SUSTAINING UTILITY NATURAL GAS EFFICIENCY PROGRAMS IN A TIME OF LOW GAS PRICES

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Contents

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Key Findings

- Natural gas wholesale prices have declined considerably over the past decade, creating some concerns about the cost effectiveness of natural gas energy efficiency programs (see figure 1).
- Despite low natural gas prices, leading states (based on energy efficiency spending and savings) continue to provide substantial cost-effective utility natural gas energy efficiency programs (see table 1).
- According to several large-scale national studies conducted over the past decade, a portfolio of natural gas energy efficiency programs can deliver savings at a levelized cost of $ 0.40 per therm or less.
- Numerous natural gas energy efficiency potential studies also project substantial future gas savings potential at $0.40 per therm or less.
- Our literature review and surveys suggested two important steps for maintaining the cost effectiveness of natural gas energy efficiency programs: (1) optimize programs; and (2) use an appropriate cost-effectiveness framework.
- Ideas for optimizing programs include partnerships and cost sharing with water and/or electric utilities, increasing incentives to participants when cost effective, and marketing and appropriately valuing non-energy benefits.
- To structure an appropriate and comprehensive cost-effectiveness framework, it is important to do the following:
    - Apply cost-effectiveness requirements at the portfolio level
    - Use a low-risk or societal discount rate
    - Appropriately value all system benefits and costs (e.g., include peak demand savings and avoided transportation, and distribution costs)
    - Provide for special treatment of low-income programs (e.g., exemption from passing the B/C test)
    - Include appropriate non-energy benefits (e.g., water, comfort, safety, operations and maintenance savings)
    - Appropriately value environmental benefits (including CO_2 reduction)
    - Incorporate some assessment of the risk of future natural gas price increases

Abstract

Natural gas energy efficiency programs are facing a number of challenges. Most prominently, low natural gas market prices over the past few years have made it more difficult for some utility programs to demonstrate cost effectiveness using traditional tests. At the same time, some climate advocates argue that public policy should not pursue natural gas energy efficiency investments because they can incentivize the continuation of technologies that use natural gas. According to these advocates, we should instead be ending natural gas use entirely. Across the nation, utilities and regulators have been wrestling with the issue of what to do about future natural gas energy efficiency programs.

In response to this uncertainty, we launched this project to assess the current state of energy efficiency efforts by natural gas utilities in the United States. We reviewed pertinent literature, interviewed national experts, and surveyed regulators in 10 states that are leaders in utility natural gas savings. We provide context for the cost-effectiveness challenges faced by natural gas utilities, report on recent results for natural gas energy efficiency program cost effectiveness, examine which tests and assumptions are being used, and identify strategies that states and utilities are using to sustain cost-effective natural gas efficiency programs. Based on our review and analysis, we conclude that natural gas energy efficiency programs are sustainable and worth pursuing for both economic and environmental reasons. We offer some practical suggestions for states and utilities to consider as they move ahead with natural gas energy efficiency.

Special note: The COVID-19 pandemic and oil market manipulation by Saudi Arabia and Russia have badly disrupted energy markets (Reed 2020; Smith 2020) as well as U.S. utility energy efficiency program delivery (Walton 2020). This paper focuses on long-term market conditions and trends prior to 2020, with the assumption (and hope) that the COVID-19 crisis will end and that markets will return to more normal patterns.

Background

Utility natural gas energy efficiency programs in the United States have a long and productive history. In fact, the first utility energy efficiency programs in the country were conducted by natural gas utilities, focusing particularly on building shell insulation and furnace measures such as "vent dampers." The impetus for these efforts was the OPEC oil embargo of 1973, with the first such programs (known at the time as "energy conservation" programs) beginning late that year. While the embargo was focused on oil, natural gas price increases tracked very closely to oil prices, essentially doubling in a period of two years. Though small in number, some early-acting natural gas utilities took action to try to help contain rising energy costs for their customers (e.g., see Crandall, Elgas, and Kushler 1985).

By the time of the second oil shock later that decade, the federal government had sprung into action, establishing the Department of Energy in 1977 and passing the National Energy Conservation Policy Act in 1978. Among other accomplishments, that act established the first—and to this day the only—significant federal requirements for utility energy efficiency programs: the Residential Conservation Service (RCS) mandate for providing home energy audits (e.g., see Kushler and Saul 1984; Crandall, Elgas, and Kushler 1985), followed by the

Commercial and Apartment Conservation Service (CACS). Aided by this federal prompt, by the early 1980s both gas and electric utilities were increasingly involved in energy conservation efforts.

RELATIONSHIP OF NATURAL GAS PRICES TO UTILITY ENERGY EFFICIENCY SPENDING

From the outset, concern over the economic impact of natural gas costs on customers has been a key driver of state policies and utility responses regarding natural gas energy efficiency. In the past two decades, natural gas prices have been very volatile, which has affected the relative level of effort devoted to energy efficiency. Figure 1 shows the nominal wholesale price of natural gas since 1960.[1]

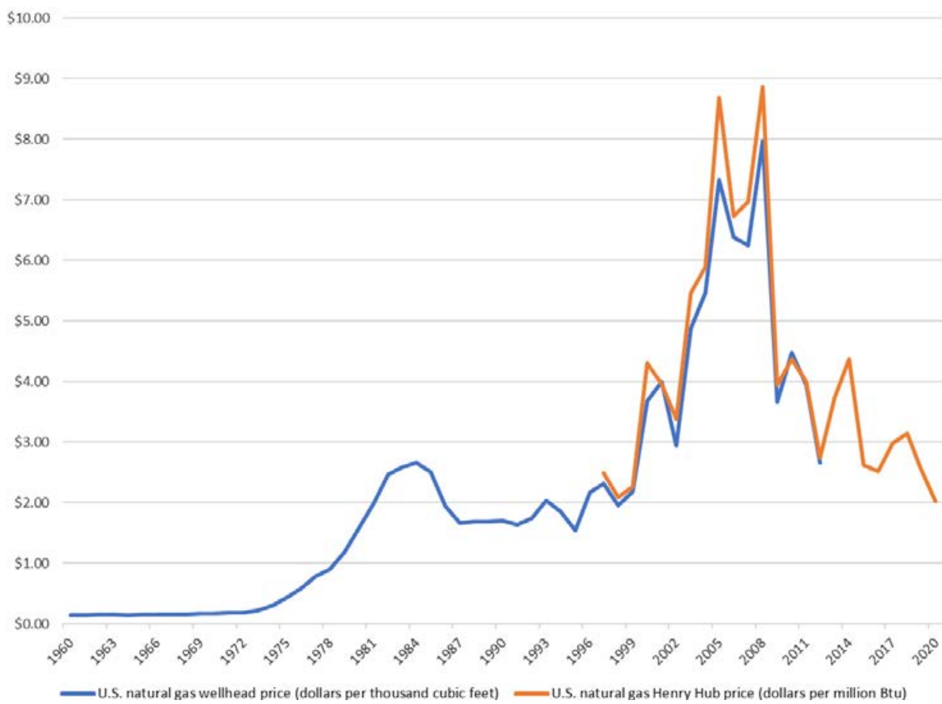

Figure 1. U.S. Natural gas wholesale prices (based on EIA wellhead and Henry Hub prices). The U.S. natural gas wellhead price (1960–2012) was taken from the Energy Information Administration's website at www.eia.gov/dnav/ng/hist/n9190us3A.htm, and the U.S. natural gas Henry Hub price (1997–2019) was taken from the EIA website at www.eia.gov/dnav/ng/hist/rngwhhdA.htm.

[1] There are two sources for the data shown in figure 1. The U.S. Energy Information Administration posts data on average wellhead prices from 1960 to 2012 and data on average Henry Hub natural gas prices from 1997 to 2019. As can be seen in the graph, the two sources provide very similar pricing for the years where the two datasets overlap. The Henry Hub is a distribution hub on the natural gas pipeline system in Erath, Louisiana, that connects with nine interstate and four intrastate pipelines. It lends its name to the pricing point for natural gas futures contracts traded on the New York Mercantile Exchange (NYMEX). Spot and future natural gas prices set at Henry Hub are denominated in US$ per million Btus and are generally seen to be the primary price set for the North American natural gas market. The Henry Hub price does not include transportation costs to deliver the natural gas to the utility service area; the actual cost to the utility of acquiring natural gas includes the cost of transporting the gas from the Hub to its service territory (i.e., a "Citygate" price). EIA data show that since 2010, the Citygate price has averaged about 47% higher than the hub price.

Prior to the 1970s, natural gas prices (and energy prices in general) were so low that energy efficiency was not even under discussion. The OPEC oil embargo changed that. The United States experienced a period of very large increases in natural gas prices (a nominal 12-fold increase from 1973 to 1984), during which energy efficiency programs were initiated and then expanded dramatically. After 1984, gas prices declined somewhat and leveled off through the 1990s. For that and other reasons, utility energy efficiency efforts plateaued and then declined considerably during the deregulation ("utility restructuring") phase of the late 1990s. Then the first decade of the 2000s saw dramatic increases and price swings for natural gas, and annual gas-utility energy efficiency spending nearly quintupled from 2006 to 2014.[2] Since that time, as natural gas wholesale prices have declined considerably, gas-utility energy efficiency spending has again plateaued. Most recently, wholesale natural gas prices have fallen to levels not seen since the 1990s.

Figure 2 helps to illustrate the importance of natural gas prices by showing the relationship of natural gas market prices to natural gas-utility energy efficiency spending.

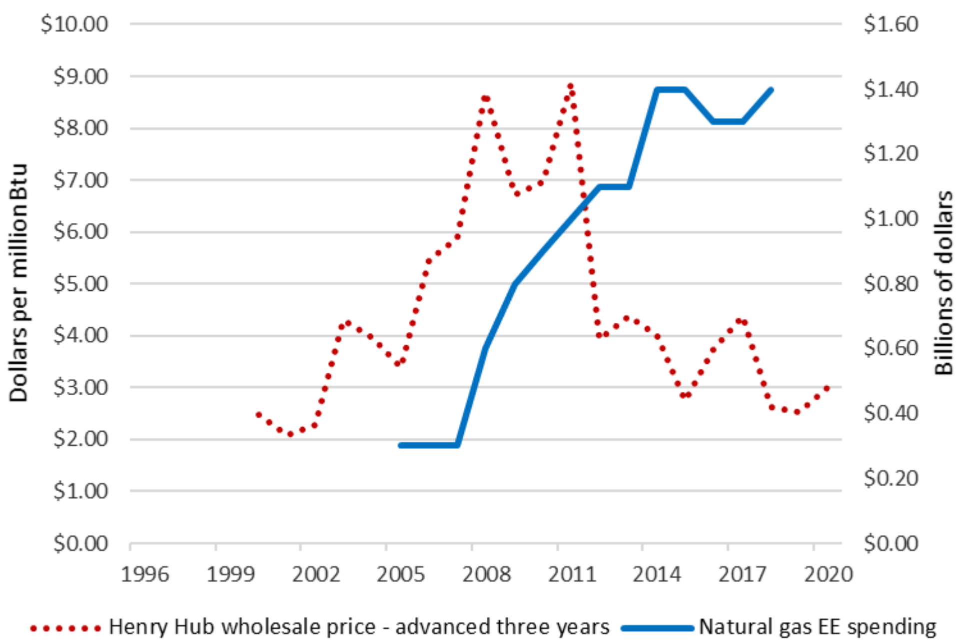

Figure 2. U.S. natural gas Henry Hub wholesale price and utility spending on natural gas. The U.S. natural gas Henry Hub wholesale price was taken from the Energy Information Administration's website at www.eia.gov/dnav/ng/hist/rngwhhdA.htm. Natural gas energy efficiency program spending was taken from ACEEE's *2019 State Energy Efficiency Scorecard*.

Because annual energy efficiency spending levels are typically set two or three years in advance, when energy efficiency plans are filed, spending in any given year is actually influenced by the market prices experienced two or three years prior. Figure 2 uses the dashed line to make that pattern more visible: it shows clearly how the large and rapid increase in gas

[2] Of course, these changes are not technically a direct "price response" by utilities. Rather, prevailing natural gas price trends influence public policy and regulatory requirements on utilities regarding energy efficiency.

utility energy efficiency spending closely paralleled the pattern of gas price increases. These gas price increases were also a major driver of the natural gas energy efficiency resource standards (EERS) passed in many states during that period (ACEEE 2019). The subsequent collapse in natural gas prices is associated with a halt in the upward surge in energy efficiency spending, and then a several-year plateau in spending. The basically flat spending since 2014 has been largely sustained by the EERS policies passed in prior years. The effects of the further price declines in 2018 and 2019 are not yet visible because of the lag in reporting of utility natural gas spending.[3]

Relationship of Natural Gas Prices to Energy Efficiency Program Cost Effectiveness

While the sustainability of the very low gas prices of the last couple of years (prior to COVID-19) is an open question (an issue that will be briefly discussed later in this paper), there is no question that recent low natural gas market prices have been putting pressure on the cost effectiveness of utility natural gas energy efficiency programs.

Michigan provides an interesting example of this relationship. Michigan is useful in this regard because it has maintained the same cost-effectiveness test framework (based on a utility cost test) since the beginning of its modern-era gas utility energy efficiency programs in 2009. Figure 3 shows the ex-post achieved overall portfolio cost effectiveness for the state's two major natural gas utilities by year, along with the average Henry Hub gas price that year. To summarize, in the past decade, Henry Hub gas prices have declined from $4.50/Mcf in 2010 to barely $2.00/Mcf at the end of 2019, and the two utilities' portfolio cost-effectiveness ratios (UTC) have declined from the range of 3.5 to 4.5 in 2011 to about 1.5 in their most recent energy efficiency plans for 2020-2021 (filed in 2019).

[3] The disruption resulting from the COVID-19 pandemic will greatly distort both natural gas prices and utility energy efficiency spending beginning in 2020.

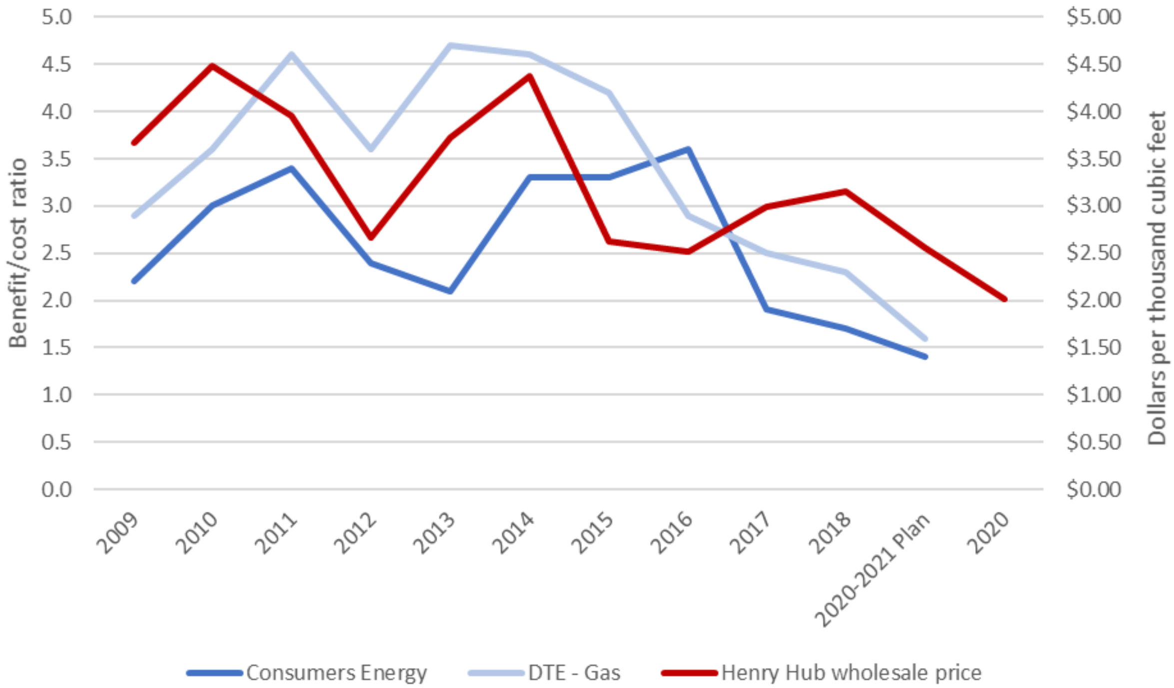

Figure 3. Benefit-cost data from two Michigan utilities and U.S. natural gas Henry Hub wholesale price. Data on Michigan utility performance was obtained from MPSC staff. The U.S. natural gas Henry Hub wholesale price was taken from the Energy Information Administration's website at www.eia.gov/dnav/ng/hist/rngwhhdA.htm.

Clearly, the very low natural gas prices of the past few years (prior to COVID-19) have created a challenge for natural gas utility energy efficiency programs, making it more difficult for some measures and even some programs to pass traditional cost-effectiveness tests. This paper examines what leading states and utilities have been doing to address this situation and thus far sustain substantial portfolios of natural gas energy efficiency programs.

Methodology

For this project, we collected information from three major sources. First, we conducted a search of available literature pertinent to the topic of utility natural gas energy efficiency in the era of lower gas prices (i.e., since approximately 2012). This included both broad overarching studies as well as more specific analyses, such as energy efficiency potential studies conducted in particular states. Second, we conducted interviews with various experts in this field, including national evaluation experts and managers from leading gas utilities. Finally, we conducted surveys with utility regulatory staff in 10 states that are leaders in natural gas utility energy efficiency. We selected these states based on their best-in-class performance on the natural gas savings metric in the 2018 and 2019 ACEEE *State Scorecard* reports (Berg et al. 2018 and Berg et al. 2019).

Results

AVAILABLE LITERATURE

To begin, we found that the literature on the subject of utility natural gas energy efficiency is relatively limited. Most of the recent focus in the industry has been on electricity, with (1) "electrification" (the replacement of devices that use fossil fuels with those that use electricity) and (2) energy efficiency as an electric system "distributed energy resource" (DER) receiving much attention. Much of this has been driven by the growing interest in exploring new ways to reduce overall carbon emissions.[4] In fact, some advocates have even questioned the need for natural gas energy efficiency programs, arguing that the climate crisis calls for phasing out the use of natural gas entirely and that investments in natural gas energy efficiency perpetuate the need for investment in the natural gas delivery system. (We discuss this issue in more depth below.)

Nevertheless, we identified a few important sources pertinent to the focus of this report. Of particular interest was a prescient report by Lawrence Berkeley National Laboratory (LBNL) (Hoffman, Zimring, and Schiller 2013). Published at a time when gas market prices had declined from previous levels but had not yet reached the valleys seen this past year, it concluded: "Low natural gas prices are creating significant benefits for consumers but cost-effectiveness screening challenges for gas efficiency efforts" (Hoffman, Zimring, and Schiller 2013, p.17). It identified three key decision areas that will have great importance when assessing the cost effectiveness of gas energy efficiency programs in a low-gas-price environment: (1) the selection of which benefit/cost (B/C) test to use; (2) the level at which the B/C screening is conducted (e.g., measure, project, program, sector, or total portfolio); and (3) the discount rate applied. We will discuss those decision points later in this paper.

A 2015 DOE report on *Barriers to Industrial Energy Efficiency* concluded:

> The expectation for natural gas prices to remain at low levels in the midterm (EIA projects Henry Hub spot prices to remain annually below $5/MMBtu through 2022) could reduce motivation for industrial plants to implement energy efficiency projects, particularly industrial plants with short-term planning horizons. To the extent that forecast prices for natural gas remain low, industrial customers may perceive the economic value of investments in efficiency to be relatively low (DOE 2015, p. 46).

A 2017 ACEEE report (Nadel 2017) was still relatively optimistic about the prospects for natural gas energy efficiency despite low gas prices:

> Energy efficiency has resulted in substantial natural gas savings. Considerable opportunities remain for additional cost-effective savings, with the achievable savings averaging about 1% of gas sales each year for the next decade or more. Recent studies have found that these savings are cost effective, even at today's relatively low natural gas prices (p. vii).

However, a precipitous further drop in wholesale market prices for natural gas by late 2019 resulted in prices about one-third less than in 2017 (i.e., ~ $2.00/MMBtu vs. $3.00/MMBtu).

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[4] As the carbon intensity of electric production decreases, fuel switching to electricity becomes an increasingly important greenhouse gas mitigation strategy (IPCC 2018).

Most recently, LBNL completed a comprehensive study of the cost of saved energy for utility natural gas energy efficiency programs across 37 different utilities/program administrators around the nation (Schiller et al. 2020). In that report, the average utility portfolio cost of saving a therm of natural gas was $0.40.[5] For the first decade or so of this century, that would have been cost effective against just the wholesale hub price available to utilities throughout the United States. In recent years, however, the wholesale price of gas has plunged, requiring more sophisticated analyses of natural gas energy efficiency cost effectiveness. The LBNL report only calculates the cost of saving energy and does not address the subject of judging cost effectiveness. We address that issue in this paper.

EXPERT INTERVIEWS

We conducted brief interviews and/or surveys in December 2019 with more than a dozen professionals active in this field. These included individuals from government agencies, consulting firms, nonprofit organizations, and utilities. In response to a structured question, all but one indicated that in the states they were familiar with, the low price of natural gas has created, at least "sometimes," a concern for the cost effectiveness of natural gas energy efficiency programs, and more than a quarter of respondents indicated cost effectiveness was a "substantial" concern.

As examples of responses to this concern, half mentioned there had been some type of adjustment to cost-effectiveness methods and/or inputs, such as focusing cost-effectiveness screening on portfolios rather than measures or programs, adding a peak capacity cost of gas to avoided cost estimates, and incorporating some consideration of non-energy benefits. More than two-thirds said there had been modifications to program designs, including pursuing partnerships for program delivery with other entities (such as water and electric utilities) to reduce costs, looking for innovative measures and delivery techniques, and increasing incentives to participants to help overcome the fact that lower gas prices tend to reduce customers' motivation to pursue efficiency upgrades.

SURVEYS OF LEADING STATES

We conducted email surveys with state utility regulatory staff in 10 states that are national leaders in natural gas utility energy efficiency achievements (CA, DC, IA, MA, MI, MN, OR, RI, UT, VT). A key goal was to determine the basic framework of how each state addresses the cost effectiveness of natural gas energy efficiency programs. Table 1 provides a summary of several factors relating to cost-effectiveness[6] methodology and results (reported as of late 2019).

[5] Interestingly, this result is very similar to the cost of saved energy reported in earlier studies by ACEEE, at $0.35/therm (Molina 2014), and LBNL, at $0.38/therm (Billingsley et al. 2014).

[6] We use the acronym "B/C" for "benefit-cost" in the table. See the National Standard Practice Manual (Woolf et al. 2017) for definitions and discussion of the various B/C tests.

Table 1. Cost-effectiveness highlights from leading natural gas energy efficiency states

State	Primary B/C test	Discount rate	Level B/C applied	Special treatment of low-income programs?	Non-energy benefits to participants	Carbon reduction included as a benefit	B/C results (B/C ratio w/ primary test or $ per therm)
CA	TRC	7.31%	Portfolio	Yes Modified B/C tests used for informational purposes	No	Yes ($68.39/ton in 2019)	SoCal -1.25
DC	SCT	4.343%	Portfolio	No special provisions	Yes (5% adder)	Yes ($100/ton)	DCSEU -$1.75/ first year therm
IA	SCT	Treasury bond rates	Portfolio and Program	Yes Exemption for low-income from B/C tests	Yes (In 7.5% general externalities adder)	Yes (In 7.5% general externalities adder)	IPL - 0.77 MAEC–1.94 BHE – 1.25
MA	TRC	2.33%	Program	Yes Includes consideration of non-energy benefits	Yes (multiple items included)	Reasonable foreseeable environmental compliance	All -2.22
MI	UCT	WACC	Portfolio	Yes Exempted from B/C tests	No	None	CE – 2.08 DTE – 2.30
MN	SCT	2.55%	Segment	Yes Doesn't need to meet B/C test	Yes (limited to O&M savings)	Yes ($25.76/ton $1.73/dtherm)	Xcel – 2.16 CP – 1.84 MERC–1.42 GM – 2.42 GP – 2.37
OR	TRC and UCT	4.50%	Program and Measure	Yes B/C tests do not apply to low-income weatherization	Yes, for TRC (water savings and O&M)	Yes ($0.16/therm)	1.20 to 2.47 across sectors All: 26.4 cents/ levelized therm
RI	RITRC	0.84%	Portfolio	Yes May consider the accrual of non-energy impacts	Yes (multiple items possible)	Yes ($68/ton)	NG – 3.11
UT	TRC, PCT, UCT, RIM	4.37%	Portfolio and Program	No No special provisions.	No	None	DEU - 1.23 3.72 1.41 .73
VT	VTSCT	3.00%	Portfolio	Yes Low-income includes a 15% adder to the energy benefits.	Yes (15% NEBs adder)	Yes ($100/ton Incl. in externalities adder of $6.06/MMBtu)	4.92

There is wide variability in terms of which cost-effectiveness test states use as their primary test for decision making. Four states use a societal test, two states use a TRC test, one state uses a utility cost test,[7] two states use multiple tests, and one state uses its own specially developed test. There is more commonality on some elements that experts say are important for having an appropriate cost-effectiveness framework.[8] For example, all but two states use a discount rate that is less than a typical "weighted average cost of capital (WACC)" rate, and most states apply the cost-effectiveness screening at a level higher than the program level (five at the portfolio level and one at the sector level).

As for other benefits included in their cost-effectiveness approach, seven states include at least some non-energy benefits for participants (e.g., water savings, avoided operation and maintenance costs, a general "adder" to reflect other benefits), and eight states include a carbon reduction benefit as part of environmental benefits, including six states that report a specific dollar value for avoided carbon emissions.

Eight of the ten states either exempt low-income energy efficiency programs from cost-effectiveness screening or provide some special provisions for how low-income programs are assessed for cost effectiveness (e.g., include certain extra non-energy benefits for participants). Those types of policies are very important for ensuring that low-income customers can receive energy efficiency services.

One particularly important observation from these results is that, despite low gas prices in recent years, and even with variability in cost-effectiveness testing approaches, utilities in all 10 states managed to deliver cost-effective natural gas energy efficiency programs as of the dates of their reporting available for this paper (i.e., 2018 or 2019 data). Indeed, many states reported cost-effectiveness ratios of 2.0 or greater. Nonetheless, average Henry Hub gas prices declined another 20% from 2018 to 2019, so there is cause for continued concern. (On the other hand, a countervailing force is that in some regions, particularly the Northeast, significant gas supply transportation constraints are putting upward pressure on costs and making programs more cost effective.)

Finally, it is also noteworthy that some of the leading states in the table are not in "cold weather" regions, suggesting that success with natural gas energy efficiency is not restricted to cold-climate states.[9]

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[7] See the National Standard Practice Manual (Woolf et al. 2017) for definitions and analysis of these cost-effectiveness tests.

[8] Key elements for structuring a well-designed cost-effectiveness test are discussed below. See also (Woolf et al. 2017).

[9] See AGA 2020 for a very recent comprehensive review of natural gas utility energy efficiency program activity across the nation.

Discussion

HOW MUCH DOES IT COST TO SAVE NATURAL GAS?

Any assessment of whether natural gas energy efficiency programs are cost effective must begin with the question of how much it costs to save natural gas. That question can be examined in terms of actual historical data as well as through future projections, such as those found in energy efficiency potential studies.

Past Performance

Perhaps the best and most current source of data on the cost of saving natural gas through ratepayer-funded energy efficiency programs is the previously cited national study by LBNL (Schiller et al. 2020). That study examined the results from 37 different utilities/program administrators, across 12 states over 6 years and found an average overall levelized program cost of saved natural gas across all of those portfolios of $0.40/therm. Interestingly, that was very close to the reported result from LBNL's previous national study (Billingsley et al. 2014), which found an overall average levelized cost of $0.38/therm, and an ACEEE study of the same period (Molina 2014), which found an average levelized cost of $0.35/therm. These results indicate that the cost of saving natural gas has been remarkably stable over the past decade.

Of course, there are differences among states, among utilities, and among programs targeted at different customer sectors. For example, the most recent LBNL study found average levelized costs of $0.43/therm for residential programs and $0.18/therm for commercial and industrial programs, and $1.47/therm for residential low-income programs.[10] Nevertheless, the overall average levelized cost across actual portfolios of delivered programs was $0.40/therm.[11]

Projections for the Future

To examine the projected cost of natural gas energy efficiency going forward, we reviewed the results of natural gas energy efficiency potential studies from eight states. The timeframe and key results from these studies are presented in table 2.

A few elements from this table are worth highlighting. In each case, we selected a "medium" or "achievable" scenario from the studies. Nevertheless, the average annual savings projected as achievable in that scenario were relatively aggressive, ranging from 0.55% to 1.34% per year. The projected cost of saved energy, even under those relatively aggressive savings levels, was comparable to or even less than the actual historical result of $0.40/therm reported by LBNL.

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[10] Nearly all states with active utility energy efficiency programs either exempt low-income programs from cost-effectiveness requirements or feature some type of special treatment for low-income programs in recognition of their substantial non-energy benefits and to help meet equity objectives (Berg and Drehobl 2018).

[11] The median cost reported was even lower, at $0.34/therm (Schiller et al. 2020).

Table 2. Natural gas energy efficiency potential studies

State	Author	Years of study	Selected scenario	Percent savings by year	Cost of saved energy*
AR	Neubauer et al. 2011	2009-2025	Medium case	Medium: 14% by 2025 (average annual: .82%)	Residential - $5.76/MMBtu levelized cost of saved energy; Commercial - $3.43; Industrial - $1.22 (2009-2025)
MI	GDS Associates, 2013	2014-2023	Achievable UTC - no spending cap	Achievable UTC: 13.4% in 2023 (average annual: 1.34%)	Achievable UTC: 5 yr - $26.37 acquisition cost per first year MMBtu saved; 10 yr - $25.57
MN	Nelson et al. 2018	2020-2029	Program potential	Program: 11% in 2029 (average annual: 1.10%)	Program 2020-2029: $2.70-$2.90/Dth ($2.70-$2.90/MMBtu)
NJ	Optimal Energy 2019	2020-2029	Maximum achievable potential	Maximum achievable potential: 11% cumulative energy savings by 2029 (average annual: 1.1%)	Maximum achievable potential – societal cost test: 2.6 (derived: $2.44 - $3.09/Mcf) ($2.36-$2.98/MMBtu)
NY	Mosenthal et al. 2014	2013-2032	Achievable	Achievable: 6% by 2020 (average annual: .75%); 11% by 2030 (average annual: .55%)	Achievable: 1.88 BCR Achievable: $4.06/MMBtu in 2030 (levelized cost)
VT	Optimal Energy 2015	2015-2029	Achievable	Achievable: 8.2% by 2029 (average annual: .55%)	$33/Annual MMBtu (first year cost)
Puget Sound Energy (WA)	Navigant Consulting 2017	2018-2037	Achievable technical potential	Achievable technical potential: 17% by 2037 (average annual: .85%)	There are roughly 60 million therms of achievable technical potential under $.55/therm (TRC cost)($5.50/MMBtu)
Focus on Energy (WI)	Garth et al. 2017	2019-2030	Business as usual (BAU) achievable; moderate incentive	Moderate incentive: 16% of baseline in 2030 (average annual: 1.33%);	N/A

* Some states report costs as the cost per "first year" unit of savings. To convert that to a "levelized cost," one would need to know the projected lifetime of measures installed. For a very crude conversion of "first year" costs to "levelized" costs, one might assume an average life of measures of 10 years and divide the first year cost by 10 (e.g., a first year cost of $2.38/therm might equate to a levelized cost of 23.8 cents/therm). Conversions to MMBtu used 1 Dth = 1 MMBtu, 1 Mcf = 1.036 MMBtu, 1 therm = .1 MMBtu.

Overall, based on both actual historical reported data and projections from energy efficiency potential studies, it appears that a portfolio of natural gas energy efficiency programs can deliver savings at a levelized cost of $0.40 per therm ($4.00 per MMBtu or Dtherm) or less. That program cost would be a good foundation for energy efficiency programs to be cost effective just relative to the average pipeline-delivered (Citygate) commodity cost to the utility during most of the 21st century to date. We illustrate that relationship in figure 4, below.

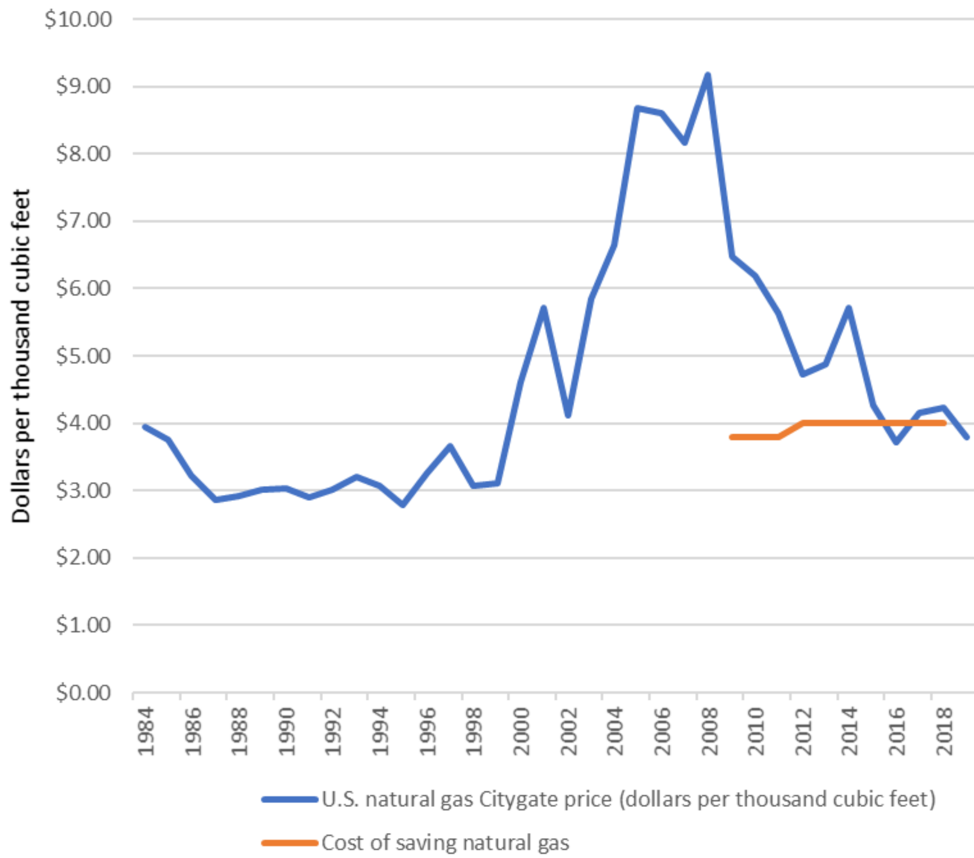

Figure 4. U.S. average natural gas Citygate price versus benchmark program cost of saving natural gas from LBNL. The U.S. average natural gas Citygate price was taken from the Energy Information Administration website at www.eia.gov/dnav/ng/hist/n3050us3A.htm. The benchmark program cost of saving natural gas from LBNL was taken from Billingsley et al. 2014 ($0.38/th) and Schiller et al. 2020 ($0.40/th).

The data in figure 4 show a simple comparison of the average levelized program cost of saving natural gas versus the average Citygate cost of natural gas to a utility. However, with the extremely low natural gas commodity cost in recent years, it has become increasingly important to consider and appropriately value other benefits beyond merely the wholesale gas commodity cost. A key remaining question for policymakers, regulators, and program administrators going forward is what cost effectiveness framework would be appropriate for assessing the value of natural gas energy efficiency programs. The next few sections of this report discuss that subject in detail.

WHAT SHOULD STATES/UTILITIES DO REGARDING GAS EFFICIENCY PROGRAM COST EFFECTIVENESS?

Optimize Programs

Before we address the elements of cost-effectiveness testing, it is important to emphasize the importance of adjusting program design, where appropriate, to best suit a low-gas-price environment. Several actions mentioned by the experts we interviewed merit endorsement. One strategy is to pursue joint marketing and program implementation with other entities like electric and/or water utilities. That can not only reduce program administration and delivery costs, but also result in a more attractive program offering for customers (e.g., more comprehensive benefits, less hassle than dealing with multiple providers).

A second strategy relates to program incentives. Several of our experts noted the concern that lower gas prices have somewhat lessened customer motivation to pursue efficiency upgrades, so increasing program incentives where possible, while remaining cost effective, helps address that concern. This would appear to be particularly feasible in the commercial and industrial sectors, where average historical costs for saving natural gas have been less than $0.20/therm (Schiller et al. 2020).

Finally, helping to ensure that programs provide and market "non-energy benefits" (NEBs) to participants (e.g., comfort, health, reduced maintenance costs) can help increase motivation to participate (and add to benefits in states that include NEBs in benefit-cost calculations).

ACEEE has several sources available for examples of exemplary natural gas energy efficiency programs (e.g., Nowak et al. 2013; Nowak, Kushler, and Witte 2019).

Structure an Appropriate Cost-Effectiveness Test

During times of high natural gas prices, gas energy efficiency programs were so easily cost effective that cost-effectiveness testing was not very consequential. As a result, approaches to cost-effectiveness testing were often cursory and incomplete. There were many oversights and omissions that can be justifiably remedied now. Importantly, we are not suggesting that cost-effectiveness analyses be unfairly distorted to support natural gas energy efficiency programs. Rather, cost-effectiveness tests should be modernized and improved according to important best practices principles, such as described in the National Standard Practice Manual (NSPM).

The NSPM manual identifies a number of key elements for designing an appropriate cost-effectiveness framework. These include identifying as a core principle that a cost-effectiveness test needs to be symmetrical (i.e., "balanced"), where both costs and benefits are included for each relevant type of impact (p. viii), and explaining the rationale for using a low-risk discount rate (pp. 72-75). As its central premise, the NSPM suggests that each state carefully and transparently develop its own cost-effectiveness framework, taking into account the specific circumstances and identified policy objectives for that state.

Many of the key principles of an appropriate framework for cost-effectiveness testing are not new, but they have not yet been widely or consistently applied. A number of those important elements are included in the examples described below, highlighted in bold. We provide these descriptions as examples of credible sources that have pointed to the importance of these factors.

A good place to start is with the early LBNL report mentioned above, which identified the choice of the correct test, the level at which screening is applied, and the discount rate as key factors to consider. That report concluded:

> Natural gas energy efficiency programs came to prominence in terms of spending, level of savings, and geographic coverage in the last decade, when gas prices were relatively high. In the 2000s, these programs had few problems passing cost-effectiveness analyses due to these high prices, and there was less incentive to investigate the full range of benefits from gas energy efficiency—many of which are not routinely considered as part of cost-effectiveness screening. The relative impact of including these benefits varies widely. In program screening, **using a lower discount rate** is likely to have a substantial impact on cost effectiveness (Hoffman et al. 2013). **Changing from a TRC to an SCT or PAC test or moving from measure- to program- or portfolio-level screening** also is likely to have a significant effect. ((Hoffman, Zimring, and Schiller 2013, 17).

Another early source of note is a policy statement issued by the Washington Utilities and Transportation Commission. It observed:

> In the past three years, the price of natural gas declined sharply in a way that few could have imagined. This price drop reduced the cost-effectiveness of conservation programs and prompted our investigation into the appropriateness of various cost-effectiveness tests. (Washington UTC 2013, 17).

This policy statement also covered each of the three key areas identified by LBNL. First, it emphasized the importance of **selecting a properly balanced test that appropriately considers both costs and benefits.** As an example, it noted:

> A major concern with the TRC is that it typically includes the full costs, but often does not include the full benefits to customers because the [risk reduction] value and many non-energy benefits are difficult to quantify. This introduces a potential bias in the TRC against conservation programs (13).

Second, it addressed the issue of the level at which cost-effectiveness screening is applied: "…ultimately we **only require that a utility's entire conservation portfolio be cost-effective"** (15).

Third, it addressed the discount rate issue:

> Regarding risk, **the discount rate applied to the stream of future energy efficiency benefits should be reflective of a low-risk investment**, regardless of the class of customer making those investments. We believe a risk-free rate of return (e.g., the long-term composite interest rate of U.S. Treasury notes) is generally the appropriate rate for discounting these future benefits when using the TRC test (16).

It also included an interesting fourth element that we have not seen operationalized elsewhere:

> Finally, there may be significant **costs associated with discontinuing and then restarting conservation programs a short time later**; utilities do not currently consider these costs in cost-effectiveness tests. Accordingly, a utility proposing to stop offering conservation programs should quantify, and include in its cost-effectiveness evaluation, the costs of discontinuing and restarting programs. Specifically, utilities should consider all quantifiable costs of starting and stopping, including, but not limited to, the effects on conservation program delivery infrastructure, trade ally networks, workforce skills related to installing energy efficiency measures, administrative costs, and advertising expenses (15).

A final useful early source is an ACEEE report (Molina 2014) that stated:

> Average natural gas commodity prices have fallen significantly in recent years, which has put pressure on gas program administrators to keep costs below avoided costs. Our analysis finds that natural gas energy efficiency programs remain a low-cost and cost-effective resource at an average portfolio cost of $0.35/therm across 10 states. This average value is lower than the average Citygate price of natural gas of $0.49/therm nationally in 2013 (EIA 2014). However, **the avoided gas commodity cost does not tell the complete story of gas energy efficiency benefits. In addition to the commodity cost of gas, avoided costs to utilities can also include avoided distribution and transmission costs, peak demand benefits, hedging against fuel price volatility, and environmental benefits** (36).

That report made two additional important observations: (1) "natural gas avoided costs vary significantly across the country due to methodology and market structure differences," and (2) **projected avoided costs "are subject to the uncertainty around future gas prices."** To illustrate these points, the report noted:

> For example, we collected a sample of recent (2012 and 2013) avoided natural gas costs, both current values and forecasts, for a handful of jurisdictions across the country. We identified a range of $0.37/therm to $1.019/therm for current and forecasted avoided gas costs (p. 36).

In addition to the important elements contained in the above examples, two more key factors have gained prominence in recent years. These are briefly addressed in the next two sections.

The Increasing Importance of Environmental/Climate and Health Objectives

Consistent with the NSPM principle that a state should reflect its policy objectives in its cost-effectiveness approach, a number of leading states (see table 1) now include an environmental benefit component in their cost-effectiveness test for natural gas efficiency programs. More than half of those top states specifically include a benefit related to CO_2 emission reductions from natural gas energy efficiency. As an illustration of the potential magnitude of benefit that might provide, using a typical range of the "cost" of carbon emissions of $25 to $100 per ton (consistent with what we see in table 1), the dollar value would be in the range of $1.50 to $5.85

per Mcf of natural gas saved. That estimate typically does not include any estimate of methane emissions in the production or transportation of the gas.

Increased attention is also being paid to the environmental health benefits of certain energy efficiency programs (e.g., weatherization and home/building retrofits) for the indoor environment (Hayes, Cubes, and Gerbode 2020). Cost-effectiveness assessments of natural gas energy efficiency programs should value those benefits as well, where appropriate.

The Risk Surrounding Future Natural Gas Prices

The assumption of future natural gas prices is clearly a crucial variable in any cost-effectiveness assessment for energy efficiency programs. The trend toward very low natural gas prices in recent years has put pressure on gas energy efficiency cost effectiveness, with the most recent trends just prior to COVID-19 threatening even more pressure. But what if those low market prices do not persist?

There is an arguable case to be made that these recent low prices are not sustainable. Numerous industry experts have maintained that the realistic average cost of production for shale gas is in the area of $4 per Mcf or higher (Mearns 2013; Berman 2017; Hughes 2019), yet we've had several years of wholesale market prices below that price. This situation recalls an old joke: Two business partners are chatting, and one says, "We're losing money on every sale," so the other responds, "Yes, but we'll make it up on volume!"

That basic scenario appears to be unfolding in the shale industry. The short story is that producers have been rapidly expanding drilling areas and production to try to maintain sufficient cash flow to cover existing debts, and in the process, they are piling up greater and greater negative balances, while the previously drilled "sweet spot" fields rapidly deplete (e.g., see Hughes 2019). In the short run, the variable costs of pumping the gas are low compared to the fixed costs involved in drilling and installing infrastructure, and therefore sellers will sell at well below the "all-in" costs they truly need to cover debt because they are still gaining revenues versus not pumping. That is not a sustainable business model.

The consequences of low gas prices and the frantic pursuit of cash flow are already visible. One expert recently coined the phrase "The Great American Shale Oil and Gas Bust," and reported that as of January 2020, there had been a total of 402 bankruptcies in the fracking industry since 2015 (Richter 2020).[12]

This report is not the forum to delve further into the subject of gas prices vs. production costs; there are a number of good sources on that issue, such as Anderson 2013, Mearns 2013, Berman 2017, Cunningham 2019, and Hughes 2019. However, the main takeaway here is that any assessment of the cost effectiveness of natural gas energy efficiency programs should at least take into consideration the risk of future natural gas prices being higher than current and

[12] Our discussion here focuses on data gathered prior to two simultaneous disruptions: the COVID-19 pandemic and the oil market manipulation by Saudi Arabia and Russia. It thus reflects trends prior to those disruptions, which presumably will still be relevant when markets return to their previous condition.

recently forecasted levels.[13] Gas price forecast variability is much greater on the high side than on the low side (New York PSC 2016). Cost-effectiveness assessments could include a consideration of utilities' costs of hedging against future price increases (Molina 2014; Baatz, Barrett, and Stickles 2018). Appropriately valuing long-term natural gas price risks is particularly important given that many natural gas efficiency measures have very long measure lifetimes.

The NSPM describes several ways that the risk of future fuel price increases can be factored into cost-effectiveness assessments:

> There are different ways to value risk reduction. For example, the most recent New England regional avoided cost study estimated a "risk premium" of nine percent. This was added to avoided energy costs to account for one aspect of efficiency's risk mitigating effects: uncertainty in the range of future wholesale energy prices (AESC Study Group 2015). Similarly, another screening tool approach is to report cost-effectiveness for several scenarios; e.g., a "best estimate" of future avoided costs, versus a probability-weighted average of future avoided costs. The difference between the two essentially represents a "risk premium" associated with future price volatility. Alternatively, Vermont's regulators have mandated since 1992 that efficiency resource costs be reduced by 10 percent to reflect efficiency's "comparative risk and flexibility advantages" relative to supply resources (VT PSB 1990) (Woolf et al. 2017, 53-54).

Examples of States with Comprehensive Approaches to Cost Effectiveness

In our review of states with substantial natural gas energy efficiency achievements, we identified a number of states that are noteworthy for their comprehensive approach to assessing cost effectiveness. Table 3 presents a state-by-state overview of some of those key elements, along with each state's most recent spending and savings data and rank from the ACEEE 2019 *State Scorecard* (Berg et al. 2019).

[13] E.g., see Optimal Energy 2015 for an example of a natural gas energy efficiency potential study that included an assessment of a high natural gas price scenario.

Table 3. States with comprehensive approaches to cost effectiveness for natural gas energy efficiency programs

State	Primary B/C (discount rate)	Citygate cost	Timing/peak costs	Local distribution costs	Non-energy benefits	Demand reduction induced price effect (DRIPE)	GHG benefits	2018 natural gas energy efficiency spending ($ per res. customer)	2018 natural gas EE savings (percentage of retail sales)
DC	SCT (5.082%)	Yes	N/A	No	Yes 5% adder	No	Yes $100 per ton	$3.7 million ($24.48) [Rank: 17]	235,409 MMBtu (.78%) [Rank: 6]
MA	TRC (2.33%)	Yes	Yes	Yes	Yes Many (equip. maint., health, property value, etc.)	Yes	Yes The cost of reasonably foreseeable environmental compliance - $5.46/MMBtu	$249.3 million ($165.03) [Rank: 1]	3,828,733 MMBtu (1.12%) [Rank: 4]
MN	SCT (2.55%)	Yes	Yes	Yes	Yes Incremental participant O&M savings	No	Yes $25.76/ton	$58.1 million ($38.12) [Rank: 9]	3,564,000 MMBtu (1.2%) [Rank: 2]
OR	TRC and UTC (4.5%)	Yes	Yes	Yes	Yes Water, O&M savings, etc.	No	Yes The cost of future compliance ($.10/Therm)	$24.9 million ($33.65) [Rank: 10]	729,000 MMBtu (.59%) [Rank: 14]
RI	Rhode Island Test (.84%)	Yes	Yes	Yes	Yes Water, other fuels, indoor air quality, etc.	Yes	Yes $56.86 per ton	$27.2 million ($112.65) [Rank: 2]	548,839 MMBtu (1.17%) [Rank: 3]

[a] DRIPE is the reduction in market price of a fuel produced by the reduction in market demand. See Synapse, 2018 for a good explanation of natural gas DRIPE. [b] Spending and ranks are based on the *2019 ACEEE State Scorecard*. [c] Savings and ranks are based on the *2019 ACEEE State Scorecard*.

Each of those states incorporates several key elements identified in our earlier literature review and discussion of appropriate approaches for assessing cost effectiveness (e.g., Hoffman, Zimring, and Schiller 2013; Washington UTC 2013). Specifically, each of those states (1) uses a "societal" or "low-risk" discount rate; (2) uses a more thorough accounting of gas commodity costs (all use Citygate prices rather than Hub prices, and most add a factor to capture additional peak costs[14]); (3) includes at least some non-energy benefits; and (4) includes some value for reduction in greenhouse gas emissions. Other states would do well to incorporate some of these practices.

NATURAL GAS ENERGY EFFICIENCY EFFORTS IN THE CONTEXT OF ELECTRIFICATION

Another important issue to consider is how the emerging trend toward electrification might impact the future of natural gas energy efficiency programs. Climate and energy experts have argued that the ultimate objective should be to decarbonize our economy, and that to do so we must transition away from fossil fuels and pursue electrification. Toward that objective, some cities now forbid new construction of buildings that heat space or water with fossil fuels[15] (University of California 2019). Some advocates have gone so far as to oppose funding for energy efficiency programs targeted at natural gas use, with the rationale that we should be using electrification to convert away from gas rather than supporting its continued use (e.g., see intervenor comments described in New York PSC 2016).

Beneficial[16] electrification plays an important role in decarbonization strategies (Billimoria et al. 2018; Farnsworth, Lazar, and Shipley 2018). However, natural gas energy efficiency and beneficial electrification can and should co-exist. Unlike oil and propane equipment replacements or new construction, both of which offer favorable economics, the economics for customers to convert existing buildings from natural gas heating to electricity are typically not yet attractive (Billimoria et al. 2018; Nadel 2018; Reeves et al. 2018; Mosenthal and McDonald 2020). Given that many buildings currently use natural gas space heating and will likely do so for many years, it is counterproductive to stop pursuing natural gas energy efficiency. That is especially true for building shell improvements, which would reduce costs and save energy and emissions no matter what the heating fuel source.[17] For

[14] There are some states, particularly in the New England region, where gas transportation supply constraints add a substantial cost premium to peak gas usage.

[15] The economics of electrification for initial fuel choice in new construction are typically more attractive than for conversion of existing fuel use.

[16] Most organizations define electrification as beneficial when it provides net societal and participant benefits. For example, the Regulatory Assistance Project states that electrification must meet one or more of the following conditions without adversely affecting the other two: 1) save consumers money over the long run; 2) enable better grid management; and 3) reduce negative environmental impacts (Farnsworth, Lazar, and Shipley 2018). ACEEE views electrification as a form of energy efficiency only when it saves total primary energy and meets customer savings and emissions reduction criteria.

[17] That is particularly the case for lower-income customers who are unlikely to be able to afford the cost of conversion to heat pump technology. For that population, the first choice would always be robust building shell

these reasons, there is still a good case for natural gas energy efficiency efforts, particularly in existing buildings, even if greenhouse gas reduction is a driving motivation.[18] Massachusetts and New York are good examples of states that are aggressively pursuing electrification while also promoting natural gas energy efficiency in support of their climate policy objectives (Massachusetts DPU 2019; New York PSC 2020). Location-specific factors, including analysis of local economics and emissions impacts, should drive decision making on the extent to which natural gas efficiency investments should be pursued.

Conclusion

Utility natural gas energy efficiency programs have been facing some challenges in recent years. In particular, the low natural gas prices that have persisted for much of the past decade have put the squeeze on cost effectiveness for many programs. Utility spending on gas efficiency nationally has flattened, and there are questions about the viability of natural gas utility energy efficiency programs. In response, we examined several sources of data on the recent status of gas efficiency efforts in the industry to see what they might suggest regarding future prospects for natural gas efficiency programs.

To begin, we examined 10 states that are national leaders in utility natural gas energy efficiency achievements. We summarized their available results, which demonstrate considerable success at delivering substantial cost-effective natural gas energy efficiency programs.

Next, we reviewed a recent national study from LBNL (Schiller et al. 2020), which analyzed 6 years of reported results from 37 program administrators across 12 states. That study found an overall portfolio program levelized cost of $0.40/therm. This was almost identical to the $0.38/therm finding from LBNL's previous national study (Billingsley et al. 2014) and ACEEE's 2014 analysis that found average levelized costs of $0.35/therm of net savings (Molina 2014). These data demonstrate that utilities have a long track record of achieving gas savings at low cost, a cost that was found to be cost effective for more than a decade.

Finally, we examined the results of natural gas energy efficiency potential studies from eight states. Each of those studies found a substantial potential for cost-effective energy efficiency savings, and leading states continue to set natural gas energy efficiency savings targets (ACEEE 2019).

While recognizing that record of success, it is nevertheless true that an environment of low natural gas market prices presents challenges. Although there are some reasons to believe that the extremely low natural gas prices of recent years may not be sustainable in the

efficiency improvements. Where feasible, enhancing the size of incentives for heat pumps for low-income populations could be considered.

[18] If a state or city has ambitious net-zero GHG goals in the 2050 timeframe, there may be exceptions in the cases of very long-lived measures whose useful life extends beyond the state's goal, foreclosing the opportunity for replacement with fully decarbonized options. Such exceptions would include end uses that are unlikely to be high priority for the potential supply of RNG or green hydrogen solutions. A 2018 NREL report (Mai et al. 2018) demonstrates the impact of equipment longevity on stock turnover (2018).

longer term (and we recommend that the risk of future gas price increases be considered in any analysis of cost effectiveness), we cannot count on that eventuality. Planning in a low natural gas price environment requires extra care in designing programs and in developing the framework for assessing cost effectiveness. This report offers examples and recommendations that others have put forth toward those ends.

Based on our analysis, we conclude that by assuring appropriate cost-effectiveness analysis frameworks, conducting comprehensive natural gas efficiency potential studies that apply those benefit-cost frameworks, and making strategic program adjustments, states should be able to maintain substantial cost-effective utility natural gas energy efficiency programs for the foreseeable future. Utility natural gas energy efficiency programs should be able to continue to produce economic and environmental savings for customers and for society.

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