clothes dryers, so they can be a demand response resource for managing peak-time loads (in both the summer and winter) and they have the capability to automatically respond to changing smart rates.

Importantly, as the demand for space cooling increases due to increasingly hot summer temperatures, control technologies for cooling, combined with other spinning reserves, can help keep buildings and occupants cool while also mitigating peak time loads coincident with hot weather. To this end, control technologies for electric space heating and cooling, specifically heat pump technology, are a high priority. Of equal importance related to managing peak loads and keeping buildings cool are other building-shell, weatherization, and ventilation strategies, along with design and passive cooling techniques like shade-promoting landscaping and siting considerations to improve shade and ventilation, cool roofs, and more reflective external walls.

Recommendations

(1) *The DPS should continue to investigate DU and EEU roles and coordination when designing, delivering, and supporting demand response initiatives.*

(2) *The DPS should encourage the adoption of equipment and appliances that can respond to utility signals, for example through DU and/or EEU incentives for customers and rate designs that allow participating customers to save money. DUs and EEUs should coordinate activities as the market evolves to advance smart rates and controllable equipment as a demand response strategy.*

10.3.4 Smart Rates

Smart rates are one way to balance supply and demand, reduce costs, and improve the environmental performance of Vermont's power supply.[213] Utilities that deploy smart rates vary the price of electricity to more accurately reflect their own costs in providing electricity to customers. Although there are different specific ways of designing smart rates, utilities typically charge lower rates during times of low demand, usually overnight, and higher rates during peak demand, usually afternoon and evening or on particularly hot or cold days. One key feature of smart rates is overall bill stability: for the average

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[213] For a complete discussion of smart rates, see *Smart Rate Design for a Smart Future* (RAP, 2015), www.raponline.org/document/download/id/7680

customer, total annual bills will remain nearly the same if their usage patterns do not change. Customers can choose to shift their consumption to lower-priced times to reduce their bills.

Traditional rates reflect highly averaged costs — e.g., across diverse customers in broad rate classes, and over many different hours of the year. Smart rates more accurately reflect the costs that individual customers are responsible for incurring to the system. This ensures a fair distribution of costs among customers; it also has the potential to create a consumer-influenced shift in load from on-peak to off-peak usage, effectively adding capacity to the grid when demand is high. Smart rates will not directly reduce consumer demand for electricity, nor will they increase energy efficiency; instead, they will shift the demand to lower-cost, off-peak times.

What are smart rates?

These are "rate designs that require the type of data collection that smart meters provide, and that are expected to produce significant peak load reductions, reduced and shifted energy consumption, improved system reliability, improved power quality, and reduced emissions. These include Time Of Use, Peak Time Rebate, Critical Peak Pricing, and Real Time Pricing." (Lazar and Gonzales, 2015) Smart rates also include rates that reflect the value of utility control of customer-sited load.

Smart rates are designed to take advantage of the data provided by AMI technology to more accurately assign costs among consumers, based on where and when they use electricity. Smart rates reinforce long-standing principles of efficient rate design, in that they reflect the utility's cost to serve a particular customer at a particular time. Efficiently designed rates reflect marginal costs, recover system costs on a volumetric basis, and send appropriate price signals to consumers who may adjust use accordingly.[214]

Section 13 of Act 199 of 2014 required that DPS work with the Agency of Commerce & Community Development to investigate the competitiveness of Vermont's industrial or manufacturing businesses with regard to electricity costs. The DPS is currently exploring how best to incorporate into rate design proceedings the impact of electricity costs on business competitiveness, along with the identification of the costs of service incurred by businesses. The design and implementation of smart rates will take into account the results of that investigation, which will be available in January 2016.

Although smart rates have been discussed and tested for at least 30 years, a new urgency for them has been motivated by a strong perceived need to link wholesale and retail power markets in ways that will enable customers to understand and influence their own consumption, and to better understand the impact their consumption has on our planet. Smart rates are being deployed across the country: Baltimore Gas and Electric is moving all residential customers with AMI to a peak time rebate structure; and the vast majority of customers in California are expected to shift to a default time-of-use rate by 2018.

214 James Bonbright, *Principles of Public Utility Rates* (Columbia U. Press, New York, 1961)

Smart rates are made possible by AMI because utilities need real-time data about customer usage to charge different rates, depending on the time of day electricity is being used. Utilities that have not yet deployed AMI should continue to evaluate the costs and benefits of transitioning. Recent developments offer new opportunities to implement smart retail rates: these include organized wholesale markets that produce transparent hourly market clearing prices, and consumer and regulatory interest in greater price-responsive demand.

Smart appliances that are coming on the market can be turned on to take advantage of low-priced electricity, then turned off when electricity is more expensive. For example, electric vehicles can be charged at night when prices are lower, and the temperature in a home with air conditioning can be slightly raised when electricity costs are high. Homeowners could use a variety of software applications or services provided by their utility to take advantage of smart rates automatically. Distribution utilities may act as managers of these smart appliances, working behind the scenes to lower peak-time use to save money for both customer and utility. Customers would be compensated for their voluntary participation in any utility or third-party-directed load management programs. Distribution utilities should coordinate their efforts with the energy efficiency utilities, so that incentives and rebates offered to customers through efficiency programs take into account the ability of new equipment and appliances to respond to utility load control signals.

Among the categories of smart rates are hourly pricing; daily pricing, including time-of-use, variable peak rate, critical peak pricing, and peak-day rebate; fixed time-of use pricing; and seasonal flat pricing. Other smart rates include vehicle charging rates, rates related to distributed generation, and rates that reflect the value of utility control of appliances or equipment. The specific type and design of smart rates for utilities in Vermont will depend on their particular AMI infrastructure, load shapes, administrative capabilities, and resource management goals.

Along with offering consumers the opportunity to save money by using electricity when rates are low, smart rates offer many benefits to the electric grid. By shifting consumption away from peak times, utilities will avoid wholesale capacity charges and lower Vermont's cost share of regional transmission projects. Smart rates can help to reduce capacity and energy charges in the long term, and to trim wholesale market prices in the short term.[215] Power supply savings, including both RNS and FCM savings, that result from peak shifting should be passed through to ratepayers.

There is some evidence that low-income consumers are less able to take advantage of smart rates because they have less flexibility in when they use electricity. In addition, some of the benefits that come from smart rates require investment in new or upgraded models of appliances, to which some low-income customers may not have access. Further, several studies have shown that low-income customers adjust

[215] Ahmad Faruqui, Sanem Sergici and Jennifer Palmer, *The Impact of Dynamic Pricing on Low Income Customers* (Institute for Electric Efficiency, The Edison Foundation, 2010), www.edisonfoundation.net/IEE/Documents/IEE_LowIncomeDynamicPricing_0910.pdf

their usage less in response to smart rates than do average customers.[216] Even so, low-income customers still benefited from smart rates because they tended to use electricity off-peak, and because overall system costs were lower. However, it is important to carefully consider the impact of specific smart rate plans on low-income customers. Utilities should take steps to ensure that low-income customers benefit from smart rates.

Recommendations

(1) *Beginning immediately, electric utilities should work in coordination with the DPS, EEUs, and PSB to create smart rate transition plans. Such plans should be incorporated into utilities' future integrated resource planning processes. Utilities should have a plan in place by 2017 to implement simple, fairly priced smart rates for each customer rate class, recognizing that utilities which have not deployed AMI capability may not be able to offer smart rates to all customers. By 2018, all Vermonters served by distribution utilities with AMI infrastructure should have access to smart rate options designed with AMI in mind.*

(2) *Utilities should make smart rates the standard rates for all customer classes by 2021, subject to the following exemptions:*

   a. *Customers without AMI or time-of-use meters are not expected to transition to smart rates. This means that utilities without AMI need not develop or implement smart rates for customers and classes using legacy meters.*

   b. *Utilities that use smart rates, including load control, to lower residential and small commercial customer costs associated with peak energy use by 10% or more by 2019 are exempt from this requirement. Through the development of their smart rate transition plans, utilities will work with the DPS to develop metrics to measure and verify this performance, which could include savings on peak energy, capacity, and regional network service, as well as credit for reducing infrastructure or other system costs.*

(3) *Customers should always retain the right to choose a flat rate, recognizing that they may pay a risk premium for guaranteed prices.*

(4) *Utilities should take intermediate steps to ensure that customers understand new and existing smart rate options during the coming transition period. Tools to use during the transition could include delivering shadow bills that show customers what their monthly bills would be under new rate plans. Utilities with an alternative regulation plan could consider offering bill guarantees for a limited period to customers who switch to smart rates, so that these customers would pay either their legacy rate or the new smart rate, whichever is less expensive.*

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216 Ibid

(5) *Utilities and the DPS should identify and address any differential effect of smart rates on low-income Vermonters by prioritizing services such as provisioning and automation of smart appliances, lowering overall energy bills through efficiency and weatherization, and ensuring simplicity in smart rate design especially for residential customers.*

10.3.5 Conservation Voltage Regulation and Volt-VAR Control

Conservation voltage regulation (CVR) is an energy efficiency program applied to an electric utility's distribution system, involving measures and operating strategies designed to provide service at the lowest practicable voltage level in a cost-effective manner, while meeting all applicable voltage standards. Field studies have shown that, in general, a one percent reduction in the voltage delivered to customers results in a one percent reduction in energy consumption.

Utilities can control distribution-line voltage by changing settings on equipment at the substation serving the line, or on equipment connected along the line. Voltage falls gradually as current flows further from the substation. Utilities must keep substation voltage at a level sufficient to ensure that voltage at the end of the line is within industry standards. Traditional methods of voltage control require a margin above minimum voltage standards; but real-time data communications and remote control allow for margins to be smaller without affecting service to customers or damaging their equipment.

Historically, CVR was a substation bus-level strategy for implementation on traditional feeders where power flows in a single direction, from the source to the load only. To adjust the voltage, CVR typically utilized stand-alone substation voltage regulators or transformers with load tap changer (LTC) controls. While down-line feeder conditions were taken into account, CVR was used primarily for gross adjustments. In Vermont, experience has shown that many circuits are not appropriate for this type of CVR implementation. For example, traditional CVR may not be a good strategy for very long circuits when voltage regulation occurs only at the substation bus; and circuits with large commercial and industrial loads that provide their own voltage regulation. In addition, CVR may not be effective with circuits containing high concentrations of distributed generation (DG).

Increasing penetration of distributed generation, in particular solar, has resulted in problems with voltage regulation, which in turn is complicated by CVR implementation. Some Vermont utilities have had to remove CVR on circuits to assure proper operation during daylight hours. DG will reduce the amount of current at the line-drop compensation (LDC) controls of regulators or tap-changing transformers located in the substations. This current reduction then reduces the apparent voltage drop across the length of the feeder, and results in low voltages delivered to customers at the ends of feeders. In some cases, CVR can also result in system problems where reverse power flow occurs.

Delivering power within appropriate voltage limits so that customers' equipment operates properly, while providing power at an optimal power factor to minimize line losses, requires the consideration of a variety of factors throughout the distribution system. These factors include, but are not limited to, substation bus voltages; length of feeders; conductor size; the type, size and location of different loads;