

The Megawatt Wall

Why Utility Demand Charges, Not the Truck, Make Electric Freight Cost More per Mile Than Diesel at Most Early Highway Charging Sites

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Abstract

Electric trucks are widely expected to undercut diesel on fuel, because electricity per mile is cheaper than diesel per mile. This paper shows that expectation can invert at the charging site, and identifies where and why. Using a library of 241 United States commercial electricity tariffs, priced with a demand-aware engine, we compute the effective cost of electricity for heavy-duty charging as a function of station utilization and convert it to cents per mile against a diesel benchmark of about 89 cents per mile (on-highway diesel at a near-record \$5.31 per gallon at 6 miles per gallon). At the near-zero utilization a new public megawatt-charging corridor site sees (a station load factor near 3%), the median territory's electricity costs \$0.505 per kilowatt-hour, or 101 cents per mile: more than diesel in 59% of territories, before the charging operator adds any margin. Diesel would have to reach \$6.06 per gallon, above even today's elevated price, before the median early-corridor territory beats it on fuel. The cause is the demand charge, which bills a site's peak power regardless of throughput and is spread over almost nothing at a sparsely used megawatt site. Utilization dissolves the wall (6% of territories exceed diesel once a corridor site matures to a 10% load factor), and managed depot charging escapes it almost entirely (1% of territories, a median of 31 cents per mile, matching independent estimates for managed depots). The result is robust: on the 79 large commercial and primary schedules that apply at megawatt scale the corridor-early figure rises to 68%, and across the diesel prices seen over the past year (about \$3.76 to \$5.36 per gallon) the corridor-early share stays between 59% and 75%. The barrier to electric freight in its first years is not the truck or the battery; it is a rate structure that turns low early utilization into a fuel-cost penalty, worst exactly where charging cannot be scheduled.

Highlights

- 241 US commercial tariffs priced for heavy-duty charging against a diesel per-mile benchmark.
- At new corridor megawatt sites, electric costs more per mile than diesel in 59% of territories.
- The cause is the demand charge on near-zero early utilization, not the truck.
- Managed depot charging beats diesel almost everywhere (31 cents/mile; 1% of territories lose).
- Robust to diesel price, truck efficiency, and megawatt-scale tariff class.

Keywords: heavy-duty electric vehicles; megawatt charging; freight electrification; demand charges; electricity tariffs; total cost of ownership; managed charging

JEL: Q41; Q48; L92; L94; R48

1. Introduction

Heavy-duty trucking is the hardest and highest-value frontier of electrification, and its promised advantage is operating cost: an electric truck uses roughly two kilowatt-hours per mile, and electricity is supposed to be cheaper than the diesel it replaces. That comparison is usually made with an average electricity price. It is the wrong price. A truck does not buy electricity at an average; it buys it through the specific commercial tariff of the utility where it charges, and for a high-power, intermittently used load that tariff is dominated by the demand charge, a fee levied on the site's peak kilowatts regardless of how many kilowatt-hours flow through it.

The companion study to this paper showed that for 350 kW passenger fast charging, demand charges turn low utilization into a large per-kilowatt-hour penalty, and that the penalty varies enormously across utility territories [3]. Freight makes the problem sharper for two reasons. First, the power is far larger: a megawatt charging system (MCS) port draws roughly one to nearly four megawatts, so the peak that sets the demand charge is three to ten times a car charger's. Second, freight has a hard external benchmark that passenger charging lacks. A truck operator will not pay more to run electric than to run diesel, so the question is not merely whether a charging site is profitable but whether the delivered cost of electricity, expressed in cents per mile, beats the diesel pump.

This paper answers that question across 241 United States utility territories. We price the electricity a heavy-duty charger would actually pay, convert it to cents per mile, and compare it to a current diesel benchmark of about 89 cents per mile. We do so for the two charging patterns that dominate freight: public megawatt corridor charging, which begins life almost empty, and fleet depot charging, which can be scheduled. The gap between them is the heart of the finding.

2. Background: why the demand charge falls hardest on freight

A commercial electricity bill has an energy charge (dollars per kilowatt-hour), a demand charge (dollars per kilowatt of monthly peak), and fixed charges. For a steady industrial load the energy charge dominates. For a spiky, low-utilization load the demand charge dominates, because the peak is set by the nameplate while the energy sold is small. The National Renewable Energy Laboratory has documented this for electric-vehicle charging generally [1, 2]; the effect scales with power, so it is most acute for the megawatt loads of heavy-duty charging.

The two freight charging patterns sit at opposite ends of this effect. A public corridor site on an interstate begins with almost no traffic: a handful of trucks a day against a multi-megawatt connection, so its load factor (average power divided by peak power) is very low and the demand charge is spread over almost nothing. A fleet depot, by contrast, charges a known set of trucks on a predictable overnight schedule, and if that charging is managed, spread across the parking window rather than started all at once, the site's peak can be held down and its load factor raised severalfold. Managed charging is well studied as an operating-cost lever for depots [5, 6]; this paper places it against the diesel benchmark across every territory.

3. Data

The rate data is the 241-territory commercial tariff library described in the companion study [3], encoded from utilities' own published tariff sheets across investor-owned, municipal, and cooperative systems and covering roughly half of United States electricity customers. Because a megawatt customer may take a different, higher-voltage schedule than a 350 kW car charger, we also flag the 79 schedules in the library that are already large commercial, primary, or industrial rates applicable at megawatt scale, and report the headline result on that subset as a robustness check (Section 5.4).

The diesel benchmark uses the on-highway price of \$5.31 per gallon [8] (national average, week ending July 27, 2026, near a multi-year high) and a Class 8 fuel economy of 6 miles per gallon, giving diesel fuel of 89 cents per mile; anchoring on a near-record price is conservative, since a lower price widens the wall. The electric truck is taken at 2.0 kilowatt-hours per mile, a central loaded long-haul figure; heavier duty cycles run higher and would deepen the wall. Megawatt-charging power levels (roughly 1 to 3.75 MW per port) follow the megawatt charging system standards [7]. All parameters are varied in Section 5.4.

4. Methods

4.1 Cost of electricity and the diesel benchmark

For a site at load factor LF over a year of $H = 8,760$ hours, the effective all-in cost of electricity per kilowatt-hour is the energy blend (weighted over time-of-use periods by a fixed public-charging session profile) plus any competitive generation adder, plus the demand charge D (dollars per kilowatt-year) divided by the throughput per kilowatt of

peak, $H \cdot LF$, plus the service charge over throughput. Because the demand term is billed-demand-invariant per unit throughput, the cost per kilowatt-hour depends on the load factor, not on the absolute power level: a megawatt site and a car charger on the same tariff and same load factor pay the same per kilowatt-hour. What differs for freight is where each pattern sits on the load-factor axis, and the diesel benchmark. Converting to cents per mile,

$$\text{electric } \$/\text{mi} = c(LF) \times e_{\text{truck}} \quad \text{and} \quad \text{diesel } \$/\text{mi} = P_{\text{diesel}} / m_{\text{diesel}} \quad (1)$$

where $e_{\text{truck}} = 2.0 \text{ kWh/mi}$, $P_{\text{diesel}} = \$5.31/\text{gal}$ and $m_{\text{diesel}} = 6 \text{ mi/gal}$. Electric loses to diesel on fuel when $c(LF)$ exceeds the parity price

$$c^* = (P_{\text{diesel}} / m_{\text{diesel}}) / e_{\text{truck}} = \$0.44 \text{ per kWh} \quad (2)$$

Crediting the electric truck's lower maintenance (about 12 cents per mile) raises the parity price to \$0.50 per kilowatt-hour. We report against the fuel-only parity of \$0.44 as the conservative, most directly comparable benchmark. Billed demand is taken at the site's nameplate peak: for a megawatt charging site this is well justified, because a single MCS session at full power sets the monthly peak, and demand ratchets then carry that peak forward across subsequent months. It is a conservative upper bound only for a site that reliably avoids coincident peaks through scheduling, which is precisely the managed-depot case treated below.

4.2 Charging archetypes

We evaluate four operating points, each a station load factor. A new public corridor site (2026 to 2028) is taken at a 3% load factor, reflecting sparse early truck traffic against a megawatt connection. This is the load-bearing assumption of the paper, so it is worth anchoring: public passenger fast charging has averaged about 16% utilization nationally in recent years, a load factor near 5%, with even the most mature metropolitan markets above 25% [3], and a new heavy-duty corridor network in its first years, with far fewer vehicles on the road and a sparse station footprint, sits well below that early-passenger level; we therefore treat 3% as an early-network figure and sweep it. A mature corridor site is taken at 10%, which brackets the upper end. An unmanaged depot, where trucks plug in together on return, is taken at 12%; a managed depot, spreading the same energy across the overnight window to hold down the peak, at 30%. All four are stated explicitly and swept in Section 5.4; the qualitative findings depend on the contrast between them, not on the exact values.

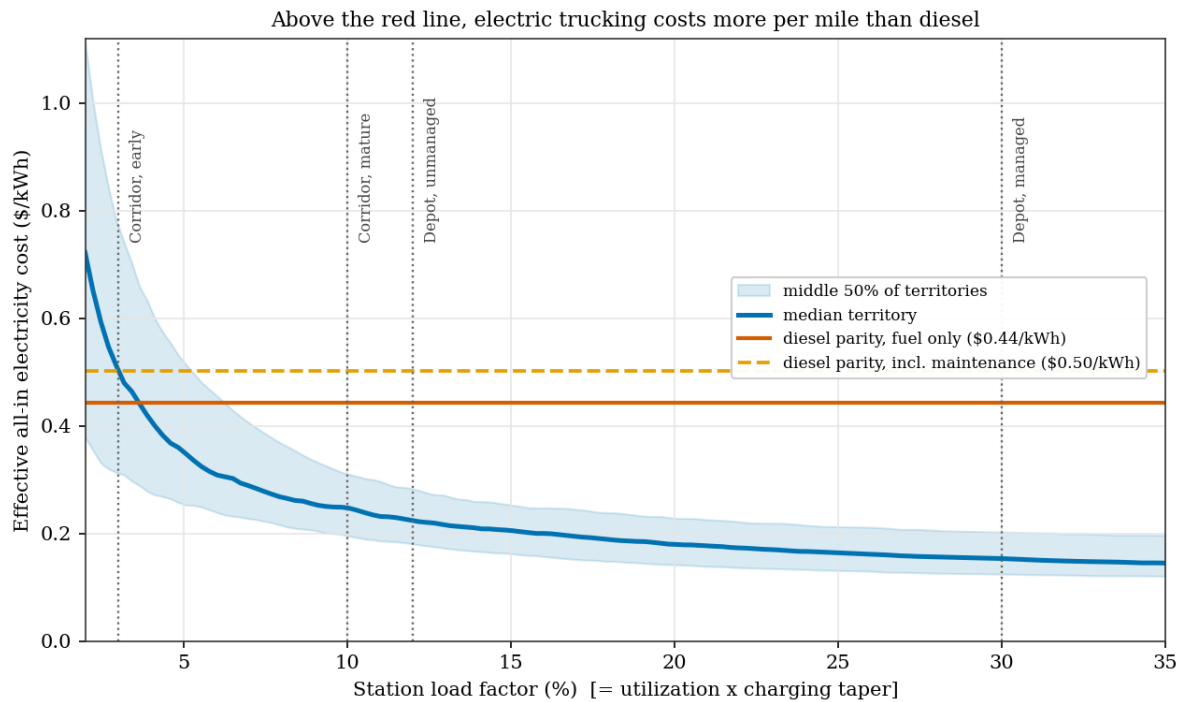


Figure 1. Effective all-in electricity cost for heavy-duty charging across the 241 territories, versus station load factor. Above the solid line, electricity costs more per mile than diesel on fuel alone; above the dashed line, more even after crediting the electric truck's lower maintenance. Dotted markers show the four charging archetypes. A new corridor site sits far above diesel; a managed depot sits well below it.

5. Results

5.1 The corridor wall

At the 3% load factor of a new public corridor site, the median territory's electricity costs \$0.505 per kilowatt-hour, which at 2.0 kilowatt-hours per mile is 101 cents per mile. Diesel is 89 cents per mile. Electric therefore costs more than diesel on fuel alone in 59% of territories, and more even after the maintenance credit in 51% (Figures 2 and 3). This is the operator's input cost of electricity, before any retail margin, so in nearly two-thirds of the country there is no price at which an early corridor site both covers its electricity and undercuts the diesel it exists to replace. The barrier is not the truck, whose energy at an average price would beat diesel comfortably; it is the demand charge spread over a nearly empty megawatt connection. Figure 4 maps the result by state: most of the country sits above the diesel line, with green islands only where power is cheap or a no-demand EV rate applies.

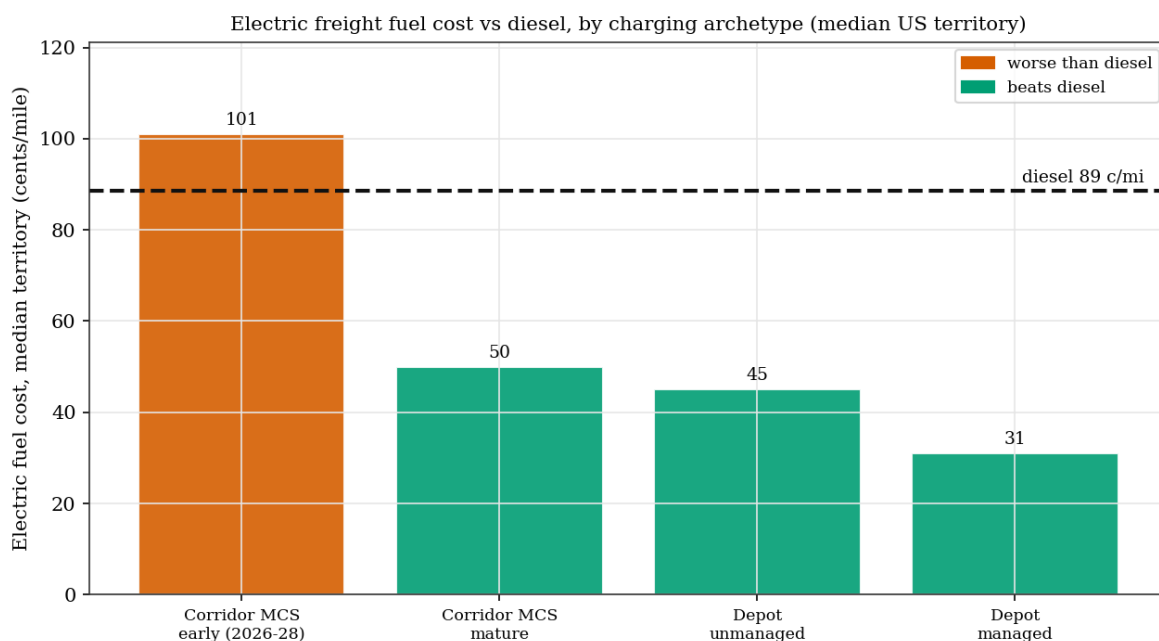


Figure 2. Electric fuel cost in the median territory, by charging archetype, against the diesel line (89 cents per mile). Only a new corridor site loses to diesel in the median territory; a mature corridor site and both depot cases beat it.

5.2 Utilization dissolves it

The wall is a low-utilization phenomenon. As a corridor site fills and its load factor rises to 10%, the median cost falls to \$0.249 per kilowatt-hour (50 cents per mile) and the share of territories above diesel drops to 6%. The same throughput that a busy site delivers spreads the fixed demand charge over enough energy to make it small. This is the optimistic half of the story, and it is real, but it takes years and a filled-out network to arrive, and it does nothing for a site in its first seasons.

5.3 The managed-depot escape

Depots can reach the low-cost regime immediately, by managing when trucks charge. An unmanaged depot, at a 12% load factor, already exceeds diesel in only 2% of territories. A managed depot that spreads charging across the overnight window to a 30% load factor exceeds diesel in just 1%, at a median of 31 cents per mile, well under half the diesel figure. That figure is of similar magnitude to an independent CALSTART estimate of about 29 cents per mile for managed depot charging [6], a useful external check on the model. The lever that rescues freight economics, then, is not a cheaper truck but control over the charging peak, available at a depot and largely unavailable at a public corridor.

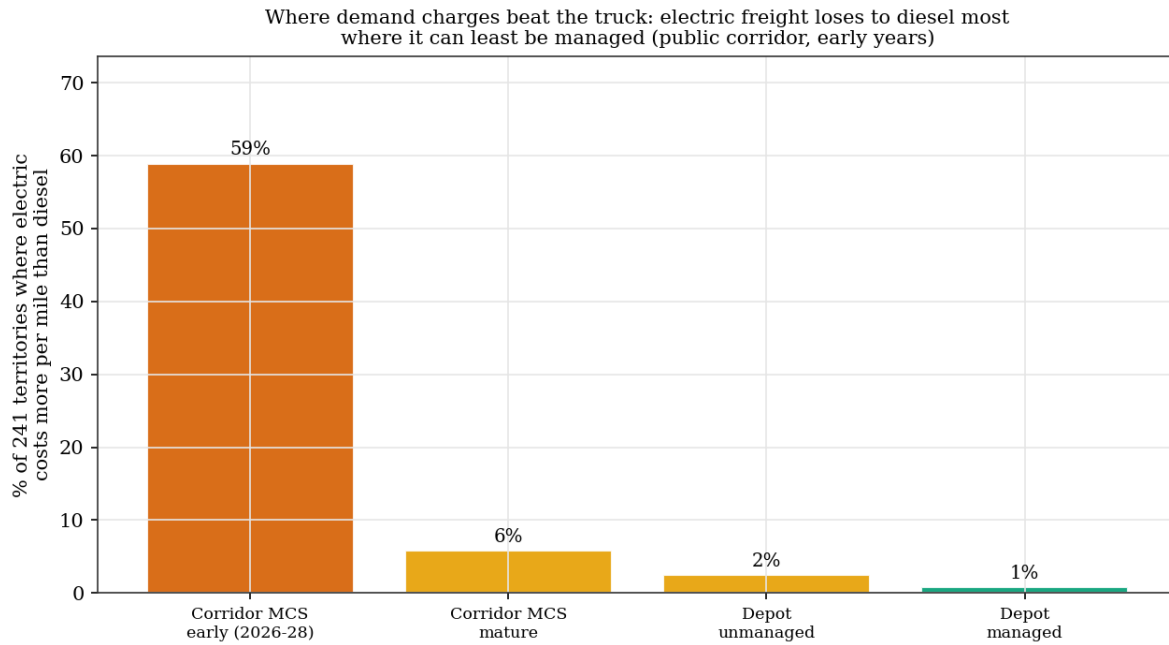


Figure 3. Share of the 241 territories where electric trucking costs more per mile than diesel, by charging archetype. The penalty is concentrated where charging cannot be scheduled and utilization is lowest: the public corridor in its early years.

5.4 Sensitivity and robustness

The corridor finding is robust. Restricting the library to the 79 large commercial, primary, and industrial schedules that actually apply at megawatt scale raises the corridor-early share above diesel from 59% to 68%, because those industrial schedules carry larger demand charges; the demand-charge mechanism is if anything stronger at true megawatt tariffs, not an artifact of small-customer rates. The finding also survives diesel-price volatility, which is its own robustness test: at the year-ago price of \$3.76 per gallon the corridor-early share above diesel is 75%, and at the near-record current price of \$5.31 it is still 59%; because a lower diesel price raises the parity bar, the wall is deepest when diesel is cheapest, so today's high anchor is conservative and the wall persists across the entire observed price range. Widening truck efficiency to 1.8 to 2.2 kilowatt-hours per mile as well, the share stays between 52% and 80%. Only 1 schedule in the library has an energy price, before any demand charge, high enough that electric never beats diesel at any utilization; everywhere else, sufficient throughput or managed charging clears the diesel bar. Table 1 summarizes.

Charging archetype	Load factor	Median \$/kWh	Electric ¢/mi	% above diesel	% above diesel (large-rate subset)
Corridor MCS, early (2026-28)	3%	\$0.505	101	59%	68%
Corridor MCS, mature	10%	\$0.249	50	6%	10%
Depot, unmanaged	12%	\$0.225	45	2%	3%
Depot, managed	30%	\$0.154	31	1%	0%

Table 1. Heavy-duty electricity cost and diesel comparison by charging archetype, across 241 territories, with the large-rate subset (79 schedules) as a robustness check. Diesel benchmark 89 cents per mile.

Electric-truck fuel cost at a new megawatt corridor site, by state
cents per mile at 3% load factor (red = above diesel's 89 c/mi; green = below; grey = no card)

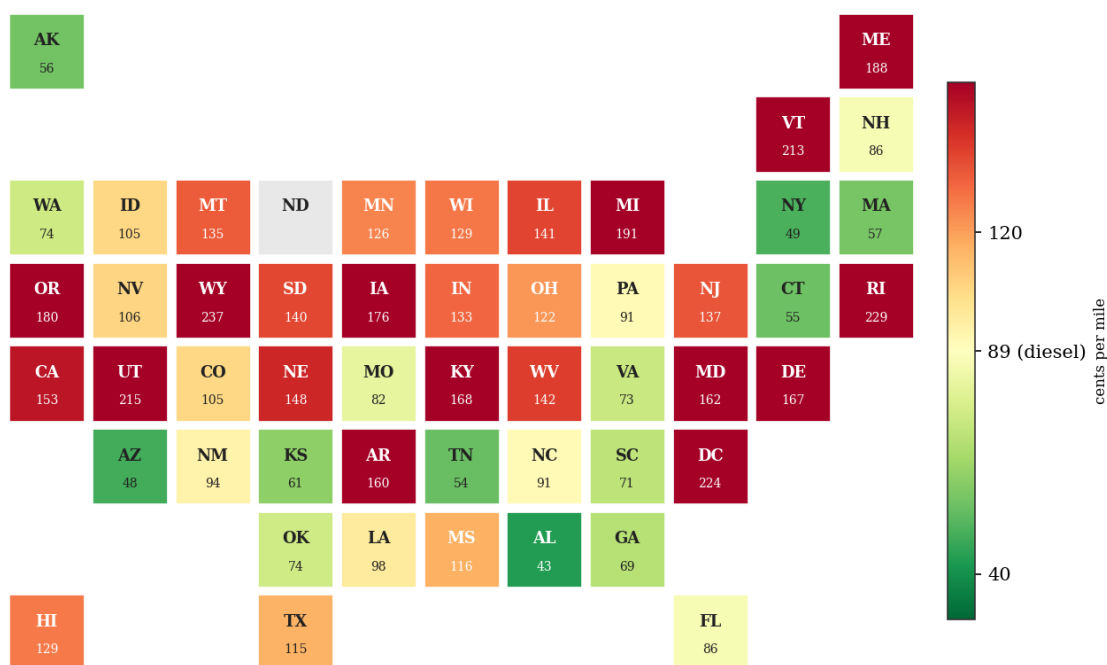


Figure 4. Electric-truck fuel cost at a new megawatt corridor site (3% load factor), by state, in cents per mile. Red states cost more than diesel's 89 cents per mile; green states beat it. The green islands are where power is cheap or a no-demand EV rate applies (for example Tennessee, Washington, New York, Arizona, Georgia); most of the country is red. Each state is the median of its modeled territories; grey states have no card in the library.

6. Discussion

The policy and investment reading is specific. Public corridor charging, the backbone of long-haul electrification and the target of federal freight-corridor programs, is the case where the demand charge bites hardest, because a corridor site cannot schedule its load the way a depot can: the operator does not control when trucks arrive. It can still influence the billed peak, by limiting the power delivered per session or by buffering the site with a battery, but that means either slowing the product or deploying capital against a billing artifact; absent such mitigation an early corridor site can face an electricity cost that no retail price reconciles with diesel, independent of the truck's efficiency. Subsidizing the hardware does not by itself fix this, because the binding cost is the recurring demand charge, not the capital.

Two levers do fix it. The first is time: as corridors fill, the wall recedes on its own, which argues for patient capital and for concentrating early public sites where truck traffic is already densest. The second is rate design: demand-relief and no-demand commercial EV rates, which the companion study found to flatten the cost curve, would do for corridor freight what managed scheduling does for depots. Extending such rates to megawatt customers, and confirming that megawatt loads are eligible for them, is the most direct lever available to regulators.

For fleets that can charge at their own depots, the message is more hopeful and equally concrete: managed charging is not a marginal optimization but the difference between beating diesel almost everywhere and losing to it in a meaningful minority of territories. The same physics that makes the corridor wall so steep makes depot load management unusually valuable.

Set against the larger picture, this is not a verdict against electric freight. Its energy is genuinely cheaper than diesel at any reasonable utilization, and most of the country crosses the diesel line well before a site is busy. The finding is

narrower and more actionable: in the first years, and on public corridors, a rate structure built for steady industrial load can make clean freight cost more than the diesel it replaces, and that is a solvable problem of tariffs and scheduling rather than of vehicles.

7. Limitations

The analysis prices the demand-charge mechanism on the companion library's schedules; at megawatt scale some sites take higher-voltage transmission service with lower per-kilowatt demand charges, which would soften the wall for the very largest sites, while others lose eligibility for the demand-relief EV rates that help car chargers, which would deepen it. The large-rate subset (79 schedules) brackets the first effect and shows the finding strengthening, but a definitive treatment would price each utility's specific megawatt and fleet schedules, which this study does not. Load factors for the archetypes are assumptions, reported and swept rather than measured. A single national session profile blends time-of-use rates. The diesel benchmark is fuel and maintenance only; it excludes the electric truck's higher purchase price and any purchase incentives, and it uses a point-in-time diesel price that is currently high by historical standards, which if anything understates the finding. Tariffs are a mid-2026 snapshot, and deregulated supply prices drift. The share of territories above diesel is unweighted, counting each territory once; because trucks do not drive everywhere equally, a share weighted by truck vehicle-miles (by state or by freight corridor) would be more representative of where electrification actually occurs, and is a natural extension we report as a next step rather than assert a direction for here. The comparison is per site and ignores network and portfolio effects.

8. Conclusion

Electric trucks are cheaper to fuel than diesel trucks, until the utility bill is read through the tariff a real charging site pays. At the near-empty utilization of a new public megawatt corridor, the demand charge alone pushes the delivered cost of electricity above diesel in 59% of United States territories, before any margin, purely because a large peak is spread over almost no energy. Utilization erases most of the gap as corridors fill, and managed depot charging erases nearly all of it at once, beating diesel in all but 1% of territories. The first years of freight electrification will be decided less by battery and truck cost, which are falling, than by two things within policy's reach: how utilities charge megawatt loads for peak power, and whether that power can be scheduled. The megawatt wall is real, but it is built of rate design, and rate design can be changed.

Declaration of competing interest

The author operates RightSite, a commercial EV-charging site-selection service that uses the tariff library and pricing methodology described in this paper. This constitutes a financial interest in the subject matter. No external funding was received for this work.

Data availability

The analysis code and a public reproducibility sample of 39 encoded rate schedules with full parameters (the highest-cost territories plus a random selection) are openly available in the GitHub repository <https://github.com/rightsitera-arch/rate-wall-reproducibility>, archived at Zenodo (DOI 10.5281/zenodo.21667465), and reproduce the pricing method. The full 241-schedule library is a proprietary dataset compiled from utilities' publicly published tariff sheets; it is available for verification under a confidentiality agreement. Diesel prices, truck-efficiency and cost figures, and charging-power specifications are from the cited public sources.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author used a generative AI assistant (Claude, Anthropic) to help write the analysis code, generate figures, conduct literature searches, and draft and edit the manuscript. After using this tool, the author reviewed, verified, and edited all content, independently checked the quantitative results and cited sources, and takes full responsibility for the content of the publication.

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Appendix A. Assumptions

Diesel benchmark. On-highway diesel \$5.31/gal [8], Class 8 economy 6 mi/gal, giving 89 cents/mile. **Electric truck.** 2.0 kWh/mile; maintenance advantage 12 cents/mile. **Parity prices.** Fuel-only \$0.44/kWh; with maintenance credit \$0.50/kWh (Equation 2). **Charging power.** MCS ports ~1 to 3.75 MW [7]; per-kWh cost is power-invariant given load factor. **Archetype load factors.** Corridor early 3%, corridor mature 10%, depot unmanaged 12%, depot managed 30%. **Rates.** The 241-territory library [3]; large-rate subset 79 schedules.

Appendix B. Diesel-parity derivation

Diesel fuel per mile = price per gallon divided by miles per gallon = $\$5.31 / 6 = \0.89 per mile. Electric fuel per mile = electricity price c times 2.0 kWh/mile. Setting them equal gives the parity electricity price $c^* = \$0.89 / 2.0 = \0.44 per kWh. A territory whose heavy-duty electricity cost at a given load factor exceeds \$0.44 per kWh delivers electric freight at a higher fuel cost than diesel. Crediting 12 cents/mile of avoided maintenance raises the threshold to \$0.50 per kWh.

This is a working paper prepared for professional discussion. It does not constitute investment advice.