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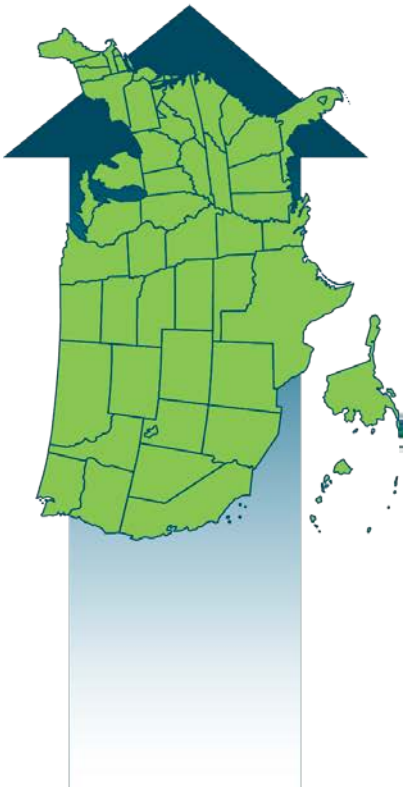
State Approaches to Demand Reduction Induced Price Effects: Examining How Energy Efficiency Can Lower Prices for All

Industrial Energy Efficiency & Combined Heat and Power Working Group

December 2015



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Contents

Executive Summary

A number of states, especially in the Northeast, are beginning to recognize Demand Reduction Induced Price Effects (DRIPE) as a real, quantifiable benefit of energy efficiency and demand response programs. DRIPE is a measurement of the value of demand reductions in terms of the decrease in wholesale energy prices, resulting in lower total expenditures on electricity or natural gas across a given grid. Crucially for policymakers and consumer advocates, DRIPE savings accrue not only to the subset of customers who consume less, but to all consumers. Rate-paying customers realize DRIPE savings when price reductions across an electricity or natural gas system are passed on to all retail customers as lower rates (depending upon regulation and market structure, residual savings may be wholly or partially retained by utilities). DRIPE savings, though seemingly small in terms of percent price reductions or dollars per household, can amount to hundreds of millions of dollars per year across entire states or grids. Therefore, accurately assessing DRIPE benefits can help to ensure appropriate programs are designed and implemented for energy efficiency measures.

This paper reviews the existing knowledge and experience from select U.S. states regarding DRIPE (including New York and Ohio), and the potential for expanded application of the concept of DRIPE by regulators. Policymakers and public utility commissions have a critical role to play in setting the methodology for determining DRIPE, encouraging its capture by utilities, and allocating DRIPE benefits among utilities, various groups of customers, and/or society at large. While the methodologies for estimating DRIPE benefits are still being perfected, policymakers can follow the examples of states such as Maryland and Vermont in including conservative DRIPE estimates in their resource planning.

What is DRIPE?

Calculating DRIPE quantifies the price benefits of two key tools in the energy policymaker's toolkit: efficiency measures (reducing energy waste across the system of generation, transmission, and consumption) and demand response (real-time conservation or load shifting measures to curtail energy demand from the grid). As energy efficiency and demand response reduce energy demand, they allow for the shedding of the most expensive marginal resources and therefore lower the overall costs of energy. This reduces wholesale energy and capacity prices, and this reduction, in a relatively competitive market, is in theory passed on to retail customers. The reductions in unit energy prices are small; however, the absolute dollar impacts are significant as the price effects are applied across the entire energy system. New technologies and practices have the potential to enhance these effects in the future. For example, smart manufacturing technologies and real-time monitoring create instant visibility of energy consumption patterns and can foster greater industrial participation in demand response (therefore lowering prices during peak demand and other high-cost periods), as well as enable deeper, more consistent energy savings year-over-year (therefore lowering pressures to invest in new supply capacity).

DRIPE is usually conceptualized as a downward movement by the demand curve in wholesale electricity or natural gas markets, leading to a new equilibrium at a lower price point along the supply curve. However, the simplicity and clarity of this model can be deceiving because of complex questions regarding the duration of the effects, the extent to which demand rebounds due to the drop in price, and the effects in transmission and distribution (T&D). The key conclusions from the studies of DRIPE examined in this paper can be summarized as follows:

- DRIPE will almost always result in lower wholesale electricity and natural gas prices.
- Lower wholesale prices should also mean lower retail rates for all customers depending on the net effects in electricity T&D, as well as the regulatory framework.
- Determining the exact effects for retail customers requires further studies concerning the impact of DRIPE in electricity transmission and distribution, the duration of DRIPE impacts, and how different regulatory frameworks deal with the pressures on price resulting from energy efficiency.

This paper examines the existing research on DRIPE and related topics with a view to clarify the gaps in our understanding of DRIPE and its importance for the industrial sector. First, we examine why DRIPE matters. Second, we discuss the various studies on DRIPE in wholesale electricity markets, in electricity transmission and distribution, and in natural gas markets. Next, we look at various experiences with DRIPE as a crisis mitigation tool, as well as the extent to which DRIPE can be negated by the rebound effect, and the usage of DRIPE by various state regulatory bodies. Finally, we contemplate the gaps in the existing research on DRIPE and what these gaps mean for policymakers.

Why Does DRIPE Matter?

While the price reductions caused by decreased demand are usually small, expressed in fractions of a cent per kilowatt hour (kWh), their absolute value can be quite large (billions of dollars) as the rate reduction is spread across all of the customers in a market. For instance, in New York State, the rate reduction from DRIPE was estimated to be between 0.4 and 0.9 cents per kWh, which would translate to total savings across the state of between $600 million and $1.5 billion (New York State Energy Plan 2009). In the case of natural gas, the rate effects could be felt nationally. Natural gas rate reductions in particular can be high in absolute terms because they affect such a large customer base, typically across many states.

The large absolute value of energy efficiency price effects can dramatically change the cost-benefit analysis of additional investments in energy efficiency. If the total value of avoided cost from efficiency measures is greater than the cost to install these measures, then the investments are worthwhile. The additional avoided cost from DRIPE can be significant; for example, in New England the avoided cost resulting from energy efficiency and demand response is 36% higher when DRIPE is included (Hurley et al, 2013). Without incorporating accurate and reliable DRIPE into the cost-benefit analysis, underinvestment in efficiency surely occurs. Therefore, producing accurate and reliable estimates for the total price effects of energy efficiency investments is very important. Inaccurate estimates or the total exclusion of these effects can lead to an inefficient level of energy efficiency investment, and therefore unnecessarily high energy prices. For example, it is quite likely that in many states the exclusion of DRIPE from the calculation of energy efficiency benefits has led to under-investment in energy efficiency, as the absolute value of the price reductions from energy efficiency would be greater than the energy efficiency installation cost. One approach to this problem has been to include conservative DRIPE estimates for cost testing energy efficiency investment in state resource plans, pending further studies on DRIPE. While these conservative estimates likely still lead to a degree of under-investment, they are closer to a correct estimate of the benefits of energy efficiency than if DRIPE is excluded completely. This approach has been adopted in Maryland and Vermont as discussed below.

What Do We Know About DRIPE?

Most published findings on DRIPE come from several states in New England as well as Maryland, because these states have begun including DRIPE in their energy plans. In addition, states such as New York, Ohio, and Illinois have begun to examine DRIPE and are moving towards including it in their energy planning as well. DRIPE in wholesale electricity markets, including DRIPE impacts on both capacity and energy prices, has received the greatest amount of attention. DRIPE in electricity T&D has received less attention, though several authors have contemplated how reduced demand affects T&D prices. Finally, DRIPE in the natural gas markets, including DRIPE resulting from decreased demand for natural gas to produce electricity, is receiving an increasing amount of attention.

In Wholesale Electricity Markets

In wholesale electricity markets, DRIPE is usually conceptualized as a downward movement in the demand curve, leading to a new equilibrium of supply and demand being established at a lower price point. This basic theoretical

model applies to price effects arising from both energy efficiency and demand response, though the duration of demand reductions is much longer in the case of energy efficiency, as the reductions continue throughout the lifetime of the project as opposed to the few minutes or hours during which a demand response resource is dispatched.

In the theoretical model, DRIPE reduces the marginal cost of electricity as by exposing market inefficiencies and substituting lower cost energy efficiency for higher cost supply. This means that greater energy efficiency will decrease the need to purchase energy from highest cost sources, and that lower peak demand will lessen the need to invest in new generation capacity. Given that the supply curve for electricity does indeed consistently have an upward slope in the United States – that is, the marginal wholesale price of electricity is higher than the average price – it is clear from the model that any major reduction in demand for electricity will lead to lower electricity prices (see Figure 1).

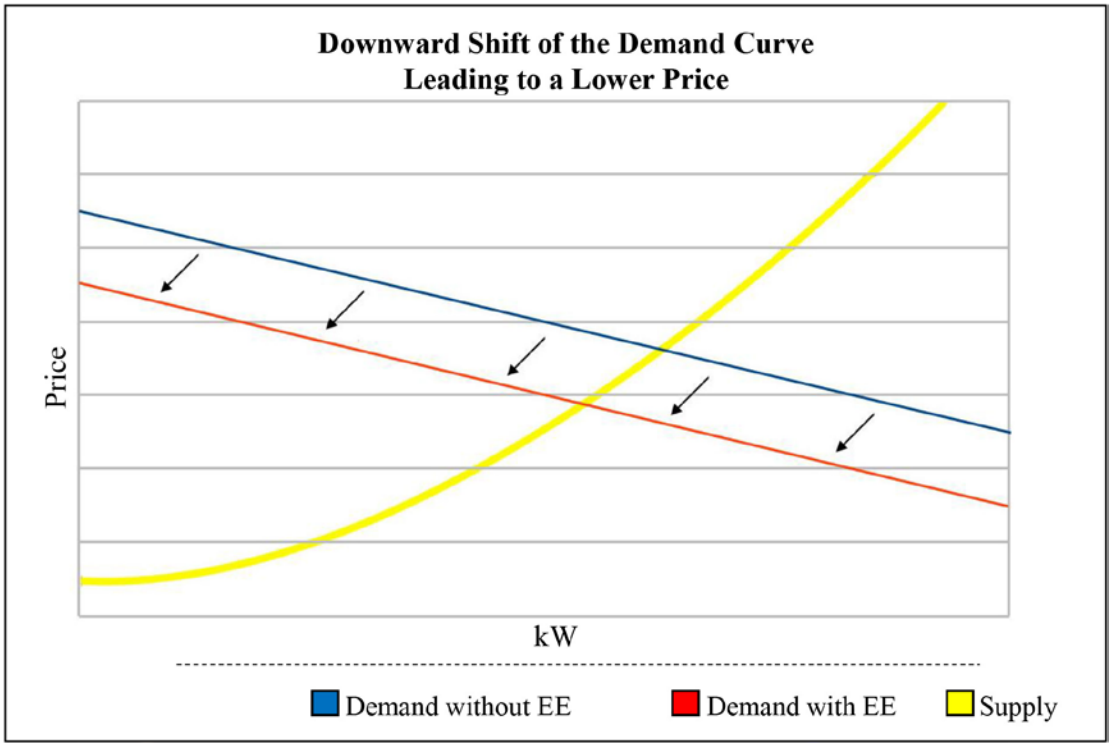

Figure 1: Theoretical effect of DRIPE on the price of electricity

While some economists view DRIPE as simply a transfer from producers to consumers, this substitution of lower cost energy efficiency for higher cost supply means that "some of the loss in welfare to producers is a genuine gain in economic efficiency" (Lazar and Colburn 2013). Thus, the demand reductions brought by energy efficiency not only reduce the price of energy by producing a downward movement of the demand curve, but this price reduction represents an increase in overall economic efficiency insofar as the marginal cost of energy efficiency is less than the marginal cost of energy. The question of what share of DRIPE constitutes a transfer and what share represents a gain in economic efficiency has been a concern for some policymakers, particularly in Maryland. To date, there has not been a study to answer this question for DRIPE in the electricity markets.

Over the past decade, the methodology for producing data on DRIPE in the wholesale electricity markets has been gradually refined; however, significant challenges still remain. This methodology typically involves reconstructing the electricity supply curve as well as the shift in the demand curve resulting from planned energy efficiency and demand response projects. The vast majority of estimates have limited themselves to the electricity markets,

though recently New England has begun incorporating the impacts of decreased electricity demand on the natural gas markets into their estimates (Hornby et al. 2013).

One of the major challenges with estimating DRIPE in the wholesale electricity market is factoring in the dissipation of effects. In the years following a demand reduction, electricity producers gradually react to the new price and the supply curve shifts as well, eventually eliminating the price effects from demand reduction (see Figure 2). The pace of this reaction by the producers is the source of much debate. Early DRIPE estimations assume that the dissipation of effects would not be total, and that some price reduction would continue in the long run, albeit a much smaller reduction than in the early years (ICF Consulting 2005). In New England, this assumption has been revised, with recent reports assuming that both energy and capacity DRIPE[1] would dissipate within 8 to 11 years (Hornby et al. 2013).

However, reports from other areas such as Maryland, still assume that some degree of DRIPE will continue indefinitely (Exeter Associates 2014). These variations in assumptions for the DRIPE dissipation rate have led estimates of the total impact of demand reductions on prices to vary by as much as 300% (Hornby et al. 2011). Given the significant impact that variations in these assumptions have had on the estimates, it is no surprise that arriving at the most accurate dissipation rate has received a great deal of attention from policymakers seeking to determine how to use DRIPE. The most recent and thorough estimates of DRIPE dissipation take into account the type of electricity generation currently in use, as well as what plans exist for investments in new generation, in order to determine how a decrease in demand might affect planned investment.

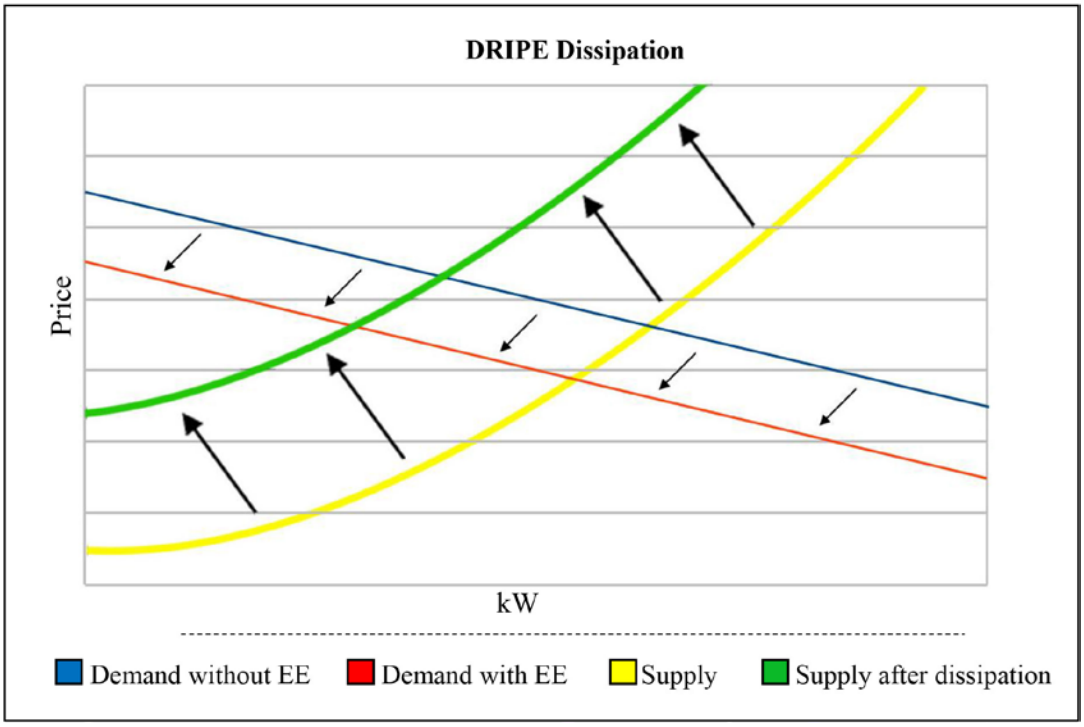

Figure 2: Theoretical model of DRIPE dissipation

New England has paid the greatest attention to DRIPE of any region in the U.S. Since 2005, the biennial *Avoided Energy Supply Cost* (AESC) reports have produced detailed estimates of the impacts of demand reductions on

[1] Capacity DRIPE refers to the effect on capacity market prices due to decreased demand, while energy DRIPE refers to the effect on energy market prices due to decreased demand for electric energy.

prices in the region (see Box 1). As the methodology was created and honed in the first few reports, the estimates differed greatly from report to report (Hornby et al. 2007; Hornby et al. 2009).

However, as the methodology has been more or less settled, more recent reports have produced far more consistent estimates; now the major variations in estimates typically arise from changes in regulations or unforeseen changes in energy markets (Hornby et al. 2011; Hornby et al. 2013). The latest report, published in 2013, estimates that the average summer peak (when demand is at its highest) reduction in electricity rates from DRIPE, including both energy efficiency and demand response, over the next 15 years is 3.44 cents/kWh, with much lower rate reductions off-peak and at different times of the year (Hornby et al. 2013). This rate reduction spread across all of the electricity consumers in New England implies a very large absolute value decrease in spending on electricity in the market.

Outside of New England, several other states and regions have also produced DRIPE estimates. In New York, the state estimated in 2009 that the initial costs of increasing energy efficiency may lead to higher rates for ratepayers for the first two years of their energy plan, but the net impact of energy efficiency will be to reduce rates thereafter due to the price suppression effects of decreased demand. The estimates for the reduction in rates resulting from New York's target of a 15% reduction in electricity demand are between 0.4 and 0.9 cents per kWh by 2015, which would mean an annual savings of between $600 million and $1.5 billion for New York ratepayers, with this figure decreasing in subsequent years as the price effects dissipate (New York State Energy Plan 2009).

Also in 2009, PJM Interconnection published an analysis of how increased energy efficiency that could be required by proposed climate change legislation might affect the market. The results of this evaluation were estimates of DRIPE that varied between $3 billion and $18 billion in total savings by the entire customer base, depending on energy prices and the extent of the demand reductions. However, the methodology used is not clear, and it is difficult to determine to what extent the figures incorporate effects such as the dissipation of DRIPE (PJM 2009).

More recently, 2014 estimates were published for the price impacts of Ohio's energy efficiency standards. The estimates showed a total savings for Ohio customers of $880 million from wholesale energy price mitigation and $1,320 million from wholesale capacity price mitigation through 2020 (Neubauer et al. 2013).

On the other hand, in the same year, a Maryland report provided both capacity and energy DRIPE estimates for energy efficiency measures to be installed from 2015-2017, breaking down the effects by region of the state and by year of installation of the measures. Of particular note, these estimates include price increases in some zones in some years due to changes in the import or export of power from these zones and the elimination of low cost marginal generation in the zone (Exeter Associates 2014). This is the only analysis which includes wholesale price increases as a result of demand reductions.

There is no empirical evidence to settle the various debates surrounding the DRIPE dissipation rate or the exact magnitude of the price effects. However, the estimates produced are fairly consistent in showing large savings on electricity throughout any given market. These savings represent a major gain in economic efficiency and they are likely to have some important ripple effects throughout the economy.

THE AVOIDED ENERGY SUPPLY COST IN NEW ENGLAND

New England's AESC reports represent the most advanced series of reports examining DRIPE, and have paved the way for creating a methodology to estimate DRIPE. The estimates in these reports are used by policymakers across New England to determine the benefits from energy efficiency and demand response.

The 2005 AESC report produced by ICF Consulting was the first New England report to take DRIPE into account. They estimated capacity DRIPE for New England pool electricity prices through 2040, with two scenarios: 'DRIPE' and 'DRIPE Light,' the latter being a set of more conservative estimates. The 35 year levelized DRIPE benefit was found to be $0.024/kWh for full DRIPE, and $0.008/kWh for DRIPE Light. While they estimated that the effects would diminish over time, the report did not have DRIPE fully dissipating within 35 years.

The 2007 AESC report was the first to be produced by Synapse Energy Economics. This report estimates energy DRIPE, in addition to capacity DRIPE, using the inverse elasticity of energy supply. It then projects DRIPE benefits for each state of New England and for each season, finding that, compared to the 2005 report, the new projections for capacity DRIPE are 60%-97% lower for every state except for Maine, for which they are 59% higher. They also assume that DRIPE will eventually dissipate completely, and they only estimate effects for 15 years.

The 2009 AESC report found that there would be no capacity DRIPE for the coming four years, as there was an excess of capacity in New England, and capacity prices would be at the regulated floors. The new capacity DRIPE estimates were slightly higher than was estimated in 2007 for the four years after the capacity prices would cross the price floor in 2013. Energy DRIPE estimates were also higher than in 2007, as they projected dissipation to occur at a slower pace, due to a more advanced methodology for estimating dissipation that took into account the rebound in demand, deferred plans for investment in new generation, and the effects of DRIPE on existing generation.

The 2011 AESC report saw its estimates for capacity DRIPE go up to more than three times the estimates in the 2009 report as the capacity prices were higher than expected and stayed above the regulated price floor, allowing DRIPE to affect prices for a longer period of time. The estimates for energy DRIPE were close to those in the 2009 report, as the methodology remained the same.

The 2013 AESC report is the first to include a section on natural gas DRIPE, which includes natural gas supply curves and estimates of natural gas DRIPE for each state. The report also includes the usual estimates of capacity and energy DRIPE for each state in New England. The new capacity DRIPE estimates are 45.3% lower than those in the 2011 report while the energy DRIPE estimates are 18% lower, in both cases largely due to a shorter estimated duration of DRIPE.

In Electricity Transmission and Distribution

There are no studies focusing on the impact of demand reductions on prices because of decreased distribution costs. However, there are a few studies on how decreased electricity demand decreases distribution costs, which puts downward pressure on retail rates. One of the key ways in which energy efficiency decreases transmission and distribution costs is through a decrease in line losses. This impact is magnified by the fact that marginal line losses are higher than average line losses, which boosts the effect of increased efficiency on decreasing losses as compared with additional investments in infrastructure. In addition, energy efficiency is typically the most cost-effective method of decreasing losses, which points to a long-term downward pressure on distribution costs resulting from increased efficiency (Lazar and Baldwin 2011).

Separately, various experiences across the U.S. with using energy efficiency as a transmission and distribution system resource have shown that this use leads to a decreased need for investment in T&D infrastructure. Notably, energy efficiency and demand response measures can be implemented in the locations where they will have the greatest effect in reducing transmission bottlenecks. This effect is particularly important because investments in T&D infrastructure constitute the majority of power system investments, and decreasing the need for investment can lower electricity costs (Neme and Sedano 2012). This, too, points to a long-term downward pressure on retail prices resulting from energy efficiency.

On the other hand, there is reason to believe that reductions in demand can lead to increased rates from utilities seeking to recover their investments in T&D infrastructure. Where utilities are operating under traditional cost-of-service regulation, there is some evidence that decreased demand has made it difficult for utilities to recover their investment in T&D infrastructure because such demand reductions mean lower revenues for utility companies and therefore lower profits for their investors. The decreased profits for investors and the difficulty in recovering investments in fixed infrastructure have led to worries about future troubles in attracting investors to the utility sector, though these troubles have yet to materialize (Kind 2013). This situation has led some utilities to seek to increase fixed charges on customers in order to increase revenues and recover their investment in infrastructure. Where the regulatory environment has moved away from the traditional model and decoupling has been implemented, this concern about decreased profits is obviated as the utility's allowed revenue is set; however, decreased demand can still put upward pressure on rates as the utility's allowed revenue must be collected from lower unit sales (Lazar, Weston, and Shirley 2011).

It is difficult to ascertain the net effect of demand reductions on the price paid for electricity T&D because of these conflicting pressures that demand reduction place on T&D rates. It is likely that the net effect will vary depending on the line losses, the state of the T&D infrastructure, the level of investment in T&D (and therefore the utility’s revenue requirement), and the regulatory framework which determines how T&D costs are reflected in rates.

In the Natural Gas Sector

There has been some attention paid to the impacts of energy efficiency on natural gas prices in addition to the cross-market DRIPE analysis in New England discussed above and the effectiveness of DRIPE in addressing natural gas crises discussed below. Notably, because natural gas is traded across a larger geographic area, the impact of DRIPE can be very large and felt by far more customers than is the case with electricity.

As in wholesale electricity markets, energy efficiency reduces gas prices by sliding the natural gas demand curve to a lower point on the supply curve. The methodology to produce DRIPE estimates in the natural gas markets can be quite simple if one only uses the inverse elasticity of supply or far more complex if one reconstructs the entire market (Hoffman 2013).

Although there is significantly less written about DRIPE in natural gas markets, there have been some studies of price effects as a benefit of natural gas energy efficiency. Notable findings include that the consumer benefits from DRIPE in the gas markets are five times the welfare transfer from producers, meaning that there is a significant net

economic benefit. In addition the reductions in gas demand have an impact on prices across the entire U.S. For example, a study in Massachusetts found that the negligible decline in gas prices caused by that state's energy efficiency programs has led to an estimated consumer savings of at least $12 million throughout the country (Hoffman, Zimring, and Schiller 2013). In New England, DRIPE for 2014 natural gas energy efficiency installations was estimated at $0.296/MMBtu on average across the region for the coming 15 years (Hurley et al. 2013).

In Crisis Mitigation

During and after the 2000 California electricity crisis and the mid-2000s natural gas crisis in the Midwest, much attention was paid to the possibility of using demand reductions as a method of avoiding price spikes. The theory behind using demand reductions to ease energy crises is the basis for demand response – it is typically more cost effective to decrease demand instead of increasing supply to meet demand, especially at peak or other high-cost times. In some emergencies, reducing demand is the only option, as supply can no longer be increased. While this would point to the use of demand reductions to ease crises as strictly the domain of demand response, there is also a case that energy efficiency can help to keep prices from reaching crisis levels.

Following the 2000 California electricity crisis, several authors suggested that greater encouragement of demand response and energy efficiency would play a crucial role in averting another crisis and keeping wholesale electricity prices low. Both the Congressional Budget Office (CBO) and the Cato Institute proposed that customers be exposed to the high wholesale cost of electricity as this would incentivize demand reductions throughout the year in the form of energy efficiency as well as short-term demand reductions or demand response at peak prices (CBO 2001; The Cato Institute 2001). These demand reductions would then push a downward shift in the demand curve, lowering wholesale electricity prices.

While exposing customers to the fluctuations of the wholesale price of electricity is typically a characteristic of demand response programs,[2] the prolonged period of high prices in California would have likely also stimulated some investment in energy efficiency as typical short-term demand response measures would prove difficult to maintain for such a long time. Furthermore, a major contributing factor to the crisis was the limited incentive to conserve electricity created by a price structure with high fixed charges and relatively low marginal electricity rates for customers. A detailed quantitative analysis of the electricity supply curve leading up to and during the 2000 crisis, conducted at the end of the crisis in 2000, shows that load reductions had a value to the system, in terms of decreased costs for all ratepayers, of at least twice the market price of electricity during most hours of the year and significantly more during peak times (Marcus and Ruszovan 2000). This demonstrates that, while demand response could play a major role in averting a crisis, incentivizing energy efficiency would have also had a significant impact in keeping prices lower.

With greater demand response and energy efficiency, a repeat of the 2000 crisis was averted in 2001. Specifically, a 14% reduction in peak demand in July 2001, the result of both increased energy efficiency and expanded demand response programs, helped keep prices from spiking as they had the year before (Weare 2003). While there were certainly other factors in avoiding a repeat of the 2000 crisis, this provides clear empirical evidence that demand reductions can play a role in keeping prices from rising too high.

Regarding the mid-2000s natural gas crisis in the Midwest, several authors suggested that increased efficiency and the deployment of renewables could decrease natural gas prices (Wiser, Bolinger, and St. Clair 2005). The American Council for an Energy-Efficient Economy estimated that customers could save more than $1 billion on gas rates throughout the Midwest due to price suppression resulting from increased efficiency. Broken up by

[2] Time of use (TOU) pricing is a common type of demand response program which seeks to incentivize demand reductions at peak times and greater demand off-peak by passing on both the higher wholesale prices at peak time and the lower prices off-peak. This pricing method contrasts with the traditional practice of charging a flat rate for electric energy at all times.

sector, 2006 savings across the region due to price decreases were projected to amount to a total of $163 million for industrial customers, $104 million for commercial customers, and $194 million for residential customers. By the year 2020, these figures should climb to $925 million for industrial customers, $362 million for commercial customers, and $641 million for residential customers (Kushler, York, and Witte 2005). This breakdown of impacts by sector is noteworthy, especially as it makes it clear that, over the long run, the greatest share of the benefits accrue to industrial customers.

The Rebound Effect

Some analysts have posited that price decreases from demand reductions lead to increased consumption by consumers, which pushes prices back up. This effect is known as the Jevons Paradox and has been studied by several economists in relation to energy efficiency. Across the board, the findings of these studies have been that the effects of the Jevons Paradox are minimal and do not significantly offset the reductions in demand resulting from energy efficiency.

In two studies on the rebound of demand due to a reduction in price, the empirical evidence shows that the rebound in demand is less than half the original decrease in demand, with the highest estimated rebound in demand coming from water heaters and air conditioners, while no rebound was found in the case of energy efficient appliances and little rebound was found in the case of lighting (Steinhurst and Sabodash 2011). The rebound in demand resulting from decreased prices is usually between 10% and 30% of the reduction (Gillingham et al. 2013). Based on these findings, it is clear that, while there is some rebound in demand, the effect is nowhere near large enough to totally offset the initial reductions in demand and therefore would not negate the price reduction caused.

Regulatory Experience with DRIPE

The regulatory bodies in all of the states of New England, as well as several states in other regions including Maryland and Illinois, have addressed whether and how DRIPE should be included in the benefits of energy efficiency. Seven of 12 restructured jurisdictions have included DRIPE in energy efficiency screening (Connecticut, Rhode Island, Maryland, Massachusetts, Washington D.C., Delaware and Maine) (Chernick and Neme 2015).[3]

Some states have ordered that DRIPE, including DRIPE benefits outside of the state (i.e. across the entire RTO) resulting from the demand reductions within the state, be included going forward in the updated avoided costs used for cost-effectiveness screening of energy efficiency programs. For example, in 2014, the Vermont Public Service Board ordered that 50% of DRIPE in the New England pool be included (Vermont Public Service Board 2014). This decision in Vermont is in line with similar moves by Rhode Island and Connecticut in including considerations of DRIPE in the rest of the New England market, and contrasts with Massachusetts' choice to only include DRIPE within the state (Massachusetts Department of Public Utilities 2009). Other states, such as New Hampshire, have chosen to exclude DRIPE from the benefits of energy efficiency (NH PUC 2014). Boxes 2 and 3 illustrate how Vermont and Maryland have included DRIPE in their regulatory processes.

[3] Many of those jurisdictions, as well as New York, Ohio, Illinois, and 10% of restructured Michigan have used price suppression effects to evaluate renewables; and price suppression affects justified generation contracts in Maryland and New Jersey.

The methodology used to estimate DRIPE has also been the subject of much contention in deciding how to include DRIPE among the benefits of energy efficiency. For example, concerns over the variations in the estimated duration of DRIPE led Maryland to decide to use the shortest estimated duration of four years instead of more recent estimates, which predicted that the effects would dissipate after ten years (Godfrey 2015).

CASE STUDY: DRIPE IN VERMONT'S SOCIETAL COST TEST

When Vermont created its societal cost test (SCT) for evaluating energy efficiency investment in 1999, DRIPE was not contemplated at all. Calls for DRIPE to be included increased over the years as the AESC reports showed a significant economic impact for Vermont, and the Vermont Public Service Board issued an order on DRIPE in 2011 in which it was decided that DRIPE would not be included in the SCT because they felt it was primarily an economic transfer and not a boost to economic efficiency. The reasoning behind this decision was that the decrease in rates from DRIPE would negatively impact investors in electricity generation and natural gas production as much as it would positively impact energy consumers (Vermont Public Service Board 2011).

This decision was reversed in 2014 when the Vermont PSB ruled that 50% of DRIPE from the New England pool be included in the SCT. This decision was based on the findings of a report by Lawrence Berkeley National Laboratory on the economic impact of the price effects of federal efficiency standards for water heaters across the U.S. The study found that, of the $48.9 billion benefit to consumers of electricity and gas, $9.8 billion was a transfer from taxpayers and landowners and $1.9 billion was lost profit to producers who had invested in natural gas extraction prior to the implementation of the standard. The study also noted that once increased energy efficiency could be anticipated by investors, they would reallocate capital away from energy production, meaning that reduced profits from energy production investments made after the announcement of the energy efficiency standard cannot be counted as a transfer (Carnall 2011).

These findings convinced the Vermont PSB that a share of DRIPE benefits to consumers does indeed represent a gain in overall economic efficiency, and therefore decided that a share of DRIPE benefits must be included in the SCT. As there has not yet been an analysis of what share of electricity DRIPE benefits in New England constitutes a transfer, the PSB decided to adopt a 50% estimate on an interim basis, until such an analysis can be conducted. The estimates used for DRIPE benefits come from the AESC New England reports (Vermont Public Service Board 2014).

CASE STUDY: DRIPE IN MARYLAND

Maryland is one of the most recent additions to the number of states that include DRIPE in the cost testing of energy efficiency investment. Unlike in Vermont, the question of whether DRIPE is a net benefit or a transfer was not considered as an issue. Instead, the greatest deal of controversy revolved around the methodology for estimating DRIPE, particularly the rate of DRIPE dissipation.

In the debate regarding how to include DRIPE, the Maryland Public Service Commission acknowledged the concern that inaccurate estimates of DRIPE would lead to inefficient amounts of energy efficiency and demand response incentives. However, they determined that it was best to implement a policy based on the most widely accepted estimates for DRIPE and modify the energy efficiency and demand response programs as new information is produced. This meant that they accepted the DRIPE estimates produced by Exeter Associates in Maryland's Avoided Energy Cost report with a modification to the rate of dissipation of capacity DRIPE effects. While Exeter Associates had used a dissipation time of 10 years for capacity DRIPE based on an average of the dissipation times in recent AESC reports from New England, the PSC ruled in 2015 that they would use a time of 4 years based on the shortest dissipation period in the recent AESC reports (Maryland Public Service Commission 2015).

Challenges for Policymakers

Few Industrial Sector-Specific Analyses

No studies estimate the price effects of reduced electricity demand in the industrial sector from participation in energy efficiency ratepayer programs, and only one study on the Midwest natural gas crisis includes information on the benefits specifically to the industrial sector resulting from energy efficiency. This gap is particularly noteworthy given that there is a collective action problem with realizing DRIPE benefits. The lack of individual incentives to carry out the investments that would produce significant savings and increased economic efficiency across the entire market points to a significant role to be played by the industrial sector, as it represents some of the largest customers who are, therefore, most able to influence prices and reap the most benefits on an individual customer basis.

Lack of Empirical Data

There are no significant works on the effects of energy efficiency on energy prices that include empirical data, and it may prove very difficult to produce any such data. One of the closest approximations of empirical data comes from the Public Policy Institute of California's report on the 2000 electricity crisis. However, these data do not control for the changes in supply that occurred between 2000 and 2001, therefore it is difficult to ascertain to what extent the avoidance of another crisis in 2001 was due to the 14% reduction in peak load year-to-year as opposed to an increase in supply. Another approximation of empirical data would be found by comparing projections of DRIPE from the AESC reports with actual prices, though it remains difficult to separate the impact of DRIPE from other effects on the prices, as is the issue with the California case.

The lack of empirical data poses a significant challenge for the study of the price effects of energy efficiency and the inclusion of these effects among the benefits of energy efficiency. Without empirical data, it is difficult to test the accuracy of projections of DRIPE, in turn making it more difficult to improve the estimation methodology by, for example, comparing the projected time frame for the dissipation of

DRIPE to the actual outcome. In turn, this inability to completely vindicate the methodology for estimating DRIPE makes the projections of benefits inherently debatable and therefore complicates any case that they should be included among the benefits of energy efficiency for planning purposes.

Impacts under Different Electricity Regulatory Frameworks

Thus far, evaluations of DRIPE have focused on wholesale electricity markets. They do not consider how DRIPE may have a different impact under other regulatory frameworks, such as the classic vertically-integrated utilities without competitive wholesale energy markets. While there would not be the clear supply curve that can be plotted in competitive electricity markets, it is likely that demand reductions could allow the electricity utility to retire some of its most expensive generation capacity, avoid investing in new capacity, or defer transmission investments.

Of particular note is the impact of demand reductions on rates charged for utilities to recover their investments in distribution infrastructure. While many utilities have claimed that the reductions in demand have forced them to levy fixed charges in order to recover their investments, there is also evidence that demand reductions significantly reduce their losses and the need for such investments. Without a study on the subject, it is difficult to know which effect dominates and how these effects play out over time.

DRIPE as a Transfer or Gain in Economic Efficiency

As Vermont's experience with deciding on how to include DRIPE in their (SCT) demonstrates, the share of DRIPE that represents a transfer as opposed to a gain in overall economic efficiency remains a significant question. While the economic theory is clear that a portion of DRIPE does represent a gain in economic efficiency, and there are quantitative estimates of the gain in economic efficiency resulting from natural gas DRIPE, we still do not have any data on this question in electricity markets. Without such data, it will remain difficult to produce precise estimates on the societal benefits of DRIPE in states that use the (SCT). It is also worthwhile to note that including the loss of revenue to producers as a result of lower prices is a policy choice, and many states do not factor it into their cost tests, but rather choose to only include the benefits to consumers that result from lower prices. For example, Illinois legislation mentions price reduction as goal of demand-side management (Neme and Chernick, 2015).

Where Do We Go From Here?

The most useful addition to the body of knowledge on DRIPE would be an empirical study of the price effects of energy efficiency. Especially given the wide variation of estimations of the value of DRIPE and the hesitance of some states to include these estimations as a benefit of energy efficiency, it would be very beneficial to produce more clearly reliable data and allow for a degree of certainty that DRIPE does in fact lower prices. Furthermore, empirical data would improve the estimations of DRIPE by providing a benchmark for comparison. Producing such data, however, may prove quite difficult as it is not simple to separate DRIPE from other effects on energy prices. It would most likely require a special situation in which both the supply and demand curves are exceptionally static aside from improvements in energy efficiency on the demand side. Barring such a special situation, empirical data would likely be best approximated by a thorough comparison of DRIPE projections with actual market behavior.

Another major possible addition would be to study how the impacts of demand reductions on wholesale prices and T&D costs translate into retail rates given various regulatory frameworks. Such a study could be completed by

carrying out a set of case studies on various electricity markets with diverse regulatory frameworks, in order to create a representative sample of how these markets react to reductions in demand.

Conducting a study on the share of DRIPE that represents a transfer versus a genuine gain in economic efficiency in electricity markets would prove very useful for informing policymaking in states that use the SCT. Such a study would help resolve the questions that states such as Vermont have had with regards to what share of DRIPE should be included in their SCT.

Finally, a study of DRIPE in the industrial sector would be an important addition to the body of literature on the price impacts of energy efficiency. This could be achieved by either focusing on markets where industrial energy efficiency is included in utility programs, by quantifying the rate impacts of its inclusion, or by focusing on markets where industrial energy efficiency is not included in order to estimate the impact of its inclusion.

Pending the resolution of the various outstanding questions concerning DRIPE, the decision by policymakers to include DRIPE using conservative estimates, as has been done in Vermont and Maryland, represents a reasonable compromise. Using such estimates likely still leads to underinvestment in energy efficiency; however, they will lead to less underinvestment than would occur if DRIPE is excluded totally, and they are unlikely to lead to overinvestment in energy efficiency, as might occur if inaccurate DRIPE estimates are used.

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