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EER Application for Harbor Craft

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Project / Letter of Intent

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December 30, 2022

Oregon Department of Environmental Quality
800 NE Oregon Street
Portland, OR 97232
Submitted via AFP

Subject: Tier 2 EER Pathway Application for Electricity Supplied to Harbor Craft at Berth

Shaver Transportation Company ("Shaver"), and Sause Bros. Inc. ("Sause"), collectively the applicants, are pleased to jointly apply for a new Energy Economy Ratio ("EER") for electricity supplied to harbor craft at berth, otherwise known as shore power or cold ironing. Both Shaver and Sause have been taking part in the Clean Fuels Program with CleanFuture serving as their credit generator and aggregator under written agreement.

The new definition from the CFP Expansion 2022 Rulemaking clarifies the definition of ocean-going vessels eligible to generate credits under the existing Energy Economy Ration (EER) in Table 7 of OAR 340-253-8010. This category of vessels was previously not defined, and the rule update clarifies that only large vessels qualify to generate credits under this EER as that was the dataset used to establish the EER. Small vessels will not be eligible to generate credits as of Jan. 1, 2023, unless a new EER is approved.

The applicants request a new EER under OAR 340-253-0100 because switching fuel from diesel burned in auxiliary engines while at berth to instead use electricity in harbor craft at berth follows the purpose of the Clean Fuels Program to encourage use of lower carbon fuels, The applicants are providing vessel-specific datasets to establish a new EER for smaller vessels that use grid-supplied electricity instead of operating diesel engines while at berth.

The accompanying data and analyses compute a range of EER value for harbor craft, describes the method used to calculate the EER values, and gives a recommendation for a specific EER for displacement of diesel with electricity while these harbor craft are at berth.

The applicants are available to supply any supplemental information to DEQ to obtain a new EER under this application.

Sincerely,

John A. Thornton
President
CleanFuture, Inc.

Justification for New EER

A new Energy Economy Ratio (EER) is needed for marine vessels that use electricity at berth instead of using diesel fuel. The CFP Expansion 2022 Rulemaking clarifies a definition of ocean-going vessels eligible to generate credits for using electricity at berth under the existing EER in Table 7 of OAR 340-253-8010. The new definition places size limits on ocean-going vessels, such that smaller vessels will not be eligible to generate credits as of Jan. 1, 2023, unless a new EER is approved.

Because the vessels at Sause and Shaver all fall below the size thresholds set for ocean-going vessels, each applicant's fleet becomes ineligible under the new CFP rules for electricity displacing diesel fuel. So, a new EER is needed for these smaller vessels.

Description of Fuel Vehicle Technology

We consider it critical to define a new vehicle class for smaller marine vessels, such that it not only covers the specific vessels relevant to this EER application, but can cover all reasonably similar vessels that would benefit from utilizing electricity at berth. Fortunately, the California Air Resources Board (CARB) has already developed such a definition. As of December 30, 2022 new CARB regulations have gone into effect for the purpose of regulating conventional air pollutants from "harbor craft." CARB defines this vehicle class specifically as a complement to ocean-going vessels, as follows:

> "Harbor Craft" means any private, commercial, government, or military marine vessel including, but not limited to, passenger ferries, excursion vessels, tugboats, ocean-going tugboats, towboats, push boats, crew and supply vessels, work boats, pilot vessels, supply boats, fishing vessels, research vessels, barge and dredge vessels, commercial passenger fishing vessels, oil spill response vessels, U.S. Coast Guard vessels, hovercraft, emergency response harbor craft, and barge vessels that do not otherwise meet the definition of ocean-going vessels or recreational vessels.[1]

With Oregon's harmonization of the definition of ocean-going vessels with California, the applicants suggest a similarly harmonized definition of harbor craft.

For a summary of engine profile data found in California harbor craft, refer to Appendix H.[2] The applicants surveyed 32 vessels with 65 auxiliary engines as a representative sample of auxiliary engines in Oregon harbor craft and found similar engine profiles in Oregon.

The specific, low-carbon fuel technology involves use of grid-supplied electricity in vessels at berth to displace diesel fuel burned at berth; known as "shore power" or "cold ironing" or "alternative marine power ("AMP") as common industry terms for describing the use of shoreside electric power while a vessel's main and auxiliary diesel engines are turned off.

Vessels are commonly powered by diesel-fueled engines to provide a) propulsion for vessels, and b) auxiliary engines that drive onboard generators for electricity or that directly drive onboard components. When vessels are stationary at berth the propulsion engine(s) are typically switched off, yet because electricity is necessary to power onboard systems such as lighting, electronics, refrigeration, and HVAC (heating, ventilation, and air conditioning), a secondary power source is necessary. Conventionally, this secondary power source consists of auxiliary engines that burn diesel fuel at berth. The purpose of this application is to develop an energy economy ratio (EER) for using shore-side electricity at berth instead of combusting diesel fuel in auxiliary engines.

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[1] 17 CCR 93118.5(d), available at https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2021/chc2021/chcfro.pdf, accessed on December 28, 2022.

[2] CARB, Appendix H - 2021 Update to the Emission Inventory for Commercial Harbor Craft: Methodology and Results, available at https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2021/chc2021/apph.pdf.

Emissions from harbor craft are produced by the propulsion engines (or main engines) and auxiliary engines that supply power or directly drive other onboard components. Most vessels have one or more auxiliary engines. While the main engines generally have more horsepower, the auxiliary engines can also contribute to health risk and greenhouse gas emissions as they are often run continuously over long periods of time and can often be run at berth near population centers.

Electrical power for vessel operations can be provided to a ship at berth via electrical cables using shore-side electrical power, or called shore power, letting the vessel shut down their auxiliary engines. Shore power requires installation of equipment both at the terminal and on the vessel itself. Providing shore power at a terminal involves upgrading equipment on the shore-side, which may include upgrading equipment at the main substation, installing a shore power substation near the berth, installing one or more shore power connections at the berth, and running power cabling among these three points. The specific equipment at each point depends on the needs of the vessels at berth.

Equipping a vessel with shore power requires installing a connection system to the vessel, which comprises the power cable(s), connectors (plugs and receptacles), and a cord management system, a shore power connection panel to safely relay the power to the vessel, and lastly a power transformer to condition the power to the voltage required on the vessel. See Figure 1 for a block diagram example.

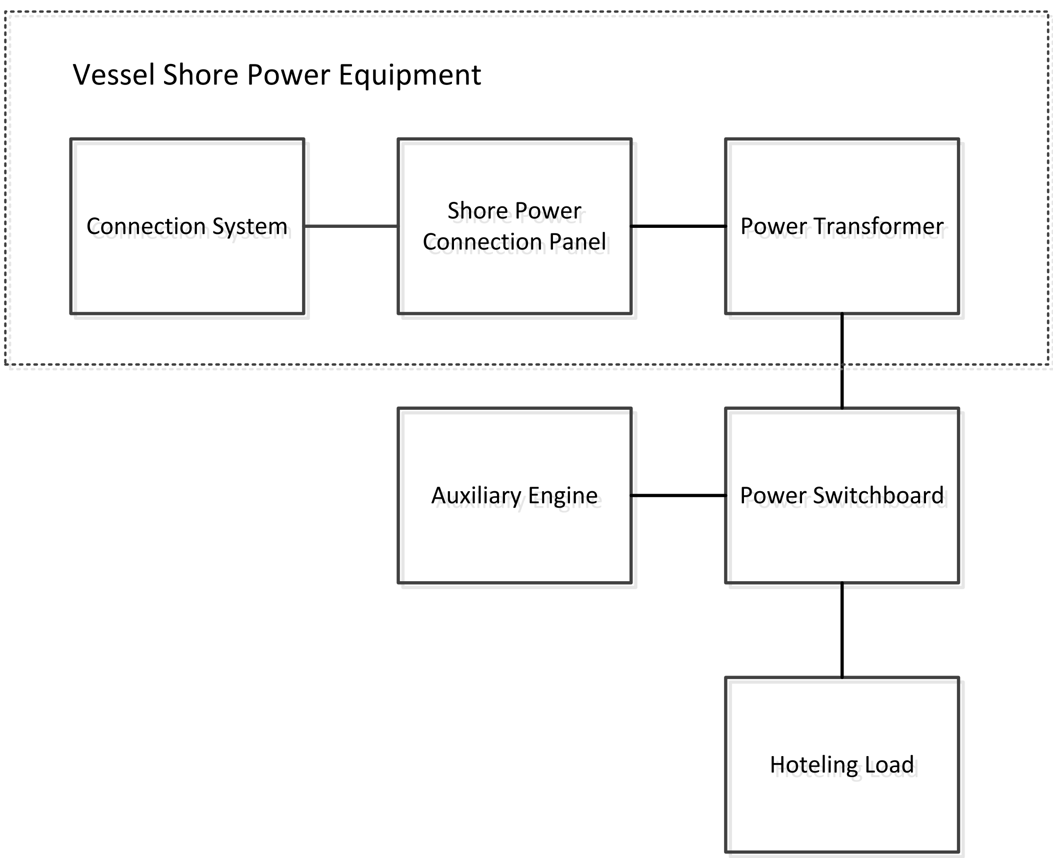

Figure 1 - Typical Configuration for Commercial Vessel with Shore Power

While running on shore power, a vessel's auxiliary engines are turned off resulting in zero emissions from the auxiliary engines during the time shore power is used. The auxiliary engines while far lower in power when compared to main engines, are often run continuously during a vessel's stay at port and are responsible for essentially all the emissions while the vessel is at berth.

Displacement Baseline

The displacement baseline is harbor craft combusting diesel fuel with an energy density of 134.47 MJ/gal, in a reciprocating engine. Diesel fuel is the default fuel used in harbor craft auxiliary engines.

Proposed EER value

The applicants propose the **EER of 3.0** apply for harbor craft using shore power electricity as a fuel switch instead of using auxiliary diesel engines at berth. Vessel-specific EER values were computed for each of the 13 harbor craft in the study accompanying this application, as shown in Table 1. Instead of unique and discrete EER values for each vessel, a single EER value of 3.0 is proposed because it is impractical to identify, track and attribute electricity use on discrete harbor craft for these and other working vessels. The value of 3.0 is proposed as a conservative EER upon reviewing vessel-specific data across the 13 commercial vessels studied for this application.

Table 1: Computed EER values in a sample of harbor craft

Vessel Data Summary

ID	Vessel Name	SURVEY	SURVEY	SURVEY	MANF SPEC	METERED	CALCULATED
Vessel ID	Name	Vessel Type (e.g., tugs, ferries, barge, dredge, crew&supply)	Engine Make	Rated Brake Horsepower	Diesel Fuel Consumption (gal/hr)	Electricity kW	EER
1	BlackHawk	Ocean Towing	John Deere	162	1.8	18.4	3.6
2	Natoma	Ocean Towing	John Deere	162	1.8	4.4	4.2
3	Navajo	Ocean Towing	John Deere	162	1.8	11.5	5.8
4	Titan	Ocean Towing	Caterpillar	99	1.8	16.8	4.0
5	Klihyam	Ocean Towing	John Deere	162	1.8	12.7	5.3
6	Mikiona	Ocean Towing	John Deere	162	1.8	16.5	4.1
7	Geronimo	Ocean Towing	John Deere	162	1.8	12.1	5.5
8	Cochise	Ocean Towing	John Deere	162	1.8	16.8	4.0
9	Mikiona	Ocean Towing	John Deere	162	1.8	15.1	4.5
10	Cascades	Tug (Barge)	John Deere	99	2.9	36.3	3.0
11	Portland	Ship Assist	John Deere	175	4.4	36.0	4.6
12	Vancouver	Ship Assist	Cummins	115	1.0	10.3	3.8
13	Samantha S	Ship Assist/Escort	John Deere	317	5.9	65.9	3.3

A sample EER calculation is shown in Equation 1 using Vessel 10 as a representative example.

Equation 1: EER Calculation in Vessel 10

$$EER = \frac{2.9\ \ gal/hr\ \times 134.47\ \ MJ/gal}{36.3\ kW\ \ \times 3.6\ MJ/kWhr} = 3.0$$

It is noted that though the proposed EER value of 3.0 is greater than the 2.6 EER value for ocean going vessel in Table 7 of OAR 340-253-8010, harbor craft auxiliary engines resemble the diesel engines used in heavy-duty on-road trucks which have an EER value of 5.0 for heavy-duty electric trucks and buses. An EER value of 3.0 seems reasonable considering that the auxiliary engine application runs at a controlled 1,800 RPM compared to an on-road engine application with a dynamic operating range for acceleration/deceleration and hills with greater variability. Also, the Table 7 value for eOGV at berth was determined for large ocean-going vessels using data for OGVs at-anchorage as a surrogate for auxiliary engine usage at berth using a top-down analysis.[3]

Explanation of data and assumptions

Each harbor craft in the applicants' fleets draws shore power at a different rate (measured in kilowatts, or kW) at different times. For each harbor craft the median kW value was used for calculating the EER, this was selected as the most proper summary statistic to characterize electric demand from hotel electric loads. The median is a more appropriate value instead of the maximum value that was earlier proposed to staff; the maximum value is an outlier as seen in the histogram in Figure 2 and the box and whisker plot in Figure 3. The median kW value was used to accommodate skewed distributions and outliers because the median does a better job of describing the center of the distribution than the mean, with typically a greater number of higher value outliers than lower value outliers across the vessel dataset.

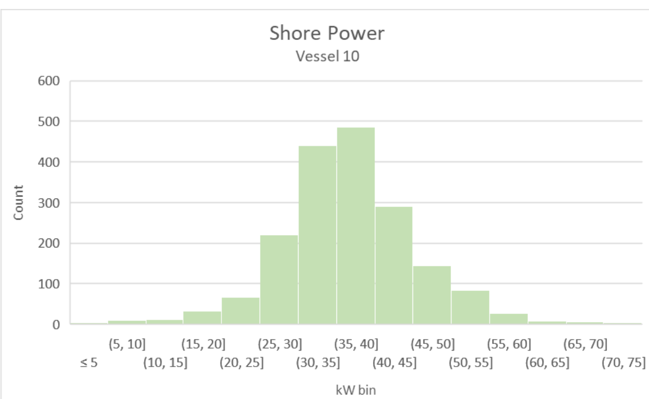

Figure 2: Shore Power kW Distribution for Vessel 10

[3] CARB, Notice of Public Availability of Modified Text and Availability of Additional Documents and Information: Proposed Amendments to the Low Carbon Fuel Standard Regulation and to the Regulation on Commercialization of Alternative Diesel Fuels, June 20, 2018. *Attachment D, Analyses Supporting the Addition or Revision of Energy Economy Ratio Values for the proposed LCFS Amendments.* Accessed at https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2018/lcfs18/15dayattd.pdf?_ga=2.81911263.811679091.1672949453-563133811.1644216503 on December 26, 2022.

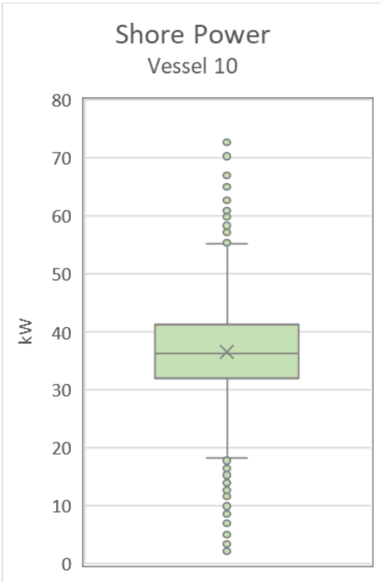

Figure 3: Shore Power Distribution in Vessel 10

The data collection at Sause comprised of a sub-meter collecting aggregated kWh supplied to the distribution panel providing power to many berth locations, a representative metering diagram is shown in Figure 2. Vessel logs were analyzed to determine whenever only a single vessel was at berth to compute vessel-specific EERs for individual vessels. Whenever multiple vessels were at berth the sub metered data was omitted from the study which was the reason for relatively short data periods for vessel numbers 3, 5, 6, 7, 8, and 9 because these vessels overlapped with other vessels at berth.

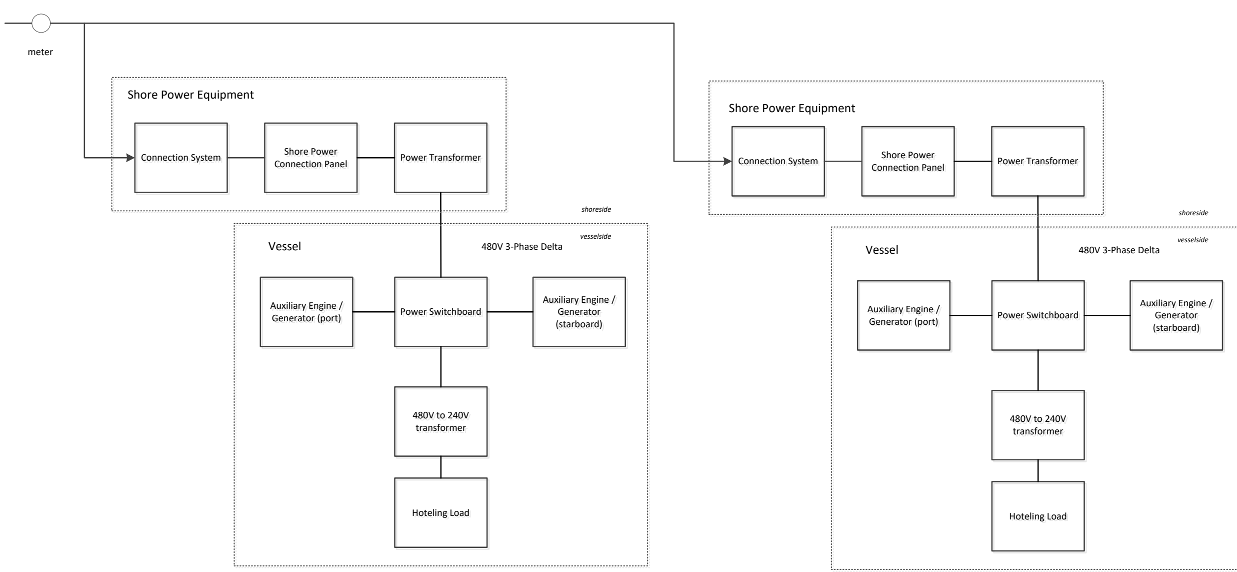

Figure 4 - Metering Configuration for Vessels at Sause

The data collection on the Shaver vessels was done onboard individual vessels by measuring the electricity supplied through shore power while at berth, and also measuring the electricity generated from each auxiliary engine. A representative metering diagram is provided in Figure 5. It was more practical to collect vessel-specific data for a pilot study with onboard metering at Shaver instead of trying to match vessel berthing logs with metered data, and this also supplied operational insights into the use of the vessels studied.

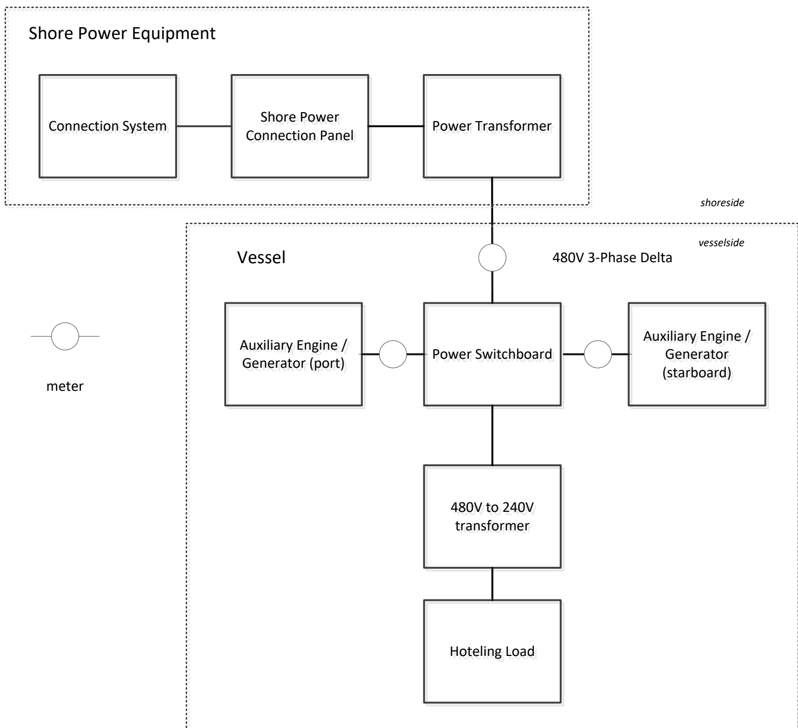

Figure 5 - Metering Configuration for Vessels at Shaver

The calculations assume 100% energy efficiency for all sources of shore power which is consistent with the treatment of electricity supplied to all electric vehicle types in the Oregon Clean Fuels Program, whereby 100% of the electricity supplied to any battery electric vehicle is reported from the meter (i.e., there is no adjustment for charger efficiency nor roundtrip efficiency in batteries). Additionally, the engine efficiency of the measured engines is assumed to be representative of the fleet-average efficiency.

Appendices

Appendix A – Vessel-Specific Data: Sause Brothers, Inc.

A data file "Sause - Vessel Data.xlsx" is submitted with this application with the vessel-specific data for a part of the Sause fleet. A summary of results is shown in Table 2.

Table 2: Data Summary for Sause Vessels

Vessel Data Summary

ID	Vessel Name	SURVEY	Metered	SURVEY	SURVEY	SURVEY	MANF SPEC	METERED	CALCULATED
Vessel ID	Name	Vessel Type (e.g., tugs, ferries, barge, dredge, crew&supply)	Hours at Berth	ENGINE MAKE	ENGINE MODEL NUMBER	RATED BRAKE HORSE POWER	gal/hr	kW	EER (energy density ULSD)
1	BlackHawk	Ocean Towing	313	John Deere	4045AFM85E	162	1.8	18.4	3.6
2	Natoma	Ocean Towing	216	John Deere	4045AFM85E	162	1.8	16.1	4.2
3	Navajo	Ocean Towing	24	John Deere	4045AFM85E	162	1.8	11.5	5.8
4	Titan	Ocean Towing	1,488	Caterpillar	3304	99	1.8	16.8	4.0
5	Klihyam	Ocean Towing	48	John Deere	4045AFM85E	162	1.8	12.7	5.3
6	Mikiona	Ocean Towing	48	John Deere	4045AFM85	162	1.8	16.5	4.1
7	Geronimo	Ocean Towing	32	John Deere	4045AFM85E	162	1.8	12.1	5.5
8	Cochise	Ocean Towing	48	John Deere	4045AMF85	162	1.8	16.8	4.0
9	Mikiona	Ocean Towing	72	John Deere	4045AFM85	162	1.8	15.1	4.5

Appendix B – Vessel-Specific Data: Shaver Transportation Company

A data file "Shaver – Vessel Data.xlsx" is submitted with this application. A summary of the EERs computed for the Shaver vessels in the study is shown below in Table 3.

Table 3: Data Summary for Shaver Vessels

Vessel Data Summary

ID	Vessel Name	SURVEY	Metered	Metered	SURVEY	SURVEY	MANF SPEC	METERED	CALCULATED
Vessel ID	Name	Vessel Type (e.g., tugs, ferries, barge, dredge, crew&supply)	Hours at Berth	Hours on Water	Engine Make	Rated Brake Horsepower	gal/hr	kW	EER
10	Cascades	Tug (Barge)	457	831	John Deere	99	2.9	36.3	3.0
11	Portland	Ship Assist	839	265	John Deere	175	4.4	36.0	4.6
12	Vancouver	Ship Assist	403	155	Cummins	115	1.0	10.3	3.8
13	Samantha S	Ship Assist/Escort	48	688	John Deere	317	5.9	65.9	3.3