Basics of Rate Design
as applied to Electric Vehicles

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*The 10 Principles of Rate Design**

To guide the development of an optimal residential retail rate design structure, the Commission set forth 10 principles:

1. Low-income and medical baseline customers should have access to enough electricity to ensure basic needs (such as health and comfort) are met at an affordable cost;
2. Rates should be based on marginal cost;
3. Rates should be based on cost-causation principles;
4. Rates should encourage conservation and energy efficiency;
5. Rates should encourage reduction of both coincident and non-coincident peak demand;
6. Rates should be stable and understandable and provide customer choice;
7. Rates should generally avoid cross-subsidies, unless the cross-subsidies appropriately support explicit state policy goals;
8. Incentives should be explicit and transparent;
9. **Rates should encourage economically efficient decision making;****
10. Transitions to new rate structures should emphasize customer education and outreach that enhances customer understanding and acceptance of new rates, and minimizes and appropriately considers the bill impacts associated with such transitions.

* ***These principles were incorporated into recent decisions (D.15-07-001, D.17-01-006, and D.17-08-030)***

****Economically efficient decision making is especially important for off-peak EV charging**

Rate Design for EVs?

Technology-specific rates are generally disfavored

- We should not be creating rates that are designed to solely benefit EVs
- But instead we need to be setting rates that reflect the cost impact of EVs on the grid (which depends on the time of charging)
- The CPUC's TOU Decision* supports a menu of cost-based rate options
  - Some of these options could benefit EVs provided charging is off-peak

*D.17-01-006

What is Marginal Cost?

The cost of providing an additional unit of electricity

(to meet customer demand)

Type of Marginal Cost	Units
Energy (Generation)	Cents per kWh or $ per MWh
Capacity (Generation, Distribution)	$ per kW or $ per kW-year
Customer (Final Line Transformer, Service Drops, Meters, Billing, Customer Service)	$ per customer-year (or month)

- *Marginal Costs are used in both Revenue Allocation and Rate Design*

Why Base Rates on Marginal Cost?

- In 1979, the CPUC declared its intention to switch the basis for setting rates from "embedded cost" to marginal cost.
  - **"We have chosen marginal costs as our foundation for [electric cost] allocation and rate design. We have used marginal costs to promote economic efficiency and to provide the greatest good for the greatest number." [D.93887 (1981), emphasis added.]**

- Ideally, MC-based rates:
  - **reflect cost causation**
  - **result in optimal levels of consumption**
  - **encourage economically efficient decision making**

Why EPMC?

- *First, … EPMC revenue allocation provides a **fair way of relating each class's revenue requirement to the costs of providing service** to that class.*
- *Second, EPMC helps **reduce interclass subsidies** that distort price signals and thus result in inefficiencies, to the detriment of society in general.* (D.87-05-071, p.3)

EPMC Has Been the Preferred Starting Point for both Revenue Allocation and Rate Design

- Revenue Allocation apportions revenue responsibility among customer classes
- Rate design apportions revenue responsibility to ***individual customers*** within a customer class.
- Consistent with many 1980s & 1990s-era CPUC decisions, EPMC, applied to both revenue allocation and rate design is:
  - **Cost-based**
  - **A reasonable balance between equity and efficiency in ratesetting, and**
  - **EPMC has been the Commission's preferred starting point to achieve fair and equitable rates**

Why Are Marginal Costs and EPMC Important for Rate Design?

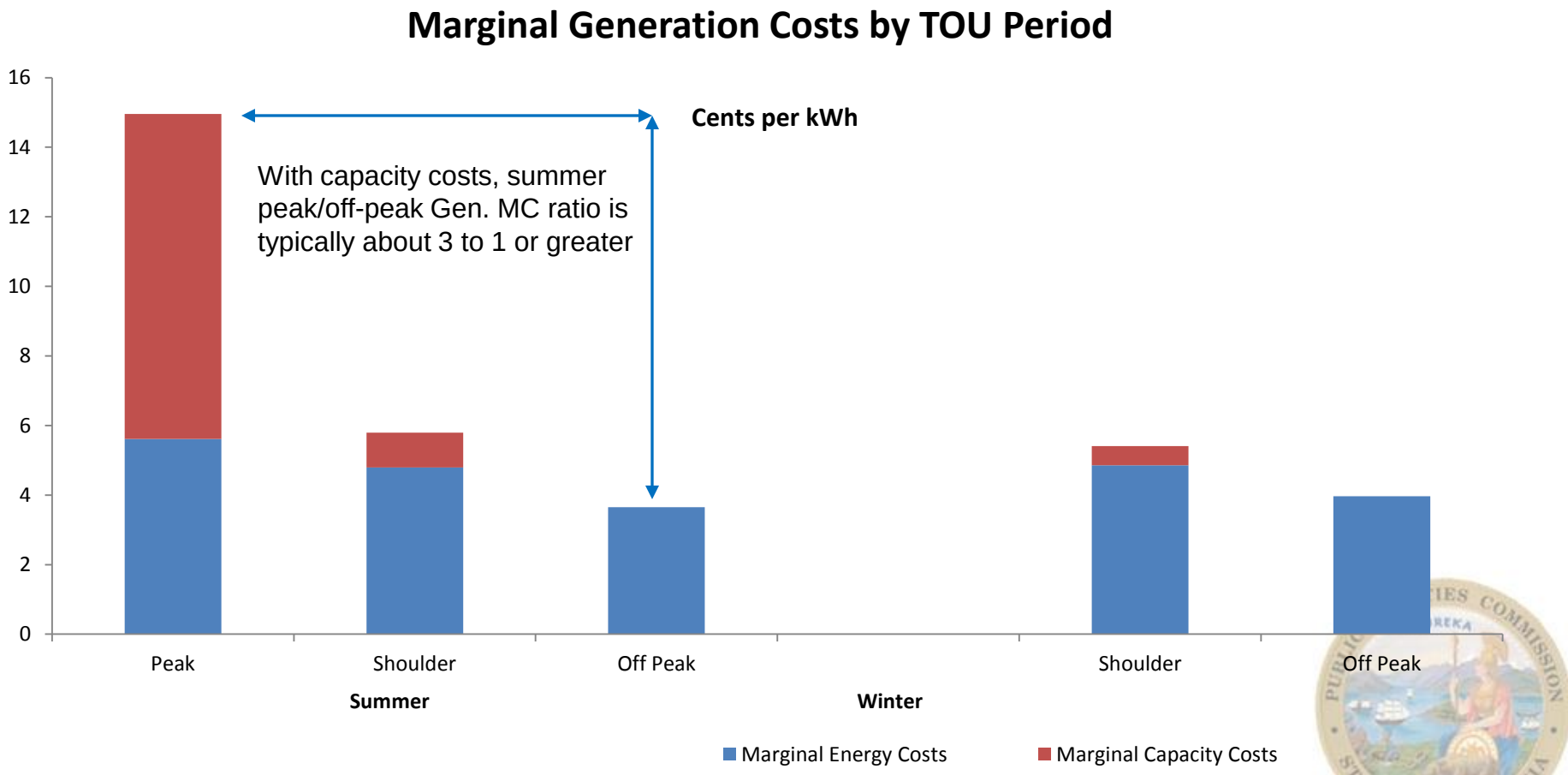
- Both Generation and Distribution MCs are Time-Dependent
- EPMC preserves the relative magnitude of peak and off-peak MCs*
- EPMC-based rate design ideally provides the correct price signal for efficient use of energy based on season and time-of-day*

***This is especially important for motivating off-peak EV charging**

Marginal Energy and Generation Capacity Costs

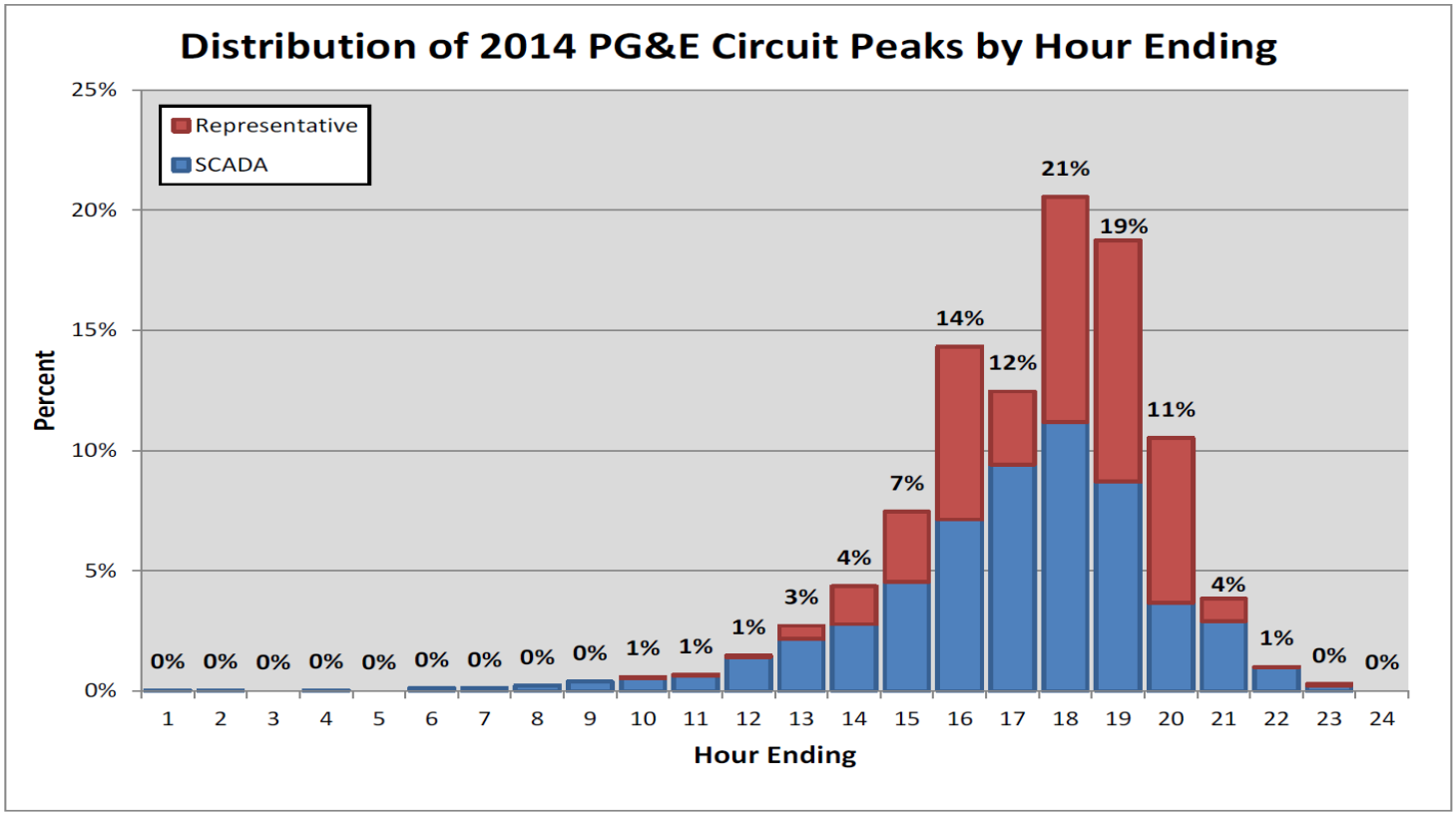
Generation Capacity Cost Has Been Typically Assigned Mostly to the Summer Peak Period;

- More costs may be assigned to non-summer hours as ramping needs increase

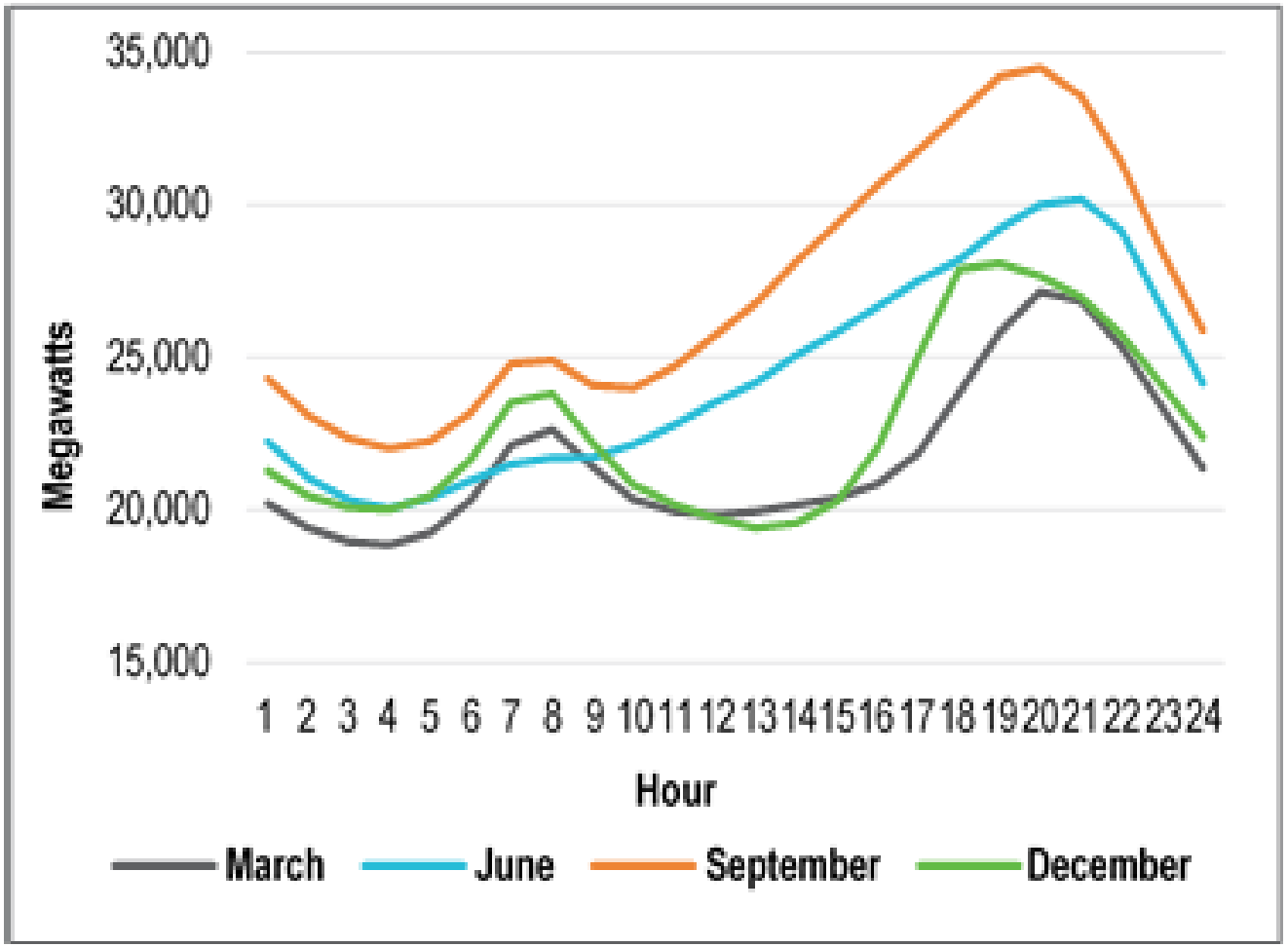


Marginal Distribution Capacity Cost is Also Time-Dependent

- About 65% of distribution circuits peak between 4 pm and 9 pm



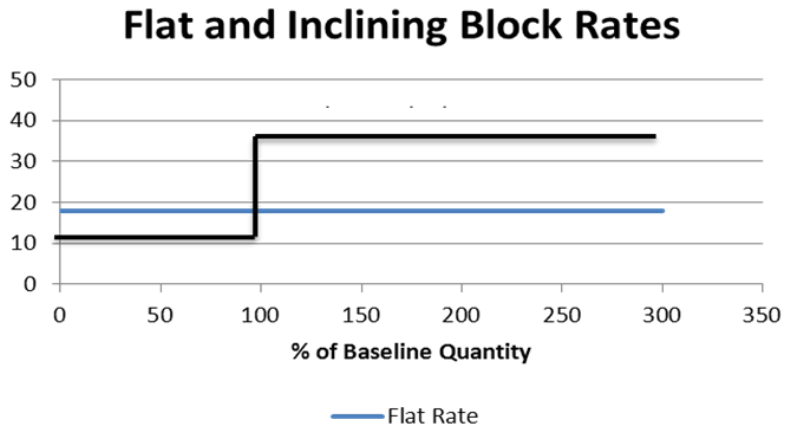
Time-Dependence Is Highly Seasonal

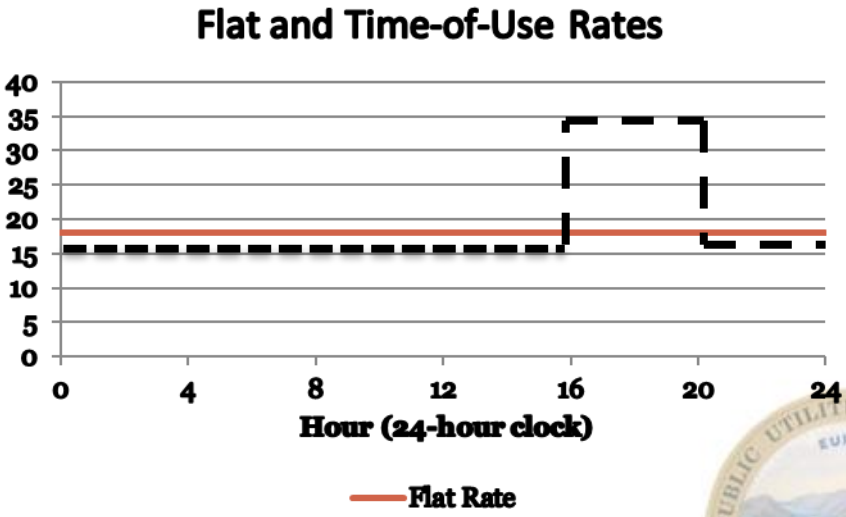


Seasonal variations on the "duck curve", 2015.

Core Elements of Rate Structure

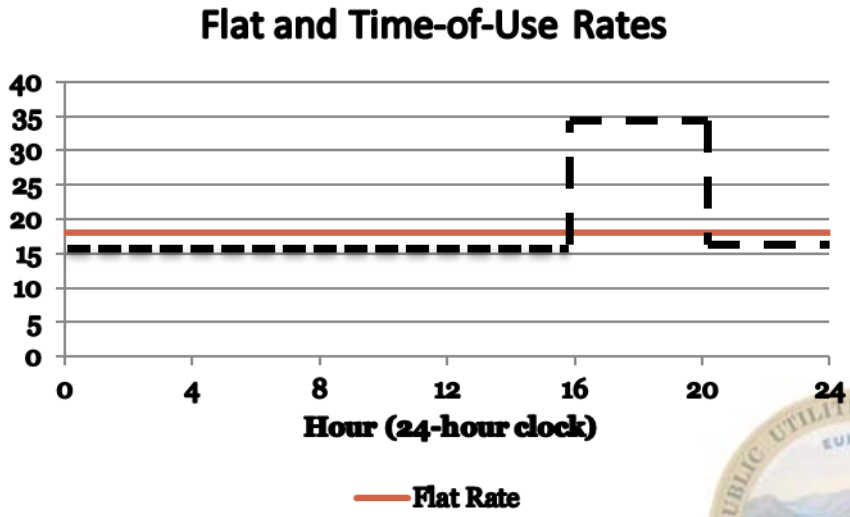
- **Fixed charge ($/month)**
- **Volumetric charge ($/kWh)**
  - Flat rate
  - Inclining block rate (rate goes up for a higher block of energy usage)
  - Time of use ("TOU" rates)-- *(need to establish time of use periods)*
  - Dynamic rates (critical peak or real-time pricing rates)
- **Demand charge ($/kW maximum demand)**
  - Non-coincident (applies anytime)
  - Coincident (Peak-related) (only applies in peak or part-peak periods)



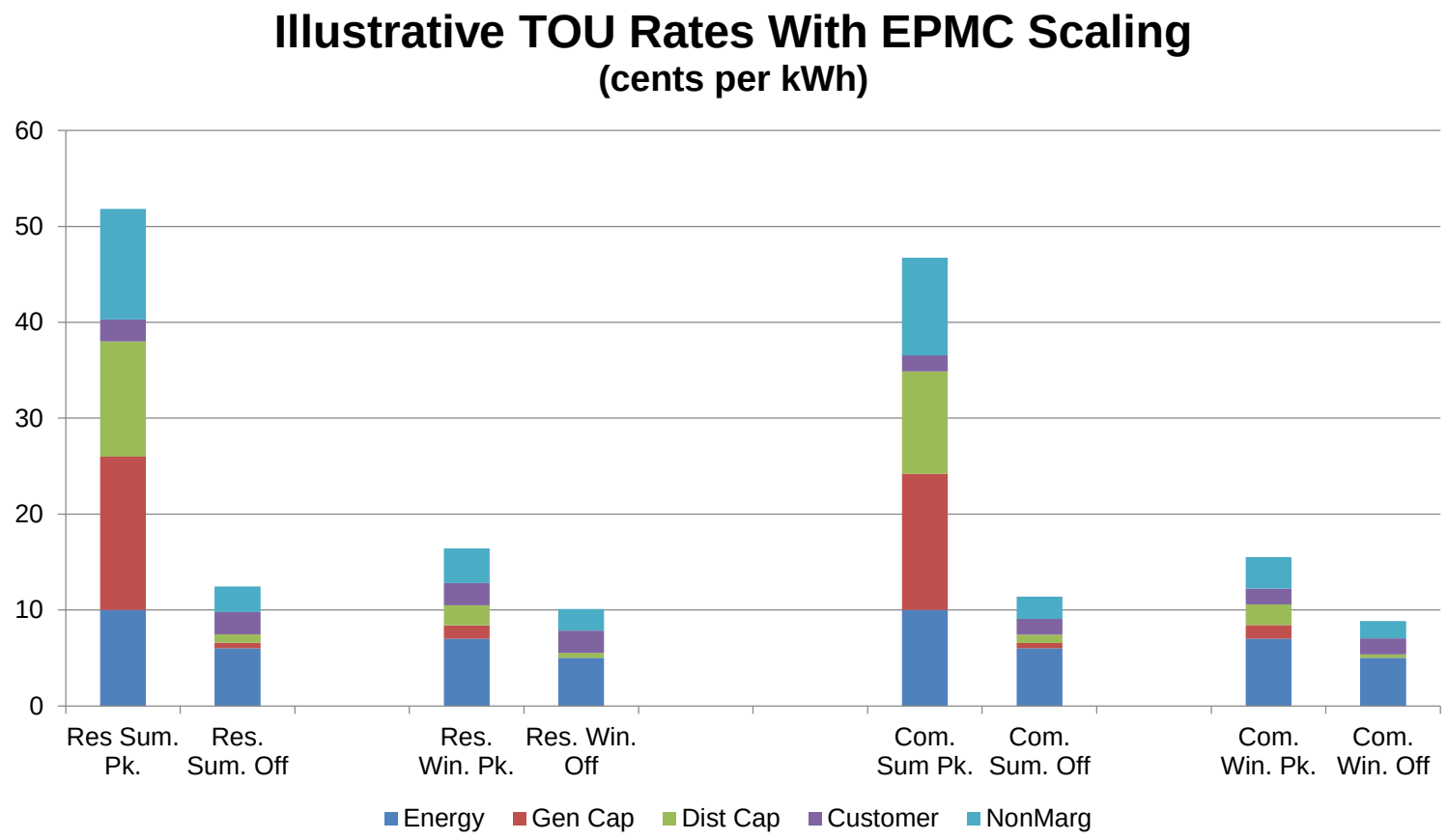


What is a TOU Rate?

- A TOU Rate is a volumetric rate (in $/kWh) that varies by season, day-type, and time of day (usually 2 or 3 periods per day)
- Generally, TOU pricing is intended to reflect the tendency of certain groups of hours to be high- or low-cost hours-
  - as indicated by marginal energy and capacity costs



Illustrative Fully Time-Differentiated TOU Rates



Time Variant Pricing

- **There are two types of TVP:**
  - **TOU** (prices are set in advance and do not change based on system conditions)
    - TOU rates are normally volumetric but coincident demand charges can be considered a form of TOU pricing
  - **Dynamic Pricing** (prices can change at short notice, depending on system conditions)
  - Both types are considered Demand Response, and are therefore preferred resources.

- TVP is now mandatory for nonresidential customers
  - Dynamic pricing is default, but customers can opt out to a non-dynamic TOU rate
- TOU is on path to becoming the default rate for most residential customers (beginning 2019 for SDG&E).

TOU vs Dynamic Rates

- Dynamic Rates are useful when reductions in peak usage are needed on a few hot summer days, to avoid possible shortages and/or wholesale energy price spikes.
- TOU rates are more predictable and can encourage longer-term shifting of energy use out of peak demand periods.
- After the energy crisis, dynamic prices were emphasized in response to potential energy shortage; more recently, emphasis has shifted to TOU.
- Both types of rates have value.

What is a demand charge?

- A non-coincident demand ("NCD") charge (in $/kW) is assessed on the customer's maximum demand in any 15-minute interval during the billing cycle *(regardless of when it occurs);*
- A peak-related (or coincident) demand charge ("CD charge") is assessed on the customer's maximum demand in any 15-minute interval during the peak (or semi-peak) TOU period.
  - **CD charges are preferable for EV fleet charging**
  - Demand charges are not currently applied to residential or small commercial customers.

Time Variant Pricing for EVs

- **TOU is Likely Best for Most EV charging– Due to Its Predictability– RTP Can be a Good Alternative in Some Instances**
  - **TOU** (prices are set in advance and do not change based on system conditions)
    - TOU rates are normally volumetric but coincident demand charges can be considered a form of TOU pricing
    - **TOU rates for EVs should avoid loading unnecessary costs into off-peak rates**
      - **Off-peak marginal energy costs are typically low**
      - **Marginal capacity costs are normally not incurred in off-peak hours**
  - **Residential EV owners should be on an optional EV-TOU rate (or RTP)**
    - **Separate metering or submetering of EV loads is desirable**
  - **Commercial demand charges should not apply to off-peak EV charging**
    - With limited exceptions where EV fleet charging causes need for distribution upgrades

Notes on Transmission Rates

- Transmission costs are increasingly significant
  - 14% of Total Rate in 2017– Up from 8% in 2011 (PG&E)
- Transmission rates are set by FERC
- Typically, transmission rates are flat
  - Volumetric, non-TOU for smaller customers
  - Demand charge (non-TOU) for larger customers
- **The CPUC just adopted* a proposal for SCE to recover 30% of transmission costs in volumetric TOU commercial EV rates (subject to FERC approval)**

*D.18-05-040

Thank you!