How Electric Utilities Can Find Value in CHP

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Executive Summary

Combined heat and power (CHP) is the most efficient way of generating power available today. CHP conveys benefits to its host facilities, but it also conveys significant benefit to the electric utility system in which it is sited. Electric utilities are best positioned to monetize and take advantage of these benefits because the benefits reduce their costs, risks, and losses more so than for any other entity. Utilities are comfortable with long-term investments, they often have access to capital at a cost lower than individual facilities, and they have significant existing relationships with their customers who could be excellent hosts for CHP.

Electric utilities can use CHP to reduce their exposure to the vagaries of consumer electric demand by investing in smaller CHP systems in a piecemeal fashion instead of making big bets on large-scale generators that may not ultimately be justified. The utilities can encourage the deployment of CHP at strategic locations, helping to mitigate peak time grid constraints that put excess strain on valuable equipment and cause major line losses. CHP can help utilities offer higher quality power to their customers and improve system reliability in the face of increasingly severe weather events. It can also help utilities cost-effectively meet environmental regulations and reduce the risk associated with upgrading existing power plants with expensive pollution control equipment.

Due to its many benefits, some utilities and states have begun to more directly target CHP opportunities and consider it in long-term generation plans. Whether owning CHP themselves, partnering with individual facilities, or acquiring it as part of their energy efficiency portfolio, utilities are finding value in CHP. Still, CHP is not currently viewed as economically beneficial by most electric utilities due to policies and regulations that prevent a utility from enjoying the many benefits it provides. Significant changes in how utilities can value and consider CHP as a system asset will be required in many states in order to better encourage deployment of this highly efficient energy resource.

The benefits of CHP are tremendous and cannot be ignored. Individual facilities, such as manufacturing companies, hotels, hospitals, and college campuses, are all excellent hosts for CHP systems. But despite CHP's cost-effectiveness, these facilities find the high capital costs of CHP equipment to be prohibitive. They are typically wary of entering into a business area — energy production — that is outside of their core competency. They also do not typically get to directly enjoy all of the benefits of CHP, so the benefits do not always appear to outweigh the costs or the risk.

Electric utilities should take advantage of the untapped potential for CHP for they are best positioned to enjoy and monetize the benefits CHP provides. Policymakers and regulators will need to become comfortable with utilities making these kinds of investments in order to reach President Obama's goal of 40 GW of new CHP by 2020.

This paper is one of three in a series on CHP and utilities. The other two papers, also available for free download from ACEEE, are:

- *How Natural Gas Utilities Can Find Value in CHP* (July 16, 2013); a white paper outlining specific examples of how natural gas utilities are currently finding value in owning and supporting CHP.
- *Utilities and the CHP Value Proposition* (July 16, 2013) — a peer-reviewed research report outlining all of the primary benefits of CHP to utilities and energy systems at large.

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Introduction

In August 2012, President Obama issued an executive order[1] that established a national goal of 40 GW of new combined heat and power (CHP) installed by 2020. To meet that goal, recent trends in CHP deployment will need to change. In the United States, 82 GW of CHP is currently installed. A tremendous opportunity for new CHP remains, as the current technical potential for new CHP, considering just *existing* facilities, is about 130 GW (SEEAction 2013).

Though a number of economic sectors could benefit from CHP, the large upfront capital costs and perceptions of risk associated with CHP systems discourage private companies from making the significant investments CHP requires. Companies that could benefit substantially from CHP are instead focused on their core businesses: manufacturing companies are focused on improving their products; hospitals are focused on healing their patients; and schools are focused on educating their students.

This reluctance of individual facilities to make investments in CHP systems creates an opportunity for utilities to invest in the remaining CHP potential. Electric utilities are uniquely positioned to take advantage of increased deployment of CHP within their service territories, realizing the efficiency and resiliency benefits that can result from these investments, because utilities:

- Can leverage their existing long-term relationships with would-be hosts of CHP systems, such as large commercial, institutional, and industrial customers;
- Can earn a reliable rate of return on investments in some states, depending on their regulatory structure;
- Are familiar and comfortable with making long-term capital expenditures;
- Can enter into long-term contracts with CHP system hosts that offer reliable payments and mitigate risk;
- Can enjoy CHP's efficiency benefits within state-level energy efficiency goals and targets;
- Have better bond ratings and access to cheaper capital than most other industries; and
- Can be instrumental in removing some of the biggest individual project barriers, such as interconnection challenges and punitive standby tariffs.

With so much cost-effective CHP potential remaining, the entity that works to acquire this energy efficiency resource stands to gain. At present, electric utilities are not significantly incentivized to invest in CHP in the United States. Despite its significant benefits, today CHP represents only about 8% of the entire U.S. electric generating capacity. CHP-based capacity could be much higher. This paper will explore the various benefits to utilities offered by CHP systems and the manner in which current policies and regulations do and do not encourage utility investments in CHP.

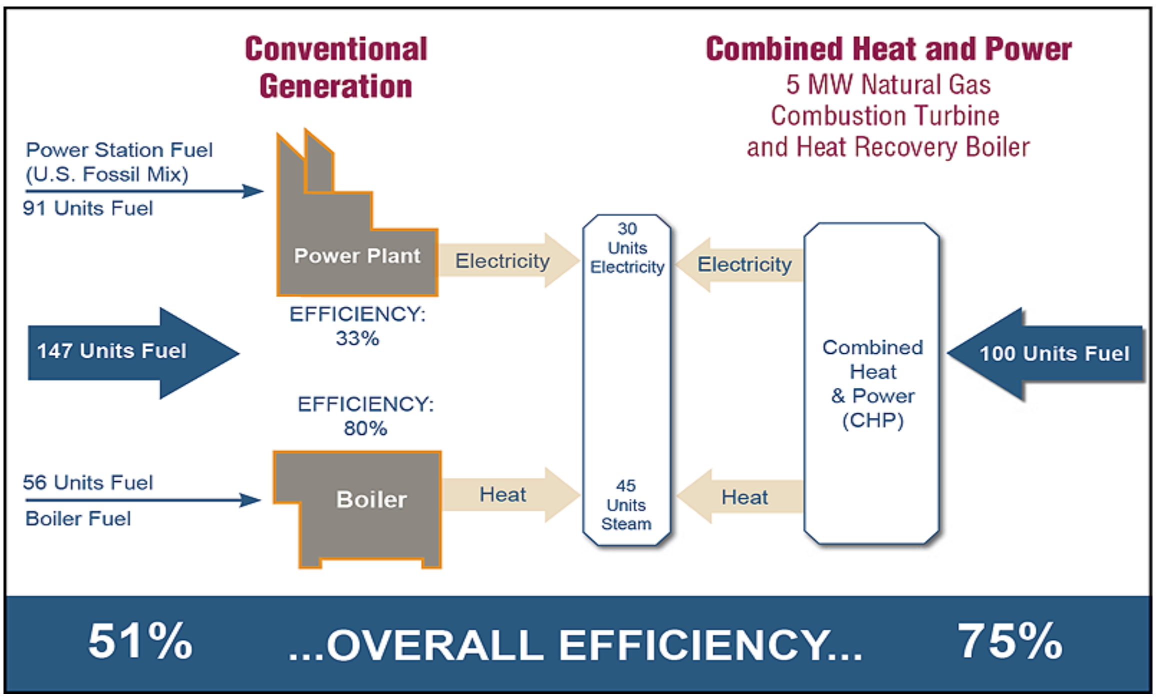
[1] http://www.whitehouse.gov/the-press-office/2012/08/30/executive-order-accelerating-investment-industrial-energy-efficiency

The Benefits of CHP to Electric Utilities

CHP is the simultaneous generation of electric and thermal energy, often using a single fuel. The simultaneous generation of these two types of energy confers tremendous efficiency benefits, as more useful energy is squeezed out of each BTU of input. CHP systems can run on a variety of fuels, including natural gas, biomass, and biogas, and they can include a wide range of technologies, including microturbines, reciprocating engines, and fuel cells.

Figure 1 shows a representative CHP system, illuminating the significant efficiency benefits of CHP over conventional power generation. By making use of the waste heat generated during power generation, CHP systems do much more with their energy inputs than conventional power plants.

Figure 1. Representative Schematic of CHP Versus Conventional Generation



Source: EPA 2013

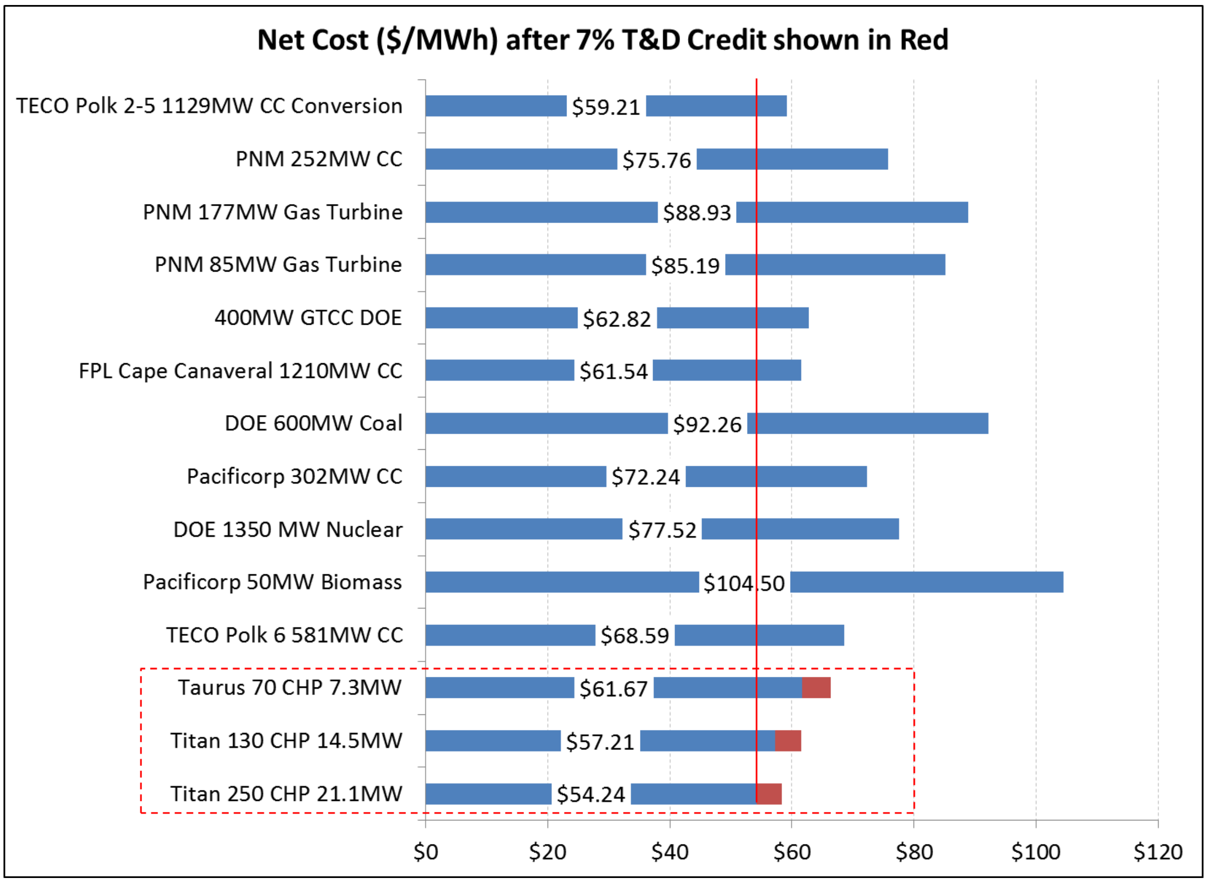
CHP systems can operate at combined efficiencies of over 80%, whereas the electric generating efficiency of an average power plant is about 36%. It offers many benefits to electric utilities and is uniquely suited to address the challenges facing utilities today, including aging infrastructure, increased catastrophic weather events, more stringent environmental regulations, and pressure to keep rates low.

Low Cost, Highly Efficient Generation Resource

CHP systems generate more useful energy from a single unit of fuel than most traditional forms of electricity generation. As one industry expert put it, "properly applied, CHP is the most efficient power generation resource on the planet" (Duvall 2013). By monetizing this benefit of increased efficiency, CHP owners and host facilities can enjoy power and thermal energy at a total cost far less than if they were generated separately. This efficiency benefit is reflected in the levelized cost of energy from a CHP system versus a typical combined cycle plant.

Several recent assessments show that a large gas turbine or engine-based CHP system has a levelized cost of about 6.0 cents/kWh or less, while CHP systems powered by biomass and biogas see levelized costs of well below 4.0 cents/kWh (Chittum and Sullivan 2012; PacifiCorp 2013). In contrast, the levelized cost of natural gas combined cycle plants ranges from 6.9 to 9.7 cents/kWh (Chittum and Sullivan 2012). Figure 2 shows one analysis of the levelized cost of energy from CHP systems versus other, more traditional centralized generation resources. As shown, the considered CHP units display the lowest cost of energy among a variety of other typical generation resources. The costs of the "typical" generation resources were all derived from existing integrated resource plans (Duvall 2013).

Figure 2. Levelized Cost of Energy of Selected Generation Resources



Source: Duvall 2013

CHP systems operate most efficiently when they are sized to a system's thermal load. Due to policies and practices that discourage exporting power from customer-owned CHP systems, CHP systems are often undersized to ensure that the electric output is not greater than the onsite electric demand, which would require power export. This leaves major efficiency savings on the table. If electric utilities owned and dispatched CHP systems, they could be fully sized to meet a facility's thermal energy demand, and any excess power beyond that which was consumed onsite could be exported to the grid, maximizing efficiency and emissions reductions. Utility-owned CHP could be designed to provide the greatest benefit to the utility while meeting the needs of the thermal host.

COST-EFFECTIVE GENERATION, DISTRIBUTION, AND TRANSMISSION RESOURCE

Siting CHP close to the point of energy consumption frees up and reduces stress on distribution and transmission lines. Strategically sited CHP can avoid or defer distribution and transmission system investments and reduce maintenance costs for a utility (MDOER 2013). In New York, a CHP system located at New York Presbyterian Hospital was sited near a substation Con Edison anticipated upgrading in 2017. The CHP system effectively offers the utility a 7 MW-equivalent reduction at the substation during system peaks, which allowed Con Edison to avoid an expensive upgrade (Jolly 2013). Through this and other targeted distributed generation projects, Con Edison has deferred "multiple traditional T&D load-relief capital projects" (Jolly et al. 2012). Similarly, Alabama Power found that customer-owned CHP systems helped it avoid the construction of about 1,700 MW of new generation capacity (SEEAction 2013).

Transmission and distribution systems are regularly upgraded and expanded to accommodate changing demand forecasts. They are explicitly designed to carry the "extreme" maximum demand, though such demand may be seen very infrequently (Lazar and Baldwin 2011). In the United States, transmission and distribution infrastructure is largely dated and in need of upgrades to meet 21st century customer needs. One 2008 study found that 70% of all transmission lines and transformers were at least 25 years old. The cost of preparing and expanding existing distribution and transmission systems for increased demand is significant. Preparing the transmission system to handle an additional kW can range from $200 to $1,000; on the distribution system, that preparation can range from $100 to $500 per kW (Hargett 2012). After seeing record investments in distribution and transmission infrastructure in recent years, the Edison Electric Institute still estimates its member utilities will spend $54.6 billion just on transmission infrastructure investments between 2012 and 2015 (EEI 2012).

Unlike an individual industrial facility, the value of strategically sited CHP for certain parts of the distribution grid can be immediately apparent and impactful to a utility, which knows exactly where its most constrained grid assets are. New CHP systems can be considered in forward-looking distribution and transmission plans, and certain investments in the grid could be directly avoided, immediately reducing costs to the utility and ratepayers. The reduced demands on distribution and transmission infrastructure also frees up distribution and transmission capacity to move power from remotely sited renewable energy resources, which are often located quite far from the end point of power consumption. For electric utilities ramping up the amount of renewable energy in their portfolios, CHP can help avoid the transmission costs associated with new renewable energy assets.

Transmission systems can also benefit from strategically sited CHP, and there is precedent for considering CHP as a transmission asset. FERC Order 1000 suggests a framework for utilities that need to make investments in transmission infrastructure to instead invest in energy efficiency and other "non-transmission alternatives" (NTAs) such as CHP. In this order, FERC suggests the cost of such investments could be spread amongst all users of the transmission system via an "interregional cost allocation method" if certain benefits might accrue across multiple transmission system regions (Lyle et al. 2012; FERC 2013). To identify these opportunities, the order further requires neighboring transmission regions to "coordinate to determine if there are more efficient or cost-effective solutions to their mutual transmission needs" (FERC 2011). The regional transmission organizations New York ISO and ISO-NE have considered how energy efficiency and NTAs could meet their regional transmission needs,[2] though the actual use of CHP as an NTA thus far appears to be limited.

In states with energy efficiency goals, CHP can offer a more cost-effective way to reach efficiency targets and earn performance incentives. A single CHP system can offer the efficiency savings of many smaller efficiency projects. In times when some utilities are reporting less low hanging efficiency fruit in the commercial and industrial sector, CHP can offer deep savings at a very low cost, enhancing the overall cost-effectiveness of energy efficiency portfolios.

SYSTEM RESILIENCY

Superstorm Sandy was only the most recent catastrophic weather event to showcase the reliability and resiliency of CHP systems. As large swaths of major East Coast cities remained without power for days, facilities served by CHP were able to maintain power, heat, and other services for residents, clients, patients, and staff (Chittum 2012). CHP systems, largely powered by the underground natural gas infrastructure, fared much better than centralized electric distribution systems, which were particularly vulnerable to the impact of downed trees given their above-ground distribution lines.

In New Jersey, the Public Service Electric and Gas Company estimated that the cost just to restore its infrastructure post-Superstorm Sandy would be $250 to $300 million. The estimate did not include the cost to "permanently repair PSE&G's damaged infrastructure or to modify the infrastructure to reduce the risk of damage of future storms" (PSEG 2012). Earlier this year PSEG announced its new Energy Strong campaign, designed to strengthen its grid against Sandy-like events in the future. PSEG requested funds totaling $3.9 billion over a ten-year period for Energy Strong, which has raised the ire of certain customer groups (PSEG 2013a; Kaltwasser 2013).

AVOIDED MARGINAL LINE LOSSES

CHP systems are by nature located at or very near the point of consumption, meaning power does not have to travel over transmission and distribution wires for long distances. During the long distance trip made by electrons generated at remotely sited power plants, an average of 7% of the energy is lost in so-called "line losses." While that number is significant, it does not reflect the exponentially higher line losses incurred as a system reaches its peak. One analysis found that during peak demand periods, line losses are about *three times* the average loss amount, resulting in tremendous lost power product and a need to produce even more power at the point of generation to get the same kW at the point of consumption (Lazar 2011; Lazar and Baldwin 2011).

[2] See Lyle et al. 2012 and Chittum and Farley 2013 for additional detail on this transmission planning opportunity.

During peak periods, then, the real value of CHP and energy efficiency investments is not their ability to help avoid a system's average line losses, but instead their contribution to avoiding marginal line losses. The value of a saved kWh grows significantly as a system nears its peak because so much more energy is lost in the transmission and distribution of the kWh consumed during a system peak than one consumed during a typical nighttime trough (Lazar and Baldwin 2011). During the 2006 summer peak period, Ontario Power Authority found that while the marginal cost of providing power from a gas turbine cost about $57/MWh in fuel costs, line losses added an additional cost of $115/MWh to the marginal cost of power (OPA 2007).

Utility systems must have enough generating capacity on hand to meet system peaks and cover the significant line losses during those times. Avoiding the need to develop peak-time (or "peaker") generation and avoiding the attendant line losses throughout the system could have major economic and environmental benefits. One analysis found that "80 GW of strategically-placed [distributed generation]," such as CHP and waste energy recovery could reduce the actual "peak US generation and transmission requirements by 100-120 GW" (Casten 2012). This could yield major additional savings in the form of avoided necessary capacity reserves (Lazar and Baldwin 2011).

Improved Power Quality and Provision of Ancillary Services

Power quality is critically important to utility customers, and CHP systems can offer cost-effective ancillary services to improve power quality where the grid needs it the most. As one assessment found:

> *It's technically feasible to use CHP generators, rather than centralized power plants, to balance supply and demand. And there is reason to believe that CHP generators may be better suited to the task. Some commonly used CHP technologies, such as reciprocating engines, are more amenable to ramping than large turbines. Further, when operating at partial load, generators will sacrifice electrical efficiency but gain thermal efficiency — potentially useful for CHP generators, but not for centralized power plants.* (Siler-Evans 2010)

Though few CHP systems currently participate in ancillary services markets, they can be very well positioned to do so. The CHP system at Princeton University earns about $600,000 per MW per year for its participation in one of PJM's multiple ancillary services markets (Nyquist et al. 2013). Most CHP systems would be able to participate given their existing setup, even if they were not originally designed to provide ancillary services. They do not typically require additional equipment other than the addition of controls. One exception is the ancillary service termed frequency regulation, which is capacity that, if successfully bid into the frequency regulation market, must be dedicated to and available for the provision of frequency regulation instead of on-site capacity needs (Webster 2013).

Ancillary services are arguably becoming even more important as more intelligent machines and controls proliferate, requiring more perfect power. Equipment that is especially sensitive to fluctuations in voltage require the highest power quality, as even a millisecond of sagging voltage can cause tens of thousands of dollars of damage (Schröder 2012). As just one example, J.R. Simplot experienced 12 separate grid outages lasting only a half second or less, which cost the company at least $7.5 million over a two-year period (Sturtevant 2013). Utilities could attract companies that are particularly concerned about reliable power by offering CHP-supplied power to their facilities.

Additionally, the ability of CHP to ramp up quickly and reduce constraints on distribution and transmission infrastructure can help mitigate the concerns of intermittency associated with some renewable resources such as wind and solar power. CHP can offer quick-response voltage support to the grid when necessary and can be a more cost-effective method of doing so than other types of ancillary services (Østergaard 2006).

Fast and Flexible Asset Development

CHP can be built much faster than most alternative resources, offering utilities and policymakers flexibility in meeting fluctuating electricity demand, especially when the future looks very uncertain. Utilities planning their next major centralized plant or transmission line must make decisions to build, and the investments to acquire land and secure contracts well before the asset is built and ready to serve customers. Utilities that develop transmission lines, for instance, are faced with waits for permits as long as ten years (Silverstein 2011).

Longer construction and permitting times of other assets mean higher carrying costs that must be borne by ratepayers. Additionally, since it is difficult to accurately predict customer demand five years into the future, building one large plant or investing in one major distribution line can be a risky endeavor. It may ultimately not be needed to the extent predicted. Instead, smaller customer-sited CHP systems can be brought online as needed, with significantly less lag time and thus less risk, allowing a utility to more tightly fit their supply to the ever-changing load shape. As electric utilities look forward and plan their next major capital investments, CHP can allow them to incrementally meet growing demand without taking on the risk of substantially overbuilding capacity (Duvall 2013).

The International Energy Agency (IEA) finds that typical construction time for large natural gas-powered CHP systems is about two years or less (IEA 2010a). In addition to the speedy construction time, one of CHP's greatest benefits is the fact that new land is not generally necessary, and new transmission infrastructure is not required. In contrast, significant time is spent just *preparing* to construct centralized power plants, during which land is acquired, transmission lines are sited, and other supporting infrastructure is developed. Once that is completed — and such preliminary work can take years — large centralized natural gas turbines have typical construction times of a little over two years (IEA 2010b). Other types of centralized generation, such as nuclear plants, have seen construction times alone of four years at best, and about five years on average (IAEA 2009).

Path to Environmental Compliance

Recognizing that CHP can offer tremendous reductions in harmful emissions, the U.S. Environmental Protection Agency (EPA) and state air regulator authorities have indicated support for the deployment of CHP and other energy efficiency measures as compliance mechanisms within specific air regulations. For instance, State Implementation Plans to meet federal air quality standards can include CHP programs and specific CHP-related emission reductions in their calculations (EPA

2012), reflecting that for over a decade EPA has made clear that the air quality benefits of CHP are substantial enough to be used for air quality compliance (EPA 2000).

Once EPA finalizes New Source Performance Standards for new power plants, Section 111(d) of the Clean Air Act directs the EPA to establish federal standards of performance for existing power plants. These standards will set rules for carbon dioxide for the first time, impacting a number of existing electric generating units. While these rules will mainly affect coal plants, many coal plants have already emerged as uneconomic, due to other recently established air rules and the changing economics of coal and natural gas (Chittum and Sullivan 2012). Investments in CHP as a compliance mechanism could reduce the cost of compliance for affected utilities and allow utilities increased flexibility in meeting the future electricity needs of their customers.

Increasingly, states are considering the emission reduction benefits in their air quality regulations, and acquiring the necessary air quality permits for CHP operations is a much less costly and risky endeavor than for centralized power plants. For instance, one "fast track" air permit for CHP in Texas reduced the time associated with acquiring state-level air permits from well over 1 year to just 4-6 weeks (ACEEE 2012). Such short permitting time periods save utilities and ratepayers money.

Additionally, CHP systems do not require the extensive water resources for cooling and steam generation required by larger centralized power plants. In places where it's challenging and costly to acquire the rights to new and adequate water resources to support power plant operations, this can have substantial economic benefit.

FUEL FLEXIBILITY

CHP is powered predominately by natural gas, but is also well established using other types of fuels. In some cases CHP systems are able to take advantage of local biomass or biogas resources, yielding local economic development impact, as well as improved emissions performance. CHP systems can also adapt to new and changing resource opportunities, such as the CHP system at Dow Chemical Company's Plaquemine, Louisiana facility, which can be powered by both natural gas and hydrogen gas.

Importantly, CHP systems can be configured to take advantage of both natural gas and biomass or biogas resources, depending on local availability. Certain CHP technologies and applications are well equipped to provide a flexible response to changing local fuel opportunities, enabling CHP owners to respond more directly to changing price signals in fuel markets.

CUSTOMER RETENTION

In some cases, customer-sited CHP could be an important customer retention strategy. For large industrial facilities that might be running at full thermal capacity, the addition of a CHP system onsite would allow them to take down certain boilers for maintenance without affecting production. Depending on the structure of the CHP business deal, onsite CHP can yield low or no cost steam resources to an industrial facility, reducing the operating and maintenance expenses of the company while improving reliability. These are the kinds of advantages electric utilities could highlight as a customer attraction and retention strategy, especially in competitive markets where customers are free to choose their energy service providers. Any service that helps a facility reduce its energy-related costs can help utilities maintain a strong customer base.

Summary of Benefits

CHP can provide electric utilities a range of benefits, the magnitude of each benefit differing for each utility due to its market and regulatory conditions. Table 1 summarizes the various benefits of CHP to electric utilities and provides examples of how such benefits are being monetized today.

Table 1. Benefits of CHP to Electric Utilities

Benefit	Benefit Magnitude	Opportunities to Monetize	Example
Low Cost Generation	Major	Rate-based generation resource; energy efficiency resource standard	Alabama, Ohio
Cost-Effectively Meets Transmission and Distribution Needs	Major	Reduced costs	Alabama, New York, Vermont
System Resiliency	Major	Customer satisfaction; resiliency portfolio standard	New Jersey
Avoided Marginal Line Losses	Major	Cost-benefit analyses	
Power Quality	Medium	Ancillary services markets, customer satisfaction	New Jersey
Fast and Flexible Development	Medium	Reduced costs	
Environmental Compliance	Major	Clean Air Act regulations	Ohio
Fuel Flexibility	Medium	Reduced costs	Louisiana
Customer Retention	Minor	Sustain customer base	

Despite these potential benefits, few U.S. electric utilities are deploying or encouraging new CHP systems in their service territories. In large part this is due to the fact that electric utilities are not economically incentivized to do so. Some notable instances exist, however, in which utilities have been direct partners in the successful acquisition of CHP resources.

Successful Utility CHP Programs

Electric utilities can enjoy the benefits of CHP in three major ways: through rate-basing the asset; through utilizing it as an efficiency resource to meet efficiency goals; and as a purely for-profit business arm. The manner in which these three approaches can be used, and the manner in which CHP benefits are monetized, will vary greatly depending on the market, and regulatory and policy framework impacting each utility.

CHP in Rate Base

Under the traditional rate-basing model, electric utilities invest in assets, which are added to their rate base. Customer rates are then set based on the rate base and structured to confer some economic benefit to the utility. For utilities that either own CHP themselves or enter in power purchase agreements (PPAs) for CHP-produced power, the costs associated with the CHP resource is typically aggregated with other costs and embedded in the utility's rate base.[3] For a traditionally regulated utility, the growth of the rate base is economically beneficial as they are typically granted a satisfactory rate of return to reach their revenue requirement.

Southern Company currently owns over 700 MW of CHP capacity across six plants, the majority of which are in Alabama Power territory. Southern Company continues to assess customers for CHP potential, "seeking win-win scenarios" in which the customer, the utility, and the utility's ratepaying customers can enjoy the benefits of CHP (Cofield 2012). Alabama Power has been able to integrate the costs of both new PPAs and utility-owned CHP into its rate base (SEEAction 2013).

Similarly, Austin Energy owns a 4.3 MW CHP system located at the Dell Children's Medical Center. The thermal energy provides cooling to the medical center, while the excess electricity, beyond what the medical center consumes, is sold by Austin Energy at retail prices to other customers. Ensuring that Austin Energy would be protected against the risk of stranded assets, the utility entered into a 30-year contract with the medical center for the energy products (TAS 2013; Takahashi 2010; Corum 2007).

Some customer-sited solar programs could offer a model for how to rate-base other distributed resources such as CHP. New Jersey S*olar 4 All* program has targeted 80 MW of new solar projects through 2013, and the $515 million investment for the first phase of the program was approved to be recovered through rates, as well as a return on equity for PSE&G (PSEG 2013b; NJBPU 2013). This program benefitted from clear guidance from regulators on how the investments in the assets would be treated, allowing utilities to develop the program with full certainty that their investments would be recoverable and the returns would be reliably in line with returns on other assets.

CHP as Efficiency Resource

In states with aggressive energy efficiency goals, CHP can help utilities meet those goals faster and at a lower cost than many other efficiency resources. In Massachusetts, energy efficiency goals and a specific portfolio standard for CHP help signal to utilities that CHP is a prioritized resource. The 2008 *Green Communities Act* required that all cost-effective CHP must be acquired by utilities within their

[3] In some states, such as California, certain types of PPA structures are not added to a utility's rate base and are instead simply directly recovered as costs on customer bills.

energy efficiency programming. In this way the cost of acquiring CHP resources — mostly executed via incentives for customer-owned CHP — is clearly recoverable for regulated utilities in Massachusetts. Massachusetts is a decoupled state, and so the cost of energy efficiency programming is part of the total costs recovered through decoupling mechanisms (Ballam 2013).

An additional incentive for electric utilities to pursue CHP in Massachusetts is a performance incentive embedded in energy efficiency goals (Hayes et al. 2011). In 2011, CHP alone met about 30 percent of the Massachusetts utilities' energy efficiency targets. It was on average the lowest cost efficiency resource, keeping the total cost of the energy efficiency portfolios low and helping utilities meet their target very cost-effectively. In fact, the presence of CHP in utilities' commercial and industrial energy efficiency portfolios was "one of the largest contributing factors" in the overall lifetime cost of saved energy decreasing from $0.022 in 2010 to $0.016 in 2011 (Mass Save 2012). As a result, Massachusetts utilities earned their performance incentive, equal to about 5 percent of their energy efficiency spending, all while providing ratepayers with an incredibly cost-effective energy resource (Ballam 2013).

In Wisconsin, Alliant Energy's *Shared Savings Program* operates as a type of on-bill financing program to encourage customers to take on major energy efficiency investments, such as CHP, that they might not otherwise take on due to capital constraints. The utility now receives a rate of return on its Shared Savings portfolio equivalent to that which it receives from its investments in more traditional assets (ACEEE 2013; Adams 2013).

Third-Party Ownership Structures

For electric utilities that cannot own generation directly, there are some models that still allow them to enjoy some of CHP's benefits. United Illuminating in Connecticut explored a zero-capital program, which helps pair third-party owners with customers interested in having CHP on-site. Five- or ten-year power purchase agreements are encouraged between the customer and the third party in the model. United Illuminating could enjoy the benefits of CHP on its system — reduced congestion, emissions, etc., — without having to own the CHP systems itself. Though the program was just a test, United Illuminating considered the value of seeking approval to operate as the third party themselves, entering into the agreements with customers and maintaining ownership of the CHP systems. To do so, it would have to develop an unregulated subsidiary that could legally own generation resources.

Another electric and natural gas utility (who wishes to remain unnamed) is currently exploring a model that would have the utility design and make the initial capital outlay to own CHP assets themselves. The customer facility at which the CHP system is sited would pay the utility a fixed flat rate each month, for ten or fifteen years, and would then be allowed to access the electricity and thermal energy produced onsite for no additional cost. The customer would enjoy lower monthly payments — paid out of their operating budget instead of their capital budget — and the utility would enjoy fixed monthly payments that offer a rate of return on its investment similar to what it is already earning on other, more traditional generation and distribution assets.

Changing the Utility Business Structure

The potential economic benefits of CHP to utilities are many. However, existing regulatory schemes and policies are not currently designed to help utilities monetize those benefits. Thus, significant CHP opportunities are left on the table and the cost savings and sustainable revenue potential for utilities goes unrealized. Today, less than a quarter percent of all active utility-owned electric generating capacity is CHP (EIA 2013; DOE 2012).

Electric utilities are not currently major players in CHP deployment because their economic incentives are fundamentally misaligned with CHP and distributed generation generally. Utilities do not or are not able to monetize CHP's many benefits, so prefer other investments. Further, where utilities have no decoupling mechanism in place, CHP's impact at the customer level generally yields a large downside — reduced electricity sales — without allowing for an upside — quantification and monetization of CHP's other benefits.

Electric utilities can see some value in CHP when it is explicitly included as part of their applicable energy efficiency goals or programming, and they can earn cost recovery on their related expenditures. However, investments in energy efficiency do not typically offer the same rate of return as other traditional investments in their rate base. Where performance incentives for reach efficiency targets are in place, utilities may see a stronger economic incentive to acquire efficiency resources, but few states have significant performance incentives in place (Hayes et al. 2011).

Where utilities can experience the value of CHP within energy efficiency programming and goals, the cost-benefit analyses that consider CHP as an efficiency opportunity do not fully value many of the significant benefits CHP provides. For instance, while most assessments of benefits to the utility or society reflect an average avoided line loss of about 7%, that value is two or three times higher during system peak periods. This means the avoided lines losses are discounted by several orders of magnitude for some time periods. While the system is not always at its peak, the marginal cost of operating a generating unit or transmitting power on transmission lines is very high during peak periods, and the benefits of avoiding such costs are not immaterial.

These benefits are also absent from considerations of CHP as a generation or distribution resource. A CHP system strategically placed could reduce constraint on a transformer, but a utility may not be evaluating such impact in a manner that shows clear benefit and allows a utility to consider CHP in its distribution plans.

Changes for the Regulated Market

For electric utilities operating in regulated markets, utility investments in CHP should be allowed to be integrated into the rate base. Utilities should be able to clearly understand the value proposition and the return on investment they can earn from ownership of customer-sited CHP. This may mean that regulators need to become familiar with the unique attributes of smaller CHP systems, and the different costs associated with identifying sites and working with individual facilities. CHP systems still offer a cost advantage, but their costs structure is fundamentally different from a large investment in a traditional power plant.

For utilities that are concerned that CHP system assets could be stranded if the host facility reduces its production or shuts down all together, regulators should be familiar with and able to approve the different contractual arrangements that can mitigate this concern. While the concern is legitimate given CHP systems' long lifespan, CHP systems can be run as stand-alone, dispatchable generators if the thermal host is lost, as evidenced in a contractual arrangement provided for in the California QF settlement agreements (see Chittum and Farley 2013).

In fully regulated states, third-party ownership of generation assets is often prohibited. CHP ownership partnerships between utilities and private third parties, such as the host site, may not be allowable under state law. Utilities in these states may not have the flexibility of working with an interested third party or other market player to spread some of the risk and will instead need to be able to integrate CHP investments directly into their rate base.

Changes for the Deregulated Market

In deregulated states, electric distribution utilities are generally prohibited from owning generation assets; investments in CHP are often a non-starter for these utilities. Third-party unregulated subsidiaries of utility companies may, in some cases, be allowed to own generation, but the rules differ from state to state. Distribution utilities in these markets need clear guidance from regulators on how to structure third party unregulated subsidiaries that might own CHP systems.

For electric utilities operating in less regulated markets, greater flexibility in working with third parties exists. Challenges in determine who within a given deal owns the various benefits — emissions reduction credits, efficiency credits, electrical output, and thermal energy output — will need to be worked out on a case-by-case basis to reflect the unique attributes of each deal. Regulators in these states could offer guidance on how the state-developed policies, such as energy efficiency resource standards, could recognize and integrate these different players' contributions to energy efficiency or emissions goals.

Distribution utilities in particular may be attracted to the benefits of CHP to their distribution systems. Treating CHP as a distribution asset is new, but given the known impact of CHP on some distribution systems, it makes sense to encourage it and allow investments in it to be recoverable in distribution utility rate cases. For distribution utilities that are allowed rates of return on their investments, investments in CHP that can be documented as directly mitigating the need for other types of assets should be allowed to earn a return.

Suggested Policy and Regulatory Responses

Many of the regulatory structures in-place do not encourage or economically incentivize utilities to invest in or support CHP systems. Regulatory and policy changes on the state level could help utilities and utility customers enjoy the many benefits of greater deployment of CHP. We suggest state policymakers:

- Offer clarity on how utility investments in customer-sited CHP systems are treated under existing policies;

- Allow the costs of utility-owned and customer-sited CHP assets to be recoverable in rates, as well as eligible for a comparable rate of return to traditional generation, distribution, and transmission investments;
- Establish methods to account for location-specific benefits of CHP (and other types of distributed generation) and provide guidance on how additional benefits should be integrated into cost-benefit analyses for energy efficiency resources and/or traditional energy resources;
- Encourage region-wide analyses of the potential for "non-transmission alternatives," such as CHP, which could be more cost effective than traditional transmission assets;
- Prioritize thermal energy planning within energy planning activities, to ensure CHP opportunities and waste energy recovery opportunities are given the same consideration as other resources when planning for long-term energy needs;
- Establish statewide energy efficiency goals and treat net CHP savings[4] from all types of CHP and waste heat recovery as equivalent to other energy efficiency resources;
- Encourage the dissemination of publicly available information about the areas of distribution and transmission resources that are most constrained, to help utilities better target and market mutually beneficial CHP installations;
- Support performance-based rate structures for utilities, which would allow them to earn revenues based on their performance in certain areas like reliability, environmental performance, etc.;
- Allow CHP to generate compliance credits in any program designed to control carbon dioxide emissions from existing fossil fuel-fired power plants under the federal *Clean Air Act*, and allow CHP supply to offset other state or regional greenhouse gas control programs;
- For markets that are no longer vertically integrated, clarify the specific types of third-party subsidiaries of electric distribution utilities that are legally allowed to own generation resources;
- Explore treating CHP and other distributed generation resources as a distribution asset, for purposes of determining distribution utilities' rate bases; and
- Aggressively pursue the quantification of CHP's reliability benefits and other benefits such as flexibility, ability to participate in ancillary services markets, etc., and more directly integrate these benefits into cost tests that consider the direct benefits to utilities.

Appendix I in Chittum and Farley 2013 offers specific examples of states and utilities that have taken some of the above steps, and specific policy language used in some of these cases.

Conclusion

CHP is the most cost-effective and efficient way to generate electricity today. Significant potential for CHP is found in existing facilities, but much of that potential is left untapped because individual facilities are wary of making such significant capital investments. Utilities are well-positioned to make these investments in CHP and can enjoy the significant benefits that CHP confers to grid systems and

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[4] Read more on ACEEE's suggested approach for measuring CHP savings within an energy efficiency standard here: http://aceee.org/blog/2012/11/determining-chp-savings-energy-effici.

electric utility companies better than individual facilities are able. By their ability to sell excess power, utilities can deploy CHP systems that maximize efficiency by fully sizing a system to meet its thermal load, something that individual facilities are sometimes unable to do due to project economics.

Most electric utilities are not incentivized to own and operate CHP systems. In fact, some utility business structures economically incentivize utilities to oppose or discourage expanded CHP. Regulatory and policy changes that allow utilities to see direct economic benefit from CHP systems are necessary to take advantage of the available potential for CHP today.

By taking advantage of CHP opportunities within their service territories, electric utilities can enjoy reduced operating costs, reduced environmental compliance costs, increased customer retention, and increased flexibility and system resiliency. Policymakers should encourage the development of policies that provide utilities with an incentive to embrace CHP.

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Appendix: Suggested Rate-Based Pilot Program Design

ACEEE recognizes that each state and utility have different needs and challenges with distributed generation such as CHP. What follows is a suggested framework for a CHP pilot program designed to cover its costs through customer rates, much like other generation and distribution assets. This model should be viewed as a starting point for a conversation about program shape. In some cases utilities may have the capabilities to administer an entire program themselves; in other cases encouraging market players to conduct some of this activity, such as in the demand response market, might be a more attractive option.

IDENTIFY OPPORTUNITY AND POTENTIAL

As part of the President's call for greater CHP deployment, the U.S. Department of Energy is supporting updated state-level analyses of CHP potential. These types of potential studies can help utilities understand some of the opportunities in the states they serve. However, they will likely need to be augmented to fully understand the most promising CHP opportunities in each service territory. Additional ways to identify potential CHP sites include:

- Consider information collected from existing activities with large customers, such as near-term expansion plans, or those looking to augment or update their on-site thermal energy systems in the near term. Review available data on boiler permits and air emissions performance reporting to identify facilities with older boilers that may need replacement in the near term.
- Approach sectors with particular reliability concerns to understand recent reliability challenges and whether on-site distribution might have immediate appeal for its reliability benefits.
- Identify facilities whose parent companies have successfully deployed CHP in other states or service territories, by working with CHP developers and considering CHP case studies.

EDUCATE

After initial sectors or types of facilities are identified for further education, conduct outreach to customers. Such outreach could comprise mailings, social media campaigns, in-person communication through key account managers, participation in trade show events, and outreach to trade association networks. Simple handouts describing the benefits of CHP and the program process should be available through all these outreach efforts.

Most customers will be strongly attracted to promises of increased electric reliability, reduced steam costs, and increased efficiency. In some cases customers may need additional steam capacity, and would be interested in hosting a CHP system that allowed them to have access to increased steam capacity, without the capital costs. For an industrial facility running at full capacity and worried about the impact of taking boilers offline for maintenance, the addition of new steam capacity onsite can provide significant breathing room to undertake maintenance upgrades without affecting production.

Converting customer interest to active participation in the next steps will require personal communication to present to customers the scope of data that will be required to participate in the next steps. Customers may also be attracted to the fact that they can benefit from new equipment, a larger boiler, or other improvements that they did not have to make themselves.

Conduct Initial Assessments

After doing an initial brief assessment of facilities' energy needs, select a dozen facilities for the initial assessment based on expressed interest and individual facility confirmation that basic energy use data can be made available for further inquiry.

Send in-house engineers to conduct initial site visits and conduct a basic facility assessment at no cost to the customer. These visits should also ascertain whether an on-site "CHP champion" might be present.

Conduct "Deep Dive" and Prepare Feasibility Assessment

Narrow down the selected facilities to at least three. Depending on in-house engineering resources, either send utility staff or contracted third-party staff to conduct a deep dive data collection effort and energy assessment to aid in the preparation of a feasibility assessment. Energy use and financial data may be required, and facilities may wish to enter into a non-disclosure agreement if they deem the data to be sensitive or proprietary. This visit may be a day-long event, and facilities would need to offer necessary employee time to help utility engineers access and understand information about the facility's energy use.

After the deep dive, the utility conducts a feasibility assessment to determine whether or not to rule out each of the "deep dive" facilities. Basic equipment quotes are gathered from a variety of vendors to enable a future investment-grade assessment.

Develop Project Priority Pipeline

Based on the results of the feasibility assessment, determine order of priority for the projects that are determined to go forward. Identify if any are in locations that are in particularly constrained areas of the distribution or transmission system. Review long-term generation, distribution, and transmission plans to understand if certain projects should be prioritized over others. Begin investigation into the necessary processes to acquire permits.

Draft Contractual Agreements and Billing Arrangements

Depending on the cost of the project, draft contractual obligations for the host facility to take the power and thermal energy for a five to ten year period. Stipulate the share of risks and the costs associated with early termination of the contract. For instance, a utility could arrange a five-year agreement with a host specifying that the host will pay the utility for thermal power for five years regardless of whether the host remains in business.

If hosts are not being asked to make significant investments and take on the bulk of project risk, a utility can reasonably expect to develop contractual agreements that allow it to enjoy most of the benefits. Unlike situations in which individual host facilities take on all the risk of a new CHP system, a facility enjoying the steam and reliability benefits of a utility-owned system will not require the same degree of direct benefit. Therefore, utilities will likely find themselves in a strong bargaining position to request ownership of assets such as energy efficiency and emissions reductions credits.

If the host facility is paying the utility a fixed cost for the power and/or thermal energy, discuss the fixed cost and clarify what such costs entail, who is paying for maintenance, etc. If the utility intends to integrate the entire cost into its rate base, but allow the host facility access to the thermal energy, discuss the circumstances under which the host facility would be capable of ramping up or down thermal demands.

For CHP systems sited on existing facilities, determine the actual real estate that will be dedicated to the plant, and the arrangements for access to the property during construction and then operation.

Design, Build, Commission and Finalize Contracts

Each utility will have its own preference of how it wishes to construct the actual plant and all of its equipment. Presumably the utility would bid out the bulk of this work and select contractors based on the cost-effectiveness of their bids, their reputation for conducting quality work, and their experience with handling similar projects.

Developer Framework to Evaluate and Measure Long Term Benefits

The benefits of CHP to the local distribution system and the larger transmission system are not adequately valued in most energy efficiency programs or considered in generation and distribution and transmission planning. The need to understand exactly how CHP affects local distribution infrastructure is high. A pilot project offers an exceptional opportunity to quantify, for the given distribution system, the degree to which CHP provides location-specific benefits. Metering of specific distribution assets, for example, would help utilities understand how strategically sited CHP can reduce load immediately on certain pieces of infrastructure.

Data from specific deployments and projects is necessary and would, ideally, be publicly available to other utilities to understand how certain applications affect the grid at large. Assumptions about how future CHP systems might impact the grid need to be based on measured and evaluated experience.

Though a CHP system may be treated as a supply-side asset to the utility, the benefits to the host facility itself should be measured and evaluated as well. There is not a sufficient body of data on how utility-owned or utility-controlled CHP sited at individual facilities impacts the facilities it serves, and improvements to onsite reliability, improved power quality, etc., need to be documented so as to be adequately reflected in future assessments of costs and benefits.

Finally, while CHP case studies abound, case studies identifying actual deployment of utility-owned CHP at individual facilities are needed. These case studies need to be specific to the service territory, and should clearly reflect the economic benefits and costs that accrue to both the utility and the customer.