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Battery Electric Trucks Are Well-Suited for Regional Haul Operations and Offer Significant Environmental and Health Benefits to Communities

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Issue

Heavy-duty diesel trucks contribute significantly to air pollution and greenhouse gas emissions, particularly in regions with high freight activity, such as Southern California. In communities near freight hubs, this has resulted in severe public health challenges. California is leading efforts to address these emissions, with regulations requiring zero-emission trucks by 2045.[1] Battery electric trucks (BETs) are a promising solution, but they have primarily been deployed in limited use cases like drayage operations.[2,3] As BET technology improves, understanding their real-world performance in regional haul applications is critical to expanding their adoption. Regional haul applications differ from other trucking operations in that they typically involve medium-distance routes, often under 150 miles, with trucks returning to a home base daily for charging. While regional haul does not account for the majority of truck miles in California, it represents a significant and growing segment of freight operations, particularly in densely populated areas where emission reductions can have the greatest impact on air quality and public health. To better understand BET performance, our team examined the real-world activity of 15 BETs operating in eight regional distribution fleets across Southern California. We analyzed the trucks' travel and charging patterns, as well as how much of their operations occurred in disadvantaged communities.

Key Research Findings

BETs are well-suited for regional haul operations. On average, the BETs in our study completed one or two tours[4] daily, traveling an average of 35 to 80 miles on each tour before returning to their home base for charging at the end of each tour. The average tour distance is well within the average estimated range for BETs of 120 to 150 miles.

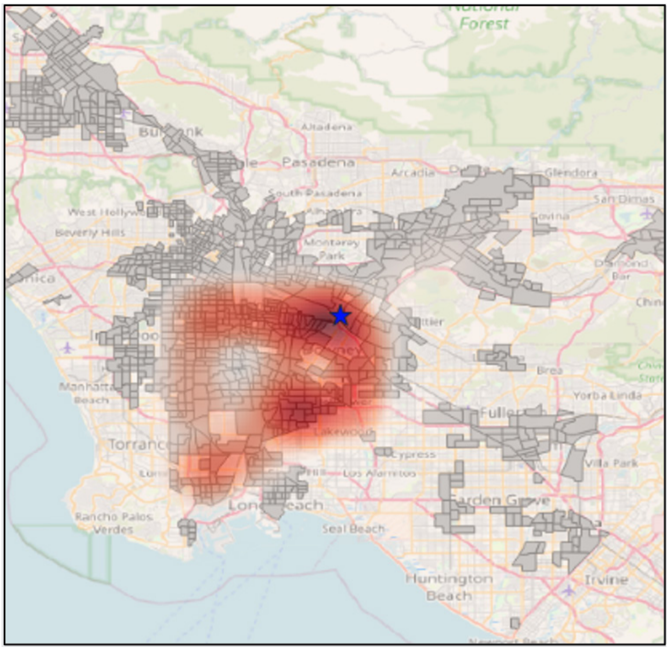

Figure 1. Operation footprint of a BET displayed in red. Darker red indicates higher density of vehicle miles traveled. Blue star reoresents the BET's home base. Grey areas represent disadvantaged communities.

BETs offer significant environmental benefits for disadvantaged communities. Of the trucks included in our study, about 54% of their vehicle miles traveled and 47% of vehicle hours traveled occurred in or around disadvantaged communities as defined by California's CalEnviroScreen (see Figure 1). Converting more diesel trucks to BET, particularly

Truck ID	EV01	EV02	EV03	EV04	EV05	EV06	EV07	EV08	EV09	EV10	EV11	EV12	EV13	EV14	EV15
# of Hours	2.73	5.41	7.34	5.17	1.05	3.46	3.37	1.36	1.41	3.71	1.06	1.66	2.74	1.44	2.84
Time of Day															
0	0.50	11.96	8.24	7.65	6.34	3.32	3.64	3.79	3.99	8.94	2.96	0.15	5.46	2.34	3.42
1	0.17	10.92	8.78	10.13	5.14	3.44	3.47	2.99	3.74	8.98	3.66	0.00	6.70	1.72	4.01
2	0.03	8.81	9.19	11.03	3.85	4.18	3.63	2.91	3.63	9.03	4.77	0.00	5.93	1.34	4.00
3	0.83	1.69	9.50	11.45	5.88	4.12	3.57	5.33	4.70	9.03	6.28	0.05	4.67	1.34	3.89
4	1.06	0.57	10.14	11.44	6.79	4.46	3.83	5.77	5.16	9.06	7.90	0.00	4.29	1.69	6.18
5	0.99	0.58	10.76	11.82	2.82	4.59	3.82	5.29	4.48	8.76	8.90	0.23	3.42	3.43	8.62
6	5.36	0.39	10.78	11.92	4.60	4.72	3.18	5.13	3.63	5.28	9.26	2.90	2.70	5.28	9.35
7	7.16	0.36	9.96	8.71	4.58	3.82	2.43	5.21	3.64	0.79	9.34	3.14	2.10	4.27	8.17
8	8.92	0.31	3.50	1.37	5.92	3.47	2.57	5.68	3.52	0.35	8.64	3.89	2.89	3.24	5.51
9	6.46	0.34	0.54	0.25	2.78	1.65	2.85	4.57	3.42	0.32	2.68	3.39	3.29	2.83	4.23
10	7.19	0.29	0.17	0.42	0.41	1.62	4.82	3.13	2.88	0.30	0.98	5.20	3.24	2.74	4.33
11	8.40	0.24	0.09	0.33	0.00	1.54	4.58	3.60	2.85	0.18	0.88	4.77	3.87	3.25	5.18
12	7.89	0.34	0.06	0.06	0.00	2.23	5.45	2.98	3.17	0.10	0.76	3.75	5.34	5.63	5.95
13	7.67	0.32	0.09	0.09	0.51	5.33	4.72	4.46	4.52	0.09	0.62	3.59	6.62	7.58	6.95
14	7.51	0.36	0.05	0.20	0.04	7.74	4.79	4.34	4.60	0.14	0.92	3.26	7.79	12.84	8.09
15	7.46	0.55	0.12	0.24	0.37	7.81	4.92	4.97	5.84	0.41	1.04	3.94	7.69	13.55	6.79
16	4.04	0.84	0.43	0.22	0.77	8.26	4.69	4.76	5.97	1.09	2.45	3.39	7.38	8.32	1.95
17	1.38	3.00	1.49	0.20	2.56	6.99	4.76	4.57	6.47	1.23	6.94	3.77	4.87	4.56	0.50
18	0.40	5.82	1.52	0.59	5.75	5.14	4.79	4.56	6.69	2.18	8.94	6.79	1.69	2.09	0.22
19	1.52	7.68	1.03	0.81	7.06	3.47	4.26	3.83	4.31	3.77	3.75	14.95	0.99	2.27	0.06
20	5.12	9.07	1.16	1.18	8.41	3.09	4.44	2.60	2.94	5.73	1.53	16.28	1.47	3.00	0.05
21	5.73	10.54	2.03	2.08	8.23	3.28	5.14	2.78	2.98	7.32	2.36	11.15	1.73	2.06	0.07
22	3.36	12.09	3.84	3.01	8.57	2.92	5.47	3.34	3.51	8.22	2.20	4.80	2.45	2.63	0.37
23	0.84	12.94	6.54	4.78	8.62	2.78	4.21	3.41	3.37	8.70	2.25	0.63	3.42	2.01	2.11

Figure 2. Percentage of charging activities by time of day for each of the 15 BETs in this study (EV01-EV15). The numbers in the cells for each BET add up to 100%. Darker grey indicates higher level of charging activities.

around communities impacted by freight activity, provides immediate pollution reduction benefits in areas that traditionally bear the brunt of emissions from diesel trucks.

Charging networks for BETs need to be carefully designed. On a few occasions when the BETs in this study used off-site charging stations, they incurred significant deadhead miles (i.e., miles not related to business operations), which wasted energy and reduced efficiency. Expanding charging networks, especially near freight corridors, is essential for eliminating wasteful side trips, improving BET operational efficiency, and reducing emissions. The development of charging networks should consider the traffic congestion and safety impacts of truck traffic that new charging stations may attract.

Varied charging times reduce impacts on the grid. Contrary to expectations, BETs were charged at various times throughout the day, rather than exclusively at night (Figure 2), which reduces pressure on the electric grid during peak hours and allows better integration of renewable energy sources like solar power[5].

More Information

This policy brief is drawn from the journal article "Real-World Activity Patterns of Heavy-Duty Battery Electric Trucks from Regional Distribution Fleets in Southern California" in the IEEE Forum on Integrated and Sustainable Transportation System available at www.ucits.org/research-project/2023-13/. For more information about the findings presented in this brief and the report, please contact Kanok Boriboonsomsin at kanok@cert.ucr.edu.

[1]State of California. Executive Order N-79-20. https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf. Date accessed: November 2023.

[2]Tanvir, S., Un-Noor, F., Boriboonsomsin, K., and Gao, Z. (2021). "Feasibility of operating heavy-duty battery electric truck fleet in drayage application." Transportation Research Record, 2675(1), 258-268.

[3]California's Joint Electric Truck Scaling Initiative. https://www.jetsiproject.com/. Date accessed: November 2023.

[4]A tour is a series of trips beginning and ending at the truck's home base

[5]U.S. Energy Information Administration. Solar and wind power curtailments are rising in California. October, 2023. https://www.eia.gov/todayinenergy/detail.php?id=60822. Date accessed: November 2023.

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