Trucks On The Grid
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Trucking Numbers

- ~70\% Of US Freight Moved By Truck*
- ~2/3 Of GDP Worth Of Freight Moved Per Year*
- 1 Million Miles Typical Truck Lifetime
- ~12 Million Trucks In The US*

*2019 DOT Freight Facts And Figures
Powertrain Electrification

- Battery Electric Vehicle
- Plug-in Hybrid Vehicle
- Combustion Engine

Applications:
- 8-19 T / Class 6-8: P&D / City Distribution
- 26 T / Class 8: Municipality
- 32-40 T / Class 8: Drayage / Shuttle
- 44 T / Class 8: Supermarket Supply
COMMERCIAL VEHICLE Batteries

- 24 kWh
  - Gen 1 Nissan Leaf

- 100 kWh
  - Tesla Model X

- 200 to 600+ kWh
  - MD/HD Truck
COMMERCIAL VEHICLE Fleet Location Scale

Small: 1-2 Trucks

Large: 100’s of Trucks
<table>
<thead>
<tr>
<th>Small Battery</th>
<th>Big Battery</th>
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</thead>
<tbody>
<tr>
<td>AC Level 2 Charging</td>
<td>DC Fast Charging (1 Shift)</td>
</tr>
<tr>
<td>DC Fast Charging (2 Shifts)</td>
<td>DC Fast Charging</td>
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</tbody>
</table>

**CHARGING**

**AC vs. DC**
CHARGING PATTERN Examples

2-shift Pick-up And Delivery

Charge trucks overnight – lowest possible rate to protect batteries

Sequentially fast charge trucks between shifts

Staggered departure

Charger Power (kW)

0 50 100 150 200

4:00 AM 7:00 AM 10:00 AM 1:00 PM 4:00 PM 7:00 PM 10:00 PM 1:00 AM 4:00 AM

x4

1-shift Refuse Collection

Charge trucks overnight – lowest possible rate to protect batteries

Trucks leave early to collect refuse

Charger Power (kW)

0 50 100 150 200

4:00 AM 7:00 AM 10:00 AM 1:00 PM 4:00 PM 7:00 PM 10:00 PM 1:00 AM 4:00 AM

x4
ENERGY MANAGEMENT
Opportunities

Incentives
• Timing
• Location

Infrastructure
• Stationary Batteries
• On-Site Generation

Automation
• Scheduling
• Ramping/Compensation
MARKET
Requirements

Productive
Reliable
Low-Risk
Easy
Innovative Trucks
Innovative Infrastructure