Needs Statement 573 – Electric Truck Charging Infrastructure: Literature Search

Prepared by: Jim Byerly, Electronic Resources Librarian

Resources searched: ASCE Database, Research in Progress, TRID, Transport Database, Web, MnDOT Library Catalog

Summary: Results are compiled from the databases named above. Links are provided for full-text, if applicable, or to the full record citation. I completed my searches using the following terminology: electric truck, e-truck, trucking, freight transportation, charging, location. The results are divided into most relevant and less relevant.

Most Relevant Results

Transport Database

Result 2.

Title Dynamic charging infrastructure deployment for plug-in hybrid electric trucks.

Author Liu Zhaocai; Song Ziqi

Source Transportation Research Part C: Emerging Technologies. 2018/10. 95(0) pp 748-772 (Apps., Figs., 90 Refs., Tabs.)

Abstract Inspired by the rapid development of charging-while-driving (CWD) technology, plans are ongoing in government agencies worldwide for the development of electrified road freight transportation systems through the deployment of dynamic charging lanes. This en route method for the charging of plug-in hybrid electric trucks is expected to supplement the more conventional charging technique, thus enabling significant reduction in fossil fuel consumption and pollutant emission from road freight transportation. In this study, the authors investigated the optimal deployment of dynamic charging lanes for plug-in hybrid electric trucks. First, the authors developed a multi-class multi-criteria user equilibrium model of the route choice behaviors of truck and passenger car drivers and the resultant equilibrium flow distributions. Considering that the developed user equilibrium model may have non-unique flow distributions, a robust deployment of dynamic charging lanes that optimizes the system performance under the worst-case flow distributions was targeted. The problem was formulated as a generalized semi-infinite min-max program, and a heuristic algorithm for solving it was proposed. This paper includes numerical examples that were used to demonstrate the application of the developed models and solution algorithms.
Result 3.

**Title**: Charging all-electric trucks: fleets evaluate power and charging infrastructure for plug-in vehicles.

**Author**: LONG MINDY

**Source**: Transport Topics. 2018/5/14. pages A1, A6-A7 (Illus.)

**Publication Year**: 2018

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Result 7.

**Title**: Electric trucks charging into market.

**Source**: Transport Topics. 2017/5/15. pages A1, A4-A9, A11

**Abstract**: Industry looks beyond batteries to power longhaul electric tractors / by Mindy Long -- Zero emissions, potential savings of electrics appeal to some carriers / by Steve Sturgess -- Electric trucks make inroads in shorthaul applications / by Mindy Long -- Maintenance costs, intervals decrease on electric tractors / by Mindy Long -- Vehicle-to-grid could benefit electric truck users, some say / by Steve Sturgess -- Toyota puts fuel cell truck to test at port / by John Lippert -- Tesla is planning to unveil electric semi-truck in September / [Associated Press] -- XL Hybrids receives award from CARB - Hydrogen fuel-cell vehicle sales rise in 2016.

**Publication Year**: 2017

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**TRID Database**

Nakamura, Toshiyuki; Schmoecker, Jan-Dirk; Fujii, Atsushi; Sun, Wenzhe; Uno, Nobuhiro. Location Optimization of Charging Stations for Electric Fleet Trucks Based on Given Tour Patterns. Transportation Research Board 96th Annual Meeting, Transportation Research Board, 2017, 16p

[https://trid.trb.org/view/1439269](https://trid.trb.org/view/1439269)

Abstract: Electric delivery trucks are becoming increasingly feasible as an environmentally friendly alternative for goods deliveries in urban areas. However, the limited cruising distance prevents electric trucks from being widely used and generate a need to install enough charging stations throughout the cities. Furthermore en-route charging means that logistics agencies have to afford extra operation costs, as they may need to adjust the delivery plan to the charging stations. In this study therefore a 2-step approach is developed to optimize the location of charging stations for electric trucks based on actual observed tour patterns. The goals is to figure out the optimal location and number of charging stations as well as to avoid changes in the delivery patterns. The first step is to generate and assign typical tours based on given tour patterns. To generate realistic tours the characteristics of the delivery tour patterns in Kyoto City are...
analysed. Indices such as tour numbers per truck and day as well as average tour distance are considered to indicate the characteristics of given tour patterns. The second step is then to optimize the charging stations for these assigned tours. Finally, the approach is tested on a grid network under various parameter settings to investigate the location plan under different tour patterns.

Web

**Electric Truck** & Bus Grid Integration, Opportunities, Challenges & Recommendations  

Truck and Bus **Charging**: A Guide for Programs to Accelerate Electrification  

Utilities Explore **Electric Truck Charging** Stations Along I-5  
https://www.ttnews.com/articles/utilities-explore-electric-truck-charging-stations-along-i-5

**Charging** all-electric trucks  
https://www.ttnews.com/articles/charging-all-electric-trucks

Least Relevant Results

Transport Database

Result 4.

**Title**  
Battery electric propulsion: An option for heavy-duty vehicles? Results from a Swiss case-study.

**Author**  
Cabukoglu Emir; Georges Gil; Kung Lukas; Pareschi Giacomo; Boulouchos Konstantinos

**Source**  

**Abstract**  
Road freight is the most energy-intensive freight mode (per tkm) and runs almost exclusively on fossil fuels. Electrification could change that, but can batteries really power actual heavy-duty operations? This study introduces a data-driven, bottom-up approach to explore the technical limits of electrification using real data from the entire Swiss truck fleet. Full electrification increased the total Swiss electricity demand by about 5% (3 TW h per year) over its current level and avoid about 1 megaton of CO₂ per year (accounting for emissions of generation). Realizing this potential required (1) an allowance to exceed current maximum permissible weight regulations, (2) a high-capacity grid access for charging at the home-base (at least 50kW) and (3) a supporting intra-day energy infrastructure (the authors explored battery swapping). Boosting the gravimetric energy density of the battery cells was generally beneficial, but only effective if the aforementioned conditions were met. Thus, right now, battery **electric trucks** are no drop-in replacements for their Diesel
counterparts. To allow their wide-spread usage, the road-freight sector would have to transform well beyond the vehicle. The required changes are substantial, but not unthinkable. Therefore, the authors think electric trucks deserve further exploration, in particular regarding their costs, life-cycle impact, technological variants and comparison to competing technologies.

Result 6.

**Title**   Life cycle GHG emissions and lifetime costs of medium-duty diesel and battery electric trucks in Toronto, Canada.

**Author**   Zhou Taylor; Roorda Matthew J; MacLean Heather L; Luk Jason


**Abstract**   Battery-electric trucks (BET) are an alternative to diesel trucks and have the potential for lower life cycle greenhouse gas (GHG) emissions and total lifetime costs (TCO). This study compares a Class 6 medium-duty BET with a Class 6 medium-duty diesel truck. Vehicle fuel consumption is simulated for Toronto driving conditions, based on different drive cycles, operating temperatures and payloads. The base case results show the BET has lower life cycle GHG emissions and higher lifetime TCO than the diesel truck, but this does not hold across all conditions. GHG emissions of the BET are higher than those of the diesel truck under 100% payload in driving conditions with infrequent stops, while the results are less sensitive to operating temperature. The lifetime cost of the BET can be lower than that of the diesel truck in situations that have driving with frequent stops/starts and with low payloads and low battery and charging station costs. These variables also affect estimated GHG abatement costs, which are highly relevant as carbon pricing is being introduced in the province.

Result 8.

**Title**   Approach for the Development of a Method for the Integration of Battery Electric Vehicles in Commercial Companies, including Intelligent Management Systems.

**Author**   Betz Johannes; Lienkamp Markus

**Source**   Automotive and Engine Technology. 2016/12. 1(1-4) pp 107-117 (Figs., Refs.)

**Abstract**   Current analyses of electric mobility reveal that the electrification of the powertrain of vehicles will change the entire automotive value chain. This paper presents the approach for the development of a method for the evaluation of an economically and ecologically rewarding integration of electric vehicles in commercial companies. First,
this method focuses on the analysis of the driving behavior of a commercial vehicle fleet and the energy flow (consumption and production) in a company. Second, it is the goal to evaluate the potential of integrating battery electric vehicles in a commercial company using a new developed fleet-management system in combination with an energy- and charging-management system. The potential of integration will be depicted by the number of battery electric vehicles that can be integrated, the reduction of the total costs of ownership, and the reduction of the produced CO\textsubscript{2} emissions.

**Publication Year** 2016

**Result 9.**

**Title** Supporting the adoption of electric vehicles in urban road freight transport - A multi-criteria analysis of policy measures in Germany.

**Author** Taefi Tessa T; Kreutzfeldt Jochen; Held Tobias; Fink Andreas


**Abstract** Policies in Germany to support electric vehicles (EVs), which are free of exhaust emissions, mostly focus on urban road passenger transport. However, road freight vehicles are a main source of the traffic air pollutants and noise emissions in cities. Available vehicle types, tour planning and purchase decisions in urban road freight transport differ from the passenger transport segment. The political and scientific literature lacks a comprehensive discussion of specific policy measures to support electric urban road freight vehicles. This article contributes to the existing body of knowledge, by undertaking a multi-criteria analysis of policy measures to support battery electric freight vehicles based on the rating by two stakeholder groups, "policymakers" and "freight electric vehicle users". These stakeholders rate 23 policy measures as suggested in the literature or which are implemented in European countries. In comparing and ranking the rating results of the groups, the authors find that the discordance between the groups can be large and offers noticeable insight and room for future research and practice. Although financial support of electric vehicles is often named in the literature as the primary measure to overcome the total cost of ownership gap of freight electric vehicles, the current study shows that the effect of special legal measures and supporting the setup of company-charging infrastructure are underestimated by the policymakers. Recommendable policy options - beyond several fiscal measures - are to request emission-free vehicles in municipal tenders, to allow drivers with a class B license to drive freight EVs over 3.5 tons, or to implement a city toll on the long-term. The practicability of other policy measures depends on the local implementation goals of the municipality. Hence, a transparent debate on the aim of supporting electric freight mobility is as necessary as choosing measures targeted at the freight transportation segment.
TRID Database

Plötz, P; Gnann, T; Jochem, P; Yilmaz, H U; Kaschub, T. Impact of electric trucks powered by overhead lines on the European electricity system and CO2 emissions. Energy Policy, Volume 130, 2019, 32-40
https://trid.trb.org/view/1607103
Abstract: No abstract provided.

Zhao, Hengbing; Wang, Qian; Fulton, Lewis; Jaller, Miguel; Burke, Andrew. A Comparison of Zero-Emission Highway Trucking Technologies. University of California, Davis; University of California Institute of Transportation Studies, 2018, 58p
https://trid.trb.org/view/1565411
Abstract: Zero-emission long-haul trucking technologies are being developed that can play a critical role in achieving California’s climate change goals and virtually eliminate air pollution from these vehicles. Hydrogen fuel-cell electric, catenary electric and dynamic inductive charging technologies are being demonstrated in small scale projects worldwide. In this study, these three zero-emission truck technologies were reviewed in detail and vehicle and infrastructure challenges and costs for each of the technologies assessed. In the near- to mid-term, electrifying the entire California state highway system or deploying large hydrogen stations at many statewide truck stops would require very large capital costs, on the order of billions of dollars, even though, at least initially, there will likely be relatively few zero-emission long-haul trucks in use. Considering technology readiness, energy efficiency, and capital cost, the most feasible approach for the zero-emission technologies for long-haul trucks may be to deploy local or regional catenary systems. Dynamic inductive charge systems could be introduced, though with perhaps more disruption as roadways are prepared for this service. Hydrogen fuel cell trucks will benefit from some scalability but will require large hydrogen refueling stations along highways. The initial “up-front” investment in infrastructure for hydrogen trucks appears somewhat lower than for the other two options but the cost of providing hydrogen to vehicles will be high, especially if provided using electrolysis. In the longer-term, all three of the technologies could become economically competitive with diesel trucking, though this depends on many factors and uncertainties.

Web

TRANSITIONING TO ZERO-EMISSION HEAVY-DUTY FREIGHT VEHICLES

Overhead-Charging Test Route for Electrified Trucks Opens in Germany
https://www.truckinginfo.com/331744/overhead-charging-test-route-for-electric-trucks-opens-in-germany

Concerns about grid’s ability to handle electric vehicles are real but not insurmountable

Exclusive: How Tesla's first truck charging stations will be built
https://www.reuters.com/article/us-tesla-trucks-charging/exclusive-how-teslas-first-truck-charging-stations-will-be-built-idUSKBN1FM0I9