Utility-Ownership of Combined Heat and Power: From Lost Load to Supply Solution

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ABSTRACT

Combined heat and power (CHP) is the most energy-efficient method of generating power, yet very few utilities evaluate it for meeting future energy demand. Investments in CHP bring energy resources that are cleaner, cheaper, and more reliable to all customers in the utility system. Some utility companies have begun to build, own, and operate CHP plants located at customer facilities that have continuous thermal loads. These investments represent a shift away from the traditional notion of CHP as a customer-owned resource operating in competition with the utility business model. In this new approach, utilities are evaluating ownership of distributed CHP as a least-cost, supply-side asset, which has the potential to expand deployment of CHP projects that would not otherwise be built.

This paper presents results from an ongoing research effort to explore the viability of utility-ownership of CHP. It analyzes national data to identify which states have experience with utility-owned CHP projects and highlights four specific examples of utility-owned projects from across the country. The findings can help inform recommendations on the types of state policies and regulatory frameworks needed to accelerate the consideration of utility-owned CHP as a more efficient and less carbon-intensive resource for meeting utility system needs.

Introduction

Combined heat and power (CHP) is the most energy-efficient method of generating power available today. This increased efficiency offers local, state, and national benefits, including reduced energy operating costs, lower emissions, stronger critical energy infrastructure, and improved local resiliency, as well as increased manufacturing competitiveness and greater economic growth. Despite these benefits, much of the potential for CHP remains substantially undeployed. While about 83 GW of CHP capacity is in operation today, almost double that amount – an estimated 149 GW – remains in untapped onsite technical potential at more than 290,000 commercial and industrial facilities in the US (DOE 2016a).

One reason CHP has not reached its full potential is because it has traditionally been viewed as a customer-owned resource in competition with the electric utility business model. For years, CHP has represented a loss of load to electric companies, leading many of them to oppose CHP and discourage their customers from investing in the technology. But the electricity industry is changing, and utilities are beginning to broaden their view on how to meet future energy needs. States and utility commissions are increasingly interested in energy resources that bring cleaner, cheaper and more reliable power to all customers in the utility system. In this paradigm, CHP could be a prime resource utilities can invest in on the supply-side to help support a broad set of priorities that serve the public interest and society as a whole.

This paper is intended to help policy makers, utility commission staff, utilities, and the general public explore the benefits of utility-ownership of CHP in their states. The first part defines how the utility-ownership model works and documents some existing applications of utility-owned CHP, although experience so far is limited. It also describes several state policy considerations for the future of utility-ownership and identifies states where utility-ownership may be poised to gain traction. The second part gives detailed examples of utility-owned projects in four states: two operational systems in Florida and Texas, and two proposed systems in North Carolina and South Carolina. It concludes with a discussion of key observations from the project examples and sets the stage for deeper consideration of CHP as a more efficient, least-cost, and low carbon resource for utility system needs.

The Utility-Ownership Model

Utility-owned CHP is not technologically different from traditional CHP, but is rather a change in how the electricity and thermal energy from the system are sold. In general, "utility-ownership" refers to a CHP system physically located at a customer site that is built, owned, and operated by a utility. The customer typically continues to buy electricity from the utility as it previously did, and also agrees to take the thermal energy generated by the CHP system under a long-term steam power purchase agreement.

From a technical and financial perspective, the CHP system is located on the "utility side of the meter," and power generated goes directly to the utility distribution system and is sold to retail customers. Because the customer hosting the CHP system takes power from their existing grid connections, they are billed for their electricity as before. This means there is no lost revenue to the utility. In the utility-ownership model, the host facility is not a customer choosing to leave the utility to generate their own power. Rather, the power is exported to the grid and the host becomes a new customer for useful thermal energy.

When properly applied, utility-owned CHP can provide value to the utility, the customer host, and all users of the utility system. The utility benefits from having a highly-efficient, cost-effective, and flexible generation resource in its fleet, while also gaining the ability to provide more value to its customers.[1] The customer host benefits from access to competitively-priced, reliable thermal energy and gains new, modern energy-efficient technology onsite, without a large outlay of upfront capital. This brings greater resilience in both thermal and electric supply and helps make host customers more competitive in their respective businesses.

All users of the electric grid can benefit when utilities consider CHP as a resource for meeting needs of their customers. Instead of viewing CHP as a demand-side management resource, it can be viewed as a supply-side resource and its costs recovered through electricity rates like other assets. While CHP is not a resource that utilities have traditionally evaluated in resource planning activities, they should be encouraged to compare its costs with other resource options. Because of the substantially increased fuel efficiency and high capacity factor, well-sited and properly applied CHP systems can be more cost-effective than other baseload resource options available. When revenues from steam sales are applied back to cost of fuel for generating electricity, CHP can offer a lower levelized cost of electricity for all customers. Figure 1 provides an illustrative example of how the levelized cost of electricity of CHP can be compared with a combined cycle gas turbine. New combined cycle power plants are a least cost resource option for baseload power in much of the U.S, and CHP can have a lower levelized cost.

[1] For a detailed discussion of the value of CHP to electric utilities, see Chittum 2013.

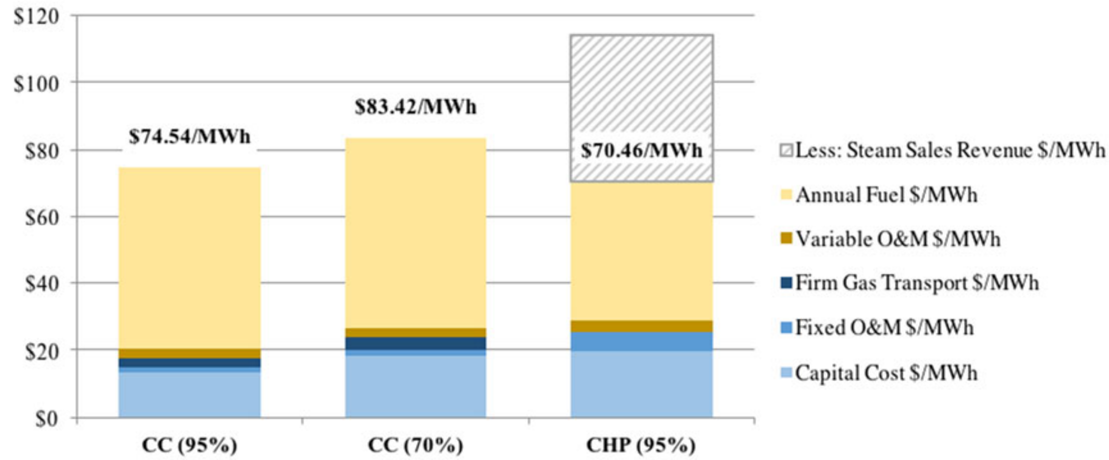

Figure 1. Example illustrating a lower levelized cost of electricity for CHP compared to combined cycle (CC) power plants. Standard assumptions for discount rate, heat rate, depreciation, cost of capital, fuel, and operations and maintenance (O&M). Capacity factors for CC are 95% and 70% and CHP is 95%. *Source:* Adapted from Sterling Energy Group, LLC.

The utility-ownership model contributes to lower costs for all customers by avoiding the need to make larger investments in more expensive options. For example, traditional utility investments tend to be hundreds of megawatts at one time even though future demand is difficult to forecast. Smaller, more incremental investments in CHP is one way to help protect customers from the risk of bearing the costs of stranded assets. And, because CHP is a distributed resource, greater deployment may deliver further cost savings to customers by avoiding transmission and distribution losses and helping defer the need to make costly system infrastructure upgrades to improve the reliability of the electric grid (NYSERDA 2011).

A look back at utility-owned CHP in the US

Because CHP has historically represented lost load to utilities, very few have invested in owning it. Still, some have successfully pursued ownership stakes in CHP projects and received regulatory approval to recover costs. To find out how many utilities already own or have a stake in CHP projects and locate the states with experience evaluating these projects, we looked at national level data from DOE's CHP Installation Database, maintained by ICF International (DOE 2015b).

The DOE CHP Installation Database tracks known CHP installations of all sizes and technology types across the country and is updated annually. There are currently about 83 gigawatts (GW) of existing CHP generation capacity at over 4,300 facilities in the US (DOE 2015b). According to internal analysis from ICF, 149 of those CHP facilities can be classified as utility-owned. These systems are found in 20 states and make up 3.6 GW or approximately 4% of total installed US CHP capacity. Figure 2 shows existing utility-owned CHP capacity by state.

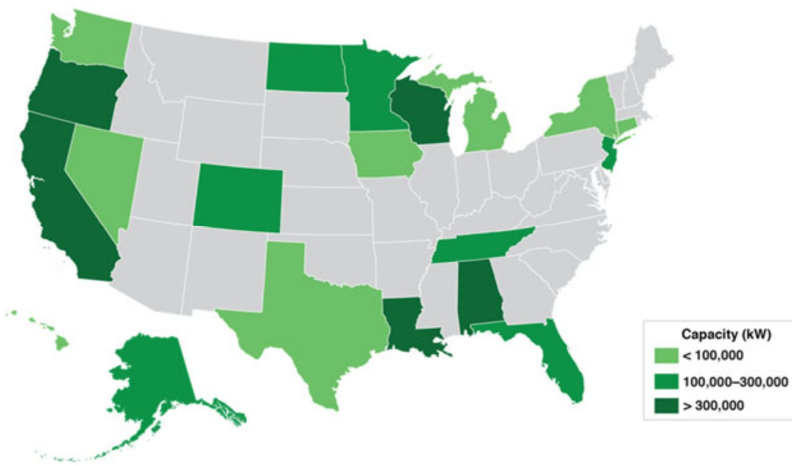

Figure 2. Existing utility-owned CHP capacity in the United States. *Source:* Internal ICF analysis of DOE CHP Installation Database (DOE 2015b).

Several factors influence how to interpret this data. First, utility's role varies in arrangements identified as utility-owned. Some utilities retain full-ownership of the CHP equipment and the energy it produces, while others have only partial ownership or a small stake in the CHP project. In the majority of existing, utility-owned installations, a set of unique circumstances led to the partnership; projects were not identified as part of a broad and integrated approach to investing in CHP for system needs. The type of utility company involved is also an important consideration, since many existing projects were developed by municipal utilities, electric cooperatives, or unregulated subsidiaries of utility companies, which operate in a different regulatory environment than investor-owned utilities.

The number of existing, utility-owned sites is overstated by the fact that approximately two-thirds are located in Alaska.[2] Many cities and communities in Alaska are not served by central station power plants or natural gas pipelines and instead meet their local power needs with diesel-fueled electric generators, some of which are configured as CHP systems to recover heat for nearby buildings. These cities and communities are all classified as electric utilities, which significantly contributes to the number of systems considered utility-owned in the US.

To date, utilities have limited experience investing in owning CHP, but some have made investments if the opportunity presented itself. Even this limited experience demonstrates how utilities can partner with their customers on CHP projects that deliver benefits to all users of the electricity system. When utilities take a more active and integrated approach to evaluating investments in CHP, they may find it is an attractive option that better positions them to meet today's energy needs.

Policy considerations for the future of utility-ownership

Most state CHP policies in place today are designed to encourage customer-ownership of CHP. One of the more common policy approaches has been to define energy savings from CHP

[2] Alaska has the greatest number of sites, but Louisiana has the highest installed capacity with over 880 MW. See Figure 1 for more on installed capacity by state.

systems as eligible to contribute toward state energy efficiency targets. Sixteen states have these policies in place, which gives utilities the motivation they need to design demand-side management programs that offer incentives for the installation of CHP.[3] However, most states do not treat CHP as an energy efficiency resource and most utilities do not currently offer programs. Based on a preliminary assessment of the 52 largest electric distribution utilities (by retail sales volume), approximately 12 offer CHP-specific programs and all are located in states where CHP savings count toward a state energy efficiency goal.[4]

The utility-ownership model is an entirely different approach to involving utilities in CHP. Instead of being motivated by a means to achieve an energy savings goal, utilities can be financially invested in CHP the same as any other generation asset, without any policy instruments like tax credits, financial incentives, or technical assistance. In this case, the right resource planning processes and regulatory authorization are all that is needed. For example, many utilities are required by state legislation or regulation to undertake integrated resource planning (IRP) efforts and those plans are then reviewed by state public utility commissions (Wilson and Biewald 2013). In recent years, some states have updated their IRP rules to ensure utilities give consideration to specific resources, such as renewable energy and energy efficiency, that were overlooked in the past but are clearly in the best interest of all customers. However, very few utilities have included CHP in their planning activities and little regulatory guidance exists on how to treat CHP as a supply-side resource.

Owning CHP is not a solution for every utility, but it is likely to be a good option in many parts of the country. Utilities operating in densely populated states with strong manufacturing sectors are likely to already be serving customers with the continuous thermal loads needed develop CHP systems.[5] Also, utilities in parts of the country with vertically-integrated markets present a near term opportunity, since the regulatory procedures for investing in CHP can be as straightforward as investing in any other resource. Ownership of CHP by deregulated utilities operating in wholesale markets is much less certain and still needs to be carefully worked out with policy makers. In these cases, utility companies may not be allowed to own generation assets like CHP. However, with greater integration of distributed energy resources, some deregulated states have explored allowing utility-ownership of generation when the assets act as distribution resources to improve the reliability of the grid.[6]

To be certain about the potential role of utility-owned CHP in any state, the full range of costs and benefits should be compared against different demand- and supply-side resources in utility planning processes. Utilities and other market players should be able to quantify the benefits and identify the lowest cost opportunities for delivering energy services, and encouraging the consideration of CHP in planning processes could bring significant benefits to the grid and its customers.

[3] For more information on current trends in utility-run CHP programs, see Hampson and Shipley 2017.
[4] Preliminary data from forthcoming ACEEE publication.
[5] States with the most technical potential include California, Texas, Ohio, Pennsylvania, New York, and Illinois. For more information on technical potential by state, see DOE 2016a.
[6] Regulatory staff in Washington, DC recently evaluated their existing legal and regulatory frameworks regarding utility ownership of DER generation and found ownership of DER could be allowed as long as the electricity generated is not sold, but instead used by the utility to support reliable operation of the distribution system (DC PSC 2017).

Examples of utility-owned CHP projects

This section describes the approach to CHP ownership taken by utilities in four states. Two of the systems are currently in operation. The other two systems are recently proposed projects seeking regulatory approval. Each example reviews details of the installation, primary drivers for partners involved, and any associated policy considerations. These particular projects were chosen because they provide insight into different ways states can think about utility-ownership of CHP and evaluate how it benefits customers.

Example 1: Florida Public Utilities, Eight Flags, LLC

Utility: Florida Public Utilities
Location: Fernandina Beach, FL
Host: Rayonier Advanced Materials
Year: 2016

Summary: Florida Public Utilities (FPU) is an investor-owned subsidiary of Chesapeake Public Utilities which owns and operates the Eight Flags CHP project, a 21 MW natural gas system. Electricity from the CHP unit is exported for distribution to FPU's retail customers and the industrial customer host purchases steam and heated water for its manufacturing process.

Project Highlights:

- Reliability was a primary driver and the CHP system is designed to survive a category 4 storm surge. It has the ability to support critical services to the residents of Amelia Island, who are especially vulnerable to severe weather and outages.
- During normal conditions, the CHP system meets approximately 50 percent of electricity demand of the 16,000 customers located on Amelia Island (Chesapeake Utilities 2016a).
- One hundred jobs were created during construction of the facility and 50 more full-time jobs are anticipated from a forthcoming $135 million expansion at the manufacturing site (Bull 2016).
- The Florida PSC cost recovery of the negotiated PPA with Eight Flags Energy for a 20-year term. In its analysis, PSC staff considered the need for power, cost-effectiveness of the contract, security provisions for early capacity payments, and performance guarantees (FPSC 2014).
- The project has been operating since July 2016 with efficiency of over 77% HHV.[7] In 2017, *Power Engineering* magazine named it "Best CHP Project of the Year" (Chesapeake Utilities 2016b).

Example 2: Austin Energy, Dell Children's Medical Center

Utility: Austin Energy
Host: Dell Children's Medical Center
Location: Austin, TX
Year: 2007

[7] Measures of efficiency are made in either lower heating value (LHV) or higher heating value (HHV).

Summary: Austin Energy is a municipal electric utility that owns and operates a 4.3 MW natural gas CHP at its customer's location, the Dell Children's Medical Center of Central Texas. The CHP system is capable of supplying one hundred percent of the hospital's electricity, heating, and cooling needs if the grid is down. During normal operation, excess electricity is exported to the grid.

Project Highlights:

- The hospital sought Austin Energy's partnership in meeting aggressive sustainability goals and becoming the first hospital in the world to obtain LEED-Platinum certification. The CHP unit reduces carbon dioxide (CO_2) emissions by 40 percent, sulfur dioxide (SO_2) by 99 percent, and nitrogen oxide (NOx) by 82 percent compared with Austin's overall fleet average (DOE 2015a).
- Reliability was a strong driver for the project. The system can run uninterrupted during a grid outage, ensuring life safety and allowing it to be a place of refuge during natural disasters or other emergencies (DOE 2015a).
- Austin Energy owns all the energy produced by the system and sells electricity, chilled water, and steam to the hospital at fixed rates over a 30–year term (DOE 2011).
- The utility's leadership was supportive of the project and effective in communicating its value to the City Council, which is the governing body that approves Austin Energy's investments (J. Collins, director of onsite resources, Austin Energy, pers. comm. March 8, 2017).

Example 3: Duke Energy, Duke University

Utility: Duke Energy Carolinas
Host: Duke University
Location: Durham, NC
Year: Proposed 2016

Summary: Duke Energy is seeking to build, own, and operate a 21 MW natural gas combustion turbine CHP system on the campus of Duke University. The plant would generate electricity for export to the grid and an estimated 85,000 pounds per hour of steam and hot water for Duke University and Duke Medical Center. It is estimated to cost $55 million and would occupy 1 acre of land.

Project Highlights:

- Duke Energy is a motivating force behind this project, having documented that CHP is a low-cost supply resource for meeting system-wide generation needs in a cost-effective way.
- Duke University is motivated by energy security, because the CHP system would be capable of operating in "island mode" and serve the campus in the event of a widespread outage. The CHP system would also offer the University lower cost steam than it could produce using its dedicated natural gas boilers.

- The North Carolina Utility Commission must grant a certificate of public convenience and necessity (CPCN) before Duke Energy can construct the facility. Duke Energy filed its application in October 2016. If approved, the utility will request project capital and operation and maintenance (O&M) cost recovery through the traditional base rate-making process in its next general rate case, as it does for all supply assets.
- Using the base plan scenario in Duke Energy's 2016 Integrated Resource Plan, the Duke University CHP proposal would be a cost competitive generation resource addition compared to traditional generation (DEC 2016a). The project is expected to realize significant savings over the 35-year agreement.[8]

Example 4: Duke Energy, Clemson University

Utility: Duke Energy Carolinas
Host: Clemson University
Location: Clemson, SC
Year: 2017

Summary: Duke Energy proposes to construct a 16 MW natural gas CHP facility to provide electric service to its retail customers and thermal energy supply to Clemson University (DEC 2017). In the event of a major grid outage, the CHP facility would be capable of islanding to supply power generation to the University. The proposed facility would commence operation in April 2019.

Project Highlights:

- The Clemson proposal is part of Duke Energy's plan to meet energy needs in its service territory with cost-effective distributed CHP.
- Clemson is motivated by both reliability and sustainability. The project comes at a time when the campus is upgrading and replacing sections of the campus' aging electrical infrastructure as part of a strategy to improve system reliability (Clemson 2016). Evaluating CHP is also an option included in the university's Sustainability Action Plan (Clemson 2011).
- A certificate of public convenience and necessity (CPCN) is not typically required for facilities smaller than 75 megawatts in South Carolina (Downey 2017). Still, Duke Energy has asked the commission to approve a 35-year contract to sell steam to Clemson and credit the revenue back to fuel for all customers.

Key observations from project examples

The following discussion compares the project examples described above. It offers some key observations in response to several questions about the viability of utility-owned CHP projects. First, what drivers motivate utilities and customers to partner on these types of projects? Second, what kinds of economic arrangements helped the project succeed? Third, what is the involvement of state regulators and what are their main considerations when evaluating utility-owned projects?

[8] For a systematic analysis of the proposed project at Duke University, see Spurr 2017.

Primary drivers for partnership

In all four examples, the need for reliable thermal energy was the key motivation for partnering. Industrial and institutional facilities commonly have high reliability requirements and a strong need to lower their exposure to risks in the event of unplanned outages. A 2015 study of how outages affect different facility types showed a 16-hour outage can cost a large commercial and industrial customer as much as $165,000, compared to just $32 for an average residential customer (Sullivan, Schellenberg, and Blundell 2015; Chittum 2017). At hospitals, where patient care is the highest priority, long power outages could mean the difference between life and death and the ability to serve community needs during disasters (DOE 2013). Many universities are home to both medical facilities and other vulnerable infrastructure such as research centers and laboratories that may rely on carefully maintained conditions. This is the case for the Duke University and Health System, where the proposed CHP system would protect the region's most advanced medical center, its largest research center, and more than 5,000 resident students (Brodhead 2016).

The utilities involved had similar, but not identical reasons for undertaking the projects. In FPU's case, co-locating a generating asset at a local industrial mill enabled the utility to better meet power needs on Amelia Island and help stabilize rising electric rates, while also enhancing Rayonier's competitiveness as a major customer. In Austin Energy's case, the hospital brought the CHP project to the utility and sought their partnership. The CHP system was a good way for Austin Energy to serve the critical energy infrastructure needs of one of its large customers and support the local community, while also testing out performance and gaining experience with distributed resources at customer sites (J. Collins, director of onsite resources, Austin Energy, pers. comm. March 8, 2017).

Duke Energy's motivation in pursuing CHP at its customer sites is perhaps the most noteworthy of the project examples because it demonstrates how CHP is a least cost supply-side resource. Duke Energy began evaluating interest in CHP from customers with continuous steam needs in 2015 (DEC 2016b) and found interest to be substantial. The utility identified the university as one of numerous potential customer steam hosts. Projections for CHP as a capacity and energy resource are included in Duke Energy Carolinas Integrated Resource Plan (IRP) and the company intends to replicate the ownership model throughout its service territory by installing smaller, highly efficient, distributed gas generation as part of their grid resources. The IRP also notes that investments in CHP can result in CO_2 emissions reductions, deferral of T&D investments, and economic development opportunities for the state.

Economic arrangements

In all four examples, the host customer was not able to justify making the investment on its own and the utility's involvement was an essential component for moving the project forward. The arrangements are structured so the utility fully owns the CHP equipment and the energy it produces. In these agreements, the utility leases a parcel of land from the customer where the system is located and enters into a long-term thermal energy purchase agreement with the customer, ranging from 20 to 35 years. Partial-ownership and split-ownership arrangements have worked at other sites, but these are not typically part of a proactive, utility-driven strategy.

System size is a key component that affects the economics of a given project. Systems should be sized so the thermal output is used continuously. Cost-effectiveness and energy efficiency both increase as the capacity factor increases, so systems that run the majority of hours per year are optimal. Typically, projects above 6 to 8 MW with very high load factors have stronger economics than smaller systems, unless there are other factors such as the need to replace existing energy infrastructure at the host site (K. Duvall, Sterling Energy, pers. comm. March 13, 2017). This underscores the importance of a large continuous demand for thermal energy as more than a technical requirement, but as a necessity for achieving economic efficiency.

Three of the project examples were generally in the size range with the strongest economics, with the exception of the 4.3 MW system at Dell Children's Medical Center. Austin Energy has not pursued more investments in owning CHP projects, primarily because of limited customer sites in their central Texas service territory (J. Collins, director of onsite resources, Austin Energy, pers. comm. March 8, 2017). Consistent heat loads are essential to the economic efficiencies that FPU and Duke are experiencing with their projects.

Role of state regulators

The role of state regulators varies depending on the laws of the state and the type of utility company involved. Both the Eight Flags system in Florida and Clemson University system in South Carolina were below the size threshold requiring commission approval for construction. In those cases, the commission only reviews the utility's contract to provide steam service to the host customer. For the project at Duke University in North Carolina, the utility must obtain a certificate of public convenience and necessity to build the proposed CHP facility, as with all new generation assets, which the Commission issues after a detailed analysis of the project and the long-range need for electricity in North Carolina. The Commission must also hold one or more public hearings related to the project.

The type of utility involved adds another dimension to the role of state regulators, as illustrated by the Dell Children's Medical Center project. Austin Energy is a municipally-owned utility governed by a city council, and few regulatory barriers were encountered when seeking approval for the project. In general, projects should not experience significant regulatory hurdles, but most utility commissions are unfamiliar with the utility-ownership approach and education may be needed for projects to move forward. When CHP is demonstrated to be in the interest of ratepayers and supports public policy goals, state regulators can feel comfortable supporting them.

Conclusion

CHP is a proven, substantial opportunity for states that want to increase energy efficiency, lower emissions, strengthen critical infrastructure, and promote greater economic growth and competitiveness. While some states have developed policies to overcome traditional barriers to CHP and provided incentives to boost investment, most states still struggle to deploy it. By encouraging utilities to view CHP as an investment opportunity instead of lost load, states may be able to tap into the large amount of CHP potential available in the US.

In this approach, utilities evaluate building, owning, and operating distributed CHP systems at their customer sites as a least-cost resource for meeting supply-side needs. Some states are actively exploring these arrangements and some utilities have begun to evaluate CHP in their integrated resource planning and other processes. However, utility system planners and state policy makers do not have much experience evaluating CHP or valuing the benefits it provides. Guidance is needed to help planners effectively compare CHP with the traditional resources evaluated in resource planning processes.

Looking forward, state utility commissions could initiate efforts to explore how they can facilitate ownership of CHP when it benefits ratepayers and is in the public interest. This could include opening up existing resource planning guidance or rules to ensure they are inclusive of CHP. Additional assistance may also be needed to help utility system planners develop best practice techniques and assumptions for valuing CHP as a resource. As the most efficient method of generating power, all utilities should evaluate the full range of benefits from distributed CHP as a supply solution to achieve more positive outcomes for all customers in the utility system.

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