Smart Rate Design for a Smart Future, Appendix B

Rate Design for Vertically Integrated Utilities: A Brief Overview

By Jim Lazar

Introduction

Most electricity consumers in the United States receive their electricity from a vertically integrated utility, meaning an electricity distribution company that also produces or acquires electricity supply on their behalf, and charges the consumer for that power on a tariff that includes production, transmission, and distribution costs in a single bill.

This category includes investor-owned utilities in most states, consumer-owned utilities in nearly all states (usually referred to as electric cooperatives), and municipally owned utility companies. Even those states that have enabled competition in the electric supply sector have generally left the consumer-owned and municipally owned utilities to be vertically integrated, although some states provide them with the option to opt in to competition.

Throughout the country, there is remarkable similarity among these utilities in the way they define customers classes and the way they design rates.

Customer Classes and Subclasses

Utility regulatory statutes generally require that service be provided on a non-discriminatory basis, but the definition of "discriminatory" means only that customers in like circumstances be treated equally. In order to define "like circumstances," utilities (globally) define different customer classes with different rate designs.

In general, small-use residential and commercial customers experience simpler rate designs, and larger users are subjected to more complex rates with more granular components. However, many utilities offer more complex (usually optional) rate designs to small customers to enable them to take advantage of low-cost energy and distribution system capacity during off-peak periods.[1]

Customer classes are defined in two different ways by different utilities. Some define classes by the type of **end use** while others define them by the **character and voltage** of electric service. Table B-1 shows how these compare, although different utilities do classification a little differently. Sometimes these classifications can be confusing; for instance, a small manufacturing facility may be classified as "industrial" in reporting data to the United States Energy Information Administration (EIA), but as "commercial" in determining the applicable rate schedule.

Table B-1

Approaches to Establishing Customer Classes[2]

Function	End-Use	Voltage
Residential	Residential	Residential Secondary
Small Retail or Office	Commercial	Secondary General Service
Medium Retail or Office	Commercial – Demand	Secondary – Demand
Large Retail or Office	Commercial – Demand	Secondary – Demand
Small Manufacturing	Industrial	Secondary or Primary
Large Manufacturing	Industrial	Primary or Transmission
Irrigation Pumping	Agricultural	Secondary or Primary

1 Such as low electric heating rates offered by summer peaking utilities.

2 "Transmission" voltage normally refers to voltages used to transport power to substations, generally above 50kV; "Secondary" normally includes only voltages under 500 V. "Primary" includes various voltages that distribution circuits operate at, including 4kV, 12 kV, 25 kV, and 34 kV.

Table B-2

Illustrative Rates for a Hypothetical Utility							
		Residential	Small General Service	Medium General Service	Primary General Service	XL General Service
Voltage		Secondary	Secondary	Secondary	Primary	Transmission
Customer Charge	$/Mo	$7.00	$10.00	$20.00	$100.00	$1,000.00
Demand Charge						
On-Peak	$/kW	None	None	$10/kW	$15/kW	$10/kW
Off-Peak	$/kW			$10/kW	$5/kW	$2/kW
Energy Charge						
On-Peak	$/kWh	$0.10	$0.10	$0.07	$0.10	$0.095
Off-Peak	$/kWh	$0.10	$0.10	$0.07	$0.05	$0.045

Table B-2 shows illustrative rate designs for a hypothetical electric utility. This shows how the residential and small commercial rate designs are simpler, giving way to more complex rates for larger consumers. For illustrative purposes, it shows time-of-use (TOU) prices for the largest customer classes.

Each of these charges, however, can be tailored in many ways. The customer charge is different by customer class because the facilities and costs associated with providing a connection are different. The demand charges may vary by time of day, season/month, and voltage level of service in order to more precisely assign the responsibility for overbuilding facilities to meet peak period requirements. The energy charges may vary by time of day, season/month, and voltage level of service. For customers who are not metered separately for demand, the energy charge normally recovers costs that for larger customers are otherwise reflected in a demand charge (although many utilities are now seeking to recover these costs in fixed monthly customer charges, as we discuss in Chapter IV of "Smart Rate Design for a Smart Future").

The customer costs that are most commonly reflected in customer charges are the costs for metering, billing, and collection; these are the costs that actually vary with the number of customers served. Some utilities also classify a portion of distribution costs as customer related (as discussed at length in Appendix D), but only a limited number reflect these in the customer charge. Many regulators seek to keep the customer charges low in order to encourage universal service, prevent higher bills for small-use, apartment, and low-income consumers, and encourage energy efficiency by reflecting most costs in the energy charge. As the Idaho Public Utilities Commission stated in a decision:

> *"Customer and minimum charges are not a favored method of collecting utility revenues because they do not track usage."*[3]

Demand charges are most often designed to recover distribution system capacity costs on the basis of the individual customer's highest peak demand during the month. Sometimes they have been used to recover generation and transmission capacity costs. In the past, demand charges have only been imposed on larger commercial and industrial customers. There are several reasons for this. First, until the advent of the "smart meter" it was much more expensive to install meters with demand registers. Second, it is widely recognized that small commercial and residential consumers have individual peaks at different hours but, since they have "diversity" among those loads, it would be unfair to charge each as though their individual peak contributed to the system peak. Third, customer understanding of rates and billing is important, and experience shows that residential and small commercial consumers generally do not understand how demand charges affect them.

Energy charges are usually designed to recover all power supply costs, including both the investment-related costs and the fuel and other operating costs. As discussed below, sometimes these are separated between "base" energy costs and "variable" energy costs. And many utilities are seeking to recover the investment-related power supply costs in fixed charges or demand charges.

3 Idaho PUC v. Washington Water Power Company, Case No. U-1008-234, Order No. 20267, p. 41.

Seasonal and Time-Of-Use Rates

Utilities build their basic infrastructure to serve the energy requirements of consumers. If consumers need power only a few hours a year, a rented generator is a cheap way to provide this; if they need power all year, a utility connection makes sense. But once the decision to install a grid and generation is made, that system needs to be sized to meet the varying day and annual requirements and additional costs are incurred to oversize the system for peak periods. These costs are often recovered in prices that vary through the day or between seasons.

Seasonal rates simply change the prices between seasons. Most utilities have summer-peaking usage, and impose higher rates in summer, while a few, primarily in New England, the Northern Midwest and the Pacific Northwest, have higher loads in the winter months. Seasonal rates can take several forms. In the simplest examples, the energy charges are higher in the peak season. Some utilities have peaks in summer and winter, and have lower costs during shoulder seasons. Illustrative examples of some residential seasonal rates are shown in Table B-3. Some utilities use seasonal variations of demand charges for their rate schedules that include a demand component.

Table B-3

Illustrative Residential Seasonal Rates

Simple Seasonal Rate	
Customer Charge	$7.00
Winter Energy	$0.08
Summer Energy	$0.12

Three-Season Seasonal Rate	
Customer Charge	$7.00
Winter (Dec-Mar)	$0.15
Summer (July-Sept)	$0.15
Shoulder Months (Other)	$0.10

Seasonal rates can be billed by utilities having only simple energy meters; smart meters are not needed for this. It is often necessary to pro-rate usage between the months if the customer's meter reading and billing cycle does not coincide with the dates when the rates change between seasons.

TOU rates are another way to reflect costs that are attributable to peak periods. While TOU rates can be billed without smart meters, it was somewhat expensive to install "interval" meters. As a result, TOU rates for residential consumers were relatively uncommon until the evolution of advanced metering infrastructure (AMI) that consists of smart meters, a data collection system, and a meter data management system. The simplest TOU rates have only two time periods, on-peak and off-peak. The most sophisticated rates change the price every hour; in general, these more complex rates are applied only to the largest industrial consumers.[4] Table B-4 provides an illustration of residential TOU pricing.

Inclining Block Residential Rates

The most common form for residential rates worldwide is the inclining block rate, which provides a limited amount of electricity at a lower price and incremental usage at a higher price.[5] Unlike TOU rates, an inclining block rate

Table B-4

Illustrative Residential Time-Of-Use Rate

Simple TOU Rate	
Customer Charge	$7.00
On-Peak Energy	$0.12
Off-Peak Energy	$0.08

Seasonal TOU Rate	
Customer Charge	$7.00
Winter	$0.08
Summer	
On-Peak	$0.15
Off-Peak	$0.10

Three-Period Rate	
Customer Charge	$7.00
On-Peak	$0.15
Mid-Peak	$0.10
Off-Peak	$0.08

4 Commonwealth Edison (ComEd), serving the Chicago area, is an exception. ComEd has approximately 15,000 residential consumers enrolled in real-time prices that are adjusted every hour based on market conditions.

5 These are nearly universal in India, China, Indonesia, Central Europe, Mexico, and in the Western United States, and also found in many other nations.

design can be implemented without any sophisticated metering or data management system.

There are many cost theories supporting inclining block rates:

- **Load Factor:** High-use customers have more peak-oriented usage (for air conditioning, heating, and other temperature-sensitive uses); therefore, high-use residential consumers are more expensive to serve.
- **Low-Cost Resources:** Utilities have limited low-cost resources, such as hydropower dams, and an inclining block rate allocates the limited low-cost resource equitably to each consumer.
- **Marginal Cost:** The long-run marginal cost of utility service (building a new system) is much greater than the regulated revenue requirement for the existing system; an inclining block rate better reflects long-run marginal cost for incremental usage.
- **Energy Conservation:** A higher rate for discretionary usage will encourage customers with high usage (who have more options to reduce usage) to pursue energy efficiency alternatives.

Inclining block rates can be combined with both seasonal rates and with TOU rates, although the more complex the rate is, the less likely customers are to understand how it affects them. Table B-5 provides examples of illustrative inclining block rates. The second provides a lower rate during the low-use winter season, even for higher users. This provides some bill relief to electric heat consumers who have high usage during the winter.

Table B-5

Inclining Block Residential Rates

Simple Inclining Block Rate	
Customer Charge	$7.00
First 500kWh	$0.08
Over 500kWh	$0.12

Inclining Block / Seasonal Rate	
Customer Charge	$7.00
First 500 kWh	$0.08
Over 500 kWh (Winter)	$0.08
Over 500kWh (Summer)	$0.12

Studies have shown that inclining block rates result in significantly reduced consumption. The lower price applied to the initial block typically affects the usage of only those customers who use only small amounts of power, and these account for a small percentage of total usage so there is very little incentive for customers to use additional power. The higher blocks apply to the customers using the vast majority of total consumption, and encourage them to conserve.[6] A well-designed inclining block rate can be expected to reduce total usage by about 10%, and reduce peak period usage significantly.

Prior to the hearings and determinations required by the Public Utility Regulatory Policies Act of 1978, many electric utilities had declining block rates, which priced incremental usage at successively lower prices, reflecting the economies of scale that existed in the post-WWII era. These have mostly been eliminated, but a few utilities still use this archaic rate form.

An inclining block rate can also be combined with a TOU rate, but it is a little complicated because of the number of variables. In general, the easiest way to do this is to impose either an inclining block rate with a surcharge for any usage during on-peak hours, or an inclining block rate with a surcharge for any usage above the baseline amount. Table B-6 provides illustrations of both of these approaches.

Table B-6

Combining TOU and Inclining Block Rate Designs

Inclining Block with TOU	
Customer Charge	$7.00
First 500 kWh	$0.06
Over 500 kWh	$0.10
Peak Period Surcharge	+$0.04/kWh

TOU Rate with Excess Use Surcharge	
Customer Charge	$7.00
Off-Peak	$0.06
On-Peak	$0.10
Surcharge > 500 kWh	+$0.04/kWh

6 See the following for a detailed analysis of this: Faruqui, A. (2008, August). Inclining Towards Efficiency. *Public Utilities Fortnightly;* Lazar, J. (2013). *Rate Design Where Advanced Metering Infrastructure Has Not Been Fully Deployed* (Appendix A). Montpelier, VT: The Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/6516; and Herriges, J., & King, K. (1994). Residential Demand for Electricity under Inverted Block Rates. *Journal of Business and Economics Statistics.*

Critical Peak Pricing and Peak-Time Rebates

In recent years, many pilot programs involving sophisticated rates designed to encourage customers to reduce usage at critical hours have demonstrated very beneficial results.[7] These generally fall into two categories.

- **Peak-Time Rebates (PTR):** Customers pay the regular rate at all hours, but if they reduce usage below their historical baseline during short periods when the utility system is stressed, they receive a rebate proportional to the lower usage. This requires measuring a customer's baseline, and then comparing actual usage during an extreme event to that historical baseline.
- **Critical Peak Pricing (CPP):** A very high price is in effect for short periods when the utility system is stressed; customers receive discounts in other hours, but pay more during critical hours. The utility informs participating customers when critical peak rates are in effect.

In essence, PTR is a carrot, with no penalty for the customer that does not change usage, while CPP is a carrot and a stick, providing both discounts to customers that reduce usage in critical hours, and higher costs for customers whose usage is concentrated during the critical hours. PTR can be a good way for residential consumers to gain experience with time-varying prices, before they become the default rate design, because they receive a bill credit if they respond by reducing usage in peak periods but are not penalized if they do not.

A typical CPP rate will limit the utility to a limited number (10 to 20) of critical peak events per year, and a limited number of hours (two to four) per event. In this manner, customers choosing this rate are limiting their exposure to high-cost periods. A PTR rate does not require this constraint because the customer bears no risk if they do not respond.

Evidence shows that both of these options can produce reductions during peak periods by as much as 30%. It is also clear that where the response of customers can be automated, for example with radio controls or internet-connected thermostats, the results are enhanced. (For peak period savings from more than 100 different TOU, CPP, and PTR rate experiments, see p. 59 of the main text of "Smart Rate Design for a Smart Future." In general, the CPP rates produce the greatest peak load reduction.)

Table B-7 provides illustrative examples of PTR and CPP residential rates. It is important to note that the "base" rate under CPP is lower because the surcharge during critical hours generates significant revenue toward the revenue requirements, whereas the PTR credit reduces utility revenue.

Table B-7

Illustrative Peak Time Rebate and Critical Peak Pricing Rates

Peak Time Rebate		Critical Peal Pricing Rate	
	$/kWh		**$/kWh**
Customer Charge	$7.00	Customer Charge	$7.00
All kWh	$0.11	All kWh Except CPP	$0.09
Rebate for Critical Peak Reductions	$0.50	Critical Peak Hours	$0.50

Default Rates and Optional Rates

Nearly every utility has a default rate for each customer class that customers receive service under unless they choose an optional rate. In most cases, the default rate is a simple flat or inclining block rate design, and the optional rates are TOU or other complex rates. Because a TOU rate is likely to provide lower bills during the off-peak and shoulder seasons, many utilities require customers to subscribe to any optional rates for a full 12-month period. Some offer a "first-year guarantee" that if the customer's bills on the optional rate exceed the bills they would experience under the default rate, the excess is refunded and the customer is moved back to the default rate. The point of these guarantees is to give customers a risk-free opportunity to respond to the more complex rate design.

An increasing number of utilities are developing optional rates for electric vehicle (EV) charging. EVs are large consumers of electricity, but have batteries and can usually be scheduled into off-peak periods. Experiments are underway to test whether EVs can be used to feed the grid during extreme periods – essentially allowing the grid to use their batteries for power storage.

7 Results from over 100 pilot programs are summarized in Faruqui et al. (2012). *Time Varying and Dynamic Rate Design.* Montpelier, VT: The Regulatory Assistance Project.

Many rate analysts believe that a utility has an obligation to advise customers to change rate schedules or even assign customers to the rate schedule that provides them with the lowest cost service. For example, if a customer chooses an optional TOU rate schedule, but their usage is such that they would pay less on a non-TOU rate, they should be educated. If every consumer were served on the rate that gives him or her the lowest total annual bill, utilities would need to increase rates slightly to cover the higher cost of serving customers, compared with a result in which consumers do not choose the optimal rate.

The optional residential rates for one very large California electric utility are listed below for illustrative purposes; this is a fairly extreme number of optional residential rates. Schedule D is the default residential rate for this utility.

Table B-8

Optional Residential Rate Schedules for Southern California Edison Company

Schedule	Description
D	Domestic Service (Default Rate)
T-CARE	California Alternate Rates for Energy, Domestic Service (Low-Income Rate)
D-FERA	Family Electric Rate Assistance
D-SDP	Domestic Summer Discount Plan
DE	Domestic Service for Utility Employees
DM	Multifamily Accommodation – Residential Hotel – Qualifying RV Park
DMS-1	Domestic Service, Multifamily Accommodation, Submetered
DMS-2	Domestic Service, Mobile Home Park Multifamily Accommodation, Submetered
DMS-3	Domestic Service, Qualifying RV Park Accommodation, Submetered
DS	Domestic Seasonal
ESC-OO	Edison SmartConnect Opt-Out
MASH-VNM	Multifamily Affordable Solar Housing Virtual Net Metering
MB-E	Medical Baseline – Exemption
TOU-D	Time-of-Use Domestic
DOU-D-T	Time-of-UseTiered Domestic
TOU-D-TEV	Time-of-Use Domestic Tiered Electric Vehicle Charging
TOU-EV-1	Domestic Time-of-Use, Electrical Vehicle Charging

Tariff Riders and Adjustment Clauses

Many utilities have multiple tariff riders and adjustment clauses that modify the rates adopted in general rate proceedings to reflect specific costs or specific cost changes that occur between rate proceedings. While the terminology may vary from state to state, we use the term "tariff rider" to describe an adjustment added between rate cases that is rolled into base rates at the time of general rate cases. We use "adjustment clause" to describe an ongoing adjustment that is periodically changed to reflect changing costs between rate cases. For example, a surcharge to recover smart meter costs imposed after they are installed, but before the next rate case, would be a "tariff rider," while a fuel and purchased power adjustment mechanism, where the price is modified every month to reflect changes in the market, would be an "adjustment clause."

Tariff riders and adjustment clauses are unpopular with consumers and consumer advocates for several reasons:

- They only tend to track costs that are rising; utilities carefully do not request riders or adjustment mechanisms for costs that decline between rate cases. There is no offsetting of declining costs against rising costs as there is in a general rate case.
- They make the rates confusing: customers cannot see the "effective rate" by looking at the tariff. However, this can be adjusted by periodic publication of "effective rates" that combine all adjustments to show how much a customer can save if they reduce usage.
- They reduce the utility's risk without any reduction in the allowed rate of return.

For an example of an illustrative inclining block rate design with multiple tariff riders, adjustments, and taxes, see Table 11 ("Customer Adjustments") on p. 74 of "Smart Rate Design for a Smart Future." Note that at the bottom, it shows how they all combine into an "effective rate" that could be printed on the bill to educate consumers about the cost of incremental usage.

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