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Port Everglades Department – Broward County
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moffatt & nichol

PORT EVERGLADES SHORE POWER AND ELECTRIFICATION MASTER PLAN FOR CRUISE SHIP TERMINALS

Feasibility Study for Shore Power Infrastructure Development for Port Everglades Cruise Terminals 2, 4, 18, 19, 21, 25, 26, and 29

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LIST OF ACRONYMS

%	Percent
2018 PEMP	2018 Port Everglades Master/Vision Plan
AQMD	Air Quality Management District
Capex	Capital Expenditure
CARB	California Air Resources Board
CLIA	Cruise Lines International Association
CMS	Cable Management System
COVID	COVID-19 Pandemic
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2eq	Carbon Dioxide Equivalent
CRP	Federal Carbon Reduction Program
CT	Cruise Terminal
DERA	Diesel Emissions Reduction Act
DCP	Design Criteria Package
ECA	Emission Control Area
FHWA	Federal Highway Administration
FDOT	Florida Department of Transportation
FPL	Florida Power & Light
GHG	Greenhouse Gas
FSFO	High Sulfur Fuel Oils
Hz	Hertz
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IMO	International Maritime Organization
IRA	Inflation Reduction Act
K	Thousand
kV	Kilovolt
Kwh	Kilowatt-hour
LNG	Liquefied Natural Gas
M	Million
M&N	Moffatt & Nichol
MARAD	United States Maritime Administration
MCFC	Molten Carbonate Fuel Cells
MDLC	Major Distribution Load Connection
MDO	Marine Diesel Oil
MGO	Marine Gas Oil

MV	Megavolt
MVA	Mega volt amp
MW	Megawatt
Mwh	Megawatt-Hour
NOx	Nitrogen Oxides
NPV	Net Present Value
O&M	Operations and Maintenance
OGV	Ocean Going Vessel
OPC	Opinion of Probable Cost
Opex	Operating Expenses
OPS	Onshore Power Supply
OSV	Offshore Service Vessel
PAHs	Polycyclic Aromatic Hydrocarbons
Pax	Passenger Capacity
PBB	Passenger Boarding Bridge
PIDP	Port Infrastructure Development Program
$PM_{2.5}$	Particulate Matter (2.5µm or smaller in diameter)
R&D	Research and Development
ROG	Reactive Organic Gas
SDG	Sustainable Development Goal
SO_X	Sulfur Oxides
SO_2	Sulfur Dioxide
SPTP	Shore Power Technology for Ports Program
STSPS	Shore-to-Ship-Power-System
ug/m^3	Micrograms per cubic metre
ULSD	Ultra-Low Sulfur Diesel
US	United States
USD	US Dollar
USEPA	United States Environmental Protection Agency
VLSFO	Very Low Sulfur Fuel Oils
V	Volt
WHO	World Health Organization

EXECUTIVE SUMMARY

Shore power infrastructure enables ships to turn off their engines while at berth and connect to local electric power. These systems are a proven way to reduce in-port and near-port emissions of air pollution. Port Everglades, a self-supporting Enterprise Fund of Florida's Broward County, and project partners Florida Power & Light (FPL) seek to supply shore power to Port Everglades' eight cruise terminals—2, 4, 18, 19, 21, 25, 26, and 29. For FPL, this involves advancing necessary improvements to bring required power supply to locations close to each cruise terminal. In turn, Port Everglades needs to distribute power to each terminal and alongside the cruise vessel berth.

This report addresses Port Everglades' portion of the shore power infrastructure system. Prepared by Moffatt & Nichol (M&N), the report identifies cruise vessel power requirements and connection points, shore power equipment typologies, and potential emissions reductions. The report then provides recommendations on the location and arrangement of shore power infrastructure and provides estimates of project costs for each improvement location. Approaches for funding and implementation are offered in the last section of the report. The work is intended as a decision-making tool for use by Port Everglades, Broward County, and FPL to advance investment in shore power and to guide follow-on planning and design of systems.

Resulting from a top-to bottom assessment of current and forecasted vessel operations, technology applications, potential installation sites, and stakeholder interviews, four scalable groupings of shore power investments are recommended (refer to exhibits offered in Appendix A). Group 1 would provide shore power to CT2 and CT4; Group 2 supports CT18 and CT19; Group 3, CT21, CT25 and CT26; and a single installation at CT29 (Group 4). FPL transformer vault rooms would be placed proximate to each grouping of equipment. Placement and arrangement of proposed shore power elements supplying CT19, CT26, and CT29 are intended to allow for flexibility in the implementation of planned cruise terminal, parking, and berth upgrades in these locations. Pre-packaged containerized/modularized solutions for shore power load transformer and switchgear are considered optimal. This approach allows equipment to be placed in tight spaces and within clearance constraints, especially when stacked. All shore power systems must be built to international IEC/IEEE 80005-1, -2 standards plus local code requirements including NEC, NBC, and OSHA as well as Florida State and FPL regulations.

Investment in shore power will occur in stages. Phase 1 would extend shore power improvements to CT2, 4, 18, 25, and 26 by Q1 of 2026. These terminals have the highest vessel throughput and are less impacted by investment projects identified in the Port's current master plan. Extension of shore power to Phase 1 terminals also provides access to each of the Port's primary cruise tenants—Princess Cruises, Holland America Line, Royal Caribbean International, Celebrity Cruises, and newcomer Disney Cruise Line. Improvements under Phase 2 would expand the system to cover CT19, 21, and 29. All Port Everglades shore power system investments would parallel improvements to supply and distribution by FPL. The estimated cost of the Port Everglades' developed and managed portion of the shore power system is $124.75 million, or approximately $15.6 million per terminal. The Port Everglades share of FPL supply and distribution upgrade costs will add to these totals.

Funding the capital expense associated with shore power systems typically involves a blend of local port authority self-finance and public grants. Shore power system users typically pay for power consumed and operational costs associated with connecting, disconnecting, and maintaining the system. Some amount of capital expense recovery may also be extended to system users. Port Everglades is encouraged to actively pursue available public grants to help reduce capital costs, such as the Diesel Emissions Reduction Act (DERA), Federal Carbon Reduction Program Funds (CRP), the 2022 Reconciliation Bill EPA Port Electrification Grants (IRA Grants), Federal PIDP Grants, Florida Seaport Transportation and Economic Development Program (FSTED), among others.

Investment in shore power is forecast to result in meaningful reductions in emissions stemming from cruise vessel hoteling operations—the period when the ship is docked at berth. At full implementation of the shore power and electrification effort (FY2030/31), the avoided port and near-port annual emissions of 11,366 metric tons of Carbon Dioxide (CO_2) over the no action scenario—a nearly 25% decrease. This level is equivalent to removing emissions generated from 2,470 cars per annum.

Avoided port and near-port annual Nitrogen Oxides (NOx) and Sulfur Dioxide (SO_2) emissions would also see significant declines. Shore power implementation is forecast to reduce NOx emissions by 75% per annum by FY2030/31; SO_2 emissions, 51%. In addition to forecast emissions reductions, implementation of shore power systems at the Port would contribute to the advancement of Broward County and cruise line sustainability goals intended to reduce respective carbon footprints and greenhouse gas emissions.

1. PROJECT OVERVIEW

1.1 SHORE POWER INITIATIVE AND ELECTRIFICATION MASTER PLAN

Port Everglades, a self-supporting Enterprise Fund of Florida's Broward County, is the world's third busiest cruise port and one of the largest container ports in Florida. Port Everglades is also a strategic petroleum receiving seaport for the 12 counties that make up South Florida. An estimated 206,000 direct and indirect jobs and $30.5 million in economic impact are derived from Port operations (Martin & Associates, 2022; Florida Ports Council, 2022).

The Port is a base of operations for multiple cruise lines, including Princess Cruises, Holland America Line, Royal Caribbean International, Celebrity Cruises, Viking Ocean Cruises, and Silversea. Disney Cruise Line will commence sailing from Port Everglades in 2023. Prior to the COVID-19 Pandemic, over 3.8 million revenue passengers were accommodated at Port Everglades' cruise terminals. A similar number of guests are expected to sail to/from Port Everglades in 2022-23 (Port Everglades, 2021).

Cruise companies and Broward County are pursuing a more sustainable, low-carbon future. For cruise lines, this includes a 40% target rate of reduction in carbon emissions by 2030 vs. 2008 levels (Cruise Lines International Association, 2021). Broward County and its Climate Change Task Force seek to achieve an 80% reduction in greenhouse gas (GHG) emissions by 2050 (Broward County Climate Change Task Force , 2020).

In alignment with Broward County climate change goals, Port Everglades is advancing initiatives to reduce GHG emissions, including installation of shore power infrastructure. Emissions from Ocean Going Vessels (OGVs) running on-board power plants while docked are contributors to air pollution. Shore power infrastructure enables ships to turn off their engines and connect to the local electric power grid.

Port Everglades and project partners Florida Power & Light (FPL) are studying the most feasible approach to supplying shore power to Port Everglades' eight cruise terminals—2, 4, 18, 19, 21, 25, 26, and 29. For FPL, this involves review of necessary improvements to bring required power supply to locations close to each cruise terminal. In turn, Port Everglades needs to distribute power to each terminal and alongside the cruise vessel berth.

This report addresses Port Everglades' side of the shore power infrastructure system. Prepared by Moffatt & Nichol (M&N), the report identifies cruise vessel power requirements, cruise ship connection points, shore power equipment typologies, and potential emissions reductions if implemented. The work then provides recommendations on the location and arrangement of shore power infrastructure and provides estimates of project costs for each improvement location. Approaches for funding and implementation are offered in the last section of the report.

The report is intended as a decision-making tool for use by Port Everglades, Broward County, and FPL to advance investment in shore power and to guide follow-on planning and design of systems.

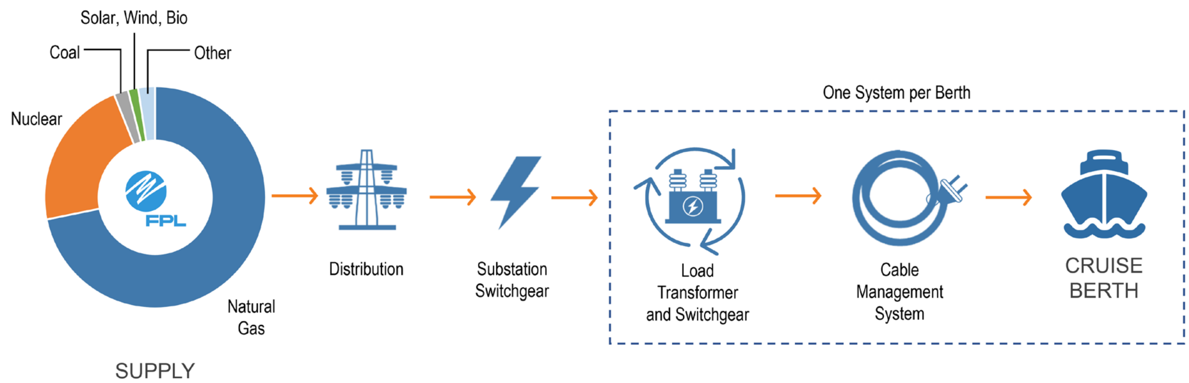
1.2 SHORE POWER DEFINED

Cruise ships run on-board power plants while docked at a berth. These hoteling operations can be significant contributors to air pollution. Exposure to air pollution associated with emissions from OGVs and other fossil-fueled power plants at ports (including particulate matter, nitrogen oxides, ozone, and air toxics) can contribute to significant health problems (USEPA, 2017).

Shore power infrastructure—also known as cold-ironing or alternative marine power—enables ships to turn off their engines while at berth and connect to local electric power. As shown in Figure 1-1, port shore power infrastructure consists of four main elements: (1.) Incoming electrical power supply to substation transformers and switchgear; (2.) On-site power distribution and control (load transformer and switchgear); (3.) transmission lines and equipment that comprise the Cable Management System (CMS), providing the essential linkage from the substation to the OGV; and (4.) OGV power supply connection point(s).

Shore power typically produces zero onsite emissions. The total emission footprint is also reduced depending on the amount of renewable electricity source inputs to the grid. FPL, the electrical utility provider in Broward County, has a varied profile of energy sources, inclusive of fossil fuels and renewable energy.

Figure 1-1. Primary Components of Shore Power with FPL as Energy Provider



Source: FPL and M&N, 2022.

1.3 SHORE POWER ASSESSMENT FOR PORT EVERGLADES SUBJECT CRUISE TERMINALS

Port Everglades, FPL, and cruise line stakeholders established a general set of guidelines for shore power assessment and planning at Cruise Terminals 2, 4, 18, 19, 21, 25, 26, and 29, herein referred to as “Subject Cruise Terminals”.[1] These guidelines are summarized below and explored in greater detail throughout the report.

- Shore power infrastructure to be delivered over two phases, with emphasis placed on powering CT2, CT4, CT18, CT25, and CT26 within two- to three-years;
- Ensure shore power equipment and related infrastructure meet high-capacity Onshore Power Supply (OPS) installation requirements established under IEC/ISO/IEEE 80005-1:2019 (International Electrotechnical Commission and Institute of Electrical and Electronics Engineers, 2019);
- Establish on-site power distribution and controls at 6,600 V or 11,000 V, 3 phase, and 60 Hz;
- Limit to the greatest extent possible the footprint of shore power equipment and related infrastructure;
- Ensure shore power investments meet the needs of cruise vessels scheduled and anticipated to homeport from Port Everglades;
- Allow for adaptability of shore power investment to evolve into a broader strategy for bringing shore power equipment and infrastructure to multiple cruise and cargo berths; and,
- Integrate equipment and infrastructure in such a way as to be visually appealing and communicate Port Everglade’s continued commitment to environmental stewardship.

Using these guidelines as a foundation, M&N advanced the shore power assessment and planning for Subject Cruise Terminals over four project stages:

- Stage 1. Technology assessment and GHG emissions inventory. Results of this stage of work are presented in Sections 2 and 3.

[1] *Specific terminals are designated by “CT” followed by the corresponding number throughout the report.*

- Stage 2. Port Everglades Subject Cruise Terminals site assessment and alternatives preparation. Work prepared under this stage is summarized in Section 4.
- Stage 3. Revised concepts for Port Everglades Subject Cruise Terminals, GHG reductions analysis, and order of magnitude cost estimate. Results of this stage are presented in Section 5.
- Stage 4. Assessment of project funding and implementation steps. Results of this stage are presented in Section 6. Final recommendations and next steps are provided in Section 7.

1.4 PORT EVERGLADES SUBJECT CRUISE TERMINAL LOCATIONS

Subject Cruise Terminals included in the study are depicted in Figure 1-2. This includes CT2 and CT4 in Northport—an area undergoing extensive investment associated with Broward County Convention Center and Hotel expansion and the redevelopment of CT4 to host Disney Cruise operations in 2023. In the Midport area, Subject Cruise Terminals include CT18, CT19, CT21, CT25, CT26, and CT29. CT18 is Port Everglade's largest cruise terminal (by total square footage) and hosts operations by Royal Caribbean's *Oasis*-class vessels.

The project area also includes service extending from a new FPL substation located south of the FPL Port Everglades Next Generation Clean Energy Center. Service to cruise terminal supporting shore power systems would extend from the new FPL substation east along Eller Drive into Midport. Service would also branch north along Eisenhower Boulevard to support shore power investments at CT2 and CT4. Additionally, service would branch south along Eisenhower Boulevard to support shore power investment at CT29.

1.5 STAKEHOLDER OUTREACH AND DATA COLLECTION

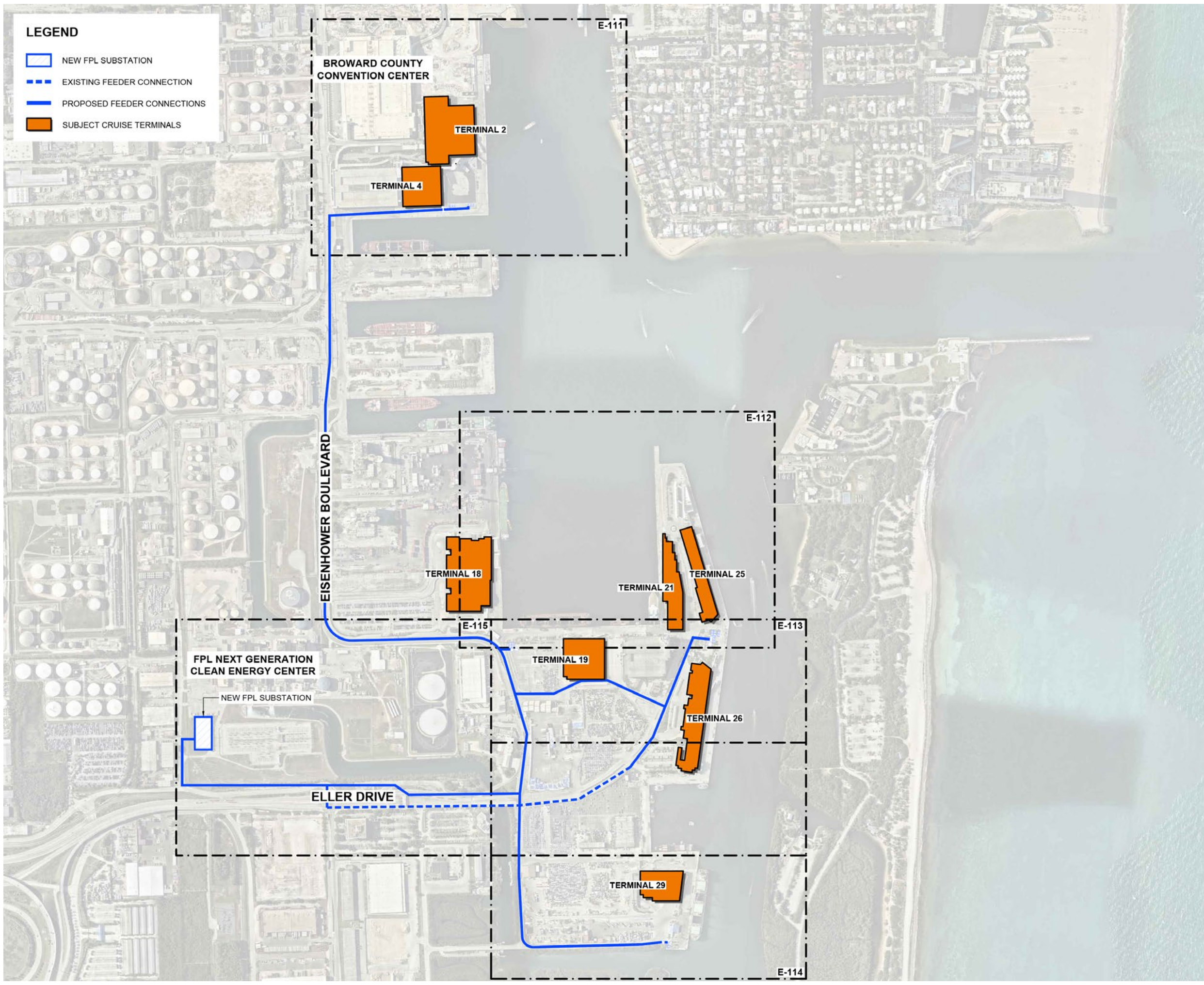
Stakeholder outreach began in July 2022 and continued throughout the assessment of Port Everglades for shore power. Outreach included monthly meetings with Port Everglades planning staff and FPL as well as meetings with Holland America Group, Disney Cruise Lines, Royal Caribbean Group, and other project stakeholders.

This assessment builds on information and data collected during past studies by Port Everglades, Broward County, the USEPA, FPL, and other sources. A listing of these sources is offered below:

- 2018 Port Everglades Master/Vision Plan (2018 PEMP) Update (Bermello Ajamil & Partners, 2020);
- 2021-2022 Port Everglades Facilities Guide and Directory (Port Everglades, 2021) and Port Everglades Cruise Guide 2022 (June 2022);[2]
- Port Everglades Utilities Maps and Electrical Distribution Plan (various);
- Cruise Ship Details for Shore Power (various) and Summary of Shore Power Loads and Vessel Shore Power Upgrade (FPL May 2021);
- 2020 Broward County Climate Change Action Plan (Broward County Climate Change Task Force , 2020);
- US EPA's Shore Power Technology Assessment at U.S. Ports (USEPA, 2017);
- IEC/ISO/IEEE 80005-1:2019 (International Electrotechnical Commission and Institute of Electrical and Electronics Engineers, 2019); and,
- Others referenced through the report and contained in the References Section (see Section 8).

[2] *Note these are continually updated, especially for FY2022/23 as cruise lines return to service.*

Figure 1-2. Location of Port Everglades Subject Cruise Terminals



Source: Port Everglades and M&N, 2022.

1.6 VESSEL OPERATIONS AT PORT EVERGLADES SUBJECT CRUISE TERMINALS

Homeporting cruise vessel operations constitute the main operations at each of the Subject Cruise Terminals and their respective berths. Ships typically arrive in the early morning and depart in late afternoon, spending a total of between 8 and 11 hours at berth. As of July 2022, 40 different vessels are planned to conduct cruise operations from Port Everglades during FY2022/23 (see Table 1-1). Most cruise operations run between October to April, with ships then repositioning to summer cruising regions (e.g., Alaska, Northern Europe, the Mediterranean Sea). A handful of vessels operate year-round from their respective terminals.

Of the vessels shown in Table 1-1, approximately 50% are currently configured to accommodate shore power. Several additional ships have shore power upfit under review or scheduled for installation. Royal Caribbean's *Vision of the Seas* will not be upgraded to accommodate shore power given the ship's age and remaining service life.

Nearly all vessels are set up for 11,000 V, 3 phase, and 60 Hz. Maximum shore power consumption levels range from a low of 6.0 MW to a high of 13.5 MW for Royal Caribbean's *Allure of the Seas*.

Cruise vessels operating from Port Everglades typically burn low sulfur Marine Gas Oil (MGO) or Marine Diesel Oil (MDO). Vessels equipped with scrubbers—devices which remove pollutants from emissions—can burn High Sulfur Fuel Oils (HSFO) which typically has a sulfur content of 2% to 3%. Over the next few years, Port Everglades will welcome an increasing number of cruise vessels operating on LNG.[3]

[3] *LNG has a low carbon to hydrogen ratio, and therefore, produces fewer moles of CO_2 per mole of natural gas (Corbin, et al., 2019). LNG does not produce SO_X or particulate matter and can produce 85% lower NO_X and up to 20% lower GHG emissions than typical diesel engines (Monios, 2018; Carnival Corporation & PLC, 2020). There are no visual emissions associated with the use of LNG.*

Table 1-1. Cruise Vessels Operating from Port Everglades, FY2022/23

Name	Class	Brand	Lower Berths	PE Terminal	Shore Pwr. Connection	Voltage (KV)	Frequency (Hz)	Max. Pwr. (MW)
Allure of the Seas	Oasis	RCCL	5,400	18	Under Review*	11	60	13.5
Apex	Edge	Celebrity	2,908	25	Yes	11	60	8
Beyond	Edge	Celebrity	2,908	25	Yes	11	60	8
Caribbean Princess	Caribbean	Princess	3,100	2, 19, 21	Yes	6.6	60	11
Costa Deliziosa	Vista/Spirit	Costa	2,260	19	-	-	-	-
Disney Dream	Dream	Disney	2,500	4 (2024)	Planned	11	60	10.5
Edge	Edge	Celebrity	2,908	25	Under Review*	11	60	8
Emerald Princess	Caribbean	Princess	3,100	2	Yes	11	60	11
Enchanted Princess	Royal	Princess	3,600	2	Yes	11	60	10
Equinox	Solstice	Celebrity	2,850	18, 25, 29	Under Review*	11	60	11
Eurodam	Signature	Holland	2,104	19, 21, 26	Yes	11	60	7
Evrima	Megayacht	Unknown		19, 25	-	-	-	-
Harmony of the Seas	Oasis	RCCL	5,400	18	Under Review*	11	60	11
Island Princess	Coral	Princess	1,950	2	Yes	11	60	9
Jaume II	High-Speed Cat.	Unknown		19, 21, 29	-	-	-	-
Liberty of the Seas	Freedom	RCCL	3,600	18, 19, 25	Under Review*	11	60	11
Marbella Discovery	Vision	Marbella	1,800	19	-	-	-	-
Millennium	Millennium	Celebrity	2,038	18, 25, 29	Yes	11	60	8
MS Queen Elizabeth	Vista	Cunard	2,547	2	-	-	-	-
Nieuw Amsterdam	Signature	Holland	2,100	19, 21, 26	Yes	11	60	7
Nieuw Statendam	Pinnacle	Holland	2,650	26	Yes	11	60	6
Odyssey of the Seas	Quantum	RCCL	4,100	18	Yes	11	60	10
Oosterdam	Vista	Holland	1,916	19, 26	Yes	11	60	7
Reflection	Solstice	Celebrity	2,994	29	Under Review*	11	60	11
Regal Princess	Royal	Princess	3,600	2	Yes	11	60	10
Rotterdam	Pinnacle	Holland	2,650	19, 26	Yes	11	60	6
Ruby Princess	Caribbean	Princess	3,070	21	Yes	11	60	10
Silver Cloud	N/A	Silversea	296	19	-	-	-	-
Silver Dawn	N/A	Silversea	596	25, 26	-	6.6	-	-
Silver Moon	N/A	Silversea	596	19, 26	-	6.6	-	-
Silver Shadow	N/A	Silversea	396	19	-	-	-	-
Sky Princess	Royal	Princess	3,600	2, 21	Yes	11	60	10
Viking Neptune	Viking Ocean	Viking	930	19	-	-	-	-
Viking Octantis	Polar 6	Viking	378	19	-	-	-	-
Viking Polaris	Polar 6	Viking	378	19	-	-	-	-
Viking Star	Viking Star	Viking	930	19	-	-	-	-
Vision of the Seas	Vision	RCCL	2,000	18, 19, 25, 29	No	11	30	N/A
Volendam	R – Class	Holland	1,432	4, 19, 21	Planned	6.6	60	6
Voyager of the Seas	Voyager	RCCL	3,100	18	Yes	11	60	9
Zaandam	R – Class	Holland	1,432	19, 21, 26	Yes	6.6	60	6
Zuiderdam	Vista	Holland	1,916	26	Yes	11	60	7

*Source: Port Everglades Master Cruise Schedule, FY22-23 (July 2022), Various Cruise Lines, and M&N, 2022. *Under Review refers to the cruise line continuing to study the need and cost to upgrade the vessel for a shore power connection.*

2. SHORE POWER TECHNOLOGY ASSESSMENT

Abatement of GHG emissions from OGVs and within ports is evolving in North America and Europe. Since 2000, more than 10 high capacity (>6.6 kV) OPS systems have been installed in the U.S. (USEPA, 2017). In Europe, the EU has set itself a binding target of achieving climate neutrality by 2050 and, as an intermediate step towards climate neutrality, committed to cutting emissions by at least 55% by 2030 (aka Fit for 55). As part of these target, shore power will be mandatory in all EU ports by 2030-2035 (Council of the European Union , 2022)[4]

The following section presents current North American shore power installations and reviews and assesses shore power technologies suitable for Port Everglades Subject Cruise Terminals.

2.1 EXISTING NORTH AMERICA SHORE POWER INSTALLATIONS

In the U.S., container ships, conventional refrigerated ships, and cruise ships are required to use shore power when docked at six ports in California (Los Angeles, Long Beach, Oakland, San Diego, San Francisco, and Hueneme) and when docked at select facilities in Juneau, Alaska[5]. Cruise facilities in Seattle and New York (Brooklyn Cruise Terminal) also have shore power systems in place. Table 2-1 presents a summary of shore power facilities in North America.

As shown, the primary wave of shore power investment occurred between 2009 and 2015 for cruise ports in the U.S. and Canada. Many of these investments are the result of regulation (California) and grant availability associated with the USEPA (Diesel Emissions Reduction Act) or Canadian Government. A second wave of shore power investment is taking root as communities, ports, and operators work to reduce their carbon footprints in general and emissions specifically.

On February 17, 2021, Miami-Dade County, FPL, and the Port's six major cruise line customers signed a joint statement to work together on the "most effective way to bring shore power to…PortMiami" (Joint Statement Regarding Shore Power at PortMiami, 2021). In March, Carnival Corporation and Miami-Dade County agreed to launch Phase 1 program at PortMiami's Cruise Terminal F (Muniz-Amador, 2021). This program was later expanded to include four additional cruise terminals—CTA, CTB, MSC Terminal, and Virgin Terminal. PortMiami is targeting October 2023 for completion of shore power infrastructure at each of these cruise terminals. Initial power available from FPL will limit the number of terminals that can be operated at one time.

Other North American ports advancing the study and implementation of shore power systems include:

- The Port of San Diego is doubling shore power capability at its B Street and Broadway Pier terminals (Cruise Industry News , 2021). Following completion in September 2022, two vessels will be able to connect simultaneously.
- The Port of Seattle is developing shore power to Pier 66—its downtown waterfront cruise terminal—by 2023. The total project cost of Seattle's project is $17 million.
- The Greater Victoria Harbour Authority is advancing the design of shore power at Victoria's Ogden Point cruise facilities. Completion of this project is planned for 2025/26.

As shown in Table 2-1, more recent shore power landside investment has ranged between $8 and $10 million per shore power connection location, with most of those providing over 12 MW of maximum capacity. Data on emissions savings due to shore power investment is limited, with five ports reporting emissions reductions (tons of CO_2) of between 1,500 (Brooklyn) and 2,900 (Seattle) annually. Emission savings vary due to multiple factors, including time at port, number of vessels outfitted with shore power connections, and port requirements/incentives to use shore power. As port and cruise line acceptance rises, overall average emissions savings are expected to increase.

[4] The EU Fit for 55 Program has 5 legislative initiatives impacting maritime issues, including a "Zero emission requirement at berth." About 7% of European ports have shoreside capability. Exemptions are in place for small ports, those receiving less than 500 calls.

[5] While shore power at commercial ports is a relatively recent innovation, this technology has been used by the US Navy for decades with expansions picking up pace in recent years as demand for greater emissions reduction to combat climate change increases. Consistent with recent Presidential Executive Orders and state-level programs like California's Low Carbon Fuel Standard (LCFS) market, the Navy has been seeking out ways to further electrify their fleets while onshore. The latest example is a first-of-its-kind agreement signed between the Navy and the Port of San Diego to jointly electrify both the Port and Naval Base.

Table 2-1. Synopsis of Existing Shore Power Port Installations for Cruise Activities – North America

Location / Facility	Year Installed	Power Source	Maximum Capacity (MW)	Frequency (Hz)	Landside Cost	Docking Time (avg hrs.)	Usage Costs (Source +Year)	Emission Reduction (tons CO_2)	Type*
Juneau / Franklin Dock	2001	Alaska Electric Light and Power (grid all hydroelectric)	11.0	60	$USD 5.5M (inc. ship upfit costs)	9	$4000-5000/day (2004)	-	Cochran Marine Shore Power System / x1 Berth
Halifax / Piers 20, 21, and 22	2014	Nova Scotia Power	-	60	$CAD 10M	9	-	-	Cochran Marine Shore Power System / x3 Berths
Port of Long Beach / Long Beach Cruise Terminal Facility	2011	Southern California Edison	16	60	-	9	Varies	-	Cavotec and Cochran Marine Shore Power System / Dual Voltage / x1 Berths
Port of Los Angeles / World Cruise Center	2004	Southern California Edison	40	60	-	9	$150 service charge + $1.33/kW facilities charge + $0.05910/kWh energy charge (2017)	-	Cavotec / Single Voltage / x2 Berths
Montreal / Alexandra Pier	2016/2017	Hydro Quebec (grid primarily hydroelectric)	-	60	$CAD 11-12M	10	-	2,800 Annually (1,500 wintering, 1,300 cruise)	Schneider Electric Canada / x4 Berths
New York / Brooklyn Cruise Terminal	2015	Con Edison	20	60	$USD 10 M	9	$0.12/kWh ($0.26/kWh to deliver) (2017)	1,500 Annually	Cochran Marine Shore Power System / Dual Voltage / x1 Berths
San Diego / B Street and Broadway Pier cruise ship terminals	2012	San Diego Gas & Electric	16	60	$USD 7 to 8M	9	-	-	Cochran Marine Shore Power System / Dual Voltage / x2 Berths
San Francisco / Pier 27	2010	SFPUC (grid primarily hydroelectric)	12	60	$USD 5.2 M	10	-	2,553 Annually (2014)	Cochran Marine Shore Power System / Dual Voltage / x1 Berths
Seattle / Terminal 91 (relocated from Pier 30)	2009 (T91)	Puget Sound Energy	12.8	60	$USD 7 to 8M (T91)	9	P: $0.068/kWh OP: $0.045/kWh (2017)	2,900 Annually (2019)	Cochran Marine Shore Power System / Dual Voltage / x2 Berths
Vancouver / Canada Place	2009	BC Hydro (grid primarily hydroelectric)	16	60	$CAD 12.4M**	10	$CAD 80.22 /Mwh ($5K assuming 60 Mwh usage) (2020)	20,000 since 2009 (+/- 2,000 Annually)	Cochran Marine Shore Power System / Dual Voltage / x2 Berths

*Notes *Cochran Marine is now Watts Marine Shore Power Solutions. **A 3% annual inflation rate has been assumed incorporated into this value.*
Sources: USEPA (USEPA, 2017)*; Various Websites and Media Releases 2021.*

Nearly all North American equipment installations have been advanced by Cochran Marine based in Seattle (now Watts Marine Shore Power Solutions). Watts Marine uses a proprietary grouping of step-down transformers and switchgear coupled with either fixed or mobile jib CMS systems. This and other shore power systems are discussed in greater depth in the next section.

2.2 SHORE POWER TYPES AND ARRANGEMENT

In this section, we present proven and emerging shore power types and arrangement to identify workable approaches for Port Everglades.

2.2.1 OPERATIONAL CONSIDERATIONS

As discussed in Section 1.2, shore power infrastructure generally consists of four main groupings of elements:

1. Incoming electrical power from the energy company and substation switchgear;
2. On-site power distribution and control, inclusive of a large power transformer with incoming primary switchgear, outgoing secondary switchgear, dual secondary voltage output taps, and protection and control features;
3. Transmission lines (typically duct banks and connector pits) and equipment that comprise the CMS, providing the essential linkage from the shore power load transformer and switchgear to the OGV; and,
4. The OGV power supply connection point.

The utility power supply point and interface are essential for operations and must be developed in strict accordance with local utility standards and requirements. As shown in Table 1-1, *Allure of the Seas has* the highest maximum demand at 13.5MW. The established peak load of 13.5 MW presents a large stepped load increase to FPL at the time of connection and a large stepped load decrease at the time of disconnection.[6] In addition, the transfer of power from ship-side generation to shore-side supply is normally completed by means of 'closed transfer.' Closed transfer occurs when there is a temporary paralleling of ship power generators to the shore-side power grid. Closed transfer results in no loss of power at any time aboard the ship and can be described as a 'bumpless transfer.'[7]

On-site power distribution and controls are required to transform the utility supply voltage, frequency to the voltage, and frequency of shore power needed by ships. This is 6,600 V or 11,000 V, 3 phase, and 60 Hz for ships sailing regularly into North American ports. Larger cruise ships generally need 11,000 V and the smaller ships 6,600 V. Power supply frequency is usually 60 Hz on board the ships unless they were designed for European ports where the grid frequency is more commonly 50 Hz. These operating voltages and frequencies are mandated under compliance with IEC/ISO/IEEE 80005-1:2019 (International Electrotechnical Commission and Institute of Electrical and Electronics Engineers, 2019).

Cruise ships have a very narrow operations voltage tolerance which can vary slightly from ship to ship. Power transformers with automatic onload tap changer systems are typically used to adjust the precise operating voltage for each ship based on a predetermined need and the operating conditions of the supply utility. The utility offers their power within a certain window of normal voltage and frequency conditions that allow for normal service variations from within the power grid. The on-site shore power system needs to adjust and compensate for grid conditions (where possible) to maintain a steady operating condition for the cruise ships while connected to shore power.

The heart of the on-site power distribution and controls system is a large power transformer, nominally 20 MVA size for cruise ships, and switchgear at the primary and secondary sides. The number of connection points the transformer needs to service governs the amount of secondary switchgear that must be provided. In accordance with international standards, a single shore power transformer can only service one ship at a time (International Electrotechnical Commission and Institute of Electrical and

[6] By standard, shore power equipment and related infrastructure meet high-capacity Onshore Power Supply (OPS) installation requirements established under IEC/ISO/IEEE 80005-1:2019 require system design at 16MW (International Electrotechnical Commission and Institute of Electrical and Electronics Engineers, 2019).

[7] Utility providers are sensitive and protective of this paralleling activity as it presents risk to their grid and customers. This risk concern by the utility is particularly high when large loads are involved, such as with cruise ship shore power loads and when the paralleling time is significant. This issue has been resolved in many other jurisdictions around North America. Technologies and methods to do this safely and reliably are well established and proven.

Electronics Engineers, 2019). There may be several possible connection points that could be used for that one load connection; however, each needs a supply circuit breaker that can be isolated from the others for electrical safety.

A key operational consideration includes the speed at which shore power can be connected and disconnected. As homeporting cruise ships at Port Everglades have visit times of between nine and eleven hours, it is important vessels can quickly connect and disconnect from the system and do so in a safe and reliable manner. These times can increase (or decrease) for several reasons including, but not limited to, weather or other contingencies. Connect and disconnect times are generally 45 minutes, or a total allowance time of 90 minutes per homeport turn.[8] Different types of CMS have advantages and disadvantages when it comes to speed of connections, amount of required infrastructure, and the electrical and civil works needed to install them. Additionally, there are the complexity of their operations and maintenance considerations (see Section 2.1.4).

Overall system operability and maintainability are also key considerations of the overall shore power systems. Reliable long-term operations are needed and major components within the contemplated shore power systems need to be easily operated and maintained. System suppliers will need to fully commission the shore power system at service commencement and also train local resources for long term operations and maintenance activities. The specialized nature of shore power systems and need for personnel trained in the hazards of high voltage electrical equipment operation and maintenance frequently results in ports outsourcing system management to a third party. This is discussed in greater detail in Section 5.5.

Shore power infrastructure constructability is also a key design criteria consideration. The electrical equipment used in a typical large shore power system installation is highly specialized and requires direct involvement by manufacturers' technicians. Systems with a high degree of modularity (having major components assembled and tested off-site) can be easier to implement on site and provide a less disruptive installation and commissioning cycle. These types of pre-configured systems can also lead to reduced site work needs and parallel construction activity schedules. Highly modular methods allow for more site work to be completed, controlled, and tested in more controlled indoor facilities and transfers their associated costs from site construction costs to equipment package supply costs. There will always be a certain degree of site installation work needed, but this can be minimized in cost and schedule by use of modularized methodologies.

2.2.2 MAINSTAY SHORE POWER SYSTEM TYPOLOGIES

Approach 1 – Traditional Shore Power System

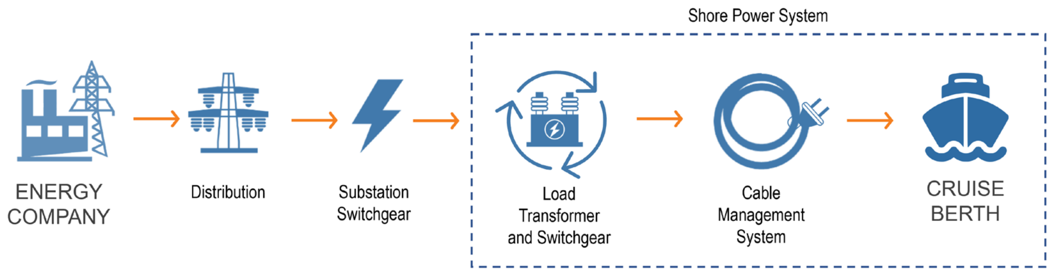
Traditional shore power infrastructure consists of the components illustrated in Figure 2-1. Key components of the shore power equipment are the primary power transformers—including automatic on-load primary tap changers—primary and secondary switchgear, the management and reporting system, and other components. This configuration is the most observed in North American installations. While all shore power systems are costly and require a high degree of maintenance, the traditional shore power system tends to be the least cost approach in terms of Capital Expenditure (Capex).

Without power factor correction (discussed in the next section), traditional shore power systems are relatively slow to adjust to variations seen on the utility primary side. Transformers are usually oil-filled, and the oil presents a flammability and environmental leakage concern. Less flammable and bio-degradable oils can be specified, which can mitigate this risk to some extent. Non-oil filled cast coil dry transformers can also be used but they still require an oil-filled automatic on-load tap changer with at least a lower volume of oil to be considered.

The switchgear on the primary side depends mostly on the utility requirements, which will be similar to any comparably sized shore power system operating at the same primary voltage class. The switchgear of the secondary side depends mostly on the number of connection points needed at the cruise berth.

[8] *Connecting and disconnecting service at North American ports is typically a third party contracted service. See Section 5.5 for more details.*

Figure 2-1. Traditional Shore Power System

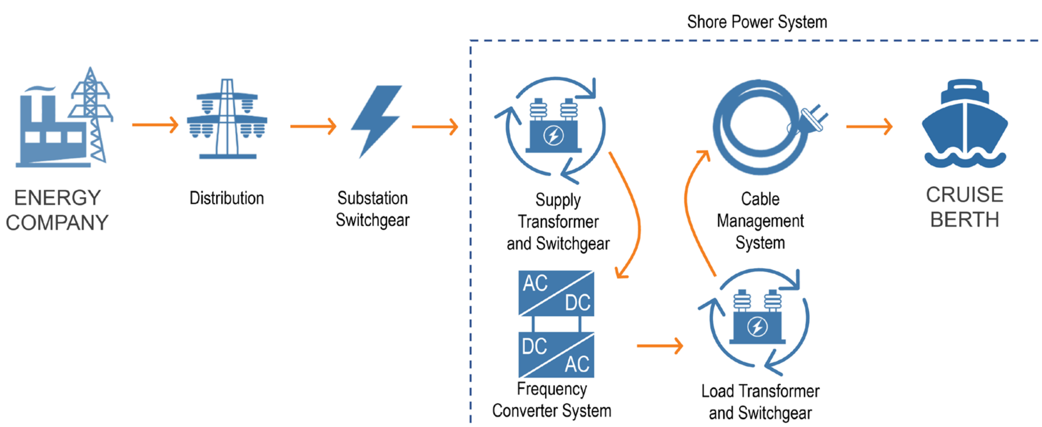


Source: M&N, 2022.

Approach 2 – Traditional Shore Power System with Power Factor Correction

The traditional system can include power factor correction via frequency conversion for more precise/stable ship voltage control (see Figure 2-2). Frequency conversion can convert shore power to shipboard use and transfer the ship's main power distribution to the shore power without interrupting power to various shipboard electrical components. As both onshore power and ship systems are set at 60 Hz frequency, frequency converter systems are not normally needed in North America. The precision and stability associated with frequency conversion offers strong appeal to cruise ships and to utilities.

Figure 2-2. Traditional Shore Power System with Power Factor Conversion



Source: M&N, 2022.

Technological advancements in recent years have led to cost effective and highly reliable solid-state frequency converter systems that offer many operational benefits well beyond simply changing the frequency. These include:

- Elimination of the need for automatic on-load tap changers;
- Higher degree of electrical isolation and faster protection response for ships load;
- More precise control of operating voltage for ships;
- Single dry type transformers and drive systems can supply all output voltage needs for ships;
- Greater stability of operating voltage to ships during utility supply side voltage variations;
- Greater isolation from ship side load characteristics to utility side power supply; transient loads on board ship side are not seen by utility at primary side; and,

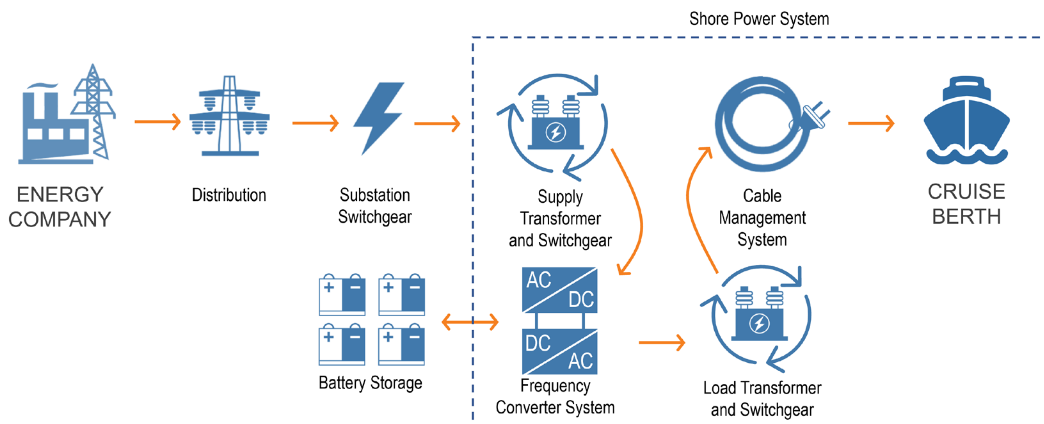
- System ability to self-load test at times of commissioning and re-commissioning eliminating need for use of large load banks.

The benefits of power factor correction via frequency conversion do come at increased cost, often amounting to an additional 10% to 20% of the Capex for transformer and switchgear equipment.

Approach 3 – Traditional Shore Power System with Modular Grid Storage

Traditional shore power supply and those with added power factor conversion can be modified to include storable grid systems. Storable grid system batteries are charged by supply transformers and switchgear when shore power is not in use and supply battery power when shore power is needed. This typology helps to offset and stabilize peak power demanded from a utility. While this is a great advantage, these types of systems add cost to the overall shore power system and require additional space allocation for battery systems.

Figure 2-3. Conventional Shore Power with Modular Grid Energy Storage



Source: M&N, 2022.

Grid energy systems are expensive. They still require a conventional shore power system and a layer of technology between the utility switchgear and shore power transformation system. However, the benefits are worth consideration. Battery supported shore power alternatives are likely the most complex electrical alternatives and supplement a conventional system with added internal energy supply features.[9] These systems can also have higher Operations and Maintenance (O&M) costs.

2.2.3 SHORE POWER COMPONENT ARRANGEMENT

Shore power systems can be dock-mounted, containerized, or barge-mounted (USEPA, 2017). Watts Marine systems installed in North America are generally the dock-mounted type (Figure 2-4), and thus, most commonly observed.

Containerized (or contained) shore power systems are increasingly observed in shore power applications (Figure 2-5). These systems are typically modular, allowing for systems to be shipped as preassembled units and stacked/arranged to reduce space needed for installation. Cavotec (https://www.cavotec.com/en), Powercon (http://www.powercon.dk/), Wärtsilä SAMCon

[9] Port Hueneme in California embarked on a grid energy system pilot project in 2016. Tesla installed 5 battery packs to supplement the shore power system. There is 2 MWH of installed battery capacity. Batteries occupy approximately 600-square feet of space. The system is running and working but it is totally automatic in the sense that a proprietary Tesla algorithm determines when to charge off the grid and when to deliver the power to the shore power system.

(https://www.wartsila.com/), Schneider Electric (https://www.se.com/us/en/, and other manufacturers continue to advance containerized shore power innovations.[10]

Barge-mounted systems require little or no dockside space. These systems are self-contained power plants that provide power for at-berth vessels. Barge-mounted systems typically use alternative fuels or technologies such as liquefied natural gas (LNG) and fuel cells. The types of systems are the least commonly observed.

Figure 2-4. Dock Mounted Shore Power

Source: Watts Marine (https://www.watts-marine.com/shore-power-solution), 2022

Figure 2-5. Containerized/Contained Shore Power Example

Source: Powercon (https://powercon.dk/shore-power/), 2022

[10] *As some manufactures are based in Europe, products contemplated for North America applications must meet local code requirements including NEC, NBC and OSHA plus state and power utility regulations.*

2.2.4 SHORE POWER CABLE MANAGEMENT SYSTEMS

Shore power CMS come in many configurations. Transmission lines from substation transformers and switchgear are routed through utility trenchworks to vault locations and/or secondary trenches along the dock. Vaults and/or secondary trenches are then linked to a CMS apparatus used on the shore side. This apparatus can range from a fixed pedestal mounted jib crane to a mobile CMS vehicle with hydraulically operated telescoping boom.

Each type of CMS has trade-offs. A fixed jib crane has limited range to reach shell door locations but is generally the least costly (see Figure 2-6). A repositionable jib crane can be moved via forklift to multiple locations, but this movement takes greater time than fully mobile units. Repositionable jib cranes are generally more expensive than fixed models but less than fully mobile units.

Mobile CMS units have maximum flexibility in movement at positioning at one or several berths (see Figure 2-7). These CMS systems generally allow for spooling of cables as part of the apparatus and have a range of up to 150 feet from the vault location. They generally also have the highest equipment cost.

Management of cables extending from vaults creates challenges and safety issues along vessel aprons, especially when ship connection points are variable. At many ports, secondary trenches running the length of the wharf are expensive to retrofit within existing structures. Products such as the Igus (https://www.igus.com/info/industries-shore-power-supply) motorized e-chain reel that spools a special energy chain enclosure can help to protect and manage cable so as to not allow it to lie exposed on the apron (see Figure 2-8).

Figure 2-6. Fixed and Repositionable Jib Crane Examples

Source: Watts Marine (https://www.watts-marine.com/services), 2022

Figure 2-7. Mobile CMS Examples

Source: Cavotec (https://www.cavotec.com/en/your-applications/ports-maritime/shore-power/shore-power-systems-for-ports), 2022

Figure 2-8. Cable Reel and Chain Enclosure Examples

Source: Igus (https://www.igus.com/info/industries-offshore-echain-reel), 2022

2.2.5 USE WITH NON-CRUISE OCEAN GOING VESSELS

Shore power systems provided for cruise ships can be used for other OGVs, including cargo vessels, ferries, and large yachts. The establishment of a system with distribution and controls able to support 6,600 V or 11,000 V, 3 phase, and 60 Hz allows for the potential to accommodate other OGVs. A switchboard with separate feeder would need to be incorporated into system design. The system would need to be carefully interlocked to make sure it can only connect to one vessel at a time and only operate at 6,600 V at a given time if the same system is capable of delivering either 6,600 V or 11,000 V.

Vessel connectivity and cable management would need to be explored at each berth to accommodate cruise ships as well as a wider variety of different cargo vessels, ferries, and large yachts. There would likely need to be separate dedicated outlets and/or cable management this is for the exclusive use of these vessels. Operation of several vessels in parallel—for example, two large yachts at a single berth—would necessitate each ship having its own on-shore supply transformer to maintain galvanic isolation.

2.3 EVALUATION OF SHORE POWER TYPES AND ARRANGEMENT

Established evaluation criteria for shore power types and arrangement included project goals outlined in Section 1.3 as well as categories of constructability, related Capex and Opex of the system, longevity, CMS type applicability, and community perception. Reviews under each criteria element are based on engagement with project stakeholders, vendors, and M&N experience on similar projects and are summarized in Table 2-2.

In review of the three approaches, a traditional shore power system with a modular energy storage (Approach 3) is not recommended due to its high cost to implement. FPL has also committed to providing necessary power supply for each of the subject terminals.[11]

A traditional shore power system (Approach 1) and the option for power factor correction (Approach 2) are both are suitable applications at Port Everglades. Both approaches meet high-capacity OPS installation and distribution control requirements. Approach 1 and 2 each have equipment vendors that can provide containerized / contained (inclusive of stacking) options to reduce the overall equipment footprint. Both approaches also can use the range of CMS options available.

The primary determining factor rests with the degree of desire by FPL and cruise lines users for more precise/stable ship voltage control and other features under Approach 2 justify a 10% to 20% increase in transformer and switchgear equipment cost. The general consensus resulting from discussions with project stakeholders was more precise/stable ship voltage control is desirable but not a critical factor at Port Everglades warranting increased project cost.

2.4 LISTING OF SHORE POWER INFRASTRUCTURE AND EQUIPMENT VENDORS

Based on M&N experience as part of the research on available shore power technologies, multiple vendors were identified, and many contacted, for additional information. The following is a list of many of the vendors currently in the market:

- Cavotec (https://www.cavotec.com/en)
- Powercon (http://www.powercon.dk/)
- Wärtsilä SAMCon (https://www.wartsila.com/)
- Schneider Electric (https://www.se.com/us/en/)
- ABB (https://new.abb.com/marine)
- Siemens (https://new.siemens.com/global/en/company/stories/industry/environmental-awareness-at-the-port.html)
- Cochran Marine (https://www.cochranmarine.com/)
- Patton & Cooke (https://pattonandcooke.com/)
- Igus (https://www.igus.com/info/industries-shore-power-supply)
- Stemmann-Technik (http://stemmann.com/)
- Shore-Link (https://shore-link.eu/)

[11] *Modular energy storage may be a suitable add-on associated with onsite energy generation and/or other elements of a microgrid development at Port Everglades. Microgrids are reviewed in Appendix C.*

Table 2-2. Evaluation of Shore Power Types Against Port Everglades Criteria and Other Factors

Planning Standard	Approach 1 Traditional Shore Power System	Approach 2 Traditional Shore Power System w/ Power Factor Correction	Approach 3 – Traditional Shore Power System w/ Modular Grid Energy Storage
1. Availability *(Goal – Shore power infrastructure to be operational by 2024/25)*	High. Most installed in North America. Anticipate 9-to-12-month delivery.	Medium. Available in Europe; may require North America certification. Anticipate 9 to 12+ month delivery. Installation may be faster.	Medium. Traditional shore power elements available but reliant on battery availability. Anticipate 9-to-15-month delivery.
2. Applicable Standards #1 *(Goal – Ensure shore power equipment and infrastructure meet high-capacity OPS installation requirements under IEC/ISO/IEEE 80005-1:2019)*	Yes	Yes	Yes
3. Applicable Standards #2 *(Goal – Establish on-site power distribution and controls at 6,600 V or 11,000 V, 3 phase, and 60Hz)*	Yes	Yes	Yes
4. Project Footprint *(Goal – Limit to the greatest extent possible the footprint of shore power equipment and related infrastructure)*	Depends. Most traditional installations use dock mounted approach, occupying more space. Some manufactures have standardized/ stacking containment.	Depends. Many manufacturers providing power factor correction features have standardized/ stacking containment.	Similar to Approaches 1 and 2. Will require additional area needed for battery storage.
5. User Acceptability *(Goal – Ensure shore power investments meet the needs of vessels scheduled and anticipated to homeport from Subject Terminals)*	Meets vessel requirements and used in other visited ports.	Meets vessel requirements and used in other visited ports.	Meets vessel requirements.
6. Aesthetics *(Goal – Integrate equipment and infrastructure in such a way as to be visually appealing.)*	Depends. Approaches with greater standardized/ stacking containment adds opportunity for branding and messaging. Small footprint will limit visual impact.	Depends. Approaches with greater standardized/ stacking containment adds opportunity for branding and messaging. Small footprint will limit visual impact.	Depends. Approaches with greater standardized/ stacking containment adds opportunity for branding and messaging. Small footprint will limit visual impact.
7. Constructability	High. Well understood, risks known.	High. Typically contained system delivered for fast installation. Relatively understood constructability.	Medium. Relatively understood constructability but more ductwork and equipment placing.
8. Relative Capex of System	Low	Medium. +/- 10% to 20% increment in cost for adding power factor correction over traditional shore power supply.	High
9. Relative Opex of System	Low	Low	Medium. More long-term flexibility as it can minimize risk of peak power availability; adds resiliency.
10. System Longevity	High. Anticipate 20+ years.	Medium: Relatively new technology but increasing in acceptance. Anticipate 15 to 25 years.	Relatively new technology so longevity not well known.
11. CMS Applicability	Adaptable to most CMS systems.	Adaptable to most CMS systems.	Adaptable to most CMS systems.

Source: M&N, 2022.

3. CRUISE HOTELING AND FORECAST SAVINGS

3.1 BENEFITS OF SHORE POWER IN REDUCING GHG EMISSIONS

The IMO estimates total shipping emitted 1,056 million tons of CO_2 in 2018, accounting for about 2.89% of the total global anthropogenic (human activity related) CO_2 emissions for that year (International Maritime Organization, 2021). As shipping continues to expand, IMO business-as-usual scenarios suggest emissions could represent 90-130% of 2008 emissions by 2050. Approaches to reducing GHG associated with shipping will require capital and operational improvements to ship energy efficiency and the communities from which they operate.

Shore power systems are a proven way to reduce in-port and near-port emissions of air pollution, benefiting air quality for communities located near or adjacent to the port, many of which are non-attainment areas for criteria air pollutants (USEPA, 2017). Improved air quality can improve human health and reduce environmental damages, resulting in economic benefits from reduced medical costs and environmental remediation expenses. As documented by several North American locations that have advanced shore power investments for cruise ships, estimated annual GHG reductions are meaningful (see Table 2-1), especially in regions where electricity is produced by renewable sources. Cruise lines have also recognized the importance of shore power in their approach to reducing emissions and operating more sustainably (Carnival Corporation & PLC, 2020; Joint Statement Regarding Shore Power at PortMiami, 2021).

In this section, GHG emissions for each of Port Everglades Subject Cruise Terminals are estimated. Forecasts of future operations are based on a target installation date of shore power infrastructure by FY2025/2026 for five terminals and all terminals by FY2030/31. We then project forward potential port and near-port GHG savings associated with the project.

3.2 EMISSION STANDARDS AND REGULATIONS

OGVs must comply with applicable international, national, and local regulations with respect to air pollution. Regulation compliance focuses on reducing diesel PM, NOx, and Reactive Organic Gases (ROG) emissions from diesel vessel engines. The IMO mandates fuel requirements for commercial vessels. A sulfur cap was implemented January 2020 for most commercial vessel fuels (less than 0.5%) (International Maritime Organization, 2021). IMO targets for 2030 and 2050 call for additional reductions in air pollutants and GHGs, particularly CO_2.

The entire east coast of the U.S. and Canada is part of the much more stringent North American Emission Control Area (ECA). While the IMO standard for sulfur is 0.5% as of January 2020, the North American ECA standard is 0.1% since 2015. The ECA also limits NOx emissions by requiring ships constructed on or after January 2011 comply with the ECA Tier II NOx standard and those constructed on or after January 2016 comply with the Tier III NOx standard (USEPA, 2021).

Cruise ships increasingly must comply with more stringent regulations levied by states, provinces, and cities. By example, the California Air Resources Board (CARB) requires operators to reduce at-berth emissions from auxiliary engines by 80% while in California Ports (California Environmental Protection Agency: Air Resources Board, 2021). The adoption of future national and/or state regulation is likely given this overall trend towards emissions-reducing legislation in other parts of the world.

3.3 CRUISE LINE INITIATIVES

The cruise industry is committed to the preservation of the world's oceans and marine life, incorporating sustainable practices into strategic plans, making a positive impact on communities, and managing resources more efficiently for enhanced energy consumption. These and other sustainably minded aims are being implemented onboard vessels, at communities visited, and throughout operational practice. To help address climate change, advance decarbonization of operations, and improve air quality, the industry overall has pledged to reduce its 2008 fleet-wide rate of CO_2 emissions by 40% by 2030 (Cruise Lines International Association, 2021).

Carnival Corporation—parent company of Princess Cruises and Holland America Line—has in place a broad set of sustainability goals intended to reduce its carbon footprint, reduce waste generated, improve water use an efficiency, and address other related sustainability targets associated with the company's operations (Carnival Corporation & PLC, 2020). Carnival Corporation established a 2030 sustainability goal to reduce the intensity of CO_2e (carbon dioxide equivalent) emissions from operations by 40% relative to their 2008 baseline. Carnival is making progress towards this goal, reporting in 2020 a reduction of 24.8% in emissions intensity relative to their 2008 baseline. One key initiative in Carnival's efforts to reduce carbon emissions is investment in liquefied natural gas (LNG) powered vessels. Carnival's *Excellence*-class vessels, its latest and largest ships which will be used across several brands, are all LNG powered. Carnival's LNG powered *Celebration* will operate year-round from PortMiami. Another stated goal aligned with the reduction of emissions is the increase of shore power (cold ironing) capacity and technology. Carnival is actively updating ships with the ability to utilize shore power technology. Carnival is also looking ahead and investing in carbon efficient technologies such as fuel cells, battery systems, and other operational systems.

Royal Caribbean Group, which includes Royal Caribbean International and Celebrity Cruise Lines, has similar progressive sustainability goals in place (Royal Caribbean Group, 2021). Royal Caribbean is advancing its program of 'Destination Net Zero' intended to achieve net zero emissions by 2050. The line has already achieved its 2020 goal of reducing greenhouse gas emissions 35% below 2005 levels. Transitioning cruise vessel new builds to lower-emission fuel alternatives is an important near-term approach being employed by Royal Caribbean to reduce the line's overall carbon footprint. Longer term, Royal seeks to extend partnerships with fuel suppliers, shipyards, academia, governments, and other stakeholders to develop alternative and accessible fuels and technologies. Royal Caribbean is also working to significantly expand the use of shore power systems in their operating ports.

3.4 ESTIMATED GHG EMISSIONS AT PORT EVERGLADES SUBJECT CRUISE TERMINALS

Subject Cruise Terminal throughput data on scheduled calls for FY2023/24 was reviewed by M&N. Additional insights on these figures was gathered from Port Everglades and cruise line interviews. M&N then prepared forecasts of vessel calls out to FY2046/47. The forecast includes periodic replacement and upgrade of cruise vessels as is typically the norm at Port Everglades and other homeports. Scheduled and forecasted cruise vessel volumes are presented in detail in Appendix B.

A total of 916 vessel calls at Subject Cruise Terminals anticipated for FY2023/24 (see Table 3-1).[12] FY2023/24 is considered representative of the Port returning to full operations post COVID-19 as well CT4 completion for Disney. Hoteling hours were estimated using timing of cruise ships in Port derived from FY2023/24. Hours were held constant for the full forecast period.

Table 3-1. Cruise Throughput and Hoteling Hours, FY2023/24

Cruise Terminal	Est. Vessel Moves / Calls	Est. Hoteling Hours	Shore Power System Installed	Est. Shore Power Connected Hours
CT2	87	833	No	N/A
CT4	79	928	No	N/A
CT18	108	1087	No	N/A
CT19	83	848	No	N/A
CT21	14 (366*)	129 (4,353*)	No	N/A
CT25	113	998	No	N/A
CT26	76	704	No	N/A
CT29	4**	54**	No	N/A
TOTALS	**550 (916*)**	**5,581 (9,805*)**		**N/A**

*Sources: (USEPA, 2020) (USEPA, 2020a) (USEPA, 2020b) (Faber, et al., 2020), Port Everglades, and M&N, 2022.*Higher number of calls and hoteling hours results from use of this berth for ferry operations by the Jaume II. **CT29 may undergo renovation FY2023/24 which would result in low usage as shown.*

12 *FY2022/23 data of 42 vessel moves / calls used for CT29. This cruise terminal may be undergoing redevelopment FY2023/24.*

A GHG forecast model was prepared using guidance and formulas from the EPA, IMO, and other sources (USEPA, 2020; USEPA, 2020a; USEPA, 2020b; International Maritime Organization, 2021). The forecast model includes estimated measurements in Metric Tons (1,000kg) of Nitrogen Oxides (NOx), Sulfur Dioxide (SO_2), Particulate Matter ($PM_{2.5}$), Carbon Dioxide (CO_2), and Carbon Dioxide Equivalent (CO_{2eq}). Vessels powered by diesel-electric engines consuming low sulfur Marine Gas Oil (MGO) was used in the model unless vessels were known/forecast to be operating with LNG, such as Princess Cruises' *Sphere*-class and Royal Caribbean's *Icon*-class. Results are presented in Table 3-2.

Table 3-2. Estimated GHG Emissions from Hoteling Cruise Vessels for FY2023/24

	Metric Tons (1,000kg)				
Cruise Terminal	**NO_x**	**SO_2**	**$PM_{2.5}$**	**CO_2**	**CO_{2eq}**
EST. EMISSIONS FY2023/24 – NO SHORE POWER					
CT2	77.288	3.849	1.508	6,319	6,399
CT4	131.562	4.572	1.790	7,506	7,602
CT18	122.384	5.486	2.147	9,004	9,122
CT19	70.489	2.694	1.053	4,420	4,478
CT21	12.133	1.122	0.252	882	893
CT25	75.830	4.980	1.950	8,173	8,280
CT26	83.496	3.265	1.278	5,357	5,426
CT29	4.166	0.151	0.059	248	251
TOTAL EMISSIONS	**577.348**	**26.119**	**10.037**	**41,909**	**42,451**

Sources: (USEPA, 2020) (USEPA, 2020a) (USEPA, 2020b) (Faber, et al., 2020), Port Everglades, and M&N, 2022.

As shown, FY2023/24 estimated CO_2 emissions associated with hoteling cruise ships at Subject Cruise Terminals are 41,909 metric tons, which is the same as the emissions produced by roughly 9,110 cars per annum.[13] Total NOx and SO_2 are forecast at 577.348 and 26.119 metric tons, respectively.

3.5 ESTIMATES OF GHG REDUCTIONS WITH SHORE POWER IMPLEMENTATION

M&N assembled forecasts for GHG emissions with and without shore power systems for two time periods. Estimates for FY2025/26 were prepared representing no shore power and shore power implemented at CT2, CT4, CT18, CT25, and CT26 (Phase 1). A second forecast for FY2030/31 was assembled representing full implementation of shore power at all Subject Cruise Terminals (Phase 2). Both forecasts included total shore power connected hours (shore power capable vessels multiplied by hoteling hours less 1.5 hours per call representing the total time to connect and disconnect shore power). We assume in both forecasts that the percentage of shore power capable cruise vessels increases to over 90% by FY2025/25.[14]

As shown in Table 3-3, 993 total vessel calls with 3,672 shore power connected hours is estimated for FY2025/26. Vessel calls are expected in climb to 996 by FY2030/31. With the addition of CT19, CT21, and CT29 to the shore power lineup, total system connected time is estimated to increase to 5,164 shore power connected hours.

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13 *A typical passenger vehicle emits about 4.6 metric tons of carbon dioxide per year. This assumes the average gasoline vehicle on the road today has a fuel economy of about 22 miles per gallon and drives around 11,500 miles per year.*

14 *The remining 10% of vessels are considered older vessels with no shore power capability or are berthed in a position that is unable to accommodate the location of the vessel's connection point. The Jaume II (or similar ferry vessel) is excluded from analysis.*

Table 3-3. Cruise Throughput and Hoteling Hours, FY2025/26

Cruise Terminal	Est. Vessel Moves / Calls	Est. Hoteling Hours	Shore Power System Installed	Est. Shore Power Connected Hours**
CT2	87	833	Yes	691
CT4	78	917	Yes	800
CT18	105	1,059	Yes	901
CT19	86	875	No	N/A
CT21	14 (366*)	129 (4,353*)	No	N/A
CT25	113	992	Yes	732
CT26	76	704	Yes	548
CT29	82	735	No	N/A
TOTALS	**641 (993*)**	**6,224 (10,468*)**	**-**	**3,672**

*Sources: (USEPA, 2020) (USEPA, 2020a) (USEPA, 2020b) (Faber, et al., 2020), Port Everglades, and M&N, 2022.*Higher number of calls and hoteling hours results from use of this berth for ferry operations by the Jaume II. **Assumes 90% of cruise vessels connect; no ferry connectivity.*

Table 3-4. Cruise Throughput and Hoteling Hours, FY2030/31

Cruise Terminal	Est. Vessel Moves / Calls	Est. Hoteling Hours	Shore Power System Installed	Est. Shore Power Connected Hours**
CT2	87	833	Yes	691
CT4	78	917	Yes	800
CT18	105	1,059	Yes	901
CT19	89	905	Yes	772
CT21	14 (366*)	129 (4,353*)	Yes	108
CT25	113	992	Yes	732
CT26	76	704	Yes	548
CT29	82	735	Yes	612
TOTALS	**644 (996*)**	**6,274 (10,498*)**	**-**	**5,164**

*Sources: (USEPA, 2020) (USEPA, 2020a) (USEPA, 2020b) (Faber, et al., 2020), Port Everglades, and M&N, 2022.*Higher number of calls and hoteling hours results from use of this berth for ferry operations by the Jaume II. **Assumes 90% of cruise vessels connect; no ferry connectivity.*

Using figures from Tables 3-3 and 3-4, estimates of avoided GHG emissions were prepared by M&N. Operational assumptions from Section 3.4 were used along with additional factors as outlined below.

- FPL provides adequate electric supply to power all ships at shore power-equipped berths.
- Implementation of shore power follows identified Phase 1 and Phase 2 timing.
- Vessel calls beyond FY2030/31 remain constant for the full forecast period.
- Vessel parameters follow forecasts assembled and detailed in Appendix B. Cruise ships are expected to make great strides in emissions reduction associated with onboard ship propulsion systems and other technologies (see Section 3-3). These advances will likely narrow the gap between the about of emissions saved vs. the no shore power alternative for FY2030/31 and beyond.
- Cruise ships average 9 hours hoteling at berth. A connect and disconnect period of 1.5 hours remains the norm for each homeport turn.

Presented in Table 3-5 are estimates of FY2025/26 GHG emissions associated with no shore power and shore power system implementation at Phase 1 cruise terminals. As shown, if Port Everglades were to install shore power facilities at CT2, CT4, CT18, CT25, and CT26 (Phase 1), it would save 8,903 metric tons of CO_2 per year over the no shore power forecast. Shore power implementation at the five terminals is equivalent to removing emissions generated from 1,935 cars per annum. Total NOx and SO_2 emissions would decrease by 59.1% and 41.5%, respectively.

An estimate of GHG emissions in FY 2030/31 associated with no shore power and shore power system implementation at all Subject Cruise Terminals is offered in Table 3-6. As shown, if Port Everglades were to install shore power facilities at all cruise terminals (Phase 2), it would save 11,366 metric tons of CO_2 per year over the no shore power forecast. Total NOx and SO_2 emissions would decrease by 75% and 51%, respectively.

Table 3-5. Estimated GHG Emissions Savings from Hoteling Cruise Vessels for FY2025/26

	Metric Tons (1,000kg)				
Cruise Terminal	**NO_x**	**SO_2**	**$PM_{2.5}$**	**CO_2**	**CO_{2eq}**
EST. EMISSIONS FY2025/26 – NO SHORE POWER					
CT2	77.287	3.849	1.508	6,319	6,400
CT4	109.244	3.797	1.486	6,232	6,313
CT18	119.534	5.345	2.092	8,775	8,885
CT19	71.641	2.734	1.069	4,485	4,545
CT21	12.133	1.122	0.252	882	893
CT25	74.990	4.950	1.938	8,126	8,231
CT26	83.496	3.265	1.278	5,357	5,426
CT29	42.265	1.400	0.699	4,708	5,522
TOTAL EMISSIONS	**590.590**	**26.463**	**10.321**	**44,885**	**46,215**
EST. EMISSIONS FY2025/26 – SHORE POWER AT CT2, CT4, CT18, CT25, and CT26 (PHASE 1)					
CT2	17.551	1.745	0.534	4,509	4,540
CT4	23.369	1.946	0.573	5,225	5,260
CT18	24.916	2.375	0.716	6,210	6,248
CT19	71.641	2.734	1.069	4,485	4,545
CT21	12.133	1.122	0.252	882	893
CT25	29.807	2.586	0.842	6,083	6,132
CT26	19.839	1.552	0.485	3,880	3,906
CT29	42.265	1.400	0.699	4,708	5,522
TOTAL EMISSIONS	**241.521**	**15.469**	**5.170**	**35,982**	**37,046**
DIFFERENCE BETWEEN SCENARIOS					
# CHANGE	**-349.069**	**-10.994**	**-5.151**	**-8,903**	**-9,169**
% CHANGE	**-59.1%**	**-41.5%**	**-49.9%**	**-19.8%**	**-19.8%**

Table 3-6. Estimated GHG Emissions Savings from Hoteling Cruise Vessels for FY2030/31

	Metric Tons (1,000kg)				
Cruise Terminal	**NO_x**	**SO_2**	**$PM_{2.5}$**	**CO_2**	**CO_{2eq}**
EST. EMISSIONS FY2030/31 – NO SHORE POWER					
CT2	77.287	3.849	1.508	6,319	6,400
CT4	23.281	3.797	1.486	6,232	6,313
CT18	119.534	5.345	2.092	8,775	8,885
CT19	71.379	3.182	1.247	5,228	5,291
CT21	12.133	1.122	0.252	882	893
CT25	74.990	4.950	1.938	8,126	8,231
CT26	83.496	3.265	1.278	5,357	5.426
CT29	42.265	1.400	0.699	4,708	5,522
TOTAL EMISSIONS	**505.365**	**26.912**	**10.498**	**45.629**	**46,961**
EST. EMISSIONS FY2030/31 – SHORE POWER AT ALL TERMINALS (PHASE 2)					
CT2	17.551	1.745	0.534	4,509	4,540
CT4	6.176	1.946	0.573	5,225	5,260
CT18	24.916	2.375	0.716	6,210	6,248
CT19	14.922	1.425	0.434	3,710	3,732
CT21	2.843	0.363	0.086	631	636
CT25	29.807	2.586	0.842	6,083	6,132
CT26	19.839	1.552	0.485	3,880	3,906
CT29	10.160	1.190	0.358	4,015	4,208
TOTAL EMISSIONS	**126.214**	**13.191**	**4.028**	**34,263**	**34,662**
DIFFERENCE BETWEEN SCENARIOS					
# CHANGE	**-378.151**	**-13.721**	**-6.470**	**-11,366**	**-12,299**
% CHANGE	**-75.0%**	**-51%**	**-61.6%**	**-24.9%**	**-26.2%**

It is important to note that while the model was used to calculate vessel emissions directly avoided from shore power implementation, it does not account for downstream emissions occurring from the additional electricity generated on land to power those vessels while they are connected. Ideally, the power coming from landside generation would derive from cleaner sources than that of the vessel engines at Port Everglades. In 2020, Florida Power & Light (FPL), the utility company responsible for providing electric service to Port Everglades, sourced roughly 73% of their power from natural gas, 22.5% from nuclear, 2.8% from solar, with the remaining sourced from other fossil fuels.[15] Both nuclear and solar produce little to no emissions while natural gas, a far cleaner energy source than diesel, is still considered a fossil fuel and as such, does contribute to polluting emissions. That said, NextEra Energy, the parent company of FPL, has committed to being emissions-free by 2045. They intend to do this by significantly increasing renewable generation capacity systemwide, especially in Florida, generating up to 83% renewable energy at full implementation, by focusing primarily on solar, with additional energy provided by both green hydrogen and battery storage methods.

[15] *Source: NextEra Energy, "By the Numbers Profile" (2020)*

4. SHORE POWER SITE ASSESSMENT AND ALTERNATIVES

In this section, alternatives for the placement and configuration of shore power equipment and infrastructure at Port Everglades Subject Cruise Terminals are discussed. Presented options offer arrangements of equipment, locations of trenchworks, and CMS placement. These options and other Project aspects were presented to Port Everglades during Client Work Session 1 held July 12, 2022.

4.1 LOAD TRANSFORMER AND SWITCHGEAR CONSIDERATIONS

As presented in Section 2.2.3, load transformer and switchgear elements are the largest space consuming aspect of the shore power system. These elements are typically dock-mounted on a foundation slab in either a stacked container arrangement or traditional lineup configuration. General space allocations and dimensions for each type are presented in Table 4-1 and associated Figures 4-1 through 4-6.

As shown below, Concept 1 (Containerized, Single Vessel) has the smallest footprint of 768 square feet; the addition of offsets to allow for access to all equipment sides as well as bollard placement for protection against vehicles increases this area to 2,016 square feet. Adding decorative screening to conceal equipment containers increase footprints to 1,040 and 2,432 square feet, respectively.[16]

A traditional lineup of transformer and switchgear elements generally has a larger footprint than the stacked container approaches presented as Concept 1 and 2. As shown in Table 4-1 and Figure 4-3, this type of equipment lineup occupies approximately 1,040 square feet.

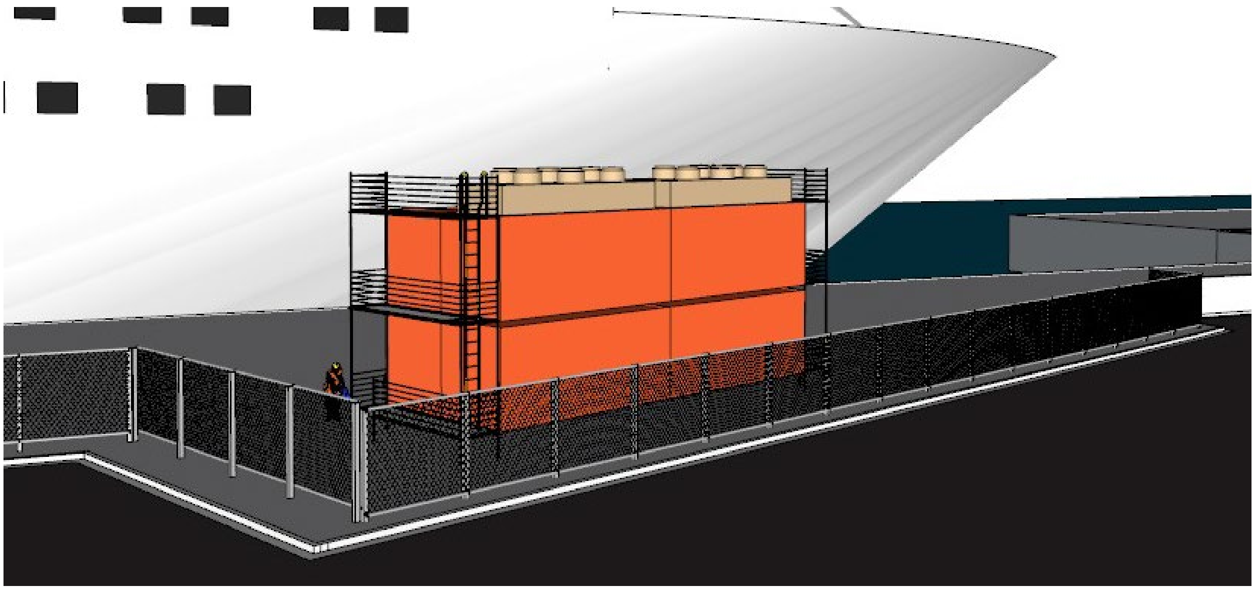
Table 4-1. Size of Load Transformer and Switchgear Configurations

	Concept 1: Containerized, Single Vessel	Concept 2: Containerized, Single Vessel, Screening**	Concept 3: Traditional Equipment Lineup, Single Vessel	Concept 4: Traditional Equipment Lineup, Single Vessel, Screening**	Concept 5: Containerized, Two Vessels	Concept 6: Containerized, Two Vessels, Screening**
Footprint: Equipment and Access Stair	768 SQF (16' x 48')	1,040 SQF (20' x 52')	1,222 SQF (13' x 94')	1,666 SQF (17' x 98')	1,600 SQF (16' x 100')	2,080 SQF (20' x 104')
Footprint: Inclusive of 12' Offset on Ends and 6' Offset along Sides	2,016 SQF (28' x 72')	2,432 SQF (32' x 76')	2,950 SQF (25' x 118')	3,538 SQF (29' x 122')	3,472 SQF (28' x 124')	4,096 SQF (32' x 128')
Height from Top of Slab *	22'	22'	16'	16'	22'	22'
Height from Top of Slab + 10' Clear for Fan Exhaust	32'	32'	26'	26'	32'	32'

*Source: M&N, 2022; *Final finished height of slab varies by location to protect the equipment and meet flood and sea level rise design criteria and codes. **Size of architectural shrouding can vary.*

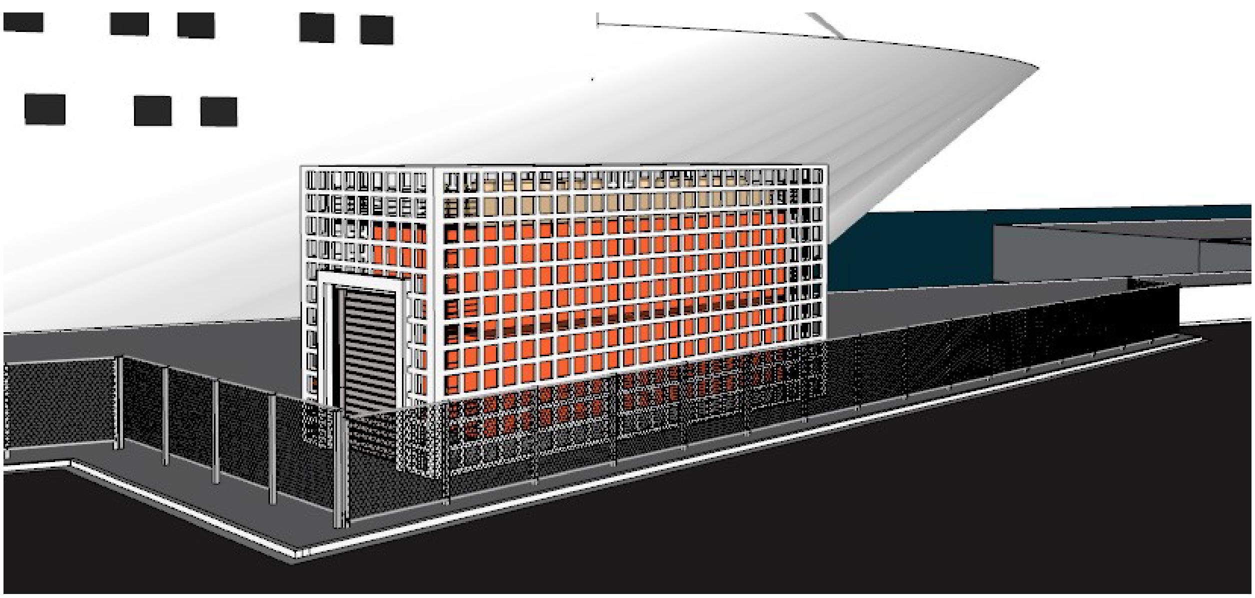
[16] Architectural shrouding is optional and not pursued in all applications of shore power system equipment. Other approaches to harmonize the aesthetics with the surrounding environment include wrapping containers/contained equipment branding/logs.

Figure 4-1. Concept 1: Containerized, Single Vessel (No Architectural Shrouding)



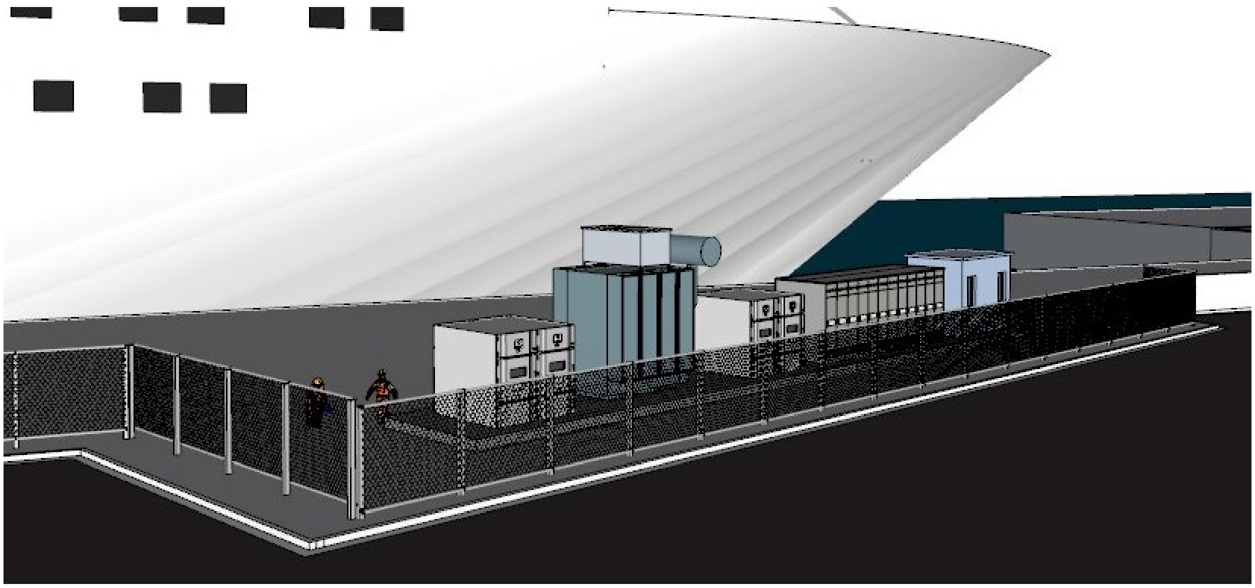
Source: M&N, 2022.

Figure 4-2. Concept 2: Containerized, Single Vessel (Architectural Shrouding)



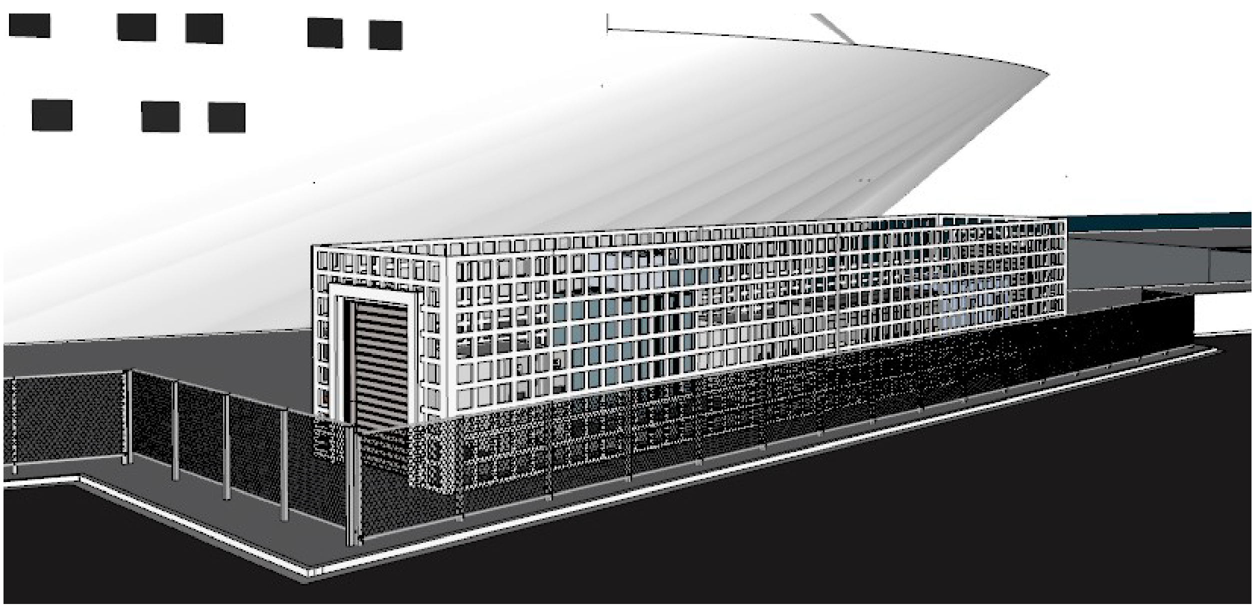
Source: M&N, 2022.

Figure 4-3. Concept 3: Traditional Equipment Line-up, Single Vessel (No Architectural Shrouding)



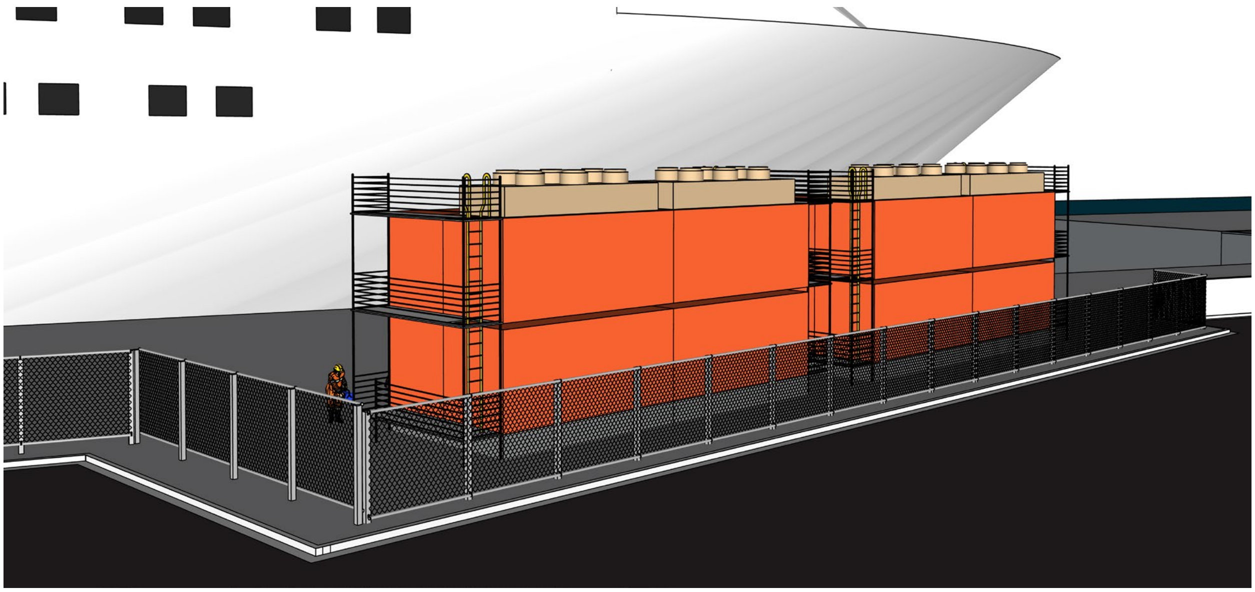
Source: M&N, 2022.

Figure 4-4. Concept 4: Traditional Equipment Line-up, Single Vessel (Architectural Shrouding)



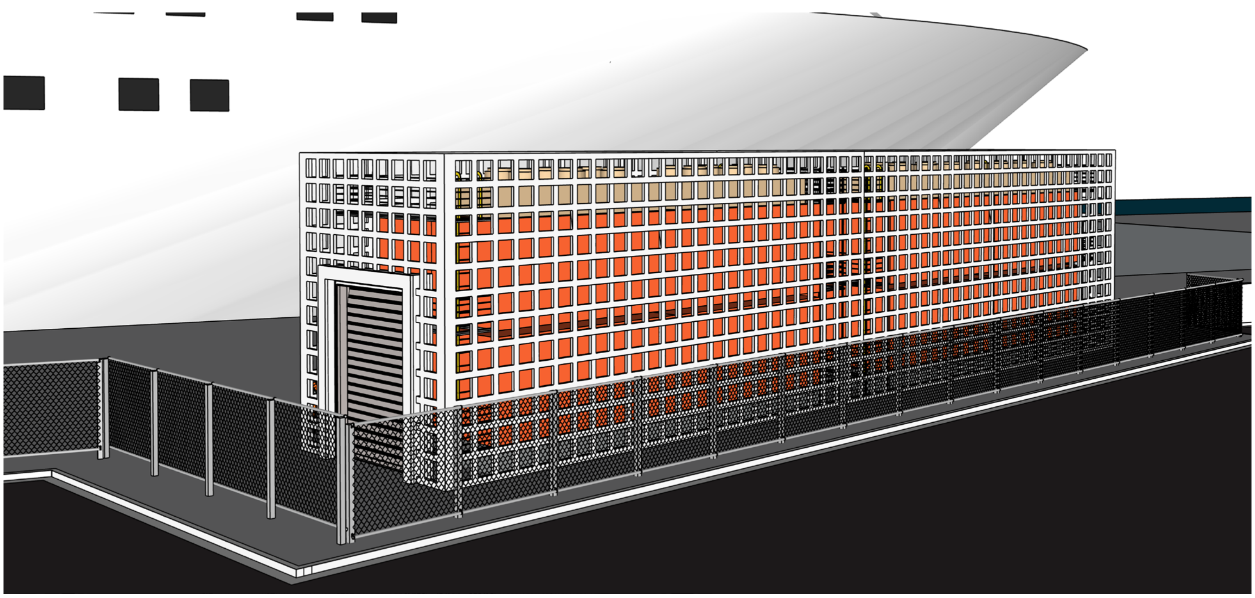
Source: M&N, 2022.

Figure 4-5. Concept 5: Containerized, Two Vessels (No Architectural Shrouding)



Source: M&N, 2022.

Figure 4-6. Concept 6: Containerized, Two Vessels (Architectural Shrouding)



Source: M&N, 2022.

A transformer vault room will be required for each cluster of shore power equipment. Each vault receives feeder service from FPL and then links to shore power equipment or other powered elements in the area. Ideally, vault rooms are placed proximal to each transformer and switchgear cluster to help minimize space consumption. Equipment within the vault is FPL's and marks where their responsibilities end, and where the Port's shore power system begins. FPL is responsible for the transformer and equipment in the vault.

Example vault sizes provided by FPL are shown in Table 4-2.

Table 4-2. FPL Example Transformer Vault Rooms

	Rectangular Vault Room, Supporting Shore Power for Up to 2 Terminals	Square Vault Room, Supporting Shore Power for Up to 2 Terminals	Rectangular Vault Room, Supporting Shore Power for Up to 3 Terminals	Square Vault Room, Supporting Shore Power for Up to 3 Terminals
Room Footprint: 4' Wide Access on One Side (Open 180° to Outside	600 SQF (30' x 20')	625 SQF (25' x 25')	800 SQF (40' x 20')	900 SQF (30' x 30')

Source: FPL, 2022.

4.2 LOCATION OF CRUISE VESSEL SHORE POWER CONNECTION POINTS

The arrangement of shore power equipment and infrastructure is dependent on the location of cruise vessel connection points. Presented in Table 4-3 are the vessels operating from Port Everglades in FY2022/23 (inclusive of Disney's *Dream* which will start operations in 2023). Approximately 70% of vessels fitted with shore power connections locate this link at starboard side aft of the vessel. Princess Cruise Line vessels are the general exception, with vessels using CT2, CT19, and CT21 having port side shore power connection points.

Looking beyond FY2022/23, Port Everglades' primary cruise tenants—Princess Cruises, Holland America Line, Royal Caribbean, Celebrity Cruises, Disney Cruise Line—have all expressed plans to continue the upfit of existing vessels with shore power connections as well as equipping new vessels with this capability. Location of shore power connection points will generally follow those already undertaken by vessel class. For example, all Royal Caribbean *Oasis*-class vessels with or planned for shore power connections will have this connection located on the starboard side, approximately 369 feet from the stern.

Table 4-3. Location of Cruise Vessel Shore Power Connection Points

Name	Class	Brand	PE Terminal	Shore Pwr. Connection	Side	Shore Power Shell Door from Stern (m)	Shore Power Shell Door from Stern (ft)
Allure of the Seas	Oasis	RCCL	18	Under Review*	Sbrd	112.4	369
Apex	Edge	Celebrity	25	Yes	Sbrd	98	322
Beyond	Edge	Celebrity	25	Yes	Sbrd	98	322
Caribbean Princess	Caribbean	Princess	2, 19, 21	Yes	Port	57	187
Costa Deliziosa	Vista/Spirit	Costa	19	-	-	-	-
Disney Dream	Dream	Disney	4 (2024)	-	-	-	-
Edge	Edge	Celebrity	25	Under Review*	Sbrd	98	322
Emerald Princess	Caribbean	Princess	2	Yes	Port	56.6	186
Enchanted Princess	Royal	Princess	2	Yes	Port	102	335
Equinox	Solstice	Celebrity	18, 25, 29	Under Review*	Sbrd	75.4	247
Eurodam	Signature	Holland	19, 21, 26	Yes	Sbrd	51.8	170
Evrima	Megayacht	Ritz Carlton	19, 25	-	-	-	-
Harmony of the Seas	Oasis	RCCL	18	Under Review*	Sbrd	112.4	369
Island Princess	Coral	Princess	2	Yes	Port	59.2	194
Jaume II	High-Speed Cat.	Balearia	19, 21, 29	-	-	-	-
Liberty Of the Seas	Freedom	RCCL	18, 19, 25	Under Review*	Sbrd	74.5	244
Marbella Discovery	Vision	Marbella	19	-	-	-	-
Millennium	Millennium	Celebrity	18, 25, 29	Yes	Port	66.4	218
MS Queen Elizabeth	Vista	Cunard	2	-	-	-	-
Nieuw Amsterdam	Signature	Holland	19, 21, 26	Yes	Sbrd	51.8	170
Nieuw Statendam	Pinnacle	Holland	26	Yes	Both	56.7	186
Odyssey of the Seas	Quantum	RCCL	18	Yes	Sbrd	117.4	385
Oosterdam	Vista	Holland	19, 26	Yes	Sbrd	52.5	172
Reflection	Solstice	Celebrity	29	Under Review*	Sbrd	75.4	247
Regal Princess	Royal	Princess	2	Yes	Port	102	335
Rotterdam	Pinnacle	Holland	19, 26	Yes	Both	56.7	186
Ruby Princess	Caribbean	Princess	21	Yes	Port	56	184
Silver Cloud	N/A	Silversea	19	-	-	-	-
Silver Dawn	N/A	Silversea	25, 26	-	-	-	-
Silver Moon	N/A	Silversea	19, 26	-	-	-	-
Silver Shadow	N/A	Silversea	19	-	-	-	-
Sky Princess	Royal	Princess	2, 21	Yes	Port	102	335
Viking Neptune	Viking Ocean	Viking	19	-	-	-	-
Viking Octantis	Polar 6	Viking	19	-	-	-	-
Viking Polaris	Polar 6	Viking	19	-	-	-	-
Viking Star	Viking Star	Viking	19	-	-	-	-
Vision of the Seas	Vision	RCCL	18, 19, 25, 29	No	N/A	N/A	N/A
Volendam	R – Class	Holland	4, 19, 21	Planned	Sbrd	62.1	204
Voyager of the Seas	Voyager	RCCL	18	Yes	Sbrd	112.4	369
Zaandam	R – Class	Holland	19, 21, 26	Yes	Sbrd	62.1	204
Zuiderdam	Vista	Holland	26	Yes	Port	59	194

*Source: Port Everglades Master Cruise Schedule, FY22-23 (July 2022), Various Cruise Lines, and M&N, 2022. *Under Review refers to the cruise line continuing to study the need and cost to upgrade the vessel for a shore power connection.*

4.3 INITIAL SHORE POWER CANDIDATE SITES

Several shore power candidate sites were reviewed with Port Everglades for shore power equipment and associated FPL feeder and vault placement. Candidate sites are illustrated in Figure 4-7.

For CT2 and CT4 in Northport, it was agreed with Port Everglades that a single, scalable location for load transformer and switchgear placement was preferable given the limited area available and ongoing expansion of the Broward County Convention Center (north of CT2). Grouping of equipment was contemplated near the southeast corner of the vessel berths supporting CT2 and CT4 (see Figure 4-7, 'A'). Load transformer and switchgear elements would ideally be placed waterside of port security fencing and east of Disney's planned generator and other CT4 elements currently in the final stages of design and permitting. FPL feeders to this location would run along the south side of Heron Parking Garage.[17] Disney expressed a need to ensure any shore power equipment placed in this zone have some degree of architectural shrouding to reduce the visual impact to the new Disney Terminal.

Several initial options were considered for CT18 and CT19. These included:

- A load transformer and switchgear element along the north end of CT18 supporting this berth (see Figure 4-7, 'B');
- A load transformer and switchgear element along the west side of CT19 supporting this berth (see Figure 4-7, 'D'); and,
- A combined, scalable facility supporting both CT18 and CT19 at the northwest corner of the at-grade parking lot adjacent to CT19 (see Figure 4-7, 'C').

From review of these options, grouping of equipment in location 'C' was selected as most optimal to jointly feed both terminals. This came after recognition of the limited space available along the north side of CT18 and review of the Port's Master/Vision Plan 2018 Update which includes creation of a new pier running north/south from the current CT19 berth face and associated parking garage and other development in the area (Bermello Ajamil & Partners, 2020).

Shore power equipment locations reviewed for CT21, CT25, and CT26 include:

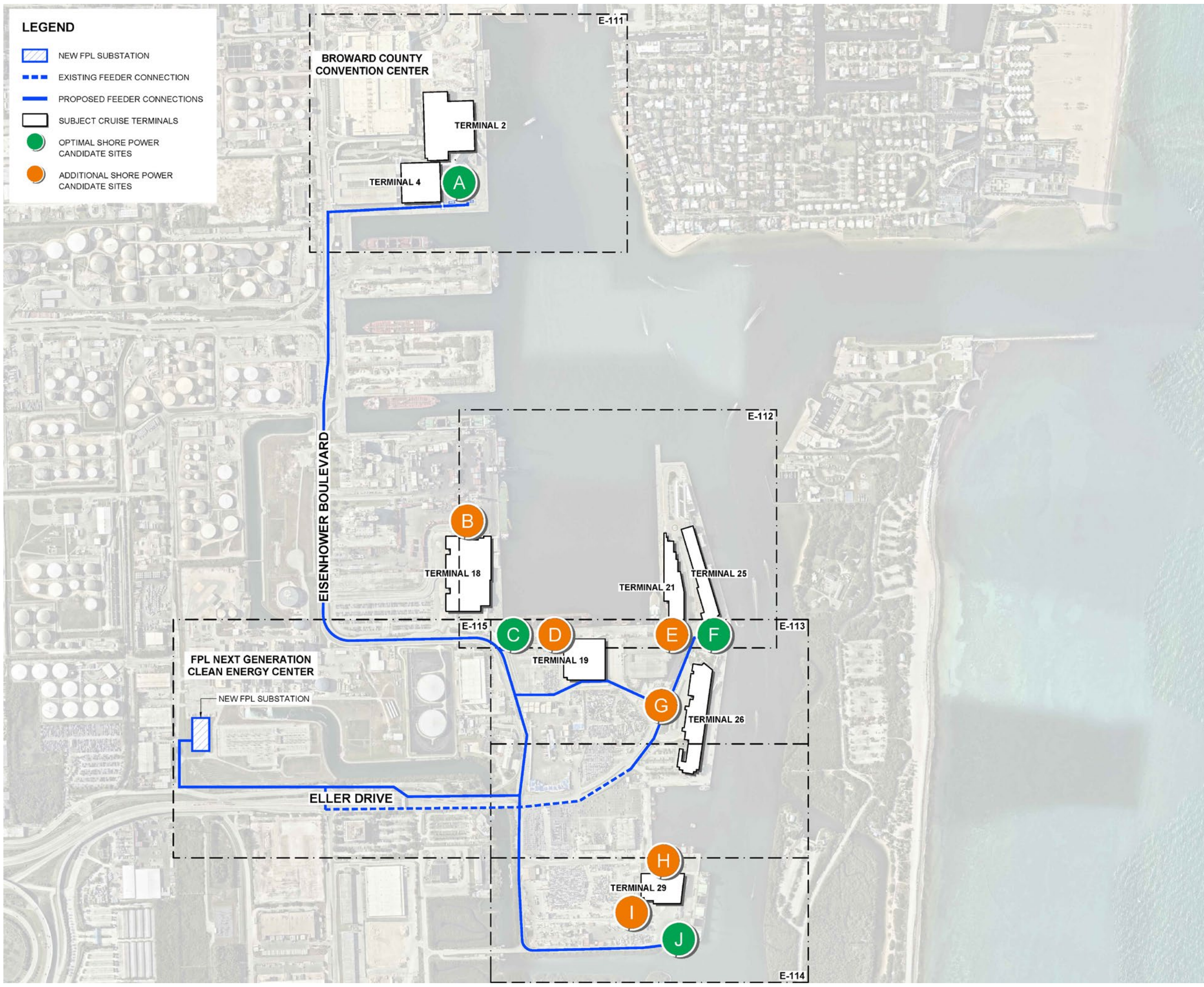
- A load transformer and switchgear element supporting CT21 at a location in the landscape island adjacent to the Harbor Master Tower (see Figure 4-7, 'E');
- A multiple load transformer and switchgear element at the parking lot and landscape area at the southeast corner of the Palm Garage (see Figure 4-7, 'G'); and,
- A combined, scalable facility supporting CT21, CT25, and CT26 at the north site of CT26 within an existing at-grade parking lot (see Figure 4-7, 'F').

Location 'E' was discarded given significant underground utility conflicts. The Palm Garage site was also discarded due to this land area being included in plans for a People Mover Station (Bermello Ajamil & Partners, 2020). The remaining site along the north side of CT26—Location 'F'—was considered the preferred option. Port Everglades requested future planning in this zone shift equipment to the northern edge of the parking lot adjacent to CT26 to allow for future northward expansion of this terminal.

T29 stands remote from the other terminals, requiring a FPL feeder to be run south along SE19th Avenue and then east along SE 36th Street. Three locations were considered for CT29 (see Figure 4-7, 'H', 'I', and 'J'). From this list, it was agreed with Port Everglades placement of equipment should occur at or near location 'J'. Location 'I' (below the existing parking ramp) was discarded given the anticipated changes being contemplated for CT29. Location 'H" was also determined to be too close to anticipated CT29 renewal areas and added cost to extend the FPL feeder and CMS trenchworks in the area.

[17] *Feeder runs along the north side of the Heron Parking Garage were considered too difficult to achieve given the number of built elements in this area.*

Figure 4-7. Cruise Terminal F Shore Power Candidate Sites



Source: Port Everglades and M&N, 2022.

5. RECOMMENDED SHORE POWER SYSTEM MASTER PLAN

Using Port Everglades and FPL feedback, a revised shore power system plan was prepared by M&N. System elements and spatial arrangement of equipment at each cruise terminal was presented to Port Everglades at the Client Work Session on August 22, 2022. Following this session, plan refinements were made with the results presented in this section.

All work offered herein is at a master planning level of design. Refinement and detail during Design Criteria Package (DCP) preparation or similar subsequent design stages will result in greater detail on the location of equipment, duct bank pathways, and other system features. Furthermore, shore power vendor offerings are increasing, and technology continues to evolve. Port Everglades should remain open to vendor creativity and alternative approaches that may present themselves during the shore power design and procurement phases.

5.1 RECOMMENDED FEATURES OF PORT-SUPPLIED SHORE POWER SYSTEMS

The recommended shore power system features and general configuration scheme is presented below. Recommendations are derived from project goals established in Section 1.3 and technology and project considerations reviewed in Sections 2 and 4.

- Shore power systems must be built to international IEC/IEEE 80005-1, -2 standards plus local code requirements including NEC, NBC, and OSHA as well as Florida State and FPL regulations, as required.
- Four (4) scalable groupings of load transformer and switchgear equipment should be pursued: Group 1 at CT2 and CT4; Group 2 supporting CT18 and CT19; Group 3 at CT21, CT25 and CT26; and, a single installation at CT29 (Group 4).
- FPL transformer vault rooms should be placed proximate to each grouping of equipment and follow the sizing guidelines offered in Table 4-2.
- Pre-packaged containerized/modularized solutions for shore power load transformer and switchgear are considered optimal given the ever-present need to conserve limited development space at the Port. This approach allows equipment to be placed in tight spaces and clearance constraints, especially when stacked as shown in Figure 4-1 and 4-2[18]. Each cruise berth will require its own set of transformer and switchgear equipment.
- Dry-type load transformers are encouraged over oil-filled types. This will help to avoid the need for oil containment and reduce oil fire flammability risk around the equipment. Use of a cast resin dry-type transformer can lower system maintenance.
- FPL transformer vault rooms shall connect to Port shore power load transformer and switchgear via a primary feeder 2W6 duct bank containing (15kV) power cables.
- Duct banks, trenches, pull boxes, and/or underground vaults run the necessary 16 MVA of 11 kV / 6.6 kV medium voltage feeders and control/communications feeders from load transformer and switchgear substations to each shore-to-ship power connection point and CMS. IEC/IEEE 80005-1 2019 and IEC/IEEE 80005-3 2019 provide governing standards for these feeders, along with the National Electrical Code (NEC) and all applicable local codes (e.g., Florida Building Code, Broward County Ordinances). Duct banks from the Port substation for these aforementioned feeders are anticipated to be approximately 4' wide by 4' deep with 36" of cover. All exposed covers for in ground components in the berth area are recommended to be aircraft traffic-rated for 100,000 lb. loading per USDOT FAA AC No: 150/5320-6G. Additional connector pits/vaults can be explored during subsequent design to account for other OGV shore power demand or to increase the range the CMS can operate given variability of ship connection locations, vessel position along the berth (e.g., port or starboard side).
- As most terminals have a varying number of cruise vessel classes with differing shore power connection points, mobile CMS systems are considered optimal to provide maximum system flexibility. Use of mobile CMS will significantly reduce the number of connector pit/vault with outlet assemblies required at each berth. CMS elements operate within a

[18] *Large and heavy components such as the power transformers would need to be installed on the lowest level.*

design range of +/-300 feet (150 feet in each direction) from the shore-to-ship power connection pit/vault. For CT4, Disney has requested a fixed jib crane as only their vessels will operate from this location.

- Shallow cable trenches along the dock surfaces are suggested at this stage of the design. These trenches measure approximately 310' long by 2' deep by 3' wide for each shore-to-ship power connection. The trenches conceal the horizontal routing of the cables from the mobile CMS. This approach minimizes cables on the apron which can pose a safety hazard and create areas that need to be worked around during vessel provisioning operations. Cable trench protection should include hinged galvanized steel covers that are set flush to the wharf surface.[19]

5.2 RECOMMENDED ARRAGEMENTS OF PORT-SUPPLIED SHORE POWER SYSTEMS

The recommended arrangement of Port Everglades shore power equipment and infrastructure is shown in Figures 5-1 through 5-6. Enlargements of each drawing are provided in Appendix A.

Load transformer and switchgear substations presented in Figures 5-1 through 5-6 represent eight containerized/contained package units with associated cooling and access risers, with four units on the bottom and four units stacked above (see Figure 4-1).[20] These elements sit on container slab and base[21]. Bollards should surround each substation to protect against potential vehicle impacts.

Duct banks, trenches, pull boxes, and/or underground vaults (labeled EDB in each drawing) run the necessary 16 MVA of 11 kV / 6.6 kV medium voltage feeders and control/communications feeders from load transformer and switchgear substations to each shore-to-ship power connection point and CMS. A single CMS per berth is shown, operating within a design range of +/-300 feet (150 feet in each direction) from the shore-to-ship power connection pit/vault to the vessel connection shell door. Shell door locations are show for listed ships, with the operational range of the CMS representing the adjacent dark line which provides a 'range of access' to these doors.

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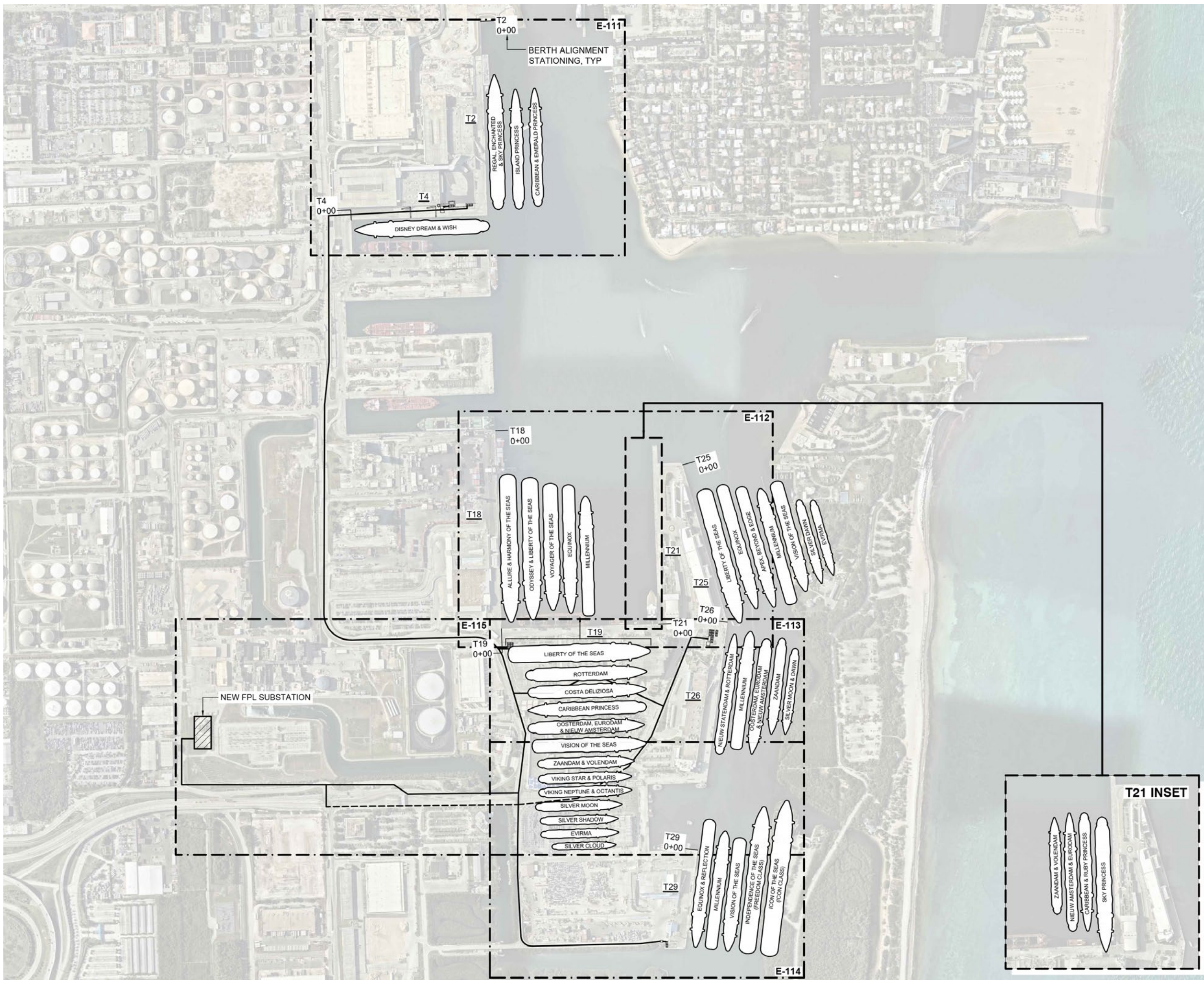
[19] *There are other methods to accomplish cable concealment and protection, such as those presented in Section 2.1.4. Additional review and study of all approaches is recommended during the basis of design stage.*

[20] *Note imagery and text denote container volumes. Any manufacturer developed containment system that fits within the areas denoted in the plan are likely suitable and should be reviewed under more detail design and procurement project stages.*

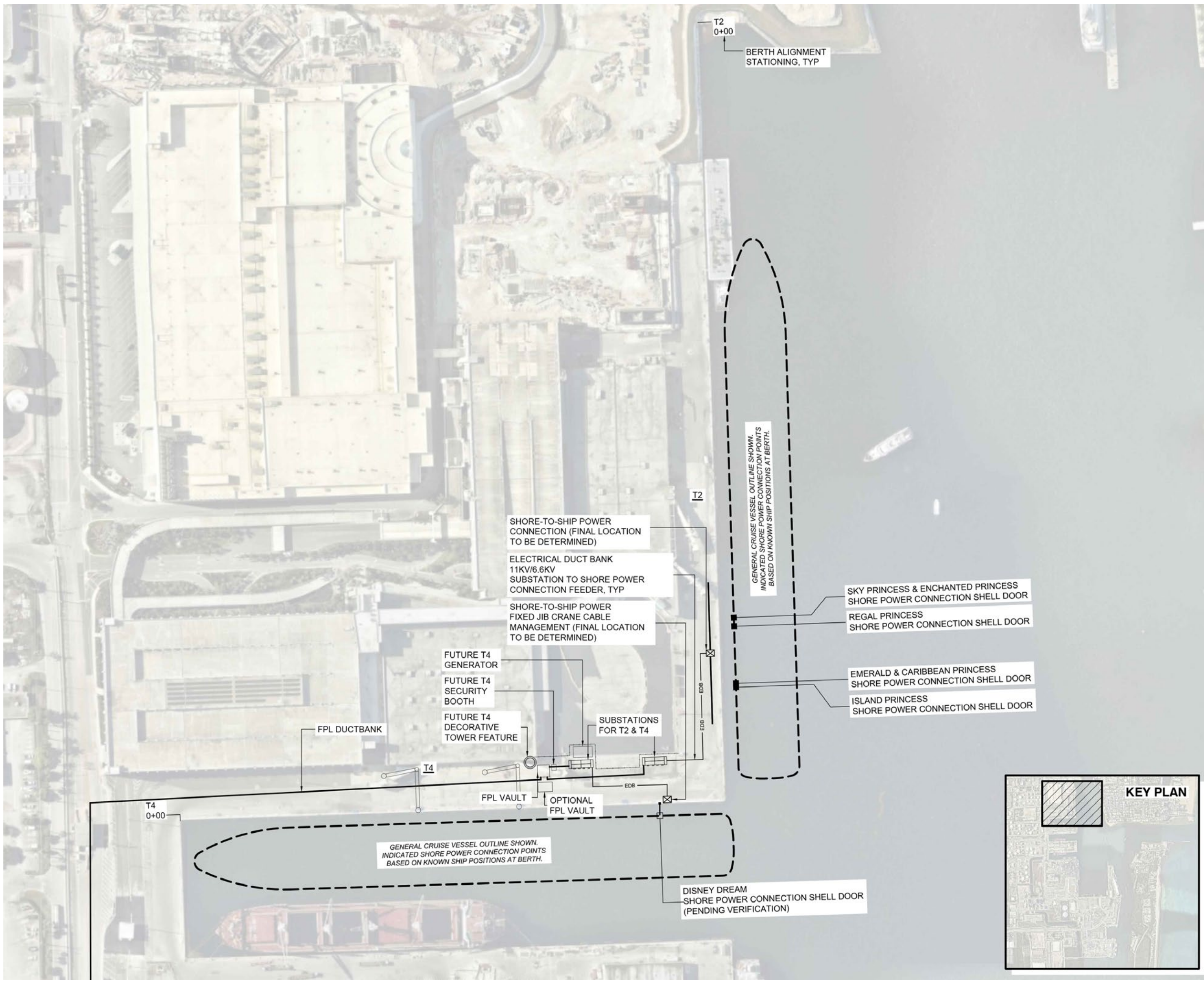
[21] *Additional investigation is required to establish the final finished height of this slab to protect the equipment and meet flood and sea level rise design criteria and codes.*

Figure 5-1. Port Everglades Shore Power Overall Electrical Site Plan



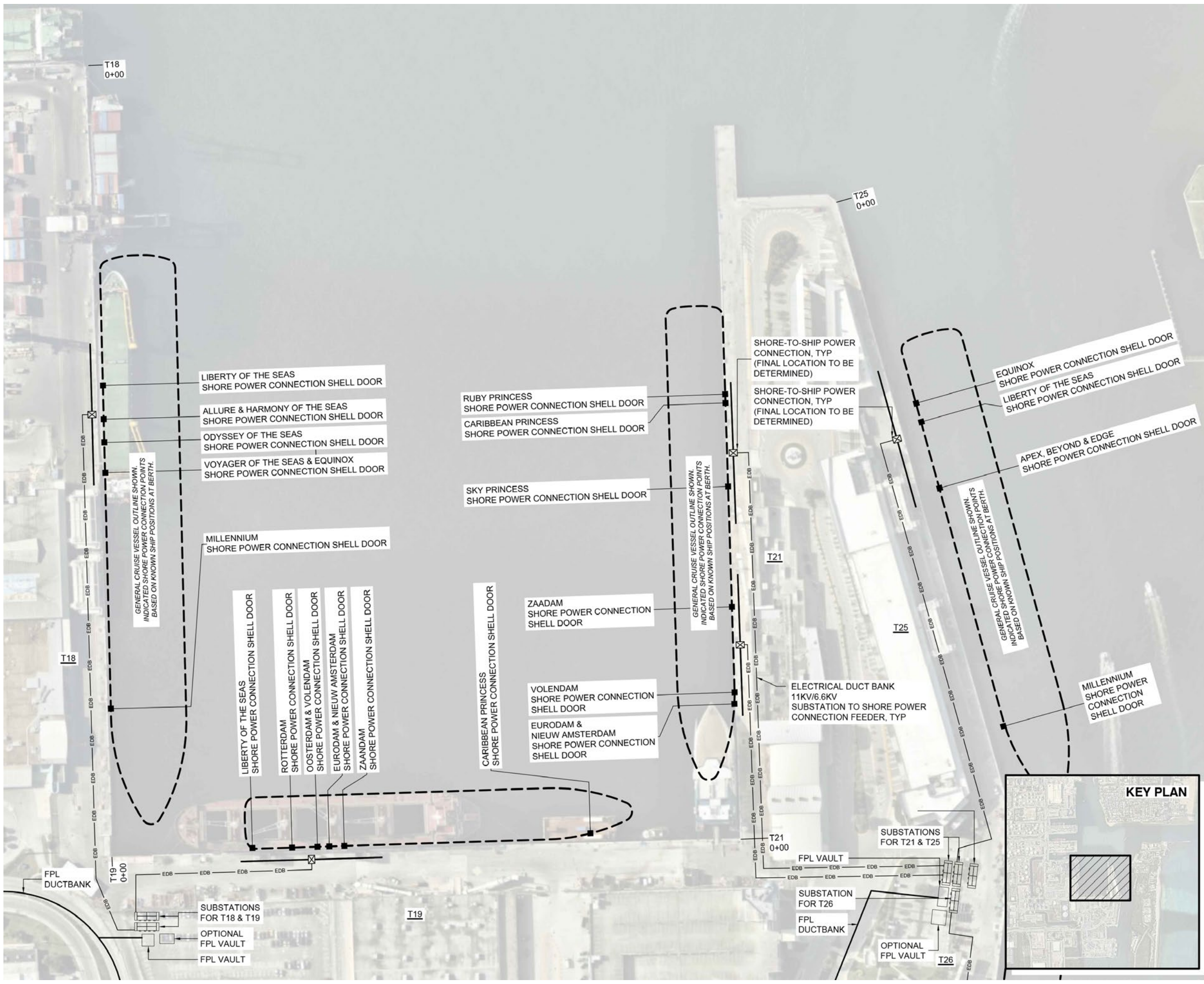
Source: M&N, 2022

Figure 5-2. CT2 and CT4 Enlarged Electrical Site Plan (Sheet E111)



Source: M&N, 2022

Figure 5-3. CT18, CT19, CT21, and CT25 Enlarged Electrical Site Plan (Sheet E112)

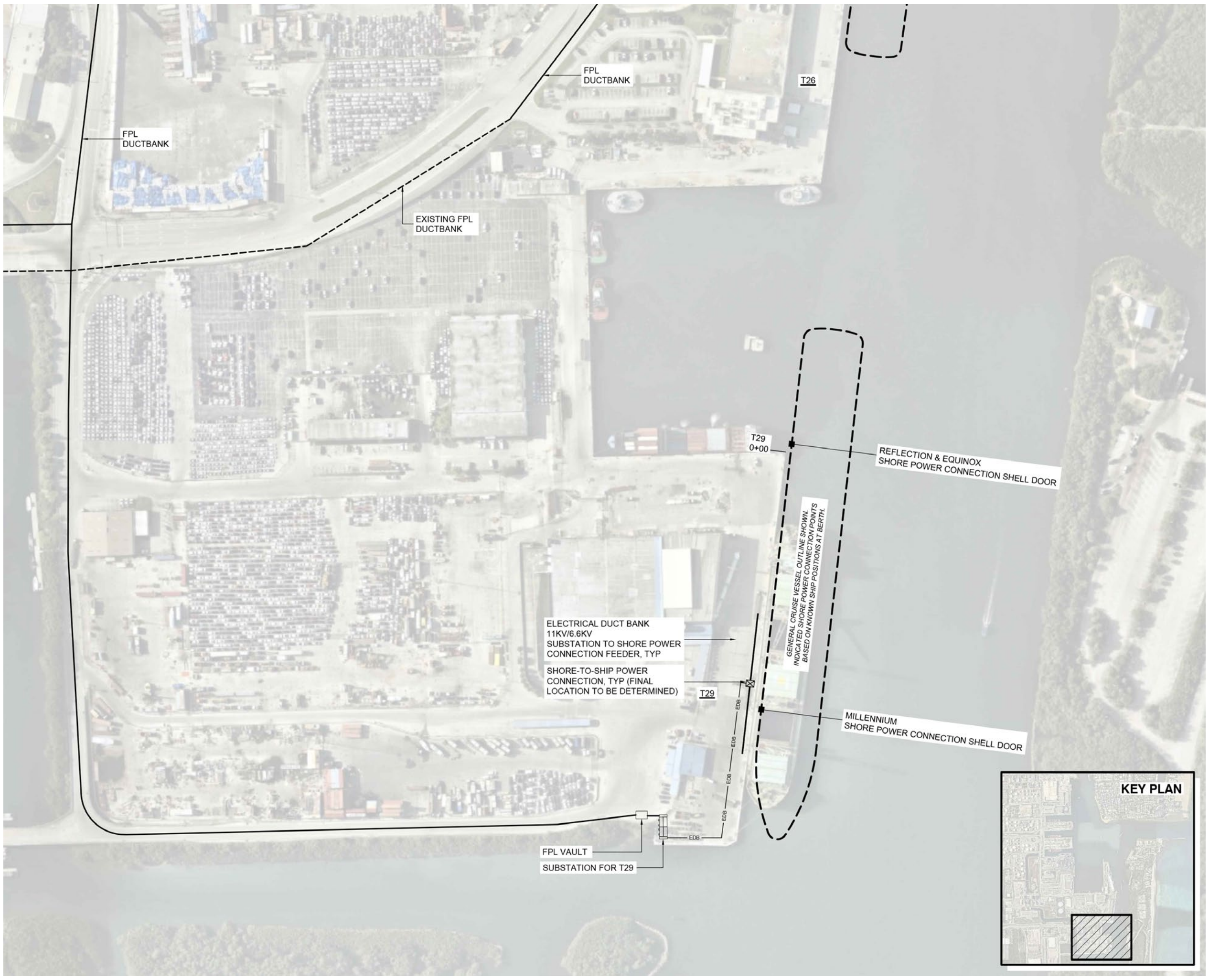


Source: M&N, 2022

Figure 5-4. CT26 Enlarged Electrical Site Plan (Sheet E113)

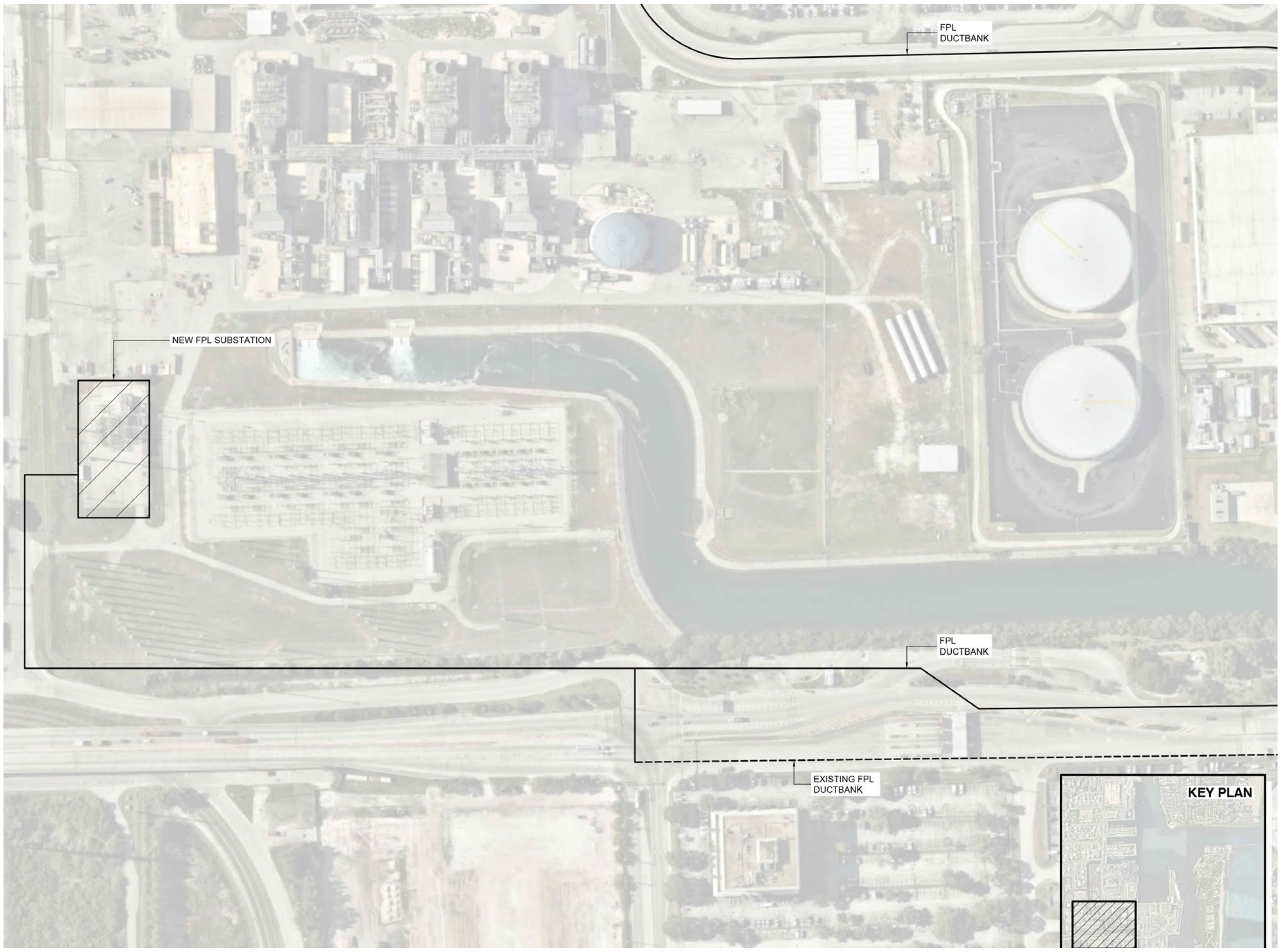
Source: M&N, 2022

Figure 5-5. CT29 Enlarged Electrical Site Plan (Sheet E114)



Source: M&N, 2022

Figure 5-6. Enlarged Electrical Site Plan for FPL New Substation (Sheet E115)



Source: M&N, 2022

5.3 FLEXIBILITY FOR PORT MASTER PLAN IMPROVEMENTS

The 2018 PEMP identifies future projects of relevance and impact to several cruise terminal locations and berths (Bermello Ajamil & Partners, 2020). As presented in Section 5.2, optimal shore power infrastructure installation points were selected to minimize impact to port operations and current and planned capital investments.

In three locations, planned projects will significantly alter the present arrangement of facilities and how these zones will operate Given these impacts, the suggested strategy for shore power investment in each of these areas is offered below.

- **Berth 19.** The 2018 PEMP calls for placement of a new pier in the middle of the basin extending from Berth 19 coupled with development of an upland terminal and parking garage. The landward southwest corner of the vessel basin was selected as the optimal location for load transformer and switchgear equipment based on its ability to support both CT18 and CT19 and to avoid planned CT19 landward upgrades.

  Shore power improvements for CT19 are slated for Phase 2, and therefore, investment may follow planned improvements to terminals, parking, and other facilities at CT19. Figure 5-7 presents the waterside view of how the shore power plan is flexible to accommodate changes to the CT19 berth, with the cluster of load transformer and switchgear elements remaining in place and the electrical duct bank adjusted to accommodate the west face of the new pier.[22]

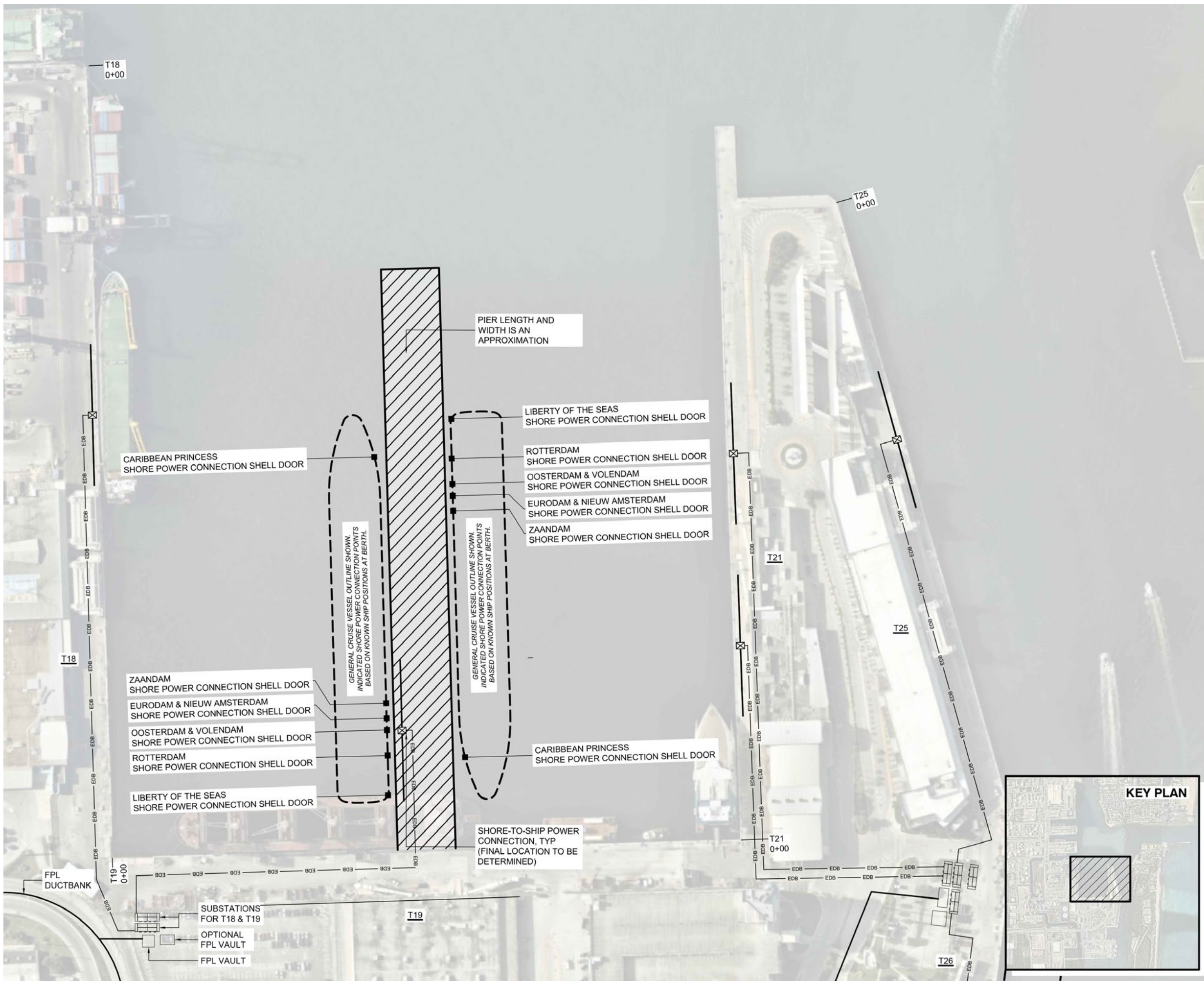
- **Cruise Terminal 26.** Northward expansion of CT26 is included in the 2018 PEMP and was discussed during stakeholder outreach. The current plan for shore power investment places a grouping of load transformer and switchgear equipment supporting CT21, CT25, and CT26 at the north site of CT26 within an existing at-grade parking lot. As shown in Figure 5-3, there is flexibility in the ultimate siting and placement of equipment in this location, with an optional location shown waterside of the fence line. Additional options can be studied in this location as well to accommodate more refined plans for the CT26 expansion, once known.

- **Berth and Cruise Terminal 29.** Similar to Berth 19, CT29 is expected to receive significant transformation. The 2018 PEMP calls for the Tracor Basin to be filled and the CT29 berth face to be extended northward. A new terminal accommodating larger cruise vessels (greater than 6,000 passengers) would be constructed in or near the current CT29 facility.

  Similar to CT19, shore power improvements for CT29 are slated for Phase 2. Holding back implementation of CT29 shore power investment to align with planned berth and terminal improvements is sensible and would likely result in a more unified approach while being delivered at a lower cost. Figure 5-5 and Figure 5-8 (future improvements) present the optional location and configuration of shore power investment at CT29. Both options show the vessel in a starboard side berthing configuration with the bow pointing south. This configuration takes advantage of the prevalence of starboard side aft shore power connection points. Due to marine operational requirements vessels can only berth portside, landside shore power arrangement offered in Figure 5-5 is considered optimal. Only vessels with port-side shore power connection points will be able to connect to the system.

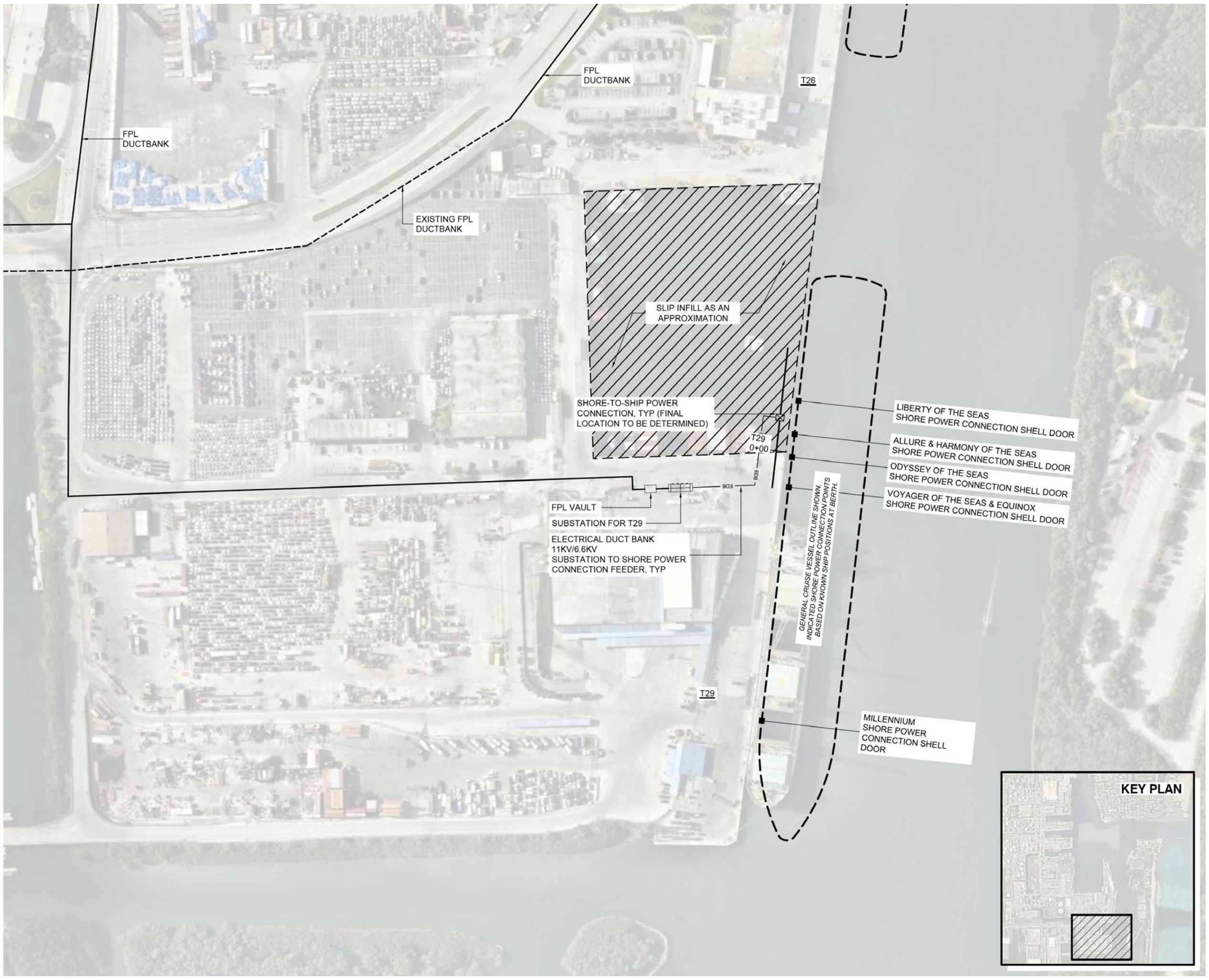
[22] *The plan could also be adjusted to serve the east face of planned Berth 19 Pier. Powering both berth faces, however, would require increased investment in transformer and switchgear infrastructure along with increased power supply from FPL. The narrowness of the pier and cables associated with the system presents additional challenges in powering and operating shore power on both pier faces.*

Figure 5-7. Berth 19 Pier Shore Power Option (Sheet 112-A)



Source: M&N, 2022

Figure 5-8. Berth and CT29 Shore Power Option (Sheet 114-A)



Source: M&N, 2022

5.4 CONSIDERATIONS IN SHORE POWER BASIS OF DESIGN

As the project moves from master planning and into basis of design, the following considerations should be accounted for:

- Continual coordination with FPL on new substation construction timing and availability of power to serve shore power systems. Port Everglades will also need to coordinate distribution routing of feeders to FPL vaults and respective placement.
- Continued coordination of CMS systems with the location of port/cruise ship operations at berth, associated passenger boarding bridge (PBB), and location of vessel connection points.
- Equipment heights with respect to site elevations and the 100-year flood and Category 5 hurricane storm surge.
- Detailed survey/mapping identifying and locating existing utilities and fuel lines to avoid conflicts with shore power system trenchwork and equipment placements. Existing utilities should be mapped using ground penetrating radar.
- Detailed survey/mapping identifying and locating above ground structures posing horizontal and vertical space constraints and/or imposing fire safety considerations.
- Integration of shore power system master plan conclusions as part of the Port's next 5-year master plan update. Equipment locations and other features should be coordinated with cruise terminal, pier, and other planned area development in each location.
- Multiple classes of ships may berth at certain terminals at different times, necessitating connection points that are flexible and able to accommodate a variety of vessels.

5.5 SHORE POWER ORDER OF MAGNITUDE COST ESTIMATE

An Opinion of Probable Cost (OPC) for each shore power equipment grouping is shown in Tables 5-1 through 5-4. OPCs are based on reasonable professional judgement and experience as well as outreach to shore power manufactures for equipment pricing as of the date of this report.[23]

Exclusions and clarifications for the OPC include the following:

- As work is presented at a planning level of design, a 15% contingency has been added to equipment items and 30% contingency for site improvements. A final OPC range of -30% (low) and +30% (high) is provided for each group.
- OPCs are presented as four groupings of improvements—CT2 and CT4 (group 1); CT18 and CT19 (group 2); CT21, CT25 and CT26 (group 3); and CT29 (group 4). Separating elements of group 2 and 3 into different phases is anticipated to add development cost associated with contractor mobilization, et.al.
- Provided OPCs exclude all costs associated with FPL system upgrades (as measured from the FPL transformer vault and associate meter back to service feeders and main substation).
- Covers for all in ground structures (i.e., pull boxes, manholes, vaults, access hatches, cable trenches) shall be Aircraft Traffic Rated for 100,000lb loading in the berth area and Traffic-Bearing (HS-20) when landside of security fencing.
- The OPC contemplates reinforced concrete pull boxes at every bend and at every 200 linear foot along the secondary feeders with the following dimensions: 4' X 6' inside with a depth of at least 8', 8" thick walls (5.5' X 7.5' outside dimension), 12" thick top slabs, and 18" thick bottom slabs.
- Secondary feeder carries 11/6.6 KV in a 9W6 duct bank configuration which includes: (1.) five power feeders (4-1000kcmil + 1-250kcmil in 6") and one 6" empty duct (spare); and (2.) three, 6" diameter conduits for low voltage power, controls/interlocks/communications (2-used and one empty duct).

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[23] *In providing the enclosed OPCs, it is recognized that M&N has no control over the cost of labor, equipment, and materials or over the contractor's means and methods of determining constructability, pricing, or schedule.*

The OPC for the CT2 and CT4 grouping (see Table 5-1) is $23.0 million, or approximately $11.5 million per installation. This includes a mobile CMS at CT2, as is the case at all shore-power equipped terminals except for CT4 which will have a fixed jib crane at for shore-to-ship connectivity.

The OPC for the CT18 and 19 grouping (see Table 5-2) is estimated at $32.4 million, or approximately $16.2 million per installation. Both terminals will use a mobile Cable Management System (CMS) as is used in all other shore-power equipped terminals besides CT4.

The OPC for the CT21, 25, and 19 grouping (see Table 5-3) is estimated at $56.2 million, or approximately $18.7 million per installation. All three terminals will use a mobile Cable Management System (CMS) as is used in all other shore-power equipped terminals besides CT4.

The OPC for CT29 (see Table 5-4), is estimated at $13.1 million. CT 29 will use a mobile Cable Management System (CMS) as is used in all other shore-power equipped terminals besides CT4.

Table 5-1. CT2 and CT4 Shore Power OPC Estimate

Item	Activity	Qty	Unit	Unit Price	Total	Description
	Equipment					
1	Portside Load Transformer and Switchgear Substation (Furnish & Install)	2	EA	$3,900,000	$7,800,000	Contained or containerized module supporting one berth. No power converter. Excludes architectural shrouding or similar.
2	CT2 Mobile Cable Management System (MCMS) – 11/6.6KW with Cabling for 150' Trench	1	EA	$1,600,000	$1,600,000	HV Tug pulled mobile MCS type.
3	CT4 Stationary Jib Crane	1	EA	$735,000	$735,000	HV Tug pulled mobile MCS type.
4	Secondary Feeder Power Cables (11/6.6 KV) (Furnish & Install)	19,091	LF	$50	$954,550	Includes 5 power cables (+ one spare duct), 3 conductors + 10% waste.
5	Shore-to-Ship Communication and Control Cable (Furnish & Install)	2,545	LF	$100	$254,500	Includes 2 communication cables + one spare duct + 10% waste.
6	Shore Power Connection Point (Outlet Assembly)	2	EA	$130,000	$260,000	Surface mounted on concrete pad. Additional study to identify if can be mounted below ground.
	15% Equipment Project Contingency (Planning Stage)				$1,740,608	
	Equipment Subtotal				**$13,344,658**	
	Site Improvements					
7	Site Demolition	1	LS	$525,000	$525,000	Based on linear footage of concrete encased 9W6 duct bank.
8	Substation Slab & Base (1 per Containerized Substation)	2	EA	$231,110	$462,220	52' x 20' x 4' reinforced structural concrete slab + 12" lime rock base.
9	Concrete Encased 9W6 Duct bank (Secondary Feeder)	1,157	LF	$1,500	$1,735,500	4' x 4' concrete encased duct bank (36" cover).
10	Reinforced Concrete Pull Box for Secondary Feeder	8	EA	$150,000	$1,200,000	Aircraft traffic rated 100,00 lbs with outside dimensions 5.5' X 7.5'.
11	Cable Trench for MCMS Cabling	310	LF	$2,700	$837,000	24" x 36" reinforced concrete U-trench (flush with the ground) with hinged lift assist lay flat lids (Aircraft Traffic Rated 100,000 lbs) for MCMS cabling. Other options may be explored for cost savings.
12	Wharf Pavement Reconstruction	591	SY	$50	$29,570	Asphalt pavement reconstruction above duct bank (secondary feeder). Includes 15% allowance for pavement reconstruction around the pull boxes + connection pit + cable trench.
	30% Site Improvements Project Contingency (Planning Stage)				$1,436,787	
	Site Improvements Subtotal				**$6,226,077**	
	Allowances					
13	Mobilization (assume 2.5% of Capex cost)				$489,270	
14	General Conditions (assume 6.5% of Capex cost)				$1,272,100	Indirect Costs
15	Allowance (Cabling)				$150,000	Based on linear footage of Concrete Encased 9W6 Duct bank
16	Allowance (Dry and Wet Commissioning)				$250,000	
17	Allowance (Surface Water Pollution Prevention Plan)				$55,000	
18	Allowance (Relocation of Other Existing Utilities)				$355,000	Based on linear footage of Concrete Encased 9W6 Duct bank
19	Engineering and Design (assume 4.5% of Capex cost)				$880,680	
	Allowances Subtotal				**$3,452,050**	
	OPC GRAND TOTAL – Equipment, Site Improvements, and Allowances				**$23,022,785**	
	Potential Grand Total OPC Range $16.1 (-30%) to $29.9 (+30%) million					

Source: M&N, 2022.

Table 5-2. CT18 and CT19 Shore Power OPC Estimate

Item	Activity	Qty	Unit	Unit Price	Total	Description
	Equipment					
1	Portside Load Transformer and Switchgear Substation (Furnish & Install)	2	EA	$3,900,000	$7,800,000	Contained or containerized module supporting one berth. No power converter. Excludes architectural shrouding or similar.
2	Mobile Cable Management System (MCMS) – 11/6.6KW with Cabling for 150' Trench	2	EA	$1,600,000	$3,200,000	HV Tug pulled mobile MCS type.
3	Secondary Feeder Power Cables (11/6.6 KV) (Furnish & Install)	40,508	LF	$50	$2,025,400	Includes 5 power cables (+ one spare duct), 3 conductors + 10% waste.
4	Shore-to-Ship Communication and Control Cable (Furnish & Install)	5,401	LF	$100	$540,100	Includes 2 communication cables + one spare duct + 10% waste.
5	Shore Power Connection Point (Outlet Assembly)	2	EA	$130,000	$260,000	Surface mounted on concrete pad. Additional study to identify if can be mounted below ground.
	15% Equipment Project Contingency (Planning Stage)				$2,073,825	
	Equipment Subtotal				**$15,899,325**	
	Site Improvements					
6	Site Demolition	1	LS	$1,115,000	$1,115,000	Based on linear footage of concrete encased 9W6 duct bank.
7	Substation Slab & Base (1 per Containerized Substation)	2	EA	$231,110	$462,220	52' x 20' x 4' reinforced structural concrete slab + 12" lime rock base.
8	Concrete Encased 9W6 Duct bank (Secondary Feeder)	2,455	LF	$1,500	$3,682,500	4' x 4' concrete encased duct bank (36" cover).
9	Reinforced Concrete Pull Box for Secondary Feeder	12	EA	$150,000	$1,800,000	Aircraft traffic rated 100,00 lbs with outside dimensions 5.5' X 7.5'.
10	Cable Trench for MCMS Cabling	620	LF	$2,700	$1,674,000	24" x 36" reinforced concrete U-trench (flush with the ground) with hinged lift assist lay flat lids (Aircraft Traffic Rated 100,000 lbs) for MCMS cabling. Other options may be explored for cost savings.
11	Wharf Pavement Reconstruction	1,255	SY	$50	$62,740	Asphalt pavement reconstruction above duct bank (secondary feeder). Includes 15% allowance for pavement reconstruction around the pull boxes + connection pit + cable trench.
	30% Site Improvements Project Contingency (Planning Stage)				$2,638,938	
	Site Improvements Subtotal				**$11,435,398**	
	Allowances					
12	Mobilization (assume 2.5% of Capex cost)				$683,370	
13	General Conditions (assume 6.5% of Capex cost)				$1,776,760	Indirect Costs
14	Allowance (Cabling)				$320,000	Based on linear footage of Concrete Encased 9W6 Duct bank
15	Allowance (Dry and Wet Commissioning)				$250,000	
16	Allowance (Surface Water Pollution Prevention Plan)				$55,000	
17	Allowance (Relocation of Other Existing Utilities)				$750,000	Based on linear footage of Concrete Encased 9W6 Duct bank
18	Engineering and Design (assume 4.5% of Capex cost)				$1,230,060	
	Allowances Subtotal				**$5,065,190**	
	OPC GRAND TOTAL – Equipment, Site Improvements, and Allowances				**$32,399,913**	
	Potential Grand Total OPC Range $22.6 (-30%) to $42.1 (+30%) million					

Source: M&N, 2022.

Table 5-3. CT21, CT25 and CT26 Shore Power OPC Estimate

Item	Activity	Qty	Unit	Unit Price	Total	Description
	Equipment					
1	Portside Load Transformer and Switchgear Substation (Furnish & Install)	3	EA	$3,900,000	$11,700,000	Contained or containerized module supporting one berth. No power converter. Excludes architectural shrouding or similar.
2	Mobile Cable Management System (MCMS) – 11/6.6KW with Cabling for 150' Trench	3	EA	$1,600,000	$4,800,000	HV Tug pulled mobile MCS type.
3	Secondary Feeder Power Cables (11/6.6 KV) (Furnish & Install)	76,808	LF	$50	$3,840,400	Includes 5 power cables (+ one spare duct), 3 conductors + 10% waste.
4	Shore-to-Ship Communication and Control Cable (Furnish & Install)	10,241	LF	$100	$1,024,100	Includes 2 communication cables + one spare duct + 10% waste.
5	Shore Power Connection Point (Outlet Assembly)	4	EA	$130,000	$520,000	Surface mounted on concrete pad. Additional study to identify if can be mounted below ground.
	15% Equipment Project Contingency (Planning Stage)				$3,282,675	
	Equipment Subtotal				**$25,167,175**	
	Site Improvements					
6	Site Demolition	1	LS	$2,105,000	$2,105,000	Based on linear footage of concrete encased 9W6 duct bank.
7	Substation Slab & Base (1 per Containerized Substation)	3	EA	$231,110	$693,330	52' x 20' x 4' reinforced structural concrete slab + 12" lime rock base.
8	Concrete Encased 9W6 Duct bank (Secondary Feeder)	4,655	LF	$1,500	$6,982,500	4' x 4' concrete encased duct bank (36" cover).
9	Reinforced Concrete Pull Box for Secondary Feeder	26	EA	$150,000	$3,900,000	Aircraft traffic rated 100,00 lbs with outside dimensions 5.5' X 7.5'.
10	Cable Trench for MCMS Cabling	1,240	LF	$2,700	$3,348,000	24" x 36" reinforced concrete U-trench (flush with the ground) with hinged lift assist lay flat lids (Aircraft Traffic Rated 100,000 lbs) for MCMS cabling. Other options may be explored for cost savings.
11	Wharf Pavement Reconstruction	2,379	SY	$50	$118,960	Asphalt pavement reconstruction above duct bank (secondary feeder). Includes 15% allowance for pavement reconstruction around the pull boxes + connection pit + cable trench.
	30% Site Improvements Project Contingency (Planning Stage)				$5,144,337	
	Site Improvements Subtotal				**$22,292,127**	
	Allowances					
12	Mobilization (assume 2.5% of Capex cost)				$1,186,480	
13	General Conditions (assume 6.5% of Capex cost)				$3,084,850	Indirect Costs
14	Allowance (Cabling)				$605,000	Based on linear footage of Concrete Encased 9W6 Duct bank
15	Allowance (Dry and Wet Commissioning)				$250,000	
16	Allowance (Surface Water Pollution Prevention Plan)				$55,000	
17	Allowance (Relocation of Other Existing Utilities)				$1,415,000	Based on linear footage of Concrete Encased 9W6 Duct bank
18	Engineering and Design (assume 4.5% of Capex cost)				$2,135,670	
	Allowances Subtotal				**$8,732,000**	
	OPC GRAND TOTAL – Equipment, Site Improvements, and Allowances				**$56,191,302**	
	Potential Grand Total OPC Range $39.3 (-30%) to $73 (+30%) million					

Source: M&N, 2022.

Table 5-4. CT29 Shore Power OPC Estimate

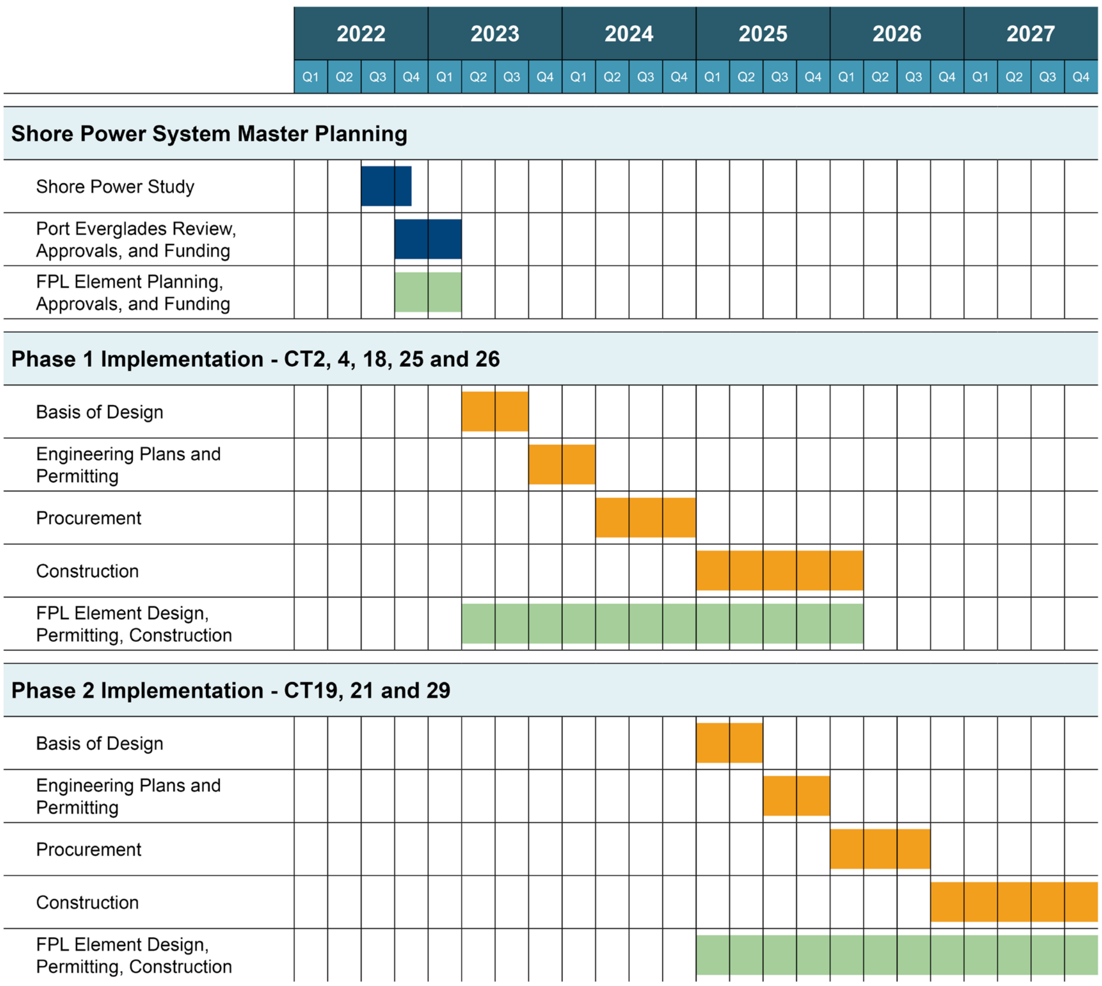
Item	Activity	Qty	Unit	Unit Price	Total	Description
	Equipment					
1	Portside Load Transformer and Switchgear Substation (Furnish & Install)	1	EA	$3,900,000	$3,900,000	Contained or containerized module supporting one berth. No power converter. Excludes architectural shrouding or similar.
2	Mobile Cable Management System (MCMS) - 11/6.6KW with Cabling for 150' Trench	1	EA	$1,600,000	$1,600,000	HV Tug pulled mobile MCS type.
3	Secondary Feeder Power Cables (11/6.6 KV) (Furnish & Install)	10,560	LF	$50	$528,000	Includes 5 power cables (+ one spare duct), 3 conductors + 10% waste.
4	Shore-to-Ship Communication and Control Cable (Furnish & Install)	1,408	LF	$100	$140,800	Includes 2 communication cables + one spare duct + 10% waste.
5	Shore Power Connection Point (Outlet Assembly)	1	EA	$130,000	$130,000	Surface mounted on concrete pad. Additional study to identify if can be mounted below ground.
	15% Equipment Project Contingency (Planning Stage)				$944,820	
	Equipment Subtotal				**$7,243,620**	
	Site Improvements					
6	Site Demolition	1	LS	$290,000	$290,000	Based on linear footage of concrete encased 9W6 duct bank.
7	Substation Slab & Base (1 per Containerized Substation)	1	EA	$231,110	$231,110	52' x 20' x 4' reinforced structural concrete slab + 12" lime rock base.
8	Concrete Encased 9W6 Duct bank (Secondary Feeder)	640	LF	$1,500	$960,000	4' x 4' concrete encased duct bank (36" cover).
9	Reinforced Concrete Pull Box for Secondary Feeder	4	EA	$150,000	$600,000	Aircraft traffic rated 100,00 lbs with outside dimensions 5.5' X 7.5'.
10	Cable Trench for MCMS Cabling	310	LF	$2,700	$837,000	24" x 36" reinforced concrete U-trench (flush with the ground) with hinged lift assist lay flat lids (Aircraft Traffic Rated 100,000 lbs) for MCMS cabling. Other options may be explored for cost savings.
11	Wharf Pavement Reconstruction	327	SY	$50	$16,360	Asphalt pavement reconstruction above duct bank (secondary feeder). Includes 15% allowance for pavement reconstruction around the pull boxes + connection pit + cable trench.
	30% Site Improvements Project Contingency (Planning Stage)				$880,341	
	Site Improvements Subtotal				**$3,814,811**	
	Allowances					
12	Mobilization (assume 2.5% of Capex cost)				$276,460	
13	General Conditions (assume 6.5% of Capex cost)				$718,800	Indirect Costs
14	Allowance (Cabling)				$85,000	Based on linear footage of Concrete Encased 9W6 Duct bank
15	Allowance (Dry and Wet Commissioning)				$250,000	
16	Allowance (Surface Water Pollution Prevention Plan)				$55,000	
17	Allowance (Relocation of Other Existing Utilities)				$195,000	Based on linear footage of Concrete Encased 9W6 Duct bank
18	Engineering and Design (assume 4.5% of Capex cost)				$497,630	
	Allowances Subtotal				**$2,077,890**	
	OPC GRAND TOTAL – Equipment, Site Improvements, and Allowances				**$13,136,321**	
	Potential Grand Total OPC Range $9.1 (-30%) to $17 (+30%) million					

Source: M&N, 2022.

5.6 SHORE POWER DESIGN AND CONTRUCTION

A schedule for design, procurement, and construction of shore power at Port Everglades Subject Cruise Terminals is provided in Figure 5-9. The schedule divides improvements across two Phases, with Phase 1 extending shore power improvements to CT2, 4, 18, 25, and 26 and Phase 2 expanding the system to cover CT19, 21, and 29. As shown, construction of Phase 1 shore power systems would commence Q1 of 2025 and be substantially complete by the end of 2025 or early 2026. Phase 2 could start as early as completion of procurement under Phase 1 and be substantially complete by end of 2027. Port Everglades may seek to align shore power investments with planned improvements to terminals, parking, and other facilities at CT19 and CT29. All Port Everglades shore power system investment would parallel improvements to distribution by FPL.

Figure 5-9. Port Everglades Shore Power Design and Construction Schedule



Source: M&N, 2022.

Several factors may accelerate or slow shore power system implementation. These include prolonged equipment procurement, manufacturing and logistical delays, funding availability, and others. The schedule assumes shore power system investment remain a top priority by Port Everglades and Broward County.

5.7 SHORE POWER SYSTEM OPERATION

The way in which ports operate their shore power systems varies by location. Provided below are two operational approaches observed in North America.

Vancouver's Canada Place

The cruise shore power system at Canada Place was funded through a partnership between Princess Cruises, Holland America Line, and the Vancouver Fraser Port Authority (VFPA). The system was designed by Cochran Marine (now Watts Marine) and Western Pacific Enterprises. As operation of cruise shore power was not considered a core competence of VFPA and given the vested interest in the system by Princess and Holland America, a maintenance and operation agreement was established between the parties that placed the running of the system into the hands of the cruise line operators. VFPA retains ownership of the system due to use of public funding for construction. The maintenance and operation agreement makes clear each party's responsibility in terms of operation, maintenance, insurance requirements, protocols for facility access, and other factors.

Princess and Holland America executed a contract with Cochran Marine to operate the system. Cochran Marine, along with subconsultant Western Pacific Enterprises, conduct annual commissioning of the system and provide any needed pre-season checks, software and system updates, post-season stowage of jib connection cranes, and other activities. On vessel call days, Western Pacific Enterprises provides a technician responsible for system connection/disconnection to the vessels.

At the time of development, only Princess and Holland America vessels had the onboard connections and ability to connect to the shore power system. As more lines called on Canada Place, a third-party agreement was developed to allow any cruise line to plug into the system. The Princess/Holland America-VFPA-3rd party cruise line agreement establishes system cost sharing. Each year, a forecast of ship shore power system use is prepared, and system costs estimated and shared with all lines. At the end of the year, the final actual costs are settled between Princess, Holland America, and each cruise line. Necessary system improvements/repairs are included in the billing. BC Hydro, the local utility provider, directly invoices each cruise line for power consumed. VFPA is not involved in any invoicing activities.

Brooklyn Cruise Terminal

The cruise shore power system at the Brooklyn Cruise Terminal (BCT) became operational in 2016 following several delays associated with Hurricane Sandy (2012) and local coordination with the New York City Economic Development Corporation (NYCEDC) and Con Edison. The BCT dual voltage system was designed by Cochran Marine (now Watts Marine).

Ports America took over as BCT's operator in 2017. When Ports America took over terminal operations, they were required to manage the shore power system. Ports America executed a contact with Cochran Marine to operate the system. Cochran Marine conducts an annual commissioning of the system and do needed pre-season checks along with software and other systems updates. On call days, Cochran Marine provides a technician responsible for system connection/disconnection to the vessels. The agreement with Cochran Marine is a year-to-year agreement.

In terms of billing, three bills are processed. Ports America pays for the upkeep of the system and these services are part of their contract and line billing. Cruise lines pay for the service technician and connection/disconnection the shore power system to the vessel. Finally, Con Edison bills the New York Department of Citywide Services for power use. This bill is passed on to the NYCEDC, then Ports America, and eventually the cruise lines. Ports America does not mark-up power consumed.

Operational Considerations

As identified in the provided two examples, third-party management is commonly observed in the operation of shore power systems. One identified exception is the Port of Los Angeles which has trained personal inhouse to operate the system.

Ports contacted were generally unable to share the operational cost arrangements with third party providers. M&N has learned from cruise line operators that costs can range from $3,000 to $4,000 per call to cover the costs shore power system connection/disconnection and to have certified personnel trained in high voltage electrical equipment operation to be onsite and/or on standby. Monthly and yearly maintenance costs are unknown and have some dependence on the equipment manufacturer's system component warranties. For example, Cavotec can be contracted to conduct regular maintenance on junction boxes and cable connection points to clean and remove moisture which can interfere with the performance of the system.

6. FEASIBILITY AND IMPLEMENTATION

6.1 FUNDING SHORE POWER SYSTEMS

Funding shore power systems can be difficult. Upfront capital costs are high, both associated with berth installed equipment and any needed upgrades to existing power networks and grids. Power provided by a utility and consumed by the cruise line generally cannot be marked up to cover system capital costs. Port locations with a seasonal cruise business or emerging/low volumes cruise ports experience periods with low or no system use, adding complexity and risk to capex payback.

Shore power system project finance typically involves public and/or private funding. We discuss each in the following section.

6.1.1. PUBLIC SECTOR INVESTORS

Ports and public authorities generally fund shore power projects through traditional project self-finance blended with awarded public sector grants. In the U.S., the Diesel Emissions Reduction Act (DERA) and USEPA have historically provided grants to help offset some amount of shore power system Capex. Developments on the west coast, especially in California, have benefitted from individual state grants or Air Quality Management District (AQMD) initiatives. The Port Infrastructure and Development Program (PIDP) and 2022 Inflation Reduction Act (IRA) are recent additional funding avenues for projects of this nature and scale.

Canada's Shore Power Technology for Ports Program (SPTP), which is part of the Government's effort to limit air pollution and GHG emissions, has historically provided up to 50% of necessary funding requested to implement marine shore power at ports. Provincial governments have also collaborated in the funding of shore power technologies.

Developments at European ports have been funded, at least partially, with public grants. These grants originate from European funds such as the European Regional Development Fund (ERDF) among others. National, regional, and local governments have also funded investment in shore power. For example, in Germany authorities agreed on a package of measures for development of shore generated power at multiple ports, including Hamburg, Rostock, and Kiel.

6.1.2. PRIVATE SECTOR INVESTORS

Involvement of private funds in infrastructure investment has become more common in recent years to support governments and public organizations in reducing/closing funding gaps. Investments are through debt or equity, depending on each project and the investors strategy. Most large infrastructure developments are capitalized with between 20% to 40% equity and the remainder from debt. The debt tends to have low loss probability, being secured to attract investors. Generally, private investors seek out large projects to finance through equity for equally large returns.

Green bonds and associated investment funds have not to date shown a great presence in the shore power arena due to the uncertainty in customer numbers during the first years of the investment. However, given the growing importance of the socio-environmental concern in society and individual strategic goals of some investment funds, the possibility of a private fund partially investing in this type of project is now more likely to be considered. Some funds have started to offer green bonds or environmentally sensible bonds, looking to fund projects that will have a positive impact even though the return on investment could be smaller. In general, green bonds have been issued for projects with high capital demands. Private investors have mainly focused on diversified assets that can result in benefits, while public authorities are looking to fund green transport alternatives.

Cruise operators are accelerating environmental actions to reduce their global footprint. As a consequence, many cruise lines have shown interest in collaborating with ports to develop shore power infrastructure as part of their sustainability objectives. A handful of cruise lines have been directly involved in advancing shore power system development, notably Princess Cruises and Holland America line in Seattle, Vancouver, and Juneau. In Seattle, Princess Cruises and Holland America Line worked with the Port of Seattle to fund a shore power project. The development was funded by the two cruise lines, USEPA grants, and City of

Seattle funds. In addition, both companies modified their fleet for the use of shore power technology. As described in Section 5.4, a similar cost sharing arrangement helped shape investment in shore power at Canada Place.

6.1.3. FUNDED SHORE POWER SYSTEMS

Table 6-1 summarizes several shore power funding examples from projects in the U.S., Canada, and Europe. Data presented was gathered from public sources and publications. Included within the Table are selected cargo shore power systems.

Several conclusions can be drawn from this work. First, almost all projects have covered a significant amount Capex from public grants, which in turn, have helped to reduce the dependence on local port authority self-finance. Another aspect which highlights the importance of public funding for shore power is how developments have occurred in countries or regions with Identifiable funds and grant opportunities available for green initiatives. These include Canada's SPTP, the public investment funds in Norway, and grants from CARB in California—which is the only jurisdiction mandating vessels connect to shore power, forcing public authorities to offer important financial aid.

In summary, shore power development projects usually involve a consortium of stakeholders contributing to the cost, including several government authorities which include municipal, regional, and national organizations, port authorities and cruise lines.

TABLE 6-1. SHORE POWER PROJECTS FUNDING STRUCTURE

Port or Terminal	Vessel Types	Date of Project	Funding Methods
Juneau (USA)	Cruise	2002	Princess Cruises paid for the majority of the investment to construct the shore side facilities.
Seattle (USA)	Cruise	2005	Grid upgrade was financed with a USEPA grant and other investment was funded through collaboration with cruise lines.
Long Beach (USA)	Cruise, container tankers	2008	70% covered with public grants and the remaining from terminals.
Vancouver – (Canada) Canada Place	Cruise	2009 to 2013	System funding originated from VFPA ($1 million CAD), Princess and Holland America ($3 million CAD), BC Provincial Government Grants ($2 million CAD), and Canada SPTP Grants ($3 million CAD).
San Francisco (USA)	Cruise, container	2010	Public funds from San Francisco, Bay Area Air Quality program, USEPA grants and Port of San Francisco.
Oslo (Norway)	Cruise	2011	Combined investment between Port Authority of Oslo, Norwegian and European public funds, and Color Line (ferry company) private investment. In addition to this first investment, further upgrades in other terminals/berths at Port of Oslo have mainly been supported with Enova's public funds.
Prince Rupert (Canada)	Container	2011	Public grants from Canada's SPTP, Western Economic diversification grants provided by the Canadian government and funds from BC Provincial Government Grants. Port authority together with partners such as CN Rail and Maher Terminals (private terminal operator) provided 25% of the funds.
Halifax (Canada)	Cruise	2014	75% of the funds came from public sources such as Canada's SPTP and the Province of Nova Scotia. Remaining funds were provided by the port authority.
Kristiansand (Norway)	Cruise	2014-2020	2014 – Mainly funded by the port authority and Color Line (ferry company). The ferry made its investment through a Norwegian public fund aiming to reduce air pollution. 2018 – Electric plant paid by the European Union Innovation Fund Horizon while the infrastructure investment, which was a smaller amount, was funded by the port authority.
Livorno (Italy)	Multi-purpose	2015	Co-financed mainly by the Italian Ministry of Environment and the regional government.
Hamburg (Germany) – Altona Cruise Terminal	Cruise	2016	Shore power project was funded by federal government and European Union public funds.
Montreal (Canada)	Cruises, bulk	2017	Public funds from Canada's SPTP and the Province of Quebec. The port authority provided the rest of funds (27%).
Bergen (Norway)	Cruise Offshore Service Vessel (OSV)	2020 2015	Cruise Terminal (2020) – Port received 60% of the funds from a state-owned grant scheme (Enova). Bergen Port and a renewables company provided the rest of the funds. The available information states cruise ships will cover the investment over time. OSV (2015) – 72% public funding from municipality, county and Enova. The rest was paid by the port authority.
Marseille (France) – Eastern Harbour	Ro-Pax	2022	80% public grants from European Regional Development Fund and Departmental Council.

6.2 PUBLIC GRANT TARGETS FOR PORT EVERGLADES

The following grant opportunities to help support Port Everglades shore power systems funding were identified by M&N. Please note, use many of the grant funds listed below will federalize most if not all of the Port Everglades electrification program:

- **Diesel Emissions Reduction Act (DERA).** The DERA Program funds grants and rebates that protect human health and improve air quality by reducing harmful emissions from diesel engines. DERA funds have played an important role in funding cruise, cargo, and ferry shore power systems in the U.S. Shore power funding examples include (USEPA, 2022):
    - The Northwest Seaport Alliance (2019) – $1.0 million awarded to Install marine shore power at two ship berths for container vessels at Husky Terminal in Tacoma, Washington.
    - Port of Seattle (2020) - $323,773 awarded to install marine shore power at Bell Street Cruise Terminal.
    - Miami-Dade County (2021) - $2.0 million awarded to install shore project to allow docked cruise ships to use electric power and shut off their diesel engines (Carnival Terminal F).
    - Port of San Francisco (2009-2010) - $1.0 million to design and install shore-to-ship electrical connection system for cruise ships berthed at Pier 27.
    - Port of Hueneme (2013) - $500,000 awarded to install shore-side power to OGVs.
    - Alabama Department of Transportation (2016) - $1.1 million awarded to repower one ferry to battery-electric and upgrade shore power connections.
    - Port Authority of New York and New Jersey (2009) – $2.8 million to install shore power at the Brooklyn Cruise Terminal.

  Request applications open at the start of each year and are due by March.
- **Federal Carbon Reduction Program Funds (CRP).** Over the next five years, the Florida Department of Transportation (FDOT) will receive $320 million in carbon reduction funds. An estimated 65% of those funds will flow into Metropolitan Planning Organizations (MPO) based on population and the remaining 35% of those funds are discretionary with FDOT. The Bipartisan Infrastructure Law specifically authorizes CRP funds for “project[s] that reduces transportation emissions at port facilities, including through the advancement of port electrification.” We conservatively forecast the Broward MPO will receive annually $300,000 to $500,000 in CRP funds to distribute each year, while FDOT will have approximately $22 million annually in CRP funds to distribute each year. Two possible approaches for Port Everglades to consider include:
    - Work through Broward County Commissioners sitting as Broward MPO Board members to program CRP funds towards port electrification. Over the next five years, this could yield between $1.5 to $2.5 million in Capex funding.
    - Approach FDOT to secure a five-year CRP funding commitment.
- **2022 Reconciliation Bill EPA Port Electrification Grants.** More commonly known as IRA, the recently passed federal reconciliation bill authorizes $3 billion in EPA port electrification grants (Section 60102). Of that amount, $2.25 billion is for all ports (likely riverine, great lakes and seaports) while $750 million is reserved for ports in non-attainment areas. Unlike the CRP program, this is a one-time appropriation, and EPA guidance has yet to be published. Two possible approaches for consideration include:
    - Work through Port Everglades advocacy groups and firms to try and shape the rulemaking process, and to specifically ensure cruise berths and supporting shoreside equipment are eligible. While rulemaking is underway, Port Everglades can further refine its planning-level costs, schedules, and sequencing.
    - Wait until the EPA releases its grant guidance (estimated 4 to 8 months from report publication) and prepare a grant at that time. The risk here is that grant guidance may not be favorable to the port or to cruise terminals/cruise berths.
- **Federal PROTECT Grants and Allocations.** FDOT will receive approximately $70 million annually for the next five years for PROTECT resiliency improvements. In addition, Federal Highway Administration (FHWA) will award

approximately $1.4 billion in discretionary PROTECT grants to eligible recipients. Based on PROTECT statutory limitations, cruise-related electrification efforts would not be competitive for PROTECT grants or FDOT allocations. However, the Port Everglades bulkhead replacement program may be competitive for PROTECT grants or FDOT allocations, provided that it meets the following criteria: a port facility, including a facility that—connects a port to other modes of transportation; improves the efficiency of evacuations and disaster relief; or aids transportation.

- **Federal PIDP Grants.** In the past, United States Maritime Administration (MARAD) has avoided funding equipment and electrification initiatives. However, the most recent PIDP grant solicitation appeared to encourage such initiatives. These grants will be announced in September 2022, and at that time, it be more apparent if electrification is a PIDP priority. Important to consider is the following:
  - Given that the average PIDP grant is approximately $20 million, a PIDP grant would likely only support the electrification of one terminal. Multi-year PIDP grants are not allowable.
  - Port Everglades may have other priorities for the PIDP program, as it has historically been focused on traditional infrastructure.
  - Spring/Summer 2023 appears to be the likely window for the next round of PIDP grants.
- **Federal INFRA/MEGA Grants.** INFRA (known statutorily as the Nationally Significant Multimodal Freight & Highway Projects) awards competitive grants for multimodal freight and highway projects of national or regional significance to improve the safety, efficiency, and reliability of the movement of freight and people in and across rural and urban areas. The Mega Program (known statutorily as the National Infrastructure Project Assistance program) will support large, complex projects that are difficult to fund by other means and likely to generate national or regional economic, mobility, or safety benefits. Both programs present opportunities for port electrification funding, but funded improvements would need to serve freight purposes in order to qualify. Cruise locations supporting some degree of freight-based services might be suitable for an INFRA/MEGA Grant application.
- **Federal RAISE Grants.** Beginning in 2021, the US Department of Transportation rebranded the former BUILD and TIGER grant programs into the Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Grant Program. The program has a dedicated $9.9 billion of funding to be dispersed over 13 competition rounds of National Infrastructure Investment, specifically targeted for upgrading and/or repairing critical pieces of our passenger and freight transportation networks.

Beyond those offered above State and local grant monies may be available to offset shore power system Capex. This includes funding for shore power as part of the annual Florida Seaport Transportation and Economic Development Program (FSTED) (Florida Ports Council , 2022).

Additional grant funds may be available to help offset costs associated with linking shore power utility upgrades and related site improvements. The range and availability of these types of funds is broad and not included herein. Port Everglades continually reviews and identifies grants for other portwide projects, and as such, should consider opportunities to 'bundle' shore power utility upgrades. FPL is also actively involved in grant identification and is working in partnership with Port Everglades to identify available funding to offset project costs.

6.3 PRIVATE OPTIONS

Due to the size of the investment and regularity of cruse homeport traffic, Port Everglades may be able to generate attention and interest in the shore power project from infrastructure investment funds. Based on conversations with investors, project risks are present but not unsurmountable. Infrastructure funds, green bonds, and other private investment sources driven by a combination of monetary and social benefit missions may be interested in investing in the shore power project.

As documented previously, cruise lines have participated in partial funding of shore power systems along the West Coast. Cruise line ESG efforts also point to a strong alignment of this project type with their carbon reduction goals at destinations.

Cruise terminal operators such as Global Ports Holdings (GPH), SSA, and others may be enticed to participate in infrastructure funding for the Port Everglades shore power project provided an adequate rate of investment return is available.

Besides infrastructure funds and cruise lines, there is another possibility to raise funds for shore power technologies through vendor financing. Vendor financing is potentially available from vendors who would install the system. The exact terms of vendor financing need to be discussed with each provider individually. These companies will normally look for a return on the investment and probably some sort of credit backstop from Port Everglades.

Schneider Electric, a potential supplier of shore power technologies, announced in 2020 a joint venture with Carlyle Group (investment fund) to take part in infrastructure, electric, and energy modernization projects. Projects advanced by this group include upgrades at JFK Airport in New York and development at the Port of Corpus Christ in Texas.

6.4 CAPEX AND OPEX RECOVERY

The business case for the implementation of shore power at Port Everglades has been structured in a way that considers a main revenue stream and different operational costs. Revenues are expected to come from service fees charged to cruise vessels connecting to shore power. In addition to a service fee, cruise vessels will need to face electricity consumption fees which will offset their current expense in fuel and shup O&M labor expenses while at berth.

Table 6-2. Summary of All Cruise Terminals OPC Estimate (Excluding FPL Share)

	OPC	OPC – 30%	OPC + 30%	Notes
CT2 and CT4 *(Detail provided in Table 5-2)*	$23,022,785	$16,115,949	$29,929,620	Phase 1
CT18 and CT19 *(Detail provided in Table 5-3)*	$32,399,913	$22,679,939	$42,119,887	Phase 1 (CT18) Phase 2 (CT19)
CT21, CT25 and CT26 *(Detail provided in Table 5-4)*	$56,191,302	$39,333,911	$73,048,693	Phase 1 (CT25, CT26) Phase 2 (CT21)
CT29 *(Detail provided in Table 5-5)*	$13,136,321	$9,195,425	$17,077,217	Phase 2
SUBTOTAL	$124,750,321	$87,325,224	$162,175,417	

Source: M&N, 2022

An estimated 14,250 cruise vessel calls are forecast between FY2025/26 and FY2046/47 (see Appendix B).[24] If Port Everglades were to divide equally the core OPC of $124.7 million, this would equate to a Capex recovery per call of +/-$8,750.

This investment—and pass along charges to cruise tenants—would be benefitted from public grants to help offset project Capex and reduce the degree of passthrough charges to users. There is normally a maximum share of the investment that can be covered with public grants and some grants are not given to projects that have received other public funds. FPL rate charges would be a direct pass through to cruise lines (e.g., no markup). If public subsidies were available to reduce to Port Everglades share of the Capex (non-FPL infrastructure) by 35%, the total OPC is lowered to $81.1 million and the Capex recovery per cruise vessel call would decline to +/- $5,690.

Once infrastructure is available, most of the analyzed examples are generally operated by a private vendor or the port authority (refer to Section 5.4). From our interviews, the per call operational cost passed along by a vendor can range from $3,000 to $4,000. No data was available on costs associated with port authority operation of shore power facilities.

[24] *CT21 ferry traffic (Jaume II) removed from this total number.*

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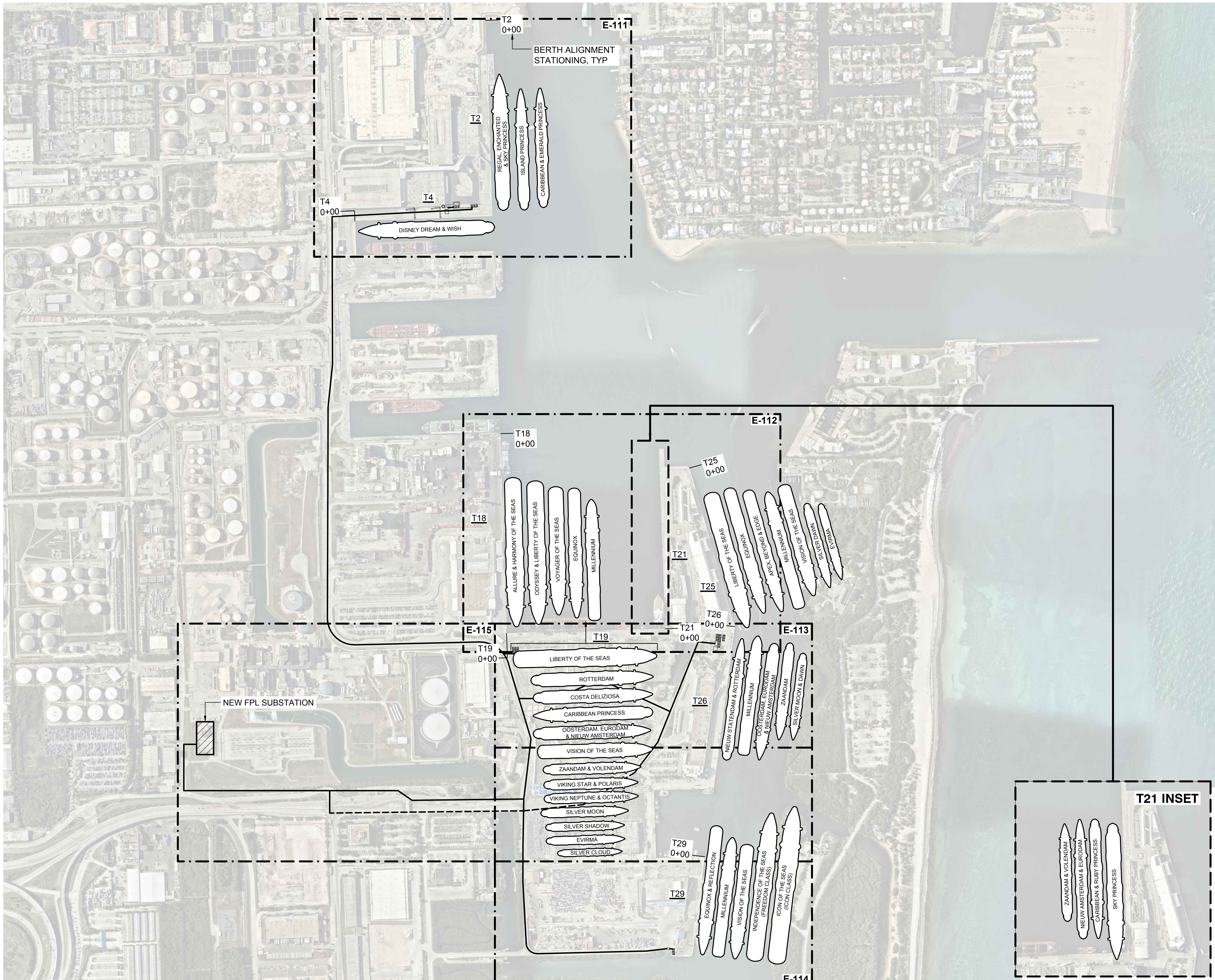
8. APPENDIX A – PORT EVERGLADES SHORE POWER DRAWINGS

8. APPENDIX A – PORT EVERGLADES SHORE POWER DRAWINGS



SITE MASTER PLAN

ISSUED FOR REVIEW: 2022-11-04

NOT TO BE USED FOR CONSTRUCTION

BROWARD COUNTY FLORIDA

Mark	Description	Date	Appr

PORT EVERGLADES
ELECTRIFICATION MASTER PLAN

OVERALL ELECTRICAL SITE PLAN

Date: NOVEMBER 2022	Rev. 0
M&N Project No. 210699-07	
Drawing code:	
Drawing Scale:	
Plot scale: 1:1 (D SHEET)	
Designed by: MK	
Dwn by: DK	Ckd by: MK
Reviewed by:	
Submitted by: MOFFATT & NICHOL	

moffatt & nichol
2937 SW 27th AVE., STE 101A
MIAMI, FL 33133
305-230-1924

SEAL

Sheet Reference No.

E-101

INDEX: 1 OF 8

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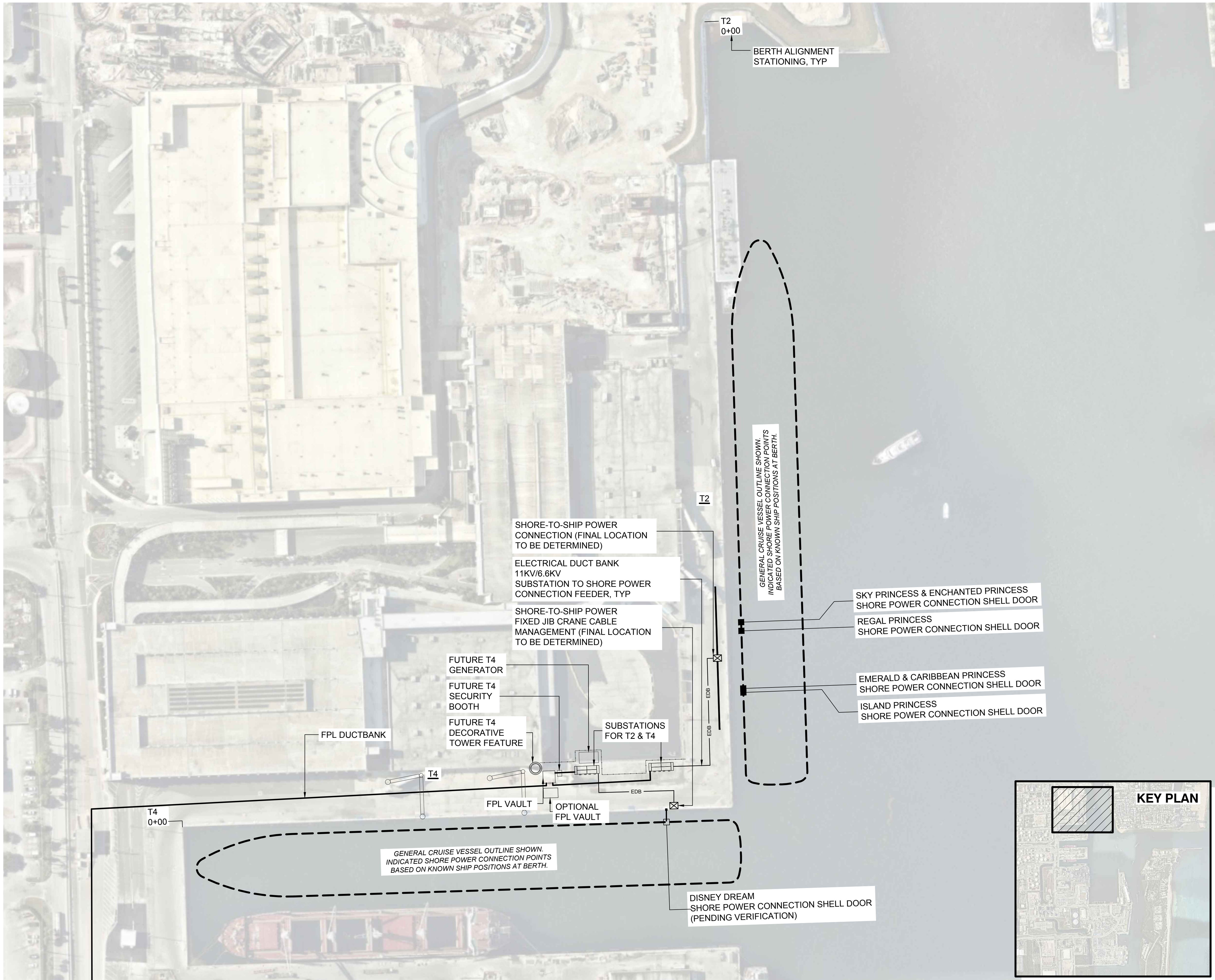

SITE MASTER PLAN
ISSUED FOR REVIEW: 2022-11-04
NOT TO BE USED FOR CONSTRUCTION

BROWARD COUNTY FLORIDA

Mark	Description	Date	Appr

PORT EVERGLADES
ELECTRIFICATION MASTER PLAN

ENLARGED ELECTRICAL SITE PLAN
BERTHS 2 & 4

moffatt & nichol
2937 SW 27th AVE., STE 101A
MIAMI, FL 33133
305-230-1924

Designed by: MK		Date: NOVEMBER 2022	Rev. 0
Dwn by: DK	Ckd by: MK	M&N Project No. 210699-07	
Reviewed by:		Drawing code:	
Submitted by: MOFFATT & NICHOL		Drawing Scale: Plot scale: 1:1 (D SHEET)	

SEAL

Sheet
Reference No.
E-111
INDEX: 2 OF 8

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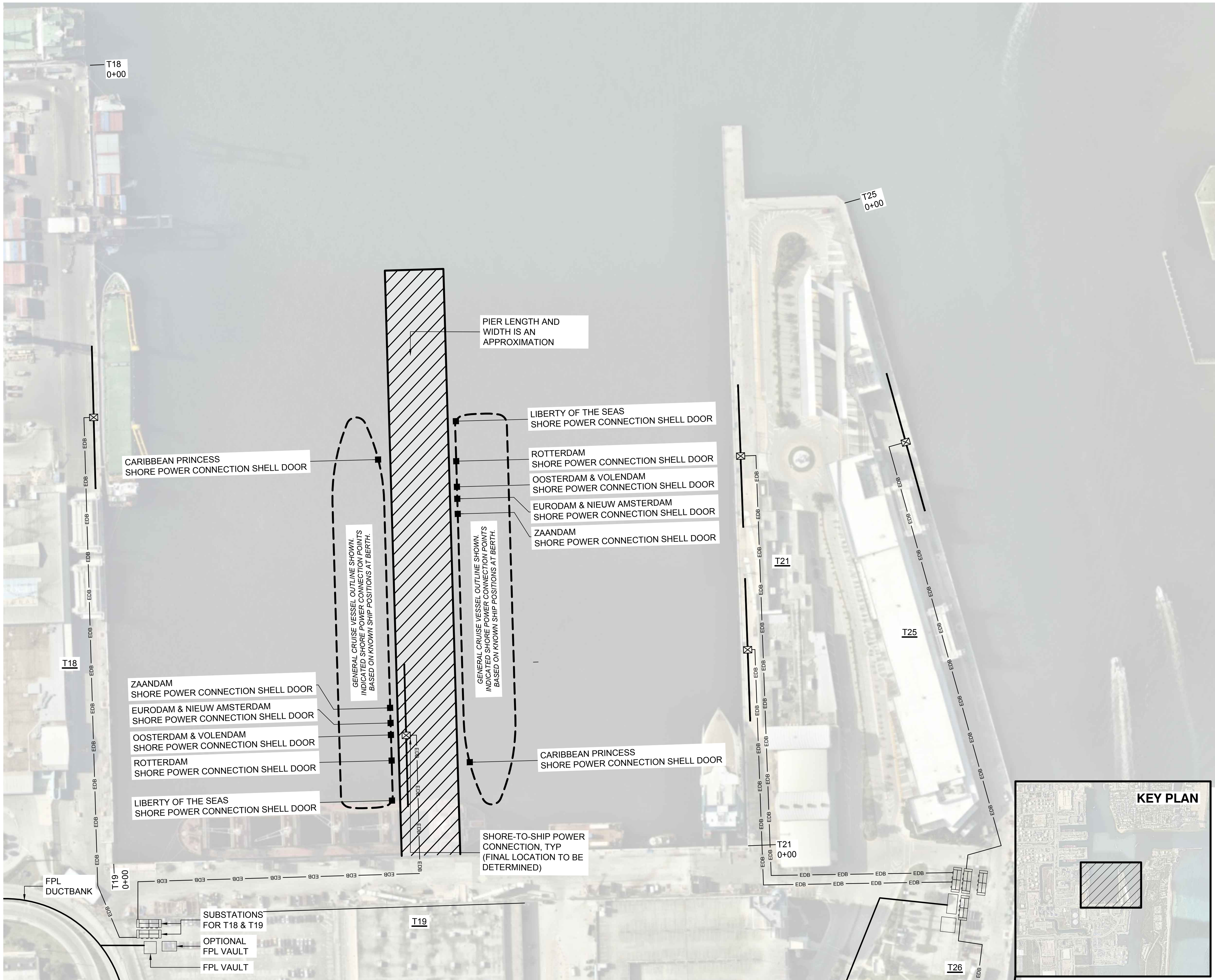

N

100' 0' 100' 200'

SCALE: 1"=100'

SITE MASTER PLAN
ISSUED FOR REVIEW: 2022-11-04
NOT TO BE USED FOR CONSTRUCTION

BROWARD COUNTY FLORIDA

Mark	Description	Date	Appr

PORT EVERGLADES
ELECTRIFICATION MASTER PLAN

ENLARGED ELECTRICAL SITE PLAN BERTHS 18, 19, 21 & 25 (ALTERNATE)

moffatt & nichol
2937 SW 27th AVE., STE 101A
MIAMI, FL 33133
305-230-1924

Designed by: DSGN		Date: NOVEMBER 2022	Rev. REVNO
Dwn by: DRFT	Ckd by: CHKR	M&N Project No. 210699-07	
Reviewed by: REVR		Drawing code:	
Submitted by: MOFFATT & NICHOL		Drawing Scale: Plot scale: 1:1 (D SHEET)	

SEAL

Sheet Reference No.
E-112-A
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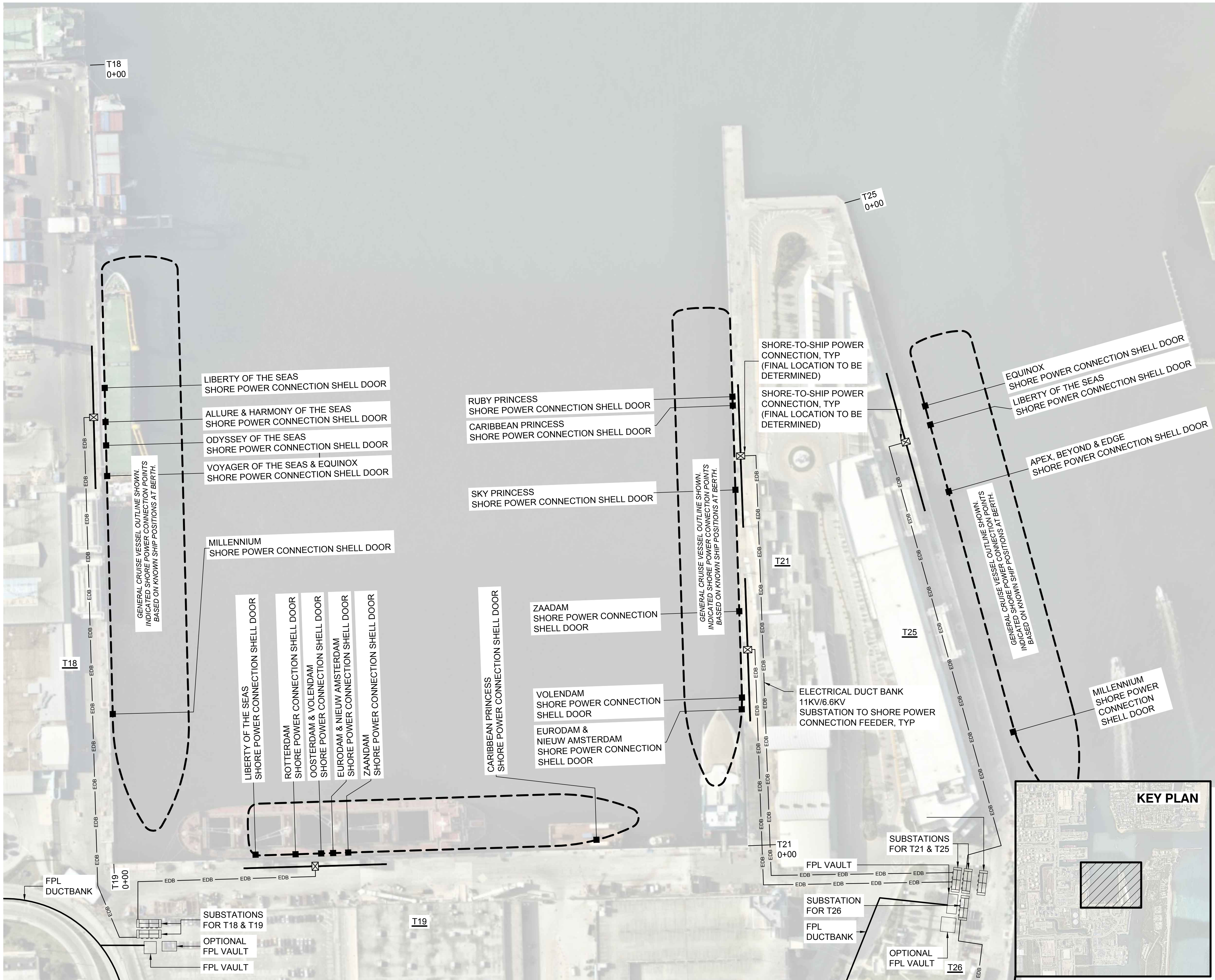

N

100' 0' 100' 200'

SCALE: 1"=100'

SITE MASTER PLAN
ISSUED FOR REVIEW: 2022-11-04
NOT TO BE USED FOR CONSTRUCTION

DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING

BROWARD COUNTY FLORIDA

Mark	Description	Date	Appr

PORT EVERGLADES
ELECTRIFICATION MASTER PLAN

ENLARGED ELECTRICAL SITE PLAN
BERTHS 18, 19, 21 & 25

Rev. 0
Date: NOVEMBER 2022
M&N Project No. 210699-07
Drawing code:
Drawing Scale:
Plot scale: 1:1 (D SHEET)

Designed by: MK
Dwn by: DK
Ckd by: MK
Reviewed by:
Submitted by: MOFFATT & NICHOL

moffatt & nichol
2937 SW 27th AVE., STE 101A
MIAMI, FL 33133
305-230-1924

SEAL

Sheet Reference No.
E-112
INDEX: 4 OF 8

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SITE MASTER PLAN

ISSUED FOR REVIEW: 2022-11-04

NOT TO BE USED FOR CONSTRUCTION

DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING

BROWARD COUNTY FLORIDA

Mark	Description	Date	Appr

PORT EVERGLADES ELECTRIFICATION MASTER PLAN

ENLARGED ELECTRICAL SITE PLAN BERTH 26

Designed by: MK	Date: NOVEMBER 2022	Rev. 0
Dwn by: DK	Ckd by: MK	M&N Project No. 210699-07
Reviewed by:		Drawing code:
Submitted by: MOFFATT & NICHOL		Drawing Scale: Plot scale: 1:1 (D SHEET)

moffatt & nichol
2937 SW 27th AVE., STE 101A
MIAMI, FL 33133
305-230-1924

SEAL

Sheet Reference No.

E-113

INDEX: 5 OF 8

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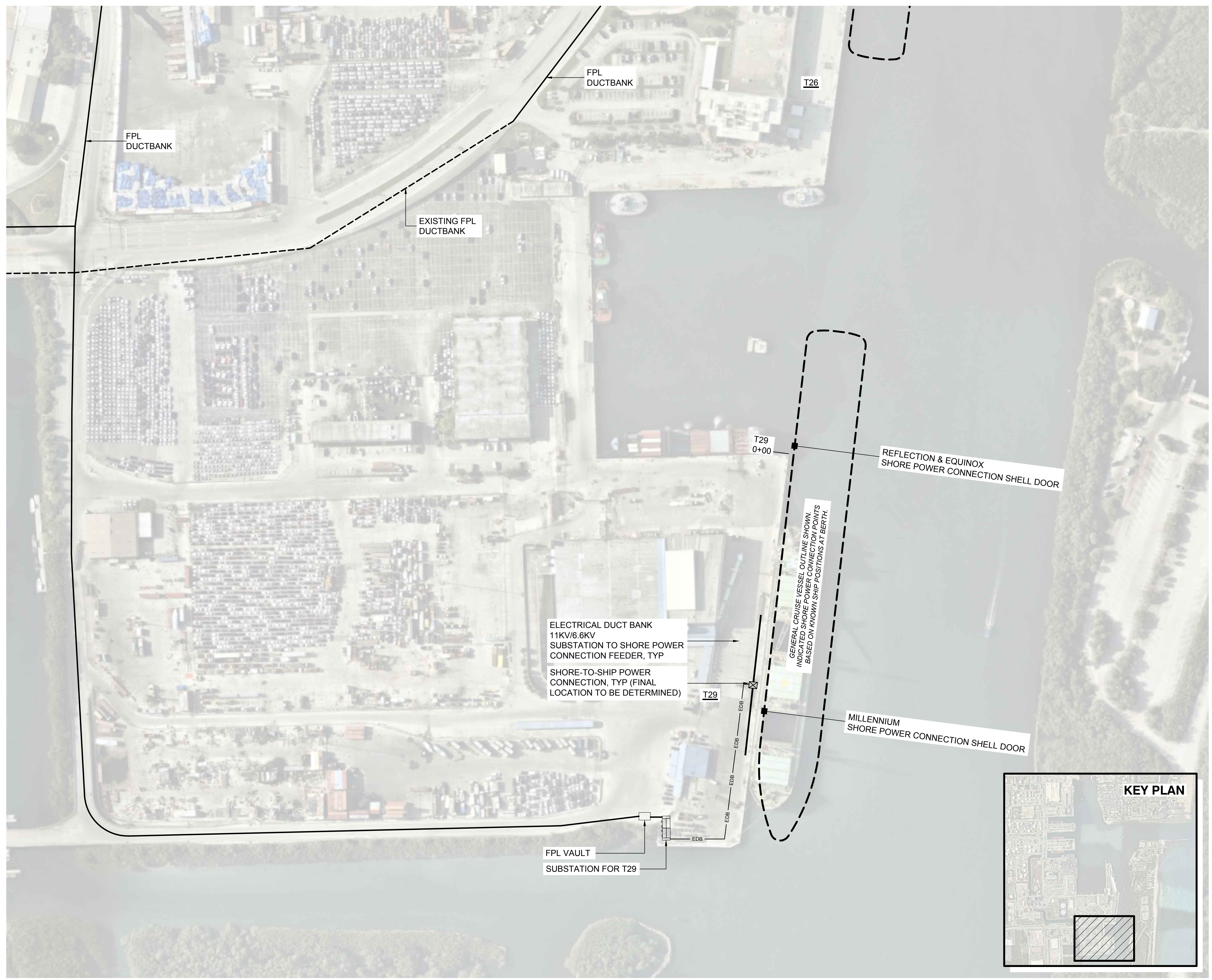

N

100' 0' 100' 200'

SCALE: 1"=100'

SITE MASTER PLAN
ISSUED FOR REVIEW: 2022-11-04
NOT TO BE USED FOR CONSTRUCTION

BROWARD COUNTY FLORIDA

Mark	Description	Date	Appr

PORT EVERGLADES
ELECTRIFICATION MASTER PLAN

ENLARGED ELECTRICAL SITE PLAN
BERTH 29

Designed by: MK		Date: NOVEMBER 2022	Rev. 0
Dwn by: DK	Ckd by: MK	M&N Project No. 210699-07	
Reviewed by:		Drawing code:	
Submitted by: MOFFATT & NICHOL		Drawing Scale: Plot scale: 1:1 (D SHEET)	

moffatt & nichol
2937 SW 27th AVE., STE 101A
MIAMI, FL 33133
305-230-1924

SEAL

Sheet
Reference No.
E-114

INDEX: 7 OF 8

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DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING

SITE MASTER PLAN
ISSUED FOR REVIEW: 2022-11-04
NOT TO BE USED FOR CONSTRUCTION

BROWARD COUNTY FLORIDA

Mark	Description	Date	Appr

PORT EVERGLADES
ELECTRIFICATION MASTER PLAN

ENLARGED ELECTRICAL SITE PLAN
BERTH 29 (ALTERNATE)

Designed by: DSGN	Date: NOVEMBER 2022	Rev. REVNO	
Dwn by: DRFT	Ckd by: CHKR	M&N Project No. 210699-07	
Reviewed by: REVR		Drawing code:	
Submitted by: MOFFATT & NICHOL		Drawing Scale:	Plot scale: 1:1 (D SHEET)

moffatt & nichol
2937 SW 27th AVE., STE 101A
MIAMI, FL 33133
305-230-1924

SEAL

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E-114-A
INDEX: 6 OF 8

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DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING

N

100' 0' 100' 200'

SCALE: 1"=100'

SITE MASTER PLAN

ISSUED FOR REVIEW: 2022-11-04

NOT TO BE USED FOR CONSTRUCTION

BROWARD COUNTY FLORIDA

Mark	Description	Date	Appr

PORT EVERGLADES
ELECTRIFICATION MASTER PLAN

ENLARGED ELECTRICAL SITE PLAN
FPL NEW SUBSTATION

Date: NOVEMBER 2022	Rev. 0
M&N Project No. 210699-07	
Drawing code:	
Drawing Scale:	
Plot scale: 1:1 (D SHEET)	
Designed by: MK	
Dwn by: DK	Ckd by: MK
Reviewed by:	
Submitted by: MOFFATT & NICHOL	

moffatt & nichol
2937 SW 27th AVE., STE 101A
MIAMI, FL 33133
305-230-1924

SEAL

Sheet
Reference No.
E-115
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DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING

9. APPENDIX B – POWER CONSUMPTION MODELING

PORT EVERGLADES ELECTRIFICATION MASTERPLAN

Terminal 2 Model

Terminal 2 predominately used by Princess and Holland America.

Data Sources

Port Everglades Master Cruise Schedule, FY22-24 *.xls (July 2022)

Vessel Data

Code	Name	Class	Brand	Shore Power	Max Pwr (MW)	Year Built	GRT	GRT Tier	Fuel	Fuel Tier
PCA	Caribbean Princess	Caribbean	Princess	Yes	11.00	2004	116000	>100,000	MGO	1
PEM	Emerald Princess	Caribbean	Princess	Yes	11.00	2007	116000	>100,000	MGO	1
PEN	Enchanted Princess	Royal	Princess	Yes	10.00	2020	141000	>100,000	MGO	3
PIS	Island Princess	Coral	Princess	Yes	9.00	2003	88000	100,000	MGO	1
PRE	Regal Princess	Royal	Princess	Yes	10.00	2014	141000	>100,000	MGO	2
PSK	Sky Princess	Royal	Princess	Yes	10.00	2019	141000	>100,000	MGO	3
PSH	Sphere	Sphere	Princess	Yes		2024	175000	>100,000	LNG	3
CQE	MS Queen Elizabeth	Vista	Cunard	No		2010	151400	>100,000	MGO	1
PAR	Arcadia		P&O	No		2005	83000	100,000	MGO	1

Calls by Cruise Ships

Code	Name	Class	Deployment	Season	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
PCA	Caribbean Princess	Caribbean	7-Day; 10-Day	Winter	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	3
PEM	Emerald Princess	Caribbean	Various	Winter	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
PEN	Enchanted Princess	Royal	10-Day	Winter	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	1
PIS	Island Princess	Coral	Various	Winter	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
PRE	Regal Princess	Royal	Various	Winter	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	1
PSK	Sky Princess	Royal	10-Day	Winter	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	1
PSH	Sphere	Sphere	TBD	TBD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CQE	MS Queen Elizabeth	Vista	Various	Winter	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
PAR	Arcadia	P&O	Various	Winter	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calls					88	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	8

Baseline // No Shore Power

Code	Name	Avg. In Port (Hrs.)	Connect / Disconnect (Hrs.)	Hotelling Hours	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
PCA	Caribbean Princess	9.00	0.00	9.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.0
PEM	Emerald Princess	9.00	0.00	9.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.0
PEN	Enchanted Princess	10.00	0.00	10.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.0
PIS	Island Princess	9.00	0.00	9.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.0
PRE	Regal Princess	10.00	0.00	10.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.0
PSK	Sky Princess	10.00	0.00	10.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.0
PSH	Sphere	0.00	0.00	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CQE	MS Queen Elizabeth	13.00	0.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.0
PAR	Arcadia	15.00	0.00	15.00	15.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baseline (Hours)					848.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.00	833.0

Network Time and Consumption // With Shore Power

Code	Name	Avg. In Port (Hrs.)	Connect / Disconnect (Hrs.)	Avg. Network Time	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
PCA	Caribbean Princess	9.00	1.50	7.50	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.0
PEM	Emerald Princess	9.00	1.50	7.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.5
PEN	Enchanted Princess	10.00	1.50	8.50	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.0
PIS	Island Princess	9.00	1.50	7.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.5
PRE	Regal Princess	10.00	1.50	8.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.5
PSK	Sky Princess	10.00	1.50	8.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.5
PSH	Sphere	0.00	0.00	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CQE	MS Queen Elizabeth	13.00	1.50	11.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PAR	Arcadia	15.00	1.50	13.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Network Time (Hours)					691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.00	691.0
Estimated Consumption (MW)					7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.00	7,135.0

PORT EVERGLADES ELECTRIFICATION MASTERPLAN

Terminal 4 Model

Terminal 4 exclusively used by Disney Cruise Lines starting FY23-24.

Data Sources

Port Everglades Master Cruise Schedule, FY22-24 *.xls (July 2022)

Disney Cruise Lines (July 2022)

Vessel Data

Code	Name	Class	Brand	Shore Power	Max Pwr (MW)	Year Built	GRT	GRT Tier	Fuel	Fuel Tier
DDR	Disney Dream	Dream	Disney	Planned	10.50	2011	116000	>100,000	MGO	1
DWI	Disney Wish	Triton	Disney	Planned	9.50	2021	128000	>100,000	MGO	3
HVO	Volendam	R - Class	Holland	Planned	6.00	1999	61200	60000	MGO	1
VST	Viking Star		Viking	No		2015	45000	60000	MGO	2

Calls by Cruise Ships

					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Class	Deployment	Season	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
DDR	Disney Dream	Dream	5/5/4	Year-Round	-	78	78	78	78	78	78	78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DWI	Disney Wish or Similar	Triton	5/5/4	Year-Round	-	-	-	-	-	-	-	-	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78
HVO	Volendam	R-Class	Unknown	Unknown	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VST	Viking Star		Unknown	Unknown	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calls					1	79	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78

Baseline // No Shore Power

					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Avg. In Port (Hrs.)	Connect / Disconnect (Hrs.)	Hotelling Hours	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
DDR	Disney Dream	11.75	0	11.75	-	916.50	916.50	916.50	916.50	916.50	916.50	916.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DWI	Disney Wish or Similar	11.75	0	11.75	-	-	-	-	-	-	-	-	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50
HVO	Volendam	9.00	0	9.00	9.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VST	Viking Star	11.00	0	11.00	-	11.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baseline (Hours)					9.00	927.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50	916.50

Network Time and Consumption

					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Avg. In Port (Hrs.)	Connect / Disconnect (Hrs.)	Avg. Network Time	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
DDR	Disney Dream	11.75	1.5	10.25	-	799.50	799.50	799.50	799.50	799.50	799.50	799.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DWI	Disney Wish or Similar	11.75	1.5	10.25	-	-	-	-	-	-	-	-	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50
HVO	Volendam	9.00	1.5	7.50	7.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VST	Viking Star	11.00	1.5	9.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Network Time (Hours)					7.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50
Estimated Consumption (MW)					45.00	8,394.75	8,394.75	8,394.75	8,394.75	8,394.75	8,394.75	8,394.75	7,595.25	7,595.25	7,595.25	7,595.25	7,595.25	7,595.25	7,595.25	7,595.25	7,595.25	7,595.25	7,595.25	7,595.25	7,595.25	7,595.25	7,595.25	7,595.25	7,595.25

PORT EVERGLADES ELECTRIFICATION MASTERPLAN

Terminal 18 Model

Terminal 18 predominately used by RCG and Celebrity.

Data Sources

Port Everglades Master Cruise Schedule, FY22-24 *.xls (July 2022)

Vessel Data

Code	Name	Class	Brand	Shore Power	Max Pwr (MW)	Year Built	GRT	GRT Tier	Fuel	Fuel Tier
RAL	Allure of the Seas	Oasis	RCCL	Planned	13.50	2010	220000	>100000	MGO	1
CEQ	Equinox	Solstice	Celebrity	Planned	11.00	2009	122000	>100000	MGO	1
CMI	Millennium	Millennium	Celebrity	Yes	8.00	2000	91000	100000	MGO	1
RHA	Harmony Of The Seas	Oasis	RCCL	Planned	11.00	2016	227625	>100000	MGO	2
RLI	Liberty Of The Seas	Freedom	RCCL	Planned	11.00	2007	160000	>100000	MGO	1
ROD	Odyssey Of The Seas	Quantum	RCCL	Yes	10.00	2021	168666	>100000	MGO	3
RVI	Vision of the Seas	Vision	RCCL	No	-	1998	78500	60000	MGO	1
RVO	Voyager Of The Seas	Voyager	RCCL	Yes	9.00	1999	142000	>100000	MGO	1
RSY	Symphony Of The Seas	Oasis	RCCL	Planned	11.00	2018	227625	>100000	MGO	3
RRA	Radiance Of The Seas	Radiance	RCCL	Planned	9.00	2001	90000	100000	MGO	1

Calls by Cruise Ships

					1	2	3	4	5	6	7	8	9	10
Code	Name	Class	Deployment	Season	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32
RAL	Allure of the Seas	Oasis	7-Day	Winter	5	-	-	-	-	-	-	-	-	-
CEQ	Equinox	Solstice	Various	Year-Round	6	8	6	6	6	6	6	6	6	6
CMI	Millennium	Millennium	Unknown	Winter	1	1	1	1	1	1	1	1	1	1
RHA	Harmony Of The Seas	Oasis	7-Day	Winter	19	24	24	24	24	24	24	24	24	24
RLI	Liberty Of The Seas	Freedom	/5/4 (<'32); 7-Day(>'32	Vinter; Summe	28	28	28	28	28	28	28	28	28	28
ROD	Odyssey Of The Seas	Quantum	7-Day	nter; Year-Rou	24	24	24	24	24	24	24	24	24	24
RVI	Vision of the Seas	Vision	Various	Winter	3	-	-	-	-	-	-	-	-	-
RVO	Voyager Of The Seas	Voyager	7-Day	Summer	22	22	22	22	-	-	-	-	-	-
RSY	Symphony Of The Seas	Oasis	Various	Winter	-	1	-	-	-	-	-	-	-	-
RRA	Radiance Of The Seas	Radiance	7-Day	Summer	-	-	-	-	22	22	22	22	22	22
Total Calls					108	108	105	105	105	105	105	105	105	105

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
RAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CEQ	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
CMI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RHA	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
RLI	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
ROD	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52
RVI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RVO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RSY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RRA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calls	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105

Baseline // No Shore Power

					1	2	3	4	5	6	7	8	9	10
Code	Name	Avg. In Port (Hrs.)	Connect / Disconnect (Hrs.)	Hoteling Hours	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32
RAL	Allure of the Seas	10.50	0.00	10.50	52.50	-	-	-	-	-	-	-	-	-
CEQ	Equinox	9.00	0.00	9.00	54.00	72.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00
CMI	Millennium	10.00	0.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
RHA	Harmony Of The Seas	10.50	0.00	10.50	199.50	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00
RLI	Liberty Of The Seas	10.50	0.00	10.50	294.00	294.00	294.00	294.00	294.00	294.00	294.00	294.00	294.00	294.00
ROD	Odyssey Of The Seas	10.45	0.00	10.45	250.80	250.80	250.80	250.80	250.80	250.80	250.80	250.80	250.80	250.80
RVI	Vision of the Seas	9.00	0.00	9.00	27.00	-	-	-	-	-	-	-	-	-
RVO	Voyager Of The Seas	9.00	0.00	9.00	198.00	198.00	198.00	198.00	-	-	-	-	-	-
RSY	Symphony Of The Seas	10.50	0.00	10.50	-	10.50	-	-	-	-	-	-	-	-
RRA	Radiance Of The Seas	9.00	0.00	9.00	-	-	-	-	198.00	198.00	198.00	198.00	198.00	198.00
Baseline (Hours)					1,085.80	1,087.30	1,058.80	1,058.80	1,058.80	1,058.80	1,058.80	1,058.80	1,058.80	1,058.80

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
RAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CEQ	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00
CMI	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
RHA	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00
RLI	231.00	231.00	231.00	231.00	231.00	231.00	231.00	231.00	231.00	231.00	231.00	231.00	231.00	231.00	231.00
ROD	543.40	543.40	543.40	543.40	543.40	543.40	543.40	543.40	543.40	543.40	543.40	543.40	543.40	543.40	543.40
RVI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RVO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RSY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RRA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baseline (Hours)	1,090.40	1,090.40	1,090.40	1,090.40	1,090.40	1,090.40	1,090.40	1,090.40	1,090.40	1,090.40	1,090.40	1,090.40	1,090.40	1,090.40	1,090.40

Network Time and Consumption

					1	2	3	4	5	6	7	8	9	10
Code	Name	Avg. In Port (Hrs.)	Connect / Disconnect (Hrs.)	Avg. Network Time	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32
RAL	Allure of the Seas	10.50	1.50	9.00	45.00	-	-	-	-	-	-	-	-	-
CEQ	Equinox	9.00	1.50	7.50	45.00	60.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
CMI	Millennium	10.00	1.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
RHA	Harmony Of The Seas	10.50	1.50	9.00	171.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00
RLI	Liberty Of The Seas	10.50	1.50	9.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00
ROD	Odyssey Of The Seas	10.45	1.50	8.95	214.80	214.80	214.80	214.80	214.80	214.80	214.80	214.80	214.80	214.80
RVI	Vision of the Seas	9.00	1.50	7.50	-	-	-	-	-	-	-	-	-	-
RVO	Voyager Of The Seas	9.00	1.50	7.50	165.00	165.00	165.00	165.00	-	-	-	-	-	-
RSY	Symphony Of The Seas	10.50	1.50	9.00	-	9.00	-	-	-	-	-	-	-	-
RRA	Radiance Of The Seas	9.00	1.50	7.50	-	-	-	-	165.00	165.00	165.00	165.00	165.00	165.00
Network Time (Hours)					901.30	925.30	901.30	901.30	901.30	901.30	901.30	901.30	901.30	901.30
Estimated Consumption (MW)					9,456.50	9,608.00	9,344.00	9,344.00	9,344.00	9,344.00	9,344.00	9,344.00	9,344.00	9,344.00

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
RAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CEQ	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
CMI	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
RHA	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00
RLI	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00
ROD	465.40	465.40	465.40	465.40	465.40	465.40	465.40	465.40	465.40	465.40	465.40	465.40	465.40	465.40	465.40
RVI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RVO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RSY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RRA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Network Time (Hours)	932.90	932.90	932.90	932.90	932.90	932.90	932.90	932.90	932.90	932.90	932.90	932.90	932.90	932.90	932.90
Estimated Consumption (MW)	9,771.00	9,771.00	9,771.00	9,771.00	9,771.00	9,771.00	9,771.00	9,771.00	9,771.00	9,771.00	9,771.00	9,771.00	9,771.00	9,771.00	9,771.00

PORT EVERGLADES ELECTRIFICATION MASTERPLAN

Terminal 19 Model

Terminal 19 serves many carriers.

Data Sources

Port Everglades Master Cruise Schedule, FY22-24 *.xls (July 2022)

Vessel Data

Code	Name	Class	Brand	Shore Power	Max Pwr (MW)	Year Built	GRT	GRT Tier	Fuel	Fuel Tier
CIN	Celebrity Infinity	Millennium	Celebrity	No	8.00	2001	91000	100000	MGO	1
CSI	Celebrity Silhouette	Solstice	Celebrity	Yes	11.00	2011	122000	>100000	MGO	1
CDE	Costa Deliziosa	Vista/Spirit (H	Costa			2010	92700	100000	MGO	1
PEM	Emerald Princess	Caribbean	Princess	Yes	11.00	2007	116000	>100,000	MGO	1
HEU	Eurodam	Signature	Holland	Yes	7.00	2008	86273	100000	MGO	1
EVR	Evrima	Mega Yacht	Ritz Carlton							
JA2	Jaume II									
RLI	Liberty of the Seas	Freedom	RCCL	TBD	11.00	2007	160000	>100000	MGO	1
MDI	Marbella Discovery	Vision	Marbella							
MRO	Mariner Of The Seas	Voyager	RCCL	Yes	9.00	2003	142000	>100000	MGO	1
HNA	Nieuw Amsterdam	Signature	Holland	Yes	7.00	2010	86000	100000	MGO	1
HOO	Oosterdam	Vista	Holland	Yes	7.00	2003	81769	100000	MGO	1
HRO	Rotterdam	Rotterdam	Holland	Yes	6.00	2021	99500	100000	MGO	3
SSC	Silver Cloud		Silversea			1194	16800		MGO	1
SSM	Silver Moon		Silversea			2020	40700		MGO	3
SSS	Silver Shadow		Silversea			2000	25000		MGO	1
VNE	Viking Neptune	Small/Specialt	Viking							
VOC	Viking Octantis	Polar 6	Viking			2021	30000		MGO	3
VPO	Viking Polaris	Polar 6	Viking			2022	30000		MGO	3
VST	Viking Star	Viking Star	Viking			2015	45000	60000	MGO	2
RVS	Vision of the Seas	Vision	RCCL	No	-	1998	78500	60000	MGO	1
HVO	Volendam	Rotterdam	Holland	Yes	6.00	1999	61214	60000	MGO	1
HZA	Zaandam	Rotterdam	Holland	Yes	6.00	2000	61396	60000	MGO	1

Calls by Cruise Ships

					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Class	Deployment	Season	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
CIN	Celebrity Infinity	Millennium	Unknown	Winter	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CSI	Celebrity Silhouette	Solstice	Unknown	Winter	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CDE	Costa Deliziosa	Vista/Spirit (H	Unknown	Winter	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PEM	Emerald Princess	Caribbean	Unknown	Winter	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
HEU	Eurodam	Signature	10-Day, Various	Winter	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
EVR	Evrima	Mega Yacht	25-Day	Winter	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
JA2	Jaume II		Various	Winter	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RLI	Liberty of the Seas	Freedom	3-Day, 4-Day	Winter	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
MDI	Marbella Discovery	Vision	Various	Winter	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
MRO	Mariner Of The Seas	Voyager	10-day	Winter	-					12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
HNA	Nieuw Amsterdam	Signature	Various	Winter	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HOO	Oosterdam	Vista	Unknown	Winter	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HRO	Rotterdam	Rotterdam	21-Day	Winter	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
SSC	Silver Cloud		Various	Winter	4	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
SSM	Silver Moon		Unknown	Winter	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SSS	Silver Shadow		Unknown	Winter	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VNE	Viking Neptune	Viking Ocean	Unknown	Winter	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VOC	Viking Octantis	Polar 6	Unknown	Winter	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VPO	Viking Polaris	Polar 6	Unknown	Winter	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VST	Viking Star	Viking Star	2- to 3-week	Winter	11	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
RVS	Vision of the Seas	Vision	10-day	Winter	9	9	9	9	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HVO	Volendam	Rotterdam	Various	Winter	4	5	5	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
HZA	Zaandam	Rotterdam	Unknown	Winter	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calls					93	83	83	86	86	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89

Baseline // No Shore Power

					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Avg. In Port (Hrs.)	Connect / Disconnect (Hrs.)	Hoteling Hours	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
CIN	Celebrity Infinity	11.00	0.00	11.00	11.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CSI	Celebrity Silhouette	10.00	0.00	10.00	10.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
CDE	Costa Deliziosa	12.00	0.00	12.00	12.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PEM	Emerald Princess	9.00	0.00	9.00	9.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00
HEU	Eurodam	9.00	0.00	9.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00
EVR	Evrima	15.50	0.00	15.50	31.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
JA2	Jaume II	24.00	0.00	24.00	96.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RLI	Liberty of the Seas	10.50	0.00	10.50	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00	252.00
MDI	Marbella Discovery	10.00	0.00	10.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MRO	Mariner Of The Seas	10.00	0.00	10.00	-	-	-	-	-	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00

HNA	Nieuw Amsterdam	9.00	0.00	9.00	45.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HOO	Oosterdam	10.00	0.00	10.00	10.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HRO	Rotterdam	9.00	0.00	9.00	45.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00
SSC	Silver Cloud	13.50	0.00	13.50	54.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00
SSM	Silver Moon	12.00	0.00	12.00	12.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SSS	Silver Shadow	12.00	0.00	12.00	12.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VNE	Viking Neptune	12.00	0.00	12.00	12.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VOC	Viking Octantis	13.00	0.00	13.00	26.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VPO	Viking Polaris	15.00	0.00	15.00	15.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VST	Viking Star	10.50	0.00	10.50	115.50	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00
RVS	Vision of the Seas	10.00	0.00	10.00	90.00	90.00	90.00	90.00	90.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HVO	Volendam	9.00	0.00	9.00	36.00	45.00	45.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00
HZA	Zaandam	9.00	0.00	9.00	9.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baseline (Hours)					1,022.50	848.00	848.00	875.00	875.00	905.00	905.00	905.00	905.00	905.00	905.00	905.00	905.00	905.00	905.00	905.00	905.00	905.00	905.00	905.00	905.00	905.00	905.00	905.00	905.00

Network Time and Consumption					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	**Name**	**Avg. In Port (Hrs.)**	**Connect / Disconnect (Hrs.)**	**Avg. Network Time**	**FY 22-23**	**FY 23-24**	**FY 24-25**	**FY 25-26**	**FY 26-27**	**FY 27-28**	**FY 28-29**	**FY 29-30**	**FY 30-31**	**FY 31-32**	**FY 32-33**	**FY 33-34**	**FY 34-35**	**FY 35-36**	**FY 36-37**	**FY 37-38**	**FY 38-39**	**FY 39-40**	**FY 40-41**	**FY 41-42**	**FY 42-43**	**FY 43-44**	**FY 44-45**	**FY 45-46**	**FY 46-47**
CIN	Celebrity Infinity	11.00	1.50	9.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CSI	Celebrity Silhouette	10.00	1.50	8.50	8.50	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00
CDE	Costa Deliziosa	12.00	1.50	10.50	10.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PEM	Emerald Princess	9.00	1.50	7.50	7.50	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
HEU	Eurodam	9.00	1.50	7.50	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
EVR	Evrima	15.50	1.50	14.00	28.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
JA2	Jaume II	24.00	1.50	22.50	90.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RLI	Liberty of the Seas	10.50	1.50	9.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00
MDI	Marbella Discovery	10.00	1.50	8.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50
MRO	Mariner Of The Seas	10.00	1.50	8.50	-	-	-	-	-	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00
HNA	Nieuw Amsterdam	9.00	1.50	7.50	37.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HOO	Oosterdam	10.00	1.50	8.50	8.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HRO	Rotterdam	9.00	1.50	7.50	37.50	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
SSC	Silver Cloud	13.50	1.50	12.00	48.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00
SSM	Silver Moon	12.00	1.50	10.50	10.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SSS	Silver Shadow	12.00	1.50	10.50	10.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VNE	Viking Neptune	12.00	1.50	10.50	10.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VOC	Viking Octantis	13.00	1.50	11.50	23.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VPO	Viking Polaris	15.00	1.50	13.50	13.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VST	Viking Star	10.50	1.50	9.00	99.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00
RVS	Vision of the Seas	10.00	1.50	8.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HVO	Volendam	9.00	1.50	7.50	30.00	37.50	37.50	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00
HZA	Zaandam	9.00	1.50	7.50	7.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Network Time (Hours)					797.00	647.00	647.00	669.50	669.50	771.50	771.50	771.50	771.50	771.50	771.50	771.50	771.50	771.50	771.50	771.50	771.50	771.50	771.50	771.50	771.50	771.50	771.50	771.50	771.50
Estimated Consumption (MW)					3,849.00	3,748.00	3,748.00	3,883.00	3,883.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00	4,801.00

PORT EVERGLADES ELECTRIFICATION MASTERPLAN

Terminal 21 Model

Terminal 21 predominately used by Princess and Holland America.

Data Sources

Port Everglades Master Cruise Schedule, FY22-24 *.xls (July 2022)

Vessel Data

Code	Name	Class	Brand	Shore Power	Max Pwr (MW)	Year Built	GRT	GRT Tier	Fuel	Fuel Tier
PAC	Caribbean Princess	Caribbean	Princess	Yes	11.00	2004	116000	>100,000	MGO	1
PEM	Emerald Princess	Caribbean	Princess	Yes	11.00	2007	116000	>100,000	MGO	1
HEU	Eurodam	Signature	Holland	Yes	7.00	2008	86273	100000	MGO	1
JA2	Jaume II		Balearia	No	-	1996	4305	10000	MGO	1
HNI	Nieuw Amsterdam	Signature	Holland	Yes	7.00	2010	86000	100000	MGO	1
PRU	Ruby Princess	Crown	Princess	Yes	10.00	2008	116000	>100,000	MGO	1
PSK	Sky Princess	Royal	Princess	Yes	10.00	2019	141000	>100,000	MGO	3
HVO	Volendam	Rotterdam	Holland	Planned	6.00	1999	61214	60000	MGO	1
HZA	Zaandam	Rotterdam	Holland	Yes	6.00	2000	61396	60000	MGO	1

Calls by Cruise Ships

					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Class	Deployment	Season	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
PAC	Caribbean Princess	Caribbean	7-Day; 10-Day	Winter	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
PEM	Emerald Princess	Caribbean	Various	Winter	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HEU	Eurodam	Signature	Various	Winter	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
JA2	Jaume II		IN PORT 352 Days	Year-Round	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352
HNI	Nieuw Amsterdam	Signature	7-Day	Winter	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
PRU	Ruby Princess	Crown	Unknown	Winter	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PSK	Sky Princess	Royal	10-Day	Winter	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
HVO	Volendam	Rotterdam	Various	Winter	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
HZA	Zaandam	Rotterdam	Various	Winter	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Calls					366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366

Baseline // No Shore Power

					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Avg. In Port (Hrs.)	Connect / Disconnect (Hrs.)	Hoteling Hours	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
PAC	Caribbean Princess	9.00	0.00	9.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00
PEM	Emerald Princess	9.00	0.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
HEU	Eurodam	9.00	0.00	9.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00
JA2	Jaume II	12.00	0.00	12.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00	4,224.00
HNI	Nieuw Amsterdam	9.00	0.00	9.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00
PRU	Ruby Princess	9.00	0.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
PSK	Sky Princess	10.00	0.00	10.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
HVO	Volendam	9.00	0.00	9.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00
HZA	Zaandam	9.00	0.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Baseline (Hours)					4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00	4,353.00

Network Time and Consumption

					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Avg. In Port (Hrs.)	Connect / Disconnect Time (Hrs.)	Avg. Network Time	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
PAC	Caribbean Princess	9.00	1.50	7.50	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
PEM	Emerald Princess	9.00	1.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
HEU	Eurodam	9.00	1.50	7.50	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
JA2	Jaume II	24.00	1.50	22.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HNI	Nieuw Amsterdam	9.00	1.50	7.50	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
PRU	Ruby Princess	9.00	1.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
PSK	Sky Princess	10.00	1.50	8.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50
HVO	Volendam	9.00	1.50	7.50	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
HZA	Zaandam	9.00	1.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Network Time (Hours)					108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00
Estimated Consumption (MW)					922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50	922.50

PORT EVERGLADES ELECTRIFICATION MASTERPLAN

Terminal 25 Model

Terminal 25 predominately used by Celebrity.

Data Sources

Port Everglades Master Cruise Schedule, FY22-24 *.xls (July 2022)

Vessel Data

Code	Name	Class	Brand	Shore Power	Max Pwr (MW)	Year Built	GRT	GRT Tier	Fuel	Fuel Tier
CAP	Celebrity Apex	Edge	Celebrity	Yes	8.00	2020	129500	>100000	MGO	3
CBE	Celebrity Beyond	Edge	Celebrity	Yes	8.00	2021	129500	>100000	MGO	3
CED	Celebrity Edge	Edge	Celebrity	Planned	8.00	2018	117000	>100000	MGO	3
CEQ	Celebrity Equinox	Solstice	Celebrity	Yes	11.00	2009	122000	>100000	MGO	1
CIN	Celebrity Infinity	Millennium	Celebrity	No	8.00	2001	91000	100000	MGO	1
CMI	Celebrity Millennium	Millennium	Celebrity	Yes	8.00	2000	91000	100000	MGO	1
CSI	Celebrity Silhouette	Solstice	Celebrity	Yes	11.00	2011	122000	>100000	MGO	1
EVR	Evrima	Mega Yacht	Ritz Carlton	No						
RLI	Liberty of the Seas	Freedom	RCCL	Planned	11.00	2007	160000	>100000	MGO	1
SSD	Silver Dawn		Silversea	No						
RVI	Vision of the Seas	Vision	RCCL	No	-	1998	78500	60000	MGO	1

Calls by Cruise Ships					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Class	Deployment	Season	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
CAP	Celebrity Apex	Edge	7-Day	Winter	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
CBE	Celebrity Beyond	Edge	7-Day	Winter	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27
CED	Celebrity Edge	Edge	4-Day, 10-Day	Winter	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
CEQ	Celebrity Equinox	Solstice	Various	Year-Round	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
CIN	Celebrity Infinity	Millennium	Various	Winter	6	6	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
CMI	Celebrity Millennium	Millennium	Unknown	Winter	6	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CSI	Celebrity Silhouette	Solstice	10-Day	Winter	2		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EVR	Evrima	Mega Yacht	7-Day	Winter	3		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RLI	Liberty of the Seas	Freedom	Unknown	Winter	1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SSD	Silver Dawn		9-Day	Winter	2		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RVI	Vision of the Seas	Vision	Various	Winter	3		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calls					124	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113

Baseline // No Shore Power					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Avg. In Port (Hrs.)	Connect / Disconnect (Hrs.)	Hoteling Hours	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
CAP	Celebrity Apex	8.50	0.00	8.50	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00
CBE	Celebrity Beyond	8.50	0.00	8.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50	229.50
CED	Celebrity Edge	9.00	0.00	9.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00	153.00
CEQ	Celebrity Equinox	9.00	0.00	9.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00
CIN	Celebrity Infinity	9.00	0.00	9.00	54.00	54.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00
CMI	Celebrity Millennium	10.00	0.00	10.00	60.00	60.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CSI	Celebrity Silhouette	10.50	0.00	10.50	21.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EVR	Evrima	16.00	0.00	16.00	48.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RLI	Liberty of the Seas	10.50	0.00	10.50	10.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SSD	Silver Dawn	12.00	0.00	12.00	24.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RVI	Vision of the Seas	9.00	0.00	9.00	27.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baseline (Hours)					1,128.00	997.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50	991.50

Network Time and Consumption					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Avg. In Port (Hrs.)	Connect / Disconnect (Hrs.)	Avg. Network Time	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
CAP	Celebrity Apex	8.50	1.50	7.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00
CBE	Celebrity Beyond	8.50	1.50	7.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00	189.00
CED	Celebrity Edge	9.00	1.50	7.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50	127.50
CEQ	Celebrity Equinox	9.00	1.50	7.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50	247.50
CIN	Celebrity Infinity	9.00	1.50	7.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CMI	Celebrity Millennium	10.00	1.50	8.50	51.00	51.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CSI	Celebrity Silhouette	10.50	1.50	9.00	18.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EVR	Evrima	16.00	1.50	14.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RLI	Liberty of the Seas	10.50	1.50	9.00	9.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SSD	Silver Dawn	12.00	1.50	10.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RVI	Vision of the Seas	9.00	1.50	7.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Network Time (Hours)					810.00	783.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00	732.00
Estimated Consumption (MW)					7,303.50	7,006.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50	6,598.50

PORT EVERGLADES ELECTRIFICATION MASTERPLAN

Terminal 26 Model

Terminal 26 is predominately used by Holland America.

Data Sources

Port Everglades Master Cruise Schedule, FY22-24 *.xls (July 2022)

Vessel Data

Code	Name	Class	Brand	Shore Power	Max Pwr (MW)	Year Built	GRT	GRT Tier	Fuel	Fuel Tier
HEU	Eurodam	Signature	Holland	Yes	7.00	2008	86273	100000	MGO	1
HNA	Nieuw Amsterdam	Signature	Holland	Yes	7.00	2010	86000	100000	MGO	1
NHS	Nieuw Statendam	Pinnacle	Holland	Yes	6.00	2018	99500	100000	MGO	3
HOO	Oosterdam	Vista	Holland	Yes	7.00	2003	81769	100000	MGO	1
HRO	Rotterdam	Rotterdam	Holland	Yes	6.00	2021	99500	100000	MGO	3
SSD	Silver Dawn		Silversea	No		2021	40700		MGO	3
SSM	Silver Moon		Silversea	No		2020	40700		MGO	3
HZA	Zaandam	Rotterdam	Holland	Yes	6.00	2000	61396	60000	MGO	1
HZU	Zuiderdam	Vista	Holland	Yes	7.00	2002	82305	100000	MGO	1

Calls by Cruise Ships

					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Class	Deployment	Season	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
HEU	Eurodam	Signature	Various	Winter	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HNA	Nieuw Amsterdam	Signature	Various	Winter	18	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
NHS	Nieuw Statendam	Pinnacle	7-Day	Winter	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
HOO	Oosterdam	Vista	Unknown	Winter	1	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
HRO	Rotterdam	Rotterdam	10-Day	Winter	13	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
SSD	Silver Dawn		Unknown	Winter	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
SSM	Silver Moon		Unknown	Winter	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
HZA	Zaandam	Rotterdam	Various	Winter	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HZU	Zuiderdam	Vista	Various	Winter	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calls					72	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76

Baseline // No Shore Power

					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Avg. In Port (Hrs.)	Connect / Disconnect (Hrs.)	Hoteling Hours	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
HEU	Eurodam	9.00	0.00	9.00	27.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HNA	Nieuw Amsterdam	9.00	0.00	9.00	162.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00
NHS	Nieuw Statendam	9.00	0.00	9.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00
HOO	Oosterdam	10.00	0.00	10.00	10.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00
HRO	Rotterdam	9.00	0.00	9.00	117.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00
SSD	Silver Dawn	12.00	0.00	12.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
SSM	Silver Moon	12.00	0.00	12.00	12.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
HZA	Zaandam	9.00	0.00	9.00	36.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HZU	Zuiderdam	8.50	0.00	8.50	51.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baseline (Hours)					655.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00	704.00

Network Time and Consumption

					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Avg. In Port (Hrs.)	Connect / Disconnect (Hrs.)	Avg. Network Time	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
HEU	Eurodam	9.00	1.50	7.50	22.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HNA	Nieuw Amsterdam	9.00	1.50	7.50	135.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00
NHS	Nieuw Statendam	9.00	1.50	7.50	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00	180.00
HOO	Oosterdam	10.00	1.50	8.50	8.50	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00
HRO	Rotterdam	9.00	1.50	7.50	97.50	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00
SSD	Silver Dawn	12.00	1.50	10.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SSM	Silver Moon	12.00	1.50	10.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HZA	Zaandam	9.00	1.50	7.50	30.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HZU	Zuiderdam	8.50	1.50	7.00	42.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Network Time (Hours)					515.50	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00	548.00
Estimated Consumption (MW)					3,301.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00	3,521.00

PORT EVERGLADES ELECTRIFICATION MASTERPLAN

Terminal 29 Model

Terminal 29 predominately used by Celebrity. Anticipate redevelopment to support RCG Oasis/Icon Class.

Data Sources

Port Everglades Master Cruise Schedule, FY22-24 *.xls (July 2022)

Vessel Data

Code	Name	Class	Brand	Shore Power	Max Pwr (MW)	Year Built	GRT	GRT Tier	Fuel	Fuel Tier
CEQ	Celebrity Equinox	Solstice	Celebrity	Yes	11.00	2009	122000	>100,000	MGO	1
CEI	Celebrity Infinity	Millennium	Celebrity	No	8.00	2001	91000	100000	MGO	1
CMI	Celebrity Millennium	Millennium	Celebrity	Yes	8.00	2000	91000	100000	MGO	1
CRE	Celebrity Reflection	Solstice	Celebrity	Planned	11.00	2012	126000	>100,000	MGO	2
CSI	Celebrity Silhouette	Solstice	Celebrity	Yes	11.00	2011	126000	>100,000	MGO	1
JA2	Jaume II		Balearia	No	-					
RVI	Vision of the Seas	Vision	RCCL	No	-	1998	78491	60,000	MGO	1
RIC	Icon of the Seas	Icon	RCCL	Planned	9.00	2015	200000	>100,000	LNG	

Calls by Cruise Ships

					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Class	Deployment	Season	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
CEQ	Celebrity Equinox	Solstice	Various	Winter	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CEI	Celebrity Infinity	Millennium	8-Day	Winter	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CMI	Celebrity Millennium	Millennium	Various	Winter	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRE	Celebrity Reflection	Solstice	7-Day	Winter	24	1	-	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
CSI	Celebrity Silhouette	Solstice	10-Day	Winter	1	2	-	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
JA2	Jaume II		Unknown	Winter	8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RVI	Vision of the Seas	Vision	Unknown	Winter	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RIC	Icon of the Seas	Icon	7-Day	Year-Round	-	-	-	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52
Total Calls					42	4	-	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82

Baseline // No Shore Power

					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Avg. In Port (Hrs.)	Connect / Disconnect (Hrs.)	Hoteling Hours	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
CEQ	Celebrity Equinox	9.00	0.00	9.00	27.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CEI	Celebrity Infinity	9.00	0.00	9.00	18.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CMI	Celebrity Millennium	10.00	0.00	10.00	20.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRE	Celebrity Reflection	8.50	0.00	8.50	204.00	8.50	-	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00	204.00
CSI	Celebrity Silhouette	10.50	0.00	10.50	10.50	21.00	-	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00
JA2	Jaume II	24.00	0.00	24.00	192.00	24.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RVI	Vision of the Seas	9.00	0.00	9.00	18.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RIC	Icon of the Seas	9.00	0.00	9.00	-	-	-	468.00	468.00	468.00	468.00	468.00	468.00	468.00	468.00	468.00	468.00	468.00	468.00	468.00	468.00	468.00	468.00	468.00	468.00	468.00	468.00	468.00	468.00
Baseline (Hours)					489.50	53.50	-	735.00	735.00	735.00	735.00	735.00	735.00	735.00	735.00	735.00	735.00	735.00	735.00	735.00	735.00	735.00	735.00	735.00	735.00	735.00	735.00	735.00	735.00

Network Time and Consumption

					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Code	Name	Avg. In Port (Hrs.)	Connect / Disconnect (Hrs.)	Avg. Network Time	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34	FY 34-35	FY 35-36	FY 36-37	FY 37-38	FY 38-39	FY 39-40	FY 40-41	FY 41-42	FY 42-43	FY 43-44	FY 44-45	FY 45-46	FY 46-47
CEQ	Celebrity Equinox	9.00	1.50	7.50	22.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CEI	Celebrity Infinity	9.00	1.50	7.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CMI	Celebrity Millennium	10.00	1.50	8.50	17.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRE	Celebrity Reflection	8.50	1.50	7.00	168.00	7.00	-	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00
CSI	Celebrity Silhouette	10.50	1.50	9.00	9.00	18.00	-	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00
JA2	Jaume II	24.00	1.50	22.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RVI	Vision of the Seas	9.00	1.50	7.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RIC	Icon of the Seas	9.00	1.50	7.50	-	-	-	390.00	390.00	390.00	390.00	390.00	390.00	390.00	390.00	390.00	390.00	390.00	390.00	390.00	390.00	390.00	390.00	390.00	390.00	390.00	390.00	390.00	390.00
Network Time (Hours)					216.50	25.00	-	612.00	612.00	612.00	612.00	612.00	612.00	612.00	612.00	612.00	612.00	612.00	612.00	612.00	612.00	612.00	612.00	612.00	612.00	612.00	612.00	612.00	612.00
Estimated Consumption (MW)					2,330.50	275.00	-	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00	5,952.00

10. APPENDIX C – EMERGING TECHNOLOGIES

EMERGING SHORE POWER SUPPLY TYPOLOGIES

Several emerging approaches for shore power and related power sources/systems were reviewed for applicability within the Port Everglades Subject Cruise Terminal context. While each emergent typology holds promise over a longer implementation horizon, they are not considered viable from a project risk, target delivery date, and anticipated total cost for Port Everglades, based on the established goals and objectives in Section 1.3. A summary of each is provided herein.

- **Hydrogen Fuel Cells.** Hydrogen fuel cells are currently used to power land-based buses, trains, and heavy-duty trucks (Carlucci, 2019). For marine vessels, hydrogen fuel-cell power is moving from limited use providing heat and power to early exploration and implementation as a full power system for smaller OGVs. This includes the world's first hydrogen fuel cell cruise ship planned for the Norwegian Fjords (Radowitz, 2020).

  Hydrogen can be produced from natural gas or renewables, and therefore, the use of hydrogen fuel cells does not result in GHG emissions or local air pollutants at berth. Hydrogen fuel cells can provide shore power in areas that may be limited by lack of capacity in the provider's electricity grid. They have the added benefits of being compact, easily transported, and relatively quick to refuel, and offer long-range power (Carlucci, 2019).

  There are technological and logistical issues with using hydrogen fuel cells to reduce emissions. Sourcing hydrogen can be energy intensive and distribution systems require development. There is currently only one known operating megawatt system using hydrogen fuel cell technology to supply 1 MW continuous electrical power. The potential availability of a deployable, compact 16MW hydrogen power supply system is currently unknown.

- **Molten Carbonate Fuel Cells.** Molten Carbonate Fuel Cells (MCFCs) use molten carbonate salt as an electrolyte (Eisler, 2018). They are large stationary power generation systems and can reach up to 60% efficiency for fuel to electricity conversion (Steilen & Jorissen, 2015). MCFCs can operate on a variety of different fuels including methane, natural gas, biogas, and coal-derived fuel gas.

  Toyota and FuelCell Energy are working on the world's first MW-scale MCFC at the Port of Long Beach (Merchant, 2017). Completed in 2021, the plant produces 2.35 MW of electricity and 1.2 tons of hydrogen. The hydrogen will be used to fuel Toyota's hydrogen fueled Mirai sedans and heavy-duty trucks coming through the port. The electricity will be sold back to the state's grid. Biogas from agricultural waste will be used to fuel the cell.

  There are several benefits of MCFCs. MCFC fuel cells do not result in GHG emissions or local air pollutants at berth. The MCFC pumping action can be used to concentrate and collect CO_2. The concentrated CO_2 can be stored underground as a form of carbon capture. Challenges associated with MCFCs are varied and include the unknown applicability and footprint of these types of MW producing facilities at a size needed for shore power. MCFC facilities have a long start-up time and the added challenge of corrosion and breakdown of cell components due to the high operating temperatures.

- **Electric and Hybrid Electric Applications.** Fully electric and hybrid electric applications continue to flourish on land, with an expectation that innovation will also make its way to OGV applications. Current applications of fully electric vessels are observed for ferries, barges, and other smaller vessels with short, defined routes (Leigh, 2021; Deutsche Welle, 2021). Shorter, well-defined routes and predictable operation make it easier to size the battery and develop a charge plan (e.g. charging can occur regularly during loading/offloading).

  Electric hybrid vessels allow use of zero emission propulsion systems while vessels are maneuvering into position at terminals or entering environmentally sensitive areas. The on-board battery systems are normally charged at sea under power of hydrocarbon fueled engines and generators. When stationed in port, they have short time capability to continue operations on battery supply but can be connected to shore power for re-charging or prolonged stays at port if the vessels are suitably equipped to receive this power. The MS Roald Amundsen is the world's first partially battery powered cruise ship and was developed in Norway in 2019 (Klesty, 2019). The existing cruise vessel can hold 500 passengers and runs exclusively on batteries for 45 to 60 minutes. The battery pack on the MS Roald Amundsen cruise ship is designed to reduce CO_2 emissions by 20%. Excess energy from the engine returns to the battery thereby reducing and avoiding the need for charging stations. Carnival Corporation announced a partnership with Corvus Energy in 2019 to test battery power on the AIDA Cruises brand in 2020 (Carnival Corporation, 2021).

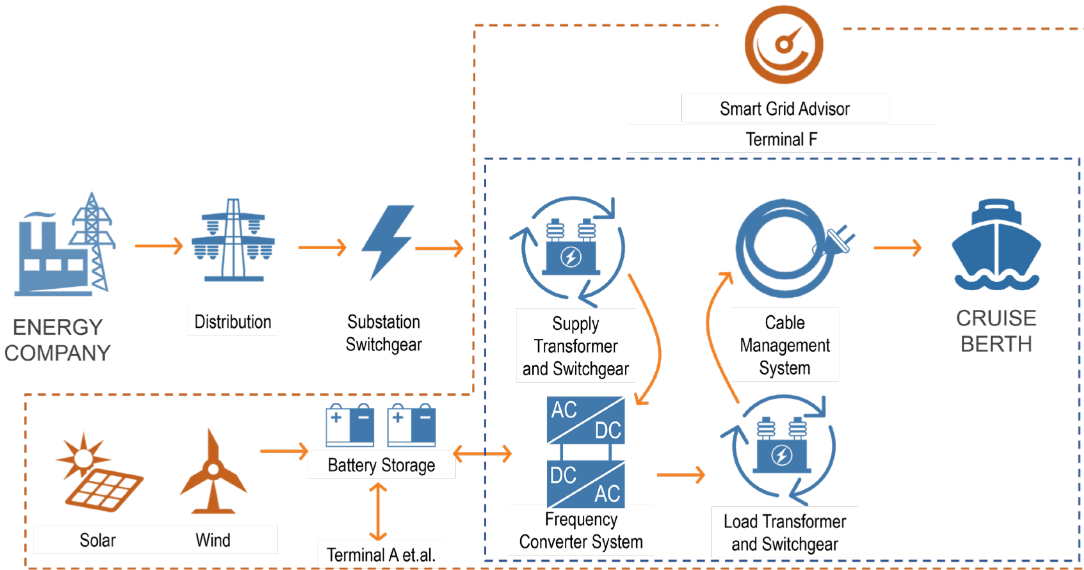
  The use of electric and hybrid electric ships appears promising as battery technology improves, batteries become more compact, and charging infrastructure becomes available. Electric and hybrid electric vessels (running on batteries) would not create GHG emissions. Issues of battery-related heat, weight, and space need continued research.

  Fully electric and hybrid vessels require methods for charging batteries, and for both types, could utilize in place shore power systems, helping prolong their longevity at ports. For hybrid vessels, batteries could be charged at sea using hydrocarbon fuel engines or at a port using shore power.

BEYOND SHORE POWER – CREATION OF A PORT EVERGLADES MICRO GRID

Microgrids are defined as a small network of electricity users with a local source of supply that is usually attached to a centralized national grid but can function independently (Siemens, 2021). They are increasing in application in many forms, including ports, as they present efficient, resilient, and sustainable distributed energy systems where energy supply is variable and needs to be operated cost-effectively and reliably. Battery systems and onsite renewable energy are often incorporated into this approach (see Figure 10-1).

Figure 10-1. Shore Power Supply with Power Factor Conversion Linked to Microgrid



Source: M&N, 2022.