Port Electrification Considerations and Case Studies

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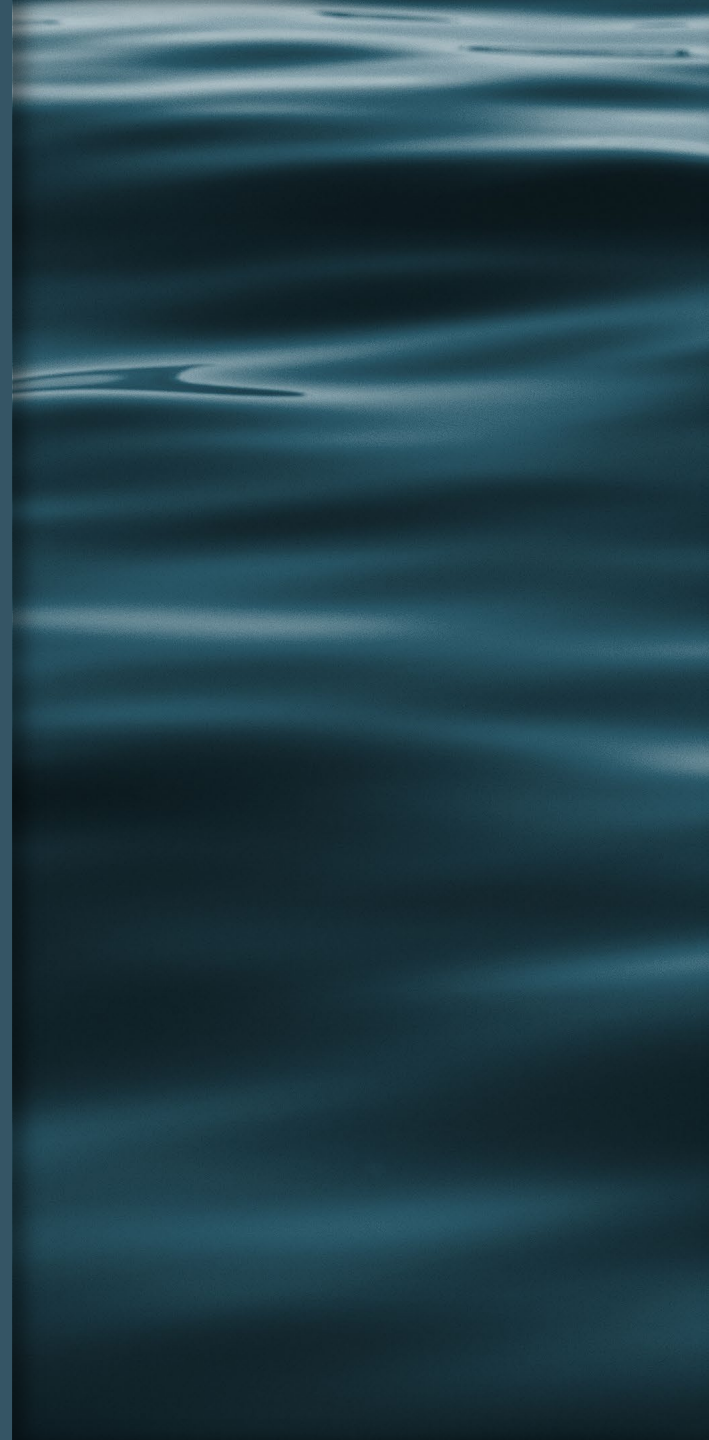

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Electrification for Decarbonizing Ports

- Drivers of Decarbonization
  - Health and Safety
  - Regulations, organizational goals, customer needs, and community demands.
  - Electrification is the primary path to net zero emissions.
- Challenges and Complexity
  - Balancing carbon neutrality with operational productivity.
  - Adapting electrified equipment within existing infrastructure.
- Operational Impacts
  - Infrastructure and traffic circulation adjustments.
  - Labor considerations for charging management and fleet monitoring.
- Port electrification is a complex task and demands a holistic approach.

Opportunities of CHE Electrification

- Reduced Emissions
- Lower Noise Pollution
- Maintenance
  - Less maintenance than internal combustion
  - Reduced downtime
  - Reduction in fuel handling
- Operating Cost
  - Grid power cheaper and less price-volatile than diesel
  - Incentives and funding from State and Federal

Challenges of CHE Electrification

- High Upfront Capital Expenditure
  - Equipment costs
  - Infrastructure development and upgrades
- Energy Demand and Reliability
  - Increased energy requirements
  - Power outages
  - Limited utility supply

EV Charging Considerations

- Strategic Placement
  - Equipment should be placed as close as possible to operations
  - Dedicated space required for EV Charging and Infrastructure
- Charging Equipment
  - Speed of charging equipment is determined by the vehicle's specifications and Port operational requirements
  - Charging speeds of level 2 EV charging reach up to 80kw
  - Charging speeds of level 3 EV (DC Fast charging) charging reach up to 400kw
- Energy Supply and Grid Capacity
  - EV Charging can add significant load to a Port’s electrical infrastructure
  - Number and size of chargers may be dependent the capacity of the local electrical utility
  - Load management software and SCADA systems can help mitigate potential grid capacity issues

Planning Considerations

- Electrified UTRs/Jockey Trucks
  - Charging Schedule
    - Consider operation availability
    - Other coincidence loads
    - Incidental charging opportunities
  - Utilization Schedule and Travel Distance
  - Battery charging is typically between 175-200 kW each at 480V
    - For example, 24 EV Chargers at 180kW each – 4.32 MW
- Top handlers Up to 400 kW
- Light Vehicles Up to 40 kW

Workforce Considerations

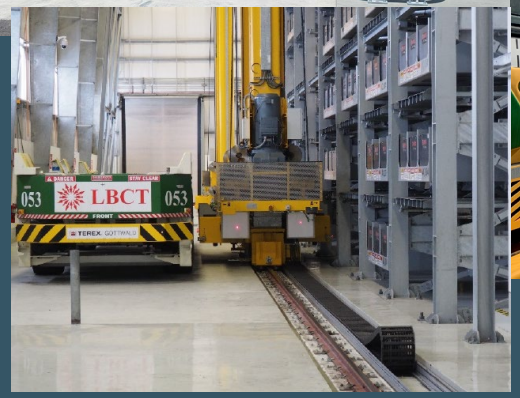
- Training and Skill Development
  - Operator Training
  - Maintenance Training
- Health and Safety
  - High Voltage Safety
  - Emergency Response
- Improved Work Environment
  - Reduced Emissions
  - Reduced Noise Pollution
- Workflow Adaptations
- Collaboration with Tenants, Unions, and Worker Organizations
  - Charging jurisdiction

eRTG Considerations

- Load is typically between 70kW and 300kW, but if fluctuates greatly depending on operational condition
- Cable Reel
  - Typically Medium Voltage 4160V connection pedestal
  - Slightly larger RTG cost investment
  - Connection pedestal
  - Changing stacks requires a shallow cable trough or slot
- Busbar
  - Low voltage (480V or 1000V)
  - Larger infrastructure investment
  - Easily shift between stacks/blocks
  - Needs busbar support structures and foundations
- Fiber communications required in both cases
- Hybrid
  - 50%-60% reduction in emissions with no additional infrastructure

Case Study #1 – Electrified CHE and Ancillary Support Vehicle Implementation

Container Terminals, California



Our experience shows, these items are key:

Robust design for a tough environment

Location of chargers with respect to charging strategy

Coordination between designers, owner, operator, equipment providers, charging system vendors, energy providers.

- ✓ *Go live and Warranty*

Testing and certification of system components

- **Experience**
  - Current LBCT Charger Vendor Outreach – Assessment of 25 industrial plug-in and wireless charger vendors with respect to 41 criteria to include:
    - Voltage range and current output
    - Safety protocols
    - Proven track record
    - Integration with fleet management systems
    - Smart charging technology
    - Installation, warranty, & support
    - Maintenance and reliability
  - POLB Pier C and J / Port of Oakland B60 SSAT Terminals
    - eUTR automated charging systems
    - eTop Handler manual charging systems
    - eRTG installations

Case Study #2 – RTGs Over Rails and Stacks

Garden City, Crandall, and Gainesville, Georgia (GPA)

- **Over Stacks:**
  - RTG Electrification GCT Phases 1, 2, and 3
    - Electrification of existing RTG fleet
    - Busbar
  - Savannah Transload Facility
    - Cable reel with above ground cable horn
- **Over Rails and Stacks**
  - Appalachian Regional Port
    - Cable reel with anchor pits
  - Blue Ridge Connector
    - Partially grant funded

- **M&N Project Scope:**
  - Collaborated with Port to define operational requirements
  - Electrical design: Medium and low voltage distribution and communications
  - Crane design: Set parameters and collaborated with crane vendor to finalize design and requirements

Case Study #3 – RMG over Rail / eUTR

Megarail, Garden City Terminal

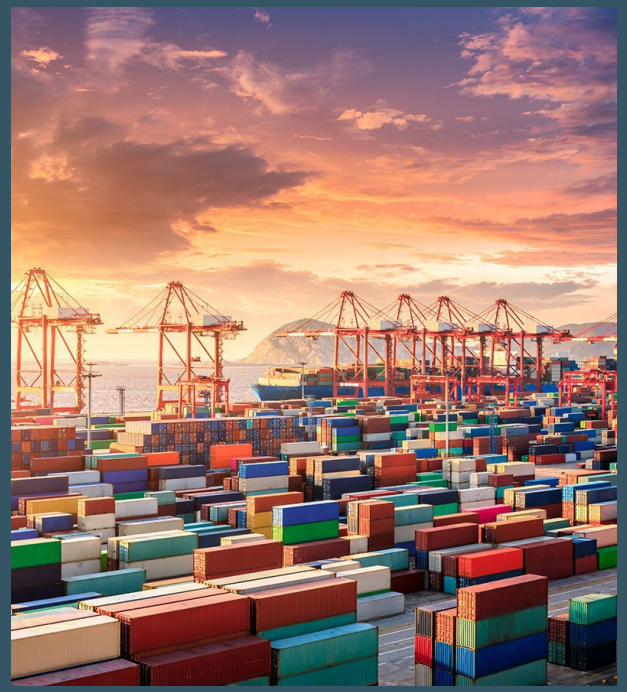
Our experience shows, these items are key:

- ✓ *Stakeholder Involvement as early as possible. Rail companies can take two years to respond with confirmation*
- ✓ *Support solicitation of a group of qualified bidders*
- ✓ *Public outreach including hosting public information open house*
- ✓ *Understanding the operational needs of the project and rail line*
- ✓ *Large rail infrastructure projects quickly become programs due to the impacts on adjacent areas and systems.*

- **Overview**
  - Largest on-terminal intermodal facility in North America
  - Project integrated rail switching operations on terminal
  - Partially grant funded to reduce rail traffic impact on neighboring communities
- **Awards:**
  - Grand Prize winner of the Georgia Partnership of Transportation Quality Pre-Construction Design Award
  - ACEC Engineering Excellence State and National Award Winner
- **M&N Project Scope:**
  - Collaborated with Port to define operational requirements
  - Rail design: Over 20 miles of new track, track alignment optimization, yard management system integration, switching controls, coordination with CSX and Norfolk Southern
  - Electrical design: Medium/low voltage distribution, lighting, and communications
  - Mechanical design: Compressed air systems for the railyard
  - Crane design: Set parameters and collaborated with crane vendor to finalize design and requirements

Case Study #4 – San Pedro Bay Clean Air Action Plan Compliance

Ports of Los Angeles and Long Beach, California



Our experience shows, these items are key:

Electrification is currently the most common path to net zero emissions

Integration requires a holistic approach

- ✓ *Equipment*
- ✓ *Power demand and grid*
- ✓ *Space and layout impact*
- ✓ *Labor impact*

- **Experience**
  - Pacific Merchant Shipping Association
    - Initial PMSA Studies to provide CAPEX and OPEX impacts of plan implementation in Ports of LA, LB, and Oakland Container Terminals.
    - Subsequent study to quantify associated electrical demand for terminal operations and electrified Truck drayage fleet.
  - National Association of Waterfront Employers
    - Current ZE CHE Technology Assessment - Study to evaluate current state, challenges, availability, advantages, and disadvantages of CHE and ancillary support vehicles with respect to:
    - Battery electric equipment (40 vendor living data base)
    - Battery charging solutions
    - Hydrogen equipment
    - Battery Energy Storage Systems

Case Study #5 – Electrification Master Plans

POLB Pier J ZE Infrastructure Master Plan, California

Our experience shows, these items are key:

- ✓ *Understanding impact of ZE transition on CAPEX and OPEX*
- ✓ *Terminal operational modifications required to support electrified equipment.*
- ✓ *Coordination with maintenance and repair functions.*

- **Overview**
  - Terminal master plan to analyze alternative ZE options for CHE and associated electrical demand for future throughput goals.
  - Evaluated alternative energy solutions.
  - Goal was to comply with CAAP with minimal impacts to operation.
- **M&N's Approach:**
  - Developed quantities of charging stations needed to support ZE terminal operations
  - Prepared ZE CHE parking and charging station layouts to consider
    - terminal operations and traffic flow patterns,
    - power infrastructure,
    - maintenance facilities,
    - operator/staff parking locations.
  - Determined CAPEX costs associated with converting yard tractors to electric power, including a benefit cost analysis

Case Study #6 – Electrification and Zero Emission Infrastructure Program

Port of Oakland Green Power Microgrid Project, California

Our experience shows, these items are key:

- ✓ *Resilient microgrid design to ensure reliable port operations.*
- ✓ *Integration of renewable energy generation and battery storage to reduce emission.*
- ✓ *Scalable infrastructure that accommodates future electrification and load growth.*
- ✓ *Close coordination with utility providers and regulatory agencies.*

- **Overview**
  - Implementing of a Green Power Microgrid to support ZE heavy-duty trucks, CHE, and terminal operations.
  - Project scope includes:
    - 145 heavy-duty EV chargers
    - 1 MW solar panel array
    - 6.5 MW battery energy storage system (BESS)
  - Substation upgrades planned to modernize the electrical grid and ensure resiliency
  - Goal is to reduce emissions and improve air quality while meeting California's decarbonization and energy resiliency targets.
- **M&N Approach:**
  - Conducted electrical load studies and power flow modeling to evaluate capacity and reliability of existing systems.
  - Designed charger layouts and substations tailored to terminal operations, utility interconnection, and site-specific conditions.
  - Developed Basis of Design Report (BODR) to align stakeholders on technical requirements, costs, delivery methods.
  - Established project schedule and milestones to meet grant deadlines.

Questions and Open Discussion

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