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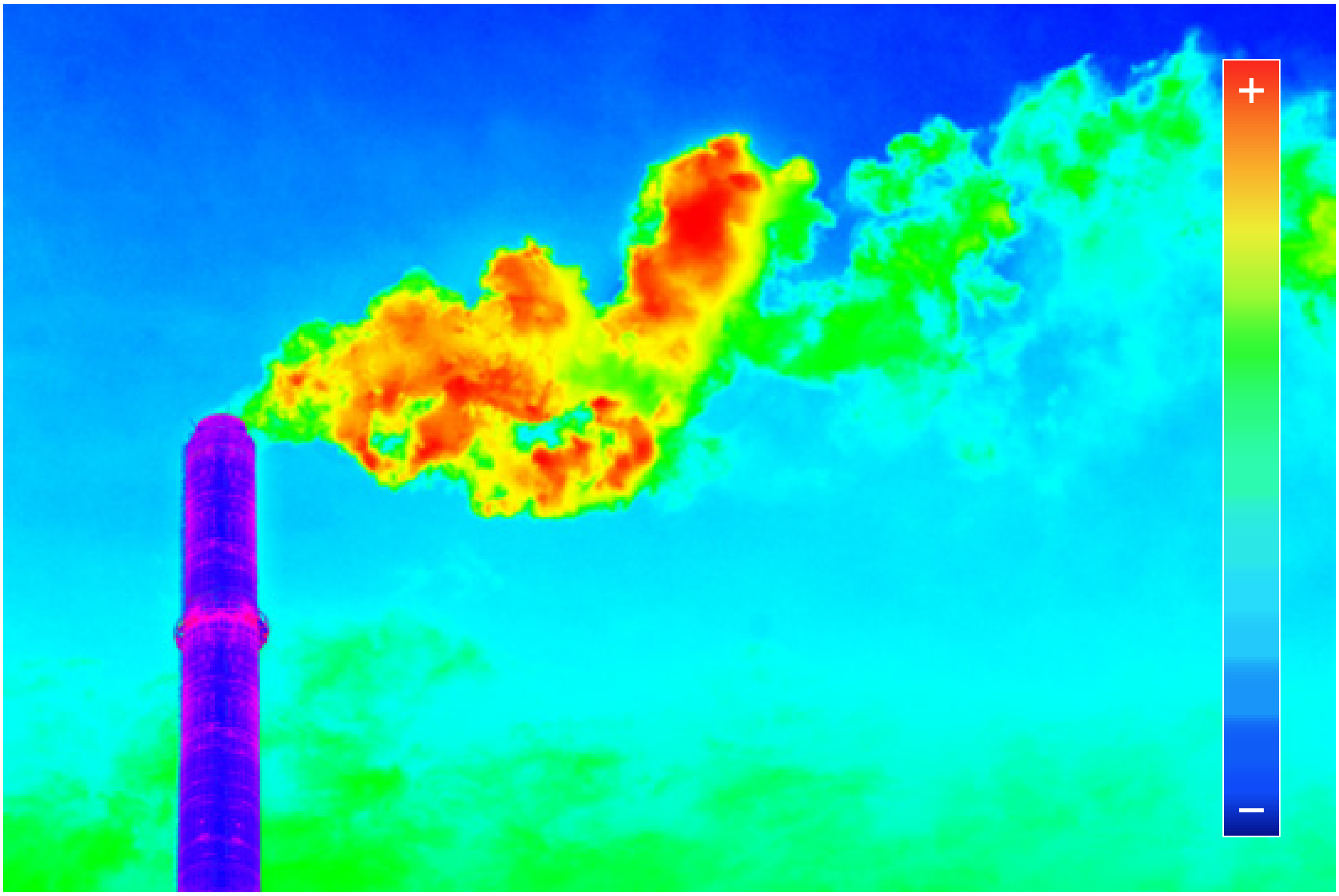

Distributed Generation: Cleaner, Cheaper, Stronger

Industrial Efficiency in the Changing Utility Landscape

The Pew Charitable Trusts

Pew's clean energy initiative

Joshua Reichert, *executive vice president*
Tom Wathen, *vice president, environment*

Initiative team

Phyllis Cuttino, *director*
Jessica Frohman Lubetsky, *officer*
Heather Messera, *officer*
Tom Swanson, *project director*
Lynn Abramson, *senior associate*
Kerry Schlichting, *senior associate*
Jason Wynne, *senior associate*
Patrick Siebenlist, *associate*

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For additional information on Pew's clean energy initiative, please visit pewtrusts.org/cleanenergy.

About the series

This document series, *Distributed Generation: Cleaner, Cheaper, Stronger*, explores the evolving nature of the U.S. electric grid and the role of specific technologies in modernizing the power generating system.

Cover photo:
Infrared thermography image showing the heat emission at the chimney of a power plant. Photo: Ivansmuk / Dreamstime.com

Contact: Michelle Blackston, communications officer
Email: mblackston@pewtrusts.org
Project website: pewtrusts.org/cleanenergy

The Pew Charitable Trusts is driven by the power of knowledge to solve today's most challenging problems. Pew applies a rigorous, analytical approach to improve public policy, inform the public, and invigorate civic life.

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Overview

Electricity is illuminating, but its generation, transmission, and distribution have long been opaque. Today, however, the once static utility industry is becoming a dynamic and transformative opportunity for the nation's economic, environmental, and energy future.

An array of technological, competitive, and market forces are changing how the U.S. generates power and the ways that Americans interact with the electric grid. A century-old centralized system is yielding to advanced, distributed-energy generation capabilities—in which power is produced at or near the place where it is consumed—that allow the industry to respond to new market opportunities and evolving consumer desires.

At the root of this evolution are years of flat electricity demand—the result of efficiency improvements; expanded, cost-effective, clean, and efficient generation options; changing expectations for energy infrastructure, such as an increased priority on reliability and security; and enhanced standards for controlling pollutants. These behavioral and economic shifts are driving the nation toward cheaper, cleaner energy sources and a decentralized fleet of power generators with growing competition. They also are putting pressure on businesses and policymakers to adapt to the evolving marketplace.

Distributed generation is not a passing fad, and new technologies pose significant challenges to long-standing business models. Utilities at the forefront of adoption and innovation are pursuing business and regulatory changes that will allow them to embrace and prosper in a new, less centralized future. At the other end of the spectrum, some utilities are trying to preserve the traditional model. And in the middle, the balance of the utility sector, also referred to in this analysis as the utility industry, is striving to understand and work with changing conditions. As the established industry struggles to modernize, more recent entrants to the sector—from solar energy and efficiency service companies to telecommunications and home security firms—are offering new goods and services in the electric marketplace.

Advancements that enable distributed generation will continue and probably gain momentum, but reluctant utility players could slow progress and delay realization of significant benefits such as a shift toward cleaner technologies. At the same time, the distributed electricity future must include and engage the utility sector; otherwise, the system could face reliability issues, fall short in capital investments, and produce higher power bills.

Historically, the U.S. utility industry has done a tremendous job meeting the key societal challenge of providing reliable electricity to the entire country. Now, as recent polling shows, the public is demanding a cleaner, cheaper, and more decentralized energy future, and involving the utility industry in the growth of distributed generation should accelerate progress toward meeting those goals. For these reasons, the national interest will be best served if utilities take an active role in the energy revolution and ensure a healthy, innovative utility sector using clean, smart, and economically promising distributed energy resources.

This report examines the history of the changing electric grid to understand why and how it is evolving. It then looks at industrial energy efficiency technologies, sometimes referred to as cogeneration, and focuses on how this type of distributed generation—which includes combined heat and power (CHP) and waste heat to power (WHP)—can contribute to a cleaner, more secure, and more resilient electric grid.

These systems, which capture waste heat to produce power and/or heat or cool buildings, can help achieve national economic, environmental, and energy goals.

The report also identifies federal programs and policies that can help increase the deployment of these efficient technologies while shaping the nation's energy future, including:

- **Technical assistance.** Several agencies are involved in efforts to close the information gap between prospective users of new technologies and project developers or manufacturers.
- **Research.** Studies and demonstration projects funded or conducted by government agencies can identify ways to overcome basic research challenges and commercialization barriers and help technologies emerge from labs and universities.
- **Disaster response and mitigation.** Targeted funding can help finance repair of energy infrastructure as well as modernization and resiliency efforts.
- **Financial incentives.** Tax credits, loans, and grant programs can help overcome upfront capital barriers that impede greater deployment of industrial energy-efficient technologies.
- **Drivers of demand.** Clear, consistent, and long-term goals can increase adoption and deployment of clean and efficient energy technologies.
- **Interconnection and standby rate reform.** Clear regulatory guidance to states can reduce regulatory barriers and cost impediments.
- **Emissions reduction.** Output-based emissions control programs can encourage greater adoption of industrial energy-efficient technologies.

The report concludes with an evaluation of the impact of key regulatory and legislative policies on the deployment of industrial energy efficiency technologies in order to help federal policymakers effectively encourage adoption of these systems. The Pew Charitable Trusts commissioned ICF International Inc. to model these policies and found that implementation of the U.S. Environmental Protection Agency's Clean Power Plan and an improved federal investment tax credit could result in a 27 percent increase in adoption by 2030.

The causes and effects of a changing electrical system

The U.S. electric power sector has historically demonstrated responsiveness to change. Throughout the 20th century, the industry expanded to meet the demands of a growing economy, security imperatives, and the government's priority for universal access to electric services. In the 21st century, utilities are again transforming in response to U.S. economic, environmental, and national security opportunities and policies.

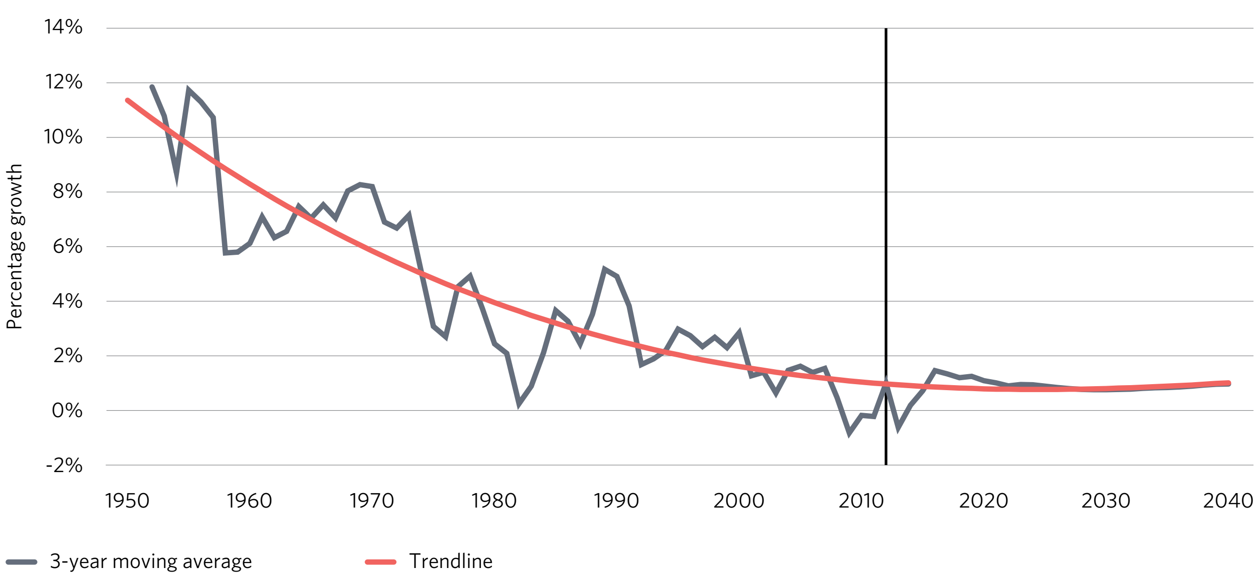
This chapter explores how the utility sector is responding to new policies, technologies, and market opportunities.

Causes

Demand for electricity is flattening

For most of the 20th century, increased energy consumption was a sign of national prosperity and a growing economy. But in the past 60 years, electricity growth rates have declined even as Americans' use of consumer electronics increased, a trend which continues today. In fact, the rate of demand has declined steadily since the 1950s to a yearly rate of less than 1 percent during the past decade.[1] Retail sales of electricity are 1 percent lower in 2015 than they were in 2007, when a record amount of power was sold to customers in the United States.[2] This decoupling of energy use from economic growth represents a major change in how the U.S. measures progress.

Figure 1
Annual Electricity Consumption Has Decreased on Average
U.S. percentage demand growth, 1950-2040



Source: U.S. Energy Information Administration
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The decline in demand stems from structural changes in the U.S. economy, such as the emergence of information technologies, the service sector, and improved productivity that allows products and processes to achieve more with less energy. For example, energy efficiency product standards prescribed by Congress over the past decade will avoid 128 quadrillion British thermal units of energy use and save consumers more than $1.7 trillion through 2030.[3] Similarly, efficiency gains and structural changes in the economy are expected to hold electricity consumption increases at less than 1 percent annually through 2040.[4]

In the electric industry, digital technologies that enable two-way communications are helping to reduce demand. These capabilities allow grid managers and end users to make more informed decisions about how and when to use energy in response to demand and price signals. This two-way communication is also helping utilities manage the increasingly diverse portfolios of generating technologies and giving consumers information about their power use, which has been shown to improve end-user efficiency.

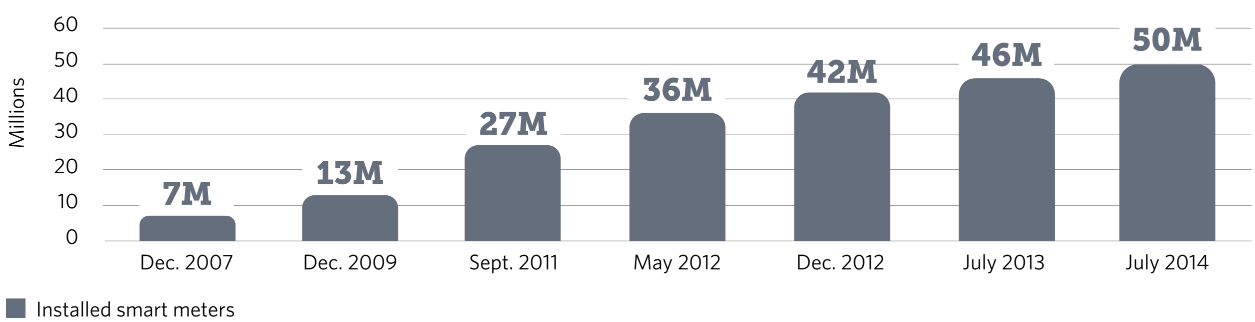
Other new technologies are making the grid "smarter." These include synchrophasors—devices that measure the electrical waves on an electricity grid, using a common time source for synchronization—automated feeder switches, voltage regulators, and other advanced controls that enable grid stability and resilience. The rapid spread of smart meters, which allow utilities and consumers to communicate digitally and make more informed decisions about energy demand, production, and use, is emblematic of these emerging capabilities.

Deployment of advanced metering infrastructure was one of the priorities of the American Reinvestment and Recovery Act of 2009, which provided $3.4 billion in federal government grants for smart grid installation efforts.[5] These investments and associated private-sector initiatives spurred a near-fourfold increase in the number of smart meters installed in the United States between 2009 and 2014.[6] Federal government reports suggest that smart meters and other advanced controls are reducing participating utilities' costs by 13 to 77 percent and have the potential to lower peak electric demand by 30 percent or more.[7]

Figure 2

Smart Meter Use Increased 614% Since 2007

U.S. installations, 2007-14, in millions



Source: Edison Foundation's Institute for Electric Innovation

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Cost-effective clean and efficient power generation options are expanding

Over the past decade, major progress has been made to increase cost-competitive power supply options.

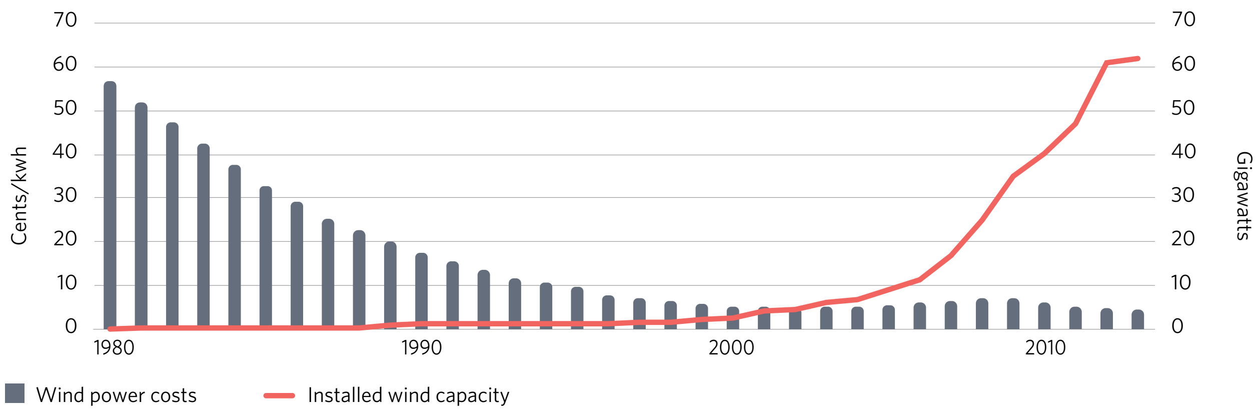
The rise of wind and solar energy generation can be traced to public policies at the state and federal levels. Most states now have renewable portfolio standards, and more than two-thirds have standards or goals for deployment of renewables in the electric mix.[8] At the federal level, targeted tax incentives, including the production tax credit (since 1992) and the investment tax credit (since 2006), have helped these industries mature.

The private sector has responded to these policy drivers by reducing costs and scaling up production of clean energy technologies. The price of wind power has declined by more than 50 percent since the production tax credit was initiated, while the cost of solar has fallen by 75 percent since 2008.[9]

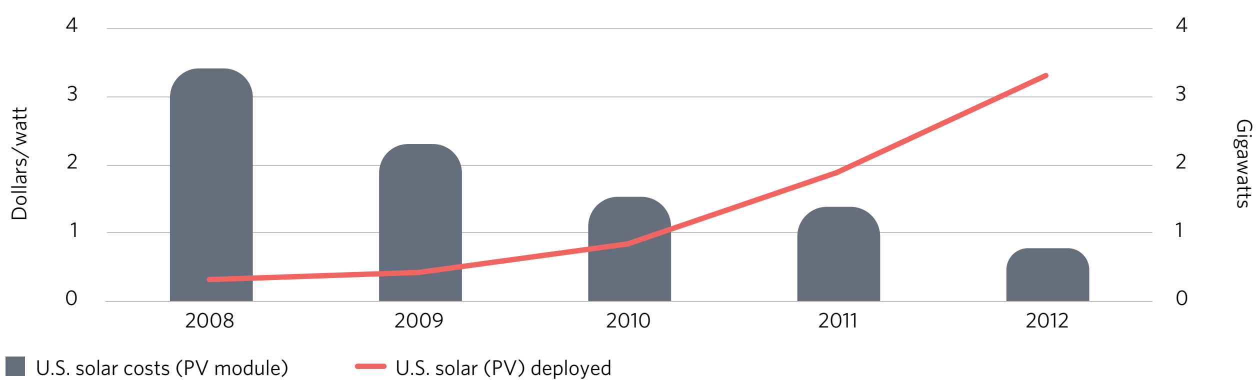
Figure 3

Solar and Wind Capacity Increased as Prices Fell

Land-based wind installations (in gigawatts) and cost (in cents per kilowatt-hour)



Solar installations (in GW) and cost (in dollars per watt)



Source: U.S. Department of Energy

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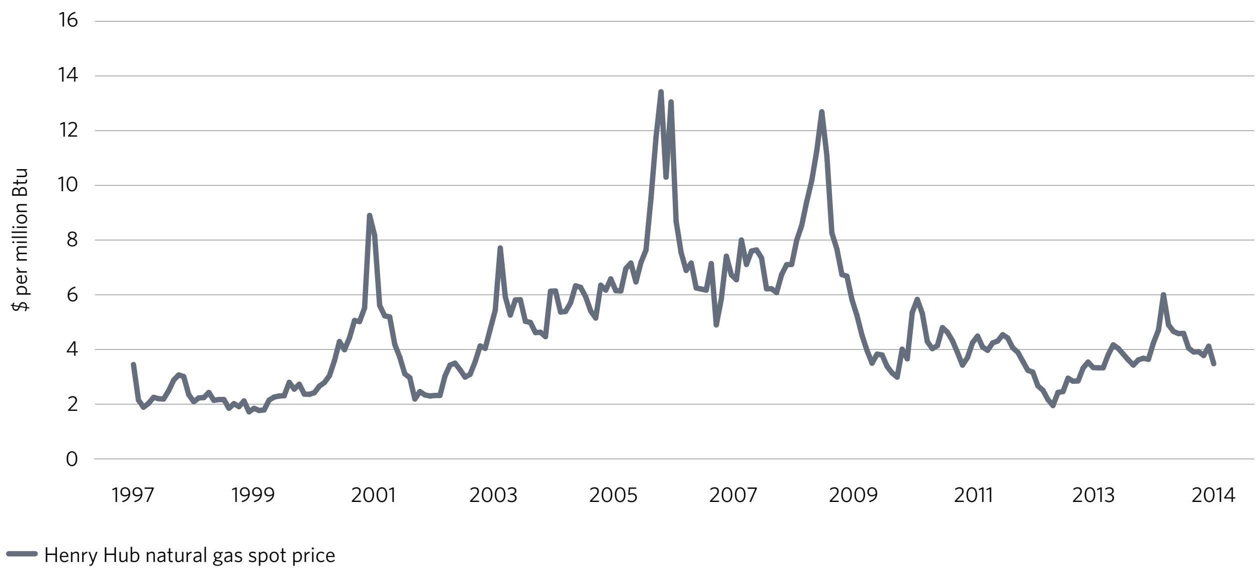
The competitive position of natural gas-fired power plants has also improved dramatically in recent years. Historically, natural gas prices have been volatile. However, with the recent rapid increase in production, which has risen 44 percent since 2005[10] because of enhanced recovery techniques for extraction from unconventional reserves, prices have stabilized at approximately half of what the commodity sold for in 2008. As gas production has increased and prices have fallen, overall consumption in the United States has grown by 22 percent,[11] and natural gas-fueled electric power generation has expanded by almost 50 percent over the past decade.[12]

Figure 4

The Cost of Natural Gas Has Generally Decreased and Stabilized Since 2008

Henry Hub natural gas spot price, 1997-2014, in $ per million Btu



Source: U.S. Energy Information Administration

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Expectations for energy infrastructure are changing

For more than 100 years, the electric power industry has responded to the public's priority for universal access to affordable, reliable electricity services in the United States. A decade ago, the National Academy of Engineering deemed electrification one of the greatest achievements of the 20th century.[13] Today, however, expectations are expanding beyond universal service and basic reliability to include enhanced security, resilience, environmental protection, choice, and flexibility.

Meeting these requirements is a challenge for America's expansive and aging fleet of power plants. More than 7,300 plants operate in the United States,[14] and over half of them were built in the 1960s and 1970s; many others have been generating for more than half a century.[15] According to a leading industry journal, many of the nation's 45,000 electric transformers have exceeded their expected useful lifetimes of 40 years.[16]

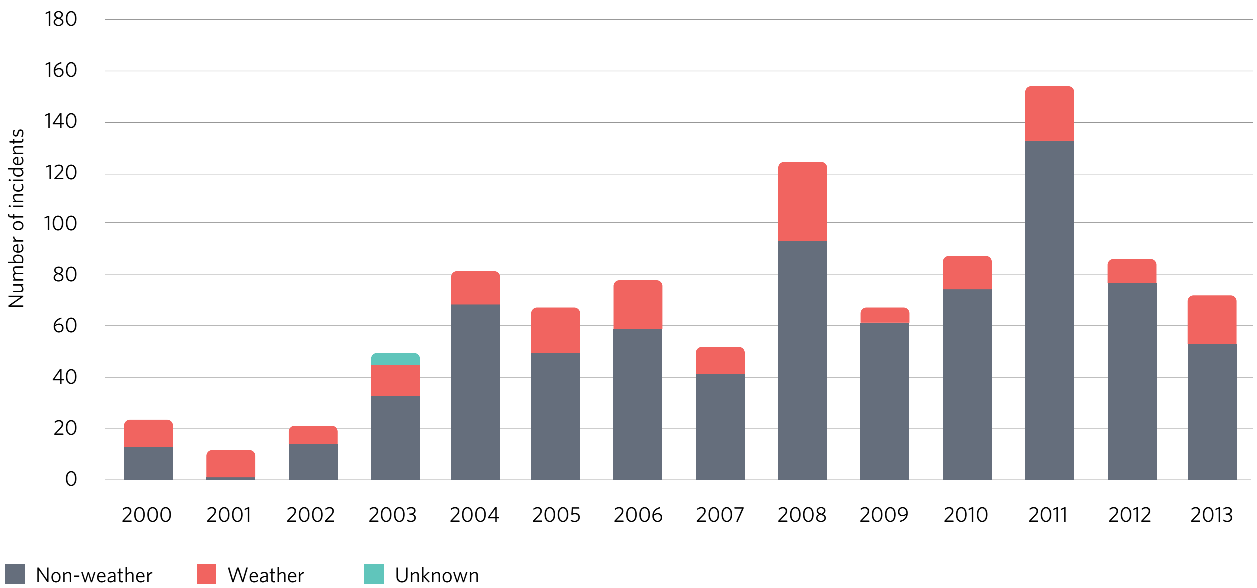
In another indication of challenges facing the nation's electric infrastructure, data show that the United States experiences more electric outages than any other developed nation.[17] From 2000 to 2014, outages increased sixfold from 2.5 to almost 18 disruptions a month.[18] The U.S. Department of Energy (DOE) estimates that these events cost U.S. businesses as much as $150 billion per year.[19] Although there is no doubt that aging, antiquated power infrastructure contributes to the increased number of outages, the rise in the number and intensity of weather events is also a major contributing factor. Expert analysis of Energy Information Administration data suggests that the quantity of weather-related incidents affecting the grid has grown two to three times in less than 20 years.

Because the U.S. electric grid is antiquated and vulnerable to outages, the American Society of Civil Engineers in 2013 gave the system a D+ grade in its regular assessment of major U.S. infrastructure.[20] And in a recent survey, senior utility executives rated aging infrastructure as the top issue facing the industry.[21]

Figure 5

The U.S. Electric Grid Experienced 300 Disturbances From 2011 to 2013

Significant incidents, by type



Source: Pew Charitable Trusts and Inside Energy

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Devastating storms such as hurricanes Katrina, Sandy, and Ike have had a profound impact on policymakers' and consumers' priorities, elevating the demand for technologies capable of maintaining critical infrastructure during emergencies and of rebounding rapidly in the face of extreme weather events. In 2012, Hurricane Sandy disrupted power to more than 8.5 million customers, with some outages lasting for weeks. The experience highlighted the frailty of the infrastructure in mid-Atlantic and New England coastal areas, just as Katrina had in Southern states in 2005. The national recovery plan for areas affected by Hurricane Sandy prioritized rebuilding with smarter, more resilient electric technologies.[22]

> Our reliance on installed, dispatchable power generation during extreme weather serves as a shining example of why diversity of baseload capacity is necessary to secure grid reliability."
>
> Senator Lisa Murkowski (R-AK)

The Distributed Power Generation System

Distributed generation is the use of small-scale power generating technologies located on-site or close to end users. The increasing popularity of these systems is driving the decentralization of the electricity industry and helping to lower costs, improve reliability, reduce emissions, and expand energy options for communities across the country. Among the leading distributed generation technologies are:

Combined heat and power and waste heat to power—By producing heat and power from a single fuel source, CHP has double the efficiency of central station power generation and can be used by manufacturers, office parks, university campuses, and metropolitan areas. WHP captures waste heat from industrial processes and recycles it to create electricity.[*]

Energy smart technologies—These products and services increase the connection and dialogue between producers and users of the electricity system. Not only do they make power generation more efficient and resilient, but they also play a key role in the integration of renewable and distributed resources into the grid by facilitating more cooperative and responsive functioning among generators.[†]

Photovoltaic (PV) solar—Generating electricity directly from sunlight, PV installations provide power to homes, institutions, and large commercial businesses. Distributed solar arrays—mounted on rooftops or on the ground—can help offset peak demand and stabilize the local grid.[‡] Compared with utility-scale projects, distributed arrays are more easily installed at a range of facilities and buildings and can provide on-site and localized energy.

Microgrids—A microgrid is a localized system that can disconnect from the traditional grid to operate autonomously, balancing supply and demand resources to maintain energy services within a defined area. By enabling the integration of distributed resources such as wind, solar, CHP, storage, and demand response technologies[§] into the system, microgrids can be more flexible and efficient. They also improve energy security because they can mitigate disturbances and continue operating in isolation even if the central grid is down.[**]

* Alliance for Industrial Efficiency, "Conventional Power Generation Is Inefficient," http://www.dgardiner.com/alliance-for-industrial-efficiency/combined-heat-and-power-and-waste-heat-recovery-a-primer/.

† Bloomberg New Energy Finance, "Energy Smart Technologies," http://about.bnef.com/services/energy-smart-technologies/.

‡ Solar Energy Industries Association, "Distributed Solar," http://www.seia.org/policy/distributed-solar.

§ Demand response is an electricity tariff or program established to induce lower electricity use by end-use customers, typically at times of high market prices or when grid reliability is jeopardized.

** U.S. Department of Energy, "The Role of Microgrids in Helping to Advance the Nation's Energy System," http://energy.gov/oe/services/technology-development/smart-grid/role-microgrids-helping-advance-nation-s-energy-system.

Environmental standards and requirements for power plants are expanding

In addition to concern over aging infrastructure, an ongoing regulatory review of environmental statutes related to clean air, clean water, and toxic substances has resulted in new standards for electric power generation, including:

- Clean Air Act requirements that coal- and oil-fired power plants reduce emissions of mercury and other toxic air pollutants.
- New national ambient air quality standards for ozone pollution.
- Updated standards under the Clean Water Act for effluents from steam electric power plants.
- Resource Conservation and Recovery Act regulations on combustion waste (ash) from coal-fired power plants.
- The first standards for greenhouse gas emissions from new and existing power plants.

Public demand for pollution control and associated regulations is putting a premium on deployment of cleaner sources of electricity, such as natural gas and renewables. Natural gas has become more attractive because it is the cleanest-burning of the fossil fuels in terms of carbon emissions and local air pollutants. Many renewable energy technologies have no emissions and have other environmental attributes, such as low water requirements.

> "People are beginning to understand that they need their own on-site capabilities to island themselves from the grid. That's because the grid's external vulnerabilities will continue to be a problem until we do have substantial amounts of distributed generation."
>
> Representative Trent Franks (R-AZ)

Effects

The power generation mix is tilting away from coal

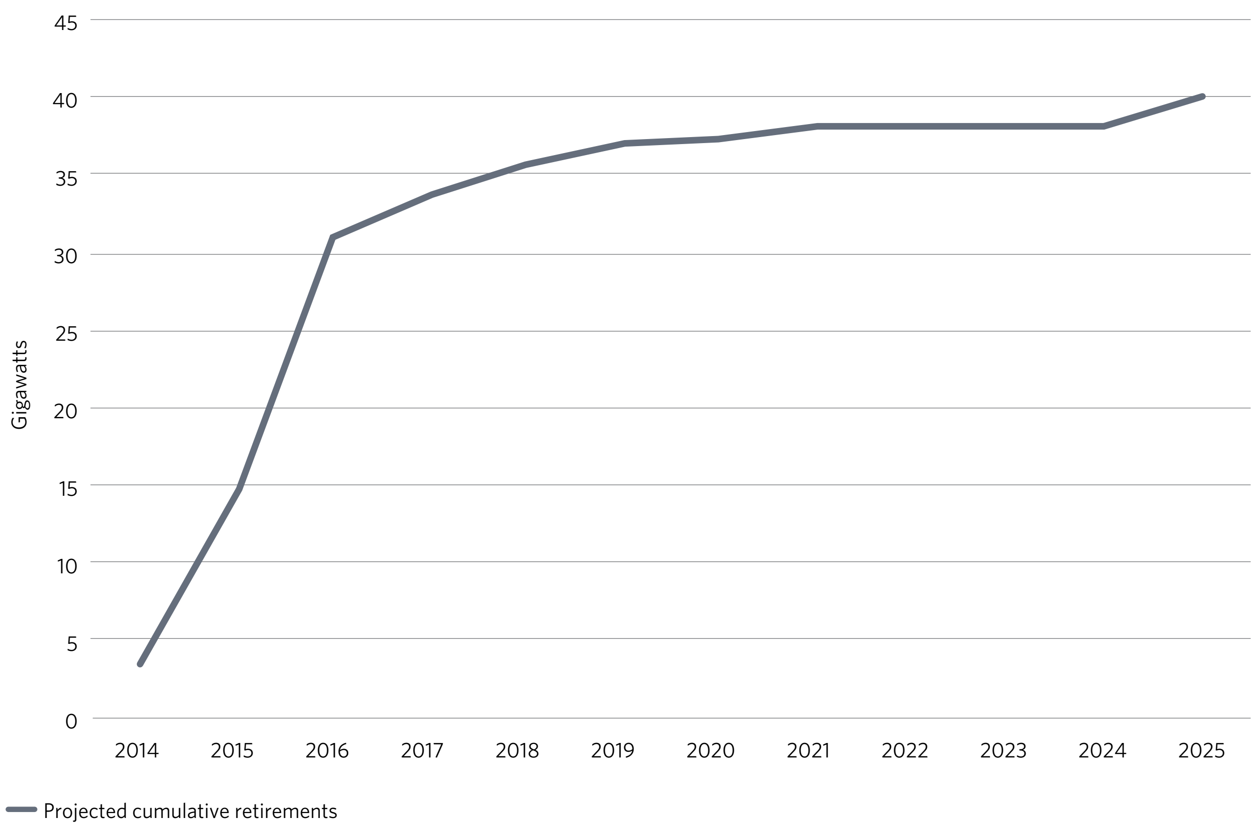
Coal was once the undisputed workhorse of U.S. power generation, but its market share has eroded considerably, declining from almost 50 percent of the national electric supply in 2007 to less than 40 percent at the end of 2014.[23]

DOE projects that as much as 60 gigawatts (GW) of coal capacity is slated for retirement by the end of this decade,[24] including more than 17 GW by December 2016.[25] Similarly, some nuclear power plants are being taken offline. Although nuclear plants are a low-carbon, reliable, and constant power option, they struggle to compete on an economic basis with newer, less costly generation technologies whose prices are declining. In 2012 and 2013, five nuclear plants closed, and DOE projects that 4 to 40 GW of additional nuclear capacity could be retired through 2040.

Figure 6

Up to 40 GW of Coal-Fired Capacity Is Scheduled for Retirement by 2020

Projected plant retirements, 2014-25, in GW



Source: U.S. Energy Information Administration

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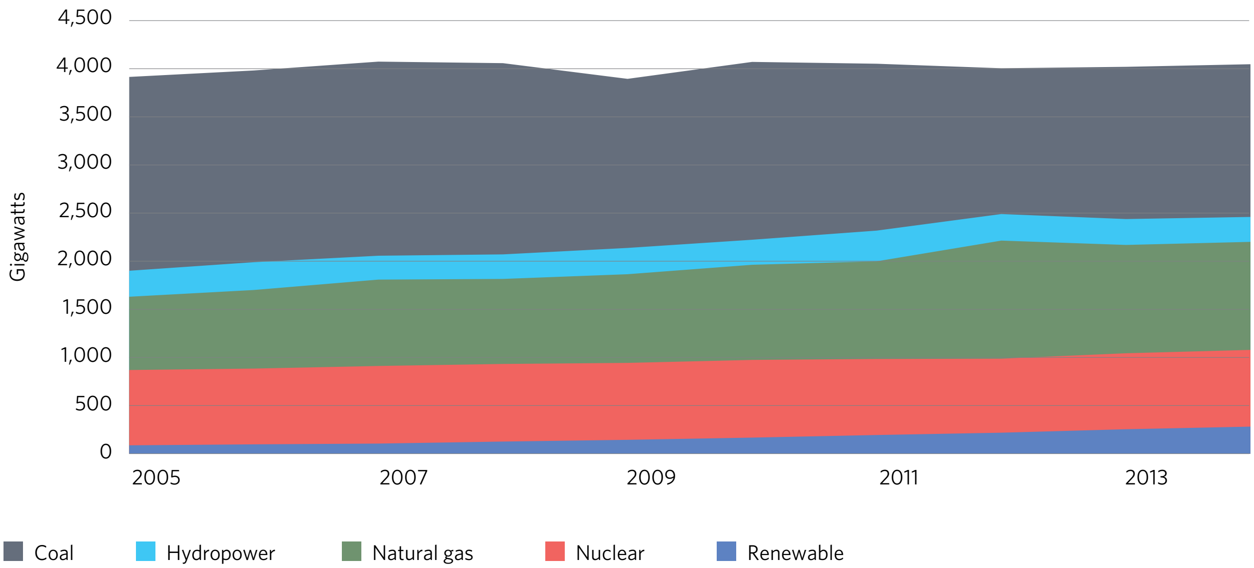
As coal and nuclear power recede, cleaner, more efficient energy sources are filling the void. Net electricity generation from natural gas has increased nearly 50 percent since 2005, while nonhydro renewable generation has risen 220 percent.[26] More than 60 GW of CHP, much of it fired by natural gas, has been added to the grid over the past 30 years.[27] Wind and solar have become significant contributors to America's power landscape, with capacity tripling since 2008.[28] By the end of 2014, the United States had more than 65 GW of installed wind capacity, 10 times more than a decade ago.[29] Similarly, as of the first quarter of 2015, more than 20 GW of solar was installed, enough to power 4 million homes.[30]

Gas and renewable energy plants account for more than 90 percent of the power capacity added in the United States since 2000.[31] The U.S. Energy Information Administration projects that gas and renewables will account for a similar share of capacity to be built between now and 2020.[32]

Figure 7

Renewable Resource Capacity Has Increased While Coal Has Declined

U.S. power generation by major source, 2005-14, in GW



Source: U.S. Energy Information Administration

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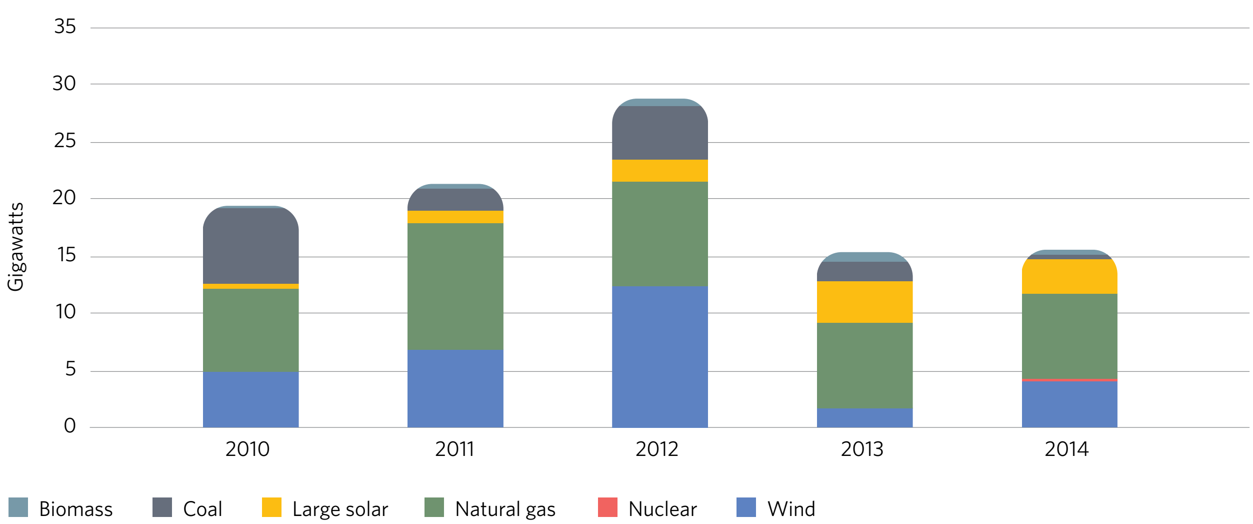
Figure 8

Wind and Solar Accounted for 48% of New Capacity in 2014

U.S. power plant additions, 2010-14, in GW



Source: U.S. Department of Energy

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Power sector emissions are falling

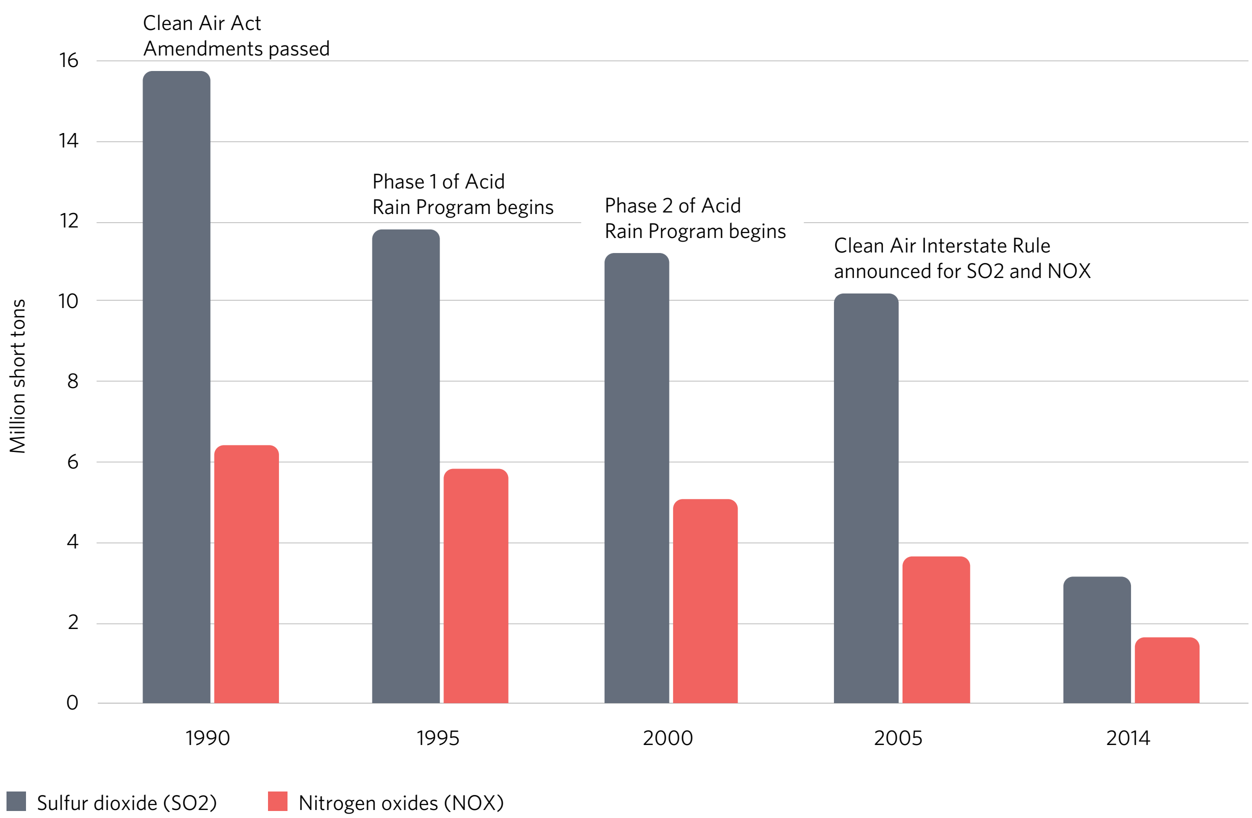
The uptick in renewables, natural gas, and efficiency across the utility industry is substantially reducing emissions nationally. Significant progress has been made to reduce local, regional, and global pollution from the U.S. power sector even as the GDP rises, demonstrating that economic growth and environmental protection can be achieved in tandem.

Sulfur dioxide emissions associated with acid rain pollution have fallen by more than 70 percent since a national policy was established in the early 1990s. Similarly, power sector emissions of nitrogen oxides that foster formation of low-level ozone, or smog, are 74 percent lower than when the Clean Air Act Amendments of 1990 were enacted.

Figure 9

The Clean Air Act Has Resulted in a More Than 70% Decline in Key Emissions

Electricity sector sulfur dioxide and nitrogen oxide emissions, 1990-2014, in million short tons



Source: U.S. Environmental Protection Agency

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More recently, attention has been directed at reducing carbon dioxide emissions associated with electricity production and overall energy use in the U.S. and global economies. Carbon dioxide is a natural byproduct of fossil fuel combustion as well as one of the longest-lasting greenhouse gases. Early in his administration, President Barack Obama set a goal for reducing U.S. greenhouse gas emissions 17 percent from 2005 levels by 2020.[33] In 2015, he committed the United States to achieving a 26 percent to 28 percent reduction in emissions by 2025 as part of an agreement with China.[34]

Electric power generation accounts for almost one-third of total U.S. greenhouse gas emissions,[35] more than any other single sector, but it has been "decarbonizing" in recent years. Since 2005, U.S. carbon dioxide emissions from utilities have declined 15 percent, to 2,051 million metric tons, about the same level as in 1996.

Figure 10

Carbon Emissions Have Fallen 15% Since 2005

Electric sector emissions, 2005-14, in million metric tons

Source: U.S. Energy Information Administration

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Competition in the electric power sector is growing

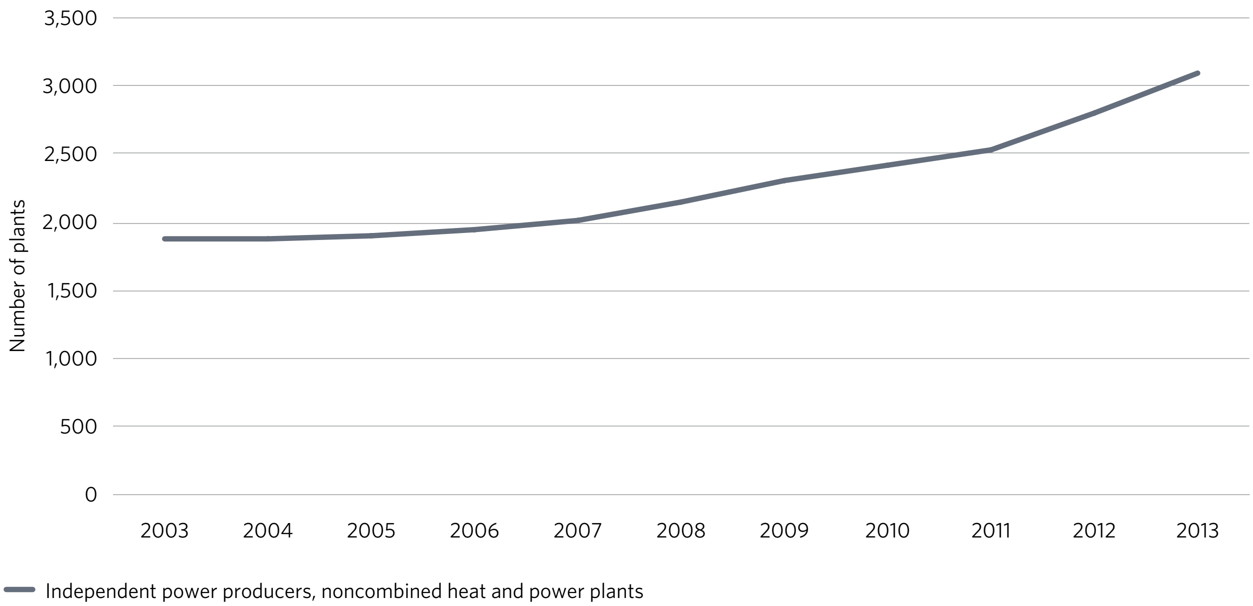
For most of the past century, quasi-public and private electric utilities were responsible for nearly all of the electric generation system, from power production to transmission to distribution. However, in recent decades, legislative and policy reforms such as the Energy Policy Acts of 1992 and 2005 have deregulated the various components of the electric system, leading to more competition.

The power sector now includes more independent and distributed power producers. At the utility level, the increased number of independent generators accounted for more than 64 percent of new power plants in the United States between 2003 and 2013.

Figure 11

Number of Independent Power Generating Facilities Increased by 65% From 2003 to 2013

Power plant growth



Source: U.S. Energy Information Administration

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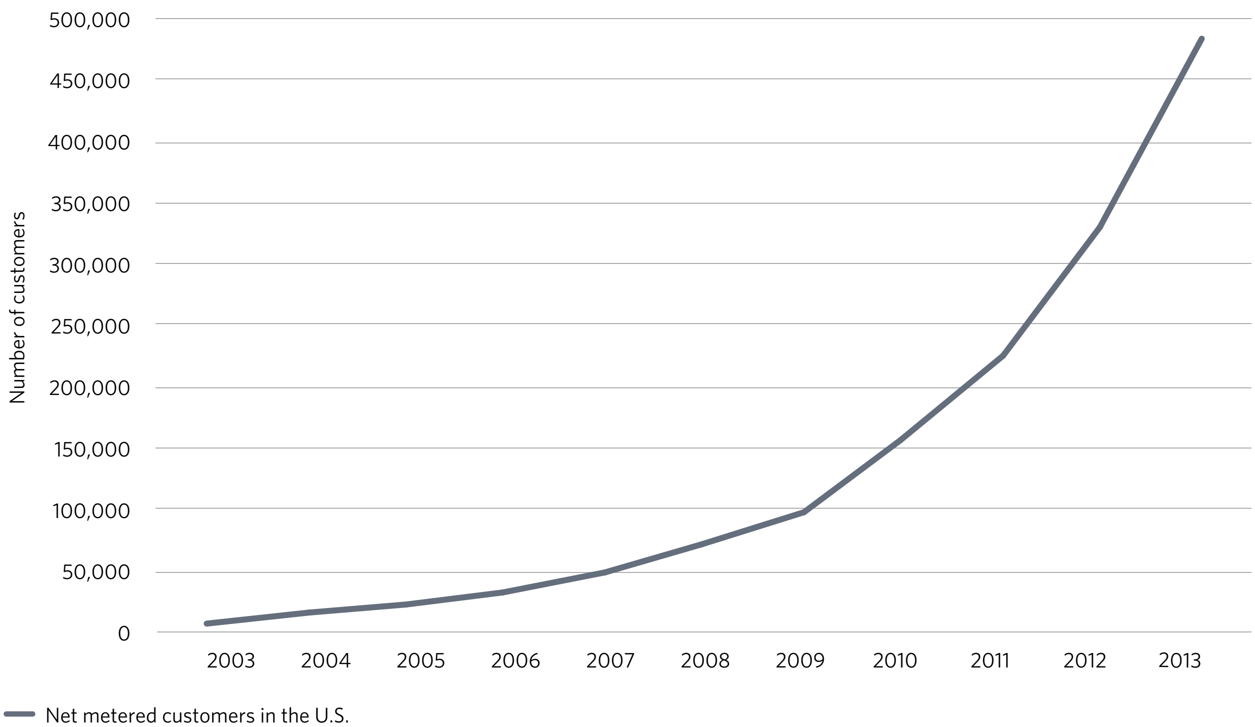
The commercial, institutional, and industrial sectors are not the only ones adopting distributed generation. Changes are also evident at the residential level. Net metering—which allows customers to generate electricity on-site, deliver it to the local grid, and offset the power they consume, thereby reducing their charges during a billing period—has helped foster the spread of rooftop solar and other distributed generation sources. The number of net metered customers has grown 50 percent annually since 2009, rising from 70,000 to more than 482,000 customers by the end of 2013, a total increase of nearly 7,000 percent since 2003.[36]

Figure 12

Net Metering Has Grown 50% Annually Since 2009, to More Than 482,000 Clients

Net metered customers in the U.S., 2003-13



Source: U.S. Energy Information Administration

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Although policy has driven the increasing shift toward distributed generation, innovative breakthroughs have also played a critical role by bringing a range of new technologies to the marketplace. Scientific know-how has led to improvements in energy generation, increased efficiency, better management to allow the grid to absorb more distributed power production, and greater consumer choice.

This "smart grid" is also enabling development of integrated household products—from appliances and thermostats to irrigation and security systems—that can be managed using a smartphone and optimized for energy efficiency, cost savings, or other priorities. A wide variety of major businesses and sectors are targeting the emerging opportunity of the "connected home," including telecommunications firms such as Verizon and AT&T; information technology firms such as Google and Apple; solar energy firms such as Solar City; home security firms such as ADT; home improvement stores such as Lowe's and Home Depot; and an array of companies that provide individual or bundled services to consumers.

These technologies and developments are presenting new options for commercial, residential, and industrial customers, allowing them to choose among an array of affordable, clean, and reliable electricity supply and demand services. Consumers now have choices among technologies, service providers, on- and off-grid services, bundled services, and utility management strategies nationwide. Moreover, residences and businesses can elect to become savers or producers of energy services, rather than simply being recipients of electricity.

To provide these options, a variety of old- and new-economy companies have made substantial purchases of distributed renewable energy sources in recent years, including Wal-Mart, General Motors, Google, Amazon, Dow Chemical, Apple, and Kaiser Permanente.[37] For many of these companies, increased energy choices offer opportunities to save money, hedge against outages, and reduce emissions.

Pressure is mounting on business and policymakers to adapt to changes

Business leaders and regulators accustomed to a relatively stable electric industry structure may be surprised by the speed and scope of the transformations underway. As they did when mobile phones and personal computers emerged, executives, public utility commissioners, and legislators are scrambling to keep pace with the financial, business, and technological innovations in the electricity marketplace.

> "Regulation should ... account for the range of system and public benefits associated with a distribution grid that can effectively integrate renewable and distributed generation."
>
> GE Digital Energy and Analysis Group

The Edison Electric Institute captured the industry zeitgeist in a 2013 report, *Disruptive Challenges: Financial Implications and Strategic Responses to a Changing Retail Electric Business*.[38] The report and the self-examination that followed among leaders in the sector demonstrate the threats posed by reduced sales and revenue as a result of emerging supply- and demand-side competition. Utility leaders are being challenged by countervailing pressures: to reap a payoff from past or new investments in traditional infrastructure such as transmission lines and substations while also funding innovative technologies and services, including solar, storage, efficiency, and demand response.

Still, many utility leaders are cautiously waiting for regulatory and legislative processes to provide much-needed policy certainty and direction on the structure of the marketplace. This is especially challenging in the United States, which has 50 sets of rules that utilities must follow. States across the country are grappling with the issues posed by distributed generation, cost recovery, the capabilities of supply- and demand-side resources, and a larger, more diverse electricity supply network.

The public and private sectors must work together to define the terms of competition with an eye toward getting a useful return on past system investments while satisfying modern priorities for reliability, affordability, and universality. They must do so without stifling new technologies and opportunities that are conducive to a more resilient, competitive, flexible, and clean electric power sector.

Industrial energy efficiency is a key player in distributed energy generation

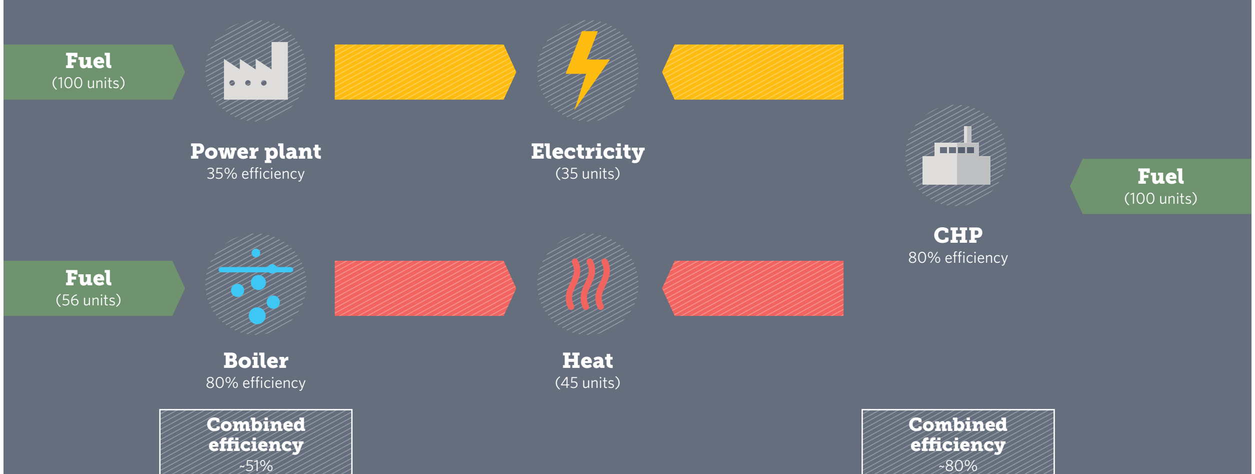
Combined heat and power and waste heat to power are established technologies often overlooked in discussions of energy policy in the United States. However, changes in the electric power sector hold great promise for expanded deployment of these technologies in the coming years.

The same factors that are driving changes in the electrical system and the shift toward other distributed generation technologies are also leading to a new wave of interest in and deployment of CHP and WHP systems. Compared with other generation options, CHP is a cheaper, cleaner, and more efficient method to produce electricity and thermal heat simultaneously for use in industrial and commercial applications. Instead of generating power and letting the waste heat escape, CHP systems harness the thermal energy and use it for heating, cooling, or process applications. By integrating thermal and electricity production, CHP systems are capable of delivering 50 percent more efficient energy services than traditional systems, which generate only heat or only power. Importantly, CHP systems can use any fuel and work well in tandem with other power generation options.

Figure 13

CHP Systems Produce Heat and Electricity From a Single Fuel Source

Traditional energy generation vs. CHP system



Source: U.S. Department of Energy

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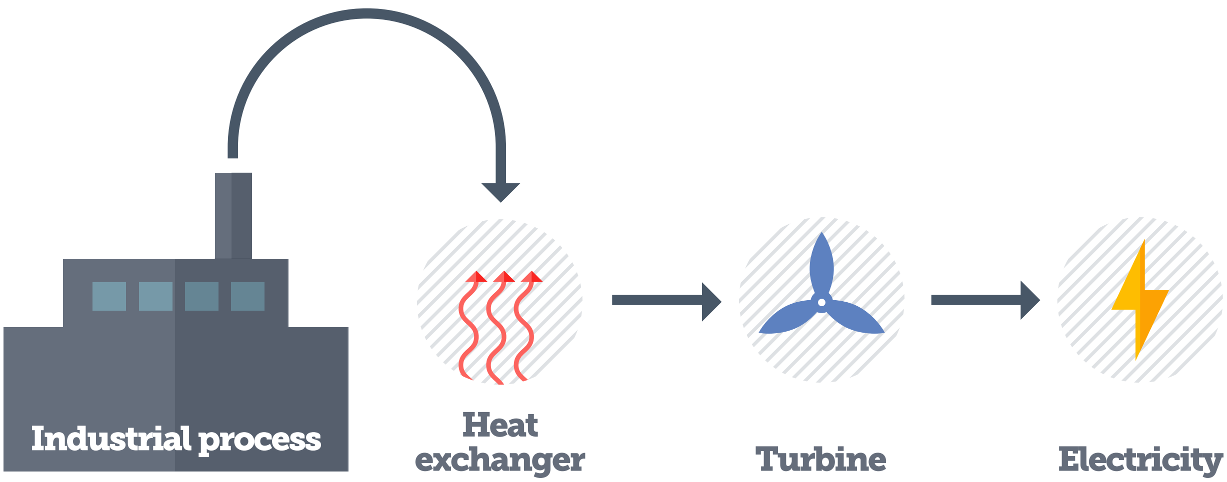
WHP uses waste heat from industrial processes to generate electricity or mechanical power. Many industrial processes discharge heat as a byproduct, some of which can be seen in the form of steam released from vents and stacks. WHP systems convert waste heat into electricity, using no additional fuel and generating no additional emissions. And like CHP, WHP generates power on-site, eliminating the need for transmission and associated losses.

Figure 14

WHP Systems Capture Waste Heat From Industrial Processes to Make Electricity

The waste heat to power process



Source: Heat is Power Association

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In today's changing marketplace, CHP and WHP offer a number of possibilities for enhancing U.S. economic, environmental, and energy security objectives:

- CHP strengthens grid resilience and energy reliability.
- CHP helps harness America's abundant and affordable gas resources efficiently.
- CHP lowers emissions of local air pollution and greenhouse gases and significantly reduces water consumption; WHP displaces those emissions.
- CHP and WHP lessen the need for large-scale investments in transmission and/or new generating capacity.
- CHP and WHP increase the inventory of distributed generation.
- CHP and WHP enhance the competitiveness of U.S. manufacturing and commercial enterprises.

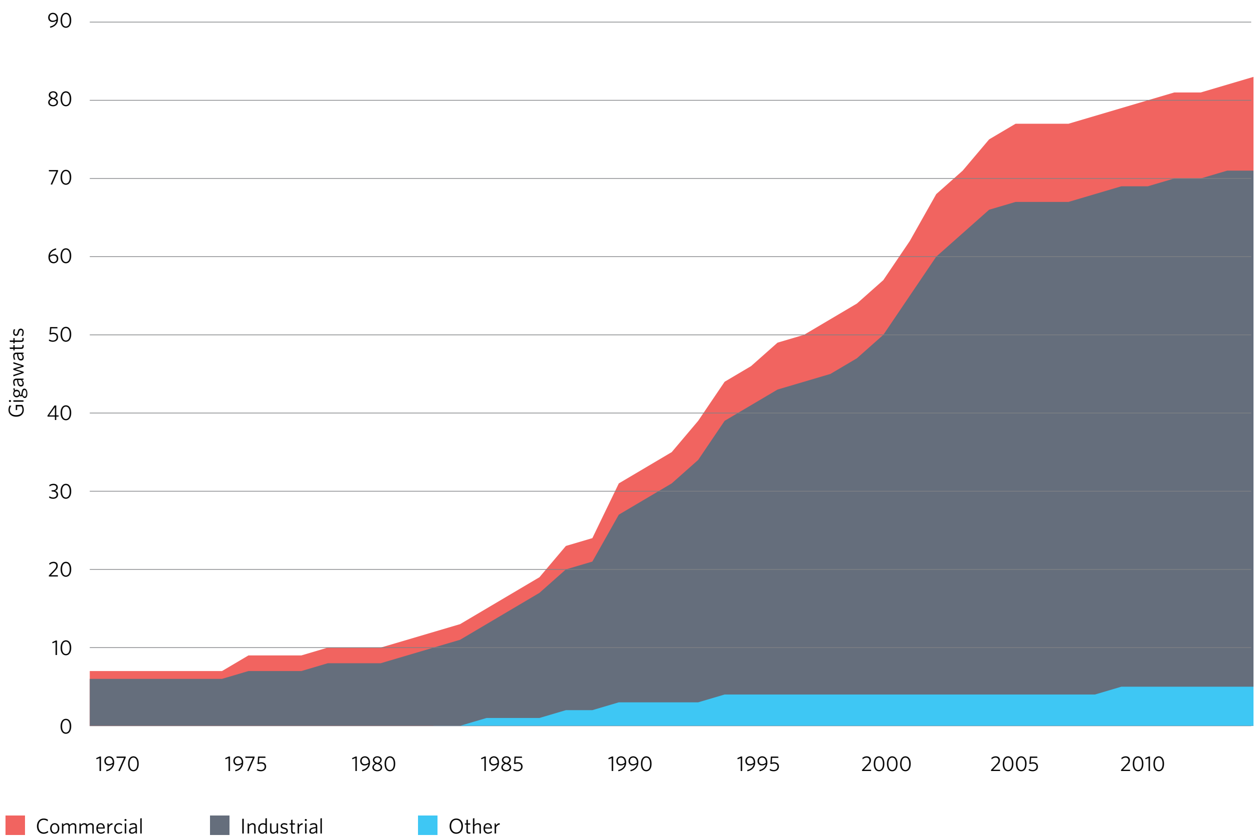
CHP has been in use to some extent since the advent of the U.S. electric system. Thomas Edison used a cogeneration system when he flipped the switch on America's first commercial power plant in 1882.[39] But with the advent of steam turbines, large, centralized, electric-only power plants became the nation's predominant model.[40]

The deployment of CHP surged in the aftermath of the oil crises of the 1970s as policymakers worked to improve energy efficiency, reduce reliance on oil, and increase use of natural gas. The 1978 Public Utility Regulatory Policies Act (PURPA) guaranteed access to the grid and favorable returns for independent power producers using cogeneration systems.[41] This policy spurred an increase in installed CHP from 12 GW in 1980 to 66 GW in 2000.

Figure 15

U.S. CHP Capacity Grew 1,085% Since 1970

Combined heat and power capacity, 1970-2014, in GW



Source: ICF International and U.S. Department of Energy

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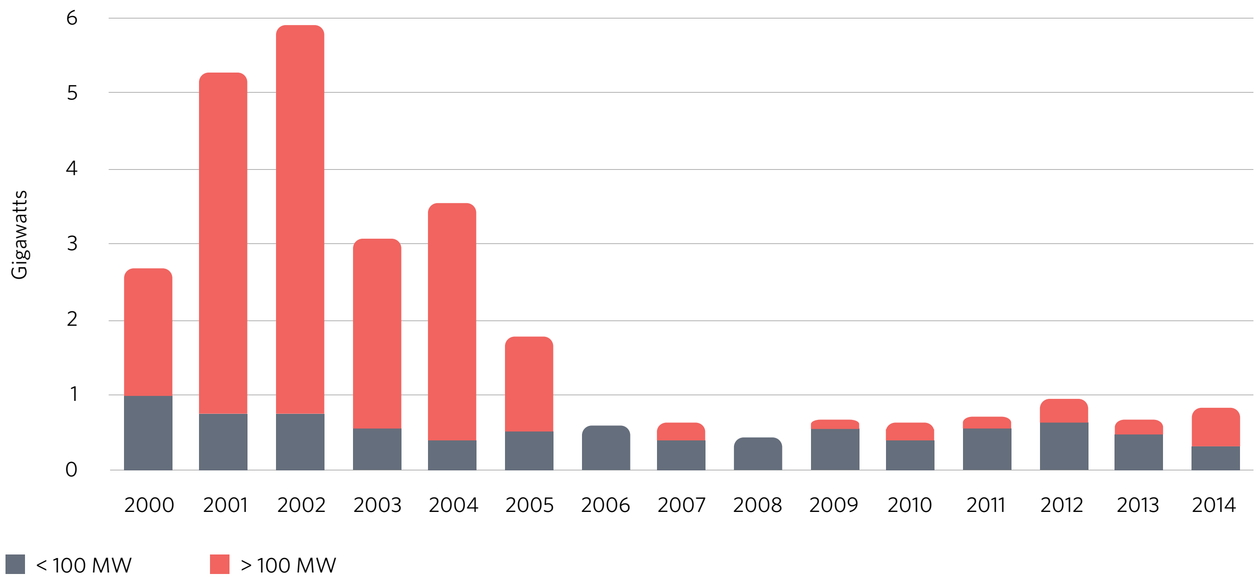
Following PURPA's success in spurring independent power production, legislators and regulators gradually took steps to open wholesale power generation markets to competition, which resulted in an increase in conventional electricity plants. In 2005, Congress amended PURPA to reflect a new goal of increasing competition in power markets. Later, policymakers substantially relaxed the requirement on utilities to purchase cogenerated power. In light of these developments, deployment has slowed considerably: More than 20 GW of cogenerated capacity was added from 2001 to 2006, but only about 4 GW between 2010 and 2014.

Figure 16
The U.S. Added Only 4 GW of CHP in the Past 5 Years
Annual combined heat and power capacity additions, 2000-14, in GW



Source: ICF International and U.S. Department of Energy

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Nationwide, more than 83 GW of CHP was deployed at more than 4,400 facilities as of Dec. 31, 2014.[42] This represents 8 percent of the nation's installed power capacity, but because cogeneration systems can operate on a full-time basis, they account for 12 percent of net generation.[43] Installed CHP and WHP in the United States have resulted in an estimated energy consumption reduction of 2 quadrillion Btu (2 percent)—equivalent to nearly 250 million metric tons of carbon dioxide emissions[44] or the annual output of 66 coal-fired power plants.[45]

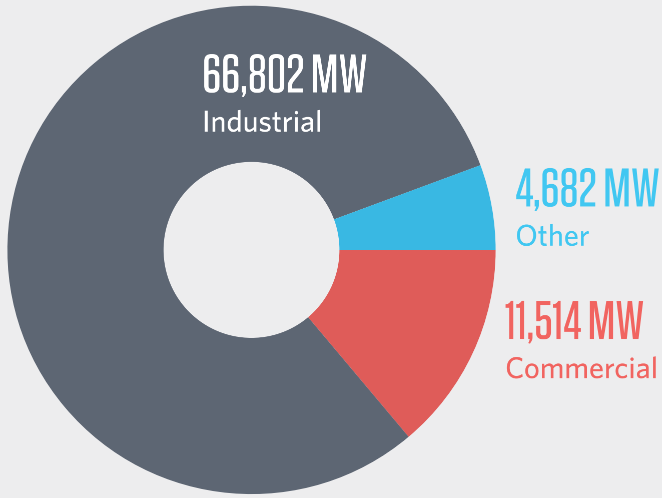
Natural gas is the fuel of choice for 70 percent of CHP installations because it is readily available in the United States, is compatible with many currently manufactured turbines, and has a lower emissions profile. Coal is the fuel source at 15 percent of CHP facilities.[46]

More than 80 percent of U.S. CHP capacity is used by energy-intensive operations in the industrial sector, with the balance deployed at commercial facilities and institutions. The chemical, refinery, paper, and food industries represent some of the largest users of CHP and WHP because of their significant electric and thermal energy requirements and the availability of waste heat from their processes. In the commercial services sector, universities, hospitals, and hotels are well-suited to cogeneration because of their need for consistent, reliable thermal energy and electric services for their residents, patients, and customers. For the CHP market, capacity is increasing fastest in the commercial and institutional sectors, but installations tend to be smaller.[47] For WHP, the chemicals and metals sectors have deployed the most megawatts.[48]

Figure 17

Over 80% of U.S. CHP Installations Are in Industrial Applications

Combined heat and power capacity by sector, in MW, fourth quarter 2014



Source: U.S. Department of Energy

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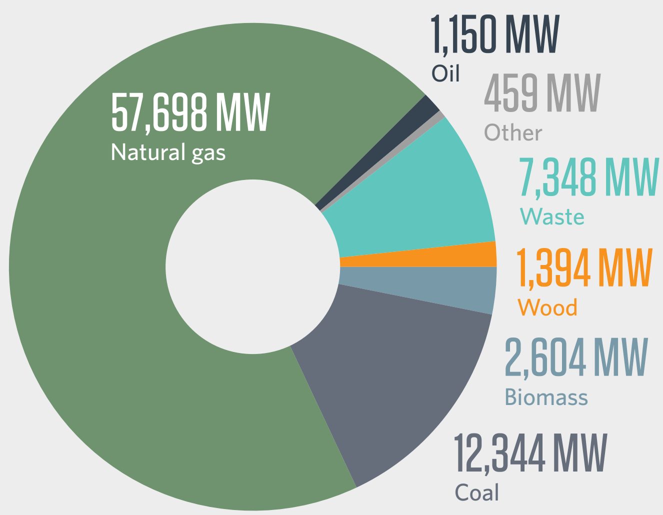
Figure 18

Natural Gas Powers 70% of U.S. CHP Systems

Combined heat and power capacity by fuel source, in MW, fourth quarter 2014



Source: U.S. Department of Energy

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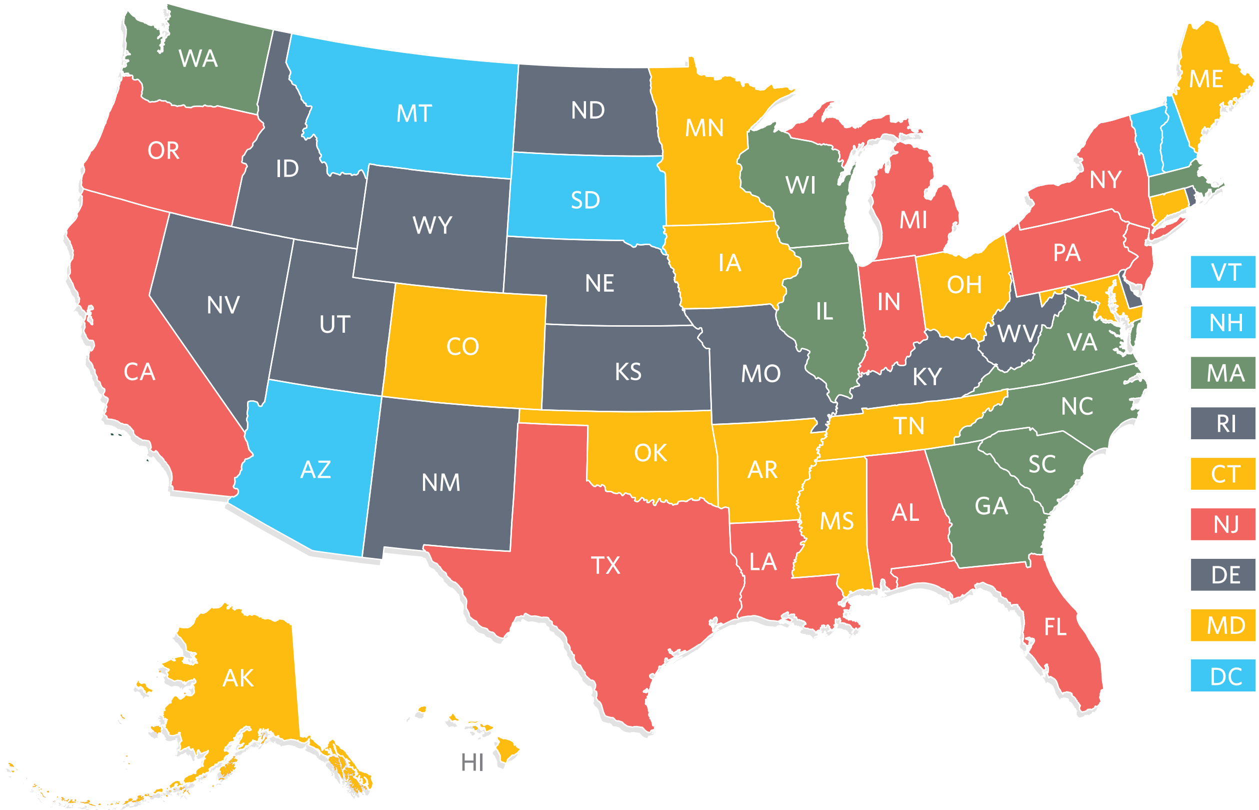
Figure 19

11 States Have More Than 2,000 MW of CHP and/or WHP Installed

Capacity by state, in MW, July 2015



Source: U.S. Department of Energy

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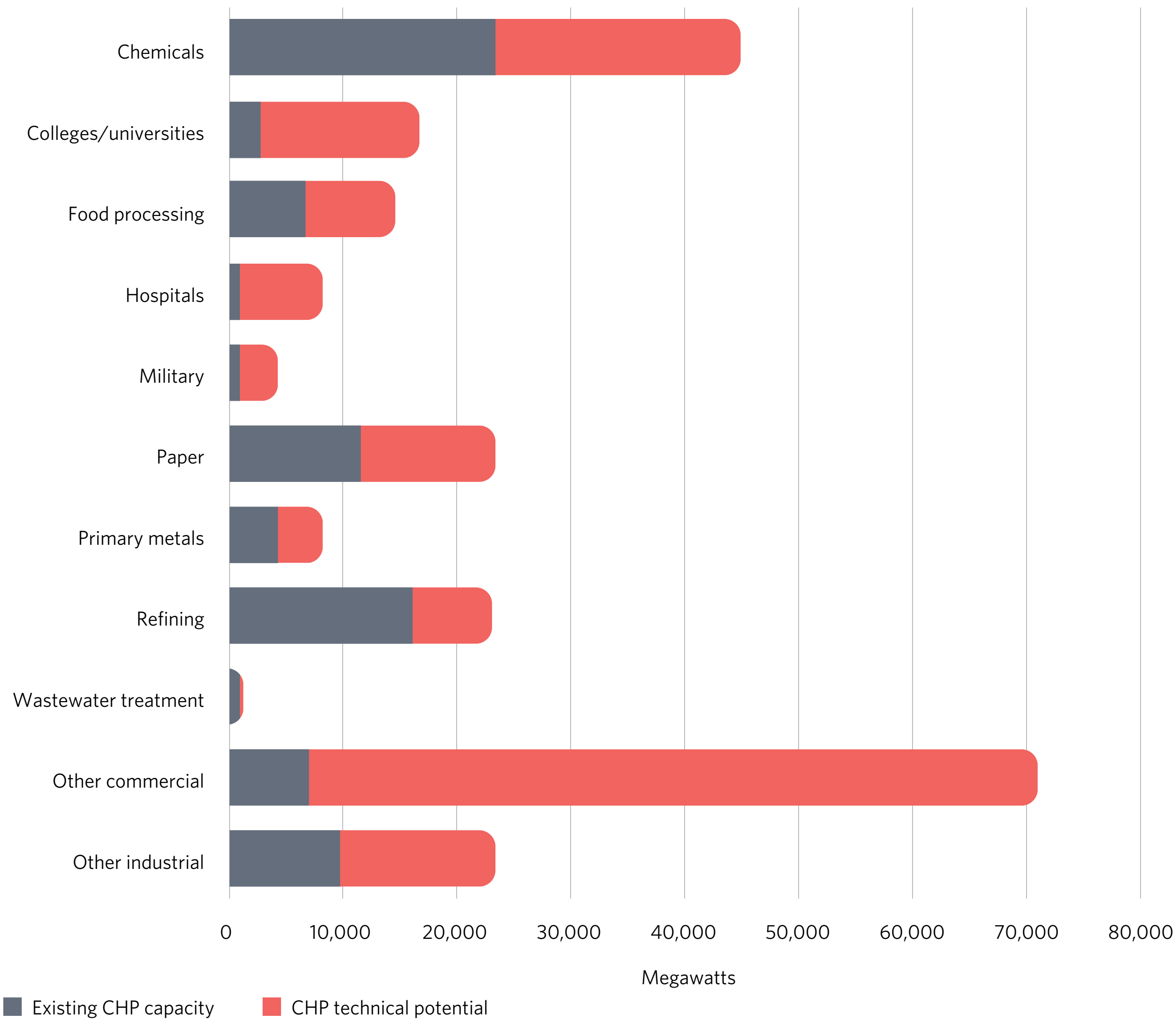
Several countries use cogeneration at a much greater rate than the United States. In China, Russia, and Denmark, for example, CHP accounts for 12 percent, 31 percent, and over 50 percent of national power generation, respectively. The U.S. is at 8 percent.

In fact, the U.S. has significant potential to expand capacity at existing and new facilities and to boost the percentage of energy that is derived from CHP. A recent study estimates U.S. technical potential at 126 GW of additional capacity across the economy: 60 GW in the industrial sector and 66 GW in the commercial sector. In the industrial sector, the most promising opportunities exist in the chemicals, paper, food, and refinery industries, while in the commercial sector, the potential is greatest at commercial buildings, hospitals, colleges and universities, and government facilities.[49] Another 15 GW of WHP potential exists, much of it in the oil and gas sector.[50]

Figure 20

The Chemical Industry Has the Most Cogeneration Capacity and Technical Potential

Installed capacity and technical potential for CHP, by sector, in MW, 2013



Source: ICF International and U.S. Department of Energy

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Federal policy matters as governments prepare for the power sector of the future

U.S. government leaders are facing environmental challenges and the need to attract private investment, spur job creation, and achieve greater energy security. At the same time, they must respond to the changing realities of who produces electricity, where and how it is managed, ongoing technological advances, and an evolving utility business model.

Nationally, CHP and WHP have not been employed to their maximum potential. Although authority to address electricity market barriers exists primarily at the state level, Congress and several federal agencies play important roles in the oversight of energy markets and in the development and utilization of CHP, WHP, and other distributed power technologies. A range of federal efforts can accelerate deployment of industrial energy efficiency technologies, from research and technical assistance to tax and regulatory policies.

The DOE and the EPA have programs and partnerships to expand adoption of CHP. DOE's Advanced Manufacturing Office works with major energy-intensive industries offering technical assistance through seven regional centers. EPA's Combined Heat and Power Partnership works closely with all stakeholders to implement new projects.

In addition, President Barack Obama announced in 2012 a goal of deploying an additional 40 GW of CHP across the United States by 2020. The DOE estimated that meeting this target would save $10 billion in consumer electricity costs and 1 quadrillion Btu and would reduce emissions by 150 million metric tons.[51]

Technical assistance

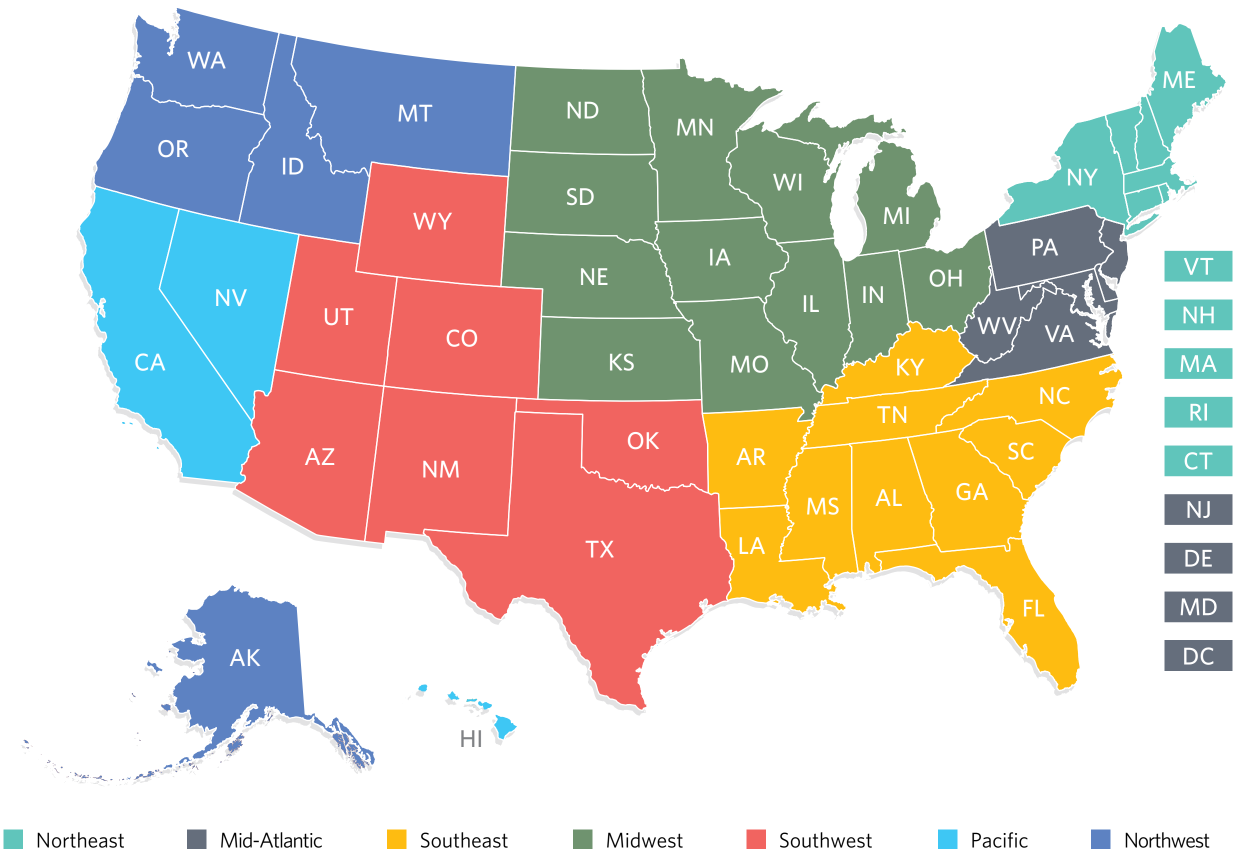
The federal government can help overcome the information gap between prospective CHP and WHP users and project developers or manufacturers through technical assistance and outreach efforts. The DOE and EPA have prioritized educating industrial and commercial businesses about the opportunities that CHP and WHP systems present, working with them to design, sometimes finance, and deploy these technologies. The DOE operates seven Combined Heat and Power Technical Assistance Partnerships (TAP) that work with stakeholders to understand financial, policy, and other options for harnessing cogeneration at the facility level. Located in California (Pacific TAP), Colorado (Southwest TAP), Illinois (Midwest TAP), New York (Northeast TAP), North Carolina (Southeast TAP), Pennsylvania (Mid-Atlantic TAP), and Washington (Northwest TAP), these regional centers conduct market opportunity analyses, provide education and outreach, and support end users in project development from system design to installation. Since 2009, the partnerships have provided technical assistance to more than 580 projects totaling more than a gigawatt of capacity.[52]

The EPA's Combined Heat and Power Partnership program promotes the technologies as emissions-reduction tools for energy producers, consumers, and regulators. The program has more than 450 participating end users, engineers, financiers, manufacturers, utilities, and public entities spanning almost every state. Since 2005, the program has assisted more than 900 successful projects with a combined capacity of more than 6.2 GW.[53]

Figure 21

7 Regional Department of Energy Programs Support Local CHP and WHP Project Development

The Combined Heat and Power Technical Assistance Partnerships



Source: U.S. Department of Energy

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Research

Through its Advanced Manufacturing Office, the DOE supports studies and demonstration projects to help overcome basic research challenges and commercialization barriers that can keep promising technologies from reaching the market. The current priority is on advanced reciprocating engines, packaged CHP systems that can avoid costly customization efforts, fuel-flexible systems, and applications in key industries.

DOE's Advanced Research Projects Agency-Energy (ARPA-E) is also helping to accelerate industrial energy deployment. ARPA-E, established in 2007, aims to improve U.S. competiveness by promoting technical achievements that can revamp the way power is generated, stored, and used. Through extensive engagement with experts, ARPA-E establishes a variety of challenges for the private sector and academia intended to rapidly advance experimentation-to-marketplace processes.[54] In early 2015, ARPA-E announced a funding opportunity for distributed generator technologies, which support CHP technologies to promote further deployment.[55]

Disaster response and mitigation

In the aftermath of major natural disasters, local governments look to federal leaders for aid to repair damaged energy infrastructure. Recently, these funding packages have targeted not only repairing but also updating old infrastructure with new, modern energy systems that encourage on-site generation where feasible. This ensures that critical facilities and utilities can operate as "islands" of power when the electric grid is offline.

Extreme weather events are becoming more frequent and more damaging to local economies and infrastructure. From fiscal years 2011 to 2013, U.S. taxpayers footed the bill for $136 billion in disaster relief from floods, storms, droughts, heat waves, and wildfires. This averages nearly $400 per household per year.[56] Communities are increasingly interested not only in rebuilding infrastructure but also in improving it with modern technologies that are more reliable. A priority of current federal emergency programs is "reducing reliance on federal funding" in future disasters.[57]

One key aspect of the societal capacity for improved hazard prevention and mitigation lies in decentralized energy production. Several federal funding sources are available to states for use in increasing the security and resiliency of the electric grid through the deployment of distributed energy generation projects. These include the following:

- **State Homeland Security Program Grants** support the implementation of strategies to address planning, organization, equipment, training, and exercise needs to prevent, protect against, mitigate, respond to, and recover from acts of terrorism and other catastrophic events. [58]
- **Hazard Mitigation Assistance Grants** support the implementation of long-term hazard-mitigation measures after a major disaster declaration. The purpose of the program is to ensure that the opportunity to materially reduce the risk of loss of life and property, such as residences, utilities, or infrastructure, during future disasters is not lost during the reconstruction process.[59] By taking action before the next disaster and using stronger and safer planning and building techniques, these measures minimize post-event disruptions and recovery time over the long term.[60]
- **Pre-Disaster Mitigation Grants** provide funds to states to engage in hazard-mitigation planning and implementation of related projects in advance of a disaster. The program also assists states in implementing sustained pre-disaster natural-hazard mitigation programs while reducing reliance on federal funding in future disasters.[61]

Combined Heat and Power Provides Energy Resiliency to Critical Facilities

Protecting the electric grid is an important part of the nation's defense against severe weather and security events. Industrial efficiency technologies, such as combined heat and power, are used by some hospitals, businesses, and communities to ensure reliable electricity. More than 8 million people along the Eastern Seaboard lost power during Hurricane Sandy, and many residents of affected communities were forced from their homes, unable to access public transportation, fuel their vehicles, or get to work.[*] However, some institutions across the region were able to continue their operations uninterrupted because of cogeneration systems that can work independently of the grid when necessary:

- **Bronx, New York:** Co-Op City in the Baychester section of the Bronx—one of the largest housing cooperatives in the world and the largest U.S. residential development (60,000 residents)—never lost power during the storm because it had invested in CHP.[†]
- **Salem, New Jersey:** Salem Community College, which has a CHP system, operated as a Red Cross disaster relief shelter, providing hundreds of residents with heat and emergency power during the storm and the cold weather that followed.[‡]
- **Manhattan, New York:** When Consolidated Edison, the region's utility, lost power Oct. 29, a cogeneration plant provided power to 290 apartments in lower Manhattan. Occupancy rose from the roughly 720 people usually housed in these buildings to nearly 1,500 as people came from other parts of the city.[§]

Access to reliable heat and power at all times is crucial for the functioning of a modern society. Uninterrupted thermal and electric power supplies are especially important for hospitals, nursing homes, water supply and wastewater treatment plants, military installations, and police and fire stations, which depend on continuous power to serve their communities. According to a report from the *American Journal of Alzheimer's Disease & Other Dementia*, during Hurricane Gustav in 2008 death rates for seniors rose 218 percent 30 days after evacuation and 158 percent after 90 days. These increases occurred in part because many lifesaving medical devices require electricity. Moving patients from one location to another can disrupt medical care and routines, leading to higher risk of hospitalization and mortality.[**]

When institutions and businesses make investments in CHP, they contribute to resiliency planning efforts and help insulate critical infrastructure from grid disruptions in the event of a disaster.

* Nasdaq GlobeNewswire, "Capstone Microturbines Power Through Hurricane Sandy," Nov. 2, 2012, http://globenewswire.com/news-release/2012/11/02/502056/10010903/en/Capstone-Microturbines-Power-Through-Hurricane-Sandy.html.

† William Pentland, "Lessons From Where the Lights Stayed on During Sandy," *Forbes*, Oct. 31, 2012, http://www.forbes.com/sites/williampentland/2012/10/31/where-the-lights-stayed-on-during-hurricane-sandy/.

‡ Nasdaq GlobeNewswire, "Capstone Microturbines Power Through Hurricane Sandy."

§ Energy Concepts, "Green Energy Plants Provide Heat and Electricity to Thousands During Super Storm Sandy," PRWeb, Nov. 14, 2012, http://www.prweb.com/releases/2012/11/prweb10125439.htm.

** Jason Oliva, "Nursing Home Resident Mortality Rates Skyrocket 218% Following Evacuation," *Senior Housing News,* Nov. 28, 2012, http://seniorhousingnews.com/2012/11/28/nursing-home-resident-mortality-rates-skyrocket-218-following-evacuation.

Financial incentives

Tax incentives and loan and grant programs can play a key role in overcoming the upfront capital barriers that often impede deployment of CHP and other distributed generation technologies.

Tax policies

The investment tax credit provided under Section 48 of the Internal Revenue Service code has proved to be a vital tool in helping the solar industry and other clean energy technologies scale up and reduce costs. However, since its adoption in 2006, the tax credit has treated CHP and WHP differently from many other technologies. For example, solar energy, fuel cells, and small wind turbines are eligible for a credit worth up to 30 percent of expenditures on clean energy-producing equipment, but the credit for CHP is more limited, applying to just 10 percent of expenditures for the first 15 MW of projects less than 50 MW in capacity. Further, the credit does not apply to WHP.

In June 2015, bipartisan, bicameral legislation was introduced in Congress to rectify these inequities. The Power, Efficiency, and Resilience (POWER) Act (S. 1516, H.R. 2657) would ensure that CHP and WHP are treated in a manner on par with other energy technologies covered by the investment tax credit.

Table 1

The POWER Act of 2015 Would Improve the Investment Tax Credit for CHP Projects and Apply It to WHP

Proposed legislative changes for industrial energy efficiency

Current policy	Proposed policy
10% ITC for combined heat and power	Expands ITC to 30%
Does not include waste heat to power	Includes waste heat to power
Applies to the first 15 MW of projects that are smaller than 50 MW	Applies to first 25 MW, eliminates project size cap
Ends Dec. 2016	Ends Dec. 2018

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The master limited partnership (MLP) is another financial tool that could encourage deployment of CHP projects. These business structures have the tax advantages of a partnership, but their ownership equity can be traded as easily as public stock. Energy projects qualifying as MLPs have access to low-cost capital and liquid investment opportunities, as well as a relatively high rate of return for investors. Although MLPs have existed since 1981 and are available to investors in fossil-fuel extraction and pipeline projects, clean and efficient energy technologies are barred from using them. Legislation to extend this instrument to renewable and efficient projects—such as S. 1656, introduced by Senator Christopher Coons (D-DE) in 2015—could help lower financing costs and allow businesses to access new markets, thereby increasing investment and deployment of clean and efficient technologies.

Loan and grant programs

The U.S. government helps companies overcome financial barriers to innovation by investing in early stage and applied research and providing access to instruments, such as direct loans and loan guarantees issued by the DOE's Loan Programs Office, to qualifying applicants for renewable resource and efficiency projects. CHP is eligible for specific federal solicitations under this funding opportunity.

The Loan Programs Office makes low-cost capital available to encourage full-scale growth of domestic energy technologies and to give private lenders certainty: If the borrower defaults, the DOE will repay the loan.[62] These loans and guarantees are helping U.S. companies transition new products and processes from research and testing to commercial development by reducing the risks associated with investing in innovation.[63]

Since the office's inception under President George W. Bush's administration in 2005, 20 projects have been brought online and are generating revenue nationwide. Borrowers have repaid $3.5 billion on these long-term loans, and the federal government has earned more than $810 million in interest.[64] These returns help offset losses inherent in lending to high-risk, prototype research. Overall, DOE expects more than $5 billion in total interest payments over the full term of the loans, all of which will be returned to taxpayers.[65]

Demand-driving policies

Establishment of a clear, consistent, and long-term goal for the deployment of clean and efficient energy has often been cited as one of the most important steps that policymakers can take to bolster adoption of these technologies.

Twenty-nine states and the District of Columbia have renewable energy standards (also called renewable portfolio standards) requiring utilities to ensure that a specific percentage of the electricity sold is generated from clean energy sources.[66] In addition, 19 states have enacted standards to encourage use of energy efficiency technologies.[67]

A national clean energy standard would help provide the long-term certainty that innovators, investors, and manufacturers need to spur invention, mobilize capital, and scale production. The resulting domestic supply chain would, in turn, continue to drive down prices for clean electric generating capacity. End users in all sectors of the economy would have an expanded menu of affordable electricity options, resulting in the deployment of more distributed energy resources.

Distributed generation grid integration policies

Although state public utility commissions are primarily responsible for managing interconnection to the local grid, the federal government also plays a role: Complicated regulatory barriers are a major impediment to the full realization of the country's CHP and WHP potential.

A bill filed in 2015—S. 1202, the Heat Efficiency Through Applied Technology (HEAT) Act—would address these obstacles by establishing a federal framework to help states develop solutions for efficiently and economically meeting growing energy demand through the use of cogeneration technologies. The policy would direct the DOE and the Federal Energy Regulatory Commission (FERC) to develop a standard set of interconnection procedures that reflect current best practices to encourage the use of CHP and WHP while also ensuring the safety and reliability of the distribution and transmission networks. In addition, the bill would require the DOE and FERC to establish model rules and procedures for determining supplemental, backup, and standby power fees for these systems that allow for adequate cost recovery for utilities.

Standby rates are a key issue related to the integration of CHP and other distributed technologies with traditional centralized power and transmission systems. Utilities charge these fees for connection to the grid and other services for customers with on-site distributed generation capabilities.[68] The rates and structures vary widely based on the costs inherent to specific situations and geographies and are intended to account for the expense of providing backup electricity to distributed generators during scheduled and unscheduled outages of their on-site systems.[69]

Although these rates allow utilities to recover costs incurred for providing backup and maintenance services, they often undervalue the benefits associated with the distributed generation project and are not applied consistently to all customers.[70] As a result, the charges can act as a barrier to regional market acceptance and inhibit deployment. To further encourage and enable deployment of CHP, WHP, and other distributed technologies, rate structures should avoid arbitrary application and reflect utilities' actual costs while encouraging adoption of cogeneration. By appropriately recognizing the full value that each customer and customer class offers to the grid, standby rates can be designed to give customers a strong incentive to use electric services efficiently and minimize the costs they impose on the grid without creating economic barriers to deployment.[71]

Emissions reduction policies

Properly formulated, output-based emissions control programs can also play an important role in overcoming regulatory barriers to the adoption of CHP.

In June 2014, the EPA released a much-anticipated draft regulation to reduce carbon dioxide emissions from existing power plants by 30 percent from 2005 levels by 2030. Finalized in August 2015, the Clean Power Plan has two major parts. First, it establishes state-by-state carbon-reduction targets. Second, it outlines three strategies that states can employ individually or in combination to meet those goals: making power plants more efficient, using lower-emitting power sources, and harnessing clean energy sources.[72]

In fact, these technologies can play a substantial role in meeting key Clean Power Plan objectives for reducing carbon emissions throughout the electricity system, not just at power plants. Expert analysis suggests that they might be the least expensive and most effective way for some Midwestern and Southeastern states to comply with the new regulations.[73]

Industrial energy efficiency market grows with increased goals and incentives

To evaluate the long-term market for CHP under different policy scenarios, Pew commissioned ICF International Inc. to conduct an analysis of several policy proposals to determine how adoption would affect future CHP and WHP market deployment.

ICF researchers first developed a "base case," or business-as-usual scenario, to determine anticipated CHP and WHP deployment trends in the absence of any new significant policy initiatives. They then compared those findings with anticipated outcomes from various regulatory and proposed tax changes. For all scenarios, ICF:

- Took prevailing and projected energy prices for commercial, small industrial, and large industrial facilities from Energy Information Administration data.
- Estimated project cost and performance parameters based on the joint DOE and EPA *Catalog of CHP Technologies*.[74]
- Reviewed the CHP Technical Potential Database (to match ref in endnote, which seems to be correct) to identify sites that are good candidates (i.e., concurrent electric and thermal demands).[75]
- Determined the likelihood that a system will be installed by a site—the market acceptance factor—based on projected payback and a national survey of potential customers.
- Calculated the estimated number of projects that will ultimately be installed over a given time frame as the sum of the technical potential data multiplied by the market acceptance factors for each industry to represent the expected market penetration by sector.

The full methodology for this analysis is provided in the Appendix.

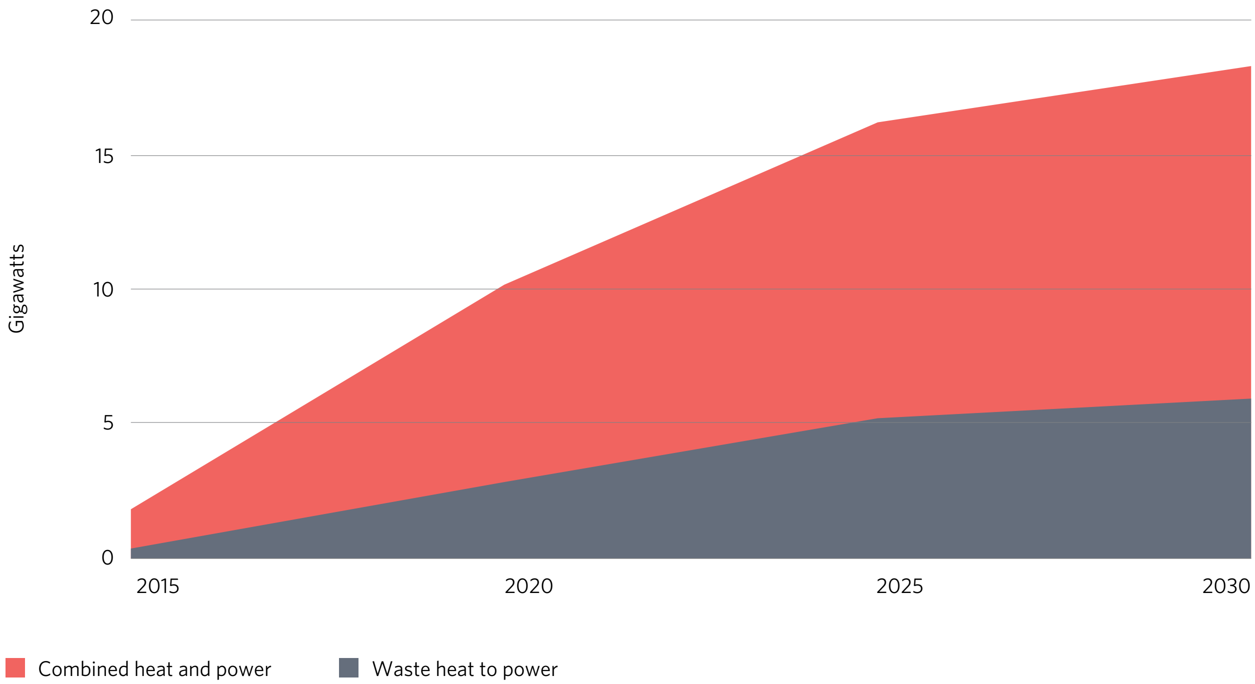
Base case

Under the business-as-usual scenario, total CHP and WHP capacity in the United States could grow by 18.3 GW through 2030, rising from 83.3 GW to 101.6 GW. California could account for almost one-third of the new capacity (5.4 GW), while Texas would add 2.1 GW. New Jersey and Massachusetts also could increase by more than 1 GW. This scenario projects that CHP could grow by 12.4 GW, with WHP making up the balance of 5.9 GW.

Figure 22

Status Quo Policy Could Result in 18.3 GW of New CHP and WHP Capacity by 2030

Anticipated industrial energy efficiency base case market penetration, 2015-30, in GW



Source: ICF International

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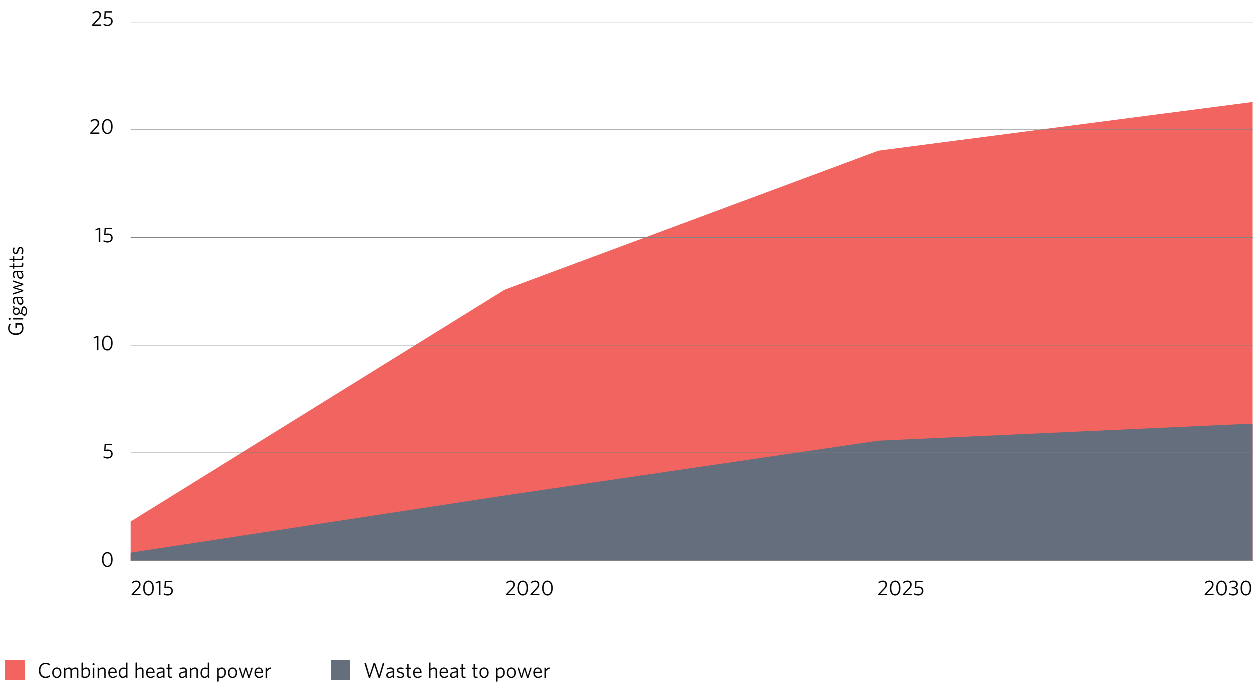
Enhanced investment tax credit

ICF modeled the impact of achieving investment tax credit parity for CHP and WHP through the POWER Act of 2015. Under this scenario, the updated credit could take effect for commissioned projects Jan. 1, 2017, and expire Dec. 31, 2018. The results show that with the help of a tax credit that is favorable to all included technologies, overall CHP and WHP deployment could increase by 3.2 GW over the base case for a projected total of 21.5 GW installed between 2015 and 2030. CHP could account for almost three-quarters of this new capacity (15.1 GW), and the WHP market would grow by 6.4 GW.

Figure 23

Improved Policy Could Result in 21.5 GW of New CHP and WHP Capacity by 2030

Anticipated market penetration with enhanced investment tax credit, 2015-30, in GW



Source: ICF International

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Clean Power Plan

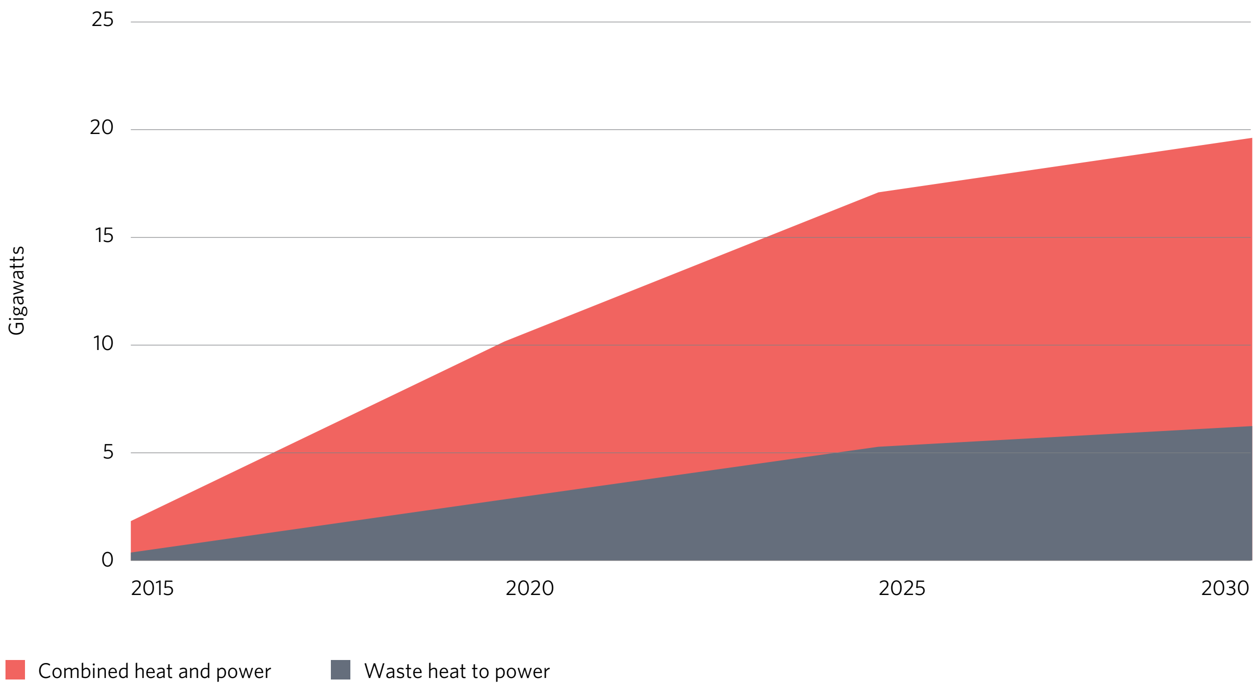
ICF also modeled a scenario using EPA's final rule assumptions for state-level carbon emissions standards and carbon prices, in which both technologies would be allowed to contribute without restriction to meeting the state emissions reduction goals for existing power plants laid out in the final Clean Power Plan. The scenario grants partial credit to CHP as an emissions control option, reflecting the underlying combustion of fossil fuels used initially to generate power before reuse. WHP, which simply captures waste heat, is allocated full credit.

Under this scenario, the ICF analysis projects that 19.6 GW of industrial energy efficiency could be deployed by 2030—13.4 GW of CHP and 6.2 GW of WHP.

Figure 24

Proposed Power Plant Rules Could Result in 19.6 GW of New CHP and WHP Capacity by 2030

Industrial energy efficiency market penetration under the Clean Power Plan, 2015-30, in GW



Source: ICF International

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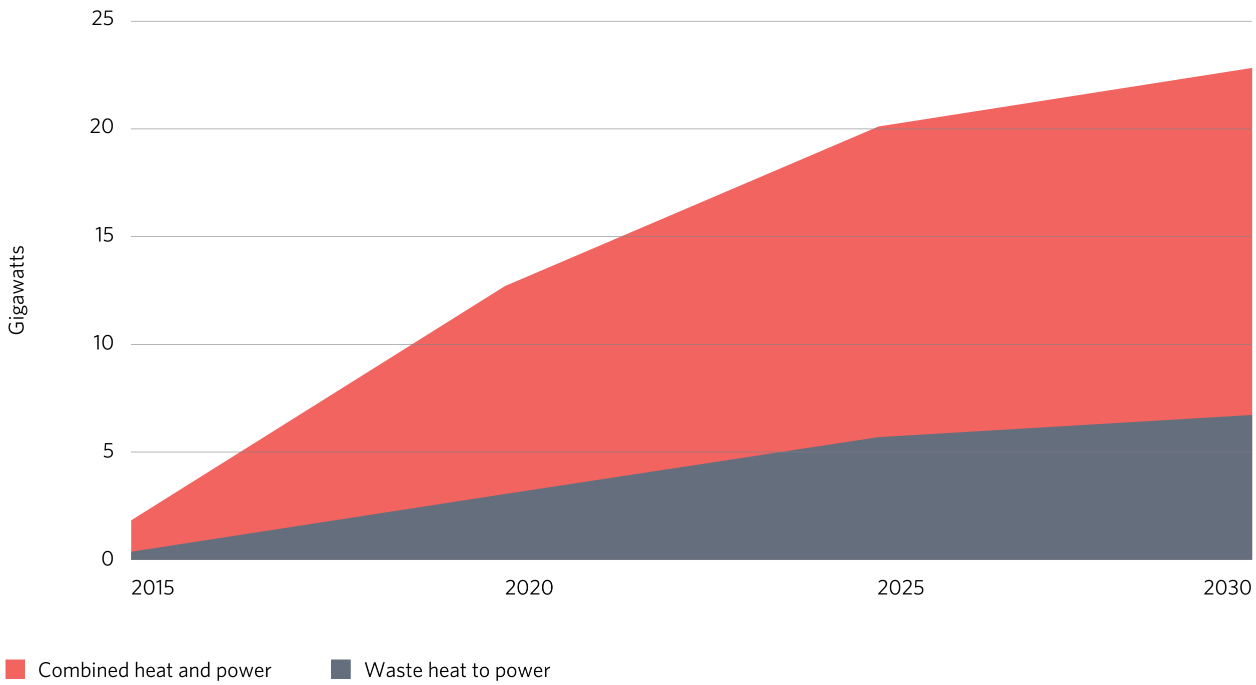
Combined policy scenario

If the POWER Act were enacted, the model shows that parity in the tax code for CHP and WHP and the implementation of the Clean Power Plan could increase overall deployment by 27 percent over the base case, with total capacity additions reaching 22.8 GW by 2030—16.1 GW of CHP and 6.7 GW of WHP.

Figure 25

The Clean Power Plan Plus an Enhanced Tax Policy Could Increase WHP, CHP Deployment by 22.8 GW by 2030

Industrial energy efficiency market penetration in improved policy landscape, 2015-30



Source: ICF International

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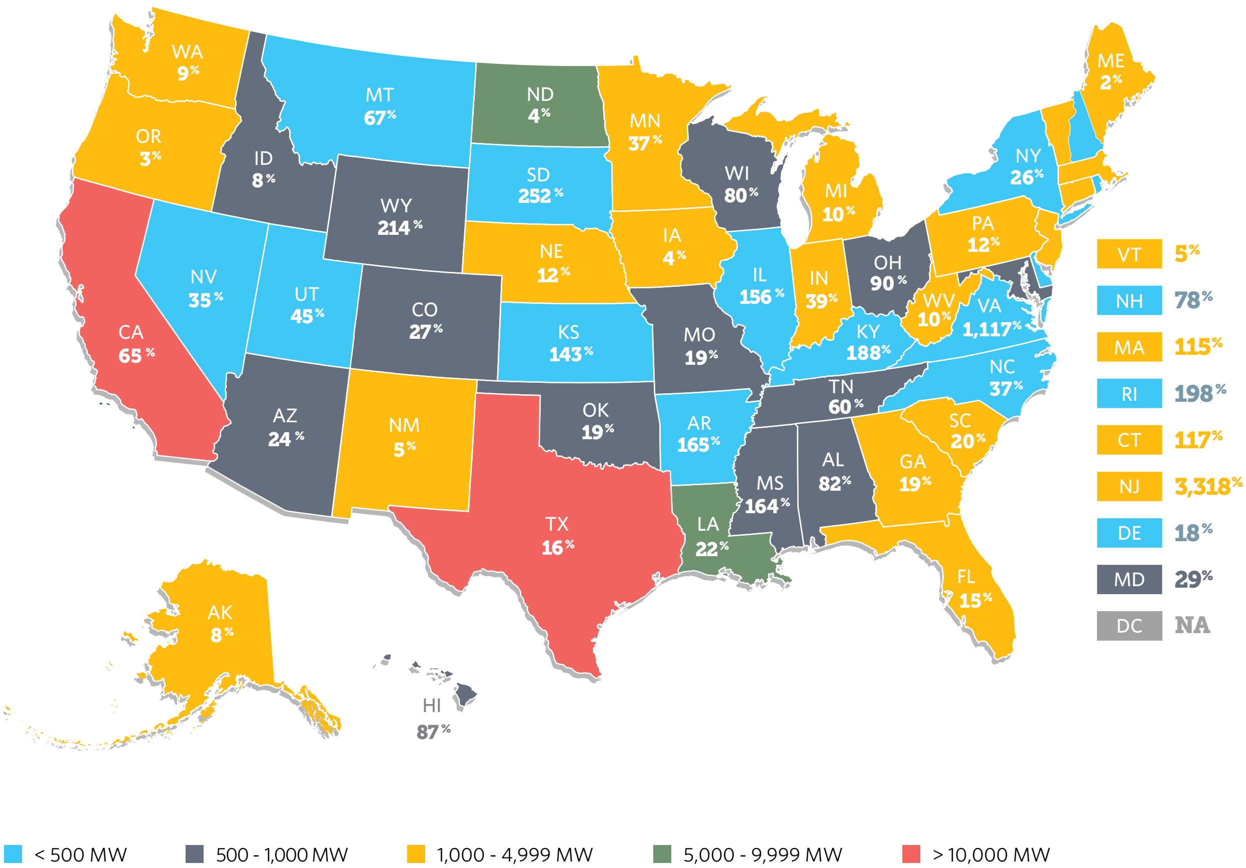
Figure 26

California and Texas Could See Largest Capacity Gains, New Jersey Greatest Percentage Change

Industrial energy efficiency market penetration and percentage growth in an improved policy landscape, 2030



Source: ICF International

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Conclusion

After a century of relative continuity, the structure and composition of the electric power system is in a period of significant and far-reaching change. New technologies, customer priorities, competition, and challenges are driving innovation in the electricity marketplace and empowering consumers to save money, reduce emissions, and achieve energy security by self-generating electricity and insulating their operations from grid power outages.

Profound impacts can be seen as a result of this continuing revolution. The components of the electric power plant fleet are evolving as the focus shifts from coal to cleaner energy options. For the foreseeable future, natural gas and renewable power plants will account for virtually all new capacity installed in the United States, and the fleet of coal plants will continue to contract. In addition, independent operators and rooftop solar generators will produce more electricity.

Increased competition, changing consumer preferences, and the overall push for efficiency bode well for the future of CHP and WHP. President Obama has set an ambitious goal for increased deployment of CHP by 2020, and the DOE and EPA are working with the industry to overcome barriers to its greater use in the industrial and commercial sectors.

Pew's research shows that, under current policies, CHP and WHP capacity in the United States is poised to increase by 22 percent through 2030. Although deployment will grow because of the Clean Power Plan, the U.S. could get closer to fulfilling the estimated potential of CHP and WHP if Congress implements effective tax reforms. Specifically, extension of the same investment tax credit that other clean energy sources receive to CHP and WHP for 2017 and 2018 could increase deployment by 26 percent over today's installed capacity. Similarly, implementation of EPA's Clean Power Plan could result in 23.5 percent increased deployment by 2030. Taken together, an enhanced ITC and the Clean Power Plan policies would increase CHP and WHP deployment by 27 percent above today's current installation levels.

America's energy future can be made cleaner, cheaper, and more secure by harnessing the full potential of CHP and WHP. Congress should work expeditiously to take advantage of these opportunities to reduce costs; support an energy infrastructure that provides more affordable, reliable, clean, and resilient power; and help domestic industries compete more effectively in the global marketplace.

Appendix: Industrial energy efficiency market assessment methodology

Base case

This analysis is based on a model, titled CHPower, that considers a broad range of technical and economic factors, as well as past market results related to the deployment of CHP and WHP. The basis of the modeling is a comprehensive ICF International database that includes information on industrial and commercial facilities throughout the United States drawn from public and private sources.

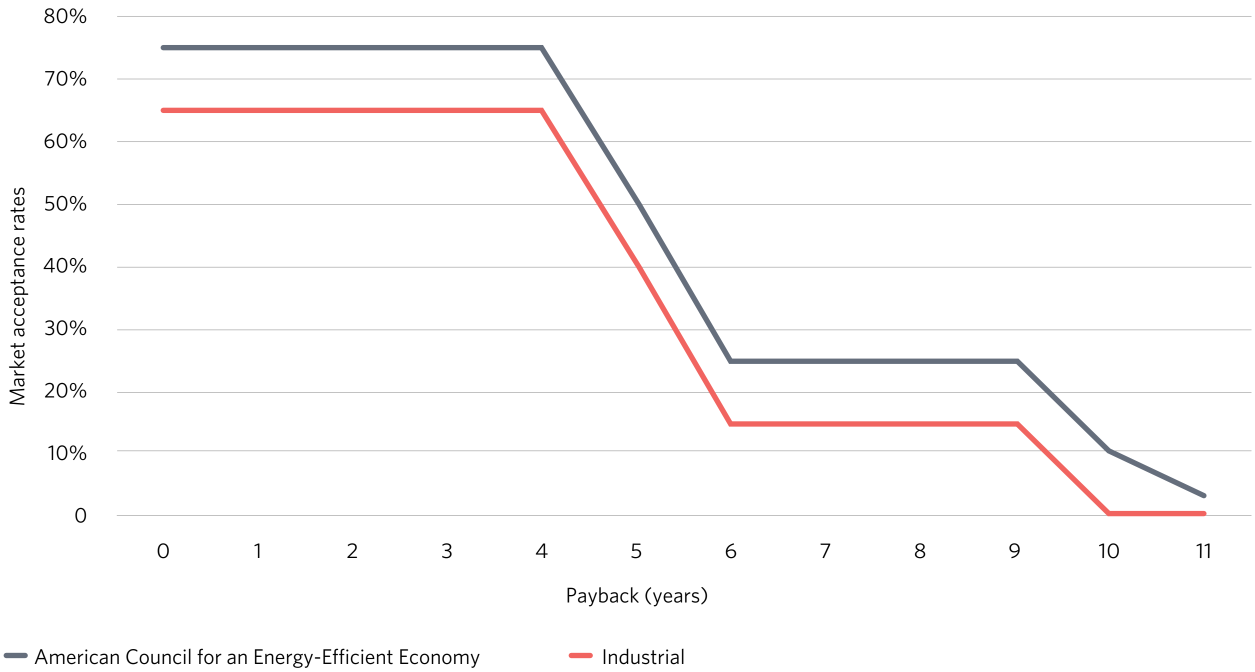
The base case considers overall technical potential for CHP and WHP opportunities at facilities with large heating and power needs. The CHPower model uses information on facility energy loads and prices to estimate potential and preliminary economics. It calculates the payback period for each candidate site based on a 12-month rolling average for electric and natural gas prices, equipment cost and performance, and any available incentives. Technical potential was modeled through 2030.

The model factors in market acceptance rates, which determine how much of the market will actually decide to invest in an industrial energy efficiency project and are a function of the payback calculated for each project. The market acceptance rates used in this analysis follow, in most respects, those used in a recent American Council for an Energy-Efficient Economy (ACEEE) study on opportunities for states to implement energy efficiency for economic growth. However, this analysis varied from ACEEE's in that separate rates for industrial and commercial systems were applied, specifically to reflect a more stringent payback requirement for industrial investors that is estimated to be 10 percent lower than the assumed commercial rates. Under this approach, the market acceptance factor with a payback of less than five years is 75 percent for commercial projects and 65 percent for industrial projects. At the six-year payback market, acceptance rates fall to 25 percent commercially and to 15 percent for industrial projects.

The only incentive assumed in the base case is the existing federal investment tax credit of 10 percent that is afforded to the first 15 MW of CHP projects under 50 MW. The model assumes this incentive will expire at the end of 2016, as currently scheduled.

Figure A1

Market Acceptance Rates Comparison



Source: American Council for an Energy-Efficient Economy

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Policy scenarios

Two scenarios were demonstrated to evaluate the market impact of specific public policies. All of the base case assumptions and analyses are built into these models.

The first policy scenario examines the impact of the POWER Act (S. 1516, H.R. 2657), a bill that would improve the current investment tax credit. A 30 percent tax credit for both CHP and WHP was applied to the first 25 MW of capacity modeled.

The second policy scenario models the impact of CHP and WHP inclusion in state compliance strategies under the Clean Power Plan. Carbon prices, the cost-benefit analysis for compliance, and the state-specific emissions rates as presented in the plan's requirements are used.[76] Approximate carbon prices in Hawaii and Alaska received special consideration: The carbon prices of Utah were used for Hawaii and of Pennsylvania for Alaska, because these states must meet similar emissions rate targets.

Since CHP generates carbon, these systems received a partial credit for their net reductions in emissions, calculated as the difference between the system's emissions in pounds per megawatt hour and the state's target emissions rate. The credit was then applied based on this difference. However, for WHP, full credit was awarded because no emissions are associated with this form of generation.

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