State and Local Climate and Energy Program

State Energy and Environment Guide to Action:
Customer Rates and Data Access

2022

Table of Contents

Preface and Acknowledgments

The U.S. Environmental Protection Agency (EPA) *State Energy and Environment Guide to Action* offers real-world best practices to help states design and implement policies that reduce emissions associated with electricity generation and energy consumption. First published in 2006 and then updated in 2015, the *Guide* is a longstanding EPA resource designed to help state officials draw insights from other states' policy innovations and implementation experiences to help meet their own state's climate, environment, energy, and equity goals.

As part of the 2022 update, each chapter reflects significant state regulatory and policy developments since the 2015 publication. *Guide* chapters provide descriptions and definitions of each featured policy; explain how the policy delivers energy, climate, health, and equity benefits; highlight how states have approached key design and implementation issues; and share best practices based on state experiences.

Unlike earlier *Guide* editions, which were released as a complete set of chapters comprising a single document, the 2022 update is being released in phases of collected chapters. This chapter is one of seven addressing state-level utility policies that support clean energy and energy efficiency:

- Overview of Electric Utility Polices
- Electricity Resource Planning and Procurement
- Electric Utility Regulatory Frameworks and Financial Incentives
- Interconnection and Net Metering
- Customer Rates and Data Access
- Maximizing Grid Investments
- Energy Efficiency Programs and Resource Standards

Guide chapters are available online on the *Guide to Action* webpage.

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Policy Description and Benefits

Summary

Customer electricity rates and data access polices can enable significant climate, environmental, health, and financial benefits, including reduced power plant emissions, lower consumer electricity bills, and the avoidance of costly power system expansions. These benefits are achieved by creating rates that accurately reflect the cost of generation, which provides incentives for customers to adjust whether and when they use electricity and to adopt distributed energy resources (DERs) like rooftop solar. DERs are electric generation, demand response, or energy storage systems located on the distribution system, typically close to load, used individually or aggregated to provide more value.

Rate design creates customer incentives around overall energy use, time of energy use, and technology investment decisions. Data access gives customers the opportunity to respond to those incentives. Rate design and data access affect the environment by shaping the demand for electricity and influencing the investment decisions in new generation, transmission, and distribution infrastructure and distributed energy resources.

Customer data access, which is enabled by grid-integrated smart meters, is fundamental to achieving the benefits of rate design because it provides customers, utilities, and grid operators the data necessary to identify opportunities for cost savings.

This chapter describes state experience in setting utility rates and increasing access to customer energy use information to enable customers to use energy more efficiently and adopt DERs that reduce emissions and provide other benefits. DERs include electric vehicles, battery storage, rooftop solar photovoltaic (PV), energy efficiency, and demand response. The chapter focuses on residential rate types and customer data policies, but also discusses some rate designs and policies applicable to commercial or industrial sectors, including time-varying rates (TVRs), demand charges, and barriers to data access. The chapter does not explain the ratemaking process, which is a very broad and complex topic, nor does it cover all possible rate designs and data access policies. Rather, this chapter reviews common and promising customer rate designs that have contributed to measurable environmental and other benefits, including time-of-use (TOU) and real-time pricing (RTP), which are types of TVR. This chapter also discusses how data access policies can lead to energy savings and emissions reductions, for example through building benchmarking. The following are examples of action steps states use to realize these benefits:

- Evaluate existing rate design structures. Engage stakeholders across the industry, customer classes, and communities to assess whether rates are transparent and equitable, accurately reflect costs, and provide stable revenue to the utility.
- Review and implement TVR programs that are aligned with state objectives. State and utility policies to adopt TVRs may be considered a good practice for meeting multiple energy, cost, and environmental benefits.
- Support deployment of advanced metering infrastructure (AMI). Leverage its use for rate design and energy efficiency to enable full benefits.
- Develop frameworks to aggregate and anonymize customer usage data. Develop approaches to data access that generate benefits without compromising customer privacy.
- Integrate energy efficiency and demand response programs and align those programs with rate design changes. These programs help offset the effect of increased rates with energy savings.

- Measure results and report progress. States can track and evaluate AMI deployment, establishment of and compliance with data protection and privacy policies, participation in new rate designs, customer satisfaction with rates, energy burdens of customer groups, and the load impacts of customer rates.

These and other action steps for states are discussed in more detail in the Action Steps for States section in this chapter, which is followed by highlighted examples of customer rate and data access policies in California, Oklahoma, and Minnesota.

Benefits

Well-designed customer rates and data access policies can provide benefits to the energy system, customers, and society. Customer rates and data access policies offer these benefits when they effectively reduce overall load and/or shift customers' electricity consumption away from peak periods to sufficiently reduce the electricity system peak load. Policies designed to incentivize DERs and reduce peak electricity load, with sufficient adoption and strategic use, can significantly reduce fossil-fired power plant operations and resulting air emissions at the site of peaking generation units. When these policies reduce demand and mitigate utility risks and costs, they ultimately benefit utility ratepayers. Customer benefits can include bill savings and reduced energy burdens. Societal benefits can include improved energy resilience, substantial environmental and public health benefits from emissions reductions associated with reduced peak demand. Rate design and data access policies can support equity if the policies lower demand sufficiently to reduce the operation, and thus emissions, from fossil fuel power plants located near people of color, low-income households, and indigenous communities. This section expands on many of the benefits of customer rates and data access policies and identifies tools to quantify and communicate the benefits.

Electricity System Benefits

Customer rates and data access policies have the potential to accelerate energy-saving practices and clean energy adoption. Research (discussed in the Current Landscape section in this chapter) has shown that many customers respond to rate signals and leverage information on their past electricity usage by installing energy-efficient products and technologies, using their technologies to generate or store energy at strategic times, and modifying their energy practices. Customer responses of lower overall use and modified electricity consumption patterns result in lower overall demand on the utility grid and avoided or reduced peak demand. Lower and more flexible electricity demand patterns can lead to reductions in fossil fuel-based electricity generation. However, customer rates and data access policies alone may not be sufficient to have meaningful impacts. To realize the full benefits of effective rate design and data access policies, they need to be paired with automating or enabling technology. For example, programable thermostats can automate customer responses and allow customers to "set it and forget it." These types of technologies and complementary utility strategies allow customers to easily understand the information on electricity usage data and rate signals and leverage it in a timely manner. Studies have shown that when customer rates and data access policies and technologies are paired together, they can result in a larger reduction in peak demand and flexible demand patterns, which can significantly and cost-effectively reduce the negative impacts of the electricity system (RAP and Brattle 2012). When aggregated together, some DERs help grid operators balance supply and demand in real time (AEE 2018).

The potential electricity system benefits of customer rates and data access policies include avoided or deferred resource costs (including centralized power generation capacity and, to a lesser extent, transmission and distribution capacity), reduced wholesale market prices, greater fairness in retail pricing (i.e., improved alignment between the costs that customers add to the system and the amount they are billed), and incentive for customer adoption of DERs (RAP and Brattle 2012). To the extent customer peak load reductions and DER investments meet capacity needs, they also benefit ratepayers by reducing the utility capacity costs; for example, for investment in new fossil power generation infrastructure (NARUC 2016).

Customer Benefits

As described, customer rates and data access policies can directly influence DER investment or can be paired with DER programs to accelerate adoption. Rate design policies that accelerate DER adoption and energy-saving practices generally result in customer bill savings. Rate designs can encourage commercial or industrial DER investment and help those customers manage their peak demand and reduce demand charges. Customer benefits of DER can also include increased electricity reliability and resilience during utility grid outages if the customer host's system allows it to use the electricity it generates onsite directly.

Environmental and Health Benefits

Customer rates and data access policies have the potential to reduce the negative impacts of the electricity system, and in particular the environmental impacts of changes in load. For example, customer responses to TOU rates avoided an estimated 12,800 tons of carbon emissions from an 8 percent peak load reduction for a California municipal utility (APPA 2020). A Colorado municipal utility avoided over 15,800 metric tons of carbon emissions through TOU rates by lowering peak electricity use by 7.5 percent compared to the previous year. The environmental benefit of changes in load depends on how customers respond to rate signals and the time- and region-specific grid conditions (e.g., marginal emission rates). As states and utilities continue to transition their baseload power generation resources away from higher emitting fuel sources and incorporate more DERs, the environmental benefits of rate design and data access policies may also increase.

Customer rates and data access policies can reduce the negative impacts of the electricity system, which include, air and water pollution, land development, and wildlife impacts. Many of the power system's environmental impacts, which can be reduced through rate design and data access policies, are regulated by state, local, and federal law and have significant legal and financial implications for generators and energy developers. In general, the environmental effects, which vary depending on how and where the electricity and its fuel supplies are generated, delivered, and consumed can include the following:

- Emissions of greenhouse gases and other air pollutants, especially from fuel combustion and gas pipeline leakage
- Water consumption for functions to produce electricity or steam, provide cooling, or extract natural gas (fracking)
- Pollution discharges into water bodies, including thermal pollution
- Solid waste production, such as hazardous coal ash
- Land clearing and development for fuel production and siting of fossil-fired and utility-scale renewable power generation and transmission or distribution infrastructure
- Impacts to air, water, waste, and land, that could affect plants, animals, or ecosystems

Some of the environmental effects can harm human health, particularly if they result in people being exposed to pollutants in air, water, or soil. Customer rates, data access, and complementary energy efficiency and DER programs help to avoid or reduce the use of fossil fuels and resulting local criteria air pollutants. Local air pollution reduction can enhance public health by reducing incidences of premature death, asthma attacks, and respiratory and heart disease; avoiding related health costs; and reducing the number lost days from school or work due to illnesses. Effective rate design and data access policies can increase the effectiveness of energy efficiency measures, which research has demonstrated improves air quality, which leads to better health outcomes (Abel et al. 2019). EPA tools to estimate the emission reductions and health co-benefits are highlighted in the following sections.

Equity Benefits

Rate design and data access policies can benefit communities where traditional fossil fuel power plants are located, pollution rates are higher, low-income energy burdens are greater, and where efficiency programs have had lower levels of implementation (NAACP 2017). Rate designs that target peak load through DER adoption or incentivizing behavior changes can reduce energy burdens by lowering the proportion of household income spent on energy bills.

Features of rate design and data access polices can also be tailored to meet the unique needs of underserved communities. For example, due to landlord-tenant split incentives or high upfront costs, low-income rental customers may not be able to replace old inefficient appliances with new smart appliances that can operate at different times or intensities in response to prices in TVRs. In addition, renters may be on a lease with the utilities included. While those types of terms can make energy more affordable, they make it hard for the customer to be accepting or responsive to energy efficiency and rate design programs. Understanding the specific needs of underserved communities and incorporating their needs into policy design and program implementation can help ensure that programs are tailored to reach customers and serve their needs.

Quantifying and Communicating the Benefits

Environmental regulators, state energy office officials, consumer advocates, utilities, and utility regulators (called in some states a public utility commission or public service commission) all have their own roles in shaping and implementing rate design and data access policies, and each group has different interest in the impacts of these policies (for more on participants and their roles, refer to the Participants section in this chapter). To help states and stakeholders analyze and quantify these impacts, EPA has a range of tools highlighted in the text box.

State air agency staff may focus on how demand response and load shifting can lessen environmental impacts by reducing emissions and contribute to meeting each jurisdiction's air quality goals. EPA's AVoided Emissions and geneRation Tool (AVERT) can be used by state energy office and air office staff to evaluate the changes in emissions related to time-varying rates, peak reduction, demand response, or other targeted energy policies. EPA's Co-Benefit Risk Assessment (COBRA) model can then be used to evaluate and quantify the health impacts of these emissions changes. With these tools, state environmental regulators can quickly and easily evaluate the impacts of one or more policies (such as rate design) and their associated changes to load and emissions at different temporal (hourly to annual) and spatial (county to region) scales. Rate design and data access can lower bills for disadvantaged communities that may suffer from high energy burdens, and accessing, analyzing, and quantifying those impacts can enable utilities to better serve their customers in need. Each jurisdiction conducts cost benefit assessments for their programs differently.

Understanding the benefits and how to quantify those benefits enables stakeholders to develop, implement, and justify programs and policies like rate design and data access. For jurisdictions that consider or account for health benefits in their decision-making processes, EPA's COBRA tool and health benefits per kilowatt-hour (BPK) values give health officials, utilities, and utility regulators the ability to quantify and monetize the health benefits of demand reduction from rate design policies. Utilities and utility regulators can use the BPK values to incorporate the public health benefits of power generation into customer rate design. For example, an analysis of BPK applications from the Regulatory Assistance Project suggests ways BPK values can inform the setting of off-peak rates, TVRs, and rates used to incentivize economic development (RAP 2021).

EPA Environmental Impacts and Health Benefits of Clean Energy Tools

EPA has a range of free tools available to support states and stakeholders with analyzing and quantifying the environmental impacts and health benefits of clean energy, including but not limited to the following:

- **AVoided Emissions and geneRation Tool (AVERT)** is a tool designed to meet the needs of state air quality planners and other interested stakeholders. Non-experts can use AVERT to evaluate county, state, and regional emissions displaced at fossil fuel power plants by policies and programs that support efficiency, clean DER, and utility scale renewable energy.
- **CO–Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool** is a tool that helps state and local governments estimate and map the air quality, human health, and related economic benefits of clean energy policies and programs at the national, state, and county levels. Analysts assessing the impacts of changes in rate design can enter corresponding changes in emissions from the electric utility sector and use the results from COBRA to inform cost-benefit analyses and other decision-making processes.
- **Health Benefits Per Kilowatt-Hour (BPK)** is a set of values that help state and local government policymakers and other stakeholders develop screening-level estimates of the outdoor air quality-related public health benefits of investments in energy efficiency and other clean DER. The Regulatory Assistance Project provides additional information on how BPK values can be used in setting rates (RAP 2021).
- **Energy Savings and Impacts Scenario Tool (ESIST)** is a customizable and transparent Excel-based planning tool for analyzing the energy savings and costs from customer-funded energy efficiency programs and their impacts on emissions, public health, and equity. ESIST enables users to develop, explore, and share energy efficiency scenarios between 2010 and 2040.
- **Emissions & Generation Resource Integrated Database (eGRID)** is a comprehensive source of data on environmental characteristics of electric power plants in the United States. The interactive eGRID Explorer dashboard offers data, maps and graphs on electric power generated, emissions, emission rates, heat input, resource mix and more.
- **Quantifying the Multiple Benefits of Energy Efficiency and Renewable Energy** describes methods, tools, and steps analysts can use to quantify these benefits so that they can compare costs and benefits and comprehensively assess the value of energy policy and program choices.

In addition to tools, EPA offers the detailed resource Quantifying the Multiple Benefits of Energy Efficiency and Renewable Energy: A Guide for State and Local Governments (EPA 2018). Also, EPA's ENERGY STAR program supports state and local governments in communicating the value streams of efficiency under three pillars: enabler of growth, mitigator of risk, and protector of the public good, and offers resources to harness the power of storytelling (EPA n.d.).

Current Landscape

Utility rates are the outcome of a complex process that must consider multiple objectives, laws, and available information and technology. Commonly there are three main priorities: 1) ensuring the utility collects enough revenue to cover its costs of service, 2) fair apportionment of utility costs among customers with fair and equitable rates, and 3) economic efficiency. Other regulatory and legislative goals may include providing stable revenues for the utility and stable rates and bills for customers, simplifying the understanding and ease of implementation, encouraging effective load management, promoting equity, and reducing negative environmental impacts through rates that encourage reduced energy use and lower emissions. State utility regulators establish rules for rates and rate designs, which can vary by jurisdiction, type of utility, and customer class. Policymakers affect customer electricity bills in many ways, both directly through rules on rate design and fixed charges, and indirectly by implementing other policies, such as rules on data access and energy efficiency, climate, renewables, electrification, as well as approving large capital expenditures such as environmental cleanup and early plant retirement.

Customers' monthly electric bills are usually comprised of multiple components that allow utilities to recover their costs and provide the utility a rate of return. The two most prominent components of residential rate design are the usage rate cost, or the volumetric charges that vary with the customers' monthly electricity consumption, and basic or fixed charges, which are a set dollar amount that customers cannot control by their usage patterns. Energy efficiency and demand response can play a major role in reducing the volumetric portion of customer bills. Pairing energy efficiency programs with the rollout of new rate designs, especially for low-income and underserved customers, is one way to mitigate the impact of higher rates, for example at peak times of day, and thereby reduce the risk of higher bills.

Rate design shapes the value of energy efficiency. If a utility seeks to recover more of its cost through fixed charges and recover less of its cost in volumetric charges, then each kilowatt-hour (kWh) saved by energy efficiency is worth a little less. A rate design with low or no fixed charges and only volumetric charges gives customers more control over their bills, by allowing customers to adjust their energy usage. Investments in energy efficiency and other clean DER that are cost-effective under one rate design with low fixed charges may not be cost-effective under a different rate design with high fixed charges. As a result, state and utility policy on rate design has a significant effect on the value and uptake of energy efficiency. If fixed charges are increased disproportionately relative to volumetric charges, a customer rate may work against state energy efficiency and emissions targets. From 2014 to 2016, in response to declining revenues and sales, electric utilities in at least 34 states proposed rate design changes that increased the monthly fixed charges, some by 100 percent or more (LBNL 2016a).

Utility regulators play an important role in ratemaking. They determine which costs incurred by a utility can be recovered through customer rates or other means, which influences what customers ultimately pay. Customer rates are designed to recover utility expenses and investments, which typically include but are not limited to utility resource procurement, asset decommissioning, grid maintenance, responses to natural disasters, and expenses resulting from the global pandemic. State regulatory bodies' authority in ratemaking includes setting the amount of revenue a utility may earn, allocating costs among customer classes, and designing customer price or structures (RAP 2016).

State policies and utility regulators also play a key role in accelerating energy efficiency and clean energy adoption by improving customer data access. For example, states can direct and support the roll-out and use of AMI and smart meters. Data access policies continue to advance, such as those that make it easier for customers to provide data to third-party service providers. AMI, which is a utility-owned two-way communication system that connects customer-site meters to utility-side meter data management and billing software, and smart meters, which have other advanced capabilities, enable utilities and customers to better understand energy use patterns and supports demand response, distributed generation, storage, and the implementation of many rate designs, including TVRs. EIA reports that 95 million AMI are installed in the United States, which represents over 60 percent of the nation's electricity meters (EIA 2020). AMI paired with customer systems and responses can provide substantial benefits for the grid, customers, and utilities, including reduced costs for metering and billing; greater customer control over electricity use and bills from greater use of new customer tools and behavior changes; lower customer bills; and lower utility capital expenditures (DOE 2016a). Duke Energy based in North Carolina, for example, currently uses AMI data for customer bill calculations and system planning, as well as outage responses (Duke n.d.). Some advantages offered to Duke Energy customers through AMI deployment include access to new energy services such as 'Pick Your Due Date and Usage Alerts' and the capability to frequently access daily usage data.

Cost and data security can be barriers to AMI deployment, but comprehensive state policies can accelerate the uptake of AMI while ensuring the customer data security. For example, the New Jersey Board of Public Utilities (NJ BPU) in 2021 approved Public Service Electric & Gas (PSE&G's) Energy Cloud AMI program that includes $778 million to install approximately 2.2 million electric smart meters. This regulatory approval followed a public work session to provide education on AMI, explain the value of data access, and present a framework for data privacy (NJ BPU 2020). The NJ BPU approval included stipulations to set up a separate docket for assessing customer data access issues. This stipulation is aimed at ensuring achievement of AMI's full potential in PSE&G's service area for both the ratepayer and the utility (NJ BPU 2021).

Some state policymakers are working on helping third parties gain access to the electricity data needed to provide targeted services, particularly for multifamily housing and building benchmarking policies. Green Button[1] is a U.S. Department of Energy (DOE)-supported initiative that helps provide customers with easy and secure access to their energy usage data in a common, customer-friendly, and machine-readable format. This tool addresses data access, privacy, and security issues while making it easier for customers to give access to energy efficiency program administrators and clean energy developers. Although policies that make it easy for customers to share their data with third parties are generally widely supported, some stakeholders have objected to policies that give third parties access to data without customers' permission.

Types of Utility Rates

This section describes common and promising rate structures, focusing primarily on the residential sector, and their benefits and risks for clean energy and equity. This section also discusses the role of energy use data, and related privacy protections.

Ratemaking issues and the types of utility rates available are often closely tied to the structure of the state's electric regulatory authority. States regulate supply and delivery of vertically integrated investor-owned utilities (IOUs). Utility regulators are responsible for rate oversight and approval for IOUs, and some cooperatively and municipally owned utilities. If not under regulatory oversight, local boards oversee cooperatively and municipally owned utilities. Some states have restructured retail electricity markets where the utility supply has been deregulated and is now separate from the delivery company. In some restructured states, retail electricity choice is available for industrial, commercial, and residential customers to choose their generation suppliers directly in a competitive market.[2]

In "retail choice" states, competitive energy suppliers can set their own generation rates, and customers can decide to buy their electricity from among the participating energy suppliers. The electricity is still delivered by the local utility, but suppliers can differentiate themselves to customers through various rate and technology options such as period of the contract, variable or fixed rates, and amount of renewable energy (e.g., suppliers may procure more of their supply from clean energy resources in response to customer interest to prevent customers from seeking alternate electricity providers). Utilities in retail choice states often have exit fees.

In retail choice states, the local regulated utilities act as a backstop, serving as the provider of last resort (POLR) if the customer has not yet identified a service provider or the alternative energy supplier leaves the market for any reason (NREL 2017a). Utility regulators still have authority over the POLR "default service" energy supply rates.[3] Utility regulators in retail choice states also retain authority over other components of rates, such as electricity delivery charges and collection of public benefits funds.

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[1] As of 2022, customers can download their electricity use and cost data from EPA's ENERGY STAR Portfolio Manager in Green Button format. Though Portfolio Manager does not currently offer the ability to upload Green Button files into Portfolio Manager, EPA is actively monitoring the development of the Green Button standard and certification programs, and is exploring future opportunities to expand Portfolio Manager's connections with Green Button.

[2] For more information on retail electricity choice and states' status, see the Electricity Utility Policies Overview chapter of the *Guide* or "An Introduction to Retail Electricity Choice in the United States" (NREL 2017a).

[3] The state of Texas does not have a default service option. Customers must choose a power provider but the Public Utility Commission of Texas has designated a POLR for each region.

Table 1 summarizes nine common types of rate designs and highlights whether each design focuses on a customer's net usage or focuses on generator output. The subsequent section provides additional discussion on each of these customer rate types and their potential impact on customer bills and DER adoption.

Table 1: Summary of Rate Designs

Rate Form	Description and Goal of Design	Metric Used
	Energy Consumption Rates	
Flat Rates	Simplest form of energy rate, consisting of a fixed (i.e., "flat") price for every kWh consumed regardless of when it is consumed or how much energy is consumed. Historically favored because of its simplicity and because of limitations of analog electric meters.	Total customer usage
Inclining Block Rates	The per-unit price of energy increases with usage. They promote reducing monthly energy usage and provide bill reductions for consumers with smaller overall usage.	Total customer usage
Time-Varying Rates	The per-unit price of energy varies in time to reflect fluctuating generation costs. Rates may be seasonal and change by the minute, or may be pre-set for two to three blocks of time per day. TVRs promote consumer decisions that help lower grid costs and impacts by providing prices to customers that reflect the time-varying cost of energy.	Customer usage during each pre-set time intervals of a day
Demand Charges	Demand charges are common for industrial and larger commercial customers but uncommon in residential rate structures. Customers pay an additional fee based on their highest usage over a set time period. Demand charges incentivize peak demand reductions and can mitigate the need for utilities to add expensive new system capacity if the time period coincides with the system's peak demand.	Customer usage during short time interval
	Technology-Targeted Rates	
Standby Rates	A combination of fixed and per-unit charges that compensates the utility for having equipment ready and electricity available to serve a customer when needed to provide non-emergency backup for the customer's DER.	Based on the potential customer need if primary generator goes offline
Net Metering	A per-unit credit that compensates customers for entire generation output at retail rates, which are equivalent to their energy consumption rates, in the form of a monthly kWh credit for net generation transferred to the grid.	Net customer usage
Buyback Rates (Feed-in Tariffs)	A per-unit credit that, unlike net metering, distinguishes the value of customer-installed generation from the customer's energy consumption rates. It compensates the customer for all generation output, or for excess generation (i.e., that which is not consumed by the customer at the time of generation), at a specified rate that is different (lower) than the customer's energy consumption rate.	Generator output
Electric Vehicle Rates	Provides time-of-use rates that incentivize off-peak charging, sometimes part of a plan that contains a monthly fee.	Customer usage during pre-set intervals
Exit Fees	Can be associated with any rate structure. Commonly associated with a standby rate. A fixed fee that allows the utility to charge customers for costs previously incurred by the utility even if the customer no longer requires grid service. Adds a disincentive for customers to depart from the grid.	Fixed fee

Energy Consumption Rates

Energy consumption rates charge customers for the amount of energy they use. While typically designed to meet the general ratemaking objectives, these rates can also incentivize energy efficiency and clean energy in a variety of ways. For example, rate structures can encourage conservation by being more expensive per kWh as usage increases, or they can encourage shifting electricity consumption to times of day when clean energy is abundant by charging less per kWh during those hours.

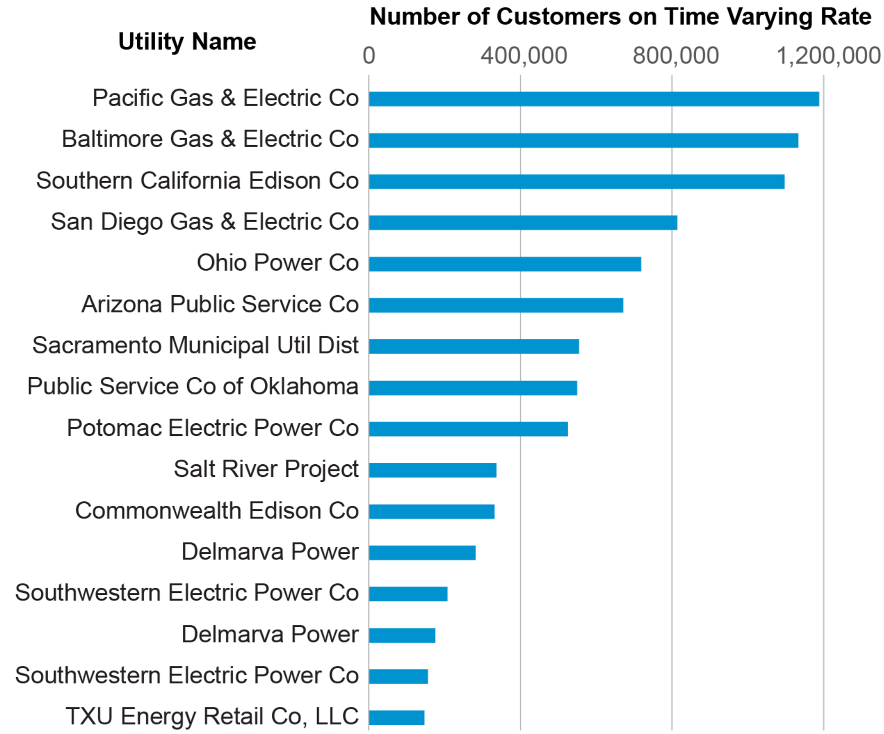
- ***Flat rates.*** Flat rates charge customers solely based on the total kWh of electricity they consume. These per-unit rates do not vary by the time that energy is used, nor do they rise or fall depending on total amount of consumption. Flat rates are typically limited to residential and small commercial customers. Customers could realize cost savings if they adopt energy storage, energy efficiency, or distributed energy resources, but flat rates do not necessarily incentivize the customer to adopt these technologies and practices in a manner that maximizes cost savings and environmental benefits across the electricity system.
- ***Inclining block rates.*** Under this commonly used rate form, the price per unit of electricity or natural gas increases with higher usage. Inclining block rates offer the advantages of being simple to understand and simple to meter and bill. Inclining block rates can also meet the policy goal of protecting small energy users. For example, San Diego Gas & Electric in California, which refers to its block rates as tiers, offers a two-tiered plan where the customer pays the lowest rate for each billing cycle until they reach 130 percent of their baseline energy use, which triggers the next tier's higher prices (SDGE n.d.). For larger users, inclining block rates offer a stronger price signal for energy efficiency and clean energy than a simple flat rate. In contrast, some utilities offer a declining block rate structure for their largest customers, in which the first block of usage is billed at a higher rate than subsequent usage. The declining block rate effectively provides a volume discount and, as such, it may disincentivize conservation, energy efficiency, and distributed generation.
- ***Time-varying rates.*** TVRs represent a relatively small but growing market share in the United States. A TVR varies by the hour the electricity is used and reflects higher costs of providing electricity service during peak periods in the day. With clear communication, TVRs encourage customers to use less electricity during peak periods when the strain on the grid would increase and utilities would turn on more expensive, fossil-fired peaking plants to meet the peak demand. There are many TVR designs, as discussed next. Utilities are increasingly deploying TVRs because of their demonstrated electricity system benefits. TVRs create incentives for greater load management, energy efficiency, DER adoption, and transportation electrification. Forms of TVRs have existed for decades, but they have historically been limited to large commercial and industrial customers. More recently, access to detailed customer energy data through the implementation of AMI has enabled small commercial and residential customers to participate in TVRs. To date, utilities across the nation have enrolled millions of customers in TVRs, as illustrated by Figure 1. Different forms of TVRs are described in the following list:
  - *Time-of-use rates:* TOU rates differ by season, month, and/or time of day. Generally, TOU rates for natural gas will only vary by season or month, while TOU rates for electricity will typically vary by season and by time of day. These higher "peak" and lower "off peak" prices in each season are pre-established in utility tariffs. TOU rates allow utilities to offer prices to customers that can better match the utility's supply costs. High price signals during peak times can reduce demand, reducing the need for utilities to build additional generation capacity or operate less efficient peaking units. Also, compared to flat rates, TOU rates can provide larger economic incentives for DER to provide higher output during times of higher utility costs and prices. Access to energy usage data and pricing information is important for customers who are on TVRs. TOU is the simplest and most common TVR for residential customers, with over 330 utilities offering this rate design and over six million residential customers enrolled in 2019 (EIA 2020).
  - *Real time pricing rates:* RTP rates typically vary hourly according to the wholesale market prices of electricity that the utility must pay. Similar to TOU rates, RTP rates encourage energy use during low-priced hours and discourage energy use during high-priced hours. Of all TVRs, RTP requires the most instantaneous customer communication to allow customers to respond to hourly changes. Customers

may wish to be notified by phone, text, or email throughout the day. A complex TVR design, RTP is among the least common for residential customers with 11 utilities offering this rate type and just under one million residential customers enrolled in 2019 (variable peak pricing or VPP, offered by only six utilities, is even less common than RTP for residential customers) (EIA 2020).

- *Critical Peak Pricing (CPP) rates and peak time rebates (PTRs):* With CPP, the utility can raise rates for a limited number of hours during the most grid-stained hours of the year. PTRs offer large credits for customer energy use reductions in response to system needs or high market prices during peak periods. CPP rates and PTRs, like RTP rates, rely on communication technology with customers. In 2019, 33 utilities offered CPP and enrolled over three million customers on this rate type (EIA 2020).

Hundreds of utilities across the United States offer some form of TVR to their residential customers. Figure 1 shows the utilities with the highest number of enrolled customers, collectively accounting for about 80 percent of the nearly eleven million total, including residential, commercial, and industrial customers, enrolled in a TVR in 2019 (EIA 2020).

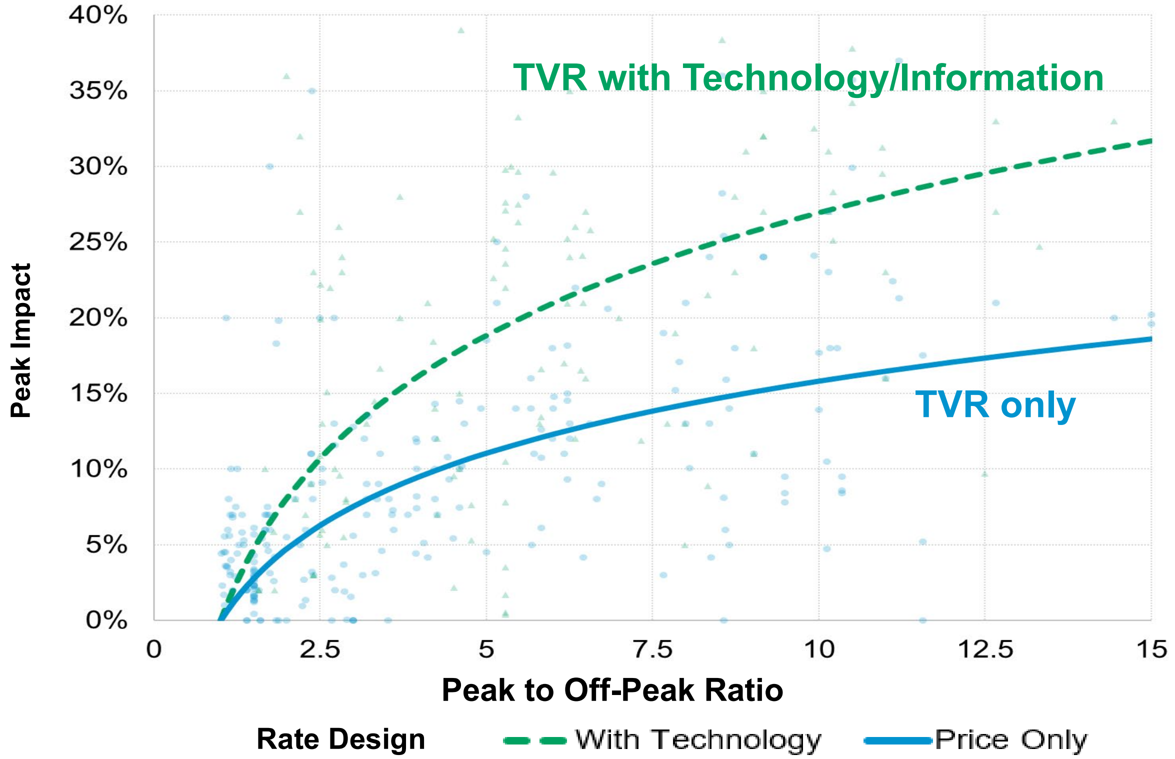
Figure 1. Utility Customers Enrolled in Time-Varying Rates in 2019



Source: (EIA 2020)

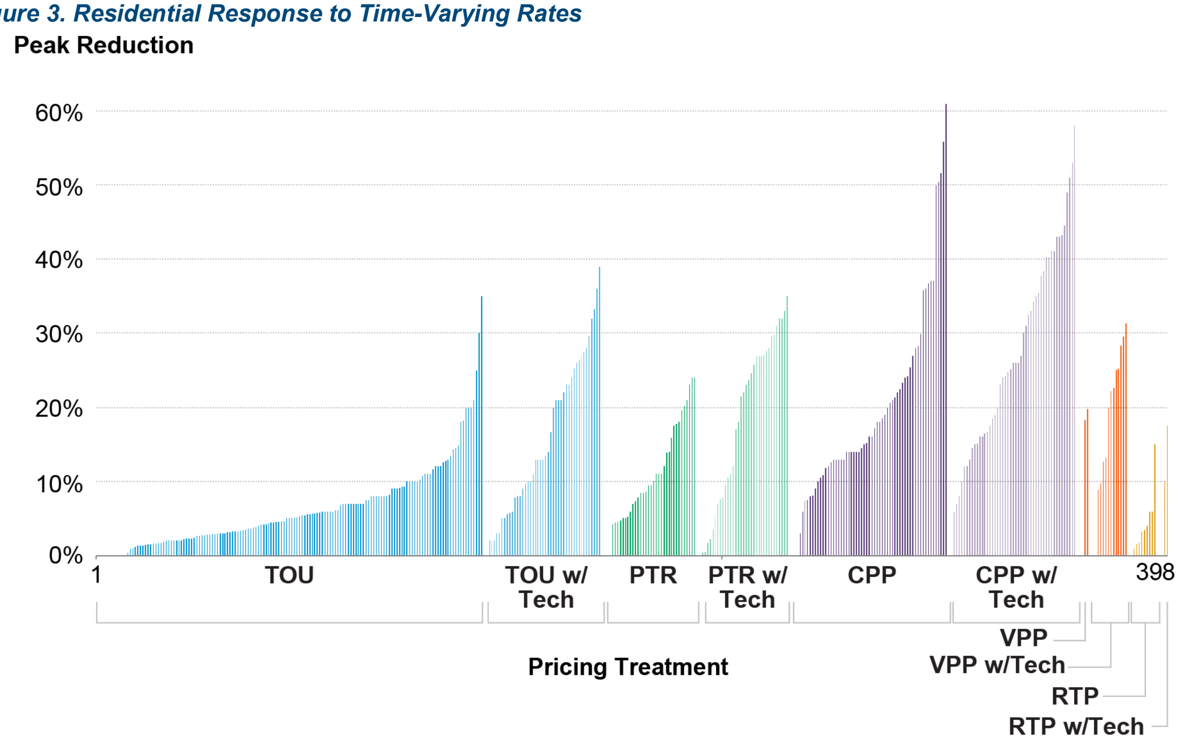
Empirical data consistently shows that customers are responsive to changes in energy consumption rates (ACEEE 2017). Research on dozens of TVR pilots and hundreds of individual treatments, as summarized in Figure 2, demonstrate significant peak reductions achieved from TVR designs. The research also showed that the response is greater when the customer on the rate design had additional technologies or information to respond to the price signal (Brattle 2021). Figure 3 compares peak reductions achieved by different types of TVR.

Figure 2. Impact on Peak Demand of Customer Response to Rate Design



Note: Data from 74 pilots and programs and 387 individual treatments. RTP treatments are excluded.
Source: (Brattle 2021)

Figure 3. Residential Response to Time-Varying Rates



Note: Results from 79 pricing pilots and programs and 398 individual treatments in the Arcturus database.
Source: (Brattle 2021)

Other studies of utility TVR programs indicate that impacts are neutral or positive, including impacts on vulnerable residential customers such as low-income households, households with older adults, or households with people who are chronically ill (Brattle 2020); (LBNL 2016b); (IL CUB 2017). So far, utilities have found that most customers remain on the TVR structure they have been defaulted into rather than asking to revert to their previous structure.

States can mitigate concerns about potential bill increases by offering customers the choice to opt out or by guaranteeing that customers will not pay more than on their old rate structure. For example, the California Public Utility Commission (CPUC) provides a 12-month guarantee that a customer will never pay more than they would have under the old rate design if they switch to TOU rates. To facilitate the evaluation of potential changes to customers' bills, CPUC offers to provide an estimate of a customer bill for a given usage on a TOU rate and the standard rate to enable a comparison (CPUC 2018b). In Oregon, Portland General Electric (PGE) provides a similar offer to calculate comparison estimates for customers. PGE also provides a bill protection guarantee that a TOU customer's energy charges will not go up by more than 10 percent in the year after enrollment (PGE n.d.).

The following summaries highlight some TVR programs and describe their outcomes.

- A study of TOU rates among Maryland's IOUs found that low- and mid-income- (LMI) customers and non-LMI customers saved an average of 5–10 percent on their bills after switching to the TOU structure over the course of a year. Demand reduction in response to the high-price times was sizeable for all customer types (Brattle 2020).
- A study on CPP rates in Green Mountain Power (VT) and Sacramento Municipal Utility District (CA) found that vulnerable groups (elderly or chronically ill) as well as nonvulnerable groups benefit financially from the pilot rate over a time period that included two summers (LBNL 2016b).
- ComEd, which serves customers in Illinois, is one of several utilities offering RTP with large price differentials between low and high price times. The prices are varied hourly for ComEd's hourly pricing program based on wholesale price signals, and customers can access online management tools in addition to viewing the previous day's hourly usage. An analysis by the Illinois Citizens Utility Board and the Environment Defense Fund conducted on anonymous usage data from 344,717 ComEd customers (approximately 10% of the company's residential customers) from prior to the implementation of RTP indicated an estimated average savings of 13.2 percent with RTP, without any behavioral change (IL CUB 2017). The study found that overall, the price savings and small percentage of customers with negative savings were found to be evenly distributed across income levels and zip codes. The study found that 97 percent of the customers would have saved some money by participating in ComEd's hourly pricing program. After RTP implementation, ComEd reported for the "Hourly Pricing" 2020 program year that it had 37,486 participants whose median annual bill savings was $120, or 11 percent, relative to ComEd's fixed price rate structure (ComEd 2021).
- Arizona's second largest utility, Salt River Project (SRP), offers three TOU rates and has enrolled about a third of its customers in one of them. SRP's peak-to-off-peak rate ratios range between 1.4 to 2.9 depending upon the defined peak and off-peak durations. SRP also offers a 90-day bill protection plan: if the customer's first three bills are higher than what they would have been on the default basic rate plan, they are credited the difference and switched back to the basic plan (Faruqui 2020).
- Fort Collins Utilities in Colorado adopted a TOU rate in 2018 after promising results from a pilot project. The utility and stakeholders chose the default TOU rate structure for rate equity within the residential class. The TOU rate also empowered customers to manage their bills with incentives to reduce consumption and shift appliance use. The TOU program resulted in 1.9 percent lower overall

energy consumption (16,775 MWh), and 7.5 percent lower on-peak electricity use compared to the previous year. These electricity savings resulted in carbon emissions reductions of over 15,800 metric tons, equivalent to 0.8 percent of the 2018 community carbon inventory (APPA 2020).

- ***Rates with separate demand charges.*** Customers subject to demand charges pay a supplemental charge in addition to the amount assessed for their total energy usage. This separate charge is based on the customer's highest electricity use over a specific time period (e.g., highest hour or 15-minute interval), which could be coincident with the utility's peak demand. Demand charges reflect the fact that portions of the electricity system are sized to accommodate customers' peak loads and allow utilities to recover the cost of corresponding transmission and distribution system investments. Demand charges are designed to send price signals for the cost imposed to build and maintain enough capacity in the electrical system including the transmission and distribution systems and their associated substations. If customers respond by curtailing demand during these hours, such fee structures may decrease the need for utilities to build additional generation capacity or operate less efficient backup units during periods of peak usage.

  Demand charges are common for industrial and larger commercial customers because of their potentially high demand spikes. Demand charges are uncommon in residential rate structures (LBNL 2016a). Between 2014 and mid-2018, 11 states have added some form of demand charge for customers with onsite generation such as rooftop PV (NRRI 2019). In recent years, states have also taken action to consider demand charge strategies and alternatives for electric vehicle charging, to keep costs manageable for both utilities and customers (EDF 2020). Demand charges can present obstacles for direct-current fast charging (DCFC) infrastructure due to its high energy usage over a short period of time. For DCFC, states are considering demand charge alternatives based on load factor (NCCETC 2022).

  Definition of system peak hours for demand charges may be set in advance or may be based on actual system conditions. Non-coincident demand charges apply to the customer's highest usage occurring any time during the billing period. Coincident demand charges apply only to defined peak periods. For a demand charge to reflect system costs, it would include coincident peak-demand charges to encourage demand reduction during peak periods. Coincident demand charges can incentivize DERs that reduce demand during the peak periods. Research on rate design in support of electricity decarbonization recommends avoiding pricing strategies that include demand charges that apply during off-peak hours (Levin 2019). Research on rate design in support of customer DER adoption recommends discouraging mandatory residential demand charges, which do not reflect time-varying system costs and disproportionately affect LMI customers (SEIA 2017).

- **Rates with fixed charges.** Fixed charges are set fees that are assessed independently from customer electricity usage. Utilities typically combine a customer fixed charge with another rate design. For example, a utility may charge a consumption-based rate in addition to a fixed daily or monthly customer access charge to help cover the utility's fixed costs.[4] Fixed charges are a complex rate design issue and can present tradeoffs between stakeholder groups. Higher fixed charges and fees can stabilize utility revenues and customer bills, but they can also weaken the price incentive for customer adoption of energy efficiency practices or investment in DER.

  Higher fixed charges can disproportionally affect low-income households, which also tend to be lower-usage customers. In 2015, the National Association of State Utility Consumer Advocates issued a resolution in opposition to utilities seeking to increase their percentage of recovered revenue through fixed charges

[4] Access charges include items such as monthly customer charges or daily facility access fees. Typically, monthly customer fixed charges cover basic customer access costs like metering, meter reading, and billing costs, but views vary on which costs should be recovered in these charges.

that disproportionately impact low-income customers (NASUCA 2015). To support DER and avoid disproportionate impacts on LMI customers, it is good practice to limit fixed charges to recovery of customer-related costs such as billing and metering (SEIA 2017). Some utilities have implemented "minimum bills" as an alternative to raising customer fixed charges.

The complex considerations surrounding high fixed charges, their impacts on energy efficiency and DER investment, and equity and social justice concerns are discussed in *Recovery of Utility Fixed Costs: Utility, Consumer, Environmental and Economist Perspectives* (LBNL 2016a). One review found that utility regulators in at least 34 states, affecting about 125 utility companies, took action to change fixed charges for small customers. Most actions resulted in higher fixed charges, including a few large increases. A few actions resulted in lower fixed charges (NRRI 2019).

Technology-Targeted Rates

Technology-targeted rates can refer to rates that customers pay according to a particular end use (e.g., rates for charging electric vehicles), or rates, which could be in the form of credit or payment, that are generated in a specific manner or by a specific technology. Technology-targeted rates can complement other rates or supplement the energy that customers purchase from the utility. They are used to value the electricity that customers generate, store, or purchase elsewhere. Some utilities have designed technology-targeted rates to incentivize customer adoption of DERs that support load flexibility, energy resilience, or clean energy objectives. This section discusses several common types of technology-targeted rates and mechanisms for compensation, including standby rates, net metering, buyback rates, technology-specific flexible DER rates, and exit fees.

- ***Standby rates.*** Facilities that use DERs frequently need supplemental power from the grid and may also need backup power when the onsite system is unavailable due to equipment failure, maintenance periods, or other planned outages. Electric utilities often assess standby charges to cover the additional costs they incur as they continue to provide adequate generation, transmission, or distribution capacity (depending on the structure of the utility) to meet customers' needs. The standby rates are different for each customer because standby rates are based on the potential electricity a customer would use if they needed to consume power supplied by the utility. Standby rates can also change based on current system and market conditions. The utility's concern is that the customer could require power at a time when electricity is scarce or at a premium cost, and the utility must be prepared to serve load during such extreme conditions, sometimes on short notice (refer to the *Guide* chapter entitled Electric Utility Policies Overview for additional discussion on how the electric power grid must match supply with demand). States are exploring new standby rate designs that encourage customer generators to efficiently use electric service and that provide customers options such as the ability to procure standby service from the open market (Littell 2018). States are also looking for ways to account for the diversity of customer types when determining the probability that the demand for standby service will coincide with peak (high-cost) hours as well as giving customers credit for demand response to mitigate charges.
- ***Net metering.*** Net metering, also known as net energy metering or NEM, is designed for customers who own DER and transfer energy back to the grid. Many states, utility regulators, and utilities are currently reviewing their net metering policies and considering alternative compensation structures. The *Guide* chapter on Interconnection and Net Metering provides details. In addition, the National Renewable Energy Laboratory (NREL) defines and compares net metering and alternative compensation mechanisms for grid-connected, behind-the-meter DER systems, and their relationship to customer rate design (NREL 2017b).

  With net metering, the customer's bill is calculated based on the net amount of electricity used by the customer (i.e., the customer's energy use minus the amount generated by a DER like a residential rooftop solar PV system). If the DER produces more electricity in any given month than the customer uses to meet its own load, the customer receives a bill credit for the surplus kWh. The credit can be used to offset electricity use in future months when the customer's load exceeds the DER production. This crediting system means that the utility is effectively purchasing the surplus electricity generated by the DER. Rates are typically set at the customer's full retail energy consumption rate.

Several aspects of net metering vary by state, including roll-over of bill credits and the maximum size of a net metered system. Net metering programs are usually designed for residential customers who install a relatively small, distributed generation system such as rooftop solar PV that will produce roughly the same amount as the customer's load. They are not used for utility-scale power producers whose systems export large amounts of electricity to the grid and support many customers' loads. Most states also set a limit on the aggregate capacity of net metered systems in each utility's territory.

- ***Buyback rates.*** Many customers with DERs are not eligible for net metering. For these customers, the compensation received for surplus power generated by DER projects can be a critical component of project economics. The price at which the utility is willing to purchase this power, here referred to generally as the buyback rate, can vary widely and is also affected by federal and state requirements. This section provides examples of buy-back rates, including net billing feed-in tariffs, and power purchase agreements.

  Buyback rates are based on the concept of net billing. Under net billing, customers are paid per kWh of excess generation. The buyback rate paid to the customer in net billing may be set as the avoided cost, which represents what the utility does not have to pay to produce or purchase due to the generation. Avoided cost rates are typically set at or below the wholesale price of energy.

  Some net billing programs are using a Value-of-Solar (VOS) tariff, or Value of Distributed Energy Resources (VDER) tariff, instead of an avoided costs rate. VOS and VDER tariffs are examples of a rate design alternative to net metering, each of which compensates customers for energy created by their DER. Compared to net metering, which pays the fixed retail rate for excess energy from the DER, the VOS or VDER tariff is calculated based on a range of costs and benefits that the DER may create for the grid or for the value to society. By including both costs and benefits in the calculations, the VOS and VDER tariff attempt to address the risk of cost-shifting to non-DER customers.

  For example, Austin Energy and Minnesota offer a VOS rate and the New York Public Service Commission (PSC) launched a VDER tariff. Austin Energy's VOS rate is the rate at which Austin Energy credits solar customers for the energy produced by onsite energy systems. Each monthly bill includes a charge for the total energy usage and a solar credit for the energy generated by their solar equipment at the applicable VOS rate. The rate varies depending upon the type of customer and the size of the solar project (Austin Energy 2019). Similarly, in 2017, the New York PSC directed regulated utilities to establish a new tariff to transition from net metering to a VDER tariff, implemented a Value Stack, and began proceedings to guide stakeholder working groups, including a VDER Working Group Regarding Low and Moderate Income (NY PSC 2017). The VDER uses the Value Stack tariff to credit solar owners for the power their systems upload to the grid rather than crediting solar production at the retail electricity rate. The Value Stack tariff accounts for factors such as the energy value, capacity value, and environmental value. Minnesota's VOS tariffs are highlighted in the State Examples section in this chapter.

  The feed-in tariff (FIT) is a type of buyback rate that is used for incentivizing renewable development, though most examples are outside the United States. A FIT consists of a contract between the utility and the renewable generator to purchase the output of the renewable generation capacity at a fixed rate for a fixed period (often 10 to 20 years). The FIT price is often higher than the utility's retail rate, and it remains fixed for the duration of the contract even if the retail rate fluctuates. This fixed price provides less uncertainty than net metering with regard to the payback period of the customer's energy system. To provide stability for both utilities and the clean energy technology industry, FITs can be designed with features such as capacity caps, incentives that decline with installed capacity levels, or incentives that are linked to market conditions.

Power Purchase Agreements (PPAs) are another type of buyback rate that are similar to FITs. It is a legal contract to purchase power, and sometimes the capacity and additional services, from an electricity generator. Unlike FITs, PPAs are individually negotiated contracts for a fixed price per kWh for a fixed period of time. FITs are put into a tariff such that every eligible customer gets the same price.

- ***Technology-specific flexible DER rates.*** As battery-powered electric vehicles and plug-in hybrid electric vehicles become more common, some utilities have begun offering rate plans (tariffs) designed specifically for households that charge electric vehicles. These tariffs usually employ a TOU rate structure to encourage electric vehicle owners to charge their cars during off-peak hours and thus prevent peak load from increasing.

  In Texas, where night-peaking wind power is abundant, the utility supplier TXU Energy's "Free Nights and Solar Days" plan does not charge customers for consumption of electricity each day from 9:00 p.m. to 6:00 a.m., albeit with rates higher than those of many other plans during the rest of the day (TXU n.d.). This arrangement enables customers to save money and charge their vehicles with renewably generated electricity, and it helps the utility by minimizing surplus generation from renewables during off-peak hours. Significant air quality benefits could also be achieved by "flattening" the load curve by shifting demand to off-peak periods and avoiding the use of fossil-fired peaking plants.

- ***Exit fees.*** Exit fees can be associated with any rate structure. Fixed operating costs for a utility investment are usually recovered over time and are often tied to electricity (kWh) consumption. When facilities reduce or end their use of electricity from the grid, this affects the utility's ability to recover fixed costs for the investments it has made to serve all ratepayers. The remaining customers may eventually bear these legacy costs. This can be particularly problematic if a large customer leaves a small electric system. To minimize potential rate increases due to the load loss, utilities sometimes assess exit fees on departing loads. Exit fees are also commonly associated with standby rates.

  As many states began to restructure their electricity markets during the 1990s, utilities that previously generated power began to focus on delivery only, which meant that more of their costs tended to be fixed (e.g., investments in transmission and distribution infrastructure). Thus, exit fees gained favor as a means to allow these utilities to recover historical or "stranded" costs. Some states, however, exempted certain generation projects from exit fees because of the other benefits they provided, such as grid congestion relief and reliability enhancement. For example, Massachusetts and Illinois exempted some or all combined heat and power projects from their stranded cost recovery fees. In California, to avoid cost-shifting between different categories of customers, the CPUC in 2018 increased the exit fees that community-choice aggregators[5] and competitive energy providers, under the state's Direct Access program, pay utilities on behalf of exiting customers when aggregators replace the regulated utility as the customers' service provider. Utilities had sought higher fees to protect their remaining customers from bearing an unfair share of the legacy utility costs, but community choice advocates argue the decision shifts too much of the stranded cost burden onto exiting customers' bills (CPUC 2018a; GTM 2018).

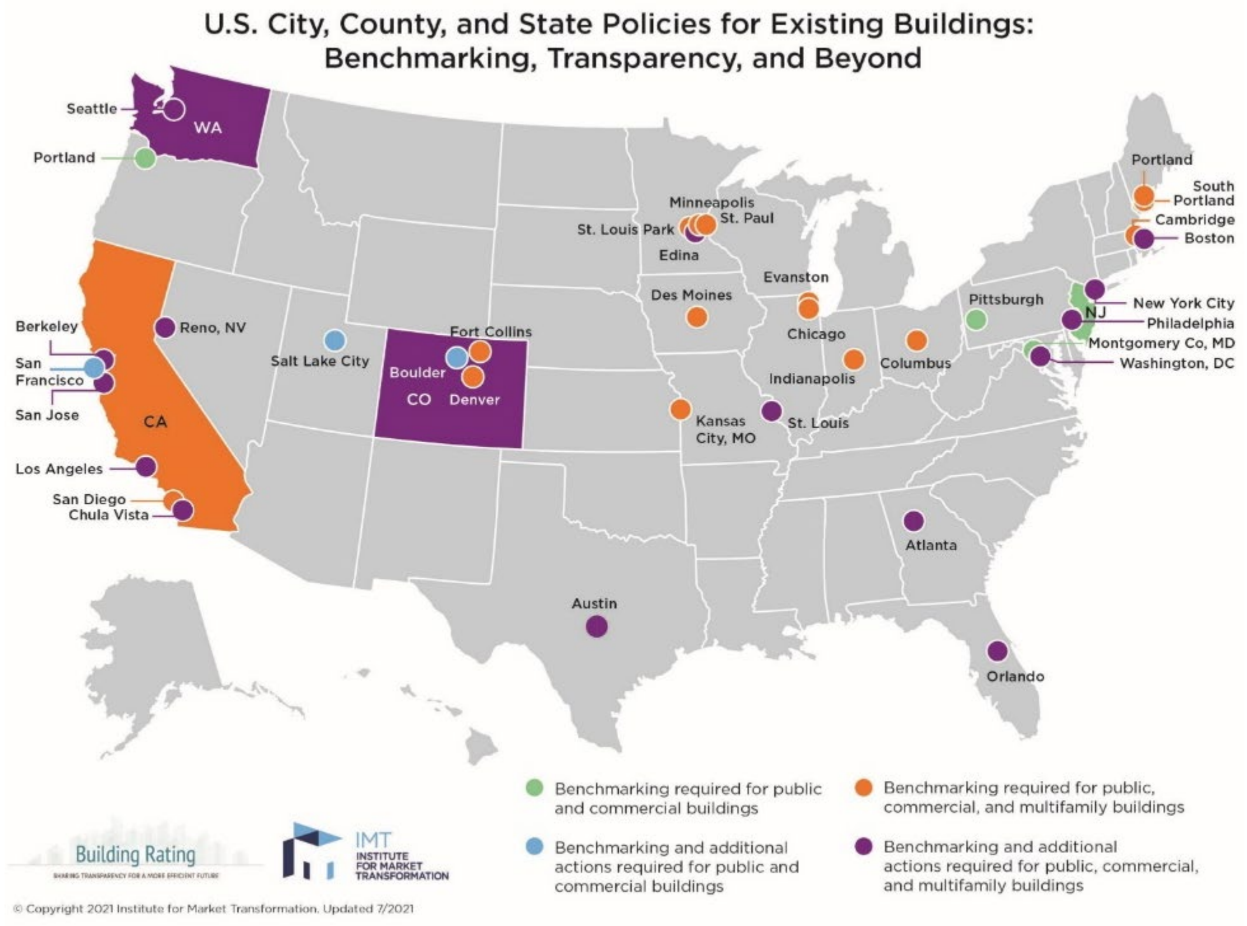
[5] For more on community-choice aggregators, refer to "Community Choice Aggregation: Challenges, Opportunities, and Impacts on Renewable Energy Markets" (NREL 2019).

Data Access

Data access is a critical component of many new rate designs and can unlock the potential for managing energy demand and avoiding negative outcomes of increasing peak loads. New state policies, such as building energy benchmarking and other data needs, are increasing the pressure on utilities and state regulators to provide data access. Providing customers, utilities, third parties, and others access to energy use information can be an important part of incentivizing clean energy resources. Each group has different data access considerations.

Building owners and managers. Access to energy use data is critical for benchmarking energy use in commercial, administrative, and multifamily residential buildings. Benchmarking allows building owners and managers to understand their buildings' energy use, identify the best opportunities for improvement, and measure the impact of efficiency efforts. The map in Figure 4, as published by the Institute for Market Transformation (IMT 2021), provides an overview of U.S. state and local policies for benchmarking and transparency in existing buildings.

Figure 4. State and local policies in place for building benchmarking



Source: (IMT 2021)

One barrier to data access in commercial or multifamily buildings is metering. Metering can present a challenge, as a single meter might register the combined energy use for multiple buildings, or a large building might have multiple meters that need to be summed to obtain total building energy use. Technical upgrades may be required on the utility's part to enable owners of these buildings to better access and properly utilize their data.

Regulators can play a role by requiring utilities to provide such data access to commercial building owners, especially if the benchmarking process is itself being undertaken due to a regulatory mandate (SEE Action 2013). For example, legislation in Washington directs the Washington State Department of Commerce to establish energy efficiency standards for existing commercial buildings.[6] Compliance requirements are expected to be phased in. The process is expected to commence with the largest buildings in 2026 and is to be extended to all commercial buildings over 50,000 square feet by 2028. Similarly, California's Energy Commission updates the Building Energy Efficiency Standards (Title 24, Parts 6 and 11) every three years (CEC n.d.). The process involves stakeholder engagements through transparent, public endeavors. This energy code is designed to optimize energy consumption in both new and existing buildings.

Customers on time-varying rates. Data access is critical to TVRs. Rate schedules that seek to reduce peak demand by shifting some usage to off-peak hours are much more likely to be effective if ratepayers can identify how specific choices and actions affect their energy use—and consequently, their bills—at different times. For example, the city of Fort Collins, Colorado provides detailed information on residential electric rates and the impacts on rates on customer bill savings (Fort Collins n.d.). The standard total monthly energy use found on most ratepayers' bills will not provide sufficient detail for them to evaluate the effects of a particular action. Many utilities are providing customers new online energy management tools, in-home energy use displays, and programmable thermostats to provide customers with better access to their energy usage information and to help them manage their energy bills. More detailed information on energy use also makes it easier for customers to track the savings afforded by smart appliances or distributed renewable energy such as solar panels. To protect customer data, DOE's Green Button program, which allows customers to download their energy use data, requires utilities to transmit any personally identifiable information (PII) in separate, secure methods that is separate from the energy data in addition to requiring customer authorization for any transmission.

Utilities. Though the utility itself has access to data—provided that its metering infrastructure is sufficiently advanced—the utility may employ an outside company to help implement its energy efficiency or clean energy programs. That company will likely need at least partial access to energy use data in order to fulfill its role. Utilities typically include provisions for data security and limitations on data usage in their contractual arrangements with outside companies. Customer consent is typically not required; some states such as Oregon and Vermont have statewide, independent energy efficiency administrators that are able to access information utilities but there are restrictions in place to prevent misuse of the data.

Third parties. Customer energy use data can be a valuable tool for third-party energy service companies to identify market opportunities and develop customer acquisition strategies. At the same time, privacy and security concerns have been cited by some utilities and consumer advocates to restrict the release of data to third parties. Many states have rules in place that allow third parties to obtain customer data from the utility with the customer's consent. Additionally, a growing number of states allow third parties access to aggregated or anonymized customer data sets without customer consent. Aggregated data sets combine the energy usage of multiple customers into a single total, while anonymized data sets provide the energy usage of individual customers but without any information that could be used to identify the customer.

A key question for these data access policies is establishing the minimum number of customers that need to be included in an aggregated or anonymized data set to ensure adequate privacy protections. This question is

[6] In 2019, the Washington State Legislature enacted House Bill 1257, the Clean Buildings for Washington Act (WA Commerce 2019).

important to utilities due to the logistical time and expense of contacting customers to obtain consent, so several states have now passed standards governing when the need for consent is triggered. Vermont, for example, has established regulations that set minimum standards for size of the geographic area covered by the data, while Colorado has regulated the number of customers included in an aggregated data pool and their relative percent of the total energy use (SEE Action 2012). Per a 2019 law, Vermont's guidelines for third-party data access allow the owner of multi-unit building to obtain aggregated energy use data from the utility. The Colorado Public Utilities Commission authorized a standardized customer consent form to release data to third parties in 2015 (ACEEE 2020). In California, the CPUC adopted rules to allow qualified third parties access to energy usage data through each utility's independent Energy Data Request and Release Process. The CPUC also established an Energy Data Access Committee, that provides advice to the utilities on their processes for reviewing third-party data access requests as well as a mediator for disputes between utilities and third-party data requestors (CPUC 2021).

In situations where customers voluntarily provide their energy use data to third parties, there is again the potential for improper data usage and breach of privacy. In these situations, there are fewer direct actions regulators can take, but they can encourage third parties to provide privacy assurances and encourage customers to request an official privacy policy (SEE Action 2012). For example, states could encourage third parties to adopt the DOE voluntary DataGuard Energy Data Privacy Program, which includes a framework and principles regarding customer data privacy developed by industry stakeholders to ensure customer privacy (DOE n.d.). Fundamental principles of the DataGuard include Customer Notice and Awareness as well as Customer Choice and Consent.

Others. For researchers and policy makers, energy use data aggregated by time period, geographic area, or demographic group can provide a valuable window into opportunities for energy efficiency or clean energy incentive programs on a larger scale (IMT 2021). However, requests for such data can raise customer privacy and utility cost concerns. A few states have promulgated special data access rules for governmental agencies or academic researchers.

Designing Utility Rates and Data Access

This section summarizes some key design issues, introduces the participants, and highlights how federal, state, and local policies can interact with utility rates.

Key Design Issues

Utilities and regulators balance competing goals in designing rates. Achieving this balance is essential for obtaining regulatory and customer acceptance.

Fairly Apportion Costs Among Customers

Utilities undergo formal processes with their regulators to determine what share of their revenue will be received from each customer class. Traditional customer classes include industrial, commercial, and residential, each with different use patterns and corresponding rate structures. In regulatory proceedings, this process is often contentious, as each customer class and key stakeholders seek to advocate for their own interests.

Ensuring equity when apportioning costs among customer classes involves greater efforts to include advocates for underserved communities, including low-income communities and communities of color. This way, resulting policies are likely to better shield groups like low-income customers from negative impacts of new rate designs. Policymaking inclusion for community advocate groups can be improved through strategies such as financial compensation and scheduling hearings for evenings or weekend times. As mentioned elsewhere in this chapter, some states have started to adopt these strategies, for example, through intervenor compensation programs.

In addition to inclusion in the design process, certain rate design features or implementation and evaluation considerations can improve outcomes of rate changes for low-income customers. Some consumer advocates promote rate design that emphasizes volumetric charges rather than fixed charges to recover utility cost increases (NCLC n.d.). Regardless of the rate structure, some states are including bill guarantees or bill protections when rates change, which can protect customers unable to afford an increase. Regulators may also choose to set targets related to affordability, like measuring number of disconnections or average bills for residential customers, to incentivize the utility to ensure rates best serve the most vulnerable customers (Synapse, RAP, and Community Action 2020). When customer rates go up, energy efficiency programs for low-income customers can help reduce bill impacts resulting from the rate changes. For more information, refer to the Energy Efficiency Programs and Resource Standards chapter in the *Guide*.

In 2021, the Oregon legislature passed a bill that would allow the Oregon Public Utility Commission to consider income and social inequities in rate design, opening the possibility of special rate structures for low- and moderate-income customers and customers living in communities with environmental justice concerns. The law enables these customers to participate in regulatory proceedings by authorizing financial assistance for their participation. In addition to rate designs to reduce energy burdens, the legislation allows the Commission to approve bill reduction programs specifically to address energy burdens, such as smart thermostat installation or home weatherization (OR H.B. 2475 2021).

Balance Rate Simplicity with Policy Goals

One challenge for promoting policy goals such as energy efficiency or DERs through rate design is balancing the desire for rates that provide the right signals to customers with rates that customers can understand and to which they can respond. As noted elsewhere, RTP is a sophisticated rate design that requires customers to keep up with prices. Rate designs that are complex or require continuous attention may not be effective at promoting efficient consumption decisions. Some utilities communicate rate offerings with simple and familiar terminology used in other consumer areas, like early cell phone plans which offered “free nights and weekends.” TXU Energy, which serves utility customers in Texas, offers a “Free Nights and Solar Days” program (TXU n.d.). However, such rate design may be simple but could promote increased energy usage rather than energy efficiency.

Research varies on customer response to the level of complexity of TVR. Empirical data from U.S. residential TOU pilots consistently show that customers understand and respond to TVRs, especially TOU rates, which are the most widely used and have been the most analyzed (discussed in the Current Landscape section in this chapter). Others point out that in the residential sector, customers might pay more attention to the total bill than to the rate design. Several utilities simplify the decision-making process for customers by offering a bill comparison of the base rate and the TVR alternative. A bill guarantee (discussed in the Current Landscape section in this chapter) is an approach regulators and utilities can use to protect TVR customers from large bill increases and reassure customers who are hesitant to enroll. The State Examples section in this chapter illustrates California’s approach.

Consider Voluntary, Default, or Mandatory Rates

A key design issue for utilities and policymakers is whether to create mandatory rates, offer voluntary rates, or establish default rates that allow customers to opt-out. Fort Collins, Colorado, for example, adopted a mandatory residential TOU rate (Fort Collins n.d.). The State Examples section in this chapter highlights an

Oklahoma utility experience with a voluntary VPP rate and California utilities' experience with default TOU rates. San Diego Gas and Electric in California has a default TOU rate with an opt-out provision, which automatically enrolls customers in the TOU rate unless they take action to opt out and change to a different rate option.

A study of utilities across the country looked at retention rates after one or two years of defaulting customers into a TOU rate and found that about 85 to 90 percent remained enrolled rather than choosing to opt out (DOE 2016b). The high retention rate for customers on default TVRs suggests utilities would accrue cost-savings from not having to recruit customers to participate. After a two-year pilot project, California's Sacramento Municipal Utility District concluded that TOU would be the default rate for all customers. Other utilities such as Xcel Energy in Colorado have been allowed by regulators to approve TOU rates for all residential customers, beginning in 2021 (CO PUC 2020).

Compensate Customers who Generate Electricity

Another key design issue is how to compensate customers who generate their own electricity with DER, such as rooftop solar PV. These customers may participate in the utility's net metering program and may experience lower bills because of their lower net energy usage. Refer to the Interconnection and Net Metering chapter in the *Guide* for more information on customer DER compensation approaches.

Participants

Participation in rate design proceedings is complicated and time intensive. Changing rate design is often a contentious process involving lengthy workshops, settlement discussions, or litigated proceedings. This section introduces key participants in the development of customer rates and data access policies and describes what some states are doing to make it more inclusive to disadvantaged customers and communities.

- ***State Utility Regulators.*** Rates for IOUs typically are approved by the state utility regulator, often called a commission, during a utility rate filing or other related filing. The staff evaluate costs and benefits to generators, utilities, consumers, and society. Many utility regulators conduct active rate reviews to maintain consistency with changing policy priorities. Electric cooperatives and municipal or public power utilities typically have a governing board that has authority over retail rates but are regulated by the commission in some states.
- ***Ratepayer advocates.*** Most state governments have staff dedicated to representing ratepayer interests in rate case proceedings. These staff may be independent organizations within state commissions (as in California), in the Office of the Attorney General (as in Kentucky, Arkansas, Alabama), or elsewhere within the state government (NASUCA n.d.). Some states including Oregon and Illinois have a Citizens Utility Board (CUB) that advocate for consumers. For example, the Illinois CUB co-authored a study on customer impacts of an RTP rate compared to a flat rate, including on low and middle income groups, finding that RTP would reduce electricity bills for these groups (Zethmayr and Makhija 2021). The Oregon CUB advocated for state legislation (OR H.B. 2475 2021), which passed in 2021, that allows the utility regulator to consider equity and income in rate design and utility programs and supports meaningful participation by underserved communities in the regulatory proceedings by allowing for financial support (OR CUB 2021).
- ***Utilities.*** **Utilities play a critical role in rate-setting.** Their cost recovery and economic focus have historically revolved around volumetric rates that reward the sale of increased amounts of electricity. Under this traditional model, anything that reduces electricity sales (including DERs) also reduces utility income and may make it more difficult to cover fixed costs if the fixed components of existing tariffs are not calculated to match utility fixed costs. This creates a disincentive for utilities to support such projects.

New ways of setting rates (e.g., revenue decoupling and performance-based rates, which are covered in another chapter of the *Guide*) can make utility incentives consistent with public policy goals such as energy savings and emissions reductions through energy efficiency and DER.

- ***State energy offices, energy research and development agencies, economic development authorities, and local governments.*** These government offices often have an interest in encouraging efficiency and DERs. They may provide objective data on costs and benefits and help balance many of the policy goals. State air agencies and environmental departments have a strong interest in lessening the negative impacts of the electricity system on air, water, solid waste, public health, and equity. State and local agencies play a critical role in demonstrating the benefits of reducing the use of fossil fuels for local and GHG pollutants. For example, the city of Portland, Maine, has adopted an energy benchmarking ordinance that requires covered properties to annually report water and energy usage in an attempt to better manage water and energy use (Portland n.d.). Inter-agency collaboration on achieving state and local goals could result in improved public health and mitigate the climate crisis (EPA n.d.).
- ***Frontline community groups, communities with environmental justice concerns, and groups representing people of color, low-income households, and indigenous communities.*** Organizations and individuals that represent the groups most impacted by cost and pollution can offer insights based on experience about relative merits and burdens of options a utility regulator may be considering, such as new customer rate options. Community organizations and utility regulators in several states are working to redesign the utility regulatory process overall to be more inclusive of low-income households and communities with environmental justice concerns.
- ***Clean DER project developers.*** Project developers establish clean technology benefits and the policy reasons for developing rates that encourage their application. They participate in rulemakings and other proceedings, where appropriate.

Interaction with Federal Programs

Several federal initiatives are relevant to customer rates and data access, including Federal Energy Regulatory Commission (FERC) rulings pursuant to federal law and national laboratory research.

The federal Public Utilities Regulatory Policies Act (PURPA) section 210 regulates interactions between electric utilities and two categories of electricity producers that are considered “qualifying facilities” (i.e., qualifying small renewable power producers less than 80 MW and qualifying cogeneration facilities). Among other policies, PURPA established avoided cost pricing, which is often referenced in rate design. States set this rate pursuant to FERC regulations (APPA, EEI, NARUC, NRECA 2021). Historically, PURPA has not spurred large growth in renewable generation because the definition of avoided cost was taken to mean the cost of the cheapest marginal power source available. For some time, the cheapest marginal power source was usually combined cycle natural gas. The low cost was not enough to support renewable growth.

In 2020, FERC amended PURPA through Orders 872 and 872-A in response to the many changes in the energy landscape in recent decades. Some of the changes gave state regulators more flexibility. For example, the changes allow states to incorporate market forces in establishing avoided cost rates for qualifying facilities (FERC 2020c; 2020a). The changes may prompt states to revisit their interconnection standards and net metering rules as regulators and utilities implement the PURPA amendments (APPA, EEI, NARUC, NRECA 2021).

More indirectly, the federal government plays a role in the evolution of electricity rate structures through the provision of analysis, funding, and research. NREL, Lawrence Berkeley National Laboratory (LBNL) and other researchers and national laboratories have produced reports exploring the economics of various renewable energy technologies (NREL n.d.). Some of these reports focus explicitly on the relationship between electricity rate structures, electricity prices, and economic feasibility of the technology in question—often solar PV.[7] These reports are freely available to the public and may be used by state officials and utilities during the ratemaking process.

The federal government also provides funding for projects that catalyze grid modernization, and this modernization process can profoundly affect data access and future rate structures. For example, the Smart Grid Investment Grants (SGIG) program, funded by the American Recovery and Reinvestment Act of 2009, distributed $3.4 billion in funds for grid modernization projects. LBNL led customer behavior research projects leveraging SGIG deployments. For more information on grid optimization for clean energy, refer to the Maximizing Grid Investments chapter in the *Guide*.

Interaction with State and Local Programs

Designing utility rates to support energy efficiency and clean energy resources can be coordinated with many other state and local policies and programs, including state policies on utility financial incentives.

Many states have decoupled utility revenues from the volume of electricity sold. This issue addresses the inherent conflict when a utility has an incentive to maximize sales (the throughput incentive) instead of promoting demand-side options such as energy efficiency and onsite generation. Decoupling can be important when examining clean technology rates. States have also considered allowing utilities to recover more of their costs through monthly bill charges rather than through rate structures applied to the volume of electricity consumption. However, such approaches could lessen the incentive for energy efficiency and customer-sited clean energy. Decoupling and other mechanisms for adjusting utilities' incentives to promote clean energy are discussed further in other chapters of the *Guide*.

Climate and environmental policy goals, and the interactions between such policies at the state and local level, could be a major driver for utilities' rate design that promotes clean energy, energy efficiency and demand response. In addition, climate goals could be critical for data access policies, especially building benchmarking requirements that may lead to more comprehensive rate structures.

Implementation and Evaluation

Implementation

State utility regulators are responsible for rate oversight and approval for IOUs and some cooperatively and municipally owned utilities. Local boards govern the cooperatively and municipally owned utilities who are not overseen by state utility regulators. As discussed in the section Types of Utility Rates, in deregulated (retail choice) states, competitive energy suppliers can set their own generation rates. However, utility regulators in retail choice states still have authority over the "default service" energy supply rates, which regulated utilities will charge for providing electricity to customers who do not receive their service from competitive suppliers. Utility regulators in these states also retain authority over other components of electricity rates, such as electricity delivery charges and collection of public benefits funds.

Utilities implement TVR marketing and education campaigns, which are important aspects of customer adoption of TVRs. Customer outreach, focus groups, and pilots help determine levels of customer awareness,

7 For example, "The Impacts of Commercial Electric Utility Rate Structure Elements on the Economics of Photovoltaic Systems" and "Impacts of Regional Electricity Prices and Building Type on the Economics of Commercial Photovoltaic Systems" (NREL 2010; 2012).

interest, and understanding of new rate designs. Customer enrollment and retention may be higher with greater outreach to understand customer groups priorities (e.g., saving money or reducing emissions), preferences and concerns.

Utilities may pair a new rate offering with outreach efforts to educate customers on the rate signals and how their energy use choices may affect their bill on a given rate plan. For example, Fort Collins Utilities customers found that the most useful outreach item was a handout with energy use and cost details for specific household appliances and electronics. The material helped customers prioritize what to turn off based on the cost to operate appliances during on- and off-peak hours. In addition, Fort Collins Utilities prioritized underserved communities through bill support and energy-savings tips for qualifying customers and developed Spanish-language versions of many of the outreach materials to better reach Spanish-speaking customers (APPA 2020). In addition to customer education, utilities may pair TVRs with technology (discussed in the Benefits section in this chapter).

Utilities typically develop and implement internal practices and prepare customer communications regarding customer data access such as privacy policies. State utility regulators may offer model policies and sample documents for small utilities to implement.

Evaluation

States may evaluate a range of factors to determine progress, success, and issues requiring attention with customer rates and data access, from AMI deployment performance to the peak period timing. Many states are evaluating whether their rate structures accurately reflect the time- and location-specific costs and impacts of generation, transmission, and distribution of electricity. To determine the cost of delivered electricity, states first need to understand and quantify the costs and benefits of different forms of generation. This can include environmental and health costs from fossil fuel generation or avoided system, environmental, and health costs from clean DERs. System benefits can include increased system capacity, potential deferral of transmission and distribution investment, reduced system losses, improved stability from reactive power, or voltage support. In restructured states, some benefits may be external to the regulated utility, but rates can capture these elements to ensure optimal capital allocation by both regulated and unregulated parties.

Other metrics that can be examined are TVR retention and attrition levels, customer adoption rates for opt-in programs, energy burden of low-income households, or emissions impacts associated with rate designs. After customers participate in TVR programs, utilities or other entities can conduct ex-post analysis. To evaluate load impact, the analysis can estimate the effect of prices on electricity use patterns throughout the day and over longer periods (EDF 2015). Significant, unanticipated, or adverse impacts may be identified and addressed through modifications such as adjusting the rate structures or altering the rate qualification criteria. For example, many states have initiated proceedings to revise net metering and develop new rate structures for clean energy resources that are more closely tied to the estimated value of the DERs (for more information, refer to the Interconnection and Net Metering chapter in the *Guide*).

Evaluating a rate offering may require funding and other resources, which state utility regulators can authorize. Such resources would allow for the monitoring of rate impacts on uptake of clean energy technologies and energy efficiency for various types of customers. LBNL research on the time-varying value of electric energy efficiency and peak demand reduction points to a lack of publicly available data on end-use load shapes (i.e., the hourly or seasonal timing of electricity savings) and energy savings shapes as well as a narrow geographic representation. The evaluation of rates and pricing, among other planning functions, are limited by this lack of available data (LBNL 2017).

Action Steps for States

This section lists action steps for states seeking to achieve or enhance the benefits of rate design and data access policies, and for ensuring ongoing success after policy adoption. States can consider the following steps:

- Assess existing rate design structures. Before making decisions to keep or change a current rate design, states can assess the current structure and alternatives. States can seek input from stakeholders across the industry, customer classes, and communities to understand the extent to which rates are transparent and equitable, accurately reflect costs, and provide stable revenue to the utility.
- Review and implement TVR programs that are aligned with state objectives. State and utility policies to adopt TVR programs may be considered a good practice for meeting multiple energy, cost, and environmental benefits. Default TVR programs, which automatically enroll customers but allow the choice to opt out, have demonstrated higher participation rates than voluntary, opt-in programs. Utilities can help protect customers by offering bill guarantees.
- Evaluate existing and potential demand charges for commercial and industrial customers. “Coincident peak pricing” demand charges in commercial and industrial rates can help reduce system-wide peak demand and help states achieve their environmental and climate goals.
- Increase AMI deployment and leverage its use for rate design and energy efficiency. State policies to support and accelerate full AMI deployment can lead to energy savings and emissions reductions from clean energy adoption, load shifting, and energy efficiency advances when paired with best practices for customer engagement and support. Comprehensive state policies can accelerate the uptake of AMI while ensuring privacy and security of customer data.
- Secure customer data and privacy. States and local governments play an important role in establishing rules for maintaining data security and customer privacy.
- Develop policies for data access. Stakeholders have increased interest in improving energy data access for customers and third-party vendors. Regulators can establish rules to require access to utilities’ customer energy data. However, some consumer advocates are concerned about data access without customer consent. State governments can protect consumer privacy while facilitating data access by requiring utilities to aggregate and anonymize customer data before making the data broadly available. Local building benchmarking and other policies are enabled by data access. State or local governments may need to address benchmarking policies and data access concurrently. This would enable building owners to get the data required by these policies.
- Incorporate incentives into the design of standby rates. States and utilities can design standby rates that encourage greater reliability and predictability of customer generation, maximize demand response, and minimize large, unanticipated peak loads. In addition, utilities may offer customers new options for procuring standby power (e.g., open market).
- Integrate energy efficiency and demand response programs and align those programs with rate design changes. States can pair targeted energy efficiency and demand response programs with rate structures to achieve greater levels of energy savings and emissions benefits. These programs are especially important to help customers offset the effect of the increased rate with energy savings.
- Measure results and report progress. States can track and evaluate deployment of AMI, establishment of and compliance with data protection and privacy policies, participation in new rate designs, customer satisfaction with rates, energy burdens of customer groups, and the load impacts of customer rates.

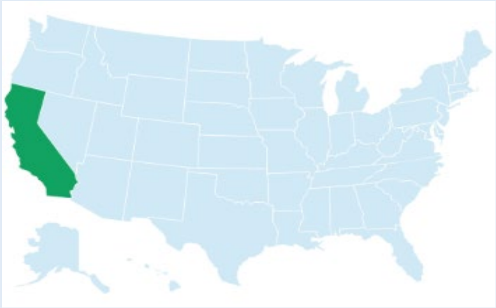
State Examples

California

In 2015, the CPUC approved the Residential Rate Reform Decision (D.15-07-001) ordering the largest IOUs, Southern California Edison (SCE), Pacific Gas and Electric (PG&E) and San Diego Gas and Electric (SDG&E), to transition customers to default or "opt-out" of TOU rates (CPUC 2015). TOUs are a type of time-varying rate structure that varies between peak, off-peak, and, in some cases, super off-peak periods to reflect electricity costs by the time of day. Under the default opt-out plan, residential customers will automatically transition to TOU rates unless they choose to opt out. TOU plans have been available for commercial customers in California since the 2000s.

To incentivize customers to participate, CPUC ordered IOUs to implement two customer protections for the default TOU rate rollout. First, customers must receive an estimate of how their TOU bill compares with the previous rate to determine if they saved money. Additionally, customers must receive a 12-month bill guarantee, such that customers whose first-year bill under the new TOU rate is higher than it would have been under their old rate will be credited the difference (CA S.B. 695 2009). Even though customers have 12 months of bill protection, they can opt out anytime they chose.

Opt-out Rate Designs in California Aim to Expand Customer Participation in Time-Varying Rates



Several major utility providers, including Southern California Edison, PG&E, SDG&E, and SMUD, have launched default or 'opt-out' time-varying rates to their customers.

Shadow bills and bill guarantee requirements were enacted in 2009 state legislation to protect customers from bill increases.

For more information, see:

- California Senate Bill No. 695, Ch 337 on energy rates
- Sacramento Municipal Utility District Time-of-Day Rate details
- SDG&E Opting Out of TOU Pricing Plans

SDG&E began transitioning existing customers to a default TOU plan in 2019 while introducing two new TOU rates in addition to the standard tiered rate. Out of the two TOU rates, TOU-DR1 is the default rate, and TOU-DR 2 is an optional rate. The default TOU-DR1 rate divides the day into three intervals: on-peak, off-peak, and super off-peak. On-peak hours are 4:00 to 9:00 p.m. every day, and off-peak and super-off peak hours vary on weekdays and weekends (SDGE n.d.). Customers can opt to stay on SDG&E's standard tiered plan when they are notified of the upcoming rate change; however, they are informed of the two customer protections to encourage them to try the TOU rate. Along with the 12-month bill guarantee, customers receive a "shadow bill" with their monthly billing statement showing their saving or bill increase between the TOU rate and the previous tiered rate.

Prior to the TOU default transition plans, per CPUC's direction, all three IOUs ran two sets of pilots: opt-in pilots and default pilots. The opt-in pilots were designed to gain insight into how customers accept and respond to TOU rates, principally by studying the load and bill impacts of implementing those rates. Another important aspect of the pilot design was assessing potential hardships on certain customers. The opt-in pilots were conducted from June 2016 to December 2017 across all three IOU service territories, testing eight different TOU rate options. More than 50,000 households were enrolled and assigned to a treatment group on one of the TOU rates or a control group on the standard tiered rate. The pilots were designed to familiarize customers with the transition to default TOU rates, and to test system operability prior to full rollout of the default TOU. For PG&E, customers in the pilot who did not opt out were assigned one default rate; for SCE and

SDG&E, customers in the pilot who did not opt out were assigned one of two default TOU rates. After SDG&E's TOU pilot, nearly 99 percent of customers stayed in the program (Utility Dive 2018). According to a survey of TOU pilots, customers managed electricity use and responded to TOUs, reducing on-peak usage by 6.5 percent on their own and 11.1 percent with technologies like smart thermostats (Utility Dive 2018).

Prior to the 2015 requirement, some of California's utilities used opt-out rate designs, including the Sacramento Municipal Utility District (SMUD). SMUD, one of the largest U.S. publicly owned utilities, launched a default TOU rate for its 600,000 residential customers SMUD customers without rooftop solar could opt out and elect the fixed rate, which charges three different flat volumetric prices based on three different durations of the year (SMUD n.d.). In SMUD's 2012–2014 pilot, customers were satisfied enough with pricing options to remain in the program and SMUD observed load reductions (George and Toyama 2015). The success of SMUD's opt-out rate design was one reason behind the CPUC's 2015 decision to require SCE, PG&E, and SDG&E switch customers to default TOUs. Residential TOU pilots demonstrated that the time-varying rate can shift electricity consumption to off-peak times (Faruqui 2020). After SMUD completed full implementation of its default TOU rate, preliminary results included an eight percent peak load reduction and an annual equivalent of 12,800 tons of carbon emission avoided (APPA 2020). In its "2030 Zero Carbon Plan," SMUD highlights several rate design initiatives, including a solar and storage VPP and a multi-DER pilot to evaluate a CPP rate, a dynamic pricing rate, and an incentive-based aggregator-managed load shifting VPP program. This project will encompass three DER types: smart thermostats, EVs and residential battery storage (SMUD 2021).

Oklahoma

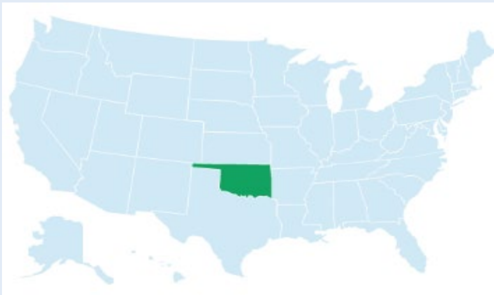
In 2012, Oklahoma Gas and Electric Company (OG&E) installed smart meters to read, connect, and disconnect meters remotely, and offered residential and business customers a voluntary variable peak pricing (VPP) program, called SmartHours (OG&E 2013). The rate structure is designed to reduce or shift some energy usage away from peak to off-peak hours when energy costs less. When the SmartHours program was first offered to customers in 2012, OG&E aimed to reduce demand and postpone construction of a new fossil fuel power plant (OG&E 2013).

Within the first year after the launch of SmartHours, OG&E reduced load by 70 MW (OG&E 2012). As of 2020, approximately 20 percent of OG&E's customers were enrolled in SmartHours and saved approximately 20 percent on summer electricity bills (Faruqui 2020). Additionally, OG&E reported a peak load reduction of around 40 percent (Faruqui 2020).

OG&E notifies SmartHours customers using their selected communication preference one day in advance of price changes. This enables SmartHours customers to save money by reducing electricity usage during peak hours or by shifting energy usage from peak to off-peak hours (OG&E n.d.). During off-peak hours, customers pay nearly half-price for electricity per kWh (OG&E n.d.).

For the SmartHours program, OG&E defines peak hours as weekday afternoons from 2:00 to 7:00 p.m. during summer months (June 1 to September 30), excluding recognized national holidays. OG&E aims to reduce summer peak demand

Variable Peak Pricing in Oklahoma Demonstrated 20% Energy Bill Reduction and 40% System Peak Reductions



Oklahoma Gas and Electric Company launched a VPP rate structure that achieved around 20 percent in customer bill savings and a peak load drop of around 40 percent.

For more information, refer to

- Oklahoma Smart Hours VPP program
- Oklahoma Rate Tariffs Variable Peak Pricing

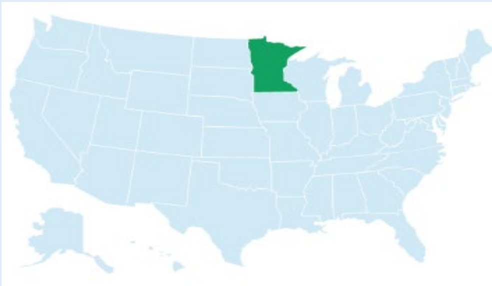
as much as possible through VPP (OG&E n.d.). During peak hours, customers are charged for energy use at one of four peak pricing levels depending upon the type of day: Low, Standard, High, Critical. The peak price is determined from the estimated customer use and the availability of cheaper electricity. OG&E partners with a thermostat-integration technology company to help customers automatically program temperature preferences in response to OG&E's rates, which are received directly from the Smart Grid system (OG&E n.d.).

Minnesota

In 2013, the Minnesota legislature became the first state to pass a VOS tariff applicable to community solar gardens[8] and as a potential replacement for the state net metering policy (MN Commerce 2014). Unlike net metering, which compensates solar generators based on the electricity retail rate, the VOS tariff compensates for the benefits of solar energy production over the expected life of the solar installation. The VOS tariff is mandatory for Minnesota's community solar projects but does not apply to residential solar customers or customers participating in other net metering or DER programs (NRRI 2019).

In the same year, the legislature initiated the state's Community Solar Garden program, beginning with a pilot project by Xcel Energy, the state's largest utility. The statute requires Xcel to purchase all energy generated by a community solar garden, and credit the subscribers at the VOS rate (Eleff 2017). Xcel works with third-party solar garden operators, which own the solar facilities and sell Solar*Rewards Community program subscriptions to community members. Xcel's Minnesota Solar*Rewards Community program is the largest community solar program in the nation (Xcel 2019). Electric cooperative utilities also own and operate community solar projects in Minnesota and offer subscriptions to their customers, but are not required to use the VOS tariff (Eleff 2017; Xcel 2019). Other chapters of the *Guide* provide more information on community solar programs.

Minnesota's Statewide Value of Solar Tariff May Improve Accuracy of Distributed Solar Generation Compensation



The Minnesota Public Utility Commission guidelines outline the methodology for calculating community benefits from solar power, as well as the benefits of renewable energy integration with the power system.

For more information, refer to

- Minnesota Value of Solar: Methodology prepared for Minnesota Department of Commerce

The Minnesota Department of Commerce developed the methodology for participating utilities to calculate the VOS tariff, which the state PUC subsequently approved (MN Commerce 2014). The legislation mandated that the VOS tariff incorporates the value of solar energy to individuals, communities, and society. Specifically, the VOS tariff accounts for the following values of distributed solar PV: the energy and its delivery, generation capacity, transmission capacity, transmission and distribution line losses, and environmental value. Environmental value reflects the avoided environmental cost of externalities, based on a social cost of carbon dioxide emissions and the Minnesota PUC-established costs for emissions

[8] Shared renewable projects, community solar, or community shared solar programs are large PV systems that provide power and/or financial benefit to multiple community members. These programs expand access to solar power to renters, those with shared roofs, and those who are unable to install solar for financial or other reasons. These programs are particularly beneficial to LMI customers, who may face several barriers to installing rooftop PV such as high upfront costs, low homeownership rates, or limited access to credit (NREL and CESA 2018; CESA 2019).

other than carbon dioxide (MN Commerce 2014). In 2017, Xcel began to credit electricity generated by community solar projects at its VOS rate (Eleff 2017).

The PUC requires the project's VOS tariff to be set at the rate in use at the time of the application. The VOS tariff is then locked in for the full term of the project's operation, adjusted for inflation (Eleff 2017). Xcel compensates solar garden subscriber customers each month through credits on their bills for all solar energy generated, based on their percent share of the total project. If credits exceed a customer's total bill in a given month, the remaining credits roll over to the next month.

As of 2018, Xcel's Minnesota Solar*Rewards Community program had 505 MW of connected solar generation. As of early 2022, Minnesota's community solar program hit 826 MW of operational capacity and is expected to continue growing (ILSR 2022; Xcel 2019). One study found that all customers, including those who do and do not subscribe to the community solar program, realize financial benefits from community solar (ILSR 2022).

Information Resources

Resources on Customer Rate Design

Title/Description
The Brattle Group. SPC44 Time of Use Pilots (2020). This report evaluates the first year of Maryland's time-of-use pilot program, looking at peak load reductions and customer bill decreases.
Citizens Utility Board and Environmental Defense Fund. The Costs and Benefits of Real-Time Pricing (2017). This report examines real-time pricing in contrast to flat rate pricing, based on data from an experimental real-time pricing program in Illinois.
Lawrence Berkeley National Laboratory. Experiences of Vulnerable Residential Customer Subpopulations with Critical Peak Pricing (2016). This report reviews literature on vulnerable populations that were exposed to critical peak pricing (CPP). The report analyzes two of the time-based rate consumer behavior studies to compare the CPP experiences of vulnerable populations vs. non vulnerable population.
Lawrence Berkeley National Laboratory. Recovery of Utility Fixed Costs: Utility, Consumer, Environmental and Economist Perspectives (2016). This report describes utility, consumer, environmentalist, and economist perspectives on fixed costs for electric utilities and their principles for recovering those costs.
National Association of Regulatory Utility Commissioners. Distributed Energy Resources, Rate Design, and Compensation. (2016). This manual from the National Association of Regulatory Utility Commissioners (NARUC) provides regulators with a comprehensive understanding of how DERs affect regulation, laying out the principles of rate design and compensation that relate to DERs.
National Renewable Energy Laboratory. Grid-Connected Distributed Generation: Compensation Mechanism Basics (2017). This report lists and describes metering and billing arrangements for grid-connected, behind-the-meter distributed generation systems.
Portland General Electric. Time of Use. (Not dated.) This is PGE's explanation of their time-of-use customer rates, explaining how customers may save depending on when they use their energy.
Regulatory Assistance Project. Why Rate Design is Important for Reducing Air Emissions. (2020). This presentation explains how good rate design can benefit air quality.
Utility Dive. An emerging push for time-of-use rates sparks new debates about customer and grid impacts (2019). This article describes time-of-use rates, time-of-use pilot programs, the intended benefits of time-of-use, and potential issues with time-of-use.
Zethmayer, Jeff, Ramandeep Singh Makhija. Using electricity customer profiles to combat GHG emissions: New evidence from ComEd AMI data (2021). This study created six typical customer-usage load profiles out of Illinois electricity customer data to gain insights on impacts of targeted programs for each customer profile in terms of emissions reductions through energy efficiency, weatherization, customer education, and demand response programs.

Resources on Customer Electricity Data Access

Title/Description
City Energy Project. Engaging Utilities for Access To Data (Not dated). The webpage from City Energy, a joint project of Natural Resources Defense Council and Institute for Market Transformation, provides how-to guides and case studies related to the ways cities can work with utilities on obtaining building energy use data. This resources includes template letters and forms.
Environmental Protection Agency. Data Access: A Fundamental Element for Benchmarking and Building Performance Standards (2021). This section of the EPA's Benchmarking and Building Performance Standards Toolkit explains data access and why it matters. It offers considerations for best practices for implementing data access policy and includes Data Access: Sample Policy Language for state and local governments looking to adopt benchmarking and building performance standards.
Environmental Protection Agency. Data Access: How to Compile and Deliver Aggregate Whole-Building Data (2021). This factsheet describes the steps utilities need to take to gather multi-unit building energy data and provide it to property owner upon request. Defines to "meter-to-building mapping."
Northeast Energy Efficiency Partnership. Advanced Metering Infrastructure: Utility Trends and Cost-Benefit Analyses in the NEEP Region (2017). This report reviews utility trends regarding costs and benefits assessed in advanced metering infrastructure proposals.

Resources on Regulatory Topics Affecting Rates and Data

Title/Description
National Association of Regulatory Utility Commissioners. Electric Vehicles: Key Trends, Issues, and Considerations for State Regulators (2019). This report explains trends in the changing electric vehicles market, issues that commissions may expect, and examples of how states are addressing electric vehicles issues, including through rate design.
National Energy Screening Project. National Standard Practice Manual for Benefit-Cost Analysis of Distributed Energy Resources (2020). This report provides a framework for utility companies and other stakeholders on the cost-effectiveness of energy efficiency and other distributed energy resources. The report describes developing cost-effectiveness tests that use the relevant impact measures.
Smart Electric Power Alliance. A Comprehensive Guide to Electric Vehicle Managed Charging (2019). This report explains managed electric vehicle charging, including benefits, utility program requirements, and the current regulatory landscape.
Smart Electric Power Alliance. EV Managed Charging: Lessons from Utility Pilot Programs (2019). This resource describes the challenges with the rapid increase of electric vehicles around the country and the impact it has on the electrical grid, including the availability of chargers. Explains the benefits of managed charging for consumers and society as a whole.

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