CLIMATE CABINET EDUCATION

RAP®

Pace Energy and Climate Center
ELISABETH HAUB SCHOOL OF LAW

RURAL ELECTRIC COOPERATIVES AND THE TRANSITION TO A CLEAN ENERGY FUTURE

A Guide for Cooperative Leaders

Climate Cabinet Education combines data science with policy expertise, local partnerships and cross-state experience to support climate leadership in local governments across the US — working towards a clean energy economy that creates jobs, improves community health, and unlocks local opportunity and leadership.

The Regulatory Assistance Project (RAP)® is an independent, global NGO advancing policy innovation and thought leadership within the energy community. RAP provides clarity, vision and new ideas to decision-makers and the broader energy community, by developing and sharing global best practices tailored to local priorities, acting as a trusted advisor to promote implementation. Our team focuses on the world's four largest power markets, responsible for half of all power generation: China, Europe, India, and the United States. raponline.org

Ken Colburn retired as RAP's director of US programs in 2020. He continues to contribute to the clean energy transition part-time through his LLC, Symbiotic Strategies.

The Pace Energy and Climate Center is a project of the Elisabeth Haub School of Law at Pace Universiy. More than a think tank, the Pace Energy and Climate Center turns ideas into action. We believe thoughtful engagement of government and key stakeholders leads to better public policy. We conduct research and analysis on legal, regulatory and policy matters because thorough, objective analyses are essential to finding solutions to today's complex energy and climate change challenges. We are lawyers, economists, scientists, and energy analysts, committed to achieving real-world progress. For more information, visit energy.pace.edu or contact pecc@law.pace.edu.

Pleiades Strategy works with mission-driven leaders striving to build an open, democratic, climate-safe future rooted in justice and equity. Experienced in policy research, communications, and partnership development, we assist organizations in understanding and shaping the policy landscape to accelerate the clean energy future and realize energy justice. We are deep systems thinkers who relish bringing clarity to complex situations through listening, strong communications, and collaborative building. We operationalize big ideas and thrive when working on multidisciplinary challenges in fast-moving, dynamic environments.

Authors, Researchers and Contributors:

Regulatory Assistance Project (lead author)
- Megan Anderson
- Camille Kadoch
- Ken Colburn
- Ruth Hare
- Donna Brutkoski

Pace Law
- Janine Midgen-Ostrander
- Craig Hart
- Jessica Laird

Climate Cabinet Education
- Emma Fisher
- Nick Arnold
- Ethan Kirkham

Pleiades Strategies
- Frances Sawyer

Acknowledgements:

We would like to acknowledge and thank the many people who reviewed and provided insights for this toolkit, including:
- Erik Hatlestad, CURE
- Gabe Pacyniak, University of New Mexico School of Law
- Matthew Popkin, RMI
- Lauren Shwisberg, RMI
- Katerina Stephan, RMI
- Dr. Leah Stokes, Rewiring America
- Rick Weston, Regulatory Assistance Project
- And many others

Design: Tim Newcomb, Newcomb Studios

B. Capture Demand-Side Flexibility

Rural electric cooperatives are required to provide member-owners with reliable energy around the clock. To do so, the cooperative matches energy supply with the highest expected energy demand that may be needed at a given time. The need for supply at these high demand times means that at times of low demand, typically nighttime hours, excess energy capacity is available. It also means that there are times of high demand on the grid each day, similar to rush-hour traffic. High-traffic energy times occur predictably in the late afternoon and early evening when people start returning home and using air conditioners, cooking, watching TV and doing laundry, while commercial buildings and offices are still open and industry is operating.

In addition to daily peaks of energy usage, there are also extreme events, usually due to weather, such as very hot summer days or extreme winter storms, that can stress the grid, causing member-owners to use more energy than usual to heat or cool their buildings. These events can lead to demand that exceeds the utility's available energy supply. Unresolved, this mismatch between energy supply and demand can lead to brownouts and blackouts.

Different options are available to cooperatives to fill both daily peak demand and these periodic, unexpected shortfalls of energy supply. Historically, cooperatives or their G&T built excess generation that could be called upon during times of grid stress. Many utilities have built (or kept old) power plants known as peaker plants, which are rarely called upon but are available when the grid approaches maximum capacity. Using peaker plants is a costly option, both in terms of finances and environmental impacts; peaker plants have high fuel costs when operated, so the power they supply can be very expensive. Additionally, if they are older plants that are mothballed and kept mainly to meet periodic energy shortfalls, they may not meet current emissions requirements but are nevertheless allowed to run in emergency situations.[87] An alternative supply option is for a utility to purchase power if it is in a regulated market.

A more efficient approach involves managing demand to more fully utilize existing grid capacity and

87 This practice is known as "reliability must run" exceptions.

to effectively integrate interconnected devices to create a smart two-way grid. In short, to meet these variations in supply and demand, cooperatives can engage their member-owners. Member-owners can be encouraged to change or shift the time they use energy through time-varying pricing and demand management programs, which are discussed below. The pricing policy can also encourage member-owners to invest in distributed energy resources, which cooperatives can encourage by providing net metering. Pricing and demand management programs can also shift the energy load of member-owners' electric vehicles or space or water heaters to absorb excess renewable energy. Further, cooperatives can offer energy efficiency programs — the most effective option to decrease peaks and manage demand.

Policies that are used to engage member-owners to capture demand-side flexibility include:

- Demand management programs (load flexibility or "load shaping").
  Time-varying pricing.
  Net energy metering and interconnection policies.
  Beneficial electrification programs.

These policies are not meant to be used in isolation, and they work well together. For example, time-of-use (TOU) pricing is a rate design that may be incorporated in demand management and beneficial electrification programs.

1. Managing Demand to Realize Utility and Member-Owner Benefits

A key to realizing system flexibility is to successfully engage member-owners. Because shaping energy demand previously was not technologically possible, cooperatives have not focused on methods to engage member-owners or communicate grid needs. Now, changes in technology allow the member-owners to save money and the utility to make the most effective use of grid assets through demand management.

Demand management[88] occurs when member-owners intentionally reduce or shift their electricity usage in response to a signal from the utility, usually with financial incentives to do so. Historically, the technology has not been available to store energy or shift energy use. Consequently, management of the grid was largely a one-way option — namely, to build more power generation to meet peak load requirements. Today, rather than dispatching supply to

Benefits of demand management

- Reduces peak demand by an average of at least 10%.[89] This reduction:
  - Saves customers money.
  - Enables the cooperative to avoid or defer the need to build or purchase additional generation capacity, which also leads to savings for customers.
  - Provides environmental benefits through reduced emissions, particularly if demand is able to be shifted to times when cleaner generating sources are abundant.[90]
- Helps integrate zero-emissions electric generation and end uses.
  - The flexibility of demand management enables the integration of variable energy resources like wind and solar by shifting electric vehicle charging and appliance use to times when these resources are abundant.
- Reduces greenhouse gas emissions.
  - When demand management programs reduce peak load, they also help to reduce air pollutants from existing fossil-fueled generating sources.
  - Demand management programs can provide flexibility to support growth of zero-emissions generation.[91]

88 Demand management has been known by various terms over the decades, including demand response and demand-side management. "Demand response" is a historical term used when such programs were used to provide cost-effective energy and capacity resources to help defer the need for new sources of power, including generating facilities, power purchases and transmission and distribution capacity additions. However, due to changes that are occurring within the industry, electric utilities are also using demand management or demand-side management as a way to enhance customer service. See U.S. Energy Information Administration. (n.d.). *Electric utility demand side management.* https://www.eia.gov/electricity/data/eia861/dsm/

75 Nadel, 2017.

76 Hurley, D., Peterson, P., & Whited, M. (2013). *Demand response as a power system resource.* Regulatory Assistance Project. https://www.raponline.org/wp-content/uploads/2016/05/synapse-hurley-demandresponseasapowersystemresource-2013-may-31.pdf

77 National Association of Clean Air Agencies. (2014). Improve demand response policies and programs. Chapter 23 in *Implementing EPA's clean power plan: A menu of options.* https://www.4cleanair.org/wp-content/uploads/Documents/Chapter_23.pdf

meet uncontrolled demand, technology advances allow management of the demand side to meet available supply. Demand management is not new, but traditional demand response programs focused on simply shedding load during periods of grid stress. Today, demand management includes the ability to respond to other grid needs. Now, average residential customers are increasingly able to control their energy usage through efficiency upgrades and energy management tools and even to become grid resources themselves through behind-the-meter solar or storage. The ability for demand to play a role in balancing grid operations is a fundamental shift from the 20th-century era of large, centrally operated generating plants.

Managing the demand for electricity is now an option that can be utilized to make more efficient use of the grid, reduce member costs and reduce environmental harm. Demand management programs are common and are fairly simple to implement. They rely on two types of mechanisms: (1) sending quantity signals to member-owners' appliances and devices (direct load control programs) and (2) sending price signals to member-owners to alter their consumption habits (time-varying rates). Utilities, municipalities and electric cooperatives have used these types of programs for decades.

Demand management programs today can provide load flexibility over different time frames, as illustrated in Figure 5.[92] It is useful to think about these types of flexibility within the time frames they can operate, moving from the longest span of years and days for shaping down to time frames of minutes and even seconds for shimmying.

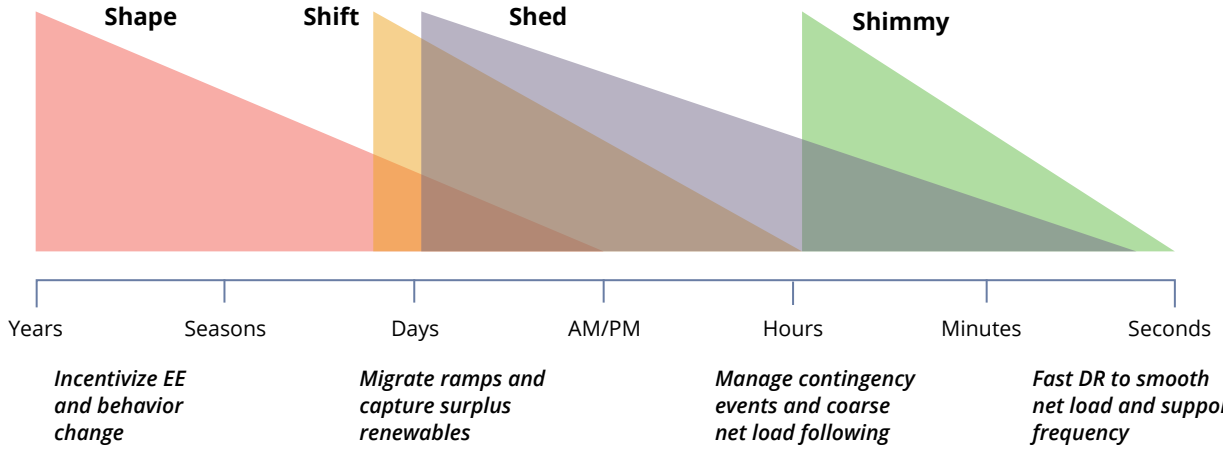
In practical terms, this means demand management can shape load away from expensive peaks. It can then shift load and grow load at times when renewable energy is available and energy is less expensive. It can shed load in a controlled manner during critical energy events, and it can shimmy load back and forth to meet short-term grid needs. EV charging is an example of a technology that can shimmy because it can occur all at once or can be turned on and off as the need arises.[93]

a. Methods to Obtain Flexibility

Encourage member-owners to shift load through time-based rates.

Methods of engaging member-owners in demand management efforts include offering **time-based rates**. Member-owners are able to see the cost savings they can achieve if they reduce air-conditioning load, turn off lights or program their dishwasher or washing machine

Figure 5. **Shape, shift, shed and shimmy — time frames of flexibility**



Source: Alstone, P., Potter, J., Piette, M. A., Schwartz, P., Berger, M. A., Dunn, L. N., Smith, S. J., Sohn, M. D., Aghajanzadeh, A., Stensson, S., Szinai, J., Walter, T., McKenzie, L., Lavin, L., Schneiderman, B., Mileva, A., Cutter, E., Olson, A., Bode, J., … Jain, A. (2017). *2025 California Demand Response Potential Study — Charting California's Demand Response Future: Final Report on Phase 2 Results*

92 Alstone, P., Potter, J., Piette, M. A., Schwartz, P., Berger, M. A., Dunn, L. N., Smith, S. J., Sohn, M. D., Aghajanzadeh, A., Stensson, S., Szinai, J., Walter, T., McKenzie, L., Lavin, L., Schneiderman, B., Mileva, A., Cutter, E., Olson, A., Bode, J., … Jain, A. (2017). 2025 *California demand response potential study — Charting California's demand response future: Final report on Phase 2 results* (LBNL-2001113), Figure 19. Lawrence Berkeley National Laboratory. https://eta.lbl.gov/publications/2025-california-demand-response

93 Linvill et al., 2019.

to less expensive, off-peak times of day. Examples of demand management in response to price signals include dynamic pricing programs, peak-time rebates, smart EV charging and smart thermostat programs. (For more detail, see Section II-B-2, "Time-varying pricing.")

Encourage member-owners to control load through smart devices that can respond to smart rates.

Controllable load, often electrified load, means that virtually all major household electricity uses can be at least partly shifted away from peak periods using smart, responsive technologies. Smart thermostats make it possible for heating and cooling uses to participate in programs like Google Nest's Rush Hour Rewards, which provide incentives to customers that let their thermostat automatically be turned down by a very small amount during peak times.[94] Electric vehicles are a controllable load and can be set to charge at certain times or price points. Grid-integrated water heaters can respond to signals from the utility or demand-side aggregator, and major appliances, such as the refrigerator, dishwasher, washer and dryer, can be grid interactive or scheduled.[95] Smart customer systems such as in-home displays or home area networks can make it easier for member-owners to change behavior and reduce peak period consumption. These programs also have the potential to help the utility save money through reductions in peak demand, which in turn enables the cooperative to defer construction of new power plants.[96] The load avoided for a single home may be small, but when many members participate, it creates a large reduction in energy demand for the cooperative.[97]

Advanced metering infrastructure (smart meters) expands the types of time-based rate programs that can be offered to member-owners.[98] The ability to institute various types of time-varying pricing is somewhat dependent on the types of meters used. Retail electricity meters are now available in a spectrum of complexity and capability. Simple conventional meters measure only kWh consumption and are read at intervals, such as monthly, to note the member-owners' consumption since the last reading. These meters are not able to provide time-of-use price signals. Somewhat more complex meters are capable of not only recording kWh consumption but also of dividing that usage between two or a few preset time periods (a TOU meter), recording the peak load since the previous reading (a demand meter) or both.

At the other end of the metering spectrum, advances in communications and digital technology are bringing down the costs of advanced metering infrastructure and smart meters for the mass market. These innovations are increasing opportunities to send not only long-term average price signals (already possible using conventional meters) but also price signals that reflect weekly, daily, hourly or even real-time variability in system costs and conditions and to record customer usage over time intervals as short as five minutes. Today, just over half of the public power meters installed in the United States are smart meters.[99] Installation of smart meters is just the start, as merely installing smart meters does not alone facilitate advanced pricing; meter data management systems investments, billing engine modifications and rate studies are needed to develop advanced pricing.

Manage member-owners' load for them through utility direct load control.

Demand management also includes **direct load control programs** which allow a cooperative or private aggregators to directly alter a member-owner's energy consumption during periods of peak demand in exchange for a financial incentive and lower electric bills for the members.[100] Radio or internet-controlled switches on residential air conditioners or electric water heaters are but one of many methods used.[101]

---

94 Linvill et al., 2019.

95 Linvill et al., 2019.

96 U.S. Department of Energy, Office of Electricity. (n.d.-a). *Demand response.* https://www.energy.gov/oe/activities/technology-development/grid-modernization-and-smart-grid/demand-response

97 Budhiraja, D. (2019, January 24). Demand response 101: *Understanding how utilities balance energy supply & demand.* GridPoint. https://www.gridpoint.com/understanding-demand-response/

98 New Hampshire Electric Cooperative, for example, used advanced metering infrastructure to determine whether it could offer lower rates to certain member segment that were already less expensive to serve. Bidgely. (2022). *Advanced rate design with analytics: A New Hampshire Electric COOP case study.* https://www.bidgely.com/resources/advanced-rate-design-nhec-whitepaper/?utm_campaign=2022-03-02-UD&utm_medium=utilitydive&utm_source=ud-email&utm_content=NHEC-Case-Study-WP

99 Zummo, P. (n.d.). *Moving public power forward.* American Public Power Association. https://www.publicpower.org/system/files/documents/Moving-Public-Power-Forward-Community-Driven-Solutions-for-Industry-Transformation_0.pdf

100 U.S. Department of Energy, Office of Electricity, n.d.-a.

101 U.S. Department of Energy, Office of Electricity. (n.d.-b). *Demand response — Policy.* https://www.energy.gov/oe/services/electricity-policy-coordination-and-implementation/state-and-regional-policy-assistanc-4

Direct load control programs represent some of the initial approaches to demand management that existed prior to much of the technology that is available today. These programs result in overall savings for the cooperative and an incentive payment for participating member-owners.[102] The majority of direct load control programs are for residential central air-conditioning switches, but some offer a credit for each controlled electric appliance the member-owner registers with the utility. Electric water heaters and pool pumps are also commonly incentivized with fixed bill credits and cycled by the utility in a similar manner. With air-conditioning, when the cooperative expects a high peak load day due to very warm weather forecasts, it will notify the member-owner in advance. When energy demand peaks, the utility will send a signal to a member's air conditioner (or other appliance) that causes it to operate for a shorter period of time.

A common feature among direct load control programs is that member-owners have a choice between the level of service interruption they will accept and the amount of an incentive they receive. Typically, these are directly variable: The more interruption a member-owner will tolerate, the higher the incentive. Residential direct load control programs with cycling options and fixed monthly bill credits offer a simple and understandable method for member-owners to reduce their addition to peak load without tying the benefit to abstract concepts like kW demand charges or kWh shifting. Until recently, cooperative direct load control programs have been enabled by a control switch installed on an individual appliance, but with advances in technology, cooperatives are now able to use programmable communicating thermostats to control household energy use.

In some areas, access to high-speed broadband is a barrier to implementing some demand respond and direct load control solutions. Cooperatives are addressing this hurdle through the installation of internet solutions, which both open new economic opportunities and energy solutions for communities.

Obtain flexibility through regional markets.

Planning and market processes are another tool for adding fflexibility to the power system. In regions with a regulated market, more innovative uses of demand management are able to bid into the market to maintain reliability by providing capacity or energy reductions or to reduce wholesale electricity prices and provide economic benefits.[103] Cooperatives may also be able to work with demand management aggregators to bid demand management programs into a regulated market and provide further economic benefit to cooperative members.[104]

b. Important Elements of Successful Demand Management Programs[105]

Experience reveals several key elements to successful demand management program design and implementation, which include the following.

- **Member education.** Not only does education through effective marketing enable meaningful demand reduction, it also leads to improved member-owner satisfaction in both the program and the cooperative. Member-owner education is key toward ensuring that demand response mechanisms are properly used by members to optimize the results. Cooperatives should prepare a budget specifically for member education.
- **Incentives and tools.** The cooperative must provide member-owners with incentives to participate and the tools needed to achieve savings. Member-owners are more likely to participate when:
  - They earn a reward, so it is important to show them their measurable savings.
  - The cooperative provides physical hardware such as thermostats and switches, as well as reliable communication of peak events and tips on how and when to conserve energy.
  - The cooperative provides immediate feedback on how much member-owners saved following a peak event.
  - The cooperative shows member-owners their savings on their monthly bill.
    - For direct load control programs, a set monthly bill credit (i.e., $4 during summer months) rather than a varying rate discount gives the member-owners confidence in future savings.
    - For TOU rates, the cooperative should use historical member-owner data to calculate the

102 Customers respond to utility signals, often with very limited notice, and most often using preheated or cooled water.

103 National Association of Clean Air Agencies, 2014.

104 National Association of Clean Air Agencies, 2014.

105 State of Michigan. (n.d.). Common demand response practices and program designs. https://www.michigan.gov/documents/energy/Common_Practices_Feb22_522983_7.pdf

potential impact.

- Multiple demand management programs are marketed together (i.e., a direct load control switch and TOU rate) rather than in separate marketing campaigns, which can reduce program costs.
- Third-party demand management program administrators participate, which provides greater variety in program design and limits the cooperative's exposure to program-related risks, such as marketing, hardware and software updating costs.
- TOU rates are the default rate for eligible member-owners (i.e., smart-metered members); this leads to very high participation.

There are some important considerations beyond reflecting costs when designing demand management programs and TOU rates. Usually, demand management programs decrease emissions. However, demand management based on price signals can shift usage from one time period that has generation with lower emissions to another time period when generation has higher emissions. Cooperatives can design the program to avoid this result by considering not only peak periods but also to send price signals to shift demand to times when generation is cleaner, such as when wind or solar resources are plentiful. Awareness of the generation resources available during certain periods of the day and night and providing demand management signals to member-owners to shift load to beneficial times will yield both economic and environmental benefits.

Demand management programs can provide an excellent opportunity to reduce peak demand and cut costs by avoiding the need for expensive peaking capacity. Great River Energy in Minnesota has long been a proponent of the flexibility and energy storage benefits of water heaters. Great River touts access to the "Midwest's largest battery," namely access to the electric water heaters located in the basements of 110,000 Minnesota homes. Great River Energy is promoting the idea of "community storage," which uses aggregated electric water heaters to build local energy-storage capability.[106] Additionally, Great River offers member-owners load management opportunities for air conditioning, water heating, space heating, EVs, interruptable irrigation and commercial and industrial uses.[107]

Program administration: The third-party option

Third-party administrators can be a valuable resource for cooperatives that do not have the specific expertise or staff resources to take on new projects. The third party can be a contractor hired by the cooperative to administer energy efficiency or demand management programs, or it can be an independent company that is authorized to perform the services. Payment can be made by the cooperative's including this cost in its budget, or payment can be made based on the administrator keeping a percentage of the savings or some combination thereof, such as payment of the cost for the service with the profit or return coming from a percentage of the savings. For a third-party administrator under contract and paid directly, the cooperative can add requirements such as using a local workforce to implement the program. Where it is an independent company that provides the services, it will be important for the cooperative to work with the company to provide it with the data it needs. The cooperative will need to develop protocols for addressing member privacy; many utilities have done this already. In fact, the U.S. Department of Energy launched in 2012 its Smart Grid Data Privacy Voluntary Code of Conduct, which provides guidance on balancing data needs and customer privacy.

Useful Resources on Customer Data

Navigant Consulting. (2015). *Value of Customer Data Access: Market Trends, Challenges, and Opportunities.* National Association of Regulatory Utility Commissioners. https://pubs.naruc.org/pub/536E2D7C-2354-D714-5129-435231D889E0

U.S. Department of Energy & Office of Electricity. (n.d.). *DataGuard Energy Data Privacy Program.* https://www.energy.gov/oe/activities/technology-development/grid-modernization-and-smart-grid/dataguard-energy-data-privacy

106 Great River Energy. (n.d.-a). Community storage. https://greatriverenergy.com/smart-energy-use/beneficial-electrification/community-storage/

107 Great River Energy. (n.d.-b). Load management programs. https://greatriverenergy.com/smart-energy-use/demand-response/great-river-energy-load-management-programs/

Useful Resources on Demand Management

Alstone, P. Potter, J., Piette, M. A., Schwartz, P., Berger, M. A., Dunn, L. N., Smith, S. J., Sohn, M. D., Aghajanzadeh, A., Stensson, S., & Szinai, J. (2016). 2015 *California Demand Response Potential Study – Charting California's Demand Response Future: Interim Report on Phase 1 Results.* Lawrence Berkeley National Laboratory (LBNL-2001115). https://eta.lbl.gov/publications/2015-california-demand-response

Hurley, D., Peterson, P., & Whited, M. (2013). *Demand Response as a Power System Resource.* Regulatory Assistance Project. https://www.raponline.org/wp-content/uploads/2016/05/synapse-hurley-demandresponseasapowersystemresource-2013-may-31.pdf

Linvill, C., Lazar, J., Littell, D., Shipley, J., & Farnsworth, D. (2019). *Flexibility for the 21st Century Power System.* Regulatory Assistance Project. https://www.raponline.org/knowledge-center/flexibility-for-the-21st-century-power-system/

Michigan New Energy Policy. (n.d.). *Common Demand Response Practices and Program Designs.* https://www.michigan.gov/documents/energy/Common_Practices_Feb22_522983_7.pdf

National Association of Clean Air Agencies. (2014). Improve Demand Response Policies and Programs. Chapter 23 in *Implementing EPA's Clean Power Plan: A Menu of Options.* https://www.4cleanair.org/wp-content/uploads/Documents/Chapter_23.pdf

Examples of cooperative demand response programs:

- Great River Energy. *Member Cooperative Load Management Programs.* https://greatriverenergy.com/smart-energy-use/demand-response/great-river-energy-load-management-programs/
- Minnkota Power Cooperative. *Rebates & Energy Incentives.* https://www.minnkota.com/our-programs/rebates-energy-incentives
- North Carolina's Electric Cooperatives. *Advanced Grid Operations.* https://www.ncelectriccooperatives.com/energy-innovation/grid-operations/
- Northern Electric Cooperative. *Understanding Demand and the Monthly Co-incident Billing Peak.* https://www.northernelectric.coop/loadmanagement

2. Time-varying pricing

Rate design refers to the elements of electricity prices that form the basis of member-owners' bills. For most retail and small commercial member-owners, the designed rate typically appears on a monthly utility bill as a fixed monthly charge and a usage component, which is generally a per-kWh charge.[108] Most member-owners rates are still flat rates, meaning that the amount members pay does not vary across the day, and member-owners pay the same price per kWh no matter how much electricity they use during peak times. A flat rate does not accurately reflect the changes in cost that the cooperative faces to serve member-owners over the course of the day.

Time-of-use electricity pricing, one of many types of time-varying pricing options, provides better price signals to member-owners by more accurately aligning rates to cooperative costs. It gives members the opportunity to take control of their energy use and electricity bills. TOU pricing enables people to choose when they power up appliances or electric vehicles based on electricity prices and to make decisions that can both save them money and reduce harmful pollution. In contrast to rates that do not change with the time of day, TOU rates give member-owners a view of varying electricity costs so they can plan ahead to avoid expensive time periods. By paying more attention to the timing of energy use, or programming charging devices to do so, members could have a new means of lowering energy bills and reducing the strain on the electric grid, while the cooperative gains flexibility in supply options.

A public power example that puts this theory into action is from Fort Collins, Colorado, where the municipal utility adopted a residential rate that is well designed because it allows customers to achieve bill savings through shifting their load. The utility moved all residential customers to TOU rates that have a very low off-peak rate and a peak rate that is three times higher than the off-peak rate. This incentivizes energy usage in off-peak hours. It also has a tier charge that applies to all usage over 700 kWh per month, which also provides an energy conservation incentive (see Table 2).[109]

108 Lazar, J. (2013). *Rate design where advanced metering infrastructure has not been fully deployed.* Regulatory Assistance Project. https://www.raponline.org/knowledge-center/rate-design-where-advanced-metering-infrastructure-has-not-been-fully-deployed/

109 City of Fort Collins. (n.d.). *Residential electric rates.* https://www.fcgov.com/utilities/residential/rates/electric/. The Fort Collins rate is beneficial for several reasons. First, by moving all customers onto the TOU rate as a default, the utility maximizes the benefits but still allows those who want to opt out the ability to do so. The rate is useful because, first, the low customer charge increases the amount that a customer can change the bill. Second, the very low off-peak rate creates noticeable bill savings for switching usage to that period. Third, setting the peak rate at three times the off-peak rate signals the extra costs to the utility during peak hours. See Linvill et al., 2019.

Table 2. **Fort Collins, Colorado, residential time-of-use rate**

Customer charge	$6.78	
	Summer	**Winter**
Off-peak	$0.069	$0.067
On-peak	$0.241	$0.216
Tier charge (0ver 700 kWh)	+0.0194/kWh	

Source: City of Fort Collins. (n.d.). *Residential Electric Rates*

a. Member-owners and TOU

What does TOU pricing mean for member-owners? When Sacramento Municipal Utility District implemented TOU pricing, people reported greater satisfaction with this plan compared to existing electricity rates, noting that TOU provides "fairer pricing" and "more opportunities to save money."[110] However, some member-owners are unable to shift demand as much as others to realize lower rates, particularly the elderly, those with disabilities and low-income households. Low-income customers still saved money under TOU rates but less than average customers. TOU rates have the potential to achieve big system benefits and many customer benefits, but for those living in leaky homes with old, inefficient appliances, those benefits are far harder to realize. Utilities build into their rates the risk of recovering their costs for procuring power during periods of high peak usage. TOU rates help mitigate that risk and can reduce the price member-owners pay.

With strong supporting policies, TOU rates can be implemented and ensure that all communities can participate in the benefits. These supporting implementation procedures include the following.[111]

Prioritize vulnerable member-owners for energy efficiency, electrification and appliance upgrade programs. Vulnerable populations, such as low-income members, elderly people and people with disabilities, may find TOU rates to be more expensive because of leaky, inefficient homes and old appliances. Cooperatives should specifically reach out to these members with weatherization and appliance upgrade programs and prioritize these members for energy efficiency and electrification programs. Note also that upgraded appliances may include timers, which allow member-owners to set an appliance, such as a washing machine or dishwasher, to operate after they have gone to bed. This is especially useful for disabled people and older adults.

Provide bill protection for up to one year. Cooperatives may want to implement bill protection whereby members will not face bill increases under a TOU rate for a period of time, preferably up to a year. This allows members to benefit from TOU savings if they are able but will not harm those who find themselves unable to adequately shift consumption during peak hours. This lead time enables members to see if they are able to shift their usage. If they are not, they have time to opt out of the program. A variant on this approach is shadow billing, where a member remains in the non-TOU program but receives a shadow bill showing what they would have paid using TOU rates. The cooperative could allow members to opt in to the program sooner and then make the program mandatory after a period of time.

Start with opt-in TOU policies with customer education. Most TOU policies are voluntary and apply only to members who opt in. Member-owner education about TOU policies and the effect of the policies is incredibly important to help members understand their current bill and the effect of TOU rates. Shadow billing, discussed above, is an effective tool to help members see the effect on them of TOU rates. Education on behavioral changes to receive more benefits under TOU rates is also important.

Allow TOU policies to be opt-out. As noted above, most TOU programs are opt-in; however, few member-owners do, particularly where member education on the benefits of TOU is poor. Thus, education about how the program works is the most critical step to encouraging more member-owner participation and ensuring that members understand how to use the program to their advantage. Putting members on TOU without them understanding how it works can have adverse consequences when they start getting bills that are higher because they did not properly use the TOU rate. Allowing members to opt out provides an important option to ensure equitable outcomes from more advanced electricity pricing, particularly for low-income renters. Opt-out provisions are preferable from

95 Environmental Defense Fund. (n.d.). *Time-of-use electricity pricing: Savings when they matter* [Factsheet] https://www.edf.org/sites/default/files/ca_tou_fact_sheet_091514.pdf

96 For more information on the suggestions referenced here, see Spiller, B. (2020, March 9). *How we can make time of use pricing work for everyone.* Environmental Defense Fund. http://blogs.edf.org/markets/2020/03/09/how-we-can-make-time-of-use-pricing-work-for-everyone/

a system benefits and cost-savings perspective because they drive cost-effective behavior, and members tend to change their behavior rather than opt out.

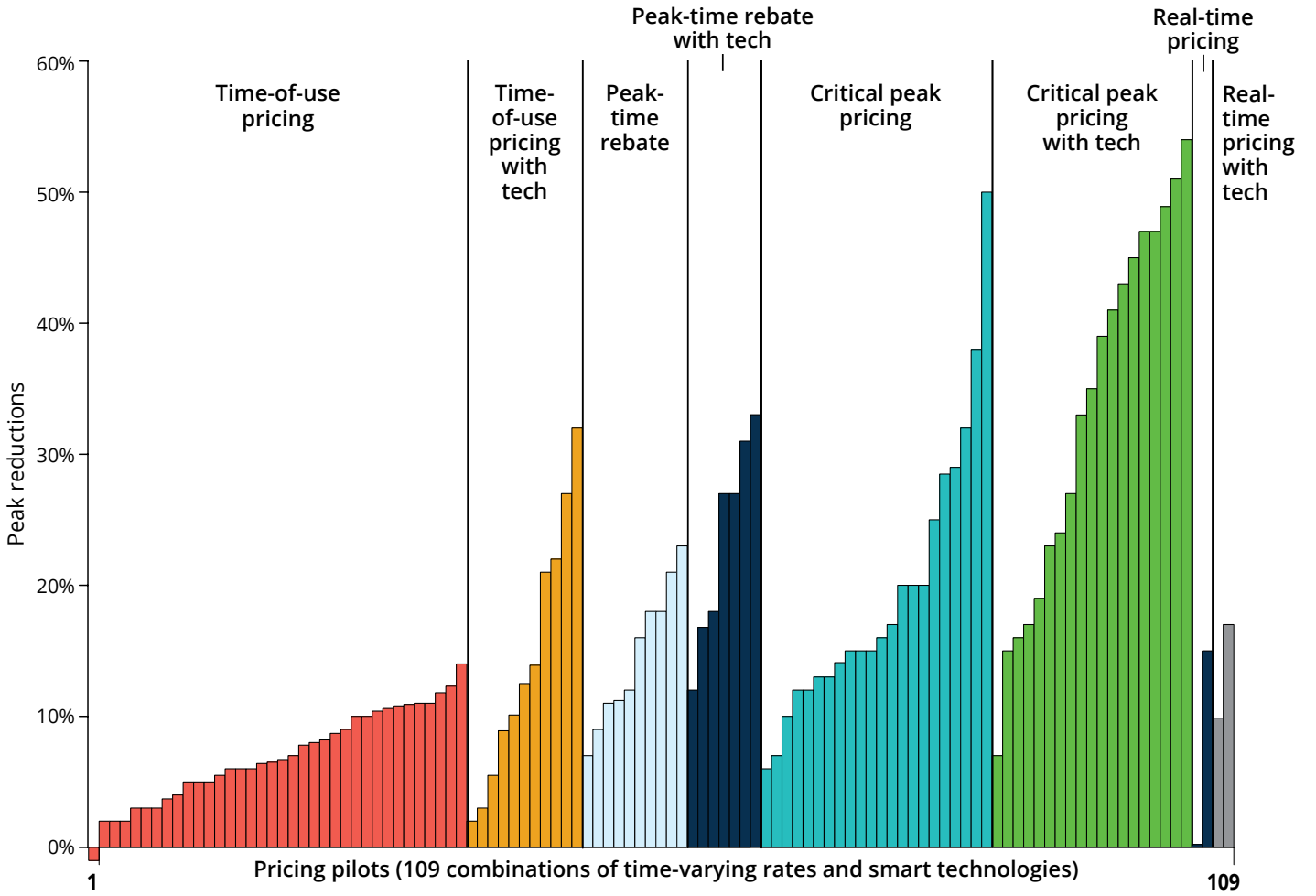
Ensure TOU rates are actionable. For TOU rates to be most effective at reducing consumption during peak hours, the price difference of peak to off-peak needs to be significant and the length of the peak hours manageable.[112] For example, peak hours cannot be so long that member-owners find it difficult to comply, and members must see real financial benefit to switching to off-peak hours. TOU time blocks should provide ample space for members to shift away from peak times and benefit from a greater number of low-cost hours.

b. Forms of Time-Based Rate Programs

The options for electricity pricing based on time of use include the following.[113]

- **Time-of-use pricing.** This pricing typically applies to usage over broad blocks of hours (e.g., on-peak equals six hours for summer weekday afternoon; off-peak equals all other hours in the summer months) where the price for each period is predetermined and constant. Rough time-varying blocks can be accomplished with traditional meters.
- **Real-time pricing.** These rates fluctuate hourly based on the hourly price of electricity.
- **Variable peak pricing.** This pricing is a hybrid of time-of-use and real-time where the different periods for pricing are defined in advance (e.g., on-peak equals six hours for summer weekday afternoon; off-peak equals all other hours in the summer months), but the price established for the on-peak period varies.
- **Critical peak pricing.** These substantially increased prices occur during periods when cooperatives observe or anticipate power system emergency conditions or a specific critical time period (e.g., 3 p.m.

Figure 6. **Average peak reduction under time-varying rate pilot programs**



Source: Faruqui, A., Hledik, R., & Palmer, J. (2012). *Time-Varying and Dynamic Rate Design*

112 Spiller, 2020.

113 Smart Grid. (n.d.). *Recovery act: Time based rate programs.* https://www.smartgrid.gov/recovery_act/time_based_rate_programs.html

to 6 p.m. on a hot summer weekday). Two variants of this type of rate design exist: one where the time and duration of the price increase are predetermined when events are called and another where the time and duration of the price increase may vary based on the electric grid's need to have loads reduced.

- **Critical peak rebates (also known as peak-time rebates).** These refunds are made to the member-owner at a single, predetermined value for any reduction in consumption during a utility-declared critical event, relative to what the utility deemed the member was expected to consume. The price for electricity during these time periods remains the same.

Figure 6 shows the average peak reduction from various pricing models in pilot programs.[114]

Among variable rate pricing options, TOU pricing is the most common and the easiest to implement. Studies have found that TOU rates can lead to demand reductions of 16% and average reductions in consumption of 2.1%, which can also provide customer savings.[115]

Useful Resources on Time-Varying Pricing

American Public Power Association. (n.d.). *Moving Ahead with Time of Use Rates.* https://www.publicpower.org/system/files/documents/Moving-Ahead-Time-of-Use-Rates.pdf

Colgan, J., Delattre, A., Fanshaw, B., Gilliam, R., Hawiger, M., Howat, J., Jester, D., LeBel, M., & Zuckerman, E. (2017). *Guidance for Utilities Commissions on Time of Use Rates.* https://votesolar.org/wp-content/uploads/2020/12/TOU-Paper-7.17.17.pdf

Huber, L. (n.d.). *TOU Pilot Strategies and Lessons.* Strategen Consulting. https://e21initiative.org/wp-content/uploads/2018/01/e21_Forum_TOUPilotBestPractices_5.05.17.pdf

Lazar, J., & Gonzales, W. (2015) *Smart Rate Design for a Smart Future.* Regulatory Assistance Project. https://www.raponline.org/knowledge-center/smart-rate-design-for-a-smart-future/

U.S. Department of Energy. (2016, November 16). *Final Report on Customer Acceptance, Retention and Response to Time-Based Rates from the Consumer Behavior Studies.* https://www.smartgrid.gov/document/CBS_Results_Time_Based_Rate_Studies.html

3. Net Metering

Net metering is a policy that allows member-owners with their own on-site generation capacity (e.g., rooftop solar) to be financially compensated by their by their cooperative for the energy they produce. Net metering, also called net energy metering, is widely regarded as having an important role in deployment of distributed generation, especially solar energy. Depending upon state law, cooperatives may have the authority to establish net-metering policies.[116] Net metering has been very successful at increasing the amount of distributed resources, but as it has increased and as utilities develop more and more of their own renewable resources, it has also posed challenges for some cooperatives. Planning processes will help the utility to prepare for the increase in member-owners generation (whether through residential solar rooftops or through larger distributed generation facilities) and to determine the amount and location of additional distributed generation resources that could be useful to the distribution grid.

Net metering allows cooperative members with on-site generation sources, such as solar PV, to offset the electricity they draw from the grid. The cooperative member pays for the net energy consumed from the utility grid. If the amount of electricity the member's system produces is more than the amount of electricity that member can use, the excess amount is exported to the cooperative's electric grid. If the net-metering member uses more electricity than the distributed generation system produces, the member imports electricity from the grid and pays the full retail rate for that electricity, just like a traditional cooperative member.[117]

Net metering requires either a single bidirectional meter (with an optional export validation meter, if gross generation measurements are desired) or two unidirectional meters. Today, net metering is the most commonly used tariff design for customers who have solar PV or any other customer-owned generation resources.[118]

114 Faruqui, A., Hledik, R., & Palmer, J. (2012). *Time-varying and dynamic rate design.* Regulatory Assistance Project. https://www.raponline.org/knowledge-center/time-varying-and-dynamic-rate-design/

115 Baatz, B. (2017, March). *Rate design matters: The intersection of residential rate design and energy efficiency.* American Council for an Energy-Efficient Economy. https://www.aceee.org/sites/default/files/publications/researchreports/u1703.pdf

116 Congressional Research Service. (2019, November 14). *Net metering: In brief.* https://sgp.fas.org/crs/misc/R46010.pdf

117 National Renewable Energy Laboratory. (n.d.). *Net metering.* https://www.nrel.gov/state-local-tribal/basics-net-metering.html

118 Zinaman, O., Aznar, A., Linvill, C., Darghouth, N., Dubbeling, T., & Bianco, E. (n.d.). *Grid-connected distributed generation: Compensation mechanism basics.* National Renewable Energy Laboratory. https://www.nrel.gov/docs/fy18osti/68469.pdf

Net metering benefits and challenges

Utilities in the United States first began offering net-metering tariffs in the early 1980s. In those early days, digital smart meters were not available. Limitations in metering capabilities, paired with billing system challenges and the desire to keep tariffs simple enough for member-owners to easily understand, led to the design of what we will call traditional net metering tariffs. Many U.S. utilities still offer traditional tariffs today. However, smart meters are now widely available that are capable of monitoring net exports and net imports of energy in small time intervals for use in a variety of distributed generation tariff designs, including those relying on time-varying rates. A growing number of utilities, including cooperatives (and the public utility commissions and legislatures that regulate them), are considering alternatives to traditional net metering. Net metering has successfully encouraged more members to install distributed generation. Net metering experience in states with high distributed energy adoption indicates that adding large amounts of these resources will cause system demand to shift, which can in turn shift peak periods and periods with significant ramping. Time-of-use rates and the redefinition of the peak period have proven to be important tools to fully utilize the higher solar production. A number of higher-adoption states, such as California, are implementing these tools. Other strategies can create more manageable load profiles, such as the robust demand management programs discussed above.[119]

Net-metering policies commonly vary with regard to the following elements:

- **Eligible technologies.** Specified renewable energy technologies may include solar PV, wind, geothermal electric, biomass and fuel cells.
- **System size caps.** A system size cap is the maximum individual system size that can be net metered. Caps can be capacity (e.g., kW) or percentage based (e.g., 120% of maximum daily load).
- **Program size caps.** These caps are the total amount of net-metering systems installed in a region or utility service territory. Net-metering program caps can be calculated in many ways, including percent of peak demand or load and capacity. Some states have no program caps, and some states have trigger mechanisms that require net-metering policies to be reevaluated when certain thresholds are met.
- **Member-owner type type.** Eligible member classes for net metering include residential and commercial.
- **Net excess generation**. Member-owners are credited for net excess generation. This varies by:
  - The rate (e.g., full retail, less than retail, no compensation) paid for excess generation to the member-owner. Rates should reflect the value to the cooperative of distributed generation.
  - The term for using credits for excess generation in a particular billing cycle and whether the credits expire. It is common for them to expire after a finite number of billing cycles (e.g., 12 months) or at the end of a calendar year, after which they are either forfeited or credited at a predetermined net excess generation rate, usually between zero and the full retail electricity rate.[120]

Interconnection policies, the process through which customers with distributed generation connect to the grid, have an impact on the number of distributed generation customers there are in a utility district. Typical barriers to interconnection are the costs and the lack of specified timelines in the utility approval process, which can cause excessive delays. If the policies are cumbersome and difficult to figure out, customers with distributed generation may not interconnect to the grid. In some cases, customers may even disconnect or defect from the grid. The decreased cost of residential distributed generation resources and improved technology of storage systems makes defection more possible. What was a theoretical risk for utilities may become an issue that cooperatives need to address as defection deprives the utility of the distributed resource and the revenues it would have collected from that customer. If the utility instead considers how distributed generation resources can serve both the customer and

119 For more on net metering evolution, see LeBel, M., Shipley, J., Linvill, C., & Kadoch, C. (2021). *Smart rate design for distributed energy resources.* Regulatory Assistance Project. https://www.raponline.org/knowledge-center/smart-rate-design-distributed-energy-resources-2/

120 National Renewable Energy Laboratory, n.d.

the utility and streamlines interconnection policies to encourage resource development in that vein, more distributed generation options, such as solar PV or customer-owned or -sited storage, will contribute as system resources.

Useful Resources on Net Metering

Lawson, A. (2019). *Net Metering: In Brief. Congressional Research Service.* https://sgp.fas.org/crs/misc/R46010.pdf

LeBel, M., Shipley, J., Linvill, C., & Kadoch, C. (2021). *Smart Rate Design for Distributed Energy Resources.* Regulatory Assistance Project. https://www.raponline.org/knowledge-center/smart-rate-design-distributed-energy-resources-2/

Institute for Local Self-Reliance. (n.d.). *Municipal Financing for Renewables and Efficiency.* https://ilsr.org/rule/municipal-financing-for-renewables-and-efficiency/

Institute for Local Self-Reliance. (n.d.). *Net Metering*. https://ilsr.org/rule/net-metering/

National Renewable Energy Laboratory. (n.d.). *Interconnection Standards.* https://www.nrel.gov/state-local-tribal/basics-interconnection-standards.html

National Renewable Energy Laboratory. (n.d.). *Net Metering.* https://www.nrel.gov/state-local-tribal/basics-net-metering.html

Office of the New York State Comptroller. (2008, April). *Green Best Practices: How Local Governments Can Reduce Energy Cost and Minimize Impact on Global Climate Change.* https://www.osc.state.ny.us/files/local-government/publications/pdf/researchbrief_green.pdf

Zinaman, O., Anzar, A., Linvill, C., Darghouth, N., Dubbeling, T., & Bianco, E. (2017). *Grid-Connected Distributed Generation Compensation Mechanism Basics.* Regulatory Assistance Project. https://www.raponline.org/knowledge-center/grid-connected-distributed-generation-compensation-mechanism-basics/