Maritime Electrification for Utilities Workshop Report

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U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

Printed in the United States of America

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Summary

The Maritime Electrification for Utilities Workshop was held on September 15, 2021, to bring together maritime and electric utility stakeholders to discuss how to work together more effectively towards greater greenhouse gas (GHG) reductions via electrification of maritime activities. The workshop was organized by representatives from the U.S. Department of Energy and Pacific Northwest National Laboratory, U.S. Maritime Administration, Washington Maritime Blue, and DNV.

In the coming decades, seaports are likely to see significant increases in electrical energy demand due to three main drivers:

- electrification and hybridization of ships and cargo-handling equipment, which will require battery recharging;
- vessels connecting to shore power while at the dock (referred to as cold-ironing); and
- local production of alternative fuels, referred to as electrofuels, that can be produced through electrochemical conversion.

This growth in demand will require maritime and electric utilities to work together in planning for infrastructure, charging times, rate structures, and other needs. The September 15, 2021 workshop invited maritime and electric utility stakeholders to discuss the opportunities for developing stronger partnerships between electric utility and maritime stakeholders. Some key findings from this workshop are highlighted below.

The budget and planning timelines for terminal operators, vessel owners, and electric utilities are long, often 2 to 6 years, which creates opportunities for closer alignment of maritime electrification projects. Engaging the right stakeholders early can help streamline these projects, but this can sometimes be a challenge because of distributed responsibility or unfamiliarity. For example, some ports and terminals spread the responsibility for electrification projects over multiple groups, such as maintenance, assets, regulatory, operations, and facilities teams. When starting to identify stakeholders, it is best to start with those who are familiar with the acquisition of new technology, not necessarily those who ensure compliance with environmental regulations. On the utility side, with some exceptions, there is often a general lack of awareness of the maritime industry, suggesting a need for educational resources to close this knowledge gap.

Baselining current electrical demand and forecasting future demand at the ports and terminals should begin as soon as possible. Baselining studies and analyses are very useful when speaking with electric utilities about future projects and planning infrastructure investments. Numerous resources exist as case studies or examples to leverage, and some federal grants can provide funding assistance in this planning. Government agencies can play other useful roles on these projects by streamlining permitting, providing grants or technical assistance, coordinating efforts across different regions of the country and internationally, or convening relevant stakeholders.

Ports are critical infrastructure, serving as the gateways through which the vast majority of trade products must pass. Moreover, during emergencies they become particularly important because they facilitate the supply chain for emergency equipment, personnel, food, and water. In addition to these critical services, electric and hybrid vessels and cargo-handling equipment may be able to play useful roles in providing power back to the grid. During non-emergency times, oversized battery packs or

containerized, swappable batteries would enable battery-operated electric vessels and cargo-handling equipment to provide useful grid services like demand response when a vessel is moored and connected to the grid.

Acknowledgments

The authors thank Karina Martija-Harris and Devon Thorsell of Washington Maritime Blue for their help in facilitating the workshop. The authors also thank all the speakers and presenters who prepared content or remarks for the workshop.

Preface

The references and resources identified in this document do not represent endorsements by the authors or their organizations.

Acronyms and Abbreviations

ABS	American Bureau of Shipping
CARB	California Air Resources Board
CHE	Cargo-handling equipment
DOE	Department of Energy
DOT	Department of Transportation
EPA	U.S. Environmental Protection Agency
eRIN	Electric renewable identification number
EV	Electric vehicle
GHG	Greenhouse gas
IMO	International Maritime Organization
LR	Lloyd’s Register
MARAD	U.S. Maritime Administration
PG&E	Pacific Gas and Electric Company
RIN	Renewable identification number
SCE	Southern California Edison
SCL	Seattle City Light
UL	Underwriter Laboratories
USCG	U.S. Coast Guard
WSF	Washington State Ferries

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1.0 Workshop Overview

The Maritime Electrification for Utilities Workshop was held virtually on September 15, 2021, for 4 hours. There were 240 registrants, 124 of whom attended the workshop as participants. As part of the registration process, registrants were asked to identify their industry affiliation as either maritime, electric utility, other, or some combination of these options. The affiliation of the workshop registrants and participants is shown in Figure 1 and Figure 2. These data indicate that about half of the workshop participants self-identified as being affiliated with maritime industry and approximately 43 participants noted at least some affiliation with an electric utility.

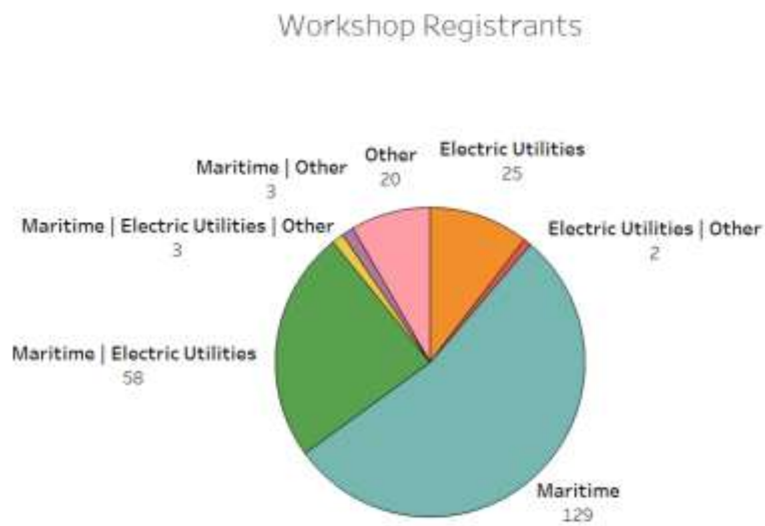

Figure 1. Industry affiliation of workshop registrants.

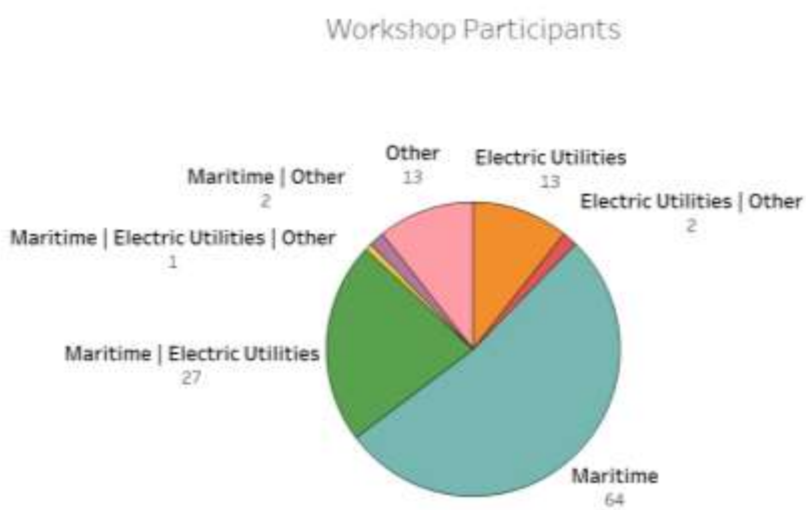

Figure 2. Affiliation of workshop participants.

Seventeen speakers from the government and private sector participated in the workshop during four different sessions Speakers who presented at the workshop included the following:

- **Jennifer States**, Vice President Projects and Strategy, Washington Maritime Blue

- **Andy Bennett**, Principal, KPFF
- **Sveinung Odegard**, VP Sales North America, Corvus Energy Inc.
- **Eileen Tausch**, PE, Applications Engineering Manager, Spear Power Systems
- **Jeremy Parkes**, Global Business Lead, Electric Vehicles, DNV
- **Cam LeHouillier**, Manager, Energy Research and Development, Tacoma Power
- **Sarah Mourino**, Director of Sustainability, SSA Marine
- **David Fujimoto**, Senior Environmental Program Manager, Port of Seattle
- **Emeka Anyanwu**, Energy Innovation & Resources Director, Seattle City Light
- **Patty Rubstello**, Assistant Secretary, Washington State Ferries
- **Dan Yuska**, Marine Environmental Technical Assistance, MARAD
- **Christopher Irwin**, Program Manager, Office of Electricity, DOE
- **Jonathan Foster**, Air Resources Engineer, CARB
- **Michael Moltzen**, Deputy Director and Section Chief, EPA
- **Leela Rao**, Environmental Specialist, Port of Long Beach
- **David Hume**, Marine Energy Manager, Pacific Northwest National Laboratory
- **Joshua Berger**, Founder and CEO, Washington Maritime Blue.

The workshop sessions addressed context setting, planning for maritime electrification, partnerships for maritime electrification, and the role of government. Three breakout discussions were held, during which participants were posed questions in unmoderated breakout groups and asked to record notes. A summary of these discussions is presented in the sections that follow. Related background information about the maritime and energy transition; useful references about port electrification; and lists of conveners, clusters, and innovation hubs and select federal funding sources are presented in Appendix A through Appendix D. Appendix E contains the slides from the workshop presentations by the speakers listed above.

2.0 Workshop Breakout Discussions

For three of the four sessions the workshop participants were divided into teams of eight to respond to questions related to the session topic. These breakout discussions lasted approximately 15 minutes and teams were asked to record their own notes. The summaries of each group discussions in response to the questions are presented below.

2.1 Breakout Discussion 1 Summary – Planning for Maritime Electrification

This first breakout discussion focused on planning for maritime electrification. Summaries of participant notes are provided below for each question in the order they were presented.

2.1.1 Can electric vessels and cargo-handling equipment (CHE) provide useful grid services or are they just another electrical load?

Vessels and CHE are likely to be useful for emergency power back to the grid for local communities, but not for baseload electricity. For cargo vessels, oversizing the battery pack or using swappable batteries would enable them to provide useful grid services when the vessel is moored and connected to the grid, or when the batteries are shoreside waiting to be deployed on a vessel. If a vessel is connected to shore power at dock overnight, the batteries onboard a vessel could, in theory, be used as grid stabilizers for demand response, or if necessary they could be removed from the grid to operate on their auxiliary engines in the case of grid instability or high grid demand. It was noted that this was part of TOTE's concept and a follow-up investigation of the concept may be worthwhile. For CHE, the duty cycle is largely committed to moving cargo and has limited opportunity to dedicate excess battery capacity to ancillary activities. In smaller ports that see less cargo throughput and that may have greater downtimes, electric CHE may have greater ability to participate in grid services.

Attendees noted that a great deal of work has been done on understanding the value to the grid within the electric vehicle (EV) community over the last 10 years, specifically vehicle-to-grid (V2G) technology, which should be leveraged. However, the following challenges with respect to the maritime industry were noted:

- The round-trip efficiency of charging a vehicle or vessel, which is then used to later provide power to the grid, is a concern.
- Some ferries have limited windows of time during which they are shut down and connected to the grid for meaningful periods of time, for example 0100 to 0400 in the morning for ferries in the Pacific Northwest around Seattle. Electricity demand is likely low during this time window and there is unlikely to be a strong need for demand response services, though this is specific to the vessel/vehicle and location.

2.1.2 What are utility planning timelines? What are the port/terminal planning timelines? What about the vessel construction/retrofit timelines?

Planning timescales vary between maritime and utility stakeholders, which highlights the need for close coordination and collaboration as soon as possible for maritime electrification projects. However, as one attendee noted, to meet the 2050 International Maritime Organization (IMO) goals, planning and implementation must start now.

Utilities produce Integrated Resource Plans bi-annually and look ahead 20 years in Washington State. Budget planning for utilities is often two or three biennial cycles (2–6 years) every 2 years; this timeline is useful when making tariff and project budget financing decisions. When drafting these plans, multiple attendees noted the need for flexibility to take advantage of technological advances that can occur throughout the planning, design, and construction process, which may take several years. Attendees noted that each utility's timeline needs to be ahead of port operator electrification timelines, so that they get the infrastructure in place to foster confidence in transitioning to clean energy operations. In terms of deployment, one attendee noted that one-off electric vehicle supply equipment deployment can take between 6 and 9 months in a faster jurisdiction, but larger deployments could take between 24 and 36 months based upon the availability of utility service.

On the maritime side, it was noted that the time horizon for vessel planning is typically ahead of the utility's planning process, yet the utilities still appear to need greater lead times. To better understand electricity demands at a port, an example was provided that suggested 1 mi of downtown Seattle uses approximately 300 MW of power, whereas one ferry may require 15 MW of power. Some electric vessels are scheduled for launch in 2030, providing ample lead time for utilities to begin planning infrastructure build-out. A terminal operator noted that for them, they often talk in terms of decades, not years, and they need equipment and infrastructure that will last a long time. This same terminal operator also noted that for them the best piece of equipment is the one they own (as opposed to one they lease or rent), which often incentivizes them to look at natural replacement cycles, which are on the longer timescale.

2.1.3 How do we think about prioritizing electric loads as it relates to maritime assets? Or how much additional power will be needed for maritime decarbonization through electrification?

Many megawatts of power will be needed to support shoreside and maritime uses over the next 20 years and beyond. Planning should start now for how to provide this increased capacity in a cost-effective manner. This is a systems-level challenge that should include consideration of efficiency measures, new technologies, freight routes and modal shifts, dispersed electrofuel production, GHG and criteria pollutant emissions by each source category, technology and commercialization readiness level, port and terminal operator equipment replacement timelines, decarbonization commitments and schedules, depth of development (study, pilot, small scale build-out, full build-out), funding requirements for each development level, optionality (future-proofing), aligning funding need with funding opportunities, grid loading and available capacity, grid non-wires solutions and increasing grid equipment utilization, grid modernization opportunities, and increasing grid flexibility for serving ports and adjacent end-users.

One group discussed interruptibility utility rate structures as a possible way to avoid the (brief) peaks in demand caused by vessel charging. An example was provided of a rate schedule that allowed a utility to contact a ferry operator planning for electric ferries and have them cease charging for around 200 hours each year.

One participant noted the importance of avoiding bespoken charging systems that prohibit different vessels from using the systems—this lesson learned in Norway should be considered here in the United States. This implies a need to build in flexibility for different types of ships (phase changes, power numbers, etc.) that sets the stage for standardization across multiple vessel types or event modes of transport. This should be unbiased and not just set by the industry leaders.

It was suggested that maritime stakeholders think about reducing the size or scale of vessels, CHE, etc. to make the energy demands more manageable for faster deployment; electrification works better and deploys faster at smaller scale with smaller vehicles. The maritime industry has generally operated around cheap fuel and (relatively) unconstrained freight networks on the landside, but this may not be the case going forward.

2.1.4 For tariffs and electric rates, how should electric vessels and cargo equipment charging be treated? Should they have unique rates? Are there examples of this anywhere else?

In an ideal world, rates would be well known to the vessel operators and ports, and standardized across ports, but this is not always the case. In California and British Columbia, many utilities have different rates for shore power or cold-ironing vessels in ports. Southern California Edison (SCE) has specialty maritime rate tariffs for port terminals and CHE and separate rate tariffs for shore power on a dedicated meter. Pacific Gas and Electric Company (PG&E) and SCE both have specialty utility rate tariffs for medium- and heavy-duty EVs and electric CHE. Many participants noted the importance of ensuring that any potential rate tariff consider aspects related to resiliency, load balancing, etc. and that port power demands are well-understood up front.

A utility’s ability to set rates can be heavily dependent on the regulatory and stakeholder regime under which they operate and therefore not every utility can make a choice to offer unique or tailored rates, incentives, etc. to their customers. Moreover, rate payers do not like to think that they are bearing the infrastructure costs and burdens for other sectors. If a tariff is used in a single location some may adopt this cost, but if others do not it can lead to competition and a loss of competitiveness if it’s a higher rate.

2.1.5 Are there useful studies, investigations, or other activities that ports and terminals should be performing before investigating electrification? Baseline measurements? Deploying sensors?

First, emissions inventory can be the landscape map upon which strategies are built and initiatives are tracked. Operational profiles are key to identifying the use of energy (power over time), available infrastructure, and to size the systems according to current and projected operational profiles, taking into account increasing energy costs and growing freight volumes. A process for building this knowledge is to first understand how much power and infrastructure are available, then available space, then equipment—instead of the predominant model of assessing equipment first. Also important to this process is an understanding of existing electrical load summaries and load shapes, grid capacities, and load profiles for electric or hybrid equipment, under direct, battery, or managed charging scenarios. Putting these together can help develop a plan that achieves the most emissions reduction and the lowest impact on the electrical grid.

For CHE, performing a baseline measurement across the fleet to understand the engine types, fuel types, levels of fuel consumption, and duty cycles is highly recommended. Ports and terminals inventory emissions to find the low-hanging fruit (i.e., the oldest and/or dirtiest equipment) that is most ripe for electrification.

Developing Terminal Infrastructure Master Plans will be necessary to design terminals for a fully zero-emissions future. Such studies are important to the electrification process. For example, one question that could be addressed in this plan is whether it is more cost-effective to bring the power to the existing parking/staging areas or bring the parking/staging areas to where existing power is?

To help perform these studies, the federal Infrastructure for Rebuilding America, Rebuilding American Infrastructure with Sustainability and Equity, and Port Infrastructure Development Program grant programs each allow infrastructure planning activities to be funded with federal dollars. One participant also noted that the right relationships are critical. The organizations that are doing decarbonization/ electrification best are not necessarily the best resourced; they tend to be the ones that have really good networks with their local government, industry, community, and client stakeholders.

2.1.6 What questions do electric utilities have about planning for maritime electrification?

Shoreside battery energy storage often does not meet the more stringent requirements for vessel batteries. For example, vessel batteries need to protect against cell-to-cell propagation. Class approvals from DNV or ABS test such systems to ensure that the fire in one cell does not spread to others, but a typical marine battery module has 20 to 30 cells per module, 9 to 12 modules per rack, and perhaps 4 to 100 racks per vessel. If these battery packs catch fire, the hydrogen fluoride gas release from such an event is of significant concern especially for more urban areas.

A persistent request is for better ways to share information and learning. A lot of utilities are doing informative pilot programs and innovative work around how they fund and deploy zero-emission technologies, but there are limited opportunities to formally share these insights or easily gain useful information and data from and about other organizations' projects. Such information exchange is not just for utility-to-utility but also from port/terminal-to-utility.

2.2 Breakout Discussion 2 Summary – Partnerships

The second breakout discussion focused on how to build effective partnerships between maritime and electric utilities for maritime electrification. Summaries of participant notes for each question are provided below.

2.2.1 Who are the critical-path stakeholders when electrifying vessels or cargo-handling equipment? Who can make or break a project?

Numerous parties were cited as stakeholders and are listed below. Generally, it was believed that critical stakeholders are those who (1) get credit for emissions reductions; (2) provide or receive funding; (3) regulate or enforce the activity; or (4) are directly affected by the activity. Critical and non-critical stakeholders include the following:

- Industry
  - Technology vendors
  - Engineering firms (e.g., naval architects, marine engineers)
  - Electric utilities or public utilities commissions
  - Standards Bodies (vessel, communications, charging, etc.) and Certification Bodies (Underwriter Laboratories, Nationally Recognized Testing Laboratories)
  - Port authorities
  - Terminal operators

  - Unions (International Brotherhood of Electrical Workers, International Association of Machinists, International Longshore and Warehouse Union)
  - Tribes (particularly waterfront/in-water work)
  - Ship owners and operators
  - Charters
  - Transportation company (shipper, intermodal yard, railroad, drayage company).
- Government Agencies
  - U.S. Coast Guard (USCG)
  - State Department of Transportation (DOT)
  - U.S. Environmental Protection Agency (EPA)
  - U.S. Maritime Administration (MARAD)
  - U.S. Department of Energy (DOE) and its National Laboratories
  - State energy and environmental agencies
  - Nonprofits and academia
  - Community-based organizations
  - Workforce development and universities/trade schools
  - Maritime cluster organizations.

2.2.2 Where can interested parties go to find information? What resources or tools are available?

The best resources are generally found by contacting those who are already executing on these projects. Other groups that may provide useful information include the following:

- EPRI (The Electric Power Research Institute, Inc.)
- Edison Institute
- NASEO (National Association of State Energy Officials)
- Electric & Hybrid Marine Expo
- MARAD Battery Workshop
- DOE National Laboratories
- Maritime Battery Forum
- DNV GL (Det Norske Veritas Germanischer Lloyd)
- Washington State Ferries
- EPA Ports Initiative.

2.2.3 Are there any third-party groups that play useful convening roles that can help facilitate discussions between ports and utilities? When should they be brought in, if at all?

There was a mixed response about the added value of engaging third-party groups; some believed they just add more complexity to an already complex project, while others thought such groups can help find funding, capital, or host sites for projects. Several participants noted that having a facilitator or convener to start the conversations between maritime and electric utility stakeholders can help get the right parties to the tables to start partnerships. Suggestions of such third-party groups included the following:

- American Association of Port Authorities
- DOE
- DOT
- EPA – Ports Initiative
- CALSTART
- Green Marine
- Washington Maritime Blue
- Grant consultants (coordinate multiple grantees & stakeholders).

2.2.4 Within the port and terminal, who are the right people or groups that need to be engaged? Is there a “Chief Electrification Officer" equivalent or is this role spread among many different people?

Generally, there is no one single person who has the responsibility for electrification of port or terminal operations. Ports and terminals have noted that they spread the responsibility over multiple people. One group noted that they have assembled a committee that includes team members from their maintenance, assets, regulatory, operations, and facilities teams, for example. There are exceptions, however; for example, Washington State Ferries has designated a Director of Electrification. One participant noted that people often go to the environmental departments within their organizations when looking for who to lead the electrification process, but this is usually the wrong place to start because they are more compliance focused rather than new technology focused. Often the executive team, ideally the Sustainability Director, or the planning department focused on forward-looking technology, is the best place to start.

2.2.5 Within the electric utility, who are the right groups that need to be engaged? Are there dedicated groups/divisions within utilities that have maritime familiarity? Should there be?

Participants noted that this is utility-dependent, but early and frequent engagement and education with certain groups at the utility is key. One participant noted that there is room for an organization to offer a maritime-specific education program that would help people that already have solid technical and infrastructure understanding come up to speed on maritime-specific needs and applications. Participants noted that it is common for many electric utility groups to have limited, if any, familiarity with maritime issues, but at the same time the electrification need is probably pretty small from their perspective. Whether a 10 MW charge rate occurring every 20 min out of each hour is from a factory, mine, or ferry is usually not a big factor. The “insulating” interface between the utility and the vessel connection, such as transformers, circuit breakers, ground fault detection, etc., is usually part of any large utility interface to such loads. Groups within an electric utility groups that should be engaged include the following:

- electrification division
- executive leadership
- system planning

- operations
- engineering (usually key to determining if a vessel charge rate can be supported and what limitations/challenges may exist)
- substations (important to begin the planning and familiarization early).

Due to EV landside efforts, some utilities (like PG&E for example) have created a dedicated point-of-contact for electrification efforts, that can help coordinate stakeholder needs and efforts

2.2.6 What questions do electric utilities or maritime stakeholders have about developing partnerships with one another?

How can stakeholders get utilities to be more forthcoming with data in a timely manner? Load assessments can take far too long and are often only made available upon the request of a meter owner. This inhibits proactive evaluation of opportunities for widespread electrification.

2.3 Breakout Discussion 3 Summary – Role of Government

This third and final breakout discussion focused on the role of government in maritime electrification. Summaries of participant notes for each question are provided below.

2.3.1 What services or activities can federal agencies provide to help with maritime electrification? Please specify.

This question generated a large number of responses from participants covering a range of actions including funding, planning, regulations, and coordination at the interagency, international, regional, and domestic levels.

One of the most often mentioned services was funding through the form of grants, incentives, loans, credits, vouchers, etc. Participants noted the need for identifying federal and state funding resources available for initiating these projects and, related to that, there is a need to understand the total investment needed so grants and approaches can be better scaled. For example, SSA Marine noted that the scale of investment required for them to hybridize their CHE is around $500M USD and $250M USD for California and Washington, respectively. However, grants alone are not going to completely cover this outlay; tools and mechanisms other than money for de-risking investments are needed. Some participants noted that some of the existing funding mechanisms are too narrow and could be made more flexible to allow for a broader range of relevant electrification activities.

Aside from financial support in asset acquisition, multiple groups noted the need for government support (funding, technical assistance, etc.) in planning and permitting. Participants also noted that government can provide useful functions with regard to regulation, laws, and policies to support and/or force adoption and investment. One participant noted considering expansion of the Renewable Fuel Standard to allow electric renewable identification numbers (eRINs) and Hydrogen renewable identification numbers (RINs), for example.

Multiple groups also noted that increased coordination among the federal agencies is required; port electrification is nuanced and needs a cohesive strategy across the various offices and agencies. Some participants noted that the federal government should provide international coordination with other regulatory bodies (IMO), standards bodies, and technology development groups; because states do not have a seat at the IMO table, they rely on the federal government to pass along their ideas and concerns.

2.3.2 What are the relevant national regulations for electric ships and cargo-handling equipment?

Ships are generally covered by USCG regulations and classification societies (ABS, DNV, etc.), but electrification regulations differ when moving from vessel to shore. While the National Electrical Code and UL may play a large role at terminals, the National Electrical Safety Code plays a role on the utility side. The Occupational Safety and Health Administration and DOT regulations also need to be consulted and may have a larger role to play for CHE. Participants noted that more support for hydrogen/fuel cell regulations is needed, and, according to those who have been through their process, the USCG approval process is not very streamlined for battery-electric or hydrogen fuel cell vessels.

2.3.3 What are the relevant national and international standards that should be consulted?

Workshop participants generally felt that utilities already had a good sense of the relevant standards (e.g., IEC 60092, IEEE 45). One participant noted that creating programs to expedite local permitting, environmental reviews, and other regulatory processes would help expedite more electrification projects. Another participant noted that while many groups are working on standards development, many of the efforts seem to be one-offs and maybe too focused on local versus international standardization.

2.3.4 What national or international groups are working on establishing standards? Where should ports and utilities look for the latest information?

Several participants noted that they would like to see more involvement of the USCG in the development of global standards for maritime electrification. One participant highlighted the MarHySafe joint development project as an opportunity for the United States to engage in some international collaborations under way; or the Charging Interface (CharIN) initiative, or the Maritime Battery Forum as other examples.

2.3.5 Which regulatory bodies need to be engaged for electric vessels? Is there a preferred order in which certain regulatory groups need to be consulted?

The main groups listed by participants are the typical classification societies such as the American Bureau of Shipping (ABS), Lloyd’s Register (LR), and (DNV) and other groups such as the Institute of Electrical and Electronics Engineers (IEEE).

Appendix A – Background on Maritime and the Energy Transition

A.1 Maritime Overview

The maritime industry is the domestic and international network of ships and ports that makes the global economy possible. In 2017, marine vessels and seaports handled 80 percent of all international trade by volume and more than 70 percent by value. Our global trade networks cannot function without ships. Currently, the maritime industry is undergoing a once in a century energy transition as it seeks to reduce greenhouse gas (GHG) emissions.

The domestic maritime industry can be sized in several ways. In terms of U.S. registered vessels there are approximately 12 million privately owned recreational boats (USCG Office of Auxiliary and Boating Safety 2019) and approximately 375,000 vessels over 5 T, including 41,000 commercial vessels, of which 9,000 are self-propelled like tugs and ferries (USCG Maritime Information Exchange 2021; Transportation and Statistics 2018), and 180 are ocean-going cargo ships of over 1,000 tons (MARAD 2020). An estimated 10,000 foreign vessels complete approximately 50,000 port calls each year, out of an estimated 291,000 total arrivals (UNCTAD STAT 2019). These ships vary tremendously in shape, size, and power requirements. Approximately 360 commercial seaports handle every type of cargo, from containers to cattle and everything in between. These ports use multiple forms of cargo-handling equipment (CHE; trucks, cranes, forklifts, etc.) to move cargo in and around ports.

A.2 Maritime and Energy

Ports and ships need energy for everything from CHE and ground transport, to vessel propulsion and electrical power generation(see Figure A.1 and Figure A.2). Ports meet their energy needs by drawing from locally generated power sources or from the regional electric grid. Vessels most often carry their energy within them in the form of fuels such as heavy fuel oil, marine gas oil, and marine diesel oil. Collectively, marine vessels account for about 4 percent of global oil demand, or about 4.3 million barrels per day according to the Energy Information Agency. Annually, this equates to roughly 330 million MT of fuel each year across the global fleet (Faber et al. 2020). The current energy demands at ports are also sizable; for example, in 2012 the Port of Los Angeles collectively consumed around 250,000 MWh of electricity at a cost of $30 million annually (Matulka et al. 2013).

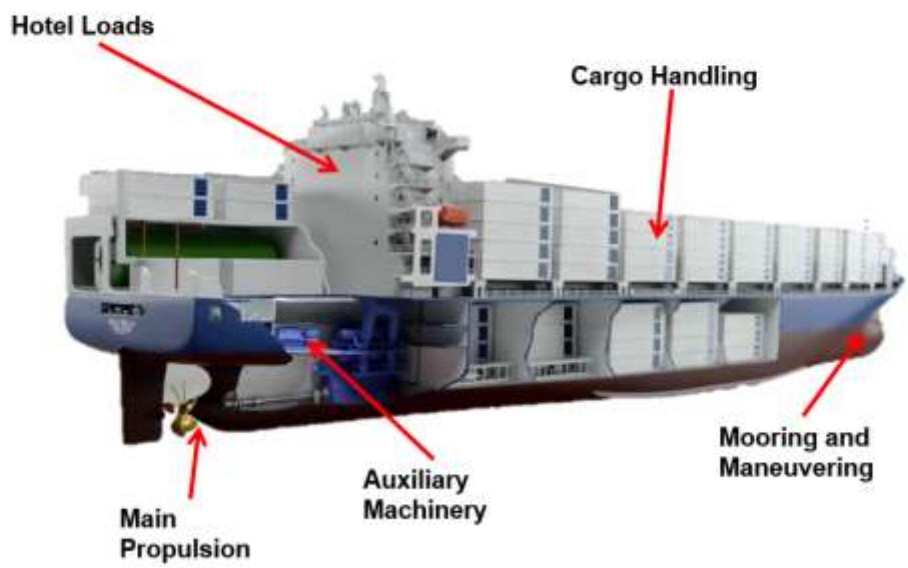

Figure A.1. Common energy consumers on a ship.

Figure A.2. Common energy consumers in a port.

The GHG emissions from all global shipping (international, domestic and fishing) is more than 1,000 million T/yr as of 2018, or about 2.9 percent of all GHG emissions (Faber et al. 2020). This is approximately three times the emissions of France in 2018. The global maritime industry is also responsible for approximately 13 percent of global nitrogen oxides emissions, 12 percent of sulfur oxides (GEF-UNDP-IMO GloMEEP Project and IMarES 2018), and large amounts of particulate matter and black carbon each year, which cause localized pollution and negatively impact human health.

A.3 Maritime Energy Transition

Numerous regulations at the state, national, and international level seek to limit emissions from vessels and port activities. To help achieve compliance with these regulations, many technologies, fuels, and operational measures could be used to reduce emissions. Aboard vessels examples include alternative fuels such as green ammonia, hydrogen, and biofuels for ships; ship hybridization or full electrification with batteries; voluntary speed reductions; and connecting ships to shore power when in port (cold-ironing). Ports will also need new technologies, such as refueling infrastructure for new fuels; recharging infrastructure for multi-megawatt fast charging of electric vessels; and electric or hybrid CHE.

Port and terminal operators are likely to see significant increases in electrical energy use due to three main drivers:

- electrification and hybridization of ships and CHE, which will require battery recharging;
- vessels connecting to shore power while at the dock (referred to as cold-ironing); and
- local production of alternative fuels, referred to as electrofuels, that can be produced through electrochemical conversion.

Planning for these future energy consumers will be essential for the port, terminal, electric utility, and for other stakeholders to ensure that ports are resilient and can scale for the future growth. For example, modeling suggests that under aggressive electrification scenarios, electricity energy demand at all ports in the United Kingdom (UK) will increase from 20 GWh in 2016 to more than 4,000 GWh in 2050 (UMAS et al. 2019). Understanding these energy loads and the unique nature of the maritime industry is a critical first step.

A.3.1 Works Cited

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Appendix B – Useful References on Port Electrification

Below is a nonexhaustive list of reference material that provides different perspectives of and approaches to maritime electrification. These documents can serve as useful references for planning for and modeling future energy needs at ports that may arise from increasing electrification of maritime assets.

- Potential Demands on the UK Energy System from Port and Shipping Electrification A Report for the Department for Transport – July 2019 – Frontier Economics
- DNV's Ports as Green Gateways to Europe – DNV
- Port Electrification Benefits the Local Economy and Environment While Providing New Electric Load for Utilities – ICF 2016
- Port of Seattle
  - Pier 66 Shore Power Project
  - Cruise Accomplishments including shore power for all cruise berths and development of the Waterfront Clean Energy Strategy – https://www.portseattle.org/page/cruise-accomplishments-sustainability
  - Charting the Course to Zero: Port of Seattle's Maritime Climate and Air Action Plan (the MCAAP) is a comprehensive plan to address climate change and air pollution from maritime sources.
- Port of Los Angeles and Port of Long Beach
  - Port Community Electric Vehicle Blueprint – July 2021
  - Moving Towards Resiliency: An Assessment of the Costs and Benefits of Energy Security Investments for the San Pedro Bay Ports – UCLA 2013
- Port of Tacoma
  - Port of Tacoma Northwest Ports Clean Air Strategy Implementation Plan – July 2021
- Port of Oakland
  - Zero-Emission Cargo-Handling Equipment Feasibility Assessment – AECOM 2019.

B.1 Select U.S. Maritime Electrification Projects

Below is a list of some recent maritime electrification project announcements. The list is not exhaustive, but it is provided as an indication of the growing trend toward maritime electrification. For a more comprehensive review of emissions reduction activities at ports, including electrification of cargo-handling equipment and shore power installations, visit the U.S. Environmental Protection Agency's (EPA's) Port Initiative, Best Port-wide Planning Practices to Improve Air Quality.

- Washington State Ferries, the largest ferry system in the United States, is acquiring 16 new vessels and retrofitting 6 others for hybrid electric over the next 20 years. Battery capacity varies across the fleet, from 6–10 MWh with 10- to 20-minute charging times. See more in the Washington State Ferries System Electrification Plan.
- In July 2021, Crowley and Jensen Maritime announced completed designs for the first full-electric U.S. tugboat. It will be built in the coming year and go into operation in the Port of San Diego by

mid-2023. It will be powered by a 6.2 MWh battery pack and two 2,100 kW electric motors. More here.

- In August 2021, SWITCH Maritime and All American Marine announced the launch and operational trials of the *Sea Change*, the world's first commercial vessel powered 100 percent by a hydrogen fuel cell. Built in Washington State for operations in California's San Francisco Bay area, *Sea Change* is a 70 ft, 75-passenger electric-drive ferry. More here.
- The *Maid of the Mist* – The New York State Office of Parks, Recreation and Historic Preservation, New York Power Authority and ABB announced in October 2020 they have launched the two all-electric, zero-emission passenger vessels in the United States to serve as tour boats for Niagara Falls. Each vessel is 28 m long, powered by 400 kW electric motors and 316 kWh battery packs. More here.
- In March 2021, Tacoma Power announced that they had created the nation's first pilot tariff to support the production of electrofuels, a carbon-neutral replacement for traditional fossil fuels. The new, lower-cost tariff is designed for industrial producers. More here.
- In 2019, the world's first battery-electric top handlers were put into service in the Port of Los Angeles. Also known as top picks, top handlers are off-road vehicles with an overhead boom for loading containers weighing up to 75,000 lb onto trucks and trains, unloading them, and stacking them on terminals between pickups and deliveries. More here.

B.2 Select International Projects

The projects listed below are provided as examples of some international projects for illustrative purposes, this list should not be considered comprehensive nor exhaustive.

- Current Direct is a new research and innovation project funded by the European Commission's Horizon 2020 program that will revolutionize the way we move goods and people by water with the use of swappable containerized batteries connected to an Energy as a Service Platform. More here.
- Operating since 2015 in Norway, the *Ampere* is the world's first all-electric battery-powered car and passenger ferry in the world. The ferry is 80 m long and 20 m wide. With a catamaran hull that is lightweight and made of aluminum, the vessel features an all-electric powertrain, with two electric motors with 450 kW of output each. The 1,000 kWh Li-ion battery system of the ferry is charged at each quay for about 10 minutes. More here.
- The world's largest all-electric ferry yet has now gone into service in Norway in 2021. *Bastø Electric* is the first of three battery-powered ferries operated by the shipping company Bastø Fosen to enter Norwegian waters, with more planned for construction. It is 139.2 m long and has capacity for 600 passengers and 200 cars or 24 trucks. It has a battery capacity of 4.3 MWh and a fast-charging system capacity of 9 MW. More here.

Appendix C – Conveners, Clusters, and Innovation Hubs

Outside of the ports themselves, some private organizations might be able to assist with introductions to maritime stakeholders or provide more information about maritime activities for specific regions. For starters, they include the following:

- Washington Maritime Blue – Seattle, WA
- SeaAhead - Boston, MA
- TMABlueTech – San Diego, CA
- Alaska Ocean Cluster – Anchorage, AK
- OpenSeas Technology Innovation Hub – Norfolk, VA
- AltaSea – Los Angeles, CA
- Marine Battery Forum (European-centric but with several U.S. members)
- Blue Sky Maritime Coalition – National
- C40 – International
- American Association of Port Authorities (AAPA) – National.

Appendix D – Select Federal Funding Sources

Various agencies and organizations at the state and federal levels might be sources of funding or technical assistance related to maritime electrification projects (planning, acquisition, modeling, etc.). Some federal programs to consider include the following:

- EPA DERA Grants
- U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy Funding Opportunity Announcements
- MARAD Port Infrastructure Development Grants
- MARAD America's Marine Highway Grants
- The FTA Passenger Ferry Grant Program – Active funding solicitation through Oct 5, 2021
- MARAD Marine Environmental Technical Assistance (META) Program
- The Department of Transportation's (DOT's) Infrastructure for Rebuilding America (INFRA) grants
- Rebuilding American Infrastructure with Sustainability and Equity (RAISE) grants – formerly known as TIGER or BUILD
- The Federal Emergency Management Agency's Port Security Grant Program (PSGP)
- The Federal Highway Administration's Congestion Mitigation and Air Quality Improvement (CMAQ) Program.

The federal Infrastructure for Rebuilding America, Rebuilding American Infrastructure with Sustainability and Equity, and Port Infrastructure Development Program grant programs from the DOT each allow infrastructure planning activities to be funded with federal dollars. At the state level funding sources vary from state to state, but California and New York were explicitly called out as having established some leading models. State agencies to consult for funding or other resources include the following:

- State Environmental Agency
- State DOT
- State Energy Agency
- Utility Programs (authorized by state public utilities commissions)
- Local Air District funds.

For a more comprehensive and curated list of maritime-relevant funding opportunities for ports and near-port communities, please visit the EPA's Port Initiative webpage.

Appendix E – Workshop Presentation Slides

The slides that follow are in the order in which they were presented during the workshop.

Maritime Electrification Workshop for Utilities

Virtual - September 15, 2021

The workshop will begin promptly at 0810 PDT, please get settled and network!

Agenda

all times in PDT

0750-0810 – **Networking**

0810-0855 - **Context Setting**

- Presentation - High level overview of maritime industry
- Presentation - Maritime electrification overview
- Presentation - System Integrator Perspective
- Presentation - Lessons from EVs

0900-1000 - **Planning for Maritime Electrification**

- Presentation - Port, terminal, and electric utility perspective on electrification
- Breakout Discussion 1 - Planning for Maritime Electrification

1000-1010 - **Virtual Network Session or Break**

1010-1100 - **Partnerships maritime and electric utility stakeholders**

- Fireside chat - Building relationships and case study
- Breakout Discussion 2 – Partnerships

1100-1200 - **Role of Government: Funding, Regulations, and Standards**

- Panel - Role of Government: Funding, Regulations, and Standards
- Breakout Discussion 3 - Role of Government

Speakers

- **Jennifer States**, Vice President Projects and Strategy, Washington Maritime Blue
- **Andy Bennett**, Principal, KPFF
- **Sveinung Odegard**, VP Sales North America, Corvus Energy Inc.
- **Eileen Tausch**, PE, Applications Engineering Manager, Spear Power Systems
- **Jeremy Parkes**, Global Business Lead, Electric Vehicles, DNV
- **Cam LeHouillier**, Manager, Energy Research and Development, Tacoma Power
- **Sarah Mourino**, Director of Sustainability, SSA Marine
- **David Fujimoto**, Senior Environmental Program Manager, Port of Seattle
- **Emeka Anyanwu**, Energy Innovation & Resources Director, Seattle City Light
- **Patty Rubstello**, Assistant Secretary, Washington State Ferries
- **Dan Yuska**, Marine Environmental Technical Assistance, MARAD
- **Christopher Irwin**, Program Manager, Office of Electricity, DOE
- **Steven Boyd**, Program Manager, EERE, DOE
- **Jonathan Foster**, Air Resources Engineer, CARB
- **Michael Moltzen**, Deputy Director and Section Chief, EPA
- **Leela Rao**, Environmental Specialist, Port of Long Beach
- **David Hume**, Marine Energy Manager, Pacific Northwest National Lab
- **Joshua Berger**, Founder and CEO, Washington Maritime Blue

Housekeeping

- Please keep yourself on mute when not speaking and be respectful to other participants.
- If you have questions for presenters, please post them in the chat. Use the vote function to upvote important questions.
- We have limited time together, please participate in small group discussions and contribute. We will be using Google Drive and Google Docs for the breakout group note taking. Table discussions are unmoderated.
- There will be time at the end of the workshop for more networking and to ask questions of presenters if they are able to stay late.
- All slides and the final report will be shared shortly after the workshop.

Pacific Northwest
NATIONAL LABORATORY

Maritime Energy Transition Overview

Maritime Electrification for Utilities Workshop

September 15, 2021

David Hume
Marine Energy Manager, PNNL

U.S. DEPARTMENT OF ENERGY BATTELLE
PNNL is operated by Battelle for the U.S. Department of Energy

What is the Maritime Industry?

The maritime industry includes the domestic and international network of ships, seaports, and their associated infrastructure that makes the global economy possible.

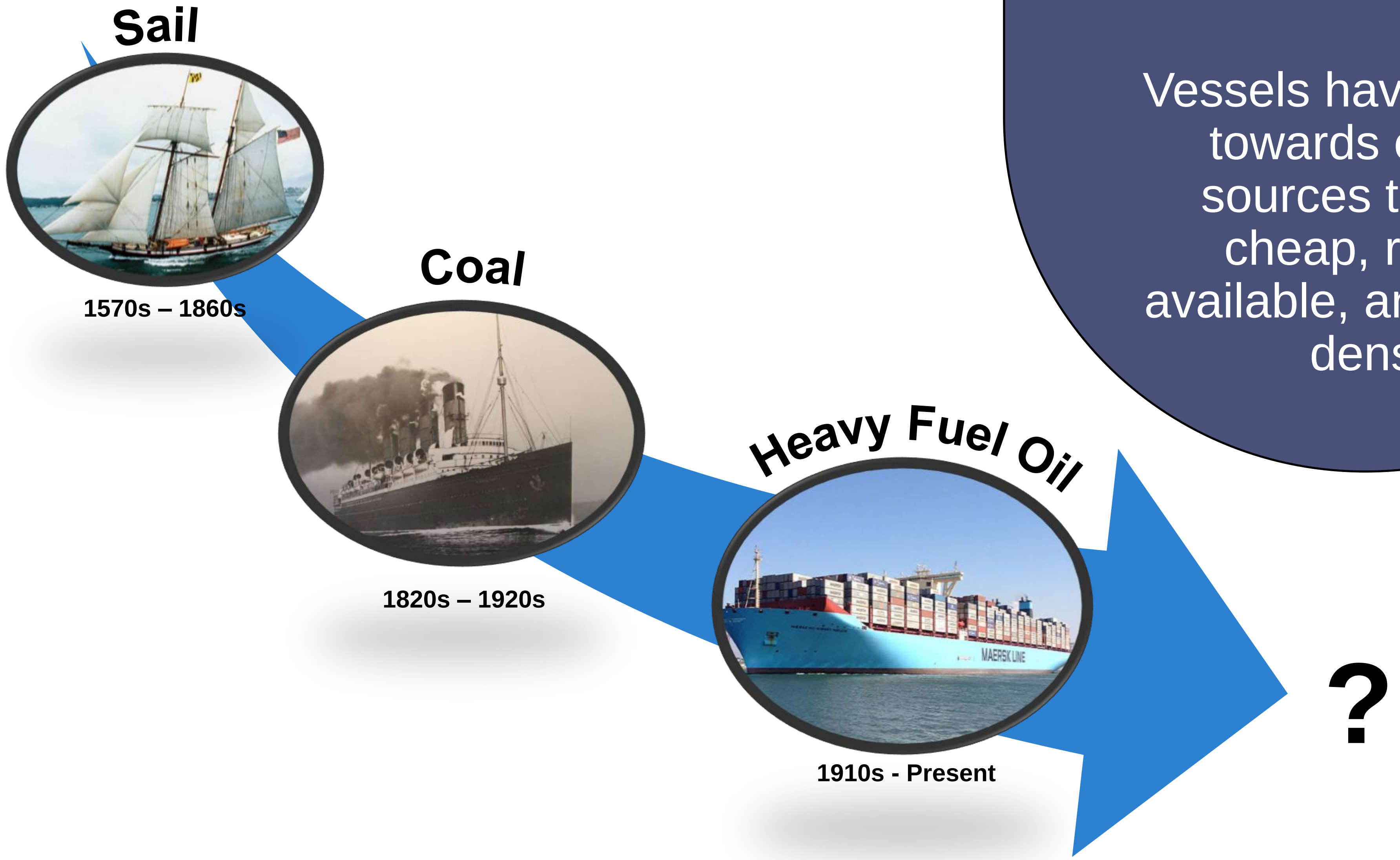
Shipping underlies the global economy – 90% of all world trade is carried by ship

Every ship is unique

Commercial vessels are as varied as the missions they serve and the cargoes they carry. Their energy demands and load profiles vary significantly, even for identical vessels.

Ships and Energy

Vessels have trended towards energy sources that are cheap, readily available, and energy dense

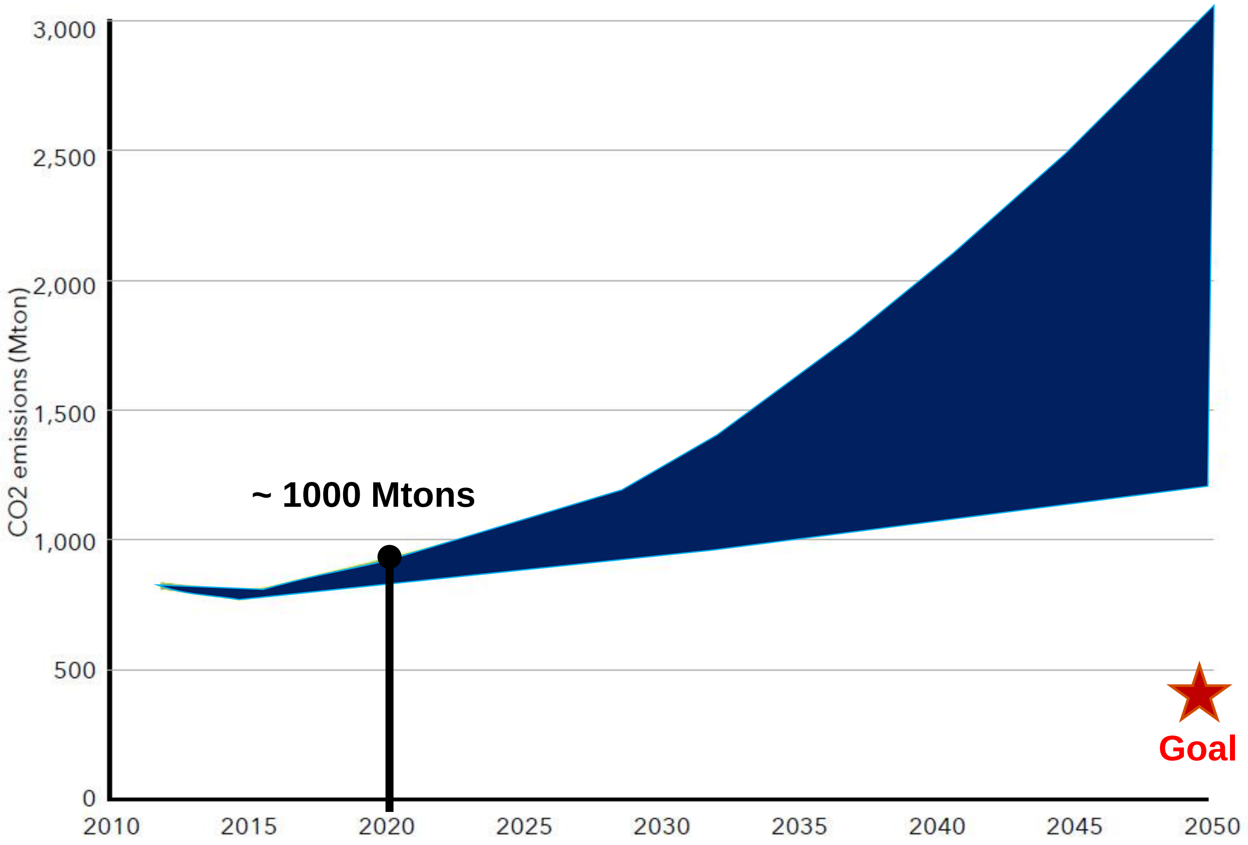


The Maersk Triple E Class vessels can carry more than 18,000 TEUs, their propulsion plant is rated at approximately **60 megawatts (MW)**

Auxiliary power demand ranges from **2 – 9 MWs**

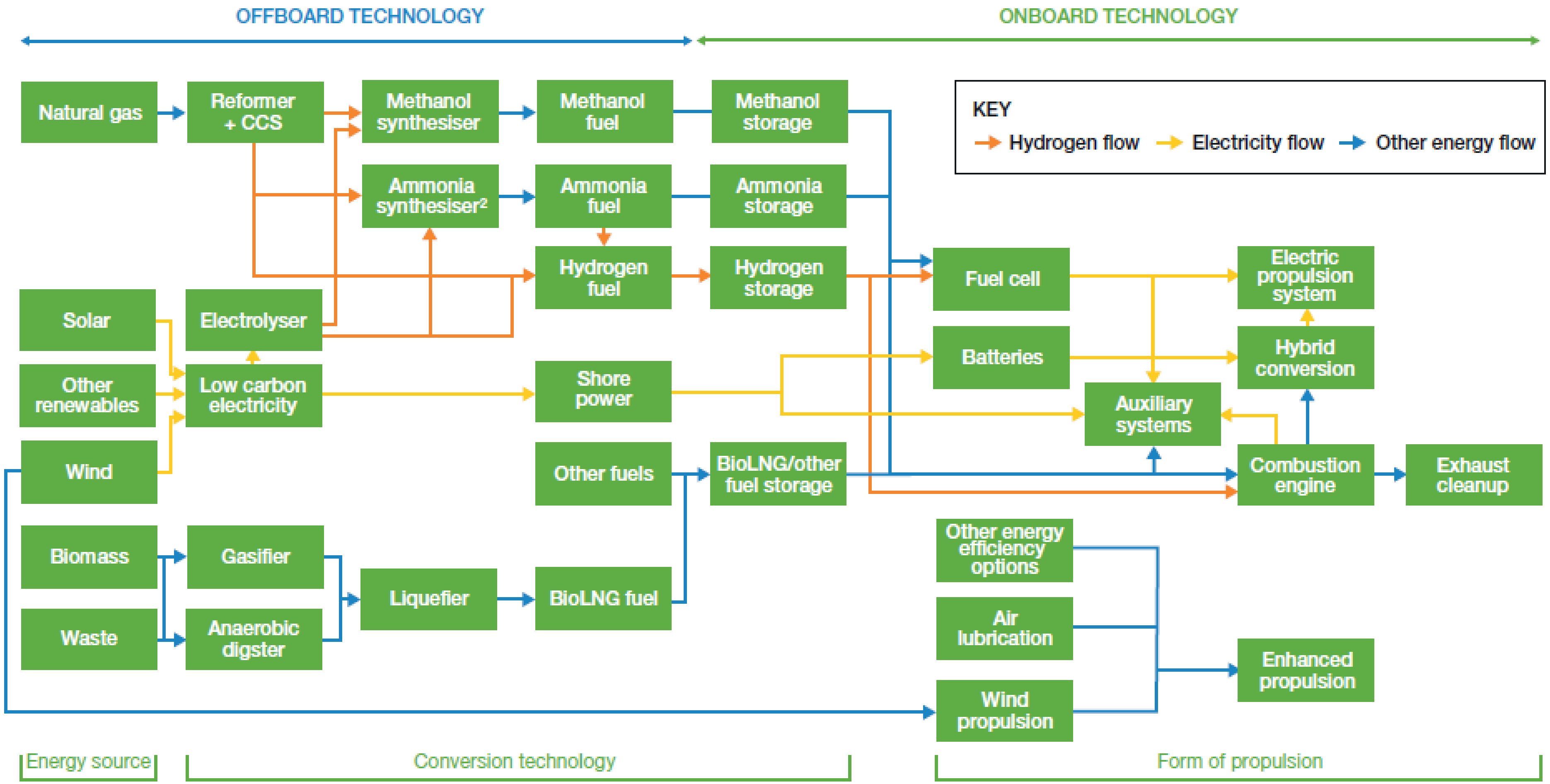
Shipping Emissions Projected to 2050

Under business-as-usual scenarios, international shipping could account for 17% of global GHG emissions by 2050. The goal is at least a 50% reduction (relative to 2008 levels) by 2050 as established by the International Maritime Organization.



Source: IMO 4th GHG Study

Numerous Technology and Fuel Pathways



1 Steam Methane Reformer (SMR) + Carbon Capture & Storage
2 Equipment used for the Haber Bosch process

Source: Frontier Economics for DfT

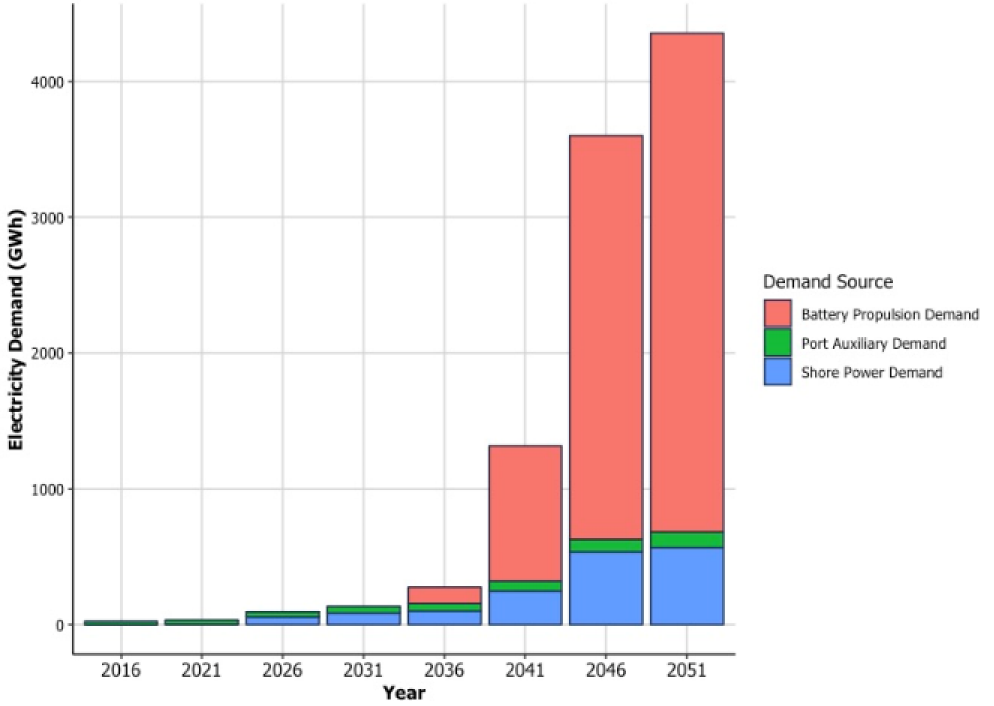
Electrification is one of several critical pathways

ENERGY CONSUMERS INSIDE A CONTAINER TERMINAL

	Diesel	Petrol	Natural gas	Electricity
Ship-to-shore cranes	●			●
Mobile cranes	●			●
Rail-mounted gantry cranes	●			●
Rubber-tyred gantry cranes	●			●
Reach stackers	●			●
Straddle carriers	●			●
Tractor-trailer units and lorries	●		●	●
Generators	●		●	
Buildings				●
Lighting				●
Reefer containers				●
Other port vehicles	●	●	●	●

Source: “Energy Consumption and container terminal efficiency”. FAL Bulletin Number 6, Issue No. 250, 2016; https://repositorio.cepal.org/bitstream/handle/11362/40928/S1601301_en.pdf

Figure 9 **Annual total UK port electricity demand under an ambitious de-carbonisation scenario**



Source: *UMAS modelling*

Note: *The three components of energy demand are battery propulsion which refers to the energy demand from electrified ships (recharging batteries); port auxiliary power demand which refers to the electrification of port infrastructure; and shore power.*

Source: “Reducing the UK Maritime Sector’s Contribution to Climate Change and the Potential Role of Targets and Economic Instruments: A Report for the Department for Transport”. July 2019.

The maritime energy transition

- The energy transition for the maritime industry will happen both at sea and on shore.
- Ports will need to be able to handle increased electrical loads due to three main drivers:
  - Electrification and hybridization of ships and cargo handling equipment which will require battery recharging
  - Vessels connecting to shore-power while at the dock (cold-ironing)
  - Local production of alternative fuels through electrochemical conversion (electrofuels)
- Proper planning at ports, terminals, and electrical utilities is required to successfully navigate this transition

Pacific Northwest
NATIONAL LABORATORY

Thank you

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Maritime Electrification Overview

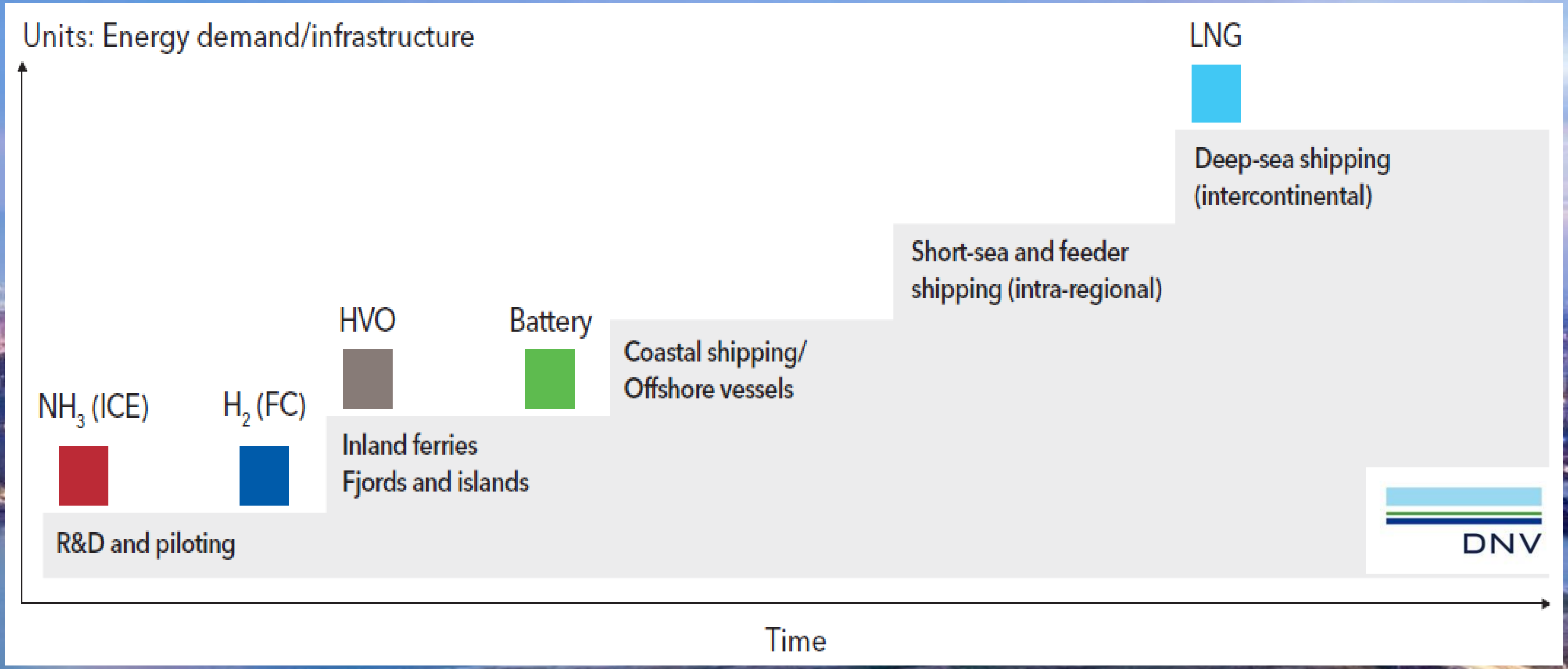
WASHINGTON MARITIME blue

Jennifer States

Vice President, Projects & Strategy

Jennifer@maritimeblue.org

Decarbonization Challenge
Acceleration Needed for Maritime Fuels & Batteries



LNG Success:

- Small, local transport first, gradual transition
- Ferries → Offshore Supply → Intra-Regional & Gen Cargo → global shipping

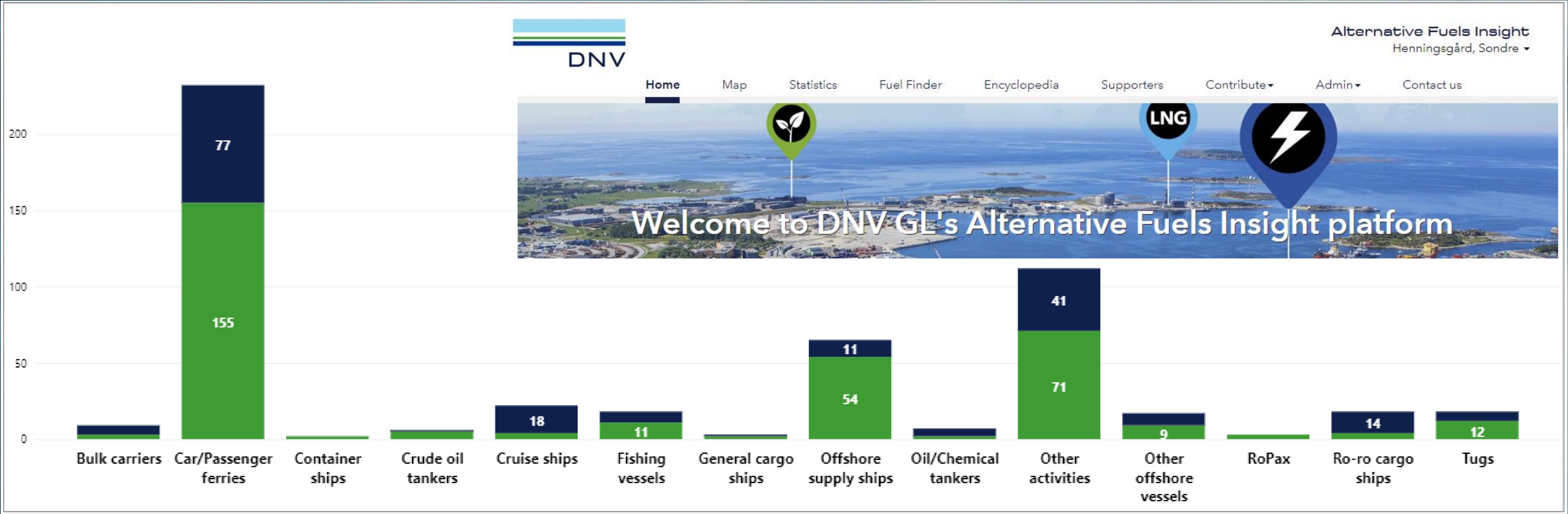
Not all the options have the potential to reach the deep-sea stage, mainly due to limited energy density

LNG: 20 years to climb these steps. Battery & H_2 can leverage landside uses (shorepower, transport, industrial) to expedite.

Current Decarbonization Opportunities

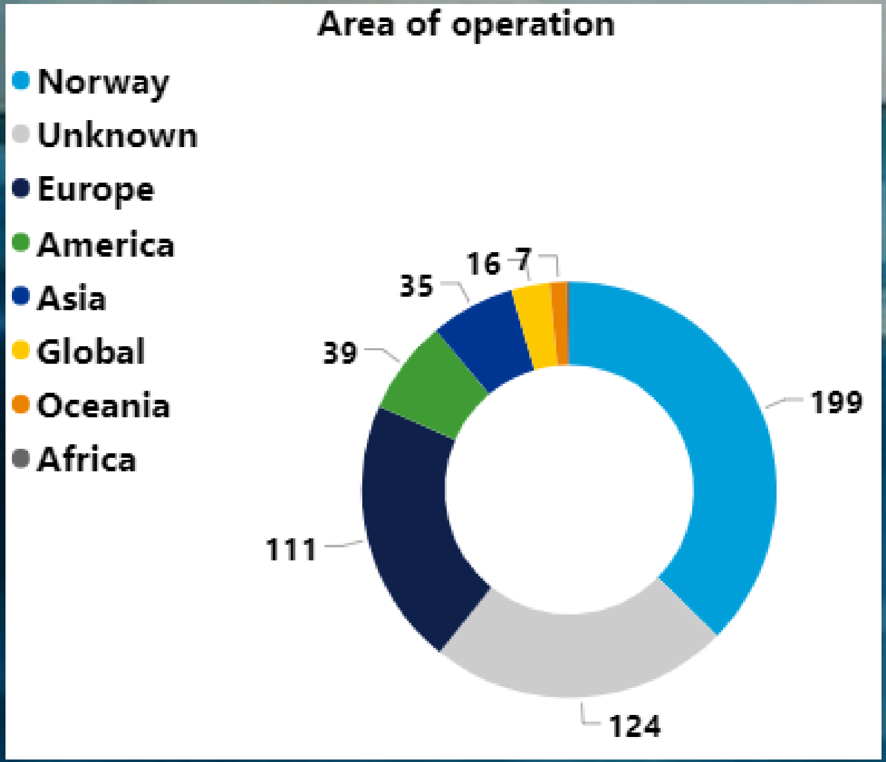
- **Shore Power for Vessels at Berth**
  - Reduces SOx emissions by 30%; PM by 65% per call
  - GHG reduction depends on local generation mix: average 36%
  - Capital cost: $2 - $10 million per berth; $1 million per ship
- **Low or Zero Emission Drayage Trucks**
  - CNG technology: significant reduction in NOx & PM v. older diesel but no reduction in carbon emissions
  - Battery electric and H2 fuel cell trucks can virtually eliminate NOx & PM and decrease carbon emissions by >60%.
  - Capital costs: $350,000 + charging infrastructure v. $120,000
- **Low or Zero Emission Harbor Vessels: Tugs & Ferries**
  - Reductions in PM ~ 70%; in NOx ~ 50%; in GHG 20% - 40% depending on degree of electrification and power source.
  - Capital costs: $1.5 - $4.0 million for new build or 15% - 30% the cost of a new tug.

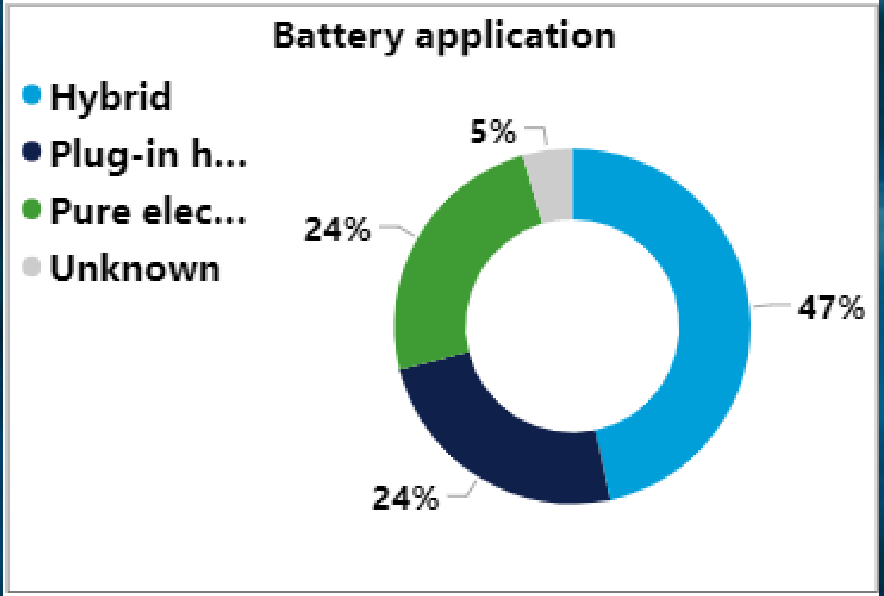
Maritime Battery Uptake Statistics

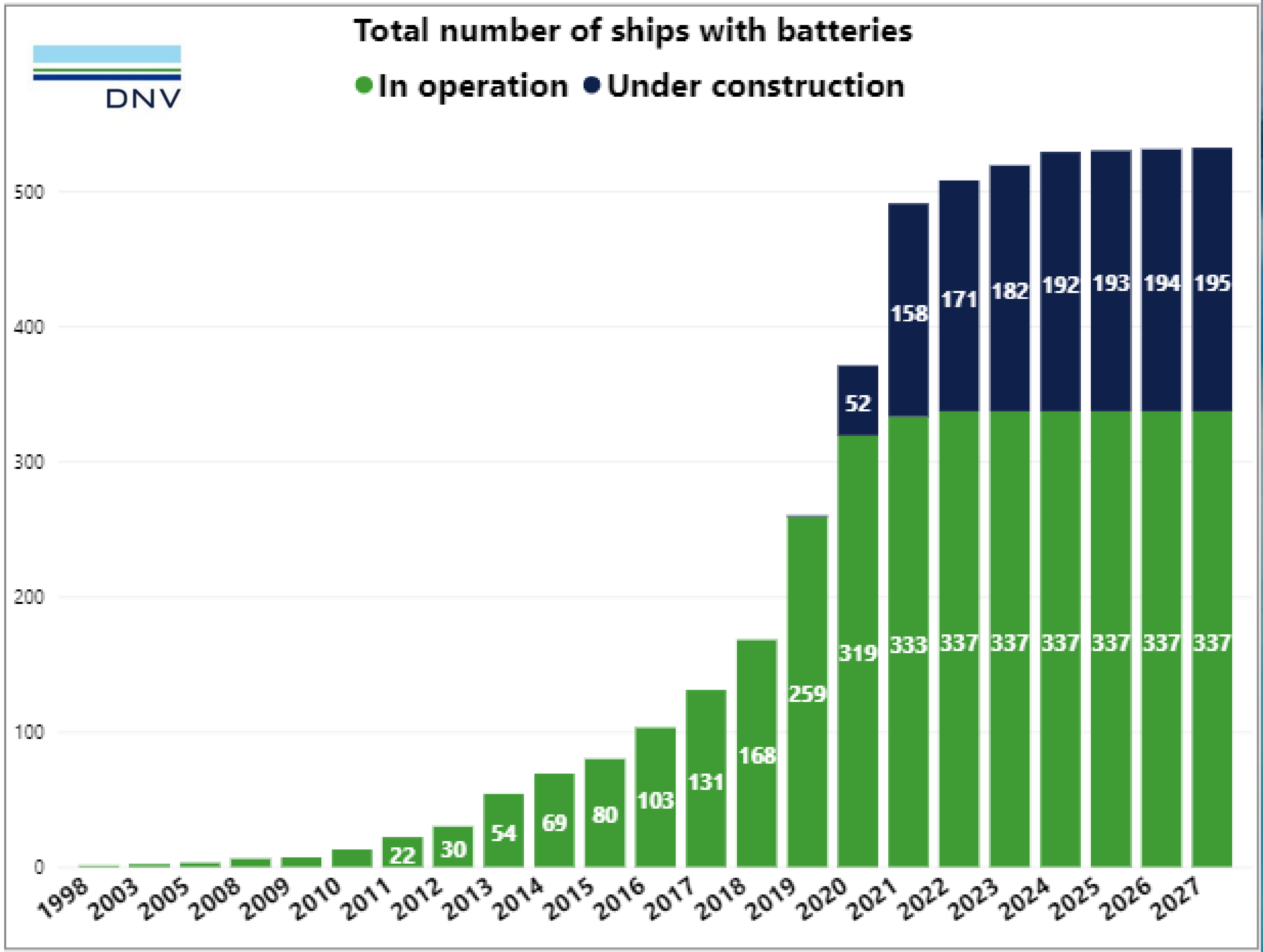


WASHINGTON MARITIME blue

Maritime Battery Uptake Statistics







Battery Utilization for Vessels

Spinning reserve
- Backup for running generators
- Fewer turbines needed online

Peak shaving
- Act as a buffer
- Level power seen by engines

Optimise load
- Optimise the operating point of the generators
- Reduce maintenance

Harvest energy
- Recover energy from cranes, drilling equipment, etc.
- Accommodate energy from renewables

Immediate power
- Instant power in support of generators

Backup power
UPS
- Battery system provides backup power, UPS like functionality

DNV

Batteries and hybrid systems represent a new way of providing power and propulsion – the trick is figuring out how to apply for different systems

Maritime Battery Feasibility Overview

Ship type	Main battery function considered	Factors which can maximize benefit	Fuel savings potential (%)	Payback time (years)
Ferry	All electric where feasible	Low electricity costs, high port time, low crossing distance	Up to 100	Less than 5
OSV	DP - Spinning reserve	Low power and energy needs for backup	5 – 20	2 - 5
Cruise	Hybrid operating in all electric, Ticket to trade	Ability to operate in all electric mode for extended period	< 5	Highly variable
Offshore drilling unit	Spinning reserve and peak shaving	Closed bus, large battery size	10 – 15	1 – 3
Fishing vessel	Hybrid load levelling and spinning reserve	Diesel sizing relative to loads	3 - 30+	3 - 7
Fish farm vessel	Hybrid load levelling and spinning reserve	Diesel sizing relative to loads	5-15 %	3-7
Shuttle tanker	DP - spinning reserve	Low power and energy needs for backup	5 – 20	2 - 5
Short sea shipping	All electric or many hybrid uses	Vessel and duty cycle dependent	Highly variable	Highly variable
Deep sea vessels	PTO supplement	Highly variable, detailed duty cycle analysis	0 – 14	Highly variable
Bulk vessels with cranes	Crane system hybridization	Integration with genset sizing	0 – 30*	0 - 3
Tug boats	All electric or many hybrid uses	Detailed duty cycle analysis	5 - 15 (100 if all electric)	2 - 8
Yachts	Silent operation, spinning reserve	Detailed duty cycle analysis	5 – 10	Highly variable
High speed ferry	All electric or hybrid	Detailed duty cycle analysis	Up to 100	3 - 6
Wind farm support vessels	DP - Spinning reserve	Low power and energy needs for backup	5 – 20	2 - 5

DNV - European Maritime Safety Administration Study on Electricity Storage on Ships


Global
Fleet
DEEPOCEAN
Scandlines HYBRID FERRY
VIKING LADY
FOSS

US Leadership

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

1st US Hybrid-Electric Fleet
WA State Ferries

- Kitsap Waterman
- Enhydra PHEV
- Sea Change – 1st Hydrogen

Washington Blue Built

Sea Change – *The first ever hydrogen powered vessel that was constructed in the US by All American Marine in Bellingham, Washington. The ferry just launched and is undergoing trials in WA, for service in the Bay Area.*

Contact:
Jennifer States
VP Projects and Strategy
Jennifer@maritimeblue.org
www.maritimeblue.org
#WaMaritimeBlue, #BuildBackBlue

Port of Lopez contract awarded, PURE Watercraft & Silverback Marine

Meet our latest fleet addition- the 100% ELECTRIC ORCA Landing Craft. With full sound attenuation and zero emissions.


Sveinung Odegard
Corvus Energy
Maritime Electrification for Utilities Workshop

Corvus Energy
440
Projects
>3 500 000
Operating hours
340+
MWh
114
Car and Passenger ferries
25
Cruise and Yachts
64
Offshore and Subsea
70
Tugs/Workboat/ Fishing/Research
24
Merchant vessels
143
Port equipment
Shore stations ++

Marine scalability – Overwhelming shore side power grids?

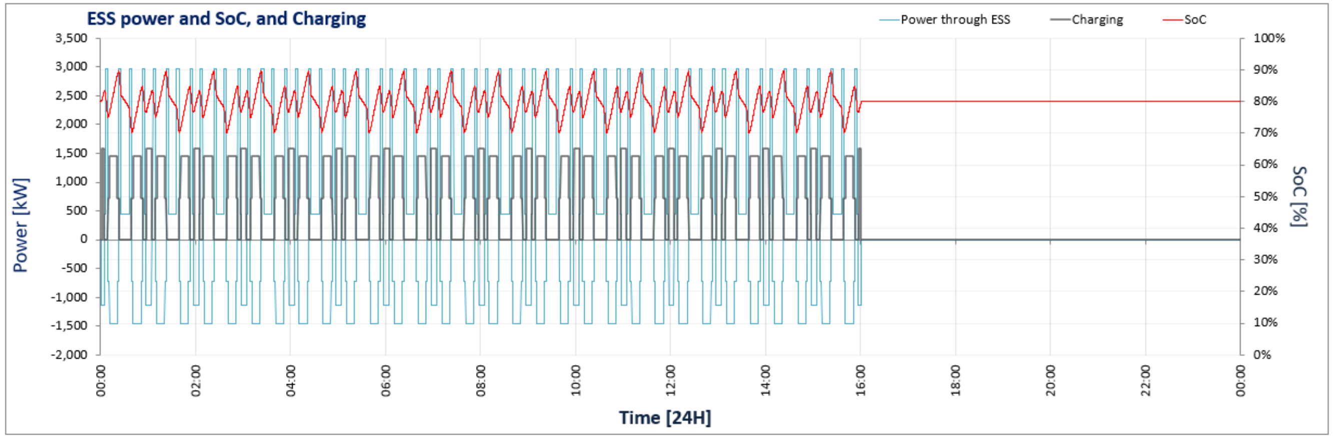
Size (typical)	500-2,000 kWh	1,500 – 6,000 kWh	2,500-10,000 kWh
Recharge time	Overnight	3 - 6 hours	10 min
Charge Power	< 100 kW	1,000 kW	10,000 kW

All numbers typical values only, and only for the purpose of illustrating how different vessels require different shore power capacities.

Increased buffer onboard – Case study

Fully recharge at each trip:

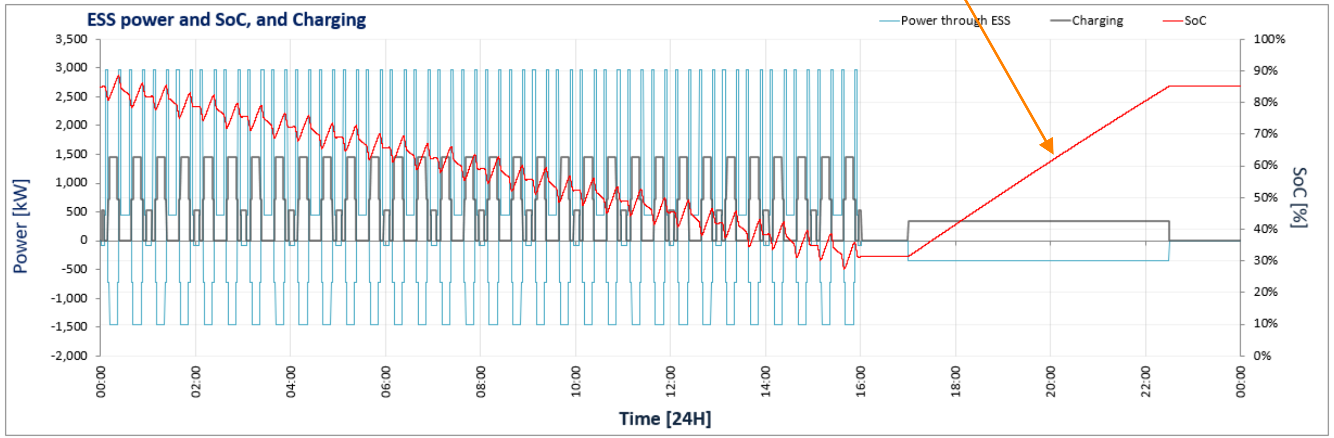
- **1,580 kW** charging power.
- Battery Size: **1,800 kWh**



Fully recharge at night

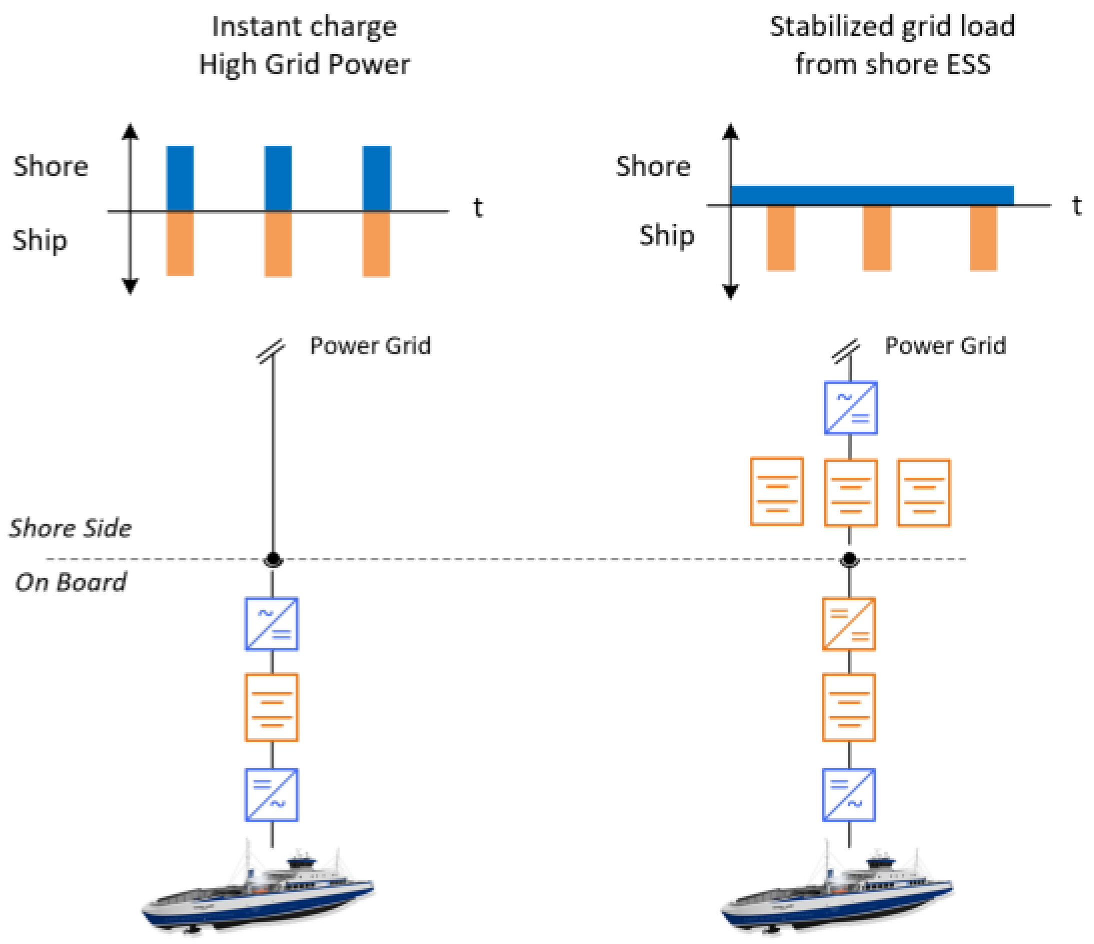
Partial recharge at each trip:

- **530 kW** charging power.
- Battery Size: **3,400 kWh.**



Corvus Energy

How can the power grid mitigate the peak powers?



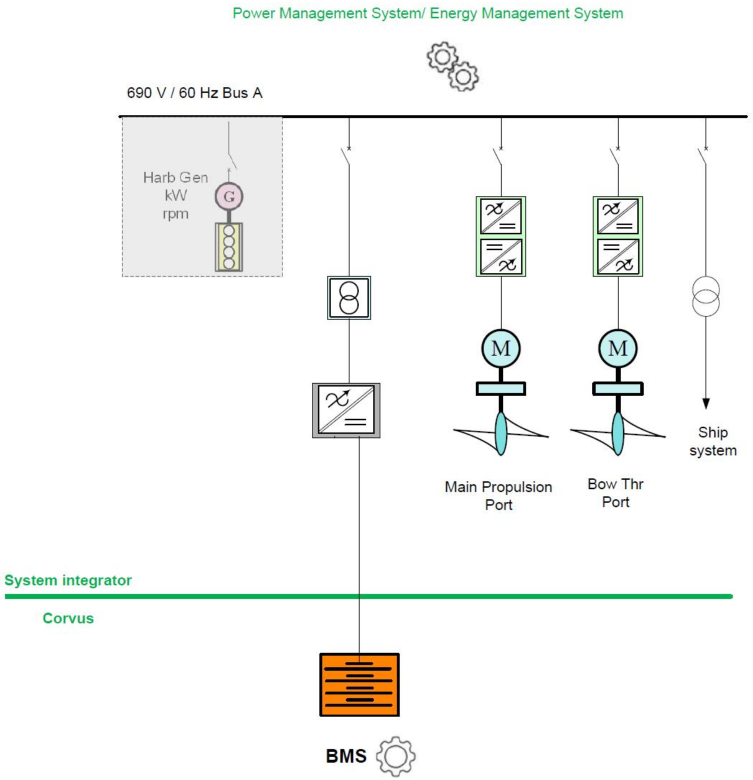
Significant peaks reductions.

Energy can be transferred both ways.

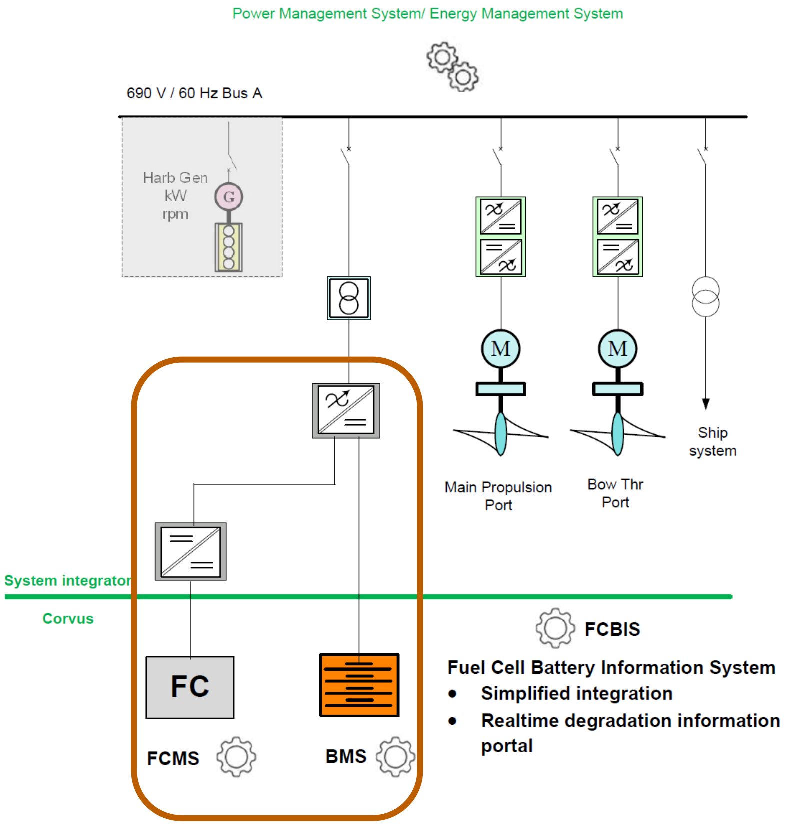
ESS can be used as backup for grid stabilization.

Fuel Cell Technology – Combined with ESS

ESS only

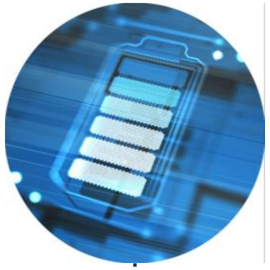


Fuel Cell combined with ESS



Fuel Cell Long-Term Roadmap

Corvus Fuel Cell Development Start



2021

2023

Selected Sailing Pilots

Commercial Deliveries of Type-Approved Corvus Fuel Cell Systems (PEM)

2024

2024-2025

Automated Factory

Second Type-Approved Corvus Fuel Cell System (SOFC/PEM)

2024* / 2026**

Thank You!

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www.corvusenergy.com

Corvus Energy

SPEAR POWER SYSTEMS

Vessel Electrification Challenges and Needs

September 15, 2021

Maritime Electrification for Utilities Workshop

Challenges:

- Difficulties with shore charging access
- Lagging transmission capabilities
- Lack of incentivization
- High capital investment

A Potential Solution:

Partnership between the energy storage system provider, vessel operators, ports, and utilities to provide affordable energy to the vessels.

Introducing Current Direct

Funded by the EU Horizons 2020 research and innovation program

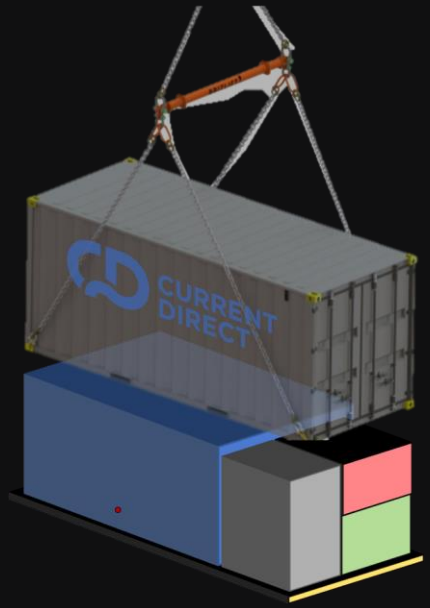
CURRENT DIRECT™

HORIZON 2020

SPEAR POWER SYSTEMS

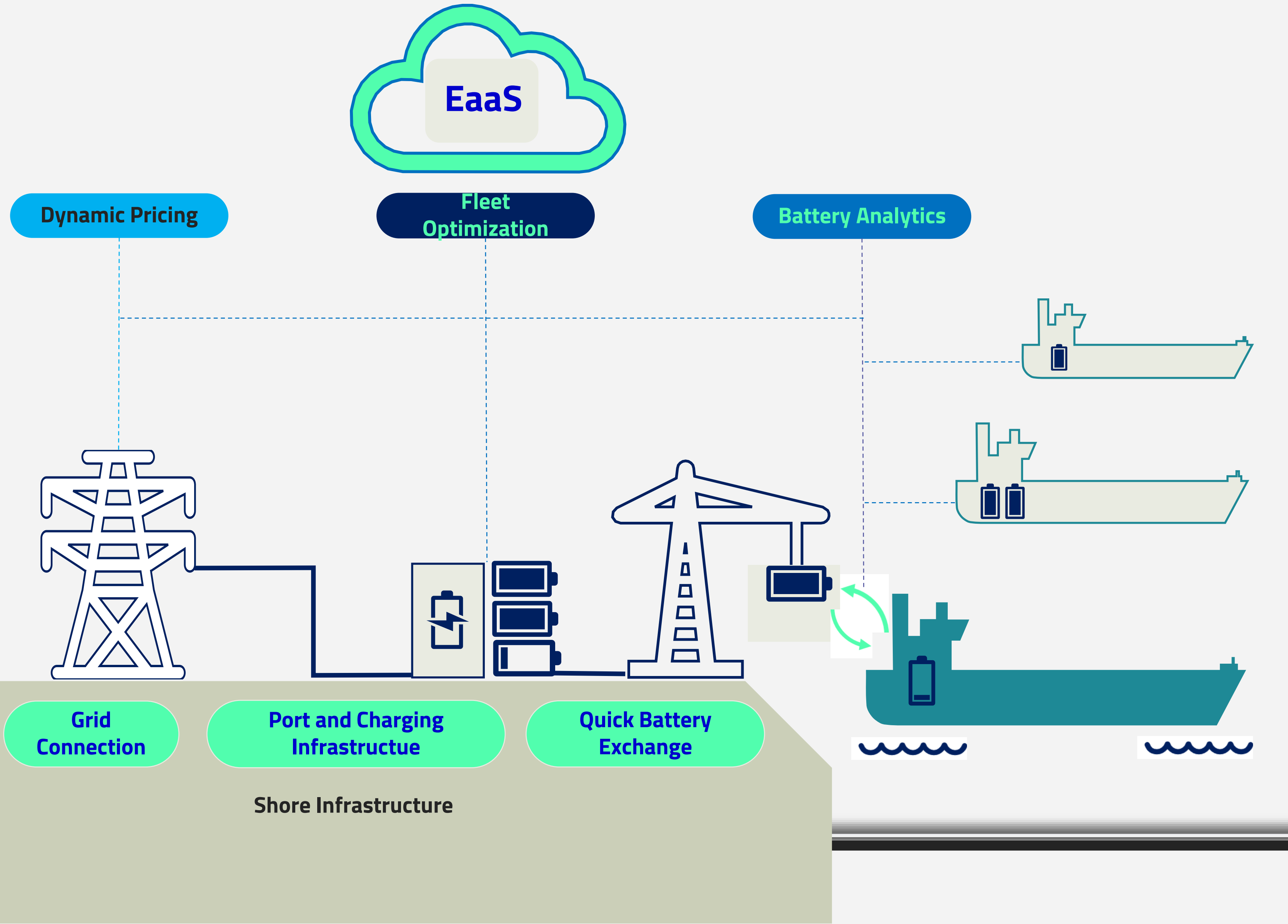
Components:

- Swappable Containerized Energy Storage
- Energy-as-a-Service (Eaas)

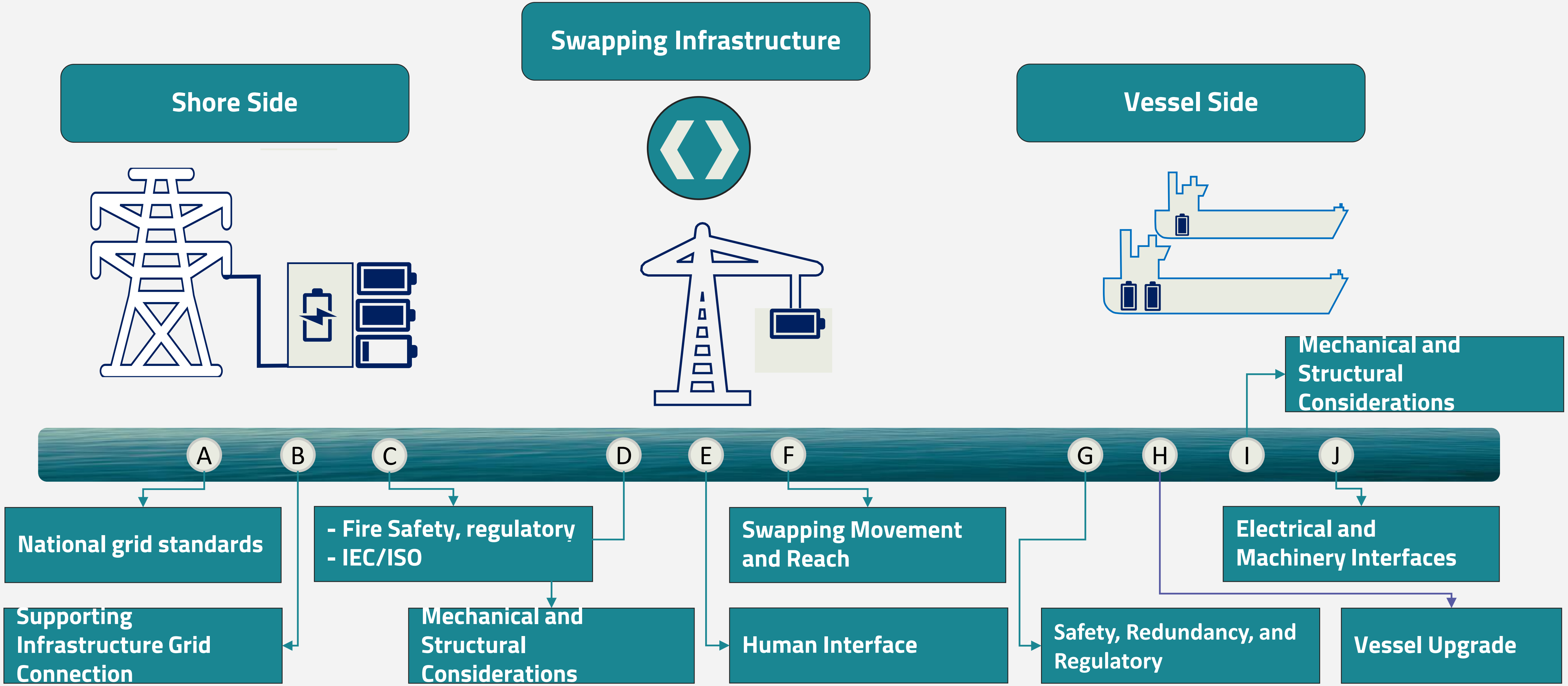


SPEAR
POWER SYSTEMS

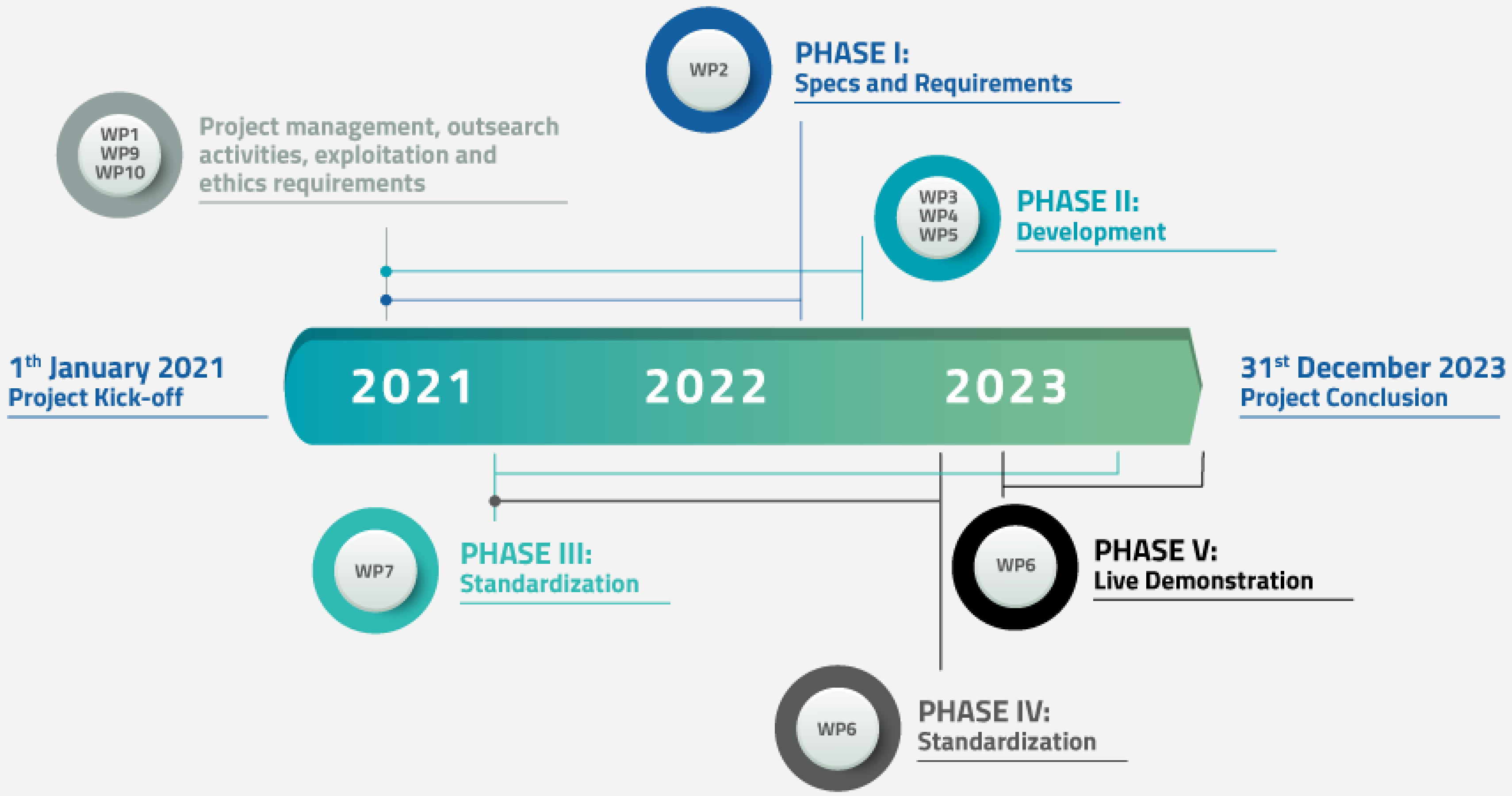
A novel ecosystem



Interfaces and topology

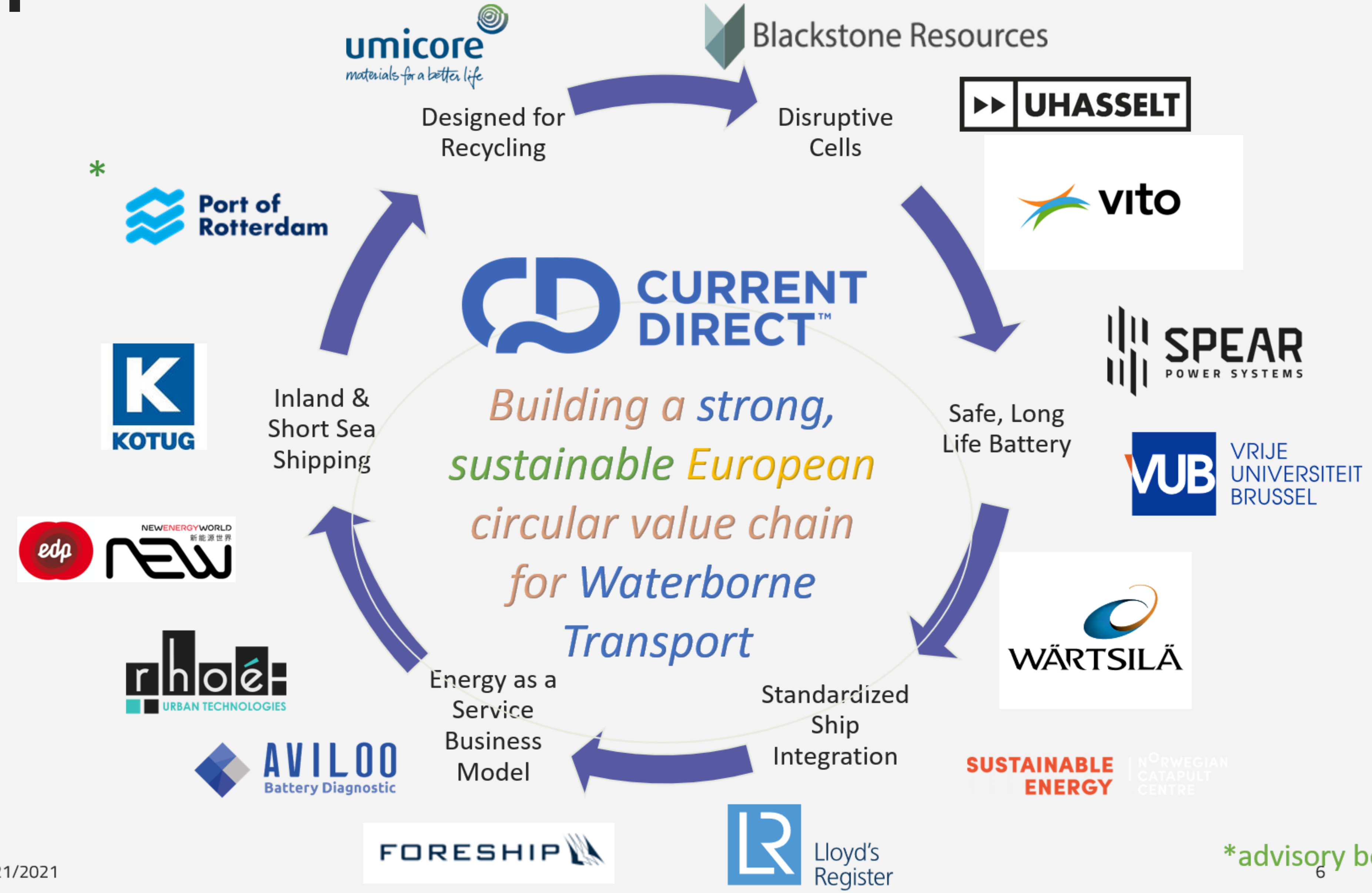


A concrete schedule



SPEAR POWER SYSTEMS

A comprehensive collaboration



*advisory board

To realize effective and widespread change in marine electrification, well developed relationships between public entities and industry collaborations are necessary.

EILEEN TAUSCH

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15 September 2021

Clean, Green Ferries

Using Grid Power to Electrify Ferries

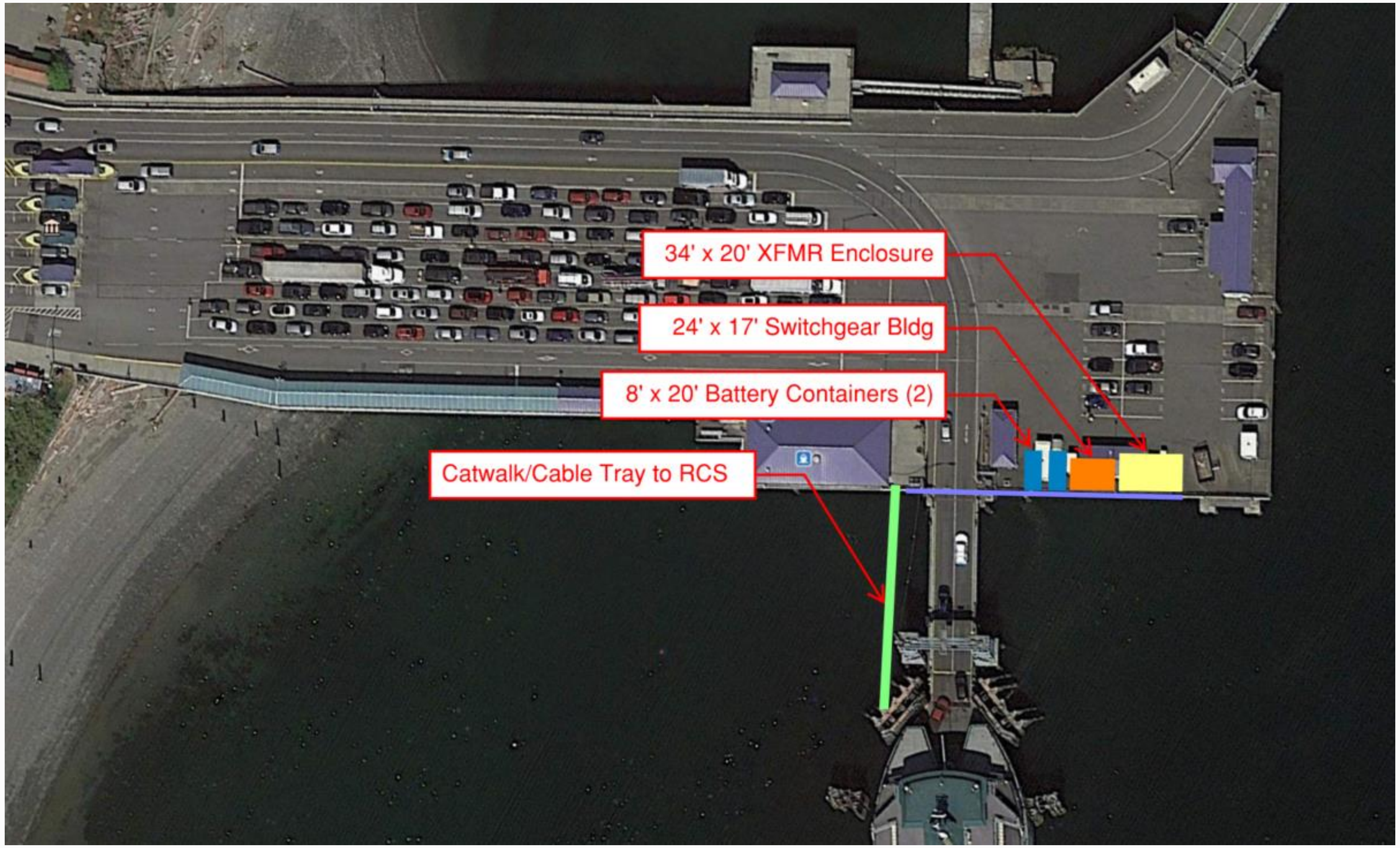
kpff

Summary

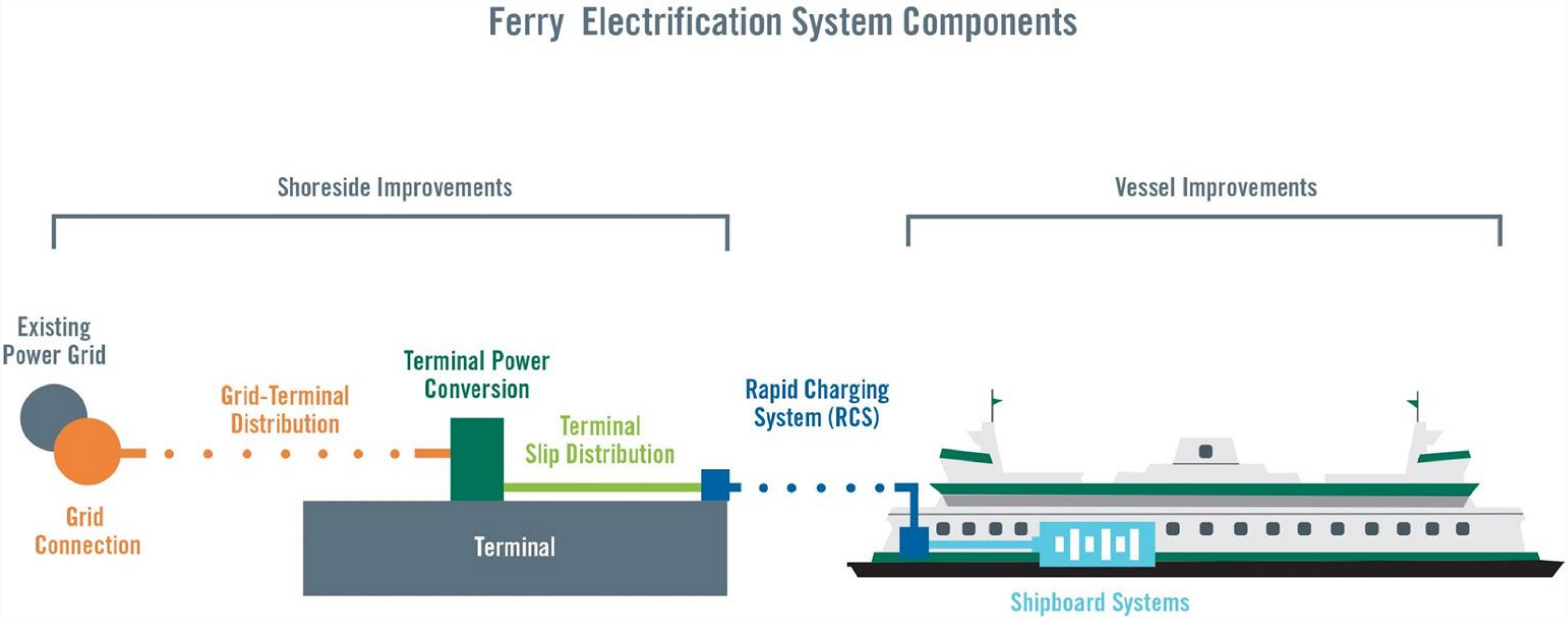
- Integrate with the local utility grid
- Locate equipment within the terminal
- Include construction impacts in the planning process

Agenda

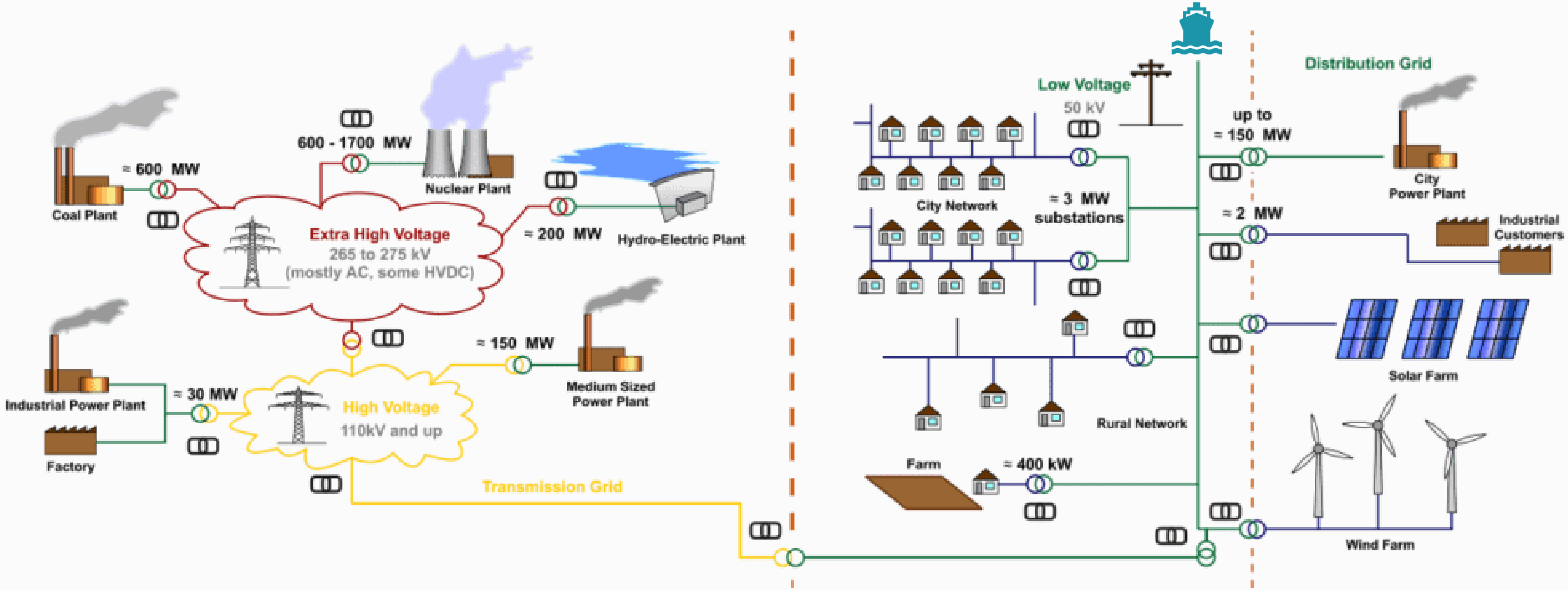
- Systems Overview
- Definitions
- Electric Ferry Power Demands
- Shoreside Batteries
- Terminal Impacts



Grid to Ferry System Overview



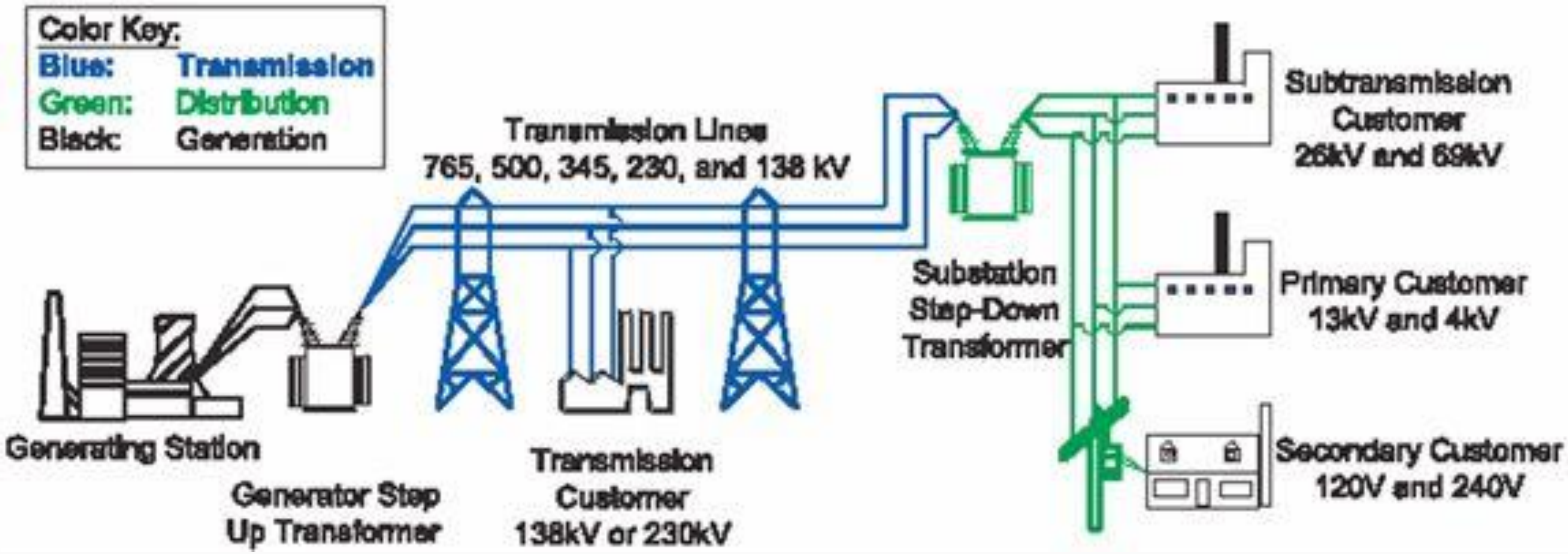
Definitions: The Grid



Definitions: Transmission and Distribution

Transmission: High-tension, high voltage lines on towers

Distribution: Medium voltage power lines on poles or in duct banks

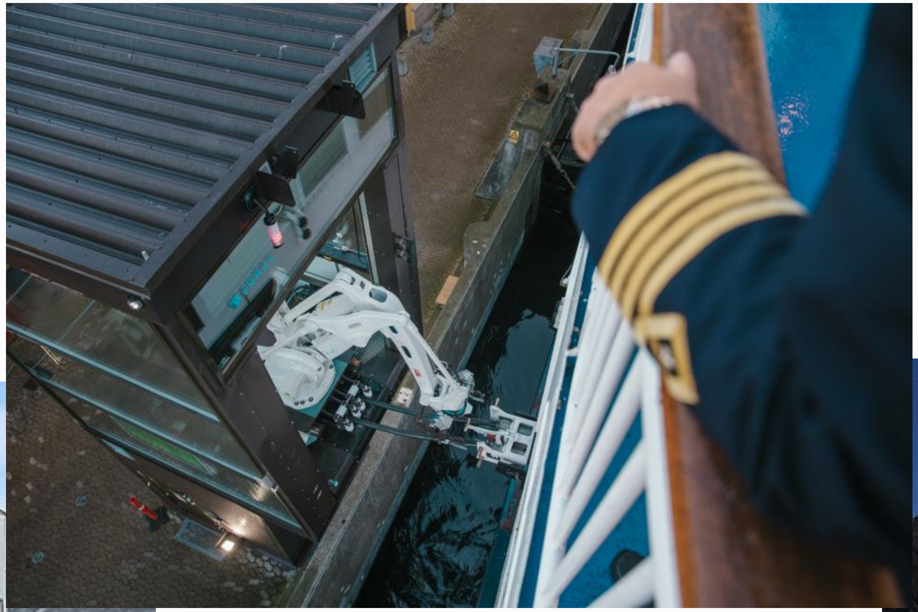


Definitions: Battery Energy Storage System

- Standard ISO 20’ or 40’ Container
- Batteries
- Energy Management System
- Safety, Alarm, and Firefighting Systems

Definitions: Rapid Charging System

Stemmann-Technik



ABB/ForSea

Cavotech

Electric Ferry Power Demands

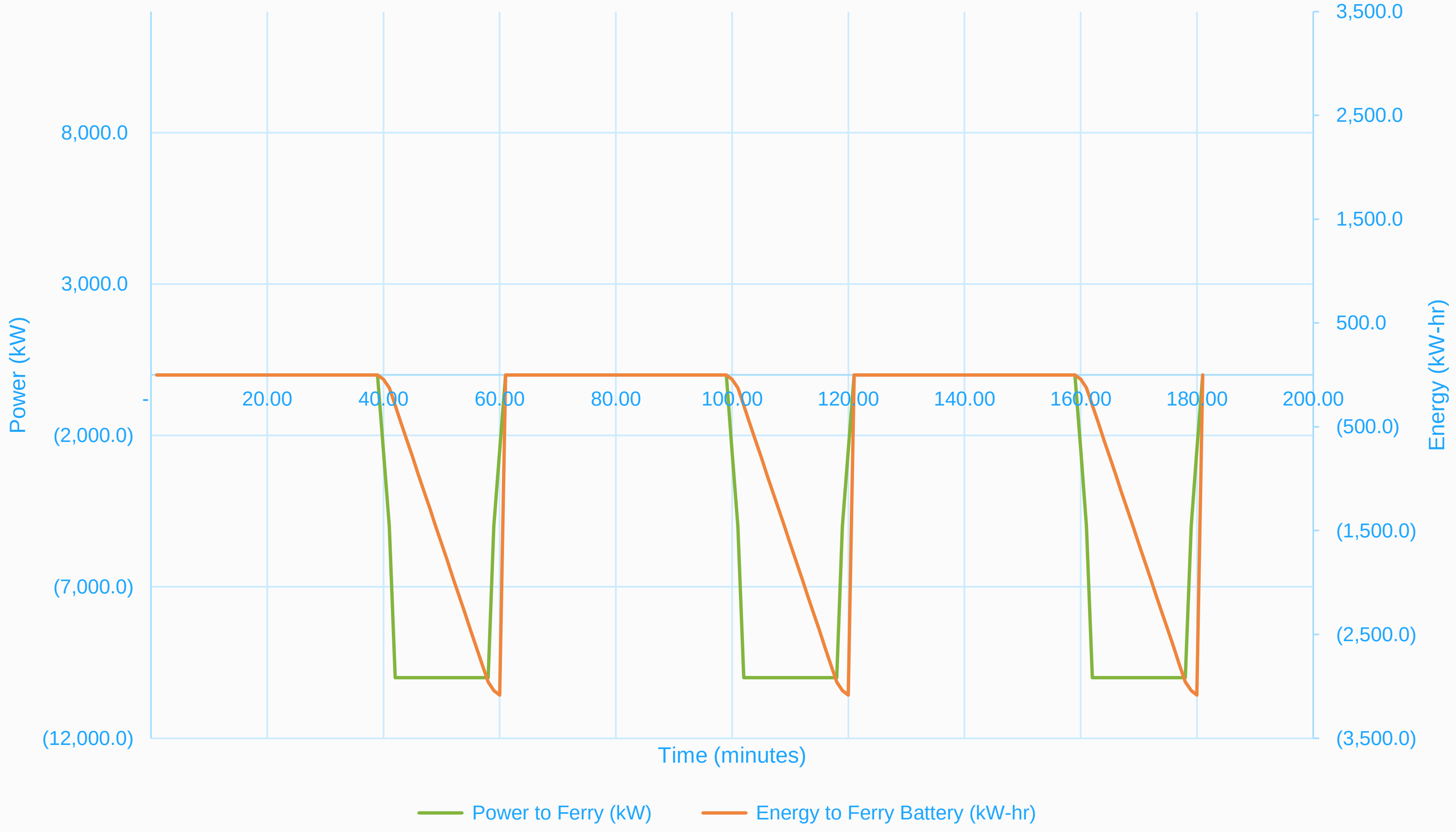
<u>Diesel to Electric Energy Conversion</u>

- Diesel Energy Density = 10.0 kW*hour/liter
- Diesel Engine Efficiency = 40%
- 1 liter of diesel = 3.94 kW*hour effective energy

<u>Example Ferry Point Design</u>

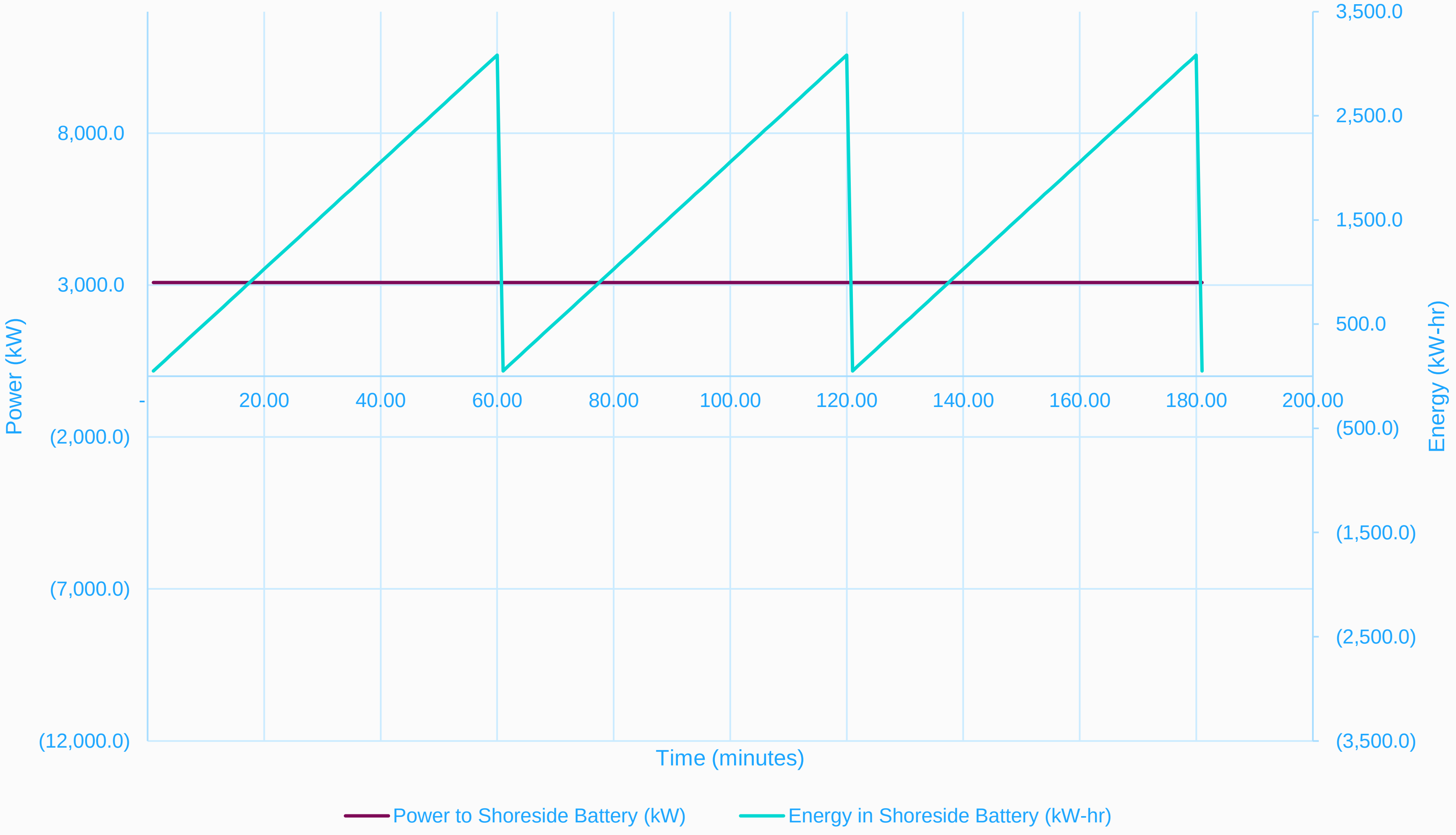
- 77.5 gal (293 l) per round trip
- Energy required: 3 MW-hours
- Dwell time: 22 minutes
- Charge time: 20 minutes
- Power ramp up / down: 2 minutes
- 10 MW peak power demand

Electric Ferry Charging Cycle



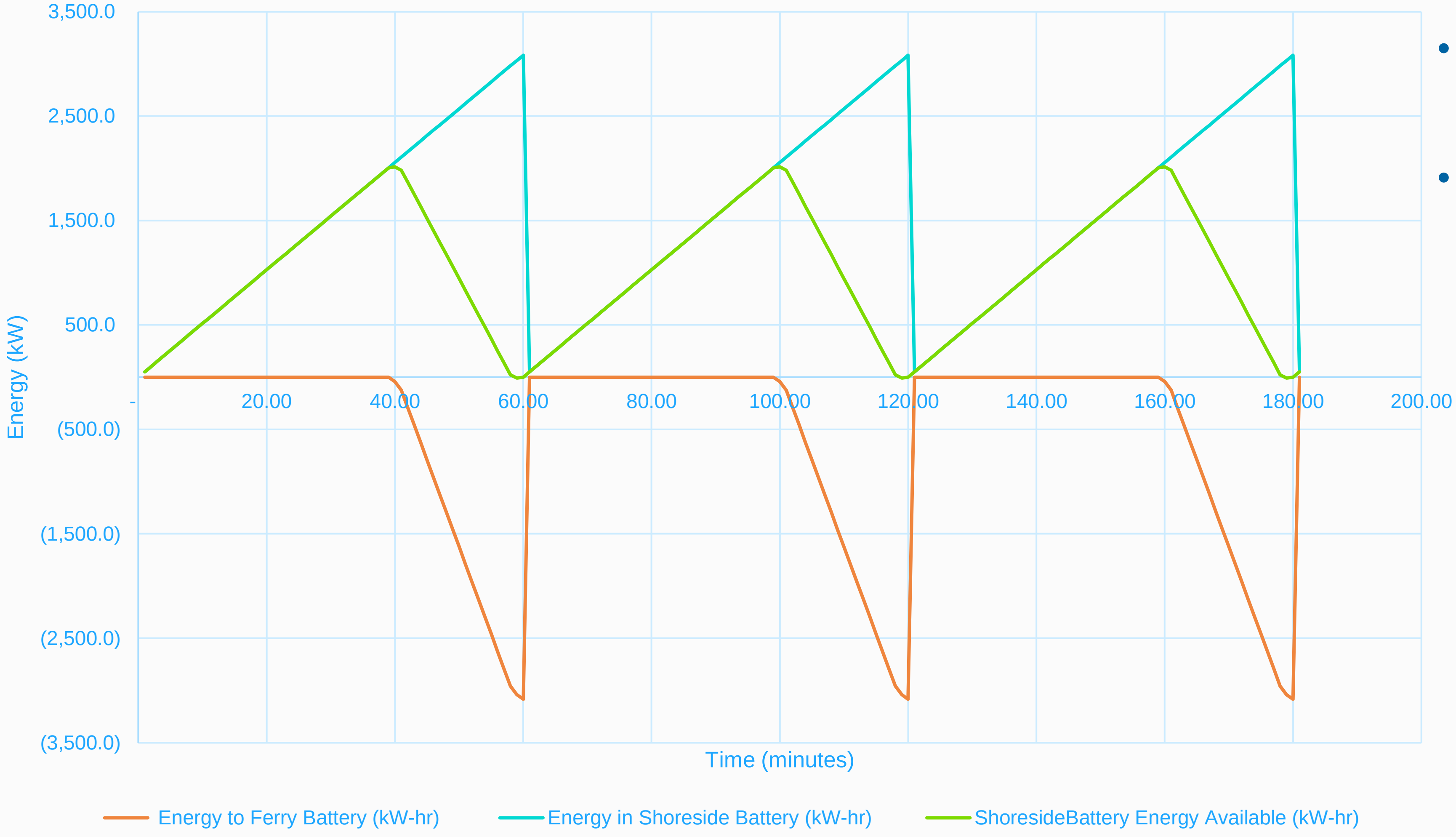
- Max Power = 10 MW
- Total Energy = 3 MW-hr
- High Peak Power
- Short Duration w/steep ramping

Shoreside Battery Cycle



- Max Power = 3 MW
- Total Energy = 3 MW-hr
- Lower Power Demand
- No ramping

Shoreside Battery Energy Cycle

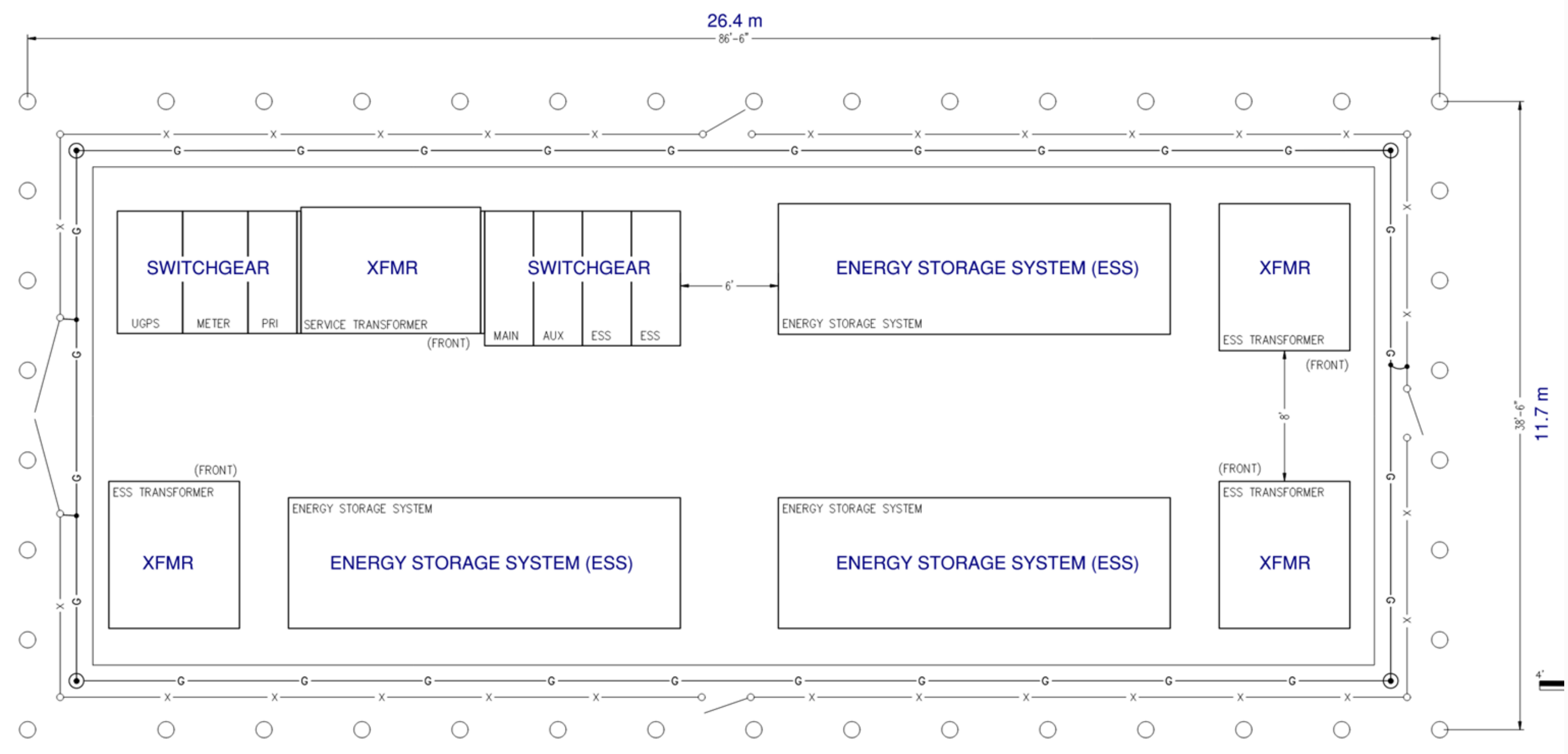


- 3 MW-hr total energy transfer
- Design for total energy transfer provides margin on capacity

Shoreside Batteries & Electrical Equipment

Delta Energy Storage System

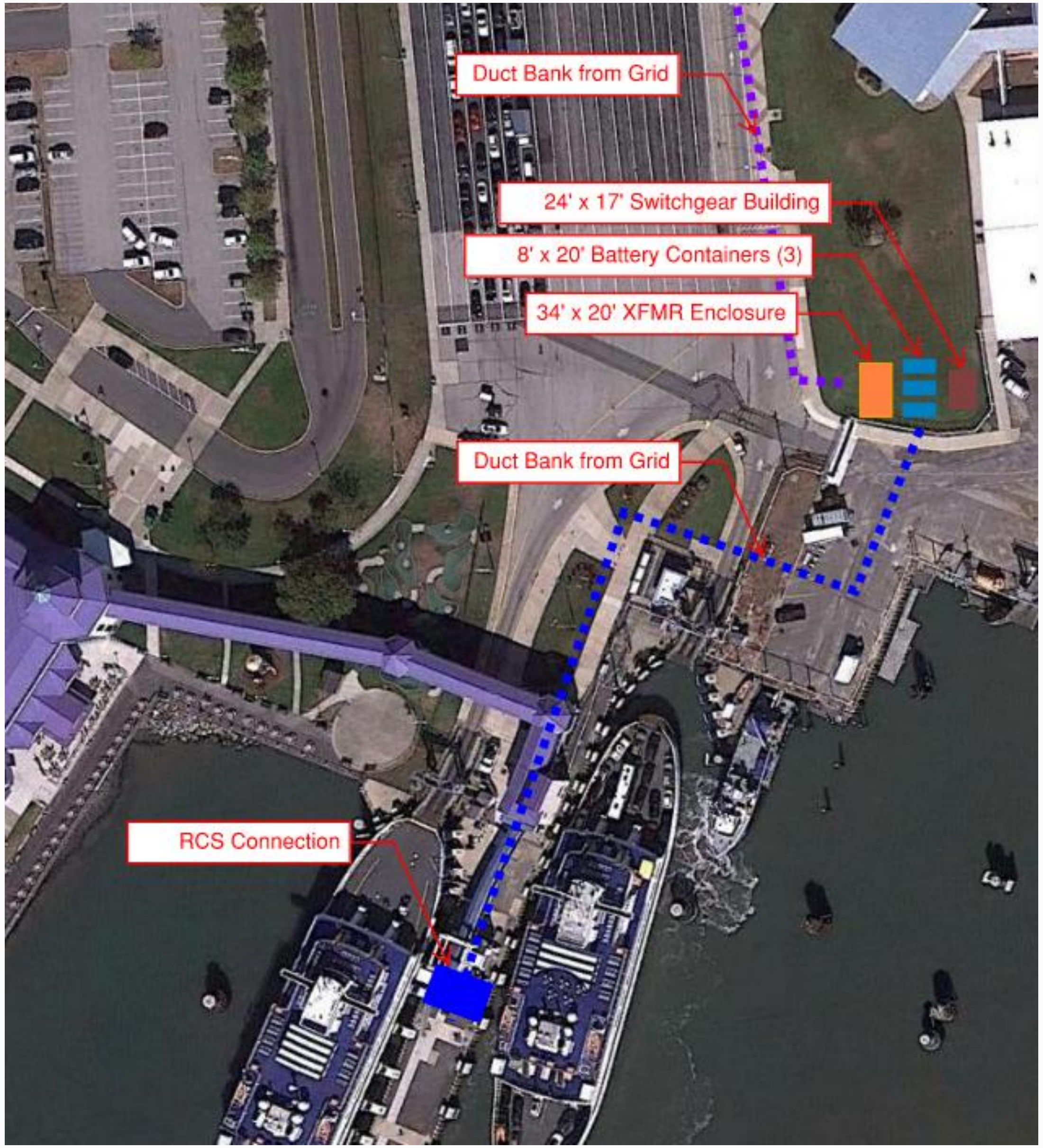
Terminal Impacts



Typical Terminal Substation

Terminal Impacts

- Space at slip for RCS: relocate other functions
- Duct banks through operating areas: phase construction
- Maintenance access for equipment: battery and transformer replacement



Thank you. Questions?

CONFIDENTIAL AGREEMENT (IF NEEDED): The information contained in this document is strictly confidential, and cannot be used without permission by KPFF Consulting Engineers.

WHEN TRUST MATTERS

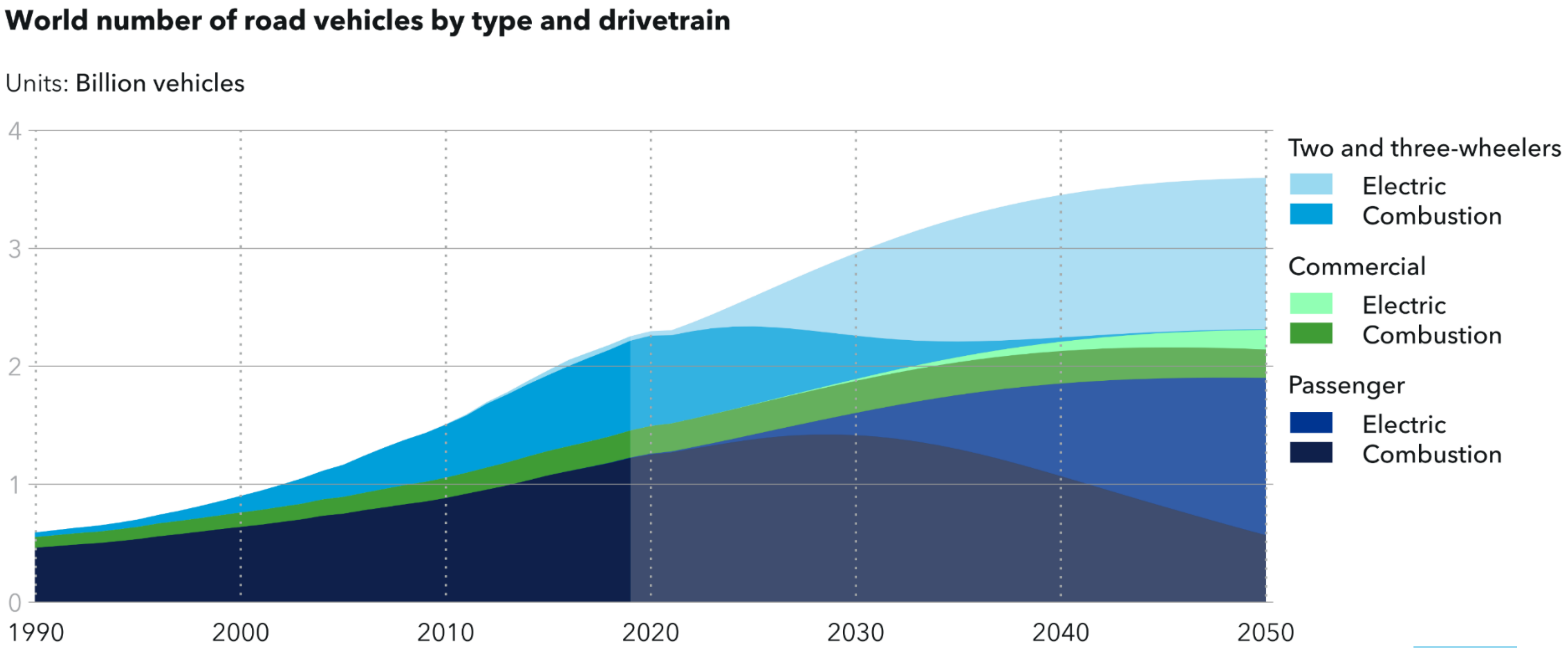
EVs and Maritime Electrification

Parallels and contrasts for electrifying transportation sectors

Jeremy Parkes, Global Business Lead – Electric Vehicles, DNV

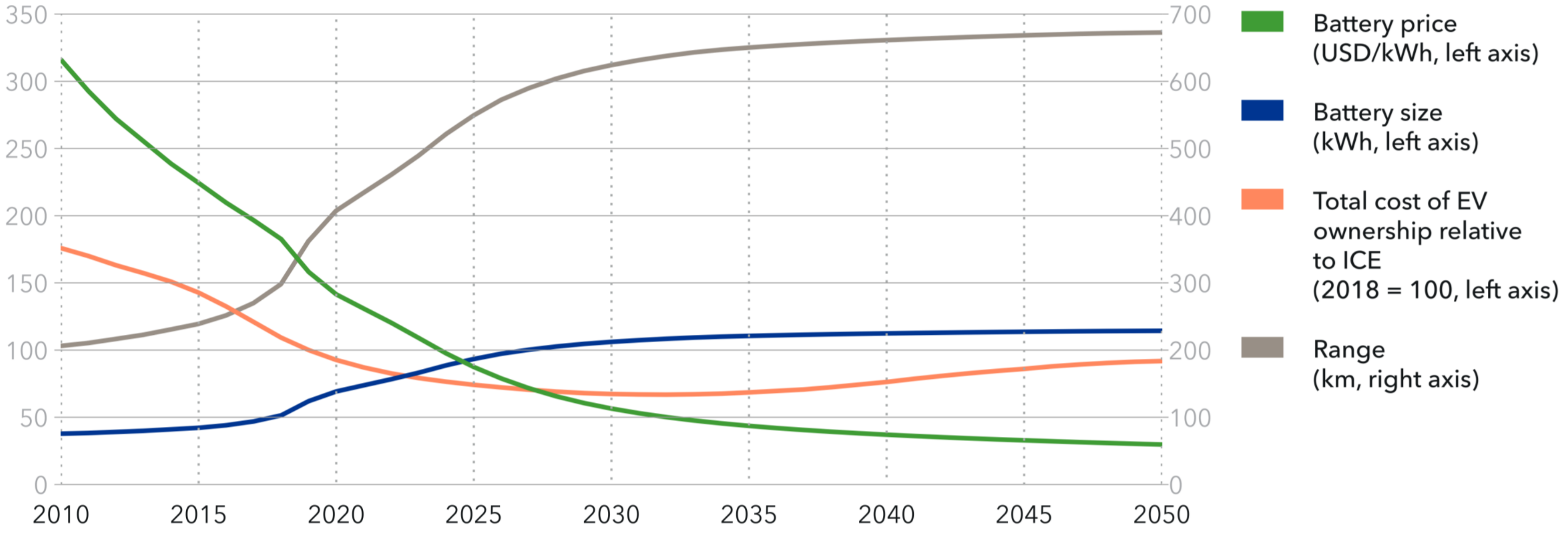
15 September 2021

The outlook for EVs

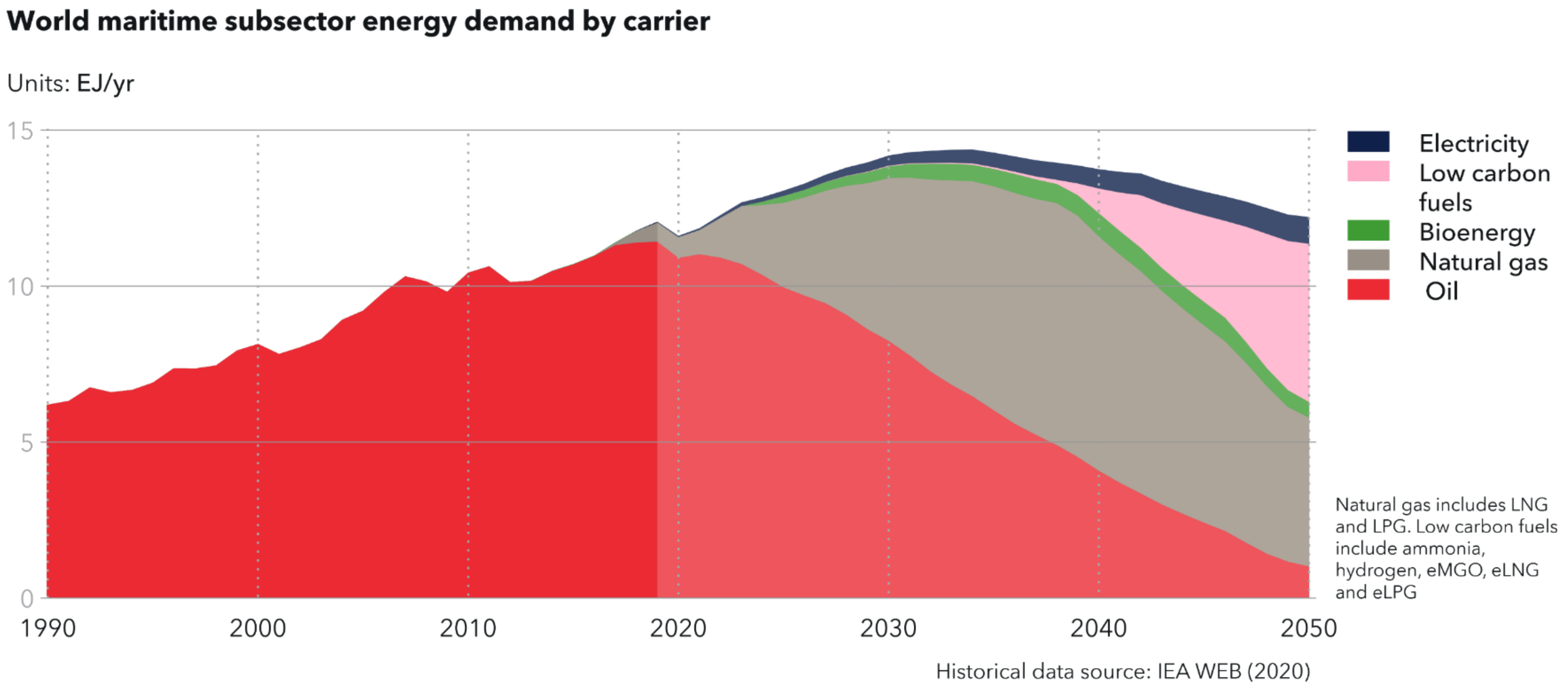


Battery development – higher energy density and lower cost

Development of key parameters of electric vehicles in Europe



The maritime fuel mix will change dramatically



Maritime Charging Demand

- Ports
  - Interest in Battery Electric growing rapidly, but technology is nascent
  - Port / industry / public partnerships leading development / demonstration of new BEV equipment
  - Cold ironing
- Harbor Craft
  - Electrified tugs
- Shipping and Maritime Trade
  - BEV possible only for short-distance hauls
  - Electrofuels such as hydrogen are in development, but transportation and safety risks still exist

Shoreside Charging Infrastructure Deployment

Economic Considerations

- Grid upgrades drive high costs when required
- Shorepower economics can be challenging:
  - Infrequent use but huge capacity required
- Charging + electrofuels + shorepower
  - Charging and Electrofuels increase usage
  - Improves economics

Technology Considerations

- Many technologies still developing
- Strategic roadmaps + pilots still needed
- Early and mid-stage adopters also needed

Battery safety – thermal runaway

Causes
- External abuse
- Internal failure

Avoid incident
- Good quality components
- Safe system integration
- Safeguard operational window

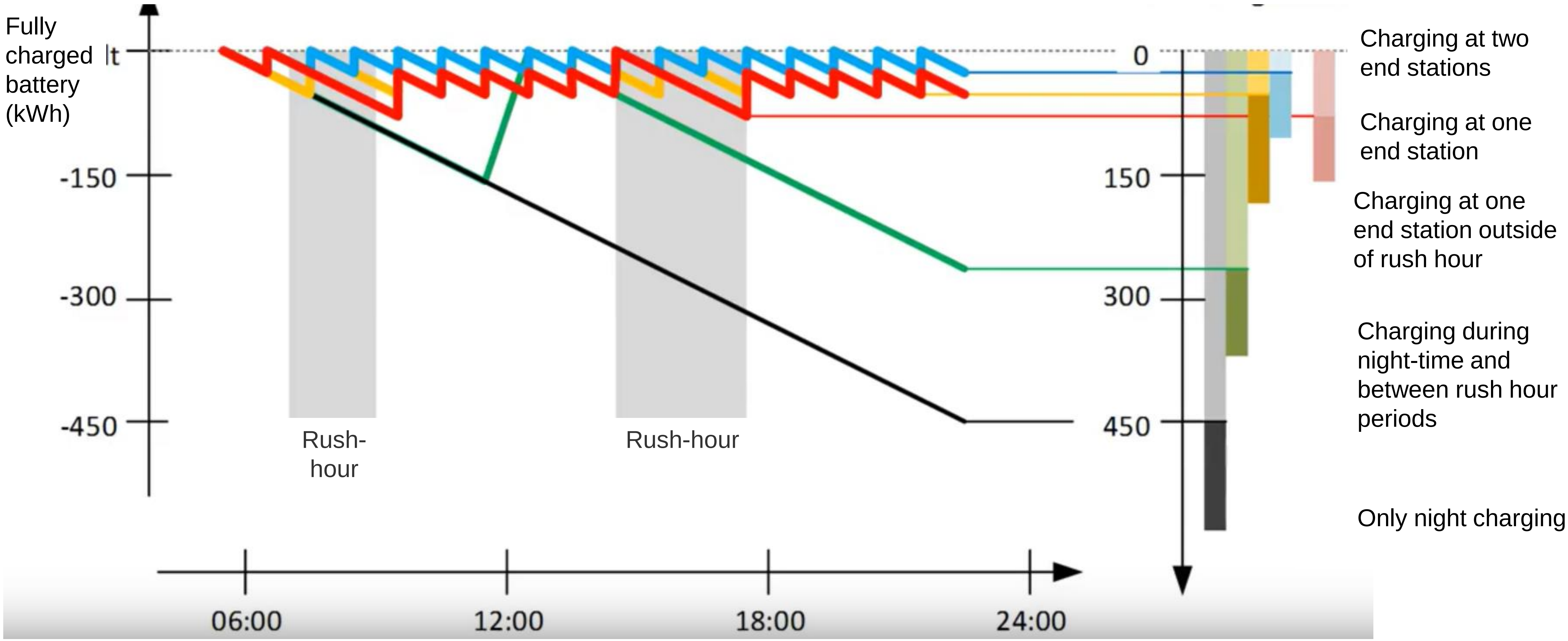
Consequences
- Toxic off gas
- Fire
- Explosion

Mitigate effect
- Containment
- Suppression
- Ventilation

All batteries can burn and emit gases, early detection off-gassing can avoid more significant impact. In general, CO is the best and easiest marker to detect.

Lessons learnt from bus charging strategies

Different charging profiles depending on battery size and charger infrastructure



Opportunities for utilities and ports

- Developing infrastructure to support shore power for vessels at berth
- Expanded energy efficiency programs for port operations
- Special tariff structures for shore power and electro-fuel generation like hydrogen
- Low or zero emission drayage trucks
- Low or zero emission harbor vessels: tugs and ferries
- Ports as a gateway to offshore wind
- Cross-sector innovations to develop effective solutions

Thank you

Jeremy Parkes

Jeremy.parkes@dnv.com

www.dnv.com

Port Electrification – A Utility Perspective

Cam LeHouillier - Energy Research & Development

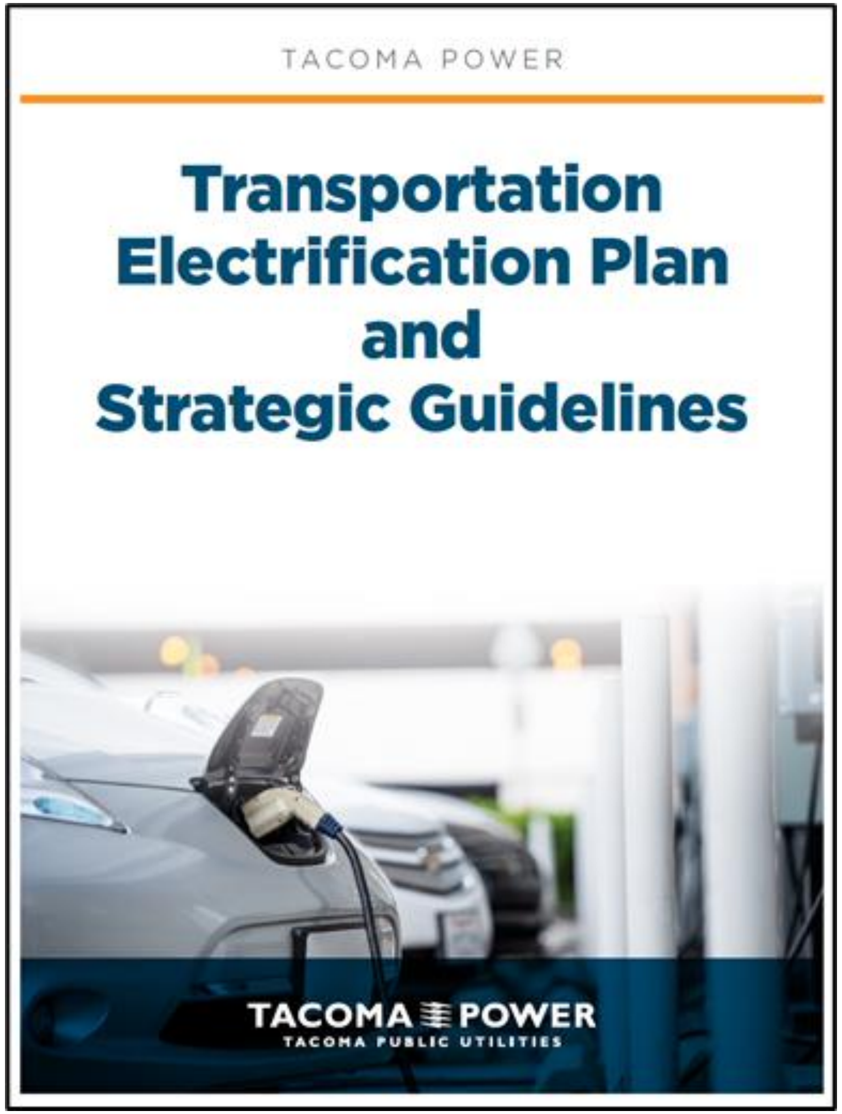
TACOMA POWER
TACOMA PUBLIC UTILITIES

Tacoma Power

- Some of the cleanest and cheapest power in the country
- Decarbonization through electrification
- Economic and environmental benefits for all communities served

Transportation Electrification

- Three quarters of Tacoma's carbon emissions come from transportation
- Strategy of decarbonization through electrification
- Improves environment, benefits utility revenue, promotes environmental justice
- Port electrification is key!



Tacoma Power Port projects

Shorepower at Husky Terminal

- Infrastructure scheduled to be energized 2022
- Supported with a special tariff
  - removed “demand charge”
  - effectively $0.115/kWh energy

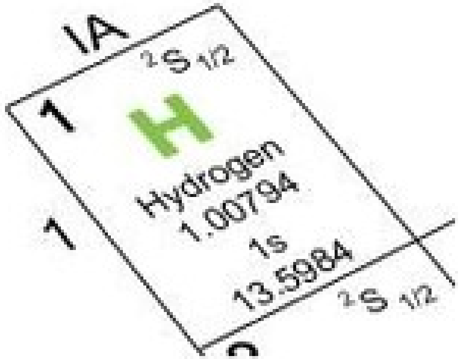
Cargo/Material Handling Equipment Charging Pilot

- Cover utility “make ready” costs and up to 50% of customer side charging equipment installation

Tacoma Power Port projects

Renewable Electrofuels Tariff

- Recognizes the flexible nature of electrolytic load
- Reduced demand charge in exchange for interruptibility
- Customers are willing to curtail operations for a minimum of 15% of hours during the year
- Curtailment minimum 1 hour up to 3 days
- Utility can count on contract for resource adequacy
- Existing customers benefit from increased revenues, jobs



WA Maritime Blue - Joint Innovation Projects

<u>High Speed Passenger Ferry</u>

- Engineering support for shoreside charging equipment, or hydrogen fueling infrastructure

<u>Tacoma Maritime Incubation Center</u>

- Supporting innovative start-ups operating at the nexus of maritime and clean energy

Ports for Clean Energy Innovation Hubs

- Ports have many potential partners, organized in a cluster
- Ports are a significant source of emissions (carbon and otherwise)
- Ports are a target rich environment – everything is run on fossil fuels
- Policy and tech developments have made opportunities available
- Working together in ports - we can overcome the challenges

Thank You!

TACOMA POWER
TACOMA PUBLIC UTILITIES

Port of LONG BEACH
THE PORT OF CHOICE

Transitioning to Zero Emission Operations at the Port of Long Beach

Leela Rao

Environmental Specialist Associate

PORT OF LONG BEACH

September 15, 2021

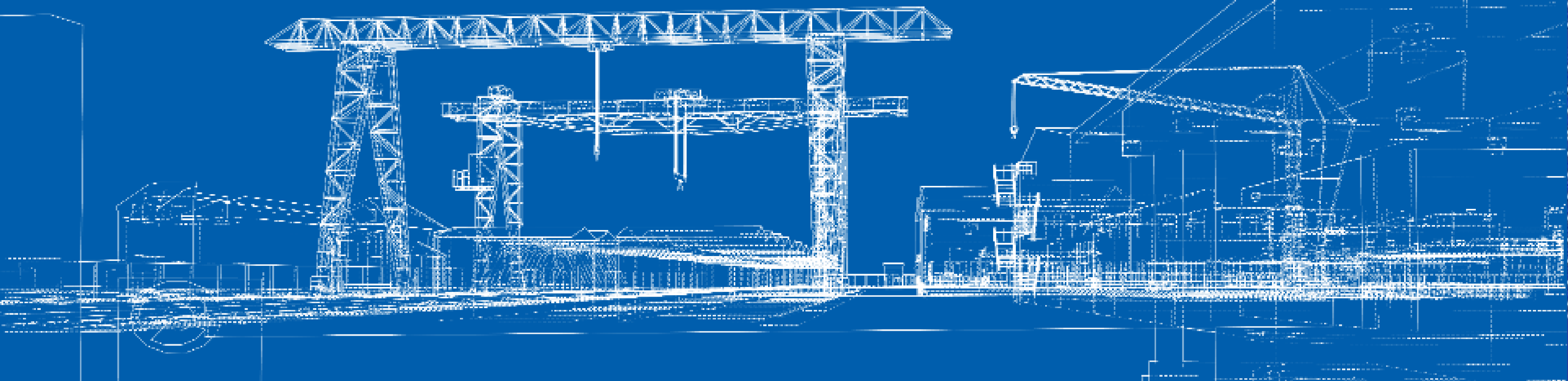
Outline

- Drivers for Port Electrification
- Port Community Electric Vehicle Blueprint
- Challenges and Opportunities

Drivers for Port Electrification

- Port Policies: 2017 Clean Air Action Plan Update
- State (CARB) Regulations
  - At berth, transport refrigeration units, harbor craft, drayage trucks, locomotives, cargo handling equipment
- Local Rules/Agreements to support federal attainment deadlines (SCAQMD)

Charging Ahead:
Port Community Electric Vehicle Blueprint



https://polb.com/environment/our-zero-emissions-future/#program-details

Infrastructure

Establish Baseline	Forecast Future Need	Evaluate Fueling/ Charging Options	Adopt Standards	Develop Design Plans
Blueprint Assessment	- Engineering Study - Blueprint Projections	- Configurations - Demonstrations	- Charging Standards - Fueling Standards - Design Standards	- Terminal Design Plans

Design Plans

- ✓ Equipment Specifications
- ✓ Operational Configurations
- ✓ Site Layouts
- ✓ Rough Costs
- ✓ Schedules
- ✓ Resiliency Considerations
- ✓ Cybersecurity Considerations

Informed by the Approach

Redevelopment

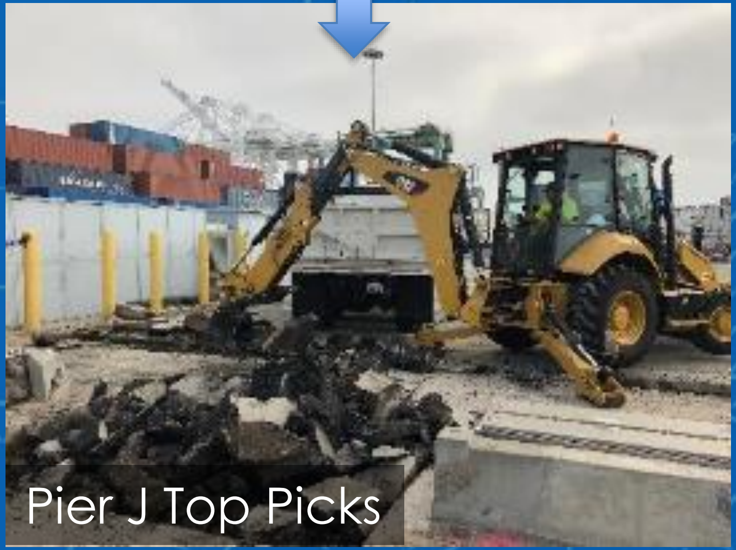
Comprehensive

Cost Effective

Permanent

Longer Timeframe

Retrofit



Incremental

Less Cost Effective

Temporary

Shorter Timeframe

Challenges and Opportunities

Mismatch in availability of funding and needs

- Large need for planning dollars today
- Funding available for equipment now
- Cannot use incentive funds for compliance

Challenges and Opportunities

Long Infrastructure Lead Times

- Utility program timelines and requirements
- Bordering utility jurisdictions
- Port construction challenges
- Equipment ready before infrastructure

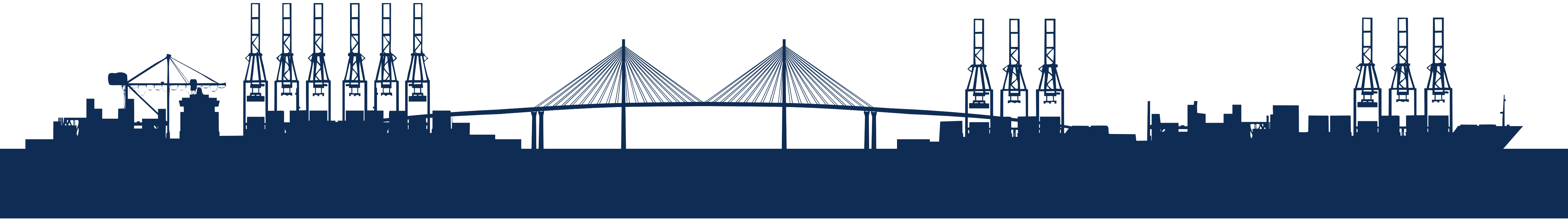
Challenges and Opportunities

General Challenges with Electrification

- Demand charges can be costly
- Capacity and resiliency questions
- Microgrid learning curve

Port of
LONG BEACH
THE GREEN PORT

THANK YOU



SSA Marine

A Carrix Enterprise

EXPANDING GLOBAL ENTERPRISE

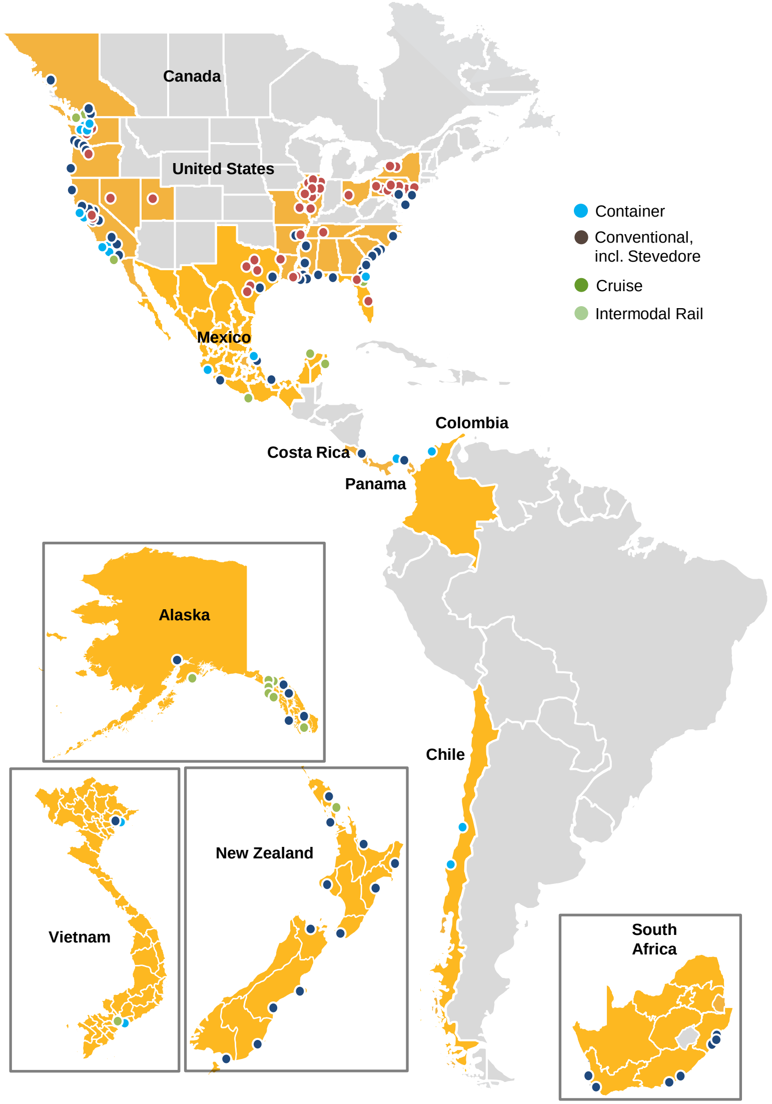
SARAH MOURIÑO
SUSTAINABILITY DIRECTOR

MARITIME ELECTRIFICATION WORKSHOP

1

ABOUT SSA MARINE

SSA MARINE IS ONE OF THE WORLD'S LARGEST TERMINAL OPERATORS



70
Years in Operation

250+
Operating Locations

17,000+
Employees

15.7M
Marine TEUs

113.5M
Tons of Conv. Cargo

14.3M
Intermodal TEUs

2.3M
Automobiles

7.0M
Cruise Passengers

SSA MARINE IS PART OF CARRIX

Carrix

- Container terminals
- Conventional terminals: capable of handling every type of dry cargo (forest products, grain, steel, fruit, pulp, mineral ores, seafood, automobiles, heavy machinery, project cargo, yachts)
- Intermodal operations: Rail Management Services, Shippers Transport Express
- Warehousing: container freight stations (CFS), cold storage
- Cruise: leading operator & service provider of cruise facilities in Alaska, Pacific Northwest & Mexico + related tourism activities
- Tideworks Technology

SSA MARINE ELECTRIFICATION PROJECTS

SSA MARINE HAS BEEN AN INDUSTRY LEADER IN TESTING AND DEPLOYMENT OF ZE EQUIPMENT

Deployed 4 battery electric Taylor top handlers (Oakland, Long Beach)

Converted 9 ZPMC Diesel-Electric 946-1,043 hp RTGs to 100% electric grid-tied RTGs (Long Beach)

Deployed 38 DINA electric UTRs (Oakland, Long Beach)

First global deployment of 6 36,000-lb zero-emission Wiggins e-Bull forklifts (Stockton, West Sacramento)

Deployed 24 Orange e-hostlers at RMS rail ramps

Currently deploying 15 Peterbuilt Class 8 battery plug-in drayage trucks for Shippers Transport Express (10 just delivered to Oakland)

Converted 58 Diesel RTG’s to electric grid-tied RTGs and purchased 6 new e-RTGs (Manzanillo, Panama)

Recently received funding to build infrastructure to support 6 electric yard tractors for RMS operations (Tacoma)

EXAMPLE 1: TAYLOR TOP HANDLER DEMONSTRATION

Port of Oakland

Port of Long Beach

A

3%

CA Tophandler Fleet

- 4 e-top handlers
- 77 total top handlers in LB; 53 in Oakland

B

99%

Publicly Funded

- $9.441M from CARB and Energy Commission

$2M

3x

Cost of Tier 4 Diesel

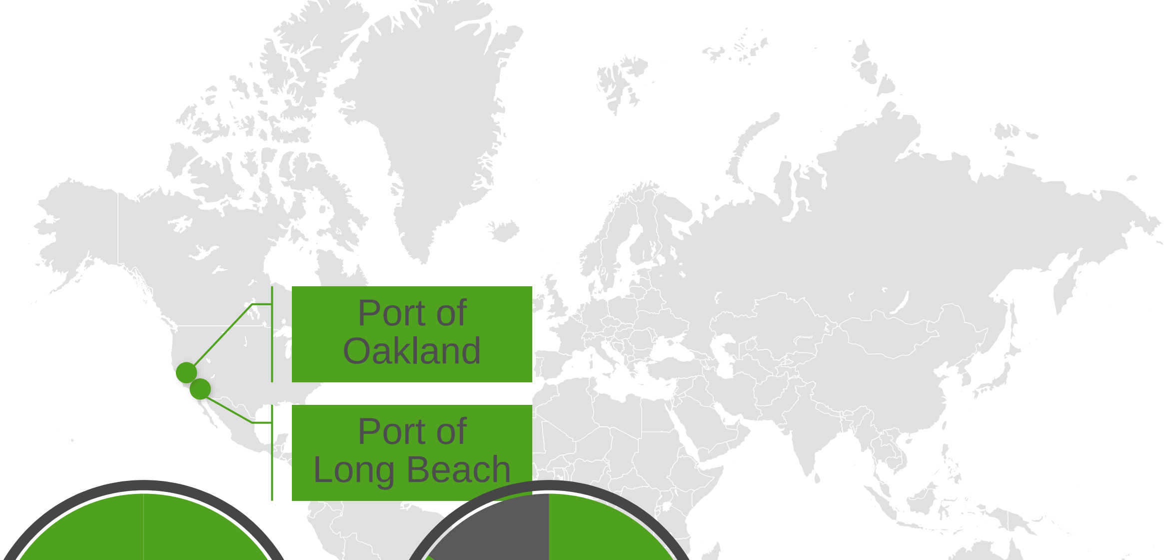
- $2M per new e-Top Handler
- $650k per new Tier 4 diesel Top Handler

Key Partners Port of Long Beach, Port of Oakland, Taylor, BYD, California Air Resources Board

Scope Deploy 4 zero-emission battery-electric top handlers: 2 currently in service at PCT (LB), and 2 more coming to C60 (LB) and B63 (OAK) in June 2021.

- Diesel Reduction: 18,000 gal/yr (4,500 gal/unit)
- Fuel Savings: $44,280/yr ($11,070/unit)
- Emission Reduction: 183 MTCO$_2$/yr (45 MT/unit)
- Among the earliest deployments of eTop Handlers
- Not enough battery range to work 2 shifts without recharging

EXAMPLE 2: DINA E-UTRS



A
64%
Fleet at Our CA Matson Terminals
- At Pier C in Long Beach (33 of 36) and B63 in Oakland (5 of 23)

B
90%
Publicly Funded
- $15.39M from California Air Resources Board

$575k
5x
Cost of Tier 4
- $450k per new e-UTR + $125k each for charging infrastructure
- $115k per Tier 4 diesel

Key Partners Port of Long Beach, Port of Oakland, DINA, TransPower, California Air Resources Board

Scope Deploy 38 zero-emission all-electric yard tractors at Matson terminals in Oakland and Long Beach, with all units expected to be in service by December 2021.

- Diesel Reduction: 152,000 gallons/year (4,000 gal/unit)
- Fuel Savings: $198,000/yr ($5,000/unit) but only until 2029
- Emissions Reduction: 1,553 MT CO_2/yr (35 MT/unit)
- Largest Global Deployment of ZE Yard Tractors
- Project delayed by the electrical integrator and SCE

3

CHALLENGES

MARINE TERMINAL OPERATORS FACE MULTIPLE CHALLENGES TO ELECTRIFICATION

Cost

Maturity and availability of technologies

Duty cycles of engines

Charging time/processes

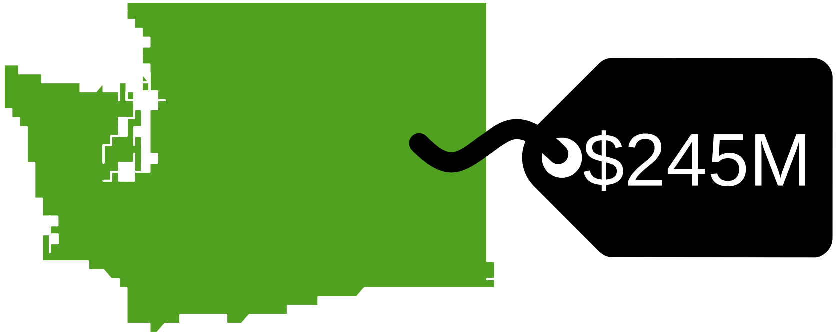
On-terminal charging infrastructure

Capacity of municipal grids to provide the necessary electrical loads

Labor

1:1 REPLACEMENT IS COST PROHIBITIVE WITHOUT GRANT FUNDING

Equipment Type	Location	Approx. # of Current Units	Price of a New Tier 4 Diesel Unit	Price of a New Electric Unit	Total Cost of Electric Fleet*
Top/Side Picks	Long Beach	90	$650k	$2M	$180M
	Oakland	70			$140M
	Seattle/Tacoma	75			$150M
UTR (Yard Tractor)	Long Beach	290	$115k	$575k	$167M
	Oakland	105			$60M
	Seattle/Tacoma	165			$95M



EXAMPLE 1: TAYLOR TOP HANDLER DEMONSTRATION

This means we would need 2x the equipment to do the same job – **doubling** the cost of implementation

3x

Cost of Tier 4 Diesel

- $2M per new e-Top Handler
- $650k per new Tier 4 diesel Top Handler

Key Partners Port of Long Beach, Port of Oakland, Taylor, BYD, California Air Resources Board

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- Among the earliest deployments of eTop Handlers
- Not enough battery range to work 2 shifts without recharging

EXISTING GRANTS ARE NOT DESIGNED FOR INDUSTRY

Operators need predictable funding that significantly reduces capital costs and does not require scrapping of existing equipment

Grant	Eligible Applicants: • Government agencies • Port authorities • Nonprofit organizations	Funding Available (2020): • $4M in Region 9 (CA) • $1M in Region 10 (WA + OR) • 45% funding for new ZE vehicle
Our Reality	Equipment Owner: • Terminal Operator	What We Can Buy: • 4 CA e-Tops (req $4.4M match) (2.5% of fleet) • 1 WA e-Top (req. $1.1M match) (1% of fleet) • 20 CA e-UTRs (req. $4.9M match) (5% of fleet) • 5 WA e-UTRs (req. $1.2M match) (3% of fleet)

INFRASTRUCTURE REQUIREMENTS ADD COMPLEXITY AND DELAY IMPLEMENTATION

HYBRID

Completed in 1.5 years

Equipment Purchase → **Equipment Deployment**

Equipment Purchase:
Terminal Operators
Tech Vendors

Equipment Deployment:
Terminal Operators

ZERO EMISSIONS

Hoping to complete within 4.5 years

Equipment Purchase → **Infrastructure** → **Equipment Deployment**

Equipment Purchase:
Terminal Operators
Tech Vendors

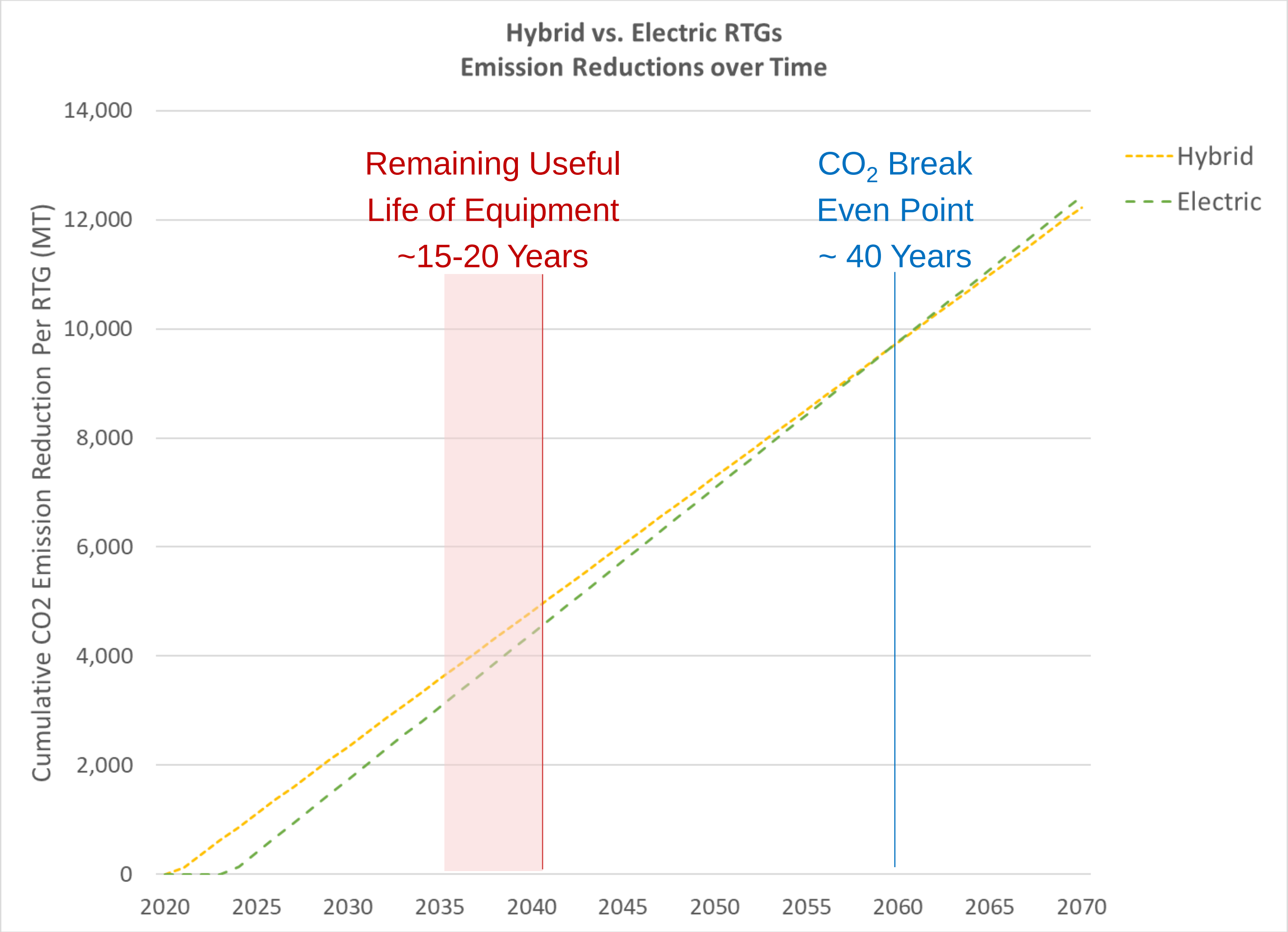
Infrastructure:
Terminal Operators
Ports Authorities
City Permitting
Utilities
Labor

Equipment Deployment:
Terminal Operators

DELAY HAS AN ENVIRONMENTAL COST

Electric RTG:
- Time to Implement: 4.5 years
- Diesel/CO_2 Reduction: 100%

Hybrid RTG:
- Time to Implement: 1.5 years
- Diesel/CO_2 Reduction: 93%



EXISTING GRID CAPACITY MAY NOT SUPPORT PORT ELECTRIFICATION GOALS

June 2021 Moffat & Nichol Report commissioned by Pacific Merchant Shipping Association examined the availability of the California power grid to meet regulatory and port requirements to transition to zero-emission freight transport

Report raised serious questions about the ability of the existing grid to meet zero-emissions goals:

- Ensuring sufficient power is available during marine terminal hours of operation with the ability to meet peak demand for stationary sources and electric vehicles
- Providing additional power capacity for operations that may overlap with regional peak power demand
- Requiring sufficient, dependable power redundancy, to allow rapid recovery from a natural or manmade disaster
- Executing needed improvement in the electricity infrastructure to create a stable and reliable power grid

KEY MESSAGES

For some CHE equipment types, plug-in electric technologies are not available or feasible for terminal operations

- Hybrid options should be an acceptable alternative in the interim
- We need commercialized, proven equipment before we can require adoption of a specific technologies

Funding opportunities need to be:

- Much larger to adequately address capital investment requirements
- Predictable and from multiple sources (local, state, federal)
- Willing to forgo requirements to scrap existing equipment

Even if we fully convert to zero-emissions equipment, existing power grids may not be able to support our operations

SSAMarine
A Carrix Enterprise

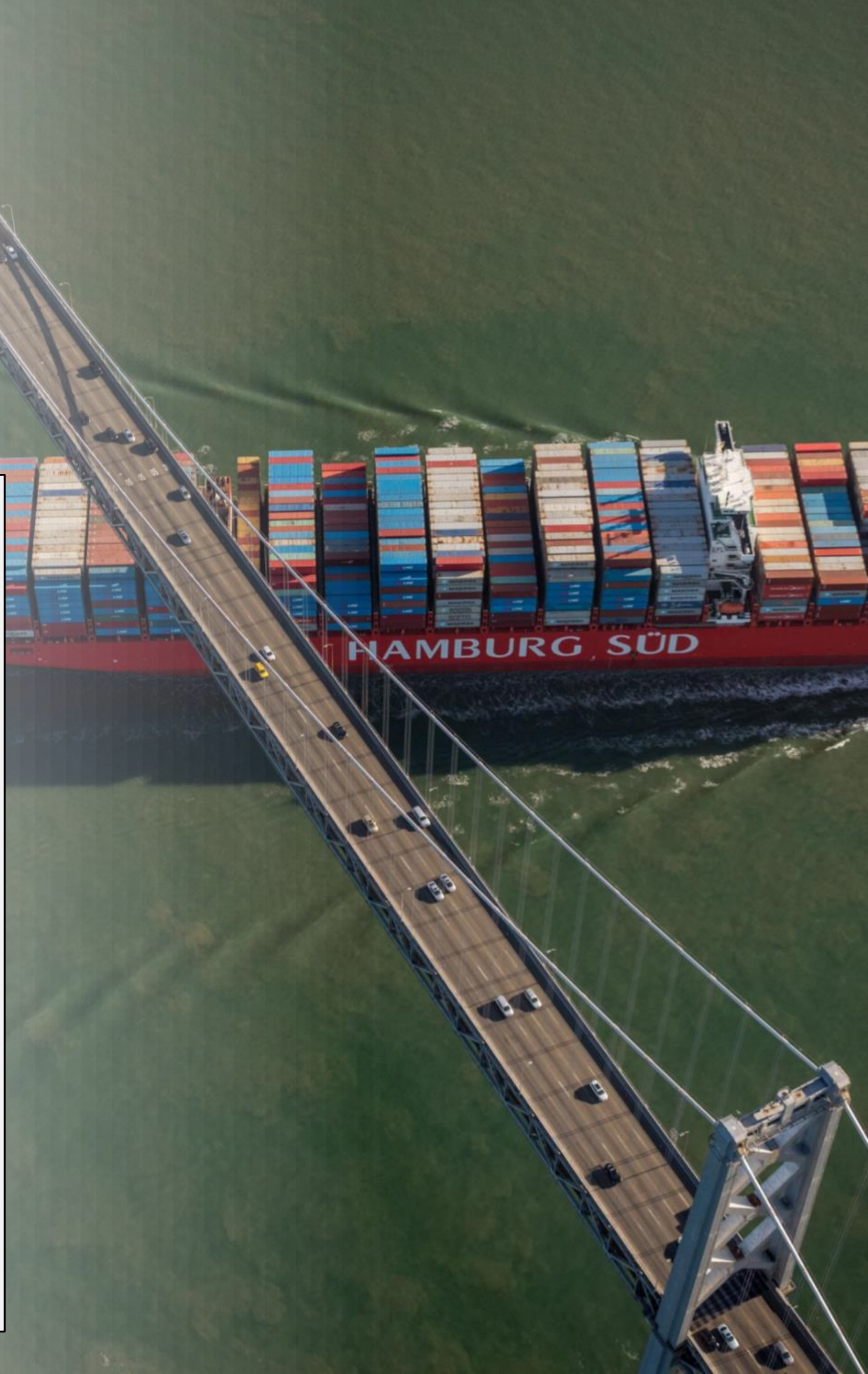
THANK YOU

SARAH.MOURINO@SSAMARINE.COM

Go to Google Drive link in chat and find the document for your table!

Breakout Discussion #1 – Planning for Maritime Electrification

- Can electric vessels and cargo handling equipment provide useful grid services or are they just another electrical load?
- What are utility planning timelines? What are the port/terminal planning timelines? What about the vessel construction/retrofit timelines?
- How do we think about prioritizing electric loads as it relates to maritime assets? or how much additional power will be needed for maritime decarbonization through electrification?
- For tariffs and electric rates, how should electric vessels and cargo equipment charging be treated? Should they have unique rates? Are there examples of this anywhere else?
- Are there useful studies, investigations, or other activities that ports and terminals should be performing before investigating electrification? Baseline measurements? Deploying sensors?
- What questions do electric utilities have about planning for maritime electrification?



10 Min Break

10 Min Break

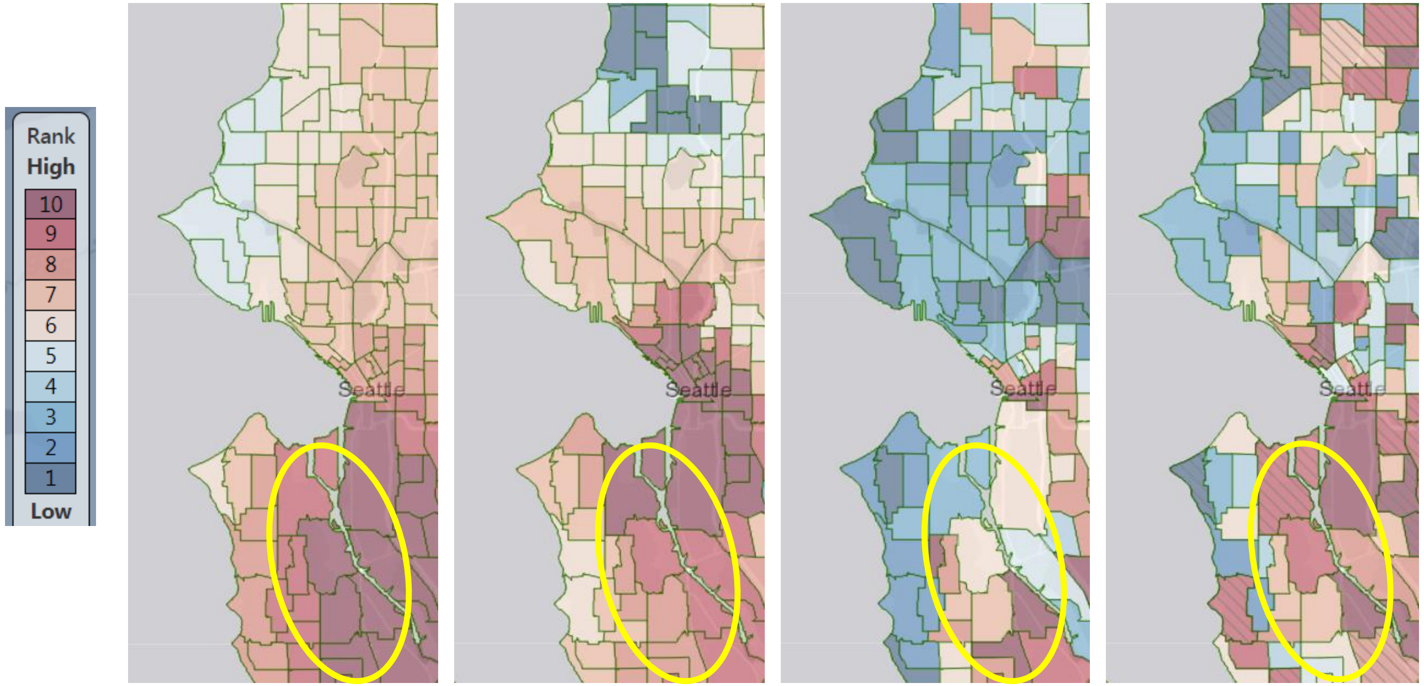
Partnering to Create Our Energy Future

Emeka Anyanwu | September 15th, 2021

Seattle City Light

WE POWER SEATTLE

Start with Equity: Electrification and Public Health



PM2.5 Concentration

Wastewater Discharge

Poverty (%)

Low Birthweight (%)

Electrification Load Growth Centralized in Waterfront

- Large-scale load growth from electrification around Seattle waterfront stands to bring tremendous environmental benefits
- Challenges the utility to explore new resources (microgrids, storage, renewable hydrogen) and partner with technology leaders such as PNNL
  - Increases need for long-term Grid Modernization

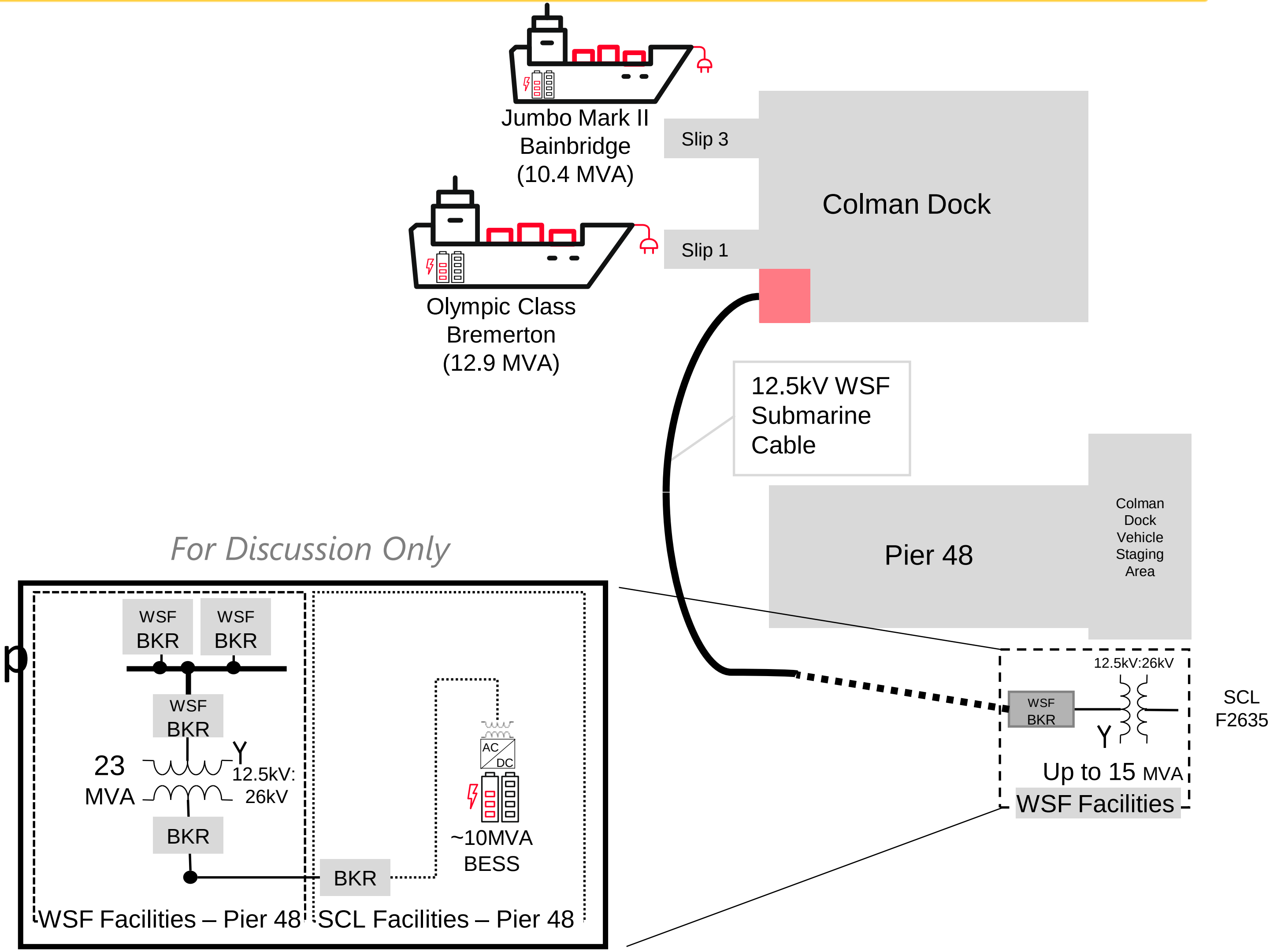
Electrification Load Growth Centralized in Waterfront

- Requires close and long-term work with our customers to conduct joint planning
  - Work with Port of Seattle and NWSA on the Seattle Waterfront Clean Energy Strategy (SWCES)
  - Work with WSF to explore potential for a large-scale battery to support Ferry electrification
  - Collaboration with other waterfront stakeholders, regional utilities, and technology providers for decarbonization plans, pilots and projects

SCL – Washington State Ferries Collaboration

- Exploring Solutions
- Case Study: Colman Dock
  - Early-Stage Feasibility Study
  - Grant Funding request
  - Technology
    - Battery Energy Storage System
    - Submarine Cables
  - Equipment and Site ownership

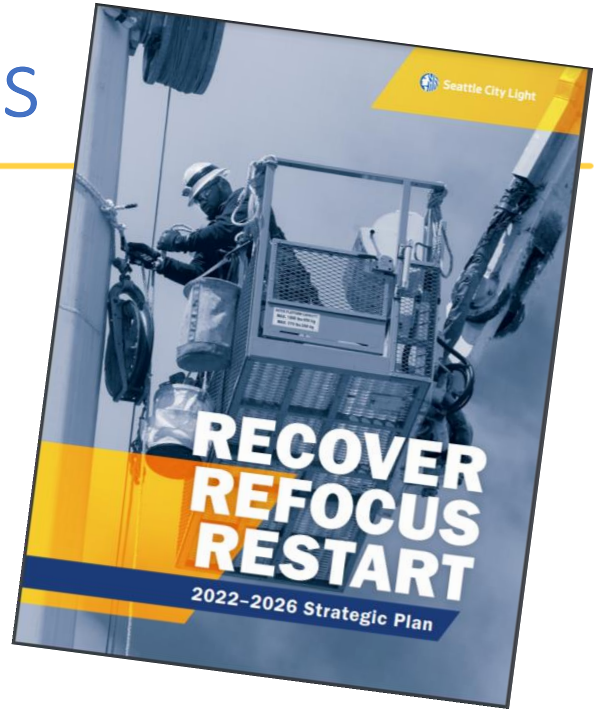
For Discussion Only



SCL – Port of Seattle Collaboration

- Partnering on Seattle Waterfront Clean Energy Strategy (SWCES)
  - SCL
  - Port of Seattle
  - Northwest Seaport Alliance
- Efficient use of existing grid resources
  - Identify maritime loads to shift to zero emission
  - Study new load impacts on grid
  - Propose traditional solutions
  - Consider alternates
  - Electrify!

2022-2026 City Light Business Strategies



- Improve the Customer Experience
- **Create our Energy Future**
- Develop Workforce and Organizational Agility
- Ensure Financial Stewardship and Affordability
- We Power

Create our Energy Future

Objective:

Build and maintain smart, resilient, flexible, dynamic and reliable grid infrastructure; prepare for increased integration of distributed energy resources and increased customer options and; work to reverse historical inequity and avoid collateral harm to underserved populations by intentionally prioritizing their needs as we create our energy future.

Projects, Initiatives and Activities:

1. Implement grid modernization roadmap – Invest in our grid as needed to handle the increased consumption.
2. Implement electrification plans – Develop, offer and implement programs authorized in the Transportation Electrification Strategic Investment Plan.
3. Fund and implement the “Utility Next” Portfolio – Deliver new programs needed to achieve Seattle’s vision of creating a clean energy vision.
4. Integrate distribution system and resource planning – Integrate and align the Integrated Resource Plan with other complementary planning efforts.

Utility Next – SCL 2.0

- Rebuild Smart
  - An equitable next-gen energy system
- Electrify
  - Downward pressure on rates, decarbonization
- Create Jobs
  - Accelerate regional economic recovery
- Leverage Partnerships
  - Partnering with PNNL and others to accelerate joint progress

Utility Next Project Overview

- Prospective Projects for Recovery & Energy Transition
  - Workforce Development
  - Transportation Electrification
  - Building Decarbonization & Green Affordable Housing
  - Grid-Interactive Buildings
  - Storage and Flexible Resources
  - Next Gen Communications
  - Grid Modernization
  - Waterfront Electrification
- Partnerships Key to Success

THE NORTHWEST SEAPORT ALLIANCE

Pacific Northwest NATIONAL LABORATORY

PACCAR

Port of Seattle

Washington State Department of Transportation

Utility Next – Leading to Results

- Large Scale Renewables RFP
- $1.5M to City Light and PNNL under the DOE H2@Scale opportunity to study 1-2 renewable hydrogen stations
- PNNL study underway of waterfront "network of microgrids"
- A CEF4 (Clean Energy Fund) – Four Preliminary Grants
- DOE Connected Communities – 5 Applications Submitted
- Exploring and partnering on Infrastructure Bill grants

Project Resourcing Approach

Flexibility and Constraints

- Staffing
- Budget
- Time

Focus

Shift

Augment

- DOE Grants
- State: CEF
- Federal Stimulus

City Light’s Main themes

- Start with equity
  - Burdened community’s see benefits <u>first</u>
- Build for the future
  - Modernize & reimagine the grid
  - Leverage technology
- Lean into partnerships
  - Next level customer relationship
  - Work with experts – PNNL, EPRI
- Be bold, be ready
  - Thriving out of adversity with Utility Next – SCL 2.0

Source: Seattle’s Equity & Environment Agenda.

THANK YOU

Seattle City Light

David Fujimoto

Senior Environmental Program Manager
Maritime Environment & Sustainability
Port of Seattle

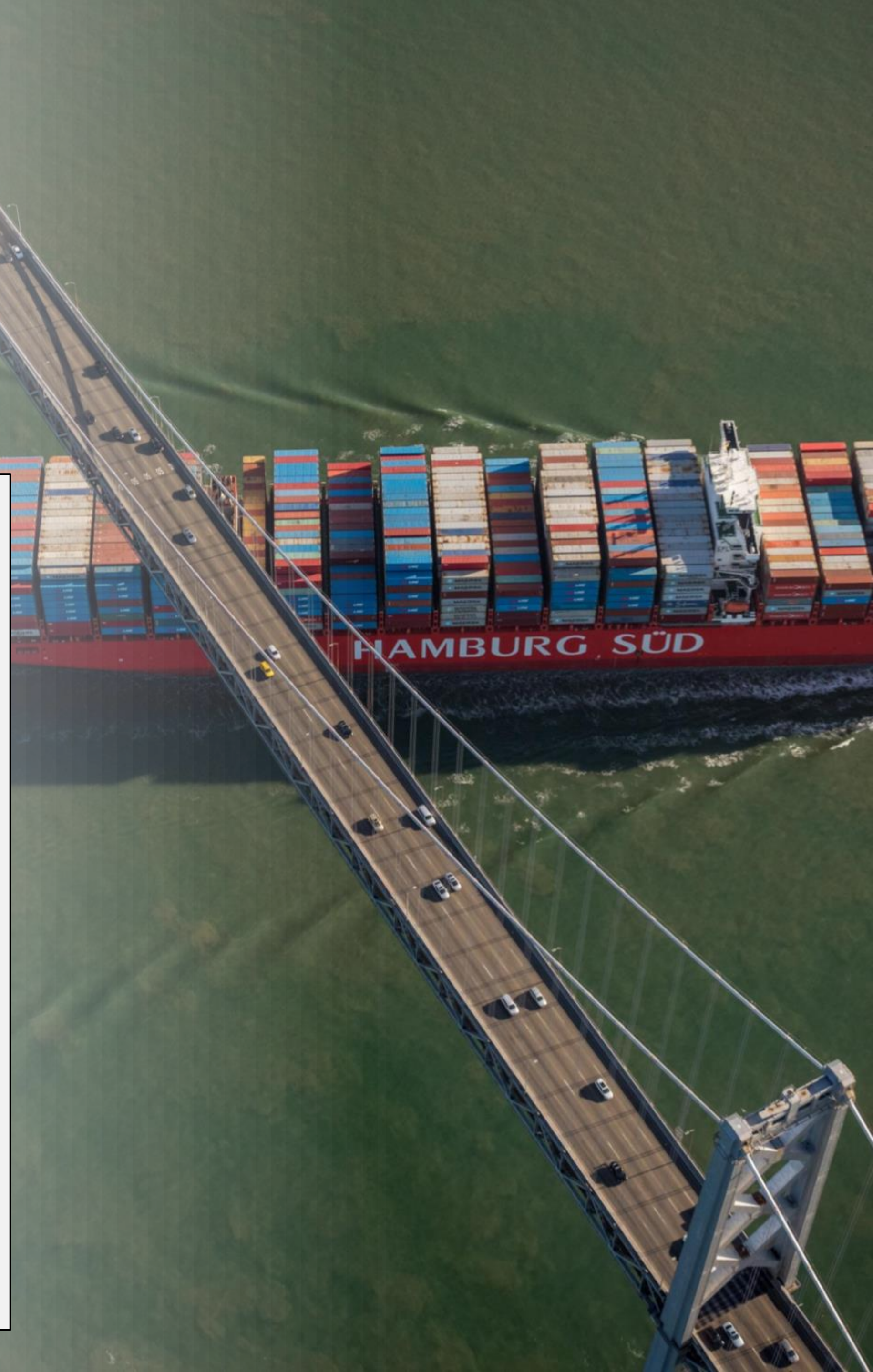
Patty Rubstello

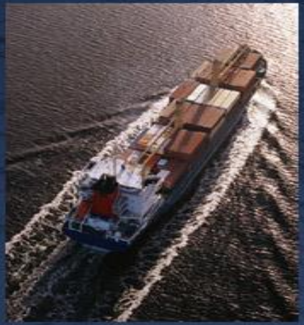
Assistant Secretary
Washington State Ferries
Washington State Department of Transportation

Go to Google Drive link in chat and find the document for your table!

Breakout Discussion #2 – Partnerships

- Who are the critical path stakeholders when electrifying vessels or cargo handling equipment? Who can make or break a project?
- Where can interested parties go to find information? What resources or tools are available?
- Are there any third-party groups that serve useful convening roles that can help facilitate discussions? When should they be brought-in if at all?
- Within the port and terminal, who are the right people or groups that need to be engaged? Is there a 'Chief Electrification Officer" equivalent or is it spread among many different people?
- Within the electric utility, who are the right groups that need to be engaged? Are there dedicated groups/divisions within utilities with maritime familiarity? Should there be?
- What questions do electric utilities or maritime stakeholders have about developing partnerships with the other?



Maritime Electrification and Utilities

September 15, 2021

MARAD
U.S. MARITIME ADMINISTRATION

Maritime Environmental and Technical Assistance (META) Program

- Technology and innovation program that performs research, demonstration, data gathering

- Collaboration w/other government agencies, industry stakeholders, NGOs, academia
  - Federal partners include: DOE, USCG, EPA, Navy, NOAA, National Labs, DOT Modes

- Long term focus area: criteria pollutant and GHG emissions reductions, alternative and renewable fuels, energy efficiency applications, green technologies (fuel cells, batteries)

- Results: peer-reviewed articles, white papers, industry guidances
  - Informs regulatory/policy actions
  - Informs industry on “what works”

- https://www.maritime.dot.gov/innovation/meta/maritime-environmental-and-technical-assistance-meta-program

What We Have Investigated/Where We're Going

Alternative Fuels

- Next generation alternative fuels from cleaner feedstocks
- H_2 for fuel cell applications
- Methanol – lifecycle analyses
- Ammonia – future work

Technologies

- Fuel cells/H_2 – vessel designs, shorepower applications, FC generator
- Batteries – risk assessment and safety
- Exhaust gas cleaning – feasibility and demo
- Landside/shipboard carbon capture - ongoing
- Port electrification – economic analyses
- Microgrids – future demonstration
- Hybrid systems – risk assessment, demonstrations

Energy Efficiency (reduce criteria pollutants and GHGs)

- Hull design changes
- Mechanical systems – ongoing testing of new technologies on training vessels
- Multi-modal analyses – vessel routing

Contact Information

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Maritime Electrification and EPA’s Ports Initiative

Mike Moltzen, Deputy Director
Transportation and Climate Division
EPA’s Office of Transportation and Air Quality

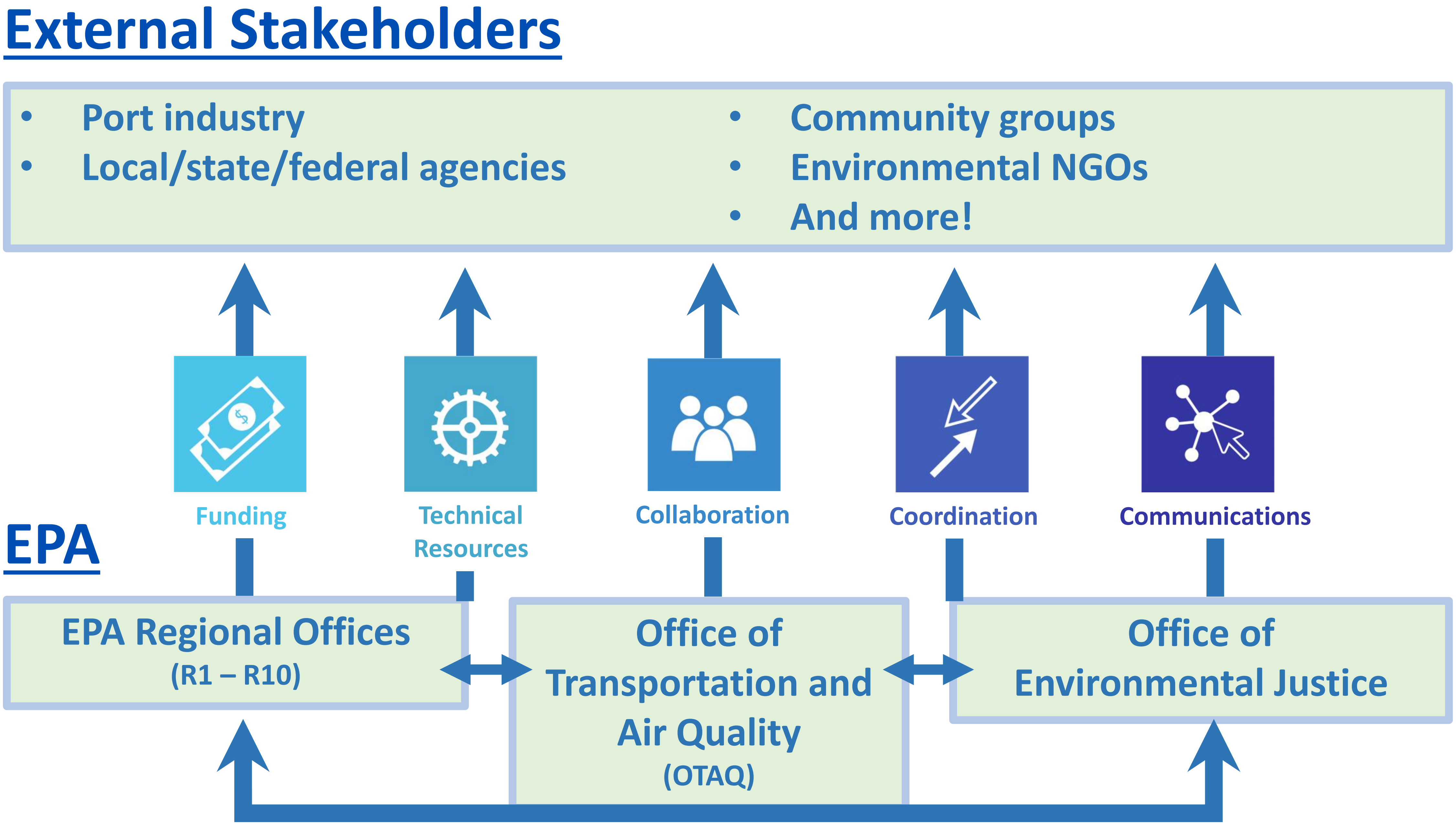
Maritime Electrification Workshop – Government Session
September 15, 2021

Promoting clean air best practices at ports

EPA PORTS INITIATIVE

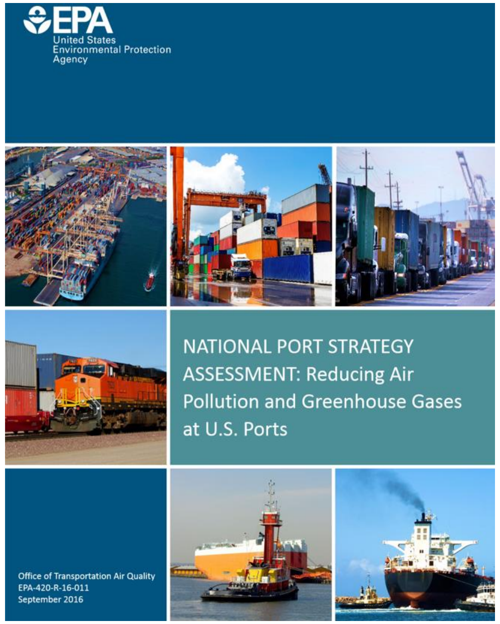
Through EPA tools and assistance in the five program areas, we aim to accelerate adoption of:

- **Cleaner technologies and other strategies**
- **Clean air planning practices** (emissions inventories, clean air plans, community engagement) that inform strategic clean air investments

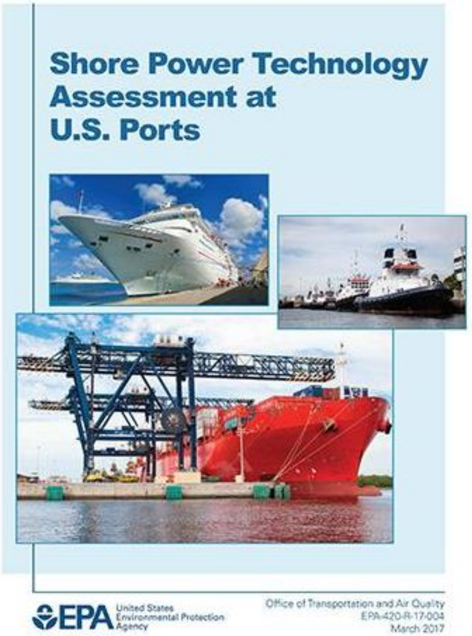

External Stakeholders
Port industry
Local/state/federal agencies
Community groups
Environmental NGOs
And more!
Funding
Technical Resources
Collaboration
Coordination
Communications
EPA
EPA Regional Offices
(R1 – R10)
Office of Transportation and Air Quality
(OTAQ)
Office of Environmental Justice

Providing tools to help identify smart infrastructure investments

Technical Resources

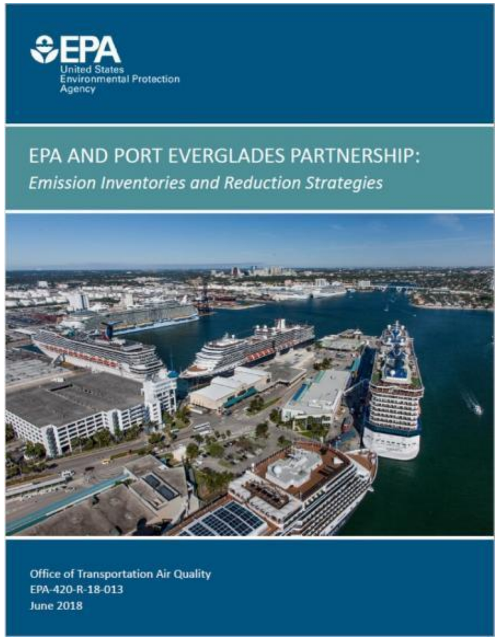


National Port Strategy Assessment: Reducing Air Pollution and Greenhouse Gases at U.S. Ports
September 2016
www.epa.gov/ports-initiative/national-port-strategy-assessment-reducing-air-pollution-and-greenhouse-gases-us

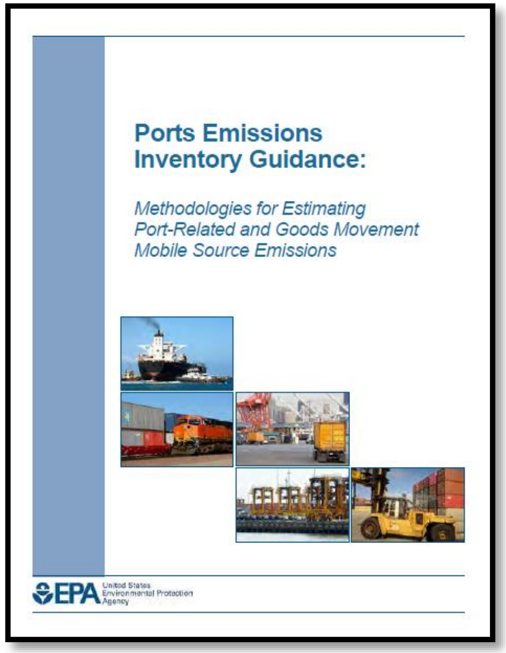


Shore Power Technology Assessment at U.S. Ports*
April 2017
www.epa.gov/ports-initiative/shore-power-technology-assessment-us-ports

***Update planned for later this year**



EPA, Port Everglades Report Shines Light on New Methods for Analyzing Potential Air Pollution Reductions
June 2018
www.epa.gov/ports-initiative/epa-and-port-everglades-partnership-emission-inventories-and-reduction-strategies



Port Emissions Inventory Guidance: Methodologies for Estimating Port-Related and Goods Movement Mobile Source Emissions, September 2020
https://www.epa.gov/ports-initiative/port-and-goods-movement-emission-inventories

Stay Tuned: Upcoming Update to Shore Power Assessment Report

Technical Resources

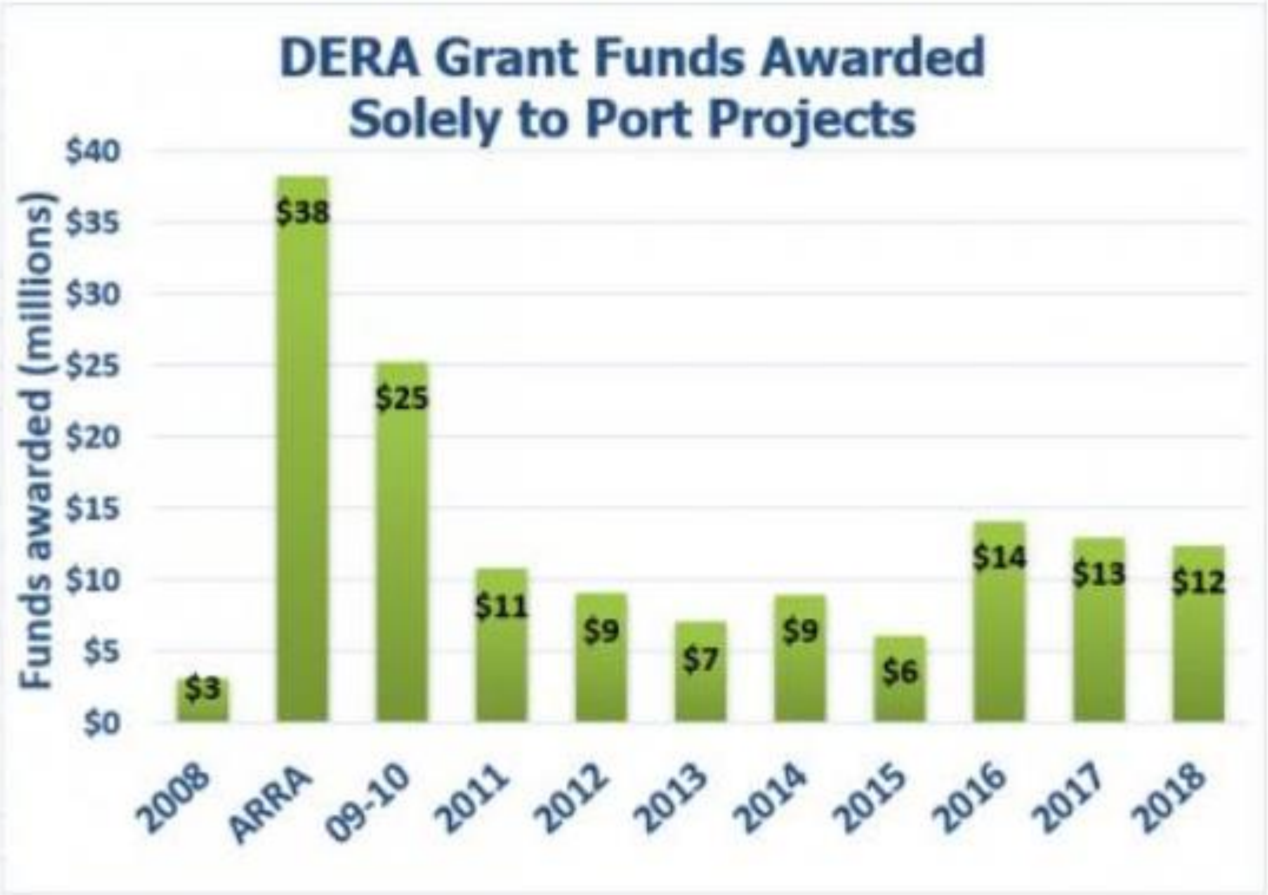
Overlay of Installed and Planned Shore Power Installations and eGRID Subregions.

- Information on new projects, standards, regulations, vessel readiness, costs
- Lessons learned in LA, Hueneme, Seattle, and NY/NJ
- Updated calculator with new emission factors and expanded options for vessel and fuel types to better estimate emissions reductions from shore power

Helping ports capitalize on funding for clean technologies

Funding

- DERA
  - Priority for port and other goods movement projects.
  - Extra points for inventories, clean air plans, community engagement.
    - DOT funding programs now includes similar criteria



- EPA Regional staff helping to make connections to other funding sources.

- Searchable table of local, state, federal, and other funding opportunities on our website:

  www.epa.gov/ports-initiative/funding-opportunities-ports-and-near-port-communities

REAL-WORLD EXAMPLES

Examples of DERA-Funded Zero Emission Projects at Ports

Communications

- All-Electric crane in Los Angeles
- All-Electric terminal tractors in Philadelphia, Long Beach, and Tacoma
- All-Electric engine replacements of marine vessels, including a ferry and tugboat
- Shore Power installations in Boston, New Bedford, Brooklyn, Los Angeles, Seattle, San Francisco, Tacoma and Hueneme

Port of Los Angeles Electric Crane Project

www.epa.gov/ports-initiative/port-los-angeles-road-heavy-duty-equipment-and-infrastructure-enhancements

CASE STUDIES

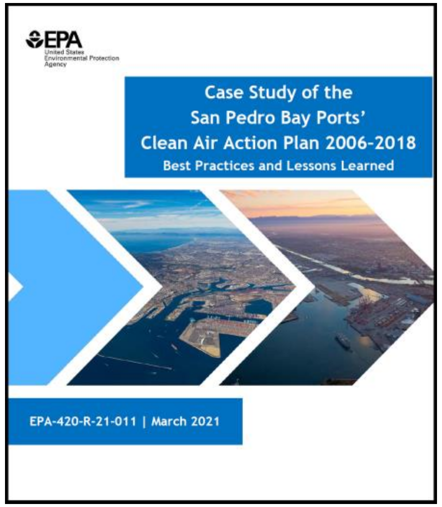
Case Study of San Pedro Bay Ports Clean Air Action Plan (CAAP)

Communications

- Highlighting aspects of the Ports of Los Angeles and Long Beach plan that can inform other port authorities and near-port communities across the country.

- Includes summary of 2006-2018 CAAP's background and history, and three focused discussions:
  - Environmental justice and levers of community influence
  - Technologies and practices for development and deployment
  - The 2017 Clean Truck Program

- Report and fact sheets: www.epa.gov/ports-initiative/san-pedro-bay-ports-clean-air-action-plan-best-practices-and-lessons-learned



Keep in touch

Communications

EPA's Ports Initiative website and newsletter sign-up:
www.epa.gov/ports-initiative

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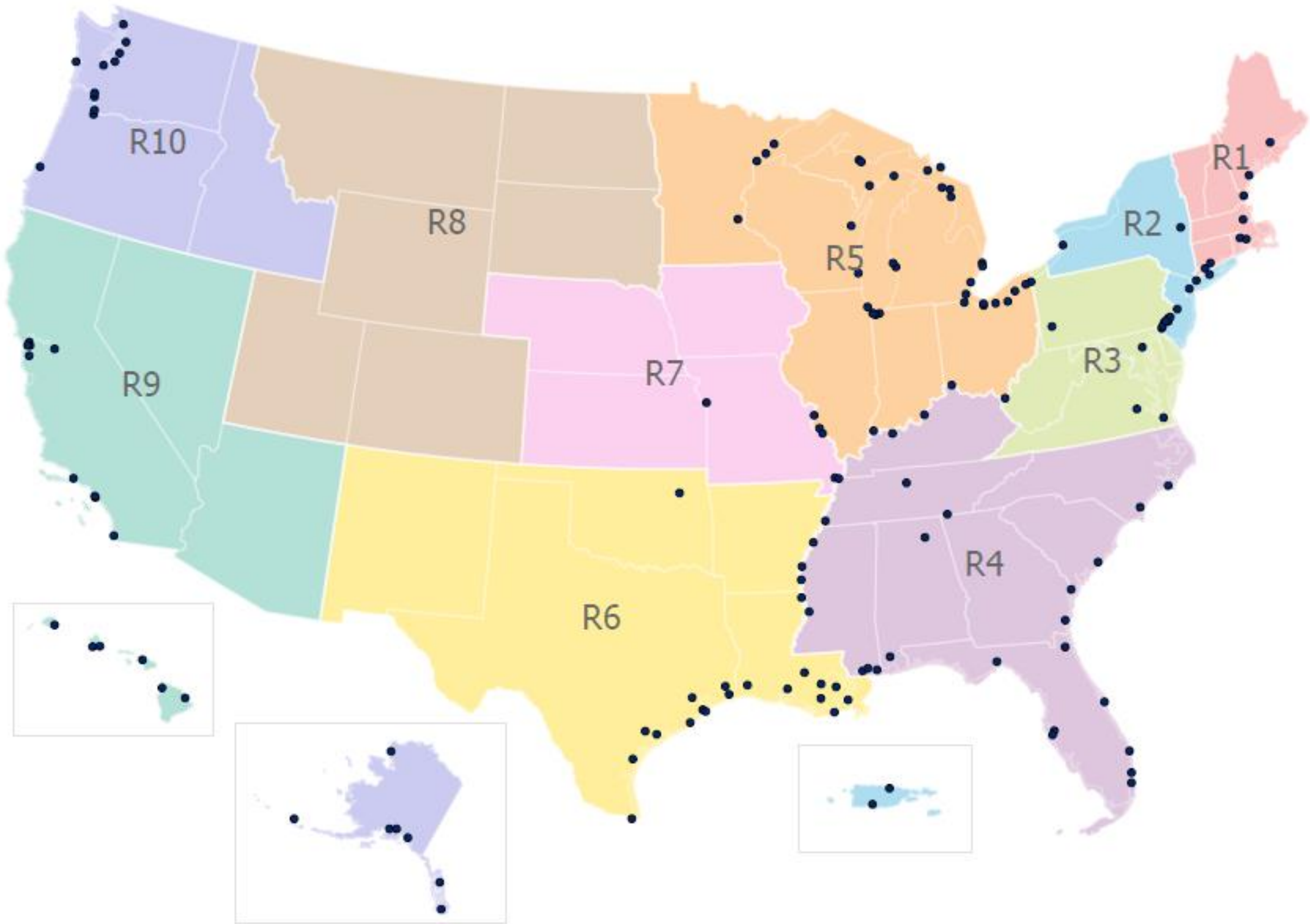
Army Corps "Principal Ports" and EPA Regions



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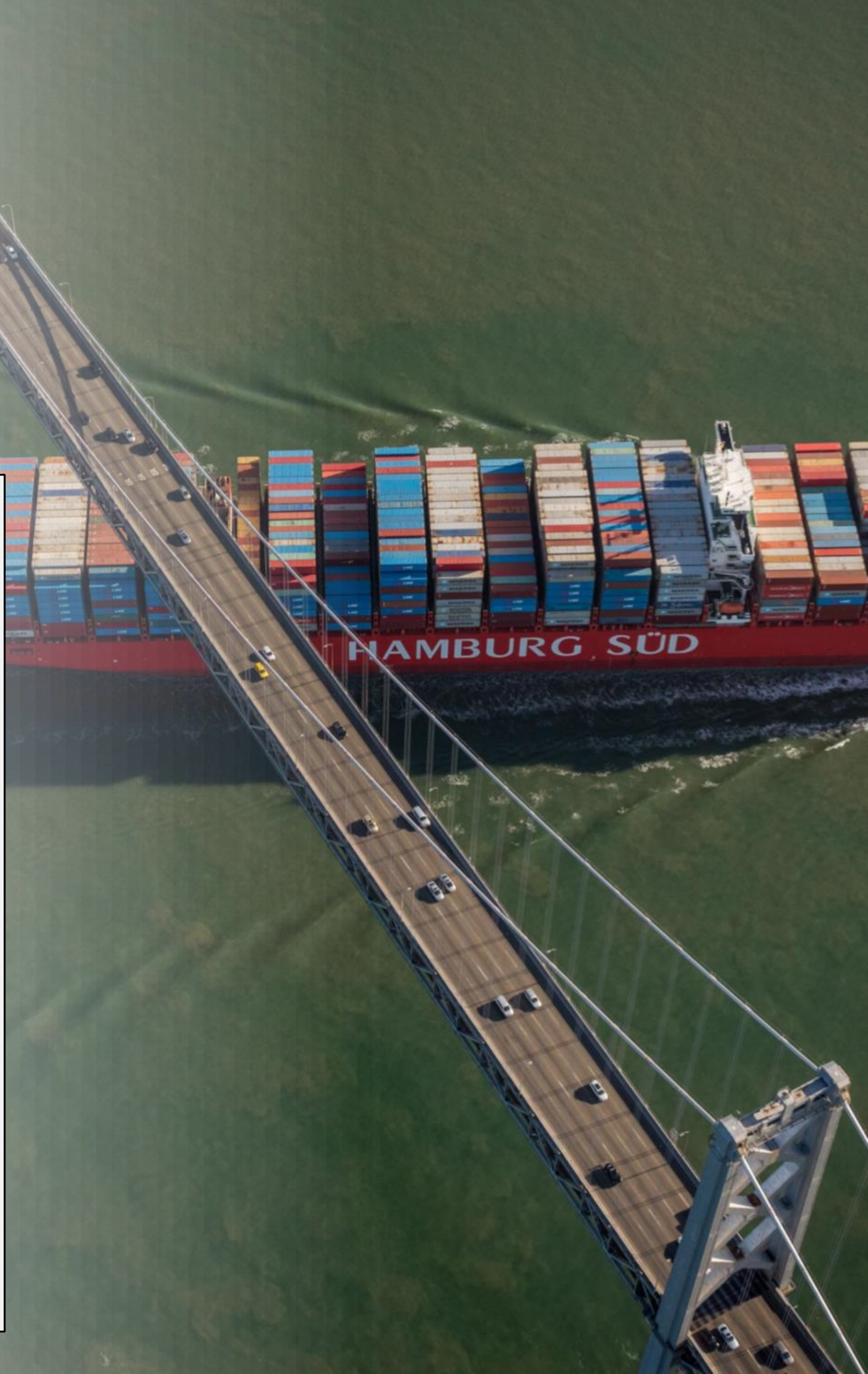
Go to Google Drive link in chat and find the document for your table!

Breakout Discussion #3 – The Role of Government

- What services or activities can Federal agencies provide to help with maritime electrification? Please specify.
- What federal and state funding resources are available to initiate these projects?
- What are the relevant national regulations for electric ships and cargo handling equipment?
- What are the relevant national and international standards that should be consulted?
- What national or international groups are working on establishing standards? Where should ports and utilities look for the latest information?
- Which regulatory bodies need to be engaged for electric vessels? Is there a preferred order that certain regulatory groups need to be consulted?



Maritime Electrification Workshop for Utilities

Virtual - September 15, 2021

Thank you for participating!
The platform will remain open till 1250 PDT for networking