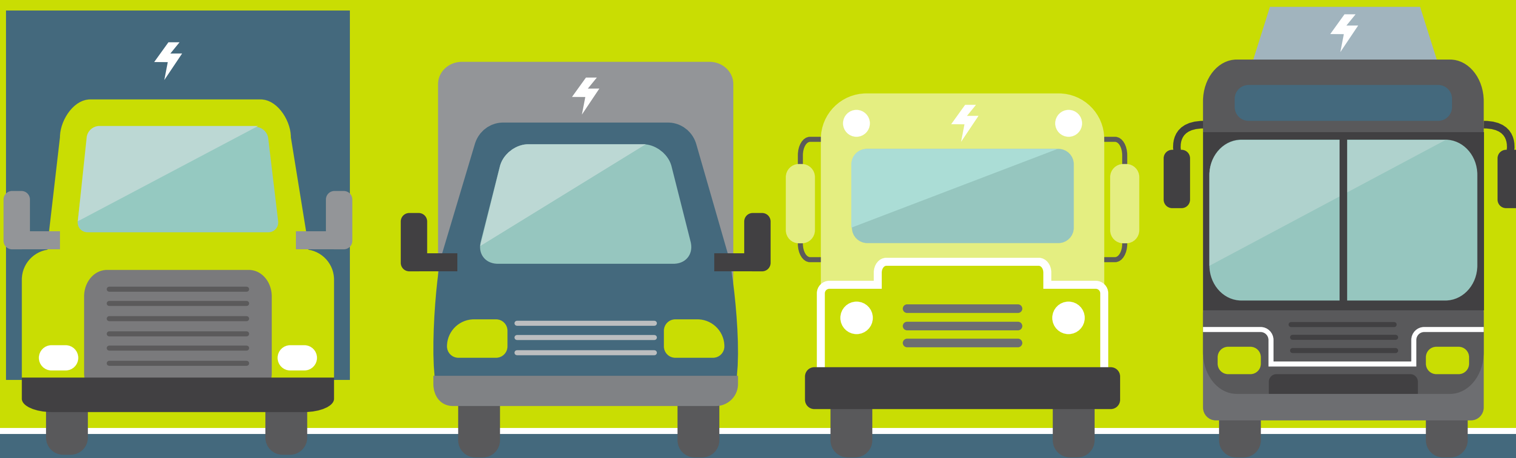
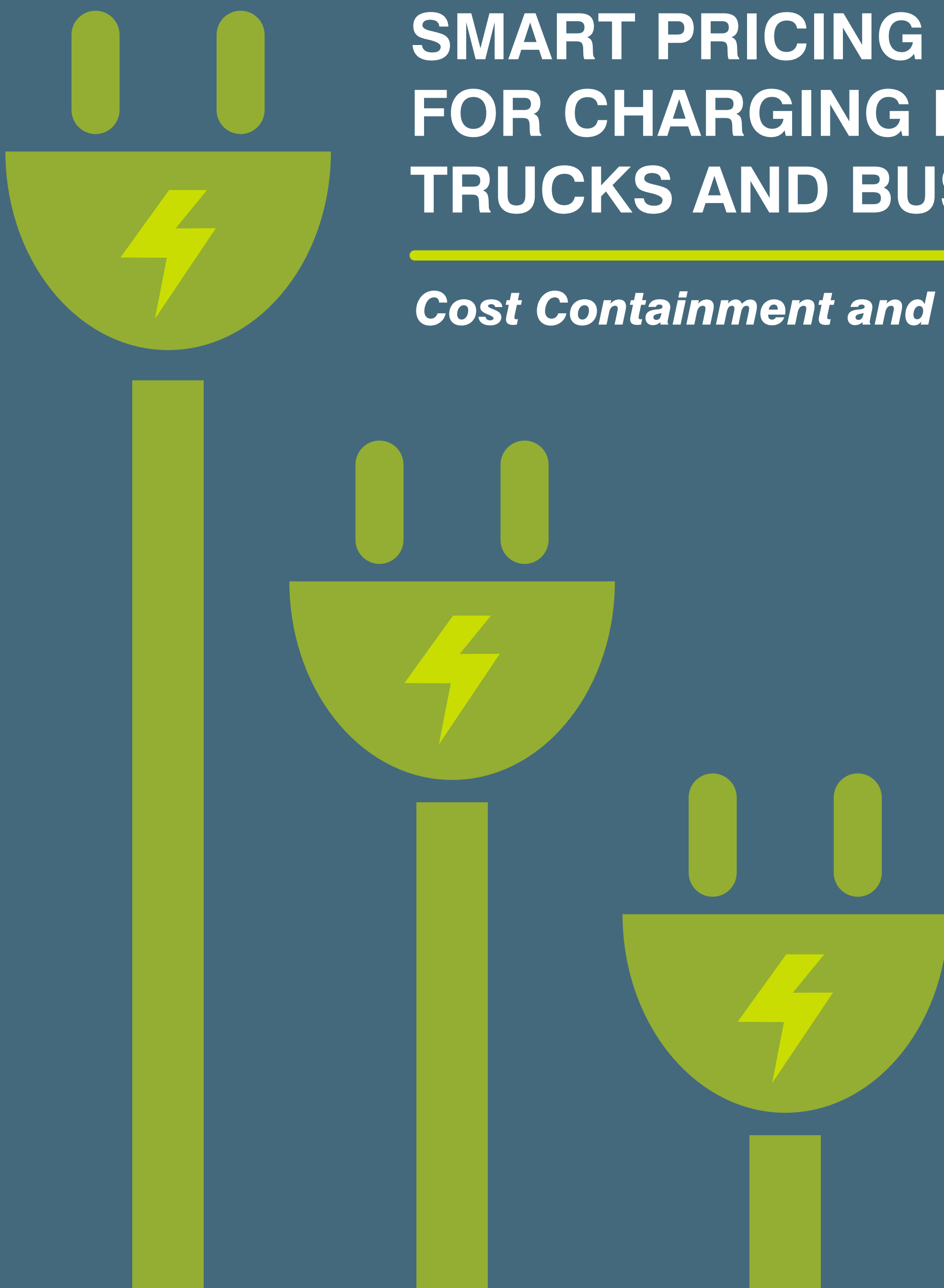




SMART PRICING PRINCIPLES FOR CHARGING ELECTRIC TRUCKS AND BUSES

Cost Containment and Bill Manageability

EDF
ENVIRONMENTAL DEFENSE FUND®
Finding the ways that work

Summary

Eliminating the greenhouse gas and toxic pollution from medium- and heavy-duty vehicles is an environmental and public health necessity. One of the most promising avenues for accomplishing this – vehicle electrification – will require more than vehicle turnover; it will require rapid construction of new charging infrastructure and close attention to how fleet owners are charged for using electricity.

The two principles of cost containment and bill manageability discussed in this short brief should be core pursuits for electric utility regulators that are developing pricing mechanisms for charging zero-emission trucks and buses. Balancing these principles in a way that works for electric customers who own and operate medium- and heavy-duty vehicles can support a successful and sustainable transformation of the truck and bus sector.

Background

Like cell phone plans, the price structures available for charging vehicles are evolving as the technology in the marketplace matures and proliferates. And it isn't just vehicle charging – electric pricing for customers of all sizes and types is in a state of change, thanks to the increasingly ubiquitous advanced metering, sensors, communications, and intelligence that allow utilities to engage users to help the electric grid operate more efficiently.[1] As more types of energy use and generation resources plug into the grid – including beneficial electrification of various types – this evolution will continue.

For electric trucks and buses, electric pricing that is well-calibrated to operational realities will play a key role in determining how quickly and effectively those vehicles can be leveraged to reduce pollution, and at what cost for vehicle owners and society as a whole.

Managed properly, large fleets of electric vehicles can be a grid asset. The electric grid, sometimes called the world's largest machine, is built so it can meet the challenge of maintaining reliability at all times of the day, including the times when the most power is needed. As a result, customers pay for a grid that can meet peak demand all day, every day, even when demand for power is much lower. So, if charging can be managed in a way that makes good use of the grid at times when it would otherwise be underutilized, EVs can play a role in keeping electric rates low for all customers, including those without EVs. For passenger vehicles that are charged at homes, pricing structures that encourage charging when demand is low and clean electricity is plentiful have produced great results for car owners, the electric system and the planet.[2]

Getting similar win-win-win outcomes for trucks and buses will be more complex, though achievable with the right policies and rate structures. Compared to passenger vehicles, trucks and buses are a tremendously diverse segment that varies by attributes such as vehicle type, duty cycle, fleet size, business model, other power needs, and experience with complex electric pricing. Electrifying most or all of these vehicles will require a variety of price structures that match these diverse characteristics.

It is critical to recognize that achieving the level and speed of transportation electrification needed to reduce climate and local air pollution will not be as easy as merely swapping motors. The core rate design principles of cost containment and bill manageability will make fleet owners' "fuel" costs more understandable, predictable and transparent while ensuring that grid investments are right-sized and that environmental benefits can be maximized.

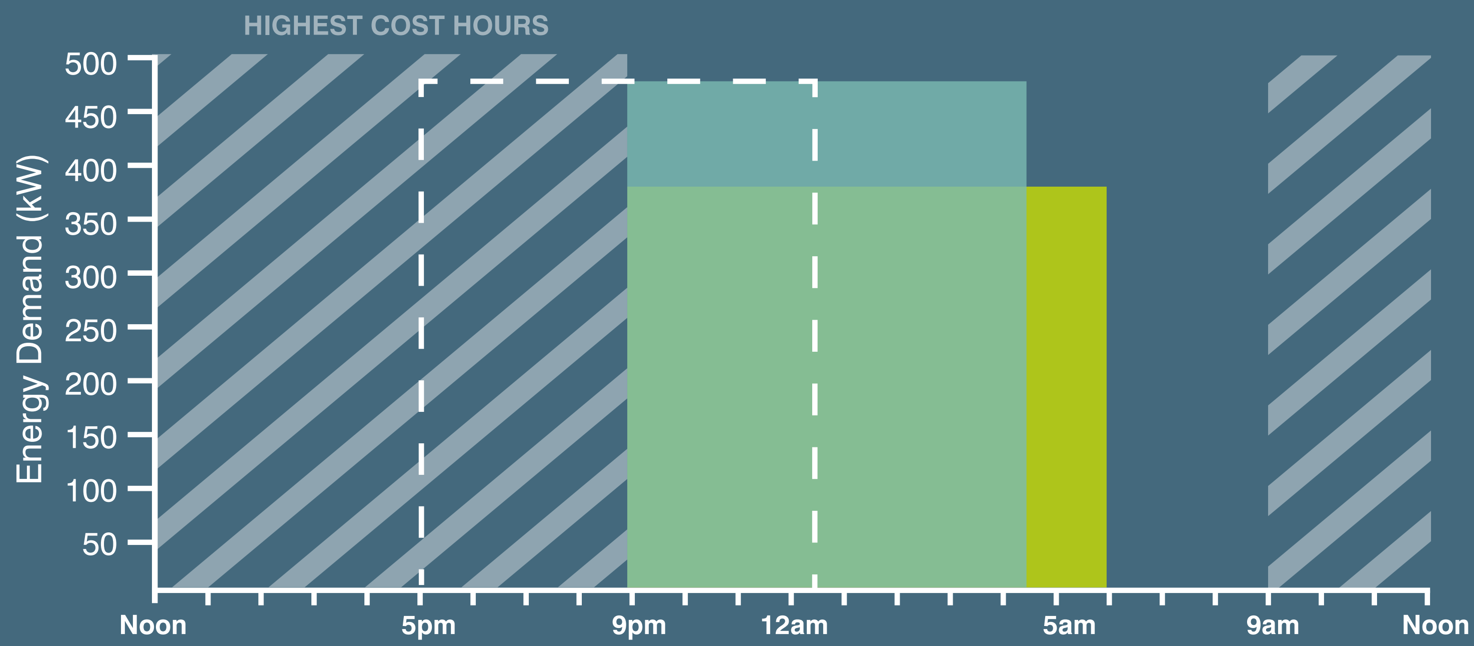
---

[1] See, e.g., American Council for an Energy Efficient Economy (R. Gold, C. Waters, and D. York), Leveraging Advanced Metering Infrastructure to Save Energy (Jan. 2020), available at https://www.aceee.org/sites/default/files/pdfs/u2001.pdf

[2] See, e.g., Synapse Energy (J. Frost, M. Whited, A. Allison), Electric Vehicles are Driving Electric Rates Down (Feb. 2019), available at https://www.synapse-energy.com/sites/default/files/EVs-Driving-Rates-Down-8-122.pdf

Charging Behavior of a Hypothetical Fleet

This figure depicts the charging behavior of a hypothetical fleet that is able to charge while vehicles sit overnight in a depot from 5pm to 6am. In the unmanaged charging base case, vehicles are plugged in upon arrival in the depot and charge at full speed. In the managed charging cases, the vehicles are charged in the manner incentivized by one of two illustrative time-of-use tariffs – one demand-based and the other fully volumetric – each of which discourages charging during a peak window running from 9am to 9pm. In recognition of the fact that this fleet's charging window is overnight, this figure shows a 24-hour period running from noon to noon.



Unmanaged Charging

Unmanaged charging can result in high peak demands at costly times.

Managed Charging: TOU Volumetric-Only

Pricing shifts charging to cheap hours but may still result in higher demand levels.

Managed Charging: TOU Demand-Based

Pricing shifts charging to cheap times while also managing demand levels.

Cost Containment

An essential principle for optimal pricing of truck and bus charging is that system and environmental costs should be contained by minimizing new demand spikes that increase costs for all ratepayers, while also increasing climate and local air pollution by requiring dirty generators to fire up in response to increased demand.

“Truly optimized charging can do more than minimize system costs – it can maximize benefits to the electric grid and the environment.”

Cost-reflective pricing is essential.

The price of electric service should reflect the costs that energy consumption places on the system, allowing customers to internalize both the costs of their consumption (including environmental costs where those are monetized, such as in states where generators are subject to a carbon price) and the benefits of their efficient charging behavior.

Cost-reflective pricing is a widely accepted aspect of electric rate design. The challenge in this space is to recognize that there are multiple possible cost-reflective price structures, which will achieve different results in the context of fleet electrification.

Pricing should incentivize customers to charge during low-cost times.

Pushing electric use into low-cost periods can be environmentally beneficial in settings where low-cost renewable generation is so productive during low-use periods that clean energy is being curtailed – a costly waste that drives up energy prices and pollution.

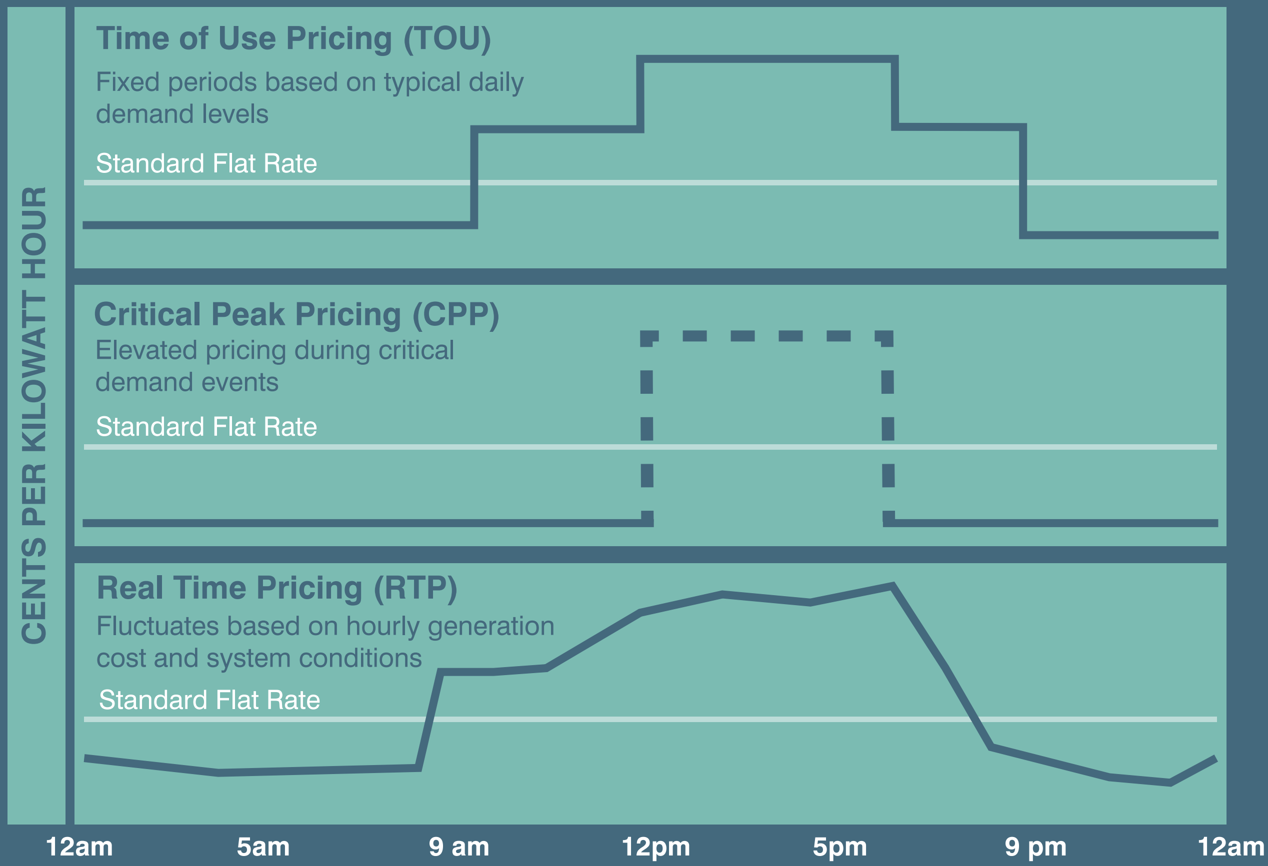
Electric service can be quantified and priced in various ways, generally based on some combination of demand (a customer’s highest rate of electricity usage, which can be expressed in kilowatts) and volume (the total amount of power used, which can be expressed in kilowatt-hours). All electric pricing should vary over the course of the day, and neither pure demand-based rates nor pure volumetric rates are perfectly cost-reflective.

A volumetric TOU rate (a rate which charges customers per-kilowatt-hour used and which is high at certain predetermined times based on when the system’s peak demand is likely to occur and low at certain other predetermined times), would provide some signal to reduce average demand during high peak times, even without a component based on a customer’s individual peak demand. For small customers, this type of rate, supported by well-tailored marketing, education and outreach, may suffice to contain grid upkeep costs in the long run if there are multiple, diverse loads driving peak demand. But the higher a customer’s potential charging demand, the more important it is that customers experience a price signal to incentivize the management of that demand (and not just the total quantity of power consumed), especially during peak times. Examples of time-variant price structures that push charging into low-cost times while also signaling customers to manage their demand include coincident peak demand charges and the subscription rates promulgated for EV fleet customers in California.

Time-variant pricing for supply aligns the incentive for customers to charge when costs are low. But it is important to provide a variety of options.

Electric bills include costs associated with the wires that deliver energy (“delivery” costs) as well as the energy that is delivered (“supply” costs). In restructured markets where generation is not a part of the utility monopoly, the wholesale cost of electricity (as opposed to the use of the wires) changes hourly or even more frequently. Not all restructured states allow retail customers to choose their own energy supplier (for example, California does not), but where customers do choose their own energy supplier – as they do in New York, for example – supply is a distinct part of the bill with its own unique pricing. To the extent that dynamic costs can be passed through to customers, that can help optimize consumption as well as provide an important cost signal in situations where renewables clear the market at low cost and the dirtiest generators are more expensive. However, a rapid, inclusive transition that works for all customers of electric trucks and buses will require that customers be able to choose from a range of time-variant options, from the least dynamic (volumetric TOU pricing for supply) to the most dynamic (true real-time pricing) – such that the benefits of the most granular pricing are available to those with the wherewithal to manage it, but there is still something that works for everyone.

Pricing Options for Generation Costs



Value-based payments for services can incentivize customers to charge their vehicles in locations where spare grid capacity is plentiful.

Costs vary geographically, but differentiated electric pricing based on location is often disfavored. However, payments to customers for environmental and grid services associated with their integration (whether managed charging "V1G" or bidirectional charging "V2G"[3]) can be differentiated based on their location. Because grid services are more valuable in some parts of the grid than others, such geographic differentiation of payments for those services would help optimize societal benefits from EV charging.

Truly optimized charging can do more than minimize system costs – it can maximize benefits to the electric grid and the environment. This is the gold standard, but getting to a point where environmental impacts are fully and fairly reflected in dynamic pricing for EV charging requires innovations in how energy commodities are priced at the wholesale level. The technology deployed to optimize charging in the near-term should have the capabilities it will need to continue to optimize charging as the wholesale markets get better at integrating renewable energy and as more opportunities for retail customers to provide services to the grid emerge.

Types of Demand-Based Rates

Non-Coincident Peak Demand Charges. Customers are charged based on their own highest demand level, whenever that occurs.

Coincident Peak Demand Charges. Customers are charged based on their highest demand level that coincides with system peak conditions. (System peak hours for purposes of these rates may be fixed in advance – TOU-style – or may be based on actual system conditions.)

Subscription Rates (new in California). Customers subscribe in advance for a particular level of demand and pay a fixed monthly amount for service. The actual subscription rates now coming online are based on a pre-subscribed coincident peak demand maximum.

(Actual tariffs in existence may use a combination of these tools.)

[3] "V2G," short for vehicle-to-grid, refers to a service based on bidirectional power flow – that is, a service made possible by discharging energy from a vehicle battery back onto the grid. "V1G" refers to services that can be provided by varying the speed and timing of vehicle charging without any need for bidirectional power flow.

Keeping Bills Manageable

The most direct way to ensure that electrifying large truck and bus fleets does not require more electric system build-out than necessary is to charge operators demand-based rates that are reflective of the customer's highest rate of electricity usage that occurs while the distribution grid is being heavily used (although for most customers, the duration of their high-demand periods also shape their contribution to system costs). Designing demand-based rates that work for trucks and buses entails considering a variety of alternatives to ensure that fleet owners can keep their charging costs at a level they can handle. A price structure that certain fleet owners find manageable may not work for others. For the transformation to happen at scale, diverse electric fleets need a range of options to keep their bills manageable.

Whether demand-based rates are manageable for fleet owners will depend in part on the details.

Rates based primarily or exclusively on non-coincident demand charges do not distinguish between high- and low-cost times and therefor do not accurately reflect the costs placed on the system from charging. These types of rates require vehicle owners and operators to focus on minimizing demand at all times of the day and night, which can create a significant obstacle for vehicle owners due to unacceptably high bills.

Coincident peak demand charges – which are based on charging demand that occurs at the same time as the system or network peak – may be more manageable, but only if the basis for the charges is understandable to the customer and the customer has the means to manage demand satisfactorily.

Assessing demand over comparatively long periods (such as a half-hour, rather than a short interval such as five minutes), and averaging across multiple days, are examples of design choices that can maintain the price signal to manage demand while avoiding excessive penalization of small spikes in demand.

Transition Strategies on the Path to Cost-Reflective Rates

As medium- and heavy-duty fleets adapt to electrification and the challenges of managing their charging in the context of price signals that are new to them, utilities have an essential role to play in helping fleet customers along the learning curve to get them to zero emissions as quickly and smoothly as possible. Available strategies include:

Demand charge holiday – This approach eliminates the demand charge component for commercial EV rates for a specified amount of time (recovering delivery costs through volumetric pricing in the meantime), and phases them back in over time.

Shadow billing – Before migrating customers to a new rate structure, utilities can mitigate the danger of "sticker shock" by providing bills that charge customers based on the rates they're familiar with while also showing how much they would be billed for consumption behavior under the new rate.

Grace period – For innovative rates, such as the subscription charge referenced in this document, utilities can offer a grace period during which bills will not go up unexpectedly. In the case of a subscription rate, if a customer exceeds their "allotted" demand, they will have a set amount of time to adjust their usage before their bill rises to a higher level and stays there.

Marketing, education and outreach – The crucial nature of comprehensive and effective marketing, education and outreach cannot be overstated. Clear communication by utilities to fleet customers concerning their rate options and how best to respond to these will be essential to ensure a smooth, effective transition.

"For the transformation to happen at scale, diverse electric fleets need a range of options to keep their bills manageable."

Alternatives to traditional demand charges can provide flexibility for customers, provided that they are structured to help constrain costs associated with charging.

For comparatively small fleets, where the risk and impact of unmanaged demand by a single customer may be low, volumetric TOU pricing may suffice to incentivize fleet operators to avoid imposing excessively high costs on the system.

As the truck and bus charging classes take shape, utility companies are responding with entirely new pricing models. For example, "subscription rates" – an alternative demand-based model in which bills are based on a pre-agreed level of demand (like in old cell phone plans) – may be particularly manageable for some fleet owners.

Technology can help customers respond.

Time-variant pricing of all types becomes more actionable with the help of enabling technology that automates charging decisions. Today's charging equipment increasingly includes these features, but durable standards will help future-proof the equipment by ensuring that it will work with tomorrow's vehicles, rate structures and market opportunities.

Battery storage (outside of the vehicle itself) can also facilitate customers' responsiveness to time-variant pricing – while potentially enhancing the environmental benefits of vehicle electrification, if done optimally.[4]

Customer marketing, education and outreach are essential.

Effective marketing, education and outreach will be essential in all cases to ensure that customers understand the price signals they will face when they charge, especially where customers are adapting to levels of electric service or price structures that are very new to them.

Bill protection can help ease customers into more complex rate structures.

Temporary bill protection measures can make bills more transparent and prevent bills that customers cannot reasonably afford as they become accustomed to more complex rates. These features can be used in connection with initial adoption of EVs, or to ease a customer's transition from a temporary rate or business practice to a more cost-reflective approach. Examples of such temporary measures that may help with transition would include demand charge holidays, whereby the demand component of rates is temporarily suspended, and shadow billing, whereby customers who are being billed under a given rate are able to see what they would have been charged for the same energy usage under one or more alternative rates.

EDF report powered by:

Elizabeth Stein
Beia Spiller
Larissa Koehler

Conclusions

Achieving cost containment and bill manageability through electric utility policies and pricing mechanisms for charging zero emissions trucks and buses requires a consideration of several design attributes. Balancing these principles in a way that works for medium- and heavy-duty fleet owners can help support the electric system while also reducing costs for vehicle owners and ratepayers more broadly – thereby helping usher in a cost-effective transition to EVs.

[4] See e.g., A. Bilich, J. Fine, and E. Spiller (2019) "Proactively planning and operating energy storage for decarbonization: Recommendations for policymakers", Energy Policy 132, pp. 876-880.