DULUTH SEAWAY PORT AUTHORITY

CLIMATE ACTION PLAN

DULUTH SEAWAY PORT AUTHORITY CLIMATE ACTION PLAN

PROJECT NO. 164602

REV. 2

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List of Abbreviations

Abbreviation	Term/Phrase/Name
BESS	Battery energy storage system
CAP	climate action plan
CCF	hundreds of cubic feet
CCS	Combined Charging Standard
CH_4	Methane
CHE	cargo handling equipment
CO_2	carbon dioxide
DC	direct current
DSPA	Duluth Seaway Port Authority
ECM	energy conservation measure
EPA	Environmental Protection Agency
GHG	greenhouse gas
GWh	gigawatt hour
HPS	high-pressure sodium
ICE	internal combustion engine
IIJA	Infrastructure Investment and Jobs Act
IMO	International Maritime Organization
IRA	Inflation Reduction Act
kW	Kilowatt
kWh	kilowatt hour
LED	light-emitting diode
LFP	lithium iron phosphate
LSW	Lake Superior Warehousing Company, Inc.
MMBtu	one million British thermal units
MW	Megawatt
MWh	megawatt hour
N_2O	nitrous oxide
NMC	nickel manganese cobalt
OEM	original equipment manufacturer
OGV	ocean-going vessel
PPA	power purchase agreement

PV	Photovoltaic
REC	renewable energy certificate
UTR	utility tractor rig
V	Volt
W	Watt
ZE	zero-emissions

Executive Summary

The Duluth Seaway Port Authority (DSPA) is committed to continually improving its environmental performance, including reducing criteria pollutant and greenhouse gas (GHG) emissions from port operations. To advance environmental performance within the Great Lakes-St. Lawrence Seaway System, DSPA has developed a Climate Action Plan (CAP) that focuses on DPSA-operated facilities, including the Clure Public Marine Terminal and Duluth Lake Port. The CAP defines existing conditions along with goals, objectives, and strategies to reduce GHG emissions from port operations. In doing so, DSPA provides an example that can be replicated by its tenants and other Great Lakes port terminals and port authorities while also providing human health benefits to DSPA staff, workers, and the surrounding community.

The planning process began with a baseline assessment of DSPA's existing climate initiatives, operational conditions, GHG inventory, and energy usage. Using 2022 as the baseline year, DSPA's scope 1 emissions totaled 586 metric tons of carbon dioxide (CO_2) and scope 2 emissions totaled 511 metrics tons of CO_2, combined totaling 1,097 metric tons of CO_2. These emissions were generated from the use of 673 kilowatts (kW) of electricity, 31,139,000 cubic feet of natural gas, 32,507 gallons of propane, 9,396 gallons of ultra-low sulfur diesel, and 14,052 gallons of biodiesel to power DSPA's operations.

DSPA primarily uses a combination of miscellaneous equipment (18), light-duty forklifts (23), medium-duty forklifts (15), trucks (8), heavy-duty forklifts (2), reach stackers (2), yard tractor (1), and two electric gantry cranes to move goods on the Clure Public Marine Terminal. An evaluation of zero-emissions (ZE) goods movement technologies was undertaken to assess deployment opportunities specific to DSPA, including during winter operations. Equivalent battery-electric cargo handling equipment (CHE) and vehicles are commercially available today to support the conversion of DSPA's fleet. Cold weather winter conditions are a major concern in Duluth because battery performance degrades as temperatures decline. For example, lithium iron phosphate (LFP) batteries are reported to lose approximately 30% of their effective energy capacity at -20°F. Even when factoring cold weather degradation, battery-electric technologies were modeled to be capable of meeting DSPA's operational requirement for terminal equipment and vehicles at Clure Public Marine Terminal.

Energy usage and peak demand models were used to forecast future electricity requirements resulting from electrified operations. Electrification of DSPA operations is projected to increase peak electricity demand by 608%, from 673 kW to 4,470 kW with 80% of the increase stemming from the installation of two new mobile harbor cranes. A renewable energy assessment was conducted to pinpoint cost-effective and feasible solutions to accommodate the increased electricity demands associated with electrification. While there is abundant rooftop space to install over 6,000 kW of solar photovoltaic generation, it is much more cost effective to continue to procure power from Minnesota Power since the utility offers a green tariff – "EnergyForward" – which is a more cost-effective way for DSPA to procure 100% renewable energy in advance of Minnesota Power's transition to zero carbon energy sources by 2040.

To achieve net zero operations by 2050, the CAP established the following objectives:

- Implement energy efficiency measures across all facilities and operations.

- Transition vehicles and equipment to ZE alternatives in a phased approach that allows for cold-weather and operational testing of available equipment.
- Integrate shore power into operations to reduce emissions from oceangoing vessels while at berth as shore power fittings become standardized and/or following an assessment of the shore power needs of the range of vessels that call on the Clure Terminal.
- Procure renewable energy sources for electricity consumption.
- Offset remaining emissions through verified carbon offset projects.
- Regularly monitor and report emissions data to track progress towards net zero.
- Foster collaboration across multiple stakeholder groups, including DSPA employees, local residents, government officials, and community groups.
- Support the development of the workforce of the future.

By implementing the strategies associated with these objectives, including establishing a tracking and reporting program; engaging key stakeholders; leveraging federal funding; and implementing energy conservation measures, electrification (including the build out of charging and supporting infrastructure), and procurement of renewable energy sources and carbon credits, DSPA will be able to achieve its net zero goal by 2050.

1.0 Introduction

In the face of escalating climate-related risks to our community and planet, the Duluth Seaway Port Authority (DSPA) has made a commitment to reduce greenhouse gas (GHG) emissions and enhance resiliency against the physical and social impacts of climate change. This Climate Action Plan (CAP) outlines DSPA's roadmap to achieving net zero operating emissions by 2050 in support of a carbon-neutral future that prioritizes environmental stewardship and economic prosperity.

1.1 Overview of Operations

The Port of Duluth-Superior is located at the westernmost tip of Lake Superior and the Great Lakes-St. Lawrence Seaway System. At 2,342 miles from the Atlantic Ocean, it is North America's farthest-inland freshwater seaport. The Port of Duluth-Superior is the largest tonnage port on the Great Lakes and ranks among the top 20 ports in the U.S., handling an average of 33 million short tons of cargo and hosting approximately 800 vessel visits each year.

DSPA is an independent public agency created by the Minnesota State Legislature in 1955 to foster regional maritime commerce, promote trade development, facilitate industrial development, and serve as an advocate for port interests here and around the world. DSPA owns and manages multiple waterfront properties, including the 144-acre Clure Public Marine Terminal and Duluth Lake Port (Figure 1). Clure Public Marine Terminal is the only breakbulk and general cargo maritime freight facility in the harbor (Figure 2). The terminal and associated warehouses are operated under contract by Lake Superior Warehousing Co., Inc., an independently owned business established in 1991.

Figure 1: Map of Port of Duluth-Superior

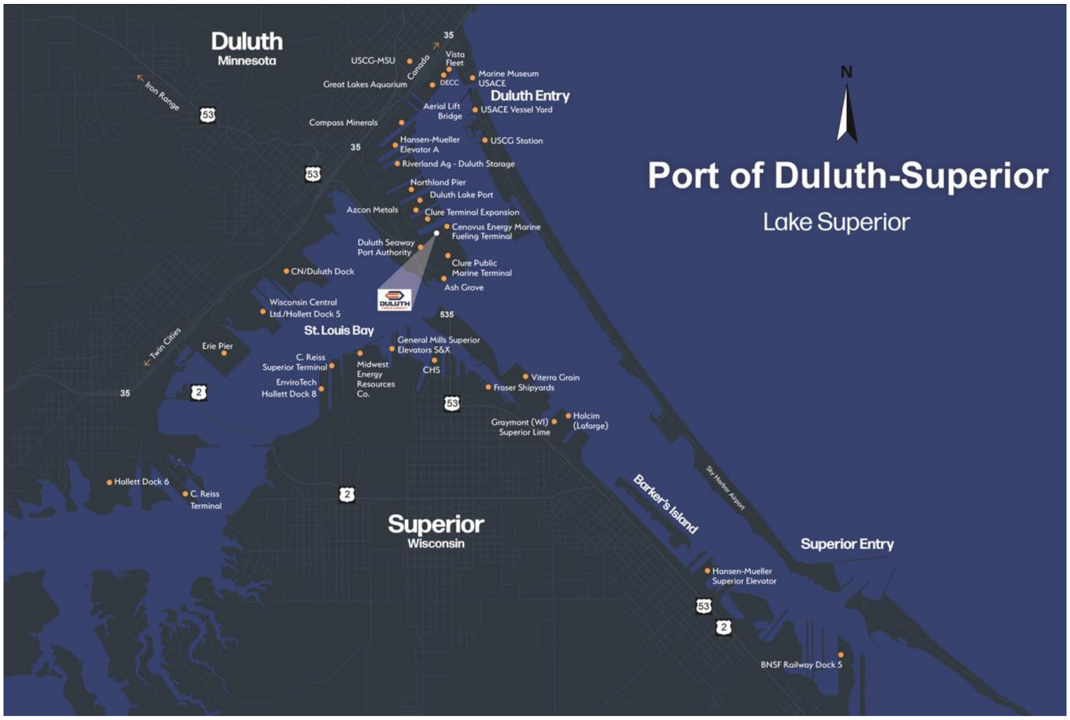
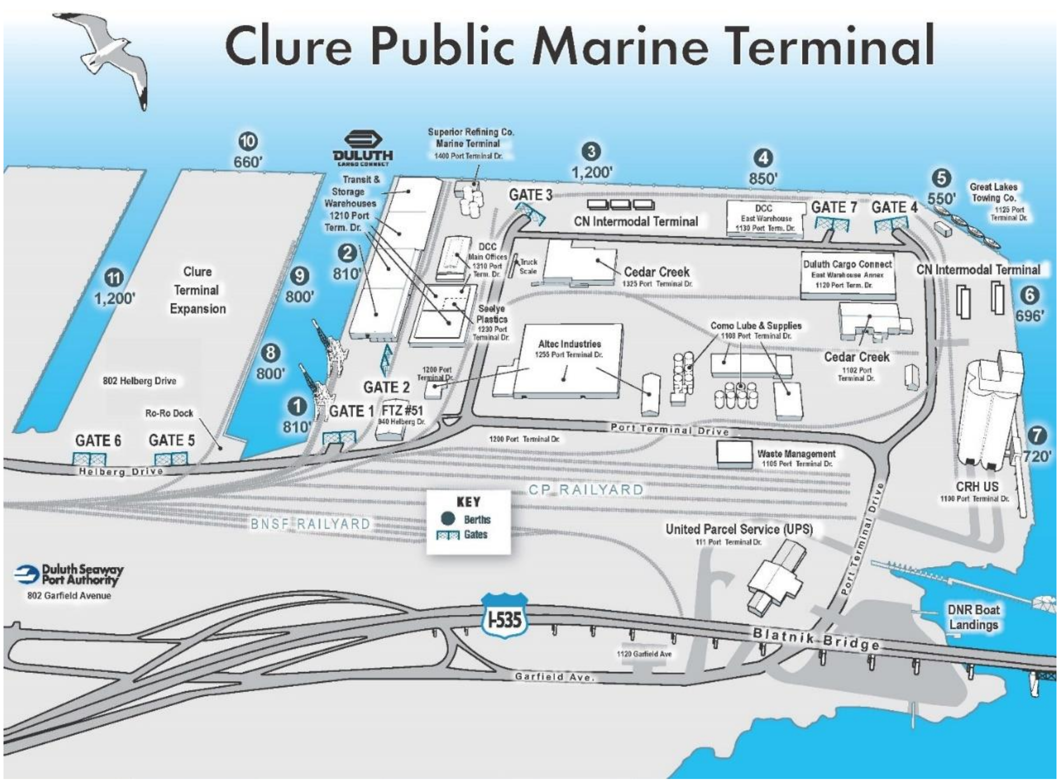


Figure 2: Map of Clure Public Marine Terminal



1.2 Approach

The planning process began with a comprehensive assessment of DSPA's existing climate initiatives, operational conditions, GHG inventory, and energy usage. Subsequently, an in-depth exploration of zero-emissions (ZE) goods movement technologies was undertaken. This exploration enabled a forecast of future energy requirements, integrating the necessary electrification of operations to align with DSPA's emissions reduction objectives. To accommodate the increased energy demands associated with electrification, a renewable energy assessment was conducted to pinpoint cost-effective solutions for renewable electricity generation and procurement. Ensuring the financial feasibility of this transition is pivotal to the plan's success. Research into federal grant opportunities aimed at enhancing operational efficiency and facilitating equipment upgrades was conducted. Finally, the plan culminates in a set of actionable strategies designed to mitigate operational emissions, foster community engagement, and implement a workforce development initiative.

2.0 Baseline Condition Assessment

Burns & McDonnell assessed baseline operating conditions and scope 1 and 2 GHG emissions sources. The assessment was based on an existing GHG emissions assessment conducted through the Green Marine Program, the Minnesota Power and Frontier Energy 2022 Energy Assessment, as well as data requests to and interviews with DSPA stakeholders. The baseline assessment also considered planned infrastructure and operational changes that could either increase or decrease DSPA GHG emissions and documented measures that the DSPA has already enacted to reduce emissions.

2.1 Climate-Related Initiatives

DSPA is a founding member of Green Marine – a voluntary partnership committed to continually improve the maritime industry's environmental performance. Green Marine's ongoing efforts encourage and promote sustainable maritime development along this binational trade corridor and around the world. Partners adopt environmental best practices and evaluate their performance each year in a variety of categories including GHG emissions. The following climate-related initiatives were included in DSPA's 2022 Green Marine Program response and Community Impacts Plan.

In 2018, DSPA implemented a debottlenecking project to streamline traffic patterns, reduce idling time and maintain efficient warehouse operations. Trucks and rail activities are now scheduled to limit wait times and reduce GHG emissions. In addition, equipment maintenance enables easy starts in all weather conditions to avoid unnecessary idling.

There have also been efforts to reduce emissions related to employee business travel. The office's location on a public transit line provides additional options for commuting. .

DSPA has also put a program in place to begin transitioning to lower emission equipment. All new equipment purchased for use in the terminal is more efficient and produces lower emission levels than its predecessor. Examples of these policies include efficient diesel and lighting equipment. All diesel engines in the terminal (including the new reach-stacker) are Tier 4 diesel which has minimal criteria pollutant emissions but still produces GHG emissions.

New lighting purchases are also more efficient and are placed in strategic locations to reduce their required uptime.

Prior to this climate action planning effort, in 2022, the DSPA completed an Energy Analysis on electrification and GHG reduction opportunities in a cooperative effort with Minnesota Power. This CAP builds on the opportunities and funding sources described in that analysis.

2.2 Current Operating Conditions

While the Port of Duluth-Superior includes a variety of backland and waterfront facilities, DSPA operates two waterfront facilities – Duluth Lake Port and Clure Public Marine Terminal.

2.2.1 Duluth Lake Port

Duluth Lake Port is a 9-acre waterfront site that is slated for redevelopment. Currently, the Duluth Lake Port property is used for tenant lease operations, and storage of equipment and supplies. Plans are underway to demolish the grain elevators, replace dock walls, and potentially establish a green fueling facility.

2.2.2 Clure Public Marine Terminal

Clure Public Marine Terminal is a 144-acre breakbulk and general cargo terminal that serves as a goods movement hub to and from the port by ship, rail, and roads. DSPA operations on the Clure Public Marine Terminal and Clure Terminal expansion include 82.7 acres, consisting of 40-plus acres of laydown space and 486,000 square feet of warehouse space. Lake Superior Warehousing Company, Inc. (LSW), serves as the operating agent and stevedoring company for the terminal, which is operated as a multi-modal logistics hub. Features and services of the logistics hub include four general cargo maritime berths at Seaway-depth, on-dock rail for direct trans-load operations, a loop track for rail access to storage areas, direct rail service by Class 1 Railroads (Canadian National, Canadian Pacific Kansas City, Burlington Northern Santa Fe, and Union Pacific), an intermodal (container) terminal served by the Canadian National Railroad, an on-site Customs and Border Protection Container Examination Station, designated Foreign Trade Zone status, truck scale, a roll-on-roll-off dock and 24-hour security. Valley Worldwide Logistics Solutions provides drayage truck operations for LSW.

DSPA leases an additional 61.4 acres of the Clure terminal property to a number of tenants, including: a Cenovus Energy fuel dock, Great Lakes Towing, Blue Linx Lumber operations, and the Ash Grove cement terminal. The CAP is focused on DSPA-operations and does not address emissions or activities associated with the leased properties, which may be addressed in a subsequent plan.

There are approximately 15-25 oceangoing vessel (OGV) calls annually at Clure Terminal for LSW's operations (additional ships call at the Ash Grove and Cenovus terminals but are not part of DSPA's operations). OGVs are typically 700-800 feet in length and typically berth for three days, during which they run auxiliary engines while at berth. Generally, there is one vessel at berth at a time, but there can be a maximum of three, which occurs approximately once a year. Laker freighters also berth at the terminal for repairs. There is shore power for winter berthing, which is provided at 400 and 600 amps at each berth.

Clure Public Marine Terminal has approximately 486,000 square feet of warehouse capacity. The majority of the warehouse space is not heated and is used to store a variety of bulk materials, such as paper, building products, super-sacks of crushed granite, cellulosic and wood pulp, semi-finished goods, and finished goods. Warehouse lighting is predominantly comprised of high-pressure sodium (HPS) fixtures, providing an opportunity for energy efficiency retrofits with light-emitting diode (LED) fixtures. Forklifts operating within the warehouses are powered by a combination of propane and diesel.

Terminal equipment includes 2 electric gantry cranes, 2 diesel fueled reach stackers, 1 diesel telehandler, 1 yard tractor, 40 forklifts, and 18 miscellaneous equipment. The reach stackers operate over 8-12-hour shifts and move 25,000-pound steel bars and containers. The yard tractor is generally operated for short periods (i.e., 3 minutes to travel a half mile distance) multiple times over an 8-12-hour shift. Approximately 8 to 20 containers are moved per shift. Forklifts consist of a combination of 6,000-, 11,000-, 12,000-, and 55,000-pound units. Most are powered by propane fueled at on-site tanks. Approximately half of the forklift fleet is in operation and runs 7 hours per day. All equipment have internal combustion engines, and consequently produce scope 1 GHG emissions.

2.3 Greenhouse Gas Emissions

DSPA completed its first GHG inventory in 2017 and has since conducted annual updates. The inventory includes scope 1 and 2 emissions using monthly data provided by Minnesota Power, Comfort Systems, and Como Oil to calculate metric tons of carbon dioxide (CO_2) emitted from purchased electricity, natural gas heating systems, and propane forklift fuel and fuel oil respectively. The inventory does not include emissions from OGVs while at berth. DSPA uses emission factors from the EPA to calculate metric tons of CO_2 emitted from natural gas and propane and fuel oil. The emission factor for purchased electricity (kilowatt hours [kWh]) is provided by Minnesota Power. In 2022, DSPA's scope 1 emissions totaled 586 metric tons of CO_2 and scope 2 emissions totaled 511 metrics tons of CO_2, coming to a combined total of 1,097 metric tons of CO_2 (Figure 3). Duluth Cargo Connect transported 456,925 freight tons of cargo in 2022, allowing DSPA to estimate its carbon intensity at 5.3 pounds of CO_2/freight ton of cargo transported.

Over the last five years (2017-2022) there has been an approximately 10% reduction in GHG emissions driven predominantly by the reductions in GHG emissions from purchased electricity (Figure 4). This reduction is largely due to the decarbonization of Minnesota Power's electricity portfolio resulting from the incorporation of more renewable energy sources.

Figure 3: DSPA 2022 Greenhouse Gas Emissions

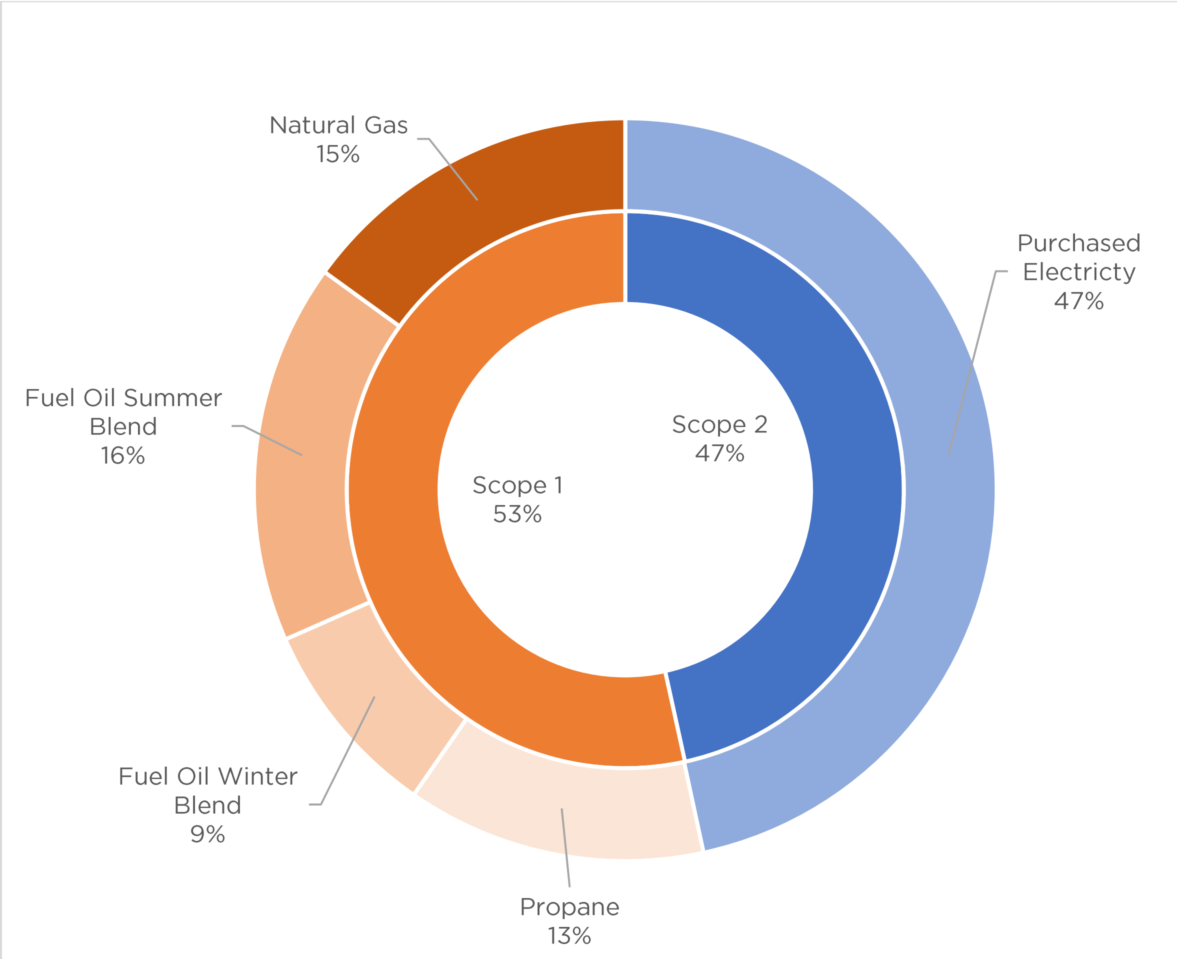
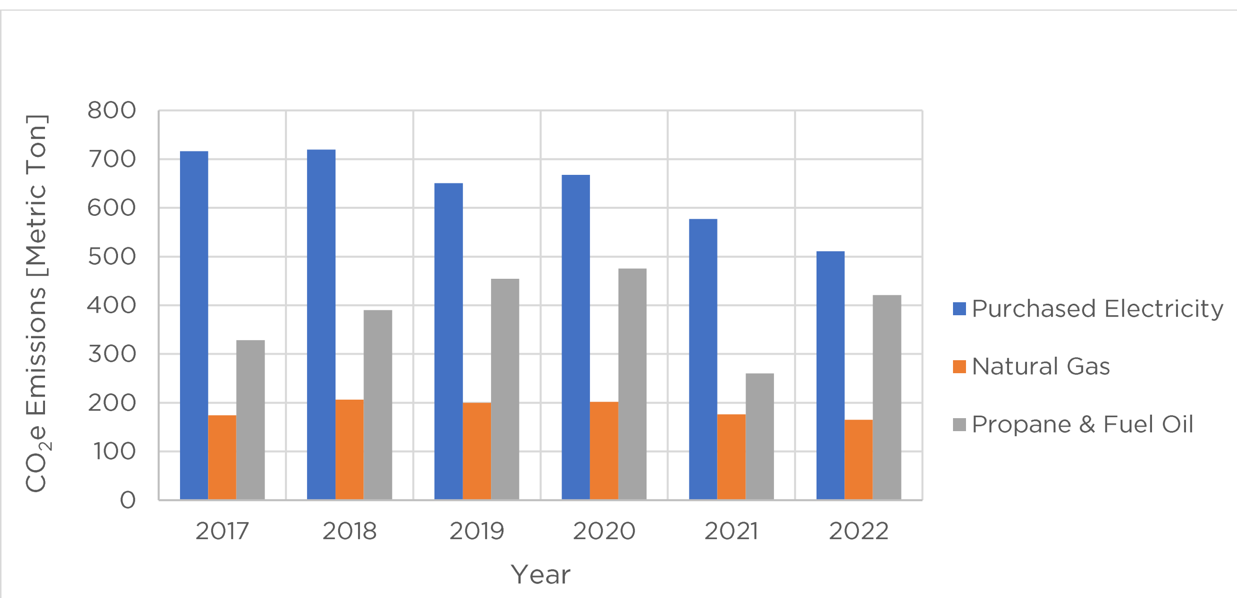


Figure 4: DSPA Carbon Dioxide Emissions by Year



2.4 Energy Use

Energy used at DSPA operated facilities includes electricity provided by Minnesota Power; fuels to power mobile equipment and vehicles; including propane, gasoline, and diesel; and natural gas for buildings provided by Comfort Systems.

2.4.1 Electricity Usage

Baseline electrical energy usage was modeled using 2022 monthly utility data provided for 22 Minnesota Power service accounts at Clure Public Marine Terminal and the DSPA Administration Building. Figure 5 shows the seasonal variation in the baseline electrical energy usage with highest usage in the late winter and early spring and lowest usage in the autumn. The large spike in electricity usage at Berth 3 in the spring is understood to be attributable to the shore power connection of laid-up vessels. In total, DSPA's electrical meters recorded 1.1 gigawatt hours (GWh) of electricity usage in 2022.

Electrical energy usage (kWh) is one component of the terminal's overall electricity usage, yet electrical power demand (kilowatts [kW]) is an equally important component. The July 2022 *Energy Analysis* report provided to DSPA from Minnesota Power specified measured peak power demand readings for some, but not all of the electrical meters. For meters not included in the *Energy Analysis* dataset, a 35% load factor was applied to their annual energy usage to estimate their peak power demand. Figure 6 presents the combined estimated power demands for each of the DSPA facilities. In total, DSPA's baseline, non-coincident peak electrical power demand is estimated at 673 kW. Electricity consumption resulted in the production of 511 metric tons of CO_2 in 2022.

Figure 5: Baseline Electricity Usage in 2022

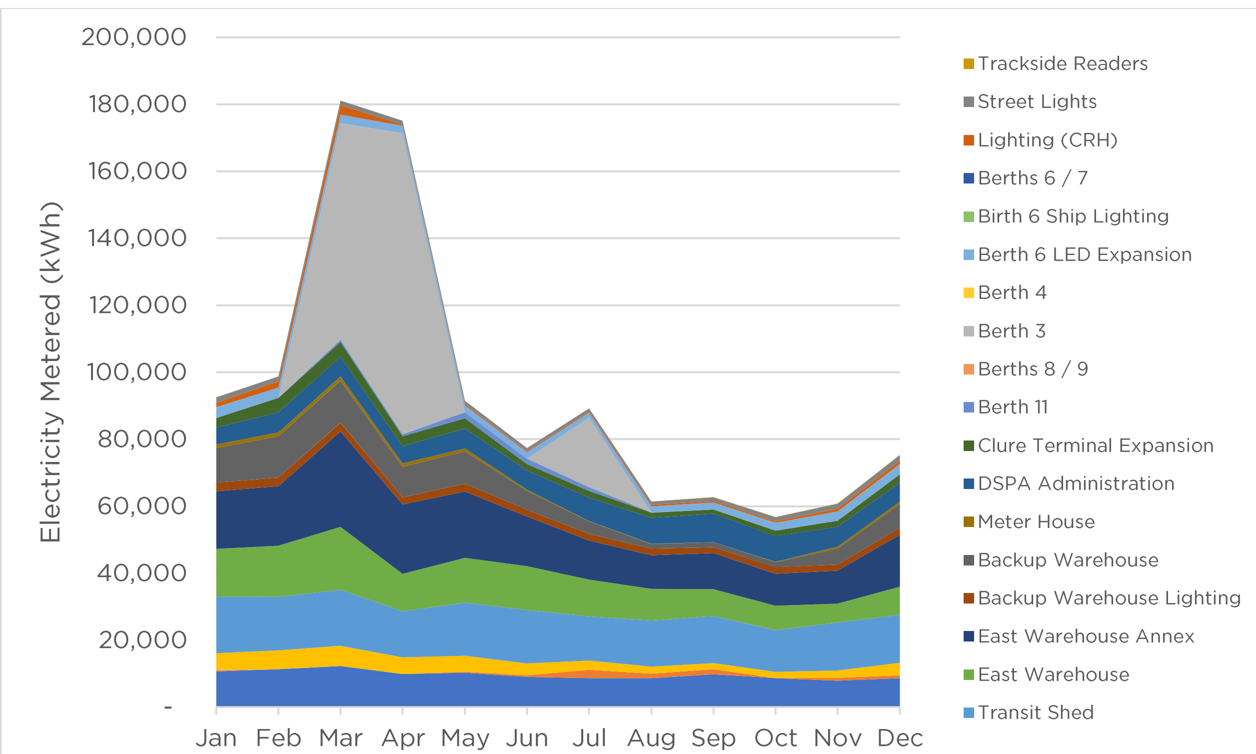
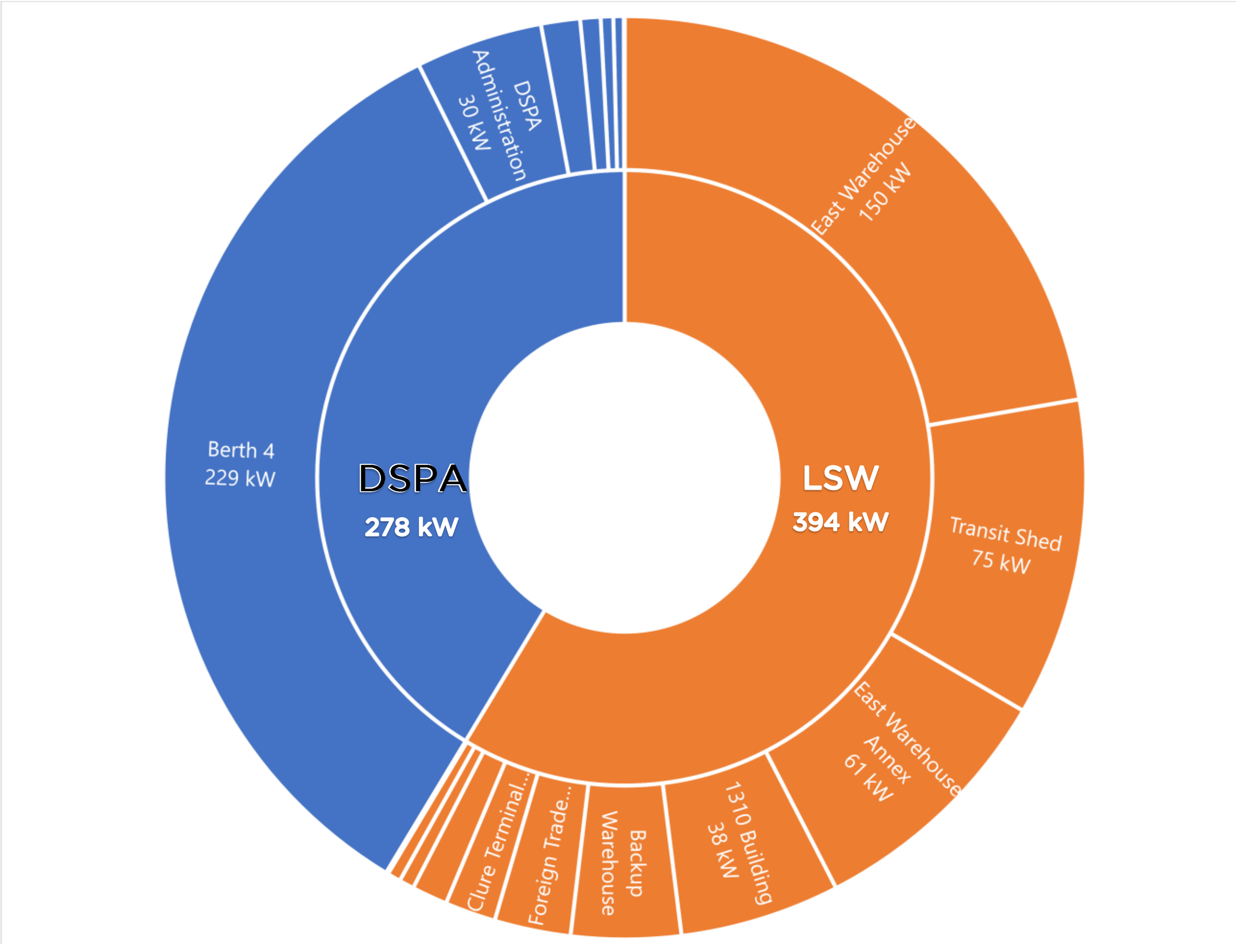


Figure 6: Baseline Peak Power Demand Estimate by Facility



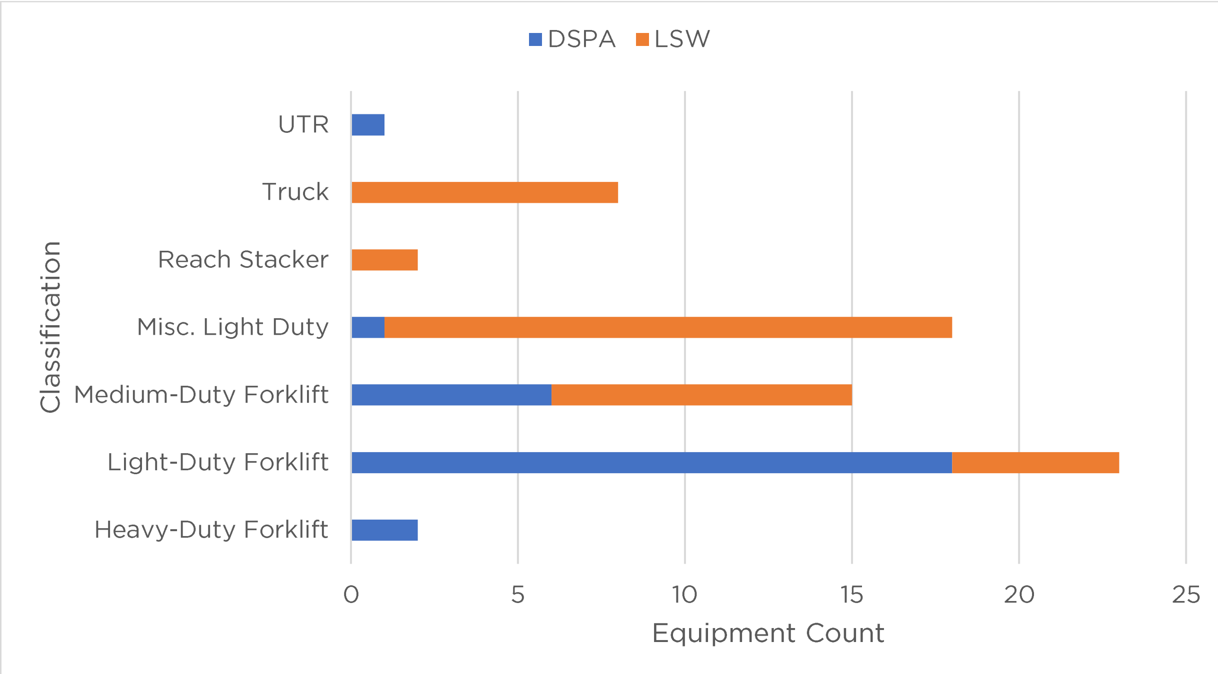
2.4.2 Vehicle and Equipment Fuel Usage

Terminal's cargo handling equipment (CHE) are comprised of internal combustion engine (ICE) units that are powered by propane, diesel, and gasoline. In 2022, 32,507 gallons of propane, 9,396 gallons of ultra-low sulfur diesel, and 14,052 gallons of biodiesel were used to operate CHE and vehicles. This equates to 421 metric tons of CO_2 in 2022 associated with fuel consumption of ICE CHE.

2.4.2.1 Equipment Fleet

DSPA provided counts and operational characteristics of DSPA's equipment fleet. This dataset specified equipment usage in terms of either hours per year or miles per year. Utilization data were missing for approximately 20% of the equipment in the dataset; for such equipment, the average usage provided for the rest of that equipment's category was set as the assumed annual usage. Figure 7 summarizes the fleet compositions of DSPA and LSW at the terminal. Miscellaneous light duty equipment included trucks, utility task vehicles, sweeper, and golf carts.

Figure 7: Existing Equipment Fleet Size



2.4.2.2 Building Heating

DSPA uses natural gas boilers for heating at the East Warehouse, Foreign Trade Zone 51, 1310 Building, and DSPA Administration building, which also uses natural gas for hot water. These facilities consumed 31,139,000 cubic feet of natural gas in 2022. Natural gas combustion at DSPA facilities emitted 165 metric tons of CO_2 in 2022. This was calculated using the default emissions factor provided by the EPA. Minnesota Power suggested transitioning to electric heat pumps for heating and hot water at the DSPA Administration building.

3.0 Technology Evaluation

The state of the ZE goods movement technologies is rapidly evolving as more manufacturers are developing electrified, battery electric, and hydrogen fuel cell CHE and on-road vehicles. Shore power is now being widely used for container vessels and cruise ships, and its use is planned to be expanded to roll-on/roll-off vessels. Hybrid diesel-electric harbor craft are also in development, and the International Maritime Organization (IMO) has established GHG reduction goals for international OGVs, targeting at least a 50% reduction in GHG emissions by 2050 relative to 2008 and encouraging the development of ships that can operate on carbon-neutral fuels. IMO has also established standards for shore power connections for OGVs in support of criteria pollutant and GHG emissions reductions of vessels while at berth. Class 1 rail lines are also pursuing decarbonization strategies, initially at switcher yards and maintenance facilities and eventually for line-haul locomotives as ZE technologies mature and improve. The biggest challenges that must be overcome to realize widespread deployment of ZE technologies include the ability of the new technologies to meet the operational needs of port terminals and significantly higher capital costs of equipment, vehicles, and supporting charging/fueling infrastructure. Equipment and vehicles that operate in closer proximity to terminals currently are more operationally viable than vehicles and vessels that must traverse long distances and/or move heavy loads due to present day limitations of the energy density of batteries and lack of robust charging networks along transit routes.

This section provides a high-level assessment of the state of ZE goods movement technologies that are currently used at Clure Marine Terminal for the purpose of evaluating the timeframe for potential deployment of the different technologies over the coming decades relative to the 2050 net zero goal. ZE technologies are evaluated based on their anticipated technological, operational, and commercial readiness for deployment.

3.1 Cranes

DSPA currently operates twin rail-mounted, electric gantry cranes. Each crane has a 90-ton lift capacity, and their combined capacity is 130 tons. The gantry cranes are used to offload general and breakbulk cargo and containers from vessels. While these cranes can either be electrified or powered by diesel generators, the cranes deployed at DSPA are powered by grid electricity.

DSPA is interested in acquiring two (2) 200-ton mobile harbor cranes at some point in the next decade. Historically, these types of cranes are powered by diesel generators, but new ZE models are now available that utilize grid power to perform lifting operations and a battery-electric drivetrain to re-position the crane. These new cranes hold the potential to increase operational flexibility at the terminal without producing any scope 1 emissions.

3.2 Shore Power

Shore power of OGVs while at berth is used to reduce criteria pollutant and GHG emissions from vessels by reducing the use of onboard diesel-powered auxiliary engines by plugging vessels into grid electricity while at berth. Shore power has been in use for decades and has been shown to be both technologically and operationally feasible.

DSPA's Clure Terminal currently has shore power connections for winter berthing. There is potential to expand shore power for the 15-25 cargo vessels calling on Clure annually; however, the use of shore power will be dependent on the shore power readiness of the ships that call on DSPA. Shore power is a significant investment; therefore, grant funding would be important to help offset shoreside infrastructure and on-vessel retrofits.

3.3 Reach Stackers

Reach stackers and top handlers and use an overhead boom to load, unload, and stack containers weighing up to 100,000 pounds. Diesel-powered top handlers are regularly operated two eight-hour shifts for five to six days per week at busy container terminals. Taylor Machine Works offers a range of battery-electric lift trucks, including a top handler and reach stacker, that use a nickel manganese cobalt battery and electric motor that provides a lifting capacity of 99,000 pounds. Taylor advertises that its battery-electric lift trucks are designed to operate for two eight-hour shifts on a single charge based on an average duty cycle.[1]

Hydrogen fuel cell ZE top handlers are currently at demonstration scale with pre-commercial units being tested at various ports.[2] The interim focus for ZE top handlers will be hybrid platforms with combined hydrogen fuel cell electric and battery powertrains. Hydrogen fuel cell top handlers are projected to be 24 percent of the market by 2050.[3]

Based on the commercial availability of battery-electric lift trucks from Taylor and their reported operational capacities, it is realistic for DSPA to transition to ZE technologies provided sufficient funding for equipment and infrastructure purchases.

3.4 Forklifts

Electric low-capacity or light-duty forklifts are commercially available and are commonly used in warehouse operations and distribution facilities, with lifting capacities up to 16,500 pounds. Commercially available battery electric pneumatic tire forklifts are typically rated up to 12,000 pounds, which generally meets the lifting requirements of light-duty forklifts at ports. Electric light duty forklifts can be integrated into terminal operations as gasoline and propane powered units require replacement or as grant funds are secured.

Large-capacity forklifts are defined for this analysis as having lifting capacities greater than 36,000 pounds. ZE large-capacity or heavy-duty forklifts are under development and are being tested in battery-electric and hydrogen fuel cell platforms. Battery-electric forklifts with lifting capacities of 36,000 pounds are offered from Kalmar, Taylor, and Wiggins Lift Company. While commercially available, these models are in the early stages of use at terminals with heavy break bulk operations.

With grant funding, pilot deployments of large-capacity battery-electric forklifts at Clure Terminal would be beneficial in assessing the operation viability for cold weather operations. It is anticipated that a greater range of ZE options for large-capacity forklifts will be available by 2030, including battery electric and hydrogen fuel cells.

3.5 Yard Tractors

Battery-electric yard tractors, also referred to as utility tractor rigs (UTRs), present the highest potential for near-term deployment of all the battery-electric CHE. Demonstration projects involving electric yard tractors have been underway for over five years at ports of Los Angeles and Long Beach, leading to significant improvements in the operational viability from early to later generations. Battery-electric yard tractors are now commercially offered by multiple OEMs, including Autocar, BYD, Capacity, Kalmar, Orange EV, and TICO. Pilot and demonstration projects have shown that later generation yard tractors often have adequate range to complete two shifts when using opportunity charging at lunch breaks and between shifts. The largest impediment to full commercial adoption of these units is the purchase cost

[1] https://www.taylorforklifts.com/battery-electric/

[2] BAAQMD. *Summary of Available Zero-Emission Technologies 2.0*. 2019 Oct 10

[3] CARB. *Hydrogen and Fuel Cell Activities in California*. *Light-Duty Hydrogen and FCEV Efforts in CA. Heavy Duty and Off-Road Hydrogen and FCEV Projects.* 2019.

of the units, which are two to three times higher than diesel equivalents; however, cost parity with diesel equivalents is expected by 2027 with incentive funding[4]. Cost parity and emission reduction regulations will increase the adoption rate for battery-electric yard tractors at that time. There is a strong potential to begin the transition of yard tractors to battery-electric technologies this decade.

Hydrogen fuel cell yard tractors are in the early pre-commercial development stage. Capacity Trucks is partnering with the Hyster-Yale Group to co-develop electric and hydrogen-powered yard tractors. Additionally, Toyota is building hydrogen fuel cell electric drivetrains for yard tractors. While early pilot projects have been initiated for hydrogen fuel cell yard tractors, there are no commercially available or operationally-proven models. Hydrogen fuel cell yard tractors/cargo handlers are projected to be 24 percent of the market by 2050.[5]

The single yard tractor operating at Clure Terminal is a strong candidate for replacement with a battery-electric unit. Its short transit distance and typical shift length of 8-12 hours could be accomplished with a single battery-electric yard tractor that is charged overnight.

3.6 On-Road Trucks

Electrification of the drayage truck fleet provides a strong near-term potential for the transition to ZE technologies. Drayage trucks generally operate within approximately 100 miles of the ports, providing more opportunities for consistent charging throughout their duty cycle. Electrification of long-haul trucks is more challenging because battery electric technologies are not able to provide sufficiently long ranges under heavy loads without significant investments in a robust highway fast-charging system. OEMs are investing in the development of hydrogen fuel cell trucks to expand the range of ZE Class 8 trucks. As energy density for battery cells increases, shorter charge times and longer ranges will increase the practicality for battery electric trucks. The greatest near-term potential for ZE Class 8 truck deployments is in drayage truck operations where commercially available battery electric trucks can be deployed within the next 5-10 years. Federal investments in highway charging infrastructure combined with further development of hydrogen fuel cell trucks will increase the potential for a transition to ZE trucks within the next 10-20 years.

ZE Class 8 trucks are being offered by almost all OEMs with a majority being battery electric and a small number being fuel cell[5]. Battery electric trucks that provide ranges of 125-350 miles per charge are commercially available from: BYD, Freightliner, Kenworth, Lion Electric, Nikola, Peterbilt, SEA Electric, and Volvo. Hydrogen fuel cell Class 8 trucks are currently in the pre-commercial development stages and are undergoing demonstration and pilot testing, with models being developed by Daimler/Volve, Hyundai, Hyzon, Kenworth/Toyota, Navistar, Nikola, and Toyota/Hino Motors. Commercially available battery electric trucks are capable of meeting the operational range requirements of drayage trucks (approximately 200 miles between charges) providing opportunities for near-term deployments particularly with the aid of grant funding. Grant funding and incentives are key because the purchase price of battery-electric Class 8 trucks typically is approximately three times more than their diesel equivalents. While the fueling and operations and maintenance cost of battery electric trucks

[4] Port of Oakland. *Revised Draft Seaport Air Quality 2020 and Beyond Plan.*

[5] Dr. David Wyatt. *Zero Emission Trucks: Batteries or Fuel Cells?* July 2022.

are anticipated to be lower, more deployments are needed to adequately compare full lifecycle costs.

The adoption rate for battery electric Class 4-8 trucks will increase significantly once cost parity and charging infrastructure is available. Currently, state and federal funding is still required to incentivize early adoption by truck operators. Based on these projections and federal investments in highway charging infrastructure, it is expected that ZE drayage trucks could be phased into operations between 2030 to 2050.

Pilot and early deployments of battery electric Class 8 drayage deployments can be pursued immediately, and it is reasonable to assume that replacement of drayage trucks could begin within the next 5 years. While DSPA does not operate drayage trucks, it could partner with local operators, such as Valley Trucking, to pursue funding for ZE vehicles and infrastructure.

3.7 Rail Locomotives

Rail locomotives are currently powered by diesel-electric motors and generally are divided between line haul and switch locomotives. Line haul locomotives are large locomotives with power greater than 2,300 horsepower that haul freight over long distances. Switch locomotives are smaller locomotives that range in power from 1,006-2,300 horsepower and pull freight throughout railyards or for short distances outside of railyards. Currently, there are no commercially available ZE line haul or switch locomotives; however, pilot projects are underway to develop and test battery electric and fuel cell locomotives. It is expected that battery electric locomotives will first be deployed in railyards to replace switch locomotives because of the units smaller sizes, lower power requirements, and the ability to install localized charging infrastructure to support operations. ZE and near-ZE locomotive technologies being contemplated include powering hybrid diesel-electric locomotives with renewable diesel, hybrid diesel-electric locomotives that could be connected to batteries or hydrogen fuel cells for ZE operations, battery electric locomotives, catenary-connected electric locomotives, and hydrogen fuel cell locomotives. Batteries and/or fuel cells would be located in subsequent rail cars (i.e., tenders) to provide adequate energy storage to support operational requirements. The use of tenders can present challenges relating to the weight of batteries and the high volume of hydrogen required to power operations.

In California, the South Coast Air Quality Management District and the U.S. Environmental Protection Agency awarded funding to BNSF Railway to repower a diesel line-haul locomotive with an EMD® Joule battery-powered system by Progress Rail. The ZE locomotive is scheduled to be delivered in mid-2023 and will include an 8-MWh battery storage system that will support operations along a 240-mile route between Los Angeles and Barstow. Wabtec is also developing a battery electric locomotive, which they refer to as FLXdrive.[6] Their first unit included a battery storage system with a capacity of 2.4 MWh, which was tested by BNSF between Stockton and Barstow, CA. Wabtec is currently developing a production model with a 7-MWh battery energy storage system.

[6] Stephens, Bill. Wabtec’s moonshot: Zero-emissions locomotives. November 29, 2021. https://www.trains.com/trn/news-reviews/news-wire/wabtecs-moonshot-zero-emissions-locomotives/

Canadian Pacific is in the process of developing and deploying a hydrogen fuel cell locomotive.[7] The locomotive uses fuel cells and batteries to power the electric traction motors of the line-hall locomotive. Canadian Pacific plans to use this approach to modernize its fleet of locomotives through replacing fuel tanks with batteries and hydrogen fuel cells and incorporating regenerative braking.

While ZE locomotives are in the early pilot stage of development, the combination of planned regulations in California and partnerships between locomotive manufacturers and Class 1 rail lines presents a reasonable opportunity for the development of commercially available ZE switcher locomotives within the decade and ZE line-haul locomotives prior to 2050.

3.8 Harbor Craft

Electric propulsion for harbor craft such as ferries and tugboats are under development with the first ZE tugboat in the U.S. to be demonstrated at the Port of San Diego in 2024.[8] Crowley Marine is developing an 82-foot battery electric tug with 8-MWh of storage capacity that can produce 70 tons of bollard pull. This amount of pull exceeds the 50-60 bollard pull of the typical medium-sized tug. The Crowley eWolf tug will be charged using a shoreside charging system developed by Cochran Marine.

The first hydrogen-powered tugboat has been developed in Spain by Astilleros Armón with plans for deployment at the Port of Antwerp-Bruges in 2023.[9] The Hydrotug is a 90-foot-long tug that uses a combination of diesel and hydrogen to produce 65 tons of bollard pull. This near-ZE tug has two 2-MW engines that incorporate European Union Stage 5 emissions treatment. Daewoo Shipbuilding & Marine Engineering Co. (DSME) has been selected to produce South Korea's first hydrogen fuel cell tugboat. DSME was awarded $17.4 million to construct and commercialize a 3-MW battery hydrogen fuel cell tugboat by 2026.[10] The U.S. EPA estimates that hydrogen fuel cell power units in harbor crafts will be about 23 percent of the new vessel market by 2050[11].

While the development of ZE harbor craft is at the early pilot development stages, there is sufficient industry interest, as well as government funding and regulations, to expect that ZE harbor craft, including tugboats, will be commercially available prior to 2050.

DSPA does not own or operate harbor craft, but as a public port authority, it can partner with local operators to pursue funding to support the piloting and deployment of ZE vessels.

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[7] Clinnick, Richard. First North American hybrid locomotive begins testing. International Railway Journal. November 30, 2021. https://www.railjournal.com/fleet/first-north-american-hydrogen-locomotive-begins-testing/

[8] Doll, Scooter. *First fully electric tugboat in US to set sail with more than 6 MWh of batteries.* 13 July 2021. Web. 12 Sept 2022. <First fully electric tugboat in US to set sail with more than 6 MWh of batteries (electrek.co)>

[9] Blenkey, Nick. World's first hydrogen-fueled tug features Schottel propulsion. Marine Log. August 17, 2022. https://www.marinelog.com/technology/worlds-first-hydrogen-fueled-tug-features-schottel-propulsion/

[10] Biogradlija, Arnes. DSME Selcted to Develop First Hydrogen Fuel Cell Tugboat in Korea. H2 Energy News. September 1, 2022. https://energynews.biz/dsme-selected-to-develop-first-hydrogen-fuel-cell-tugboat-in-korea/

[11] US EPA. *Assessment of Fuel Cell Technologies at Ports.* July 2022.

3.9 Ocean-Going Vessels

The transition of vessels to ZE technologies will involve ship owners, ship builders, fuel producers, and port and terminal operators. Key investments are needed in the development of ships that can operate on ZE fuels; generation of sufficient quantities of ZE fuels such as green ammonia, green hydrogen, green methanol, and biofuels; and ZE fueling infrastructure at major ports. The Global Maritime Forum and the World Economic Forum have formed the 'Getting to Zero Coalition,' which includes 200 organizations comprised of 160 companies within the maritime, energy, infrastructure, and finance sectors that are working with governments and IGOs to develop commercially viable ZE OGVs by 2030 with the final goal of achieving decarbonization of the shipping industry by 2050.[12] While there is strong commitment from industry and governments to transition shipping to ZE technologies, shipping lines, such as Maersk and CMA CGM are just beginning to order and deploy container vessels with dual-fuel engines that are capable of operating on green methanol. Beyond the ships, significant investment in green fuel generation, storage, and fueling infrastructure are needed to facilitate this transition. In summary, ZE OGV technologies are in the early stages of commercial development and are currently being integrated into a limited number of container vessels; however, the numbers and types of vessels expected to be capable of using green fuels will grow in the coming decades as shipping lines progress towards their 2040-2050 net zero goals.

As more and more vessels are incorporated into the supply chain that have the ability to operate on green fuels, it is possible that in future decades that green fuel bunkering and fueling infrastructure will be needed. DSPA may play an important role in developing that infrastructure, potentially at the Cenovus Energy fuel dock.

3.10 Light-duty Passenger and Fleet Vehicles

The availability and diversity of electric passenger cars, trucks, and vans is improving year over year. With many of the DSPA fleet vehicles operating close to the port at low daily mileages while spending the majority of their operational time idling, these vehicles are prime candidates for conversion to electric models. It is anticipated that DSPA fleet vehicles can be converted to electric models as vehicles are upgraded and replaced at the end of their useful lives.

3.11 Charging Infrastructure

Deployment of battery-electric equipment requires significant investments in supporting electric infrastructure. Wide-scale transitions to battery-electric vehicles and CHE will quickly grow loads to levels that will require major upgrades to the local electric transmission and distribution system. Currently, there is a lack of standardization among chargers used by different OEMs for their respective CHE and vehicles. Equipment not only require different plug configurations, but also charge at different voltages. This can limit operational flexibility as well as the ability of terminal operators to deploy equipment/vehicles from multiple OEMs.

[12] Global Maritime Forum Getting to Zero Coalition. https://www.globalmaritimeforum.org/getting-to-zero-coalition. Accessed November 2022.

The standardization situation is improving through the emergence of the Combined Charging Standard (CCS), which now serves as the leading charging standard for heavy duty vehicles.

In addition to the need to standardize chargers, ports and terminal operators also must work with labor to ensure that vehicles are plugged in and charged. Inductive or wireless charging provides an option that removes the need to plug in vehicles by installing a wireless pad in the ground that wirelessly charge vehicles when positioned over the in-ground pads or coils using resonant electromagnetic induction. Both Level 2 and direct current fast charging (DCFC) speeds can now be achieved using inductive charging.

While the cost of deploying charging infrastructure is significant, charging technologies are sufficiently developed to achieve the 2050 ZE goal for CHE and vehicles. Reductions in the cost of chargers and speed of charging along with the development of a robust charging network along key trucking routes will be essential to achieving the 2050 net zero goal.

3.12 Cold Weather Impacts on Battery Performance

Duluth's climate zone poses a unique challenge to the operation of a battery-electric equipment fleet. On cold winter days (sub-freezing), the conversion process of batteries' chemical energy to electrical energy is constrained. However, the level of this reduced energy conversion efficiency varies based on battery chemistry, so it is important for DSPA and LSW to consider these nuances when soliciting battery-electric equipment from vendors.

Among the various battery chemistries available for cargo handling equipment, lithium-ion batteries using nickel, manganese, and cobalt (NMC) stand out as a preferable option for Duluth due to their high energy density and better performance in cold weather. However, these batteries are relatively costly, have shorter life cycles, and use rare earth metals associated with environmental and human rights issues stemming from their mining.

Another lithium battery technology, lithium iron phosphate (LFP), sacrifices energy density and cold weather performance for lower cost and longer lifespan. Many automotive manufacturers are adopting this battery chemistry in their platforms due to its improved sustainability. LFP batteries are typically rated for operation between -20°F to 120°F. At -20°F, their effective energy capacity is typically ~70% of the nameplate battery capacity rating. Due to the growing popularity of this chemistry, this assessment's modeling work assumes that LFP battery-electric equipment will be used to be more conservative around its operational constraints.

Traditionally, lead acid batteries have been used in light-duty electric equipment like light-duty forklifts and golf carts. These batteries have a relatively broad operating temperature range, from -40°F to 120°F. Despite this flexibility, their capacity significantly diminishes in cold temperatures. For example, at -20°F, a typical lead acid battery loses ~60% of its capacity, while LFP batteries only experience a ~30% reduction. Additionally, the overall round-trip efficiency of lead acid batteries is approximately 85%, 10% lower than LFP batteries' efficiency.

Given the importance of the iron industry to the Port's past and future, it is worth nothing that several companies are now testing iron-air batteries. Early indications are that this battery technology can be far cheaper in terms of energy capacity compared to lithium-based chemistries and can also achieve very high energy densities. However, such technology currently has a significantly lower operational lifespan in terms of charge/discharge cycles and a far lower round-trip efficiency relative to lithium chemistries. If technological breakthroughs are made that mitigate these weaknesses of iron-air technology, it may become an option for use in mobile equipment. However, for the foreseeable future, such technology is better suited for stationary, long-term energy storage.

Regardless of battery technology, cold temperatures degrade battery-electric equipment's performance more-so than the performance of the terminal's existing fossil fuel equipment fleet. The following suggestions provide means of either accounting for or mitigating this undesirable characteristic:

1. When specifying technical requirements for battery-electric equipment, consider the battery capacity reduction in cold temperatures to ensure the equipment can operate throughout a half-shift before needing to charge.
2. Implement temperature compensation or charge control for batteries exposed to outdoor conditions or significant temperature fluctuations. It is advisable for DSPA and LSW to use a charge/discharge control device or a predetermined charge/discharge dispatch during colder months.
3. Established heated charging depots within buildings or use battery blankets as a straightforward method to prevent capacity deterioration in batteries due to cold temperatures.

3.13 Summary

The technological readiness of ZE CHE and vehicles has greatly improved in the last decade with more and more grid connected and battery electric equipment being commercially available today. Hydrogen fuel cell technologies tend to lag battery-electric CHE and vehicles by approximately 3-5 years. While a number of battery-electric models are commercially available, the costs of these vehicles are often 2-5 times greater than comparable ICE models. Table 1 summarizes the commercial availability of the technologies assessed.

Table 1: Technological Readiness of Cargo Handling Equipment, Vehicles, and Vessels

Equipment / Vehicle	Commercial Availability Electric/Battery Electric	Commercial Availability Hydrogen Fuel Cell	Emissions Scope (1,2,3)	Comments
Shore to Ship Cranes	Available	N/A	1	Grid powered. Widely deployed. Proven technology.
Mobile Harbor Cranes	Available	5-10 years	1	Battery-electric models require frequent charging.
Reach Stackers	Available	1-5 years	1	Operate 1-2 shifts with opportunity charging
Forklifts	Available	1-5 years	1	Light and medium forklifts are common. Heavy duty available from select manufactures.
Yard Tractors	Available	1-5 years	1	Operate 1-2 shifts with opportunity charging.
On-Road Trucks	Available	Available	3	Applicable for drayage operations.
Switch Locomotives	5-10 years	5-10 years	3	Pilot deployments.
Line Haul Locomotives	10+ years	10+ years	3	Energy density of batteries and hydrogen fuel cells are major constraints.
Harbor Craft	Available	1-5 years	3	Battery electric tugs available.
Oceangoing Vessels	N/A	10+ years	3	Green methanol or ammonia for dual fuel ICE.
Light-Duty Passenger Vehicles	Available	Available	1	Hydrogen fuel cell models are limited.

4.0 Future Energy Assessment

For the DPSA to achieve its net zero emissions target, the current mixture of energy sources powering its operations must evolve from their present-day baseline. In the case of DSPA's mobile equipment, the conversion of the fleet from its current mixture of propane, diesel, and gasoline fuel sources to battery-electric equipment holds the potential to dramatically reduce the total energy used at the terminals due to the inherent efficiency advantage of electric drive trains relative to internal combustion engines. However, energy end uses like building heating may currently be more energy efficient using natural gas compared to grid electricity. One certainty is that DSPA's electricity needs will increase in a ZE future in both power (kW) and energy (kWh) terms.

To quantify the growth of electrical energy needs in a ZE future, the existing equipment fleet's composition and utilization rate were analyzed to determine the electrical power demand and energy requirement of an equivalent future battery-electric fleet following today's operational schedule.

4.1 Future Operational Modeling Process

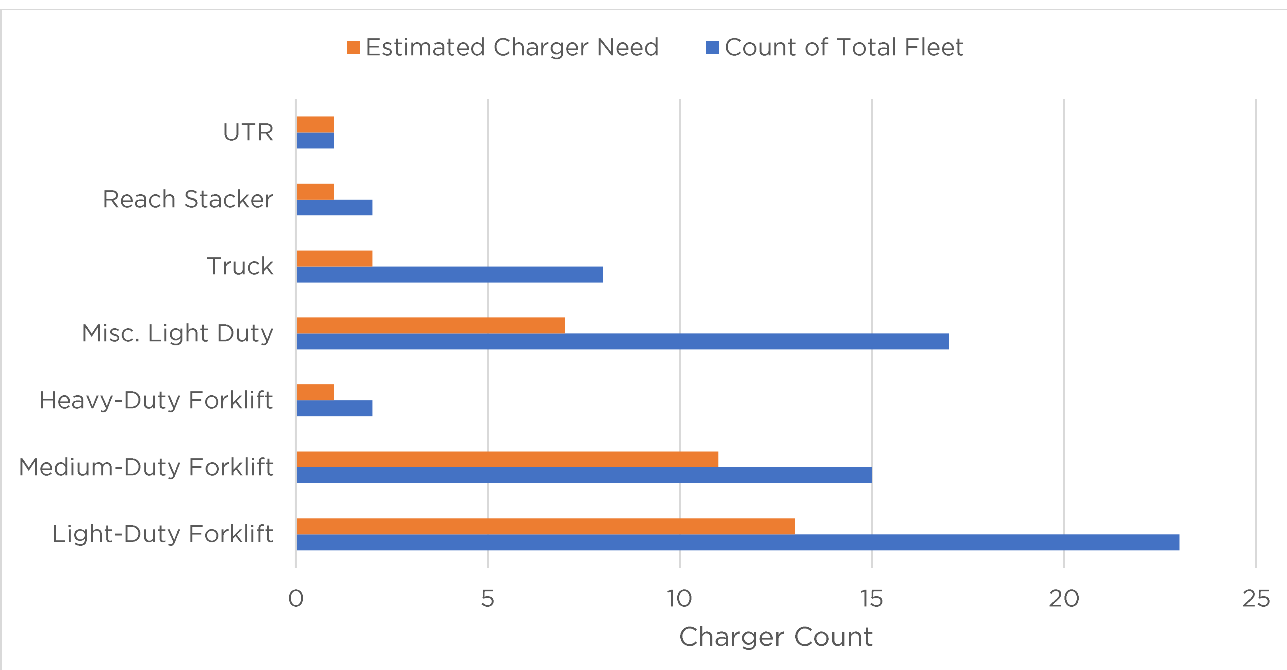
For each class of equipment within the fleets of DSPA and LSW, assumptions were established regarding the equipment's technological characteristics once converted to battery-electric models. These assumptions are summarized within Table 2. All values are based on Burns & McDonnell's industry experience with available battery-electric equipment offerings. The "Electrical Energy Burn Rate" metric has been calibrated downward for the "Miscellaneous Light Duty" and "Light-Duty Truck" equipment types based on indications of generally light usage of this equipment from the operational dataset provided by DSPA. Accordingly, the "Maximum Charging Power" metric for these equipment types has been constrained to Level 2 charging speeds (requiring 208 V or 240 V service) rather than DCFC speeds (requiring at least 480 V service) due to the lack of need for rapid recharging of such equipment (i.e., over lunch break). The other classes of equipment are understood to be operated at much higher duty cycles, so DCFC has been assumed necessary to sustain fleet operations for a complete day, particularly during periods of cold weather when the equipment's effective battery capacity is expected to reduce by 30%.

Table 2: Battery-Electric Equipment Specifications

Equipment Class	Electrical Energy Burn Rate (kWh per hour)	Battery Energy Capacity (kWh)	Cold Weather Effective Battery Energy Capacity (kWh)	Maximum Power Draw (kW)
Light-Duty Forklift	8	53	37	10
Medium-Duty Forklift	17	90	63	36
Heavy-Duty Forklift	42	166	116	100
Miscellaneous Light Duty	4	30	21	10
Light-Duty Truck	0.6	80	56	19
Reach Stacker	54	300	210	120
UTR	15	220	154	120
Mobile Harbor Crane	120	250	175	43 (battery charging for re-positioning) 1,617 (grid power draw for lifting ops)

These equipment assumptions were used in conjunction with the equipment quantity information shown in Figure 8 to develop an hourly operational model of the fleets to estimate both the average daily electricity usage and required charger quantities for each class of equipment.

Figure 8: Fleet Size and Charger Need



4.1.1 Forklift Modeling

The annual engine hours per year dataset provided by DSPA was used as the basis for modeling the operation of the forklift fleet. This dataset indicated that, on average, less than half of the light-duty forklift fleet is used for more than 2 hours per workday. For these forklifts used more than 2 hours per workday, it was assumed that dedicated chargers would be needed on a 1:1 basis. For the portion of the fleet used less than 2 hours per workday, a 4:1 forklift-charger ratio was assumed.

4.1.2 Utility Tractor Rig Modeling

It was assumed that the sole UTR at the terminal would have its own dedicated 120-kW DCFC charger due to its observed moderate usage (i.e. 2-4 hours per workday).

4.1.3 Reach Stacker Modeling

The fleet dataset noted two reach stackers in use at the terminal: one older, one new. The older reach stacker was observed to have very limited usage while the newer one was observed to be heavily used. Consequently, a single 120-kW DCFC was assumed to be sufficient for future electrification.

4.1.4 Truck Modeling

All eight light-duty trucks provided in the fleet inventory were observed to have relatively light usage. Two Level 2 chargers are assumed to be required to meet their charging needs.

4.1.5 Mobile Harbor Crane Modeling

It is assumed that the two planned mobile harbor cranes will be operated with grid-power for purposes of estimating their peak power demand. It is also assumed that such cranes may be needed to work in tandem with one another for large lifts, disallowing the application of a diversity factor to their power demands.

Future electricity usage (kWh) of these cranes has been estimated based on the assumption that both cranes perform 10 lifts per working day (i.e., 5,200 lifts per year.

4.1.6 Miscellaneous Equipment Modeling

All other equipment provided in the dataset not within the aforementioned categories was grouped within a “Miscellaneous” equipment category containing equipment like golf carts, sweeper machines, and mowers. Based on the presence of these examples in the dataset’s labeling, it was assumed that all of this equipment will require Level 2 charging, not DCFC. Nearly all of this equipment’s electricity usage was indicative of, on average, less than 2 hours per day of use. Three equipment have usage exceeding 2 hours per day and were assumed to need their own dedicated chargers, while the remaining fourteen equipment were assumed to share chargers on a 4:1 ratio.

4.2 Electricity Demand and Usage Estimate

With the charger needs for each equipment class established, the next step in the Future Energy Assessment was the hourly modeling of peak power demand (kW) and average electricity use (kWh). The terminal’s operations were understood to primarily consist of a day shift that is operated year-round. Accordingly, most of the equipment fleet’s charging was modeled as occurring in the overnight hours beginning at 8 PM once Minnesota Power's peak demand charge period for its EV charging rate ends. However, for purposes of modeling peak demand, it was assumed that all chargers could be in use at the same time. To remain conservative in the modeling, it has been assumed that the mobile harbor cranes could also be operated at the same time during which the CHE fleet is largely charging. However, if such a coincidence can be avoided, the terminal's future coincident peak power demand would be driven purely use by the mobile harbor cranes operating during daytime, not by other CHE nighttime charging.

Figure 9 depicts the relative contribution of each type of equipment charging to the facility's peak demand. Cumulatively, these demands are estimated to lead to a 608% increase in peak demand compared to the terminal's baseline power demand. The procurement and operation of two new grid-connected mobile harbor cranes is the primary driver of this peak demand increase, as they alone represent a quintupling of the terminal's assumed baseline electricity peak demand.

Figure 10 presents a similar graphic except with the data presented in units of electricity use, not power demand, which shows only a 22% increase in electricity usage from fleet electrification. This disparity in the percentage increases of power demand and electricity consumption is attributable to the intermittent nature of the fleet charging loads and anticipated mobile harbor crane usage.

Figure 9: Peak Electrical Power Demand Growth Estimate

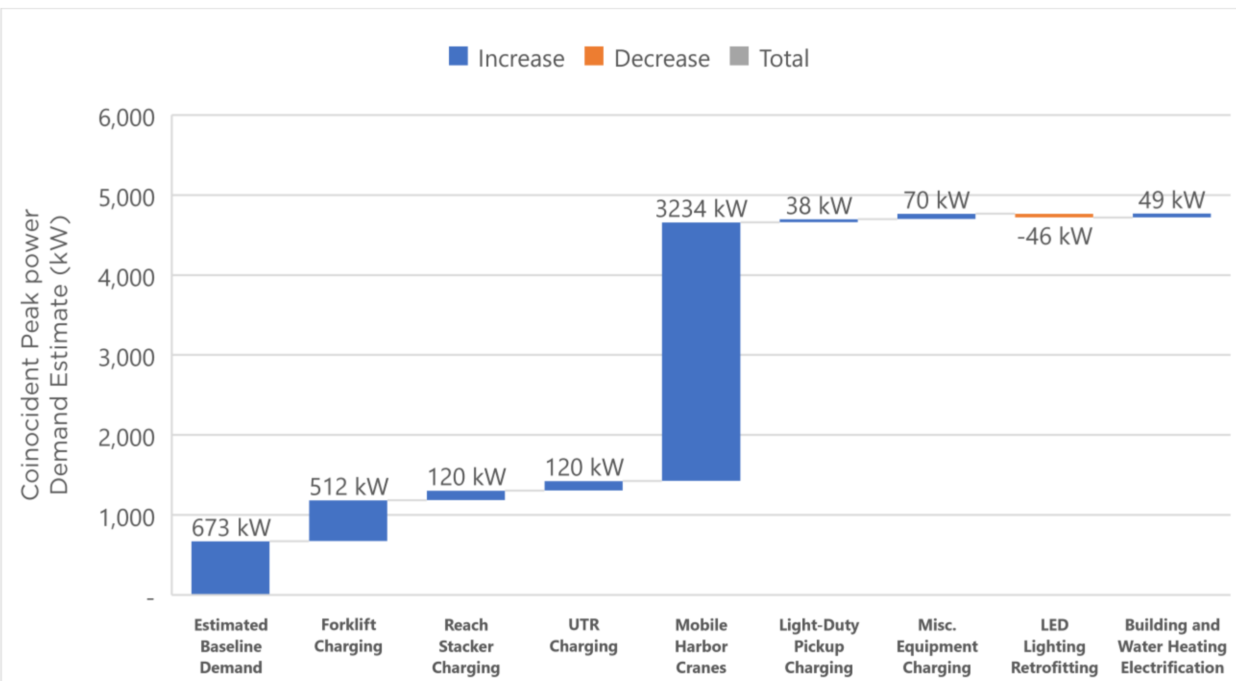
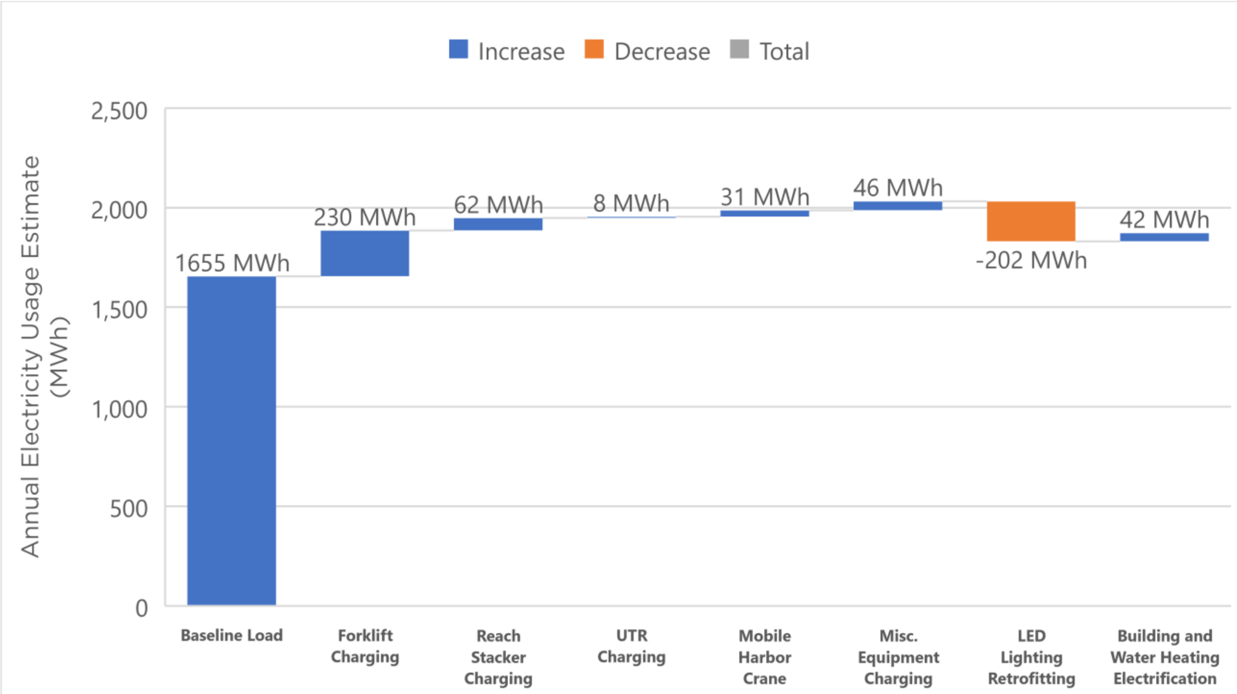


Figure 10: Electricity Usage Growth Estimate



4.3 On-Site Energy Systems Assessment

When faced with the prospect of increasing power demand and electricity usage at the terminals, it is prudent to first investigate whether clean, distributed energy resources like solar, wind, or battery energy storage systems can meet these new demands either more cost-effectively or with lower emissions than Minnesota Power – DSPA's electric utility provider. Accordingly, an assessment of on-site solar, battery storage, and wind systems was conducted to determine if the development of such systems will provide DSPA with either cost savings or emissions reductions relative to relying upon Minnesota Power to meet the new electrical demands.

Figure 11 compares the relative costs of grid electricity from Minnesota Power with various on-site energy systems based on the assessment's findings. The grid electricity supplied from Minnesota Power was judged to be cheaper than the solar or battery scenarios. While the wind power scenario held promise from a financial perspective with a similar electricity cost as Minnesota Power, further pursuit is not recommended due to the lack of available open land area on which a turbine could safely be sited. Consequently, the recommended path forward for the DSPA to source its future energy is to pursue enrollment on Minnesota Power's "EnergyForward" rate which is certified as providing 100% renewable energy (see Section 7.1.3).

While the assessment accounted for the financial value of applicable incentives to the on-site energy systems, it did not assume the receipt of any grant monies for developing such systems. Instead, the on-site resources were evaluated as if the DSPA were to finance and develop such systems with its own capital. If grant money is received to develop the systems, the project economics could shift making on-site solar and/or battery systems a cheaper source of electricity which could reduce the DSPA and its tenants operating costs and scope 2 emissions alike.

Figure 11:Estimated Levelized Cost of Energy by Resource Type

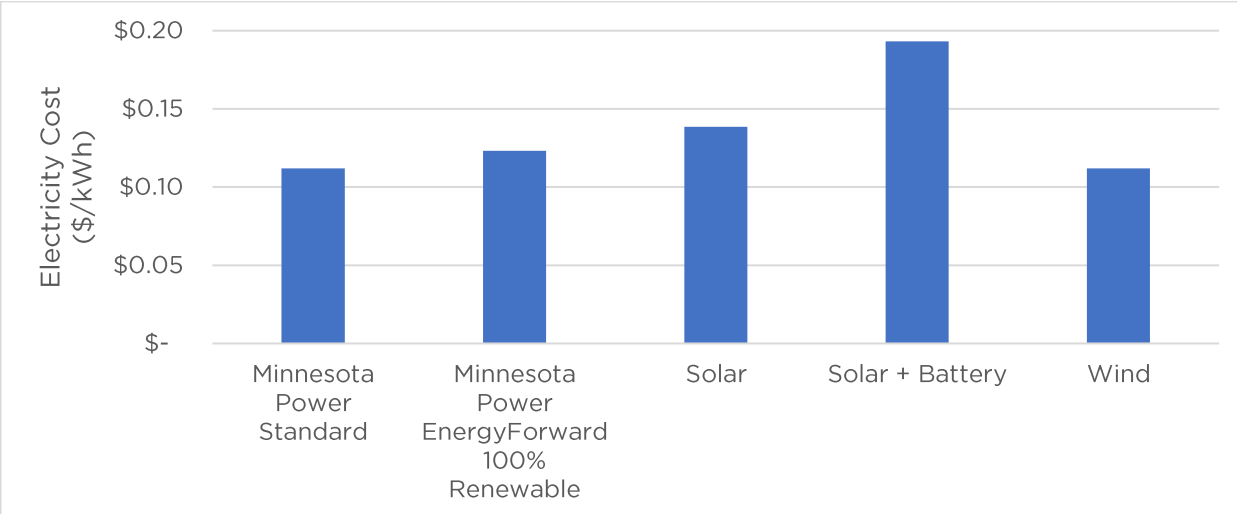


Table 3 presents the general assumptions used to reach these findings and is followed by a more detailed description of the process through which each technology was assessed.

Table 3: Modeling Assumptions

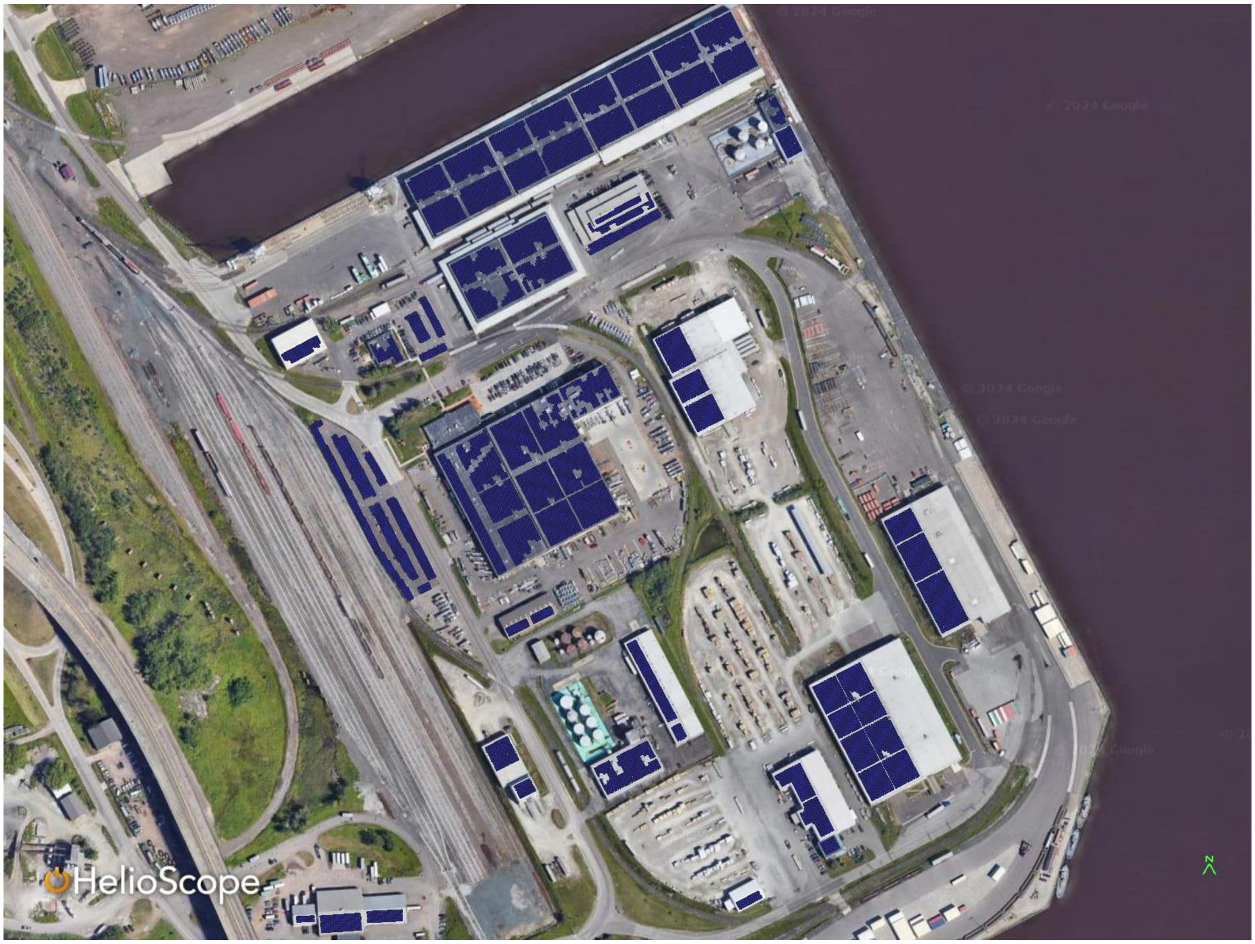
Assumption	Value
Rooftop Solar $/Watt (W) Install Cost	$3.00/W
Wind Turbine Install Cost	$5.00/W
Battery Install Cost	$225/kW, $400/kwh
Inflation Rate	2.5%/yr
Analysis Period	25 years
Real Discount Rate	4%/yr
Investment Tax Credit	30% of system cost
Electricity Bill Escalation Rate (above inflation)	0%
Minnesota Power: Rate 25D – Demand Charge	$8/kW
Minnesota Power: Rate 25D – Energy Charge	$0.1126/kWh

4.3.1 Rooftop Solar Photovoltaic Feasibility

Preliminary solar photovoltaic (PV) system layouts were created for all buildings on the terminal to determine the maximum system size that could theoretically be developed on the terminals' rooftops. While solar PV systems can also be developed atop parking lots or in existing empty spaces, this assessment only focused on rooftop solar potential due to the other installation types' conflicts with competing land uses for terminal operations. Rooftop solar has the added benefit of being co-located with existing electrical use at each building, simplifying the interconnection process of the systems by generating the power at the same location where it is needed.

In total, it is estimated that 6.2 MWdc of installable solar PV generation potential exists across the terminal's buildings, inclusive of DSPA operations and lease properties. The subsystems comprising this total are illustrated in Figure 12.

Figure 12: Maximum Rooftop Solar Capacity (Preliminary)



Most of this capacity exists atop DSPA's West and East Warehouses and Altec Industries' facilities. If all 6.2 MWdc of capacity is developed, it is expected to generate 7,100 GWh of electricity per year, more than three times DSPA's expected future annual electricity need. While many of the facilities' roofs may not have sufficient structural integrity to support the added weight of the solar systems, it is helpful to understand that DSPA has ample solar generation capacity to offset electricity usage on an annualized basis.

Once the maximum rooftop solar capacity at DSPA facilities was understood, System Advisor Model software from the National Renewable Energy Laboratory (NREL) was used to combine the solar generation potential, estimated future electrical load profile, and predominant electricity rate from Minnesota Power (25D) to judge the financial feasibility of developing such solar systems.

4.3.2 Battery Energy Storage Feasibility

A preliminary investigation of battery energy storage system financial feasibility was conducted, but no clear business case for investing in such a system was identified within the current electricity rate structure offered by Minnesota Power. Minnesota Power's "25", "25D", and "29EV" electricity rates all offer electricity at a flat price per kWh which does not vary based on the time of day, eliminating any opportunity to charge the battery when power is cheap and discharge the battery when power is expensive. While the 25D rate does carry a demand charge indexed to a meter's peak power (kW) demand, the demand charge ($8/kW) was observed to be too low to be the sole savings mechanism to achieve payback for the battery's costs. The 29EV rate has a time-based demand charge, but the time period at which the demand charge is applied is from 3 PM to 8 PM. Accordingly, the terminal should have little need to charge its equipment during these hours. The chargers can be programmed to delay their charging until after this demand charge period, negating the need for a battery to avoid such charges. While a battery could be used to store excess solar energy rather than exporting it to the grid in exchange for a reduced bill credit, this difference in bill credit value was not found to be sufficient to lower the levelized cost of energy of a hybrid solar plus storage system relative to a solar-only system.

4.3.3 Wind Turbine Feasibility

A wind resource model was developed to study the performance of a 1- MW turbine at the Clure Public Marine Terminal. A wind resource file was downloaded from NREL's Wind Toolkit for the Clure Public Marine Terminal location, but such data is subject to significant uncertainty. The resource file indicated relatively strong wind energy potential, particularly in the January through April timeframe. While a 1-MW turbine was identified as being an appropriate size to meet DSPA's annual future electricity demand, there does not appear to be sufficient open land area at Clure Public Marine Terminal where such a turbine could be installed. For a system of this size, a setback radius from existing structures of roughly 80 meters is desirable, but no such area was identified on DSPA property that could meet this criterion. This lack of available area was judged to be a fatal flaw in the development of on-site wind. While smaller turbines could be pursued, their performance is far lower than the performance of larger turbines like the 1 MW model assessed, and their levelized cost of electricity is likely to be significantly higher than the $0.11/kWh levelized electricity cost identified for a 1 MW turbine.

If, in any event, the DSPA wishes to further assess the viability of on-site wind energy resources, it is highly recommended that an anemometer station be installed atop the Ash Grove Cement Terminal to verify the wind resource potential at the terminal or adjacent sites.

5.0 Goals & Objectives

In response to the urgent need for climate action, the following set of recommended goals and objectives have been created. These goals and objectives are designed to guide DSPA's efforts towards reducing emissions, building resilience, and fostering sustainability across all aspects of its operations and community engagement initiatives.

5.1 Achieve Net Zero Operating Emissions

DSPA is committed to achieving net zero operating emissions by 2050.

5.1.1 Objectives

- Implement energy efficiency measures across all facilities and operations.
- Transition vehicles and equipment to ZE alternatives in a phased approach that allows for cold-weather and operational testing of available equipment.
- Integrate shore power into operations to reduce emissions from OGVs while at berth as shore power fittings become standardized and/or following an assessment of the shore power needs of the range of vessels that call on the Clure Terminal.
- Procure renewable energy sources for electricity consumption.
- Offset remaining emissions through verified carbon offset projects.
- Regularly monitor and report emissions data to track progress towards net zero.

5.2 Community Engagement

DSPA will collaborate with the local community and organizations to identify climate-related vulnerabilities and improve resilience.

5.2.1 Objectives

- Develop partnerships with local organizations and community groups, and/or expand such existing partnerships, to collaborate on climate resilience initiatives.
- Implement programs and initiatives that directly contribute to climate adaptation and mitigation.
- Evaluate and adapt strategies based on the evolving climate risks and vulnerabilities within the community.

5.3 Expand Workforce Development

DSPA will include climate-related workforce development in its larger workforce development efforts, ensuring employees are equipped to address the challenges of a changing climate and drive sustainable solutions.

5.3.1 Objectives

- Offer comprehensive training programs to terminal staff focused on climate-related skills and competencies, such as the operation and maintenance of ZE technologies.
- Collaborate with and support local education institutions and workforce development boards in developing climate-focused programs, ZE operations and maintenance training and certifications, and internship opportunities for early-career professionals.

6.0 Strategy

The following section presents key strategies for achieving a net zero emissions goal for DSPA owned and operated facilities by 2050. These items provide DSPA with clear, actionable steps towards realizing its climate action goals and objectives. Implementing these strategic recommendations positions DSPA for short- and long-term progress towards a more sustainable and resilient future.

6.1 Tracking and Reporting

For the successful execution of this strategy, DSPA will continue monitoring and evaluating its performance on an ongoing basis. DSPA may consider publishing an annual sustainability report. Such a report would serve as a comprehensive overview, enabling stakeholders to remain informed about DSPA's advancements in climate action.

Moreover, the act of reporting itself serves as a catalyst for effective data management, providing DSPA with the necessary insights to identify areas of strength and weakness. By systematically assessing its performance and disclosing this information transparently, DSPA not only fosters accountability but also creates opportunities for continuous improvement. This process ensures that the organization remains agile and responsive to emerging challenges and evolving stakeholder expectations.

The most important metric for DSPA to be tracking and reporting is its total GHG emissions. DSPA can increase the accuracy of its scope 1 and 2 emissions inventory through improved data collection, monitoring updates, and following the EPA *Greenhouse Gas Inventory Guidance* methodology. DSPA's scope 1 emissions sources include direct emissions associated with the combustion of natural gas, propane, and fuel oil. DSPA currently calculates CO_2 emissions using volume units multiplied by emission factors derived from the EPA. This methodology does not account for methane (CH_4) and nitrous oxide (N_2O) emissions. DSPA's scope 2 emissions are calculated using a market-based emission factor provided by Minnesota Power. To provide stakeholders with the most representative data, we recommend following best practices in the EPA *Greenhouse Gas Inventory Guidance* to the extent reasonably achievable.

Per the EPA *Greenhouse Gas Inventory Guidance*, the equation DSPA uses to calculate direct CO_2 emissions from stationary and mobile combustion of natural gas, propane, and fuel oil is recommended when fuel consumption is known only in mass or volume units, and no information is available about the fuel heat content or carbon content. This methodology is considered acceptable, but it has the most uncertainty because its emission factors are based on default fuel heat content, rather than actual heat content.[13][14] Should fuel carbon content and heating values be unavailable, we highly recommend CH_4 and N_2O emissions be incorporated using the current methodology.

The most accurate method for calculating GHG emissions from stationary and mobile combustion requires the actual fuel carbon content and heat content, which can be obtained from the supplier or from sampling and analysis. If fuel use is provided in energy units (e.g., mmBtu or therms), fuel use can be multiplied directly by the emission factor. The EPA GHG Emission Factors Hub can be used to determine the emission factors for CO_2, CH_4, and N_2O per energy unit.[15] DSPA should use the newest emission factors available, regardless of the reporting year. If the emission factors have been updated, the newest emission factors should be applied to previous years to properly reflect the changes in emissions over time. If the fuel carbon content is known, CO_2 emissions should be calculated separately with the following equation:

Mass of CO_2 emitted = Fuel x CC x 44/12

Where: Fuel = Mass or volume of fuel combusted

CC = Fuel carbon content, in units of mass of carbon per mass or volume of fuel

44/12 = ratio of molecular weights of CO_2 per energy unit

Given that the boundaries of this CAP include all DSPA operations in the Clure Public Marine Terminal and Duluth Lake Port, this GHG inventory should also use the appropriate methodology for calculating CH_4 and N_2O emissions of DSPA-owned on-road vehicles. The only difference between offroad vehicles (e.g., forklifts or telehandlers) and on-road vehicles (e.g., trucks) is that fuel consumed can be replaced by distance traveled multiplied by the emission factor for each fuel type (e.g., gasoline or diesel).

DSPA's scope 2 emissions are calculated by multiplying purchased electricity (kWh) by a supplier-specific emission factor provided by Minnesota Power. This falls under the marked-based method and is acceptable. However, unlike scope 1 emissions, if the emission factor provided changes, previous years' emissions should not be adjusted to reflect the new factor. Additionally, if DSPA uses market-based instruments to reduce its scope 2 emissions, such as renewable energy certificates (RECs) or a power purchase agreement (PPA), the associated emissions must be calculated separately with the emission factors provided. Often this factor is zero, but this is not always the case.[16] RECs and PPAs will be discussed further in Section 7.4.

Implementing these best practices will improve DSPA's ability to compare its emissions inventory against previous reporting years. Previous years should be recalculated using improved methodology to the greatest extent possible, but the ability to do so may be

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[13] EPA. December 2023. *Greenhouse Gas Inventory Guidance: Direct Emissions from Stationary Combustion Sources*. https://www.epa.gov/sites/default/files/2020-12/documents/stationaryemissions.pdf

[14] EPA. December 2023. *Greenhouse Gas Inventory Guidance: Direct Emissions from Mobile Combustion Source*. https://www.epa.gov/sites/default/files/2020-12/documents/mobileemissions.pdf

[15] EPA. 2024. "GHG Emission Factors Hub." https://www.epa.gov/climateleadership/ghg-emission-factors-hub

[16] EPA. December 2023. *Greenhouse Gas Inventory Guidance: Indirect Emissions from Purchased Electricity*. https://www.epa.gov/sites/default/files/2020-12/documents/electricityemissions.pdf

limited by the availability of historic data. In this case, it is important for DSPA to be transparent when communicating any changes in its inventory to stakeholders.

6.2 Energy Conservation Measures

An energy analysis was conducted of DSPA facilities by Minnesota Power and Frontier Energy to identify energy conservation measures (ECMs) and other opportunities (e.g., electrification and renewable energy deployment) to increase energy efficiency and reduce GHG emissions. The analysis identified the following ECMs: installation of LED lighting, air handler fan variable speed drives, and interruptible heat pump for the administration building. Combined, these ECMs are projected to result in 74.3 tons of CO_2 annually, of which replacement of HPS lighting with LED lighting throughout warehouses and break rooms comprises 61.8 tons.

6.3 Zero Emissions Technology Deployment

As noted in the Technology Evaluation (Section 3), there are an increasing number of battery-electric CHE and vehicles that are commercially available that can be used to replace the majority of DSPA's ICE fleet. Hydrogen fuel cell equipment are increasingly being developed for port operations but currently have a limited offering of commercially available CHE. In addition, there is currently a limited supply of green hydrogen – hydrogen produced through the electrolysis of water with 100% renewable energy. Therefore, the remainder of this strategy focuses on electrification of DSPA operations.

6.3.1 Electrification

Electrification of port operations will involve the deployment of battery-electric CHE and vehicles, installation of charging infrastructure, installation of shore power to serve OGVs at berth, and improvements to on-terminal electrical infrastructure and potentially the utility distribution system.

6.3.1.1 DSPA Cargo Handling Equipment and Vehicles

Conversion of DSPA's ICE fleet to battery-electric CHE and vehicles will reduce GHG emissions from 421.2 to 314.2 metric tons of CO_2 when powered by Minnesota Power's standard electricity power supply 2022 with an EPA emissions factor, resulting in a net reduction of 107 metric tons of CO_2 annually.[17] Electrification when combined with the procurement of renewable electricity has the potential to reduce GHG emissions by 421 metric tons of CO2 based on 2022 emissions. Based on the Technology Review (Section 3) as well as the Future Energy Assessment (Section 4), battery-electric CHE are commercially available today to replace the majority of DSPA's fleet of CHE and vehicles even under the unique operating environment of the Duluth winters.

Replacement of DSPA's ICE fleet can be staggered over time based on the remaining useful lifespans of existing equipment and vehicles or it can be implemented broadly if sufficient funding can be obtained through state and federal grants. A phased approach has the added advantage of allowing cold-weather and operational testing of available equipment. One of the biggest challenges to electrifying port operations is overcoming the higher capital costs of the CHE as well as the supporting electrical infrastructure. Grant programs, such as the

[17] Assumes EPA emissions conversion factor of 0.00046 metric tons of CO_2 per kWh applied to Minnesota Power's electric power supply.

EPA's Clean Port Program, provide a compelling opportunity to implement wide scale decarbonization of port operations in the next five years. While battery-electric equipment does have drawbacks relative to traditional fossil fuel models in terms of fueling/charging times and operational range, its advantages of reducing air and noise pollution are significant as are the potential operational and maintenance savings. Minnesota Power provides DSPA with a relatively clean and affordable source of grid electricity, further bolstering the operational economics of a battery-electric fleet relative to operating with fossil fuels.

6.3.1.2 Shore Power

Deployment of shore power at Clure Public Marine Terminal has the potential to further reduce emissions from OGVs at berth. Shore power is a proven technology that is used globally to reduce both criteria air pollutant and GHG emissions. By plugging vessels into shore power, the vessels do not need to run their diesel-powered auxiliary engines. Prior to deployment of shore power it is recommended that an assessment be performed of vessels calling on the terminal to determine if the vessels are shore power ready. While many bulk vessels are not shore power ready today, it is anticipated that a greater proportion of the fleet will be as we progress towards 2050.

6.3.2 Charging Infrastructure

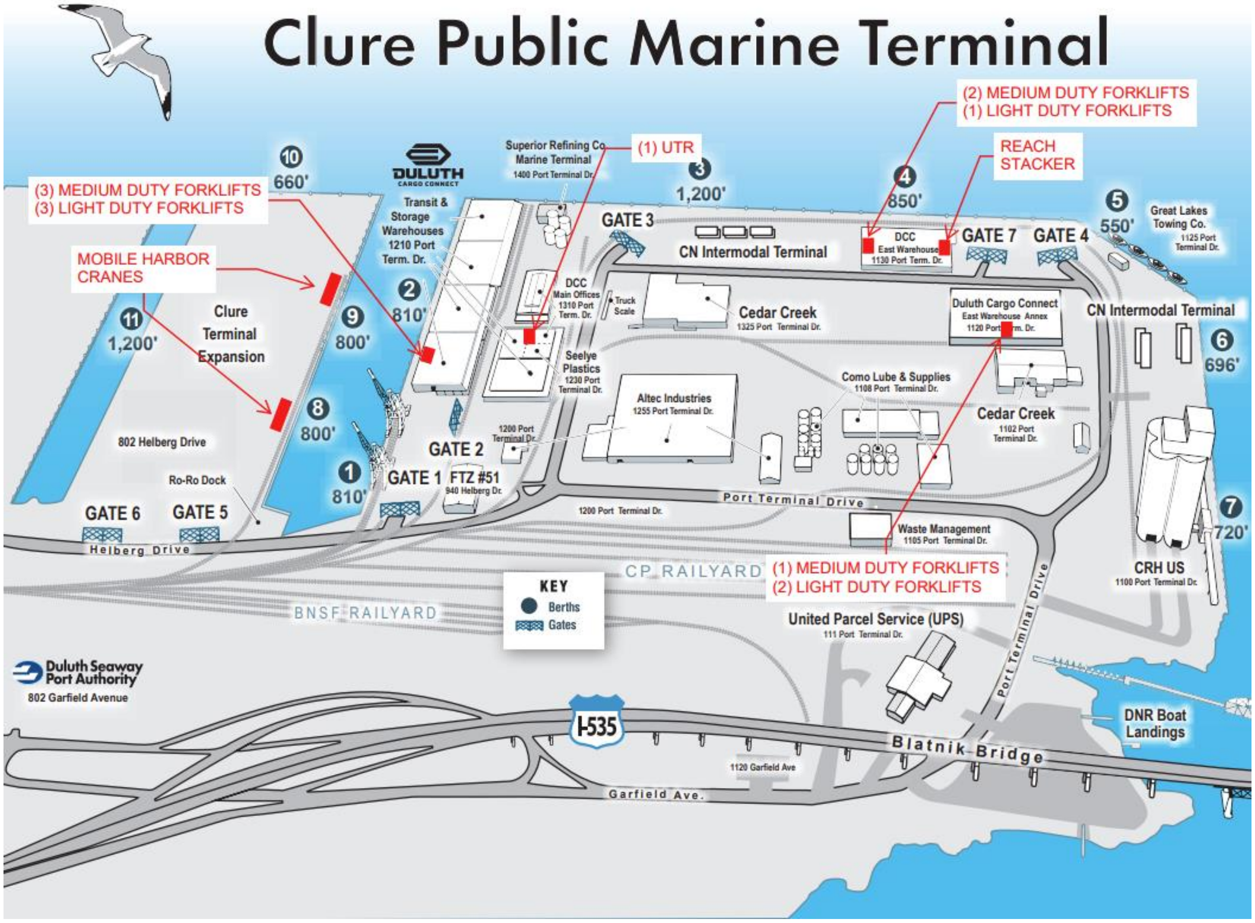
Charging infrastructure requirements for existing DSPA CHE and vehicles was identified in the Future Operational Modeling Process (Section 4.1). The modeling factored in charging requirements based on current operations under winter environmental conditions. Table 4 summarizes the type and number of chargers required for each type of CHE / vehicle. In general, most CHE do not require an individual charger per vehicle as the ratio of vehicle units to chargers is 1.7:1.

Table 4: Required Chargers for Full Electrification

Vehicle / Equipment	Units	Chargers	Charger Description
UTR	1	1	120-kW DCFC
Reach Stacker	2	1	120-kW DCFC
Trucks	4	2	15-kW DCFC
Misc. Light Duty	17	7	15-kW DCFC
Heavy Duty Forklift	2	1	120-kW DCFC
Medium Duty Forklift	15	11	36-kW DCFC
Light Duty Forklift	23	13	16-kW DCFC
Mobile Harbor Crane	2	2	43-kW DCFC
Total	66	38	

Chargers can be located throughout Clure Public Marine Terminal in proximity to the nearest electrical service connection that make operational sense to minimize disturbances to the terminal and deployment costs. Figure 13 shows preferred locations for forklifts identified by DSPA staff.

Figure 13: Preferred Charging Locations of Forklifts at Clure Public Marine Terminal



6.3.3 Electrical Upgrades

Electrification of the DSPA fleet is projected to increase peak energy demand by 3.1 MW. Overall peak energy demand is projected to increase from 673 kW to 3.8 MW, inclusive of ECMs and electrification combined. Deployment of charging infrastructure will require on-terminal upgrades of electrical equipment, including transformers, switchgear, and new conduits.

It is recommended that DSPA engage Minnesota Power to confirm available network capacity for the interconnection of the new CHE charging and crane electrical loads. Should distribution grid upgrades be required, deployment of battery energy storage systems could be evaluated relative to utility upgrade costs.

6.4 Renewable Energy

Decarbonization of DSPA operations is dependent on the procurement of renewable energy resources. Renewable energy can be generated and stored on site using solar and/or wind or it can be procured directly by Minnesota Power. While this assessment found significant solar generation potential across the terminal's rooftop areas, such systems are not likely to provide a cleaner *and* cheaper source of electricity than what is already available from Minnesota Power. In light of this, DSPA can participate in Minnesota Power's renewable energy program.

The state of Minnesota is committed to providing customers with 100 percent carbon-free electricity by 2040. Under Minnesota Power's EnergyForward strategy, all customers now receive 50 percent of their electricity from renewable sources such as wind, solar, and hydro. Minnesota Power's Renewable Source program allows customers, including commercial and business, to pay a small markup to add more renewable energy to the power grid equal to a percentage of their monthly energy use, up to 100 percent. Renewable Source is supplied with energy from the Ashtabula Wind Energy Center in North Dakota. Today, Renewable Source is 100 percent wind, but it could include other forms of renewable energy—solar, biogas, hydro, or biomass—in the future.[18] By participating in this program, DSPA would be supporting Minnesota Power's plans to continue the growth of renewable energy and its progress towards the Minnesota state goal of being carbon free by 2040.

A REC is a market-based instrument representing proof that 1 MWh of electricity was generated from a renewable energy source. When a REC is purchased, it is retired to ensure that the environmental benefits associated with renewable energy generation are not double counted. Once retired, the REC cannot be sold or used again. As a Renewable Source participant, the RECs are retired on a customer's behalf and are not counted toward Minnesota Power's compliance with the state's renewable energy standard. By retaining rights to the RECs, customers can reliably know that their power is sourced from renewable energy.

In the event that Minnesota Power's Renewable Source program is unable to meet DSPA's electricity demand, DSPA could consider entering into an independent offsite PPA with a project developer. A PPA is a contract for the purchase of power and associated RECs from a specific renewable energy generator (the seller) to a purchaser of renewable electricity (the buyer). Physical PPAs deliver energy physically to a company through the grid, and virtual PPAs are financially settled transactions. GHG Protocol and EPA quality criteria for contractual instruments used in the market-based method for scope 2 accounting are described in the EPA's *Greenhouse Gas Inventory Guidance* on indirect emissions from purchased electricity.

6.5 Offsetting

Given the winter climate of Duluth, natural gas is projected to be the most efficient energy source for building heating for the foreseeable future. While there is the potential in the future for the procurement of renewable natural gas, it is more likely that the 165 metric tons of CO_2 annual emissions will need to be offset to achieve DSPA's 2050 net zero emissions goal.

While reducing absolute emissions is DSPA's priority, carbon offsetting serves as a powerful tool in reaching net zero operating emissions by 2050. Carbon offset credits represent a reduction in GHG emissions that can be traded to compensate for emissions occurring elsewhere. Offsets are produced via diverse mitigation projects governed by registry methodologies or protocols. There is no compliance market in Minnesota, so DSPA's approach would be to purchase credits sold on the voluntary carbon market. Regardless of

[18] Minnesota Power. 2024. "Renewable Source." https://www.mnpower.com/ProgramsRebates/RenewableSource

project type, high-quality credits must fulfill the P.A.V.E.R. requirements: permanence, additionality, verifiability, enforceability, and real.

Permanent: The reduction must last in perpetuity, and the emission reductions cannot be reversed.

Additional: The reduction would not have occurred during a business-as-usual scenario.

Verifiable: The reductions must be independently monitored and confirmed.

Enforceable: The reduction must be counted only once by a single organization and then retired.

Real: The reduction must be legitimate and not a product of flawed accounting.

To help guide the evaluation of carbon credits, the Integrity Council for the Voluntary Carbon Market has developed the Core Carbon Principles to provide a credible means of identifying high-integrity carbon credits based on the latest science and best practice.[19] Carbon credits issued by reputable carbon offset programs, such as Verra, the Climate Action Reserve, or the American Carbon Registry, are reviewed by accredited third-party verification and validation bodies. That said, project description documents should be thoroughly vetted before purchasing credits, and additional interviews or site visits may be warranted.

6.6 Stakeholder Engagement

The successful execution of this plan requires collaboration across multiple stakeholder groups, including DSPA employees, local residents, government officials, and community groups. DSPA's Community Impacts Plan, last updated in 2021, was created to minimize negative impacts attributable to DSPA's activities on the surrounding community. The plan's process provides insight into existing community engagement efforts. DSPA staff are members of and take leadership positions in numerous professional, recreational, community, regional, and national committees that support two-way open communication. DSPA staff meet regularly with elected officials, and the community is actively and continuously informed of DSPA activities through periodic press releases, interviews, written position statements such as op-eds, public meetings, and through its successful quarterly magazine.

DSPA can take advantage of these existing channels of communication to make progress towards the objectives suggested under Community Engagement. Given that there are already multiple active climate action collaboration groups in Duluth, it may be most efficient and respectful of community stakeholders' time to work within the existing framework rather than initiating a separate task force effort. It is also recommended that DSPA maintain a list of partner organizations that play important roles in the community. Successes can be shared through the quarterly magazine or aforementioned sustainability report (Section 7.1.1).

[19] The Integrity Council for the Voluntary Carbon Market. 2022. "The Core Carbon Principles." https://icvcm.org/the-core-carbon-principles/

6.7 Summary of Projected GHG Emissions Reductions

Implementation of the combined electrification and renewable energy procurement strategies can reduce GHG emissions from 1,097 to 165 metric tons of CO_2 annually (Figure 14). When ECMs and offsetting for natural gas emissions are considered, DSPA can achieve its net zero emissions goal. Emissions reduction strategies will be phased in over time as funding is available to support capital purchases, equipment and vehicles require replacement, and renewables are increasingly phased into the energy portfolio (Table 5).

Figure 14: Projected GHG Emissions Reductions from DSPA Operations

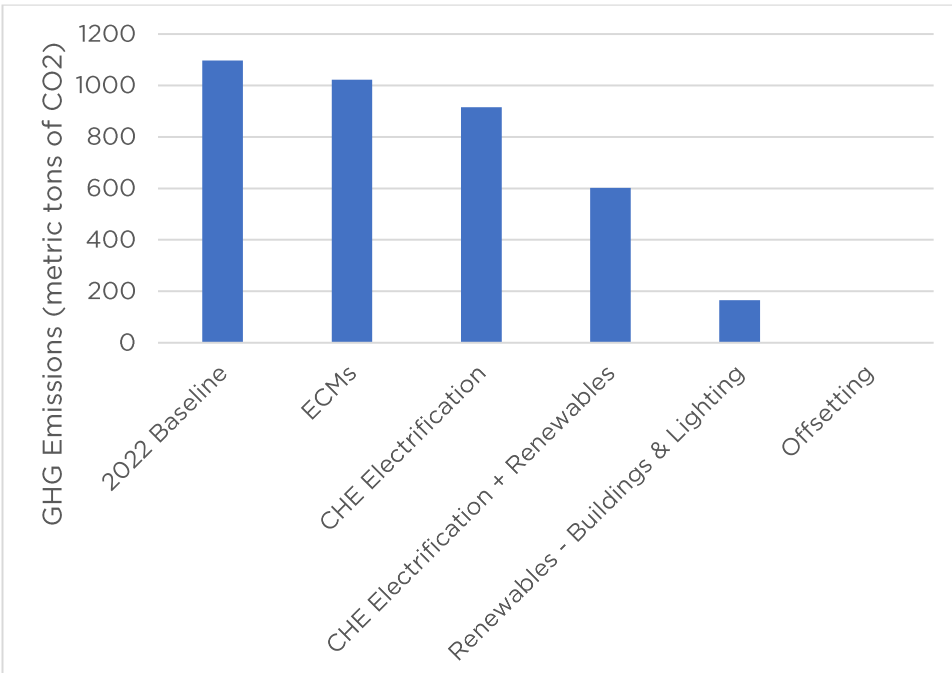


Table 5: Phased Implementation of Emission Reduction Strategies

Strategy	Timeframe	Notes
Tracking and Reporting	2024-2050	Ongoing process of planning, assessment, review, and improvement
Stakeholder Engagement	2024-2050	Ongoing process of engaging and educating stakeholders within the Port, surrounding community, and beyond
Electrification	2025-2045	Phased implementation as funding is obtained, assets require replacement, and operational and commercial viability of technologies mature
Renewable Electricity	2024-2040	Accomplished through Minnesota Power's conversion to a carbon-free portfolio
Offsetting	2045-2050	Final investment following completion of other emissions reduction strategies

7.0 Funding

One of the biggest challenges to decarbonization is the upfront capital costs to procure ZE CHE / vehicles, charging infrastructure, renewables, and electrical upgrades both at the port and with the utility's transmission and distribution system (if needed). State and federal funding provide opportunities to offset these investments.

The Infrastructure Investment and Jobs Act (IIJA) and Inflation Reduction Act (IRA) provide historic funding to enhance U.S. infrastructure, including supporting the development of renewable energy resources, EV charging infrastructure, and hydrogen fueling infrastructure. The $1.2 trillion IIJA provides funding for the nation's core infrastructure, including roads, bridges, rail, transit, seaports, airports, electric grid, water systems, broadband, and ZE charging and fueling infrastructure, among other items. Port authorities are eligible to pursue over $30 billion in funding to improve infrastructure with many programs specifically supporting decarbonization and resiliency improvements. Examples of programs that are targeted at ZE infrastructure deployment include: $2.5 billion for Charging and Fueling Infrastructure Competitive Grants, $5 billion National Electric Vehicle Formula Program, $6.4 billion Carbon Reduction Formula Program, $7.5 billion RAISE/BUILD programs, and $10 billion National Infrastructure Project Assistance Program. Section 60102 of IRA allocates $2.25 billion in rebates and grants to purchase or install ZE port equipment, to conduct permitting in support of the installation of ZE port equipment, and to develop climate action plans. The IRA also expands the eligibility of the solar and energy storage Investment Tax Credit to ports.

The EPA Clean Ports Program – which opened February 28, 2024 and requires applications be submitted by May 28, 2024 – is a $3 billion, one-time funding opportunity for ZE equipment, infrastructure, and planning activities at ports. Pursuit of this opportunity will require quick action from DSPA to develop a competitive application. Optional, non-binding letters of intent are due March 28, 2024. A 10% local match is required for implementation projects between $10 and 150 million and no local match is required for planning projects.

Table 6 summarizes an initial assessment of the eligibility of CAP components for various federal funding programs. An analysis to match project elements to additional funding programs and assess application competitiveness and readiness is recommended.

Table 6: Component Eligibility for Upcoming Federal Funding Opportunities

Eligible Component	EPA Clean Ports	EPA Climate Pollution Reduction Program	EPA Diesel Emissions Reduction Act	DOE Energy Efficiency and Conservation Block Grant	DOT Port Infrastructure Development Program	DOT Reduction in Truck Emissions at Port Facilities
Zero Emission Roadmap	•				•	
Electric Mobile Harbor Cranes	•	•			•	
Electric Forklifts	•	•			•	
Electric Reach Stacker	•				•	
Electric Yard Tractor	•	•			•	•
LED Lighting				•		
Electric Heat Pumps				•		
Solar Array / Wind Turbine	•					
Shore Power	•		•		•	

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