

It also establishes the foundation required to scale infrastructure investments (Recommendation 6) and to enable viable Scope 3 value-transfer mechanisms (Recommendation 7).

6. Build a Future-Focused Infrastructure Plan that Scales with Growing Demand:

Infrastructure must not be built prematurely but must be ready once demand materializes. As demand grows, supply and the infrastructure necessary to transport, store, and blend those fuels must also scale with market growth.

Next steps:

- Conduct a renewable bunkering infrastructure analysis focused on:
 - Segregated RD tankage
 - Marine-grade blending systems
 - Dock upgrades and pipelines
 - CI-tracking capabilities
 - Permitting pathways and capital structures

This plan prepares the Port to deploy investments strategically and ensures that supply-chain reliability improves, not deteriorates, as more vessels adopt RD. As marine fueling storage and infrastructure in the Seattle-Tacoma gateway is privately owned and operated, this effort would involve partnership with fuel producers and distributors.

7. **Design a Scope 3 Market that makes Low-Carbon Fuels Economically Viable:** Marine operators cannot absorb green premiums because there is no commercial framework that rewards them for using lower-carbon fuels. Without a functioning Scope 3 market or a way to transfer emissions reductions to customers, fleets have no pathway to recover incremental RD/BD costs, suppressing demand and slowing adoption.

Next steps:

- Develop a Port-led Scope 3 emissions accounting and attribution framework enabling operators to document, certify, and transfer emissions reductions to customers.
- Explore green-corridor agreements, voluntary “Low-Carbon Marine Fuel” programs, or shipper–operator contracting models that allow fleets to monetize low carbon fuel use.
- Integrate Scope 3 value mechanisms into broader decarbonization pathways so early adopters are not financially penalized as RD/BD markets mature.

12. The Path Forward

Washington's maritime sector is technically ready for renewable fuels, particularly RD. Vessels can use it without modification, operators are interested, and experience from other jurisdictions has demonstrated that the fuel performs as intended. Yet renewable marine fuels have struggled to take hold in Puget Sound not because of technical limitations, but because the surrounding market system has not been designed for success. Inconsistent supply, limited tankage, weak and volatile credit signals, unresolved warranty concerns, and the absence of a commercial pathway for operators to recover green premiums have collectively constrained adoption.

At the same time, this assessment reveals a clear and actionable opportunity. Across producers, distributors, vessel operators, and OEMs, there is broad willingness to move if the right enabling conditions are put in place. Stakeholders consistently emphasized that progress depends less on modern technology and more on economic clarity, operational certainty, and coordinated market signals. The pathway outlined in this report responds directly to those needs, presenting a self-reinforcing strategy to move from technical readiness to reliable, scalable deployment.

This progression mirrors the experience of global leaders in maritime decarbonization, from California to Amsterdam and Singapore, who first established the business case, then resolved technical and warranty concerns, validated real-world operations through pilots, and only then scaled infrastructure and long-term supply agreements. The same logic applies in Puget Sound. Specifically, this roadmap:

- Establishes the economic foundation Washington has lacked through credit and carbon-intensity modeling.
- Resolves long-standing warranty uncertainty through coordinated OEM and fuel-producer guidance.
- Aligns decarbonization pathways to operational reality through segment-specific strategies for tugs, fishing vessels, workboats, and government fleets.
- Converts interest into evidence through multi-vessel pilots that validate performance, cost, and supply logistics before demand scales.

A central insight of this assessment is that the barrier is not insufficient demand, but insufficient coordination of that demand. Estimated harbor craft fuel use in Puget Sound is ~53 MM gals/yr, a volume that exceeds the minimum thresholds producers and distributors

identified as necessary to justify dedicated supply and infrastructure investment. However, this demand is fragmented across vessel classes, operators, and fueling arrangements, and is not currently organized into the aggregated, multi-year offtake commitments required to unlock capital.

Unlocking supply therefore requires multimodal demand aggregation, using harbor craft as an entry point but not the ceiling. By aligning marine demand with larger, creditworthy diesel users, such as ferries and other port-adjacent fleets, the Ports can help translate existing fuel use into durable, investment-grade market signals that attract supply, stabilize pricing, and enable dedicated tankage and distribution infrastructure.

Finally, designing a workable Scope 3 framework is essential to sustaining adoption. Without a mechanism to document, attribute, and transfer emissions reductions, marine operators have no way to capture the value of lower-carbon fuels and are left to absorb higher costs. Integrating Scope 3 value transfer into broader decarbonization pathways ensures that early adopters are rewarded rather than penalized and that voluntary markets can function alongside regulatory programs as renewable fuel markets mature.

Taken together, these actions move the Ports from today's fragmented conditions toward a resilient renewable fuels ecosystem, one that supports local fleets, strengthens regional competitiveness, and accelerates the transition toward zero-emission maritime operations. The Port of Seattle can play a uniquely catalytic role by lifting coordination barriers, convening cross-sector stakeholders, and aligning policy, infrastructure, and market design around a shared, investable pathway. With this roadmap, and in partnership with regional stakeholders, Washington can convert technical readiness into a reliable, scalable market for renewable marine fuels in Puget Sound.

13. Appendix

Previous Report: Port of Seattle Commercial Harbor Craft Decarbonization

Role of the Study

- Engaged 13 CHC operators (tugs, fishing, tourism, shipyards) to shape the Port of Seattle’s next steps, with a primary focus on electrification and hybrid vessels, and a secondary lens on alternative fuels.

Key Takeaways	
Optimistic	<ul style="list-style-type: none"> Strong sector-wide interest in electrification and hybridization. Broad support for a Puget Sound-wide charging network with the port as convener. Hybrid vessels seen as realistic near-term steps. Openness to alternative fuels, with RD/BD and hydrogen most favored.
Cautious	<ul style="list-style-type: none"> Full electrification limited by battery size, vessel power needs, and cost. High capital costs for newbuilds/retrofits, especially for small operators. Charging standards, grid capacity, and permitting remain major gaps. Regional coordination is essential to avoid misaligned infrastructure.
RD/BD Implications for Harbor Craft	<ul style="list-style-type: none"> Many operators have experience with BD or RD (including R99 in CA). RD/BD viewed as low-disruption, drop-in options for near-term emissions cuts. Especially useful while operators plan hybrid/electric transitions or face long vessel replacement cycles. Help align with evolving regulatory expectations (e.g., CA CHC rules).

Time Horizon / Role

- Primary pathway: electrification/hybridization.
- RD/BD: complementary, transitional fuels for hybrid vessels and hard-to-electrify routes; not the long-term end state.

Operator-Level Signals

- Opportunities:

- Engine compatibility, no major vessel modifications, operational familiarity.
- Supports compliance and reduces emissions during fleet turnover.
- Barriers:
 - Price premiums, supply uncertainty in WA vs CA, and limited long-run climate benefits.

Key Takeaways

RD/BD are practical, operator-friendly bridge fuels, but long-term decarbonization centers on electrification, hybrids, and ZE systems.

Electrification Feasibility

- Electrification is technically possible for many harbor craft, but not universally feasible due to route length, duty cycles, and vessel constraints.
- Short, predictable routes (e.g., small ferries, harbor tugs) are the strongest candidates for electrification today.
- Battery system integration (USCG rules, isolation/void spaces, weight, space constraints) is one of the biggest physical blockers.
- Electrification is not viable for many fishing vessels or long-route tugs without diesel backup.

Major Barriers

- Infrastructure (Top red-level theme across the doc)
 - Lack of shore power is the single largest obstacle in Puget Sound.
 - Existing dock power (often 240V) is far too weak for fast charging.
 - No universal charging standard for marine vessels yet.
- Capital Costs
 - New hybrid or electric vessels cost 30–200% more than diesel.
 - Retrofitting older vessels is often not financially viable.
 - Small operators are at risk of being left behind, which will lead to potential consolidation of the market.
- Operational Constraints
 - Battery weight and volume severely limit design.
 - Range is insufficient for long tows, fishing trips, or multi-day work.
- Utilities & Grid Issues
 - Demand charges undermine economics

- Example: Crowley has to limit average load to <500 kW to avoid penalties).
- Most ports do not have anywhere near the required grid capacity.

RD & Biofuels

- RD (R99) is widely seen as the most viable near-term decarbonization pathway.
- Supply is constrained because California absorbs nearly all available RD.
- Many operators want RD but can't reliably source it in WA today.

Hydrogen / Ammonia / Methanol

- Hydrogen and ammonia are viewed as long-term, not near-term.
- Safety concerns (H₂ explosions, ammonia toxicity) repeatedly mentioned.
- Methanol shows interest but lacks bunkering and infrastructure.
- Batteries outperform hydrogen for most CHC use cases in the near term.

Market Readiness & Operator Attitudes

- Operators want to decarbonize but refuse to compromise reliability or safety.
- There is a strong “show me it works” mindset – no one wants to sacrifice uptime.
- Many fleets are old, slowing adoption of new propulsion systems.

Key Takeaways from Past Interviews

These interviews covered perspectives from vessel operators, shipyards, fuel suppliers, port authorities, and regulators. They provide a granular look at the state of electrification, RD, BD, methanol, and other fuels (hydrogen, ammonia, LNG/bio-LNG, RNG) in the PNW maritime sector. Below are the key insights grouped by pathway.

Electrification

Only a small share of harbor craft can ever go fully electric, but hybrids can deliver 25–50% fuel savings now and are seeing rapid uptake.

- Full electrification is constrained by battery weight, sourcing, limited range, dockside power shortages, and Coast Guard rules requiring diesel backup.
- Hybrid requests are rising 30–40%, while true electric demand remains limited to near-shore tourism vessels.

- Charging is the biggest barrier: most docks lack 480V/100A service, and fast charging (1,000A+) is unrealistic without major grid upgrades.

Implication: Ports should prioritize hybrid vessels + shore-power buildout, not full electric.

Renewable Diesel (RD / HVO)

RD is the fastest, lowest-risk decarbonization tool, but California absorbs ~99% of U.S. supply, leaving little for maritime in WA.

- Strong drop-in fuel: up to 80% GHG cuts, no engine modifications, positive operator experience.
- Economics improve under LCFS/CFS, but maritime loses out because it cannot generate RINs, pushing RD toward road and aviation.
- Long-term scalability is limited by global feedstock constraints.

Implication: RD is a bridge fuel, not a long-term strategy; WA should push for maritime credit parity and secure regional supply.

Biodiesel (BD)

BD can cut 50–85% GHGs but is operationally inconsistent and constrained by warranties, cold flow issues, and California restrictions.

- B20–B30 widely used; B50–B100 possible but risky.
- Higher blends cause filter clogging, microbial growth, and water absorption in some fleets.
- Competes with SAF and on-road markets and receives no RIN/LCFS maritime support.

Implication: BD is helpful but niche; best treated as part of a diversified portfolio rather than a primary fuel.

Methanol

Methanol is the most commercially advanced zero-carbon liquid fuel, with real orders underway, but PNW has zero infrastructure today.

- Storage and transfer volumes double due to low energy density.
- No WA regulations yet; formal methanol bunkering rules expected ~2028.

- High capex (tanks, pipelines, barges) and unclear community acceptance remain major risks.

Implication: Ports must choose whether to move early to become a transpacific hub or wait until demand solidifies.

Hydrogen, Ammonia, LNG/RNG

All three are future options, but each faces large, and different, barriers.

- Hydrogen: Technically immature; suitable mainly for pilots and auxiliary loads before 2035.
- Ammonia: High decarbonization potential but safety, toxicity, and regulatory gaps push commercial use into the 2030s.
- LNG/RNG: Viable bridge but threatened by methane slip and tightening IMO climate rules. Bio-LNG supply is limited.

Implication: Ports should stay flexible, support pilots, and avoid overbuilding single-fuel infrastructure.

Conclusion (Cross-Cutting)

No single fuel solves maritime decarbonization.

Electrification delivers the largest near-term cuts through hybrids, RD is the fastest drop-in solution but supply-limited, BD is helpful but inconsistent, methanol is the strongest long-term liquid fuel but requires major infrastructure, and hydrogen/ammonia/LNG require significant safety, policy, and technological progress.

Other Key Information

Oregon's Clean Fuels Program (CFP)⁵⁹

CFP, administered by the Department of Environmental Quality, is a statewide low-carbon fuel standard that requires a gradual reduction in the average lifecycle GHG emissions per unit of energy from transportation fuels used in the state. Using a 2015 baseline, the program currently targets a 10% CI reduction by 2025, 20% by 2030, and 37% by 2035, applied to the

⁵⁹ Oregon Dept. of Environmental Quality – Oregon CFP – [Link](#)

combined gasoline and diesel pool rather than individual fuels. Like California’s LCFS, the CFP is technology-neutral and uses a credit/deficit system: fuels with CI below the annual standard generate credits, and higher-CI fuels generate deficits that regulated parties must cover by purchasing credits or blending in lower-carbon options. Lifecycle CI values are based on GREET-style models approved by DEQ, and electricity, biofuels, renewable diesel, and other alternative fuels can all earn credits as they displace fossil gasoline and diesel.

New Mexico’s Clean Transportation Fuel Program (CTFP)⁶⁰

CTFP, authorized by HB 41 in 2024 and implemented by the Environment Department’s Climate Change Bureau, is the newest state clean fuel standard and is being designed to mirror the credit-trading structure in CA, OR, and WA. The program will set declining CI standards for transportation fuels used in New Mexico, requiring at least a 20% reduction in average CI below 2018 levels by 2030 and 30% by 2040.

Fuel producers and importers that supply fuels below the CI standard will generate tradable credits, while those whose fuels exceed the standard will incur deficits and need to buy credits or lower their CI. Rulemaking is underway, but the intent is a technology-neutral, market-based program that both cuts transport emissions and stimulates in-state investment in low-carbon fuels, including electricity and advanced biofuels.

CA CHC Regulations

Benefits of Tier 4 Engines

- Tier 4 engines, though more complex than Tier 3, offer greater fuel efficiency and lower long-term operational costs.
- Their advanced emission-control systems enhance overall performance and align with sustainability goals by achieving low NOx, PM, HC, and CO emissions.⁶

Current Opportunities

- Adopting Tier 4 engines and DPFs delivers cleaner air and health benefits, future-proofs vessels against stricter regulations and enhances fuel efficiency.⁶
- California’s requirement to meet or exceed Tier 4 standards positions it as a leader in maritime emissions reduction.³

⁶⁰ New Mexico Environment Department – Clean Transportation Fuel Program – [Link](#)

Current Risks

- Upgrading to Tier 4 engines and installing DPFs require significant capital and cause downtime, leading to lost revenue and temporary layoffs.³
- Compliance also involves rigorous testing, certification, and recordkeeping, increasing administrative complexity.⁶
- Although extensions are available, full sector compliance may take years, and the mandate to repower before the normal end of life adds financial pressure.

PSEI Harbor Vessel Review

Type	NO _x	VOC	CO	SO ₂	PM ₁₀	PM _{2.5}	DPM	BC	CO _{2e}
➡ Assist/Escort	1,115	21	194	0.6	26.7	25.8	26.7	20.1	66,912
Commercial fishing	180	5	29	0.1	6.2	6.0	6.2	4.7	12,396
Derrick barge	25	1	4	0.0	0.9	0.8	0.9	0.7	2,024
Excursion	106	225	411	0.1	7.8	7.3	3.4	2.9	10,016
Ferry	3,652	57	771	2.2	69.6	67.0	69.3	52.2	247,330
Government	151	13	112	0.1	4.4	4.2	4.2	3.2	11,657
➡ Harbor tug	546	15	112	0.4	14.1	13.7	14.1	10.6	50,262
➡ Ocean tug	971	17	185	0.6	20.5	19.7	20.5	15.3	71,450
Tank barge	17	1	3	0.0	0.4	0.4	0.4	0.3	2,263
Workboat	21	22	66	0.0	0.8	0.7	0.4	0.3	2,668
Total	6,784	377	1,887	4.1	151	146	146	110	476,977

Fig 22: 2021 Puget Sound Total Area Commercial Harbor and Govt. Vessel Emissions, tpy²²
As highlighted above, ferries dominate total harbor-craft emissions, by a wide margin, while ocean tugs and harbor tugs are the next most significant emitters, especially NO_x, PM, and CO_{2e}.

Type	Vessel		Engine			Model year			Horsepower			Annual Hours		
	Count	Count	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
➡ Assist/Escort	14	31	1981	2005	1995	1,500	5,100	2,899	1,392	3,364	2,763			
Commercial fishing	382	750	1913	2017	1975	100	6,200	922	48	96	48			
Derrick barge	14	0	na	na	na	na	na	na	na	na	na			
Excursion	63	114	1970	2018	1998	85	2,200	388	0	3,000	824			
Ferry	40	99	1959	2017	2000	300	3,300	2,089	0	6,836	4,112			
Government	48	86	1968	2021	2007	0	3,017	690	0	6,549	444			
➡ Harbor tug	60	111	1951	2021	1999	65	2,200	889	0	6,500	1,476			
➡ Ocean tug	34	68	1965	2017	1995	1,000	5,000	2,146	0	4,509	1,217			
Pilot boat	2	4	1999	2001	2000	1,100	1,100	1,100	763	834	799			
Tank barge	22	0	na	na	na	na	na	na	na	na	na			
Workboat	27	40	1989	2016	2006	15	600	282	125	1,360	707			
Total	706	1,303												

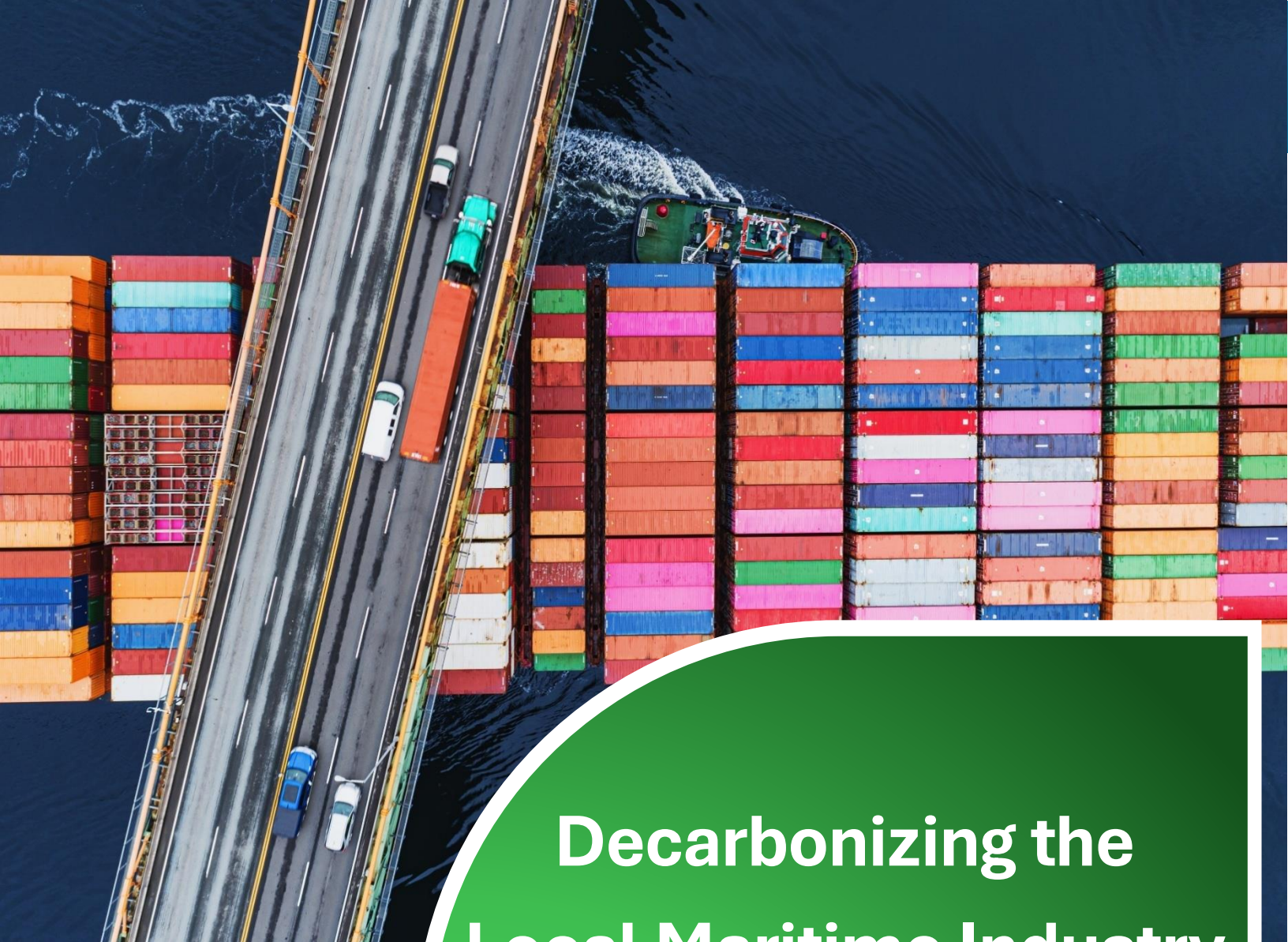
Fig 23: 2021 Commercial Harbor and Government Vessel Propulsion Engines⁶¹

⁶¹ Puget Sound Maritime Air Forum – Puget Sound Maritime Air Emissions Inventory – [Link](#)

Type	Vessel		Engine			Model year			Horsepower			Annual Hours		
	Count	Count	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Assist/Escort	14	32	1977	2016	2001	101	550	201	530	5,811	2,856			
Commercial fishing	382	377	1913	2017	1977	100	1,609	374	48	96	48			
Derrick barge	14	50	1963	2017	1993	20	2,800	288	2	1,625	688			
Excursion	63	41	1974	2017	1999	7	99	40	0	2,000	445			
Ferry	40	89	1959	2021	2002	13	1,210	361	0	7,567	2,430			
Ferry boilers		43	1959	2015	2002	60	60	60	0	3000	1,123			
Government	48	11	1968	2014	1999	19	1,555	690	50	674	674			
Harbor tug	60	80	1975	2021	2006	17	180	99	0	6,500	1,385			
Ocean tug	34	77	1968	2017	1999	75	311	157	0	3,570	985			
Pilot boat	2	4	1999	2001	2000	43	50	47	327	357	342			
Tank barge	22	99	2000	2015	2009	25	441	266	0	3,259	390			
Workboat	27	7	1990	1990	1990	30	85	58	250	500	350			
Total	706	910												

Fig 24: 2021 Commercial Harbor and Government Vessel Auxiliary Engines ²³

According to Fig. 4 and 5, (excluding ferries) tugs are the true heavy lifters of the harbor, operating with the highest horsepower, the longest annual run times, and some of the largest multi-engine configurations. Their uniquely intense work profile makes them the most energy- and emissions-dominant vessels in the harbor fleet, and therefore a critical and challenging target for decarbonization.



Decarbonizing the Local Maritime Industry

An Assessment of Renewable Fuel
Potential for Harbor Craft in the Puget
Sound

Supplemental Doc I | December 2025

This report and the associated supplemental materials were prepared by Earth Finance in support of the Port of Seattle, based on the research, technical assessment, and stakeholder interviews conducted during the project period. The analysis, findings, and recommendations represent Earth Finance’s best judgment at the time, drawing on information available as of the publication date, and are provided for informational purposes only. The opinions, findings, and conclusions expressed in this report are those of Earth Finance and do not necessarily reflect the views of the Port of Seattle or any of its commissioners, employees, or partners.

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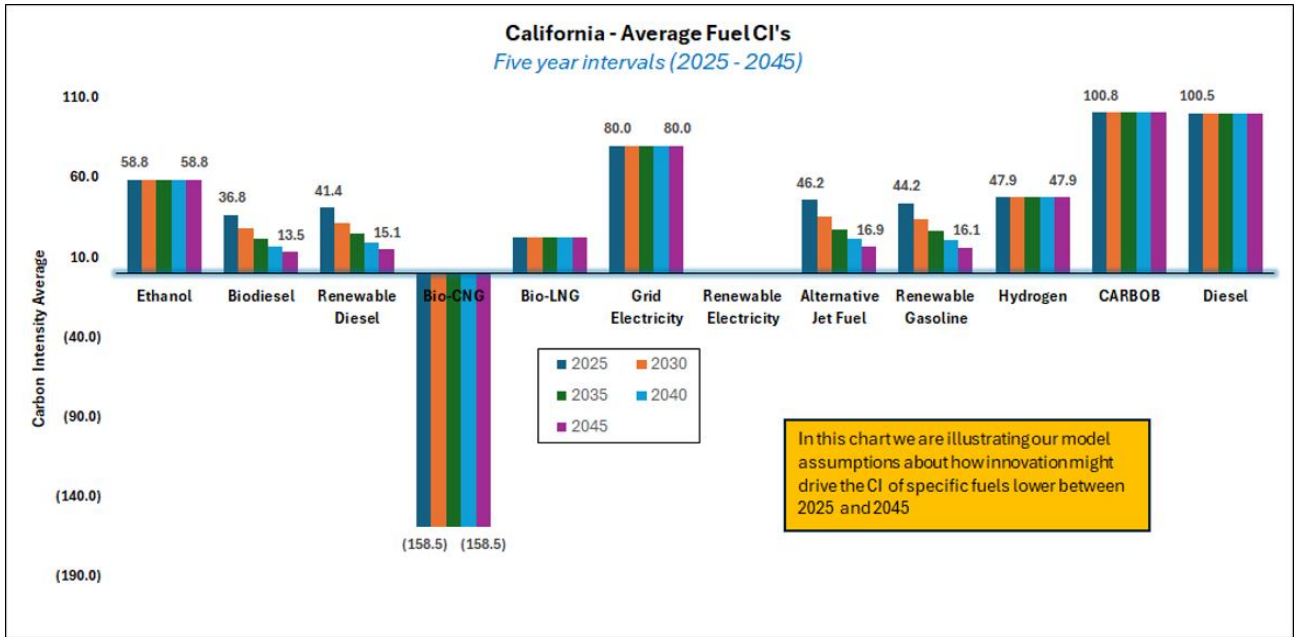
Credit Price Projection

California's LCFS

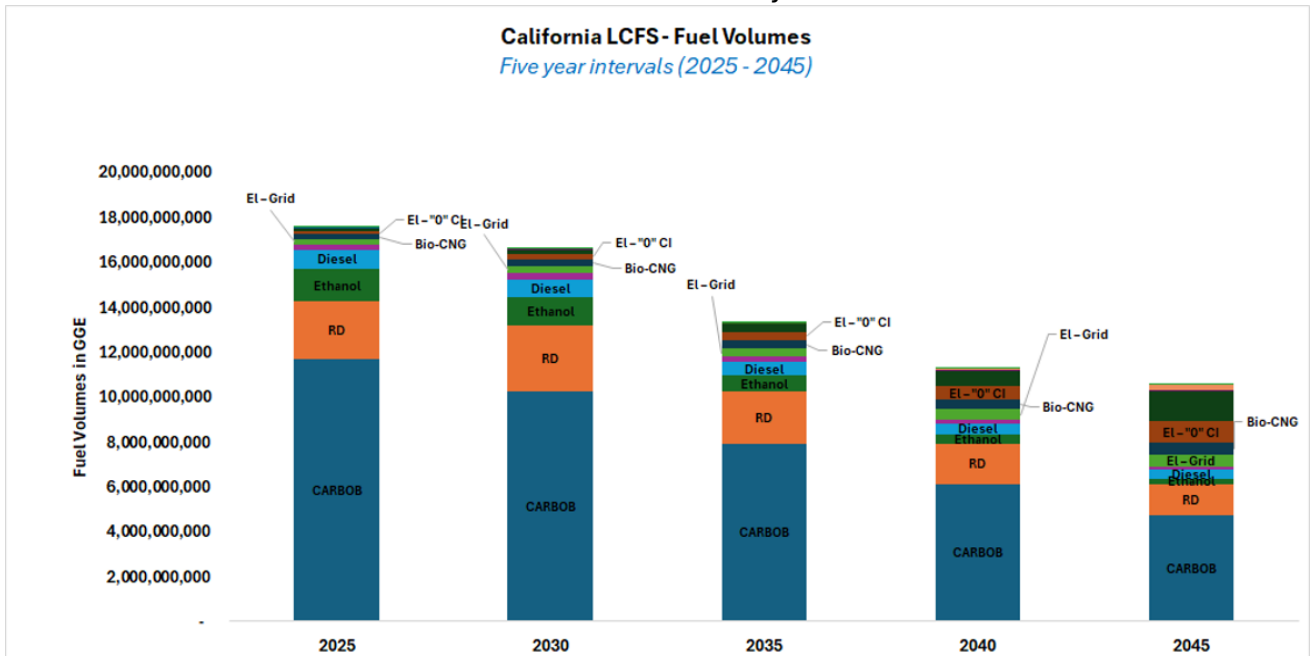
A clean fuels market model was developed to help reduce uncertainty around future clean fuel credit markets and support more informed planning by fuel suppliers, infrastructure developers, and end users. The model provides a quantitative, transparent framework to examine how changes in clean fuel policies, such as more stringent CI targets, may influence credit and deficit generation, renewable fuel demand, and credit pricing over time. As LCFS-type programs increasingly shape investment decisions related to renewable diesel production, SAF expansion, biofuel infrastructure, and other low-carbon technologies, tools like this will be increasingly important for evaluating market dynamics and managing risk in the coming years.

The model was initially calibrated to California, where in 2024–2025, CARB finalized a new set of amendments that substantially accelerate and deepen the CI reduction trajectory, with targets now set to achieve approximately 30 % CI reduction by 2030 and 90 % reduction by 2045 from a 2010 baseline. These updated benchmarks were approved by CARB and then by the California Office of Administrative Law (OAL), and the amended LCFS regulation took effect on July 1, 2025. These changes will alter the balance of credit generation and deficits, with implications for future credit availability and prices. While California is the starting point, the model approach we developed is designed to be transferable to other Clean Fuel Standard markets on the West Coast and other parts of the United States. More specifically, Washington's CFS, with the passage of HB 1409 in 2025, could yield a similar view, deepening our understanding of how revised CI targets could affect credit markets in the state. Several exhibits from the California-based model are included below to illustrate how this type of analysis could be applied to Washington and other markets.

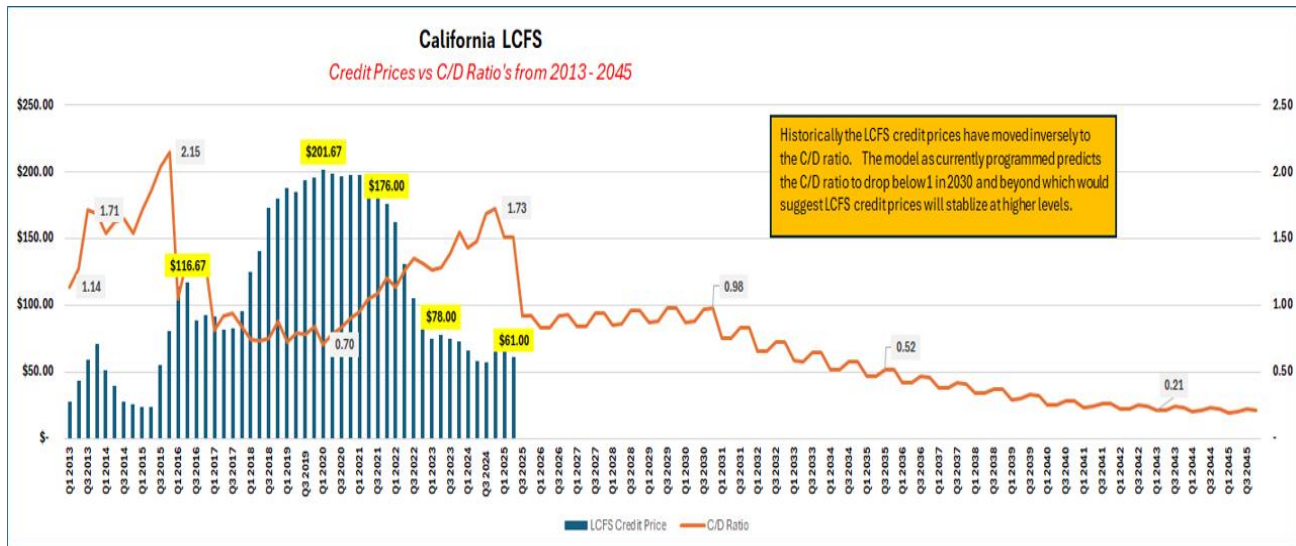
In Exhibit 1 shown below, we are illustrating the projected average CI of major transportation fuels in California from 2025 to 2045, which is a key input to the market model and can be adjusted as fuel pathway technology shifts. For example, RD is assumed to decline from a CI of ~42 in 2025 to about 28 by 2045. These assumptions materially affect projected credit and deficit volumes and will need to be validated and refined as part of scenario development. Given ongoing innovation in fuel pathways, actual CI reductions could be faster than shown, which would meaningfully change market outcomes.



In Exhibit 2, we illustrate the projected mix of California transportation fuels at five-year intervals, showing how total volumes and fuel composition are expected to evolve over the next 20 years. This is critical to estimating future credit and deficit volumes and assessing potential credit price movements. The assumed fuel mix and volumes are broadly consistent with scenarios modeled by CARB.



And finally in Exhibit 3, we have built a combination chart that overlays historical California LCFS credit prices alongside the quarterly C/D ratio. The data show an inverse relationship between the C/D ratio and credit prices, with lower ratios generally associated with higher credit prices. Using this credit market model we can project future C/D ratios in California, which will give us directional guidance on how credit prices will move. Under the more stringent LCFS amendments adopted in 2024, modeled outcomes suggest increased upward pressure on LCFS credit prices in the post-2030 period.



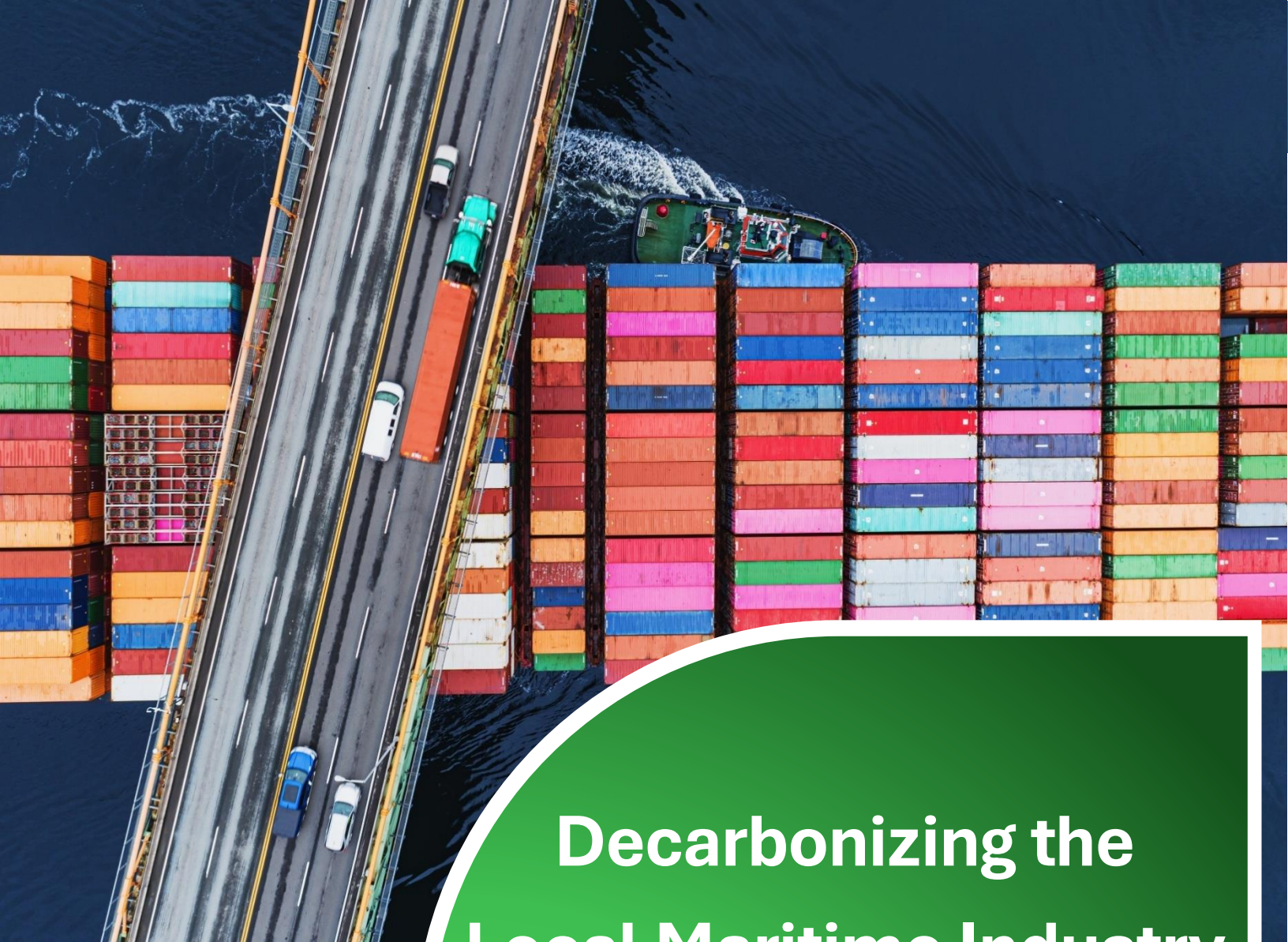
Next Steps and Implications for Washington’s CFS

The California-based modeling framework illustrates how credit supply–demand dynamics and CI trajectories can materially influence clean fuel economics over time. Extending this approach across West Coast clean fuel programs would enable Washington to more clearly understand when and under what conditions its CFS can support competitive deployment of low-CI fuels, including renewable diesel in the marine sector. Key next steps include:

- Multi-market credit competitiveness modeling: Apply a consistent modeling framework across California, Oregon, Washington, and British Columbia to compare credit economics over time and identify when Washington’s CFS is likely to become competitive in attracting low-CI fuels.
- Review of maritime credit treatment: Assess the Washington Department of Ecology’s assumptions and methodologies for credit generation from maritime fuels, including how marine pathways are modeled relative to on-road and aviation fuels and the implications for total credit supply.

- Sensitivity and scenario testing: Evaluate how modeled outcomes change under alternative assumptions, such as faster CI improvements for renewable diesel, accelerated electrification, delayed infrastructure development, or shifts in fuel demand growth.
- Benchmarking for investment signals: Compare modeled Washington CFS trajectories with California and Oregon to assess relative competitiveness, expected credit price behavior, and the strength of investment signals for long-lived assets such as dedicated tankage, blending infrastructure, and multi-year offtake agreements.

Together, these steps would allow Washington policymakers, ports, and market participants to plan infrastructure investments and fuel transition strategies based on clearer expectations of future CFS credit economics, rather than reacting to short-term market signals.



Decarbonizing the Local Maritime Industry

An Assessment of Renewable Fuel
Potential for Harbor Craft in the Puget
Sound

Supplemental Doc III | December 2025

This report and the associated supplemental materials were prepared by Earth Finance in support of the Port of Seattle, based on the research, technical assessment, and stakeholder interviews conducted during the project period. The analysis, findings, and recommendations represent Earth Finance’s best judgment at the time, drawing on information available as of the publication date, and are provided for informational purposes only. The opinions, findings, and conclusions expressed in this report are those of Earth Finance and do not necessarily reflect the views of the Port of Seattle or any of its commissioners, employees, or partners.

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A Sequenced Pathway to Accelerate Renewable Marine Fuels in Puget Sound

Moving from Roadmap to Implementation

This assessment establishes what needs to happen to accelerate renewable marine fuels in Puget Sound. The next step is to determine where to start, how to sequence action, and how to focus limited time and capital on the interventions that matter most. Given market uncertainty, infrastructure lead times, and the need for cross-sector coordination, successful implementation will require a disciplined approach to prioritization, one that balances impact, feasibility, and timing while remaining adaptable as market conditions evolve.

To support this transition from strategy to execution, we recommend that the Port, along with its partners, develop a prioritization scorecard, an impact-versus-feasibility screen, and a time-phased implementation roadmap that converts this report into a shared operating plan.

Proposed Implementation Framework

- 1. Define prioritization criteria (scorecard)**
 - Emissions impact, market-leverage potential, feasibility, delivery risk, and time-to-impact, cost, funding readiness, and scalability (including multimodal aggregation)
- 2. Score and validate actions**
 - Apply the scorecard across the seven recommendations and key sub-actions
 - Ground scores in interview insights, infrastructure constraints, and credit modeling
 - Validate assumptions with core stakeholders
- 3. Prioritize using an impact vs. feasibility lens**
 - Identify “start now” actions (high impact / high feasibility) and defer or redesign low-impact, low-feasibility items
 - Flag actions that require de-risking before launch
- 4. Identify dependencies and sequencing**
 - Clarify prerequisites (e.g., economic clarity and OEM certainty before aggregating demand)
 - Map interdependencies across pilots, aggregation, etc., with clear decision gates
- 5. Develop a phased implementation roadmap (Gantt)**
 - Sequence near-, mid-, and longer-term actions
 - Translate priority actions into workstreams with owners and milestones

- Align timelines with permitting, funding, and market signals
- Define clear KPIs and success metrics