Sandia National Laboratories

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Port Electrification Project

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Project Objectives & Goals

Goal of project

By performing case studies on port electrification, to gain deeper insight into the costs and benefits of electrification for military and commercial ports in the U.S.

- including a better understanding of the potential role of energy storage

Project Objective

To perform case studies on three East Coast ports to understand the costs and benefits of port electrification

- while considering the potential for energy storage to reduce costs.

The ports studied were:

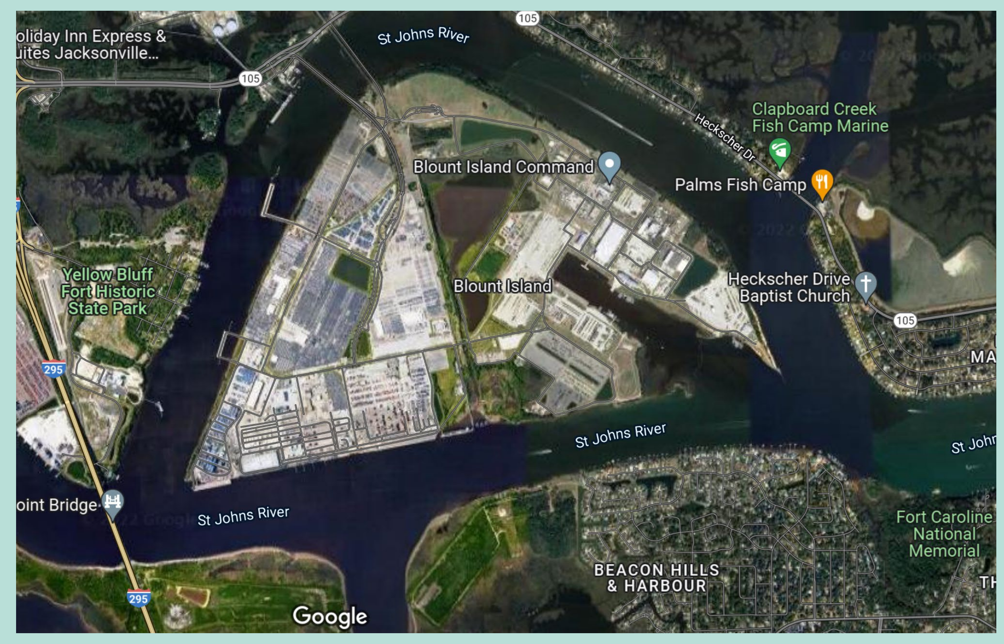
- **JAXPORT Container Port, Blount Island**
- **US Marine Corps (USMC) Blount Island**
- **Massport: Conley Container Terminal and Flynn Cruiseport**

The evaluation focused on three main areas of port activity:

1. **Trucking centers** – the electrification of trucks providing port cargo transfer
2. **Shore power** – powering ships from the grid while at berth
3. **Port cargo handling** – switching cranes from diesel to electric

Blount Island

Blount Island is on the St. Johns River in Jacksonville, Florida. One side of the island hosts a Jacksonville Port Authority (JAXPORT) container port, and the other side hosts the U.S. Marines Blount Island Command.



Massport

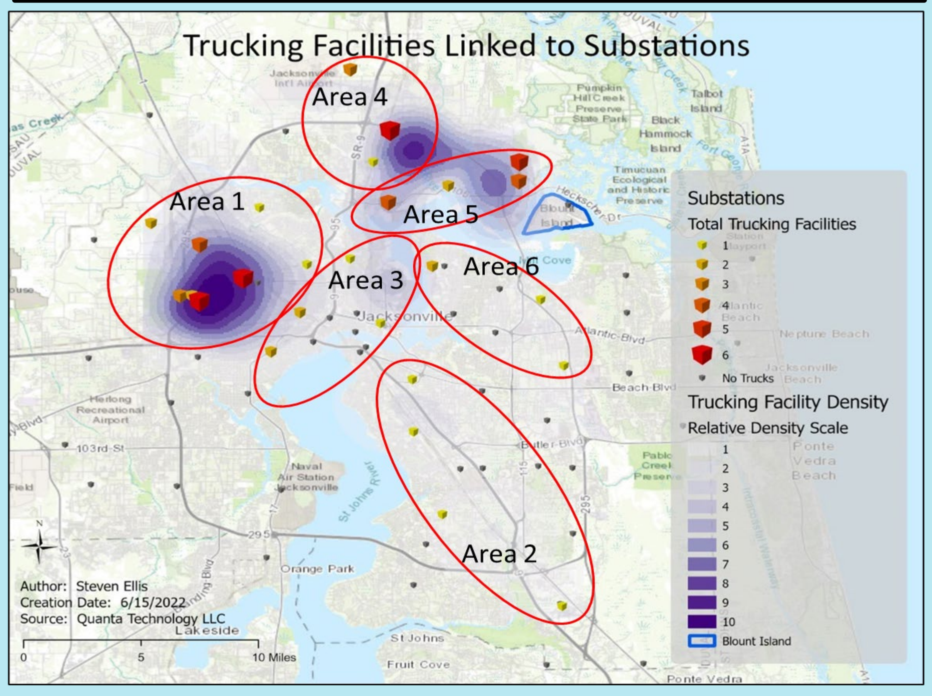
Massport is a port facility in Boston, Massachusetts serving the New England region. It consists of the Conley Container Terminal, the Flynn Cruiseport, the Boston Autoport, and the Boston Logan International Airport.

Trucking Facility Electrification Impact Assessment

Methodology Steps:

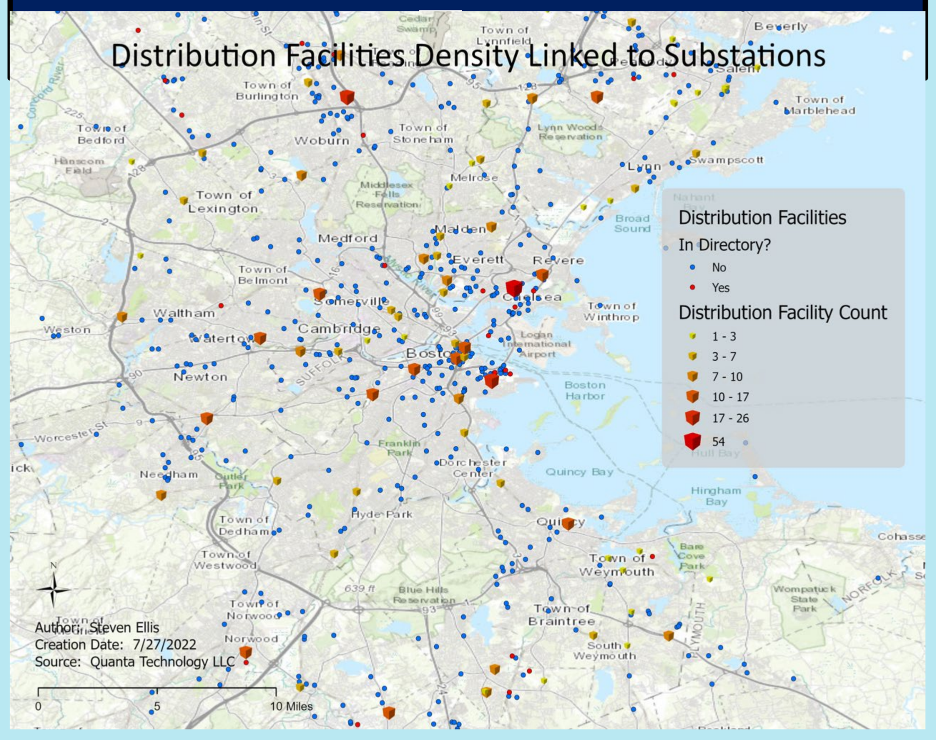
- Identifying potential locations for drayage e-truck charging stations
- Projecting e-truck adoption for trucking facilities
- Projecting the number of required chargers and charging profiles in each facility
- Projecting the charging load for different regions
- Charging load are mapped to help utilities understand where concentrated loads may occur in relation to feeders / substations
- Assessing the potential benefits of storage deployment (as a mitigation solution)

JAXPORT Blount Island



Area	Electric Truck load 2027 (kW)	Electric Truck load 2032 (kW)	Electric Truck load 2037 (kW)
1	8,600	18,800	31,000
2	1,400	3,000	5,000
3	2,800	5,800	9,600
4	2,200	4,800	8,000
5	4,600	9,800	16,200
6	1,200	2,200	3,800
Total (MW)	**20.80**	**44.40**	**73.60**

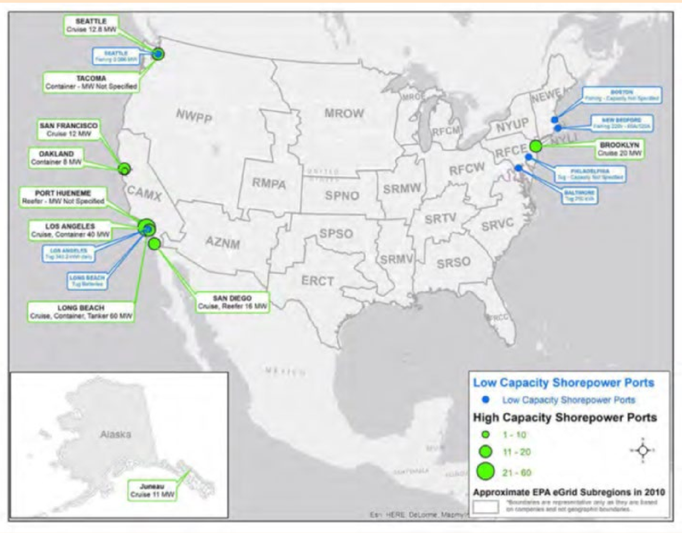
Massport Container Terminal



	2027	2032	2037
Projected number of E-Trucks	3,231	8,079	12,927
Projected number of Chargers (200kW charger)	1,285	2,177	3,709
Total charger load in MW	257	435	742

Shore Power

Location of shore power in the US (EPA, 2017)



Shore power allows for a vessel to plug into the local grid while at-berth, as opposed to running its auxiliary engine

This reduces emissions, and should provide a cost savings

Shore power installations in the U.S. are concentrated on the West Coast

USMC Blount Island could potentially save $7m/year

USMC Blount Island

Emissions Comparison for one Shore Power Connection

(in Metric Tons, except for %)	NO_x	SO_2	$PM_{2.5}$	CO_2	CO_2eq
Annual Vessel Power Emissions	110	16.9	2.35	5,550	5,630
Annual Shore Power Emissions	1.4	1.1	0.25	3,550	3,560
Difference (Vessel – Shore Pwr)	-108.6	-15.8	-2.1	-2,000	-2,070
Percent Difference	-99%	-94%	-90%	-36%	-37%

USMC Blount Island

Auxiliary Engine vs. Shore Power Cost Comparison

	Fuel Consumption* (gal/day)	Power Consumption* (kWh/day)	Fuel Cost (USD/yr)	Power Cost (USD/yr)	Savings (USD/yr)
Ship 1	4,200	22,167	5,370,000	1,250,000	4,120,000
Ship 2	3,150	22,167	4,020,000	1,250,000	2,770,000
TOTAL			9,390,000	2,500,000	6,890,000

*Fuel and power consumption estimates based on discussions with USMC Blount Island

Electrification of Cranes

- Ship to Shore (STS) cranes has a higher contribution to port power consumption (compared to other types of cranes)
- STS crane operation cycle has two phases: (1) Ship to Platform (STP) and, (2) Platform to Shore (PTS). Total cycle duration: ~120 seconds
- If multiple cranes operate at the same time, they might create huge spikes (each crane around 4MW)
  - The large short-lived spikes in demand indicate that ultracapacitor storage could be of great benefit

Energy Storage and Port Electrification

By smoothing power consumption over time and reducing peak demand, energy storage can:

- Help minimize the cost of required transmission and distribution upgrades
- Decrease utility demand charges

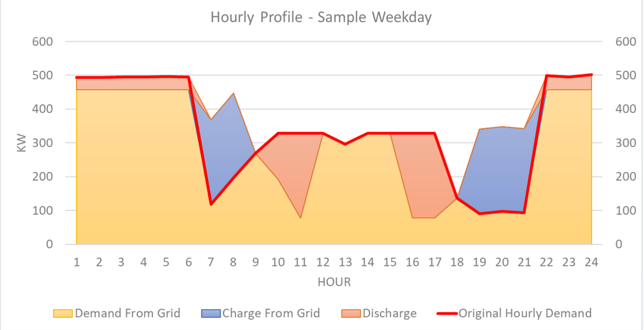
This applies to:

- *Crane electrification*
- *Shore power provision*
- *Trucking facility electrification*

Example

Warehouse facility with 8 electric trucks

- TOU rate and demand charges between 12PM-6PM



BESS kW	250 kW	Annual energy cost saving	$ 25K
BESS duration	4hr	Annual demand charge saving	$ 12K
BESS CapEx	$ 300K	PBP [with 30% ITC] - yr	5.7

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