Agenda

1. Why Fleet Electrification Now????
2. Fleet Electrification Opportunities
3. Fleet Electrification Planning Process
4. EV Depot Charging and Load Patterns
5. Charging Equipment and Distribution
6. EV Time of Use Electric Rates
7. Transit Agency Fleet Electrification Example
8. Port Cargo Handling Equipment Electrification Example
Why Fleet Electrification Now?

- Battery and vehicle cost declining (Tesla / BYD / Li Ion)
- Technology improvements (energy density)
- Local / Regional air quality improvement
- Vehicle O&M and fuel savings
Fleet Electrification Opportunities

- Bus Fleets
  - Foothill Transit CA
- Cargo Handling
  - Port of Oakland CA
- Long Haul Trucking
  - BYD / Tesla / Others
- Local Delivery
  - UPS
FLEET ELECTRIFICATION PLANNING

- Operation Assessment
- Energy Requirements
- Facility Needs
- Phasing Implementation
- Equipment Market
- Charging Needs
- Utility Distribution
- Financial Analysis & Funding
Operations Assessment

- Central or decentralized vehicle locations
- Parking and vehicle duty cycle assessment
- Size of fleet and retirement schedules
- Operations and shift schedule
Equipment Market

- Operations and duty determine vehicle and charger equipment *
- MD / HD manufactures have common standards
- Battery sizes increasing (60 kWh to 200 kWh)
- MD / HD Range improving (150 to 250+ miles)
- Not all vehicles require a DC fast charger (i.e. on board charging)
- Multiple charging standards (Level 2, J1772, CCS1, J3105, etc.)
Energy Requirements

• Forecast usage based on normal and adjusted operations
• Plan for the expected or known equipment
• Optimize charging infrastructure based on energy and operations
• Battery size and capacity improvements continue
Charging Needs

• Based on operations and energy consumption
• Determine standard based on available equipment.
• Establish depot(s) charging locations.
• Determine type (ground vs overhead) and charger capacity (50 v 300 kW)
• Consider multi-port and multi-vehicle charging systems
Facility Needs

- Based on charging needs
- Determine where the chargers / EVSE go
- Do we have enough capacity at the facility
- Consider future expansion and operation changes
- Optimize around cost and operational impacts
Utility Distribution

• Based on facility needs and charging demands

• Develop or use existing EV programs for infrastructure funding.

• Determine what distribution upgrades are needed to support new loads.

• Establish what the utility fund up to:
  – The utility transformer
  – The DCFC charger
  – The EV connection
Phasing Implementation

- Phasing of new equipment in conjunction with retirement plans
- Phasing of infrastructure to meet EV expansion
- Fits with business plan, facility upgrades, grid capacity, onsite power
- Moving towards 100% electrification
Financial Analysis and Funding

- Consider retirement schedules and cost to replace vehicles
- Compare all capex costs of EV and ICE vehicles
- Incorporate all O&M, fuel, and electricity costs
- Grants and polices supporting vehicle electrification
- Prepare long term lifecycle analysis of options (15-20 year)
Utility Consideration
Load Profiles

- MD / HD fleet depot EV loads depend on fleet operations and equipment
- Some fleet charging can be managed to use low cost off-peak energy
- Other fleet charging cannot be managed due to operations
- The utility can greatly influence behavior through EV TOU rates
Load Profiles

- Bus Charging Depot (160 buses @ 325 kW each)

Unmanaged Charging

Managed (Optimized) Charging
Load Profiles

- Port Charging Depot (52 Yard Trucks @ 200 kW each)

Unmanaged Charging  Managed (Optimized) Charging

Inflexible Operations
DEPOT CHARGERS

**SAE J3068**
- 3 Phase AC Power
- 480V, 160A (133 kW)
- 600V, 160A (166 kW)

Requires onboard charging equipment, but uses simpler infrastructure.

**SAE J1772 CCS – 1 & 2**
- DC Power Addition to AC Ports
- Favored in US & EU
- 1000 VDC, 350A (350 kW)

**J3105-1**
- Overhead Panotgraph
- Up to 500 kW
- Standard: OPP Standard
Depot Charger Types and Vendors

• **Ground Mount Depot Chargers:**
  - DC Fast chargers Power Range:
    • 50kW to 500kW
  - Vendors:
    • ChargePoint, Siemens, ABB, Heliox

• **Overhead Depot Chargers**
  - DC Fast Chargers Power Range:
    • 300kW-500kW
  - Vendors
    • ABB, Siemens, Heliox
Distribution Upgrades

• MD/HD load profiles need thorough analysis (2 MW ~ 20 MW)
• Depot chargers should be assumed to be at full load for distribution analyses
• Line extension rules and upgrade cost sharing may need reconsideration
• Vehicle charging revenues will help pay for new infrastructure (ebuses must charge)
• Consider charger rebates, distribution upgrade cost sharing (i.e. SCE)
Distribution Upgrades

ICE Depot
(500 kW)

12 kV ; 7.5 MW load

Building / Lights

EV Depot
(7,500 kW +)

12 kV ; 15,000 kW load

Transformers
Switchgear
Chargers

Transformers
Switchgear
Chargers
EV Time of Use Rates

- MD/HD programs typically require use of EV TOU rates
- EV TOU rates are becoming the norm for most utilities
- EV TOU rates can be very effective at shifting load (85%+)
- Large peak to off peak ratios are important (3:1 to 6:1)
- Demand charge grace period is sometime employed
- New metering and billing systems are not needed
EV Time of Use Rates

Depot (Weekday Non-Summer)

Depot (Weekday - Summer)
Port of Oakland Utility
Cargo Handling Equipment Electrification

- 350+ HD vehicles at 9 terminals
- 24/7 operations
- Local air quality improvement initiatives
- Limited electrical system capacity
- Initiative to electrify CHE (trucks, top picks, etc.) over 20 years
- Need to plan for future electrical growth and capacity
Port of Oakland Utility
Cargo Handling Equipment Electrification

- **Operational Assessment:**
  - Yard trucks, cranes, picks, forklifts
  - 24/7 operation
  - Down time in early morning and lunch

- **Equipment Market Analysis:**
  - Yard Trucks available
  - Top picks under development
  - Large batteries & high charge rates

- **Energy Consumption Analysis:**
  - Mileage per day and duty of vehicles
  - Determine miles, kWh/mile, kWh
  - Developed hourly kWh charging patterns

- **Charging Needs:**
  - AC/DC conversion on board
  - 480/277 3 phase transformers
  - 200-350 kW charging required
Port of Oakland Utility Cargo Handling Equipment Electrification

• Facility Needs:
  – Centralized charging depots
  – New EVSE required
  – New low voltage electrical
  – New depot substations

• Phasing Implementation
  – Plan for phased EV growth / adoption
  – Plan charging depot and distribution system accordingly

• Utility Distribution Upgrades:
  – Additional transmission lines
  – Increase substation capacity
  – Distribution transformers and feeders

• Financial Analysis and Funding:
  – Facility upgrade costs
  – Funding support
  – Revenues / Costs
Port of Oakland Utility
Cargo Handling Equipment Electrification

Example Daily Vehicle Charging Profile

Example Conceptual Charging Depot Layout
Foothill Transit
Bus Fleet Electrification
Foothill Transit

- 350+ buses at 2 large depots in Southern California
- 5 am – 12 am operations
- Commitment to electrify fleet with state mandate
- Initiative to electrify all buses over next 10 years
- Need to plan for future charging infrastructure
### Foothill Transit
#### Bus Fleet Electrification

<table>
<thead>
<tr>
<th>Operational Assessment:</th>
<th>Energy Consumption Analysis:</th>
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</thead>
<tbody>
<tr>
<td>– Number of buses &amp; range of buses</td>
<td>– Miles per day per bus</td>
</tr>
<tr>
<td>– Number and mileage of each route</td>
<td>– Number of buses to charge</td>
</tr>
<tr>
<td>– Existing demand of depot</td>
<td>– When is the energy needed</td>
</tr>
<tr>
<td>– Is there space at Depot</td>
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<thead>
<tr>
<th>Market Analysis:</th>
<th>Charging Needs:</th>
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<tbody>
<tr>
<td>– What eBuses are available</td>
<td>– Charging equipment types</td>
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<tr>
<td>– Expected adoption rate</td>
<td>– Quantity</td>
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<tr>
<td>– Charging technology to meet operations</td>
<td>– Peak power and voltage</td>
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### Foothill Transit
Bus Fleet Electrification

<table>
<thead>
<tr>
<th>Facility Needs:</th>
<th>Distribution Upgrades:</th>
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<tbody>
<tr>
<td>– Existing capacity sufficient</td>
<td>– Extra transformer capacity</td>
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<tr>
<td>– Space for new equipment</td>
<td>– Enough capacity in distribution system</td>
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<tr>
<th>Phasing Implementation:</th>
<th>Financial Analysis:</th>
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<tr>
<td>– Plan for phased replacement of buses</td>
<td>– CAPEX vs OPEX</td>
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<tr>
<td>– Plan for phased infrastructure upgrades</td>
<td>– Total Cost of Ownership</td>
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<td></td>
<td>– Funding availability</td>
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Foothill Transit
Bus Fleet Electrification

• Plan to transition bus fleet over 10 to 12 years (slow)
• Infrastructure costs and EV vehicle costs could be a barrier
• Rebates, grants, and cost sharing will help enable ebus implementation
• State mandates will drive changes regardless of economics
• Every transit agency in California is planning for electrification
Final Thoughts

• Fleet Operators
  – 100% fleet conversion are large multi-year capital investments
  – Technical and economic feasibility study is needed
  – Utilities are stepping up and supporting customers

• Electric Utilities
  – MD / HD EV fleets and charging depots are significant infrastructure and revenue opportunities
  – Electrical improvement cost sharing programs are beneficial to both fleet and utility
  – EV TOU rate programs enable efficient use of infrastructure
CREATE AMAZING.