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# Solving the charging challenge for commercial electric fleets

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**Executive Summary**

The transition to electric heavy-duty trucks is upon us, sparked by continuous improvements in battery-electric truck and charging technologies, availability of federal and state incentives, and growing recognition of the climate needs. But even as household name brands have made public pledges to electrify their truck fleets, concerns that charging infrastructure will be too costly and unable to be rolled out to meet the projected transition timelines threaten to slow the market-wide transition. This paper will dive into one of the most common barriers for fleet charging infrastructure, interconnection delays, and evaluate cost impacts using experience from the Volvo Low Impact Green heavy Transport Solutions (LIGHTS) project in Southern California, and offer both technological and policy solutions to help scale fleet charging infrastructure.

## 1 Introduction

Real-world, on-the-ground experiences and pilots are important pieces for identifying gaps and informing actions needed to support the rapid transportation decarbonization. The Volvo LIGHTS Project, led by the South Coast Air Quality Management District and sponsored by the California Air Resources Board, is an extraordinary union of public and private stakeholders that have the expertise, capital, and commitment to advance battery-electric freight solutions beyond the ‘demonstration’ phase into revenue-generating applications for fleets, and charging infrastructure deployment insights was a key outcome of the project. There are three major costs for fleets when considering charging infrastructure projects – (1) chargers and construction costs, (2) interconnection, and (3) electricity bills. Using data collected from one of the fleet partners within the Volvo LIGHTS project, Dependable Highway Express (DHE) in Ontario California, we evaluated the cost of infrastructure deployment, focusing on the financial impacts of delayed interconnection, the roadblocks encountered, and explored how onsite battery storage and solar panels, and managed charging can address many of these barriers.

The ambitious targets and accelerated timelines for the deployment of battery-electric heavy-duty trucks have created unprecedented challenges for developing charging equipment and the grid in a timely manner. Fleets in key corridors are already facing interconnection delays that can be detrimental to states and industry meeting their sustainability targets.

The paper is organized as follows. Sections 2 and 3 summarize the Volvo LIGHTS project contributions and financial impacts of interconnection delays at the DHE site. Using lessons learned from this commercial pilot, we expanded our analysis to assess the full financial impact of delayed interconnection of charging equipment other commercial fleets are facing today. In Section 4, we propose technical solutions that can not only mitigate interconnection delays due to capacity constraints, but also result in overall bill savings and power security for fleets. Finally, in Section 5, we suggest supportive policies that are needed to roll out charging infrastructure as well as other complementary technologies in a timely manner.

# 2 A Modern Freight Facility

DHE has been providing intrastate and interstate less than truckload (LTL) and delivery in California since 1950. The cross-dock facility in Ontario, California that was one of the Volvo LIGHTS sites operates 24 hours a day Monday through Friday. Typical routes for trucks originating from this facility range from 85 to 500 miles, and there are currently over 60 vehicles and more than 150 trailers and gears at this site. As part of the Volvo LIGHTS project DHE was able to introduce and integrate the following on-road and off-road battery-electric solutions in their regular operations.

*Table 1: DHE's Battery-Electric Vehicle Deployment within Volvo LIGHTS*

| Battery-electric vehicle type | Number | Battery capacity (kWh) |
|---|---|---|
| Volvo VNR Electric Class 8 truck | 2 | 264 |
| Orange EV T-Series electric terminal truck, extended duty | 1 | 160 |
| Orange EV T-Series electric terminal truck, standard duty | 1 | 80 |
| Yale ERP-VT 4000 lbs. electric power forklifts | 14 | 25.2 |

To accommodate these different on-road and off-road vehicles, DHE explored a combination of charging stations with varying power outputs, as well as complimentary onsite battery-electric storage systems (BESS) and solar generation to mitigate electricity costs and enhance power security in the event of an outage.

- Two ABB HVC 150C kW chargers with 6 charging ports
- Two 22 kW Orange EV charging cabinets
- Five 7.7 kW EVoCharge Electric Vehicle Charging Stations
- Eight 8 kW ACT Quantum Chargers
- In-Charge US monitoring system
- 864kW Solar panel, Annual production target 1.291 GWh, 2367 panels
- BESS with two Chint Power Systems 30kW inverters and two 65kWh energy storage

The total cost of installing the charging infrastructure, including soft costs such as design, engineering, permitting, as well as hardware and installations by providing cost ranges was between $800,000-$1,000,000. However, this was without accounting for the solar panel and BESS that came much later in the project. The solar panel cost between $900,000-$1,000,000 after rebates, and the BESS cost between $55,000 - $65,000 after all rebates. A breakdown of these different costs and incentives received for this project is provided in Table 2. It should be noted that as this project was financed through the Volvo lights project, it does not take advantage of State incentive programs for charging. As we are assessing upfront costs, revenues from California's Low Carbon Fuel Standard (LCFS) program are not included in the incentives listed below.

*Table 2: Breakdown of Cost Estimates and Rebates*

| Item | Cost Estimates |
|---|---|
| Hardware | $ 200,000 |
| Engineering design and project management | $150,000 |
| Permitting and other fees | $1000 |
| Electric upgrades | $400,000 |
| Construction work | $300,000 |
| Solar panels | $2,000,000 |
| BESS | $180,000 |
| **Incentives** | |
| **Solar panels** | |
| Federal tax credit | $600,000 |
| Federal depreciation credit | $200,000 |
| State depreciation credit | $150,000 |
| **BESS** | |
| Federal tax credit | $50,000 |
| Federal depreciation credit | $30,000 |
| State depreciation credit | $16,000 |
| Self-Generation Incentive Program (SGIP) credit | $15,000 |

Based on the engineering assessment, the DHE site required an electrical upgrade from 1MW to 2.5 MW costing around $700k. At the time of the project, the onsite solar and BESS system were handled by a different department of the utility company than the interconnection of the charging stations. This resulted in longer than usual lead times as DHE had to apply for multiple interconnection requests and therefore the systems coming online sequentially rather that concurrently. If the systems were allowed to be interconnected concurrently, the electrical costs, permitting, and other soft fees may be slightly lower than listed above and could have reduced the lead time.

*Figure 1: Aerial view of the DHE cross-dock facility in Ontario, California.*

## 3 Financial Impacts of Interconnection Delays

With expedited electrification timelines needed to meet state and federal decarbonization targets, utilities are facing rapid interconnection requests of electric charging equipment as well as other behind-the-meter (BTM) resources, such as onsite solar and storage. This influx of interconnection requests is already causing delays of upwards of two years from some fleets to energize their charging stations. These delays can be a result of a variety of reasons, ranging from upstream grid congestions, complex permitting processes, labor and equipment shortages, as well as misalignment of grid planning procedures with electrification timelines. While much attention has gone into the impact of rapid electrification on utilities and states to meet these decarbonization targets, the financial impact of delayed interconnection on fleets has yet to be explored. Here we will present the financial burdens a fleet (such as DHE) experiences because of these delays in the deployment process. These costs are primarily due to operational costs, locked capital, and resources, and missed financial support opportunities such as federal and state rebate or tax incentives.

As mentioned above, DHE was an early adopter, participating in the Volvo LIGHTS project, and electrified 4 trucks and 14 forklifts at its cross-dock facility in Ontario, California. During the project DHE experienced a 6-month delay for interconnection of their depot charging stations. Fortunately, they were able to utilize the charging stations that were energized at a nearby dealership in Fontana, California; however, this came at an additional cost. The charger was located approximately 11 miles from the DHE facility. This added travel time had significant cost implications in the range of $70,000-$80,000. This includes the lost revenue and extra costs, such as additional staff time and fueling, incurred with truck origination from a nearby dealership where chargers were installed instead of the DHE terminal. Further costs faced due to locked capital in equipment are summarized in the table below totaling over $250,000 in locked capital.

*Table 3: DHE's Locked Capital Costs and Operations*

| Item | Cost Range |
|---|---|
| DHE Staff time | $45,000-$55,000 |
| Relocation of equipment to provide space for chargers | $20,000-$30,000 |
| Property value | $95,000-$100,000 |
| Managed charging software | $90,000-$100,000 for 3 yrs. |

These delays are not unique to DHE. Commercial fleets across the U.S. operating battery-electric trucks in revenue-generating service are incurring a cost of $2,500-$5,000 per charge port per month, and this quickly adds up and negatively impacts the total cost of operations. On average, for smaller truck deployments (1-2 battery-electric trucks), the utility interconnection time has been about 31 weeks. For larger truck deployments (10+ battery-electric trucks), the lead time has been more than a year, thereby placing these fleets in danger of losing their grant funding (average amount is $300,000) or having to reapply for their truck rebate vouchers (average amount is $125,000). This data is based on 8 independent projects totaling 40+ battery electric truck deployments across the U.S. by the Volvo Group North American truck brands.

It is evident that interconnection and grid readiness is a backstop for meeting decarbonization targets. To ensure that fleets are not bearing the brunt of the burden, technical solutions and policies must be explored to ensure fleets have access to charging they need in line with federal and state targets.

# 4 Technology Solutions for Utility Bill Savings and Reduced Grid Expansion

One of the most impactful reasons for interconnection delays is when an upstream grid upgrade is triggered or when a significant site upgrade is required that requires trenching. One solution to prevent this delay is to minimize the peak load through technologies such as active managed charging and onsite renewables. Many fleets are already exploring usage of onsite solar and storage to ensure power security as they electrify and reduce the cost of charging. Depending on the electricity rate options available, and fleet duty cycles, the cost of electricity can make or break the business model. Demand charges in sites with low load factors are often the culprit for very high electricity bills, particularly, in the early stages of fleet electrification. If these technologies are deployed strategically, fleets can see a drastic reduction in electricity bills as well utilities will have lower on-peak load injections which trigger upstream grid upgrades. In this section, we will explore the potential savings from smart charging and onsite solar and storage at DHE and on-peak load reductions that could eliminate the need for site and grid upgrades many depots are facing.

In an effort to reduce electricity costs DHE installed onsite smart chargers with cloud-based managed charging software to minimize charging costs while on a commercial electric vehicle rate offered by the local utility. DHE also integrated onsite solar panels and BESS to further reduce electricity costs from peak demand charges. A number of integration challenges prevented DHE from realizing the full potential of these technologies. Using site data logged from 2021 we evaluated the bill savings seen for this site under the rate and grid integration restrictions as well as avoided grid impacts and depot site upgrades needed through reduced peak demand power. As DHE's class 8 trucks were using the off location charging stations while awaiting necessary site upgrades in 2021, this assessment is limited to DHEs forklift and yard truck charging needs.

*Table 4: DHE's potential electricity and peak load savings using managed charging and on-site solar and storage.*

| | Yard tractors | | Forklifts | |
|---|---|---|---|---|
| Simulation type | Electricity cost ($/yr.) | Maximum grid demand (kW) | Electricity cost ($/yr.) | Maximum grid demand (kW) |
| Unmanaged charging | $8,695 | 150 | $28,202 | 500 |
| Managed charging | $2,141 | 27 | $11,038 | 148 |
| Managed charging with solar + battery | $872 | 8.7 | $5,610 | 106 |

Table 4 presents a comparison of electricity savings from DHE's fleet of yard trucks and forklifts when comparing three charging scenarios. The first is when the fleet's charging is not optimized, or unmanaged, and vehicles charge at full power as soon as they return to depot. The second is managed charging, where charging is optimized to reduce peak load and subsequently cost. Finally, the third assesses the savings if the on-site solar and storage were able to be combined with DHE's managed fleet charging. What's clear is the significant savings in electricity costs with managed charging reducing bills by 60% and when including on-site solar and storage this is even further reduced by 80%. These types of electricity bill reductions can have dramatic impact on fleets experiencing fuel cost savings when electrifying. Assuming similar peak load savings could be translated to the charging usage of the class 8 trucks, the depot sites upgrades could be reduced by 1.2 MW, almost eliminating the need for the $700k electrical upgrade.

Further, when translating this to grid impacts and make ready capacity costs at depot sites, peak load is reduced by over 80%. This could significantly reduce or even eliminate the needs to site and grid expansion for many fleets and utilities. A study done by Emerging Futures assessed the New Jersey Statewide impact if all the charging needed to support 100% electrification of Class 3 to 7 trucks utilized managed charging or were connected to on-site solar and storage. The findings showed dramatic reductions of peak load by over 10 GW. This has the potential to save over $2 billion in avoided costs attributed to grid expansion and makeready.

By exploring non-wires alternatives such as managed charging, onsite solar and storage, fleets can significantly reduce their net peak load on their charging sites. In many cases, if properly leveraged, utilizing non-wires alternatives can prevent some or most site upgrades needed to accommodate large charging hubs which is often the cause of the longest interconnection delays seen by fleets today. This would mean fleets would see savings on grid expansion, on their bills, as well as avoiding large financial penalties attributed to interconnection delays. In instances where grid upgrades are necessary, these behind the meter solutions facilitate continued safe and reliable electricity services for fleets without disrupting transportation electrification timelines.

# 5 Policy Solutions for Expedited Infrastructure Interconnection

While BTM technologies can relieve short and intermediate backstops during energizing charging infrastructure, robust policies are needed to enable expedited interconnection of chargers – a critical path for the U.S. to meet its decarbonization targets. There has been considerable progress in developing necessary policies and funding programs to drive the deployment of zero-emission commercial vehicles and the supporting charging infrastructure. However, complimentary policies are needed to enable the efficacious and timely roll out of charging infrastructure in line with state and federal targets for zero-emission vehicles deployed. It is not unfathomable that the utilities will soon be facing an unprecedented rise in electrical load, and design, review, and interconnection requests. Without policies to ensure that the utilities are ready to respond to these requests, the risk of fleets bearing the significant financial burden for delayed interconnection will remain high. This in turn will negatively impact the market growth and delay advancing climate goals. Below are some action items for the regulators, utilities, and industry stakeholders in the broader energy infrastructure ecosystem.

<u>Fully leverage onsite capabilities:</u> As discussed previously, non-wires alternative have the potential to offer significant fleet savings as well as mitigate or serve as an intermediate solution for grid expansion. While there are some utility policies and programs to support the deployment of managed charging and BESS, there is no provision to allow such technologies in lieu of site upgrades or allow flexible interconnections. Utility regulators, especially in regions with expected interconnection delays should modernize interconnection processes to allow for non-wires alternatives when defining site capacity needs. While some states such as New Jersey are moving in the right direction towards offering cost recovery for makeready when utilizing such technologies, there is still no policy to allow non-wires alternatives in lieu of site upgrades. This would prevent triggered upstream grid upgrades and expensive overbuilds and allow for an intermediate step to support the energization of chargers while utilities do the necessary upstream grid upgrades needed to support this new load.

<u>Collaboratively develop a deployment plan:</u> State agencies, transportation industry, utilities, and community groups need to collaborate and conduct a comprehensive needs assessment and deployment plan for the additional electrical capacity and distribution demand, as well as the number of chargers needed to support the anticipated large volumes of zero-emission vehicles in their service territories. This includes all parties working together to gather necessary data, such as fleet deployment plans, to support developing a robust and comprehensive charging infrastructure deployment and grid readiness plan in line with state decarbonization targets and timelines.

<u>Update grid planning procedures:</u> Present grid planning in many utility service territories is done using a top-down approach often spreading forecasted new load and other BTM resources homogeneously throughout their territories. When it comes to commercial fleets, however charging sites needed are in key industry hot spots and corridors within a utilities service territory. A top-down approach would

result in grid buildout locations are misaligned with the needs on the ground. Regulations should be in place to modify grid planning and load forecasting to a more bottom-up approach that includes outreach to industry stakeholders that would include fleets, vehicle manufacturers, and other solution providers. This would allow utilities to learn about anticipated deployment volumes and timelines to better align grid buildout and modernization as well as the other needs of these new utility customers.

Pre-build in critical deployment areas: Insufficient and misallocated distribution system capacity could delay or substantially increase the costs of building and vehicle electrification and integrating renewable and storage resources. Currently, laws and regulations in many states prevent utilities from expanding the grid capacity for needs that are not identified as arising within a 5-year timeline, unless there is a guaranteed load through an interconnection request from a customer. However, significant system upgrades often take five or more years to plan and build and, as a result of the expedited timelines for building and transportation electrification in ambitious states, location-specific grid constraints are already preventing new projects coming online. Insufficient grid capacity is discouraging industry investment in electrification and creating a risk of failure to meet state electrification goals. States must create a pathway for utilities to pre-expand the grid to ensure there is sufficient capacity for electrification and BTM resources, while ensuring there are guardrails in place to protect ratepayers.

Streamline permitting processes: Many fleets are new to the electricity sector and navigating the often complex and lengthy permitting and interconnection applications can cause significant delays and frustrations. States should be requiring counties and cities to implement streamlines permitting processes for charging infrastructure such as AB 1236 in California. Further, one of the biggest complaints is a lack of application status transparency. Ensuring that online application platforms include real-time status checks and allow for simplistic modifications and re-application process can significantly reduce stress and delays for installing charging infrastructure.

Foster Transparency: To better support fleets developing charging infrastructure deployment, transparency of available grid capacity as well as potential cost of makeready is vital when businesses are deciding where and when they can install this equipment. Utilities should regularly update publicly available hosting capacity maps to aid fleets in selecting charging sites where there is readily available grid capacity. Further cost ranges for make ready should be available to developers, prior to submitting interconnection service applications, to incorporate in financing decisions and ensure capital for installation is available in advance.

Increase staffing and equipment stock to support future deployments: With the rapid influx of applications many utilities are not prepared to handle the volume of applications with their current staff. State policy makers should work with utilities to ensure sufficient skilled labor is available to do the necessary grid upgrades and manage such activities. This includes planning with utilities to build internal staff capacity to prevent interconnection delays. Further, exploring intermediate and temporary solutions such as allowing third party contractors to perform a portion of the site and grid upgrades can significantly reduce the short-term strain on utilities to meet this demand in a timely manner. Finally, shortages in key equipment, such as switch gear, can impose significant delays on the deployment of infrastructure. Utilities and public agencies (state and federal) should together work with industry to identify equipment needs, and ensure utilities are sufficiently stocked to meet the infrastructure timelines needed to deploy electric vehicles.

Be accountable: Meeting our transportation decarbonization targets requires an all-hands-on deck effort. Sometimes traditional procedures and approaches need to be adapted to better serve new realities. This is why it is vitally important to set clear metrics and targets for charging infrastructure including interconnection and permitting process timelines. These targets set allow for stakeholders, such as utilities, to ramp up efforts in certain areas and allow a way for everyone to better understand the challenges and opportunities to smooth pains faced by all stakeholders involved.

## 6 Conclusions

With ambitious targets and aggressive timelines for the widescale deployment of zero-emission commercial vehicles, utilities are seeing an unprecedented and steep rise in requests for connecting charging infrastructure to their grids; without a comprehensive plan and support in place, the utilities will not be ready to move on these requests, thereby creating significant interconnection delays that have business ramifications for commercial fleets and national decarbonization targets. Many early adopting fleets are already experiencing significant financial impacts as a result of delays, such as losing access to incentives, limited spots in procurement programs, revenue loss, or jeopardizing sponsored projects. The good news, as outlined in this paper, is there are a number of feasible technical and policy solutions that can ensure that the needed charging infrastructure is available to foster the market development and seamless transition to zero-emission vehicles creating a win-win situation for all stakeholders.

## Acknowledgments

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## Presenter Biography

Dr. Pamela MacDougall is Environmental Defense Fund's national lead on grid modernization policies and regulations that both bolster the widespread use of clean energy technologies in medium- and heavy-duty transport and improve energy reliability through deployment of localized microgrid systems. She currently focuses on working to advance the integration of medium and heavy-duty zero-emissions vehicles into the national electric grid and managed EDF's national grid modernization efforts to drive investments that increase the efficiency of the electric system and enable the integration of renewables and other emerging sources of energy.

Dr. Aravind Kailas is the Advanced Technology Policy Director at Volvo Group, where he oversees policy development and public affairs campaigns to further Volvo's interests in automation, connectivity, and electromobility. Additionally, Dr. Kailas manages the Group's engagement in California, and has been pivotal in launching numerous high-visibility initiatives in the state. He has also successfully advocated for many federal and state policies to develop the market for zero-emission heavy-duty trucks, buses, and off-road vehicles in the U.S., and spearheaded the infrastructure deployment for introducing Volvo's electric trucks in North America.