State Ranking of Potential Electric Bill Savings through Industrial Energy Efficiency

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ABSTRACT

State regulators and policymakers can help the industrial sector seize enormous opportunities to save money through energy efficiency – making manufacturers more competitive while reducing carbon dioxide (CO_2) emissions and achieving emissions targets. In a scenario where each state achieves 1.5% electricity savings per year across all sectors and deploys a portion of its technical potential for new combined heat and power and waste heat to power, states can:

- Save businesses $298 billion in cumulative cost savings (2016-2030) from avoided electricity purchases;
- Save 396 million megawatt-hours of electricity in 2030; and
- Cut CO_2 emissions by 174.5 million short tons in 2030 – equal to the emissions from 46 coal-fired power plants.

The top ten states that would experience the greatest utility bill savings from energy efficiency improvements in the industrial sector are: California, Texas, New York, Massachusetts, Florida, Ohio, New Jersey, Pennsylvania, Illinois, and Indiana. Many of these states have significant manufacturing industries.

The full state ranking provides policymakers, industrial companies, utilities, and others information about the potential opportunity for industrial energy efficiency and resulting cost savings and emission reductions. This is particularly important for states considering how to preserve manufacturing competitiveness, while addressing CO_2 emission reductions and planning for future investments in the electricity sector.

Introduction

The Missed Cost-Saving Opportunity of Industrial Energy Efficiency

The industrial sector – including manufacturing, mining, construction and agriculture – is the largest energy user in the U.S. economy, consuming about one-third of all U.S. energy demand, as shown in Figure 1 (EIA 2015). Of the industrial subsectors, manufacturing accounts for the vast majority of energy consumption. In 2012 alone,

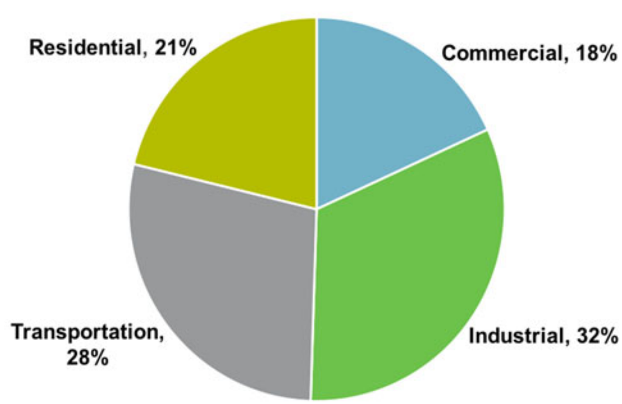

Figure 1. Share of total U.S. energy consumed by end-use sector in the United States in 2015. *Source*: EIA 2015.

manufacturers consumed 74% of industrial energy, equal to 24% of all energy used in the United States (DOE 2015b).

Industrial energy consumption comes with a significant cost. In fact, industry currently spends $230 billion each year on energy (DOE 2015a). Energy consumption and spending is highest in energy-intensive industries, such as petroleum refineries, bulk chemicals, and paper products. Many of these industries are also particularly sensitive to international competition and energy costs represent a considerable bottom-line expense (EIA 2012).

Industrial energy use is also projected to grow. According to the U.S. Energy Information Administration (EIA), virtually all of the growth in U.S. energy demand from 2012 to 2025 will come from the industrial sector. During this period, industrial energy demand will increase by 22% to comprise more than 36% of all U.S. energy consumption (DOE 2015b).[1] This increase in energy demand could increase greenhouse gas emissions from the industrial sector 18% from current levels by 2025 (Larsen et al. 2016).

The large energy consumption and growing demand in the industrial sector creates an opportunity for significant savings. Studies and practical experience at manufacturing plants, for example, show large potential for energy efficiency improvements in the manufacturing subsector. According to the U.S. Department of Energy (DOE), a combination of cost-effective measures, including process and material efficiency improvements, demand response, combined heat and power (CHP), and waste heat to power (WHP) could reduce energy use in the industrial sector between 15% and 32% by 2025 (DOE 2015b).

Cost savings in the industrial sector are of particular importance to the U.S. economy, as this sector drives a significant amount of economic activity. In 2013, the industrial sector contributed $2.08 trillion, or about 12.5%, to U.S. gross domestic product and supported more than 17.4-million jobs (DOE 2015b). Many of these are high-paying jobs. In fact, compensation for manufacturing jobs in 2012 was more than 25% greater than the average compensation for all U.S. jobs (DOE 2015b).

Overview of Industrial Energy Efficiency and CHP/WHP

The industrial sector uses energy for three main purposes: processes, cross-cutting support equipment, and facility operations. Process-related applications account for 80% of industrial energy use and include process heating and chemical processes (ASE 2012). Cross-cutting equipment and supportive systems, including motor-driven equipment, such as pumps, air compressors, fans, mixers, CHP, and WHP account for 15% of industrial energy use. Facility operations themselves, including building systems, such as heating, ventilating and air conditioning (HVAC), lighting, and appliances, account for 5% of industrial energy use, usually from electricity.

Energy is lost throughout industrial processes due to equipment inefficiency, as well as mechanical and thermal limitations. Improving the efficiency of these systems – producing the same output with less energy – can result in significant energy savings, cost savings, and reduced CO_2 emissions. There are a variety of mechanisms to improve industrial energy efficiency, including:

[1] From 30.6 quadrillion Btu in 2012 to 37.4 quadrillion Btu in 2025.

- **Energy assessments**. Independent and internal assessments both help determine where the energy efficiency opportunities exist in a plant. By examining the system, these assessments can identify opportunities to improve facility productivity, reduce waste, and save energy.
- **Energy management and voluntary standards**. Energy management is the systematic tracking and planning of energy use for equipment, buildings, industrial processes, facilities, or entire corporations. Energy management programs often include metering and monitoring energy usage, identifying and implementing energy-saving measures, and verifying savings. The International Organization for Standardization (ISO) offers a voluntary standard (ISO 50001) that provides a framework for managing and improving energy performance, which industrial facilities can adopt.
- **Energy-efficient processes and technologies**. A variety of best practices and equipment can help industrial plants save energy. Energy-efficient technologies include variable speed drives, advanced sensors and controls, high efficiency condensing boilers, CHP, and WHP.

CHP and WHP are of particular importance to industrial efficiency (and related emission reductions). CHP increases fuel efficiency by generating both heat and electricity from a single fuel source. In this way, CHP can make effective use of more than 70% of fuel inputs and produce electricity with roughly one-quarter the emissions of an existing coal power plant (DGA et al. 2016). WHP uses waste heat from industrial operations to generate electricity with no additional fuel or incremental emissions. CHP and WHP systems also provide resiliency benefits. They can operate independently of the grid, enabling host facilities to keep the lights and power on despite extreme weather events that may compromise electric reliability.

Utility Planning

States can encourage industrial energy efficiency through utility resource planning processes. Under traditional regulation, utilities submit filings to a regulatory authority (a public utility commission, or PUC) projecting electric demand and modeling the resources that will be required to meet this demand during a future period, usually 20 years. In the context of resource planning, energy efficiency – especially industrial efficiency – is often the least-cost resource available to utilities (Hoffman et al 2017, Molina 2014). PUCs have the authority to require increased implementation of this least-cost resource, reducing the need for additional power plants and saving all customers money through lower utility costs.

Well-designed utility programs targeted to industrial facilities are a proven way to increase deployment of industrial energy efficiency, including CHP and WHP. These programs are typically funded through a fee on utility bills and make efficiency investments cost-effective for industrial companies. Such programs typically provide industrials with a “fresh” look at potential savings, technical expertise, and financial assistance to implement projects. In a sense, the utility becomes a partner with the industrial in finding energy reduction opportunities.

Although industrials have an incentive to reduce costs (including energy), there are often cost-effective energy-saving opportunities that companies have not yet captured. Large industrials typically report that their energy efficiency investments must realize a very short (one- to two-year) payback period requirement, which means that many projects that are cost-effective in the long-term will not be completed without shrinking the payback period. Utility programs help expand the menu of options that an industrial facility can reasonably consider.

Utilities often make long-term investments in infrastructure and are more willing to consider investments that will take more than one to two years to recoup. Utility programs offset up-front investments in energy efficiency, often through financial incentives like rebates. An industrial company that would not invest in an energy efficiency project with a four-year payback period could offset some of the costs with utility incentives, reducing the payback to two years or less, and meeting its internal rate-of-return. As Figure 4 illustrates, the combination of capital investment by a company and utility industrial energy efficiency program incentives results in a larger return-on-investment (ROI), making projects feasible that previously were not. Utility programs can also provide participants access to technical experts and program staff, who can supplement company resources and identify potential projects.

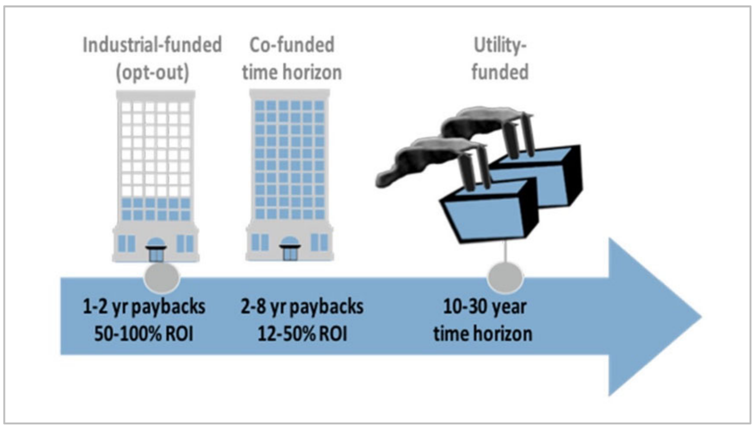

Figure 4. Utility industrial energy efficiency programs reduce the payback period for projects. *Source:* Schlegel and Zuckerman 2015.

Many industrial companies are already saving energy and money each year from industrial efficiency utility programs. For example, Nissin Brake, an Ohio-based automotive supplier, received rebates from AEP Ohio for investing in energy-efficient air compressor controls, air drying, and lighting. The utility rebates reduced the payback period from three years to less than two, making the investment viable and saving the company over 800 kilowatt-hours per year. Nissin Brake's Manager of Production Support has stated that the company would not have invested in the energy efficiency improvements absent AEP Ohio's support (AIE 2016).

Quantifying Industrial Energy Efficiency Electric Bill Savings

One of the primary benefits of industrial energy efficiency are bill savings to manufacturers. To better understand the extent of this benefit, we analyzed potential bill savings for the industrial sector from utility programs. We sought to quantify the impact of industrial energy efficiency and CHP on industrial utility bills, GHG emission reductions, and energy usage by state. To do so, we used DOE and industry data of industrial CHP potential by state and the American Council for an Energy-Efficient Economy's (ACEEE's) State and Utility Pollution

Reduction Calculator Version 2 (SUPR 2) to estimate energy savings, avoided costs, and emissions reductions at the state, regional, and national level over a 15-year period (2016 – 2030).

The analysis shows industrial companies can save $298 billion (2016-2030) in a scenario where each state achieves 1.5% electricity savings per year across all sectors and deploys a portion of its technical potential for new CHP and WHP. Bill savings from energy efficiency programs allow companies to invest more money to expand operations and hire more employees, improving economic outcomes for states focusing on these investments.

Methodology and Assumptions

This analysis relies on data from ACEEE's SUPR2 model to estimate energy savings, avoided costs, and emission reductions at the state, regional, and national level over a 15-year period (2016-2030).[2] SUPR 2 is a tool designed by ACEEE that calculates the costs and emission benefits of various carbon reduction options.[3] Users can choose from 19 policies and technologies to build their state's compliance scenario, including energy efficiency, renewable energy, nuclear power, emissions control, and natural gas.

Our analysis estimates the bill savings that would occur in a scenario where every state:

1. Achieves an annual 1.5% electricity savings per year by 2030 relative to forecasted industrial sector electricity sales from EIA's 2013 Annual Energy Outlook (AEO),[4] and
2. Installs a portion of its technical potential for new CHP and WHP.

Industrial energy efficiency (IEE) methodology. Our analysis assumes a universal 1.5% savings scenario, regardless of the level of the existing target. This allows us to compare results across states. Eligible industrial energy efficiency activities under a state savings target could include installing an energy management system, investing in process efficiency, and improving facility insulation.

SUPR 2 assumes that efficiency savings ramp up gradually because it takes time to design, approve, and implement efficiency programs. Specifically, the model assumes that each state adopts a savings target that grows at a rate of 0.25% of electricity sales per year. Policies are assumed to begin in 2016, and energy savings are projected through 2030. The 2016 starting point is based on statewide 2011 or 2012 (as available) electricity savings levels. Note that state-specific energy savings are based on annual forecasted retail electricity sales by state for the residential, commercial, and industrial sectors in 2012. Since SUPR 2 was originally developed to explore CPP compliance options, which is limited to the electricity sector, natural gas savings are not addressed in this analysis.

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[2] The results presented in this paper draw upon an analysis performed by Meegan Kelly of ACEEE.

[3] The SUPR2 tool is based on options that the Environmental Protection Agency (EPA) identified in its greenhouse gas regulations, the Clean Power Plan (CPP). In an Executive Order signed in March 2017, President Trump directed the EPA to start the process of withdrawing and rewriting the CPP. Although the CPP is likely no longer a viable near-term policy pathway, many states are nonetheless adopting internal carbon reduction plans despite the lack of federal leadership.

[4] Our analysis assumes that there is technical potential in each state to achieve a 1.5% energy savings target.

We consider 1.5% to be a reasonable savings target, as many states have already adopted comparable goals. Of the 26 states with energy efficiency resource standards (EERS) requiring electricity savings, six states (Arizona, Maine, Maryland, Massachusetts, Rhode Island, and Vermont) have more ambitious targets (setting incremental savings targets of 2% or more of sales per year), and four states (Connecticut, Illinois, Minnesota, and Washington) have targets of 1.5% or more of sales per year. The remaining 16 states with EERS have less ambitious energy savings targets in place (Berg, Gilleo, and Molina 2017). While 24 states have not yet adopted savings targets, we believe this is due to lack of political will, rather than available reductions.

Further, states are also achieving their EERS targets, suggesting that greater savings are available. In 2012, 15 states met or exceeded their electricity savings targets, and 6 others came within 90% of their savings targets for the year. Only one state met less than 80% of its target (Downs and Cui 2014).

Combined heat and power (CHP) methodology. For CHP, we assume a scenario in which each state installs a portion of its estimated on-site technical potential. This analysis relies on two sources of publicly available data to calculate the portion of each state's technical potential for new CHP and WHP that is economically feasible: (1) DOE's most recent (spring 2016) state estimates of technical potential, and (2) a 2013 state-by-state estimate of economic potential from ICF International for the American Gas Association (AGA).

First, the analysis examined the total on-site CHP and WHP technical potential from DOE's 2016 study in each state. This analysis is limited to technical potential at commercial and industrial host facilities; it does not include export potential.

Second, to estimate what portion of on-site CHP and WHP potential could be considered economic, we relied on findings from a 2013 AGA study. That study split technical potential into three categories: less than a 5-year payback, a 5- to 10-year payback, and more than a 10-year payback. We limited our analysis to potential in the first two bins (assuming investments with longer payback would not be made). This tells us what percent of technical potential could be considered to have a strong or moderate economic potential in a given state. We applied this percentage to DOE's most recent estimates of total on-site technical potential. In states where no economic potential was identified, we assumed a minimum of 10% would be deployed, recognizing that many states pursue policies to help overcome economic barriers to CHP deployment.

Finally, we used these state estimates of strong to moderate CHP potential as inputs for SUPR 2, to determine associated emissions reductions, avoided costs, and energy savings. SUPR 2 provides results assuming three levels of deployment in each state: low (40 MW), medium (100 MW), and high (500 MW). All three options are evenly split between the commercial and industrial sectors and we assume the full potential is installed in equal annual increments from 2016 through 2030. The options can also be combined or selected more than once (up to 10 times) to model the desired amount of CHP.

National Results

This industrial efficiency scenario would achieve considerable energy and cost savings. If every U.S. state adopted this scenario, it would result in a total of $298 billion in cumulative cost savings for industrial energy consumers, 396 million megawatt-hours of annual electricity savings in 2030, and 174.5 million tons of annual CO_2 reductions in 2030 (the equivalent of the annual CO_2 emissions from 46 coal-fired power plants) (Table 1). All results are over a 15-year period (2016-2030). Note that *annual savings* are the savings experienced in 2030 from the measures that have been installed and are still saving energy in years 2016 through 2030. *Cumulative cost savings* reflect savings under a policy or program *through* 2030 (i.e., the sum of annual cost savings from 2016 through 2030).

Table 1. Cumulative utility bill savings, annual CO_2 reductions, and annual electricity savings in 2030

	Cumulative electric bill savings, 2016 – 2030 (million 2011$)	2030 Annual electricity savings (MWh)	2030 Annual CO_2 savings (short tons)
Industrial Energy Efficiency	$157,750	212,480,929	141,866,557
CHP and WHP	$140,590	183,855,000	32,625,000
Total	$298,340	396,335,929	174,491,557

Regional Results

The ten states with the largest potential electric bill savings from the industrial sector are California, Texas, New York, Massachusetts, Florida, Ohio, New Jersey, Pennsylvania, Illinois, and Indiana. Electricity savings from these states alone would result in a combined $162.5 million in cumulative utility bill savings for industrial customers through 2030, representing more than half of the total cost savings for all states in this analysis. Table 2 shows these ten states and the associated cumulative bill savings.

Table 2. Top ten states with largest potential electric bill savings from industrial energy efficiency (IEE) and CHP/WHP

Ranking	State	2030 Cumulative Utility Bill Savings, IEE & CHP/WHP (million 2011$)
1	California	$35,310
2	Texas	$23,175
3	New York	$20,030
4	Massachusetts	$15,997
5	Florida	$12,851
6	Ohio	$12,525
7	New Jersey	$11,782
8	Pennsylvania	$11,208
9	Illinois	$10,834
10	Indiana	$8,775
TOTAL		$162,486

Why All Stakeholders Should Support an Expansion of Industrial Energy Efficiency

Our analysis shows that energy savings from the industrial sector will result in significant utility bill savings for industrial companies. As elaborated below, these savings would also benefit *all* ratepayers by reducing their electricity bills. State policymakers and regulators should maximize the potential for industrial energy savings by creating and expanding utility industrial energy efficiency programs. Such programs not only offer economic and air quality benefits to industrial customers, but to all energy consumers and to state economies more broadly.

Benefits to All Electric Consumers

Because energy efficiency is the cheapest source of energy, it should be the first choice for electricity planning. Figure 2 summarizes results from a recent ACEEE study, which found that it cost an average of only 2.8 cents per kilowatt hour to run efficiency programs in 20 states from 2009 to 2012 – about one-half to one-third the cost of alternative new electricity resource options.

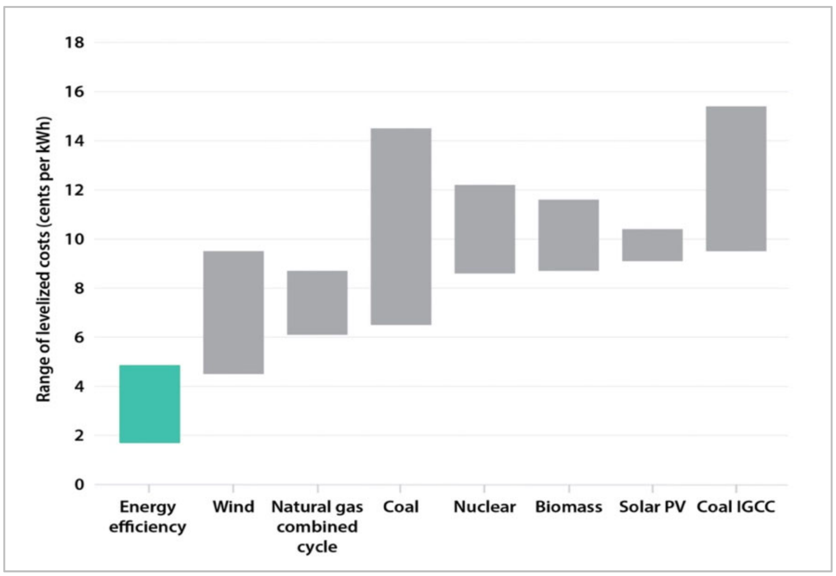

Figure 2. Levelized cost of saved energy by resource. *Source:* Molina 2014.

Further, *industrial* energy efficiency is the cheapest source of efficiency, as Figure 3 illustrates, and has the lowest cost of saved energy on a national level, when compared with other sectors.

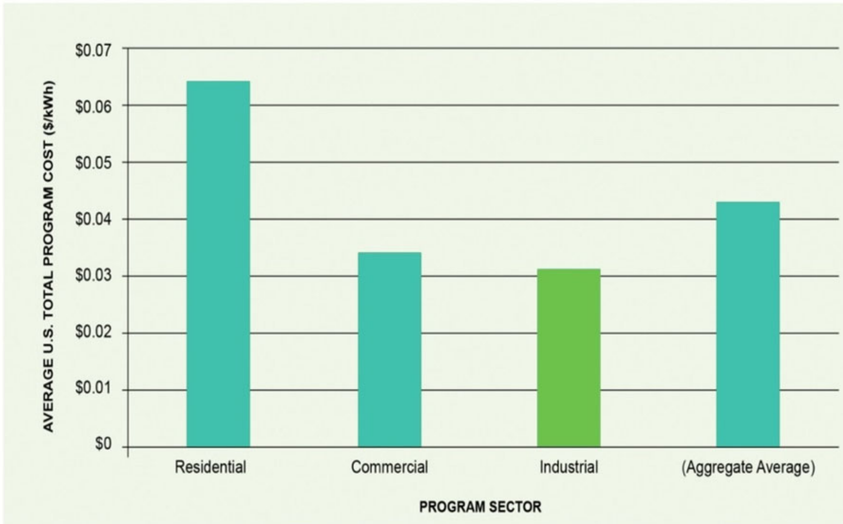

Figure 3. Cost of saved energy by sector. *Source:* DOE 2014.

Industrial energy efficiency can also provide jobs and contribute to economic development. State industrial energy efficiency programs, in particular, can attract new industrial companies to a state and potentially help retain current companies. The investments they support create direct jobs in manufacturing, engineering, installation, operations, and maintenance of equipment which, in turn, increase the economic competitiveness of companies that install the systems and receive the energy savings.

In addition to cost saving, emission, and jobs benefits, CHP systems can improve electric reliability because they have the ability to operate independently of the grid and serve power and thermal needs during outage events. This allows facilities with CHP to remain operational during extreme weather events and to serve as places of refuge for emergency workers, displaced people, and evacuated patients from medical facilities without power.

As a testament to the power resiliency of CHP systems, during both Hurricane Katrina in 2005 and Hurricane Sandy in 2012, facilities with CHP continued to have access to power, hot water, and cooling, including several hospitals that were able to continue serving patients throughout the storms (Gowrishankar, Angelides, and Druckenmiller 2013). Indeed, while more than eight-million residents in the Mid-Atlantic lost power during Hurricane Sandy in October 2012, CHP systems helped several large energy users — including New York University, Long Island's South Oaks Hospital, Co-op City in the Bronx and New Jersey's Bergen County Utilities Authority — stay warm and bright (Hampson et al. 2013).

Benefits to Manufacturers and Other Large Energy Users

Large energy users, such as manufacturers, would also benefit from policies, especially well-designed utility programs that support industrial efficiency. First, since industrial efficiency reduces electricity costs for all consumers, it helps manufacturers lower their energy bills. Second, utility efficiency programs make efficiency investments possible at manufacturing plants that the companies otherwise would not make due to their internal hurdle rates.

Third, improving energy efficiency in industrial facilities reduces the output of waste and emissions, assisting with companies' sustainability goals. In fact, 43%, or 215, of the companies in the Fortune 500, have set targets to reduce greenhouse gas emissions, achieve energy efficiency savings and deploy renewable energy (WWF et al. 2014). Improving energy efficiency can also increase productivity, reliability, and competiveness.

Finally, manufacturers benefit from enhanced grid reliability afforded by CHP systems. Manufacturing facilities with CHP can keep the lights on and production processes moving during extreme weather events that might otherwise compromise the grid (Ribiero et al. 2015). Power outages can be very costly for companies. Although costs vary by manufacturer, a one-hour outage at an industrial manufacturing facility may cost a company up to $50,000 in losses (Shipley et al. 2008). Furthermore, the U.S. Department of Energy estimates that outages cost U.S. businesses up to $150 billion per year (Pew 2015).

Benefits to Utilities

Utilities have an interest in keeping industrial companies competitive in international markets. If a company is forced to close because it cannot compete, utilities will lose a large and steady electricity customer. Traditionally, utilities have simply offered inexpensive electricity to industrial customers to help retain their industrial base. But, as this study and others demonstrate, utility industrial efficiency programs can further reduce electricity bills for large energy users, thus creating a new tool for utilities to help companies stay competitive.

There is also increased interest by utilities in utility ownership of CHP in cooperation with large customers. Utilities are particularly well-suited to help finance CHP projects because they can make long-term investments and often have strong existing relationships with potential host facilities. Such projects can be mutually beneficial to the utility and the host, especially if the project is located in an area with load congestion problems. The benefits that CHP offers electric utilities include more cost-effective electricity generation, reduced exposure to variability in customer demand, improved system reliability, reduced emissions, and avoided or deferred investments in distribution and transmission systems (Chittum 2013). Finally, utility-owned CHP systems can provide an additional revenue stream for utilities.

Conclusion

Industrial energy efficiency, CHP, and WHP represent not only an opportunity for making each state's manufacturing sector more competitive, but also for achieving considerable low-cost emission reductions. Indeed, if all states adopted and met a 1.5% energy reduction target and deployed an economically viable portion of their CHP technical potential, it would result in $298 billion in cumulative cost savings from avoided electricity purchases and more than 174 million tons of annual CO_2 reductions in 2030. State policymakers, regulators, manufacturers, utilities, and others should seize this opportunity for industrial energy efficiency and resulting cost savings.

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