State Ranking of Potential Carbon Dioxide Emission Reductions through Industrial Energy Efficiency

The Alliance for Industrial Efficiency

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About the Alliance for Industrial Efficiency

The Alliance for Industrial Efficiency is a diverse coalition that includes representatives from the business, environmental, labor, and contractor communities. We are committed to enhancing manufacturing competitiveness and reducing emissions through industrial energy efficiency, particularly through the use of clean and efficient power generating systems such as combined heat and power (CHP) and waste heat to power (WHP). The Alliance for Industrial Efficiency is a project of David Gardiner and Associates.

Contents

I. Executive Summary

This report ranks states on their potential for energy savings in the industrial sector to reduce carbon dioxide (CO_2) emissions. It finds that solely by increasing industrial energy efficiency, including combined heat and power (CHP) and waste heat to power (WHP), states can:

- Reduce annual CO_2 emissions by 174.5 million tons in 2030 – equivalent to the emissions from approximately 46 coal-fired power plants;
- Achieve nearly one-third (29 percent) of the national emission reductions called for under the U.S. Environmental Protection Agency's (EPA) Clean Power Plan (CPP);
- Save 396 million megawatt-hours of electricity in 2030;
- Make industrial companies more competitive by cutting their energy bills; and
- Save businesses $298 billion in cumulative cost savings (2016-2030) from avoided electricity purchases.

The largest opportunities for industrial CO_2 emission reductions are in manufacturing states. The top ten states that would experience the greatest total CO_2 emission reductions from industrial energy efficiency improvements and CHP/WHP are: Texas, Ohio, Illinois, Indiana, Pennsylvania, Kentucky, Michigan, California, Georgia, and Alabama. Most of these states have significant manufacturing industries.

This analysis assumes a scenario where each state achieves a 1.5 percent electricity savings target and installs a portion of their technical potential for new CHP and WHP. Of the total emission reductions achieved by this scenario in 2030 nationally, 40 percent come from states in the Southeast and 34 percent come from states in the Midwest. The large industrial sectors in these geographic regions contribute to the large potential energy (and related emission) savings.

As this report demonstrates, industrial energy efficiency delivers significant economic and emissions benefits for all consumers. As such, this report is aimed at helping state policymakers, industrial companies, utilities, and others seize the opportunity for industrial energy efficiency and resulting cost savings and emission reductions. This is particularly important as states consider how to implement the CPP and as they undertake other planning for the electricity sector. To help realize the tremendous potential for emission reductions and economic savings in the industrial sector, we recommend supporting utility policies that help fund these projects and remove barriers to deployment.[1] We further recommend that states work with industrial companies to create appropriate incentives in state CPP compliance plans. Although the Supreme Court stay of the CPP final rule has led some states to cease

[1] U.S. DOE, Jun. 2015, "Report to Congress: Barriers to Industrial Energy Efficiency" (http://www.energy.gov/sites/prod/files/2015/06/f23/EXEC-2014-005846_6%20Report_signed_v2.pdf).

CPP planning, many states are continuing to draft their compliance plans and states will likely need to identify greenhouse gas reduction strategies in the near future.

II. Background

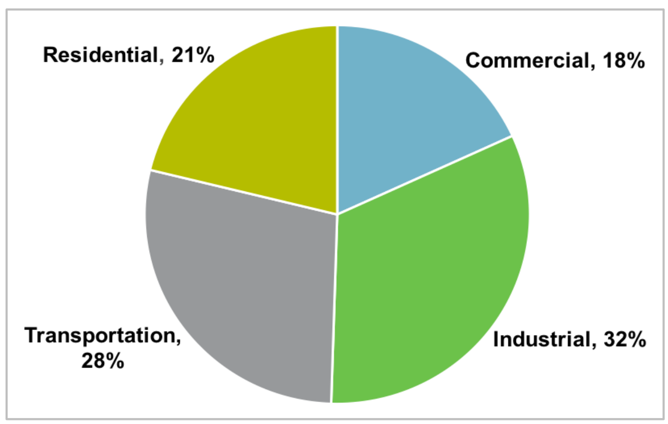
1. The Cost Savings and Emission-Reduction Opportunity in the Industrial Sector

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 (Figure 1).[2] Of the industrial subsectors, manufacturing accounts for the vast majority of energy consumption. In 2012 alone, manufacturers consumed 74 percent of industrial energy, equal to 24 percent of all energy consumed in the United States.[3]

This energy use comes with a significant cost. In fact, industry currently spends $230 billion each year on energy.[4] Within the industrial sector, energy consumption and spending is highest in key 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 significant bottom-line expense.[5]

What's more, industrial energy use is 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 that period (2012 to 2025), industrial energy demand will increase from 22 percent to more than 36 percent of all U.S. energy consumption (from 30.6 quadrillion Btu in 2012 to 37.4 quadrillion Btu in 2025).[6] Such an increase in energy demand may increase greenhouse gas emissions from the industrial sector 18 percent from current levels by 2025.[7]

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



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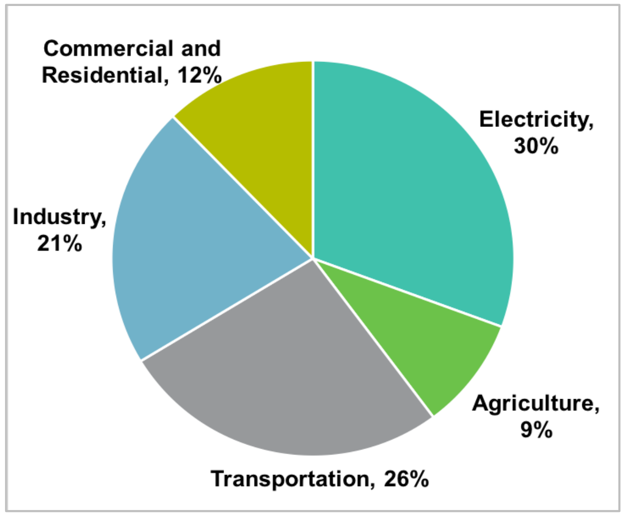
[2] U.S. EIA, Apr. 2015, "Annual Energy Outlook 2015" (https://www.eia.gov/forecasts/aeo/section_deliveredenergy.cfm). Note that these projections are from the reference case.
[3] U.S. DOE, *supra* note 1.
[4] U.S. DOE, Fall 2015, "Better Plants Progress Update" (http://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/2015%20Better%20Plants%20Progress%20Update.pdf).
[5] U.S. EIA, Sep. 2012, "Industries consumed more than 30% of U.S. Energy in 2011" (https://www.eia.gov/todayinenergy/detail.cfm?id=8110).
[6] U.S. DOE, *supra* note 3.
[7] Rhodium Group, Jan. 28, 2016, "Taking Stock: Progress Toward Meeting US Climate Goals"

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, have shown there is a large potential for dramatic 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, CHP, and WHP could reduce energy use in the industrial sector between 15 and 32 percent by 2025.[8]

Cost savings in the industrial sector is of particular importance to the U.S. economy, as it drives a significant amount of economic activity. In 2013, the industrial sector contributed $2.08 trillion, or about 12.5 percent, to U.S. gross domestic product and supported more than 17.4 million jobs.[9] Many of these are high-paying jobs. Indeed, in 2012, compensation for manufacturing jobs was more than 25 percent greater than the average compensation for all U.S. jobs.[10]

Figure 2. Total U.S. GHG emissions by economic sector in 2014



Further, the industrial sector is a significant source of greenhouse gas (GHG) emissions. Industry accounts for 21 percent of U.S. GHG emissions (Figure 2). GHG emissions from industry primarily come from burning fossil fuels for energy and producing goods from raw materials.[11]

2. Overview of Industrial Energy Efficiency and CHP/WHP

Companies in the industrial sector use energy for three main purposes: processes, cross-cutting support equipment, and the facilities themselves.[12] Process-related applications account for 80 percent of industrial energy use and include process heating and chemical processes.[13] Cross-cutting equipment and supportive systems, including motor-driven equipment, such as pumps, air

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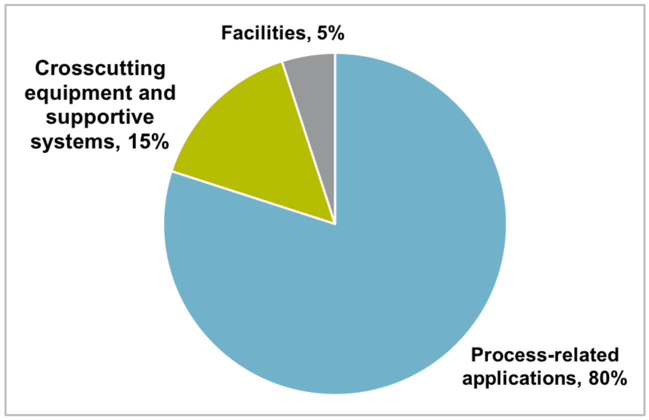
(http://rhg.com/reports/progress-toward-meeting-us-climate-goals).
[8] U.S. DOE, *supra* note 1.
[9] U.S. DOE, *supra* note 1.
[10] *Id.*
[11] U.S. EPA, Aug. 2016, "Sources of Greenhouse Gas Emissions" (https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions).
[12] Alliance to Save Energy, Aug. 9, 2012, "Industrial Energy Efficiency 101: The Basics Of How Industry Uses And Conserves Energy" (https://www.ase.org/resources/industrial-energy-efficiency-101-basics-how-industry-uses-and-conserves-energy).
[13] *Id.*

compressors, fans, mixers, CHP, and WHP account for 15 percent of industrial energy use. Facility operations themselves, including building systems, such as heating, ventilating and air conditioning (HVAC), lighting, and appliances, account for five percent of industrial energy use, usually from electricity (Figure 3).

Figure 3. Industrial energy uses



Throughout industrial processes, energy is lost due to equipment inefficiency, as well as mechanical and thermal limitations.[14] Improving the efficiency of these systems can result in significant energy savings, cost savings, and reduced CO_2 emissions.

There are a variety of mechanisms to improve industrial energy efficiency. Such practices include:

- **Energy assessments**. Independent assessments help industrial customers determine where the energy efficiency opportunities exist in a plant.

- **Energy management and voluntary standards**. Energy management is the systematic tracking and planning of energy use and can be applied to 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.[15] 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, CHP, and WHP.[16]

CHP and WHP are of particular importance to industrial efficiency. By generating both heat and electricity from a single fuel source, CHP dramatically lowers emissions and increases overall fuel efficiency – allowing utilities and companies to effectively “get more with less.” CHP can make effective use of more than 70 percent of fuel inputs. As a consequence, CHP can produce electricity with roughly one-quarter the emissions of an existing coal power plant.[17] WHP uses waste heat from industrial

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[14] U.S. DOE, “Industrial Energy Efficiency Basics (http://energy.gov/eere/energybasics/industrial-energy-efficiency-basics).
[15] ACEEE, “Energy Management” (http://aceee.org/topics/energy-management).
[16] Alliance to Save Energy, *supra* note 12.
[17] David Gardiner & Associates and Institute for Industrial Productivity, 2015, “Combined Heat and Power as a Compliance Option under the Clean Power Plan” (reporting incremental emissions of Natural gas CHP of 450 to 600 lbs/MWh, compared to 2000 to 2200 lbs/MWh for coal) (http://www.dgardiner.com/wpcontent/uploads/2015/08/CHP-Pathway-Final-Report-8-18-15.pdf).

operations to generate electricity with no additional fuel and no incremental emissions. Due to their scale, a single CHP or WHP investment can achieve significant emission reductions. CHP and WHP systems can operate independently of the grid, enabling host facilities to keep the lights and power on despite extreme weather events that may compromise the grid.

3. Clean Power Plan and Utility Planning

State policymakers should capitalize on energy efficiency improvements in the industrial sector as a central component of planning future power needs and reducing emissions. In particular, states have primary authority to develop plans to achieve emission targets set by the Environmental Protection Agency's Clean Power Plan (CPP) and to undertake utility planning to meet electric utility power needs (often known as "integrated resource planning").

3.1 The Clean Power Plan

The CPP establishes customized targets for states to reduce the carbon pollution produced from power plants that reflect each state's energy mix. In February 2016, the Supreme Court stayed implementation of the CPP pending judicial review. Despite the stay, some states are choosing to continue to work to cut carbon pollution from power plants and explore pathways to compliance. Currently, twenty-eight states are either continuing planning or assessing planning.[18] Nineteen states have suspended planning. Three states and the District of Columbia are exempt from the final rule. EPA continues to provide tools and support to states that are moving forward with planning and seek the agency's guidance. Moreover, absent the CPP, states will likely need to identify strategies for reducing CO_2 emissions in the foreseeable future.

EPA has confirmed that states can use industrial energy efficiency to meet their emission targets under the CPP.[19] Industrial energy efficiency represents not only an opportunity for achieving significant, low-cost emission reductions, but also a means of supporting in-state jobs, economic competitiveness, and improved energy reliability.

The final rule clarifies that the following types of industrial energy efficiency measures would comply with the CPP:

- Process efficiency improvements
- Equipment upgrades
- CHP and WHP

[18] E&E Publishing, "E&E's Power Plan Hub" (http://www.eenews.net/interactive/clean_power_plan).
[19] 80 Fed. Reg. 64662, at 64724, October 23, 2015, "Carbon Emissions for Existing Stationary Sources: Electric Utility Generating Units; Final Rule," ("Importantly, affected EGUs also have available numerous other measures that are not included in the BSER [Best System of Emission Reduction] but that could materially help the EGUs achieve their emission limits and thereby provide compliance flexibility. Examples include, among numerous other approaches, investment in demand-side EE…")

- Smart manufacturing
- Strategic Energy Management
- Superior Energy Performance/ISO 50001

Under the CPP, states have the flexibility of adopting either a rate-based or mass-based compliance approach. Under a rate-based approach, states can issue emission rate credits (ERCs) to industrial energy users that generate, measure, and verify reductions from industrial energy efficiency. ERCs are awarded for electricity that is produced with emissions below the target emission rate. Industrial energy efficiency measures installed on or after January 1, 2013 that are still achieving savings in 2022 can earn ERCs.

Under a mass-based approach, total emissions in the state cannot exceed a set budget (in tons) and any reductions achieved during the compliance period can count toward the state target. States can directly allocate a portion of allowances to industrial energy users, who can sell them to the owners of electric generating units (EGUs). States can also auction allowances and direct auction revenue to support industrial energy efficiency programs.

3.2 Utility Planning

In addition to the CPP, states can also encourage industrial energy efficiency through utility planning. Under traditional utility regulation, utilities submit filings to a regulatory authority (a Public Utility Commission, or PUC) detailing their load forecasts and describing the resources that will be required to meet electricity or gas demand during the forecast period. Because energy efficiency is a low-cost resource (Figure 8, Section IV.1), PUCs can require energy efficiency as a utility system resource and reduce the need for additional power plants, which would reduce total resource costs for utilities.[20]

Well-designed utility industrial efficiency programs are a proven way to increase deployment of industrial energy efficiency measures, such as CHP and WHP, thereby saving energy, reducing GHG emissions, and saving companies money. These programs, which are typically funded through a small fee on utility bills, can finance energy efficiency projects, making efficiency investments pencil out for industrial companies.

Although energy use presents a significant cost to industrial customers, there are often cost-effective energy-saving opportunities that companies have not yet captured. Large industrial customers 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 approved and initiated.

[20] ACEEE, Jul. 2, 2014, "Utility Initiatives: Integrated Resource Planning" (http://aceee.org/policy-brief/utility-initiatives-integrated-resource-planning).

Utilities have a much larger appetite for long-term investments than most industrial customers, allowing them to help finance projects that may not bring quick returns. Through incentives and rebates, utility programs offset up-front investments in energy efficiency. An industrial customer 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 their internal rate-of-return. Programs can include:

- ***Program rebates*** to make longer term investments (e.g., those with returns of two to eight years) cost-effective.
- ***Access to technical experts and program staff*** who can supplement company resources and identify potential projects.

Many industrial companies are already saving both energy and money each year from energy efficiency improvements made possible, in part, through industrial efficiency utility programs (Figure 10, Section IV.2).

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 they would not have invested in the energy efficiency improvements absent AEP Ohio's support. Figure 4 highlights four industrial energy efficiency projects that used utility incentives.

Manufacturers, in particular, that have taken the step to invest in energy efficiency are already gaining impressive paybacks. Some of these investments occur outside of traditional utility programs. For instance, more than 150 manufacturing participants in the Department of Energy Better Plants program, which represents 11.4 percent of U.S. manufacturing, have reported cumulative energy cost savings of $2.4 billion. Just by continuing these efforts, this group of manufacturers could save a projected $11 billion by 2020. Better Plants partners report cumulative avoided carbon emissions of almost 27-million metric tons – equal to the annual emissions from seven coal-fired power plants.[21]

To view the Alliance for Industrial Efficiency's industrial energy efficiency program case study series, visit: http://alliance4industrialefficiency.org/resources/casestudies/

[21] U.S. DOE, *supra* note 4.

Figure 4. Example Industrial Energy Efficiency Projects

HARBEC, Inc. (Ontario, NY)

Type of Project: Combined Heat and Power (CHP)
Investment: $1,500,000
Payback period: 8 years
Utility Incentives: $100,000
Savings: Averaged $20,000 reduced electric and gas costs monthly

Nissin Brake (Findlay, OH)

Type of Project: Lighting, compressed air, chiller upgrades
Investment: $1.67 million since 2008
Payback period: 2-3 years for most projects
Utility Incentives: More than $289,000 since 2008
Savings: $3.4 million in avoided energy costs since 2009

United Technologies Corporation (Farmington, CT)

Type of Project: 3-year agreement with utility to increase efficiency
Investment: $15 million over three years
Payback period: To be determined / ongoing project
Savings: $1.1-$2.3 million annually

Crown Battery (Fremont, OH)

Type of Project: Lighting upgrade, battery charging upgrade, geothermal cooling, etc.
Investment: $1,299,480
Payback period: Approximately 4.5 years
Utility Incentives: $316,893
Savings: $150,000 to $210,000 annually and rising

Both the CPP and utility planning present choices to state policy makers about the future mix of EGUs, other power sources such as renewable energy, and energy efficiency in all sectors. By opting for more industrial efficiency, state policy makers can drive a more competitive industrial sector in their state. A more efficient industrial sector places less demand on power plants – reducing the need for new construction, decreasing emissions, and lowering electricity costs for all consumers.

III. Results: Industrial Energy Efficiency CO_2 Reductions

Our analysis found that states can achieve significant CO_2 emission reductions by implementing industrial energy efficiency measures (including CHP and WHP deployment), while also saving all electricity consumers hundreds of billions of dollars and making their industrial companies more competitive. Thus, industrial energy efficiency can help states achieve their CPP target and meet long-term electricity demand, while strengthening their economy.

1. Methodology and Assumptions

This analysis estimates energy savings, avoided costs, and emission reductions at the state, regional, and national level over a 15-year period (2016-2030) using data from the American Council for an Energy-Efficient Economy (ACEEE) and the State and Utility Pollution Reduction Calculator Version 2 (SUPR 2).[22] SUPR 2 is a tool designed by ACEEE that calculates the costs and emission benefits of various CPP compliance options. 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.

This analysis produced an estimate of the savings that would occur in a scenario where each state:

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

Since it can take time to design, approve, and implement efficiency programs, SUPR 2 assumes that efficiency savings ramp up gradually. Specifically, SUPR 2 assumes that each state adopts a savings target that ramps up at a rate of 0.25 percent 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 actual statewide 2011 or 2012 (as available) electricity savings levels.[23]

Many states already have energy savings targets in place. Four states (Arizona, Massachusetts, Rhode Island, and Vermont) already have incremental savings targets of 2 percent or more of sales per year, and four other states (Illinois, Maine, Maryland, and Minnesota) already have targets of 1.5 percent or more of sales per year.[24] Seventeen states currently have an annual energy savings target less than 1.5 percent.

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.

To calculate the portion of each state's technical potential for new CHP and WHP that is economically feasible, this analysis relies on two sources of publicly available data: (1) DOE's most recent state estimates of technical potential,[25] and (2) a 2013 state-by-state estimate of economic potential from ICF

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[22] ACEEE, Jan. 19, 2016, "State and Utility Pollution Reduction Calculator Version 2 (SUPR 2)" (http://aceee.org/research-report/e1601).
[23] ACEEE, Jan. 2016, "User Guide for the State and Utility Pollution Reduction Calculator Version 2 (SUPR 2)" (http://aceee.org/research-report/e1601).
[24] *Id.*
[25] U.S. DOE, Mar. 2016, "Combined Heat and Power (CHP) Technical Potential in the United States" (http://www.energy.gov/sites/prod/files/2016/04/f30/CHP%20Technical%20Potential%20Study%203-31-2016%20Final.pdf).

International for the American Gas Association.[26] From these reports, we determined what percentage of technical potential had a less than 10-year payback period, and thus considered to have a strong or moderate economic return in each state and used these state-specific amounts of CHP and WHP capacity as inputs for SUPR 2.

For more details on methodology, see the Appendix (Section V.1).

2. National Results

The industrial efficiency scenario we envision would achieve significant carbon emission reductions and energy and cost savings. If every U.S. state adopted this scenario, it would result in a total of 396 million megawatt-hours of annual electricity savings in 2030, 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 (Figure 5),[27] and $298 million in cumulative cost savings from avoided electricity purchases in 2016-2030 (

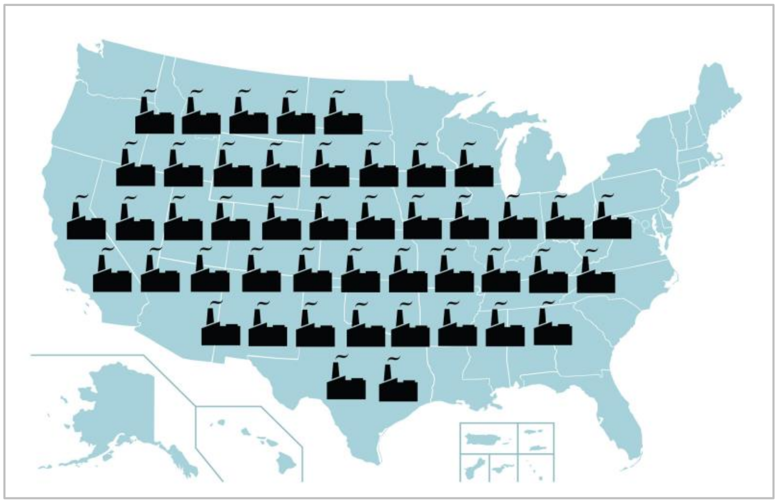
Table 1). All results are over a 15-year period (2016-2030).

Table 1. Annual CO_2 reductions, annual energy savings, and cumulative utility bill savings in 2030

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

[26] American Gas Association (AGA), May 2013, "The Opportunity for CHP in the United States" (https://www.aga.org/opportunity-chp-us-may-20node3).
[27] U.S. EPA, May 2016, "Greenhouse Gas Equivalencies Calculator" (https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator).

Figure 5. 174.5 million tons CO_2 reductions is equivalent to emissions from 46 coal-fired power plants



3. Regional Results

Table 3 ranks states based on the annual projected CO_2 savings from this scenario. Our analysis finds that the ten states with the greatest potential for CO_2 emission reductions from the industrial sector are Texas, Ohio, Illinois, Indiana, Pennsylvania, Kentucky, Michigan, California, Georgia, and Alabama (Table 2). Electricity savings from these states alone would result in a combined $130,115,000 in cumulative utility bill savings through 2030.

These states have large industrial sectors, which likely contributes to their potential CO_2 emission reductions under this scenario. The top ten states combined can achieve reductions of about 85.5 million short tons of CO_2, which is almost half that of the total emission reductions (174.5 million short tons CO_2) achievable by all states from industrial efficiency and CHP/WHP. There is clearly a significant opportunity for these ten states in particular to achieve emission reductions, lower energy use, and save *all* consumers money on their electricity bills through industrial energy efficiency and CHP/WHP.

Table 2. Top ten states with largest potential annual CO_2 reductions from IEE and CHP/WHP

Ranking	State	2030 Annual CO_2 reductions, IEE & CHP/WHP (short tons)	2030 Cumulative Utility Bill Savings, IEE & CHP/WHP (million 2011$)
1	Texas	16,424,917	$23,175
2	Ohio	10,277,039	$12,525
3	Illinois	9,919,055	$10,834
4	Indiana	9,164,632	$8,775
5	Pennsylvania	7,646,666	$11,208
6	Kentucky	7,589,721	$8,254
7	Michigan	6,912,665	$7,853
8	California	6,203,406	$35,310
9	Georgia	5,744,788	$6,390
10	Alabama	5,570,862	$5,792
TOTAL		**85,453,751**	**$130,116**

Of the total emission reductions achieved by this scenario in 2030 nationally, 40 percent come from states in the Southeast and 34 percent of emission reductions come from states in the Midwest (Figure 6). The large industrial sectors in these geographic regions contribute to the large potential energy (and related emission) savings.

Figure 6. Combined reduction in CO_2 emissions by region in 2030

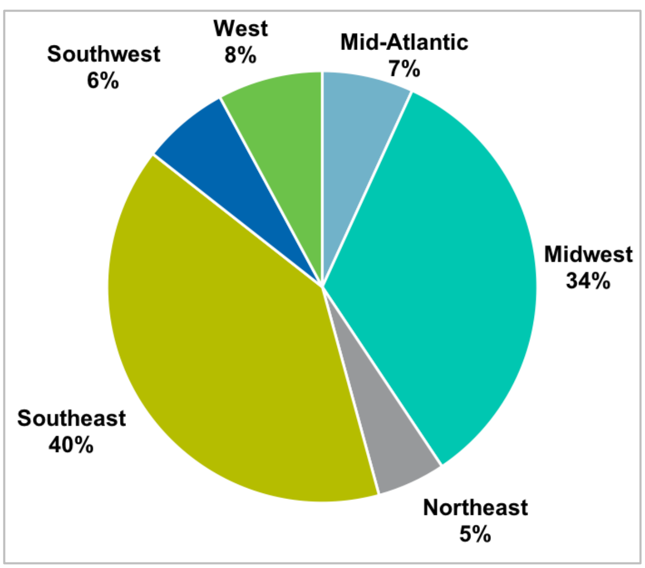


Table 3. State ranking of annual CO_2 reductions from industrial energy efficiency, with annual energy savings and cost savings in 2030

Ranking	State	2030 Annual CO_2 reductions, IEE & CHP/WHP (short tons)	Per Capita 2030 Annual CO_2 reductions, IEE & CHP/WHP (short tons)	2030 Annual Electricity Saved, CHP/WHP Only (MWh)	2030 Annual Electricity Saved, IEE Only (MWh)[28]	2030 Annual Electricity Saved, IEE & CHP/WHP (MWh)	2030 Cumulative Utility Bill Savings, IEE & CHP/WHP (million 2011$)
1	Texas	16,424,917	0.598	17,238,000	20,209,881	37,447,881	$23,175
2	Ohio	10,277,039	0.885	3,183,000	12,010,126	15,193,126	$12,525
3	Illinois	9,919,055	0.771	4,437,000	10,431,613	14,868,613	$10,834
4	Indiana	9,164,632	1.384	1,820,000	11,032,560	12,852,560	$8,775
5	Pennsylvania	7,646,666	0.597	5,850,000	10,893,635	16,743,635	$11,208
6	Kentucky	7,589,721	1.715	4,508,000	8,975,183	13,483,183	$8,254
7	Michigan	6,912,665	0.697	3,503,000	6,969,209	10,472,209	$7,853
8	California	6,203,406	0.158	22,970,000	12,053,601	35,023,601	$35,310
9	Georgia	5,744,788	0.562	3,345,000	7,019,021	10,364,021	$6,390
10	Alabama	5,570,862	1.147	2,705,000	6,976,763	9,681,763	$5,792
11	Florida	5,309,566	0.262	14,720,000	3,777,972	18,497,972	$12,851
12	Wisconsin	5,278,981	0.915	4,069,000	4,949,697	9,018,697	$6,569
13	Tennessee	5,238,374	0.794	3,796,000	5,977,014	9,773,014	$5,609
14	Minnesota	4,676,326	0.852	1,812,000	5,222,297	7,034,297	$4,857
15	Louisiana	4,201,349	0.900	5,706,000	5,959,981	11,665,981	$7,446
16	New York	3,846,703	0.194	18,360,000	2,949,626	21,309,626	$20,030
17	Colorado	3,832,667	0.702	1,085,000	3,504,382	4,589,382	$3,248
18	Missouri	3,785,347	0.622	1,268,000	3,587,036	4,855,036	$3,078
19	South Carolina	3,738,895	0.764	2,274,000	5,910,952	8,184,952	$5,223
20	North Carolina	3,709,942	0.369	2,914,000	5,656,033	8,570,033	$5,358
21	Iowa	3,646,603	1.167	912,000	4,231,243	5,143,243	$3,066
22	Washington	3,062,450	0.427	1,094,000	6,575,397	7,669,397	$3,897
23	Massachusetts	2,913,079	0.429	12,362,000	3,761,823	16,123,823	$15,997
24	New Jersey	2,878,827	0.321	11,830,000	1,716,668	13,546,668	$11,782
25	Oklahoma	2,825,290	0.722	818,000	3,145,688	3,963,688	$2,243

[28] Each state achieves an annual 1.5 percent electricity savings target per year through 2030.

Ranking	State	2030 Annual CO_2 reductions, IEE & CHP/WHP (short tons)	Per Capita 2030 Annual CO_2 reductions, IEE & CHP/WHP (short tons)	2030 Annual Electricity Saved, CHP/WHP Only (MWh)	2030 Annual Electricity Saved, IEE Only (MWh)[28]	2030 Annual Electricity Saved, IEE & CHP/WHP (MWh)	2030 Cumulative Utility Bill Savings, IEE & CHP/WHP (million 2011$)
26	Virginia	2,565,734	0.306	3,065,000	3,577,783	6,642,783	$4,081
27	Mississippi	2,422,187	0.809	1,691,000	3,224,843	4,915,843	$3,519
28	Kansas	2,229,175	0.766	640,000	2,156,645	2,796,645	$1,818
29	West Virginia	2,177,934	1.181	1,262,000	2,359,097	3,621,097	$2,339
30	Arkansas	1,960,639	0.658	806,000	3,369,615	4,175,615	$2,566
31	Arizona	1,958,698	0.287	809,000	2,911,138	3,720,138	$3,055
32	Nevada	1,838,795	0.636	626,000	3,115,560	3,741,560	$2,495
33	Nebraska	1,799,244	0.949	370,000	2,113,214	2,483,214	$1,389
34	Wyoming	1,678,242	2.863	1,554,000	2,214,891	3,768,891	$1,760
35	Oregon	1,342,282	0.333	643,000	185,971	828,971	$2,122
36	Hawaii	1,246,271	0.871	2,007,000	970,907	2,977,907	$7,508
37	New Mexico	1,071,691	0.514	648,000	1,527,805	2,175,805	$1,434
38	Utah	1,030,937	0.344	458,000	2,185,680	2,643,680	$1,399
39	Idaho	1,030,926	0.623	183,000	2,271,595	2,454,595	$1,177
40	Connecticut	958,300	0.267	5,412,000	810,741	6,222,741	$6,444
41	Maryland	878,996	0.146	1,792,000	1,102,930	2,894,930	$2,151
42	North Dakota	741,953	0.980	180,000	862,590	1,042,590	$557
43	Delaware	482,985	0.511	1,262,000	517,304	1,779,304	$1,166
44	Alaska	466,595	0.632	1,864,000	450,325	2,314,325	$2,740
45	South Dakota	463,726	0.540	182,000	516,709	698,709	$395
46	Montana	426,267	0.413	180,000	906,727	1,086,727	$645
47	New Hampshire	396,560	0.298	2,002,000	410,543	2,412,543	$2,228
48	Maine	326,707	0.246	627,000	661,466	1,288,466	$1,075
49	Rhode Island	263,677	0.250	1,554,000	202,176	1,756,176	$1,425
50	Vermont	250,183	0.400	1,089,000	314,101	1,403,101	$1,207
51	District of Columbia	84,702	0.126	370,000	43,171	413,171	$273
TOTAL		**174,491,557**	**N/A**	**183,855,000**	**212,480,929**	**396,335,929**	**$298,340**

3.1 Per Capita Emission Reductions

The report also ranks states with the largest potential per capita CO_2 emission reductions. This helps to identify many smaller, less populous states where CHP/WHP and industrial efficiency have significant potential relative to their size to reduce emissions. Table 4 highlights the ten states with the greatest potential to reduce their emissions on a per capita basis.

Table 4. States with the largest per capita potential annual CO_2 reductions from IEE and CHP/WHP

State	2030 Annual CO_2 reductions, IEE & CHP/WHP (short tons)	Per Capita 2030 Annual CO_2 reductions, IEE & CHP/WHP (short tons)
Wyoming	1,678,242	2.863
Kentucky	7,589,721	1.715
Indiana	9,164,632	1.384
West Virginia	2,177,934	1.181
Iowa	3,646,603	1.167
Alabama	5,570,862	1.147
North Dakota	741,953	0.980
Nebraska	1,799,244	0.949
Wisconsin	5,278,981	0.915
Louisiana	4,201,349	0.900

Several states like Kentucky, Indiana, and Alabama – which are also in the top ten for absolute emission reductions – have large per capita *and* significant total emission-reduction potential. Other less populous states, such as Wyoming and North Dakota, show great emission-reduction potential when taking population into account, although they appear lower in the ranking of absolute CO_2 emission reductions.

There may be several reasons other than population alone that explain why certain states show high per capita emission-reduction potential, such as high coal use or significant export of power to other states. Regardless, the per capita ratio highlights where low population and high CO_2 emission states may be particularly good candidates for industrial efficiency policies and CHP/WHP technologies as emission-reduction measures. This suggests that policymakers in these states should still pursue opportunities to encourage CHP/WHP and industrial efficiency.

4. Clean Power Plan Targets

Nationally, the CPP requires reductions of annual electricity sector CO_2 emissions of over 586 million short tons by 2030.[29] Our analysis shows that industrial energy efficiency and CHP/WHP would result in an annual national reduction of over 172 million short tons of CO_2 by 2030 (Figure 7).[30] Thus, IEE and CHP/WHP can play a central role in helping states achieve their compliance targets, assuming that the rule is largely unchanged following judicial review.

Figure 7. National CPP target achievable through industrial energy efficiency

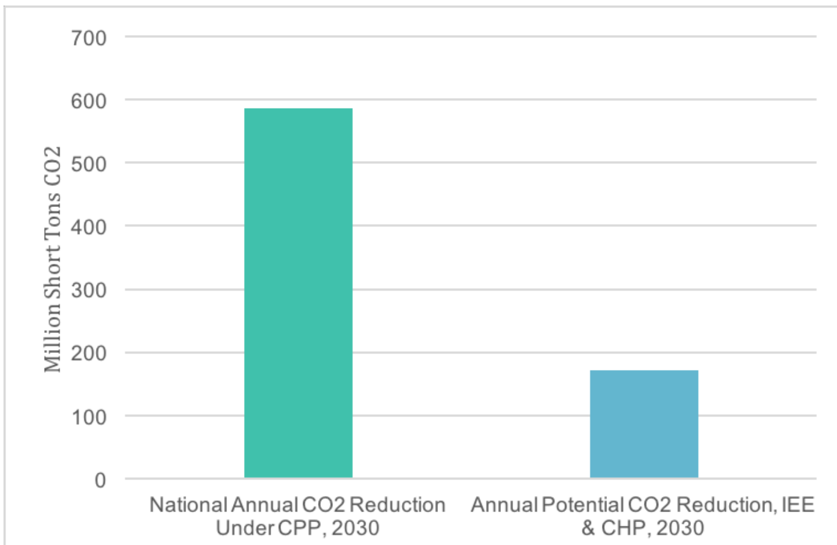


Table 8 in the Appendix (Section V.2) lists each state's CPP target and notes how much of that target can be achieved through a combination of industrial energy efficiency and CHP/WHP. Table 5 summarizes how much of their CPP target the "top ten" states for total potential CO_2 reductions from industrial energy efficiency can achieve. In light of the tremendous potential for IEE deployment, industrial energy efficiency should be a cornerstone of each of these state's compliance plans once the stay is lifted and planning resumes in earnest. Putting aside California, each of the remaining "top ten" states can achieve between one-quarter and over one-third of its CPP target. Although these states have relatively ambitious CPP targets, industrial energy efficiency can play a significant role in achieving them.

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[29] U.S. EPA, Nov. 2015, "Clean Power Plan Final Rule Technical Documents" (https://www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-technical-documents).
[30] Does not include Alaska, Hawaii, Vermont, or the District of Columbia, which do not have CPP targets.

Table 5. Share of CPP target that industrial energy efficiency would meet for top ten states for total potential CO_2 reduction

State	CO_2 Reduction Required Under the CPP, 2030 (short tons)	Industrial Sector Annual CO_2 Reduced, 2030 (short tons)	CPP Target IEE Would Meet (%)
Texas	62,259,493	16,424,917	26%
Ohio	28,665,011	10,277,039	36%
Illinois	35,731,028	9,919,055	28%
Indiana	34,446,081	9,164,632	27%
Pennsylvania	30,167,435	7,646,666	25%
Kentucky	29,649,708	7,589,721	26%
Michigan	22,316,390	6,912,665	31%
California	1,310,093	6,203,406	>100%[31]
Georgia	16,496,203	5,744,788	35%
Alabama	18,691,307	5,570,862	30%

5. ERC and Allowance Savings

The CPP final rule explicitly states that industrial energy efficiency, including CHP and WHP, may qualify for ERCs,[32] and allows most industrial CHP and WHP systems to qualify.[33] One ERC equals an emissions-free megawatt-hour of electricity. The operator of a coal or natural gas plant can add the emissions-free megawatt-hour of acquired ERCs to the megawatt-hour that the plant actually produced during the year. The operator then divides that combined number of megawatt-hours into the amount of CO_2 emitted by the plant to determine the plant's effective emission rate for compliance purposes. The plant is in compliance if its effective emission rate is equal to or less than the plant's allowed emission rate.[34]

Industrial hosts can generate revenue from the sale of either ERCs or allowances. As Table 6 shows, if the price per unit of trading (either per megawatt-hour under a rate-based approach or per ton of CO_2 under a mass-based approach), is assumed to be $10, the ERC market would total almost $4 billion and the allowance market would total over $3 billion. If the price per unit of trading is assumed to be

[31] California can exceed its CPP target through IEE and CHP alone due to the extensive policies that the state has already implemented to reduce CO_2 emissions, as well as the tremendous remaining potential for further emission reductions in the industrial sector.
[32] 80 Fed. Reg. 64662, at 64902, Oct. 23, 2015, "Carbon Emissions for Existing Stationary Sources: Electric Utility Generating Units; Final Rule," ("Electric generation from non-affected CHP units may be used to adjust the CO_2 emission rate of an affected EGU").
[33] *Id* at 64953, §60.5850, "What EGUs are excluded from being affected EGUs?"
[34] Natural Resources Defense Council (NRDC), Sep. 29, 2015, "Emission Rate Credits in the Clean Power Plan" (https://www.nrdc.org/experts/dylan-sullivan/emission-rate-credits-clean-power-plan).

$20, the size of the ERC market would be almost $8 billion and the size of the allowance market would be approximately $6.3 billion.

Table 6. Estimated market for IEE and CHP/WHP savings in 2030

Assumed price per unit of trading[35]	Size of ERC Market ($ billion)	Size of Allowance Market ($ billion)
$10	$3.963	$3.171
$20	$7.927	$6.341

Note: We apply the price per trading unit to combined annual energy savings in 2030. For the size of the ERC market, 1 MWh = 1 ERC. For the size of the allowance market, 1 MWh = 0.8 short tons of CO_2.[36]

This data does not suggest that industrial energy efficiency and CHP/WHP would capture the entire ERC and/or allowance market, but rather these figures demonstrate that money can be generated in this scenario given these assumed prices. If an industrial customer were able to capture even a small percentage of the market, it could be used to finance industrial energy-efficient retrofits and CHP/WHP installations.

IV. Conclusion: Why All Stakeholders Should Support an Expansion of Industrial Energy Efficiency

Our analysis shows that there is significant potential for CO_2 emission reductions and energy savings from the industrial sector. Capitalizing on these savings would also benefit all consumers by dramatically reducing their electricity bills. State policymakers and regulators should maximize the potential for industrial energy savings and CO_2 reductions by creating and expanding utility industrial energy efficiency programs. Such programs have benefits to not only industrial customers, but all energy consumers and to state economies, more broadly.

[35] Synapse Energy Economics, Inc., Mar. 16, 2016, "Spring 2016 National Carbon Dioxide Price Forecast" (http://www.synapse-energy.com/sites/default/files/2016-Synapse-CO2-Price-Forecast-66-008.pdf). This report uses $20 as a "low" carbon price. We also included $10 as a price to: (1) include a conservation estimate and (2) recognize that prices will be lower during the earlier part of the compliance period given anticipated coal retirements and fuel switching.

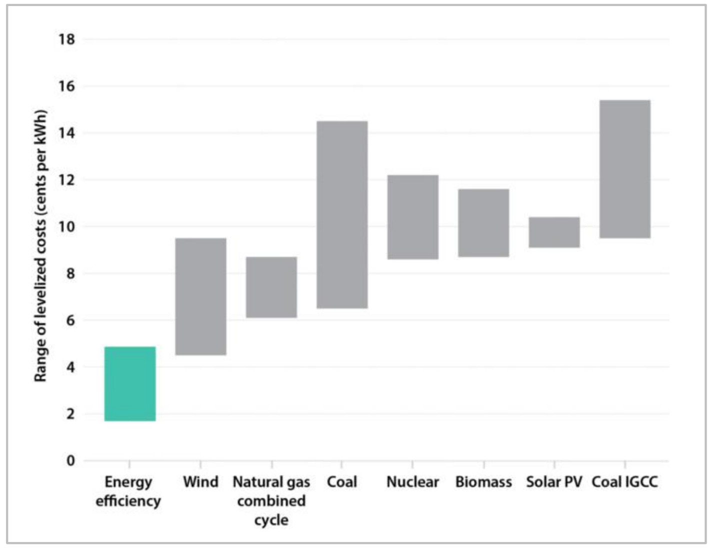
[36] These assumptions are consistent with EPA's approach in the Clean Energy Incentive Program. EPA proposed that the allocation of allowances in the Clean Energy Incentive Program be based on a 0.8 short tons of CO_2/MWh factor (p.58 of "Clean Energy Incentive Program Design Details" submitted on June 16, 2016: https://www.epa.gov/sites/production/files/2016-06/documents/ceip-design-details-nprm.pdf).

1. Benefits to All Electric Consumers

As demonstrated in this report, industrial energy efficiency could save businesses $298 billion by 2030. As a result, state policy makers, especially PUCs, should support expanding efforts and programs to capture industrial efficiency.

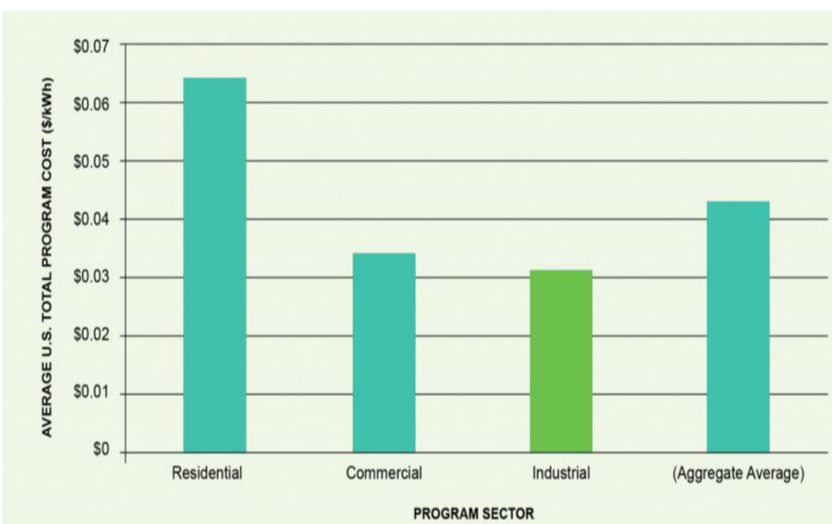
Because energy efficiency is the cheapest source of energy, it should be the first choice for all electricity planning. Figure 8 summarizes results from a recent ACEEE study, which found that the cost of running efficiency programs in 20 states from 2009 to 2012 had an average cost of 2.8 cents per kilowatt-hour – about one-half to one-third the cost of alternative new electricity resource options.[37]

Figure 8. Energy efficiency has the lowest range of levelized costs



Further, *industrial* energy efficiency is the cheapest source of efficiency, as Figure 9 illustrates, and has the lowest cost of saved energy on a national level, when compared with other sectors.

Figure 9. Industry has lowest cost of saved energy on national level



These savings benefit all bill payers. Industrial energy efficiency produces demand reduction induced price effects (DRIPE). 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.[38] DRIPE savings accrue to all consumers and, by reducing

[37] ACEEE, Mar. 25, 2016, "The Best Value for America's Energy Dollar: A National Review of the Cost of Utility Energy Efficiency Programs" (http://aceee.org/press/2014/03/new-report-finds-energy-efficiency-1).
[38] State and Local Energy Efficiency Action Network (SEEAction), Dec. 2015, "State Approaches to Demand Reduction Induced Price Effects: Examining How Energy Efficiency Can Lower Prices for All" (https://www4.eere.energy.gov/seeaction/system/files/documents/DRIPE-finalv3_0.pdf).

industrial electricity demand, utilities can defer or avoid capital investments, further reducing rates for all ratepayers.

Although DRIPE effects are outside the scope of this report, a detailed discussion on this benefit can be found in the recent SEEAction report *State Approaches to Demand Reduction Induced Price Effects: Examining How Energy Efficiency Can Lower Prices for All.*[39]

Industrial energy efficiency is also the cheapest way for states to meet their Clean Power Plan (CPP) targets, providing a significant portion of needed reductions. Although the Supreme Court stay of the CPP final rule has led many states to cease CPP planning, many states are continuing to draft their compliance plans and states will undoubtedly need to identify greenhouse gas reduction strategies in the near future. Industrial energy efficiency can help states achieve their CPP targets (Section III.4). By relying on low-cost emission reductions from the industrial sector, policymakers can reduce the economic impact of CPP compliance.

Industrial energy efficiency can also provide jobs and contribute to economic development. State industrial energy efficiency programs, in particular, are key tools in attracting new industrial companies to a state and are an effective way to retain current companies. These investments 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.

Preliminary work by NRDC in a 2013 issue paper finds that each gigawatt of installed capacity may be reasonably expected to create and maintain between 2,000 and 3,000 full-time equivalent jobs throughout the lifetime of the system. This estimate includes direct jobs in manufacturing, construction, operations and maintenance, as well as indirect jobs from the redirection of industrial energy expenditures and the spending of commercial and residential energy bill savings on other goods and services.[40] By supporting industrial energy efficiency programs, states can attract new industrial companies to the state and deter existing companies from leaving.

In addition to cost saving, emission-reduction, 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 serve as places of refuge for emergency workers, displaced people, and evacuated patients from medical facilities without power.[41]

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[39] *Id.*

[40] NRDC, Apr. 2013, "Combined Heat and Power Systems: Improving the Energy Efficiency of Our Manufacturing Plants, Building, and Other Facilities," (http://www.nrdc.org/energy/files/combined-heat-power-ip.pdf).

[41] *See, e.g.,* U.S. EPA, June 18, 2014, 79 Fed. Reg, 34830, 34899, "Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units" (noting that CHP "reduce[s] demand for centrally generated power and thus relieve[s] pressure on the grid.")

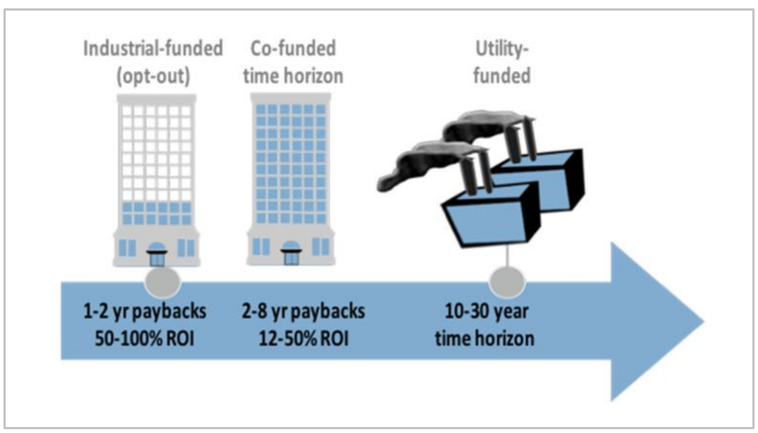
As a testament to the power resiliency of CHP systems, during both Hurricane Katrina in 2005 and Hurricane Sandy in 2012, facilities with CHP continued to have access to power, hot water, and cooling, including several hospitals that were able to continue serving patients throughout the storms.[42] Indeed, 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.[43]

2. 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.

Utility industrial energy efficiency programs are of particular importance because utility investments make possible energy efficiency improvements that the companies would not implement on their own. Manufacturers typically limit investments to those that will be paid back in under two years. Utility programs allow them to leverage limited resources. As Figure 10 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.

Figure 10. Utility industrial energy efficiency programs reduce payback period[44]



[42] NRDC, Apr. 2013, "Combined Heat and Power Systems: Improving the Energy Efficiency of Our Manufacturing Plants, Building, and Other Facilities," at 6 (http://www.nrdc.org/energy/files/combined-heat-power-ip.pdf).
[43] ICF International, prepared for Oak Ridge National Laboratory, Mar. 2013, "Combined Heat and Power: Enabling Resilient Energy Infrastructure for Critical Facilities" (http://www1.eere.energy.gov/manufacturing/distributedenergy/pdfs/chp_critical_facilities.pdf).
[44] Schlegel and Associates presentation, 2015.

Further, improving energy efficiency in industrial facilities reduces the output of waste and emissions, assisting with companies' sustainability goals. In fact, 43 percent, 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.[45] Improving energy efficiency can also increase productivity, reliability, and competiveness.

Manufacturers also 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.[46] 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.[47] Furthermore, the U.S. Department of Energy estimates that outages cost U.S. businesses up to $150 billion per year.[48]

3. Benefits to Utilities

As discussed, utilities – whose emissions are highly likely to be regulated through the Clean Power Plan or some other mechanism – can achieve the most cost-effective emission reductions by implementing industrial energy efficiency programs. Moreover, industrial energy efficiency is the cheapest source of efficiency and has the lowest cost of saved energy on a national level, when compared with other sectors (Figure 9, Section IV.1).

In addition, utilities have an interest in keeping industrial companies competitive in international markets. If a company cannot compete and closes, utilities lose a large and steady electricity market. Traditionally, utilities have simply offered inexpensive electricity as the prime method of helping companies compete. But, as this study and others demonstrate, utility industrial efficiency programs can reduce electricity bills for large energy users, thus creating a new tool for utilities to help companies stay competitive.

Finally, there is increased interest by utilities in considering 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-

[45] Calvert Investments, Ceres, David Gardiner and Associates, World Wildlife Fund, "Power Forward 2.0: How American Companies Are Setting Clean Energy Targets and Capturing Greater Business Value" (http://www.calvert.com/nrc/Literature/Documents/sri-20140619_power_forward_2.0_low.pdf).
[46] ACEEE, Oct. 2015, "Enhancing Community Resilience through Energy Efficiency" (http://aceee.org/sites/default/files/publications/researchreports/u1508.pdf).
[47] U.S. DOE, Oak Ridge National Laboratory, Dec. 1, 2008, "Combined Heat and Power: Effective Energy Solutions for a Sustainable Future," (http://info.ornl.gov/sites/publications/files/Pub13655.pdf).
[48] The Pew Charitable Trusts, Oct. 2015, "Distributed Generation: Cleaner, Cheaper, Stronger: Industrial Efficiency in the Changing Utility Landscape" (http://www.pewtrusts.org/~/media/assets/2015/10/cleanercheaperstrongerfinalweb.pdf).

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.[49]

[49] ACEEE, Jul. 18, 2013, "How Electric Utilities Can Find Value in CHP" (http://aceee.org/white-paper/electric-utilities-and-chp).

V. Appendix

1. Methodology and Assumptions

The findings in this paper are based on separate analysis for industrial energy efficiency and CHP/WHP, as elaborated below. The results (i.e., CO_2 emission reductions, energy savings, and bill savings) from each scenario were totaled to find combined savings.

Industrial Energy Efficiency (IEE)

Our analysis assumes a scenario in which each state achieves a 1.5 percent annual electricity savings target and estimates how much of those savings can be attributed to the state's industrial sector. We used two data sources: (1) ACEEE's SUPR 2 calculator[50] and (2) ACEEE's *Change Is in the Air* study.[51] In the first step, we select the implementation of a 1.5 percent statewide savings target option in SUPR 2, which provides estimates of annual energy, cost, and emissions savings through 2030. Choosing this option in the calculator already excludes savings from CHP/WHP, but it does not disaggregate the results by sector. We disaggregated the data in the next step of the analysis.

The second step is to estimate how much of the savings can be attributable to the industrial sector. To do so, we collected unpublished data from *Change Is in the Air*, which provides a sector-specific estimate of savings from a 1.5 percent annual savings target. It assumes the 1.5 percent annual savings target is achieved relative to the forecasted electricity sales using EIA's 2013 Annual Energy Outlook (AEO) in each sector in each year. Note that since it can take time to design, approve, and implement efficiency programs, SUPR 2 assumes that efficiency savings ramp up gradually. Specifically, SUPR 2 assumes that each state adopts a savings target that ramps up at a rate of 0.25 percent 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 actual statewide 2011 or 2012 (as available) electricity savings levels.[52]

Using these projections, we estimated the ratio of industrial energy savings to total energy savings in the year 2030 and applied this percentage to SUPR 2 results for energy, emissions, and cost savings to find the share from the industrial sector. Take, for example, the following results (Table 7) from the state of Kentucky, where the industrial sector accounts for 54 percent of total savings:

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[50] ACEEE, *supra* note 22.
[51] ACEEE, Apr. 29, 2014, "Change Is in the Air: How States Can Harness Energy Efficiency to Strengthen the Economy and Reduce Pollution" (http://aceee.org/research-report/e1401).
[52] ACEEE, Jan. 2016, "User Guide for the State and Utility Pollution Reduction Calculator Version 2 (SUPR 2)" (http://aceee.org/research-report/e1601).

Table 7. Impacts of industrial energy efficiency in 2030 in Kentucky

	Industrial Sector Savings (54% of SUPR 2 Results)	**Savings from All Sectors (100% of SUPR 2 results)**
Annual CO_2 reductions (short tons)	6,545,721	12,119,000
Cumulative utility bill savings through 2030 (million 2011$)	$5,337	$9,882
Annual energy saved (MWh)	8,975,183	16,617,000

Combined Heat and Power (CHP) and Waste Heat to Power (WHP)

To analyze the impacts from CHP and WHP, we assumed a scenario in which each state installs a portion of its estimated on-site technical potential. For this analysis, we relied on two sources of publicly available data: (1) the most recent state-by-state estimate of technical potential from DOE[53] and (2) a 2013 state-by-state estimate of economic potential from ICF International for the American Gas Association.[54]

We began with the total on-site technical potential from DOE's 2016 study in each state. On-site technical potential includes CHP and WHP at industrial and commercial host facilities. It does not include export potential, which is the electricity in excess of what can be used by the host facility and that could be sold to the electric grid. DOE's 2016 technical potential study found approximately 149 gigawatts of total on-site CHP and WHP potential across all states. When export potential is included, there are 240 gigawatts of technical potential nationwide. Including export potential in a future analysis would result in a significantly greater potential energy savings and carbon reductions resulting from CHP and WHP.

To estimate what portion of on-site CHP/WHP potential could be considered economic, the team relied on findings from the 2013 AGA study. That study sorted technical potential into economic potential by simple payback using three bins: (1) less than a 5-year payback, (2) a 5- to 10-year payback, and (3) more than a 10-year payback. For this analysis, we reviewed potential projects with less than a 10-year payback (assuming investments with longer payback would not be made), compared to the total technical potential in each state. This step allowed us to determine what percent of technical potential could be considered economic in a given state. We applied this percentage to the most recent estimates of total on-site technical potential from DOE. In states where no economic potential was identified, we assumed a minimum of 10 percent would be deployed, recognizing that many states pursue policies and provide assistance aimed at addressing economic barriers to greater CHP and

[53] U.S. DOE, *supra* note 25.
[54] American Gas Association, *supra* note 26.

WHP deployment. The estimates of CHP and WHP potential vary significantly by state but, on a national basis, result in the installation of approximately 40,000 megawatts by 2030. Again, these findings are conservative, since they are limited to on-site CHP and WHP potential.

We used the state-specific amounts of CHP/WHP capacity as inputs for SUPR 2, which produces estimates of emission reductions, avoided costs, and energy savings in each state from CHP. SUPR 2 provides three options to choose from that represent the construction and operation of different amounts of CHP/WHP. The low option represents 40 megawatts, the medium option represents 100 megawatts, and the high option represents 500 megawatts. All options are evenly split between the commercial and industrial sectors and the analysis assumes an even amount of CHP/WHP is installed each year starting in 2016 such that the full amount is installed by 2030.

2. Clean Power Plan Data

Table 8 shows the state-by-state results for statewide CO_2 emission reductions resulting from industrial energy efficiency and CHP/WHP compared to each state's CPP targets under the rule that is currently before the D.C. Circuit. It includes the CO_2 emission reductions required under the CPP for each state, the annual CO_2 emission reductions achievable by the industrial sector, the percentage of the state's CPP target can be met by the industrial sector alone, each state's mass emission-reduction goal as a percentage, and what portion of that percentage can be met through industrial energy efficiency.

Table 8. Percentage of CPP Targets Achieved Through Industrial Energy Efficiency

State	CO_2 Reduction Required Under the CPP (short tons)	IEE and CHP/WHP 2030 Annual CO_2 Reduced (short tons)	EPA's Mass Emission-Reduction Goal (%)	CPP Target IEE and CHP/WHP Would Meet (%)
Alabama	18,691,307	5,570,862	25%	30%
Alaska*	N/A	482,985	N/A	N/A
Arizona	10,294,285	1,958,698	25%	19%
Arkansas	13,093,585	1,960,639	30%	15%
California	1,310,093	6,203,406	3%	>100%
Colorado	13,308,872	3,832,667	31%	29%
Connecticut**	-281,720	958,300	-4%	N/A
Delaware	828,467	482,985	15%	58%
District of Columbia*	N/A	250,183	N/A	N/A
Florida	19,337,491	5,309,566	16%	27%
Georgia	16,496,203	5,744,788	26%	35%
Hawaii*	N/A	1,342,282	N/A	N/A
Idaho**	-53,937	1,030,926	-4%	N/A
Illinois	35,731,028	9,919,055	35%	28%
Indiana	34,446,081	9,164,632	31%	27%
Iowa	13,117,250	3,646,603	34%	28%
Kansas	12,664,964	2,229,175	37%	18%
Kentucky	29,649,708	7,589,721	32%	26%
Louisiana	8,964,171	4,201,349	20%	47%
Maine**	-1,785	326,707	0%	N/A
Maryland	5,823,399	878,996	29%	15%
Massachusetts	1,020,501	2,913,079	8%	>100%
Michigan	22,316,390	6,912,665	32%	31%
Minnesota	11,990,138	4,676,326	35%	39%
Mississippi	2,138,972	2,422,187	8%	>100%
Missouri	22,576,565	3,785,347	29%	17%
Montana	7,844,214	426,267	41%	5%

State	CO_2 Reduction Required Under the CPP (short tons)	IEE and CHP/WHP 2030 Annual CO_2 Reduced (short tons)	EPA's Mass Emission-Reduction Goal (%)	CPP Target IEE and CHP/WHP Would Meet (%)
Nebraska	8,869,989	1,799,244	33%	20%
Nevada	2,013,146	1,838,795	13%	91%
New Hampshire	645,319	396,560	14%	61%
New Jersey	2,669,953	2,878,827	14%	>100%
New Mexico	4,927,081	1,071,691	28%	22%
New York	3,339,027	3,846,703	10%	>100%
North Carolina	16,011,107	3,709,942	24%	23%
North Dakota	12,874,519	741,953	38%	6%
Ohio	28,665,011	10,277,039	28%	36%
Oklahoma	12,373,878	2,825,290	23%	23%
Oregon	924,014	1,342,282	10%	>100%
Pennsylvania	30,167,435	7,646,666	25%	25%
Rhode Island	213,561	263,677	6%	>100%
South Carolina	9,894,297	3,738,895	28%	38%
South Dakota	1,581,643	463,726	31%	29%
Tennessee	13,038,835	5,238,374	32%	40%
Texas	62,259,493	16,424,917	25%	26%
Utah	8,388,050	1,030,937	26%	12%
Vermont*	N/A	263,677	N/A	N/A
Virginia	8,300,391	2,565,734	23%	31%
Washington	4,498,370	3,062,450	30%	68%
West Virginia	20,993,575	2,177,934	29%	10%
Wisconsin	14,330,614	5,278,981	34%	37%
Wyoming	18,583,661	1,678,242	37%	9%

**Alaska, District of Columbia, Hawaii, and Vermont do not have CPP targets.*

***Connecticut, Idaho, and Maine have already achieved annual emission levels for Clean Power Plan compliance.*