Rate Design to Maximize the Benefits of Transportation Electrification

Presentation to the EV Charging Rate Design Working Group

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- Founded in 1996 by CEO Bruce Biewald
- Leader for public interest and government clients in providing rigorous analysis of the electric power and natural gas sectors
- Staff of 40+ includes experts in energy, economic, and environmental topics

EV Rate Design Report

Stems from recommendations in the **Pennsylvania EV Roadmap**

Commissioned by the Pennsylvania Department of Environmental Protection's Energy Programs Office

Objective: Assess what rate design modifications are required to drive further adoption of EVs in a manner that:

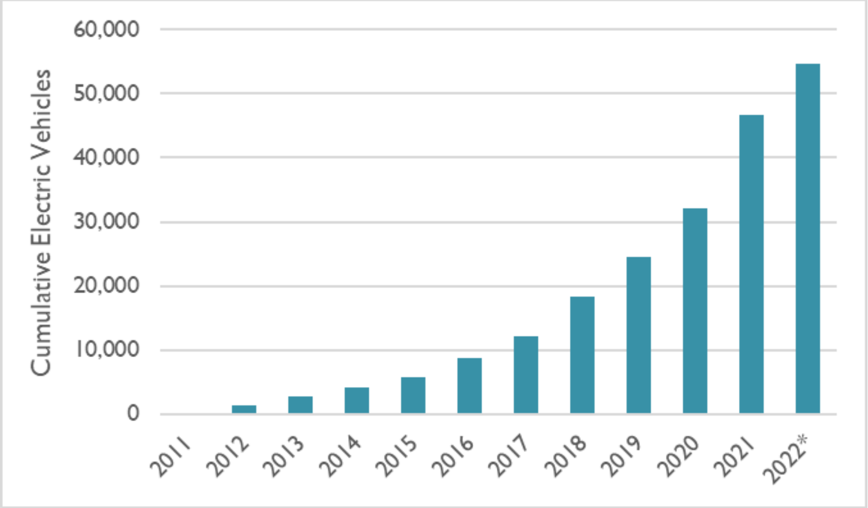
(1) Efficiently uses the grid,

(2) Facilitates widespread availability of electric vehicle charging stations, including publicly-accessible DCFC, and

(3) Maximizes the environmental benefits (emissions reductions) from EVs.

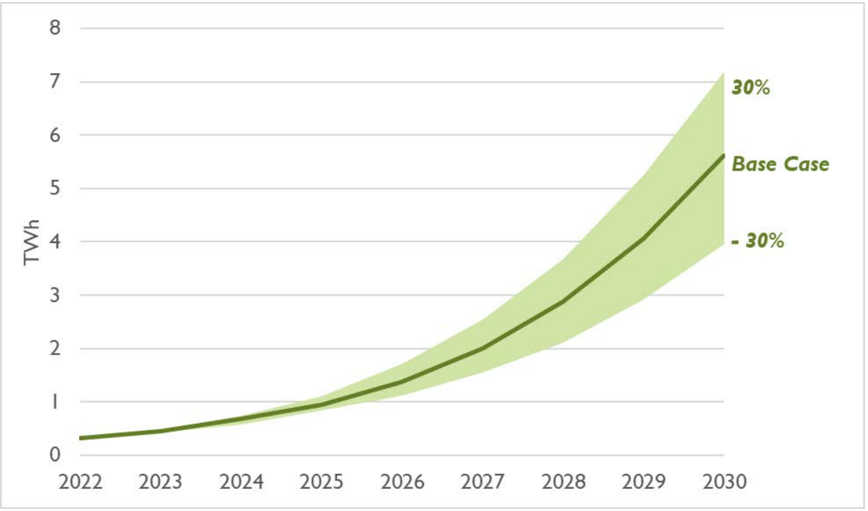
Electric Vehicle Adoption is Growing Rapidly in PA

EV adoption in Pennsylvania 2011-2022



More than **50,000** EVs are on Pennsylvania's roads today.

Projected electricity consumption from EVs 2022-2030



By 2030, we forecast that:

- The number of EVs in Pennsylvania is likely to increase almost **17 fold**.
- Approximately **9 percent** of vehicles (**900,000**) in Pennsylvania are likely to be electric.
- EVs are expected to increase electricity consumption by more than **4 percent** across the state.

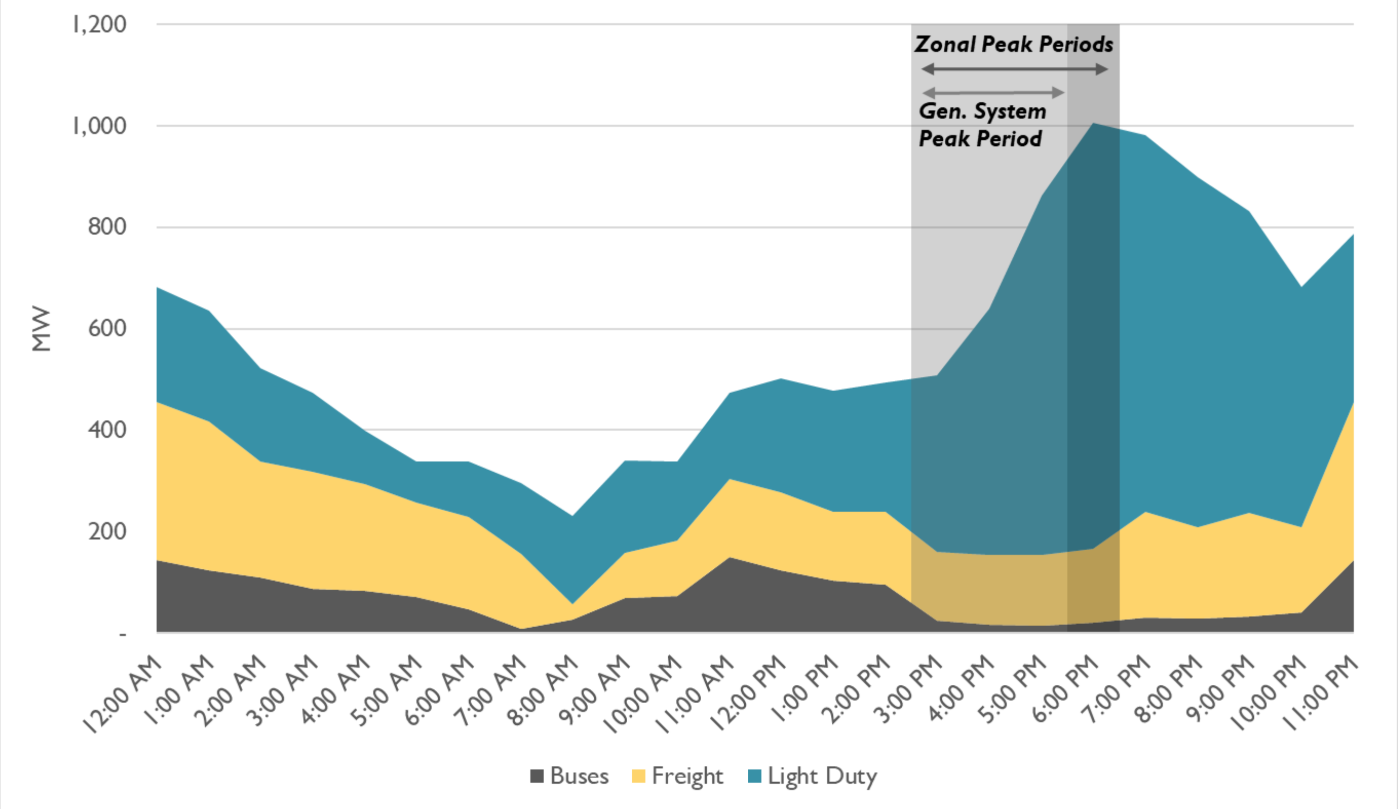
Potential Benefits of EVs

- **Emissions Reductions:**
  - By 2030, EVs will reduce annual tailpipe emissions in Pennsylvania by about 6%
- **Fuel Cost Savings:**
  - At $2.00/gallon gasoline prices, EVs save drivers $700/year
  - At $4.00/gallon gasoline prices, EVs save drivers $1,700/year
- **Downward Pressure on Electricity Rates:**
  - Additional electricity consumption can help spread fixed costs over greater electricity sales, reducing electricity rates for all customers
  - Depends on whether EVs help use the grid more efficiently, or whether they primarily charge during peak hours
    - Unlike traditional appliances, EVs are very flexible in terms of when they use electricity. Most light-duty vehicles sit idle ~80% of the time, providing plenty of opportunity to shift the timing of charging.

Potential Peak Demand Impacts

- EV adoption could add up to 1,000 MW of demand by 2030, increasing generation capacity, transmission, and distribution capacity needs by ~2.5%.
- This additional demand could erase benefits of downward pressure on rates.

Potential increase in peak demand by 2030 due to EVs



Rate Design

- EV rates can help to:
  - Avoid grid upgrades by encouraging customers to charge off-peak
  - Encourage EV adoption through low-cost charging options, making EVs more affordable

- A rate schedule is generally comprised of one or more of the following three rate elements:

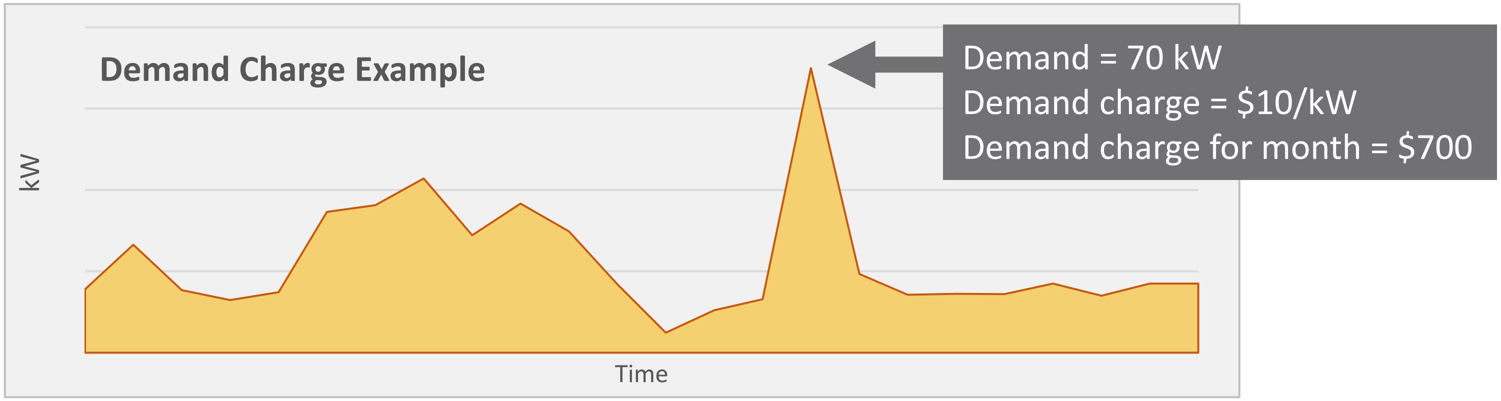
Fixed Charge	$/month	Flat fee regardless of usage
Volumetric Rate	$/kWh	Based on volume of energy (kilowatt-hours) consumed over the course of the month
Demand Charge	$/kW	Based on the customer's maximum demand (kW) during month

- Within each of these elements, there are many design options with different implications for EV adoption and charging patterns

Rate Design Barriers to EV Adoption

- **Lack of Fuel Cost Savings**
  - A key motivation for EV adoption is fuel cost savings
  - Flat rates do not provide lower electricity prices when costs on the grid are low, making charging more expensive than it could be

- **Demand charges** tend to pose the biggest barriers for commercial customers (including public DCFC and fleets)



Demand charges are difficult for customers with low load factors, where the quantity of electricity consumed (kWh) is low but the demand (kW) is high.

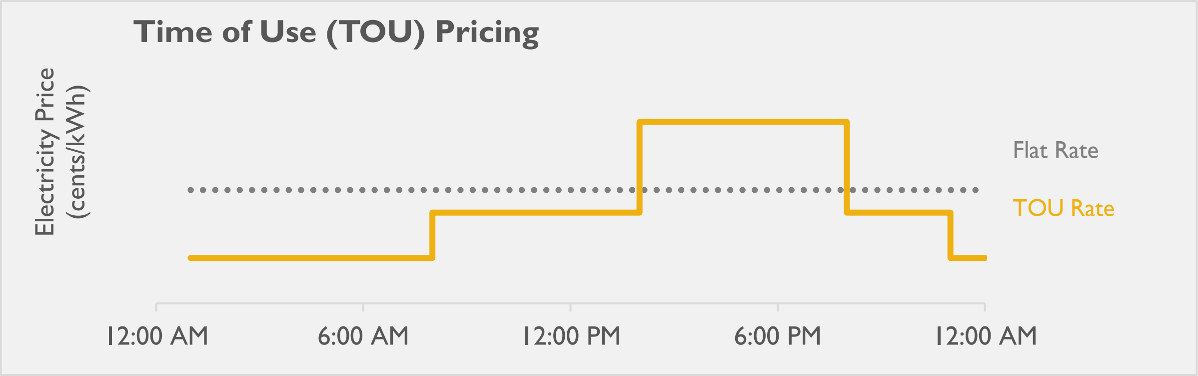
EV Rate Options: Residential

EV Rates for Residential Customers

Key Considerations

- *Simple and understandable*
- *Optional – not all rates work for all customers*
- *Sufficient bill savings to attract enrollment*
- *EV-only options*
- *Minimize cost of enrolling in the rate (such as requirements for a second meter)*

Time of Use (TOU) Rates



Benefits:

- EVs have an incentive to charge during off-peak hours
- Cost of charging during off-peak hours is lower, enhancing fuel cost savings and supporting greater EV adoption
- Relatively simple to understand

Challenges:

- Customers may be unwilling to enroll whole home load on TOU rate
- Separate EV-only rate requires a separate meter or approved submetering
- On-peak to off-peak price ratio must be high enough to make enrollment and load shifting worthwhile through bill savings

Residential TOU EV Rates

- Very common across the country
- Shown to be highly effective, with 80 – 90% of charging occurring outside of peak hours
- Of 10 jurisdictions surveyed, most TOU rates have on-peak to off-peak price ratios greater than 2:1
- TOU rates in Pennsylvania only apply to supply costs, and thus the on-peak to off-peak ratios are generally mild, providing lower bill savings

Residential Subscription Rates

- Flat monthly fee
- Unlimited or pre-specified quantity of electricity during off-peak hours
- High price for on-peak hours

Example: Austin Energy's EV360 program provides unlimited charging during off-peak hours (7 pm-2 pm) for $30/month. On-peak charging is $0.40/kWh in summer and $0.14/kWh in winter. 99% of charging occurs during off-peak hours.

Benefits:

- EVs have an incentive to charge during off-peak hours
- Enhanced fuel cost savings
- Extremely simple to understand and stable bills

Challenges:

- Requires a separate meter or approved submetering
- Best for EV customers who drive a lot, not necessarily lower-usage EV customers

Off-Peak Charging Credits

- Provides a credit to customers who charge vehicles off-peak

Example: ConEdison provides a $0.10/kWh rebate for charging between midnight and 8 am. Customers can earn an additional $35/month for avoiding any charging during peak summer hours (2 pm – 6 pm).

Benefits:

- EVs have an incentive to charge during off-peak hours
- Enhanced fuel cost savings
- Customers do not risk higher bills – they simply receive a credit
- Less stringent metering required to provide bill credits

Challenges:

- Submetering options can be expensive

EV Rate Options: Commercial

Commercial EV Customers

Examples:

- Public DCFC
- Transit vehicles
- School buses
- Municipal fleets
- Commercial fleets (delivery vehicles, forklifts, etc.)

Image credit: Lord Alpha, Wikipedia

Image credit: City of Houston

Convert Demand Charges to Volumetric Rates

- Higher volumetric rates in exchange for reduced or eliminated demand charges
- May be permanent or temporary

Example: NV Energy offers a temporary conversion of demand charges to time-of-use volumetric rates. The demand charge is gradually phased back in from 2020 – 2029.

Benefits:

- Reduces bills for low load-factor customers, helping to support fleet adoption and DCFC construction

Challenges:

- Requires well-designed volumetric rate to provide efficient price signals. (Flat volumetric rates do not accurately reflect costs on the grid.)
- If temporary, must be in place long enough to support business case for DCFC and fleets, or will not accomplish goals

Replace Non-Coincident Demand Charges to On-Peak Demand Charges

- Demand charge only applies during pre-defined on-peak hours

Example: Ameren Illinois eliminated its off-peak demand charge for a limited number of education facilities, transit facilities, or public charging facilities with demands greater than 150 kW. The standard demand charge still applies during on-peak hours.

Benefits:

- Reduces bills for customers who can shift load to off-peak hours or use storage to reduce peak demand

Challenges:

- Some utility costs are related to a customer's non-coincident demand. May require alternative fees to efficiently recover such costs.

Low Load-Factor Rates

- Caps demand charges for customers with low load factors
- May or may not increase volumetric rate proportionately

Example: For DCFC customers, Arizona Public Service limits the monthly billed demand relative to the Customer's monthly kWh usage. Monthly billing demands are limited to a kW no higher than what would result with a load factor of 25% through 2025. The load factor limit ratchets down from 2025 – 2031.

Benefits:

- Reduces bills for low load-factor customers

Challenges:

- May not be fully cost-based, depending on design
- If temporary, must be in place long enough to support business case for DCFC and fleets, or will not accomplish goals

Load Attraction/Economic Development Rates

- Temporary discounted rates to encourage new load on system

Example: Alabama Power's Economic Development Incentive offers rate reductions to customers who add at least 250 kW of electric vehicle fleet load and who commit to a contract for a six-year or ten-year period. Under the ten-year contract, base rate charges are discounted by up to 45 percent in the first year, declining to 15 percent in the fifth year.

Benefits:

- Supports EV load growth while industry is nascent

Challenges:

- Must recover at least marginal costs in order to benefit other customers
- May be viewed as unfair by some
- If temporary, must be in place long enough to support business case for DCFC and fleets, or will not accomplish goals

Recommendations

Rate Design Recommendations

1. Modify existing TOU rates by **strengthening on-peak to off-peak price ratio to 2:1 or higher**
    - Objective: Provide greater fuel cost savings to increase enrollment and encourage customers to shift load
    - Can be accomplished in many ways: shortening off-peak period, introducing super-off-peak period, applying TOU rates to distribution costs, or adopting a subscription rate with free off-peak charging
2. Consider adopting **submetering standards** to allow separate metering of EV load and avoid costly second meters
3. Implement **alternatives to traditional demand charges**, such as:
    - <u>On-peak demand charges,</u> which apply only during peak hours and more precisely target the hours that the system is most stressed.
    - <u>Conversion of demand charges to volumetric rates</u> for low load factor customers, at least temporarily while EV charger utilization is low.
    - <u>Load attraction or economic development rates</u> designed to support the growth of the nascent EV market.
4. Ensure adequate focus on **education and outreach** to ensure success

Contact

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Appendix

Residential TOU Examples

Utility	Rate	Season	On-peak to off/super-off-peak price ratio	Whole-house or EV only
SDGE (CA)	TOU-5	Summer	6.3:1	Whole-house
		Winter	4.2:1	
	TOU - 2	Summer	2.8:1	Whole-house
		Winter	1.9:1	
	EV TOU	Summer	2.8:1	EV Only
		Winter	1.9:1	
Con Edison (NY)	TOU Residential	Summer	14.2:1	Either
		Winter	5.2:1	
SCE (CA)	TOU Residential	Summer	3.7:1	EV Only
		Winter	2:1	
PSEG (NY, Long Island)	Short Peak - TOU Residential	Summer	1.7:1	Whole-house
		Winter	1.5:1	
		Shoulder	1.3:1	
	Early Peak -TOU Residential	Summer	1.6:1	Whole-house
		Winter	1.5:1	
		Shoulder	1.3:1	
Hawaiian Electric Company	TOU-RI, separately metered EV	No seasonal variation	2.2:1	EV only
Pepco (MD)	Plug-in Vehicle (PIV) TOU	Summer	1.4:1	EV Only
		Winter	1.8:1	
	Residential Plug-in Vehicle (R-PIV) TOU	Summer	1.3:1	Whole-house
		Winter	2.1:1	
Northern States Power – Xcel Energy (MN)	Electric Vehicle Home Service	Summer	8.2:1	EV Only
		Winter	7.2:1	
	Res. EV Svc (EV Accelerate at Home)	Summer	3.2:1	EV Only
		Winter	2.6:1	
PacifiCorp (OR)	Separately Metered EV Service	Summer	1.4:1	EV Only
		Winter	1.2:1	
Baltimore Gas & Electric (MD)	Residential EV TOU	Summer	2.3:1	Whole-house
		Winter	2.3:1	
Salt River Project (AZ)	Residential EV Price Plan	Summer	3.8:1	Whole-house
		Winter	1.6:1	
		Shoulder	3.3:1	

Different use cases; different rates

- **Public DCFC:**
  - Demand charges very difficult to translate into prices charged to EV drivers
  - Very difficult to throttle customers' charging
  - May not have space or economics to install storage to manage demand charges

- **Fleets:**
  - May be able to easily shift charging to overnight hours to avoid certain demand charges (e.g., coincident peak demand charges)
  - May be good candidates for demand response programs (direct load control, V2G)