Appendix F: Grid Impact Analysis

Purpose

This analysis estimates the additional grid electricity needed to support a fully zero-emission CHE fleet at California seaports and intermodal railyards. This preliminary analysis is designed to provide a general understanding of the State's current utility-provided load capacity and future electrification needs. However, a more detailed assessment is necessary to evaluate the full grid impact.

Methodology

To conduct the gird analysis, staff made the assumptions listed below.

- 96% of zero-emission CHE is electric, while the remaining 4% is powered by hydrogen fuel cells.[1]
- All electric CHE are charging simultaneously, without managed charging, energy storage systems, or microgrids (worst-case scenario).
- 1:1 replacement ratio for zero-emission and existing diesel equipment, applicable to equipment in operation through January 2025. This analysis does not account for any additional CHE that may be added to facilities in the future.
- Uniform power demand across the same type of zero-emission CHE regardless of OEM, based on the EPRI Dynamic Energy Forecasting Tool.[2]
- Each substation's remaining load capacity will only be used for electric CHE charging, not for other future seaport/intermodal railyard electrification projects (additional circuit infrastructure may be required in practice). This does not take into account additional demand sources for California seaports and intermodal railyards listed in Table 11 in the battery-electric CHE Infrastructure Requirements and Considerations section.
- Facilities needing <5 MW of load capacity could meet demand by reallocating power from existing neighboring circuits (without major infrastructure upgrades).

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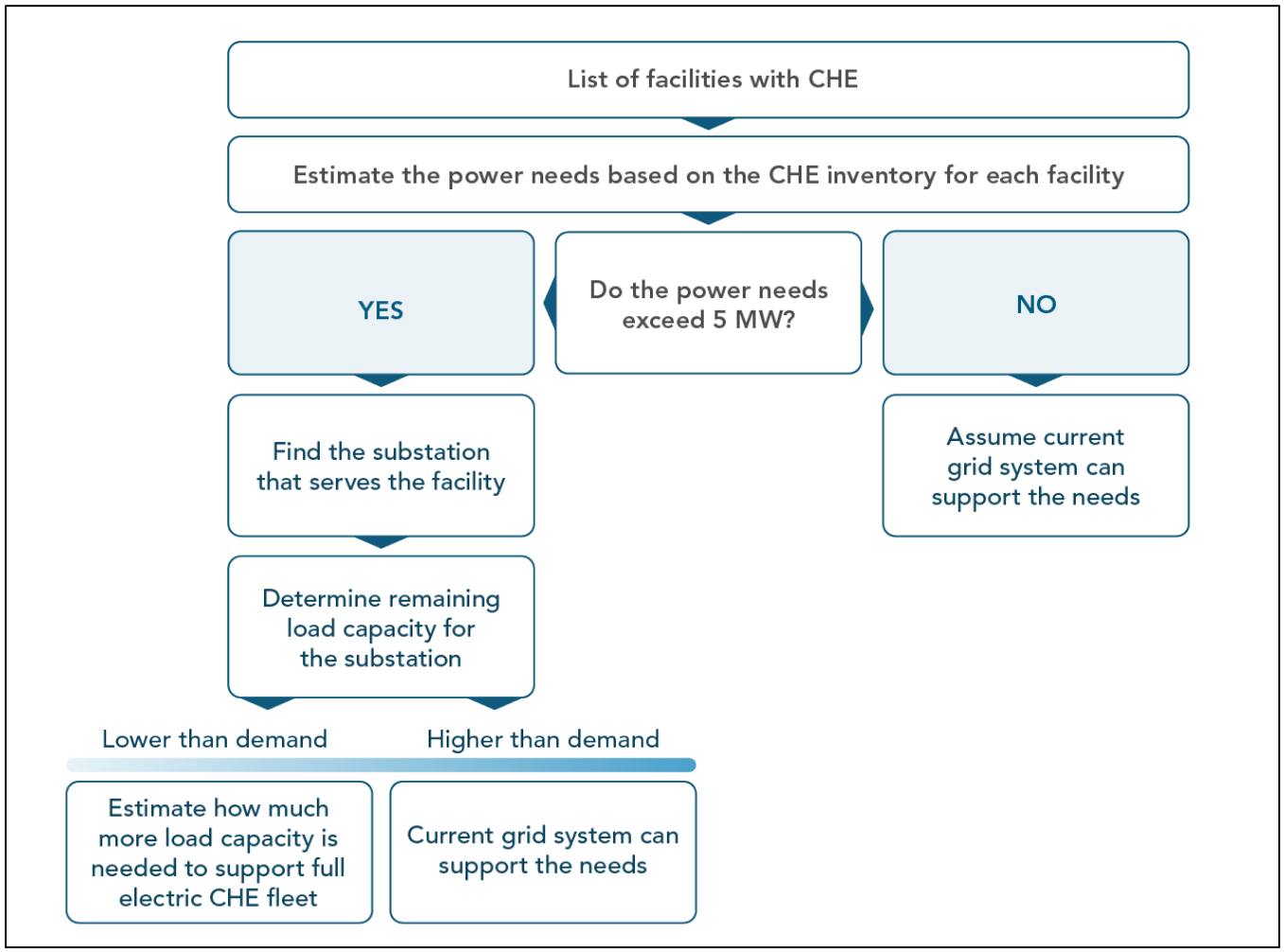
[1] Based on information provided by "California Launches World-Leading Hydrogen Hub," Governor of California, July 17, 2024. Accessed April 28, 2025. *https://www.gov.ca.gov/2024/07/17/california-launches-world-leading-hydrogen-hub*, where the goal was set for over 200 pieces of CHE to be hydrogen fuel cell.

[2] EPRI, "Zero-Emission Planning and Grid Assessment for the Port of Los Angeles," Report, June 2023. *https://kentico.portoflosangeles.org/getmedia/6b15966c-e99f-4ec0-9eca-3b9974e8a976/epri-pola-ze-planning-grid-assessment*

- Analysis includes all CHE operating at seaports and intermodal railyards, regardless of existing fuel types (e.g., gasoline, propane, etc.).
- Analysis excludes existing electric or hydrogen fuel cell CHE.
- Analysis focuses on substation load capacity (If substation data was not available, staff used circuit load capacity).
- Analysis is based on remaining load capacity through January 2025.

These assumptions may not reflect operations at all facilities in California. This approach represents a worst-case scenario – an unmanaged charging scenario – used to estimate the maximum additional power needed. This analysis provides insights into the scale and locations where infrastructure upgrades (at the substation level) may be necessary to support a fully zero-emission CHE fleet at California seaports and intermodal railyards. Figure F-1 illustrates the methodology staff used for this analysis.

Figure F-1: Grid Impact Analysis Methodology



List of Facilities and Fleet Size Data

Staff obtained a list of facilities in California with CHE activity and fleet size data from the 2022 CARB CHE Inventory,[3] and the Port of Los Angeles and Port of Long Beach 2023 Air Emissions Inventory Reports.[4] Table F-1 lists the facilities included in the analysis. Existing electric and hydrogen fuel cell CHE are excluded.

[3] California Air Resources Board, "Cargo Handling Equipment Emissions Inventory," Report, December 2022. *https://ww2.arb.ca.gov/sites/default/files/2023-04/2022%20CHE%20Emission%20Inventory%20Document_6April2023.pdf*

[4] Port of Los Angeles, "Inventory of Air Emissions 2023," August 2024. *https://kentico.portoflosangeles.org/getmedia/3fad9979-f2cb-4b3d-bf82-687434cbd628/2023-Air-Emissions-Inventory* ; Port of Long Beach, "2023 Air Emissions Inventory," August 2024. *https://polb.com/environment/air/#emissions-inventory*

Table F-1: List of Facilities Included in the Grid Impact Analysis

Facility Name[5]
Bay Area Bulk Terminal
BNSF Commerce
BNSF Los Angeles (Hobart)
BNSF North Bay Intermodal Yard
BNSF Oakland
BNSF Oakland International Gateway
BNSF San Bernardino
BNSF Stockton
Concord Naval Weapons Station
LA Berth 240
Pier 80 (closed in 2016) & 94 Port of San Francisco; Redwood City
Port of Hueneme
Port of Long Beach
Port of Los Angeles
Port of Oakland
Port of Oakland - Old Army Base
Port of Redwood City
Port of Richmond
Port of Sacramento
Port of San Diego
Port of San Francisco
Port of Stockton
UPRR City of Industry
UPRR Commerce
UPRR ICTF
UPRR LATC
UPRR Lathrop
UPRR Oakland

Estimated Power Needs

Table F-2 shows the estimated charging power demand for each CHE type, based on the EPRI Dynamic Energy Forecasting Tool.[6] Staff calculated the total power demand per facility by multiplying charging power by population for each CHE type.

[5] List of facilities is based on facilities that provided reporting data to CARB through January 2025 and may not be a complete list of all facilities in California with CHE operations.

[6] EPRI, "Zero-Emission Planning and Grid Assessment for the Port of Los Angeles, 2023 Technical Report," June 2023. *https://kentico.portoflosangeles.org/getmedia/6b15966c-e99f-4ec0-9eca-3b9974e8a976/epri-pola-ze-planning-grid-assessment*.

Table F-2: Electric Equivalent Charging Power for Different CHE Types[7]

Equipment Type	Fuel Type	Electric Equivalent Charging Power (kW)
Aerial Lift	Diesel	15
Aerial Lift	Gasoline	15
Cone Vehicle	Diesel	116
Crane, Material Handling	Diesel	200
Crane, Off-Road	Diesel	716
Dozer	Diesel	200
Excavator	Diesel	65[8]
Forklift, Heavy Lift	Diesel	200
Forklift, Heavy Lift	Gasoline	200
Forklift, Heavy Lift	Liquefied Petroleum Gas	200
Forklift, Telehandler	Diesel	400
Loader or Loader-Excavator	Diesel	65
Railcar Mover	Diesel	15
Reach Stacker	Diesel	200
Rubber-Tired Gantry Crane (RTG)	Diesel	216
Shuttle and Straddle Carriers	Diesel	100
Side Handler	Diesel	400
Sweeper	Diesel	116
Sweeper	Gasoline	116
Top Handler	Diesel	400
Utility Truck, Other (fuel trucks, water trucks etc.)	Diesel	116
Utility Truck, Other (fuel trucks, water trucks etc.)	Liquefied Petroleum Gas	116
Yard Truck	Diesel	200
Yard Truck	Gasoline	116
Yard Truck	Liquefied Natural Gas	200
Yard Truck	Liquefied Petroleum Gas	200

For facilities needing <5 MW of electric load capacity, staff assumed power needs could be met by reallocating existing load capacity within neighboring circuits, which is less likely to

[7] CHE types are based on the 2022 CARB CHE Inventory and the Port of Los Angeles and Port of Long Beach 2023 Air Emissions Inventory Reports.

[8] Staff assumed that excavators have the same charging power as loaders due to the similarity in equipment type.

trigger significant utility infrastructure upgrades. Therefore, this analysis focuses on larger facilities with load capacity needs ≥5 MW. These facilities are more likely to face grid capacity challenges and require infrastructure upgrades.

Identify Substation

Staff used two approaches to identify the substations serving the facilities under analysis:

- Utility provider engagement - Directly requested information on the remaining load capacity for substations linked to identified facilities.
- Online mapping tools - Used tools such as the Demand Response Provider Evaluation Portal from Southern California Edison to locate substations based on geographic proximity and infrastructure data if the initial approach did not yield sufficient data.

Once substations were identified, staff collected detailed information on each substation's remaining load capacity, focusing on available capacity through January 2025.

Load Capacity Demand

After gathering substation load capacity data, staff estimated the additional grid capacity required for a fully zero-emission CHE fleet at California seaports and intermodal railyards. This involved:

- Calculating the total projected power demand of a fully zero-emission CHE fleet. Based on charging power provided in Table F-2, approximately 960 MW total load capacity is needed.
- Comparing projected demand against existing substation capacities to identify shortfalls and areas where grid capacity needs expansion.

This analysis provides a preliminary estimate of the scale of infrastructure upgrades necessary to fully support electric CHE operations.

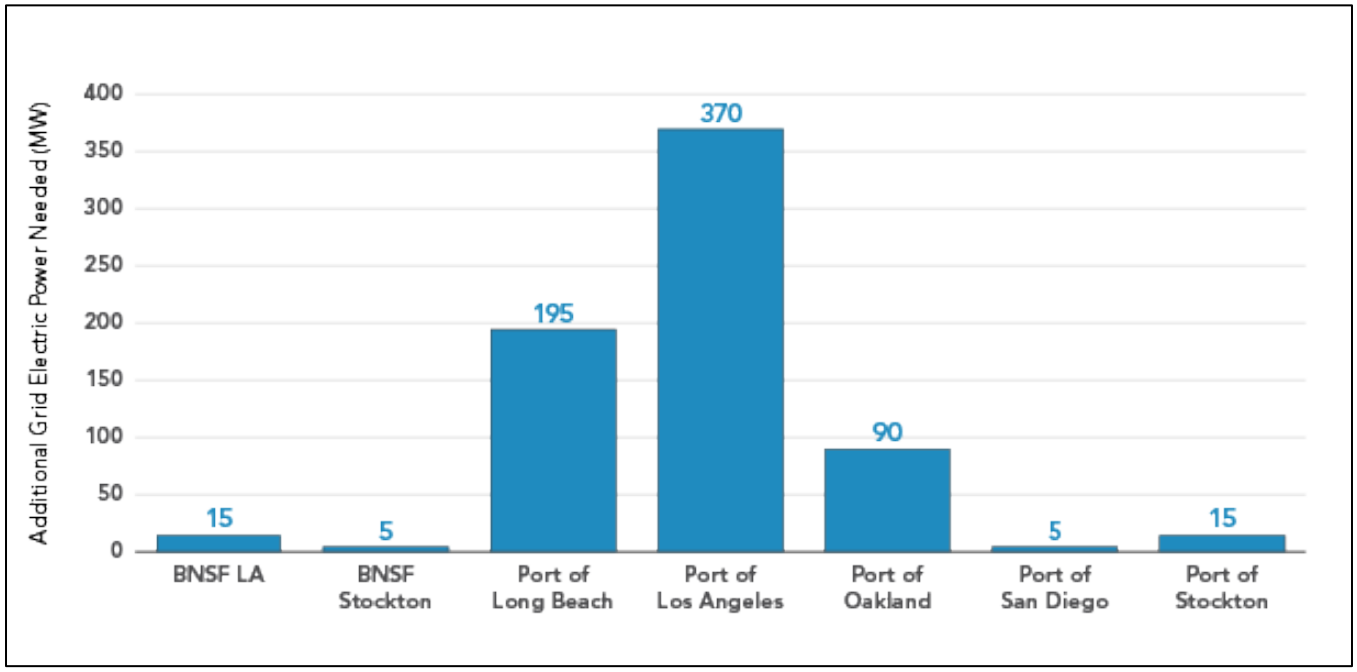
Results

Based on staff's preliminary analysis, approximately 960 MW of total load capacity is needed to support zero-emission CHE at California seaports and intermodal railyards. This includes both capacity that can be supported by existing infrastructure and additional load required beyond current capacity. Of the total estimated 960 MW of load capacity needed, existing utility-provided load capacity can meet approximately 265 MW. To support future CHE charging demands, utilities will need to upgrade the substations near CHE facilities and expand the load capacity to address the remaining 695 MW of unmet demand.

Of the 28 facilities analyzed, the existing utility-provided load capacity is sufficient for 21 facilities. They either require < 5 MW of electric load capacity or have needs of ≥5 MW that can be met by the existing remaining load capacity at the nearby substation. Seven

facilities are expected to require substation upgrades to support fully zero-emission CHE. Figure F-2 summarizes the facilities requiring additional grid capacity and their estimated power demand based on the assumptions listed above. The Port of Los Angeles, Port of Long Beach, and the Port of Oakland have the largest power deficits, driven by the high population of CHE operating at their terminals.

Figure F-2: Additional Load Capacity Needed to Support Fully Zero-Emission CHE by Facility



Future Work

This analysis is preliminary and based on data available through January 2025. In addition, the assumptions used in this analysis may not reflect operations at individual facilities. This initial analysis serves as a starting point to identify potential challenges and prioritize areas for further investigation. To fully assess the grid impacts and infrastructure needed to support zero-emission CHE at California seaports and intermodal railyards, staff propose the following steps:

- Comprehensive site studies: conduct detailed facility-specific assessments to determine the power needs and infrastructure upgrades required for electrification.
- Cumulative load analysis: account for all ongoing and planned electrification projects at these locations, not just CHE, to better understand cumulative electrical demand and potential impacts on grid capacity.

- Circuit-level evaluations: analyze the circuit feeding each facility to assess load capacity. Determine whether existing circuits can support new charging loads or if new circuits, substations, or system upgrades are necessary.
- Refine hydrogen fuel cell technology adoption rates based on the needs of each facility. Integrating hydrogen could:
    - Reduce overall power demands.
    - Minimize the need for extensive electrical infrastructure upgrades.
    - Provide operational flexibility for seaports and intermodal railyards transitioning to zero-emission operations.