Pennsylvania EV Rate Design Project

Summary for the Drive Electric PA Coalition Meeting

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Synapse Energy Economics

- 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

Overview of Project

Project Objective

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.

Why EV Rates?

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

In turn, this can:

- **Reduce rates** for all customers by spreading the fixed costs over more kWh, while adding no additional infrastructure costs
- **Reduce emissions, achieve policy goals**

Synapse scope of work

Report Outline

1. Background: Role of Rate Design in Managing Potential Costs and Benefits of EVs
2. Maximizing Net Benefits: Analysis of rate design alternatives and impacts on the grid
3. Rate Design Recommendations

Timeline

Kickoff: this week!

Research and analysis: May – August

Draft Report: September 2022

Final Report: November 2022

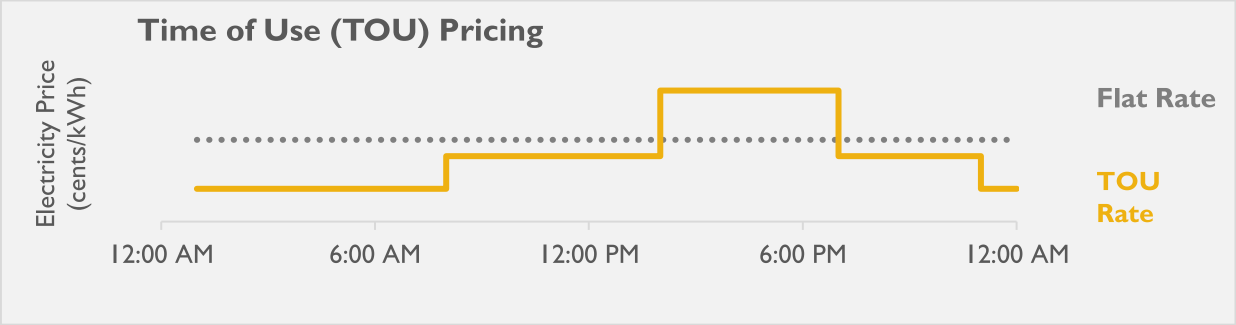
Section 1: Background

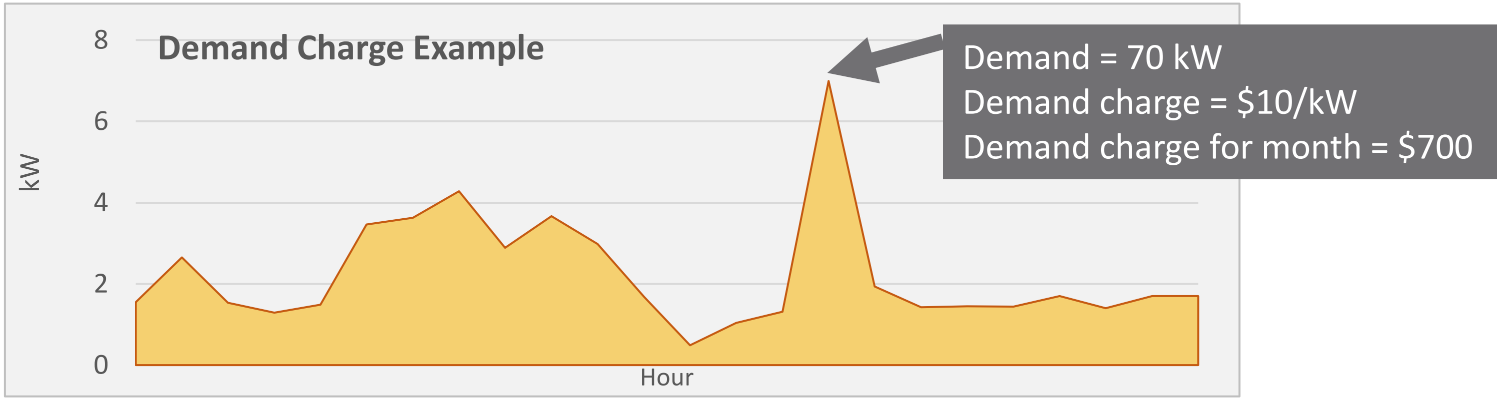
- **Discuss** EV benefits and role of rate design in managing potential costs
  - Environmental benefits through emissions reductions
  - Potential financial benefits to both EV customers and all ratepayers
  - Potential increase in system capacity needed to serve additional peak load
- **Summarize** existing rate designs and their impacts on EV charging.
  - Standard rates and EV charging pilots, temporary demand charge discounts
  - *When do customers tend to charge under existing rates? (Home, fleet, DCFC)*
- **Forecast** impacts of EVs on the grid and utilities at two different penetration levels under current rate designs.
  - *If current charging patterns continue, what does the future look like?*

Section 2: Maximizing Net Benefits

Analysis of rate design alternatives and impacts on the grid

- Informed by analysis and supplemented with real-world examples.
- Considers impacts on utilities and ratepayers





Section 2: Maximizing Net Benefits (cont.)

Rate designs that increase benefits:

- Shape *when* EVs charge to less carbon-intensive hours and less costly hours
  - Time-of-Use rates
  - Dynamic pricing (hourly pricing, critical peak pricing, etc.)
  - Must be customer-friendly!

- Target EVs with greatest impacts
  - Local heavy-duty vehicle pollution concerns?
  - Transit? Commercial fleets?

- Maximize adoption (next section)

Section 2: Maximizing Net Benefits (cont.)

Rate designs that facilitate greater EV adoption:

- Analyze financial benefits of various rate designs, since adoption is largely driven by economics for EV owners, fleet operators, and charging station owners
    - *Example: Demand charges and the impacts on large fleets and public DCFC*
    - *Example*: *TOU Rates – what are the potential savings for a customer who charges off-peak?*
  - Must ensure utilities recover costs associated with EV charging
- Forecast impact of rates on EV charging patterns, the grid, utilities, and utility ratepayers

Rate designs that are feasible:

- Analyze the processes, opportunities, and challenges with implementing the rate designs

Section 3: Rate Design Recommendations

Recommend optimal rate designs, with quantification/summary of:

- Emissions impacts
- Cost impacts (positive & negative) on the grid and ratepayers
- Electric bill savings for EV customers (and incentive to electrify)
- Feasibility of implementation (highlighting any current regulatory or statutory barriers)
- Role of the Pennsylvania Public Utilities Commission and state legislature, and venues for rate design changes (such as through existing dockets, electric utility rate filings, or new commission-initiated investigations)

Unique EV Customer Considerations

Who are C&I 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

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
  - Critical Peak Pricing may be more economic than demand charges, while providing price signals that can be more easily communicated to drivers

- **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)

Stakeholder Input

Questions, Suggestions, Data

- Favorite/least favorite rate designs?
- Current environment: What is currently working, and what isn’t?
- Data: Charging patterns for fleets, buses, workplaces, individual EVs
- Barriers?

Contact

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Appendix: Modeling EV Tailpipe Emissions Impacts in EV-REDI

What is EV-REDI?

- EV-REDI (Electric Vehicle Regional Emissions and Demand Impacts) models multiple impacts of transportation electrification for specific states.
- EV-REDI can quantify the impacts of increased EV penetration on electricity sales, greenhouse gas emissions, and avoided gasoline consumption.

Parameters

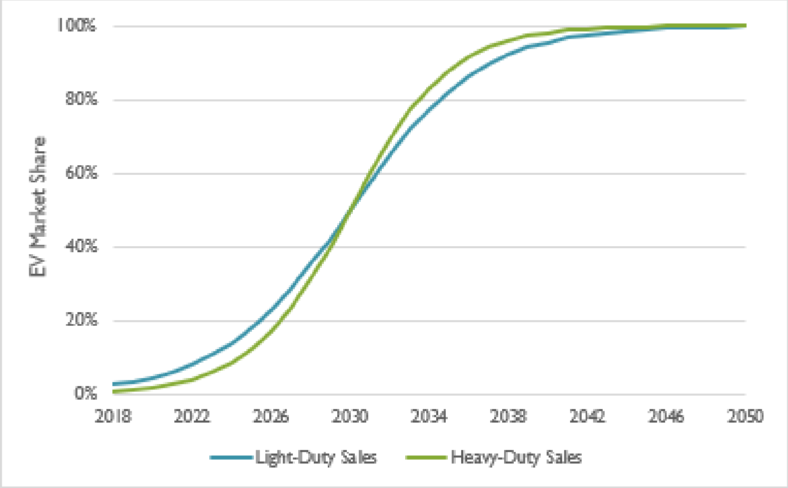
- EV-REDI incorporates state-specific data for many key input parameters, including:
  - Vehicle lifetime (set along a distribution, and is state-specific)
  - Vehicle miles traveled (varies according to vehicle lifetime)
  - Efficiency by production year (both for EVs and ICEs)
  - Trends in vehicle preferences (i.e., differentiation between passenger cars and SUVs/pickups/ crossovers)
  - Differentiation between PHEVs and BEVs
- All data is state-specific, wherever possible.
- Separate trajectories for LDVs, MDVs (e.g., UPS trucks), heavy-duty single (e.g., dump trucks), heavy-duty combination (e.g., semi trucks), and buses.
- Where available, data can be incorporated on splits between public and private vehicles fleets.

Key inputs

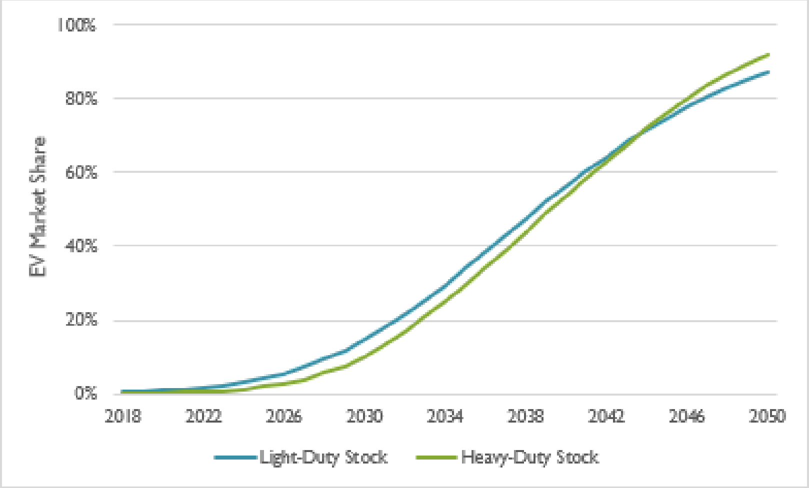
Assumption	Description	Source
Vehicle sales growth rate	Increases according to LDV sales growth rates in the EIA Annual Energy Outlook. The LDV growth rate is applied to all vehicle types (MDV, HDV, buses), and is census division-specific.	EIA. Annual Energy Outlook
Historical vehicle sales	National vehicle sales data is scaled down for each state based on the state's share of national vehicle stock.	National sales: Bureau of Economic Analysis https://www.bea.gov/national/xls/gap_hist.xlsx State-level stock: FHWA Highway Statistics https://www.fhwa.dot.gov/policyinformation/statistics.cfm
Share of PHEVs to BEVs	Example: For LDVs, share of BEVs increases from 57% of EVs in 2022 to 87% of EVs in 2040. All electric HDVs are assumed to be BEVs.	BNEF Electric Vehicle Outlook 2018 global sales projection
VMT per vehicle	State-specific based on total vehicles and total VMT in each state.	FHWA Highway Statistics https://www.fhwa.dot.gov/policyinformation/statistics.cfm
VMT change over vehicle lifetime	For LDVs, annual mileage decreases by roughly 25% after 10 years. Source is for residential vehicles only, but data is used for all LDVs. HDV mileage is assumed to be independent of age.	National Household Travel Survey 2017 https://nhts.ornl.gov/
Vehicle lifetime	Modeled as a distribution. Example: In New York, about 80% of cars last more than 10 years and about 20% of cars last more than 20 years. Light trucks last a bit longer than cars on average. The distribution is scaled for each state so that the average vehicle age matches the state's average vehicle age	RL Polk, National Vehicle Population Profile, 1975-2009 (state-level average vehicle age data from Alliance of Automobile Manufacturers)
Gasoline emissions rate	Each gallon of gasoline sold in the US is about 10% ethanol. We assume an emissions rate of 8.6 kg CO2 gallon, which includes emissions from both the gasoline and ethanol components.	EIA. https://www.eia.gov/environment/emissions/co2_vol_mass.php and https://web.archive.org/web/20170320182853/https://www.eia.gov/tools/faqs/faq.php?id=307&t=11
ICE efficiency	New vehicle MPG based on AEO; values are projected to change over time in line with CAFE standards (though we also have an option to select (a) a CAFE rollback or (b) a CAFE enhancement). Values are specific to each vehicle type.	EIA. Annual Energy Outlook
EV efficiency	New vehicle efficiencies based on projections in NREL's "Electrification Futures Study Technology Data." Efficiencies are specific to each vehicle type and improve over time.	NREL. https://data.nrel.gov/submissions/78

Key outputs

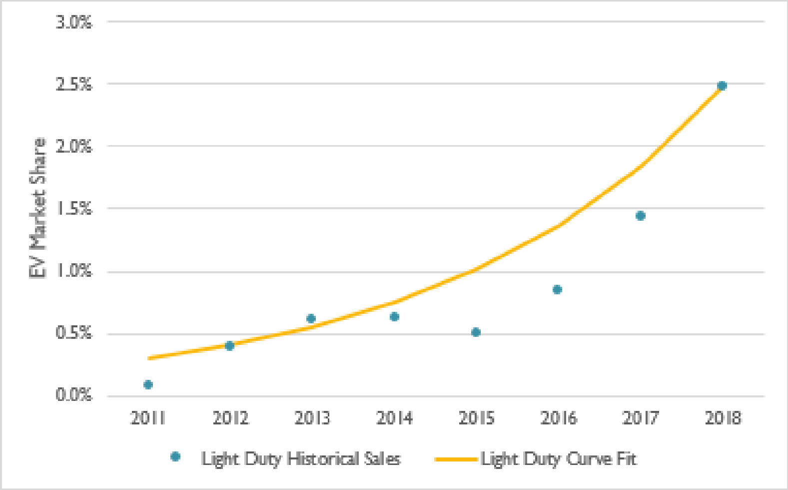
Electric Vehicle Sales



Electric Vehicle Stock



Trajectory Fit to Historical Sales



Tailpipe CO_2 Emissions