A number of factors and trends are motivating retail rate reforms

- Utilities are deploying advanced metering infrastructure (AMI)
- Distributed energy resource (DER) cost declines and technological innovations
- Utilities are reaching net energy metering (NEM) caps
- Concerns about utility fixed cost recovery and revenue sufficiency
- Desire for fair and equitable compensation for net electricity export
- Variable renewable energy (VRE) integration issues (e.g., over-generation and net load shape impacts)
There are several studies and actions that precede changes to rate design

- Resource valuation analysis
  \((\text{quantifies benefits and/or costs of additional resource})\)

- Cost-benefit analysis
  \((\text{quantifies ratio of costs to benefits depending on perspective})\)

- Rate and bill impacts analysis
  \((\text{quantifies change in average and/or participating customer’s rate or bill})\)

- General rate case
- Commission investigation
- Legislative directive or order
- Stakeholder collaborative
Retail rates are designed based on two broad concepts

- Recover a utility’s costs (i.e., revenue requirement), apply sound ratemaking principles; and are considered just and reasonable
- Satisfy certain policy and/or market objectives that can vary based on a state’s distinct rules, regulations, and policies, as well as different stakeholder motivations
Five policy-driven objectives used as the basis for EV retail rate design

- Recover a utility’s costs (i.e., revenue requirement), apply sound ratemaking principles; and considered just and reasonable
- Satisfy certain policy and/or market objectives that can vary based on a state’s distinct rules, regulations, and policies, as well as different stakeholder motivations

Promote EV adoption
Grid management
System economic efficiency
Decarbonization
Equity
EV rate design typically comprised of five (5) different components

- Metering Configurations
- Temporal Differentiation
- Locational Differentiation
- Demand Charges
- Charging Controls
Metering Configurations

Whole home/facility consumption
via account meter

EV charging consumption
via account meter

Submetering via EVSE or vehicle
Temporal Differentiation

Average Winter Day

Average Summer Day

Seasonal Differentiation

August Day

Sub-hourly Differentiation

Hourly and Period Differentiation

Note that figures show temporal differentiation in load but there is also temporal differentiation in system costs and emissions that could be used as the design basis.
Locational Differentiation

Bulk power system

Distribution system

Site-specific
Demand Charges

- Max demand period
- Demand ratchet
- Seasonal
- Coincident peak
- Non-coincident peak
Charging Controls

Utility system | Account meter | EV Supply Equipment (EVSE) | Electric Vehicle

One-way communication

Utility control via account meter or EVSE

Two-way communication

Customer control via EVSE
Promoting EV adoption will limit rate design choices in terms of cost and simplicity

<table>
<thead>
<tr>
<th>Rate Objectives</th>
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- Promoting EV adoption will limit rate design choices in terms of cost and simplicity.
- Rate Objectives: Promote EV adoption, Grid management, System economic efficiency, Decarbonization, Equity.
- Metering Configurations: Whole home/facility consumption, EV charging consumption, Account meter, Submetering via EVSE or vehicle.
- Temporal Differentiation: Seasonal, Period, Hourly, Sub-hourly.
- Locational Differentiation: Bulk power system, Distribution system, Site-specific.
- Demand Charges: Max demand period, Demand ratchet, Seasonal, Coincident peak, Non-coincident peak.
- Charging Controls: Two-way communication, One-way communication, Utility direct control via EVSE, Customer control via EVSE.
EV grid management rates communicate power system conditions either via price or load signals.

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Economic efficiency communicate marginal system costs to encourage charging that minimizes costs

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Decarbonization rates communicate marginal emissions rates with differentiation consistent with them.

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<td>Customer control via EVSE</td>
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Equitable EV deployment rates are based on choices that limit incremental costs

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Other types of program incentives may or may not be combined with rates to achieve program objectives.

Source: Smart Electric Power Alliance, 2021.
Available at: https://sepapower.org/resource/managed-charging-incentive-design/
Observations: Regulatory and Rate Activity

- **Motivation**: The overwhelming majority of rate activity (>85%) is focused on managing and shifting demand.

- **Rate Design**: Static TOU rates are the dominant rate structure (>90% residential; >80% commercial).

- **Demand Charges**: Over 20 states are examining demand charge alternatives for public and DCFC, particularly at lower load factors.
Utilities perceive uncertainty among top barriers to implementing EV managed charging programs

Figure 10. Barriers to Implementing a Managed EV Charging Program

- Uncertainty Around EV Customer Participation: 60%
- Limited Info on Program Design: 35%
- Uncertainty Around the Availability of EVs to Manage: 35%
- Other: 33%
- Lack of Staffing Resources to Develop a Program: 33%
- Regulatory and Policy Limitations: 31%
- Limited Managed Charging Equipment Vendor Options: 19%
- Lack of Internal Utility Support to Develop a Program: 6%

N=48. Note: Utilities selected all that applied.
Source: SEPA, 2021
Available at: https://sepapower.org/resource/the-state-of-managed-charging-in-2021/
Forward-looking considerations for EV rate design

- Implications of EV rate designs for other DER objectives and policies
- Alignment of system value with EV charging
- Revisiting EV rate designs as EV deployments increase and/or system conditions change
Questions/Comments

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Appended slides on customer response to EV retail rates
Do customers respond to EV rates?

- Reviewed eleven (11) evaluation reports of EV rate offerings published between 2013-2020
- Most evaluation reports were outcomes of short-term (6 months – 2 years) pilots; very few system-wide roll outs were evaluated
- Pilots were evenly split between having whole house vs. EV-only metering
- Most pilots had at least a 2:1 peak-to-off peak price ratio and a small number had 4:1 or greater price ratio
Properly designed rates can be an effective tool for managing EV charging behavior


The higher the price ratio, the more off-peak charging is pursued

<table>
<thead>
<tr>
<th>Tests of Pairwise Differences in Percentage Charging Shares Between Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day Type</td>
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<tr>
<td>----------</td>
</tr>
<tr>
<td>Weekday</td>
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<td></td>
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- Values in the table represent differences in the share of charging load for customers on different rates
- Comparing customers on lowest price ratio (EPEV-L) and customers on highest price ratio (EPEV-H) shows lowest price ratio customers had larger share of peak period consumption but highest price ratio customers had larger share of super off-peak consumption
The higher the price ratio, the quicker customers learn to shift charging to the off-peak period

- Figure depicts the monthly share of charging that occurred as a function of the number of months after a customer started in the study
- Customers on EPEV-H (highest price ratio) exhibited consistent charging behavior through the entire duration of the study
- Customers on EPEV-L and EPEV-M increased charging consumption in super off-peak period by 1.8%-2.9% per month for the first four months, but remained relatively stable thereafter

Customers are more responsive to changes in the peak or off-peak prices, but less so super off-peak

- Charging timers likely made it easier for customers to charge in the overnight super off-peak hours (12-5AM)
- Customer schedules likely limited long charging events to the off-peak (5AM-12PM and 8PM-12AM) or especially the super off-peak period
- Customers also did not seem to differentiate much between the on-peak and off-peak period in their EV charging decisions

<table>
<thead>
<tr>
<th>Season</th>
<th>EPEV-L</th>
<th>Peak to Super Off-Peak Ratio</th>
<th>Peak to Off-Peak Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>EPEV-L</td>
<td>1.9</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>EPEV-M</td>
<td>4.0</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>EPEV-H</td>
<td>6.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Winter</td>
<td>EPEV-L</td>
<td>1.3</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>EPEV-M</td>
<td>2.9</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>EPEV-H</td>
<td>4.6</td>
<td>2.5</td>
</tr>
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</table>

Customers who owned a PV system are significantly less responsive to prices than their non-PV counterparts

- PV owners exhibit more consistent shares of charging by period across the three rates relative to non-PV owners
- Selling PV electricity back to the grid may be valued more highly by customers than using it to charge their EV
- PV owners may have certain characteristics that cause them to place an even higher premium on charging overnight regardless of the prices they face