EV State Working Group - Heavy Duty Truck Charging

NARUC 2021
EDF Core Staff on Charging

Timothy O’Connor  Senior Director, Energy Transition
Pamela MacDougall  Lead on Charging and Infrastructure Strategy
Larissa Koehler  Lead on Electric Vehicle Policy
Elizabeth B. Stein  Lead Counsel, Energy Transition Strategy
Presentation Roadmap

• Part 1 - Discussion of recent study on **heavy duty charging** – Tim O’Connor (15 min)

• Part 2 – Discussion of studies, research and observations on **electric vehicles as a grid asset** - Pamela MacDougall (15 min)

• Part 3 – **Principles and recommendations for utility commissions engaging in transportation electrification planning** - Pamela MacDougall and Elizabeth Stein (15 min)

• Part 4 – Discussion and Q&A (15 min)
Heavy Duty Fleet Electrification - Charging Analysis

NARUC 2021

Tim O’Connor
Senior Director, Energy Transition
Goals of Study

- **Fleet needs**: How effective will electrification be at meeting fleet operational needs without modification of routes and timetables?

- **Electric load**: What is the aggregate and peak facility electrical load for a combination of charging strategies, charger sizes, and traction battery capacities needed to accommodate a 40-50 heavy-duty battery electric truck deployment project?

- **Charging rates and scenarios**: Under what charging scenarios can a target facility maximize the fraction of trips successfully charged while minimizing power demands and expected infrastructure costs? Also, how are the costs of charging and peak load impacted by managed charging under different electric rate variants?

- **Distributed energy resources**: What role do distributed energy resources (DERs), including on-site solar photovoltaic (PV) generation and battery energy storage systems (BESS), have on the charging infrastructure costs and emissions reductions profiles of each deployment? Also, how do DER scenarios affect the aggregate facility load profile under various utility rates?
Assumptions

- Using Existing Rates (TOU, Demand Holiday, Subscription) in California

- Infrastructure
  - Charging Station Power (50, 150, 350, 800 kW)
  - Traction Battery Capacity (300, 500, 750, and 1000 kWh)
  - Solar Sizing: 80% of annual energy consumption

- Infrastructure programs:
  - Low Carbon Fuel Standard (LCFS)
  - Investment Tax Credit (ITC)
  - Self Generation Incentive Program (SGIP)

- Fleets: Based on 2019 & 2020 Driving Data

<table>
<thead>
<tr>
<th>Fleet</th>
<th>Annual VMT</th>
<th>Number of Trucks</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFI</td>
<td>40,000</td>
<td>50</td>
<td>Chino</td>
</tr>
<tr>
<td>Schneider</td>
<td>67,000</td>
<td>42</td>
<td>Stockton</td>
</tr>
</tbody>
</table>
**Finding: Electric Trucks Can Meet Most of the Duty Cycle Needs**

**Influencing Factors**

<table>
<thead>
<tr>
<th>Fleet</th>
<th>Schneider</th>
<th>NFI Current Technology</th>
<th>NFI Advanced Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario Name</td>
<td>Baseline</td>
<td>Current Technology</td>
<td>Advanced Technology</td>
</tr>
<tr>
<td>DCFC Power Level (kW)</td>
<td>150</td>
<td>150</td>
<td>800</td>
</tr>
<tr>
<td>Truck Battery Capacity (kWh)</td>
<td>1,000</td>
<td>500</td>
<td>1,000</td>
</tr>
<tr>
<td>% of Successful Trips</td>
<td>88%</td>
<td>71%</td>
<td>93%</td>
</tr>
<tr>
<td>Maximum Number of Chargers In Use</td>
<td>25</td>
<td>40</td>
<td>40</td>
</tr>
</tbody>
</table>

**Charging Window**

Schneider fleet has an average charging window of 110% longer than NFI, and median charging window 550% longer than NFI.

**Driving Distance**

Schneider fleet has an average trip distance 65% higher than NFI Chino, and a median trip distance 134% higher than NFI Chino.
Finding: A small amount of on-route charging can unlock even more potential

Shared Charging has potential to help meet business needs

Most failed trips could be completed successfully with the addition of minimal on-route charging -- 70 minutes for NFI's failed trips, and 30 minutes for Schneider's
### Finding: Infrastructure Is Costly

<table>
<thead>
<tr>
<th>NFI Charging Infrastructure</th>
<th>Current Technology Managed</th>
<th>Advanced Technology Managed</th>
<th>Advanced Technology Unmanaged</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scenario</strong></td>
<td><strong>Charger Rating</strong></td>
<td><strong>EVSE Capital Costs</strong></td>
<td><strong>EVSE Installation</strong></td>
</tr>
<tr>
<td></td>
<td>150 kW</td>
<td>Power Cabinet + Dispenser $107,000</td>
<td>$375,000</td>
</tr>
<tr>
<td>Warranty (increase from 2-5 years)</td>
<td>$15,500</td>
<td>$65,250</td>
<td>$65,250</td>
</tr>
<tr>
<td>Cable Management</td>
<td>$1,500</td>
<td>$1,500</td>
<td>$1,500</td>
</tr>
<tr>
<td>Sales Tax (8.5%)</td>
<td>$2,000</td>
<td>$2,000</td>
<td>$2,000</td>
</tr>
<tr>
<td>Commissioning/Activation Fees</td>
<td>$2,000</td>
<td>$2,000</td>
<td>$2,000</td>
</tr>
<tr>
<td><strong>Total Installed Cost (per Charger)</strong></td>
<td><strong>$171,540</strong></td>
<td><strong>$656,299</strong></td>
<td><strong>$656,299</strong></td>
</tr>
<tr>
<td><strong>Total Site Work Cost</strong></td>
<td><strong>$551,000</strong></td>
<td><strong>$1,586,000</strong></td>
<td><strong>$1,586,000</strong></td>
</tr>
<tr>
<td><strong>Subtotal Scenario Cost</strong></td>
<td><strong>$7,412,600</strong></td>
<td><strong>$27,837,950</strong></td>
<td><strong>$27,837,950</strong></td>
</tr>
<tr>
<td><strong>Design, Permitting, Management Fees</strong></td>
<td><strong>$2,223,780</strong></td>
<td><strong>$8,351,385</strong></td>
<td><strong>$8,351,385</strong></td>
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<tr>
<td><strong>Contingency</strong></td>
<td><strong>$741,260</strong></td>
<td><strong>$2,783,795</strong></td>
<td><strong>$2,783,795</strong></td>
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<tr>
<td><strong>Total Scenario Cost</strong></td>
<td><strong>$10,377,640</strong></td>
<td><strong>$38,973,130</strong></td>
<td><strong>$38,973,130</strong></td>
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**Total Scenario Cost**

$8,979,810
Finding: Value of electrification projects (NPV) only positive with LCFS, ITC and SGIP incentives

LCFS Revenues

<table>
<thead>
<tr>
<th>EV Carbon Intensity Basis</th>
<th>Smart Charging</th>
<th>Grid Average</th>
<th>Renewable/Zero CI</th>
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</thead>
<tbody>
<tr>
<td>Current Technology</td>
<td>$1,198,583</td>
<td>$1,196,396</td>
<td>$1,495,495</td>
</tr>
<tr>
<td>Advanced Technology</td>
<td>$1,502,603</td>
<td>$1,511,064</td>
<td>$1,888,829</td>
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</table>

ITC + SGIP Incentive
~ $3.4 Million
Finding: Electrification Results in Annual Fuel and Emissions Savings

Electrification Does Result in Fuel Savings

<table>
<thead>
<tr>
<th></th>
<th>Diesel</th>
<th>Electricity</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schneider Annual Fuel Cost</td>
<td>$1,536,656</td>
<td>$981,843</td>
<td>$554,813</td>
</tr>
<tr>
<td>NFI Annual Fuel Cost</td>
<td>$1,387,735</td>
<td>$639,424</td>
<td>$748,311</td>
</tr>
</tbody>
</table>

Emission Reductions are Significant

NFI tailpipe reductions annually:
- 5,295 MT CO2e/year,
- 6,240 kg NOx
- 69 kg PM2.5
Finding: Charging Costs go down with managed charging

<table>
<thead>
<tr>
<th>Energy</th>
<th>Demand</th>
<th>Fixed</th>
<th>Total Bill</th>
<th>Rate Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>$636,364</td>
<td>$0</td>
<td>$3,061</td>
<td>$639,424</td>
<td>Demand Holiday</td>
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<tr>
<td>$525,505</td>
<td>$437,338</td>
<td>$3,061</td>
<td>$965,904</td>
<td>Demand Holiday*</td>
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<td>$350,796</td>
<td>$883,764</td>
<td>$3,061</td>
<td>$1,237,621</td>
<td>TOU</td>
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<tr>
<td>$725,817</td>
<td>$70,964</td>
<td>$0</td>
<td>$796,781</td>
<td>Demand Subscription</td>
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</table>

<table>
<thead>
<tr>
<th>Energy</th>
<th>Demand</th>
<th>Fixed</th>
<th>Total Bill</th>
<th>Rate Type</th>
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<tbody>
<tr>
<td>$578,549</td>
<td>$0</td>
<td>$3,061</td>
<td>$581,609</td>
<td>Demand Holiday</td>
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<tr>
<td>$470,269</td>
<td>$400,565</td>
<td>$3,061</td>
<td>$873,895</td>
<td>Demand Holiday*</td>
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<tr>
<td>$342,364</td>
<td>$760,266</td>
<td>$3,061</td>
<td>$1,105,691</td>
<td>TOU</td>
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<tr>
<td>$685,175</td>
<td>$64,997</td>
<td>$0</td>
<td>$750,173</td>
<td>Demand Subscription</td>
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</table>
Finding: Pairing managed charging with DERs saves money by further reducing and shifting demand.
Finding: Managed charging and DERs reduce peak energy use.
Four Key Takeaways

1. Existing and upcoming electric Class 8 truck models, paired with commercially available charging equipment, can meet the technical requirements of the vast majority of truck-trips analyzed with on-site (depot) charging – though operational challenges remain.

2. Charging infrastructure investments required for Class 8 fleets are significant and can vary dramatically.

3. Policies and programs that reduce the infrastructure costs required for fleet electrification will be essential to accelerate the transition of Class 8 trucks.

4. Managed charging and on-site distributed energy resources (DERs) like batteries or solar will be critical to making infrastructure costs affordable.
Plug-in Vehicles for the Greener Grid

NARUC 2021

Pamela MacDougall, PhD
Senior Manager, Grid Modernization
EVs can do more than just drive

The goals of VGI are to:
- Assist with **renewable integration** and reduce peak demand
- **Scale up EV deployment**, and reduce cost of ownership
- Help to **mitigate grid upgrades**, lowering ratepayer costs

Plug-in EVs (PEVs) can enable this via a combination of:
1. Thoughtful placement of EVSE
2. V1G = Managed charging
3. V2G = Bi-directional smart charging
4. V2B = Vehicle to Building Charging
What is the Flexibility Potential?

Study by MISO showed expected future EVs in aggregate can have 10 GW of upward and downward ramp capacity at any time of the day.

Source: Greenblatt, Jeff and Margaret McCall. “Exploring enhanced load flexibility from grid-connected electric vehicles on the Midcontinent Independent System Operator grid” Available at: https://cdn.misoenergy.org/Exploring%20enhanced%20load%20flexibility%20from%20grid%20connected%20EVs%20on%20MISO%20grid543291.
Example: VGI and Distribution Grid

*What happens when every house has an EV?*

Study done to evaluate impact on grid feeders at 100% residential EV penetration.

**Measurements**: Voltage Stability and Available Capacity (Overloading).

**Data:**
- 50 feeders from PG&E
- Charging data from ChargePoint
EV and Grid models validated with real data.

Expanded Results to all 3000 PG&E Feeders

Main Results:

- If charging is unmanaged, utilities will face large problems with voltage stability and overloading.
- If 28% of the EVs are smart charging off-peak on TOU rates, almost all grid issues can be addressed.
- We need to get EV customers on time-variant rates.
VGI as Storage is Cost-Effective

How Much Storage?
• V1G ~ 1 GW of storage
• V1G and V2G ~5 GW of storage.

How Much Savings?
• V1G system-wide investment of ~$150 million, compared to $1.45-$1.75 billion for stationary (non-EV) storage.
• V2G is worth $12.8 to $15.4 billion in equivalent stationary storage.

LBNL Study shows without impacting driving V1G and V2G can provide storage….at a much lower cost.

VGI can provide a range of benefits

State/City
- Meeting renewable and EV goals

ISO
- Reduced cost and aid with balancing and transmission issues
- Integration of renewables

Utility
- Reduced cost of grid management
- Reduced grid upgrade costs.
- Integration of renewables and EVs

EVSE (charging station) operator
- Improved business case

3rd party
- Entry to market

EV owner / clean energy owner
- Reduced cost of ownership

Source of image: Rocky Mountain Institute
Solutions to unlock the potential that VGI holds…
Need to Create Business Opportunities

Achieve Favorable Economics:
• Access to Wholesale Market Prices
• Storage Mandates: Allow V1G to participate
• Bring Your Own Device Programs
• Effective, actionable price signals for the full spectrum of EV owners
Need to Align Utility Business Model and Societal Interests

Utilities making large headway with:

- Time-Variant Rates
- Billions in Infrastructure Programs

Don’t have comparable progress for VGI

Not necessarily in utilities’ interest to invest in non-wires solutions.

For example, a **Utility Performance Incentive Mechanisms** that reward achievement of specified outcomes can help.
Ensuring use of proper communication standards

Demand Response (Open ADR)

Get Price Signals to Customers (OpenADR, OCPP, and ISO 15118)

Customer Service Choice (OCPP)

Roaming Billing (OCPI)

Avoid Stranded Assets (OCPP)

Communication standards allow a more seamless experience
Pursue beneficial metering and telemetry programs

Solutions:
• Set Metering Requirements that Match the VGI Service
  • e.g., 4 second telemetry is not needed for an hourly TOU rate.
• Define Sub-metering Requirements
• Allow 3\textsuperscript{rd} party metering
  • e.g., CAISO Allows 3\textsuperscript{rd} party metering for DER wholesale participation

Pilot Programs:
Electric Vehicle Sub-Metering Pilot
• e.g., Minnesota Xcel Energy
Get the Grid Ready: It’s Time to Modernize

Enhanced Visibility
• Wide Area Monitoring and Control
• Information Communication Technology Integration

Smart Technology
• Advanced metering infrastructure
• Grid Automation

Advanced Billing Systems
• Subtractive Billing

Holistic and Streamlined Interconnection Practices
Recommendations for Successful Infrastructure Programs and Policies

Upcoming White Paper by Larissa Koehler & Pamela MacDougall
High-level applicability of recommendations

These recommendations are meant to apply to utility commissions that are already embarking on EV infrastructure planning and deployment.

- Prior to getting to this point, states and utility commissions should observe that vehicle electrification is here, and utility participation in the transition is a key component of meeting long-term climate goals. Short-, medium-, and long-term utility planning therefore needs to become aligned with these goals.
Recommendation 1: Differentiate policy approaches between LDVs and MHDVS

Utility regulators and utilities should create policies and programs that account for the differences between, and therefore lend more tailored support for, the deployment of infrastructure necessary to support the electrification of both medium- and heavy-duty vehicles (MHDVs) and light-duty vehicles (LDVs).
Recommendation 2: Equity Should Come First

State policymakers and utilities should prioritize charging station deployment in:

• Low-Income Communities
• Areas with Disproportionate Air Quality and Environmental Impact
• Emphasis on MHDVs in these areas

Programs should ensure deployment barriers for all stakeholders are identified and overcome. Particularly:

• small and women/minority-owned businesses
Recommendation 3: Targeted Marketing, Education, and Outreach is Necessary

Utilities, in collaboration with various local organizations and businesses, should develop targeted marketing, education, and outreach (ME&O) materials to help disseminate information to potential EV purchasers, recognizing that different communities and market segments will need nuanced approaches to how information is provided and presented.

• e.g., LDVs and MHDVs have wildly different infrastructure barriers and needs
Recommendation 4: Fostering Accountability Drives Results

Utilities should be required to collect and monitor data to show the extent to which EVs are being effectively integrated into the grid, ensure prudent expenditure of ratepayer funds, and demonstrate achievement of pre-determined metrics and goals.

- Conduct Grid Impact and Market Potential Analyses
- Develop, and Update Hosting Capacity Maps
- Publish Frequent Reports
Recommendation 5: Develop Robust Vehicle-Grid Integration Strategies

1. Seek to Mitigate Fleet Charging Infrastructure Cost
2. Seek to Mitigate Grid Build-Out and Integrate More Renewables
3. Leverage EVs to Boost Resiliency and Reliability
4. Use price signals, communications protocols, and supporting technologies to foster a robust VGI marketplace.
Recommendation 6: Safeguard EV Charging Infrastructure

To better harness the benefits of EVs and provide a better customer experience, state and utility policymakers must establish infrastructure, communication, and safety standards to help harmonize transportation electrification efforts.
Recommendation 7: Broaden Infrastructure Programs to include Low-Cost Solutions

Key Finding of GNA Study was clear benefits of managed charging and DERs, such as solar and storage. These include:

- Lower total cost of ownership for fleets
- More adaptive response to grid conditions
- Reducing grid impact, including peak load
Electric Pricing for Charging MHDVs

• Keep bills manageable (preferably competitive with diesel) while moderating costly grid impacts.
• Evaluate the impact of existing rates in various fleet scenarios – and consider new approaches to improve the electrification business case for fleets and/or the system impact.
• Expect to need a suite of options for diverse MHDV customers.
Electric service pricing can help optimize VGI

Price signals can provide incentives for EV operators…
• to charge during off-peak times or when there is a surplus of renewables
• to charge in a manner that avoids unwanted demand spikes, and even provide ancillary services or improve system reliability
• to charge in places where capacity exists
• to deploy clean energy DERs such as distributed solar and storage
  and
• to discharge when beneficial to the grid for reliability and other purposes